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WASWANUPI LAKE AREA (EAST HALF), ABITIBI-EAST COUNTY

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Department of Mines

Honourable C. D. FRENCH, Minister

A.-O. DUFRESNE, Deputy Minister

GEOLOGICAL SURVEYS BRANCH

I. W. JONES, Chief

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GEOLOGICAL REPORT 59

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**WASWANUPI LAKE AREA**

(EAST HALF)

ABITIBI-EAST COUNTY

by

Donald A. W. Blake



QUEBEC  
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1953

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent and reliable data collection processes to support informed decision-making.

3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and reporting, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data security and privacy. It stresses the importance of implementing robust security measures to protect sensitive information from unauthorized access and breaches.

5. The fifth part of the document provides a summary of the key findings and recommendations. It concludes that a comprehensive data management strategy is crucial for the organization's long-term success and growth.

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WASWANUPI LAKE AREA

(East Half)

ABITIBI-EAST COUNTY

by Donald A. W. Blake

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INTRODUCTION

Location and Access

The east half of the Waswanipi Lake area was examined by the writer during the summer of 1949. The area mapped comprises 230 square miles, of which about one-fifth is the eastern part of Waswanipi lake. It is bounded by longitudes 76°15' and 76°30'W., and by latitudes 49°45'N. and an east-west surveyed line four miles south of latitude 49°30', and includes parts of the townships of Ailly, Bellin, Bossé, Nelligan, La Rouvillière and Montviel.

Waswanipi lake, the centre of which lies about 87 miles north-northeast of the town of Senneterre on the Quebec-Cochrane line of the Canadian National railway, is most easily reached by hydroplane. Alternatively, there is available a long, but relatively easy, canoe route, from Senneterre down Bell river to Mattagami lake and thence up Waswanipi river, through Olga and Goéland lakes, to Waswanipi lake. The southeastern end of the last-named lake is only three miles or so north of the winter road, cut in 1949 by the Quebec Department of Mines, from the Senneterre-Lac Madeleine road to Bachelor lake.

The greater part of the map-area itself can be conveniently reached from the shores of Waswanipi lake or from one or other of the only two navigable rivers, Waswanipi in the north and Bachelor in the southeast. Taylor lake, in the east-central part, can be reached only by air or on foot, for Taylor creek, the small stream draining this lake, is rendered unnavigable by many rapids and fallen trees. A six-mile stretch of Waswanipi river, which flows westerly and southwesterly across the northern part of the area, is fast-flowing water. Within this stretch there are two major rapids, both of which, however, can be navigated in a freighter canoe powered by outboard motor. Inexperienced canoeists should avoid these rapids by portaging over Indian trails on the river's northern bank. The section of Bachelor river within the map-area is navigable with some difficulty. Near its mouth a mile-long portage is necessary on the north side of a turbulent rapid, and upstream there are log jams and numerous meander bends.

### Field Work

Rock outcrops were located by systematic traverses run at one-half to one-third of a mile intervals. The more abundant and better exposed outcrops on the shores of Waswanipi lake and river were examined in detail.

The base-map on which the geology was plotted is, except for a small section, a copy at one-half mile to the inch of plans prepared by the Surveys Branch of the Department of Lands and Forests, Quebec, and based mainly on vertical aerial photographs. The small section west of longitude  $76^{\circ}25'$  and south of latitude  $49^{\circ}40'$  is a copy of a part of Sheet No. 32F\* which was prepared for the most part from oblique aerial photographs. Because this part of the base-map was found to be not sufficiently accurate for the field work, the lake shores and stream courses were redrawn in greater detail from vertical aerial photographs.

### Previous Work

The first known geological studies in the region were made by Robert Bell (2, 3)\* in 1895 and 1896, when he explored the basin of Nottaway river. In 1912, J.A. Bancroft (1) mapped portions of the drainage basins of Harricana and Nottaway rivers. At later dates, the Waswanipi Lake region was covered by the reconnaissance surveys of Lang (10) in 1931, Norman (16) in 1935, and Sproule (17) in 1936. The adjoining fifteen-minute areas lying to the west (5), north (8), east (11), and south (12) of the present map-area were mapped by geologists of the Quebec Department of Mines in 1948, 1949, 1946, and 1934, respectively.

### Acknowledgments

The late Ronald A. Lay, of McGill University, Montreal, and Arthur Mathieu and Pierre Sauvé of Ecole Polytechnique, Montreal, rendered very able assistance in the field. Lay, after whom Lay peninsula is named, most unfortunately lost his life by drowning in Waswanipi lake. The cook, Menesippe Taillefer, and the two canoeemen, Paul Dallaire and James R. Digby, discharged their duties in a satisfactory manner. The writer is also indebted to Ronald Thierry, the Hudson's Bay Company post manager at Waswanipi Post, and his wife for many courtesies and assistance rendered during the summer.

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\* Waswanipi Sheet, 1" = 4 miles, National Topographic Series, Department of Mines and Resources, Ottawa, 1938.

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

## DESCRIPTION OF THE AREA

### Climate

An amateur study of the weather in the region was made from June 10th to September 5th in 1948 while the writer was in the Waswanipi Lake area (West Half). It consisted of daily observations of the temperature, barometric pressure, humidity, degree of overcast, wind direction, quantity of rain, and changes in lake level.

The cool spring-like weather of June was followed by long spells of hot days in July and August when the temperature sometimes approached 90°F. As the weather became warmer, the rainfall increased. During the first month of the season, about 40 per cent of the days were rainless and relatively clear, but from July 15th to August 12th there were only four days without rain and the sky was nearly continuously overcast. The level of Waswanipi lake dropped five feet from June 10th to July 21st at a gradually decreasing rate. There followed a three-day heavy rain. This was reflected by a rise in lake level which culminated a week later when the lake had risen two feet. Ordinarily there is a difference of twenty-two feet between the high-water level in the spring and the low-water level in the fall, and, as a result, large low-lying areas are flooded annually. The flooding is so extensive that in some places a canoe can be paddled inland between the trees for several miles. An average of four feet of snow accumulates in winter and the lake freezes to a depth slightly greater than two feet. The date of break-up has lately been averaging between May 1st and 10th, and of freeze-up between December 16th and 24th.

### Timber

The forest growth which, with the exception of grassy swamps, covers virtually the entire land area, is mainly spruce. Where the ground is well drained, however, as on elevations and along Waswanipi river, poplars and birch grow in large groves. Alders, which are found nearly everywhere and especially along creek banks and lowlands, render travel on foot slow and laborious.

### Native Population and Animal Life

Thirty-three families of Swampy-Cree Indians congregate each summer at Waswanipi Post, at the north end of Waswanipi lake (Plates I and II). There they sell their winter's catch of furs to the Hudson's Bay Company. Their winter trap-lines extend one hundred miles north, sixty miles east, and forty miles south and west.

Their catch, diminishing as the years go by, consists of muskrat, ermine, mink, lynx, and otter, in order of abundance. Beaver are trapped in the summer, and they alone are increasing in number. Efforts on the part of the government to persuade the Indians to farm have had only slight success. Since 1946 they have tended a few cattle and goats and one family boasts a large garden at Pusticamica lake.

Moose and bear are the only large game animals in the region. Only three moose were seen by the party, but tracks were frequently encountered. Fish are plentiful in Waswanipi lake, and pike, the most abundant, are netted in large numbers by the Indians. An attempt several years ago to establish commercial fishing proved unsuccessful after four years' operation.

#### Topography

The map-area, like most of the surrounding region, is a monotonous plain. Despite the flatness, however, three types of topography, each with a different origin, can be distinguished. A low, absolutely flat area borders the east shore of Waswanipi lake and extends up to five miles inland. This tract, which is underlain by post-glacial layered clay, silt, and sand, obviously marks the extension of Waswanipi lake at one of its earlier stages (Plate III-A). Along the eastern boundary of the map-area, disconnected bed-rock hills, not exceeding one hundred feet in elevation, give the country a slightly rugged aspect. It is here, on the tops of the small hills, that many of the rock exposures were found. Elsewhere, the terrain is gently rolling and, for the most part, is the expression of slightly dissected, irregular accumulations of glacial debris (Plate III-B).

#### Drainage

The streams in the flat area east of the lake have developed quite noticeable dendritic patterns. Some, such as the lower part of Taylor creek, the northeast-trending section of Bachelor river, and the east-west stretch of Waswanipi river, appear to be structurally controlled. Elsewhere, the streams follow haphazard courses through glacial debris (Plate IV-B). Although there are few lakes, the large number of water-saturated grassy swamps attest to the general undrained character of most of the terrain.

All drainage courses in the area, except for some in the northeast corner, run either to Waswanipi lake or to Waswanipi river. The latter (Plate IV-A), the major drainage artery of the region, flows westward across the map-area, taking in Waswanipi lake, and,

together with the northward-flowing Bell river, empties into Mattagami lake. Mattagami lake, which is forty miles to the west-northwest of Waswanipi lake, is drained northward to James bay by Nottaway river.

## PLEISTOCENE GEOLOGY

### General

In the Waswanipi Lake area, the constructional effects of continental glaciation far outweigh the destructional effects. Striae, glacial grooves, chatter marks, roches moutonnées, and the absence of residual soil, indicate that some ice erosion occurred. Glacial deposits, on the other hand, are very much in evidence. They can be classified according to their origin as morainic deposits and proglacial deposits. The morainic deposits, which in this region are composed mostly of boulders, gravel, and sand, are found mainly as a thin irregular ground moraine. In places, the outward form of the ground moraine is strongly suggestive of low, broad drumlins.

Investigations were made of annual moraines and exposures of varved clay found in the area, and a discussion of each follows.

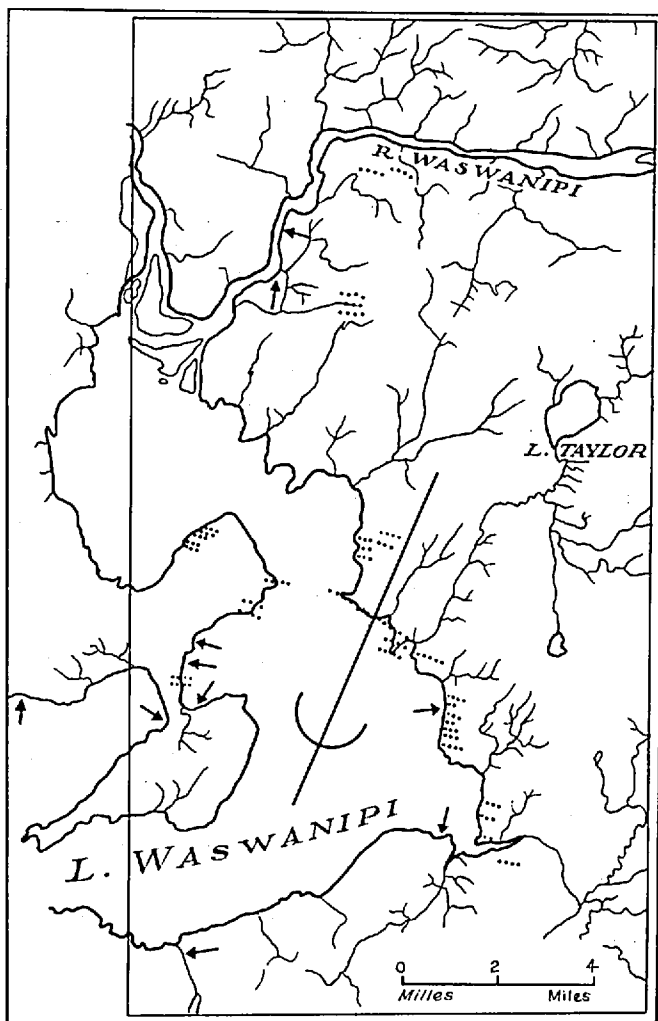
### Annual Moraines

Annual, or washboard, moraines, such as have been described in other areas by Norman (15), Mawdsley (14), and others, were found in several localities in the present map-area (Figure 1). Here, they vary in their characteristics, but they are typically long, nearly straight ridges up to fifty feet in width and ranging from five to twenty feet in height. They are arranged with their length at right angles to the direction of ice movement at roughly 1,000-foot intervals. The ridges are composed of unsorted glacial débris ranging in size from fine sand to large boulders, and their sides rest at about the angle of repose of this material. They are separated by flat stretches underlain by varved clay.

It is thought by most geologists that they were formed in a proglacial lake during the declining stages of the ice age, and, further, that the distance between moraines represents the annual retreat of the ice sheet. Their exact mode of formation, however, is a matter of speculation.

### Varved Clay

Clay is widespread in the area and underlies most of the low-lying swampy tracts. The meandering sections of streams are invariably flanked by low clay banks, and, in several places on the



Dots indicate positions of known annual moraines;  
arrows the positions of exposures of varved clay

FIGURE No.1

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No. 1003

lake shore, clay banks up to twenty-five feet high were found. It is in these latter, especially, that the laminated character of the clay is most easily recognized and studied. The scattered distribution of the sites at which marked stratification was observed indicates, with little doubt, that all the clay in the area is similarly stratified (Plate V-A). The clay in every respect is typical of late-Pleistocene varved clay formed in proglacial lakes, in this case lake Barlow-Ojibway. In all the occurrences studied, the character of the varves was found to be so nearly the same that only one exposure of the varved section need be described.

The occurrence selected for illustration is not actually within the map-area. It is on the north shore of the southwest bay of Waswanipi lake, two miles beyond the west boundary of the map-area. The bank of varved clay exposed here is twenty-five feet high and offers an excellent opportunity for the study of what is probably a complete section (Plate V-B).

Coarse, grey, cross-bedded sand is found at the base of the section and upward becomes progressively finer and more uniformly bedded. The third foot up from the base of the bank consists of fine sand and silt with interbedded lenses and irregular layers of coarse sand. At the top of the third foot, a clay bed half an inch thick is found between layers of silt and sand. From there upward, the clay layers become progressively more numerous. Two to four clay layers, separated by silt, are found in each foot up to the tenth.

In the tenth foot, eight layers of brown clay (summer layers) totalling about four inches in thickness are interbedded with a corresponding number of layers of cream-coloured silty clay (winter layers). This one-foot section thus represents eight years of deposition, during which the ratio of thickness of the summer layers to that of the winter layers was 1:2. This ratio is reversed in the eleventh foot and from there to the top of the bank it decreases progressively and at the same time the number of layers per foot, and hence the number of years of deposition represented by each thickness of one foot, rapidly increases. Results of observations illustrating these features are given in the following tabulation:

	<u>Ratio of thickness</u> <u>summer layers</u> <u>to winter layers</u>	<u>Years represented</u> <u>per foot</u>
10th foot .....	1 : 2	8
11th foot .....	2 : 1	11
19th foot .....	1 : 1	23
21st foot .....	1 : 2	42

In the twenty-second and twenty-third feet, the clay is indistinctly, but very finely, layered and, at the top, grades into soil which covers the bank to a depth of two feet. The top of the bank is flat and extends back as a miniature plateau for some distance. Streams have eroded away the clay on both east and west sides of the bank, thereby producing what has the appearance, from the lake, of a small mesa. The flat top must have been the lake bottom at the time of drainage of lake Barlow-Ojibway. If, therefore, the coarse sands at the base of the clay bank represent the base of the section, a complete record of the proglacial lake at this locality is contained in the above-described exposure. In this probably complete section, three hundred and fifteen years are represented, with an estimated possible error in counting of twenty-five years. This means that about three hundred and fifteen years lapsed between the time when the ice front stood at Waswanipi lake and the time when lake Barlow-Ojibway was drained. That the retreat of the ice sheet was quickened during the final one hundred and fifty years is suggested by the accelerated rate of varve thinning observed toward the top of the section.

A few boulders and stones were found imbedded in the varved clay, and the beach fronting the bank is strewn with them. They evidently fall from the bank as the waves of the present lake remove the sand and clay. It must be assumed that erratics contained in the varved clay were dropped from icebergs during their slow underwater melting.

Although there is no sign of the varves in the above locality having been disturbed, they are seen to be highly contorted on the isthmus joining the two parts of Lay peninsula. There, where the beach sand has been washed away, the clay is exposed on a nearly horizontal plane. The varves dip steeply to the southeast and, over the exposed distance of sixty feet, are buckled into at least five isoclinal folds, inclined to the northwest. Because the fold axes are nearly parallel to the direction of ice movement, the folding could not be due to a re-advance of the ice sheet. It must be concluded, then, that the deformation in this locality was produced by a drifting iceberg and, further, that the iceberg drifted with a northwest-flowing current. Elsewhere in the area, the varved clay, except for minor undulations, is undisturbed.

The clay in many instances was seen to overlie glacial till, but in no case was the reverse seen to be true. Although there is evidence indicating that there was a re-advance of the ice sheet in the Maicasagi area (8) to the north, it evidently could not have extended far south into the present area.

GENERAL GEOLOGY

General Statement

Almost everywhere throughout the area, the thick mantle of glacial and post-glacial deposits effectively conceals the consolidated rocks. However, from the distribution of the small number of exposures found, it is thought that by far the greater part of the area is underlain by granite. There are also, however, sedimentary and volcanic rocks of Precambrian age. These are exposed in two main belts that extend northeasterly across the central and southern parts of the map-area and in a third, small belt west of O'Sullivan river. Within the granite masses, they are represented by scattered inclusions and roof pendants. An outlier of Upper Ordovician limestone covers an area of unknown extent in the western and southwestern part of the map-area. Only three small outcrops of this formation were seen.

Table of Formations

CENOZOIC	Quaternary	Glacial till, gravel, sand, silt, varved clay
PALAEZOIC	Upper Ordovician	Fossiliferous limestone
PRECAMBRIAN	Acidic Intrusives	Pink biotite granite, pegmatitic granite, pegmatite
		Quartz leucodiorite
		Hornblende granite
		Gneissic biotite granite
	Sedimentary- volcanic Series	Fine-grained, impure quartzite and other sedimentary rocks  Altered andesitic lava

Sedimentary and Volcanic Rocks

One of the two principal sedimentary-volcanic belts crosses the southeastern corner of the map-area. It is a relatively small part of a large zone of these rocks that extends for several miles to the northeast beyond Bachelor lake and southwest beyond Esther and Wedding lakes.

Clearly recognizable lavas are exposed in two groups of outcrops three-quarters of a mile southeast of, and a mile and a half east of, the sharp bend in the general course of Bachelor river. Here, well-developed, though squeezed, pillow lavas, together with minor amounts of vesicular lavas and lava breccias, form a band which follows the general east-northeast trend of the belt. South of this band, however, there are fine-grained, sheared, basic rocks whose original nature remains in doubt, though they are believed to have been derived from lavas. The pillows have yellowish-green borders which stand out in relief, so that their size and shape was clearly marked. They average one foot in length, but occur up to three or four feet in length, whereas their width is seldom greater than four inches (Plate VI-A).

Under the microscope, the lavas in nearly every case are seen to be greatly altered. Often the only minerals which can be identified are chlorite, epidote, and magnetite, which occur in a felted mass. In one thin section, plagioclase phenocrysts up to one-sixteenth of an inch in length occur in a very fine matrix of plagioclase laths arranged in a felted pattern with minor amounts of uranalite, chlorite, and magnetite. The plagioclase, in this case, has the composition of andesine so that the lava is classed as an andesite. In two of the sections examined, considerably-altered hornblende and plagioclase are present in approximately equal amount, with magnetite as an accessory mineral.

North of the lavas and separating them from the granite is a band of sedimentary rock. About a mile wide at the map's eastern boundary, this band apparently thins out westwardly to end about midway across the map-area. The rocks are fine-grained, thinly-bedded, impure quartzites. Nearly-pure quartz laminae alternate with laminae rich in recrystallized basic minerals of which biotite, arranged parallel to the bedding, is the most prominent. The fact that these sedimentary rocks are cut by many dykes of granite suggests that their outcrops are not far distant from the margin of the granite mass to the north.

The second of the two main belts of Keewatin-like rock is a narrow belt that trends northeastward from about the middle of the east shore of Waswanipi lake along the lower part of Taylor creek, passes

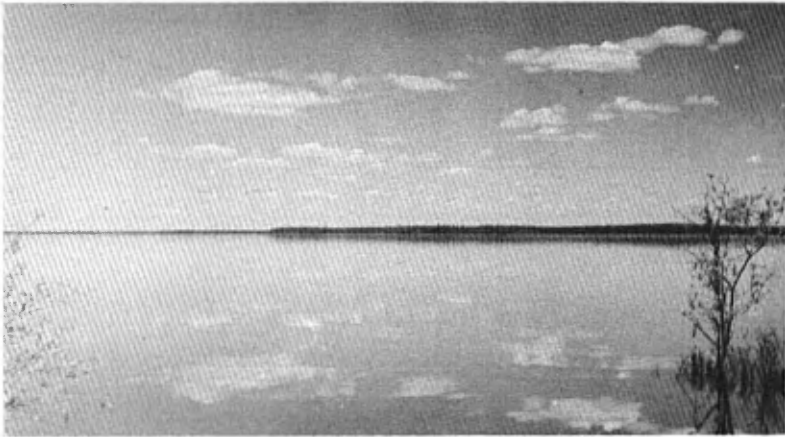


Waswanipi Post at the north end of Waswanipi lake where nearly three hundred Indians congregate each summer .  
The new government school and four hospital buildings may be seen on the higher ground at left centre .



The Hudson's Bay Company store and factor's residence at Waswanipi Post.

Plate III



A - Looking north along the east shore of Waswanipi lake . Note the low, featureless land which is mostly underlain by varved clay .



B - View northwestward from the low hills southeast of Bachelor river showing the heavy forest cover and gentle relief .

Plate IV

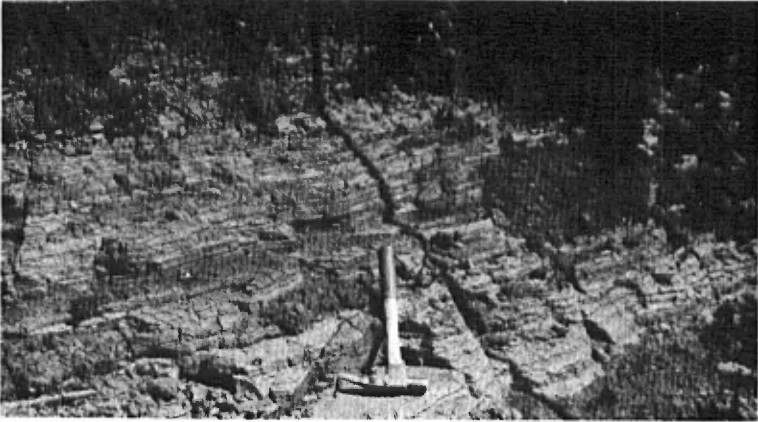


A - A quiet stretch of Waswanipi river .



B - O'Sullivan river, viewed upstream from its mouth .

Plate V



A - Exposure of varved clay on the south bank of Waswanipi river midway between the lower two rapids.



B - Exposure of a probably complete section of varved clay on the north shore of southwest bay of Waswanipi lake, two miles west of the western boundary.

Plate VI



A - Pillow lava southeast of Bachelor river .



B - Large inclusion of the sedimentary-volcanic series contained in the pink biotite granite and pegmatite . South bank of Waswanipi river about midway across the map-area .

Plate VII



A - Pegmatite dykes cutting finer-grained, massive, pink biotite granite. North bank of Waswanipi river, one-third of the way from the western boundary.



B - Outcrop of Upper Ordovician limestone, partly covered by boulders, exposed on the north shore of Lay peninsula.



Upper Ordovician limestone exposed on the south shore of Waswanipi lake .

through Taylor lake, and thence swings sharply east before leaving the map-area about six miles south of its northeast corner. It is evidently the eastward continuation of the volcanic-sedimentary belt that, mapped by Claveau (4, 5, ), follows Iserhoff river and the north shore of the southwest bay of Waswanipi lake. The limited number of exposures seen indicate that this part of the belt is composed entirely of sedimentary rocks and is not over a mile in width. Its boundaries, as drawn on the map, are, of course, largely inferred. Although no exposures of sedimentary rock were seen on Lay peninsula, in the western part of the area, arbitrary contacts have been drawn on the map to indicate the trend of the belt toward its western extension as mapped by Claveau.

The fresh surface of the rock is typically dark grey or nearly black, and the bedding is extremely fine and regular. Under the microscope, quartz is seen to make up from 50 to 90 per cent of the four slides examined, the remainder being mostly hornblende and biotite. Epidote, chlorite, and magnetite are present in small amount, and feldspar, chiefly plagioclase, makes up about five per cent of two of the slides. The laminations, which are generally less than one-sixteenth of an inch in thickness, are marked by the alternation of layers of quartz grains with layers of strongly-aligned hornblende and biotite grains. Locally, the rocks have been intruded by numerous dykes of granite and pegmatite, near which porphyroblasts of feldspar, up to one-third of an inch in length, have developed. The marked schistosity is everywhere parallel to the bedding, which regularly strikes northeasterly and dips to the southeast at about 60 degrees.

In the southwest corner of the map-area, near the mouth of O'Sullivan river, three small outcrops of sedimentary rock were found. They indicate that a narrow band of dark-weathering, fine-grained, impure quartzite extends to the southwest where it might join the band of magnetic sedimentary rocks mapped by Claveau (5). Although none of these magnetic sedimentaries were found in place in the present map-area, a strong magnetic anomaly was detected a mile east of O'Sullivan river and three-quarters of a mile south of the lake. In the exposures within the present area, the sedimentary layers are typically thin and well developed. They are often injected in lit-par-lit fashion by white-weathering, fine-grained granite, which has produced partial granitization in some places.

Contained in the granite masses are large and small inclusions and roof pendants of the sedimentary-volcanic series (Plate VI-B). The largest roof pendant seen, and the only one shown on the accompanying map, is well bedded, impure quartzite exposed on the south shore of Waswanipi river about midway across the area.

### Acidic Intrusives

#### General Relationships

Claveau (4), in the Iserhoff River area, mapped three main bodies of granitic intrusive rock, each of which has definite and constant characteristics. He named them "quartz diorite" (oldest), "quartz syenite", and "pink granite" (youngest). In the Waswanipi Lake area (west half) (5), he encountered the same rocks, but he made two changes in nomenclature. The term "quartz diorite" was replaced by the more accurate term "gneissic biotite granite", and "quartz syenite" was replaced by "hornblende granite". The second change was warranted by the fact that the body of what is, in the Iserhoff River area, a typical quartz syenite, contains a higher percentage of quartz as it passes eastward into the Waswanipi Lake area, where it has the composition of a normal hornblende granite. The three granites, as separated by Claveau, continue without change along strike into the present map-area, where they are easily recognized and separated. They are from oldest to youngest, as follows:

Gneissic biotite granite  
Hornblende granite  
Pink, massive biotite granite, pegmatitic  
granite, and pegmatite

A fourth and minor granitic type, found associated with the hornblende granite, occurs as ill-defined bodies and dykes in all three map-areas. Claveau described it under the name "quartz leucodiorite".\*

The gneissic biotite granite is definitely older than the pink biotite granite and its related rocks since in all three areas it is found as roof pendants and inclusions within the latter.

The hornblende granite, which is separated from the pink biotite granite by the Taylor Creek sedimentary band, is probably the older of the two. This is thought likely because it is cut by coarse pegmatite dykes, which resemble those associated with the pink biotite granite.

The hornblende granite is believed to be younger than the gneissic biotite granite, but the evidence for this is meagre. In the

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\* Claveau also recognized a fifth type of acid intrusive which he termed "biotite-hornblende granite". This he considered to be closely related to the hornblende granite.

Iserhoff River area, an inclusion of granitic rock that corresponds to the gneissic biotite granite was seen in the quartz syenite, a facies of the hornblende granite.

The quartz leucodiorite, which is found only in association with the hornblende granite in dyke-like bodies, is thought to be of the same age as the hornblende granite. It and the lamprophyre dykes found to the west (5) probably represent complementary offshoots from the thoroughly differentiated magma that gave rise to the hornblende granite.

Although the relative ages of the three granitic bodies are not definitely fixed, they undoubtedly, together, represent only one major intrusive cycle. That they are genetically closely related is indicated by their great similarity in chemical composition. From one to another, the plagioclase component varies only slightly in composition, and the potassic feldspar is invariably microcline.

#### Gneissic Biotite Granite

This, the oldest of the granites, is found in the northern part of the area as roof pendants and inclusions in the massive biotite granite and related rocks. Elongated areas in which the older granite predominates are shown on the accompanying map. As mapped, however, their outlines are necessarily arbitrary, for outcrops are small and few in number. The roof pendants and inclusions, wherever found, are cut, in a complex fashion, by large and small dykes and irregular bodies of the massive biotite granite, pegmatitic granite, and pegmatite.

The gneissic biotite granite is a medium- to coarse-grained rock, white to grey on its weathered surface. Its gneissic character is strongly developed. Under the microscope, it is seen to consist of a relatively unaltered aggregate of subhedral grains of plagioclase, microcline, quartz, and biotite, with minor alkaline amphibole. Microcline, which is completely unaltered, is present in amount ranging from negligible to as much as 50 per cent of the rock. Plagioclase ( $An_{18-22}$ ), most of the grains of which are slightly altered to kaolin, sericite, and some calcite, makes up the remainder of the feldspar content. Quartz ranges from 5 to 25 per cent. Biotite is the chief ferromagnesian mineral, but alkaline amphibole (hastingsite) occurs with the biotite in small amount. Together, they form less than 15 per cent of the rock. The ferromagnesian minerals are slightly altered to epidote and chlorite. Other persistent minerals, though present in small amount, include sphene, apatite, and magnetite. The magnetite is in part an alteration product of the ferromagnesian minerals. Myrmekitic structure, which indicates rapid cooling, was observed in most of the slides.

In some places, the gneissic biotite granite has a porphyritic facies in which there are feldspar phenocrysts up to an inch in length. Because these phenocrysts are aligned parallel to the gneissic banding, and because the rock shows little sign of deformation, it is thought that the gneissosity is primary in origin. Inclusions, probably of sedimentary origin, now highly altered and partially granitized, are found locally in the granite. They are, in every case observed, oriented parallel to the gneissic banding.

#### Hornblende Granite

That section of the map-area lying between the two main belts of sedimentary and volcanic rocks is believed to be underlain almost entirely by hornblende granite. This is part of a fairly large batholith that extends, with a general trend somewhat north of east, for some forty miles, from near Bell river in the west almost to Bachelor lake in the east. This batholith varies in width between four and nine miles. Roughly one-quarter of its total extent is contained within the present map-area.

The typical rock is pink-weathering hornblende granite. Although massive and equigranular in places, it is usually porphyritic and slightly gneissic, with phenocrysts of feldspar, in many places more than one inch long, and lens-shaped basic inclusions, numerous in some exposures, oriented parallel to the gneissic banding. These features, and the fact that the granite appears fresh and undeformed, indicate that the banding was produced during emplacement. In many places, the inclusions are partly granitized and contain numerous feldspar porphyroblasts. The granite surrounding the inclusions, in a few instances, was seen to be more basic than usual as a result of contamination.

In thin-section, the rock is seen to be composed chiefly of subhedral grains of microcline, plagioclase, and quartz which, together, give the rock a typical granitic texture. In the six slides examined, the quartz content varies between 8 and 25 per cent. Those sections which contain the higher percentage of quartz were of specimens taken from the more easterly parts of the batholith as exposed in the area. Microcline is uniformly distributed through the rock in amount varying between 10 and 40 per cent. The feldspar phenocrysts also are microcline; they have fairly sharp crystal outline though with some tendency to irregular embayment at their margins. Plagioclase, of composition  $An_{16}$  to  $An_{26}$ , makes up the remainder of the feldspar. The essential ferromagnesian mineral is hornblende, which forms not more than 10 per cent of the rock. Biotite, however, is occasionally present, in amount subordinate to the hornblende. The hornblende and biotite are, to a greater or lesser extent, altered to

chlorite and epidote, and the plagioclase is usually heavily clouded by alteration products. Sphene, apatite, and magnetite are invariably present as accessory minerals.

#### Quartz Leucodiorite

There are a few exposures of a grey, slightly gneissic, medium-grained, biotite granite in the southwest corner of the map-area. Apparently, it forms several large and small dykes striking in a northeasterly direction. In one place, this rock was seen to cut across the porphyritic hornblende granite. The one slide examined is rich in quartz and plagioclase and contains a very minor amount of potassic feldspar in the form of microcline. Small biotite flakes make up 5 per cent of the rock, and their rough alignment produces the slight gneissosity. Similar northeast-trending dykes cutting hornblende granite in the area to the west were described by Claveau (5). There, the rock contains about 80 per cent plagioclase and 20 per cent quartz and biotite and was termed by Claveau "quartz leucodiorite". The dykes in the present map-area resemble those to the west in all respects except for a slight difference in composition. Quartz is more plentiful, and a small amount of potassic feldspar is present. In spite of this difference, however, the writer, for the sake of uniformity, has designated this rock, also, as quartz leucodiorite.

#### Pink Biotite Granite, Pegmatitic Granite, and Pegmatite

As previously mentioned, the acidic intrusive rocks included in this group are usually associated with the older gneissic biotite granite. Together, they are thought to underlie the greater part of the northern half of the map-area, that is, most of the area north of the Taylor Creek sedimentary belt. Similar granitic rocks extend, as a large batholith, west, north, and east, well beyond the limits of the map-area.

A great difference in grain size is the major feature distinguishing the three facies of this intrusive complex. The typical biotite granite is pink-weathering, fine- to medium-grained, and generally massive, although, rarely, an alignment of the crystals is noticeable. Examination of eight slides revealed that the rock consists essentially of plagioclase ( $An_{8-14}$ ) and microcline, in about equal amount, and quartz (20 to 30 per cent). Biotite, not exceeding 5 per cent, is present in all the slides, and most of them contain apatite, magnetite, and pyrite as minor accessory minerals. The feldspar and biotite grains are slightly altered. The pegmatitic granite facies has very much the same composition, but is coarser in grain. It is found both cutting the biotite granite and gradational

into it. The pegmatite, which occurs abundantly as dykes and irregular masses, is a coarse-grained aggregate of pink orthoclase, white plagioclase, and quartz (Plate VII-A). Crystals of these minerals may be as much as two or three feet in their greatest dimension. Except for occasional small flakes of biotite and muscovite, the pegmatite is apparently barren of other minerals. In some places it cuts, and in others is gradational into, the pegmatitic granite.

#### Upper Ordovician Limestone

The presence of large, angular, glacially-transported slabs and boulders of Palaeozoic limestone in the Waswanipi Lake region has been known for many years. Although geologists suspected the existence of limestone outcrops, it was not until the summer of 1948 that F.J. Sugden (18), geologist for the Dominion Gulf Company, made the first discovery of the rock in place. On the southern shore of Waswanipi lake, at the mouth of a small creek about two miles east of O'Sullivan river, he found five feet of horizontal strata, exposed at low water, along the walls of a miniature canyon. An additional four feet of the rock was seen below the water level. The outcrop extends about 70 feet inland, where it disappears beneath glacial till. Laterally, the beds are exposed for some 30 feet east and west along the lake shore, where, at both ends, they are concealed by sand and gravel.

By a study of the distribution of limestone boulders and by a close examination of the shore of Waswanipi lake at low water, the writer was able to find two other exposures of what appear to be the same limestone formation on the northwest side of Lay peninsula, that is, some eight miles north of the exposure described by Sugden. They are to be seen only at very low water along a gently-sloping boulder shore. Each is about 400 feet long, and their exposed width varies with the lake level. Inland, the formation becomes buried beneath boulders and drift (Plate VII-B). The distribution of limestone boulders and slabs suggests that this rock is fairly widespread in the district. It is even possible that all the area between the north shore of Lay peninsula and the south shore of Waswanipi lake is mainly underlain by limestone. It also seems probable that this limestone outlier owes its preservation to the protection afforded by its having been deposited in a broad basin in the Precambrian erosion surface.

The limestone is medium grey, weathers light grey, and breaks easily, along thin discontinuous layers of argillaceous material, into slabs from one to five inches in thickness. Dolomitic material is present in small buff-weathering patches. In some places, especially where fossils are absent, the limestone contains calcite crystals up

to one-eighth of an inch across, but elsewhere it is not visibly crystalline. Analysis of a six and one-quarter pound sample of the limestone in the laboratories of the Quebec Department of Mines gave the following result:

CaO .....	50.67	per cent
MgO .....	0.75	"
Al <sub>2</sub> O <sub>3</sub> .....	0.92	"
SiO <sub>2</sub> .....	5.82	"
TiO <sub>2</sub> .....	0.03	"
Fe <sub>2</sub> O <sub>3</sub> .....	0.52	"

Dr. T.H. Clark, of McGill University, Montreal, made a study of the fossils contained in a collection submitted to him by the writer. His report is summarized in part below:

Fossils are probably sparingly present in the outcrops, and are none too plentiful as identifiable species. Nevertheless, the list given below provides enough information for a sure correlation of the limestone.

Species	Localities						
	1	2	3	4	5	6	7
1. <u>Receptaculites oweni</u> (Hall)			x		x		
2. <u>Halysites gracilis</u> (Hall)		x			x		x
3. <u>Streptelasma corniculum</u> (Hall) or <u>S. rusticum</u> (Billings)	x		x		x		
4. <u>Plasmopora lambi</u> (Schuchert)					x		
5. <u>Pleurocystis</u> sp.		x					
6. <u>Heterocrinus?</u> sp.						x	
7. <u>Rafinesquina alternata</u> (Emmons)	x						
8. <u>R. sp.</u> , cf. <u>R. trentonensis</u>	x						
9. <u>Strophomena incurvata</u> (Shepard)		x					
10. <u>Platystrophia</u> sp., cf. <u>P. extense</u> (McEwan)				x	x		
11. <u>Dalmanella</u> sp.				x			
12. <u>Hormotoma major</u> (Hall)					x		x
13. <u>Ilospira angustata</u> (Ulrich and Schofield)			x				
14. <u>Lophospira augustina</u> (Billings)					x		
15. <u>Maclurites crassus</u> (Ulrich and Schofield)	x			x	x		x
16. <u>Maclurina manitobensis</u> (Whiteaves)							x
17. <u>M. cuneata</u> (Whitfield)	x				x		
18. <u>Triptoceras</u> sp.					x		
19. <u>Actinoceras</u> sp.						x	

Though at first sight this fauna seems to be of Trenton age, very few of its species occur in the Trenton beds of the Ottawa-St. Lawrence lowland area. Instead, one finds in the Liskeard formation of lake Temiskaming (200 miles southwest of Waswanipi lake) a fauna almost completely embracing that of the present report. From the Liskeard formation, Hume (9) gives a list of 37 species for the upper Liskeard limestone, and with few exceptions the Waswanipi species occur in this list. Unless further collecting should show sedimentary types differing lithologically from the beds described by Hume, or other important relevant information, it seems best to refer the Waswanipi beds to the upper limestone horizon of the Liskeard formation.

Hume determined the Liskeard limestone to be of Trenton age largely because of the similarity of its fauna with that of the Galena limestone of Minnesota. Since Hume's work, considerable doubt has been expressed as to the Trenton age of the Galena limestone beds (19, 7) and, though it now appears that the Galena is to be correlated with the Trenton, parts of its fauna recur in the Arctic Richmond. This recognition carries with it the revision of the age of the Ordovician limestones north of the Ottawa-St. Lawrence belt. The Nelson River limestone of Hudson Bay (600 miles northwest of Waswanipi lake), the Red River and Stony Mountain limestones of Manitoba (750 miles west of Waswanipi lake), and the Liskeard limestone of Lake Temiskaming are now all dated as Richmond. This means that the Waswanipi Lake exposures carry the area of outcrop of the western (Arctic) type of Richmond 150 miles farther east than has hitherto been recognized.

#### STRUCTURAL GEOLOGY

Because of the scarcity of rock exposures, it is impossible to decipher at all accurately the structure in the map-area. The gneissosity of the hornblende granite and of the gneissic biotite granite strikes generally from northeasterly to easterly. The strike of the Precambrian sedimentary and volcanic formations is almost everywhere parallel to the banding of the granite, and the bedding planes dip at high angles.

Quite possibly, one or more fold axes trend across the area in a northeasterly direction, but their location would be a matter of speculation.

The bedding in the sedimentary band that passes through Taylor lake dips consistently toward the southeast at about 60 degrees. North of this band, sedimentary rocks are contained in the granite as small roof pendants and large inclusions, and in these the strata dip uniformly to the north. Drag folding in this area indicates that an

anticlinal axis exists to the south. Thus, it is possible that these sedimentary remnants represent the nearly engulfed northern limb of an anticline, whereas the sedimentary belt passing through Taylor lake forms the southern limb.

Although major shear zones and faults probably occur throughout the area, only a few can actually be observed. That there is a fault or a zone of weakness along Waswanipi river seems reasonably certain for the following reasons. Except for a sharp elbow in the western part of the map-area, the river follows an almost straight westerly course for more than thirty miles. A highly-fractured rock outcrop altered to a red colour is found where the river turns sharply southwestward. In the centre of this outcrop there is a 30-foot gap, bordered by strong easterly-striking shearing. In the area to the west of the present map-area, the presence of a large diabase dyke paralleling the river, and of reversed structures on opposite sides of the river, are additional indications of the existence of a fault with marked displacement.

Small shear zones and faults are found frequently, both in the granites and in the sedimentary and volcanic rocks. Those shear zones or faults that have a reasonable degree of prominence are indicated on the accompanying map.

#### ECONOMIC GEOLOGY

Although the summer's work failed to reveal any mineralization of economic interest, the presence of ore deposits is not precluded. The finding, during the past few years, of deposits of considerable interest in the Bachelor Lake area, immediately east of the present area, is proof of the occurrence of gold, lead, zinc, and copper in some parts of the general region.

The granites, for the most part, appear to be practically barren, but signs of mineralizing action were seen on some of the exposures of sedimentary and volcanic rocks. Small veins of quartz and carbonate are in places abundant, and considerable hydrothermal alteration along fractures and shear zones was often noted.

Within, and bordering, the shear zone in the sedimentary rocks west of O'Sullivan river, there is intense hydrothermal alteration and a large amount of finely-disseminated pyrite. A two and one-quarter pound sample taken across the zone was assayed in the Quebec Department of Mines laboratories and found to contain 0.05 per cent copper, 0.05 per cent zinc, and 'traces' of lead and silver. Disseminations of pyrite were seen in many places in the sedimentary and volcanic rocks in the southeastern corner of the area, but

apparently they are less frequent here than in the rocks of the south-west corner. Any sedimentary or volcanic rock bordering, or contained in, the batholith of hornblende granite, as in these two cases, should not be neglected by the prospector. This granite shows many signs of having been thoroughly differentiated, and it is quite possible that the resulting residual solutions formed worth-while mineral deposits in the included and surrounding rocks and, possibly, even in the granite itself.

Although evidence of mineralization is meagre in the Taylor Creek sedimentary band, the band's position between two granite masses, and the presence of minor zones of hydrothermally-altered rock containing some disseminated pyrite, indicate that this section of the area may warrant further investigation.

It must be pointed out, however, that the scarcity of rock exposures in the map-area is a definite hindrance to prospecting.

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