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ONTARIO DEPARTMENT OF MINES

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HON. PAUL LEDUC, *Minister of Mines* H. C. RICKABY, *Deputy Minister*

FORTY-EIGHTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

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Geology of the Keezhik-Miminiska Lakes Area

By

V. K. PREST

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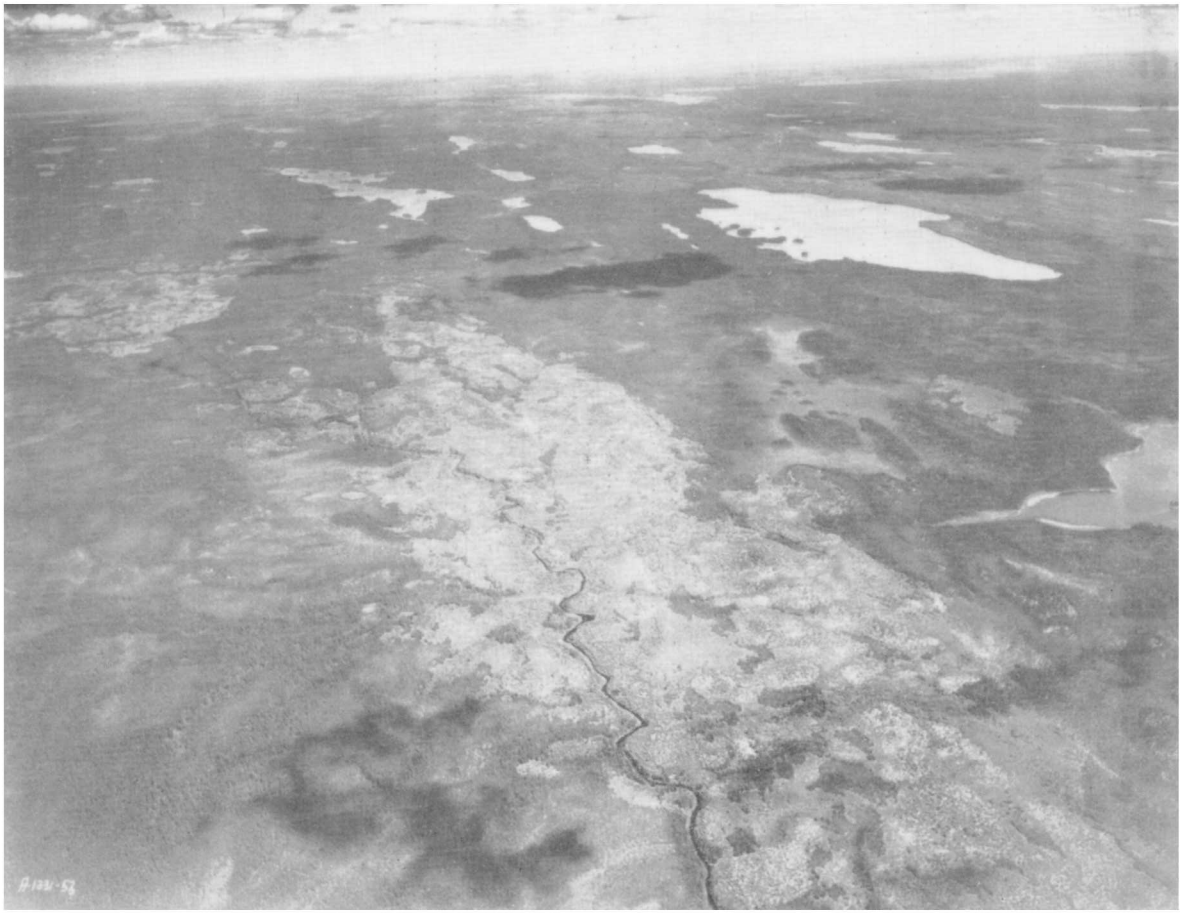
(In pocket at back of report)

Map No. 48e—Keezhik-Miminiska Lakes Area, District of Kenora (Patricia Portion), Ontario. Scale, 1 mile to the inch.



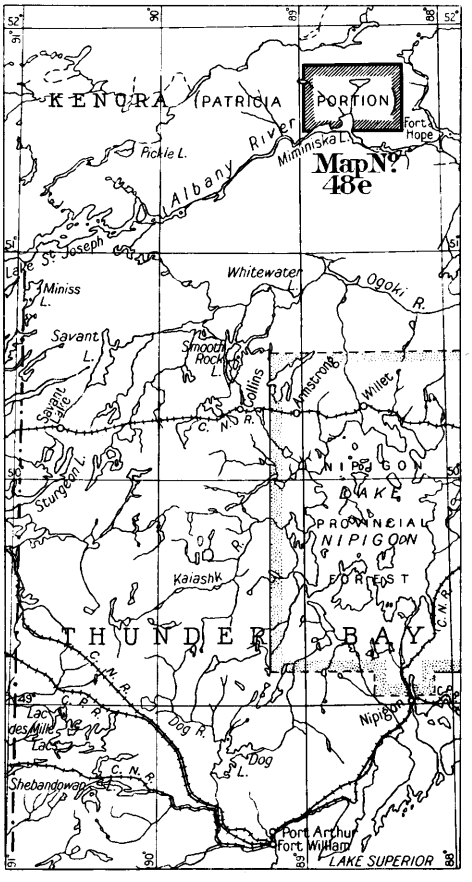
View looking up Ferguson creek towards Ferguson and Seagreen lakes, showing the typical flat, drift-covered nature of the Keezhik-Miminiska Lakes area.

Geology of the Keezhik-Miminiska Lakes Area

By V. K. Prest

INTRODUCTION

The area surrounding Keezhik, Miminiska, and Troutfly lakes, which was geologically examined during the summers of 1937 and 1938, has an extent of about 550 square miles. Miminiska lake is an expansion of the Albany river and is situated 90 miles due north of Lake Nipigon. The area surrounding this lake



Key map showing the location of the Keezhik-Miminiska Lakes area.
Scale, 60 miles to the inch.

was mapped during the summer of 1937 and the work pushed northward to Keezhik lake, a quite unexplored section, where an interesting series of lavas, tuffs, sediments, and basic intrusives were encountered. This section was mapped in more detail in 1938 and the work continued westward towards Troutfly lake. It was thought that the Keezhik-Troutfly section might represent the continuation of the Crow River belt, but a large granitic area was found to intervene.

The only mineral prospect worked during the summer of 1937 was a gold-quartz vein on Keezhik creek. In this section some thirty claims were staked along the strike of the "break," approximately N. 50° E. Visible gold was observed in one vein, but values were reported as being low. At the mouth of Keezhik creek, bodies of pyrite occur near the sedimentary-volcanic contact; pyrite and quartz with traces of gold have also been reported. Drilling here did not warrant further exploration. Prospecting in the Keezhik lake section uncovered a network of quartz stringers in a mineralized rhyolite porphyry, which gave a low gold assay, but nothing was done beyond blasting a small prospect pit. Several prospectors visited these areas in 1937, but there was no activity the following summer.

The geology was compiled from shore-line examination and pace-and-compass traverses. In the Miminiska lake section the shores often provided good exposures, but outcrops inland were scarce and hard to find. When outcrops were discovered, traverses were run along the strike to pick up further outcrops and obtain all possible information. Around Keezhik lake shore-line exposures are very scarce, and most of the rock was encountered far inland.

General Description and Access

Miminiska lake lies in an east-west trending belt of sediments, which pinch out approximately 4 miles west of the entrance of the Albany river into Miminiska lake, but continue eastward to the Fort Hope area, where they have been described by E. M. Burwash.[1] This belt of sediments at its widest part is about 8 miles across and is bounded on both sides by intermediate to basic volcanics. The Miminiska rocks are separated from the Keezhik belt of volcanics by granitic intrusives, which extend some distance east of Keezhik creek.

The greater part of Keezhik lake lies in a belt of volcanics with some sediments, into which a series of basic rocks have been intruded. Beyond the west end of Keezhik lake the belt narrows greatly, owing to the intrusive granitic masses and tighter folding, and around Troutfly lake granite is the prevalent rock type. The belt is similarly narrowed east of Keezhik lake where the granite contact curves toward the southeast. As the drift hills strike approximately N. 65° E. in this section, there is only a relatively small area of volcanic exposures beyond Keezhik lake.

The area can be conveniently reached by airplane from either Collins or Sioux Lookout on the Canadian National railway. The most travelled canoe route to Miminiska lake and also to the Hudson's Bay post at Fort Hope is from Ombabika, a flag station on the C. N. R., east of the north end of Lake Nipigon. This route runs due north to the Albany river and then westward to Miminiska lake or northwest to Fort Hope. Keezhik lake can be reached either by a northerly route from Fort Hope or by Miminiska lake and Keezhik creek. The canoe route from Pickle lake to Troutfly lake or the northwest end of the area requires a long trip via the Crow (Kawinogans), Otoskwin, and Trading rivers. This section of the area however holds less economic interest.

The canoe route from Ombabika to Miminiska lake has some 18 portages, the longest of which is three-quarters of a mile, and takes about eight days with moderate loads, but this time can be cut down by the use of a small motor. Transportation by plane is highly advisable, as Miminiska is only an hour's flight from Collins and an hour and a half from Sioux Lookout.

[1]E. M. Burwash, "Geology of the Fort Hope Gold Area, District of Kenora (Patricia Portion)," Ont. Dept. Mines, Vol. XXXVIII, 1929, pt. 2, pp. 12, 25-38.

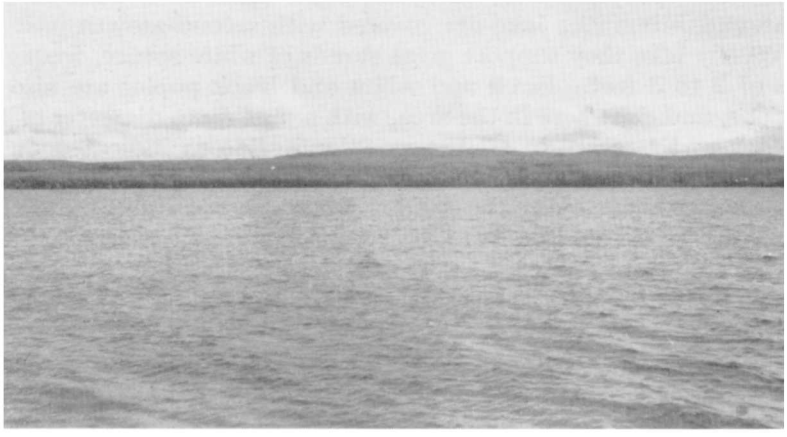
Acknowledgments

The party was accorded many courtesies and much assistance by the several prospectors in the area during the summer of 1937. Special thanks are due to P. G. A. Curry and J. Bresnahan, who were quite familiar with the area and able to supply the party with valuable information. Frank Trethewey tendered the party many favours during his frequent visits to the area.

H. W. Salter, J. W. Britton, and J. J. Ivan were members of the field party in 1937, and J. W. Britton, J. H. Douglas, and J. S. Talbot in 1938. These men performed their share of the work in a very efficient manner, which the writer greatly appreciates.

Previous Geological Work

In 1886 Robert Bell reported on part of the Albany river, including the section around Miminiska lake, for the Geological Survey of Canada.[1] In 1926



Drift hills on the portage route to Nesting lake, seen from Keezhik lake.

H. S. Wilson mapped a large area for the Nipissing Mining Company, including the region around Miminiska lake and part way up Keezhik creek. In 1928 E. M. Burwash[2] mapped the Fort Hope area and entered Miminiska lake from the east. Some of the geology around Miminiska lake was reported on by W. S. Dyer[3] in 1933.

Topography

The area is generally flat-lying and covered with a heavy drift mantle. Keezhik and Troutfly lakes are at a much higher elevation than Miminiska lake, which is 951 feet above sea-level. Miminiska lake is divided into two parts by a large peninsula, which contains a few quite prominent outcrops but is generally low-lying. The southern side of both parts of the lake is bordered by a region of high drift hills, some of which are reported as being from 300 to 400 feet in height.[4]

[1]Robt. Bell, Geol. Surv. Can., Vol. II, 1886, pt. G, pp. 15, 16.
[2]E. M. Burwash, op. cit.
[3]W. S. Dyer, "Geology of the Pashkokogan-Misehkow Area," Ont. Dept. Mines, Vol. XLII, 1933, pt. 6, pp. 8, 9, 15, 17.
[4]E. M. Burwash, op. cit., p. 21.
W. S. Dyer, op. cit., p. 3.

These morainic hills die out eastward toward Wottam lake, but continue westward to Snake falls on the Albany river and westward for many miles. Similar groups of high drift hills occur along the south shore of the East arm and the western part of Keezhik lake and at the south end of Troutfly lake. With the exception of the two last-mentioned localities, all the drift features in the area trend at approximately N. 70° E. In these two exceptions, the hills have a curved ground plan, which suggests that they may have been formed near a small lobe of the ice-sheet that once covered the country.

A well-developed esker in the Wottam lake section was traced intermittently for over 3 miles. Extensive tracts are covered with drift, which forms a blanket-like deposit. There are no deposits of clay within the boundaries of the map area. With the exception of the northwestern corner of the area, the drainage is toward the Albany river.

Natural Resources

Most of the area that is not drift-covered is low-lying and swampy, generally with much black spruce, which seldom reaches a diameter of 8 inches. The drift sections around Miminiska lake are covered with second-growth jack pine, but around Troutfly lake they support great stands of white spruce, frequently with diameters of 2 to 3 feet. Birch and white and black poplar are also found in these sections, and elsewhere in the area, with a maximum diameter of 16 inches. This mixed growth occurs in all the woodland sections indicated on the map accompanying this report. Balsam and cedar are locally abundant. A few dwarfed black ash occur along the Albany river where it enters Miminiska lake. Wild berries are rather scarce. The only recent burn of any magnitude is around Trading and Talbot lakes.

Game is not abundant, although several Indian families derive a fair living from hunting and trapping. Fish are plentiful and include pike, pickerel, whitefish, sturgeon, suckers, brook trout, and lake trout. Bird life is surprisingly abundant, some 60 species being noticed each summer. Warblers, flycatchers, sparrows, and thrushes are the most common types nesting in the area.

The climate of the area in general has been well summarized by E. M. Burwash.[1] Prospectors report that it is quite variable from year to year. The summer of 1937 was rather hot and moderately dry, whereas 1938 was very wet and comparatively cool. Thunderstorms were very frequent. Growth was well advanced by June 1, and the leaves had fallen from the birch and poplar before the beginning of October.

Abundant water power is available from two falls on the Albany river. Snake falls, south of the southwest corner of the area, has a drop of 9 feet and runs through a narrow rock gorge. Miminiska falls, at the outlet of Miminiska lake, has a drop of 10 feet. In the "List of Water Powers" of Ontario[2] it is stated that Miminiska falls has an estimated capacity, at 80 per cent. efficiency, of 12,087 horse-power at ordinary 6 months' flow. Similarly Snake falls has an estimated 4,676 horse-power.

GENERAL GEOLOGY

The consolidated rocks of the area are all pre-Cambrian. The oldest rocks present are the interbedded dark-green to black volcanics and tuffs bordering the Algoman granite batholith north of the East arm of Keezhik lake. Overlying

[1] E. M. Burwash, op. cit., pp. 17, 18.

[2] L. V. Rorke, "List of Water Powers in the Province of Ontario," Ont. Dept. Surveys, 1931, p. 14.

these basic volcanics is a mixed series of fresher-looking volcanics, bedded tuffs, and sediments. Of approximately the same age, is a variable series of paler-coloured volcanics, which are best exposed around the North bay of Keezhik lake. These volcanics are usually acidic in composition. Overlying this series and exposed in South bay, Keezhik lake, and east of Nesting lake is a thick conglomerate band containing quartz, iron formation, and volcanic and porphyry boulders. Younger greenstones of andesitic composition overlie the conglomerate, and these may be continuous with the volcanic belt extending southward to Miminiska lake.

Volcanic rocks form the borders of the basin of Miminiska lake and may be older than the sediments (Timiskaming?) that fill it. A conglomerate occurs at the contact of these two rock types north of the western part of Miminiska lake, continuing through to Howell's lake and southwest to the Albany river at the nose of the major fold. Where best exposed, the sedimentary and volcanic contacts appear to be conformable. The volcanics on the south side of the sedimentary belt appear to have been thrust over the sediments from the south. Basic and ultrabasic intrusives have come in along this faulted section and further metamorphosed these rocks.

Various granitic rocks are intrusive into the volcanic and sedimentary belts of the whole area, and while they are mostly of Algoman age, some of the porphyries may be Keewatin. Keweenawan diabase and gabbroic dikes cut directly across the strike of the volcanics and sediments.

The sediments of the basin of Miminiska lake are remarkably fresh, but eastwards in the Wottam lake section, they have been metamorphosed to schists. The sediments are so folded that their true thickness is not known, but it is probably not great.

Table of Formations

QUATERNARY	
Pleistocene:	Sand, gravel.
PRE-CAMBRIAN	
Keweenawan:	Olivine diabase, diabase and gabbro dikes.
	Intrusive contact
Algoman:	Quartz, feldspar, and granite porphyries. Biotite granite and quartz diorite. Porphyritic and pegmatitic granite and syenite.
	Intrusive contact
Pre-Algoman:	Hornblendite, gabbro, and diorite.
	Intrusive contact
Timiskaming(?):	Slate, greywacke, arkose, feldspathic sandstone, conglomerate, quartzite, iron formation. Derived schists, including garnet, staurolite, and mica schists.
Keewatin:	Basic sill-like intrusives. Lavas, mainly intermediate to basic in composition; pyroclastics, hornblende gneiss, amphibolite, eclogite. Conglomerate. Lavas, mainly acid to intermediate in composition; pyroclastics, bedded tuffs, sediments, iron formation. Lavas, dominantly basic in composition; pyroclastics, iron formation.

Keewatin Series

Basic Volcanics

The dark-green and grey to black volcanics bordering the Algoman batholith north of the East arm, Keezhik lake, consist of massive flows and tuffs. Much of

the tuffaceous material has been worked over by water forming black-bedded tuffs, which are easily mistaken for true slates. The lavas are exceptionally uniform, dull-looking rocks, devoid of pillow structures, amygdules, or breccias. Only the banded nature of some of the tuffs breaks the monotony of the series. The banded rocks are present in about equal proportions with the massive lavas. The banding is often quite fine. Where siliceous members are present the individual beds are about one-eighth of an inch in thickness, but elsewhere the bands are from an inch to a foot or more in thickness. Associated with the fine-grained massive lavas are coarser phases representing thick flows.

The intrusion of the granitic batholith on the north has undoubtedly caused considerable recrystallization of the original materials, so that the volcanics are now masses of hornblende and basic feldspar, but such metamorphism is not especially marked along the actual contact zone. This belt of volcanics dips steeply south or vertically over its entire length, and strikes quite consistently at S. 70° E. At its greatest width the series is about one mile across.

A very persistent band of iron formation occurs in this volcanic belt, but was found outcropping in only one place over a traced length of seven miles. It was accurately located at numerous positions along the strike by means of its strong magnetic attraction. Stratigraphically it lies just within the border of the massive volcanics on the south side of the main banded tuff horizon. Where observed, it was about thirty feet wide, but elsewhere seemed much narrower. At the extreme west end of the traced length its boundaries were closely defined, although not actually observed, and it was found to be about 10 feet in width.

The volcanics of the belt north of Troutfly lake and west of Nesting lake are probably of the same age as the basic volcanics just described. They vary from intermediate to basic in composition and include pillow lavas, massive volcanics, tuffs, and breccias as well as a band of iron formation. The outcrop areas are large and prominent. A stretch of drift hills 3 miles wide separates the volcanics west of Nesting lake from those north of Troutfly lake, but they are in all respects similar and join up structurally, although different stratigraphic horizons are present. The tuffaceous horizons aid in revealing the structure and trend of the rocks. As a rule the outcrops are elongated parallel to the strike of the volcanics.

The iron formation horizon of the volcanic band north of Troutfly lake was traced for several miles and observed in a few places. It is about 10 feet wide and is a strikingly banded black and white rock but sometimes shows yellowish or brownish bands where it has a micaceous appearance. The bands are uniformly from one-eighth to one-quarter of an inch in width and consist of alternate quartz and magnetite horizons.

Acid to Intermediate Volcanics; Sediments

North of the East arm of Keezhik lake, the basic volcanics already described grade upward (southward) into a series of sediments, bedded tuffs, and lavas, which have a fresher appearance than the northern volcanics. The sediments occur as narrow beds and include sandstone, greywacke, and shale. Sheared lavas and bedded tuffs are the common rock types. All are exposed at the east end of the East arm. Associated with the lavas is a narrow band of finely bedded iron formation, which is considerably altered and in which hematite is an important constituent. Minor quartz stringers occur in this iron formation, but there is very little mineralization. This formation is exposed on the south side of the creek flowing into the East arm, and the sediments occur along the north bank.

At approximately this same time, or only slightly later, a series of light-coloured acid to intermediate volcanics were extruded in the Keezhik lake section.

The rocks of this region present a striking contrast in colour and character to all the other volcanic rocks. They are readily classed together from field observations, although the composition of various members may vary greatly. They are all rather fresh-looking rocks, buff to greenish in colour, and usually massive. Dacite is the most prevalent type; but rhyolite, andesite, and even basalt occur in this series. The latter types have been considerably carbonatized and weather to a light-green or buff. Coarse-grained phases are common amongst the andesitic members, and some definite intrusives with hornblende phenocrysts are represented. Pillow structures are numerous in the hard, fine-grained dacites and in places reveal the direction of the top of the flows. This group of rocks is best exposed in the vicinity of the North bay. They also extend eastward to the East arm, where breccia members are present; but owing to the granitic intrusions in this section, they are of little value in determining the sequence or structure.

A band of iron formation occurs in this series and while it was not found exposed, it was traced by magnetic deflections of the compass along the whole length of the west shore of the North bay and northeast to the largest lake on the creek flowing into the North bay. Most of this section is heavily drift-covered.

Fresh, light-coloured volcanics are also exposed along the east side of Nesting lake, where they are overlain by a conglomerate band. The volcanic horizon immediately underlying the conglomerate is a carbonatized pillowed hornblende andesite, the hornblende occurring as long needles, which are very conspicuous on the pale weathered surface. It strikes N. 40° E., dips 80° S. E., and faces southeast.

The pillow lava, conglomerate, and overlying sheared greenstone horizon, are all truncated on the southwest by a diorite dike, on the other side of which tuffaceous rocks striking northwest-southeast are the common volcanic types. This whole section has been greatly folded. The tuffaceous rocks are in part bedded tuffs and have been highly recrystallized by the granitic intrusions on the southeast. Associated with the tuffs is an impure quartzite, which forms an island in Nesting lake and outcrops along the north shore.

These tuffaceous rocks and sediments are grouped with the acid volcanic series of Keezhik lake, as they more closely resemble it than any other type, and because of their position above the intermediate to basic volcanics west of Nesting lake. Heavy drift areas prevented the solving of the true relationships of all these rocks. A large area of these recrystallized tuffs bounded on the north and south by typical Algoman granite occurs east of Troutfly creek.

Conglomerate

The Keewatin conglomerate occurs between two volcanic horizons. It is best exposed east of Nesting lake, but small outcrops were found on the north shore of the South bay of Keezhik lake. In the South bay the overlying rocks are not exposed, but the conglomerate can be seen to be resting on a dense pillow lava. At Nesting lake the conglomerate rests on the andesite pillow lava already described and is overlain by rather soft, green, banded volcanics grading upward through breccia into more massive types. The conglomerate band is 800 feet wide in this section. The upper contact dips at 50° S. E., but the lower contact appears to be steeper.

The lower half of the conglomerate contains boulders of a variety of volcanic rocks, many of which are similar to types found around Keezhik lake. Boulders of quartz, jasper, chert, and highly siliceous banded iron formation are also common and are the sole constituents of the uppermost part. No granitic

or porphyry boulders were seen. Banded ferruginous boulders up to 3½ by 1½ feet were observed. The groundmass consists of fine volcanic materials.

Younger Intermediate to Basic Volcanics

Probably closely related to the green volcanics overlying the conglomerate east of Nesting lake are the volcanic rocks exposed at the east and west ends of the South bay of Keezhik lake. These volcanics are quite similar to those described to the west of Nesting lake, but on the whole appear fresher. The volcanics at the east end of the South bay can be traced directly to Miminiska lake. The series consists of fine-grained massive lavas, dioritic phases, pillow lavas, intrusives, and pyroclastics. Schistose phases of these rocks are not abundant. They usually weather a dull-green colour, but where scraped and polished by glacial action have a black surface and appear more basic than they actually are.

Conglomerate east of Nesting lake composed of boulders of quartz and cherty materials in a volcanic groundmass.

A notable example of this is in the vicinity of Ivan lake. The lavas in this locality have been made more resistant than the surrounding rocks by the intrusion of small dikes and barren quartz stringers and hence form prominent outcrops.

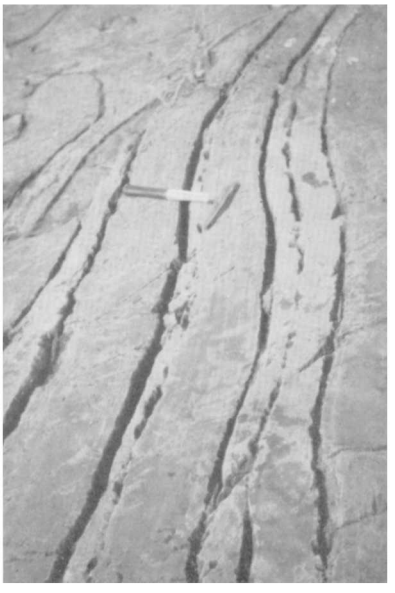
Normally the lavas of this series contain equal proportions of hornblende and basic oligoclase. Occasionally quartz is present. Magnetite is the dominant accessory. Basaltic members of the series contain up to 65 or 70 per cent. hornblende.

Pillow lavas are important members of the series in the section between Howell's lake and Keezhik creek. Near Keezhik creek pillow structures were found up to 20 feet by 4 feet. North of the western part of Miminiska lake, pillow lavas were observed continuously over a width of a mile and a half. Volcanic breccia is also present, usually near the north side of the belt. In the Howell's lake section and westward, coarse-grained flows and dioritic intrusives are the prevalent rock types. These are hard, massive, and fresh in appearance.

The volcanics occurring along the south shore of Miminiska lake are probably related to those just described and include lavas, intrusives, and pyroclastics. Inland from the south shore of the western part of Miminiska lake, these rocks are especially dark-coloured and are very tough and resistant. They form prominent outcrops between the shore line and the high drift hills on the south.

The lavas are unsheared and fine- to medium-grained, with many pillow structures. One large dioritic intrusive represents a sill and is shown on the accompanying map.

On Miminiska peninsula the lavas give way northward to a series of tuffs and ultrabasic rocks. The latter include fine-grained amphibolite and coarser-grained eclogite. These are for the most part intrusive and have caused much alteration of the neighbouring rocks, producing various gneisses. Probably some sediments were present interbedded with the tuffs and lavas. Explosive breccia occurs on the east side of Miminiska peninsula and at the outlet of the Albany river. Massive recrystallized tuffs and related intrusive diorite are also present and consist of quartz and feldspar, with a minor quantity of hornblende needles.



Differential weathering of tuffs north of the western part of Miminiska lake. The hammer handle points north and is almost on the contact of the tuffs with poorly formed pillow lavas.

They are a dull-grey colour and have a sugary texture. The most pronounced alteration and gneissic development is along the zone closest to the trace of the thrust fault separating the volcanic belt from the fresh sediments of the Miminiska lake basin proper. The rocks in this gneissic zone all dip to the south at angles steepening southward from 30 to 70 degrees. Garnets are common in some of the intrusive rocks such as the eclogite, as well as in the gneisses along the thrust zone.

The volcanic series appears to have been thrust over the sediments of the Miminiska basin and at the same time to have been overturned.

Basic Sill-like Intrusives

Basic rocks often showing intrusive relations with the older rocks are numerous in the Miminiska lake section. They usually follow the general trend of the volcanic flows, but have intrusive contacts in places. Some are probably true sills. A variety of ages are no doubt represented, but most of these rocks are thought to have been intruded during the period of volcanic activity that gave rise to the

lavas with which they are now associated. Others are distinctly later. An elongate dioritic mass occurs along the contact of the sediments and volcanics west of Keezhik creek and has caused some alteration of the sediments. This may imply a recurrence of volcanic activity after the period of sedimentation. The large gabbro intrusion that follows the trend of the sediments in the northern part of the Miminiska lake basin may be more closely related to the Keewatin volcanics than to the pre-Algoman basic intrusives of the East arm of Keezhik lake, with which it is now grouped.

Timiskaming(?) Sediments

The sedimentary belt of the Miminiska lake section includes quartzite, greywacke, arkose, grits, argillite, iron formation, and conglomerate. The most prevalent types are the impure or argillaceous quartzites and siliceous greywackes, which are often tough, resistant rocks and consequently form prominent outcrops. Interbedded with these are argillites, greywackes, and feldspathic sandstones, the last being only partially recrystallized. Bedding is often very well displayed by these distinctive rock types. All these rocks, and especially the resistant quartzites, are well exposed on the Miminiska peninsula, Miminiska island, and the island south of it.

Another very common sediment is the feldspathic grit or sandstone, which is typically best developed at a horizon north of the quartzites and greywacke, but south of the iron formation. It consists of sub-rounded to sub-angular grains of quartz and feldspar up to one-fifth of an inch in diameter. This rock is well exposed on the islands near the north shore of the western part of Miminiska lake.

Microscopic studies bear out the field appearance of these sediments; they are remarkably fresh. The resistant rocks are impure quartzites and siliceous greywackes. The greywackes consist of grains of quartz and feldspar up to one-eighth of an inch in diameter in a poorly sorted, fine groundmass of quartz, feldspar, and micas, with minor amounts of magnetite, tourmaline, and other minerals. The larger grains are sub-rounded to rounded. Magnetite in some cases is quite abundant. These sediments give evidence of transportation for moderate distances and rapid deposition. The impure quartzites, which in the field are fine, dense rocks, are made up of an equigranular mass of quartz and probably feldspar, with considerable quantities of mica. The more highly argillaceous members of the series are like the quartzites, but contain abundant mica and often some carbonate.

On the small island near the point on the west shore of the western part of Miminiska lake, and on the northwestern side of Miminiska peninsula there is a peculiar conglomeratic rock. On the west this consists largely of yellowish-weathering quartz porphyry boulders with a maximum size of 14 by 8 inches in a softer indefinable groundmass. On the peninsula, however, boulders of sediments are to be found with the porphyry boulders. The boulders are all siliceous types. Microscopically the groundmass appears to be arkosic. The groundmass fragments are usually angular, whereas the boulders and pebbles are well rounded. The softer pebbles are usually greatly elongated due to shearing. The average size of the pebbles is about 2½ inches by 1 inch.

Lying north of the feldspathic grits is the banded iron formation. This is best developed around the eastern part of Miminiska lake, where it is highly folded and crumpled, and in the Wottam lake section. It consists of interbanded magnetite-rich horizons and beds of argillite, quartzite, and more rarely greywacke. The magnetite-rich horizons occur up to 10 inches in width on the north side of the formation, but become narrower southward until they are only an

inch or two in width. Over a 5-foot section near the central part of the formation there were 12 horizons of magnetite, each 3 or 4 inches wide. On the north there are usually 6 to 8 inches of argillaceous sediments to every 3 or 4 inches of magnetite. Here also the magnetite is often interbanded with quartzite. The magnetite bands of the iron formation are reported by E. M. Burwash[1] to contain less than 40 per cent. iron.

The magnetite bands in the iron formation consist almost entirely of magnetite and quartz, which occur as equidimensional grains. The argillaceous bands in the iron formation consist of a fine dense mass of quartz and abundant green

Iron formation, eastern part of Miminiska lake. Magnetite bands alternate with argillite, greywacke, or quartzite.

mica, often with some carbonate. The mica occurs as minute rods and blades. These bands are seen to be well bedded. The gritty bands in the iron formation contain less mica, are rather poorly sorted as to grain size, and poorly bedded.

North of the iron formation the rocks are dominantly argillaceous, but there are a few gritty bands and quartzite horizons. North of the western part of Miminiska lake, west of Howell's lake, and along the northern stretch of the Albany river, these fine-grained sediments give way northward to coarse sandstone and conglomerate. The sandstone horizon is very narrow. In the Howell's lake section the matrix is more argillaceous.

The conglomerate contains boulders of granitoid rocks, volcanics, porphyries, sediments, iron formation, quartz, chert, and jasper. The boulders form about 80 per cent. of the rock north of the western part of Miminiska lake, 65 per cent. near Howell's lake, and only 50 per cent. in the Albany river section. The granitoid boulders vary from granite and pegmatite to diorite. The more siliceous types are more or less equidimensional, whereas the more basic types have been elongated by shearing. Volcanic and slaty pebbles or boulders are usually much elongated. The volcanic boulders, many of which are spotted types,

[1]E. M. Burwash, op. cit., pp. 47, 48.

are all dark-weathering but are not basic. Quartzite, arkose, and greywacke are also present as boulders, especially in the western sections of the conglomerate.

Granite boulders up to 14 by 6 inches were found in the conglomerate north of the western part of Miminiska lake. These have angular outlines, whereas the other boulders are more rounded and elongated. The granite boulders are medium-textured with quartz grains with a maximum diameter of one-sixth of an inch, and they contain very little mafic material. Granitic rocks in places form about 45 per cent. of the boulders present. Pure quartz pebbles and boulders are of sporadic occurrence.

The source of the granite boulders is not known. The same is true for part of the sedimentary boulders, which closely resemble some of the fresh sediments now occupying the Miminiska basin. Many of the sedimentary types could have

Banded sedimentary schists, near the crest of a minor anticline, east of Wottam lake.

been derived from the sediments interbedded with the older lavas, as seen in the Keezhik lake section. The conglomerate band is between 300 and 400 feet in width.

Eastward from the western part of Miminiska lake, the boulders become smaller and the conglomerate finally gives way to a coarse arkose. This is exposed in a few places along the lower reaches of Keezhik creek. It lies north of a soft black argillite, as does the conglomerate in the western sections. West of the north-south stretch of Keezhik creek at the sedimentary-volcanic contact, the sediments are greywacke, fine feldspathic sandstone, and impure quartzite, the arkose horizon either occurring south of these rocks or else grading laterally into them.

The sedimentary belt can be readily traced through to the Wottam lake section, but here the sediments have been largely metamorphosed to garnet, staurolite, and mica schists. The largest garnets and staurolites occur in the argillaceous sediments close to or within the iron formation. The development of garnet and staurolite has been a very selective process, depending upon the composition of the original sediment. For this reason certain beds contain staurolites up to one inch or more in diameter, whereas the neighbouring bed contains abundant small garnets. Sometimes both garnets and staurolite occur in the same bed.

Folding in the Wottam lake section has resulted in a repetition of the iron formation. Two bands, approximately 3,000 feet apart, are present. Between these bands with their accompanying garnetiferous and staurolite horizons the

rocks are less altered and consist of mica and graphitic mica schists. In places they may still be termed argillites, greywackes, etc. At the extreme east end of the mapped sedimentary belt the iron bands must come very close together, as the garnet and staurolite horizons span the whole section and magnetic attraction is intense. Part of the attraction is due to small quartz-magnetite veinlets.

Microscopic examination shows tourmaline to be present in the sediments over most of the area. Where quartz-tourmaline veins have come in, tourmaline schists have resulted. The black argillites north of Wottam creek are seen under the microscope to be spotted graphitic schists. The spots are due in part to poorly formed cordierite porphyroblasts with flecks of graphite in and around them. Some spots are due to segregation of the graphite.

The garnet and staurolite schists contain abundant brown and green biotite, the former parallel to the schistosity and the latter cutting across it. The magnetite is also coarser than in the Miminiska lake section. The highly argillaceous sediments occurring between the iron formation horizons, towards Frond lake are seen under the microscope to be highly crenulated mica schists containing abundant tourmaline. Dioritic to ultrabasic dikes were found cutting the sediments locally, and the latter have often caused further mineral changes in the sediments.

The sediments of the Wottam lake section and eastward are thus seen to be distinctly different in character from their counterparts to the west.

Pre-Algoman Basic Intrusives

A series of basic rocks intrudes the volcanics and sediments of the East arm of Keezhik lake, forming a chain of islands and shoals and prominent outcrops. Hornblendite is the dominant type, forming conspicuous outcrops. It is a very hard, massive, black rock, consisting of about 90 per cent. hornblende and 10 per cent. feldspar. Dioritic types of intrusives are closely connected with the hornblendite but are slightly younger in age. At the east end of the East arm the intrusive has a flaky weathered surface and is a diorite or gabbro in composition. In this section it is at least 400 feet wide, but the southern contact is hidden under the drift hills. Judging from the exposed portions the dike dies out a short distance east of the end of Keezhik lake.

Prominent outcrops of these basic rocks occur on the north shore of the East arm where they appear to form a small stock. Soft biotite-rich rocks along the north edge of the stock may represent the altered country rocks.

It would appear that these basic intrusives have invaded the folded Keewatin rocks and penetrated laterally more or less along the bedding to form elongate bodies.

The large gabbro sill in Curry bay and the western part of Miminiska lake may be of the same age as these basic intrusions.

Algoman Intrusives

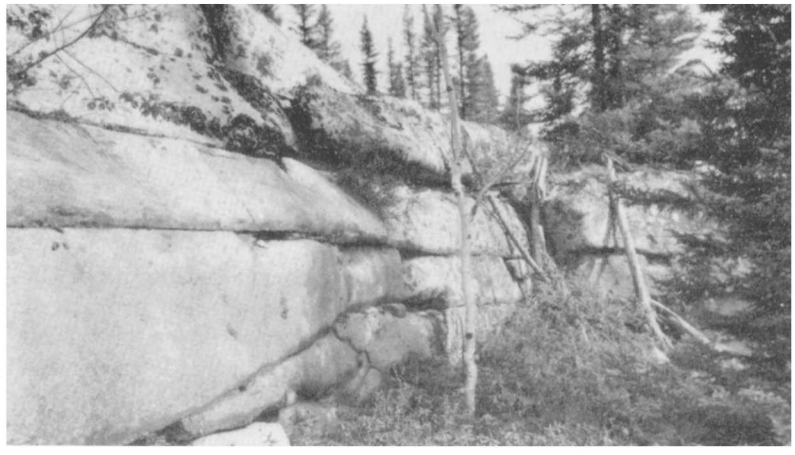
The Algoman is represented by granite, syenite, and quartz diorite, the diorite probably representing the major batholithic intrusion.

South of Wottam lake, what appears to be a narrow tongue of granite strikes in a northeast-southwest direction and tapers off to a point, as shown on the accompanying map of the area. It is a coarse-grained, white-weathering granite, which under the microscope is seen to consist of quartz, microcline, albite, biotite, muscovite, and the accessory minerals epidote, apatite, and zircon. Dikes of similar material cut the sedimentary schists northeast of Wottam lake.

The granite tongue is cut by many pegmatite dikes and quartz veins. The pegmatite dikes, which have a maximum width of 4 feet, consist of feldspar crystals up to 10 by 4 inches in a groundmass of quartz and feldspar with much tourmaline and muscovite. The dikes and veins are most prevalent along the north edge of the granite outcrop. They occur in three sets, striking at N. 35° E., N. 50° E., and S. 50° E., the first set being the youngest and best developed.

A small outcrop of granite was found north of the western part of Miminiska lake, fairly close to exposures of the volcanics. It weathers pinkish and consists of quartz, albite, and biotite. These two occurrences represent the only granite masses seen in the Miminiska lake section.

Granitic rocks form large outcrops from the northernmost small lake on Keezhik creek northwards into the South bay of Keezhik lake. These rocks are very variable in composition and texture. Typical granite is not abundant.



Horizontal jointing in granite north of Talbot lake.

The rocks are usually either porphyritic or pegmatitic types, and the mafic mineral is either biotite or hornblende. Syenite is present, with hornblende as the mafic mineral. The exposures on Keezhik creek immediately north of the small lake probably represent the contact zone, as inclusions of volcanics are abundant, and in places over 50 feet in diameter. They show sharp contacts and in many places are cut by small granitic stringers.

North of Keezhik lake the granitoid rocks are massive pink of light-weathering rocks of medium to coarse texture. A section studied microscopically showed the feldspar to be oligoclase, and the rock may therefore be termed a quartz diorite. Biotite is the only mica present, except north of Talbot lake where muscovite accompanies the biotite. Around Troutfly lake the granitoid rocks are porphyritic granites, large phenocrysts of orthoclase up to 2½ inches by three-quarters of an inch in size occurring in a coarse-grained groundmass of orthoclase, biotite, and quartz. This rock type is closely related to the porphyritic and pegmatitic facies around Keezhik creek and South bay. North of Troutfly lake the age relationships between the porphyritic granite and the common granite or quartz diorite of the north may be observed. The batholithic intrusion appears to cut off the westward extension of large dike-like masses of the porphyritic granite in the volcanic series. Field relationships do not indicate that the porphyritic granite is an offshoot from the main mass but rather that it

is somewhat earlier although most probably closely connected with the same parent magma.

The porphyritic granite forms prominent outcrops along the east side of Troutfly lake and displays two well-developed joint systems: N. 68° E., with a dip of 55° S.E.; and N. 20° E., with a dip of 85° N. W. A third poorly developed system strikes at N. 50° E. and dips at 20° N. W.

The peninsula separating the main part of Keezhik lake from the East arm contains outcrops of a granitic rock of a different character. This is a sheared, quartz-feldspar porphyry representing a small stock. The rock is chiefly made up of much altered albite phenocrysts. The groundmass is a schistose aggregate of abundant white mica with quartz and feldspar.

The evidence suggests that this porphyry body is older than the fresh Algoman intrusives, which do not show either shearing or alteration effects. There are several dikes in the Keezhik-Miminiska Lakes area which are similar to this mass and may be related in age. These porphyries are mapped along with the Algoman rocks, since age relationships have not been definitely determined.

Minor acid intrusives are rather scarce in the area, but small feldspar porphyries are of sporadic occurrence. Quartz porphyry and quartz-feldspar porphyry bodies with widths up to a hundred feet are well exposed on the Albany river at the west end of the area. These occur near the sedimentary volcanic contact where there has been much shearing. The quartz porphyries and granitic dikelets are very similar to the fresh Algoman rocks, whereas the feldspar porphyries are sheared and altered. This may be due to an inherent tendency to shearing owing to the amount of feldspar present or to an earlier age, as already suggested. A large granitic dike occurs on the peninsula at the north end of Howell's lake, fairly close to the sedimentary-volcanic contact, and other smaller dikes occur to the east along this same zone. A highly sheared quartz-feldspar porphyry occurs as an 80-foot sill in the gneissic rocks along the high escarpment at the trace of the thrust fault in the eastern part of Miminiska lake. Granite dikes, pegmatite, and porphyry occur in the sediments at the east end of the Wottam lake section. These are all young Algoman-type intrusives.

Keweenawan Dikes

Two large dikes from 150 to 300 feet in width cutting at nearly right angles across the sedimentary and volcanic belts form the main representatives of the Keweenawan period. The large dike in the eastern part of Miminiska lake is an olivine diabase. The olivine, which is frequently partially altered, in places occurs as fresh phenocrysts up to a quarter of an inch in diameter. Augite and chlorite fill the interstices between the large, lath-shaped crystals of acid labradorite and the olivine phenocrysts. Biotite is present as an alteration product of the augite. Magnetite is an accessory and also an alteration product of the olivine, along with serpentine.

The other large dike, which runs southward from Keezhik lake through Wottam lake, is very variable over its length and often appears diabasic. One thin section studied was a quartz gabbro. In many sections the dike would best be termed a diorite. This dike was found cutting Algoman granitic intrusives in both the sedimentary and volcanic series. It definitely does not cut through the granitic tongue mapped south of Wottam lake.

Small diabase dikes are scattered throughout the area. One of these was found cutting the hornblendite of the East arm of Keezhik lake, but none were

seen cutting a granite mass. The main minerals are augite, labradorite, magnetite, and a little white mica. They are usually fine, dense rocks with minute feldspar laths readily discernible in the hand specimen.

STRUCTURAL GEOLOGY

Folding

Keezhik Lake Section

The granite mass occurring between Miminiska and Keezhik lakes divides the area into two distinct structural units. The volcanics in the Keezhik lake section occur in the north limb of a syncline; the basic volcanics occupying the northern and basal part, while the younger acidic volcanics and sediments occupy most of the basin. The uppermost or youngest rocks of the syncline lie in the Nesting lake–South bay section near the bordering granite mass on the south. Here the conglomerate overlies the acid volcanic series but is in turn overlain by greenstone. The nose of the syncline occurs in the vicinity of Nesting lake, where the rocks swing sharply around, and pitches to the east at about 50 degrees. Except for this local section of the syncline, the structural flexures are quite open over the whole Keezhik lake section, and the strike of the rocks is uniform over a long distance. From the east end of Keezhik lake they strike northwest as far as the North bay, where the regional strike changes rather abruptly to southwest. This trend continues to the nose of the fold where the strike swings to the south and southeast.

The acid volcanics of the Keezhik lake basin seem to represent a period of volcanic activity that was localized in that area, so that to the east and west only basic and intermediate volcanics should be encountered.

The greenstones exposed north of Troutfly lake probably represent the north limb of a syncline. These rocks have an east-west trend, but near Talbot lake they show many minor contortions imposed upon them by the invading porphyritic granite dikes and the granitic batholith.

Miminiska Lake Section

The sediments of the Miminiska lake section may be Timiskaming in age. This is indicated by the large number of granitic boulders in the conglomerate exposed along part of the sedimentary-volcanic contact. Such a sequence suggests a synclinal structure for the area, with the nose of the fold along the north-south stretch of the Albany river. Structural evidence, however, is not conclusive as to the relative ages and attitude of the two rock series. Evidence of the structure or of the direction of flow tops in the volcanic belt north of Miminiska lake is usually wanting, owing to the massive nature of the series. Near the sedimentary contact west of the north-south stretch of Keezhik creek, the pillow lavas show tops facing the north. North of the western part of Miminiska lake a narrow zone of pillow lavas was found between two fine-grained massive horizons. This zone dips 70° N.E., with tops facing north.

It is possible that the sediments of the Miminiska lake basin and the acidic volcanic series of the Keezhik lake section with its associated sediments are of the same age, as both series appear to underlie the greenstone and are separated from it in places by a conglomerate band.

The southern volcanic belt along Miminiska lake does not bear the same relations to the sediments as does the northern belt, but rather is thrust over the

sediments from the south. Determinations on pillow lavas also show that the series is overturned to the north. The dips throughout the whole belt are invariably to the south and range from 30 to 65 degrees. The flatter dips occur in the gneisses along the northern side of the belt and, therefore, closest to the trace of the thrust fault across Miminiska peninsula.

From the eastern part of Miminiska lake eastwards an anticlinal structure is well developed but on a smaller scale, as folding is closer and has resulted in a repetition of the iron formation. Determinations on drag folds and fracture cleavage, as well as the general lithology, show that the structure is a narrow, tightly folded anticline, overturned to the south. Around Wottam lake this anticline plunges east at 20 degrees, but east of this lake the anticline plunges at 20° or 25° W.

Faulting

No evidence of faulting was found within the volcanic belts, possibly owing to their massive nature and lack of horizon markers. The scarcity of outcrops also makes recognition of faulting difficult. The faults recognized in the area are confined to the Miminiska lake section. A large fault is believed to extend across the northeastern part of Miminiska lake, striking in a northeast-southwest direction and accounting for the displacement of the iron formation from the northwest corner of the lake to the north end of Miminiska island. The iron formation at both these localities is highly contorted. A similar type of fault is believed to extend along the Albany river west of Howell's lake, where the conglomerate horizon seems to be considerably displaced on either side of the river. A minor fault occurs at the southwestern tip of the conglomerate, at the west end of the area, beyond which it could not be picked up.

The most striking evidence of faulting in the area is the northward-facing escarpment on Miminiska peninsula, where the volcanic series has been thrust northward over the sediments in the Miminiska basin. South of the fault trace the rocks are metamorphic gneisses, mostly derived from volcanic rocks, dipping south at angles of 30 to 45 degrees, whereas north of it the rocks are rather fresh, unaltered sediments with a vertical dip. Amongst the gneisses are various basic intrusives. The escarpment is only developed on the peninsula, but evidence of the fault can be picked up again north of the Albany river where it leaves Miminiska lake. Here a series of basic intrusives with some gneisses outcrop in a low woodland section and lie stratigraphically north of the typical volcanics of the southern belt. The escarpment on the peninsula in the eastern part of Miminiska lake rises almost vertically about 75 feet above the lake.

ECONOMIC GEOLOGY

While little evidence of mineralization has been found in the area up to the present, the possibilities of finding deposits of economic value cannot be overlooked. The claims drilled along the lower part of Keezhik creek show that low values are contained in some veins. Drilling was also done some years ago on a quartz vein near the bend in the Albany river at the west end of the area, and low values were reported. A number of porphyry bodies heavily mineralized with pyrite occur on a small island in Howell's lake. There was also much massive stibnite occurring here as float, but only minor amounts were found in place. Neither the porphyry bodies nor the quartz stringers within them carry a gold content. Quartz veins are uncommon throughout the sediments and volcanics around Miminiska lake, except near the contact on the north, where

both porphyries and veins may be found. This section, however, seems to have been well prospected.

A well-developed "break" occurs along the southern volcanic-sedimentary contact. This is especially well seen north of the Albany river where it leaves Miminiska lake. Here there is a stockwork of sheared wall-rock and quartz veins over 100 feet in width. An assay of one sample from this zone proved barren.

The Wottam lake section is quite unlike any of the others, as it contains abundant quartz veins up to 4 feet in width. Tourmaline is a common mineral in many of these veins, and some contain traces of sulphides. A low gold assay was obtained from a quartz-arsenopyrite showing in the sediments south of Wottam lake. This section has been little prospected.

Many veins occur in the basic volcanics north of the East arm of Keezhik lake, but no well-developed ones were seen, nor was there any apparent mineralization. The veins follow the regional trend. The overlying series of the more acid lavas appear to offer better prospects. Quartz and quartz-carbonate veins are numerous and were often found to be heavily mineralized. Both pyrite and arsenopyrite are present. Siderite is the common vein-forming carbonate, so that the veins weather brownish, in striking contrast with the green volcanics. An assay of 0.07 ounces gold per ton was obtained from a network of quartz stringers in a mineralized porphyry dike on the creek entering the northeast end of the North bay of Keezhik lake. An assay of the porphyry itself did not give any values. Veins are more numerous on the east side of the North bay, but the west side should be an equally favourable site for prospecting. This volcanic series seems to have responded to deformation by the development of fractures, which have acted as loci of vein deposition.

At the east end of the East arm, there are interbedded lavas, tuffs, and sediments in which mineralized quartz stringers were found carrying pyrite and chalcopyrite.

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