THESE TERMS GOVERN YOUR USE OF THIS PRODUCT

Your use of this electronic information product ("EIP"), and the digital data files contained on it (the "Content"), is governed by the terms set out on this page ("Terms of Use"). By opening the EIP and viewing the Content , you (the "User") have accepted, and have agreed to be bound by, the Terms of Use.

EIP and Content: This EIP and Content is offered by the Province of Ontario's *Ministry of Northern Development, Mines and Forestry* (MNDMF) as a public service, on an "as-is" basis. Recommendations and statements of opinions expressed are those of the author or authors and are not to be construed as statement of government policy. You are solely responsible for your use of the EIP and its Content. You should not rely on the Content for legal advice nor as authoritative in your particular circumstances. Users should verify the accuracy and applicability of any Content before acting on it. MNDMF does not guarantee, or make any warranty express or implied, that the Content is current, accurate, complete or reliable or that the EIP is free from viruses or other harmful components. MNDMF is not responsible for any damage however caused, which results, directly or indirectly, from your use of the EIP or the Content. MNDMF assumes no legal liability or responsibility for the EIP or the Content whatsoever.

Links to Other Web Sites: This EIP or the Content may contain links, to Web sites that are not operated by MNDMF. Linked Web sites may not be available in French. MNDMF neither endorses nor assumes any responsibility for the safety, accuracy or availability of linked Web sites or the information contained on them. The linked Web sites, their operation and content are the responsibility of the person or entity for which they were created or maintained (the "Owner"). Both your use of a linked Web site, and your right to use or reproduce information or materials from a linked Web site, are subject to the terms of use governing that particular Web site. Any comments or inquiries regarding a linked Web site must be directed to its Owner.

Copyright: Canadian and international intellectual property laws protect the EIP and the Content. Unless otherwise indicated, copyright is held by the Queen's Printer for Ontario.

It is recommended that reference to the Content be made in the following form:

Moore, E.S. and Armstrong H.S. 1945. Geology of the East Bull Lake area; Ontario Department of Mines, Annual Report, 1943, v.52, pt. 6, 19p.

Use and Reproduction of Content: The EIP and the Content may be used and reproduced only in accordance with applicable intellectual property laws. *Non-commercial* use of unsubstantial excerpts of the Content is permitted provided that appropriate credit is given and Crown copyright is acknowledged. Any substantial reproduction of the Content or any *commercial* use of all or part of the Content is prohibited without the prior written permission of MNDMF. Substantial reproduction includes the reproduction of any illustration or figure, such as, but not limited to graphs, charts and maps. Commercial use includes commercial distribution of the Content, the reproduction of multiple copies of the Content for any purpose whether or not commercial, use of the Content in commercial publications, and the creation of value-added products using the Content.

Contact:

FOR FURTHER INFORMATION ON	PLEASE CONTACT:	BY TELEPHONE:	BY E-MAIL:
The Reproduction of the EIP or Content	MNDMF Publication Services	Local: (705) 670-5691 Toll Free: 1-888-415-9845, ext. 5691 (inside Canada, United States)	Pubsales.ndm@ontario.ca
The Purchase of MNDMF Publications	MNDMF Publication Sales	Local: (705) 670-5691 Toll Free: 1-888-415-9845, ext. 5691 (inside Canada, United States)	Pubsales.ndm@ontario.ca
Crown Copyright	Queen's Printer	Local: (416) 326-2678 Toll Free: 1-800-668-9938 (inside Canada, United States)	Copyright@gov.on.ca

FIFTY-SECOND ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

1943

PART VI

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. LESLIE M. FROST, *Minister of Mines* H. C. RICKABY, *Deputy Minister*

FIFTY-SECOND ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. LII, PART VI, 1943

Geology of the East Bull Lake Area

By

E. S. MOORE and H. S. ARMSTRONG

PRINTED BY ORDER OF
THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO
Printed and Published by T. E. Bowman, Printer to the King's Most Excellent Majesty
1945


THE HUNTER-ROSE CO. LIMITED TORONTO
PRINTERS · BOOKBINDERS

TABLE OF CONTENTS

Vol. LII, Part VI

ILLUSTRATIONS

SKETCH MAP, SECTION, AND PLAN

COLOURED GEOLOGICAL MAP

(In pocket at back of report)

Map No. 52d—East Bull Lake Area, District of Algoma, Ontario. Scale, 1 inch to 1 mile.

Geology of the East Bull Lake Area

By E. S. Moore and H. S. Armstrong

INTRODUCTION

The East Bull Lake area comprises four townships, 123, 124, 130, and 131, which form a square block covering approximately 145 square miles. East Bull lake, from which the area is named, is one of its largest lakes and is situated a little south of the centre of the block. The Forestry station of the Ontario Department of Lands and Forests for the Massey district is located on the highway at the east end of this lake, about 22 miles from Massey. The highway from Massey, on the Soo line of the Canadian Pacific Railway, traverses the central

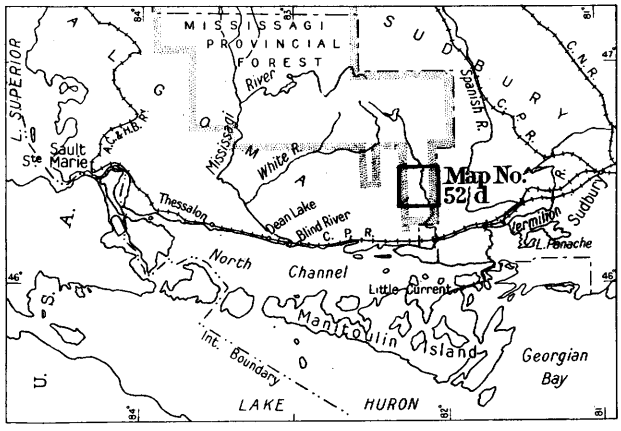


Fig. 1—Key map showing the location of the East Bull Lake area. Scale, 60 miles to the inch.

part of the East Bull Lake area and continues northward to a point some 30 miles from the Forestry station, serving a number of hunting and fishing camps. The River aux Sables traverses the area from north to south and is joined by the West branch near the centre of the group of four townships. These streams are navigable for canoes, but numerous rapids and falls and many stretches of swift water make their ascent difficult, especially during the season of low water.

This area has attracted prospectors because small showings of gold, molybdenum, copper, and nickel have been found and the main route to Whiskey lake, lying just to the west, runs through it. The results of prospecting have, however, been disappointing.

The area, from a strictly geological viewpoint, has been regarded as important because it was believed to be the locality where the Algoman granite mapped to the west would meet the Killarney granite coming in from the east. The Lake Huron sheet[1] (No. 155A) of the Geological Survey shows the East Bull Lake area as almost a blank, with much Algoman granite in the Whiskey Lake area immediately to the west and a very large mass of Killarney granite about 3 miles distant on the east. It was fully expected that the main contact zone between these granites would be found in this area, but it must be still farther to the east. Although some Killarney granite was found near the central part

[1]W. H. Collins, 1933.

of the area, its extent was small compared with the amount of Algoman, which continued as two bands right across the area in the northern and southern sections, leaving the position of the main contact zone still unsettled.

Acknowledgments

The senior author wishes to express his sincere appreciation of the excellent services rendered by the junior author. He served as first assistant on the field party, which was engaged in the area in the summer of 1942, and was largely responsible for direction of the work during the absence from the area of the senior author while engaged in reporting on properties north of Lake Huron. Much of the credit for completing the accompanying map is due to the junior author. The authors' thanks are due to Edward R. Rose and Clarke R. Lewis, field assistants, for their intelligent and faithful services during the field season. A number of persons in the Massey district aided us in our work, and special appreciation is expressed for the help given by L. Landriault, deputy chief ranger of the Ontario Department of Lands and Forests, and his staff. Our thanks are also due to Taylor Carmichael for assistance kindly rendered on several occasions.

Timber and Game

The East Bull Lake area was lumbered many years ago, and fires are reported as having swept over it in 1923. It is covered with green forests but there is very little large timber, only a few scattered pines and spruce. It is well wooded, however, with second growth, and there are some good stands of small red pine and, on the sand plains, of jackpine. Spruce, poplar, birch, cedar, and maple are the common trees. There is some scrub oak, and in most places an undergrowth of hazel is a great impediment in travelling.

Black bears are numerous. They are troublesome because of their habit of smashing canoes, boats, and other articles. A few moose and some deer were seen, and porcupines are very numerous. There is a considerable number of beaver in the area, as indicated by new houses and areas recently flooded by the building of dams.

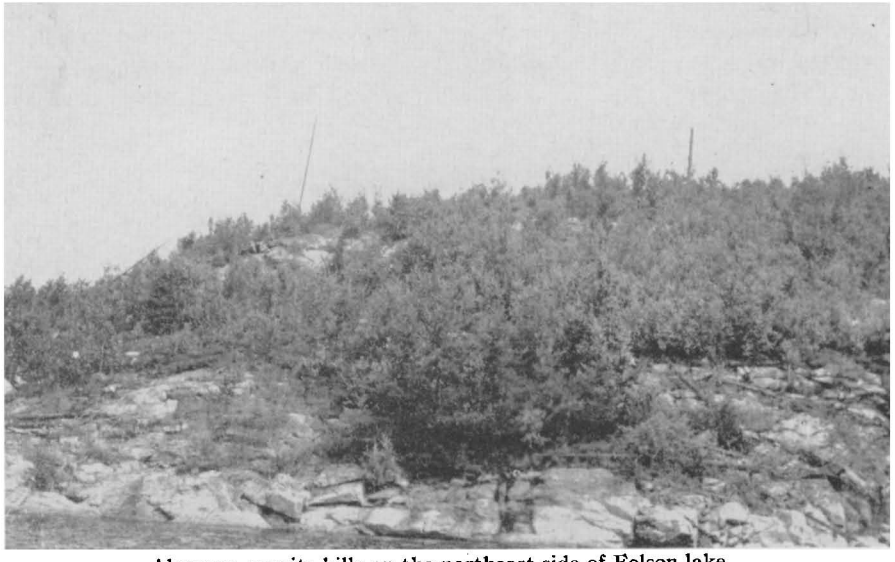
Fish, such as lake trout and pickerel, are plentiful, and brook trout are reported as occurring in the River aux Sables. No pike were found and this probably accounts for the great numbers of frogs found in the marshes and marshy bays of the larger lakes.

Topography and Drainage

The area is very rough in the central and northern sections, where the East Bull Lake gabbro, the Algoman granite, and the Keweenawan diabase form many high hills. There are no bench marks to fix altitudes, and any figures for elevations are estimates or aneroid readings. Probably the highest hill in the area is the diabase hill on the south side of the highway, one mile directly north of Millen lake. It was estimated to rise about 500 feet above the River aux Sables, which flows past it. Elevations of 100, 150, and 200 feet above the river or lakes at the foot of the hills are fairly frequent. A number of high, southeast-facing cliffs were seen in the old gabbro area. There are two of these, each estimated at about 175 feet high, west of East Bull lake and south of the creek draining this lake. One is on the west side of a narrow lake about half a mile south of the west end of East Bull lake, and the other about a mile and a half to the west of this lake. These cliffs strongly suggest fault scarps or a system of strong

joints having a general direction approximately northeast. This is roughly normal to the prevailing direction of most of the dikes in the area, the strike of the Huronian quartzites, and the trend of many of the hills. The existence of large faults in several places in the area is suspected, but owing to the lack of key geological horizons their presence could not be verified. There are also many cliffs of granite and gabbro that face more nearly south and strike a little south of east.

The hills of East Bull Lake gabbro present topographical features in the aerial photographs that are rather characteristic of this rock. It occurs in large flaring humps with steep faces to the south and southeast and it also presents



Algoman granite hills on the northeast side of Folson lake.

large plateau-like areas with very little glacial drift. The granite occurs in large ridges, but much of the surface over the granite is relatively flat, deeply drift-covered, and in many sections swampy.

The southern part of the area is on the whole not nearly as rugged as the northern and central sections.

Sand plains of considerable size occur along the River aux Sables. A large one extends north from the junction of the West branch and southeast below the junction. There are several sand and gravel terraces along the east side of this plain north of the junction. They rise in steps of from 7 to 8 feet, and the highest is from 25 to 30 feet above the present level of the river. The conditions indicate that the river has in the past flowed at an elevation 25 or 30 feet above its present level, and this raising of the level was probably due to a natural dam of some sort below the junction that has since been eroded away.

There is only one large stream in the area, the River aux Sables and its West branch. Cameron creek drains a considerable area in the southern part of township 130, but it is a relatively small stream, as are all the other creeks. If it were not for roads and trails, large sections of this area would be accessible only with great difficulty; there are only a few portages between lakes and few streams that can be navigated with canoes. Some new portages were cut in to

the chain of lakes east of Millen lake and one to the northwest of Ortona lake, but it is difficult to reach the northwest corner of township 131 and some of the eastern sections of the area.

GENERAL GEOLOGY

Very little geological work had previously been done in the East Bull Lake area. The Geological Survey had a reconnaissance party through this region about ten years ago, but no report on the work was published. Douglas[1] in 1924 reported on the Whiskey Lake area in 1924, and he also did the geology along the tote road from Massey to Whiskey lake; up the main road to East Bull (Bull) lake; and along the portage route from East Bull lake to Whiskey lake.[2] A small map was published on this work,[3] showing the various rocks found along these routes, but they were not classified as to geological age. The East Bull Lake gabbro was mapped as greenstone along with the Keewatin greenstones, because they were not recognized as two quite different formations.

The classification of the rocks of the East Bull Lake area, whose distribution is shown on the accompanying map, is as follows:—

CENOZOIC	
PLEISTOCENE AND RECENT:	Glacial drift, sand, and clay.
PRE-CAMBRIAN	
KEWEENAWAN:	Olivine diabase dikes. Killarney granite. Diabase dikes. Nipissing quartz diabase bosses, sills, and dikes.
	Intrusive contact
HURONIAN (Bruce series):	Mississagi conglomerate, quartzite, and argillite.
	Unconformity
MATACHEWAN(?):	Porphyrite or porphyritic diorite.
	Intrusive contact
ALGOMAN:	Granite: Grey, pink, and red; equigranular and porphyritic; biotite and hornblende types. Granite or syenite with 25 to 75 per cent. Keewatin greenstone or East Bull Lake gabbro. Syenite: Red, mostly porphyritic, biotite and hornblende types.
	Intrusive contact
HAILEYBURIAN:	East Bull Lake gabbro (anorthosite, amphibolite, and norite).
	Assumed intrusive contact
KEEWATIN:	Greenstone; ellipsoidal lavas; bands of agglomerate, tuff, and greywacke; chlorite and hornblende schists.

The Keewatin of this area is very similar to that of many other areas in the Canadian shield. The East Bull Lake gabbro, though never actually seen cutting the Keewatin, must be considered a separate and younger formation. Its position in the sequence and its character make it similar to the Haileyburian of other areas.

There is a great admixture of Keewatin rocks and Algoman granite in the southwestern part of the area. Here they are so mixed up that in many places it is impossible to say whether a section should be mapped as granite or greenstone. There is a similar mixing of the Killarney granite and East Bull Lake gabbro just south of East Bull lake.

[1]G. Vibert Douglas, "The Whiskey Lake Area (District of Algoma)," Ont. Dept. Mines, Vol. XXXIV, 1925, pt. 4, pp. 34-49.
[2]Ibid, pp. 38-40.
[3]Ibid, map facing p. 38.

A large body of red syenite occurs in the southern part of the area, and it seems to be closely related to the Algoman granite. It is considered as older than the granite because there are in it many small, irregular injections of highly siliceous granite. It is cut by Keweenawan diabase and it is older than the Killarney granite. The Algoman granite is similar to that in many other areas in that it contains more sodic feldspar than normal granite. Most of it is massive, and there is relatively little real granite gneiss.

The large dike of porphyrite, or porphyritic diorite, crossing the highway 2¼ miles north of the south boundary of the area, may be Matachewan in age, because it comes in at this horizon in the geological column, or it may be a late phase of the Algoman or even younger. This dike contains all the rock of this type seen in the area, and the fact that it cuts the syenite is the only data available regarding its age.

Huronian sediments, mapped as Mississagi, occur in two areas, one on the east side of Whiskey lake and the other south of Millen lake, along the boundary between townships 123 and 124. The rocks are similar to the Mississagi described in adjacent areas.

The rocks mapped as Nipissing quartz diabase are similar to such rocks in many other areas. There are, however, numerous dikes of diabase without quartz. They are closely related in age to the quartz diabase; but as some of them cut the quartz diabase, they are a little younger. This diabase was found only in dikes, which are small compared with most of those of Nipissing age.

It was expected that much Killarney granite would be found in this area, but the quantity is relatively small. Further, most of it is in dikes and small irregular intrusions in the East Bull Lake gabbro, and it was impossible to map separately any large mass of it. It is very difficult to distinguish the Killarney from the Algoman granite in the field, because they look much alike. The Killarney was found, however, cutting the Nipissing and normal Keweenawan diabase in a few places, and these diabases everywhere cut the Algoman granite. The olivine diabase is the latest igneous rock in the area, and it is remarkably fresh.

Keewatin

A considerable mass of Keewatin rocks is found in the southwestern and southern parts of the East Bull Lake area. These rocks were much more widespread before the intrusion of the East Bull Lake gabbro and the Algoman granite. Small remnants of them occur in the granite in township 131 and in other places, indicating that at one time they probably covered the whole area. The rocks are very similar to the Keewatin in other areas: fine-grained pillow and amygdaloidal lavas, coarser diabasic or gabbroic rocks forming the lower parts of thick flows; chlorite and hornblende schists, agglomerate, tuff, and a little greywacke.

Distinct pillows were not seen in many places, but about a quarter of a mile south of the southwest bay of Folson lake a series of flows with pillows and some amygdules may be seen. Three such flows were crossed in a distance of a little more than a quarter of a mile.

The common type of rock in the Keewatin is greenstone that was originally basalt or andesite and is now composed mainly of secondary minerals, such as saussuritized plagioclase, uralite, and sericite. The quantity of agglomerate, tuff, and greywacke is small. Agglomerate and tuff were seen in a narrow band enclosed in lavas in two areas: north of Cameron creek and south of the west end of East Bull lake; and about 2½ miles southeast of this lake. This is believed

to be the same band. A strip of greywacke was observed near the centre of the south boundary of township 130.

There are many bands of chlorite schist along shear zones in the greenstone. Some of these contain a number of quartz veins slightly mineralized. Hornblende schists are found in many places close to granite intrusions.

It is difficult to make much out of the structure of the Keewatin section because of the extent to which the greenstones are cut up by the granite. In general the Keewatin formations occupy a synclinal belt with the axis of the major syncline striking N. 70° W.

Haileyburian

East Bull Lake Gabbro

The East Bull Lake gabbro is a striking feature of this area. It occurs in rugged hills in two main bands. One runs in a direction a little south of east from the west end of Folson lake, around East Bull lake, to the east border of the area, except where cut off for 1½ miles by Algoman syenite and granite. The other band runs west across the northern half of townships 124 and 131 with an interrupted link with the southern band. It is believed that these two bands are part of one large mass that was cut up during the injection of the Algoman granite.

Exposures of this gabbro are excellent, because it is on the whole much less drift-covered than the granites. It forms high hills and small plateau-like areas, flanked by vertical cliffs, some of which are 175 feet high. These cliffs mostly face nearly south and southeast, suggesting fault scarps.

Most of this gabbro is readily distinguished in the field from the Keewatin rocks, which are finer grained and more sheared, and from the Nipissing diabase, which is usually fresher in appearance and diabasic in texture. There is, however, some of this rock that has undergone recrystallization near large granite intrusions, and this type may strongly resemble the Nipissing diabase. In thin section, however, it lacks the quartz-feldspar intergrowth so characteristic of all thin sections of the Nipissing diabase studied.

The East Bull Lake gabbro shows many facies—normal gabbro, anorthosite, amphibolite, and norite. The rock is normally coarse grained and consists of labradorite; some anorthite and andesine; augite or diopside, mostly altered to fibrous amphibole; hornblende; ilmenite, mainly altering to leucoxene; and rods of apatite. Enstatite was found in one thin section, indicating a norite facies, and orthorhombic pyroxene was observed by the junior author in a number of outcrops. The prevalence of such pyroxene indicates a considerable proportion of the noritic facies in the gabbro in township 131 and in the Millen Lake area in township 124.

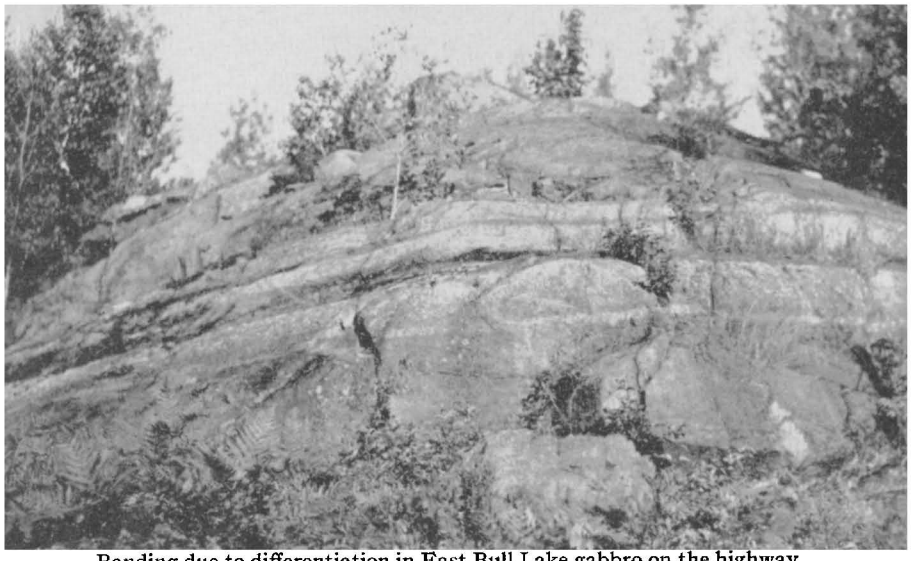
Anorthosite occurs in many places as nearly white to grey blotches or in fairly regular bands, indicating zoning due to differentiation as illustrated in the photograph on page 7. Some of the anorthosite is very coarse in texture, crystals of plagioclase reaching 2½ inches in length. The gabbro weathers in rather a peculiar way. Along most small cracks there is whitish kaolin, and on a hot day thin flakes of rock curl off from the surface. The feldspars also show kaolinization and saussuritization, giving them a thin whitish film of weathered material.

There are a number of contact effects near granite intrusions. Some of the gabbro has been changed to very coarse-textured amphibolite with groups of radiating crystals of amphibole as much as 3 and 4 inches in length. In other places the gabbro is highly epidotized. On some islands in Folson lake and

along part of the west shore, the gabbro is porphyritic near the granite. Porphyroblasts of plagioclase one-quarter to one-half inch in length have been formed. Bronzite was found in some sections.

The gabbro has been sheared and slightly brecciated in a few places and impregnated with pyrite, pyrrhotite, and chalcopyrite. The pyrrhotite carries a little nickel, and this mineralization will be discussed later under Economic Geology.

The East Bull Lake gabbro is regarded as Haileyburian in age; there does not seem to be any doubt that it is younger than the Keewatin, although it was



Banding due to differentiation in East Bull Lake gabbro on the highway just north of the Forestry station on East Bull lake.

never found actually in contact with Keewatin rocks because a few feet of drift always covered the contact. It is cut by the Algoman syenite and granite. It is also similar in composition to the Haileyburian rocks of many other areas.

Algoman

Algoman rocks occupy the greater part of the East Bull Lake area. They are specially prominent in the two northern townships, coming in from the Blind River area[1] on the west and extending as an unbroken mass to the north. In the southern part of the area, the Algoman granite is so mixed with Keewatin greenstone in many places that the rocks could not be mapped separately.

Algoman rocks comprise granite, pegmatite, syenite, and hybrid rocks formed at the contact of the granite with Keewatin greenstone and East Bull Lake gabbro. The granite and syenite are regarded as closely related in origin.

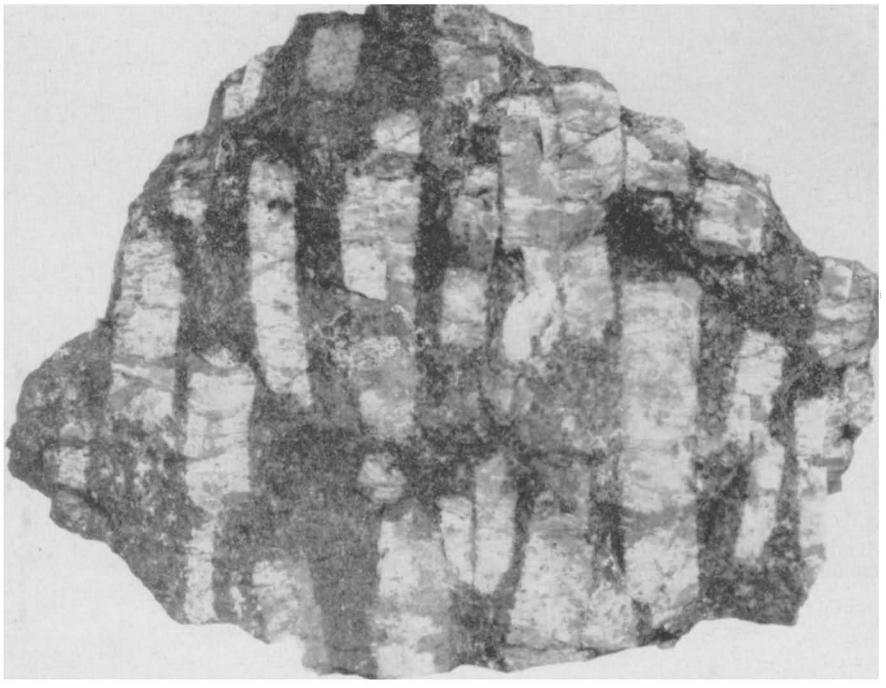
Syenite

The syenite is regarded as probably older than the granite, though it is very fresh in appearance. This is assumed because of the tendency of differentiation

[1]W. H. Collins, "North Shore of Lake Huron," Geol. Surv. Can., Mem. 143, 1925, Map No. 1970.

of most magmas to trend from the more basic to the more acid and because the syenite has in many places been injected by acid granite in small irregular masses.

The syenite normally consists of orthoclase and microcline and a little albite or oligoclase with hornblende or biotite or both of these minerals. Titanite associated with ilmenite and hornblende is abundant in one thin section. Where these minerals are present in a specimen they are always closely associated. Apatite and pyrite are common in small rods and grains. Epidote has developed in the syenite near its contact with basic rocks.



Specimen (nearly natural size) of porphyritic Algoman syenite with parallel phenocrysts of flesh-coloured orthoclase in a dark hornblende-biotite groundmass.

The syenite is mostly massive, red to to pink in colour, and fresh in appearance. Most of it is porphyritic, with flesh-coloured orthoclase in phenocrysts as much as 1¾ inches in length. In one area, the phenocrysts are tabular in form, about a quarter of an inch in thickness and 1¾ inches in length, and closely spaced in parallel arrangement (see photograph above). This type of syenite has a dark groundmass composed of hornblende and biotite.

Granite

The Algoman granite of the area is on the whole more massive, i.e. less gneissic than that in many other areas. It ranges in colour from grey to pink to brick-red. In composition, it ranges from biotite to hornblende in type. Like the Algoman granites found elsewhere it is distinctly of the sodic type, containing, in addition to orthoclase and microcline, quite a high proportion of albite or oligoclase. This proportion in some thin sections approaches 50 per cent., making the rock nearer a quartz monzonite than a normal granite. Quartz is abundant in most specimens. Where the granite is weathered, the orthoclase

is almost always more altered than the plagioclase and shows considerable quantities of sericite and kaolin.

Titanite is present in many sections and abundant in a few. Augite, in a distinct twinned crystal, occurs in one specimen, and apatite and pyrite are also present. Epidote is developed in some places near the contact of the granite and basic rock.

Much granite is coarsely porphyritic, that in the northern part of township 124 being characteristically so. Pink or red phenocrysts of orthoclase range from half an inch to an inch in length.

Brick-red Algoman granite (left) cutting East Bull Lake gabbro (right), on a small island in the eastern part of Folson lake.

A brick-red granite occurs in several places along the contact with East Bull Lake gabbro. Such an occurrence was found at the south end of the narrow lake northwest of Ortona lake, on islands in Folson lake, and on the shore of that lake. This red rock, contrasting strongly with the dark gabbro and grey granite in colour, makes Folson a very beautiful lake. The red granite grades into grey granite; examination under the microscope shows that the only cause for the red colour is found in a staining of the slightly altered feldspar, which shows a faint red. It is believed that when the granite intruded the gabbro it absorbed some iron from it and this produced the red colour.

Some of the granite contains considerable quantities of pegmatite in small dikes and irregular injections. These consist mainly of quartz and orthoclase and are too small to be of economic interest. Many quartz veins, not mineralized or only slightly so, occur in rocks near Algoman intrusions and in some places in the granite itself.

Matachewan(?)

A large dike, mapped by Douglas[1] as porphyrite, is crossed by the highway and township line about 2¼ miles north of the southeast corner of township 130. In the field, this rock appears somewhat similar to some of the Matachewan

[1]G. Vibert Douglas, op. cit., map facing p. 38.

diabase in other areas because it contains greenish-white phenocrysts of plagioclase with irregular outline and a maximum length of 1 inch. A thin section showed the following minerals: plagioclase, mainly andesine; some labradorite; green and a little blue hornblende; and leucoxene. There is no pyroxene; although much of the amphibole is fibrous, thus suggesting its derivation from pyroxene, the crystal outlines do not indicate that it is pseudomorphic after pyroxene. There is a little ophitic texture and a little graphic intergrowth of quartz and feldspar, but less than that seen in the Nipissing quartz diabase. The rock is a sort of cross between porphyritic diabase and diorite and might be best classified as a porphyrite.

Only one occurrence of this rock was found. The dike containing it is about 400 feet wide and was traced for 2 miles. It strikes at N. 75° W., which is roughly parallel to the general trend of most of the rocks of the area. It cuts the Algoman syenite, but no other rock was seen in actual contact with it. It may be a late Algoman intrusion or later in age.

Huronian (Bruce Series)

Mississagi

There are two areas of Huronian sediments in the East Bull Lake area. A few outliers occur near Whiskey lake in the northwestern part of township 130. These are related to the large bodies of Mississagi quartzite mapped by Collins[1] around Whiskey lake, on the Blind River map-sheet. There is a larger area crossed by the boundary between townships 123 and 124, just south of Millen lake. In the first area the rock is a quartzite, and in the second the formation comprises a basal conglomerate, followed by a coarse quartzite, above which is an argillaceous quartzite, with a purer quartzite at the top.

The conglomerate contains boulders of granite almost identical, when seen in thin section, with the Algoman granite on which the conglomerate lies in some places. The lower quartzite member varies from a coarse feldspathic quartzite to one with only a few scattered particles of feldspar. The materials are poorly assorted and mostly not much rounded. Small pebbles of quartz, with a diameter ten times as great as the average diameter of the grains, are scattered through the finer-grained materials. A little recrystallization of the grains has occurred, resulting in serrated boundaries between them. The rock contains a few very small grains of tourmaline and zircon. The colour of this quartzite ranges from white, greenish white, and grey to pink.

A thin-bedded argillaceous quartzite lies above the basal quartzite member. It breaks into thin slabs and irregular blocks and in different bands the content of quartz ranges from 10 to 50 per cent. The matrix for the quartz grains is composed of a fine-grained mixture of sericite, biotite, and clay minerals. There are many specks of iron oxide from the weathering of grains of disseminated pyrite.

The upper member is a purer quartzite and rather finer grained than the basal quartzite.

All members of the Mississagi formation carry disseminated pyrite, pyrrhotite, and chalcopyrite, which on weathering make rusty spots on the surface. In a few places the sulphides are sufficiently abundant to give rise to patches of brownish gossan. This attracted prospectors to the Millen Lake area some years ago, and claims were staked for gold.

Thickness and Structure.—It is difficult to determine the thickness of the

[1]W. H. Collins, op. cit., map No. 1970.

Mississagi formation because no complete section was found in one locality. The dip also varies in different sections from nearly zero to 80 degrees. The strike ranges from N. 82° W. to N. 30° W. and the dip from southwestward to nearly south. Sections of the basal conglomerate are as much as 8 feet in thickness and contain boulders of the underlying Algoman granite up to 2½ feet in diameter.

The main section of the quartzite is split up by two or more diabase sills, as illustrated in Fig. 2. Making allowances for changes in dip, it is estimated

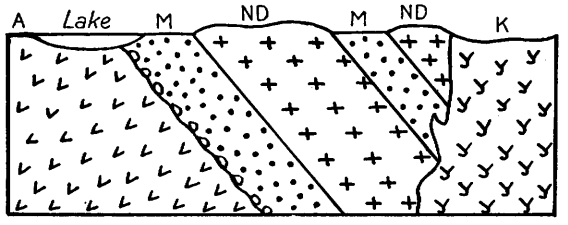


Fig. 2—Cross-section illustrating the relations of Algoman granite (A), Mississagi conglomerate and quartzite (M), Nipissing diabase sills (ND), and Killarney granite (K) for one mile southwest of Millen lake.

that the maximum thickness of Mississagi strata exposed south of Millen lake is in the neighbourhood of 1,000 feet.

The relations of the Mississagi formation, Nipissing diabase, Algoman granite, and Killarney granite southwest from Millen lake are believed to be as illustrated in Fig. 2.

Keweenawan

The Keweenawan system in this area comprises several formations: the Nipissing quartz diabase, a set of diabase dikes without quartz, Killarney granite, and olivine diabase.

Nipissing Quartz Diabase

Quartz diabase occurs in large dikes, in bosses and small irregular intrusions, and as sills in the Mississagi quartzite. It forms the highest hills in the East Bull Lake area, one a mile north of Millen lake being estimated at 500 feet above the River aux Sables. Others around Millen lake are from 130 to 250 feet above the lake.

The outcrops of this rock are mainly confined to the western part of township 130 and an area along the boundary between townships 123 and 124. It is possible that some intrusions of this rock cut the East Bull Lake gabbro and were not recognized in the field. The East Bull Lake gabbro is recrystallized to some extent in some contact zones near granite and can be distinguished from the quartz diabase only in thin sections. There are bodies of such rock along the southeast shore of Folson lake and some of them may be quartz diabase, although they have all been mapped with the gabbro.

In contrast to the quartz diabase, numerous dikes of the diabase without quartz, which followed the quartz type, cut the gabbro.

The quartz diabase in this area is typical of that in many other areas. It has, in most specimens, a distinct ophitic texture with quite fresh, lath-shaped labradorite crystals; augite, which is partly or entirely altered to fibrous amphi-

bole, leaving the outlines of the original crystals; ilmenite; and quartz, which is mostly in graphic intergrowth with feldspar, these being the last primary minerals to form. Secondary minerals are leucoxene from ilmenite, sericite and kaolin from feldspars, and a little chlorite. Where the diabase has been intruded by granite, the pyroxenes are mainly changed to hornblende.

Near the base of the sills southwest of Millen lake, many blocks of quartzite are included in the diabase, some of them as much as 3 feet in length.

Diabase Dikes

A very large number of normal diabase dikes were intruded shortly after the quartz diabase. A large number of these have been placed on the accompanying map, but they are so numerous that it would be impossible to map them fully in one season. They range in width from a few inches to 150 feet, most of them being less than 50 feet wide. They are relatively short, but few were traced for their full length. They show a remarkable parallelism in strike. Large numbers strike at N. 70° W., and very few of them vary as much as 30 degrees from this direction. They are particularly abundant in the Algoman granite and the East Bull Lake gabbro, but a few were found cutting Nipissing diabase. Some are cut by Killarney granite south of East Bull lake, and their age is thus fixed within narrow limits. These dikes seem to occupy a stratigraphical position very close to that of some so-called trap dikes in the Sudbury nickel field.

The rock composing these dikes is a brownish-grey type, and thin sections from different dikes show variations from distinct diabase to andesite. The texture is fine- to medium-grained. In some specimens the rock has a distinct ophitic texture, and the minerals are labradorite and a little andesine, augite, ilmenite, and apatite. In most sections the augite is partly altered to fibrous amphibole and in some entirely altered, and the ilmenite is partially or wholly replaced by leucoxene.

In other specimens andesine is the dominant feldspar, and the ferromagnesian content is mainly hornblende with a few flakes of biotite. The ophitic texture is not well developed in this type, and the rock is andesitic in character.

No quartz that was considered as definitely primary was found in any of these dikes. Moreover, the rock lacks the typical graphic intergrowth of quartz and feldspar observed in thin sections of the rocks mapped as Nipissing diabase.

One thin section showed a narrow band of mylonite composed of finely crushed feldspar, indicating that movement had taken place in the dike under severe pressure.

Killarney Granite

As previously stated, it was expected that large bodies of Killarney granite would be found extending into this area from the east. Relatively little of this rock was found, however, except in small dikes and irregular intrusions so distributed through the East Bull Lake gabbro that in most cases mapping it separately was impossible.

The Killarney was distinguished from the Algoman granite because it was found in a few places south of East Bull lake cutting the Keweenawan diabase dikes, which in turn cut the Nipissing diabase and Algoman granite. A body of granite, one mile southwest of the west end of Millen lake, is also mapped as Killarney because it is believed to cut the Mississagi quartzite and Nipissing diabase. A number of irregular dikelets cut Nipissing diabase in the vicinity of Millen lake, and there are some similar dikelets in the Algoman granite north of the lake.

The Killarney granite shows in thin section that the feldspar is mainly orthoclase with a little albite. This is in contrast to the Algoman granite, which contains a much higher proportion of sodic plagioclase. It contains hornblende or biotite, or both, quartz, and a little magnetite. The orthoclase is more altered than the plagioclase.

The Killarney magma is regarded as the source of the pyrite and other sulphides that are disseminated through the Mississagi sediments.

Olivine Diabase

Several large dikes of olivine diabase cut the East Bull Lake gabbro, Algoman granite, and Mississagi sediments. They run nearly parallel across the area with a strike between N. 60° W. and N. 50° W. and are thus parallel to a number of the normal diabase dikes. They are from 100 to 300 feet in width.

The olivine diabase does not form prominent ridges as the Nipissing diabase does, but it is often found in low land. Long narrow depressions follow the dikes in most places, and these may be readily picked out on the aerial photographs of the area. The rock weathers brown on the surface, thus serving to distinguish it from other basic rocks. Beneath the surface, it is, however, remarkably fresh. Ophitic texture is a very striking feature in thin sections. The rock consists of fresh labradorite and some anorthite; augite or diopside; olivine, ranging from little to quite a large proportion; ilmenite; apatite; zircon; and in some sections a little biotite. In some sections the olivine is unaltered and in others it shows the characteristic alteration to serpentine along cracks and cleavage planes. Some of the ilmenite is fresh and some slightly altered to leucoxene.

The olivine diabase is the youngest consolidated rock in the area.

Pleistocene

The area was thoroughly glaciated, and drift is seen almost everywhere, but it is much more prevalent on the granite areas than on those of East Bull Lake gabbro and Nipissing diabase. The gabbro supplied many unusually large fragments to the drift. In one depression, about a quarter of a mile north of East Bull lake, a huge pile of blocks was seen, the largest measuring 60 by 18 by 12 feet and estimated to weigh about 1,100 tons.

The ice advanced over the area in a direction of about S. 15° W. Compass readings taken in different places showed that the striations varied in direction from S. 10° W. to S. 25° W.

Another feature observed in the area were gullies along which torrents must have flowed at an earlier time, because the bottoms of these depressions are bedded with large boulders and they are so arranged that they must have been rolled about by streams of far greater strength than any that have flowed in the gullies in Recent times. It is suggested that in Pleistocene time these depressions were occupied by streams issuing from a melting glacier lying not far to the north.

There are sand plains along the northern section of the River aux Sables, the highest of which lies about 30 feet above the stream. It is believed that the channel of the stream draining this area was blocked for a time by a drift barrier that dammed the river, and that this natural dam was gradually cut away, lowering the level of the river.

STRUCTURAL GEOLOGY

The most striking feature in the structure of the East Bull Lake area is the nearly uniform trend of almost all formations and most depressions in a general

direction between N. 70° W. and N. 40° W. It is probable that the older formations were folded along axes running in this general direction at the time that the Algoman rocks were intruded. The area is so predominantly igneous in character that there is little that can be said about folds. There are also almost no definite data regarding faulting. A number of very prominent cliffs of East Bull Lake gabbro and granite suggests faults along lines running nearly east-west and northeast-southwest. These are best shown in the area between East Bull and Folson lakes and extending to about 1½ miles south of the west end of East Bull lake. Long narrow depressions, some of which are occupied by lakes with high gabbro cliffs on the north and northwest sides, suggest the presence of faults. On the other hand, these may be due to a series of major joints.

Rock cut in pyrrhotite-chalcopyrite-pyrite stringers in sheared East Bull Lake gabbro, Belanger-Ritchie property, township 123.

ECONOMIC GEOLOGY

Considerable interest has been shown in this area by prospectors, and a number of claims have been staked at various times. Small nickel-copper, gold, and molybdenite deposits have been discovered, but little of economic interest has been found.

Nickel-Copper

Nickel and copper have been found in an area about half a mile long and 15 chains wide in township 123, three-quarters of a mile southeast of the east end of East Bull lake. A number of claims have been staked and restaked in this area over a period of a good many years and much stripping and test-pitting have been done on showings of pyrrhotite, chalcopyrite, and pyrite. The claims cover what is known in the area as the Belanger-Ritchie property, because Mr. Belanger, of Timmins, had a considerable amount of work done on it and R. M. Ritchie, of Massey, has restaked the claims.

The accompanying plan (Fig. 3), a copy of which was kindly supplied by Mr. Ritchie, shows the main workings, but there are a few additional pits and trenches in the same neighbourhood.

The most interesting of the showings are those in the northwest section of the plan. In a pit on the west face of a low hill and just above a swamp to the west, there is a mass of slightly brecciated gabbro, about 10 feet in diameter, impregnated with pyrrhotite, chalcopyrite, pyrite, and a little magnetite. In places the pyrrhotite is almost massive, but the sulphides grade out into barren

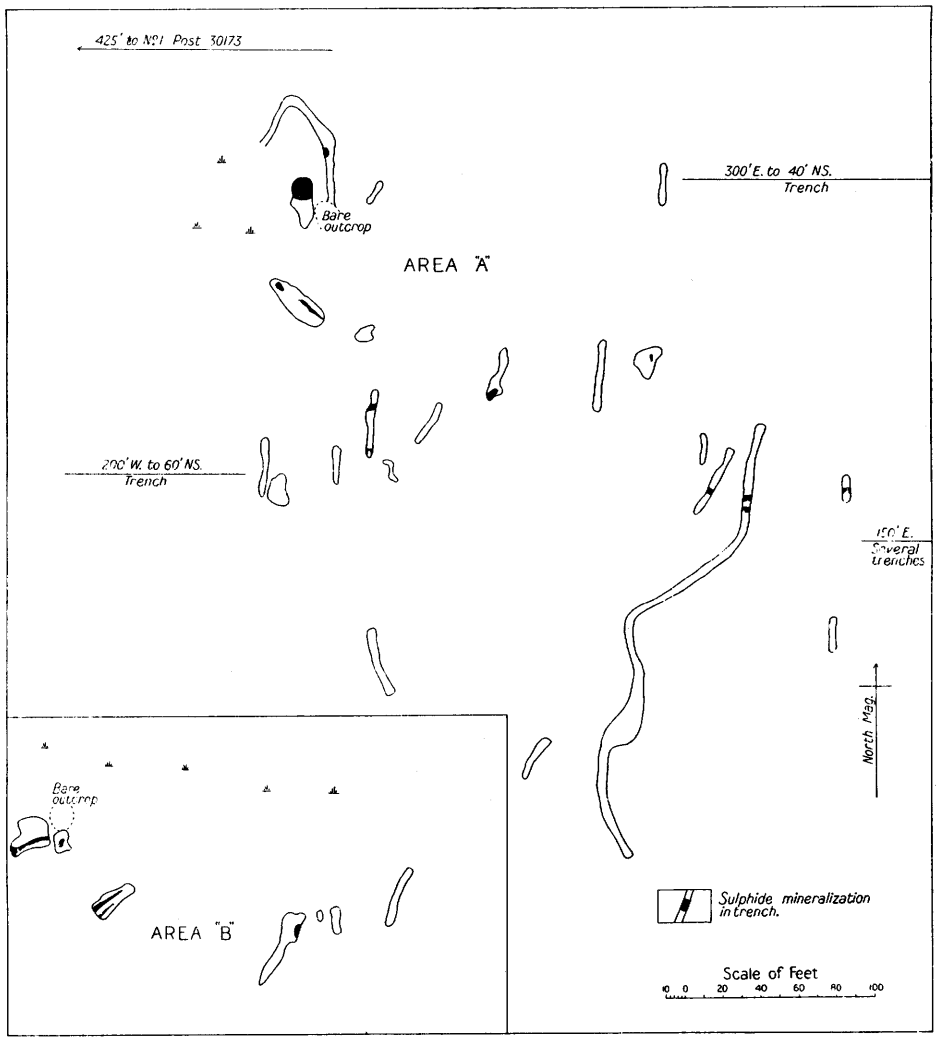


Fig. 3—Plan of workings on pyrrhotite-chalcopyrite-pyrite showings, Belanger-Ritchie property, township 123.

gabbro. The dip needle is strongly affected over this body, but the effect is limited to the part exposed in the pit.

About 50 feet south of the pit described is a pit and a cut in the face of the hill, running up the slope for 20 feet. This pit is about 10 feet deep, and from a point near its bottom narrow oxidized bands run up the cut to a point near its upper end. These pinch and swell, and contain pyrrhotite, chalcopyrite, and pyrite. These mineralized bands are in a narrow shear zone in the gabbro, and they dip 70° N.E.

Southeast and east of these pits are a number of other pits and some trenches in drift and gabbro. The pits were sunk on patches of gabbro with disseminated sulphides, which are conspicuous because they have oxidized at the surface. The dip needle is affected by these, and other small bodies of sulphide, which are not exposed at the surface, can be located with the needle; but the effect on the needle is confined to very small areas.

The sulphides occur in narrow shear zones or slightly brecciated patches in the gabbro, and they are confined to bodies of very small dimensions. They replace the gabbro, some of which is highly altered near the sulphides. Thin sections show saussuritized plagioclase; pyroxene altered to fibrous amphibole and replaced by hornblende; much zoisite; and some chlorite and sericite. The feldspars are stained light brown.

An assay plan submitted by Mr. Ritchie showed copper, in specimens taken from various pits on the property, running from 0.10 to 1.60 per cent. and nickel, 0.10 to 1.20 per cent. The writer submitted a well-mineralized sample from the 10-foot body described above to the Provincial Assayer, who reported: copper, 2.61 per cent.; and nickel, none. These sulphides might be expected to carry nickel, but on the assay plan the nickel from this pit is shown as only 0.19 and 0.36 per cent. in two assays. The bodies of sulphide so far found are very small, and although there are a considerable number of them they show no relation to one another because there was no major structural factor controlling their location.

About a mile and a half west of the property described, a very narrow shear zone was seen in the gabbro, running east-west. There was sufficient pyrrhotite present in this zone to affect the compass across a very narrow width. This was observed on two traverses about half a mile apart.

As Killarney granite intrudes the gabbro in many places, it is believed that this mineralization was due to the Killarney granite magma.

Gold

Many quartz veins occur in the East Bull Lake gabbro and the Keewatin greenstones, near the Algoman and Killarney granites, and in the granites themselves. None of them are of large size, and most of those in the Algoman granite are quite barren of sulphides. They apparently consist mainly of quartz closely related to pegmatites. In some places, the quartz in the basic rocks forms networks of veins or stockworks.

The Mississagi strata south of Millen lake, in the vicinity of the boundary between townships 123 and 124, show in a number of places considerable sulphide mineralization. The sulphides are mainly disseminated pyrite with some chalcopyrite and pyrrhotite and a little galena. Oxidation of the sulphides has produced patches of gossan and rusty spots in the sediments. These have attracted attention, and a few old pits in the gossan were found. No large bodies of sulphides were observed; and, although a prospector reported that some low values in gold had been obtained, the deposits were soon abandoned. According to Douglas,[1] claims were taken up in this area in 1923 and 1924 by W. J. Parkin, Moses Sadowski, F. Miner, and J. Miner. Douglas[2] submitted several samples from the deposits to the Provincial Assayer, and returns on all of them were nil for gold.

The mineralization of the Mississagi conglomerate and quartzite in this area is similar in many respects to that in the sediments on Whiskey lake, described

[1]G. Vibert Douglas, op. cit., p. 48.
[2]Ibid, pp. 48, 49.

by Douglas.[1] In that area it was assigned to the influence of the Nipissing diabase near which it was mostly found. It may have come from the diabase magma in the Millen Lake area also, but since Killarney granite occurs in this vicinity and mineralization is associated with it south of East Bull lake, it is considered that the sulphides were probably derived from the Killarney magma.

Several stockworks comprising quartz veins are shown on the accompanying map, as well as a number of single veins in the area south of East Bull and Folson lakes. One of the most interesting of these is situated 1¼ miles south of the southeast bay of Folson lake, in slightly schisted Keewatin greenstone close to Algoman granite. A group of quartz veins cut the schist for 5 chains along the strike, which is N. 45° W., across a width of 2 chains. The veins are narrow, but they swell to lenses as much as 3 feet in width. They run under drift to the east and west, but at the west end the band of veins narrows before disappearing under the drift. Some of the veins are quite barren, but others are mineralized with pyrite. A specimen of the best-mineralized quartz was submitted to the Provincial Assayer, who reported that it did not contain any gold.

Another group of quartz stringers was seen in the granite close to greenstone about 35 chains northwest of that described. The quartz is unmineralized.

There are two similar groups of quartz stringers in the East Bull Lake gabbro 1¼ miles southwest of the west end of East Bull lake. They contain little or no sulphide. They occur in association with small injections of granite. Other groups of veinlets occur in several places in the Keewatin rocks and some of them have been prospected, but none of those seen showed any promise economically.

Molybdenum

There is a little molybdenite showing in a pit and trench about 1½ miles along the Whiskey lake road west of the highway, in the southern part of township 130. The pit is about 6 chains north of the Whiskey lake road. A few flakes of molybdenite occur with disseminated pyrite, chalcopyrite, muscovite, and quartz in a small vein in granite. Nothing of economic importance was found.

[1]Ibid.

INDEX, PART VI