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BOUCHER - CARIGNAN AREA (COMTE DE LAVIOLETTE)

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BOUCHER - CARIGNAN AREA

by

M. A. KLUGMAN

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BOUCHER - CARIGNAN AREA

LAVIOLETTE COUNTY

by M.A. KLUGMAN

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BOUCHER - CARIGNAN AREA

LAVIOLETTE COUNTY

by

M. A. Klugman

INTRODUCTION

General Statement

The Boucher-Carignan area was mapped by the writer during the summer of 1957. The area was mapped under the programme being carried out by the Geological Surveys Branch of the Quebec Department of Mines.

The map-area is located within the Laurentian uplands, and has a maximum elevation of approximately 1,500 feet, and there is local relief up to 900 feet.

The map-area lies within the Grenville sub-province of the Precambrian shield. All of the consolidated rocks of the map-area are of Precambrian age. Listed in order of abundance they are: paragneisses and orthogneisses (which underlie more than two-thirds of the map-area), granitic rocks, gabbro, syenitic rocks, and various minor intrusives. The paragneisses and the orthogneisses of the map-area strike roughly north and dip towards the east. Near the granitic and gabbroic masses the regional trend has been greatly disrupted by the intrusion of these rocks. The structures in this area probably represent the western limb of a major syncline. Numerous minor folds have been traced in the field. A major fault, expressed as a broad shear zone cuts across the north-eastern corner of the map-area. This shear zone, which is associated with a fault exposed at La Tuque, can be traced down the St. Maurice

valley into the map-area from La Tuque.

No economic deposits of major importance were observed. However, concentrations of magnetite and pyrite were observed at several localities, as well as many commercial gravel and sand deposits, some of which are being or have been worked.

Location

The map-area is bounded by longitudes 72°45' and 73°00', and by latitudes 47°00' and 47°15'. The map-area includes nearly all of Boucher township, major parts of Pollette and Carignan townships, and small parts of Turcotte, Baril, and Mekinac townships and of Batiscan Seigneurie in Laviolette County. The total area is about 205 square miles.

There are no towns in the map-area. The villages of Rivière-aux-Rats and Grande Anse are situated on the east bank of St. Maurice river. They lie three-and-a-half miles by road south of the northern boundary and near the centre of the map-area, respectively. The town of La Tuque, 17 miles north of the map-area, is 131 miles from Quebec City, 176 miles from Montreal, and 105 miles north of Trois-Rivières.

Access

The transcontinental line of the Canadian National Railways passes through La Tuque. Highway 19 follows the east bank of St. Maurice river, down the centre of the map-area from its northern to its southern boundary. The highway joins La Tuque to Trois-Rivières, 105 miles to the south. Numerous gravel roads, used in lumbering operations and as service roads to fishing clubs, traverse the map-area. In the northwestern corner of the map-area are two

lumber roads. The one follows Rivière-aux-Rats out of the northern boundary of the area, and the other runs along the north bank of Wessonneau river and leaves the map-area in the northwest. Both of these roads are joined to Highway 19 by a ferry at Rivière-aux-Rats, which is operated by the Consolidated Paper Company. One other road on the west side of St. Maurice river runs due west out of the map-area to the Laurentian Fishing Club. It is connected to Highway 19 by a privately operated ferry at Grande Anse. Five gravel roads join points on the east side of St. Maurice river to Highway 19. In the north two roads run southeast to a lumber camp near the eastern boundary, and to Lac Vassal, respectively. The first is a lumber road and the second is maintained by the operator of the fishing club at Lac Vassal. In the centre of the map-area a lumber road joins Lac Batiscan and the southern end of Lac Vassal to Highway 19. Another lumber road runs due east from Grande Anse to Dickey Lake, however, this road can only be traversed for one-and-a-half miles from the St. Maurice river. A well-maintained lumber road runs northeast from the southern boundary to Lac St. Michel. The road is owned and operated by the Consolidated Paper Company, and serves both a fishing camp on the lake and a lumber camp to the north. The eastern section of the map-area can be reached, in part, by roads from without the area, namely those following Mekinac river valley.

Numerous portages join many of the lakes to either St. Maurice river or one of the lumber roads. There are also portages linking many of the lakes in the map-area. A winter road connects Lac Polette, on the west-centre boundary, to St. Maurice river.

A paved and maintained emergency landing strip was completed for the Royal Canadian Air Force, just south of the town of La Tuque, in 1954. This strip is also used by private and scheduled commercial aircraft, is located at Lac a Beauce, seven miles north of the northern boundary of the map-area.

There are only two rivers in the map-area which are navigable by canoe. These are St. Maurice river and Rivière-aux-Rats. Wessonneau river is navigable along some stretches, but fast water and rapids make it impractical for regular use.

Field Work and Acknowledgements

The base-map employed is the western half of the unpublished preliminary map no. which is being compiled by the Topographical Survey of Canada, and is to be published on a scale of 1:50 000. The scale of the base-map is one inch to ½-m. Traverses were spaced at half mile intervals, with closer spacing in areas where necessary. The mapping was done by pace and compass with the aid of aerial photographs, which were supplied by the Royal Canadian Air Force. On the larger rivers and on the lakes the mapping was done from canoes. In parts of the map-area exposures are not plentiful, but in all cases sufficient data was obtained to make interpretation possible.

The writer was ably assisted in the field by T. Hashimoto, who performed the duties of senior assistant, and by E. Langlois, A. LaPointe and P. Ayers who served as junior assistants. Mme. Bastien performed her duties as cook. The writer is indebted to the Consolidated Paper Company for the use of their camp at Rivière-aux-Rats as a base-camp, and also for many other courtesies during the field season. The writer is also very grateful to Mme. Elisabeth

McKenzie and the members of her organization for unlimited help and assistance. The writer would also like to thank the jobbers of the area for their help. The writer is also indebted to the people of Rivière-aux-Rats for their many courtesies. Dr. F. F. Osborne made useful suggestions, for which the writer is thankful.

Previous Work

The first geological work carried on in this region was done by A. P. Low (1891), who travelled west, through the two Wayagamack lakes which lie northeast of the map-area, to St. Maurice river and then turned south down the river and through the area. O'Sullivan (1908) mapped the geology along the transcontinental railway from Hervey Junction, to the southeast, to Doucet, to the northwest. I. B. Crosby (1932) studied the physiography and drainage of the St. Maurice valley with the accent on the glacial geology. M. Tiphane (1954) mapped an area northeast of the present map-area, and M. A. Klugman (1956) mapped the area immediately to the north.

DESCRIPTION OF THE AREA

Settlement and Resources

Inhabitants

There are only two settlements in the map-area, the villages of Rivière-aux-Rats and Grande Anse. They are both situated on the east bank of St. Maurice river and lie three-and-a-half miles by road south of the northern boundary and in the centre of the area, respectively. Both are permanent settlements. A number of farms and residences are scattered down both sides of St. Maurice river, with the main concentration of habitation on the east side.

A number of summer cottages are also located on the banks of St. Maurice River.

Industry

There is no industry within the area, but the pulp and paper mills at La Tuque and Grand Mere have an effect on some of the inhabitants, in that their occupations depend directly upon the pulp and paper industry.

Agriculture

Farming is confined to the valley of St. Maurice river, as other sections of the area are too hilly and the soil is too rocky for farming. The farms are located on river terraces and as a result the soil is very sandy. Hay and dairy products are the main crops.

Timber Resources.

The area is thickly wooded with black spruce the dominant growth. Maple is also abundant, with balsam fir, white birch, poplar, plain, jackpine and tamarack in subordinate amounts. Much pulp wood is cut in the area for the Canadian International Paper Company and the Consolidated Paper Company mills downstream on St. Maurice river at Grand Mère, Shawinigan Falls and Trois-Rivière. Most of the cutting is done by independent "jobbers" on contract to these paper companies.

Hardwood is also being lumbered in the area for local consumption, and for saw mills downstream.

Fish and Game

Fish and game are plentiful in the area. There are several fishing and hunting clubs which have been granted the fishing and hunting rights on certain lakes and in certain designated areas. Two big lodges are located in isolated localities, one on Lac Petit Carignan and one on Lac St. Thomas. Brook trout and lake trout are the most common varieties in the lakes and streams, while pike, white-fish, and catfish are the most abundant in the rivers. Moose and deer are also plentiful, and partridge and wood-hens are abundant.

Water Resources

A number of small dams have been built on some of the rivers for water control. A large dam, north of the area at La Tuque on St. Maurice river, was built and is maintained by the Shawinigan Power Company, to supply power to La Tuque, the C.I.P. mill at La Tuque and the Shawinigan System. The dam has a head of 114 feet and its control of the flow of water has a marked effect on St. Maurice river in the area.

Climate

No weather data is available from within the map-area, but weather observations have been made at La Tuque, which lies 17 miles north of the map-area, since 1911. The mean annual temperature at La Tuque is 38.23°F. The hottest months are June, July and August with mean temperatures of 61°F, 62°F and 61°F respectively. August and September are the rainy months with average rainfalls of about three-and-a-half and five-and-a-half inches respectively.

TOPOGRAPHY

The map-area lies within the Laurentian uplands, and its highest elevation is approximately 1,550 feet above sea-level. The local relief is from 150 feet in the heavily drift-covered sections of the map-area, to 900 feet along the margins of the main river valleys. In parts the relief is modified by moraine, which mantles much of the map-area, particularily in the northwest and west-centre, and in the south and east-centre.

The map-area is drained by St. Maurice river, either directly, or through Lac Polette and Wessonneau river; Rivière-aux-Rats; Lac Carignan; Lac Petit Carignan; Lac St. Thomas; and Lac St. Michel. Most of the smaller rivers in the map-area have steep gradients, except where they traverse moraine-mantled sections, while two of the major rivers, St. Maurice river and Rivière-aux-Rats, are in a mature stage of the river cycle. The other major river, Wessonneau river, has a steep gradient along most of its length within the map-area.

Geomorphologically the map-area is a dissected peneplain modified locally by lithologic and structural controls, and to a lesser extent by a mantle of moraine. Three factors control the nature of the local relief. They are joint patterns, the structure and composition of the underlying bedrock, and to a minor extent glacial and post-glacial deposits. The major joints commonly parallel the bedding of the gneisses in the paragneisses. A less prominent set of joints occurs at right angles to the bedding, and is in places important as a topographic control.

The area is moderately rugged with most of the hills having steep south-facing slopes and gentle north-facing slopes. An exception is the valley of St. Maurice river which in places steep

west-facing or east-facing slopes, or both. Steep scarps border parts of the south bank of Wessonneau river.

Away from the major rivers, and above the scarps which border the rivers in places the local relief is never more than 350 feet. In many places the rise away from the major rivers is more gentle but an accordance of summit levels at 940 feet is the dominant feature both to the east and the west of St. Maurice river. The maximum relief in the map-area is 900 feet on the north and south sides of Rivière-aux-Rats.

In the north east quarter of the map-area, east of St. Maurice river and north of Lac Batiscan and Lac au Castor the drainage is controlled by the gneissic layering of the para-and orthogneisses and by the jointing which is parallel to and at right angles to it. The trend of the drainage is NNW and is clearly seen by the elongate shaped lakes (Petit Lac Carignan) and the tributaries which run at right angles to them and the NNW flowing streams. These two structural features have in places produced a sub-parallel drainage pattern and in others a sub-rectangular drainage pattern. In some places this angular drainage pattern has been modified by drift.

South of Lac Batiscan and Lac au Castor and east of St. Maurice river the trend of the drainage in the southern part is just east of north and swings to north-south in the central part at these lakes. The drainage in this part is again controlled by the gneissic layering of the para- and orthogneisses and by the parallel and right-angled jointing in the gneisses and by the rectangular jointing in the massive igneous rocks. The relief in this quadrant of the map-area is more gentle than in the northeast quadrant, due to a greater effect of drift. The drainage here is sub-rectangular.

In the northwest quadrant of the map-area north of the portage opposite Grande Anse and west of St. Maurice river the control of the drainage by the geologic structure is less prominent. The cause for this is the more complex geologic structure and there is a greater diversity of rock-types than in the eastern half of the map-area. The drainage is partially controlled by the NNW trend of the gneissic layering in the para- and orthogneisses, but dominantly by the jointing which strikes northwest and by the fairly thick veneer of drift in some parts. In parts the drainage is controlled by the contacts of the igneous masses with the adjacent gneisses, and also by the joint sets in the igneous rocks.

South of the portage opposite Grande Anse, in the southwest quadrant of the map-area the relief is more subdued with local relief here having a maximum of 200 feet. Particularly along the western margin of the area, the topography is modified by moraine. The drainage in these parts is irregular because of the moraine. The drainage control in this quadrant is similar to that of the northwest quadrant in that there is a diverse assemblage of rocks in the southern part. The dominant drainage trend is from the northwest, with the major control being jointing in the gneisses and igneous rocks.

Most of the major topographic features of the area are pre-last glacial, with many of the major valleys now partially filled with gravel, sand and clay into which the present rivers are now cutting. The St. Maurice valley has a maximum width of two miles within the map-area with high, 40 foot, terraces bordering the river in the wide parts. Only in the extreem south does the width of the valley decrease to half-a-mile, where the river is bordered

by steep slopes on both sides. Throughout its length the valley is mainly bordered by steep slopes.

Rivière-aux-Rats flows in a broad valley within the map-area, with many meanders and ox-bow cut-offs. It is bounded by Cenozoic terraces, with the bed-rock rising as cliffs on the north side and as steep slopes on the south.

Wessonneau river has a steep gradient throughout its lower reaches, flowing directly on bed-rock, but near the western border of the map-area the gradient is more gentle with minor meanders.

GENERAL GEOLOGY

General Statement

The consolidated rocks of the map-area are all of Precambrian age. Listed in order of abundance they are: well-layered paragneisses, which have some interlayered orthogneisses in them (these rocks underlie more than two-thirds of the map-area), biotite granite, hornblende granite, gabbro and meta-gabbro and various minor intrusives.

Although contact between layers in the gneisses are well defined, the tracing of individual layers is almost impossible because of the thinness of the layers and the small size and wide spacing of the exposures. Most of the paragneisses have been injected in varying degree by granitic material. Individually these injections are difficult to trace, however, it is possible to trace zones of intense injection, and these have been outlined by dotted lines on the accompanying map. Zones of this nature have been called Lit-par-lit injection (reaction) gneisses. The tracing of these zones has greatly facilitated the structural interpretation

of the map-area.

The contacts between meta-gabbro and the adjacent rocks are in places sharp, while in others should more properly be described as gradational. However, these units can more easily be traced than the lit-par-lit injection gneiss zones, and unlike the lit-par-lit injection gneisses, represent distinct lithologic units.

Most of the gneisses strike northwesterly and dip east. The major fold structures of the map-area also strike northwesterly. In the south part of the map-area the strike of the gneisses is north-south, swinging slightly toward the north-northeast in the central and then toward the north-northwest and northwest in the northern half of the map-area.

These strikes are in agreement with the writer's work to the north (Klugman 1956) and Tiphane (1954) who mapped the area to the northeast of the present map-area. However, the trends do not agree with those reported by O'Sullivan (1908) and Bancroft (1916) who mapped areas to the north and adjacent to the map-area respectively.

The contacts between the gabbro, biotite granite and hornblende granite are in places easily seen, but due to the sparse exposure observed contacts cannot be drawn. The topographic expression of these rock-types also greatly facilitates the delineation of their boundaries. Age relationships between the intrusive bodies, where they are in contact, are also clear, as are the age relationships between the intrusives and the gneisses where their contacts can be seen. The presence of granitic lit-par-lit injection into the gneisses adjacent to the granitic rocks also determines the age relationships.

Large stretches of the map-area are mantled by moraine, through which the underlying bedrock protrudes in many places.

Table of Formations

Cenozoic	Pleistocene and Recent	Sand, gravel, clay, till, boulder moraine
Precambrian	Intrusives	Pegmatite (not shown on map). Pink biotite granite Pink hornblende granite. Gabbro and metagabbro.
		Reaction Gneisses (quartzofeldspathic) or lit-par-lit injection gneisses. Quartzofeldspathic actinolite gneiss; quartzofeldspathic biotite gneiss; quartzofeldspathic pyroxene geniss; quartzofeldspathic gneiss; garnetiferous quartzofeldspathic gneiss.
	Grenville Series?	Hornblende andesine gneiss (amphibolite; garnetiferous andesine hornblende gneis; biotite hornblende andesine gneiss; pyroxene andesine gneiss; quartzite; limestone

Grenville Series?

The paragneisses of the Boucher-Carignan area do not bear much resemblance to the rocks of the Grenville Series described by Logan (1863) in the "type area" of Grenville township, Quebec. Quartzite is not abundant but it occurs at several places throughout the map-area. Limestone is also rare but is found in the map-area, mainly in the centre-east part. In most localities quartzite and limestone occur together, the quartzite forming the "backbone between two layers of limestone. The exposure of limestone at this locality is probably due to the protection to weathering given it by the quartzite. It is therefore probable that other layers of limestone may occur within the map-area, but because of its susceptibility to weathering, it probably underlies local depressions or small valleys and is now concealed. Bancroft (1916) has reported a thin layer of crystalline limestone along the railroad just east of the present map-area.

Because of the dissimilarity between the metasedimentary rocks of the present map-area and those of the "type area", it is unwise to blindly accept these rocks as part of the Grenville Series. It is possible however that these rocks are part of the Grenville Series that is neither present nor exposed in the type locality.

The gneisses, which crop out in 70 per cent of the map-area, commonly contain abundant dark minerals with feldspar and with or without quartz. The exceptions are the lit-par-lit quartzofeldspathic (Reaction) gneisses which contain little dark minerals and are composed mainly of quartz and feldspar. These gneisses show good linear structures with elongated quartz lenticles and feldspars which have a preferred orientation in the direction of the

layering. They are most commonly medium-grained and pink to greyish pink. The majority of the gneisses in the map-area are predominantly fine- to medium-grained, and are from light grey to grey-green. Gneissic structure is distinct, and lineation can be observed in all hand specimens. The layers are well defined, with light and darker layers alternating.

The minerals which are used in naming the rocks are feldspar, quartz, pyroxene, hornblende, biotite and garnet. In some gneisses in which feldspar is abundant the varietal name for the feldspar is used in compounding the rock name. This has also been used in the case of the pyroxene when a specific variety dominates.

Much of the quartz has undulose extinction, and many of the plagioclase grains are bent and have part of their twinning obliterated.

Hornblende Andesine Gneiss

Hornblende andesine gneiss underlies about 55 per cent of the map-area. The thickness of the individual layers is diverse. Most of the layers are one to two inches thick, but layers as much as three feet and as little as a fraction of an inch thick are not uncommon. The layers are commonly well defined and are produced by alternating layers rich in light or dark minerals.

The weathered surface is from light yellow-grey to a deep red-brown, but the rock is easily recognized in spite of variation in texture and colour. The weathered surface commonly has a distinctive "salt-and-pepper" appearance. The fresh surface is from light grey to grey-green. In places the contact between the gneiss and adjacent acid igneous intrusives is not sharp but rather gradational and, therefore, difficult to place.

The rock has a grano-blastic and commonly equigranular texture. The average grain-size is medium. The amount of hornblende present in the rock is diverse, with a maximum of 40 per cent. Essential minerals of the rock are; hornblende, plagioclase, and biotite. Apatite and magnetite are always present, while quartz is seldom absent. Accessory minerals include alkali feldspar, garnet, hypersthene, augite, zircon, limonite, epidote, sphene, and chlorite. Where these accessory minerals occur in abundance in the hornblende and andesine gneiss, the rock is considered as a variety rather than a separate rock-type. These impure or variable types are described following the end of this section.

The plagioclase is from An_{28} to An_{58} with an average composition of An_{42}. It is twinned according to the albite law, and pericline twinning is also commonly present. Carlsbad twinning was also observed in some grains. Some of the grains of plagioclase have been granulated and recrystallized. Alteration in the plagioclases is not extensive, however, in some sections alteration to sericite and epidote was observed, and in some a cloudiness of the plagioclases was noted. In one thin-section, however, alteration to a felted, very fine-grained aggregate of alteration products was notable. Most of the thin-sections contained plagioclase grains which showed the effects of stress. This is exhibited by bent plagioclase grains and a partial loss of twinning in the grains. The degree of loss of twinning is diverse. In some thin-sections the deformation and loss of twinning is so great that accurate determination of the plagioclase composition is difficult. Myrmekitic textures around the margins of some of the grains was observed in a few places. The plagioclase makes up from 25 to 52 per cent of the rock.

The hornblende is strongly pleochroic in most cases from pale olive-green or pale green to dark olive-green or dark green. Other pleochroism observed is from reddish-olive-green to pale olive-green. The reddish and olive-green colours are probably due to a moderately high percentage of iron present in the hornblende. Alteration of some of the hornblende to biotite and magnetite was observed in several cases, and alteration to chlorite in one thin-section is fairly extensive. The hornblende makes up from 25 to 40 per cent of the rock.

Biotite makes up from four to 18 per cent of the rock. It appears to be of two origins, as a primary mineral and as a secondary mineral after hornblende and pyroxenes. Two varieties of biotite occur, one pleochroic from honey-yellow to very dark brown and the other from red-brown to very dark brown. The difference between the two is probably the difference in the iron content of the biotites. This variation appears to have no relationship to whether the biotite is primary or secondary. In some rocks the two occur together in the same rock.

Quartz, apatite, and magnetite are present. Quartz never makes up more than two per cent of the rock as a constituent mineral. It always appears to be of secondary origin, either introduced at a later date or as an alteration product. The latter case seems to be the most prominent. The grains commonly have an undulose extinction which is the result of stress. Some very small grains are sometimes poikioblastically enclosed in the feldspar and hornblende.

Apatite commonly makes up to three per cent of the rock. In some thin-sections it occurs in or close to the dark minerals

whereas in others it is randomly distributed throughout the rock.

Magnetite is always present in amounts of up to eight per cent in some thin-sections. In those rocks where magnetite is abundant, many of the adjacent light coloured minerals are stained yellow.

Hypersthene and augite are abundant in some thin-sections reaching a combined percentage of 20 per cent. However, in most thin-sections they are only present in small amounts up to three per cent. In the rock in which they are in large amounts, this is undoubtedly the result of alteration from a gabbroic rock. This however, is not the only orthogneiss in this assemblage as alteration to hornblende and biotite are pronounced in other thin-sections. Alteration of the pyroxenes to hornblende, biotite, and magnetite is common, and in some thin-sections a relic pyroxene cleavage can be seen. In most thin-sections which contain pyroxene the accessory minerals, sphene, magnetite and apatite are all spatially related to the dark minerals. Schiller structure was observed in a number of hypersthene grains, and several grains of augite showed polysynthetic twinning.

Garnet in amounts of up to five per cent is regarded here as an accessory mineral to the rock. Where more is present the rock is described as a separate variety.

Orthoclase is also present as an accessory mineral, and where present in small amounts (four per cent) is regarded by the writer as being of metamorphic origin, and not necessarily related to any acid intrusive. Zircon is present in very small amounts in some of the thin-sections examined.

Amphibolite For the purpose of this report amphibolites are considered as varieties of hornblende andesine gneiss which contain hornblende, and its alteration products, as the most abundant constituent in the gneiss.

The amphibolites occur as layers or lenses in the hornblende andesine gneiss and to a lesser extent as interbeds in the other layered rocks. They also occur around the margins of gabbroic bodies and in places they grade into the gabbro. Where the accessory minerals apatite, sphene and magnetite are spatially associated with the dark minerals, the amphibolites are assumed to be orthoamphibolites (Patchett 1954; Klugman 1956). Where the field relationships show an intimate association of amphibolite to gabbro they are also considered to be orthogneisses.

There is the possibility that amphibolites which are conformably interbedded with other metasedimentary rocks may be of igneous origin, in the form of sills or flows. However, when they occur as interbeds in other metasedimentary rocks they are considered to be paraamphibolites, unless there is a petrographic relationship of the accessory minerals sphene and magnetite to the dark minerals, or relict pyroxene grains or structures.

Garnetiferous Andesine Hornblende Gneiss is also considered as a variety of hornblende andesine gneiss. Compositionally they are better regarded as varieties of amphibolite as all of the garnet rich varieties observed in the field have the dark minerals predominating. Garnetiferous andesine hornblende gneiss occurs sporadically throughout the area, and nearly all occurrences are spatially related to gabbro or identifiable orthoamphibolites. The rock has a dark salt and pepper weathered surface with the garnets

standing out in relief. On the fresh surface they are dark green-black with white and the garnet stands out. The principal constituents are hornblende, 40 per cent; plagioclase An_{47}, 23 per cent; garnet 20 per cent; and magnetite eight per cent. Accessory minerals are quartz, biotite, chlorite, sericite, and apatite, with the chlorite and sericite occurring as alteration products of hornblende and plagioclase respectively. Some of the biotite present is also secondary.

Lit-par-lit injection of granitic material into the hornblende andesine gneiss and its varieties has taken place to diverse extent. Where lit-par-lit injection is obvious in the thin-section, the minerals so introduced have not been included in the petrographic description of the overall rock. In some thin-sections it is difficult to determine the origin of the quartz and alkali feldspar as it shows not apparent relationship to the lit-par-lit injection. It is quite possible however that the potash feldspar in particular is the result of metasomatism. In some specimens the lit-par-lit injection has been great, and here porphyroblasts of potash feldspar (principally microcline) are numerous.

Accessory minerals in the granitic material of the injection include garnet, magnetite and zircon.

Biotite Hornblende Andesine Gneiss

Biotite hornblende andesine gneiss was identified in the field as amphibolite because of its close resemblance to amphibolite in the hand specimen. It is usually darker than the hornblende andesine gneiss because of the higher percentage of dark minerals. It most commonly occurs spatially related to gabbroic bodies and

also as interbeds in the other gneisses. Because of its mineralogical relationships it is believed to be an altered product of basic igneous rocks. In some places it appears to form parts of orthoamphibolite where the amphibolite occurs as layers in the other gneisses.

Thin-section examination shows the rock to be medium-grained gneissic and equigranular with the essential minerals plagioclase, hornblende and biotite in amounts of 38 per cent, 25 per cent and 18 per cent respectively. Other minerals include garnet, up to 12 per cent, and the accessory minerals augite one to two per cent, magnetite five per cent, and apatite one per cent. In places there has been lit-par-lit injection but the potash feldspar and quartz so introduced are not included in the overall composition.

The average composition of the plagioclase is An_{42}. There is little alteration of the plagioclase. Much of the plagioclase shows evidence of stress in the form of curved twinning, partial destruction of twinning and undulose extinction.

Hornblende is apparently present both as a primary mineral and as a secondary mineral after pyroxene (augite). It is strongly pleochroic from dark olive-green to pale olive-green. The hornblende itself is altered, principally around its margins, to biotite and magnetite.

Biotite occurs both as a primary mineral and as an alteration product after pyroxene and hornblende. It is pleochroic from honey brown to very dark brown (the primary variety) and from red-brown to very dark brown (the alteration product). The biotite is altered to magnetite, particularly the red-brown variety. The biotite also indicates applied stress in the form of curved laths and plates of biotite.

Augite, although present in very small amounts, is significant in that it is the primary source of much of the hornblende, biotite and magnetite present. Two features support the igneous origin of the biotite hornblende andesine gneiss. The first is the presence of augite and the second is the spatial relationship of all the dark minerals and the magnetite to one another.

Garnet is present in amounts up to 12 per cent. Where this amount of garnet is present the rock is considered as a garnetiferous variety of biotite hornblende andesine gneiss, and not as a separate rock-type.

Apatite occurs as subrounded grains which in places have a spatial relationship to the dark minerals and in other places appears to have a random distribution in the rock.

Magnetite always occurs near to or in the dark minerals.

Pyroxene Andesine Gneiss

Pyroxene andesine gneiss occurs as layers within the hornblende andesine gneiss. In the field it is not distinguishable from the hornblende andesine gneiss or the darker amphibolite. In the hand specimen it is dark green on the fresh surface and reddish-brown grey on the weathered surface, has a pronounced gneissic texture, and is medium-grained.

Under the microscope the rock is seen to be prominently gneissic with the dark minerals oriented with their long axes parallel to and in the plane of the gneissic layering. The constituent minerals are plagioclase and pyroxene (augite and hypersthene). Accessory and alteration minerals are hornblende, biotite, chlorite, sphene, magnetite, apatite and zircon.

Plagioclase, which makes up from 45 per cent to 72 per cent of the rock, is from An_{41} to An_{48} in composition. The plagioclase shows very little alteration. Some grains have bent laths and a partial loss of twinning.

The pyroxenes make up from 12 per cent to 20 per cent of the rock. In some hypersthene is predominant and in others augite is. Hypersthene is pleochroic from very pale pink to very pale green, in some grains shows schiller structure, and alters to hornblende, biotite and magnetite. A few grains have a limonite stain. Augite in places shows faint polysynthetic twinning, and is commonly green in colour although some grains show a bluish tinge possibly due to the presence of titanium. The augite is altered to hornblende, biotite, magnetite and sphene and all alteration minerals show a spatial relationship to the augite as do the alteration products of hypersthene.

Biotite occurs entirely as an alteration mineral after pyroxene and hornblende. The biotite, which makes up as much as four per cent of the rock, occurs as both green and brown varieties both of which are strongly pleochroic.

Hornblende, present in amounts up to six per cent, occurs as an alteration product of pyroxene. It is strongly pleochroic from pale buff brown to deep brown.

Magnetite makes up to eight per cent of the rock in places and occurs almost entirely as a secondary mineral after the dark minerals. Sphene, which occurs in trace amounts is also a secondary product, after augite. The other alteration mineral is chlorite which alters from biotite and hornblende.

Other minerals present in minor amounts are apatite and zircon, while epidote occurs as an alteration product of the lit-par-lit injected potash feldspar.

Lit-par-lit injection of quartz and potash feldspar makes up as much as 20 per cent of the total rock in some localities.

Quartzite

Quartzite is not abundant, and was observed in only three places in the map-area. The localities are two-and-a-half miles west of Grande Anse, three miles southwest of Rivière-aux-Rats, and near lac au Castor. In all three occurrences the quartzite can be traced over a moderate distance and in the case of the locality west of Grande Anse it can be followed for one-and-a-quarter miles. When present it can easily be seen in the field because of its white weathered surface and the small ridges it forms. These ridges are purely local phenomena as it is sometimes found cropping out along the bottom of a valley. At the locality two-and-a-half miles west of Grande Anse, the quartzite forms the spine of the ridge along the sides of which limestone crops out.

In the hand specimen it is white to yellow-white, massive, medium- to coarse-grained with, here and there, some visible biotite or graphite.

The quartzite is most commonly impure with impurities, principally potash feldspar, making up as much as 30 per cent of the rock. When highly impure the dark minerals, biotite, graphite, and magnetite, give to the rock a slightly gneissic appearance.

Under the microscope the quartzite is seen to be medium- to very fine-grained, with many of the grains having sutured

margins. The gneissic structure can be partially seen in the form of narrow lenticles of finer grained quartz, as well as by the preferred orientation of the dark minerals which have their long axes parallel to and in the plane of the layering. Some of the quartz grains have partial undulose extinction.

Quartz is the most abundant mineral with potash feldspar occurring in amounts up to 17 per cent. Plagioclase makes up approximately one per cent, with biotite being the prominent dark mineral. The biotite is pleochroic from light buff-brown to dark brown and makes up as much as ten per cent of the rock.

Epidote is present both as an alteration product of potash feldspar and as an accessory mineral not associated with feldspar. Other minerals present are apatite (two per cent), zircon, pyrite, and magnetite.

Limestone

Limestone outcrops in three places on the west side of St. Maurice river one-and-three-quarter, two-and-a-half, and three miles west of Grande Anse. The limestone in the second occurrence occurs as the flanks of a hill which has its spine formed by quartzite. The limestone exposures converge one-and-a-quarter miles along strike and can be traced for another half mile. To the northeast of this occurence is another ridge of similar character which is the offset continuation of the previously described occurence. This exposure is also a quartzite spine flanked by limestone, and it can be traced northward for almost one-and-a-quarter miles from the northwest-southeast striking fault. The The third exposure is not as easily defined as it is not protected

by a resistant spine of quartzite.

In the field the limestone is of diverse purity, with impurities making up as much as 27 per cent of the rock. It is very coarsely crystalline, massive, and is from white through grey-white to dirty white in colour. Visible impurities in the hand specimen include garnet, biotite and, in one locality in particular, thin flakes of graphite. One exposure near the fault is highly sheared.

In the more pure limestone microscopic examination shows it consist of 90 per cent calcite with diopside making up seven per cent, apatite two per cent, and with a diverse limonite stain. In some places calcite is seen to replace apatite. The rock is very coarse-grained, highly crystalline and massive.

Under the microscope the impure limestone is medium- to coarse-grained, strongly crystalline and massive, with calcite making up about 75 per cent of the rock.

The major impurities are quartz, ten per cent; plagioclase An_{32}, eight per cent; and, potash feldspar, five per cent. The potash feldspar includes both orthoclase and microcline and both are perthitic. Diopside makes up five per cent of the rock. Sphene, apatite and magnetite are the accessory minerals, each of which makes up approximately one per cent of the rock. Epidote occurs as an alteration product after potash feldspar. A limonite stain is also present in places.

Much of the quartz and potash feldspar in the rock appears to have been injected, but some, particularly quartz and plagioclase, is enclosed in calcite grains and does not appear to be connected or related to any outside source. The diopside is

most commonly isolated from an outside source. In many places it is spatially associated with quartz. Some of the diopside may have had a partial outside origin, but some, however, appears to be primary and may have preceeded the formation of the limestone. It is therefore possible that this impure limestone may have been of a metamorphic origin.

Reaction Gneisses

Quartzofeldspathic or reaction gneisses are common throughout the map-area. They are probably the result of intense lit-par-lit injection or alkali metasomatism by granitic material into the adjacent country rock. Most of these rocks therefore are altered varieties of some of the previously described gneisses in the map-area.

Zones of much lit-par-lit injection or reaction gneiss are indicated on the accompanying map. Individual layers of the introduced material are from fractions of an inch to tens of feet thick and made up largely of potash feldspar and quartz with either hornblende or biotite or both as accessory minerals. At some localities the injection material is more or less contaminated by the minerals of the invaded country rock. In the country rock, where injection has been great, porphyroblasts of potash feldspar are common.

Highly distorted and deformed reaction gneiss is found in the vicinity of massive granitic bodies. It is especially abundant in the zone of shearing which cuts across the northeastern corner of the map-area. They are also found far from any exposured granitic masses.

Quartzofeldspathic Actinolite Gneiss

Quartzofeldspathic actinolite gneiss is a well-layered gneiss which occurs as interbeds in the hornblende andesine gneiss particularly in the northern part of the map-area. Its exact extent is not known as it resembles a quartzose variety of hornblende andesine gneiss in the hand specimen, and only where actinolite can specifically be identified in the field can its distribution be determined. Megascopically it is medium-grained, grey to green, strongly gneissic, and weathers to a red-brown. In all occurrences lit-par-lit injection of granitic material has been extensive.

Thin-section examination shows it to be medium-grained with a clearly discernable gneissic layering. An accurate determination of the percentage composition of the rock is difficult because of the extensive lit-par-lit injection of granitic material. The approximate percentages of the essential minerals, including the injected material, are; plagioclase up to 46 per cent; orthoclase 12 to 40 per cent; quartz 15 to 30 per cent; actinolite eight per cent; biotite four per cent; and, hornblende three per cent. Accessory and alteration minerals include hypersthene, apatite, epidote, chlorite, magnetite, and a limonite stain.

Plagioclase has the composition of An_{32} and is, in places, bent with some obliteration of twinning. Some grains show a felted aggregate alteration to sericite. Plagioclase in some places shows penetration along fractures in quartz.

Actinolite is very pale green to colourless, with a few of the coloured grains showing a very weak pleochroism. The extinction angle is from 12° to 13°. Alteration to biotite and magnetite is seen in some grains.

Biotite is present as an alteration product, principally after hornblende. It is pleochroic from green to dark green.

Hornblende is also green and can easily be confused with the biotite. It occurs primarily as an alteration product of hypersthene.

The hypersthene is pleochroic from very pale pink to very pale green and forms only a very small percentage of the rock. It alters to hornblende, biotite, chlorite and magnetite.

Apatite is present both as sub-rounded and as lath-shaped grains and has a random distribution with no apparent relationship to any of the dark minerals. Magnetite is common and occurs mainly as a secondary mineral.

Most of the quartz and orthoclase was introduced by lit-par-lit injection of granitic material. However, a high percentage of the quartz is also found in the body of the gneiss. Scattered grains of orthoclase lie within the gneiss itself but these grains are always adjacent to the injected layers. In places the orthoclase shows alteration to epidote. Myrmekitic textures are prominently developed around several of the quartz and orthoclase grains, and much of the quartz has undulose extinction.

Quartzofeldspathic Biotite Gneiss

Quartzofeldspathic biotite gneiss is medium- to coarse-grained, yellowish-pink, and varies from very gneissic to slightly gneissic. It occurs as conformable layers, up to six feet thick, interbedded with the other layered gneisses, and is found throughout the map-area.

Under the microscope it is medium- to coarse-grained, granoblastic, with alternating coarse- and medium-grained layers. The

constituent minerals are quartz, orthoclase perthite, biotite and plagioclase. Accessory and alteration minerals include actinolite, allanite, apatite, zircon, magnetite, epidote, and sericite. Limonite stain is widespread, particularly along the layering.

Quartz makes up 20 per cent of the rock and is mainly of secondary origin, being introduced by lit-par-lit injection. Most of the quartz has an undulose extinction.

Orthoclase, which is highly perthitic, makes up as much as 60 per cent of the rock and appears to be mainly the result of injection and metasomatism.

The plagioclase composition is difficult to determine due to a moderate degree of alteration to sericite and deformation, but it appears to have a composition of approximately An_{31}. It makes up five per cent of the rock.

Biotite makes up approximately five per cent of the rock. It is very strongly pleochroic from pale brown to dark brown, and occurs principally as a primary mineral.

Actinolite is present in amounts up to two per cent and is almost colourless to pale green. Some alteration to biotite was observed.

Magnetite is widespread occurring both as a primary and secondary mineral after actinolite and biotite. It makes up five per cent of the rock.

Other accessory minerals are allanite, apatite and zircon which occur in trace amounts throughout the rock. Epidote is present as an alteration product of orthoclase.

Quartzofeldspathic Pyroxene Gneiss

The quartzofeldspathic pyroxene gneiss is the highly altered product of pyroxene andesine gneiss. Megascopically it is medium-grained, green-grey, with a distinctive layered appearance in which the dark layers have a salt and pepper weathered surface. It occurs as well-defined layers closely associated with layers of metagabbro and other orthogneisses.

Essential minerals are quartz, orthoclase, plagioclase and pyroxenes. Biotite and magnetite are the only other minerals which make up more than one per cent of the rock. Accessory minerals are chlorite, zircon and apatite.

Under the microscope the rock is medium-grained with an excellent pronounced lit-par-lit injection. Overall the rock is light coloured with scattered dark specks as the total dark minerals make only ten per cent of the rock.

Quartz makes up 50 per cent of the rock and shows some undulose extinction. The injected quartz is coarser grained than earlier or primary quartz.

Orthoclase is slightly perthitic and makes up 35 per cent of the rock.

Plagioclase has a composition of An_{24} and makes up five per cent of the rock. Other minerals are augite, two per cent; hypersthene, which is faintly pleochroic from pale green to pale pink, two per cent; biotite, pleochroic from brown to dark brown, three per cent; and, magnetite, two per cent. Chlorite, which together with biotite and magnetite, is an alteration product of the pyroxenes, and zircon and apatite make up the remainder. Limonite stain is noted around the pyroxenes.

Quartzofeldspathic Gneiss

Quartzofeldspathic gneiss might also be called lit-par-lit gneiss in that it appears to be either entirely or predominently the result of lit-par-lit injection of granitic material. In some cases it forms a mixed rock with the country rock it has intruded, and in others it is entirely made up of the injected material. Furthermore it has in some places itself been injected by later granitic material.

Three minerals predominate in the quartzofeldspathic gneiss, quartz, orthoclase perthite and, plagioclase. Together they make up approximately 90 per cent of the rock.

Under the microscope the rock is granoblastic, strongly gneissic with alternating finer- and coarser-grained layers in many parts. This is probably the result of more than one period of lit-par-lit injection of granitic material. In many places well-developed lenticles of quartz were observed. Strain features such as fine granulation of quartz and feldspar and undulose extinction in all of the light minerals is also common. The potash feldspar is most commonly perthitic but to diverse extent, with myrmekitic textures developed around many of the grains.

The determination of the composition of the plagioclase is difficult in some thin-sections due to the deformation of the rock and also the alteration of the plagioclase to a fine-grained aggregate of alteration products, including among others sericite and epidote. A composition of An_{38} was determined in one thin-section.

Other minerals present include magnetite and apatite which are always present as separate minerals. Sericite is also present but only as an alteration product within the feldspar. Magnetite

makes up from three to six per cent of the rock and is principally a secondary mineral after actinolite and biotite. Apatite makes up as much as three per cent in one rock and occurs randomly distributed throughout the thin-section.

Actinolite comprises four per cent of the rock in one thin-section, with biotite the other obvious dark mineral. The biotite is pleochroic from light brown to dark brown and makes up to seven per cent of the rock. It alters to magnetite and chlorite (pennine). A limonite stain can be seen in some thin-sections adjacent to some of the dark minerals.

Garnetiferous Quartzofeldspathic Gneiss

Apart from the greater percentage of garnet, garnetiferous quartzofeldspathic gneiss, greatly resembles quartzofeldspathic gneiss. Quartz, potash feldspar and plagioclase together make up from 68 to 90 per cent of the rock, with the relative amounts of quartz and potash feldspar dependant on the degree of granitic material injection and introduction. Lit-par-lit injection is also prominent in this rock-type with different grain size in adjacent layers in many places.

The quartz shows undulose extinction in most places and intergrowth between quartz and potash feldspar is present. The potash feldspar is commonly perthitic and the plagioclase, which has an average composition of An_{37}, is commonly bent and has its twinning partially obliterated. Garnet makes up from five to 25 per cent of the rock.

Magnetite and biotite are always present in amounts from two to three per cent. The biotite shows alteration to magnetite and both minerals are commonly surrounded by a limonite stain.

Other minerals present include apatite, zircon and the alteration product epidote, after feldspar.

The rock is not found widely distributed throughout the area and is most commonly associated with the fault zone in the north-east part of the map-area.

Gabbro and Meta-gabbro

Numerous small bodies of gabbro are exposed in the area, particularly in the west, southwest and south. Nearly all of the bodies are elongate with their long axes approximately paralleling the regional gneissic layering.

Several of these bodies are intruded by granite, and some are entirely surrounded by granite, particularly in the south and southwest parts of the map-area. These bodies in the southern half of the map-area may once have been larger bodies, which have subsequently been dissected by the intrusion of granite. Apart from the massive intrusion by the granite, the gabbro is cut by numerous granitic stringers and apophyses. In the field the rock is medium-grained, grey to green-brown on the weathered surface and black-green on the fresh surface. In many places it weathers to a crumbly rusty rubble.

Under the microscope the rock is seen to be from fine- to coarse-grained, seriate and granular. The rock appears to have undergone a great amount of stress as shown by bent plagioclase laths, partial obliteration of twinning, and undulose extinction in some of the plagioclase and also in the other colourless minerals. Many of the biotite flakes are also bent as are some of the amphiboles and pyroxenes. Cataclastic structures are also

present in the form of finely granulated zones between the coarser grains. This is most evident in the colourless minerals.

Some poorly developed kelyphitic rims are found in some of the thin-sections examined. These rims are the result of replacement of the pyroxenes by amphibole, biotite and magnetite.

Plagioclase has a diverse composition ranging up to An_{50}. It shows very little effects of alteration, and makes up 35 per cent of the rock.

Augite and hypersthene are the two pyroxenes present. The relative percentages give to the gabbro a diverse composition ranging from a noritic gabbro to a gabbro. The content of hypersthene ranges from six per cent to 14 per cent, and the augite ranges from two per cent to 11 per cent. The augite in places shows polysynthetic twinning. Hypersthene is nearly always dominant. Both minerals alter to hornblende, biotite and magnetite.

Hornblende is the most abundant dark mineral making up as much as 50 per cent of the rock. The hornblende is pleochroic from grass green to insipid greenish-yellow and occurs predominantly as a secondary mineral after pyroxene, with magnetite and in places biotite. Most of the gabbro might better be called uralatized gabbro. In some thin-sections the hornblende is pleochroic from dark brown to honey brown or ochre brown.

Biotite is present in most thin-sections, occurring principally as an alteration product of pyroxene and hornblende. Biotite is pleochroic from deep brown to light honey brown and makes up up as much as seven per cent of the rock. Some plates of biotite are bent showing the effects of strain.

Other minerals always present are magnetite and apatite. Apatite commonly makes up less than one per cent of the rock. Magnetite, which occurs spatially related to the dark minerals, makes up as much as three per cent of the rock. It appears to be an entirely secondary product after the dark minerals.

Garnet was observed in some thin-sections and in one case garnet constituted 12 per cent of the rock making it a garnetiferous gabbro variety. This particular occurrence also contained potash feldspar, in the amount of five per cent, and the plagioclase was far more sodic having a composition of An_{39}.

Numerous meta-gabbro sills, with a few dykes, are found throughout the area. Not all of the meta-gabbro bodies in the map-area are shown on the accompanying map, as many of them are too small. Some of the contacts outline zones of much intrusion rather than discrete bodies of meta-gabbro. Most of the bodies show a high degree of shearing, and many are deformed to diverse extents. The mineralogical composition is diverse because of the injection of granitic material. Besides the meta-gabbro two other varieties can be recognized, a quartzose variety and a garnetiferous variety. Both are evidently metamorphosed and contaminated products of the regional and local metamorphising.

Under the microscope the meta-gabbro is seen to be medium-grained, gneissic with abundant evidence of stressing and shearing. Plagioclase is usually the most common mineral ranging from 30 to 46 per cent of the rock. The plagioclase has both albite and pericline twinning in many places and shows little alteration. Where present the alteration is mainly to epidote. It has a composition of from An_{42} to An_{68}. Determination of the composition

is difficult in many places due to the high degree of distortion and deformation of the grains. In many the grains are bent, in some cases broken, the twinning has been partially obliterated, and undulose extinction is common.

Hornblende is the next most abundant mineral, making up from 25 to 40 per cent of the rock. It is most commonly pleochroic from brown to insipid green-brown to green but varieties showing a pleochroism from olive green-brown to honey brown are also present. The hornblende is almost entirely secondary being an alteration product of pyroxene. The spatial relationships of the alteration products hornblende, biotite, magnetite and sphene to pyroxene is marked in some places.

In most cases two pyroxenes are present. Augite is the most common and when two are present the most abundant. It is present in amounts of from seven per cent to 15 per cent. In many places the augite shows excellent polysynthetic twinning. Hypersthene is pleochroic from pale pink to pale green and makes up as much as five per cent of the rock. Both pyroxenes alter to hornblende, biotite, chlorite, magnetite and sphene.

Biotite makes up as much as eight per cent of the rock. It is pleochroic from rich brown to deep green-brown, deep red-brown honey-red, and deep brown to honey-brown. It too is predominantly an alteration product.

Other minerals present include sphene (less than one per cent), apatite (three per cent), magnetite (one to ten per cent), chlorite (trace), and the introduced minerals quartz (four to ten per cent) and potash feldspar (up to five per cent). Lit-par-lit injection is prominent in some thin-sections, and the quartz and

potash feldspar included in the body of the meta-gabbro is spatially related to it.

All of the light coloured minerals show diverse undulose extinction.

In the quartzose meta-gabbro the included quartz makes up as much as 14 per cent of the rock. In one of the thin-sections examined garnet makes up ten per cent of the rock. Myremekitic textures around many of the quartz grains were observed and cataclastic texture in the form of finely granulated quartz, plagioclase, pyroxene and hornblende was seen to transgress the gneissic-layering. Titaniferous augite was identified in one specimen as was ilmenite and leucoxene.

In the garnetiferous meta-gabbro garnet makes up five per cent of the rock.

Pink Hornblende Granite

The diverse composition of the granite and monzonite in the area is well shown in the thin-sections. The difference between hornblende granite and biotite granite is better seen in the field as nearly all of the hornblende has altered to biotite. A monzonite phase was also noted in the thin-section, so the overall composition of the granite can be said to grade from monzonite to biotite granite.

In the field the most abundant variety appears to be hornblende granite. Seven irregular bodies were outlined in the area, and a number of smaller concordant bodies were also observed. Most of the hornblende granite is exposed in the south-west corner of the area, particularly west of St. Maurice river. It intrudes all of the previously described rock types.

The hornblende granite and the monzonite are possibly the result of partial assimilation of the pyroxene-hornblende-plagioclase rich country rock, and may thus be an early phase of the more pure biotite granite. The spatial relationship of the hornblende granite and biotite granite would tend to support this.

The hornblende granite is medium- to coarse-grained, massive, equigranular and pink to dirty grey on the weathered surface.

Under the microscope the rock is seen to be hypidiomorphic granular, with much granulation and prominent undulose extinction in the light coloured minerals.

Constituent minerals include quartz, orthoclase perthite and microcline perthite, orthoclase, microcline, plagioclase, biotite, hornblende, and pyroxene. Alteration minerals include sericite, kaolin, clinochlore, chlorite, epidote, iddingsite, limonite and magnetite. Apatite and pyrite are the accessory minerals.

Quartz makes up approximately 25 per cent of the rock. It has undulose extinction and forms poikiolitic textures with potash feldspar in places. Plagioclase makes up as much as eight per cent in the non-monzonitic varieties and as much as 30 per cent in the monzonitic rock. Its composition is from An_{15} to An_{28}. In places it is highly altered to sericite, its grains are commonly bent, and twinning has been partially obliterated in many grains.

Potash feldspar is present as both perthitic and non-perthitic orthoclase and microcline. In many places there has been a high degree of alteration to a felted aggregate of sericite, kaolin and epidote particularly in the orthoclase. Microcline and orthoclase make up from 56 to 60 per cent of the rock. Twinning in the

microcline has been destroyed in places and strain shadows are common.

Hornblende forms a very small percentage of the rock and is in most places altered to biotite, chlorite and magnetite. It is pleochroic from deep green to pale yellow-green.

Biotite is also present in minor amounts and is most commonly altered to chlorite and magnetite. It is pleochroic from deep red-brown to honey brown.

Augite is present in partially relict form in one thin-section showing a high degree of alteration to hornblende, biotite, chlorite and magnetite.

Magnetite is present as a primary mineral as well as a secondary mineral in one thin-section where it makes up 15 per cent of the rock. Normally, however, it is only present in amounts of two to three per cent. Pyrite and apatite occur in trace amounts with apatite always present as disseminated grains throughout the rock.

Pink Biotite Granite

The biotite granite masses have the same habit as the probably genetically related hornblende granite and are common in the same areas. It intrudes all of the other rocks of the map-area, either as irregular masses, concordant masses, transgressive layers, or as lit-par-lit injections in the layered rocks. There has also been much injection along the shear zone through Lac Carignan and across the northeastern corner of the map-area.

Under the microscope the biotite granite is seen to be medium- to coarse-grained, hypidiomorphic granular, with quartz,

perthite (both orthoclase and microcline), orthoclase, microcline, plagioclase and biotite the most abundant minerals. Alteration and accessory minerals include clinochlore, muscovite, sericite, kaolin, epidote, apatite, limonite and magnetite.

Quartz comprises 25 to 30 per cent of the rock and commonly shows undulose extinction. The grain size is from medium to coarse, probably the result of some granulation and secondary crystallization. It also forms poikiolitic textures with the potash feldspars.

Most of the feldspar, particularly the potash feldspars, show a moderate to high degree of alteration to sericite, kaolin and epidote, in the form of a very fine-grained felted aggregate. The potash feldspars together make up from 55 to 60 per cent of the whole.

Plagioclase, which like microcline, shows bent crystals and partial destruction of twinning, and also undulose extinction, has a composition of An_{18}. It also shows alteration to a very fine alteration aggregate but not to the extent of the potash feldspars. Plagioclase comprises from five to eight per cent of the rock.

Biotite constitutes from one to six per cent, is pleochroic from brown to honey-brown, and is altered to clinochlore and magnetite. It also shows effects of stress in the form of bent plates and undulose extinction.

Chlorite and muscovite are alteration products each of which makes up approximately one per cent of the rock. Magnetite is present in amounts of two per cent and apatite, which occurs disseminated throughout the rock makes up less than one per cent.

Pegmatite and Mylonite Dykes

Pegmatite dykes and irregular masses cut all of the previously described rock types. The term dyke does not accurately describe the form of the pegmatite bodies. They can have any shape, dykes, sills, lens- and tear-shaped bodies and irregular masses of pegmatite were all observed in the field. The grain size is diverse with some of the feldspar crystals reaching 12 inches in diameter. The average grain-size, however, is more in the range of six inches. The width and length of the pegmatites is diverse, ranging from several inches wide to over 10 feet and extending over a traceable distance of 50 feet before disappearing beneath the overburden.

Most of the observed pegmatites were in the southern part of the map-area, although they were observed in all parts.

The principal minerals are: pink potash feldspar, plagioclase and quartz, with more or less biotite, hornblende and augite. Garnet, magnetite, epidote, allanite, pyrite, pyrrhotite, chalcopyrite and bornite are present in places.

None of the observed pegmatites were zoned, all were simple pegmatites.

Mylonite dykes were observed in the northeast corner of the map-area, in or closely related to the shear-zone through Lac Carignan. Their composition is similar to that of the pegmatites, but are fine- to very fine-grained. They are probably the result of mylonitization of granite or pegmatite.

CENOZOIC

Pleistocene and Recent

Large parts of the map-area are mantled by moraine, through which the underlying bedrock protrudes in many places. The most heavily mantled areas lie in the northwest, west-centre, southwest, east-centre, and southern parts. The moraine is not only confined to the valleys and low-lying sections but is also found as scattered erratics and as a uniform cover on some of the higher mountains. Much of the moraine is concentrated on the northern slopes of the mountains. A few drumlin-like hills are found in the north-eastern part. The moraine on the northern slopes, and the drumlin-like hills together with observed glacial striae, indicates that the continental ice-sheet moved in a south-southeasterly direction across the map-area.

The unconsolidated morainal material is composed of clay, sand, gravel, and boulders of all sizes. The accumulations on the northern slopes of mountains and hills is characteristically unsorted and unstratified. In the flatter areas and in the valleys where the glacial material has been reworked by water, sorting and stratification of the material has taken place to diverse extent. This is particularly true in the valleys and around the unconsolidated material is well stratified.

Clay, sand, boulder and pebble beds are often found alternating with one another indicating an oscillation in the water level. More commonly however, there appears to be a regional sorting, with a well-stratified sequence of one type in one area and another type in another area.

The valleys of St. Maurice river, Rivière-aux-Rats, and Wessonneau river are pre-last glacial in origin and are partly filled with commonly well-sorted gravel, sand and clay, into which the present rivers are now cutting.

The depth of the unconsolidated material in St. Maurice river valley is unknown, but at La Tuque, 20 miles north of the map-area, the depth is known to be more than 230 feet. Several well-defined terraces in these deposits can be traced along St. Maurice river and Rivière-aux-Rats. The elevation of these terraces above sea-level are as follows: 675 feet, 625 feet, 425 feet, and 375 feet. The most extensive terrace-levels are those at 625 feet, which can be traced throughout the length of the area, and at 375 feet, which is extensive in the northern part.

Glacial erratics, some of which are ten feet or more in diameter, occur on many of the hilltops and at scattered localities far from any other glacial material.

STRUCTURAL GEOLOGY

The over-all structure of the area is relatively simple. More than three-quarters of the area is underlain by paragneisses, related layered igneous rocks, and injection gneisses. On the present scale of mapping the rocks cannot be separated into lithologic units. There are exceptions to this, however. In some parts interpretation of zones of much lit-par-lit injection and zones of meta-gabbro injection has been possible. These zones, which commonly do not indicate discrete units, are shown on the accompanying map, and have greatly facilitated the interpretation of the regional and local structure.

Except locally, the gneissic structures all strike north and northwest and dip east. Near the granitic and gabbroic masses the regional trend has been greatly disrupted by the intrusion of these rocks. In the southern part of the map-area the strike is a few degrees east of north, swinging to due north in the centre part and then toward the northwest in the northern half of the map-area. Because of the relative concordance of the massive intrusives in the southern and southwestern parts the trends of the gneisses have not been much disrupted except in very restricted areas immediately adjacent to parts of the intrusives.

The overall structure of the map-area is a northerly and northwesterly striking foliation, dipping toward the northeast, that has locally been distorted and displaced by folding and by later intrusions.

It is possible that this structure represents the western major limb of a major syncline which strikes roughly northwest. The folding and the observed minor drag folds observed in the map-area have their axial lines striking northwest. These structures seem to substantiate the foregoing major structure.

Folds

Several folds have been traced in the field. The largest of these is a syncline west of St. Maurice river in the northern half of the map-area immediately to the east and north of Lac St. Thomas. The strike of the axis is north on the southern end turning to north-northeast over most of its traceable length. This synclinal structure can be traced for five miles. Over most of its length the syncline is symmetrical with gentle dips of

approximately 15 degrees. The syncline plunges toward the southeast. The northern nose of the syncline is intruded by an elongated gabbroic mass which roughly follows the axis of the syncline.

North of Wessonneau river, along the synclinal axis, is a small southeast-plunging anticline whose attitudes closely correspond to the larger syncline to the southeast.

A small partially developed syncline, with a traceable length of three-quarters of a mile, is exposed one mile east of Rivière-aux-Rats. The strike of the axis parallels the axis of the large syncline on the west side of St. Maurice river.

Three miles south of this structure is a complex of a tight syncline flanked by two anticlines. These folds lie due east of the southern end of the large syncline west of St. Maurice river. The axes of these folds are parallel to the other fold axes. The western anticline is the largest structure being one mile wide. The syncline and the eastern anticline appear to be a large drag fold.

Faults

A major shear zone associated with a fault, which is exposed at La Tuque, can be traced down the St. Maurice valley from La Tuque, through Lac Carignan and across the northeastern corner of the map-area. The strike of the shear zone is 350° and the zone is characterized by highly brecciated, deformed and altered paragneisses which have undergone a high degree of alkali metasomatism and mylonitization. This zone is up to three-quarters of a mile wide.

The only other major fault observed in the field is on the west side of St. Maurice river opposite Grande Anse. The strike

of the fault is 120° with no dip determined. However, it is believed that it is a high angle fault. The displacement on the fault is principally lateral with the northern block moving east relative to the southern block. The horizontal displacement, as gauged by the quartzite spined ridges is half-a-mile. The trace of this fault can be followed for four miles to where it extends out of the western boundary of the map-area.

No other major faults were observed in the field, but it is probably that other faults do exist in the map area. Minor faults, too small to plot were observed in many places. It is very probably that many of these are joints along which there has been movement.

Joints

Jointing is common throughout the map-area, particularly in the massive igneous rocks. In the igneous bodies the strike of the joints is approximately north-south, with steep dips either to the east or to the west. In both the paragneisses and orthogneisses the primary jointing is parallel to the gneissic layering and at right angles to it. The dips of the joints parallel to the gneissic layering are either in the plane of the layering or at right angles to it. The dips of the joints at right angles to the gneissic layering is steep in both a northerly and southerly direction

ECONOMIC GEOLOGY

Sulphides

Disseminated pyrite occurs in many of the rocks of the map-area. Areas where pyrite is more concentrated than normal are indicated on the accompanying map by the symbol "P".

Disseminated pyrrhotite occurs in the hornblende-orthoclase-plagioclase gneiss in the southern part of the area. Its location is shown on the accompanying map by the sumbol "po".

Oxides

Disseminated magnetite is a common constituent in many of the rocks of the map-area. Where magnetite is concentrated in greater amounts than normal it is shown on the accompanying map by the symbol "M". One such occurrence of magnetite is located on the south side of the creek flowing from St. Thomas lake to St. Maurice river. It is too small to be of economic significance.

Graphite

Small flakes of graphite, shown by the symbol "G" on the accompanying map, occur in the limestone at the northern end of the large quartzite-limestone ride north of the fault opposite Grande Anse.

Biotite

Books of biotite, as much as nine inches across, were observed in pegmatite on the west side of the large peninsula in Lac Polette, just north of the contact between the gabbro and gneisses. This locality is denoted by the symbol "Bi".

Radioactivity

Nearly all pegmatites in the area show radioactivity slightly greater than background. Scattered crystals of allanite were observed, many of them surrounded by radioactive halos, in some of the pegmatites. Radioactivity in the other pegmatites is probably produced by the K_{40} in the feldspar.

Sand and Gravel

Sand and gravel deposits are common along St. Maurice river, Rivière-aux-Rats, and to a lesser extent along Wessonneau river. Many of them, particularly those on the east bank of St. Maurice river, are being, or have been, worked.

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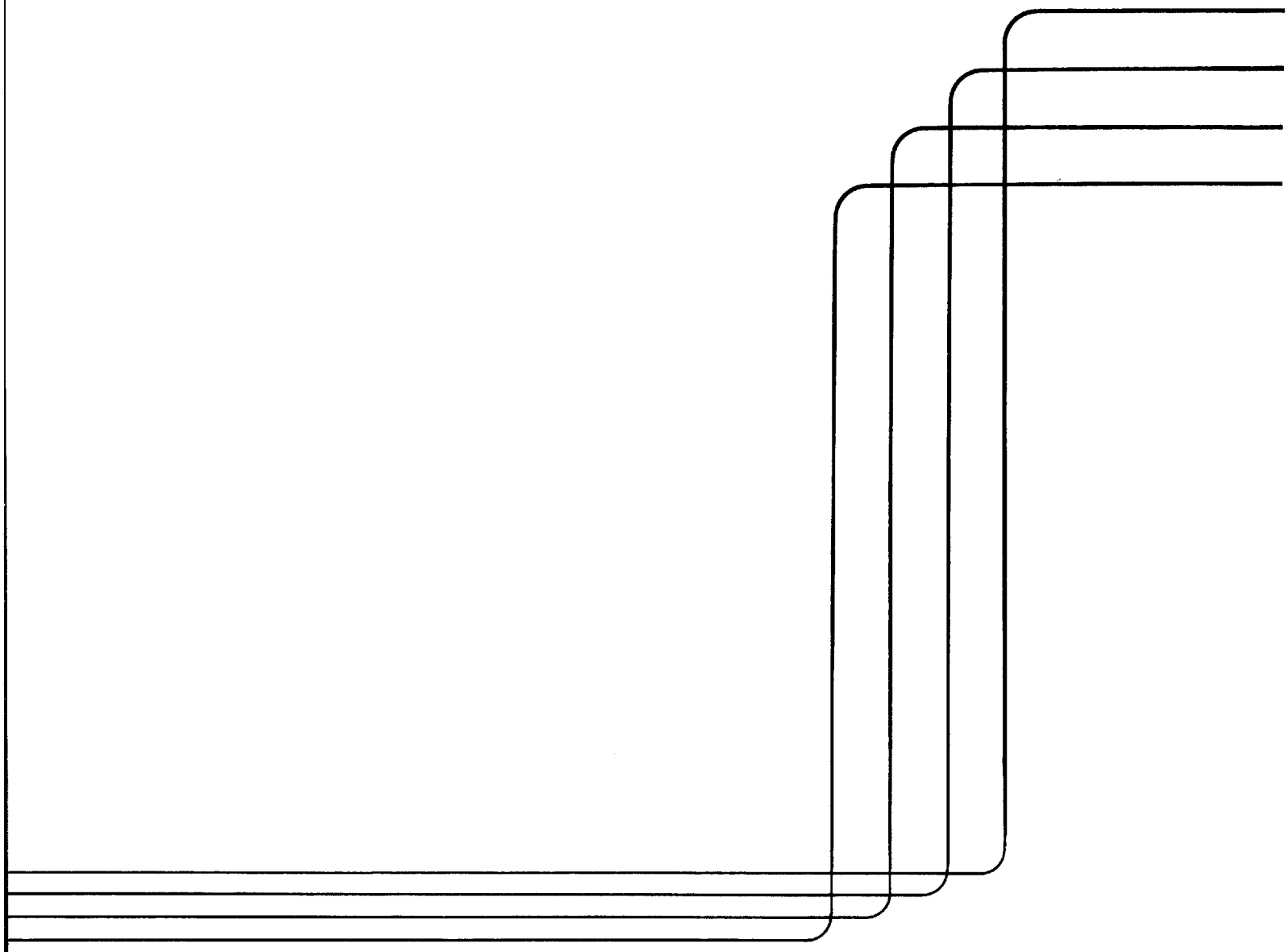

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