# FORTY-NINTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

1940

PART VII

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. ROBERT LAURIER, *Minister of Mines* H. C. RICKABY, *Deputy Minister*

# FORTY-NINTH ANNUAL REPORT

OF THE

# ONTARIO DEPARTMENT OF MINES

BEING

## VOL. XLIX, PART VII, 1940

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## COLOURED GEOLOGICAL MAPS
**(In pocket at back of report)**

Map No. 49k—Big Duck–Aguasabon Lakes Area, District of Thunder Bay, Ontario. Scale, ½ mile to the inch.

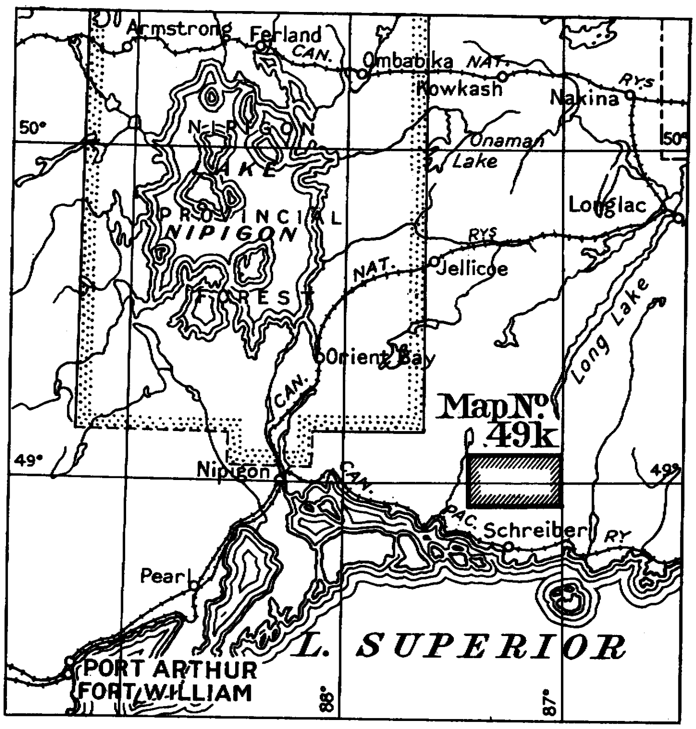
Map No. 49m—Kenogamisis River Area, District of Thunder Bay, Ontario. Scale, 1 mile to the inch.

# Geology of the Big Duck-Aguasabon Lakes Area

By M. W. Bartley

## INTRODUCTION

During the field season of 1939, a geological reconnaissance was made of an area in the district of Thunder Bay, 15 miles north of Schreiber on the Canadian Pacific railway and 50 miles south of Geraldton on the Canadian National railway. The area mapped is bounded on the north by latitude 49° 05′, on the south by latitude 48° 70′, on the west by longitude 87° 24′, and on the east by longitude




Key map showing the location of the Big Duck–Aguasabon Lakes area. Scale, 40 miles to the inch.

87° 00′. The survey was a northward continuation of the geological examination of the northwestern part of the Schreiber area made in the summer of 1937.[1]

A base map was prepared from areal maps supplied by the Ontario Forestry Branch and from the National Topographical Survey map No. 42E. The geological data was obtained from shore-line work and pace-and-compass traverses at 20-chain intervals.

## Acknowledgments

The members of the party are much indebted to various individuals in the area for their cordial hospitality and assistance during the summer. In particular the writer wishes to thank R. Ross and H. Bishop, of the Ontario Forestry Branch;

[1] M. W. Bartley, Ont. Dept. Mines, Vol. XLVII, 1938, pt. 9, pp. 29-40.

C. Barker, of Geraldton; R. Gray, of Schreiber; and the Pulpwood Supply Company, of Longlac. Able assistance was rendered in the field by W. A. Norfolk, A. M. Burslem, and E. O. Chisholm. Mr. Norfolk acted as senior assistant and did a considerable part of the geological mapping. Assays were made by the staff of the Provincial Assay Office.

## Access and Canoe Routes

The area is most conveniently reached by air, either from Geraldton or from Pays Plat, the Ontario Forestry Branch air base on Lake Superior. Big Duck lake is 50 miles south of Geraldton and approximately 18 miles northeast of Pays Plat.

From Schreiber, the canoe route to Big Duck lake is by way of Big Duck creek and Maude, Catharine, Louise, and Charlotte lakes, with five portages aggregating 10½ miles. A route leading to Aguasabon lake at the east end of the area starts at the Trans-Canada Highway bridge crossing Aguasabon river and proceeds up the river to Aguasabon lake with a quarter-mile portage, 18 miles up river.

Travel through the area is arduous due to the swiftness of the streams and the lack of portages between navigable lakes.

## Previous Geological Work

The earliest reference to the geology of the area is contained in a report by E. V. Neelands,[1] who in 1900 was attached to an Ontario Land Survey party in the Long Lake–Pic River area. In 1909, W. H. Collins[2] made a reconnaissance of the area between the Pic and Nipigon rivers. T. L. Tanton,[3] in 1920, investigated the mineral deposits of the western part of the area, around the Zenith zinc mines and Big Duck lake. In the same year, P. E. Hopkins[4] conducted a reconnaissance of the Schreiber–Duck Lake area for the Ontario Department of Mines.

## History and Development

The Zenith zinc mine, discovered in 1880, was the pioneer development of the area. Development and production did not commence until 1898, when a trial shipment of ore was sent to a smelter.

Gold was first discovered at Big Duck lake in 1906, but little interest was displayed until 1914, when spectacular gold showings were found on the Beaver (McQuaig) and Sjolander-McKirdy properties. About the same time, copper-bearing quartz veins were discovered near Big Duck lake. Massive pyrrhotite bodies were discovered on Nickel lake in the autumn of 1914, but were found to be non-nickeliferous.

Considerable work has been done on the gold showings, but the erratic distribution of the values caused the projects to be abandoned.

## Topography

Bed rock is exposed over most of the area with the exception of a few small areas of sand in the vicinity of Aguasabon and Lower lakes. The terrain is ex-

[1]E. V. Neelands, "Report of the Survey and Explorations of Northern Ontario, 1900," Ont. Bur. Mines, 1901, pp. 147-157.

[2]W. H. Collins, "Report on the Region Lying North of Lake Superior between the Pic and Nipigon Rivers," Geol. Surv. Can., Pub. No. 1081, 1909.

[3]T. L. Tanton, "Nipigon-Schreiber District, Ontario," Geol. Surv. Can., Sum. Rept. 1920, pt. D, pp. 2-7.

[4]P. E. Hopkins, "Schreiber–Duck Lake Area," Ont. Dept. Mines, Vol. XXX, 1921, pt. 4, pp. 1-26.

tremely rugged with deep valleys and block-like hills. In places, cliffs rise as much as 500 feet directly from the valley floor, but most of the hills have more gradual slopes up to heights of 1,000 feet. The greenstone areas present bolder relief and higher hills than do the granite portions. Glacial striae are remarkably scarce. A few erratics were found on some of the hills.

## Natural Resources

### Forests

Large sections of the area have been burned over and are now covered by a second growth of poplar, birch, balsam, spruce, and some jackpine. Spruce and balsam are the principal woods of economic value, and good stands suitable for

Pulpwood supply raft on Aguasabon lake.

pulpwood occur along the Aguasabon watershed. A few isolated clumps of large jackpine, suitable for tie-making, escaped the forest fires, but they are not readily accessible.

### Fish and Game

Commercial fishing is not carried on, but most of the lakes are well stocked with game fish, such as speckled trout, brown trout, pickerel, and black bass. The Big Duck section is well known to sportsmen and is the centre of a fast-growing tourist industry.

Moose are very abundant. Deer are not. Bear and wolves are seen occasionally, and small animals, such as porcupine, mink, and muskrat, are present in many parts of the area. The number of beaver is increasing annually, but as yet they are not abundant. In the autumn, partridge and ducks are plentiful.

### Water Power

The abundance of waterfalls in the area provides sites suitable for the small-scale development of hydro-electric power. The largest of these waterfalls are situated on the Aguasabon river at the lower end of Lower lake and on the creek flowing south from Big Duck lake to Charlotte lake.

## GENERAL GEOLOGY

All the consolidated rocks in the Big Duck–Aguasabon Lakes area are pre-Cambrian in age. They consist of a narrow band of Keewatin-type lavas and pyroclastics bordered by a narrow fringe of sediments and intruded by granite, porphyry, and diorite. The greenstone belt is almost enclosed by extensive intrusions of granite and syenite.

The general geology is summarized in the following table:—

| | |
|---|---|
| QUATERNARY | |
| PLEISTOCENE: | Sand and gravel. |
| PRE-CAMBRIAN | |
| KEWEENAWAN: | Diabase dikes and sills. |
| | *Intrusive contact* |
| POST-KEEWATIN (Algoman?) | LATE: Chiefly granite, syenite, and granite gneiss; quartz and feldspar porphyry and pegmatite. |
| | *Intrusive contact* |
| | EARLY: Diorite, gabbro, and pegmatitic diorite. |
| | *Intrusive contact* |
| KEEWATIN: | Volcanic group: Massive basic to intermediate lavas, pillow lava, volcanic tuff and agglomerate, amphibolite, hornblende and carbonate schists, small areas of acid lava, and perhaps some of the diorite included under early post-Keewatin. |
| | Sedimentary group: Quartz-mica, quartz-mica-garnet and garnet-mica schists and gneisses. |

### Keewatin

The Keewatin rocks form a belt about 4 miles wide, which extends from east to west across the area. This formation rests upon and is bounded by batholithic intrusions of granite. In the southeastern part of the area, the Keewatin forms a very shallow capping over the granite, as is evidenced by the gentle dips in the greenstone and the numerous sill-like intrusions of granite. The lavas are terminated to the west and north by granite, but toward the southeast they extend into the Schreiber area.

The Keewatin series consists chiefly of hornblende schist, pillow lava, and volcanic fragmental types, such as agglomerate, tuff, and some breccia. It also contains occasional flows of rhyolite and horizons composed of feldspar basalt porphyry (leopard rock). In addition there are narrow zones of quartz-mica, quartz-mica-garnet, and mica-garnet schists and gneisses.

The field relations of these types do not yield any information concerning their relative ages. Wherever observed their boundaries are parallel to the strike of the schistosity. Tops and bottoms are not definitely known, but wherever indications were noted, the mica schists appear to underlie the volcanics. Tanton[1] came to a similar conclusion in the same area.

The sedimentary rocks are characteristically found at the contact with the granite. The one exception is the occurrence on the northeast side of Cable lake. Hopkins notes that the oldest rocks are mica schists and states:[2]—

> They appear to be highly metamorphosed clastic rocks occurring near the periphery of the Keewatin, suggesting that they may be a basal portion of the Keewatin.

They are highly schistose and lighter in colour than the hornblende schists. Quartz, biotite, and garnet are the most abundant minerals, with lesser amounts

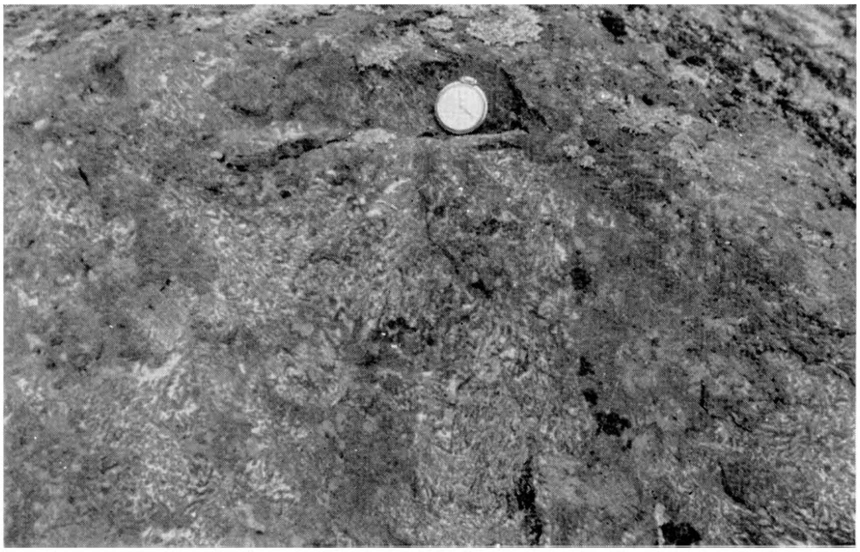
[1]T. L. Tanton, op. cit., p. 4.
[2]P. E. Hopkins, op. cit., p. 4.

of plagioclase, hornblende, epidote, sericite, and chlorite. Distinct banding as well as the abundance of quartz points to a sedimentary origin. Occasionally narrow bands of iron formation and conglomerate are found.

The volcanic series of rocks is now almost entirely represented by hornblende schist. Metamorphism has to a large extent obliterated the original structures. Distinct bands of tuff and agglomerate, however, are distinguishable. Smaller zones of ellipsoidal lava were observed. Chloritic schists are conspicuously absent, and mica schists occupy localized zones of intense deformation.

The fragments in the agglomerate have been almost completely replaced by epidote and carbonate. The matrix of the fragmentals as well as the hornblende schist is composed chiefly of hornblende, cloudy andesine, some chlorite, carbonate, and epidote.

Acid volcanics are relatively scarce. They appear as scattered patches in the basic lavas, especially in the vicinity of Aguasabon lake.



Pegmatite-diorite south of Little Duck lake. The light minerals are plagioclase; the dark, hornblende.

## Post-Keewatin (Algoman?) Intrusives

The rocks of the post-Keewatin intrusives consist of three types: diorite-gabbro, granite-syenite, and quartz and feldspar porphyry. The last two are definitely post-Keewatin, but the diorite-gabbro group in places displays a gradational contact, as if it might be in part Keewatin. All the acid intrusive rocks in the area are considered to be of the same epoch, probably Algoman, but they differ considerably in relative ages.

The tongue and bosses of quartz porphyry, feldspar porphyry, and granite porphyry and the dikes of aplite and pegmatite are believed to be largely the cause of such mineralization as occurs in the area.

### Diorite, Gabbro, and Pegmatitic Diorite

Diorite, gabbro, and pegmatitic diorite occur as a border phase between the volcanics and the granite-syenite mass to the south. At the south end of Aguasabon lake a mass of diorite intrudes the greenstone as a sill with islands of granite scattered through it. The supposition is that it represents the roof of a batholith close to the surface. Isolated occurrences of diorite are found near Burslem lake.

A coarse massive rock resembling diorite and occurring haphazardly in the region south of Big Duck lake appears to be a basic phase of the syenite. On the trail south of Little Duck lake the diorite becomes pegmatitic in character. The rock is in some places difficult to separate from the coarser-textured phases of the greenstone, and errors have undoubtedly been made in the mapping. Contacts tangential to the strike, however, show very clearly the intrusive nature of the diorite.

The proportion of dark and light minerals varies. In some exposures the rock is composed of so large a proportion of dark minerals that it has a dark-green to nearly black colour. In others, the rock has a speckled appearance, with white to pale-greenish feldspars and dark-green to black amphiboles and pyroxene as constituents.

The chief constituents of the diorite are brown and blue-green hornblende, andesine feldspar in laths, epidote, some chlorite, and in places minute amounts of quartz. Masses of pyrite are quite common in the darker varieties.

### Granite-Syenite

The granites are of two distinct types, namely: (1) a grey granite and granite gneiss and (2) a red hornblende granite. The grey granite appears to be slightly older than the red granite, and dikes of the latter cut the grey variety in many places. Both granites are usually in sharp contact with the Keewatin.

The grey granite occurs around Rope and Winston lakes. The red variety has a much wider distribution, occupying the batholithic bodies that envelope the greenstone belt. The Rope lake granite is medium- to coarse-grained with grey feldspars and abundant bluish quartz. Muscovite, biotite, garnet, and a small percentage of hornblende are also present. The second type of granite is markedly uniform in character, massive, red, and medium-grained. A thin section of a specimen from the southern batholithic mass is composed of quartz, orthoclase, hornblende, some oligoclase, biotite, and sericite. Garnets are characteristically absent.

Masses of syenite occur haphazardly in the granite zones. They are most abundant south of Big Duck lake. The rock has a granitic texture and is pink in colour; the main minerals are orthoclase, microcline, hornblende, and minor amounts of biotite, magnetite, and sericite.

### Quartz, Feldspar, and Granite Porphyries

The porphyries are most prevalent in an area 10 miles square in the vicinity of Big Duck lake. They are dominantly of the light-grey quartz porphyry type, although there are many feldspar and quartz-feldspar varieties present. The porphyries occur both as dikes and stocks, the largest occupying the north shore of Big Duck lake.

The quartz porphyries have a waxy appearance, are often greenish in colour, and may be extremely hard or soft depending on the amount of sericite produced. The feldspar porphyries are characteristically dull and "bony" in appearance. Both varieties range from the massive, unaltered type to the highly schistose phase. The latter usually have a high carbonate content due to secondary carbonatization. In thin section, the quartz porphyries are seen to contain large, well-rounded phenocrysts of bluish quartz, with an occasional well-formed orthoclase crystal set in a groundmass of fine, crystalline quartz, feldspar, calcite, sericite, talc, and some chlorite. The feldspar porphyries are characterized by well-formed phenocrysts of orthoclase.

It is believed that the mineral deposits around Big Duck and Little Duck lakes are genetically related to these porphyry intrusions.

A few of the schistose porphyries are heavily mineralized with sulphides and contain fine native gold. Pits have been sunk on some of these, but evidently the gold values were not high enough to make mining profitable.

Numerous granite porphyries are scattered throughout the area, usually not far from the larger granite bodies.

### Keweenawan

The youngest rocks of the area are diabase dikes. None appears to be wider than 200 feet, and only one, at the extreme east end of the area, has been traced continuously for more than one mile. As in the case of the porphyry dikes, the diabase is probably much more abundant than is indicated on the map. The dikes trend in a general north-south direction and are apparently discontinuous.

Two types of diabase are common: (1) the normal diabase with large plagioclase laths and black pyroxene grains set in a matrix of chlorite, epidote, biotite, and carbonate, and (2) olivine diabase containing phenocrysts of olivine in a matrix similar to the normal type.

### Pleistocene

Glaciation has been wide-spread over the region, but only one stria, which strikes S. 20° E., was noted.

Glacial deposits are not abundant. Sand and gravel deposits are locally distributed along the Aguasabon river in the Aguasabon-Lower Lakes basin and at the south end of Owl lake. An isolated esker extending for approximately 2 miles was encountered southwest of Harvie lake.

## STRUCTURAL GEOLOGY

### Folding

The Keewatin rocks have been closely folded. The strata dip at steep angles to the north and northeast. The greenstone belt, in general, appears to be the south limb of an overturned anticline, the north limb having been obliterated by the north granite batholithic intrusion. At the eastern extremity of the area, the dips flatten and the attitude is that of a recumbent fold. No doubt considerable cross-folding has occurred, as is indicated by the variation in strike of the schists. Repetition of beds will satisfactorily explain the great thicknesses of agglomerate and tuff present.

Foliation and bedding planes in the tuff are essentially parallel.

### Faulting

The area as a unit has been greatly disturbed by faults of several ages. Both horizontal and vertical displacements have broken the Keewatin into large blocks, which are displaced with respect to one another to such an extent that it is at present almost impossible to identify small structural units that might be common to two adjacent blocks.

The major faults of the area displace the Keewatin and Algoman-type rocks only, others displace Keweenawan diabase as well. The main period of faulting, therefore, is believed to be pre-Keweenawan.

### Shearing

Intense regional deformation has completely transformed the greenstones to hornblende and mica schists. Shearing movements have also affected the granite masses to some extent. This is quite evident in the vicinity of Winston lake and in the northern section where the granitic rocks have a pronounced gneissic structure.

## ECONOMIC GEOLOGY

Evidence of mineralization has been found in many parts of the area, but with the exception of the Zenith zinc mine, none of the deposits has been brought to the production stage, and the Zenith was producing for only a short time. In 1914, when prospecting activity was at its height, many showings were opened up and a number of shafts were sunk in the vicinity of Big Duck and Little Duck lakes. Most of the workings are now grown over and are difficult to find.

The mineralization occurs in the form of calcite lenses, carbonatized and silicified zones near quartz porphyry and hornblende schist, and in the quartz porphyry bodies themselves. The principal showings are replacement deposits, calcite being the dominant gangue mineral. Flour gold is present in some of these; copper, lead, and zinc sulphides in others. The values quickly diminish a short distance from the veins and lenses. Occasionally veins of rusty sugary quartz are encountered, containing small quantities of visible gold, but these veins are not extensive.

## DESCRIPTION OF PROPERTIES

Very little, if any, development work has been undertaken since 1921, and there is very little to add to the descriptions furnished by Hopkins.[1]

### Gold

#### Beaver or McQuaig

The Beaver or McQuaig property consists of one claim located on the trail between Big Duck and Little Duck lakes. A shallow shaft, now flooded, was sunk on a narrow carbonate replacement zone, striking N. 65° E. and dipping 70° N.W. The total width of the zone is not more than 3 feet, and the mineralized section not more than 12 inches. The minerals present are calcite, pyrite, sphalerite, galena, some chalcopyrite, and sericite. Intercalated bands of mixed carbonate, actinolite, and chalcopyrite are prominent. A grab sample of the best-looking material taken by the writer and submitted to the Provincial Assay Office returned an assay of 0.20 ounces per ton in gold. Hopkins states in his report:[2]—

> At a depth of six feet considerable gold in a fine flour state could be seen over a width of 10 inches near the centre of the footwall section of the vein. In 1915, a small open cut was made and a 40-foot shaft sunk from which 2,710 pounds of ore were sorted and shipped to a smelter yielding 2.0 ounces of gold and 3.9 ounces of silver per ton, total value $43.00 per ton. Visible gold was reported to occur at frequent intervals to the bottom of the shaft, where the vein was said to be about four feet wide.

#### Sjolander-McKirdy

Two claims lying directly north of the west end of Big Duck lake at the contact of hornblende schist and quartz porphyry are known as the Sjolander-McKirdy group. The deposit has an over-all width of 25 feet and is composed

[1] P. E. Hopkins, op. cit., pp. 20-23.
[2] Ibid., p. 20.

of a 5-foot carbonate-quartz vein, with 10 feet of mixed schist, carbonate, and quartz on either side. The main vein strikes N. 70° E. and dips 65° N.W. The whole zone is heavily mineralized with pyrite, galena, sphalerite, chalcopyrite, and a little pyrrhotite. The showing has been stripped for 50 feet, and near the boundary between the two claims an open cut, 25 feet long and 8 feet deep, has been blasted across the deposit. A grab sample of the carbonate-quartz material taken by the writer and submitted to the Provincial Assay Office assayed 0.07 ounces in gold per ton. Hopkins reports:[1]—

Assays of channel samples taken in sections across this open cut indicate favourable values in gold across seven feet near the hanging wall part. Considerable gold in a state of fine division occurs about five feet from the hanging wall. . . . In the early part of 1915, 500 pounds of vein matter were shipped to a smelter.

Open pit on the Sjolander-McKirdy property. The white streak is a chip-sample groove across the carbonate vein.

Farther east on the same strike, a shallow pit was sunk on a heavy sulphide zone composed mainly of pyrite, mixed carbonate, cherty quartz, and a green mica, probably mariposite.

### Fisher

A property consisting of one claim on the same strike as the Sjolander-McKirdy and closely resembling that property is known as the Fisher. A 2-foot vein of mixed carbonate and quartz, striking N. 70° E. and dipping 65° N.W., is located approximately 1½ chains north of the trail between Big Duck and Little Duck lakes, about half way between the two lakes. A number of trenches and shallow pits, now filled in, dot the showing. The footwall side of the vein is a garnetiferous mica schist, and the hanging wall is hornblende schist. There are relatively more sulphides and quartz stringers here than on the Sjolander-McKirdy property. Other veins appear in the neighbouring porphyry but are small and sparsely mineralized.

[1]P. E. Hopkins, op. cit., p. 21.

### Other Properties

Other gold-bearing veins are found in many places around Big Duck lake. They are of two types: (1) narrow carbonate shear zones, carrying pyrite and sphalerite with many tiny quartz stringers, and (2) large lenses of sugary quartz with pyrite, chalcopyrite, galena, sphalerite, and in some cases feldspar. The Cooper, St. Louis, and Duck Lake Company properties are of the latter type. The values are believed to be below commercial grade.

## Zinc and Lead

### Zenith Mine

The Zenith mine is located about 2 miles southwest of Little Duck lake in a massive diorite body. Lenses and narrow veins of dark-brown sphalerite occupy fractures in the diorite. These small bodies outcropping on the hilltop and on the

Zenith zinc mine. Two adits with their dumps can be seen in the side of the hill.

southern slope of the hill have been explored by a shallow open cut and short adits. The largest of the workings measures 15 by 20 feet, and this appears to have been the full dimension of the largest concentration of sphalerite.

The fractures vary in strike from northeast to northwest, dipping at 45° N.W. and N.E., with many rolls and flexures.

The property was first operated in 1898-99, when 1,065 tons of ore was shipped to a smelter. In 1900 further development was undertaken, and by the end of 1901, 2,700 tons of sphalerite had been mined and concentrated for shipment. The mine then lay idle until 1928, when another attempt was made to find more extensive bodies. Carter,[1] Uglow,[2] and Hopkins[3] have described the property and its development.

[1]W. E. H. Carter, Ont. Bur. Mines, Vol. X, 1900, p. 86.
[2]W. L. Uglow, Ont. Bur. Mines, Vol. XXV, 1916, pt. 2, pp. 7, 8.
[3]P. E. Hopkins, op. cit., p. 23.

### Little Duck Lake

The property of the Little Duck Lake Mining Company, situated on the north shore of Little Duck lake, has been opened up by two shafts and a number of shallow pits. The veins strike north-south and dip steeply to the east. Their extent could not be ascertained owing to the heavy overburden, but like other deposits in the area they probably consist of short lenses. The vein material is composed of calcite with massive sphalerite, galena, disseminated pyrite, and some chalcopyrite.

### Other Properties

Hopkins[1] mentions other occurrences of zinc at the Gesic, McQuaig, and Sjolander-McKirdy properties.

## Copper

### Estell and Burstrom

On the Estell group of three claims on the south shore of Big Duck lake and the Burstrom claims, situated a quarter of a mile west of Big Duck lake, considerable amounts of chalcopyrite and some copper carbonate are found. The deposits consist of a series of wide sugary quartz veins containing disseminated sulphides. They have been explored by means of trenches and shallow pits. According to Hopkins[2] they carry low values in gold and as much as 4 per cent. copper.

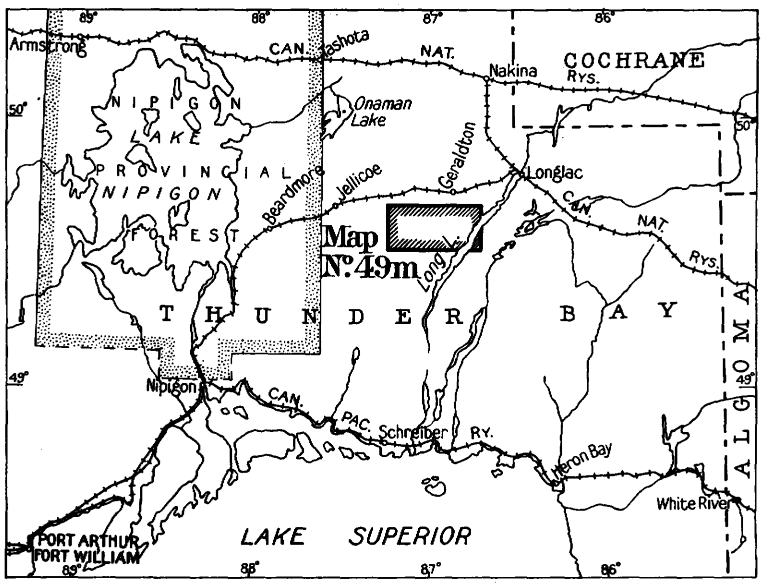
[1]P. E. Hopkins, op. cit., p. 24.
[2]Ibid, pp. 22, 23.

# Geology of the Kenogamisis River Area

**By R. D. Macdonald**

## Introduction

The townships of Lindsley, Errington, and Ashmore, district of Thunder Bay, were geologically mapped by E. L. Bruce[1] in 1934. Since that time the importance of the area in the production of gold has greatly increased and the successes obtained there have encouraged prospecting in the surrounding areas. As the area to the south was known to contain volcanic and sedimentary rocks, it was examined and mapped during the summer of 1939 to estimate its economic possibilities and to delimit the various rock formations.




Key map showing the location of the Kenogamisis River area. Scale, 50 miles to the inch.

Pace-and-compass methods were used in the mapping, and traverses were run at 20-chain intervals. The base map used was an aerial photographic map prepared by the Topographical and Air Survey Bureau of the Department of Interior, Ottawa. Owing to the lack of surveyed lines in most parts of the area rock outcrops were tied in with topographical features.

### Acknowledgments

The writer wishes to express his thanks and appreciation for assistance received during the field season. A. A. Brant afforded many conveniences for the party during the season. Information concerning roads and trails was obtained from A. F. Matheson, of Bankfield Consolidated Mines, and J. D. Bâby, of Beardmore. Able assistance was rendered in the field by W. K. Gummer, D. H. Mode, and A. O. MacIntosh. Mr. Gummer, as chief assistant, did a considerable portion of the field mapping and completed the compilation drafting of the map.

[1]E. L. Bruce, "Little Long Lac Gold Area," Ont. Dept. Mines, Vol. XLIV, 1935, pt. 3.

The writer is indebted to the Department of Geology of Princeton University for the use of its laboratory facilities during the preparation of the report. The constructive criticisms of the manuscript by Professors A. F. Buddington, E. Sampson, H. H. Hess, and A. K. Snelgrove are much appreciated.

### General Description of the Area

The map area is situated in the district of Thunder Bay and lies 50 miles north of Lake Superior and 50 miles east of Lake Nipigon. The town of Geraldton, situated on the Canadian National railway between Port Arthur and Longlac, is the nearest point of departure for the area. The area, extending westward from Long lake for a distance of 20 miles and southward from the townships of Lindsley, Errington, and Ashmore for an average distance of 8½ miles, comprises approximately 170 square miles.

A good highway now leads from Geraldton, past the Little Long Lac mine, to the Hard Rock mine on Little Long Lac. Another road runs westward from Little Long Lac and extends beyond the south end of Wild Goose lake. Within the Kenogamisis River area the only means of travel is by water routes or trails. The eastern and southern parts of the area are accessible by canoe routes and portages connected with Little Long Lac. The east side of the area can be reached directly by water from the town of Longlac at the north end of Long lake. Little Long Lac, the Kenogamisis (Wintering) river, and Finlayson and Gamsby lakes, with connecting portages, form the main travel route in the area. A trail leading from Marron lake to Goldfield lake is the best means of access to the north-central part of the area. A lumber road runs north from Marron lake and connects with the highway running westward from the Little Long Lac mine. The northwestern part of the area can be reached only by trail. The best trail follows the Colter-Lindsley township line south from Wild Goose lake.

### Previous Work

Detailed accounts of previous work done in the Little Long Lac and adjoining areas have been presented by E. L. Bruce[1] and H. C. Laird.[2] The following list includes some of the references more pertinent to the Kenogamisis River area:—

E. L. Bruce, "Little Long Lac Gold Area," Ont. Dept. Mines, Vol. XLIV, 1935, pt. 3.
E. L. Bruce, "The Eastern Part of the Sturgeon River Area," Ont. Dept. Mines, Vol. XLV, 1936, pt. 2.
A. G. Burrows, "Longuelac to Jellicoe and Orient Bay," Ont. Bur. Mines, Vol. XXVI, 1917.
H. W. Fairbairn, "Geology of the Northern Long Lake Area," Ont. Dept. Mines, Vol. XLVI, 1937, pt. 3.
H. C. Laird, "The Western Part of the Sturgeon River Area," Ont. Dept. Mines, Vol. XLV, 1936, pt. 2.
G. B. Langford, "Geology of the Beardmore-Nezah Gold Area," Ont. Dept. Mines, Vol. XXXVII, 1928, pt. 4.
Map No. 308A, "Lake Nipigon Sheet," Geol. Surv. Can., 1935.
Map No. 313A, "Little Long Lac Area," Geol. Surv. Can., 1934.

### Topography and Drainage

The topography is in many respects similar to that of the adjoining Little Long Lac area. The greatest variations from a general flatness are produced by deposits of glacial material, the most marked of which are esker ridges. In some parts of the area the irregular deposition of glacial material has resulted in an

[1]E. L. Bruce, "The Eastern Part of the Sturgeon River Area," Ont. Dept. Mines, Vol. XLV, 1936, pt. 2, pp. 2, 3.
[2]H. C. Laird, "The Western Part of the Sturgeon River Area," Ont. Dept. Mines, Vol. XLV, 1936, pt. 2, pp. 63, 64.

irregular rolling topography. Undrained pot-hole lakes are abundant in these regions. Broad, gently rolling sand plains are common in the southwestern part of the area.

Numerous muskegs and swamps are present in the areas of lower relief. Many of them are irregular in shape, but the majority show a northeasterly trend. This is especially noticeable in the northwestern part of the area.

Because of the presence of such extensive deposits of glacial and muskeg material, outcrops of consolidated rocks are few, and in most cases they do not form marked ridges or hills. Exceptions to this occur along the west side of Long lake where granite hills are present, and in the central part of the area where the volcanic rocks form distinct ridges.

The greater part of the area lies on the James Bay drainage slope. The streams on this slope either drain to Little Long Lac and northeastward by the Kenogamisis river or to Long lake and by the Kenogami river to James bay. The streams in the far western part of the area drain to Lake Superior by way of Wild Goose lake, the Sturgeon river, and Lake Nipigon. The height-of-land between the two drainages crosses the western part of the area in a north-northeasterly direction. Owing to their proximity to the height-of-land the streams are mostly small and unfit for canoe use. The lakes are usually shallow, and their shores characteristically have but few outcrops. Most of them occupy basins that are bordered by glacial material. Since the area shows a general flatness, and much of it consists of muskeg, the drainage is slow.

### Natural Resources

Spruce, pine, balsam, birch, and cedar are the most abundant trees in the area. The pine is of economic value and was cut in previous years. During the late summer of 1939, timber roads and trails were cut from the highway near Mosher lake in Errington township to the south end of Little Long Lac for the purpose of opening up additional timber country. The glacial deposits of sand and gravel would be suitable for construction purposes, should the occasion arise for their use.

Game is plentiful in the less accessible parts of the area. Moose, deer, caribou, bear, beaver, muskrat, and other small animals are to be found. Moose are plentiful in the southern part of the area. Although beaver and muskrat are present, there are not now sufficient fur-bearing animals to make trapping profitable. Pike, pickerel, and stream trout are the commonest fish. Except for Long lake, the lakes are too shallow for lake trout.

Despite the fact that the gradient of the Kenogamisis river is steep and numerous rapids are present in its course from Gamsby lake to Little Long Lac, there is little likelihood of hydro-electric power being developed, since the volume of water is relatively small. Power from Lake Nipigon is now available for the Little Long Lac area.

## General Geology

The consolidated rocks of the area are all pre-Cambrian in age. These are overlain in many places by Pleistocene deposits of sand and gravel. Muskeg accumulations of Recent age occupy considerable portions of the area. Since there is reason to doubt the correctness of the use of the terms Keewatin and Timiskaming, with the age relations that the two terms imply, the terms Keewatin-type and Timiskaming-type are here used. The Keewatin-type rocks include basic to acidic volcanics, their schistose derivatives, and volcanic fragmentals. The Timiskaming-type rocks include various types of greywacke, quartzite, slate, and pebble conglomerate. A more highly metamorphosed group of sediments, comparable in type to Coutchiching rocks, is present. They include micaceous and quartzose paragneiss, mica schist, and garnetiferous and staurolitic gneiss. The following table lists the rocks in their possible age sequence. Modifications that might be applied to the table are discussed under the section on the age relationships of the rock groups.

**Table of Formations**

| | |
|---|---|
| QUATERNARY | |
| RECENT: | Drift, muskeg accumulations. |
| PLEISTOCENE: | Sand, gravel, till. |
| | *Unconformity* |
| PRE-CAMBRIAN | |
| KEWEENAWAN: | Quartz diabase dikes. |
| | *Intrusive contact* |
| ALGOMAN(?): | Biotite granite.<br>Granite-pegmatite.<br>Hybrid rocks. |
| TIMISKAMING-TYPE: | Micaceous greywacke, chloritic and arkosic greywacke, quartzite, conglomerate, slate and slaty greywacke. |
| KEEWATIN-TYPE: | Dacite, agglomerate and tuff, andesite, chlorite and hornblende schist, hornblende gneiss and coarse amphibolite. |
| COUTCHICHING-TYPE: | Micaceous paragneiss, quartzose paragneiss, mica schist, garnetiferous gneiss, staurolitic gneiss. |

**Coutchiching-type Rocks**

A large part of the area is underlain by schistose to massive micaceous rocks. These occur between the granite and the southern volcanics in a belt ranging from 2 to 7½ miles in width. Owing to their lithological character and their apparent stratigraphical position they are termed Coutchiching.

The rocks have been separated into general lithological groups in order to facilitate their designation on the map. They consist of micaceous paragneiss, quartzose paragneiss, mica schist, garnetiferous gneiss, and staurolitic gneiss. In their eastward extension the rocks correspond lithologically to the mica schist group of the Pagwachuan Lake area.[1] The northern part of the belt probably corresponds to the southern belt of sediments in the Beardmore-Nezah area.[2]

The term paragneiss has been used to designate a group of massive to slightly fissile sediments that appear on weathered surface as homogeneous or bedded rocks. The paragneisses occur most commonly to the south of the southern volcanic belt in a zone that is less than 1½ miles wide.

On the basis of their megascopic appearance the paragneisses have been divided into micaceous and quartzose types. The micaceous type, although it appears quite massive on weathered surface, shows a glistening foliation surface owing to the parallel arrangement of disseminated biotite crystals. The name of the quartzose paragneiss is derived from the quartzitic appearance of the rock. This type does not show the glistening foliation surface that characterizes the micaceous paragneiss.

Microscopic examination shows both types to have a subequigranular groundmass of quartz and minor amounts of feldspar. The constituents of the

[1]R. D. Macdonald, "Geology of the Pagwachuan Lake Area," Ont. Dept. Mines, Vol. XLVI, 1937, pt. 3, pp. 26, 30-33.

[2]G. B. Langford, "Geology of the Beardmore-Nezah Gold Area," Ont. Dept. Mines, Vol. XXXVII, 1928, pt. 4, map No. 37k.

groundmass form an interlocking mosaic rather than a granular aggregate, such as is common for the Timiskaming greywackes. Biotite constitutes up to 20 per cent. of the quartzose and up to 35 per cent. of the micaceous paragneisses. In contrast to the micaceous paragneisses, the biotite of the quartzose paragneisses is irregularly formed and poorly oriented. The orientation of the biotite, rather than the amount, may be an important factor in the different appearance of the two rocks. Chlorite is quite abundant in some of the finer-grained rocks. Variations in the relative proportions of biotite and chlorite can be seen in the same slide, where differences in grain size of bands is apparent. In one section showing a marked preponderance of chlorite over biotite, the texture of the groundmass is more like the clastic greywackes of the Timiskaming sediments.

Hornblende is an important constituent of some of the micaceous paragneisses. It is usually a pale-green variety and occurs as stubby to elongate crystals. Some specimens show a banding of hornblende-rich and biotite-rich portions. Hornblende may be present in amounts equal to or greater than biotite, but is usually much less.

A more schistose rock is the dominant type to the south of the paragneiss zone. These rocks, the mica schists, are dark-grey to rusty-brown fissile schists. Quartz is the dominant mineral of the groundmass; fresh-looking oligoclase feldspar is present in lesser amounts. The quartz and feldspar form a mosaic in which the grains are two to three times as long as wide, the long dimensions being subparallel to the foliation. Biotite, in well-formed plates, constitutes from 30 to 40 per cent. of the rock. Chlorite occurs as a minor constituent in some of the rocks. Apatite, sphene, and tourmaline are common as accessories.

A distinctive group of rocks, which has been classed with the mica schists, was given the field term of "spotted" mica schists. They are highly fissile rocks with lustrous foliation surfaces and a spotted appearance due to the presence of larger clusters or crystals of biotite. The groundmass consists of fine equigranular quartz and lesser feldspar, with fine platy biotite and chlorite.

Some of the micaceous rocks are coarse enough to merit the term gneiss. Owing to the fact that the gneisses usually contain garnet or staurolite as important mineral constituents, they are called garnetiferous gneisses and staurolitic gneisses. The garnetiferous ones are more abundant, and the staurolitic ones usually contain some garnet. The rocks are medium- to coarse-grained and coarsely foliated. The groundmass consists mainly of quartz with interstitial well-formed plates of biotite. Dodecahedral garnet, staurolite, and some biotite occur as porphyroblasts. The foliation, as indicated by the biotite plates, is deflected around the larger porphyroblasts. Magnetite, tourmaline, and apatite are the chief accessory minerals. Chlorite is present in some sections.

### Keewatin-type Rocks

Keewatin-type rocks occur in two belts within the area. The larger belt crosses the central part of the area with a general trend slightly north of west. It connects on the east with the southern belt of volcanics in the Northern Long Lake area.[1] In its extension to the west it probably connects with the southern volcanics in Legault, Leduc, and Vincent townships.[2] The second belt of volcanics lies in the northeastern part of the area. In its eastward extension it probably connects with the volcanics on the southwest side of West Side bay,

[1]H. W. Fairbairn, "Geology of the Northern Long Lake Area," Ont. Dept. Mines, Vol. XLVI, 1937, pt. 3, map No. 46b.
[2]E. L. Bruce, "The Eastern Part of the Sturgeon River Area," Ont. Dept. Mines, Vol. XLV, 1936, pt. 2, map No. 45a.

Long lake.[1] Recent stripping and trenching in an area south of the central part of Croll township has exposed volcanic rocks. Since these are in line with the volcanics on West Side bay and those in the Kenogamisis River area, they probably represent a portion of a continuous band. In its westward extension the belt ties up with rocks that were previously mapped as diorites and chloritic greywackes.[2] The reasons for the different interpretation now placed on them are dealt with after the petrographic descriptions.[3] In the absence of outcrops the northern contact of this belt has been placed on the map so that it lies to the south of areas showing magnetic attractions, since these attractions are probably caused by drift-covered iron formation of the Timiskaming sediments.

The southern volcanic belt consists dominantly of basic flows, probably originally andesites but now highly altered. They show variations in coarseness of grain, amount of foliation, and mineral composition. The main types are fine- to medium-grained rocks of andesitic nature; coarser-grained, more schistose hornblendic rocks; and coarse-grained amphibolitic rocks. The andesites have a fine-grained groundmass of quartz and oligoclase with abundant hornblende and some chlorite. The hornblende schists and gneisses represent andesitic phases, which have been reconstituted by intense dynamic action. A segregation of the basic and acidic minerals in rough bands is present in the coarser gneisses. The coarse-grained massive rocks have the megascopic appearance of intrusive hornblende diorites, but, because of their association with andesitic flow material, they are considered to be coarser-grained portions of the flows that have largely withstood shearing action, owing to their massive nature. They consist of oligoclase, hornblende, quartz, iron-poor epidote, chlorite, and magnetite.

The volcanic fragmentals of the southern belt consist of agglomerate and minor amounts of tuff. The groundmass of the agglomerate is highly sheared and consists mainly of quartz, chlorite, epidote, and carbonate. Although they have been elongated to some extent by shearing, the fragments still retain an angularity. They are light-grey on weathered surface and consist of highly altered material with a felted texture. Chlorite, epidote, kaolin, quartz, feldspar, and calcite are the main mineral constituents. Tuff occurs as a minor associate of these fragmentals. They are highly sheared but retain a granular fragmental texture. The minerals are oligoclase, biotite, chlorite, epidote, calcite, and metallics. No bedding was seen in any of the tuffs of this belt.

The volcanics of the northern belt differ in several respects from those of the southern belt. Lithologically they differ in the presence of a greater proportion of tuff and acidic flows; mineralogically they differ in having chlorite as the dominant ferromagnesian constituent rather than hornblende.

Much of the flow material is also considered to be altered andesite and megascopically resembles that of the southern belt in its basic appearance and sheared nature. The main mineral constituents are albite, chlorite, hornblende, epidote, quartz, sericite, calcite, and opaque metallics. Acicular to platy hornblende is present only in the more coarsely crystalline types. Chlorite has a fibrous to platy habit and in the finer-grained rocks is the dominant ferromagnesian constituent.

Flow material of a more acidic nature than the andesites is present in appreciable amounts in the northern volcanics. The material is characteristically dense in appearance and has a light grey-green colour. The presence of quartz

[1]H. W. Fairbairn, op. cit.

[2]E. L. Bruce, "Little Long Lac Gold Area," Ont. Dept. Mines, Vol. XLIV, 1935, pt. 3, map. No. 44d.

[3]Page 20.

phenocrysts indicates an acidic nature, but since the feldspars are now altered to albite, it is impossible to tell what they originally were. Since they show no evidence of an appreciable potash-feldspar content, they are considered to be altered dacites. Some show flow banding and others are brecciated. Examples of these occur on the island in Little Long Lac that is crossed by the Ashmore township line.

Agglomerates and tuffs are quite abundant in the northern belt. The agglomerates consist of elongate fragments of light-grey porphyry in a darker, more chloritic groundmass. The porphyry fragments have a trachytic-textured groundmass of quartz, feldspar, chlorite, and epidote, with phenocrysts of albite and elongate eyes of quartz. The groundmass in which the fragments lie is a sheared granular mosaic of quartz and albite with abundant chlorite, epidote, calcite, and kaolin. An example of this type occurs on the north side of the island on the Ashmore township line in Little Long Lac.

The tuffaceous rocks are commonly associated with the agglomerates but are more abundant. Most of them are bedded, but massive types are present. They range in colour from light- to dark-green and have a granular fragmental texture. They are highly feldspathic, consisting of albite, chlorite, epidote, sericite, and calcite. Quartz may or may not be present; biotite is sometimes present as a minor constituent.

Since the finer-grained tuffs resemble the finer chloritic greywackes, it was not always possible to be certain in distinguishing between the two. Thus, some of the rocks classed with the Timiskaming sediments may be tuffaceous. This is especially true of the rocks occurring on the south side of the peninsula in Little Long Lac on the Ashmore township line and the rock in the southwest corner of claim T.B. 13,107.

A few outcrops of amygdaloidal volcanics were observed, but they are uncommon. One such occurrence is in the outcrop on the south boundary of claim T.B. 13,108. The amount of the material in the area has not warranted it being separately designated on the map.

A few narrow bands of iron formation occur in both volcanic belts, but they are too small to designate on the map. The usual type is a banded magnetite and silica rock. A different type occurs in some places in the southern volcanics, in which the iron formation is a banded magnetite and chlorite-actinolite rock. Langford[1] attributes this type to metamorphism that caused the iron to combine with other constituents.

The classifying of the rocks of the northern belt as extrusive rather than intrusive types necessitates a few words of explanation. The problem of distinguishing the coarser andesitic rocks from some of the hornblendic diorites, especially when they are sheared and metamorphosed, is a difficult one if their relationships to the surrounding rocks are obscured by drift. Petrologically, there would be no justification for considering the rocks to be extrusive. Many of the so-called tuffs are too fine to distinguish from fine chloritic greywackes; but others, of coarser grain, have a granular fragmental texture and also have a high feldspar content that would not be normal for a greywacke of equivalent grain size. The presence of material that is distinctly of extrusive origin is the main reason for considering the belt to be composed mainly of extrusive rocks. This material consists of agglomeratic and amygdaloidal volcanics and acid flows, some of which show flow banding and brecciation.

[1]G. B. Langford, op. cit., p. 88.

### Timiskaming-type Rocks

A belt of rocks in the northern part of the area consists of sediments similar in lithology to Timiskaming sediments. These represent the southward continuation of the Timiskaming sediments in the southern parts of Lindsley and Errington townships[1] and consist of greywacke, quartzite, conglomerate, slate, and micaceous greywacke.

Greywackes are the dominant rock type. They vary from fine chloritic types to coarser feldspathic types. The chloritic greywackes are fine-grained rocks consisting dominantly of quartz with lesser amounts of albite, chlorite, sericite, calcite, and epidote. Biotite occurs in some sections but it is minor in amount. The feldspathic greywackes have a medium-grained inequigranular groundmass of quartz and feldspar, the two constituents occurring in more or less equal amounts. The other constituents, such as chlorite, sericite, calcite, epidote, and biotite, are not as abundant as in the chloritic greywackes. Gradations between these two types are common.

Conglomerate occurs in the northern part of the area in association with greywacke. It is minor in amount and occurs only in thin, localized lenses. In the largest outcrop observed, situated 35 chains south-southwest of the 1-mile post on the Lindsley township line, the conglomerate has a width of approximately 50 feet. The rock here is typical of the conglomerate in the area. It contains pebbles of feldspar porphyry, trachyte, spherulitic lava, and quartz-carbonate vein material. The groundmass consists of medium-grained quartz and feldspar, biotite, chlorite, and calcite. The average size of the pebbles is about one-quarter of an inch in length. The rock is, therefore, distinctly different from the coarse boulder conglomerates of the Little Long Lac area, both in the size and composition of the materials composing it.

A distinctive type of sediment occurs with the coarser greywackes. It has the ordinary clastic texture of the coarser greywackes but contains lens-like inclusions of finer-grained argillaceous material. These inclusions, some of which are 2 to 3 inches in length, may be sheared pebbles of finer-grained greywacke material or lenses formed contemporaneously with the enclosing sediments. Microscopically the rock shows a peculiarity in the development of irregular to elongate crystals of actinolite. Chlorite is the common ferromagnesian mineral in the surrounding rocks but occurs in restricted amounts in the actinolitic rock. An example of this type occurs 10 chains south of the southeast corner of Lindsley township

Impure quartzite is a minor constituent of the greywacke belt. It occurs as massive beds and is apparently local in distribution. It is a medium-grained, light greenish-grey rock, consisting mainly of quartz. Feldspar is the next most abundant mineral; lesser amounts of chlorite, sericite, light-green biotite, and epidote are present.

Although slate is relatively minor in amount, it is of common occurrence in the greywackes. The slates have a very fine grained groundmass composed of quartz with interstitial chlorite, sericite, and clouded opaque minerals. A slightly coarser grained rock, which is really a slaty greywacke, is commoner than the slate.

The Timiskaming-type rocks include a group of sediments that are characterized by the presence of megascopically visible biotite. These occur to the south of the chloritic and arkosic greywackes and extend southward to the southern volcanic belt. All the rocks in this zone are not distinctly micaceous, but biotite is sufficiently prevalent to designate them as micaceous greywackes.

[1]E. L. Bruce, Ont. Dept. Mines, Vol. XXIV, 1935, pt. 3, map No. 44d.

Megascopically the micaceous greywackes do not differ much from the granular greywackes to the north. In general they are a lighter-grey in colour, and the bedding is more massive. Most of them still retain a granular texture similar to that of the northern greywackes, and on weathered surface they appear much alike. On a freshly broken foliation surface, however, fine lustrous mica shows up. They have an inequigranular groundmass of quartz and feldspar. The feldspar, an acid oligoclase, forms from 20 to 40 per cent. of the rock, the coarser-grained rocks being higher in feldspar content. Biotite is the next most abundant mineral, varying in amount from 5 to 20 per cent. of the rock. Chlorite, sericite, epidote, and calcite are common as minor constituents.

The mineralogical differences between the chloritic greywacke and the micaceous greywacke consist mainly in the presence of albite, chlorite, and sericite as important constituents in the former, and oligoclase and biotite in the latter. A gradation apparently exists between the two types, but the scarcity of outcrops made it impossible to obtain definite proof of such a gradation. Some of the micaceous greywackes have a higher content of biotite than the purer quartzose paragneisses of the Coutchiching-type rocks. This may be a result of a greater amount of ferromagnesian constituents in the high-biotite greywacke or a greater amount of dynamic action in the regions of the highly micaceous greywackes.

#### Age Relationships of the Rocks of Coutchiching, Keewatin, and Timiskaming Types

A problem arises in attempting to correlate chronologically the formations in the Kenogamisis River area with those in the Little Long Lac area, where the term Timiskaming was applied to the sediments and Keewatin to the volcanics. The rocks in that area were considered to occupy the northern limb of a syncline, the axis of which lay to the south of the area.[1] The presence in the Kenogamisis River area of a belt of sediments bordered on the south by volcanics gives a general picture of the completion of the major synclinal structure. Certain factors, however, tend to throw some doubt on such a contention. The first of these is the presence of a narrow volcanic belt in the northeastern part of the area. Lying as they do in the supposed Timiskaming zone, the volcanics may be explained in three ways: (1) They may be volcanics of Timiskaming age; (2) they may be Keewatin in age and owe their position to faulting; (3) volcanics and sediments of more than one age may be present in the Little Long Lac and Kenogamisis River areas.

The sediments in the northern part of the Kenogamisis River area differ in several respects from those in the central part of the Little Long Lac area. Conglomerate, arkose, and iron formation are common in the Little Long Lac area; very little conglomerate and arkose are present in the Kenogamisis River area, and no outcrops of iron formation were observed. The conglomerate differs from the Little Long Lac conglomerates in coarseness, composition, and extent. Whereas those of the Little Long Lac area are fairly extensive, with boulders of granite, porphyry, and greenstone, those in the Kenogamisis River area are local and contain pebbles of porphyry, acid lava, and quartz. A few compass attractions noted in drift-covered portions of the sedimentary belt may be taken as an indication of the presence of iron formation, but, even if this is so, the two belts show a marked difference in the relative amounts of iron formation present. Langford has noted the same conditions in the Beardmore-Nezah area. In his description of the Timiskaming sediments he states:[2]—

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[1]E. L. Bruce, op. cit., pp. 16, 17.
[2]G. B. Langford, op. cit., p. 88.

They are mostly greywacke and slate with minor amounts of iron formation and conglomerate. The last two types are confined to the northern part of the area, where they form a more or less continuous band from east to west.

Other differences in lithology could be mentioned, but these may be mineralogical differences produced by metamorphism of originally similar rocks.

These factors, together with structural features, which are discussed in a following section,[1] allow more than one interpretation as to age. The micaceous schists and apparently overlying volcanics fit in lithology and age sequence with Coutchiching and Keewatin. The northern belt of sediments would lie in the stratigraphic position of the Timiskaming, but if they are Timiskaming the term must be extended to include the northern volcanic belt. This may be the simplest and least confusing interpretation of the age relations. It is possible, however, that the northern volcanic belt might be justifiably classed as a separate formation and, although it is Keewatin in type, a different formational name should be applied to it. Involved with this postulation is the possibility that only those sediments lying to the north of this volcanic belt should be called Timiskaming.

The absence of proof for or against major faulting in the area is one of the main reasons for doubt concerning the age relationships of the formations. Since faulting could cause the repetition of a formation, the apparent age sequence may not be the true one. Because of the uncertainty concerning the correct age relationships of the rock groups in the area, it was thought better to use the terms Coutchiching, Keewatin, and Timiskaming as descriptive terms for the rock types, with reservations on the age relations that the names imply.

### Algoman(?)

Granite rocks that constitute the northern part of a batholithic mass occupy the southern part of the area. The various types probably belong to one general period of intrusion. Since they are found to intrude only the Coutchiching-type rocks they can only be designated as post-Coutchiching in age. It is likely, however, that the intrusive rocks were associated with the movements that folded the rocks of Coutchiching, Keewatin, and Timiskaming types. They are tentatively classed, therefore, as post-Timiskaming or Algoman in age.

The presence of overburden made it difficult to obtain information concerning the exact location of the contact between the granite and the schistose country rock. It is probable, however, that the contact is a gradational one, since numerous schist inclusions are present in the granite and granite dikes intrude the schists. Some of the dikes cutting the micaceous schists are pegmatitic; others are granitic.

The intrusive rocks consist of granite, pegmatite, and hybrid types. The typical granite is medium-grained and grey to pink in colour. It is usually massive; the faint gneissosity showing in some outcrops is probably the result of incorporation and almost complete assimilation of blocks of schistose country rock. The main mineral constituents are microcline, oligoclase, quartz, and biotite. Much of the biotite is bleached, and some is altered to chlorite. Sericite, clinozoisite, and kaolin are present as secondary constituents. Quantitative estimates of the proportion of potash feldspar to plagioclase show that the ratio between the two ranges from a low of 23 to a high of 45 per cent. in potash feldspar. Thus the rocks are not true granites but are granodiorites and quartz monzonites, most of them falling in the granodiorite zone. The term granite is retained, however, as the descriptive term that would normally be applied to them in the field.

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[1]Page 24.

Granite-pegmatite occurs as dike-like bodies intruding granite or mica schist and as irregular-shaped masses in granite. Many of the mica schist inclusions show a peripheral zone of pegmatite. This feature is especially noticeable in the granite area along the west shore of Long lake. The pegmatite consists dominantly of quartz, feldspar, and white micas.

Some granitic and pegmatitic dikes occur in the schists at considerable distances north of the contact between the schists and granite. The granite types are usually pink in colour and differ mineralogically from the normal granites in the presence of appreciable amounts of apatite and sphene.

A group of basic hybrid rocks occurs in the area between Rogers creek and Finlayson lake. The rocks vary from types similar in appearance to the normal granite to coarsely crystalline basic rocks composed dominantly of hornblende. They apparently occupy a contact zone between schists and granite. The irregular distribution of the various types within the zone makes it impossible to designate an even gradation across the zone, so they have been designated as a group on the map.

The first feature indicating a change from the normal granite is the presence of appreciable quantities of apatite and sphene. Megascopically the rock is like the normal granite with the possible exception of a slightly coarser grain and a slight increase in ferromagnesian content.

The first marked change from the normal granite is seen in the development of a porphyritic texture. The porphyritic rocks show variations in composition, but they are characteristically more basic than the normal granite and contain phenocrysts of feldspar. The minerals present are quartz, plagioclase, microcline, biotite, hornblende, chlorite, epidote, apatite, and sphene. Quartz ranges in amount from 12 per cent. in the more acidic types to less than 1 per cent. in the more basic types; microcline is present only in the more acidic types, where it forms less than 5 per cent. of the rock. The plagioclase, an acid oligoclase, constitutes approximately 65 per cent. of the rock but decreases in amount with the increase of basic minerals. Biotite attains a maximum of 18 per cent. as against 5 per cent. in a normal granite. Although hornblende is not present in the normal granites, it is present in the porphyritic hybrids to a maximum of 25 per cent. Chlorite and epidote are irregularly distributed. Apatite and sphene are characteristically present as crystals and grains scattered through the groundmass.

Another group consists of rocks high in hornblende. Intermediate between this type and the porphyritic type is a gneissic rock composed dominantly of plagioclase, hornblende, chlorite, and quartz. Biotite occurs in minor amounts as remnant inclusions in hornblende. Apatite and sphene are again present. The hornblendic rocks are massive and medium to coarse in grain. The finer-grained types have elongate crystals of hornblende; the coarser-grained types have blocky crystals. The hornblende forms approximately 70 per cent. of the rock. The most basic type contains diopside as well as hornblende, the two forming 78 per cent. of the rock. Biotite occurs in relatively minor amounts except in the finer-grained phases, where it may form as much as 12 per cent. of the rock. The feldspar, apparently an acid oligoclase, is highly altered and forms between 15 and 30 per cent. of the rock. Potash feldspar occurs in small veinlets and as interstitial replacement material. Chlorite and epidote are minor. Apatite and sphene are present, but in the coarser rocks apatite predominates over sphene.

Since the lack of outcrops made it impossible to establish the relationships of the hybrid rocks to the granite and schists, it is impossible to come to a definite conclusion concerning their origin. The more likely possibilities are: (1) They may represent basic intrusions or flows in the schists that have been subsequently intruded and altered by the granite; (2) the basic rocks may be border segregates of the granite mass that have been subsequently altered by the action of gases and solutions coming from the main granitic body; or (3) the basic rocks may have been formed directly by the action of the granite on the mica schists.

Some doubt is thrown on the first possibility by the apparent absence of basic intrusions or flows in the belt of micaceous schists. This possibility, then, requires the unusual circumstances of basic intrusions or flows in the micaceous schists as well as their occurrence along the granite-schist contact. The shape of the area occupied by the rocks is irregular and therefore unlikely to represent flow or dike material, as such bodies are ordinarily elongated parallel to the strike of the formations.

The second possibility is one that is difficult to substantiate since no field evidence could be obtained for or against it. If the rocks do represent basic segregates, they are an unusual occurrence since no comparable types are known in the area.

The third possibility may have been the formation of basic hybrids from schists containing an abundance of lime. This would not hold if the intruded schists were the ordinary quartz-feldspar type. Nockolds[1] has discussed such processes of contamination and concludes that: "The effect of lime on an ordinary granite magma is to produce rocks of tonalitic, granodioritic, dioritic, or even ultrabasic nature." Since no quantitative figures are available on the amounts of lime present, it is impossible to say how effective such a process might have been in this case. The presence of hornblende in amounts up to 30 per cent. in some of the micaceous schists is evidence that the schists contain the necessary chemical constituents for its production. The greater amount of hornblende in the hybrid rocks may be the result of more intense thermal metamorphism near the granite with consequent alteration of the biotite to hornblende. That such a process may have been effective is indicated by the remnant biotite in the hornblende of many of the hybrid rocks.

### Keweenawan

Diabase dikes, presumably of Keweenawan age, are the youngest consolidated rocks in the area. Most of the dikes are less than 200 feet in width, but a few show greater widths. The largest single mass occurs 50 chains northwest of the south end of Little Long Lac, but in this case the width may be due to the joining of two dikes. The presence of overburden made it impossible to trace any of the dikes for any great distance; the greatest length, measured on a dike situated to the east of Rogers creek, is approximately 90 chains. Evidently the dikes are irregular in width and discontinuous. Although they all have a general northerly trend, different dikes show variations in strike from N. 15° W. to N. 10° E.

The rocks are quartz diabases and are usually medium-grained. They have an ophitic texture and consist of plagioclase, pyroxene, magnetite, and interstitial granophyric material. The plagioclase, an andesine-labradorite, occurs as lath-shaped crystals and shows only slight alteration to sericite. Some, if not all, of the pyroxene falls within the pigeonite group. It is considerably altered to hornblende and biotite. Magnetite or ilmenite forms over 5 per cent. of the rock. Quartz occurs in interstitial grains and granophyric intergrowths with

[1]S. R. Nockolds, Jour. Geol., Vol. 41, 1933, p. 578.

potash feldspar. Microcline occurs in small interstitial grains forming less than 5 per cent. of the rock.

### Pleistocene and Recent

The pre-Cambrian rocks are overlain by extensive Pleistocene and Recent deposits. Their extent may be gauged by referring to the map. In most drift-covered sections it was impossible to obtain an estimate of the thickness of the drift, but between Gamsby and Finlayson lakes the Kenogamisis river has cut into glacial material for a depth of approximately 70 feet. This probably comes close to a maximum thickness for the area.

The major topographical features are produced by glacial deposits. The general northeasterly trend of many of these has had a marked effect on the drainage systems in the area. Four main types of deposits are present. The first of these consists of irregular-shaped hills of unsorted sand and gravel. Their general east-west trend indicates that they were formed along ice fronts. A second type of deposit is exemplified by the ridge in the granite country 2 miles west of Long lake. These ridges have a northeasterly trend, gently sloping sides, and fairly flat tops. Although they form marked topographical features, the thickness of drift on them may not be great and may merely form a covering over a core of pre-Cambrian rock. Eskers are also present. They form steep-sided, sinuous ridges with a general northeasterly trend. The two best examples in the area are the one that extends southwest from Goldfield lake and the one lying to the east of Eldee lake. As fresh cuts were not present, it was impossible to tell whether or not they are stratified. Gently rolling sand plains, probably outwash in character, are present in the region of the height-of-land. The broad extent of these plains accounts for the lack of outcrops in a large part of the southwestern sector of the area. To the north of Gamsby lake more pronounced ridges with an east-northeast trend are present. The trend is probably a reflection of the structure of the underlying rocks over which the glacial material forms a thin mantle.

Recent deposits consist chiefly of accumulations of organic material in muskegs and swamps. Many of the lakes also show accumulations of organic material and silt. The flat marshy area in the region immediately west of Finlayson lake may have been formed in Recent times by the reworking of the glacial material between Gamsby and Finlayson lakes.

## Structural Geology

The interpretation of the structure in the area is based on evidence that cannot be taken as conclusive. Primary structures in the volcanics, which might be useful in determining tops, are rare and where present are usually too highly sheared to be of value. Gradations in grain size are quite common in the Timiskaming-type sediments and were used as a means of determining the attitude of the formation. The Coutchiching-type sediments also show grain gradations, but in most cases the rocks are so sheared as to make the determinations doubtful. Minor drag or Z-shaped folds were not used as indicators of bedding tops.

### Folding

The highly folded nature of the rocks is shown by the steep or vertical dips of the sediments. The bedded tuffs give evidence of similar conditions in the volcanics, since their bedding planes are also steep or vertical. The regularity of the bedding is a marked feature of the sediments. Warping of the beds is present in some places, but it is minor in comparison to the contorted nature of the sediments in the central part of the Little Long Lac area.

The attitude of the Timiskaming-type rocks is used as a basis in determining the structure of the area. The dips in the southern part of the belt are steep and in some places at angles as low as 50°S. The dips in the northern part of the belt are mainly vertical, with variations of about 10 degrees to the north or south. The attitude of the beds, as determined by grain-size gradations, is to the north. The most southerly determination lies 15 chains north of the sediments-volcanics contact; the most northerly lies 25 chains south of the contact between the sediments and the northern volcanics. Minor folds may be present in the series, but, from the evidence obtained, the major structure faces north.

A few determinations of grain gradation were obtained in the northern part of the Coutchiching-type belt. Although the dips are vertical to as low as 60° S., the grain gradations indicate that the tops face north. The evidence obtained in the Coutchiching-type belt is scanty, but if it gives a true indication of the structure, the southern volcanics would lie stratigraphically between two sedimentary series. No indication of an unconformity is available from present information.

In the Little Long Lac area Bruce[1] has presented evidence concerning the attitude of the sediments and concludes that they occupy the northern limb of a syncline and that "the southern limb of the syncline lies south of the present [Little Long Lac] map-sheet." The disagreement as to the location of the axis of the syncline may, in part, be attributed to differences in methods used for determining tops of beds. The attitudes of drag folds were not used in the Kenogamisis River area because it was noted in some cases that they gave opposite results to those obtained by gradations in grain size. Conflicting evidence such as this coincides with conditions as found by Gunning and Ambrose in the Rouyn-Harricanaw area.[2] They state:—

> If the attitudes of the cleavage planes and drag-folds were used, they would indicate that the south limb of the syncline faces south in the same direction as the north limb, in complete disagreement with the testimony of the pillows, gradation in grain size, cross-bedding, and textural changes in flows.

Gradations in grain size showing tops facing north were found along the south boundary of Errington township, indicating that a synclinal axis would lie to the north of the Kenogamisis River area. The presence of volcanics in the northern part of the area that might extend in strike to the south of the Mosher lake conglomerate may be taken as some evidence for a synclinal structure within the central belt of the Little Long Lac area. The apparent lack of such volcanics was taken by Bruce[3] as evidence against a synclinal structure, even though the Mosher lake conglomerate and the conglomerate to the north gave the general appearance of equivalent horizons outcropping on different limbs of a syncline. The great difference in the width of the volcanics to the north and south of the conglomeratic sediments would still present a problem, but many of the other apparent anomalies could be explained by such a structure. Whether this is the case or not, the information obtained on the structure in the Kenogamisis River area indicates that the rocks occupy the southern limb of a syncline, the axis of which lies to the north of the area.

### Shearing

Most of the rocks show a moderate schistosity, with some zones showing the effects of more intense shearing. The Coutchiching-type rocks are usually the most schistose, but some portions of the northern volcanics are markedly sheared.

[1]E. L. Bruce, op. cit., p. 17.
[2]H. C. Gunning and J. W. Ambrose, Trans. Roy. Soc. Can., Vol. 33, Sec. 4, 1939, p. 33.
[3]E. L. Bruce, op. cit., pp. 16, 17.

The majority of the Timiskaming-type rocks are only slightly sheared; a few zones of more intense shearing occur in the chloritic greywackes. It is probable that a greater proportion of the rocks than is apparent are sheared, but these, being more easily eroded, would underlie the drift-covered portions of the area.

The major shearing is parallel with the bedding; a secondary shearing, lying oblique to the bedding, was noted in a few places. In the more highly schistose Coutchiching-type rocks the bedding structures are often obscure, and in some places the shearing does not conform to the bedding. The common feature, however, is a parallelism and regularity of schistosity and bedding.

#### Faulting

No direct evidence for major faulting was obtained in the area. Some of the shear zones might be indications of faulting, but since the zones lie parallel to the rock structures no measurement of movement could be obtained. The only topographical break that might indicate a fault scarp occurs in the volcanic belt on the south side of the small lake 50 chains south of Goldfield lake, but the presence of a fault could not be proved. The anomalous strikes of the volcanics on the east side of Little Long Lac, near the Ashmore township line, may be an indication of a fault or fold running in a northeasterly direction and lying beneath the Little Long Lac basin. Minor cross-faulting occurs in various places but it is of little significance.

## Historical Geology

The interpretation of the geological history of the area is based on structural and regional evidence. Although it is admitted that this evidence cannot be considered as proof for one interpretation alone, the interpretation to be presented seems the most probable.

The earliest record is that of a period of sedimentation under relatively quiet conditions. Well-bedded sediments of comparatively uniform character were deposited in a gently subsiding depositional basin. The general quiescence of the period is inferred from the lack of any sediments coarser than a grit. This early period was followed by a period of vulcanism during which andesitic and a few, more acidic lavas were poured out on the earlier-formed sediments. Volcanic fragmental material, erupted during this period, was laid down with the flows. No direct evidence is present for any major structural disturbance between the periods of sedimentation and vulcanism, since the two formations are apparently conformable. The absence of an angular discordance between the two formations, however, does not preclude the possibility of deformation having taken place in the post-sedimentary, pre-volcanic period.

Following the period of vulcanism, sediments were again deposited. The character of the sediments is, for the most part, indicative of sedimentation under conditions of gradual subsidence. Certain coarser-grained and conglomeratic horizons probably indicate local minor disturbances. This period of sedimentation was followed by a second volcanic period during which andesitic and dacitic lavas were poured on the surface. Proportionately more fragmental material was deposited during this period than in the previous period of vulcanism. Evidently bodies of water were present, since much of the tuffaceous material is bedded. These two formations are also apparently conformable.

The time, or times, at which the formations were folded into their present position is difficult to determine. If the movement, or at least the major part of it, took place in one period, that period can properly be correlated with the time of intrusion of the granite in the southern part of the area. This event would necessarily be subsequent to the emplacement of the younger volcanics, since they are deformed to as great an extent as the other formations. As an alternative to this, it is possible that several movements of lesser intensity may have had the cumulative effect of folding the rocks. Under these conditions the forces must have acted in a uniform manner to fold the rocks so that they would show no apparent unconformity in their folded position.

The age of the granite has been placed tentatively as Algoman, but since there is some doubt as to whether the sediments in the northern part of the area are Timiskaming or whether the term should be restricted to the conglomeratic sediments of the Little Long Lac area, there are two possibilities as to its age. The conglomerates of the Little Long Lac area, since they contain granite pebbles, provide evidence for two periods of granitic intrusion.[1] The granite, then, may have been intruded prior to the formation of the conglomeratic sediments or subsequent to their formation. The few acid dikes that occur in the northern part of the area were probably intruded subsequent to the major folding, but since they are themselves markedly sheared they must have been involved in some of the movement.

The next event for which there is definite evidence was the emplacement of diabase dikes. These rocks are correlated with similar types to the west that are Keweenawan in age. It is possible that sediments were deposited in Keweenawan and post-Keweenawan times, but if so they have been completely removed by subsequent erosion. Erosion, then, has been the dominant factor from Keweenawan to Pleistocene times.

During the advance of the Pleistocene ice-sheet, erosion was the dominant factor. In its period of retreat glacial debris was deposited irregularly on the land surface. Since the glacial period some erosion by streams has taken place, and organic material has accumulated in the lakes, swamps, and muskegs.

## Economic Geology

The success of gold-mining activities in the Little Long Lac area has done much towards extending the search for gold to surrounding areas. So far nothing of promise has been encountered in the Kenogamisis River area. This may merely be a reflection of the limited amount of prospecting that has been done, but several factors indicate that the chances for the localization of economically valuable deposits are poorer than in the Little Long Lac area. The limited amount of outcrop has deterred prospecting, but both areas are about equally poor in amount of outcrop; consequently this alone cannot be taken as the reason for the lack of success in the Kenogamisis River area.

The essential features of the gold-bearing belt as contrasted to the area to the south have been described by Bruce. Since his statements have a direct bearing on the economic possibilities of the Kenogamisis River area, the pertinent statements are included here:[2]—

> Gold-bearing veins have been found only in the northern part of the belt of Timiskaming sediments. . . . The sediments along the north side of the major syncline are heterogeneous with at least two conglomeratic horizons, several discontinuous bands of iron formation, zones of massive greywacke, more thinly bedded greywacke, chloritic schists, sills of diorite, and east-west dikes or possibly sills of feldspar porphyry. Farther south the sedimentary series is less heterogeneous and is apparently a monotonous succession of rather slaty greywackes. The northern belt has undergone minor folding, a feature that is not present or at any rate has not been recognized in the rocks farther south. The gold deposits so far found in the Timiskaming sediments are located in the highly disturbed heterogeneous portion of the syncline.

[1]E. L. Bruce, op. cit., p. 18.
[2]Ibid, p. 29.

Although the statement concerning the sediments "farther south" was probably applied only to the sediments in the southern part of the Little Long Lac area, it can also be applied to the chloritic sediments in the northern part of the Kenogamisis River area. South of these the rocks are micaceous, but most of them are undeformed. The characteristic feature of the sediments of the Kenogamisis River area, then, are comparative homogeneity of rock types, the lack of complicated folding within the major folding, the lack of pronounced shear zones, and the lack of dioritic and acid porphyry bodies. Because of these conditions, the chances for obtaining structures suitable for the localization of ore are poorer in the Kenogamisis River area.

Some of the above statements cannot be strictly applied to the volcanic belt in the northeastern part of the area or to some of the chloritic greywackes lying close to them. The volcanics are irregularly, but markedly, sheared and in many places are drag-folded. This may be due in part to the heterogeneous nature of the volcanics. The chloritic sediments, although they usually show uncontorted bedding, are in some places markedly sheared. The northern volcanics and the chloritic greywackes are apparently the most favourable rocks of the area. The micaceous rocks to the south of the southern volcanic belt are massive and dense. Although small irregular quartz veins occur in them, they are apparently too impervious to allow regular and continuous veins to form. This applies to a lesser extent to the micaceous greywackes north of the southern volcanic belt. The shearing in the southern volcanics is less regular. Quartz veins are quite numerous in them, but they are lenticular and short. No mineralization, other than a small amount of pyrite, was seen in any of them.

During the summer of 1939 no prospecting was carried on in the area. In previous years stripping and trenching were done in various parts of the area. The greatest amount has been done on the surveyed claims south of the central part of Ashmore township and in the region south of Marron lake. A good deal of surface stripping and some trenching has also been done in the southern volcanics.

Irregular quartz veins and stringers have been uncovered in claims T.B. 12,954, 13,107, and 13,108. The mineralization is either quartz and tourmaline or quartz and irregularly disseminated pyrite. A few sheared zones in the northern sediments contain quartz vein-material. In the usual type, the quartz occurs as closely spaced stringers in the more highly sheared portions of the rock. Small amounts of disseminated pyrite are present in some veins, but others are barren. No gold values are known to be present.

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