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# ST-AUGUSTIN-HA!HA! BAY AREA

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SECOND INTERIM REPORT

on

ST. AUGUSTIN - HA HA BAY AREA

DUPLESSIS COUNTY, NORTH SHORE, GULF OF ST. LAWRENCE

by

RAYMOND DAVIES

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by

RAYMOND DAVIES

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## INTRODUCTION

### General Statement

In spite of relatively easy access geological data on the eastern part of the Grenville sub-province is scant. This may be due to the lack of important mineral discoveries, its remoteness, and the little interest generally shown by mining companies for areas of high grade metamorphic rocks typical of so much of the area. In 1962 the writer initiated a program of geological mapping in the area between Tête-á-la-Baleine and Lobster Bay for the Geological Survey Branch of the Quebec Department of Natural Resources at a scale of 1 mile = 1 inch. Mapping was started near St. Augustin village (Davies, 1963) and during the 1963 field season was extended to the south and southwest. This report describes the latter area extending along the coast between Gros Ile Tickle and Ha Ha Bay and covering approximately 260 square miles.

The area is part of the southeastern plateau belt of Labrador-Ungava. It lies on the North Shore of the Gulf of St. Lawrence about 350 miles east of Sept-Iles.

Claims have been staked at several points within, and adjacent to the area mapped, but all have been allowed to lapse. These claims were all in accessible areas along the coast and are thus not a good indication of the potential of the area as a whole.

## Location

The area is bounded by latitudes 51°00'N and 51°10'N and by longitudes 58°30'W and 59°00'W. It lies on the coast on the north shore of the Gulf of St. Lawrence about 350 miles east of Sept-Iles and includes part of Cook and Haudebourg townships in Duplessis County. The villages of St. Augustin and La Tabatiere lie 4 miles north of the eastern half and 12 miles south of the western half of the area respectively.

## Access

Villages along the coast may be reached either by ship (Clarke Steamship Co. Limited) leaving Quebec fortnightly, and taking about five days to reach St. Augustin, or by 'plane (Northern Wings) on a tri-weekly summer service from Havre St. Pierre or Sept-Iles, weather permitting.

The southeast half of the area is coastal, consisting of numerous islands with long runs of fairly sheltered water. Some of the latter, such as Grand Rigolet and Petit Rigolet , are of sufficient depth to accommodate coastal steamers. Travel is by fishing boat or small boats with outboard motors. A freighter canoe may be used in good weather, but should not be depended upon.

The northwest half of the area may be reached by canoe via Deer, Kecarpoui, and Pagachou lakes. Well-cut portages, each less than 1 mile in length, connect these lakes with the coast. Portages are also cut from Kecarpoui lake through to Three Mile lake and Rocky lake. Pagachou lake may also be reached from St. Augustin village via

Pagachou river, but the latter, being tidal, is difficult to traverse at low tide. The above lakes, as well as many smaller ones, are suitable for float planes. Absence of bush, other than in the deeper valleys, makes the area ideal for work involving helicopters.

Due to poor bush cover travel on foot is relatively easy. However, mapping is slowed down by local relief which is at a maximum along lines perpendicular to the strike. Landmarks are easily recognisable and allow for minimum use of the compass.

Winter travel is by dog team and certain trails have been cut specifically for this purpose. Teams are kept by many if not most local families.

## Field Work

Base maps were compiled by Aéro Photo Inc. Quebec at a scale of 1 mile = 2 inches from aerial photographs obtained from the R.C.A.F. and controlled by triangulation. Nautical charts at a scale 1 : 36501 and published by the Department of Mines and Natural Resources, Ottawa, were of considerable value in mapping the coastal section.

Mapping was carried out at a scale of 1 inch = 1 mile.

Coastal shorelines, and those of larger lakes and streams, were examined in some detail. Intervening ground was covered by traverses spaced at approximately 1/2 mile intervals. Traverses were run from point to point and positions of points of interest marked on an acetate overlay on an airphoto. Normal pace and compass traverses were impractical due to the ruggedness of the terrain and the difficulty of keeping to a straight line.

Exposure in the area is abundant, the bush being confined mainly to the relatively narrow sheltered valleys, while the tops of hills and coastal islands have only a moss covering with numerous exposures of bare rock. Individual outcrops are too numerous to record and therefore only areas of poor exposure have been outlined on the map. Outcrops observed in the latter areas are marked, as are also outcrops along the wooded shores of lakes. Coastal shorelines consist of almost continuous outcrop unless otherwise shown. To give some indication as to areas traversed, outcrops at which geological information was recorded are marked on the map.

Frank Fenzel of McGill University acted as senior assistant, Georges Simard of Laval as junior assistant, and D.Roberts of Quebec Hill School as student assistant. G.Lavallee and T.Maurice served as canoemen while J.Belvin was cook. W.Driscoll skippered his fishing boat which the party hired during the last two weeks of the season. All these men performed their respective duties in a highly satisfactory manner.

Acknowledgments

The writer is indebted to Rev. Father Paul Longlies O.M.I. at St. Augustin for the valuable assistance given to the party throughout the summer ; also to the many people of St. Augustin and La Tabatiere whose help, co-operation, and advice is greatly appreciated.

The writer is especially grateful to Professor Krank of McGill University who suggested the area as a thesis topic, and to Dr Marcel Morin, field supervisor, who visited the party during the summer. Discussions with the above and other members of staff and graduate students at McGill University were of considerable help in the

preparation of this report.

## Previous Work

Very little information is available on the geology of this part of Quebec. De Puyjalon (1882, 1898) reported on the minerals of the North Shore including the present area. Longley (1944a, 1944b) described briefly the area between Aguanish and Lobster Bay and in more detail the Lobster Bay Nickel Prospect. Hale (1962) did a reconnaissance survey of an area covering 7,000 square miles which includes the area mapped by the writer. The latter paper describes in a very general fashion the economic and geological features of the district.

## DESCRIPTION OF THE AREA

## Settlement and Resources

### Inhabitants

While there are no villages within the area, St. Augustin and La Tabatiere lie close to the northeast and southwest boundaries respectively. Families from both villages, however, have cottages on the coastal islands where they spend the summer months fishing.

Most of the inhabitants are of European extraction. Four Indian families, recently resettled at Romaine, returned to St. Augustin in the spring of 1963. There was talk that other families were to follow. St. Augustin was, up to a few years ago, the home of a fairly large Indian community. In early historic times the area was the home of the Eskimo and Eskimo relics are occasionally found along the coast.

### Industry

Almost the entire population is dependent on fishing and to a lesser extent on trapping for their living. However, in recent years more and more of the younger men travel to Sept-Iles to seek summer work. Lumber at present is of minor importance. A small sawmill run by the Roman Catholic mission, besides supplying local needs, produces small quantities of lumber which are shipped to other villages along the coast. Certain individuals are occupied part of the time in boat-building, satisfying local demand only. A fish processing plant situated at La Tabatiere provides jobs for a number of people during the summer. Small quantities of bake-apples are shipped out each year by the local Hudson Bay Co. Store.

Perhaps the greatest potential industry of the area is tourism. From a scenic point of view this part of the coast is probably the most beautiful. Few places can boast so much protected coastline, such ruggedness, and lack of monotonous bush. Wild life abounds and many trout and salmon streams are easily reached. Deep sea fishing might be an added attraction.

## Agriculture

There is no agriculturally suitable land within the area mapped.

## Timber Resources

Wooded areas are few and confined to the valleys of the larger lakes, rivers, and streams, and also to the bottoms of sheltered bays. Higher areas either have a moss covering with patches of forest scrub or bare rock. The whole area may be classed as coastal tundra (Hare, 1959).

The most common trees are black and white spruce, balsam fir, white birch, and tamarack. Alders and willows predominate along the banks of all streams. The diameters of the larger trees found in the area average 24 inches (2 feet above ground) though they are by no means abundant.

Fish and Game

Large game seen in the area include caribou, black bear, and wolf. Four beaver were counted during the summer. Snowshoe hare and red squirrel were common. Also seen were porcupine, muskrat, red fox, otter, and ermine. Reported present by local trappers are mink, marten, lynx, woodchuck, and mole. Arctic fox, and on rare occasions polar bear, are reported to enter the area, having been carried south on ice-floes. Other than beaver and red fox, fur-bearing animals were scarce during the fall of 1962 in contrast to 1961 which was a good season all round.

Common along the coast are the marine mammals i.e. seals, porpoises, and whales. 1963 saw an increase in the price of seal skins and this stimulated the hunting and fishing of seals in the area by the local population. Seals found in the area include the Harbour, Grey, Harp, Hooded, Ringed, and occasionally Bearded seal.

Bird life abounds and space does not permit a detailed description. The area is a breeding ground for numerous species of water fowl. A group of off-shore islands southeast and including the southeast side of Outer Island has been established as a bird sanctuary. A warden is in charge during the summer months to prevent the robbing of eggs and killing of young birds. Game birds common in the woods are spruce and white partridge.

Fishing, as already mentioned, is the most important summer occupation. Atlantic salmon, cod, trout, herring, mackerel, and capelin account for the major production. The fish is either frozen, salted, or to a lesser extent canned. Other fish caught by the party are flatfish, sculpins, and lumpfish.

Lobsters and scallops are fished commercially while 'wrinkles', clams, and mussels are taken for local consumption.

## Weather

Conditions during the summer of 1963, as in 1962, were generally overcast with precipitation chiefly in the form of showers. Heavy rain was experienced on occasion and fog was frequent. The greatest number of fine days occurred in July and September as did the strongest winds.

Below is a table showing the mean maximum and minimum temperatures for the season :

| Month | Maximum | Minimum |
|---|---|---|
| June | 60 | 31 |
| July | 66 | 44 |
| August | 62 | 34 |
| September | 55 | 34 |

During this period the lowest temperature 24° was recorded on several days in June and September, and the highest temperature of 90° on July 13. Snow fell at St. Augustin on October 5.

## Physiography

### Topography

The area is part of the southeastern plateau belt of Labrador-Ungava (Hare, 1959), which includes the country south of Lake Melville and the Lake Plateau, and east of Romaine river, excluding the Mealy Mountains. This physiographic division is for the most part a rough, undulating plateau. The St. Augustin - Ha Ha Bay area lies along the southern margin which is severely dissected. It is barren and for the most part consists of bare rock, having been swept clear of glacial drift by marine submergence. The area has a well-developed ria shoreline. The deeper valleys and runs (submerged valleys) between the islands form a well-defined pattern and were developed in pre-glacial times by subareal erosion. They show no relationship to the foliation or to the direction of glacial movement. One such submerged valley (Tucker Cove - Passage Fournier) is occupied by a weakly resistant gabbro dyke, a continuation of the gabbro dyke crossing the St. Augustin area. Shores of other submerged valleys show evidence of shearing and alteration.

Differential weathering of the moderately dipping gneisses has produced between the major valleys a homoclinal valley and ridge topography. These valleys contain smaller lakes and streams and are often underlain by concordant meta-gabbros (amphibolites). Examples of some of the more prominent of these valleys are the outlets of Kecarpoui, Deer, and Rocky lakes, the portage from Tucker Cove to Pagachou lake, Baie Lessard, and Kecarpoui bay.

Effects of glacial erosion are the rounding of hills and ridges, development of grooves and glacial fluting when ice movement paralleled the foliation, and the plucking of joint blocks from southeast slopes. A result of the latter is the prominence of cliffs on the north and northwest shores of lakes and submerged valleys.

Relief varies from very little on the outer islands, increasing steadily inland to about 500 feet in the northwest corner of the area.

## Drainage

Unlike the St. Augustin area there are no major rivers, the area lying between the St. Augustin - Northwest river to the north and the Robertson lake drainage system to the west. It is divided into three drainage basins. The northwest and largest of these includes lakes Arrow, Three Mile, Ivry, and Rocky, and empties into Kecarpoui bay via Kecarpoui lake. The north is drained via Pagachou lake and Pagachou river emptying into St. Augustin bay to the northeast. A small area in the southwest is drained via Deer lake which empties into Ha Ha bay.

As already mentioned the larger lakes and streams occupy zones of fracture while the smaller lakes and tributary streams follow the foliation of the gneisses. Small lakes and ponds are numerous both in the homoclinal valleys and occupying shallow depressions in bedrock gouged out by ice movement. The drainage forms a rectangular to trellis pattern.

The pattern of the submerged coastal area is the same as that of the mainland. Submerged valleys are up to 50 fathoms deep, with Petit and Grand Rigolet deep enough throughout to accommodate coastal steamers.

## Physiographic History of the Area

St. Augustin - Ha Ha Bay area lies on the southeast boundary of the Canadian Shield. Its physiographic history is thus closely associated with that of the shield as a whole.

Prior to Pleistocene glaciation the area was reduced to a peneplained surface. No consolidated sediments younger than Precambrian occur in the area.

In pre-Pleistocene times the peneplained surface stood at a higher level than today to allow for the down-cutting of the deep valleys. The steep sides and narrowness of the present valleys indicate a youthful drainage system.

During, and immediately after Pleistocene glaciation the area was covered by glacial deposits, particularly in the lower-lying areas. Glaciers modified the land surface, smoothing off the hills, gouging out depressions, and where ice movement was parallel to the valleys it modified their walls giving them a U-shaped form. With retreat of the glaciers clays were deposited offshore in the submerged valleys. The high ground submerged by the ice was washed clear of glacial debris, with only small patches of reworked material being preserved in protected places.

During re-emergence the clays were eroded and covered by sands and gravel by advancing river mouths. Clays are exposed today in many of the bays along the coast and in several places contain Recent marine shells not found on present beaches. The latter suggests earlier deposition at depth.

## GENERAL GEOLOGY

### General Statement

The St. Augustin - Ha Ha Bay area lies in the eastern portion of the Grenville sub-province. All the consolidated rocks are considered Precambrian in age though gabbro, diabase, and related dykes may be younger. Apart from the latter intrusives the rocks are typical of other parts of the Grenville sub-province.

Gneissic rocks of varying composition, including paragneisses underlie the entire area. They vary in composition from granitic to

## Table of Formations

| | |
|---|---|
| Pleistocene and Recent | Sand, silt, gravel, clays, peat |
| | Unconformity |
| | Diabase and related dykes, calcite veins |
| ? | Intrusive Contact |
| Eocambrian | Anorthositic-gabbro dykes |
| | Intrusive Contact |
| | Pegmatite and aplite<br>Intermediate dykes and sills - granodiorite, quartz-monzonite, monzonite, orthoclase diorite |
| | Intrusive Contact |
| | Meta-gabbro (including amphibolite) |
| | Intrusive Contact |
| Precambrian | Pegmatite<br>Interlayered meta-gabbro (including amphibolites)<br>Porphyritic granite and granodiorite gneiss |
| | Probable Intrusive Contact |
| | Green pyroxene plagioclase gneisses<br>Fine- to medium-grained pink granitic gneiss<br>Grey garnetiferous-biotite-plagioclase gneiss<br>Light grey plagioclase gneiss<br>Sillimanite-biotite-garnet gneiss<br>Calc-silicate rocks<br>Quartzite (+sillimanite and garnet-iferous varieties<br>Banded fine-grained pink and grey gneisses<br>Dark grey biotite-hornblende gneiss |

quartz dioritic. The mineralogy is that of the granitite and upper amphibolite facies. Layers and lense-like bodies of foliated porphyritic (porphyroblastic) granite and granodiorite, as well as larger irregular masses around which the gneisses are folded, occur in the east, and characterize what may be termed the 'eastern zone'. The 'western zone' is characterized by the presence of green pyroxene-plagioclase gneisses. The boundary between the two zones runs just west of Eagle Harbour, through Baie Lessard, to Rocky Lake. The gneisses and paragneisses have conformable contacts with each other and with the porphyritic granite and granodiorite. However, the latter may show intrusive relations locally.

While many meta-gabbros (including amphibolites) are interlayered several are clearly intrusive. Some of the latter are probably younger than the period of regional metamorphism. Other younger intrusives are granodiorite-monzonite dykes, aplites, and pegmatites, while the youngest intrusives are gabbro, diabase, and related dykes.

Unconsolidated gravels, sand, silt, and clay of Pleistocene and Recent age are widespread but in minor quantities.

## Gneisses

Gneisses of various composition, colour, and texture underlie most of the area.

Because the rocks are closely banded, mapable units often show considerable range in composition. For clarity, and to bring out the structure of the area, the major map units chosen are a) fine- to medium-grained pink granitic gneisses, b) green pyroxene-plagioclase gneiss, c) grey garnetiferous gneiss, d) dark grey biotite-hornblende gneiss, and e) mixed gneisses. Light grey plagioclase gneisses and sillimanite-garnet gneisses do not occur as mapable units but are characteristic components of the mixed gneisses. It must be borne in mind that all the gneisses are mixed to some degree, but in the 'homogeneous' units as mapped one rock type predominates.

To avoid needless repetition the mineralogy of all the gneissic units is treated under a single heading. The estimated range in mineral composition of the various units is tabulated in the appendix (Tables I and II).

Fine- to medium-grained pink granitic gneisses

There are essentially two types. One is a well-foliated medium-grained variety found only in the western zone, and the other a fine-grained variety, weakly foliated, found throughout the area. The former is characterized by the presence of hornblende or its chloritic alteration which is rare in the fine-grained variety. Otherwise composition and mineralogy are essentially the same, consisting essentially of quartz, potash felspar, and plagioclase with a little biotite. As the two varieties are not easily separated in the western zone, they have been mapped as one unit.

Fine-grained pink granitic gneiss : Present throughout the area, the fine- to medium-grained pink granitic gneiss is a major constituent of all the mixed zones. It occurs as conformable layers 6 inches to greater than 100 feet thick. Contacts are generally sharp, but there are gradations into the fine-grained grey plagioclase gneiss with which it forms thick, closely banded units.

The pink colour is a reflection of the potash felspar and slightly grey varieties indicate higher oligoclase content. This pink colour is generally preserved on the weathered surface, making the rock a conspicuous field unit.

The rock has a low mafic content and consists essentially of potassic felspar, plagioclase, and quartz. Some varieties have small red garnet porphyroblasts as a characteristic accessory. Foliation is weak but a faint banding conformable with the contacts is usually present, particularly on fresh surfaces. The banding results from both slight variations in composition and grain size.

In this section mafics show strong preferred orientation, while the felspar and quartz show slight elongation parallel to the foliation. There is also varying degrees of segregation of the two minerals.

The range in mineral composition estimated from study of 10 thin sections is shown in Table I (1).

Well-foliated pink granitic gneiss : Well-foliated medium- to coarse-grained pink granitic gneiss is confined to the western zone in which it constitutes the majority of granitic gneisses. It is apparently closely associated with the green gneisses with which it is interlayered. There is often a subtle gradation into the latter with varieties intermediate between the two. This is in marked contrast to the fine-grained variety with its sharp contacts.

Colour is predominantly pink to pinkish grey but many are tan coloured while others contain a little green plagioclase. Most important minerals are quartz, potash felspar, and plagioclase, with about 5 percent biotite and/or hornblende. Hornblende is generally present in those varieties containing green felspar. The range in mineral composition estimated from study of 11 thin sections is shown in Table I (2).

Hornblende or its chloritic alteration product accompanies the biotite and together with texture and coarser grain size distinguishes these rocks from the fine-grained variety.

The most characteristic feature is the well-developed foliation, in which the mafic constituents are concentrated as thin folia about 1/4 inch apart between granular layers of quartz and felspar. In low mafic varieties the foliation is marked by a segregation of quartz and felspar. There is sometimes a tendency towards an augen structure. Lineation of mafics and quartz felspar aggregates is well-developed.

Green pyroxene-plagioclase gneiss

Together with the well-foliated pink granitic gneiss into which it grades, the green gneiss is confined to the western zone. In fact it is the most conspicuous rock in the zone.

Most varieties are medium-grained, olive-green to greenish-grey, and are composed essentially of green or greenish-grey plagioclase with lesser amounts of quartz and potash felspar. All contain pyroxene with hornblende or biotite or both. The composition is granodioritic to quartz-dioritic. The estimated range in mineral composition of 11 thin sections is shown in Table II (3).

Foliation is well-developed and is similar to that of the well-foliated pink granitic gneiss. Lineation of mafics, particularly biotite, and quartz-felspar aggregates on foliation planes is also pronounced.

Weathering is generally deep and only along shorelines was the gneiss recognisable by its green colour. Elsewhere it is a rusty, dirty brown colour, and generally friable. The deep weathering of this gneiss may lead to it being poorly exposed with respect to interlayered bands of more resistant granitic rocks.

A similar gneiss was found in the St. Augustin area (Davies, 1962) though at the time it was not differentiated from the grey granodioritic gneisses.

The green colouration of the plagioclase is apparently related to the presence of amphibole and/or pyroxene (probably their alteration) as it is absent in the garnetiferous gneisses described below, which are devoid of these minerals. Guy-Bray (1961), from a study of the green colouration, concluded that it was due to the presence of chlorite films along fractures and cleavages in the plagioclase.

Grey garnetiferous - biotite - plagioclase gneisses

Grey garnetiferous biotite gneiss occurs as relatively narrow bands in zones of mixed gneisses. It was mapped as a separate unit only in the western zone where it acts as a characteristic marker horizon.

The gneiss is medium-grained, grey, and well-foliated. Essential minerals are plagioclase and quartz, with lesser amounts of biotite, garnet, and potash felspar. Biotite is segregated into thin folia 1/8 to 1/4 inch apart as in the well-foliated gneisses above. Occasionally fine sillimanite needles are present, and together with the biotite exhibit a strong lineation. Characteristic are the red garnet porphyroblasts up to an inch in diameter and generally constituting no more than 5 percent of the rock. However, locally they may constitute as much as 20 percent of the rock. Crystals are often fractured and poikilitic and may occur singularly or as masses elongated parallel to the foliation. The garnets occur both in the gneiss and in associated concordant quartz-felspathic bands or veins. Presence of garnet with the biotite in place of hornblende or pyroxene distinguishes these rocks from others of a similar composition, such as the green pyroxene-plagioclase gneisses. In none of these rocks does the plagioclase exhibit a green colouration. Table I (4) is the estimated range in composition of the group from the study of 5 thin sections.

Sillimanite - biotite - garnet gneiss

Included in the mixed gneisses at a few places are zones composed of garnetiferous quartz-felspathic material, generally massive and medium- to coarse-grained, in which occur easily-weathered layers or lenses, a fraction to 2 to 3 inches wide, composed of sillimanite, biotite, and garnet. The sillimanite usually exhibits a prominent lineation. These zones are relatively narrow and nowhere greater than 100 feet wide. They do not constitute mapable units but are conspicuous and serve as an excellent marker horizon. While the sillimanite layers are easily weathered, the quartz-felspathic material is resistant and the differential weathering results in a very broken outcrop.

The sillimanite occurs as prisms varying in size from minute needles to 1 inch long and 1/8 inch wide. Together with the biotite with which it is intimately mixed, it shows a pronounced lineation in the foliation plane. Garnet occurs as masses of small crystals elongated in the direction of this lineation.

Light-grey plagioclase gneiss

The light-grey plagioclase gneiss is fine- to medium-grained and composed essentially of plagioclase and quartz with varying amounts of potash felspar. Mafics include biotite and hornblende with pyroxene in low potash felspar varieties. It is similar in appearance to the fine-grained pink granitic gneiss with which it is often associated. Table I (5) is the estimated range in composition of 3 thin sections.

Dark-grey biotite-hornblende gneiss

Dark-grey biotite-hornblende gneiss occurs in the eastern zone and is best exposed in the neighbourhood of Ile aux Graines.

It is fine- to medium-grained, dark-grey to dark pinkish grey, and composed essentially of plagioclase, biotite, hornblende, and opaque minerals with considerable potash in the pink varieties. Table I (6) is the estimated range in composition of 3 thin sections.

Because of the dark colour this unit is conspicuous particularly along the coast. It also serves as an excellent marker horizon, as layers are relatively homogeneous.

Foliation is well-developed as is also the lineation of biotite and hornblende.

Mixed gneisses

Various combinations of rock types give rise to the mixed units as mapped. Two of these units are composed essentially of pink granitic gneisses and green pyroxene plagioclase gneiss depending on which is dominant. A third unit consists of banded fine-grained pink and light grey gneisses. The fourth unit is the most diverse, consisting of three or more main rock types.

Banded fine-grained pink and grey gneisses : As well as being a common constituent of the fourth unit mentioned above, they constitute a distinct unit themselves in the western zone. Banding may be on a large or small scale, and gradations in composition occur between the two main components.

The pink bands are essentially the fine-grained granitic gneiss and the grey bands the light-grey plagioclase gneiss.

Mixed gneisses (three or more main components) : This unit may include any of the gneisses already mentioned, excluding the green pyroxene-plagioclase gneiss and the well-foliated granitic gneiss, but including the paragneisses and the porphyritic granite and granodiorite. The latter is an important constituent, generally occurring as concordant layers.

Quartzites

Quartzites are scattered throughout the area but are best exposed at a number of localities in Petit Rigolet. Layers more than 50 feet thick were observed in Clay cove but in general they are much narrower. Several can be traced for more than a mile. They are a common constituent of the mixed gneisses, and their greatest value is that they act as excellent marker horizons.

Most of the quartzites are fairly pure, glassy white to grey recrystallized quartz rocks, but may contain conspicuous amounts of microcline, garnet, and sillimanite. They all exhibit banding (bedding) parallel to contacts and to the foliation of the gneisses. This banding may be the result of the segregation of microcline and quartz, the presence of garnet-rich layers or presence of sillimanite needles along certain planes. The sillimanite exhibits an excellent lineation when present. More often however the banding is simply due to difference in colour of the quartz, presence of minor amounts of micas and black opaque minerals.

The quartzites are well jointed, breaking into angular blocks or slabs conspicuous in the field. In many cases they form prominent cliffs.

While many of the narrow layers (4 - 5 feet) might conceivably have been veins, the banding in the thicker layers is most certainly bedding. Other sedimentary features such as ripple marks were not observed. Their regular width, continuity, and concordant contacts with the gneisses also points to a sedimentary origin.

<u>Calc-silicate rocks</u>

Calc-silicate rocks are very limited in occurrence. They were observed only in the eastern half of the area in layers generally less than 20 feet wide. Their susceptibility to weathering, together with their narrow width, may account for their absence in the western zone or in areas away from the shorelines. Like the quartzites they are excellent markers and are commonly found in the zones of mixed gneisses.

The rocks are well-banded, with individual bands a fraction of an inch to several feet wide. Individual bands vary considerably in composition, being composed of different combinations of calcite, diopside, scapolite, biotite, quartz, and potash felspar. Sphene is a common accessory. Narrow calcite bands (1 - 12 inches wide) are occasionally present interlayered with the silicious varieties. Nothing as well-developed as the limestone occurrence in Goose Bay (Davies, 1962a) was observed. The silicious varieties are composed of various combinations of the minerals mentioned above; the most common silicate associations are scapolite-diopside, usually but by no means always with scapolite predominant, scapolite-biotite, quartz-scapolite-diopside, and calcite-microcline-diopside-scapolite.

Calcite-rich zones in particular have been folded. Different degrees of structural competency of the various bands are evident. More resistant bands have fractured and the individual segments are often completely enclosed in the calcite which has apparently flowed into the fractures. Differential weathering of the different bands has given rise to an extremely irregular weathered surface.

## Amphibolites

Amphibolites are mentioned here for the sake of completion. They are probably of more than one age and of more than one origin. Some have obviously been involved in the complete regional metamorphic history, being either sills, volcanic flows, or calcarious sediments that are folded along with the gneisses. Others have been injected at a late stage and show little effect of the folding, or metamorphism. However, as many of these bodies cannot clearly be placed in one group or the other, they are considered together under the heading meta-gabbros in the next section.

## Mineralogy of gneisses and paragneisses

Quartz occurs both as irregular grains elongated to varying degrees parallel to the foliation, and as small rounded inclusions in the felspars particularly the potassic felspar. The latter are most conspicuous in the fine-grained varieties, and may represent original detrital grains or perhaps an earlier smaller grain size, the small grains having been isolated in the felspars during grain growth. On the other hand they may be a feature similar to myrmekite common in these rocks where plagioclase abuts on potassic felspar. Strong strain or undulating extinction is common to all specimens.

Plagioclase is oligoclase-andesine ($An_{26-42}$). The granitic varieties tend to be more sodic, 21 thin sections averaging $An_{24.8}$ compared to $An_{31.2}$ for 22 thin sections of the granodioritic varieties. Cyrstals are anhedral, unzoned, and exhibit polysynthetic twinning (mostly albite) with associated pericline twinning. Twin lamellae often wedge out near grain boundaries. Many are bent and the grains fractured indicating deformation.

Alteration of oligoclase to albite and sericite is a conspicuous feature of the granitic varieties. The alteration is irregular, occurring as patches in the clear oligoclase, selectivity replacing certain twin lamellae and along cleavages. Twinning in the albite is pronounced and is continuous with that of the poorly twinned oligoclase. Because of the abundant sericite identification of the albite by optical means is often difficult. The more calcic andesine of the granodioritic gneisses exhibits slight sericitization but albite is lacking. One fine-grained granitic variety, but by no means abundant in the area, and characterized by its distinct bright brick-red colour, contains clear unaltered sodic oligoclase ($An_{12}$).

Potassic felspar is mostly twinned microcline perthite with the perthitic plagioclase occurring as veins, rods, or patches. It occurs as unaltered anhedral grains which often appear to be later than the plagioclase and quartz.

Biotite is the main mafic constituent and is pleochroic from pale brown to dark brown or reddish brown. Flakes are subhedral and generally undeformed though occasionally bent flakes are encountered. It shows a marked preferred orientation and is the most important element of the foliation and also the lineation of all these rocks. Slight alteration to chlorite particularly along cleavages is common. Biotite itself occurs as an alteration product of the hornblende, and as reaction rims around black opaques. In the calc-silicate rocks it is light brown in hand specimen and slightly pleochroic pale brown in thin section.

Hornblende in varying amounts is a constituent of all the gneisses except the garnetiferous varieties and most of the pyroxene-plagioclase gneisses, and is rare in the fine-grained pink varieties. It is strongly pleochroic according to the scheme X pale brown Y greenish brown Z dark green. It is anhedral and often altered to pseudomorphous masses composed of biotite, chlorite, opaques, and carbonate. In 7 thin sections studied, the hornblende has the following properties $Z \wedge c$ 13-17°

(average $15.36^{\circ}$) 2V = $44-74^{\circ}$.

Pyroxene is the important mineral present in the green pyroxene-plagioclase gneiss. It is found also in the fine-grained grey gneisses which are possibly related, being abundant in the western zone. Both clino- and ortho-pyroxene are present, either coexisting or alone. Crystals are anhedral to subhedral and stubby. Hyperthene is the more common and is strongly pleochroic from pink to pale green. Clino-pyroxene is pale green and only weakly pleochroic. When coexisting it may form partial rims around the hyperthene. Clino-pyroxene is also a major constituent in the calc-silicate rocks. In these rocks it is dark green in hand specimen and occurs as subhedral to anhedral crystals occasionally up to an inch or more in length. In thin section it is slightly pleochroic, varying from light green to pale greenish brown to colourless. A study of 5 thin sections of the calc-silicate rocks and 4 thin sections of green pyroxene-plagioclase gneisses showed the clino-pyroxene to be diopside-salite-augite (Winchell, 1959, p.408 and 410). Optical properties lie within the following ranges $2V\gamma = 50-64^{\circ}$ $\gamma nc = 40-46^{\circ}$.

Garnet is the main mafic constituent accompanying the biotite in the grey garnet-biotite-plagioclase and sillimanite-biotite-garnet gneisses and is a conspicuous minor constituent in some zones of the fine-grained pink granitic gneisses. It is not found together with hornblende or pyroxene. Crystals are subhedral to euhedral porphyroblasts, generally small, but sometimes an inch in diameter. More often than not they occur as clusters rather than single grains. The colour is red in hand specimen and slightly pinkish in thin section. Grains are often fractured and poikilitic.

Sillimanite when present occurs as euhedral prisms varying in size from fine needles to crystals 1 inch long and 1/8 inch wide. The prisms show an excellent lineation.

Scapolite, white in hand specimen and colourless in thin section, is a common constituent of the calc-silicate rocks. It is the calcium-rich variety with indices of refraction $N_O$ 1.590 $\pm$ .003 and $N_E$ 1.560 $\pm$ .003. Thus the composition is 70-75 percent $Ca_4Al_6Si_6O_{24}CO_3$ (meionite) or Ca mizzonite (Winchell, 1959, p.353).

Calcite constitutes the thin limestone bands and is an important constituent of the calc-silicate bands.

Accessory minerals : Short prisms of apatite and rounded crystals of zircon are common, as are irregular grains of opaque iron ores. Occasionally bottle-green spinel is intergrown with the latter. Sphene is usually associated with the black opaques as masses of irregular grains. Chlorite, sericite, carbonate, leucoxene, and 'serpentine' are common alteration minerals.

Porphyritic (porphyroblastic) granites and granodiorite

Though these rocks range in composition from granite to granodiorite, they are not easily separated in the field as changes from one to another are generally gradational. However, a few sharp contacts were observed, and in all cases the granite appeared to cut the granodiorite. The granodiorite dominates in the more uniform layers within the gneisses, while the lense-like and irregular masses are predominantly granitic. On a regional scale the foliation is concordant with that of the gneisses, while locally these rocks may cut the gneisses.

Granite

The granitic varieties are pink and composed essentially of large potash felspar phenocrysts (porphyroblasts) in a medium- to coarse-grained matrix of essentially quartz and potash felspar with plagioclase, biotite, hornblende, and opaque minerals.

Foliation is poor and results from the preferred orientation of the felspar phenocrysts (porphyroblasts).

Granodiorite

The granodiorites are grey and medium- to coarse-grained, composed essentially of plagioclase and quartz, with potash felspar, biotite, hornblende, and opaque minerals. Large phenocrysts (porphyroblasts) of grey plagioclase are common but are not as abundant as the felspar phenocrysts (porphyroblasts) in the granite. Large augen-like crystals of potash felspar are common.

Foliation is well-developed due to the segregation of mafics and quartz felspar aggregates, and the parallel orientation of phenocrysts (porphyroblasts) and augen.

Mineralogy

The mineralogy of these rocks is essentially the same as that of the gneisses. Plagioclase composition covers approximately the same range $An_{25-34}$ . However, the average for both granitic and granodioritic varieties are $An_{29.1}$ and $An_{30.6}$ respectively. In the granitic gneisses the average tends to be lower. Alteration to albite and sericite in the granitic varieties similarly is a common feature. Hornblende has the same pleochroic formula. However, the extinction angle tends to be a little higher. $\gamma nc = 13-22^{\circ}$ (average $18.8^{\circ}$) and $2V\alpha = 54-78^{\circ}$ from the study of 8 thin sections.

Origin of the gneisses and porphyritic granite and granodiorite

Due to the high grade of metamorphism accompanied by metasomatism and intense deformation under which the rocks were capable of 'plastic' flow, little evidence of the original nature of the rocks is preserved.

All the gneisses excluding the coarse-grained porphyritic varieties exhibit concordant compositional layering. Nowhere was the foliation seen to transect this compositional layering. Banding is often closely spaced and regular over considerable distances, and often the granitic gneisses themselves are banded, with individual bands differing only slightly in composition and grain size. This banding conforms with the few narrow layers of metasediments i.e. quartzites and calc-silicate rocks.

The coarse-grained gneisses, while generally concordant, transect the compositional layering locally. Further, the coarse-grained granite gneiss may cut the granodioritic variety while the reverse is not true. However, no large discordant masses occur. The greater mobility of the coarse-grained gneisses, particularly the granitic variety, may be due either to the material being intruded as magma or rheomorphism of bands with a granitic composition (igneous or sedimentary). Whichever is the case the important point is that the coarse-grained gneisses are essentially concordant with the general compositional layering.

From the point of view of composition the quartzites, calc-silicates, and garnet (sillimanite)-biotite gneisses are accepted metasedimentary rocks. These rocks constitute an extremely small part of the total rock mass. They are narrow bands generally less than 100 feet thick. On the other hand they are continuous and relatively undisturbed, suggesting that they are part and parcel of the gneissic succession. Further they are distributed throughout the succession. There is no difficulty in finding a possible original material, either sedimentary or volcanic, for the gneisses of the area.

While proof either way is not available, the writer feels that the majority of gneisses represent original sediments and volcanic rocks, probably with a certain amount of intrusive material occurring as sills. Recrystallization occurred during regional metamorphism with the introduction (or redistribution) of potash. While much of the rock was deformed plastically, fusion of the granitic material occurred in regions of more intense deformation or greater $P_{H_2O}$. It is noteworthy that the coarse-grained porphyritic gneiss (more mobile) is confined to the eastern zone which is also a zone of more hydrous minerals (hornblende with absence of pyroxene).

Finally the writer believes that whatever the original composition, and without clear evidence to the contrary, the gneissic sequence must for practical purposes be treated as a stratigraphic column. This approach is the most likely to produce a clear picture of the structure, if one is to be found.

## Older Intrusives

### Gabbro and Meta-gabbro

#### General Statement

Scattered across the area are dykes and sill-like bodies of gabbro or meta-gabbro, varying in width from less than a foot to 700 feet. They are seldom traceable as outcrop any great distance away from the coast, since they are easily weathered and support a more dense cover of vegetation. However, the valleys they occupy or give rise to are prominent features on the air photographs.

Most are sill-like bodies conformable with the gneisses. They are generally well-foliated and include the amphibolites already mentioned. They are highly altered and are essentially hornblende-andesine rocks. Several, however, are less altered particularly away from the contacts and together with pyroxene may contain labradorite. The plagioclase becomes more sodic towards the contacts, while pyroxene gives way to hornblende. One such body is well-exposed west of Baie Querry.

Dykes are less abundant. They may be narrow bodies almost completely absorbed by the gneisses and whose foliation is oblique to its contacts but parallel to the gneisses it cuts. On the other hand a large body in Deer Lake, approximately 700 feet wide, cuts the gneisses almost at right angles, and apart from the amphibolitic zone along the contact is essentially unaltered olivene gabbro. Foliation and banding is parallel to its contacts. It is identical with the two olivene gabbros mapped in the St. Augustin area (Davies, 1962b).

Folding and lineation in the sill-like bodies is parallel to that in the gneisses. Many layers are broken up and occur as lenses strung out parallel to the foliation. Others show beautiful pinch and swell structure.

Foliation is most marked in the narrow bodies, along contacts, and in places that have suffered more intense deformation. As the development of foliation is dependent largely on the orientation of biotite flakes, the better foliated varieties generally have a high biotite content. Garnet may occur at contacts with the gneiss where it accompanies biotite to the exclusion of hornblende.

The presence of potash felspar and abundant biotite is ascribed to the metasomatic addition of potash from the surrounding gneisses during metamorphism. The greatest degree of alteration is found in the smaller bodies, near contacts in the larger bodies, and in those bodies that have been strongly deformed structurally.

Though the relative ages of these gabbroic bodies are not known, they all appear to have been involved to varying degrees in the regional metamorphism of the area. Some have been strongly folded or broken up, while others show little effect of the deformation undergone by the gneisses. This may be due to different degrees of structural competency during deformation but does suggest the possibility of two ages of intrusion, one after the major folding of the gneisses, and one during or prior to the folding. All are cut by pegmatite, granite, or aplite veins.

Fresh gabbro

Included are rocks with a gabbroic composition which may or may not have been recrystallized. Both olivene and hornblende gabbro occur, the latter being the more common. They are related and occur together in the Deer lake body. The latter intrusive is the only one in the area containing olivene. In the St. Augustin area (Davies, 1962b) two similar bodies of olivene gabbro were mapped. Contacts with the gneisses were not seen, but both bodies were fairly massive and were apparently short but thick dyke-like intrusives. The Deer lake body, while by no means well-exposed, throws some light on the nature of these rocks. A good example of 'fresh gabbro' occurring as a sill is that exposed on the west side of Baie Querry. It is essentially a recrystallized hornblende gabbro. Both occurrences will be described briefly.

Deer Lake intrusive : The mass as deduced from airphotos and available outcrops is approximately 700 feet wide and 3/4 to possibly 1 1/2 miles long. It is intrusive into fairly flat-lying gneisses in the form of a lense-like dyke. Topographically it consists of a resistant core of olivene gabbro surrounded by a zone of easily weathered hornblende gabbro. The hornblende gabbro is exposed at one point along the contact with the gneisses over a width of about 3 feet. It is here altered to hornblende-biotite-andesine gneiss with a strong foliation parallel to the contacts. Patches in the altered zone containing pyroxene rather than hornblende exhibit a weak ophitic texture. Other than at the contacts the rock is medium-grained with ophitic texture. Plagioclase is strongly zoned with rims up to 15 percent more calcic than the cores. In places it is banded, probably the result of flow. This banding is parallel to the contacts and steeply dipping. Weathering has given rise to concentrations of black sands in Deer lake. Similar black sands are associated with the olivene gabbro in Lake La Sarre.

Baie Querry : This is an interlayered body exposed along the shore for about 1/4 mile. It is at least 55 feet thick and the contact exposed on the west is sharp. The body is layered, the result of magmatic differentiation or metamorphism or both. Foliation, lineation, and axes of minor folds are parallel to those in the gneiss. Conspicuous are the pyritic zones, 1 - 2 1/2 feet wide, which weather to give a thin, blistered, and highly coloured gossan surface. One zone occurs 6 inches to 5 feet above the western contact and is continuous along the shore. A second zone, approximately 40 feet above the western contact, is less continuous, occurring as discontinuous pods. Other smaller irregular masses occur throughout the body. Mineralized masses are elongated parallel to the foliation. The mineralized zones are all medium-grained pyroxene-andesine rocks, while the rest of the body is a recrystallized hornblende gabbro. While the composition of the plagioclase in the latter rocks is labradorite or bytownite, it is unzoned. The texture is that of a metamorphic rock. The grain size in general increases away from the contact. The sill is displaced by a right hand fault with a horizontal displacement of 50 feet. The fault zone in turn is cut by a young diabase dyke.

Mineralogy

a) Olivene gabbro : As mentioned above the olivene gabbro is associated with and grades into the hornblende gabbro and altered varieties. It is hard, medium-grained, and dark grey to black in colour. A single thin section consisted essentially of 35-40 percent plagioclase, 20 percent hypersthene, 5 percent clino-pyroxene, 30 percent hornblende, and 10 percent olivene, with minor amounts of opaques, spinel, chlorite, and carbonate. The rock has an ophitic texture.

Plagioclase laths are strongly zoned with cores up to 15 percent more calcic than the rims. The most calcic grains were determined as labradorite ($An_{70}$). Fine-grained incipient alteration of calcic cores is evident.

Both clino- and ortho-pyroxenes occur. The clino-pyroxene is nonpleochroic colourless and cloudy due to incipient alteration, and occurs in large skeletal grains. The ortho-pyroxene is hypersthene, pleochroic from colourless to pink. It occurs as small stubby crystals which form rims around the clino-pyroxene and olivene. Olivene occurs as irregular fractured grains. Together with the clino-pyroxene it was the first mineral to crystallize.

Hornblende is present as small anhedral crystals. It is strongly pleochroic from pale brown through reddish brown to dark brown and forms rims around the hypersthene.

Black opaques and green spinel are accessory minerals. Carbonate and chlorite are alteration minerals. In some cases almost the entire rock may be altered to chlorite. A thin section of such a specimen still containing remnants of all the original minerals except plagioclase was very pale coloured. In fact all the constituents had a washed-out appearance.

b) Hornblende gabbro : Included here are two varieties. The first is the variety found with the olivene gabbro above. It has an ophitic texture, contains zoned plagioclase, and except for olivene has the same mineralogy as the olivene gabbro. The estimated composition of the major constituents of one thin section is 50 percent plagioclase, 20 percent hypersthene, 10 percent clino-pyroxene, and 20 percent hornblende.

The second variety is that which has recrystallized. It displays both a lineation and foliation due to segregation and preferred orientation of mafic constituents. The texture is essentially crystalloblastic. Further the plagioclase is unzoned and occurs as equidimensional grains rather than as laths. It is labradorite, the most calcic determination being $An_{70}$. Both ortho- and clino-pyroxene are present. Orthopyroxene is hypersthene, strongly pleochroic from pale green to pink. $2V\alpha = 40\text{–}44^\circ$. The clino-pyroxene is pale green and weakly pleochroic $2V\gamma = 56^\circ$ $\gamma \wedge c = (35^\circ)$? Hornblende is strongly pleochroic from pale brown to dark green or greenish-brown. Optical properties fall within the following ranges $2V\alpha = 68\text{–}80^\circ$ $\gamma \wedge c = 10\text{–}16^\circ$. The composition of one thin section is estimated as 50 percent plagioclase, 20 percent hypersthene, 10 percent clino-pyroxene, and 20 percent hornblende. Opaques, spinel, and apatite are accessory minerals. Sericite is a minor alteration mineral.

Altered gabbro (amphibolites)

Most of the gabbros fall into this group. Degree of alteration is variable as already mentioned, but three distinct varieties are recognised, hornblende-andesine, hornblende-biotite-andesine, and biotite-garnet-andesine gneiss. The two biotite varieties are typical of contacts and narrow bands. The hornblende-biotite-andesine variety is also common in strongly sheared portions of the larger masses. The essential difference of these rocks from the fresh gabbros is the better development of the foliation and the composition of the plagioclase which is andesine rather than labradorite.

Hornblende-andesine gneiss: These rocks are generally medium-grained, dark greenish-black gneisses, or amphibolites with well-developed lineation due to orientation of the hornblende crystals.

Mineralogical composition of two typical thin sections is given in the interim report of the St. Augustin area (Davies, 1962b). They consist essentially of plagioclase, hornblende, biotite, and opaque minerals with or without hypersthene, and with minor amounts of chlorite and apatite.

Hornblende is strongly pleochroic from light brown through greenish-brown to dark brown. Crystals are anhedral and contain inclusions of plagioclase and opaque minerals. Biotite is pleochroic from light brown to dark reddish-brown. Orientation of the biotite flakes gives the rock its pronounced foliation. Hypersthene shows fairly strong pleochroism from colourless to pale red. It occurs as anhedral grains generally interstitial to the hornblende.

Plagioclase occurs as anhedral equi-dimensional grains interstitial to the ferromagnesians. It is well-twinned and relatively unaltered. The composition was determined as $An_{38}$.

Opaque minerals are associated with the other mafic constituents as fairly large irregular grains. Apatite is present as subhedral to euhedral crystals.

Chlorite has formed during later alteration of the rock.

Hornblende-biotite-andesine gneiss : Apart from a better foliation as a result of the higher biotite content, these rocks have the same appearance as the biotite-poor variety just described.

Mineralogical composition of a typical thin section is given in the interim report for the St. Augustin area (Davies, 1962b). It is composed essentially of plagioclase, potash felspar, hornblende, and biotite, with minor amounts of apatite, sphene, opaque minerals, and sericite.

Hornblende is strongly pleochroic from light brown through dark greenish-brown to dark green, and occurs as anhedral grains. Biotite is pleochroic from light brown to dark reddish-brown.

Plagioclase is badly altered to sericite. Its composition was determined as $An_{32}$. The potash felspar is strongly perthitic and untwinned.

The opaque minerals include both iron sulphides and oxides. Sphene occurs as irregular grains and as rims sround the iron ores. Apatite is present as subhedral to euhedral crystals.

Chlorite is due to later alteration of the rock.

Biotite-garnet-andesine gneiss : This is a relatively rare and minor variety, forming a narrow zone, generally no more than 6 inches wide at the contacts of thicker bodies with the gneisses.

A thin section of a typical specimen contained approximately 45 percent andesine ($An_{42-44}$), 10 percent pink garnet, 40 percent biotite, and 5 percent black opaques with minor amounts of apatite, zircon, and spinel.

Foliation is well-developed with the preferred orientation of biotite flakes. Anhedral fractured and poikilitic garnet porphyroblasts have both pushed aside and enclosed the biotite.

## Younger Intrusives

### Granodiorite-quartz monzonite-monzonite

Exposed in the coastal portion of the area is a group of dykes and sills of quartz monzonitic, monzonitic, and granodioritic composition. They are not nearly so abundant as in the neighbourhood of St. Augustin bay (Davies, 1962), and are found less frequently towards the west. Their width varies from a few feet to 150 feet. Contacts are sharp and there is a suggestion of an east-west trend.

The rock is fairly dark coloured, but when rich in pink felspar has a pinkish or mauvish tint on the weathered surface. Several varieties occur, differing in grain size, degree of development of foliation, and composition. All, however, are composed essentially of the same minerals. Plagioclase, potash felspar, and quartz constitute about 2/3 to 3/4 of the rock, with hornblende, biotite, and opaque iron ores constituting the remainder. Disseminated pyrite is a common constituent. Apatite is always present as well as minor amounts of zircon. Alteration minerals are chlorite, carbonate, sphene, and sericite. Modal analyses of 4 typical specimens are given in the interim report on the St. Augustin area (Davies 1962b). Mafic minerals show varying degrees of preferred orientation, while the felsic minerals occur as a granular mosaic. The rock is generally medium- to fine-grained. A few specimens contained phenocrysts of plagioclase and others large poikilitic flakes of biotite.

Plagioclase is finely twinned and generally slightly altered to sericite. The composition varied between $An_{23}$ and $An_{28}$. In a few cases it has been partially altered to albite and sericite in the same fashion as the gneisses. Antiperthitic replacement by orthoclase was occasionally present. Potash felspar is always perthitic and when present in minor quantities is interstitial with the quartz, to the plagioclase.

Hornblende is anhedral to subhedral and strongly pleochroic from light brown to dark green. It is often partially altered to chlorite, and in most cases appears to have undergone late magmatic or deuteric alteration to biotite. The chlorite is light green and slightly pleochroic. It often occurs as pseudomorphs after hornblende. The biotite is present as irregular flakes and is pleochroic from light to dark brown.

Opaque minerals are intergrowths of magnetite and ilmenite occurring in fairly large grains. Occasional grains of pyrite are common. Leucoxene is disseminated through the chlorite masses.

Apatite is relatively abundant as small subhedral to euhedral crystals. Small rounded euhedral prisms of zircon are fairly common. Sphene was seen as rims around magnetite but generally occurred as irregular grains. Carbonate was present with the mafic minerals as an alteration product.

Foliation, where observable in the field, is parallel to the contacts. It is best developed in those rocks rich in biotite. Some dykes have quartz-felspathic veins (segregations) parallel to the foliation and in a few cases the latter show drag folding.

These rocks are more easily weathered than the country rock, which can be explained by their well-jointed nature. Joints are closely spaced, and on weathering the rock breaks into angular blocks or flat angular slabs in the shallower dipping varieties. Jointing in the dykes is not continuous into the gneiss. However, certain joints in the gneisses are obviously younger than the dykes passing uninterrupted through them and occasionally exhibiting minor displacements. Other displacements along minor faults show strong dragging in the dykes. Displacements from a few inches to 12 feet were observed.

The weathered surface is smooth when fine-grained and rough when coarse-grained, and when rich in biotite is pitted due to the removal of biotite flakes.

Cutting these dykes and sills are pegmatite and aplite veins, and in one case a diabase dyke. Inclusions of hornblende-biotite-andesine gneiss and calc-silicate rock were seen in several of these dykes in the St. Augustin area (Davies, 1962b) and in the present area one of these dykes was seen cutting a meta-gabbro.

Ile Lecouvre intrusive

Comprising the small islands along the south of Ile Lecouvre is a rock of a special character. It is green-grey in colour and medium-to coarse-grained. The green colour is distinctive but unlike the charnockitic gneisses the rock is massive and only occasionally is a faint foliation discernible. Further the rock is remarkably homogeneous. While contacts with the gneisses and foliated porphyritic granites was not observed, the outcrops transect the foliation of these rocks. Cutting the green rock are both dykes and irregular masses of pegmatite, aplite, and diabase.

Mineralogically it is similar to the intermediate dykes. The estimated composition of 2 thin sections is 35-40 percent plagioclase (approx. $An_{30}$), 20 percent microcline perthite, 20-30 percent quartz, 5-10 percent hornblende, 1-2 percent biotite, and 1-5 percent opaques (including pyrite). Accessory minerals include apatite, sphene, and zircon. Chlorite, carbonate, and muscovite occur as alteration minerals. The texture is allotriomorphic granular. Composition is that of a quartz monzonite.

Plagioclase is slightly altered to sericite. Twin lamellae are often bent and/or fractured with thin films of chlorite along many of the fractures. Many grains are antiperthitic and myrmekite is common adjacent potash felspar. The potash felspar is weakly twinned perthitic microcline. Quartz exhibits strong undulatory extinction and contains numerous oriented rutile needles.

Hornblende is the dominant mafic constituent and is strongly pleochroic from pale brown to green. It is subhedral and alters to chlorite. Biotite is pleochroic from pale brown to dark reddish-brown. Flakes are sometimes bent and large skeletal-like flakes suggest a late, possibly deuteric formation. Alteration to chlorite is common. Accompanying the chlorite is the carbonate and muscovite.

Zircon is present as rounded grains and prisms. Subhedral crystals of apatite are common and sphene occurs as irregular grains often associated with the opaque minerals.

Probably related is a coarse-grained massive pinkish grey-white granite occurring as two small islands 1 mile to the southeast. It is identical with some of the rock types associated with the leuco-granodiorite and -orthoclase diorite on Ile Galibois (Davies, 1962b). It is cut by diabase and contains angular inclusions of quartz, meta-gabbro, and calc-silicate rocks.

The estimated composition of this granite is 20 percent oligoclase, 50 percent twinned perthitic microcline, 20 percent strained quartz, 2 percent biotite, and 7 percent hornblende with traces of apatite, opaques, sphene, and chlorite.

Hornblende is pleochroic from pale brown to slightly bluish-green. It appears to have formed late, filling fractures in quartz grains and seems to be replaced by biotite.

Plagioclase shows slight zoning with partial alteration to albite and sericite. It formed earlier than the microcline which often surrounds it and appears to replace it.

Age

Both the intermediate dykes and the Ile Lecouvre intrusives are apparently related. They are older than the diabase but younger than at least some of the meta-gabbros, (amphibolites). It is interesting to note that the albitization of the plagioclase affected these rocks as well as the gneisses. They also show strong alteration of the mafic constituents. At least the dykes have intruded along joint planes and are unaffected by the folding in the area. They have their own joint system but are cut by later joints. Finally the foliation is parallel to the contacts and is clearly the result of flow during intrusion. The above features suggest a time of intrusion after consolidation of the gneisses but while minor mechanical adjustments were still taking place. Conditions were still suitable for chemical adjustments both to the gneisses and the intrusives, thus accounting for the latter's similarity in many respects to the gneisses.

## Granite, Pegmatite, Aplite, etc.

There are no large bodies of granite in the area other than the coarse-grained foliated porphyritic variety already described. However, the lense-like mass exposed around Rocky lake is massive and is very similar to the small granite masses near St. Augustin village which are clearly intrusive. Unfortunately the Rocky lake body is poorly exposed and since it differs from the foliated porphyritic variety only in texture it has not been differentiated on the map. As already mentioned the foliated porphyritic varieties show intrusive relations locally. It is possible that the massive granite above is related but is a more mobile phase.

Pegmatites are widespread and of several ages. The oldest are parallel to the foliation of the gneisses and often show pinch and swell structure. Cutting them are somewhat irregular masses while the youngest are narrow straight-walled dykes. The latter two types are generally coarser-grained and in addition to quartz and felspar contain biotite and hornblende. Magnetite is often present and occasionally garnet. The width of the younger dykes is 8 inches to 6 feet.

Aplites like the pegmatites are of several ages. The youngest are vertical straight-walled dykes with sharp contacts and are similar in their field relations to the intermediate dykes described above. It should be noted that some aplites and pegmatites are younger than the intermediate dykes. They vary in width from 6 inches to 40 feet. One aplite dyke was observed cutting a young pegmatite dyke. Three were also observed showing small left hand displacements.

Quartz veins are relatively rare. Of interest are a number of narrow (1 - 1 1/2 inch wide and approximately 1 - 2 feet long) lenses associated with sulphides in a meta-gabbro on the north shore of Baie Querry.

## Gabbro Dykes

Three coarse-grained gabbro dykes occur in the area. One, passing through Tucker Cove, is the southern extension of the dyke crossing the St. Augustin area (Davies, 1962). Another is exposed on the islands south of Kecarpoui Bay, and the third just west of Eagle Harbour. The latter is the only one with both contacts exposed, and is approximately 200 feet wide. Though variation in composition is common, the typical rock is a greenish-grey and composed essentially of plagioclase and pyroxene, and has a decussate texture. All three dykes are vertical and strike 5-15$^{\circ}$ east of north.

The Tucker Cove occurrence is somewhat different to the other two. It is exposed at the bottom of the cove and at the narrow neck or tidal rapid at the entrance to the cove. The susceptibility to weathering of this dyke is responsible both for Tucker Cove and Passage Fournier to the south. Boulders of 'red rock' were seen east of Passage Fournier on Ile aux Graines. They are identical to the 'red rock' exposed in the northernmost outcrops of this dyke in the St. Augustin area.

The dyke is coarser-grained and like in the St. Augustin area is characterized by the presence of pink felspar. A thin section of this dyke containing pink felspar consists essentially of about 60 percent plagioclase laths with excellent decussate structure enclosing anhedral crystals of pyroxene (about 15-20 percent) and black opaques (about 10 percent). Masses of alteration minerals such as blue-green amphibole, chlorite, and biotite constitute another 15-20 percent.

Plagioclase is highly altered to chlorite, sericite, and carbonate, and in hand specimen is pink. Twinning is still evident and many grains are zoned. The least altered laths are andesine ($An_{43}$), while the most altered grains are more sodic.

Pyroxene is monoclinic and reddish, and is closely associated with the black opaques. The red colour is most intense in the centres of grains, the rims tending to be pale green.

Alteration of both pyroxene and opaques to brown biotite is common. Green biotite is common in the alteration masses. When lying between the latter and the pyroxene, half the crystal may be brown and the other half green. Anhedral crystals of blue-green amphibole (uralite?) form partial rims around the pyroxene. Fine fibrous masses of blue-green amphibole also occur together with green chlorite interstitial to the plagioclase laths as well as an alteration of the pyroxene. Other alteration minerals include carbonate and epidote.

Apatite is the most abundant accessory mineral. Sphene is associated with the black opaques and zircon is present in small amounts.

The dyke is cut by numerous diabase dykes which occur also in the gneisses on either side of it. They are vertical or steeply dipping and strike approximately parallel to the gabbro dyke. They are concentrated also on the shores of Passage Fournier. Several inclusions of quartz were observed in the gabbro and are presumably quartzites plucked from the walls of the intruded rocks.

The two dykes to the west are more resistant to weathering than the adjoining gneisses and are similar to the smaller gabbro dyke observed in the St. Augustin area just west of St. Augustin river. That in Eagle Harbour is approximately 200 feet wide. In places the large dyke gives way to a swarm of finer-grained dykes. The width of the swarm however is approximately the same as that of the large dyke.

The rock is medium-grained with a diabasic texture. Composition is gabbroic throughout and red felspar is generally lacking.

The dyke west of Eagle Harbour on crossing Petit Rigolet is offset about 1/8 mile to the left. This may be due to post-dyke faulting or to the dyke having intruded along a fracture zone that had already been faulted. It is also possible that the Kecarpoui Bay dyke is the southern extremity of the Eagle Harbour dyke offset to the right. It certainly does not extend much further north of that shown. Both dykes, like that in Tucker Cove, are cut by diabase dykes.

## Diabase and Related Dykes

Fine-grained dykes of variable composition, and seldom more than 15 feet wide, are widely distributed, but are abundant around Ha Ha Bay, and in the neighbourhood of the gabbro dykes. They cut the latter and are the youngest intrusives in the area. The dominant trend is north-south and dips are steep.

Most are grey to greenish-black or black diabases. They may be porphyritic with phenocrysts of hornblende or of white felspar which near the contacts are oriented parallel to and in the centre of the dyke roughly perpendicular to the contacts. Other dykes are amygdaloidal, the white amygdules presumably being zeolites.

The estimated mineralogical composition of a typical thin section is plagioclase (40 percent), amphibole (50-55 percent), with 5-10 percent biotite and black opaques. Amphibole occurs in the fine-grained sub-dolerite groundmass. It is pleochroic from pale brown to slightly bluish-green. Black opaques are distributed throughout the rock while biotite has resulted from the deuteric alteration of the amphibole.

Occurring only in the west around Ha Ha Bay and south of the area towards La Tabatiere are red and brown trachytic dykes. They are readily weathered and form spectacular gashes in the bedrock. For the same reason the rock is often poorly or not exposed. A brief examination of several thin sections shows that they are all essentially felspathic rocks. Some have diabasic texture but most show excellent flow structure. Porphyritic varieties contain felspar phenocrysts up to an inch long. The red colour is due to the alteration of the felspars which are invariably cloudy. This alteration is incomplete in some phenocrysts which in the hand specimen have grey cores. The composition of the felspars was not determined but twinning when present is simple. Indices of refraction are less than balsam. Mafics if present are biotite, amphibole, and opaques occurring interstitial to the felspar laths of the groundmass. The amphibole is pleochroic from brown to blue-green. Carbonate is a common constituent in the groundmass. Euhedral apatite is evidently an early accessory mineral as it occurs as inclusions in the felspar phenocrysts. Clear interstitial grains may be quartz or possibly a felspathoid. One section contained fine disseminated purple fluorite, while another contained an isotropic glassy material.

Less abundant are grey-green porphyritic dykes. Felspar phenocrysts (untwinned or simple twins) are red with grey cores when alteration is incomplete. Black opaques occur in the groundmass and as inclusions in the phenocrysts. The groundmass is highly altered, and apart from opaques, only carbonate was identified. However, the groundmass still shows in both hand specimen and thin section a strong flow structure.

West of Ha Ha Bay are several narrow pale green to yellow coloured dykes.

While the dykes are structurally undisturbed they have been intensely altered to carbonate (over 50 percent). However, the original texture is perfectly preserved and shows that the rocks were porphyritic with euhedral crystals (felspars, felspathoids?) lying in a fine-grained groundmass composed in part of fine lath-shaped crystals (felspar?). The latter show a fluidal texture. Opaque minerals occur with the carbonate as well as an anisotropic colourless mineral too fine to identify but which is possibly felspar. The one dyke has apparently been finely brecciated and cemented by carbonate.

Other distinctive dykes including lamprophyres occur south of the area in and adjacent to the Mutton Bay syenite. All the above dykes are apparently related to this intrusive and increase in abundance on approaching it. The red dykes cut it while the lamprophyres both cut it and are cut by it, having been intruded before final consolidation. Many of the diabases are older than the syenite which contains diabase inclusions. However, a few dark coloured dykes (probably diabase) also cut it.

All the above dykes have intruded along joint planes, are relatively fresh, and show no signs of tectonic disturbance. Apart from a few red dykes, they break with a concoidal fracture. They are well-jointed, there being two prominent sets, one parallel to the walls of the dyke, the other perpendicular to the walls. Joints are generally closely spaced and have resulted in the dykes being less resistant to erosion than the country rock.

The dominant trend in the area is north-south and the dips in all cases are steep.

'Calcite' quartz and quartz-epidote veins

Hydrothermal activity followed the intrusive phase and resulted in deposition of calcite and quartz, occasionally with epidote, as veins in open fractures. However, such veins are rare.

## PLEISTOCENE AND RECENT

Deposits of glacial origin are represented by unsorted gravel and sand in shallow depressions, and by erratic boulders on tops of hills. Sand and gravel, exposed in valleys and on marine beaches, is of glacial origin but has been reworked.

Grey clay is found in sheltered coves and bays along the coast. It is seldom exposed much above the high water level and is believed to have been deposited during marine submergence. At several localities around Kecarpoui Bay and the east side of Ha Ha Bay it contains a variety of marine shells. Similar fossiliferous clay is exposed on the shore of a fresh water lake near the Hudson Bay store at La Tabatiere to the south of the area. Many of the shells, while still living today along the Labrador and Arctic coasts and in the Gulf of St. Lawrence, and in deeper waters to the south, were not found alive in the present area. They probably do occur in deeper water. However, it is unlikely that they were washed ashore as they were found only associated with the clay and not along sandy beaches. Of particular interest is the scallop 'Chlamys islandicus'. Those found embedded in the clay have extremely thick shells compared with any dragged in the area at the present time. Several local scallop fishermen were questioned and could not recall ever dragging live specimens of the thick variety. A tentative list of shells found in the clay includes :

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Mollusca

Gastropoda : Buccinum kroyeri. Buccinum undatum. Trichotropis borealis.

Pelecypoda : Mya truncata. Hiatella artica. Mytilus edulis. Astarte 'banksii' or 'striata'. 'Tellina groenlandica' or 'macoma calcarea'. Chlamys islandicus. Astarte 'undata'. Clinocardium ciliatum or cardum islandicum. Mya arenaria. Astarte castanea. Leda minuta (inflated). Venericardia borealis. Cyrtodaria siliqua.

Arthropoda

Balanus crenatus.

Brachiopoda

Hemithyris psittacea.

Annelida

Spirorbis 'borealis'.

Coral

Celleporaria sureularis. Lepratia 'pertusa'.

Note : Most common are those underlined.

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Identification of the above was made by reference to Bousfield (1960) and the Dawson collection at the McGill Redpath Museum.

Overlying the clay in most cases is unsorted gravel and boulders. This material has been washed down the sloping shorelines by wave action during marine emergence. While the larger material settled on the clay, the sands were washed out into deeper water.

The coarse material resting on the clay has given rise in many cases to peculiar stone walls or barricades. They occur in sheltered bays, coves, and runs among the islands where wave action is at a minimum. When well-developed the walls are ± 4 feet high and ± 5 feet wide. They are composed of well-packed boulders and cobbles with a sharp drop on the seaward side. The landward side slopes gently into clay-bottomed ponds. These ponds are remarkably free of all coarse material. The walls mark the low water level at which time they are completely exposed and the ponds they enclose are drained through gaps in the wall. At high water the ponds fill and the walls are submerged to a little more than a foot. The walls have many forms dependent presumably on the depth of water, currents, and the amount of coarse material available. In narrow channels where tidal currents are strong they tend to form parallel and close to the shore. In larger shallow bays they are further from the shore and more sinuous. These are on the whole concave shorewards. Those at the mouths of rivers are often crescents starting at the shore and concave upstream. In all cases there is some connection with the shore. They have apparently formed by the combined action of ice and tide on a sloping clay surface. Boulders along shallow shorelines would tend to be pushed across the seaward-sloping clay bottom into deeper water where the layer of ice could no longer reach them. This would presumably occur during falling water when the shore ice would slump seaward. During rising water the ice would move shoreward but would not as effectively push the boulders up the slope. The boulder would tend to concentrate at a point where the pushing action of the ice lost its effectiveness. The crescent-shaped walls at the mouths of rivers have formed the same way. However, in this case the tide would push the ice up and down stream rather than against the shore.

Whereas most walls are straight or smoothly carved, two sections may join at an angle. The joint is often marked by a large boulder apparently offering more resistance to the shore ice.

The possibility should not be overlooked that some of these stone walls might have been made or modified by man. According to Hawkes (1916, p.88) the northern Labrador natives understood the making of dams across streams emptying into the sea in which salmon are shut off at low tide. Many small streams along the coast do have small rock walls across their mouths. Further, at the mouth of the Coxipi river to the east are numerous stone walls including the crescent-shpaed ones already described. This river is also one of the better salmon and trout rivers and fish are caught in nets set just off these walls. It is interesting to note that the Bushman-Hottentot peoples of Southern Africa constructed tidal fishtraps consisting of stone weirs similar to those above (Clark, 1959, p.230). Once caught the fish were driven into reed baskets. The gaps in many of the otherwise perfect stone walls could have been used to accommodate such baskets.

Evidence of glacial erosion is abundant. Beautifully striated glacial pavements, friction cracks, fluting, grooves, and potholes are found along the coast where they have only recently been exposed by marine emergence. Hills have been rounded off and plucking is evident on their south and south-east slopes. This is well-demonstrated in Petit and Grand Rigolet and Three Mile Lake where the northern shores are rugged and broken and the south shores smooth.

Movement of the ice is generally to the southeast. Occasionally deep striae parallel to the regional trend have superimposed upon them a second set of finer striae controlled by local topography. Evidently the deeper striae are those of the continental ice sheet that covered the area and the finer striae those caused by valley glaciers present during retreat of the ice cap.

Most of the coarse unconsolidated material can be matched by local rock types. However, pebbles and boulders of sillstone and fossiliferous limestone are common. Crinoid plates are the only identifiable fossils but ill-defined casts are also present. It is quite possible that this material has been carried down the coast from the Strait of Belle Isle by ice at the present time. Icebergs are commonly blown in among the islands during the spring. The other possibility is that antliers of paleozoic rocks do or did occur to the north. In the western half of the area boulders of coarse-grained anorthosite are encountered which are probably derived from the body to the northeast described by Hale (1962).

## STRUCTURAL GEOLOGY

### Foliation and Bedding

The gneisses of the St. Augustin - Ha Ha Bay area are banded with the alternation of layers of varying composition and texture. Individual layers may occur as mapable units but often they are closely spaced and in the extreme case may be only an inch or two thick. The latter may be described as lit-par-lit gneisses when there is a separation of pegmatitic and gneissic layers.

A prominent $S_1$ foliation is displayed by those gneisses rich in dark minerals, due to the preferred orientation of the latter and their concentration in thin folia. Rough segregation of the quartz and felspar is generally present and in certain granitic gneisses lacking dark minerals it alone constitutes the foliation. Other elements of the $S_1$ foliation are felspar porphyroblasts and augen-like aggregates.

$S_1$ is generally concordant with the large scale layering but discordance is not uncommon on a small scale. Porphyritic granite and granodiorite locally cut the gneisses. Dark bands may cut across the $S_1$ foliation of the porphyritic granite and granodiorite. In most cases these are clearly basic dykes but some might conceivably represent bedding though this is considered most unlikely. Occasionally such dykes, highly altered, while cutting the $S_1$ are also foliated parallel to $S_1$.

Banding in the gneiss is believed a reflection of the original bedding. Where quartzites and relatively undeformed calc-silicate rocks were observed these layers are parallel to the foliation in the adjacent gneisses. The porphyritic granite and granodiorite are sills emplaced in the gneisses before or during regional deformation. Whether they represent injected magmas or are the result of anatexis they were obviously more mobile than the gneisses and behaved as incompetent members of a layered sequence.

Lineations

Linear structures are displayed by most of the gneissic rocks, particularly those rich in mafics. They include the corrugation of the foliation plane, axes of minor folds and occasional drag folds, and pinch and swell structures. The mafic-rich gneisses also show the alignment of dark minerals (hornblende, biotite, and pyroxene) on the foliation planes. Hornblende gives a strong lineation to many of the meta-gabbros. In quartz-felspathic rocks a lineation of ellipsoids of quartz and felspar and of felspar phenocrysts (porphyroblasts) is commonly present. Other minerals showing lineations are sillimanite, clusters of garnets and wollastonite and diopside in the calc-silicate rocks. Except for axes of folds accompanying the pinch and swell structure most of the above lineations are b-lineations (parallel to fold axes). Axes of folds accompanying the pinch and swell structure are at right angles to the b-lineation. Occasional lineations of micas in thin meta-gabbros are also perpendicular to the b-lineation particularly near contacts and are presumably due to slippage or perhaps due to flow.

Horizontal equal area projections were made of all lineations and plotted either as mineral lineations or axes of minor folds including those accompanying pinch and swell structure. Poles to S planes were plotted on the same projections. See projections 1-16 in appendix. The area was divided into 16 domains, the boundaries of which include the hinge lines of major folds, major faults or lineaments, and the boundary between the east and west zones. See sketch map in appendix. Projections show that each of these domains is structurally homogeneous with the b-lineations forming a maximum perpendicular to the partial girdle of poles of the S planes. In the latter girdle also fall the axes of folds accompanying pinch and swell structures and rare mineral lineations (on slip planes?). Study of the 16 projections shows that the area can be regrouped into 3 major structurally homogeneous domains. One comprises the whole western zone (projections 1-7) and the data indicates folding about a N-S axis plunging to the N and lss commonly to the S at a low angle (0-40$^{o}$). S planes dip both E and W though most commonly to the E. Projections 8-13 and 15 form another domain in which folding is about an axis plunging to the SE or NW at angles of 0-50$^{o}$. Foliation dips both NE and SW though generally to the E. The third domain includes two areas to the north (projections 14 and 16). It should be noted that most of the lineations of projection 14 were taken on minerals found in the limestone and calc-silicate rocks. These rocks were strongly deformed which probably accounts for their spread. Folding is about an axis plunging NE at 15-50$^{o}$. Foliation also dips to the NE at 10-55$^{o}$.

Folding

Folding in the area is on both a large and small scale. The major folds in most cases are clearly visible on air photographs and this is borne out by field mapping. As these folds are obvious on the geological map there is no need to describe each of them in detail here. It should be mentioned, however, that many of the folds are symmetrical while others are overturned to the east or west, the latter being the more common. The western zone tends to be more intricately folded than the eastern zone and is ascribed to a greater 'plasticity' which is borne out by the generally better development of foliation in this zone.

Minor folds as mentioned earlier are of two types. However, both are very similar in appearance. All are open folds with a wavelength to amplitude ratio of 10:1. Those folds whose axes are perpendicular to the axes of major folds in almost all cases were the result of folding of the foliation planes in the gneissic country rock which accompanies pinch and swell structure in certain competent layers e.g. pegmatites (granite) and amphibolite. Where the latter rocks are not exposed the true nature of these folds may not be clear. The axes of the other set of minor folds parallels the mineral lineations and also the axes of the major folds. Very rarely were drag folds observed in the area.

Faults and shear zones

A prominent feature of the area are three sets of linear valleys or drowned valleys, representing faults or fracture zones.

The most prominent set strikes parallel to the coast and includes Pagachou river and lake, Petit Rigolet, and Grand Rigolet. Evidence of faulting is shown by the displacement of folds and characteristic marker horizons, and also by abundant shearing of the rocks along the linears.

The second set strikes a little east of north. The most prominent of these is occupied by Kecarpoui lake, and mapping indicates the displacement of geological units. At its southern extremity on the shore of Ha Ha Bay a small breccia zone offers further evidence of faulting. Belonging to the same set is the linear occupied by the gabbro dyke which passes through Tucker Cove and Passage Fournier.

The third set and least prominent strikes east-west. Shearing and evidence of displacement was found in one of these linears extending eastward from the south of Kecarpoui lake just to the north of Clay Cove.

Numerous minor faults and shear zones were observed along the well-exposed shorelines. Many show dragging of the country rock into the fault plane indicating that the rocks were still in a plastic condition at the time of faulting. They were observed cutting all the intrusive rocks except the gabbro, diabase, and related dykes. The gabbro dyke, offset on crossing Petit Rigolet, may be faulted but as already mentioned could just as easily have been intruded along a fracture zone previously faulted.

The fracturing or shearing associated with the major faults is characterised by red alteration of the felspars, giving all the rocks a granitic appearance. Dragging of the country rock is rare. Fracturing is rather in the form of numerous closely spaced joints. Such fracture zones vary in width from 1 or 2 feet to more than 50 feet. Similar fracture zones occur elsewhere in the area but are seldom more than 10 feet wide.

Faulting took place during closing stages and after regional metamorphism and was apparently complete by the time the gabbro, diabase, and related dykes were intruded. The latter dykes intruded along joint planes opened during intrusion of the 'Mutton Bay' syenite.

Jointing

Joints are well-developed throughout the area. The majority strike parallel to one or the other of the prominent linears and are generally steeply dipping. More variable are joints parallel or sub-parallel to the foliation.

The younger intrusives have their own joint sets, usually with a definite relationship to the contacts with the country rock.

## ECONOMIC GEOLOGY

### Sulphides

The economic geology of the area and surroundings is well described by Hale (1962). As mentioned by Hale, the most likely sources of economic mineralization are the gabbro and anorthosite masses occurring on the Mecatina river to the west and at Old Fort lake and Lobster Bay to the east. Sulphides are known to occur at the contact of the latter body with the gneisses and are described by Longley (1944). The writer (1962b) suggested that the anorthosite dyke crossing the St. Augustin area was probably of equivalent age. However, work in the present area has thrown more light on the subject. Longley's description of the Lobster Bay occurence very closely fits the description of the meta-gabbro west of Baie Querry. Further, the assay results presented by Longley indicate a similar mineralization and values of the same order of magnitude as those presented below. In the present area sulphide concentrations were observed only in the meta-gabbros at the localities listed. It is interesting that the best sulphide showing in the St. Augustin area was also in a meta-gabbro body.

North side of Baie Querry: Small hornblende veins ½-2 inches wide with occasionally lense-like cores of quartz, occur in a meta-gabbro over a strike length of 20 feet and thickness of 3 feet. Pyrite and chalcopyrite are associated with the hornblende. Three grab samples assayed:

(1) .01 percent copper, .02 percent zinc, .010 percent silver.

(2) .15 percent copper, .01 percent nickel, .01 percent lead, .02 percent zinc, .002 oz/ton gold, .016 oz/ton silver.

(3) .02 percent copper, .01 percent nickel, .002 oz/ton gold, .013 oz/ton silver.

West side of Baie Querry: Near the eastern contact of a meta-gabbro is a heavily stained zone 1-3 feet wide, extremely rich in pyrite.

Four grab samples assayed as follows:

(1) .01 percent copper, .01 percent nickel, .052 oz/ton silver.

(2) .02 percent copper, .01 percent nickel, .01 percent lead, .040 oz/ton silver.

(3) .02 percent copper, .01 percent nickel, .01 percent lead, .05 percent zinc, .030 oz/ton silver, traces of gold.

(4) .02 percent copper, .01 percent nickel, .002 oz/ton gold, .071 oz/ton silver.

Clay Cove: Cutting the meta-gabbro at the bottom of the cove is a zoned quartz vein. It is exposed on the shore for a length of 65 feet and varies in width from 2-4 feet, the widest portion being to the south. The quartz is rich in pyrite, and at the southern end, exposed for about 25 feet, is a core of coarse-grained massive pyrrhotite up to 2 feet wide. The latter contains a little pyrite and narrow veinlets of chalcopyrite. Two channel samples across the massive sulphide core were assayed and gave the following results:

(1) .25 percent copper, .10 percent nickel, .015 oz/ton silver.

(2) 6.30 percent copper, .08 percent nickel.

A grab sample assayed .56 percent copper, .01 percent nickel, .04 oz/ton silver. A sample of pyrite-rich meta-gabbro at the contact assayed .10 percent copper, .15 percent zinc, and .015 oz/ton silver.

Black Sands

Weathering of the meta-gabbro (olivene gabbro) in Deer lake has given rise to concentrations of black sands at points along the lake shoreline. Similar concentrations were observed in Lake La Sarre in the St. Augustin area near a similar olivene gabbro. Trappers report other occurrences in the interior and while they may not be of commercial value themselves, they serve as a means of pin-pointing gabbro bodies that may be prospected for base metals.

Pegmatites

Magnetite and mica occur in minor quantities in many small pegmatites. On Wakeham Island a 15-25 feet wide pegmatite contained a little fluorite and pyrite.

Sand and Gravel

No important deposits of sand or gravel occur in the area. However, small quantities may be obtained from beaches along the coast.

Limestones

Limestones are almost totally lacking in the area.

Molybdenite

Though not located within the area mapped, but within the proposed map area for 1964, is an occurrence of molybdenite. It occurs on the side of the road between the wharf and the Hudson Bay store at La Tabatiere. The molybdenite occurs as scattered irregular masses of flakes in a pink to green syenite which is intrusive into the gneisses and probably related in age to the gabbro and diabase dykes.

Two other occurrences of what the local people call 'lead' were also reported in or close to the contact of the same syenite body. Longley (1944b) mentions molybdenite as being the commonest metallic mineral along the coast.

Recommendations

The most favourable host rock for base metals and precious metals is the meta-gabbros. Unfortunately they are the most susceptible to weathering. This does have certain advantages, however, in that they may be identified on aerial photographs from the dense vegetational covering. These bodies would also be readily detected in a magnetometer survey. As the area is relatively free of glacial overburden a geochemical survey along the bands of meta-gabbro may prove a useful tool.

The other economically favourable host rock is apparently the Mutton Bay syenite with its showing of molybdenite. It is interesting that an almost identical syenite body on the Labrador coast is, according to Krank (personal communication) also associated with molybdenite mineralization.

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APPENDIX



TABLE I

Estimated Range in Mineral Composition - Gneisses

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| | Vol.% | Vol.% | Vol.% | Vol.% |
| Plagioclase | 5 - 30 | 10 - 55 | 30 - 80 | 25 - 50 |
| | $An_{15-32}$ | $An_{16-33}$ | $An_{22-42}$ | $An_{22-35}$ |
| | $An_{23.83}$(Av.) | $An_{25.68}$(Av.) | $An_{31.77}$(Av.) | $An_{29.5}$(Av.) |
| | + albite | + albite | | + albite |
| Potash Felspar (perthite) | 30 - 60 | 20 - 50 | 5 - 30 | Tr - 50 |
| Quartz | 20 - 50 | 10 - 50 | 5 - 30 | 15 - 35 |
| Pyroxene | - | - | Tr - 10 | - |
| Hornblende | 0 - 1 | 0 - 5 | 0 - 1 | - |
| Biotite | Tr - 10 | 0 - 5 | Tr - 10 | Tr - 15 |
| Garnet | 0 - 2 | - | - | 1 - 5 |
| Opaques | Tr - 3 | Tr - 3 | Tr - 3 | Tr |
| Sillimanite | - | - | - | 0 - 5 |
| Zircon | Tr | Tr | Tr | Tr |
| Apatite | Tr | Tr | Tr | Tr |
| Chlorite/ serpentine etc. | 0 - 2 | 0 - 2 | 0 - 5 | Tr |
| Carbonate | 0 - Tr | 0 - Tr | 0 - Tr | - |
| Sphene | 0 - 1 | 0 - Tr | 0 - Tr | - |
| Epidote | - | - | 0 - Tr | - |
| Sericite | Tr | Tr | Tr | Tr |
| Leucoxene | Tr | - | 0 - Tr | - |

1. Fine-grained pink granite gneiss (10 thin sections)
2. Medium-grained well-foliated granite (11 thin sections)
3 Green pyroxene-plagioclase gneiss (11 thin sections)
4. Grey garnet-(sillimanite)-biotite gneiss (5 thin sections)

Each of the above show the ranges in percent of minerals present in several thin sections. Percentages are visual estimates only.

TABLE II

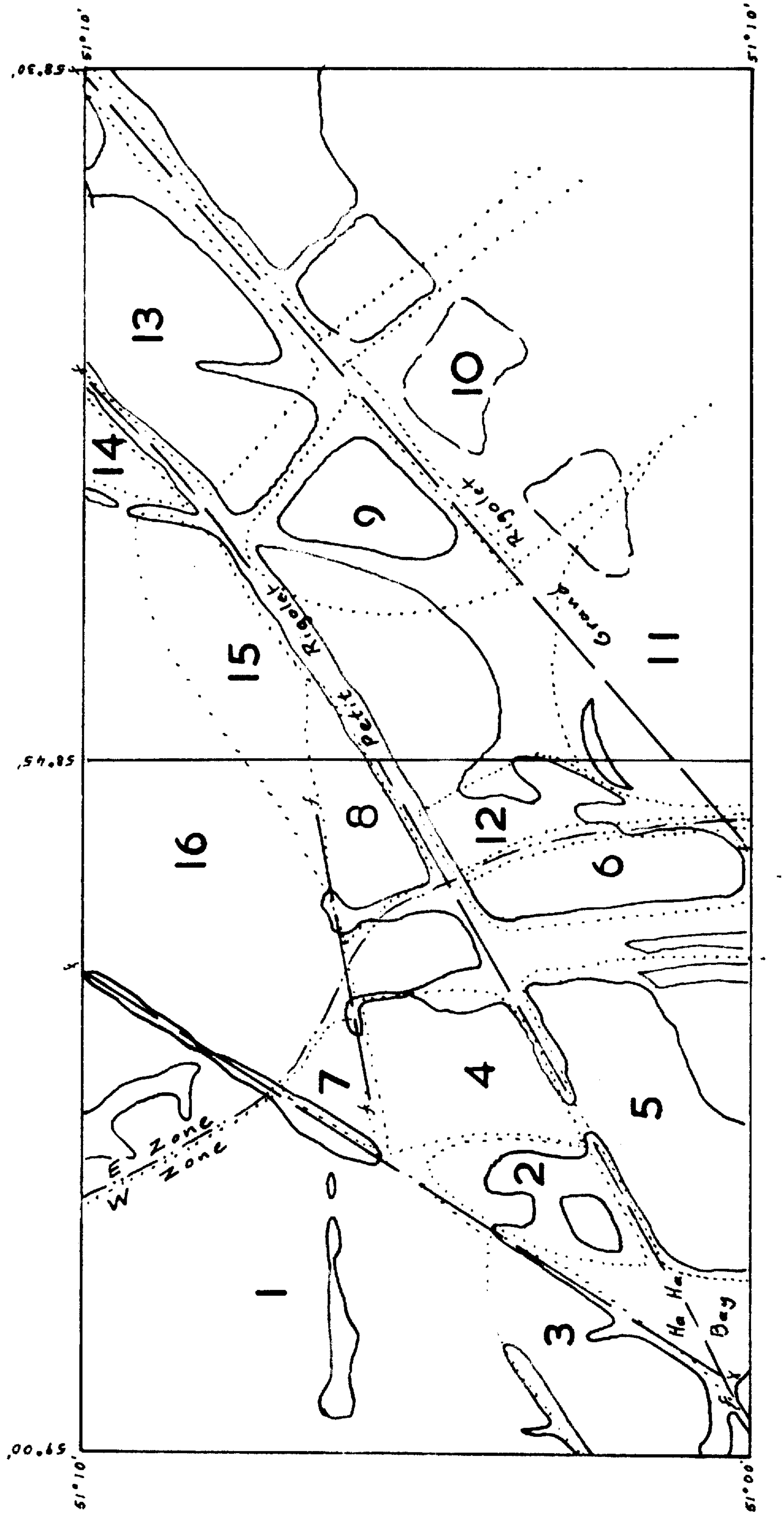
Estimated Range in Mineral Composition - Gneisses

| | 5 | 6 | 7 | 8 |
|---|---|---|---|---|
| | Vol.% | Vol.% | Vol.% | Vol.% |
| Plagioclase + alteration products | 50 - 60 | 35 - 55 | 5 - 25 | 25 - 65 |
| | $An_{28-38}$ | $An_{27-29}$ | $An_{25-32}$ | $An_{25-34}$ |
| | $An_{33.17}$ | $An_{28}$ | $An_{29}$ + albite | $An_{30.57}$ |
| Potash Felspar | Tr - 5 | 10 - 30 | 40 - 60 | 10 - 40 |
| Quartz | 25 - 40 | 5 - 25 | 20 - 50 | 10 - 25 |
| Pyroxene | 0 - 5 | - | - | - |
| Hornblende | 0 - 1 | 5 - 25 | 0 - 3 | 2 - 20 |
| Biotite | 2 - 3 | 1 - 5 | Tr - 5 | Tr - 10 |
| Opaques | 1 - 3 | 3 - 5 | Tr - 3 | 1 - 7 |
| Zircon | Tr | Tr | Tr | 0 - Tr |
| Apatite | Tr | Tr - 3 | Tr | Tr - 1 |
| Chlorite | 0 - Tr | - | Tr - 1 | 0 - Tr |
| Carbonate | 0 - Tr | - | - | 0 - Tr |
| Sphene | 0 - Tr | 0 - Tr | Tr | 0 - Tr |
| Sericite | Tr | Tr | Tr | Tr |

5. Light-grey plagioclase gneiss (3 thin sections)
6. Dark-grey biotite-hornblende gneiss (3 thin sections)
7. Coarse-grained porphyritic granite (gneiss) (5 thin sections)
8. Coarse-grained porphyritic granodiorite (gneiss) (7 thin sections)

Each of the above show the ranges in percent of minerals present in several thin sections. Percentages are visual estimates only.

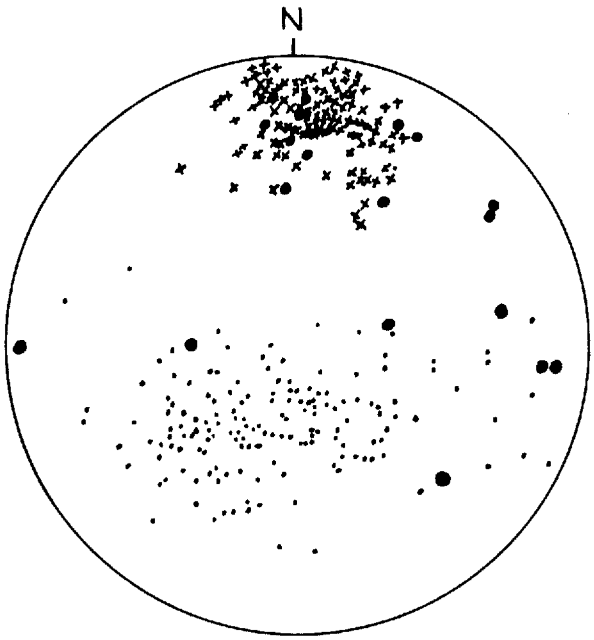
Index map to the areas covered by the horizontal equal area lower hemisphere projections of S planes, minor fold axes and lineation due to preferred orientation of minerals in the gneisses.


Grand Rigolet
Petit Rigolet
Ha Ha Bay
E Zone
W Zone
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Horizontal equal area lower hemisphere projections of approximately 700 lineations and fold axes and approximately 700 S planes in the areas shown on the index map.

LEGEND

- ● Projection of minor fold axes
- ✕ Lineation due to preferred orientation of minerals in gneiss
- • Projection of poles to S planes (foliation and coincident lithological layering) in gneisses

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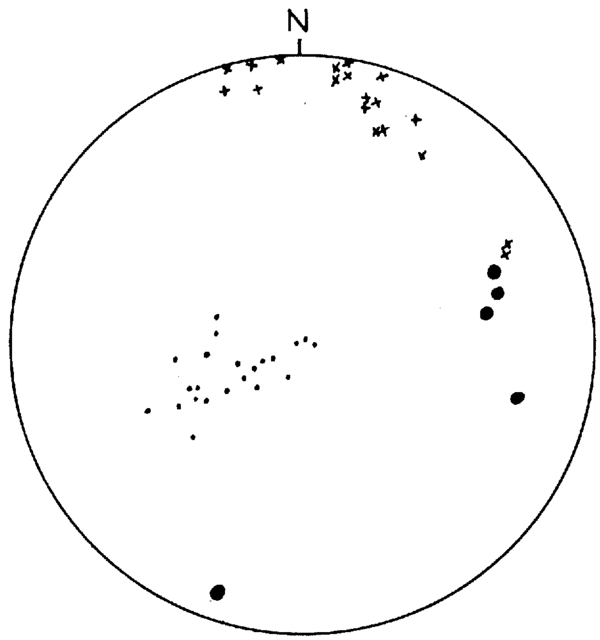


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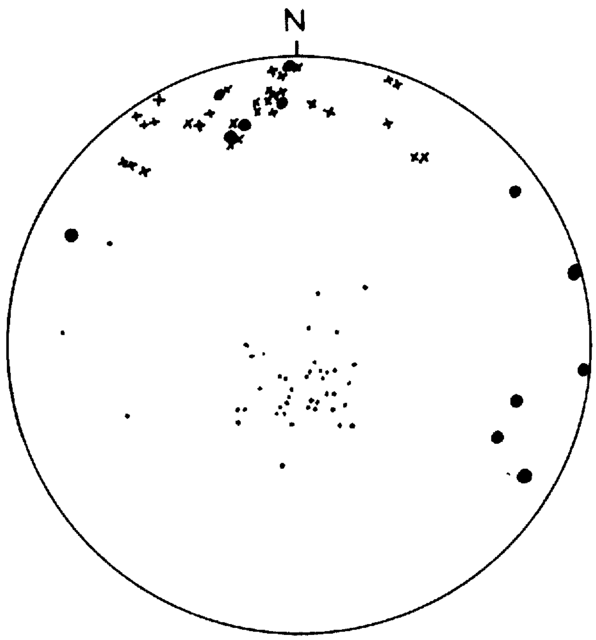


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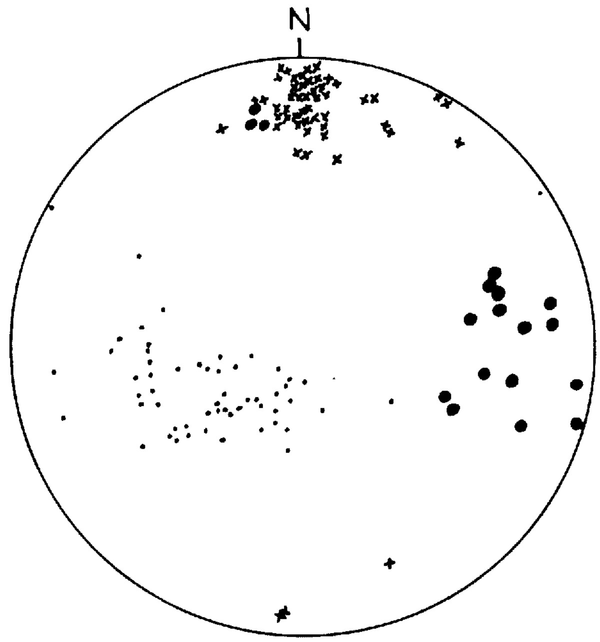


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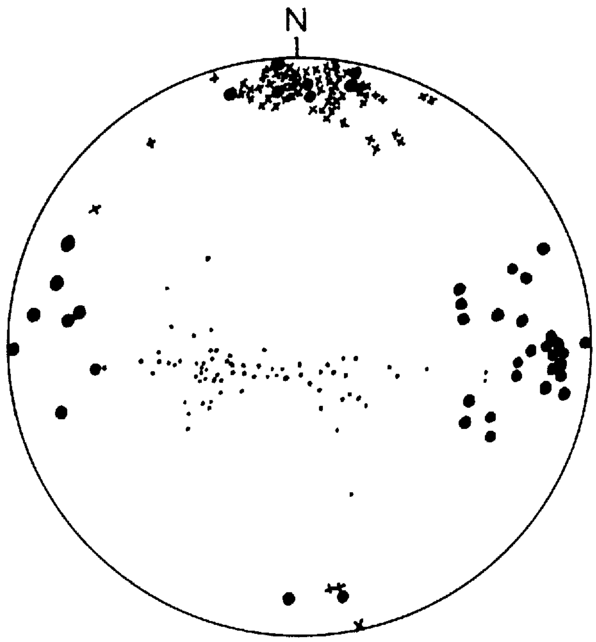


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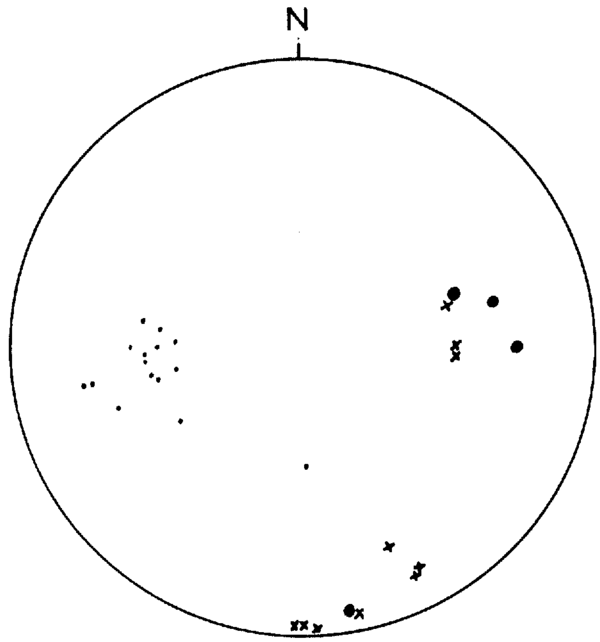


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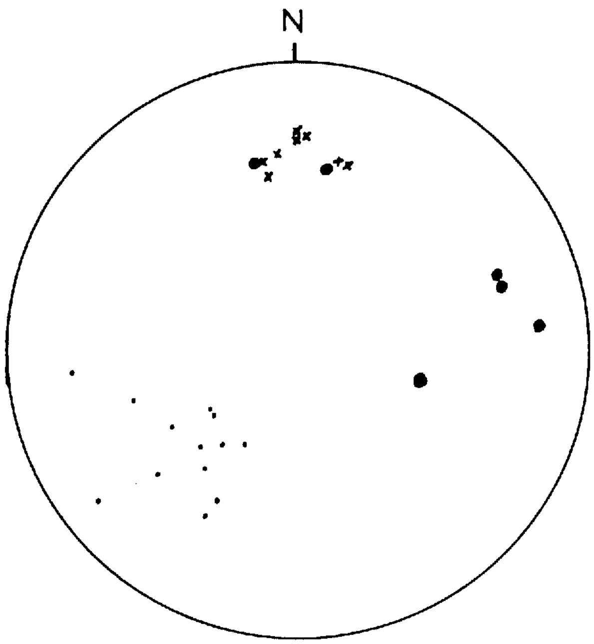


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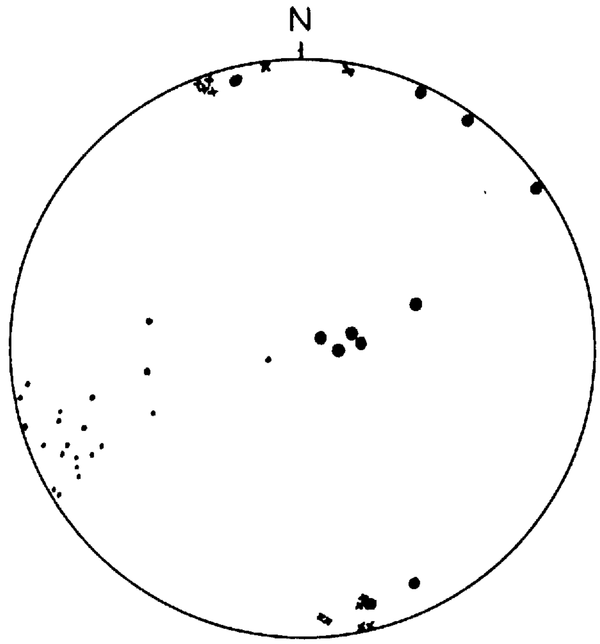


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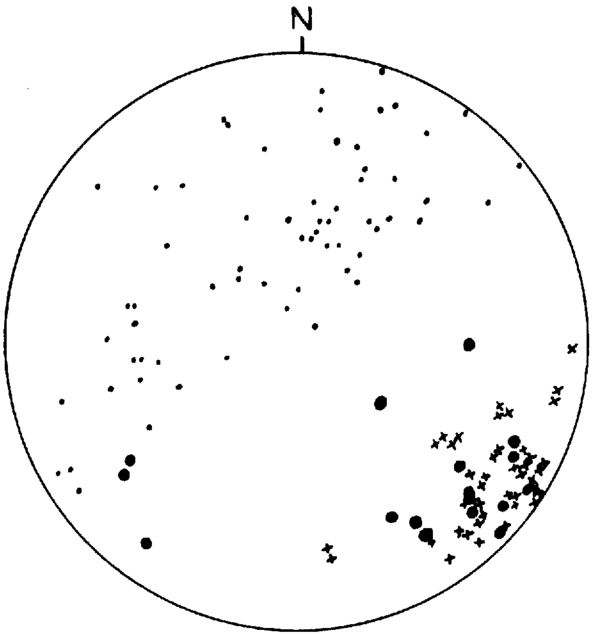


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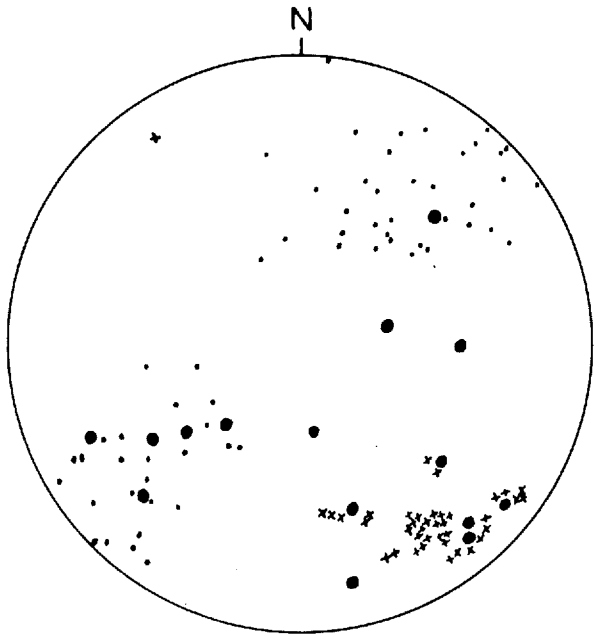


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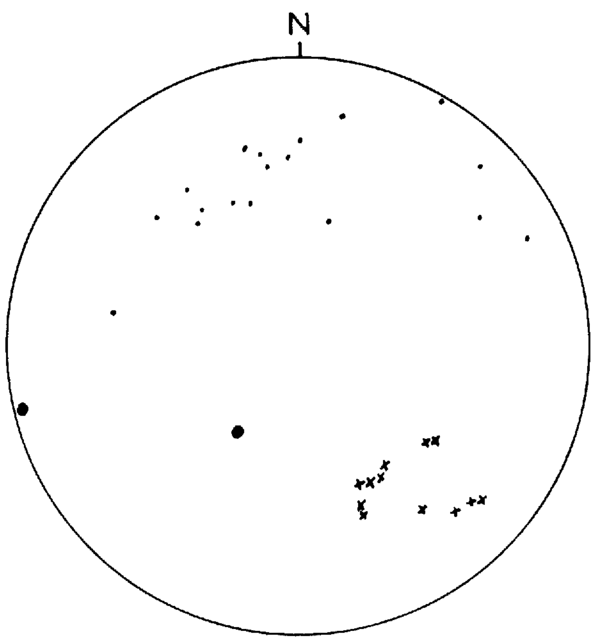


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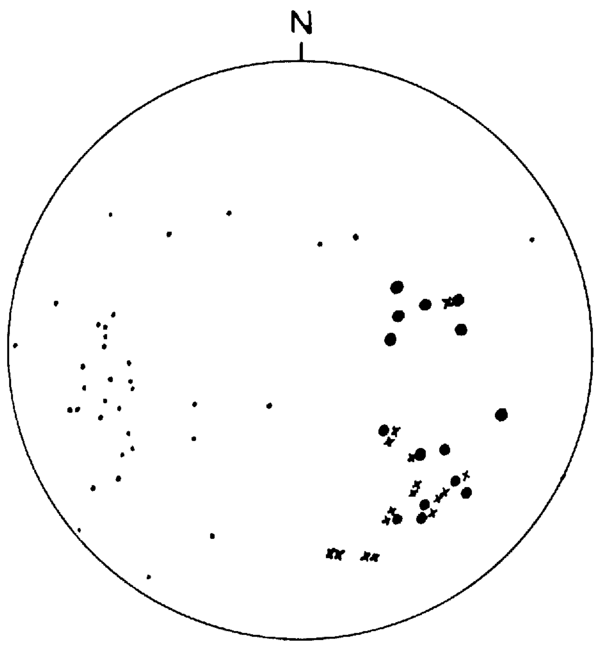


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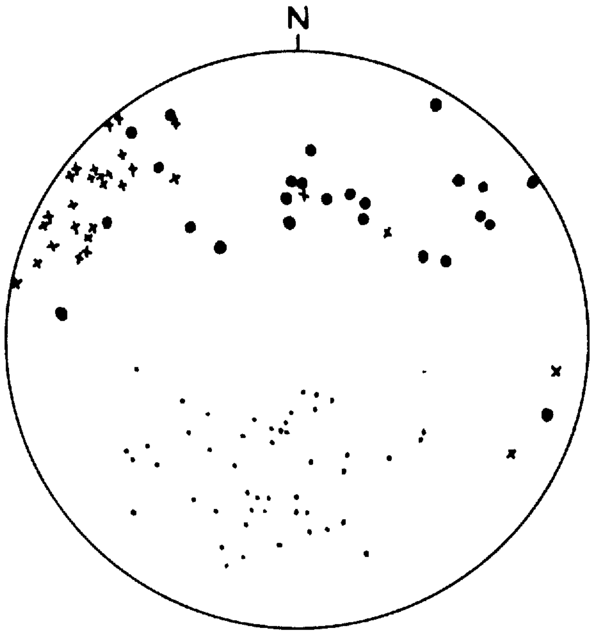


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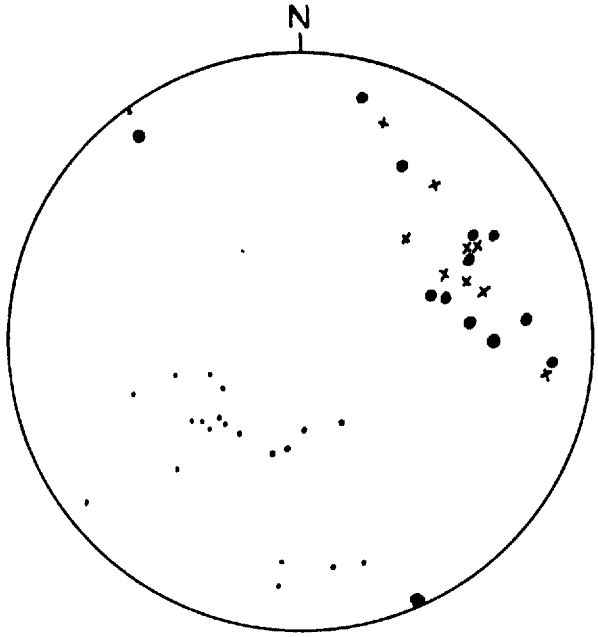


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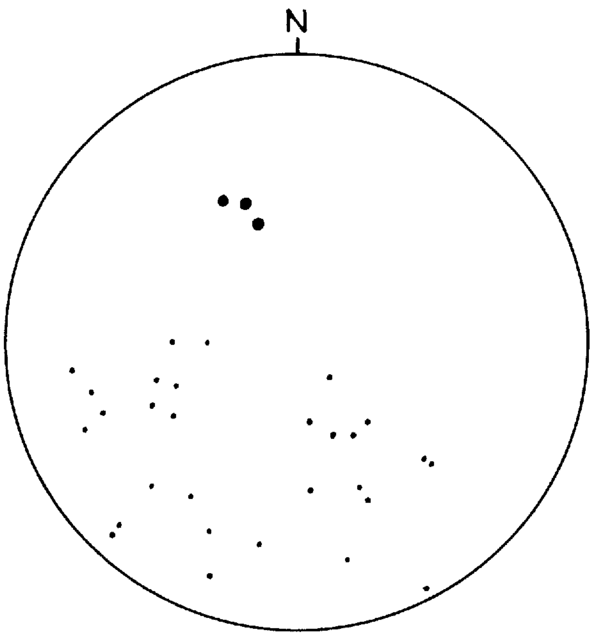


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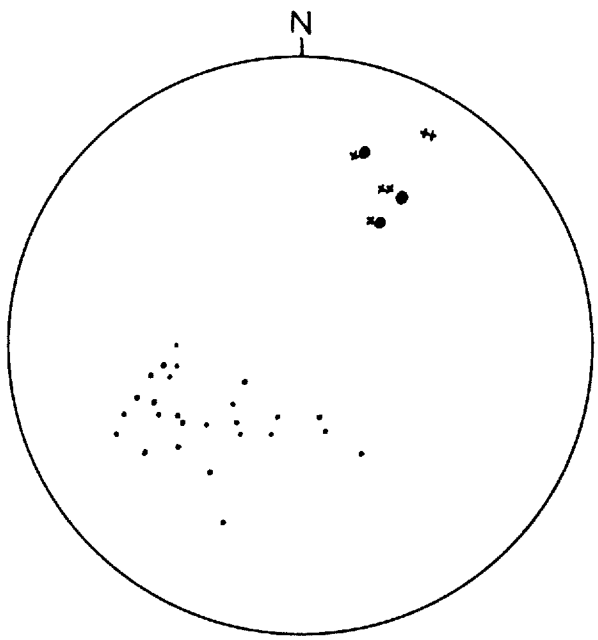


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