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GEOLOGY

of the

MANIGOTAGAN - RICE RIVER AREA

Rice Lake Mining Division

Manitoba

by

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GEOLOGY OF THE MANIGOTAGAN-RICE RIVER AREA

INTRODUCTION

LOCATION AND ACCESS

The region included in this report and on the accompanying maps consists of a fifteen minute sheet along the east shore of Lake Winnipeg bounded by longitudes 96° 15' and 96° 30' west and latitudes 51° 00' and 51° 15' north and a further strip along the shore of the lake extending northwest from latitude 51° 15' to Rice River, a distance of about seven miles.

During the summer months regular boat service is maintained to Manigotagan Settlement from Winnipeg by way of the Red River and Lake Winnipeg. Supplies are generally brought into the area this way. In addition, a mail boat arrives twice a week from Riverton on the west shore of the lake. These boats also carry passengers. More rapid transportation may be acquired by aircraft from Lac du Bonnet, a distance of 60 miles.

TOPOGRAPHY, DRAINAGE, AND FOREST GROWTH

The east shore of Lake Winnipeg marks approximately the contact between the Precambrian and the overlying Palaeozoic rocks. As is characteristic, the border of the shield area there is low with extensive portions entirely underlain by glacial drift and swamp, within which portions few or no rock outcrops are found. Following the flooding of the Red River in the spring of 1950 and in part due to an extensive rainy spell in the area itself the previous fall, the level of the lake remained high during the summer of 1950, with resultant flooding of swampy areas extending inland from the lake shore. Swampy basins situated inland remained extremely wet throughout the field season. This constituted a distinct handicap to work.

The main drainage within the area is west to Lake Winnipeg. The principal rivers are the Manigotagan River in the south half and the Wanipigow or Hole River in the north half. Both these are navigable without difficulty. Rice River at the extreme north border of the area investigated is navigable for a few miles but then becomes too shallow for the use of anything but lightly loaded, small canoes.

Large growth consists of spruce, tamarack, balsam, various species of pine, poplar, birch, elm, and oak. Underbrush is largely alder, willow, and hazel bush. Lumbering is an important industry at Manigotagan, timber being at present cut in and removed from the area to the east. A sawmill is operated at Manigotagan, and until a few years ago another one was situated on Black Island.

PREVIOUS WORK

The earliest government survey report referring to this area is that of J. B. Tyrrell and D. B. Dowling[1]. This report covers a much larger area than the one considered here but abounds in detailed descriptions of many rock exposures. Brief reference is made to the Manigotagan area by E. S. Moore in his report of 1912[2]. Further references to the area are contained in a report by J. F. Wright[3].

All previous work done in this area by government surveys was of a reconnaissance nature.

PRESENT WORK

The present survey is an extension of the mapping of the volcanic-sedimentary belt extending eastward along the Wanipigow and Manigotagan Rivers from the Lake Winnipeg to the interprovincial boundary. The accompanying map adjoins the English Brook Area on the east, mapped by G. A. Russell in 1948[4].

The period May 23 to August 25 was spent in the area. Traverses at intervals of 1200 to 1500 feet were run by pace and compass control, locations being spotted on vertical aerial photographs.

1 J. B. Tyrrell and D. B. Dowling: East Shore of Lake Winnipeg; Geol. Surv., Canada, Ann. Rept. 1898.

2 E. S. Moore: Region East of the South End of Lake Winnipeg; Geol. Surv., Canada, Sum. Rept. 1912.

3 J. F. Wright: Geology and Mineral Deposits of a Part of Southeastern Manitoba; Geol. Surv., Canada, Mem. 169, 1932 (reprinted 1938).

4 G. A. Russell: Geology of the English Brook Area, Manitoba; Manitoba Mines Branch, Prelim. Rept. 48-3, 1949.

Areas of rock outcrop are shown by solid heavy lines on the map. Glacial drift and swamp are indicated in the usual manner. Centres of vertical aerial photographs are designated by a small circle and number.

The work was considerably assisted by the efficient and capable service of Messrs. G. J. Genik, H. R. McCabe, S. Root, and J. R. Day, all students at the University of Manitoba.

GENERAL GEOLOGY

Rocks of both Precambrian and Palaeozoic age occur within the area. The Rice Lake Group of steeply dipping volcanic and sedimentary rocks and the intrusives into these are overlain to the west by flat-lying Ordovician sandstone (Winnipeg Formation) and dolomite (Red River Formation). The contact between the Precambrian and Palaeozoic rocks was not seen, but on the northwest side of Black Island it is determinable to within a few hundred feet.

As far as could be determined all rocks of the Rice Lake Group are conformable and consist of interbanded volcanic and sedimentary types. Schists and gneisses derived from the sediments are common though subordinate in amount.

Large masses of gabbro, quartz diorite, and more granitic types intrude the Rice Lake Group. Along the east shore of Lake Winnipeg and extending northwest from Wanipigow River, most of the gabbro is intensely foliated and metamorphosed to a hornblende-plagioclase gneiss with considerable addition of granitic material. Much of the granite is in reality a granite gneiss, some of which contains numerous inclusions of older basic rock.

Exposures of the Ordovician rocks are confined to the shores of Black Island. These outcrops generally take the form of steep cliffs capped by glacial drift. Tyrrell and Dowling report an exposure of sandstone on a point southeast of Clement's Point at the mouth of Manigotagan River. This outcrop, possibly covered by the high water, was not seen by the writer.

The classification of the rocks of the area is shown in the table of formations on the next page.

TABLE OF FORMATIONS

	Pleistocene	Sand, gravel, clay
	UNCONFORMITY	
PALAEOZOIC	Ordovician	Red River Formation ..... Dolomite. Winnipeg Formation ..... Sandstone.
		UNCONFORMITY
PROTEROZOIC or ARCHAEOZOIC	Intrusive Rocks	Buff, pink or grey granite to quartz diorite Granite gneiss with injections of aplite and pegmatite; few or no inclusions Granite gneiss generally with numerous inclusions of older basic rock Quartz diorite, usually porphyritic with numerous large plagioclase phenocrysts and often blue quartz eyes Hornblende-plagioclase gneiss derived from gabbro, largely granitized Diorite, gabbro, minor peridotite.
		INTRUSIVE CONTACT
ARCHAEOZOIC	Rice Lake Group	Arkose, quartz-sericite schist, tuff, minor conglomerate; Quartzite, impure quartzite, subordinate derived mica schist, some with garnets and staurolite; Rhyolite, rhyolite porphyry, rhyolite breccia; Andesite, basalt, chlorite schist.

DESCRIPTION OF ROCK TYPES

Rice Lake Group

The greater bulk of the Rice Lake group is made up of quartzose sedimentary rocks which outcrop along the Manigotagan River and apparently underlie Lake Winnipeg between the mainland and Black Island. Thin bands of volcanic rock occur close to the granite contact south of Wood Falls. The volcanic rocks exposed on the northeast side of Black Island and on the islands to the north are largely pyroclastic.

The quartzose sediments include quartzite, various impure quartzites containing biotite, and frequent thin bands of biotite schist containing quite subordinate quartz. All gradations between fairly pure dense quartzite to schist are found. Some of the more micaceous members contain garnet or staurolite crystals.

The volcanic rocks include andesite and basalt, in places exhibiting pillow structure, and rhyolite, most of which is either porphyritic or fragmental.

Andesite, Basalt, Chlorite Schist (1)[1]

Rocks of this unit are poorly exposed, the best occurrences being those on Black Island where most of the flows contain pillows. However, these are poorly preserved except in a few places. On the southeast side of Black Island about a mile west of Gray Point tops of flows face north. On the north side of the island tops face north also. Most of the andesite and basalt is medium- to dark-green, commonly with a tinge that suggests epidote, and for the greater part are now altered to a green chlorite schist. This is especially true of the band exposed along the east side of Gray Point.

Rhyolite, Rhyolite Porphyry, Breccia (2)

Two small outcrops of rhyolite are found south of the Manigotagan River near the east boundary of the map area. There the rhyolite weathers an orangey-green colour and varies in texture from cherty to finely porphyritic (seedy). Generally thin flows of both varieties are interbanded, and the rock is

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1 Numbers in parentheses refer to the map units on the accompanying map.

somewhat schistose. It is seen to be composed of about equal amounts of plagioclase and chlorite derived from the alteration of biotite.

Exposures of rhyolite breccia are encountered on islands north of Black Island and in one small outcrop on the south side of Black Island near the east end. Light angular fragments of cherty rhyolite and porphyritic rhyolite occur in a slightly darker greenish groundmass of porphyritic rhyolite. The compositions of both the fragments and the groundmass are about the same, but in the groundmass the plagioclase is considerably altered to saussurite. Generally the fragments measure an inch or so but in places large blocks as much as 3 feet across are seen. In other places the rhyolite breccia contains interbedded rhyolite tuff and thin porphyritic rhyolite flows which give the weathered surface a ribbed appearance.

Quartzite, Impure Quartzite, Mica Schist (3)

The rocks of this unit occur in scattered, low outcrops along and on either side of the Manigotagan River. For the most part the rocks are fine- to medium-grained light grey to brown weathering impure quartzites, generally poorly bedded except where they are interbedded with more micaceous beds. Many exposures are of a purer dense fine black quartzite with less biotite. Those beds containing moderate amounts of biotite are generally somewhat foliated; the dense black quartzite, on the other hand, is quite massive. Some phases which contain considerable biotite and are consequently more foliated would more properly be designated as quartz-mica schist. These schists may contain as much as 50 per cent quartz and commonly contain small pink garnet crystals. The dense black quartzite is composed of about 75 per cent quartz and perhaps 20 per cent biotite. It also may contain garnets.

Commonly interbedded with the grey to brown quartz-mica schists and black quartzite are narrow bands of darker brown almost pure biotite-muscovite schist, which probably represent original clay beds. Some of the mica schist beds contain small brown tabular crystals of staurolite.

In general the rocks of this unit are poorly bedded. However, many isolated outcrops exhibit pronounced bedding owing to the presence of thinly interbedded quartzites, and mica schists; these beds range in thickness from a few inches to a foot.

Arkose, Quartz-sericite Schist, Tuff, Conglomerate (4)

Lithologically this unit is quite different from the one above, but its position in the sequence is not certain as the two units do not occur together. Included here are the following rock types:

a. Well- to poorly-bedded light cream medium-grained arkose, composed of a mixture of quartz, albite, sericite, and minor orthoclase and biotite. Some bands are quite thick and massive; elsewhere individual beds measure one or two inches in thickness.

b. Quartz-sericite schist, a schistose phase of the arkose which contains more sericite.

c. Dark green to grey finely laminated highly crenulated tuff. This overlies the quartz-sericite schist and occurs on islands north of it.

d. Conglomerate, which outcrops on a small reef east of Black Island. The rock is well-bedded. Pebbles and boulders from ½ inch to a foot in diameter lie in a groundmass of phyllite composed of about 75 per cent sericite with less chlorite and the occasional quartz grain. The pebbles and boulders are of a coarse massive grey to pink granite and vein quartz. Most of the granite pebbles are porphyritic, with large tablets of plagioclase (oligoclase) partly altered to sericite in a medium-grained groundmass of quartz, plagioclase, myrmekite, and minor chlorite and biotite. Accessories include apatite, magnetite, and carbonate. The origin of these granite pebbles is unknown.

The hematite deposit at Red Cliff (or Red Rock) on Black Island occurs in the quartz-sericite schist. On the shore of Lake Winnipeg at Hole River Indian Reserve the quartz-sericite schist contains irregular sub-horizontal streaks of red hematite stain. The formation there is almost vertical.

Intrusive Rocks

Intrusive rocks, that range from granite to gabbro in composition, and related granite gneisses and granitized gneisses underlie the greater part of the map area. The oldest of these

is a hornblende gabbro (5) with minor associated serpentinized peridotite (5A). The porphyritic quartz diorite (6) seems to be a late phase of the gabbro. The more intermediate and granitic rocks are definitely younger than the gabbro. Parts of the gabbro have been intensely granitized and altered to a hornblende-plagioclase gneiss.

Several trap dykes, now largely altered to chlorite schist intrude the quartz diorite along the shore of the lake north from Hole River Reservation.

Gabbro, Diorite (5), Peridotite (5A)

The best exposures of these rocks occur just south of the mouth of Wanipigow River. Other outcrops are located in the area north of the Manigotagan River. The rock varies from medium- to coarse-grained, dark green to black (and often brownish weathering), massive to schistose. The minerals of the gabbro are found to be in varying stages of alteration. The plagioclase may be poorly twinned and partly altered to saussurite. Original augite is now largely represented by dark green hornblende or lighter fibrous actinolite. Granular epidote is a common associate of these minerals. In still other places the ferromagnesian mineral is chlorite with minor actinolite.

Most of the gabbro is somewhat foliated. In some places the schistosity is quite pronounced. This is so in the gabbro on and near Black Island. There the texture is partly diabasic, and the rock is quite rotten, readily breaking off in slabs.

In the rock mass south of Wanipigow River ill-defined gradations to a brownish orangey-coloured quartz diorite are found. This is distinguishable with difficulty from some phases of the gabbro which also weather a brownish colour. However, in the same mass definite intrusions of quartz diorite (7) are found.

A similar discoloration of the gabbro is produced by irregular injections and stringers of red micropegmatite, particularly noticeable in the outcrops north of the Manigotagan River. The micropegmatite in these places appears to fuse into the gabbro, being bordered by a few inches of reddish coloured gabbro which grades outwards into normal black gabbro. Where the injections form a stockwork pattern the whole outcrop is patchily coloured red.

The micropegmatite consists of about equal quantities of oligoclase, microcline, and quartz, with subordinate biotite and epidote. The red coloration in the gabbro is due to abundant hematite dust in the plagioclase. The plagioclase crystals are definitely embayed and cut up by the microcline and quartz.

Some of the gabbro on islands north of Black Island contain interstitial quartz and myrmekite, although no micropegmatite was noted.

West of Clangula Lake a few outcrops of peridotite occur. Outcrops typically weather blue-green with red hematite stains, and are cut by small semi-parallel carbonate stringers in a characteristic checkerboard fracture pattern. The peridotite is almost completely altered to felted serpentine with lesser magnetite, tremolite, and carbonate.

The peridotite bodies are no doubt related to those described by Russell in the English Brook Area[1]. The age relation of the peridotite is not known with certainty but it is most probably older than the granitic rocks, likely related to the gabbro.

Hornblende-plagioclase Gneiss (6)

East of Black Island and on the mainland a wide band of hornblende-plagioclase gneiss (6) parallels the shoreline. Most of this is a light- to dark-grey colour, partly banded and typically characterized by needles of hornblende. Numerous injections of granitic material are present, and the gneissosity is mainly due to these. Lighter coloured bands have been impregnated with varying quantities of granitic material. The borders of the mass are poorly defined. In places numerous dark green to black finely foliated amphibolite inclusions are present, and in a few places original gabbroic texture may be observed.

In contrast to the gabbro, the minerals of the hornblende-plagioclase gneiss are well formed and fresh looking. The least granitized specimens contain about 60 per cent hornblende, the remainder of the rock being made up of plagioclase and quartz with minor chlorite, carbonate, and apatite. Lighter portions contain far less hornblende and more granitic material, as much as 60 per cent. In some places biotite has formed at the expense of hornblende.

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[1] G. A. Russell: Geology of the English Brook Area, Manitoba; Manitoba Mines Branch, Prelim. Rept. 48-3, 1949.

Quartz Diorite (7)

This rock is typically porphyritic, consisting of large, more or less equidimensional white plagioclase phenocrysts in a medium- to coarse-grained groundmass of quartz, plagioclase, chlorite, and epidote. The rock weathers a typical orangey colour, commonly with a tinge of epidote green, and also olive green where much chlorite is present. For the most part the quartz diorite is somewhat foliated, especially those portions high in chlorite. Commonly the rock is characterized by large blue quartz eyes. Generally the chlorite content is high, and this, together with the coarsely porphyritic nature and the presence of blue quartz eyes enables a distinction to be made between the quartz diorite and other granitoid rocks in the area. As noted previously, phases of the gabbro and also injections into the gabbro appear to be the same as the quartz diorite. On the other hand, rocks similar to the quartz diorite are found as phases of the granite-quartz diorite unit (10).

Granitic Rocks and Associated Gneisses (8, 9, 10)

As could be expected these rocks exhibit considerable variation in appearance and composition. On the basis of feldspars the composition ranges from quartz gabbro (rare) to microcline granite. The average composition probably approaches quartz diorite or granodiorite. Composition of the feldspars range from labradorite to oligoclase, and microcline is present in varying amounts.

The more massive "granite" (8) is generally coarse-grained, buff, or grey. In addition to plagioclase and quartz the rock contains biotite, usually some epidote, magnetite, sphene, and apatite. In places hornblende is present along with biotite, but usually in subordinate amounts.

In both the massive granite and granite gneiss microcline often figures prominently, but more so in the hybrid gneisses where it may equal the plagioclase in amount. The gneiss is made up of "granites" of varying texture, composition, and colour. Greyish granite is commonly injected with thin bands of buff material usually containing more microcline and less plagioclase than the grey rock. Often "ghosts" of dark grey granite containing more biotite than normal are enclosed in lighter grey or buff granite. Elsewhere the granite gneiss exhibits a distinct stratiform structure. This variety is generally fairly uniform in composition in any one outcrop. The stratiform structure results from the alignment of biotite flakes.

Large areas of gneiss contain numerous distinct inclusions of darker granitized hornblende-plagioclase gneiss identical with unit (6). These inclusions take the form of irregular blocks, bands, ribbons or thin wisps. Where quite granitized these inclusions have been altered to a light greyish brown colour, become finer grained, and contain biotite instead of hornblende. They then greatly resemble sedimentary gneisses, but their origin can readily be traced to hornblende gneiss.

Along the shore of Lake Winnipeg north from Hole River Reservation numerous small trap dykes, now largely altered to chlorite schist are found intruding the quartz diorite. These dykes generally parallel the foliation in the quartz diorite. Presumably they are also younger than the granitic rocks and gneisses.

Palaeozoic Rocks

Ordovician (11, 12)

Except for a narrow fringe on the northeast, all of Black Island is underlain by sediments believed to be Ordovician in age. The greater part of the island is drift-covered and outcrops are confined to the cliffs along the shore.

On the northwest and southeast sides of the island, cliffs of Winnipeg sandstone as much as 60 feet high are exposed. For the most part this rock is fine-grained, almost pure silica, white, unconsolidated sand. Parts of it weather a buff to brownish colour owing to some iron impurities. The purer sands have been used in the past as glass and foundry silica sands.

A peculiar feature of this formation is the presence of beds of more highly consolidated, very porous, buff to grey sandstone. These have been noted at the tops of cliffs, underlain by the unconsolidated sand. At other places it is exposed at water level and apparently overlain by the unconsolidated sand. At one locality on the northwest side of the island. small concretionary-like pyrite or marcasite spheres were found in the grey porous sandstone. These may possibly represent fossils, but have not yet been identified.

Some of the more consolidated sandstone is highly ferruginous. The iron mineral is limonite which imparts a deep chocolate-brown colour to the rock. This is not an extension of the hematite deposit at Red Cliff on the southeast side of

the island.

On the southeast side of the island and west of Red Cliff a two-foot band of grey fissile shale is interbedded with the sandstone.

The only certain outcrops of the Red River dolomite were found under uprooted trees in the northeast part of the island. The dolomite is hard, buff to grey, and mottled.

No fossils were found in any of the Ordovician rocks.

More complete data on the Winnipeg formation was gathered by Mr. F. S. Gamey, Resident Engineer, Manitoba Mines Branch. During July, 1950 the silica sands on the northwest side of the island were sampled by him. At the present time Mr. G. Macauley, a graduate student at the University of Manitoba, is making a complete investigation of the Winnipeg sandstone, the results to be embodied in a thesis for the M.Sc. degree.

STRUCTURAL GEOLOGY

The absence of distinctive horizon markers within the Rice Lake Group makes structural determinations uncertain.

As noted previously, the sediments along the Manigotagan River are commonly well bedded. Dips are generally steep, commonly 80 degrees to vertical. For the most part secondary cleavage is parallel to the bedding. In only one or two places does the cleavage transect the bedding. In these places, light-grey unfoliated quartzite is interbedded with darker grey to brown quartz-biotite schist. The attitude of the bedding and cleavage indicates northerly-facing tops of beds. Drag folds are uncommon but where found indicate that tops face north. Grain gradation is absent. The determinations mentioned above place the minor rhyolite and basalt south of the Manigotagan River as older than the sedimentary rocks. There is no evidence of anticlinal or synclinal structure along the river.

The disposition of the lavas on Black Island and the tuff-arkose unit north of Hole River Reserve is difficult to reconcile with the lavas and sediments along the Manigotagan River. Pillows within the lavas face north. Hence it appears that the sedimentary unit (3) is older than the lavas. There is no way of explaining this anomalous condition on structural grounds. It seems more likely that the lavas on Black Island are really younger than both the sedimentary units (2, 3) and the lavas south of Manigotagan River.

As previously stated, the exact relationship between the two sedimentary units is not certain. Two facts are pertinent in this respect. First, the conglomerate of unit (3) is not basal and does not contain pebbles of underlying rock. Rather it contains only granite boulders of unknown origin and quartz pebbles. Secondly, on the small island closest to the mainland east of Black Island, one thin band of dark black quartzite of unit (2) is interbedded with arkosic sediments of unit (3). The situation gives the impression that unit (3) overlies unit (2).

The sedimentary beds and associated volcanic rocks in the vininity of Black Island appear to be folded into a broad anticline which plunges southeast. This is readily apparent from mapping of the formations. It is interesting to note that the granite contact, gneissosity in the granite, the shoreline of Lake Winnipeg, and the bedding in the sediments (the limb of the anticline) are all parallel, and further, that the granite-sediment contact approximates the shore of the lake.

Secondary cleavage within the sedimentary rocks has already been mentioned. Small drag folds are occasionally observed.

In the quartz-sericite schist on the point at Hole River Reserve, interesting joint patterns are well developed. At this outcrop the bedding strikes about east and dips 80 degrees north. One set of joints is horizontal. A second set strikes at 335 degrees and dips 85 degrees southeast. A third set strikes 185 degrees and dips 75 degrees east. Linear streaks in the schist appear to plunge 40 degrees in an easterly direction in the plane of the bedding.

Little need be said of structures in the granite gneiss apart from the fact that they generally parallel those in the sedimentary rocks.

The Palaeozoic rocks are flat-lying and generally without visible structure.

ECONOMIC GEOLOGY

Although a considerable diversity of mineral deposits is known, the area in many respects is not considered very promising. This opinion is based on several factors. First, a considerable part of the region is underlain by granitic rocks and related gneisses generally unfavorable to the occurrence of mineral deposits. Second, the generally great proportion of sedimentary rocks and derived schists do not appear to have been favourable for the formation of veins. Third, strong structures are absent, due probably to lack of contrasting rock types. An exception to this may be the anticlinal fold of the rocks east of Black Island, but most of this is covered by water. Finally, extensive areas of drift and swamp cover much of the rock in the area.

Despite these conditions, occurrences of gold-bearing quartz veins, serpentine, hematite, silica sands, and red ochre have been observed. It will be noticed that many of these fall within the industrial mineral category. In addition to these, disseminated pyrrhotite was found in gabbro on an island north of Black Island. However, no nickel reaction could be obtained from samples of the gabbro.

GOLD

Two small shear zones in gabbro occur on neighboring points on the north shore of the Manigotagan River near its mouth. Only minor quartz-carbonate stringers are present, and alteration is slight. The zones pass into the lake on the west and under heavy drift to the east. Minor gold values are reported.

Numerous quartz stringers occur in a fractured zone about a half mile east of the mouth of Wanipigow River. These are in quartz diorite intruded by a small, dark green, schisted trap dyke. Minor disseminated chalcopyrite and pyrite occur, for the most part in the chloritic schist. Some carbonate is present. An old shaft is located a few hundred feet inland from the lake.

Numerous other small quartz lenses are found all along the shoreline north from Wanipigow River, usually associated with trap dykes intruding the quartz diorite. Most are small, discontinuous, and barren.

On the Goldshore property, a quartz vein is located on the shore of the lake about 2½ miles due north of the mouth of Wanipigow River. The vein, similar to the others, occurs along a trap dyke contact. Scattered chalcopyrite and pyrite mineralization is present. The vein was trenched and drilled during the summer of 1949, and encouraging gold values are reported.

Farther north an adit has been driven into the cliff on the north side of Steeprock Creek about a quarter mile from its mouth. A quartz vein about 12 feet wide is exposed at the tunnel entrance, and at the face, about 30 feet south, it averages 5 feet wide. The vein is a fracture filling in granitized hornblende-plagioclase gneiss. On the top of the cliff and a few feet farther south two shafts have been put down on the vein. Little quartz was seen. Finely divided pyrite occurs in chloritic seams within the quartz, but on the whole mineralization is very sparse. Wall rock alteration is negligible.

Small pyritized seams were noted on the south side of Black Island west of Gray Point. These were right at water level and not well exposed. They occur in albitized basalts.

Several quartz veins with minor pyrite intrude quartz-sericite schist at Red Rock.

HEMATITE

Steep cliffs of red iron ore outcrop at Red Cliff on the south shore of Black Island. The adjacent rock is quartz sericite schist. The iron formation consists of oolitic and pisolitic hematite mixed with calcite. Several cherty quartz veins intrude the schist here.

Brownell and Kliske[1] report that drilling has disclosed that the hematite rests on a massive pyrite zone in phyllite, and conclude that the deposit is due to weathering and oxidation of the zone in Precambrian times. The phyllite is no doubt the finely laminated tuff of map unit (3) and overlies the quartz-sericite schist of the same unit.

Mention has already been made of the hematite stain in quartz-sericite schist at Hole River Reservation.

OTHER MINERALS

Much of the peridotite is similar to that which was formerly quarried at Clangula Lake. However, no chrysotile was noted. Extensive fracturing tends to make this rock a poor ornamental stone.

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[1] G. M. Brownell and A. E. Kliske: The Hematite on Black Island, Lake Winnipeg, Manitoba; Trans. Can. Inst. Min. and Met. vol. 48, pp. 284-293, 1945.

The silica sands on Black Island have already been mentioned and reference made to the work being carried out by F. S. Gamey.

On the north shore of Black Island at the top of the cliffs is a mantle of red to brown ochre. Some of this may be suitable for gas filters.