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WASWANIPI LAKE AREA (WEST HALF), ABITIBI-EAST COUNTY

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GEOLOGICAL REPORT 58

WASWANIPI LAKE AREA

(WEST HALF)

ABITIBI-EAST COUNTY

by

Jacques Claveau

QUEBEC

RÉDEMPTI PARADIS

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WASWANIPI LAKE AREA

(West Half)

ABITIBI-EAST COUNTY

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INTRODUCTION

Location and Access

The area described lies some 85 miles north-northeast of the town of Senneterre, a junction point on the Quebec-Cochrane branch of the Canadian National railway. It was mapped during the summer of 1948 and is adjacent to the eastern border of the Iserhoff River area mapped by the writer in 1946 (10)*. Bounded on the west and east by longitudes 76°45' and 76°30'W., and on the north and south by latitude 49°45'N. and a line four miles south of, and parallel to, latitude 49°30'N., it includes parts of the townships of Bossé, Bergères, Vignal, Ailly, Meulande, and Montviel.

Waswanipi lake is about a one-hour flight from Senneterre, where hydroplane service is available and affords the simplest means of access to the area.

Two canoe routes lead to the area and each involves several days of travel. Both start on Bell river, either at Senneterre or, preferably, at Cedar Rapids, a point along the Bell some 45 miles north of Senneterre which can be reached by a good gravel road. The more direct route follows Bell river downstream to the mouth of Wedding river, an important tributary of the Bell. It continues up that river to a point at its headwaters near Esther lake, where a portage leads northward to Duplessis stream, the latter flowing east-northeast into the lower part of O'Sullivan river, which, in turn, empties into the mid-southern part of Waswanipi lake, one mile east of the eastern boundary of the map-area. The other route, though less direct, has fewer and shorter portages. It follows Bell river northward (downstream) to Mattagami lake and there turns eastward, crossing the lake to the mouth of Waswanipi river. This river leads, by way of Olga lake, to Goéland lake, the southeastern portion of which is in the northwest corner of the map-area.

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*Numbers within brackets refer to publications listed under 'Bibliography' at the end of the report.

Most parts of the area, with the exception of the west-central sector, lie within easy reach of the southwest bay of Waswanipi lake, the northwest bay of that lake, the southeast corner of Goéland lake, or the segment of Waswanipi river linking these two lakes. Waswanipi river in its course through the area has only one short rapid, followed by about two miles of swift water (Pl.V-B). The rapid can be navigated by canoe by hugging the north shore of the river, or can be avoided by portaging along a well-beaten trail on the south bank. The stretch of swift water below the rapid offers no particular difficulties and can be run by canoe with ease. Even on upstream travel, these fast waters were repeatedly negotiated in a loaded freighter canoe equipped with a 2.5 h.p. outboard motor by threading the lanes of weaker current.

Some of the larger streams of the area are navigable by canoe over appreciable distances. These include the lower course of east-flowing Iserhoff river, its tributary the North Iserhoff, Ailly and McLeod brooks, and Vignal creek. The Iserhoff, which empties into Waswanipi lake at the head of its southwest bay, is navigable along the portion of its lower course included within the map-area. Near the point where it crosses the west boundary, it is joined on the north by the North Iserhoff which is navigable for some four and a half miles upstream. From the upper limit of navigability of the North Iserhoff, a blazed line leads north for three and a half miles to the eastern edge of the Waswanipi hills, which feature the less accessible west-central sector of the area. Ailly and McLeod brooks flow into the northwest bay of Waswanipi lake and are navigable upstream for about three miles and two miles respectively. Vignal creek, which empties into Waswanipi river near Goéland lake, can be ascended for some three and a half miles from its mouth, and, at moderately high water, as far as the fork two and a quarter miles northwest of McLeod lake. This brings the northern part of the Waswanipi hills and of the remote west-central sector of the area within easy reach from canoe routes.

Field Work and Mapping

The whole land area was covered systematically by pace-and-compass traverses run at intervals of a little over half a mile across the trend of the general structure. The shores of those parts of Waswanipi and Goéland lakes lying within the area, and the banks of Waswanipi river, were examined in detail.

The base-map used for plotting the geology was a copy at half a mile to one inch of a part of the original plans which served in the compilation of the Waswanipi sheet (32F) of the National Topographic Series, Department of Mines and Resources, Ottawa. Being based

for the most part on oblique aerial photographs, the plans in their original form were found unsatisfactory for field mapping at half a mile to one inch. With the help of more recent vertical aerial photographs and of survey plans prepared by the Quebec Department of Lands and Forests, the outlines of lake shores and stream courses were redrawn in the field in somewhat greater detail. In addition, the positions of most of the streams relative to that of the shoreline of Waswanipi lake and river had to be altered to fit measurements obtained from the vertical aerial photographs and confirmed by the rough ground measurements derived from the geological traverses.

Acknowledgments

Able assistance was rendered in the field by D.A.W. Blake, of McGill university, Félix Couture, of Ecole Polytechnique, and Roger Blais, of Laval university. The two canoemen, Gontran LeBel and Paul Dallaire, and the cook, Ernest Bordeleau, discharged their respective duties in a very satisfactory manner.

Previous Work

The earliest recorded geological work in the region is that of Robert Bell (1, 2), who surveyed the basin of Nottaway river in 1895 and 1896. J.A. Bancroft (3), in 1912, mapped portions of the basins of Harricana and Nottaway rivers, including Goéland lake. In later years, geological reconnaissance surveys covering the present as well as surrounding areas have included those of Lang (4) in 1931, Norman (7) in 1935, and Sproule (8, 9) in 1936.

Geological work carried out by the Quebec Department of Mines at half a mile to the inch in adjoining areas includes that of MacKenzie (5, 6) in 1934 and 1935 in the area to the south, of Claveau (10) in 1946 in the area to the west, and of Imbault (11), carried on concurrently with the present work, in the region to the northwest.

GENERAL DESCRIPTION OF THE AREA

Timber

The greater part of the area is heavily forested with tall stands of timber, chiefly black spruce with subordinate balsam fir and jack-pine. Birch grow in clusters in the few places in the area where the soil cover is thin and well drained, as in the Waswanipi hills (which are southwest of McLeod lake), on the high ground stretching south and southwest of the southwestern tip of Waswanipi lake, and on the upper slopes of the Waswanipi River valley. Aspen,

although occasionally found on low hills, thrive most notably along the lower reaches of most of the large, sluggish streams.

Alders are widespread in the region. They grow thickly along streams and throughout most of the areas of tall timber.

Animal Life

Fresh tracks of moose and bear were seen occasionally in the area, but the animals themselves were not encountered. Small fur-bearing animals of economic value, such as beaver, otter, mink, muskrat, and fox, are very rare or entirely lacking. The few large animals that enter the area are quickly tracked down and killed for food by the Indians living on the reserve at the north end of Waswanipi lake, and, similarly, few of the smaller fur-bearing animals that establish quarters in the region escape capture in the trapping season. Partridge and rabbit are equally rare for the same reasons.

Fish are plentiful in Waswanipi and Goéland lakes and in Waswanipi river. Most abundant are pike, which grow to a considerable size and are the staple food of the Indians.

Physiography

Topography

The greater part of the region is of subdued relief and may be described as a low plateau with gently undulating surface, except for an extensive, low and flat swampy tract in the east-central part of the area, and a restricted cluster of relatively outstanding hills - the Waswanipi hills - close to the western boundary, west and southwest of McLeod lake.

In the low plateau region, the relief is generally negligible or confined to broad undulations. A few restricted sections, however, display sharply dissected forms, though the local relief is still of a low order (less than 100 feet). This is the case, for example, along the course of Waswanipi river between the rapids and Goéland lake, a stretch along which the river flows through the plateau in a well-defined trench, the sides of which have been dissected in varying degree by the major tributary streams of the river (Plate VIII).

In the southern part of the low plateau region of the area, low but sharply rising hills are found around the southwestern tip of Waswanipi lake and again southward and southwestward along the course of the two parallel, north-flowing streams.

The swampy tract of the east-central part of the area extends in a zone two to six miles wide around the northwest bay of Waswanipi lake and takes in, as well, the area where Vignal creek has its origin between McLeod lake and the Waswanipi hills. It is a featureless plain sloping imperceptibly eastward and characterized by extensive muskegs and numerous swamps. It is obvious that this tract constitutes a former extension of Waswanipi lake during one of its earlier stages. Even at present, the area lying between the lower reaches of McLeod and Ailly creeks is virtually part of the lake, especially at the seasonal periods of high water.

The group of outstanding hills, termed the Waswanipi hills, represent an elevated portion (Pl. I) of the granite batholith that underlies most of the low plateau region. They rise west and southwest of McLeod lake and straddle the boundary between the present area and the adjoining Iserhoff River area to the west, forming a massif of north-south elongation, some eighteen square miles in area. Of this, two-thirds, or approximately twelve square miles, lies within the present area. The massif is carved into a series of disconnected, sharply rising hills which assume various shapes, but do not differ greatly in height. The local relief is of the order of 200 to 250 feet and the group as a whole rises between 300 and 400 feet above the level of Waswanipi lake. Most of the hills are bare at the top or only thinly moss-covered.

Drainage

The streams of the map-area drain to Waswanipi or Goéland lake, or to the west-flowing segment of Waswanipi river which links these lakes. Waswanipi river is the major drainage artery of the whole region centred upon Waswanipi lake. Rising far east of the lake, this river flows in a general westward direction and unites with the Bell at Mattagami lake to form the Nottaway, which drains to James bay.

TABLE OF FORMATIONS

CENOZOIC	Quaternary	Sand, gravel, clay
PRECAMBRIAN	Keweenawan	Olivine diabase Quartz diabase
	Acidic Intrusives	Pink biotite granite, pegmatitic granite, pegmatite
		Lamprophyre dykes
		Quartz leucodiorite
		Biotite-hornblende granite
		Hornblende granite
		Gneissic biotite granite (Olga quartz diorite)
	Basic Intrusives	Andesine anorthosite and related diorite Diorite
		Porphyry and other dykes associated with the sedimentary-volcanic series
	Sedimentary-volcanic Series	Impure feldspathic quartzite, magnetite-rich quartzite, mica schists Hornblende gneiss (recrystallized andesite)

GENERAL GEOLOGY

General Statement

Rock in appreciable amount is exposed over less than half of the area mapped. However, from the general distribution of these exposures it is possible to infer that by far the greater part of the area is underlain by granitic rocks which are of five fairly distinctive types. Most abundant is a pink biotite granite and its related pegmatitic facies, which underlie more than half of the area. It is the youngest of the five granites. Next in size is a body of hornblende granite which occupies the southern part of the map-area. A gneissic biotite granite, which is presumably the oldest granitic intrusive, is encountered in moderate abundance as roof pendants in the pink biotite granite. Of the two remaining types, one, a biotite-hornblende granite, forms small masses in the northwest corner of the

area, and the other, a quartz leucodiorite, occurs in large and small dykes cutting the hornblende granite.

Sedimentary rocks are found in two comparatively small bands in, respectively, the northwest corner and the southern half of the map-area, and also as two large inclusions in hornblende granite, in the southeast corner of the area.

Volcanic rocks occur in very subordinate amount and are seen only in the more southerly of the two sedimentary bands.

Small masses of basic intrusive rocks which are older than the granitic rocks are exposed in the southern and northern parts of the area, either as inclusions in the granites or as intrusions in the sedimentary rocks.

A limited number of lamprophyre dykes were seen, most of them associated with the hornblende granite and the biotite-hornblende granite.

Two diabase dykes which cut the pink biotite granite along Waswanipi river are presumably the youngest intrusive rocks of this map-area.

Sedimentary and Volcanic Rocks

Of the two main bands of sedimentary rocks in the area, one is in the extreme northwest corner where it borders the shore of Goéland lake for a width of a mile to a mile and a half with trend between north and north-northeast. A narrow strip of east-trending sedimentary rocks on the east side of this band is possibly a part of it and has been shown as such on the map. A few restricted exposures of similar sedimentary rock occurring within granite south of the point of outlet of Waswanipi river into Goéland lake are considered as related to the main band, though, possibly, not actually connected with it.

The rocks of the band are predominantly fine-grained, thinly bedded, micaceous and feldspathic quartzites (Pl.VI-B). Mica - either biotite or muscovite, or both - forms up to 20 per cent of the rock and feldspar up to 40 per cent. Examination of thin sections showed that both microcline and plagioclase are present, with the latter apparently the more abundant.

In the western part of the band, the only beds other than quartzite are minor intercalates of mica schist and of coarse-grained basic beds of the composition of greywacke. In the northeastern part of the band, however, some hornblende-bearing gneisses are encountered which are quite unlike the typical sedimentary rocks and may represent

recrystallized andesite flows intercalated with them. Imbault (11) found similar gneisses to be predominant over typical sedimentary rocks in the area to the north and he believes them to be recrystallized volcanic flows.

The other main band of sedimentary rocks extends, with trend a little south of west, directly across the southern part of the map-area, along the north shore of the southwest bay of Waswanipi lake and the valley of the Iserhoff. It is about two miles wide and lying centrally within it is an intercalated band of volcanic rocks rather less than a quarter of a mile in width. As the accompanying map indicates, outcrops along the course of the band have a limited distribution, so that its continuity and north and south limits, as mapped, are in large part inferred. The most typical sedimentary rocks of this band are found at the east end, to the north of the volcanics, and consist of finely laminated, impure, feldspathic quartzites. The grain is very fine and the laminae, only a small fraction of an inch in width, are alternately siliceous (light-coloured) and basic (dark-coloured). In several exposures, the basic material of the dark laminae is recrystallized to closely packed hornblende prisms of relatively large size, aligned parallel to the bedding. At the easternmost part of the band, and south of the volcanics, the rock is more commonly a micaceous feldspathic quartzite which is well bedded, but lacks the strongly laminated character. At its west end, the band consists predominantly of fissile biotite schists with local intercalates of coarse hornblende gneiss which probably represent recrystallized andesite in thin flows among the sediments.

Two restricted occurrences of sedimentary rocks were encountered in the extreme southeast corner of the map-area. One forms what appears to be a narrow, northwest-trending strip along the shore of Waswanipi lake. It consists of impure quartzites and micaceous schists which are strongly drag-folded in many places and are commonly injected by a coarse, gneissic, whitish-grey granite in concordant ribbons and in thick lenses lodged in the 'nose' of the drag-folds. The other occurrence is about one mile to the south. It lies within hornblende granite and seems to form a band a quarter of a mile in width trending about west-northwest. The sedimentary rocks here are iron-bearing and produce a strong magnetic 'anomaly'. A similar 'anomaly' noted about half a mile farther to the southwest suggests the presence of another band; however, owing to the absence of exposures, no information is available on the character of the rocks at that point. The exposed iron-bearing band consists of fine-grained hornblende-bearing quartzites and biotite schists. The beds are commonly thin and well developed and in many places are intruded by granitic veinlets. Magnetite in a very finely divided state is

disseminated throughout the rock and occurs in greater concentration along certain layers. In two thin sections examined, it constitutes from 30 to 35 per cent of the rock.

The volcanic rocks that form a zone centrally within the southerly band of sedimentary rocks are predominantly medium-grained plagioclase-hornblende gneisses. In the western part of the band this zone appears to follow the course of Iserhoff river, though, as shown on the map, not all the exposures lying in the immediate vicinity of the river can be interpreted as being of volcanic origin. Of the four groups of exposures seen along the river, the two middle groups alone consist, in whole or in part, of plagioclase-hornblende gneiss, which the writer regards as recrystallized andesite. Of the remaining two groups, the most westerly includes sheared, rusty, impure quartzite with finely disseminated sulphides (presumably sphalerite for the most part). In the easternmost group the rock is a fine-grained dark quartzite which is crisscrossed by veinlets of carbonates and sparsely mineralized with sphalerite, pyrite, and chalcopyrite.

At the eastern end of this volcanic zone, on the other hand, or more accurately at the point on the north shore of the southwest bay of Waswanipi lake where the eastward extension of this inferred volcanic zone would be expected, extensive exposures of a dark, gneissic, hornblende rock of unmistakable igneous character are encountered. Certain unusual surface features exhibited by the rock suggest deformed and largely obliterated pillows. Examined in thin section, the rock is seen to be igneous and of intermediate composition, sufficiently fine-grained to be termed an andesite. The gneissic character is very marked and the rock appears to be largely recrystallized. Several large crystals of plagioclase (An_{35} approx.) seen throughout the fine groundmass seem to be of porphyroblastic character.

Dyke Rocks Associated with the Sedimentary Bands

A number of dykes of various compositions are found cutting the sedimentary rocks. Some, of granitic and of lamprophyric composition, are generally fresh and show only moderate or no deformation. They are known to be fairly late in the intrusive sequence of the area and are discussed later in this report. Others, including porphyritic and amphibolitic types, are metamorphosed and are generally deformed and intruded concordantly in the sedimentary rocks. They appear to constitute the oldest known intrusive rocks of the area and were probably folded with the sedimentary rocks.

A typical porphyry dyke, some eight to twelve inches in width, was seen in the northeasternmost exposure of sedimentary rocks

in the southwest bay of Waswanipi lake. The rock is from light green to light grey in colour, schistose, and contains many white phenocrysts of feldspar. It tends to break most readily parallel to the planes of schistosity, which then appear as lustrous surfaces owing to the presence of thin films of sheared micaceous material. Most of the phenocrysts have diffused borders and many have been crushed into tiny, lenticular or eye-shaped, whitish aggregates. Examined in thin section, the uncrushed phenocrysts are seen to be nearly completely sericitized. The groundmass also is largely converted to fine sericite except for narrow zones, or pocket-like aggregates, of fine-grained fresh feldspar and quartz which seem to be of secondary origin. A very pale green, actinolitic amphibole in long, narrow crystals that parallel the schistosity is distributed in small amount throughout the rock.

Most commonly, the amphibolitic dykes, which presumably represent metamorphosed basic rocks, are seen cutting the sedimentary rocks of Goéland lake. One particularly unusual dyke, seen near the shore of that lake at a point about half a mile northeast of the largest island lying at the mouth of Waswanipi river, has a very striking coarse nodular structure. From the small portion of it that is exposed, it appears to be lenticular in shape, with maximum width about four feet. This shape may be a result of deformation during folding, the original dyke having possibly been drawn out into several lenticular bodies. Small exposures of a similar rock on the northwest side of the largest island at the mouth of Waswanipi river lie in the trend of this dyke and may represent its continuation.

The nodular rock consists of actinolite and a minor amount of biotite, the actinolite in long needles, closely packed into nodules that are up to several inches in diameter, and the biotite forming the 'matrix' between the nodules. Biotite is in very subordinate amount, however, making up probably less than 10 per cent of the rock, and between many of the nodules it appears as a mere stringer. It tends to take on a whitish cast on the weathered surface of the rock and thus is readily distinguished, as a rule, from the dark green actinolite. Replacement of the 'matrix' by white carbonate is not unusual. Occasional dark-coloured fragments in the dyke appear to have been derived from the adjacent sedimentary rocks.

Dykes of somewhat similar composition, but lacking the nodular structure, are found in the sedimentary rocks exposed just north of the nodular dyke. Under the microscope, these dykes are seen to consist of a fine aggregate of actinolite with interspersed biotite and fairly abundant tiny granules of sphene.

Other amphibolitic dykes which appear to be related to this group in character and composition, though they seem to contain

rather more biotite, intrude the sedimentary rocks at the northwest end of the northernmost island at the mouth of Waswanipi river.

Basic Intrusives

Diorite

Several large and small bodies of intermediate to basic rock occur in the hornblende granite of the southern part of the area in the form of inclusions, or perhaps more accurately as roof pendants, since they generally show a common orientation of structures.

These rocks usually consist of plagioclase and hornblende in varying proportions and form characteristic medium- to coarse-grained aggregates in which the plagioclase tends to occur in euhedral to subhedral crystals in a groundmass of hornblende. They are thought to be of igneous origin and, tentatively, are termed 'diorite', though they may have been gabbroic originally.

Examination of thin sections of the rock shows that the plagioclase is highly altered. Its present composition appears to lie between intermediate and calcic oligoclase, but it is possibly degraded. The hornblende, in large to small crystals, is moderately pale green, occasionally bluish-green; much of it seems to be of uralitic nature, and it may be wholly derived from pyroxene. A few flakes of biotite occur with the hornblende.

In some of these rocks, the plagioclase is in very small amount, or even entirely lacking. The rock is then a felty mass of coarse hornblende and might be termed an amphibolite. Locally, this type contains a considerable amount of coarse chlorite.

Caught up within these dioritic roof-pendants are small inclusions of a fine-grained, dark rock believed to be of sedimentary origin. Their contacts with the host rock are fairly sharp, though some euhedral crystals of plagioclase of the enclosing diorite may penetrate their borders. Such crystals are found also disseminated throughout the inclusions. The diorite was presumably intruded in a former sedimentary assemblage, of which the inclusions are small remnants, and the growth of phenocrysts of plagioclase in the fine-grained inclusions suggests incipient assimilation of the latter by the dioritic magma.

The various dioritic inclusions or roof pendants found throughout the hornblende granite suggest the former existence of a large dioritic or gabbroic mass in the region previous to the intrusion of the granite.

Andesine Anorthosite and Related Diorite

A low hill, rising some 1,200 feet north of Waswanipi river at the point where the latter flows into Goéland lake, consists predominantly of a white feldspathic rock which is cut by numerous dykes, stringers, and irregular patches of pegmatitic, aplitic, and granitic rock.

The feldspathic rock of this hill is unlike that of any of the other igneous bodies encountered within the map-area. For the most part it is white to creamy-white, medium-grained, and ferromagnesian minerals are in very small amount or entirely lacking. It thus has the general features of anorthosite. Locally, however, this white feldspathic rock grades into a coarse-grained hornblende-feldspar rock which, megascopically, may be termed an altered gabbro or a diorite. A small amount of quartz is invariably present, but in all cases this appears to be introduced quartz. In the feldspathic facies, it forms occasional blebs which have a very erratic distribution. The hornblende-bearing facies is distinctly gneissic and carries quartz in large irregular grains and in small veinlets following, or cutting across, the gneissic trend.

Thin sections of the feldspathic rock show an aggregate of subhedral grains of andesine (An_{36}) together with a very small amount of quartz which is clearly of secondary origin. The andesine exhibits various stages of alteration to white mica and epidote. Some grains are only slightly altered, others have been converted to a felty aggregate of mica shreds with disseminated grains of epidote. The epidote is of rather consistent occurrence in the feldspar, in which it is present in very fine granules along the cleavage planes and in small nests of granules where cleavage planes intersect. Its distribution and mode of occurrence leave no doubt that it is derived from the plagioclase. A few larger grains of epidote and clinozoisite which are found along grain boundaries may be of extraneous origin.

The hornblende-bearing facies consists of andesine (An_{30}), deep green hornblende, and chlorite. The andesine is in subhedral grains but, as compared with those in the feldspathic facies, they tend to be much larger. The hornblende shows sub-crystalline outlines and is generally unaltered. The chlorite is in large flakes pseudomorphic after biotite, some of which is preserved as ragged cores in the chlorite. Fine granules of sphene are found along the cleavages, and more abundantly at the tips, of the chlorite flakes. It is believed that the sphene is derived from TiO_2 contained in the biotite molecule and liberated during its alteration to chlorite. Its mode of occurrence seems to indicate that, after its formation, the sphene, following the cleavage planes of the chlorite, tended to migrate toward, and thus to segregate at, the tips of the chlorite flakes. No

sphene is found in the relict biotite in chlorite and very little is seen in any mineral other than the chlorite.

The plagioclase exhibits various stages of alteration and many of the crystals show zoning. The product of alteration is mostly white mica, though some cloudy patches in highly altered andesine appear to contain epidote grains. However, the more characteristic occurrence of epidote in this facies is as large and small crystals, usually in association with hornblende. It is likely that the epidote is introduced; the same is probably true of the notable amount of apatite present in the rock. Quartz is also clearly of extraneous origin, as it is seen exclusively in large and small patches replacing the plagioclase and the hornblende. The quartz, epidote, and apatite are readily interpreted as emanating from the neighbouring granites, since the small plug of feldspathic rocks is crisscrossed by small granitic bodies and dykes.

The feldspathic and feldspar-hornblende rocks of this occurrence are similar in some respects to those of the eastern part of the Bell River complex, a large mass of anorthosite-gabbro extending from Bell river to Ramsay bay at the southwestern part of Goéland lake, and they are regarded by the writer as a very small offshoot from that mass. Some major discrepancies lie in the character of the plagioclase. That in the small plug at Waswanipi river has the composition of An_{36} for the pure feldspathic member and An_{30} for the hornblende-bearing member, whereas in the Bell River complex the average plagioclase is about An_{63} for the anorthosite and An_{57} for the gabbro (12). It should be pointed out, however, that the Waswanipi River plug, being a very small mass and predominantly feldspathic, obviously would have lacked sufficient mobility to be introduced into the overlying sediments had it consisted of plagioclase with a high lime content and, consequently, a high-melting point. Therefore, it might be expected that the plug would be of a somewhat more sodic character than its much larger parent mass.

The presence of biotite in the hornblendic facies of the Waswanipi River plug is in accordance with a more sodic character. This mineral is absent in the more basic parent mass. The fact that the biotite was rich in TiO_2, as evidenced by the abundance of sphene resulting from its break-down, favours a genetic relationship of the plug with the Bell River complex, as the latter is known to carry abundant titanium oxide in the form of titaniferous magnetite.

In a rigid sense, the feldspathic facies of the Waswanipi River plug cannot be termed anorthosite because of its sodic feldspar. It is strictly an andesinite, though the term andesine anorthosite

might be acceptable and would better convey the genetic relationship of the plug to the anorthosite of the Bell River complex. The hornblende-bearing facies is essentially a diorite.

Granitic Intrusives

Classification, Correlation, Genetic Relationships

In the Iserhoff River area (10), the writer recognized three main types of granitic intrusive rocks which formed three main bodies of different ages, namely:

Pink granite (youngest)
Quartz syenite
Quartz diorite (oldest)

A fourth type, of unknown age and found in one small and ill-defined occurrence in association with the quartz syenite, was also described under the designation 'quartz leucodiorite'.

In the present area, the four types of intrusive rock mentioned above were again encountered, as well as a new, or fifth, granitic type termed biotite-hornblende granite. However, two changes have been made in the nomenclature adopted for the Iserhoff River area.

First, the term 'quartz diorite' is replaced by 'gneissic biotite granite' in order to eliminate a somewhat misleading designation. In the report on the Iserhoff area, mention was made of the inadequacy of this term, though it was retained for purposes of correlation with certain rocks of the areas to the west to which the term 'Olga quartz diorite' was originally applied. The terms 'quartz monzonite' or 'oligoclase granite' were thought to be more suitable to describe the rocks of the original 'Olga diorite' group, though still not entirely satisfactory. In the present report, the rocks related to this group are termed 'granite' and the prefix oligoclase is eliminated on the basis that all the granites of the area are prominently plagioclase-rich and, thus, the abundance of oligoclase in this rock is not a clearly distinctive feature. Its biotite content, coupled with its strongly gneissic character, is, on the other hand, highly characteristic, whence the new designation, 'gneissic biotite granite'.

The second change in the nomenclature of the acidic rocks is that of 'quartz syenite' to 'hornblende granite', a change which is justified by a change of facies in what is, actually, a continuous granitic body. This body underlies the southern parts of both the

Looking north in the Waswanipi hills. Though several of the hills rise somewhat steeply, this feature is not conspicuous at the elevation from which the picture was taken.

Plate I

Looking southwest across the southern part of Goéland lake from the southeast shore of the lake two miles north of Waswanipi river. The elevated massif on the far horizon is the Dalhousie mountains which lie southwest of Ramsay bay.

Typical sand beach, Waswanipi lake.

Stream cutting across the sand beach shown in plate III. Erosion shows a thick layer of cross-bedded sands resting between horizontal beds.

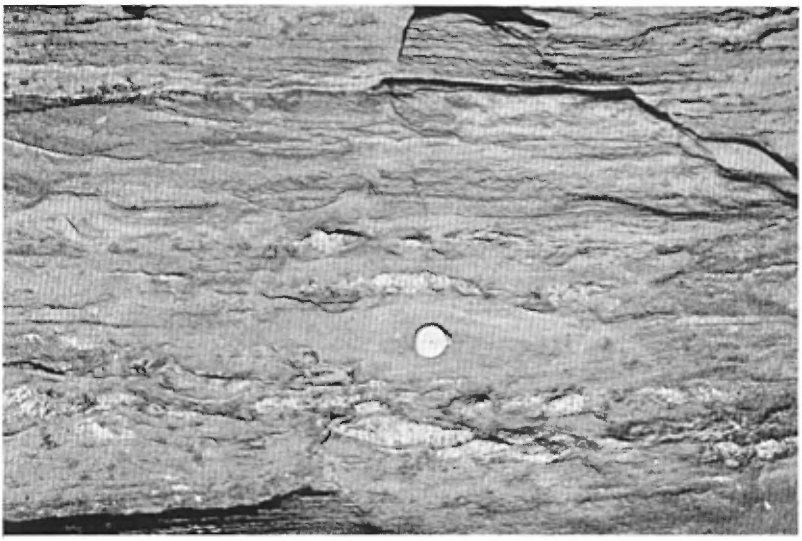
Plate V

A - View looking east up Waswanipi river from a hill on the south side of the main rapid.

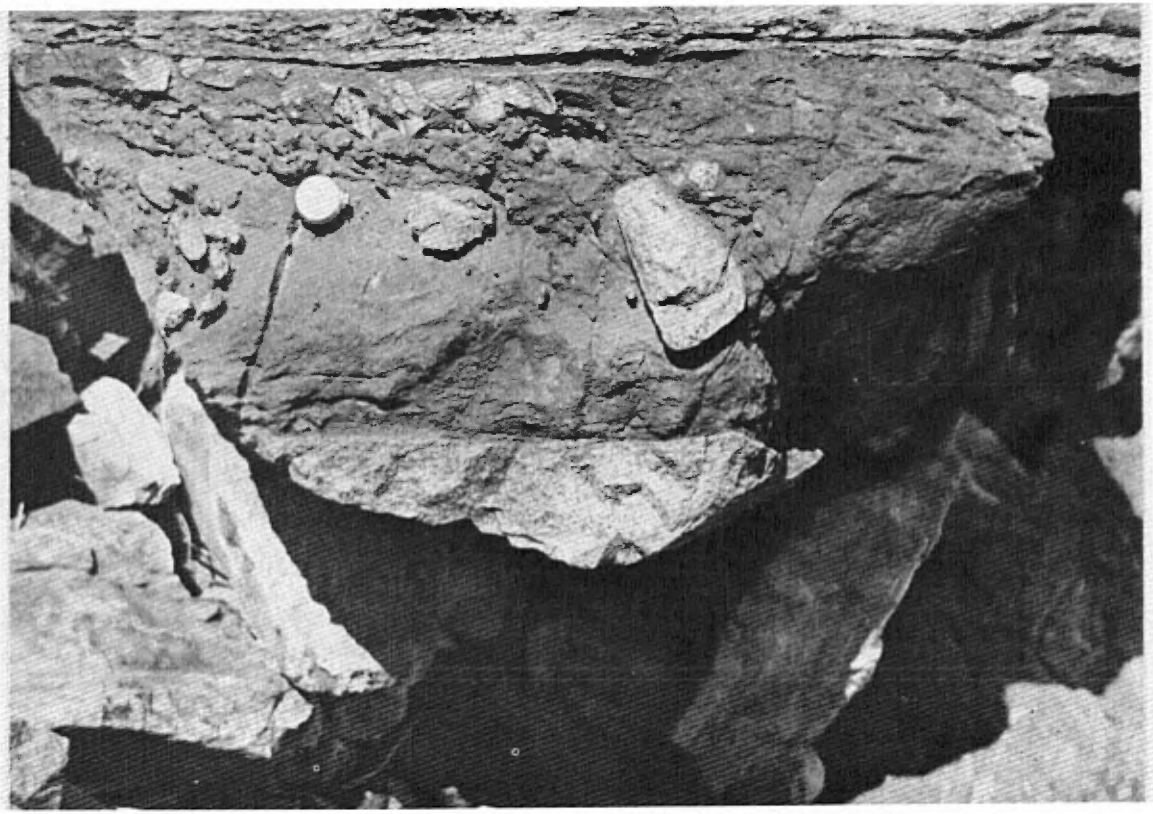
B - View looking west down Waswanipi river and the stretch of swift water extending below the main rapid.

Plate VI

A - Steeply dipping sedimentary rocks on the southeast shore of Goéland lake, three-quarters of a mile north of Waswanipi river.

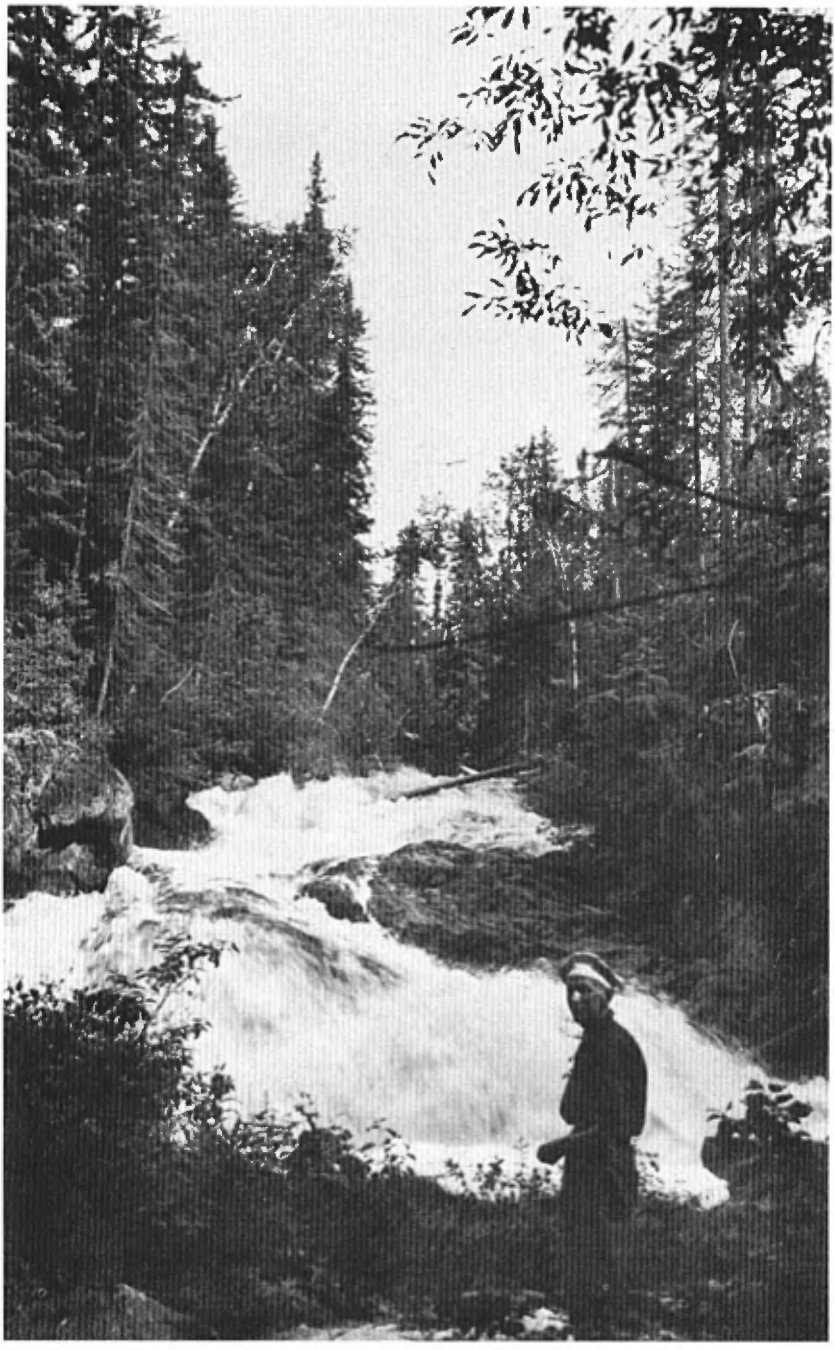


B - Sedimentary rocks on the southeast shore of Goéland lake, one and three-quarter miles north of Waswanipi river. Note well-preserved bedding and stringers and lenses of quartz and pegmatite parallel to the bedding.



Lamprophyre dyke cutting biotite-hornblende granite on the southeast shore of Goéland lake, a mile and a half north of Waswanipi river. Note rounded "pebbles" of granite included in the lamprophyre; also the "sheets" or "leaves" of granite in the dyke near its left border.

Plate VIII



Falls and cascades along Vignal creek near its confluence with Waswanipi river.

Iserhoff River and Waswanipi Lake areas. In the Iserhoff River area, the rock is hornblende-bearing, characteristically low in quartz, and thus of a syenitic nature. In the Waswanipi Lake area, the rock of this same intrusive body, though still syenitic in the southwest corner of the map-area, is typically a hornblende granite throughout its whole extent across, and south of, the southwest bay of Waswanipi lake.

The problem of age relationship, raised in the Iserhoff River area by the single occurrence south of the Iserhoff of a small exposure of quartz leucodiorite in association with the quartz syenite, has been solved in the mapping of the present area by the discovery of several large and small dykes of a similar rock cutting the hornblende granite of the southwestern part of Waswanipi lake. The rock of the dykes can here again be adequately termed quartz leucodiorite and is indistinguishable in hand specimen from the leucodiorite previously found in the Iserhoff River area. Furthermore, there is a suggestion that the Iserhoff leucodiorite occurs along the same structures as those along which the Waswanipi leucodiorite dykes have been intruded, for, though six miles to the west, the Iserhoff occurrence lies in the general trend of the major dyke off the southwestern tip of Waswanipi lake.

The new granitic type encountered in the present area, namely the biotite-hornblende granite, is restricted to the northwest corner of the area and forms small bodies related to a large mass well exposed in the area to the northwest (11). It was not positively recognized in the Iserhoff River area, where it may occur, however, in small offshoots around Ramsay bay. In general composition and appearance in hand specimen and in thin section, this granite is closely allied to the hornblende granite of the south, and, though the two types are perhaps not of contemporaneous age, they appear to be very closely related. It is probably not entirely safe to consider them of the same age, however, as the southern granite contains no biotite and carries a slightly more sodic plagioclase, namely An_{16-18}, as compared to An_{23} for the biotite-hornblende granite.

The pink granite or youngest acidic intrusive of the Iserhoff River area extends eastward into and entirely across the present area, of which it underlies the northern two-thirds or more. The rock here is similar to that in the Iserhoff River area though perhaps with a tendency to be more pegmatitic.

To summarize the above discussion, the nomenclature of the acid intrusives in the Iserhoff River area and in the Waswanipi area, as well as the correlation between the two areas, are shown in the table below, in which the rocks are listed in order of age, with the youngest group at the top:

ISERHOFF RIVER AREA	WASWANIPI LAKE AREA (West Half)
Pink granite, pegmatitic granite, pegmatite	Pink biotite granite, pegmatitic granite, pegmatite
Quartz leucodiorite	Quartz leucodiorite
(Possibly present in small offshoots around Ramsay bay)	Biotite-hornblende granite (northwest corner of area)
Quartz syenite (southern part of area)	Hornblende granite (southern part of area)
Quartz diorite (oligoclase granite)	Gneissic biotite granite (Olga quartz diorite)

The arrangement in order of age shown above is tentative in part. The biotite-hornblende granite is indicated as being closely related to the hornblende granite, though the question is left open as to whether it is contemporaneous with it or slightly younger. Obviously, either interpretation could be wrong; the biotite-hornblende granite could be older than the hornblende granite, or it could even be younger than the leucodiorite.

The gneissic biotite granite is assumed to be the oldest of the group on the basis of its strongly gneissic character. Its age relations are established with certainty, however, only with respect to the youngest member, the pink biotite granite, in which it is included.

Notwithstanding the still unsolved problems of the relative ages of these acid intrusives, there is no doubt in the writer's mind that the several types are closely related genetically and represent successive stages of injection of a granitic magma during a single igneous cycle. The strongest proof of their consanguinity lies in the fact that they are all uniformly rich in plagioclase (even the pink biotite granite, which is the least sodic type, contains an average of 35 to 40 per cent plagioclase) and, furthermore, that the plagioclase shows relatively limited variation in composition between the several types, as shown by the following determinations:

	Plagioclase
Gneissic biotite granite	An_{18-20}
Hornblende granite	An_{16-18}
Biotite-hornblende granite ..	An_{23}
Quartz leucodiorite	An_{22}
Pink biotite granite	An_{12-15}

The quartz leucodiorite presumably represents a rather minor intrusive stage marked by the injection of dyke-like bodies. In fact, it is of aplitic nature and could represent white-coloured diaschistic dykes or leucophyres related to the hornblende granite. The occurrence of dark diaschistic dykes or lamprophyres associated with both the hornblende granite of the south and the biotite-hornblende granite of the north lends some support to this possibility. These lamprophyres, found cutting these two granites or the sedimentary rocks that surround them, but nowhere seen cutting the great masses of younger pink granite, clearly seem to be derived from these two hornblende-bearing granitic bodies which, as mentioned previously, may represent only one intrusive stage.

It is known from cutting relationships of lamprophyre and leucodiorite dykes at the southwest part of Waswanipi lake that the lamprophyre is younger than the leucodiorite, a fact which further tends to confine the leucodiorite to the role of a differentiate dyke, if it is accepted that the lamprophyres followed closely in time of intrusion the consolidation of the hornblende granite.

Gneissic Biotite Granite

Distribution - This granite cannot be outlined in sharply defined masses, though it is of common occurrence in the western part of the map-area throughout most of Vignal township and the northern part of Bergères. It is found in intimate association with the youngest granitic type, the pink biotite granite, by which it is cut in a most complex and widespread fashion. There are some indications, however, that, at the southern and northern borders of the area outlined above, this granite may form two continuous zones, one of which lies against the southern side of the sedimentary rocks of Goéland lake and the other against the northern side of the sedimentary rocks of Iserhoff river. This interpretation is shown on the map and is based on the fact that the outcrops in the vicinity of the sedimentary belts are almost exclusively of gneissic biotite granite, relatively free of the pink biotite granite which is found so abundantly in the gneissic granite elsewhere. On the other hand, the evidence is only partly conclusive because of the limited number of exposures.

In the area extending between these two zones, it is impossible to separate effectively the gneissic biotite granite from the pink biotite granite and its related pegmatitic facies. Certain areas have been outlined on the map in which the gneissic granite is predominant, or at least in unusual abundance. The boundaries of such areas in the field are extremely indefinite and the interpretation given on the map is arbitrary. It serves to show the complex nature of the rock basement rather than to give an accurate picture.

The sedimentary rocks on the shore of Waswanipi lake, in the southeast corner of the map-area, are characteristically injected concordantly, even in some of their tightly drag-folded parts, by a gneissic biotite granite which the writer believes to be related to the granite discussed above. This constitutes the only noteworthy occurrence of the gneissic biotite granite observed outside of its main area of outcrop in the west-central part of the map-area.

Description - This granite is a strongly gneissic, medium- to coarse-grained, typically greyish rock whose dark mineral constituent is biotite, though subordinate amounts of hornblende occasionally accompany the biotite.

Where the gneissic granite is exposed in the immediate vicinity of the sedimentary rocks of the north and of the south, it has in many places been observed to inject the sedimentary rocks lit par lit, thus producing banded gneisses, some of which show a partially developed augen structure.

A puzzling feature often seen in the gneissic biotite granite, in the Waswanipi hills in particular, is the presence of dark bands or zones parallel to the gneissic trend. These bands, which range in width from a fraction of an inch to a few feet, are nowhere present in large numbers and often only a single narrow band is found in otherwise normal granite in the midst of a fair-sized exposure. The bands have sharp contacts and uniform widths. They consist of biotite, chiefly, with varying amounts of quartz and feldspar, and resemble sedimentary beds in various stages of assimilation. Some bands have been seen to pinch out fairly abruptly at one end, though the greater number are continuous within the limits of the observed granitic exposures. Where exposures of gneissic granite containing some of these biotite-rich bands show minor crumpling or wrinkling, it is observed that both rocks have been deformed together.

Since the gneissic character of the granite is considered as dating from the time of its emplacement, this clearly implies that the dark bands were present in the granite at the time of its consolidation. As the bands do not resemble primary segregations, they must constitute inclusions of an older rock formation and thus may be regarded as deeply-buried remnants of a former sedimentary assemblage intruded concordantly by the granite.

Thin sections of the gneissic biotite granite show a fairly typical equigranular aggregate of subhedral plagioclase crystals (An_{18-20}), a small amount of microcline, and from 10 to 15 per cent quartz. The dark minerals include biotite, up to 15 per cent, and, occasionally, a minor amount of hornblende. Epidote is invariably

present and in some sections is fairly abundant. It occurs in large crystals in association with the biotite and in small granules in some of the plagioclase crystals, in which case it is obviously a product of degradation of the host mineral. Other persistent minerals, though present in very small amount, include sphene and apatite.

The rock is fresh except for a slight to moderate alteration of the plagioclase. It shows no signs of severe deformation and it is concluded that the gneissic character must be of primary origin and acquired during emplacement and crystallization under stress.

Hornblende Granite

Distribution - The north-central part of a large body of hornblende granite underlies all of that part of the map-area south of an east-northeast line passing through the mouth of Iserhoff river and through the northern part of the southwest bay of Waswanipi lake. This body, which is some 25 miles long and seven miles wide, elongated in an easterly to east-northeasterly direction, extends for some distance south of the present map-area (6).

Description - The rock of this mass is medium- to coarse-grained, pale pink in colour, moderately to slightly gneissic, and typically hornblende-bearing. It is commonly porphyritic, with the feldspar phenocrysts often roughly aligned parallel to the gneissic trend and up to half an inch or even an inch in length.

The quartz content of the rock is nowhere very high and in that part of the mass lying in the southwest corner of the area it is distinctly low, and there, also, the porphyritic texture is uniformly lacking. In these respects it is similar to the rock in the westward extension of this body, in the Iserhoff River area (10), where it is non-porphyritic and has the composition of a quartz syenite rather than of a typical granite.

In thin section, the average rock is seen to consist essentially of hornblende and plagioclase (An_{16-18}) with variable amounts of quartz and microcline. The porphyritic facies contains phenocrysts of both microcline and plagioclase and those of microcline have inclusions of medium-sized euhedral to subhedral crystals of plagioclase. Most of the plagioclase crystals are strongly zoned and show light to moderate alteration. Otherwise, the rock is rather fresh looking. Granulation is sometimes observed, but it is strictly of local occurrence and the granite in general has not suffered much deformation. Thus, it seems obvious that the gneissic character and the rough alignment of the phenocrysts parallel to the gneissic trend were acquired during the emplacement of the mass.

In the quartz-poor facies of the southwest corner of the area, very little microcline was seen. On the other hand, small amounts of a pale green pyroxene were present, a condition that had also been noted in some of the quartz syenite of the Iserhoff River area (10).

The hornblende granite occasionally contains some biotite, but it is always very subordinate to the hornblende. Plentiful epidote, and lesser sphene and apatite, are invariably present, generally in association with hornblende.

Biotite-Hornblende Granite

Distribution - This granite is restricted to the vicinity of Goéland lake, in the northwest corner of the map-area. Three small bodies are shown on the map. Two of these are exposed along the shore of the lake and constitute the southeast border of a large body described by Imbault (11) as underlying part of Goéland lake. The third body lies on the northeast side of the sedimentary belt bordering Goéland lake and extends into the adjacent area to the north.

Description - The rock is greyish-pink to grey, medium- to coarse-grained, distinctly gneissic, and characterized by the presence of biotite and hornblende in about equal amount.

The small bodies of this granite exposed in the area represent border facies rather than the average rock of the masses of which they form the marginal parts. The writer had an opportunity to examine thin sections of the rock of the main mass studied by Imbault (11). They were found to be not unlike those of the hornblende granite of the southern part of the present map-area.

The chief points of difference between the hornblende granite and the small bodies here under discussion are that the latter are rather finer grained, they contain, as already noted, about as much biotite as hornblende, and the plagioclase is more calcic - An_{23} as compared to An_{16-18} - and, as a rule, less strongly zoned.

Plagioclase and quartz are the most abundant constituents; microcline is present only in small amount. In addition to hornblende and biotite, there is plentiful epidote and a moderate amount of both sphene and apatite.

Quartz Leucodiorite

Distribution - The leucodiorite is found as dykes, large and small, cutting the hornblende granite near the southwest corner of the southwest bay of Waswanipi lake. The largest of these is about

a quarter of a mile wide and was traced along its length over a distance of nearly two miles. This dyke is particularly well exposed where it crosses the southwest tip of Waswanipi lake. At the lake shore, its width exceeds a quarter of a mile. Eastward from that point, scattered outcrops indicate that it becomes narrower and probably breaks into a number of smaller dykes before again reaching the shore of the bay. Westward, the terrain is drift covered, but the dyke probably persists for some distance beyond its most westerly exposure.

Other leucodiorite dykes, some of them several tens of feet in width, are found north of the main dyke, cutting the hornblende granite that surrounds the lake.

All the larger dykes observed strike between east-northeast and northeast. Several of the smaller ones, however, have other trends. One of those examined strikes due north; it is cut by a dyke of lamprophyre.

Description - The leucodiorite is a grey, moderately fine-grained rock which is typically biotite-bearing, and from very weakly gneissic to massive.

Under the microscope, this rock shows a fresh, equigranular aggregate of subhedral plagioclase (An_{22}), subordinate amounts of quartz and biotite, with relatively common epidote and sphene and some apatite. In the two sections examined, plagioclase makes up more than 75 per cent of the rock and no potassic feldspar is present. One section contains about 20 per cent quartz, the other about 10 per cent. Biotite, including associated epidote and sphene, was estimated as between 5 and 10 per cent. The only alteration is a slight cloudiness in some of the plagioclase crystals.

Lamprophyre Dykes

A number of black dykes thought to be closely related to the hornblende-bearing granites of the area should be discussed at this point. One of these dykes was observed cutting quartz leucodiorite, so that they are evidently younger than the latter, but they are presumably older than the pink biotite granite, in which they are never seen.

The dykes have been observed thus far only in association with the hornblende granite of the southern part of the area and the small bodies of biotite-hornblende granite in the extreme northwest, and, more rarely, with the sedimentary rocks lying in the vicinity of these two granites. They vary in width from a small

fraction of an inch to one foot, are irregular in trend, and appear somewhat deformed.

The rock breaks with a typical conchoidal fracture. It is commonly fine-grained, though in the central part of some of the larger dykes the grain is somewhat coarse. The dykes found in the biotite-hornblende granite contain abundant magnetite and have a hard, rusty surface crust which is about one-eighth of an inch thick. This is absent in the lamprophyres of the southern part of the area.

An invariable characteristic of the dykes is that they carry foreign matter in the form of inclusions. In the northern dykes, these inclusions may be several inches in diameter and all those sufficiently large to be identified in hand specimen are seen to be rounded (Plate VII), and to consist of granite. In the southern dykes, the inclusions are microscopic to sub-microscopic in size and, as seen in thin sections of the rock, they are literally innumerable. They are angular and consist of individual minerals, or, more rarely, of small assemblages of minerals, or of rock fragments.

Examination under the microscope shows that the northern dykes differ markedly in composition and texture from the southern dykes. A thin section from one of a group of three or four large lamprophyre dykes found cutting the southern of the two small granite bodies around the southeast shore of Goéland lake shows a felty mass of carbonate, actinolite, pale green hornblende, biotite, and many small, cloudy patches with euhedral to subhedral outlines and laden with iron dust. The biotite is the greenish variety and occasional crystals are of the size of phenocrysts. Other phenocrysts are present which, though they are now completely altered, probably consisted originally of olivine, as suggested by the crystal outline and the relict pattern of typical irregular fractures speckled with iron dust. It is also possible that pyroxene was present in the original rock and that most of the cloudy patches mentioned above represent original grains and small crystals of that mineral.

Thin sections of two lamprophyre dykes found in the southern part of the area were examined. One of these cuts the hornblende granite, the other the sedimentary rocks of the northeast shore of the southwest bay of Waswanipi lake.

In both sections, the microscope reveals a cloudy groundmass, brownish in natural light, in which are embedded innumerable angular fragments of various minerals, ranging in size from about one-tenth of an inch to sub-microscopic. Much of the groundmass itself seems to consist of very minute fragments partially obscured by a semi-opaque, unresolvable brownish dust.

A few of the 'fragments' have subhedral outlines and may represent original phenocrysts. Otherwise, they are all from strongly angular to sub-rounded. The most abundant fragments are quartz, plagioclase, and microcline. Others, which are much less numerous, include hornblende, biotite, and epidote. Still others, but these are rare, consist of an assemblage of two or more minerals and thus are true rock fragments. The rock fragments in both thin sections appear to be granite. However, occasional fragments of what was taken to be sedimentary rock were seen in the field in lamprophyre dykes cutting such rocks.

The differences between the northern and southern dykes are more apparent than fundamental, for both groups represent magma that picked up foreign matter during its injection along fracture planes. The northern dykes suggest a fairly basic composition for this magma since they are largely amphibolitic, rich in magnetite, and perhaps originally contained olivine and pyroxene. The groundmass of the southern dykes cannot be resolved. It is so fine-grained as to be practically isotropic and thus near glass in nature. However, it imparts a very dark, almost black, colour to the rock and is very likely of the same basic composition as the groundmass of the somewhat coarser-grained northern dykes.

The fact that the dykes found in the granite carry exclusively fragments of granite or of minerals typical of granite, and that those found in the sedimentary rocks, though they may contain occasional sedimentary fragments, still contain an overwhelming proportion of granitic fragments, suggests a very intimate relationship between the lamprophyre dykes and the hornblende-bearing granites in which they are most commonly found.

The writer believes that the granitic fragments of the dykes were caught up during the passage of the lamprophyric magma through the hornblende granites. Furthermore, since even the dykes in the sedimentary rocks carry a load of fragments which are overwhelmingly of granitic origin, it is believed that all the dykes were derived from within the granite bodies in which they originated through differentiation. If thus interpreted, the lamprophyre dykes found in the sedimentary rocks must extend directly into a granitic body below.

The fragmental nature of the dykes, their narrow and irregular width, and the occurrence within the border of one of the dykes of sheets or leaves of granite (Plate VII), are features that suggest the injection of the lamprophyric magma in narrow shear zones along which a great abundance of comminuted material would have been available to be picked up, rather than along tension fractures.

Pink Biotite Granite, Pegmatitic Granite, Pegmatite

Distribution - This granite and its related facies underlie well over half of the total map-area in a great mass stretching from a short distance north of Iserhoff river to the northern boundary of the area. An older gneissic biotite granite is commonly found throughout the western part of this mass as what appear to be large roof pendants, complexly and abundantly injected by the pink granite and its pegmatitic facies. The tracts in which this older granite seems to be preponderant have been outlined on the map.

Description - Throughout this mass, the pink granite is in large part of a pegmatitic nature. A common facies is a coarse-grained, pink rock very low in dark minerals, which, in texture and composition, is about midway between a true granite and true pegmatite.

The relationship between the several facies of the mass are very complex. The intermediate facies just described is gradational into a granitic and a pegmatitic facies, and all three of these are in turn complexly injected by pegmatite in the form of dykes, ribbons, and splashes.

The granitic facies (pink biotite granite) is a pink, medium-grained, massive rock. Examination of seven thin sections of this rock revealed that, on the average, plagioclase is slightly predominant over potassic feldspars and that the proportion of quartz is never outstanding. The average composition is approximately as follows:

Plagioclase	40%
Microcline	30-35%
Quartz	25%
Biotite	5% to 'trace'

The pegmatitic facies is usually a very coarse aggregate of red potassic feldspar, cream-coloured or whitish plagioclase, and white quartz, with occasional flakes of muscovite and biotite. No rare minerals were seen in the pegmatites of the area, though the spectrographic analysis of a sheared pegmatite, collected at the big elbow of Waswanipi river at the eastern border of the area, revealed 'traces' of manganese, copper, lead, vanadium, and gadolinium.

Late Basic Dykes

Two dykes found cutting the pink biotite granite along the western part of Waswanipi river appear to be the latest intrusive rocks of the area. Both are diabase, but one is quartz-bearing and

the other olivine-bearing. It is likely that one is slightly older than the other, but both are assumed to be of the same general period, namely, Keweenawan.

Quartz Diabase

The quartz diabase dyke occurs on the south shore of Waswanipi river about three and a half miles from Goéland lake. It is about fifteen feet wide and strikes northeast. The rock is dark-coloured, medium-grained and massive, and looks rather fresh.

Under the microscope, it is seen to consist of pyroxene (50 per cent) and plagioclase, with small amounts of magnetite, sphene, epidote, and primary quartz. The pyroxene (enstatite) is little altered. The plagioclase, on the other hand, is too highly altered to permit positive determination of its composition.

Olivine Diabase

The olivine diabase dyke is three-quarters of a mile east of the quartz diabase dyke and a little south of the bend in Waswanipi river four and a half miles east of Goéland lake. It is some 300 feet wide, with easterly trend, and has been traced over a distance of three-quarters of a mile. As it is coarse-grained and rich in plagioclase, it does not appear particularly dark in hand specimen.

The thin section examined contains about 70 per cent plagioclase (An_{60}), 20 per cent olivine, and 10 per cent augite, biotite, apatite, and magnetites; also a few tourmaline crystals. Alteration is very slight and is limited to partial serpentinization of the olivine and occasional cloudiness of the plagioclase.

STRUCTURAL GEOLOGY

Folding Trends

The gneissic structure of the hornblende granite that occupies the southern part of the area, and the bedding and schistosity of the rocks of the adjacent sedimentary band, are characterized by persistent easterly trends and steep southerly dips. Bedding and schistosity in the belt of volcanic rocks intercalated in the sedimentary band have a similar trend and generally the same dip, except at the western end of the belt, where the dip is steeply to the north.

Data are lacking in the present area to establish whether the volcanic belt is simply interbedded with the sedimentary rocks, or whether the sedimentary rocks on either side of the lavas represent repetition by folding. The composite band continues, and is somewhat

better developed, in the adjacent Iserhoff River area (10), where it was suspected to represent an anticlinal fold with the lavas lying in the central part of the fold. Thus, there might be an anticlinal axis trending slightly north of east through the volcanic belt of the present area. Obviously there are many other possible interpretations, but more field evidence is needed before they can be given consideration.

In the northern sedimentary band, the trend of the structures changes from northeast near Waswanipi river to north in the northern part of the band. In the southern half of the band, drag folds indicate the presence of a synclinal axis trending northeast through the centre of the band and, west of this, an anticlinal axis passing along the western side of the large island which lies at the entrance of Waswanipi river into Goéland lake.

Immediately north of this large island is a smaller one, narrow and elongated to the northwest. Cross-bedding determinations at the northern end of this island show that the beds are facing east, which also is the direction of dip. Thus they are on the west limb of a syncline whose east limb presumably is the west limb of the anticline already referred to, the axis of which follows the northwestern side of the large island.

All these folds plunge to the southwest at an angle of 25 to 30 degrees.

The trend of the large inclusions of strongly gneissic biotite granite lying in the pegmatitic granite of the Waswanipi hills varies only slightly on either side of an east-west line. Linear elements in the inclusions have a common easterly plunge of 25 to 40 degrees.

Shearing and Faulting

A major shear zone or strike fault, which, in the adjoining area to the west (10), was postulated as following the Iserhoff River valley, is thought to enter the present area a short distance south of the Iserhoff in the zone of sedimentary rocks lying south of the river. It is indicated by the east-west depression marking this part of the sedimentary band, by the absence of outcrops, and by the general easterly fissility and shearing of the sedimentary and volcanic rocks exposed along the south side of the river. The rocks exposed along the river are not regarded as representing the actual site of the fault or shear zone, but their deformation is interpreted as due to their close proximity to the fault. Following a trend slightly north of east, the zone probably reaches Waswanipi lake in the small bay north of the headland three and a half miles northeast of the mouth of the Iserhoff.

There is little doubt that Waswanipi river follows a major east-west zone of weakness. Evidence to that effect includes the straight course of the river, the common occurrence of strong easterly shears in the rocks exposed along its shores, and the presence of the large, east-trending dyke of olivine diabase just south of the river. Reversed structures on opposite sides of the river near Goéland lake, and difficulties of correlation between the rocks of the north and south shores in that vicinity, suggest that the zone of weakness represented by Waswanipi river may be a fault with marked displacement.

Of the minor shear zones and faults of the area, some of which are shown on the map and seem to fall into one of three patterns - north, east and northeast trending - two may be briefly mentioned. One is a northeasterly fault on the south side of the southwest bay of Waswanipi lake, about two miles east of the Bergères-Bossé township line. A pronounced escarpment consisting of porphyritic hornblende granite, tinged a pervasive deep red colour by hydrothermal alteration, marks the south side of the fault. On the north side, the rock is largely plagioclase amphibolite intruded by granite. A fine-grained black rock, containing fragments of granite and outcropping along the stream that occupies the fault zone, probably represents a lamprophyre dyke intruded along the zone.

The other noteworthy structure is a northerly trending shear zone in pegmatite on the west side of the mouth of a brook flowing south into the sharp elbow of Waswanipi river, near the eastern boundary of the area. It is possible, and even probable, that the rectilinear course of the brook and of the Waswanipi south of the elbow is controlled in part by the extension, northward and southward, of this shear zone. These topographic features certainly suggest that this zone of fracture may have some degree of prominence.

ECONOMIC GEOLOGY

Very little mineralization was encountered in the area. That the sedimentary and volcanic rocks have at some time been subjected to mineralizing processes is indicated by the presence in them of small quantities of sulphides, by fractures filled with quartz and carbonate, and by occasional zones of hydrothermal alteration in the vicinity of some of these fractures. These occurrences, however, are rare and are devoid of economic interest.

In the northern sedimentary band, the only mineralization seen was a few specks of galena in some beds along the shore of Goéland lake, about a mile and a half north of Waswanipi river.

In the southern band, sphalerite occurs sparsely disseminated, and occasionally as small lens-shaped minor concentrations, in the sheared volcanic and sedimentary rocks along Iserhoff river.

Lenses of pyrite with small amounts of associated sphalerite were also observed in the nose and along the limbs of a small drag-fold in sedimentary rocks on the north shore of the southwest bay of Waswanipi lake, five and a half miles northeast of the mouth of the Iserhoff.

The gneissic biotite granite of the area proved to be devoid of any unusual minerals wherever it was examined. The southern porphyritic granite, on the other hand, has certain features deserving of attention. It is part of a batholith elongated in an east-west direction whose southern boundary lies against the northern edge of most of the Bachelor-Burge-Madeleine Lakes mineralized belt. The mass shows signs of having been subjected to marked differentiation; its composition varies considerably from place to place and the mass is cut by late acid and basic differentiates. It may, therefore, be an intrusive mass that generated residual mineralizing solutions which may have formed deposits, not only in the surrounding rocks but also in the mass itself and in the large bodies of other rock included in it. Along the northeasterly trending fault on the south side of Waswanipi lake the rock shows considerable hydrothermal alteration, and it seems to be intruded by a dyke thought to be a late basic differentiate of the mass. This occurrence suggests the possibility that other fractures in the hornblende granite may have been invaded by residual mineralizing solutions.

The large mass of granite and pegmatite underlying the greater part of the northern two-thirds of the area has not shown any promise from the economic standpoint. The numerous bodies of pegmatite encountered may bring to mind the economic possibilities of these rocks by reason both of their essential constituents and of certain minerals they frequently contain as accessories. In neither respect is the pegmatite seen in the area of any interest.

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