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Geology of the

Muskrat Dam Lake Area

District of Kenora

By
L. D. AYRES

Geological Report 74

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Geological Maps
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Map 2162 (coloured)–Rottenfish River, Kenora District, Ontario.
Scale, 1 inch to ½ mile.
Map 2163 (coloured)–Sandhill Crane Island, Kenora District, Ontario.
Scale, 1 inch to ½ mile.
Map 2164 (coloured)–Axe Lake, Kenora District, Ontario.
Scale, 1 inch to ½ mile.
Map 2165 (coloured)–Munekun Lake, Kenora District, Ontario.
Scale, 1 inch to ½ mile.

Chart
(back pocket)

Chart A (coloured)–Figure 4, Figure 5, Figure 6, Figure 7.

ABSTRACT

The Muskrat Dam Lake area comprises 1,700 square miles in the Patricia Portion of the District of Kenora about 150 miles north-northwest of Pickle Lake.

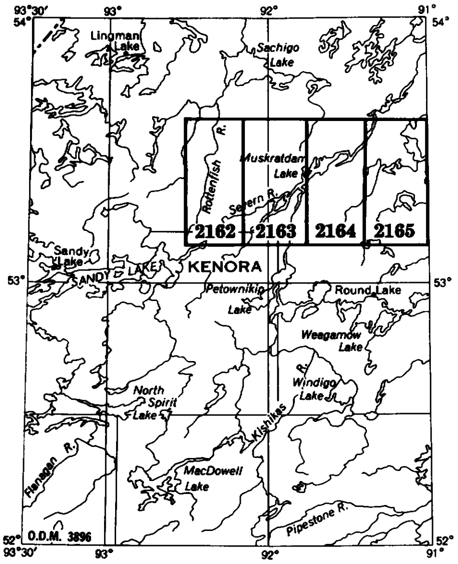

Figure 1—Key map showing location of map-area. Scale, 1 inch to 50 miles.

Early Precambrian, volcanic, sedimentary, and gabbroic rocks, which were variously metamorphosed to the greenschist, almandine amphibolite, and hornblende hornfels facies, form two isoclinally folded belts that underlie 30 percent of the area and are bordered by composite granitic batholiths. The east-trending Muskrat Dam Lake belt is at least 65 miles long, ranges in width from 4 to 11 miles, and contains an 18,500-foot thick metavolcanic-metasedimentary sequence that is characterized by marked facies changes; six formations have been recognized. In the western part of the belt, the major rock types, in order of decreasing abundance, are as follows: felsic metavolcanic flows and pyroclastic rocks; mafic metavolcanic flows; metagreywacke and metasiltstone; intermediate metavolcanic flows and pyroclastic breccia; slate; metaconglomerate; marble and calc-silicate rocks; and metamorphosed iron formation and ferruginous metasediments. In the eastern part of the belt, mafic metavolcanic flows form most of the sequence. The north-trending Rottenfish River belt, which is separated from the west end of the Muskrat Dam Lake belt by 4 miles of granitic rocks and by several faults, is at least 17 miles long, has an average width of 2 miles, and contains a 6,000-foot thick, dominantly mafic, metavolcanic sequence.

Slightly differentiated metagabbro and metadiorite sills, which have an average thickness of 2,000 feet and a maximum thickness of 7,800 feet, intruded the metavolcanic-metasedimentary sequence in both belts. At least one sill was intruded after the initiation of folding.

The belts were intruded by two composite granitic batholiths that underlie 70 percent of the map-area, range in composition from diorite to quartz monzonite, and are dominantly trondhjemite and quartz monzonite.

Late diabase dikes trend north-northeast and west-northwest.

Thick Pleistocene drift covers much of the bedrock. An interlobate moraine, an end moraine, a complex esker system, and numerous drumlins are all related to a southwesterly-moving, ice lobe.

Twenty-two sulphide mineral concentrations were found but these contain only trace amounts of economically important elements. Gold has been reported from the area, but ninety-nine sampled quartz veins contained only trace amounts of gold. Several metamorphosed iron formation units were found, and aeromagnetic data suggest that extensive iron formation units are buried beneath glacial drift.

Geology of the
Muskrat Dam Lake Area
District of Kenora

By

L. D. Ayres[1]

INTRODUCTION

The Muskrat Dam Lake area comprises about 1,700 square miles in the Patricia Portion of the District of Kenora and is bounded by latitudes 53°10′ and 53°35′ North and by longitudes 91°00′ and 92°30′ West. Muskrat Dam Lake, in the centre of the map-area, is about 150 miles north-northwest of Pickle Lake[2], about 230 miles north of Sioux Lookout, and about 190 miles north-northeast of Red Lake.

Contoured topographic maps at a scale of 1:250,000 (about 1 inch to 4 miles) were issued for a large part of northwestern Ontario in 1964 and 1965 by the Canada Department of Mines and Technical Surveys[3]. The Makoop and Opasquia sheets of this series provide topographic coverage for the map-area.

The map-area is in the Red Lake Mining Division. There has been no mineral production, and in 1964 no major mineral occurrences were known.

Acknowledgments. Assistance in the field was provided by V. A. Jones, R. A. MacDonald, and B. Mottershead in 1963 and by C. J. Hodgson, M. H. D'Arcy, J. N. O. Hodgson, and L. P. Menec in 1964. Mr. Jones and Mr. C. J. Hodgson, as senior assistants, were responsible for part of the geological mapping. The basemaps were redrawn by C. E. Blackburn and M. E. Coates.

Conversations with W. Cruickshanks, J. R. Cryderman, N. Firth, E. Garvey, and H. McLaughlin, who were prospecting in the area in 1963, enabled the author to locate several previously unknown mineral showings and outcrops. T. Beardy, who resides at Muskrat Dam Lake and is the only permanent resident in the map-area, also helped the author find several mineral showings.

Means of Access. The only rapid access to the area is by float-equipped aircraft, which can be chartered at Sioux Lookout, Pickle Lake, or Red Lake. In addition, regularly scheduled flights to Sandy Lake (about 75 miles west of Muskrat Dam Lake) originate at both Sioux Lookout and Red Lake and flights to Round Lake (about 35 miles south of Muskrat Dam Lake) originate at both Pickle Lake and Sioux Lookout.

---

[1] Geologist, Ontario Department of Mines, Toronto. Manuscript received by the Director, Geological Branch, 7 December 1966.

[2] At time of mapping the closest road was at Pickle Lake but a road is presently (1966) being constructed north of Pickle Lake.

[3] Name changed to Canada Department of Energy, Mines and Resources.

The aircraft on these flights can be chartered from either Sandy Lake or Round Lake.

Many streams in the map-area can be travelled by canoe, but travel on some of the small streams is time-consuming because of numerous rapids and poorly marked portages. All portages located during the mapping are shown on the geological maps. The Severn River, the major waterway, flows along the axis of the Muskrat Dam Lake metavolcanic-metasedimentary belt for 35 miles, and there are no major rapids between the east end of Muskrat Dam Lake and the west end of the belt. The only access to the Rottenfish River belt is via the Rottenfish River from Rottenfish Lake; the first rapid on this route is 20 miles north of Rottenfish Lake.

Field Methods. In the 1963 and 1964 field seasons about 75 percent of the area was covered by traverses along the major rivers and lakes and by pace-and-compass traverses in forested areas. In these forested areas, the spacing between traverses ranged from ½ mile to several miles, depending on the outcrop density and geological complexity.

Outcrop density is generally low, but most outcrops can be readily located on aerial photographs. Before traversing, all outcrops were outlined on the photographs and zig-zag traverses were run from outcrop to outcrop; areas between these outcrops were given only cursory examination. In spite of the wide traverse spacing, the author believes that most outcrops in the traversed areas were located and examined. Outcrops in the granitic areas known to exist but not examined on the ground are shown by the undifferentiated granite code on the geological maps (Map 2162 to Map 2165, back pocket).

The remainder of the area was not traversed because of either inaccesibility or lack of outcrop. In the spring of 1964 a Cessna 180 aircraft was used to confirm the lack of outcrop in some parts of the area and to check for outcrop along the shorelines of several lakes.

Uncoloured parts of the maps represent: (1) areas beyond the limits of mapping (labelled on map face); (2) mapped areas within the metavolcanic-metasedimentary-metagabbroic belts in which outcrop is rare or absent and interpretation was not attempted because of geologic complexity; and (3) areas within the limits of mapping which are assumed to be underlain by granitic rocks but which were not mapped because air photograph interpretation and aerial reconnaissance indicated very low outcrop density.

The basemap is derived from preliminary editions of the Makoop and Opasquia topographic sheets and was provided by the Canada Department of Mines and Technical Surveys at a scale of 1:125,000. For mapping purposes the basemap was enlarged to a scale of 1 inch to ½ mile (1:31,680) and was redrawn so that topographic details could be added along lakeshores and streams. Geological data were plotted in the field on acetate sheets attached to aerial photographs from surveys flown in 1954 and 1956. In most parts of the area the photographs were at a scale of 1 inch to 1 mile, but in areas of high outcrop density the photographs had been enlarged to a scale of 1 inch to ½ mile. The geological data were later transferred to the basemap by means of a sketchmaster.

The 15th base line and the meridian south of the base line were surveyed in 1955 and 1957. Mile posts were located in the field only when they occur on outcrops.

Two uncoloured preliminary geological maps at a scale of 1:125,000 (about 1 inch to 2 miles) were issued in 1964 (Ayres 1964a and m). Nine uncoloured preliminary geological maps at a scale of 1 inch to ½ mile were also issued in 1964 and show all outcrops examined during the 1963 field season (Ayres 1964b, c, d, e, f, g, h, j, and k). Two preliminary maps at the same scale were issued in 1965 and show part of the area mapped during the 1964 field season (Ayres 1965a [which is Ayres 1964b revised and reissued with the same map number] and Ayres 1965b). More structural symbols are shown on the 1 inch to ½ mile preliminary maps than on the geological maps accompanying this report. See Figure 2 for the areas covered by preliminary maps.

Natural Resources. The map-area is in the Northern Coniferous Section of the Boreal Forest Region (Rowe 1959) and is poorly drained. Black spruce and balsam fir are the dominant tree species: black spruce is found in all parts of the map-area, and balsam fir is found everywhere except in swamps and muskegs. Stands of tall timber, which include black spruce, white spruce, balsam fir, trembling aspen, and balsam poplar, are restricted to well drained areas along the shores of major streams and lakes. These well drained areas are commonly less than ¼ mile wide. White birch is found in stream valleys and on poorly drained knob-and-kettle moraine. Jackpine is restricted to well drained glacial features such as eskers, sandy outwash, drumlins, and interlobate moraine. Tamarack and alder are common in the numerous swamps. Rare mountain maple and mountain-ash were found near the south boundary of the map-area.

Commercial fishing for whitefish and pickerel is carried out annually at Muskrat Dam Lake and at several other large lakes in the area. Pike and pickerel inhabit many of the lakes and rivers, and lake trout are found in some of the larger lakes. Sturgeon are found in the Severn River.

Wildlife observed during the two field seasons include bear, beaver, lynx, mink, moose, otter, and squirrel. Birds, including duck and grouse, are abundant in many parts of the area.

Physiography. Elevations in the map-area range from 830 to 1,200 feet. The highest hills are Pleistocene eskers and moraine, and the highest elevation is on the Sachigo interlobate moraine at the west boundary of the map-area. Local relief is commonly less than 100 feet.

Most streams in the map-area are part of the Severn River drainage system, but the Rottenfish River and adjacent streams in the northwest part of the area are part of the Sachigo River system. These two rivers merge several hundred miles downstream and eventually flow into Hudson Bay.

In general, drainage is poorly established. A large part of the area is swamp and muskeg which has developed on Pleistocene, lacustrine silt and clay. The impervious clay prohibits drainage, and the water table is commonly perched on top of the clay. These clay deposits have been dissected by the Severn River, and along part of the river, well drained areas extend as far as a quarter mile inland. At several places adjacent to the river, however, swamps are perched on top of clay banks that are 10 to 15 feet high. The river is constantly eroding the clay banks, causing slumping of the overlying forest (Photo 1). Many of the small lakes and streams have swampy margins, and because of the swamps, campsites are rare on Rottenfish Lake and along the upper 15 miles of the Rottenfish River.

Many outcrops along the lakeshores are low and have a clay capping, but inland most outcrops are 10 to 75 feet higher than adjacent swamp and are commonly well exposed. The inland outcrops appear to have been subjected to Pleistocene wave action, which removed much of the original drift-cover.

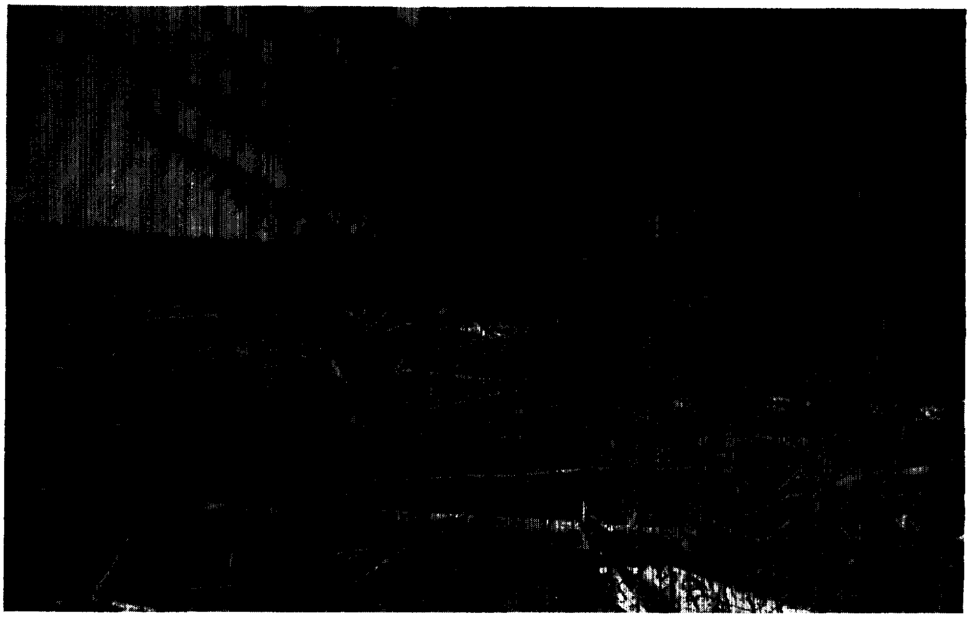

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Photo 1—Slumping of forest along Severn River caused by erosion of underlying clay bank.

In most parts of the area, bedrock has no noticeable effect on topography other than forming rock hills. East of the Rottenfish River, however, many faults are marked by negative lineaments.

Between the middle of June and the middle of September, the water-level of the Severn River decreases by about 2.5 feet. All outcrops along the river were located in the fall; some of these are beneath the water in the spring. Care must be taken when landing aircraft on the river or on Muskrat Dam Lake because firstly, the river contains much suspended clay and depth-visibility is less than 6 inches, and secondly, mud flats, which in September are covered by less than two feet of water, form ⅓ to ⅔ of the river's width. Other streams and lakes are clear or slightly murky, and the drop in water-level during the summer is less than on the Severn River.

Previous Geological Work. Four previous reconnaissance surveys have included parts of the map-area. In 1886, A. P. Low travelled along the Severn River (Low 1887) and observed the metavolcanic rocks of the Muskrat Dam Lake belt. In 1912, Tyrrell (1913) found the east end of this belt during an exploration trip along the Schade River. Then in 1937, Satterly (1938) mapped the Severn River between Sandy Lake and the west end of the Muskrat Dam Lake belt as well as the area near Rottenfish Lake. In 1960 and 1961, Hudec (1964), while mapping the Big Trout Lake area northeast of the map-area, briefly visited the northeast corner of the present area.

Nearby areas to the south were mapped by Satterly (1939), Carruthers (1961), and Donaldson (1961), and to the north by Satterly (1937b).

Aeromagnetic maps were not available when the mapping was done but were issued in 1966 and 1967 (O.D.M.-G.S.C. 1966a, b, c, d, e, f, and g; 1967a, b, c, d, e, and f).

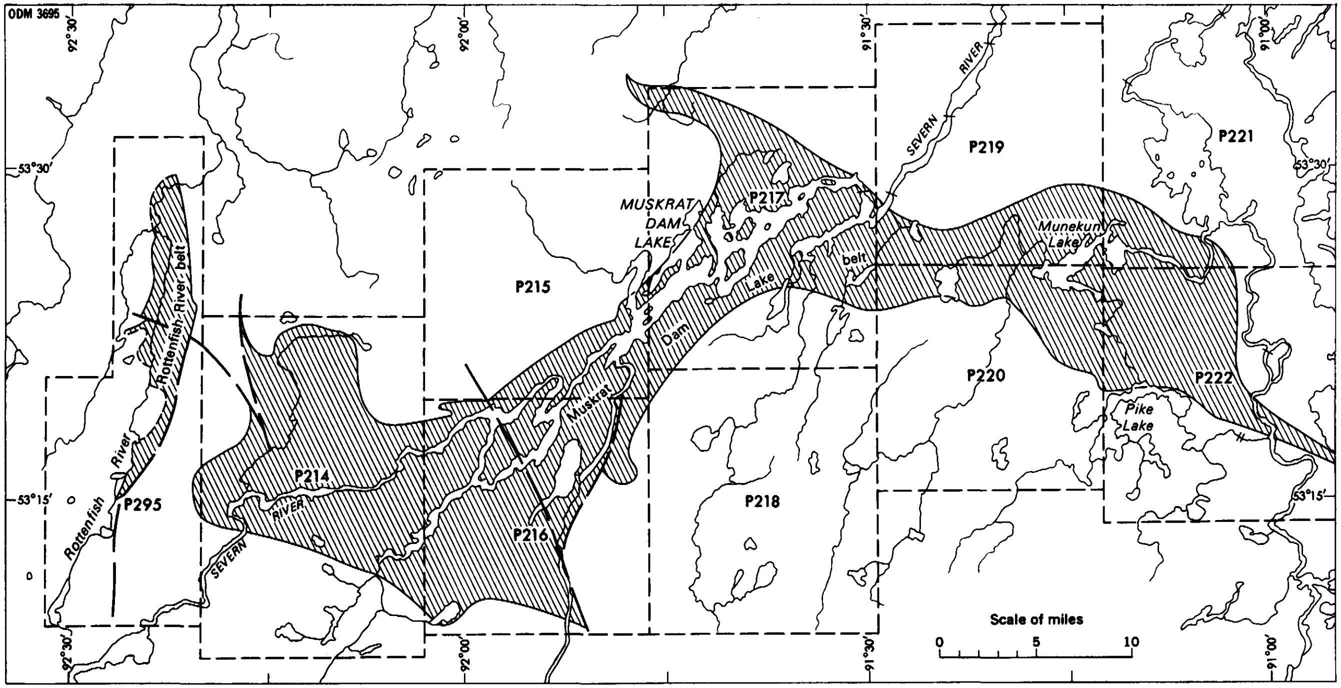

Figure 2—Sketch map showing areas covered by preliminary maps and main metavolcanic-metasedimentary belts.

GENERAL GEOLOGY

INTRODUCTION

In the map-area, Precambrian metavolcanic-metasedimentary-metagabbroic assemblages form two belts that are bordered by composite granitic batholiths (Figure 2, and Figure 4 on Chart A, back pocket). The larger belt, the east-trending Muskrat Dam Lake belt, has been mapped for a strike-length of 65 miles and generally ranges in width from 4 to 11 miles. At the east edge of the map-area, however, the belt abruptly decreases in width from 8 miles to ½ mile, and aeromagnetic data (O.D.M.-G.S.C. 1966f and g) suggest that the belt extends, as a narrow unit, at least 12 miles farther east. At its west end, the belt is 8 miles wide and ends abruptly against granitic rocks; part of the western contact is a fault. North of Muskrat Dam Lake the belt bifurcates, and a narrow branch extends for 8 miles northwest of the main belt.

Table 1 TABLE OF FORMATIONS

CENOZOIC
RECENT
Organic mud; lacustrine and fluvial clay, silt, and sand
PLEISTOCENE
Till, lacustrine varved clay and silt, fluvial sand and gravel, beach sand and gravel
Unconformity
PRECAMBRIAN(?)
LATE MAFIC ROCKS
Diorite
Intrusive Contact(?)
PRECAMBRIAN
LATE MAFIC ROCKS
Diabase
Quartz-bearing diabase, olivine diabase, and granophyre
Intrusive Contact(?)
Lamprophyre
Intrusive Contact
INTRUSIVE ROCKS
Granitic Batholiths
Granitic Phases
Pegmatite and aplite; porphyritic, biotite quartz monzonite, granodiorite, and trondhjemite; equigranular, biotite quartz monzonite, granodiorite, and trondhjemite; porphyritic, hornblende-biotite granodiorite; equigranular, hornblende-biotite granodiorite, trondhjemite, and tonalite
Intrusive Contact
Early Mafic Phase
Diorite, syenodiorite, and mafic-rich trondhjemite
Intrusive Contact(?)
Late Porphyritic Felsic Dikes

Intrusive Contact

Uralitized and Metamorphosed Intrusive Rocks
Uralitized and metamorphosed gabbro, diorite, albite granite, and albite syenite

Intrusive Contact

Early Porphyritic Felsic Dikes

Intrusive Contact

METAVOLCANIC-METASEDIMENTARY ASSEMBLAGE
- Muskrat Dam Lake Belt
  - Metasedimentary-Metavolcanic Formation of Undetermined Stratigraphic Position[1] (0-9,000′)
    - Metagreywacke, metasiltstone, metaconglomerate, metavolcanic flows and breccia of intermediate composition, and felsic metavolcanics
  - Upper Metasedimentary Formation (0-5,500′)
    - Metagreywacke, metasiltstone, slate, metaconglomerate, marble, calc-silicate gneiss and granofels, felsic metavolcanics, and ferruginous metasediments
  - Upper Mafic Metavolcanic Formation (0-16,500′)
    - Mafic and intermediate metavolcanic flows, metamorphosed pyroclastic rocks of intermediate composition, felsic metavolcanics, metamorphosed iron formation, and ferruginous metasediments
  - Felsic Metavolcanic Formation (0-6,000′)
    - Metamorphosed felsic and intermediate pyroclastic rocks; felsic, intermediate, and mafic metavolcanic flows; metagreywacke; slate; metamorphosed iron formation; and ferruginous metasediments
  - Lower Metasedimentary Formation (0-3,000′)
    - Metagreywacke, metasiltstone, metaconglomerate, calc-silicate gneiss, and ferruginous metasediments
  - Lower Mafic Metavolcanic Formation (0-4,000′)
    - Mafic metavolcanic flows, and metamorphosed volcanic breccia of intermediate composition
- Rottenfish River Belt[2]
  - Metamorphosed iron formation and ferruginous metasediments
  - Felsic metavolcanic flows and pyroclastic rocks
  - Mafic and intermediate metavolcanic flows

NOTES
[1] possibly part of the upper metasedimentary formation
[2] stratigraphic sequence unknown; relationship to sequence in the Muskrat Dam Lake belt is also unknown

The smaller north-trending Rottenfish River belt is approximately perpendicular to, and is separated by several faults and by 3 to 5 miles of granitic rocks from, the west end of the Muskrat Dam Lake belt. It has been mapped for a strike-length of 15 miles and appears to be about 2 miles wide although the western edge was defined only in the northern part of the belt. Recent aeromagnetic data (O.D.M.-G.S.C. 1967a and b) suggest that (1) the belt is at least 17 miles and possibly 22 miles long, and (2) the maximum width of the belt is 3½ miles. Neither end was found, and correlation with other belts is hampered by several major faults and by lack of outcrop at the north end and in the south half of the belt. The south part of the belt may join the Sandy Lake belt (Satterly 1940).

The Rottenfish River belt is composed dominantly of mafic metavolcanics and metagabbro with minor felsic and intermediate metavolcanics and rare ferruginous metasediments and metamorphosed iron formation. Stratigraphy and structure are poorly known, but the metavolcanic sequence appears to be about 6,000 feet thick and to have been folded into an isoclinal anticline. This sequence cannot be correlated with the western part of the Muskrat Dam Lake belt, where five formations have been tentatively recognized (Figure 3).

The Muskrat Dam Lake metavolcanic-metasedimentary assemblage is isoclinally folded and is characterized by marked facies changes. West of the Windigo River fault the sequence (Table 1), from bottom to top, comprises the 4,000-foot thick lower mafic metavolcanic formation, the 1,500-foot thick lower metasedimentary formation, the 6,000-foot thick felsic metavolcanic formation, the 3,500-foot thick upper mafic metavolcanic formation, and the 5,500-foot thick upper metasedimentary formation. The figures given above are maximum thicknesses, and the thickest continuous section is 18,500 feet (Figure 3). Felsic metavolcanics are thickest in the centre of this segment of the belt but are thin or absent at the margins and near the fault. Conversely, mafic metavolcanics are thickest at the margins of the belt, but are thin and locally become intermediate in composition toward the centre. The lower metasedimentary formation is locally absent in the northwest part of the belt.

East of the Windigo River fault, the upper mafic metavolcanic formation predominates and is at least 16,500 feet thick near Munekun Lake. Felsic and intermediate metavolcanics are rare, and thick metasedimentary units are found only near the base of the section along the north edge of the belt between the fault and Munekun Lake.

In both belts, metavolcanics range in composition from mafic to felsic: mafic metavolcanics generally form flows; intermediate metavolcanics form about equal volumes of flows and volcanic breccia; and felsic units are dominantly pyroclastic. In the metasedimentary formations, metagreywacke and metasiltstone predominate although slate and metaconglomerate are locally abundant, especially in the upper formation. Marble and calc-silicate gneiss and granofels are locally present.

Narrow layers of ferruginous metasediments and metamorphosed iron formation are present in all but the lower mafic metavolcanic formation and the metasedimentary-metavolcanic formation of undetermined stratigraphic position.

Uralitized and metamorphosed gabbro and diorite form at least four sills and one irregular body in the Muskrat Dam Lake belt and several sills in the Rottenfish River belt. The sills have a maximum thickness of 7,800 feet and several have been traced along strike for more than 15 miles.

The metavolcanic-metasedimentary-metagabbroic assemblage has been variously metamorphosed to the greenschist, almandine amphibolite, and hornblende hornfels facies.

Felsic intrusive activity appears to have been initiated during the period of volcanism and sedimentation, because some felsic porphyry dikes were intruded by metagabbro sills. The composite granitic batholiths postdate the metagabbro: the first stage in their development was the local intrusion of diorite, syenodiorite, and mafic-rich trondhjemite; the second stage was the widespread intrusion of granite magma ranging in composition from tonalite to quartz monzonite. Trondhjemite and quartz monzonite predominate in the batholiths.

Rare post-batholith diabase dikes form three sets which have slightly different compositions and which trend north-northeast, north-northwest, and west-northwest. Several other late mafic dikes were found, one of which appears to contain altered glass.

Pleistocene deposits that include till, lacustrine clay, interlobate and end moraine, and eskers, cover much of the bedrock and hamper the deciphering of the stratigraphy and structure.

METAVOLCANIC-METASEDIMENTARY ASSEMBLAGE

LITHOLOGY

Metavolcanic Rocks

Metavolcanic rocks, including those of pyroclastic origin, form at least 75 percent of the metavolcanic-metasedimentary sequence in the Muskrat Dam Lake belt and most of the sequence in the Rottenfish River belt. They range in composition from mafic to felsic and, on the basis of colour index, can be subdivided into mafic metavolcanics (more than 35 percent mafic minerals [clinopyroxene, amphibole, biotite, and chlorite]), intermediate metavolcanics (15 to 35 percent mafic minerals), and felsic metavolcanics (less than 15 percent mafic minerals). Mafic types form about 70 percent of the metavolcanic sequence, intermediate types about 7 percent, and felsic types about 23 percent.

Mafic Metavolcanics

Mafic metavolcanics were derived predominantly from basaltic and andesitic flows and have been metamorphosed to the greenschist, almandine amphibolite, and hornblende hornfels facies ("facies" being defined according to Fyfe *et al.* 1958). The colour of the weathered surface varies from pale-green to dark-green, and a deepening in the colour generally indicates an increase in metamorphic grade. On fresh surfaces, colour varies from grey-green to almost black. Mafic metavolcanics are commonly well foliated and, in the hornblende hornfels facies are locally gneissic; massive varieties are rare.

The major mineral assemblages[1] in the greenschist facies are:

1. Albite (range An_3–An_8, average An_5) + amphibole ± quartz ± epidote ± carbonate
2. Actinolite + albite (An_0–An_8) + chlorite ± epidote ± carbonate ± quartz
3. Chlorite + albite (An_3–An_9) + carbonate ± quartz ± epidote ± white mica
4. Actinolite + epidote + carbonate ± quartz
5. Albite (An_0–An_9) + biotite + blue-green hornblende ± quartz ± epidote ± carbonate
6. Chlorite + actinolite + epidote + carbonate + quartz.

The almandine amphibolite and hornblende hornfels facies have approximately similar mineralogy and their major assemblages are:

1. Blue-green hornblende + reversely zoned plagioclase (range An_{20}–An_{47}, average An_{36}) ± quartz ± epidote ± carbonate
2. Blue-green hornblende + normally zoned plagioclase (range An_{12}–An_{50}, average An_{28}) + biotite + quartz ± epidote ± carbonate
3. Normally zoned plagioclase (range An_{15}–An_{50}, average An_{36}) + blue-green to dark-green hornblende + clinopyroxene ± quartz ± epidote ± microcline.

Biotite-bearing assemblages in all facies contain about 10 percent quartz, but biotite-free assemblages commonly contain less than 5 percent quartz. Minor minerals in most of the assemblages are iron-titanium oxide, pyrite, pyrrhotite, sphene, and locally chalcopyrite, apatite, tourmaline, and garnet.

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[1] In this and following sections, the mineral assemblages are listed in order of decreasing abundance, and the minerals in each assemblage are also given in order of decreasing abundance.

ODM8121

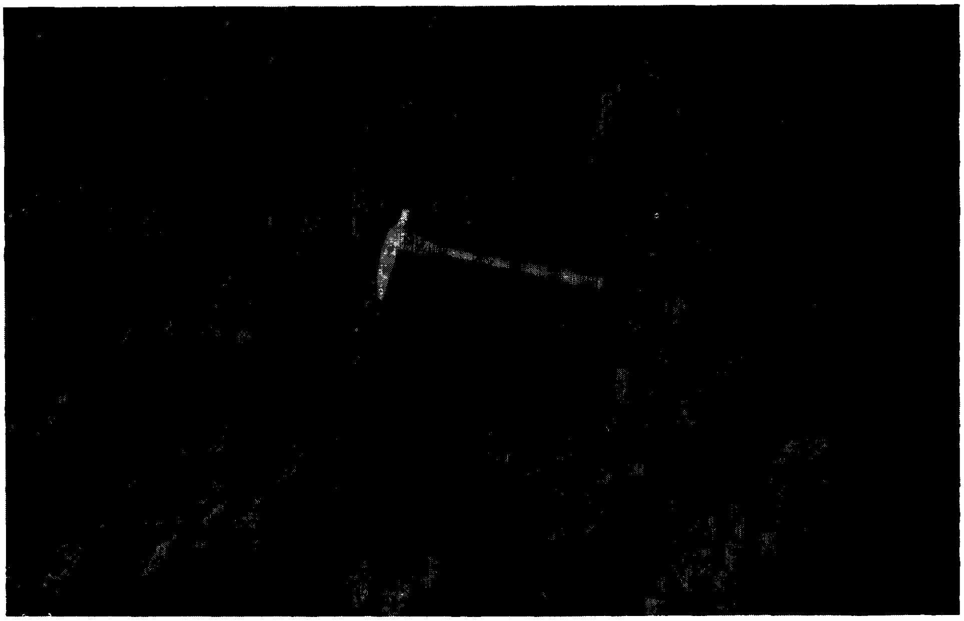
Photo 2—Porphyritic meta-andesite on the north side of the Severn River east of Sandhill Crane Island. Note the glomeroporphyritic nature of some of the phenocrysts.

Flow contacts were only rarely observed, but some flows are at least 150 feet thick. Narrow interflow layers of felsic metatuff, metachert, and metamorphosed iron formation locally facilitate recognition of flow contacts. Thin flows, and the upper and lower parts of thick flows, are fine-grained; the central part of thick flows is fine- to medium-grained and texturally resembles metagabbro sills (see "Uralitized and Metamorphosed Gabbro and Diorite" section) but is finer-grained, more highly recrystallized, better foliated, and locally gradational with pillowed lava. Thick flows are most abundant between Munekun and Pike lakes.

In many greenschist facies samples, the primary randomly-oriented lath-like habit of plagioclase is preserved through pseudomorphic replacement by single albite grains or by aggregates of tiny albite granules. Plagioclase with primary composition (normally zoned andesine) was found in two samples. In higher-grade metamorphic facies, only rare relics of the primary texture remain.

Porphyritic flows, which contain subhedral to euhedral lath-like plagioclase phenocrysts as much as 3 inches long (Photo 2), were found west of the southern part of the Severn River fault and along the Severn River east of Sandhill Crane Island. On the west side of the fault, where the metamorphic grade is moderately high (Figure 5 on Chart A, back pocket), the phenocrysts are oriented and are commonly bent, fractured, and recrystallized. East of Sandhill Crane Island, where the metamorphic grade is lower, the phenocrysts are randomly oriented, locally form glomeroporphyritic aggregates (Photo 2), and retain primary composition (oscillatory zoned andesine), although the groundmass is generally recrystallized.

Rare flows contained equant pyroxene phenocrysts as much as 3 millimetres in diameter that are now pseudomorphed by actinolite.



ODM8122

Photo 3—Balloon-shaped pillow in mafic metavolcanic flow on shore of Munekun Lake. Note the well developed selvage, the narrow, highly vesicular zone immediately below the selvage (partly weathered out), and the chert in the interstice between pillows (upper right corner).

Non-distorted pillows are common in the greenschist facies and are generally balloon-shaped although irregular spherical bun-shaped and loaf-shaped pillows are locally present. Pillows range in length from 2 inches to 15 feet and in thickness from 2 inches to 5 feet, but average dimensions are 4 feet long and 2 feet thick. Pillows less than 1 foot in diameter are commonly spherical, but, as the volume of the pillow increases, the length-to-thickness ratio also increases and in the largest pillows is about 4:1. In the almandine amphibolite and hornblende hornfels facies, pillows are distorted and range in length from 5 to 10 feet but are only 1 to 6 inches thick. Pillow selvages are locally amygdaloidal and range in thickness from ½ inch to 2 inches. Rarely, a highly vesicular zone less than 1 inch thick occurs immediately below the selvage but is thickest at the top of the pillow (Photo 3).

In general, pillows are closely packed, but at Munekun Lake botryoidal chert (Photo 3) and pyrite locally fill interstices as much as 5 inches wide between pillows. On the south shore of the Severn River, south of Sandhill Crane Island, carbonate and minor quartz fill irregular interstices between pillows and partly replace the edges of the pillows.

Some flows are pillowed throughout their entire thickness, but in other flows pillows are restricted to the upper part of the flow.

Spherical to lenticular amygdules, which range in length from ½ millimetre to 5 millimetres, are rare in mafic metavolcanic flows but are common in metavolcanic flows of intermediate composition. Most amygdules are composed of quartz, which locally contains minor pistacite and hornblende, but rare amygdules are composed of carbonate. Composite amygdules, which have a quartz core and a pistacite rim, were found in intermediate flows south of Fox Bay.

ODM8123

Photo 4—Gneissic mafic metavolcanics along the Schade River, about 100 feet north of the contact with the southern granitic batholith.

Mafic metatuff was only rarely observed but may have been overlooked in some outcrops because bedding is poorly developed. Most mafic metatuff units are associated with mafic flows.

Metavolcanic breccia composed of lenticular to angular mafic fragments as much as 3 feet long in a mafic matrix is rare; in pillowed sequences these breccias locally contain pillow fragments. Sparse lenticular felsic fragments that have an average length of 2 inches but are as much as 10 feet long are present in many mafic flows. These fragments are generally concentrated in layers, 2 to 5 feet thick, near the top of the flow, but are locally randomly distributed throughout the flow.

Gneissic layering has developed in most of the hornblende hornfels facies mafic metavolcanics adjacent to the granitic batholiths (Figure 5 on Chart A, back pocket) and in most large mafic inclusions in the batholiths. The layers are both continuous and discontinuous; they resemble bedding, range in thickness from a fraction of an inch to 4 inches, and are characterized by differences in both grain size and mineralogy (Photo 4). In most outcrops the layering reflects differences in the hornblende-to-plagioclase ratio, and hornblende-rich layers are generally finer-grained than hornblende-poor layers. In some outcrops, however, especially along the northwest edge of the Muskrat Dam Lake belt, clinopyroxene-rich and rare garnet-rich layers have developed and alternate with hornblende-rich layers. The gneissosity probably formed by metamorphic differentiation.

An unusual rock of undetermined origin forms a concordant layer several hundred feet thick in almandine amphibolite facies mafic metavolcanics north of the east end of Muskrat Dam Lake. The layer is pale-green on fresh surfaces, weathers pale-brown, and is composed of 90 to 95 percent coarse-grained clinopyroxene with minor interstitial, perthitic microcline, sphene, and carbonate. The clinopyroxene is equant, highly strained, and as much as 2 inches long.

Intermediate Metavolcanics

Intermediate metavolcanics have been metamorphosed to the greenschist, almandine amphibolite, and rarely to the hornblende hornfels facies but were probably derived dominantly from andesite, dacite, and rhyodacite. In comparision with mafic metavolcanics, they are characterized by lower colour index, ubiquitous quartz, the presence of medium- to coarse-grained, subhedral to euhedral, commonly acicular, amphibole porphyroblasts in some units, and the common occurrence of biotite. They are well foliated and are commonly green, pale-green, grey, or brown on both fresh and weathered surfaces.

Intermediate metavolcanics are rare in the Rottenfish River belt, but in the Muskrat Dam Lake belt they form lenses as much as 500 feet thick in both the felsic and mafic metavolcanic formations, and, on the limbs of the Fox Bay syncline, they locally form the entire thickness of the upper mafic metavolcanic formation.

The major mineral assemblages in the greenschist facies are:

1. Albite (An_3–An_5) + chlorite + carbonate + quartz
2. Albite (An_2–An_7) + blue-green hornblende + biotite + quartz ± carbonate ± epidote
3. Albite (An_3) + quartz + chlorite + carbonate + white mica
4. Albite (An_5) + quartz + biotite + carbonate
5. Albite + chlorite + quartz + white mica + biotite + carbonate.

In the almandine amphibolite facies the two major assemblages are:

1. Reversely zoned plagioclase (range An_{28}–An_{55}, average An_{35}) + blue-green hornblende + quartz + biotite ± epidote ± carbonate
2. Plagioclase (An_{26}) + quartz + biotite + chlorite + cummingtonite.

Minor minerals in most of the assemblages are iron-titanium oxide, leucoxene, sphene, pyrrhotite, pyrite, apatite, and rare tourmaline, chalcopyrite, and garnet.

Intermediate flows are generally fine-grained and equigranular, but in the greenschist and the lower part of the almandine amphibolite facies they locally contain fine- to medium-grained lath-shaped to stubby plagioclase phenocrysts. Many flows are amygdaloidal (see "Mafic Metavolcanics" section) and contain ovoid to lenticular, felsic to intermediate fragments that are as much as 6 inches long and locally have a marked reaction rim. Amygdules are rarely concentrated in layers (2 to 3 feet thick) that might be flow tops. Thin flow layers were observed in a few intermediate flows.

Pillows are rare; but, on the north limb of the Sandhill Crane anticline, a thin porphyritic intermediate layer in the felsic metavolcanic formation contains ovoid pillows about 3 feet long and 6 inches thick with 1-inch wide selvages. The approximate composition of this layer is 10 percent albite (An_3) phenocrysts, 55 percent groundmass albite and quartz, 25 percent chlorite, 5 percent carbonate, and 5 percent white mica, leucoxene, and pyrrhotite.

The metamorphosed pyroclastic rocks have been subdivided into three types according to Fisher's (1961) classification: metatuff, which has a grain size less than 2 millimetres; metalapillistone, which has fragments between 2 and 64 millimetres in diameter; and metamorphosed pyroclastic breccia, which contains fragments larger than 64 millimetres. Most of the intermediate pyroclastic deposits are metamorphosed pyroclastic breccia and coarse-grained metalapillistone that have a metatuff or fine-grained metalapillistone matrix. Rare thin metatuff and fine-grained metalapillistone interbeds occur in the breccia.

There are two types of metamorphosed intermediate pyroclastic rocks, which have approximately equal areal extents, and these are mafic to intermediate fragments in a felsic to intermediate matrix, and felsic to intermediate fragments in an intermediate to mafic matrix. The second type is generally interbedded with felsic pyroclastic rocks. Fragment population varies from homogeneous to heterogeneous, and the fragments are lenticular to angular and have an average length of 2 inches; the largest observed fragment was 10 feet long. Matrix forms between 10 and 75 percent of these pyroclastic rocks and in many outcrops shows marked variations in composition across strike.

Felsic Metavolcanics

Felsic metavolcanics have been metamorphosed to the greenschist, almandine amphibolite, and, rarely, to the hornblende hornfels facies and were derived dominantly from rhyodacite and sodic rhyolite. Potassic varieties such as quartz latite and potassic rhyolite are rare; quartz-poor varieties are absent. Felsic metavolcanics commonly weather white, pale-brown, or pale-grey but are white, yellow, pale-green, brown, grey, or black on fresh surfaces. Most outcrops are well foliated and are locally schistose. Felsic metavolcanics are distinguished from mafic and intermediate metavolcanics by low colour index and the common occurrence of white mica.

In the greenschist facies the major mineral assemblages are:

1. Albite (An_3–An_7) + quartz + biotite + white mica ± carbonate ± microcline ± epidote
2. Albite (An_2–An_4) + quartz + white mica ± carbonate ± epidote ± microcline
3. Albite (An_1–An_5) + quartz + white mica + chlorite + carbonate ± epidote
4. Albite (An_2–An_5) + quartz + biotite ± epidote ± carbonate ± microcline
5. Albite (An_3) + quartz + white mica + chlorite + biotite + carbonate.

In the almandine amphibolite facies the major assemblages are:

1. Plagioclase (An_{11}–An_{32}) + quartz + blue-green hornblende + biotite ± epidote ± carbonate ± microcline
2. Plagioclase (An_{27}) + quartz + biotite ± epidote ± microcline
3. Plagioclase (An_{13}) + quartz + microcline + white mica + biotite + epidote + carbonate.

Minor minerals in most of the assemblages are leucoxene, iron-titanium oxide, pyrite, pyrrhotite, apatite, and rare zircon, tourmaline, sphene, and garnet.

Felsic flows appear to form most of the felsic metavolcanic formation south of Fox Bay and they were locally identified in other parts of the area. In the greenschist and the lower part of the almandine amphibolite facies, many flows are porphyritic and contain fine- to medium-grained phenocrysts of relatively uniform size. The phenocrysts are: lath-shaped to stubby, slightly oriented plagioclase which rarely contain primary oligoclase; minor quartz and microcline; and rare altered hornblende. No primary groundmass textures were observed.

Flow layers, which range in thickness from 1 millimetre to 15 centimetres and are commonly contorted, were observed in a few flows. Rare felsic fragments are present in the flows.

The high viscosity of the felsic flows is shown by a thin flow in the upper mafic metavolcanic formation north of the intersection of the Severn River and Rottenfish River faults. The south edge of this flow thins from 100 feet to zero in a lateral distance of about 100 feet.

Felsic pyroclastic deposits are characterized by rapid vertical and lateral changes in both lithology and composition, and they locally grade into muscovite-bearing metagreywacke which was probably derived from felsic metavolcanics (see "Metagreywacke and Metasiltstone" section). Metatuff and fine-grained metalapillistone predominate, but coarse-grained metalapillistone and pyroclastic breccia are found in many parts of the sequence.

In the greenschist facies, primary clastic texture is commonly preserved, and primary plagioclase composition (oligoclase to labradorite) is also locally preserved. Primary plagioclase can be recognized by oscillatory zoning, broken zoned grains, and wide range in composition. Sorting is poor, and metatuff contains abundant silt-size quartz and plagioclase (Table 3). Sand-size grains in the pyroclastic rocks consist of: randomly oriented, anhedral to euhedral, rounded to angular plagioclase; rounded to angular, locally recrystallized quartz; and lenticular, equigranular to porphyritic, felsic metavolcanic and rare intermediate to mafic metavolcanic fragments. Grains larger than sand are generally metavolcanic fragments.

Bedding is absent in many outcrops but, where present, ranges from thinly laminated to very thick-bedded (bedding thickness is classified according to Dunbar and Rogers [1957, p. 97]). Rare graded bedding was found.

Table 2 FIELD CRITERIA[1] USED, IN THE GREENSCHIST FACIES, TO DISTINGUISH BETWEEN FELSIC METATUFF, PORPHYRITIC FELSIC FLOWS, AND POORLY BEDDED, MUSCOVITE-BEARING METAGREYWACKE

FELSIC METATUFF

1. Abundant sand-size, lenticular, felsic fragments.
2. Rare sand-size, lenticular, mafic fragments.
3. Abundant angular, sand-size plagioclase.
4. Rare sand-size quartz.
5. Rare felsic metavolcanic lapilli.
6. Abundant, wispy, very fine-grained, quartz-plagioclase-white mica matrix.

PORPHYRITIC FELSIC FLOWS

1. Sand-size rock fragments absent.
2. Rare metavolcanic lapilli.
3. Subhedral to euhedral, locally oriented, fine- to medium-grained, plagioclase phenocrysts.
4. Rare fine- to medium-grained, quartz phenocrysts.
5. Abundant very fine-grained, locally aphanitic, quartz-plagioclase-white mica groundmass.

MUSCOVITE-BEARING METAGREYWACKE

1. Rare visible, sand-size rock fragments.
2. Abundant sand-size quartz.
3. Abundant angular to rounded, sand-size plagioclase.
4. Sand-size quartz and plagioclase appear to form an intact to slightly disrupted framework; visible matrix is rare.
5. Rare quartz, metachert, and felsic and mafic metavolcanic pebbles.

Note
[1] Most of these criteria are more easily recognized on weathered surfaces than on fresh surfaces.

Metatuff is well exposed along the Severn River on the south limb of the Sandhill Crane anticline and closely resembles both porphyritic felsic flows and poorly bedded muscovite-bearing metagreywacke, with which it is interbedded (Table 2).

ODM8124

Photo 5—Metamorphosed, felsic pyroclastic breccia south of Munekun Lake. Fragments range in composition from felsic to intermediate and matrix is felsic.

These rock types cannot be differentiated in highly foliated or schistose outcrops. Modal analyses of metatuff (analysis 92) and muscovite-bearing metagreywacke (analysis 98) are given in Table 3.

There are two other major varieties of metatuff along the Severn River. The first is a thinly-laminated metatuff composed of silt- and clay-size particles, and it forms rare layers less than 10 feet thick; the laminae are discontinuous and lenticular. The second is a biotite-rich irregularly layered metatuff that contains about 40 percent intermediate metavolcanic lapilli and medium- to coarse-grained andesine-labradorite phenoclasts in a silt- to sand-size biotite-quartz-plagioclase matrix, and it forms units as much as 100 feet thick. The second type of metatuff may be a mud-flow deposit.

Metamorphosed felsic pyroclastic breccia and coarse-grained metalapillistone are interbedded with felsic metatuff and metamorphosed intermediate pyroclastic rocks, and form units that range in thickness from less than 10 feet to several hundred feet. Commonly, lenticular to angular felsic fragments occur in a felsic to intermediate matrix (Photo 5) and the largest observed fragment was 2 feet long. In metamorphosed pyroclastic breccia south of Munekun Lake, some felsic fragments have a marked reaction rim.

Metamorphosed ash-flow tuff was not positively identified but may occur in the felsic metavolcanic formation south of Fox Bay. There, several outcrops contain oriented subhedral plagioclase phenocrysts and rare quartz phenocrysts in a recrystallized groundmass. The plagioclase phenocrysts, in contrast to phenocrysts in definite felsic flows, have a wide range in grain-size.

Metasediments

Metasediments that have been metamorphosed to the greenschist, almandine amphibolite, and hornblende hornfels facies form about 25 percent of the metavolcanic-metasedimentary assemblage in the Muskrat Dam Lake belt but are rare in the Rottenfish River belt. Metagreywacke and metasiltstone predominate, but minor slate, metaconglomerate, marble, calc-silicate gneiss and granofels, ferruginous metasediments, and metamorphosed iron formation are present.

Metagreywacke and Metasiltstone

In general, similar mineral assemblages have developed in metagreywacke, metasiltstone, slate, and metaconglomerate. In the greenschist facies the major assemblages are:

1. Quartz + albite (An_3–An_5) + white mica + chlorite + carbonate + microcline
2. Albite (An_5) + quartz + biotite + chlorite + white mica ± carbonate
3. Albite (An_6) + quartz + biotite ± epidote
4. Albite + quartz + biotite + white mica + carbonate ± epidote
5. Albite (An_5) + quartz + chlorite + carbonate + biotite.

In the almandine amphibolite and hornblende hornfels facies the major assemblages are:

1. Plagioclase (range An_{11}–An_{43}, average An_{30}) + biotite + quartz + blue-green hornblende ± tremolite(?) ± epidote ± carbonate ± microcline
2. Plagioclase (An_{25}–An_{44}) + quartz + biotite ± epidote ± microcline
3. Plagioclase (An_{25}–An_{33}) + quartz + biotite + white mica ± microcline ± epidote
4. Quartz + oligoclase-andesine + biotite + garnet + white mica ± epidote
5. Quartz + plagioclase (An_{18}–An_{25}) + biotite + cordierite + andalusite + staurolite + Mg-chlorite ± garnet
6. Plagioclase (An_{18}) + quartz + biotite + staurolite + Mg-chlorite + white mica + andalusite.

Minor minerals in most of the assemblages are leucoxene, iron-titanium oxide, pyrite, pyrrhotite, apatite, tourmaline (especially in the almandine amphibolite facies), and rare sphene, zircon, allanite, and chalcopyrite.

In the greenschist facies, primary clastic texture is preserved in most metasandstone and coarse-grained metasiltstone, and primary oligoclase-andesine is preserved in a few samples. Metasandstone is generally poorly sorted and has a disrupted framework; the matrix is composed dominantly of silt-size quartz and plagioclase (Table 3). Sand-size plagioclase is rounded to angular and is locally subhedral; sand-size quartz is rounded to angular. Lenticular sand-size rock fragments occur in many samples but are generally not abundant; equigranular to porphyritic felsic metavolcanic fragments predominate, but minor intermediate metavolcanic, metachert, and granophyre (plagioclase + quartz) fragments are present.

Most metasandstone in which primary texture is preserved is feldspathic metagreywacke, defined according to Pettijohn (1957). Lithic metagreywacke was locally found associated with metaconglomerate and felsic metatuff. Quartz metagreywacke,

Table 3 | MODES OF METASEDIMENTARY ROCKS

	88	92	98	711	323	715
Sand-size quartz	33.7	4.6	24.6	23.2	32.8	52.0
Sand-size plagioclase	8.1	19.1	17.1	32.8	25.2	36.7
Sand-size microcline	trace	...	...	...	...	...
Sand-size rock fragments	...	31.7	25.2	2.0	2.7	...
Silt-size quartz and plagioclase	35.7	18.0	15.9	23.0	20.2	...
Biotite	...	trace	...	9.3	18.7	...
Chlorite	11.9	1.3	1.0	1.9	0.1	1.4
Muscovite	0.6	18.4	11.8	1.3	...	trace
Carbonate	8.8	3.1	3.9	6.2	...	0.2
Epidote	...	3.8	...	...	0.1	1.2
Actinolite	...	...	...	...	...	8.4
Opaque minerals	1.2	trace	0.5	0.2	0.2	trace
Others (apatite, zircon, allanite)	...	trace	trace	0.1	trace	0.1
Plagioclase composition	An_5	An_5 to An_{40}	An_3	An_5	An_6	labradorite

Location and Description

88 to 323-from the Fox Bay syncline, about 8 miles west of Sandhill Crane Island; arranged in order of decreasing age

88-metasandstone lens in black slate, felsic metavolcanic formation

92-metatuff, felsic metavolcanic formation

98-reworked (?) metatuff, felsic metavolcanic formation

711-feldspathic metagreywacke, upper metasedimentary formation

323-feldspathic metagreywacke, upper metasedimentary formation

715-granitoid fragment from metaconglomerate layer in upper metasedimentary formation, north of Severn River, 1.5 miles west of Sandhill Crane Island; probably contains introduced quartz

which is the dominant type of metasandstone in the North Spirit Lake Belt, southwest of the map-area (Donaldson and Jackson 1965), is rare. Most of the metagreywacke is sodic; potassic varieties are rare.

Metagreywacke and metasiltstone have been subdivided into three types: (1) muscovite-bearing, in which white mica is more abundant than biotite; (2) biotite-bearing, in which biotite is more abundant than white mica; and (3) amphibole-bearing, which contains more than 5 percent amphibole. The three types are interbedded but generally one type predominates so that members can be mapped.

Muscovite-bearing metagreywacke weathers pale-grey, and is white, cream, or grey on fresh surfaces. It is rare except in the upper metasedimentary formation where it is commonly associated with felsic metavolcanics. This association with felsic metavolcanics, the local gradation into felsic metatuff (Table 2), and a higher lithic metagreywacke to feldspathic metagreywacke ratio than either biotite-bearing or amphibole-bearing metagreywacke suggest that most muscovite-bearing metagreywacke represents eroded felsic volcanic rocks or reworked felsic tuff.

The average grain-size of the sand fraction in the muscovite-bearing metagreywacke is coarse to very coarse sand, defined according to Dunbar and Rodgers (1957, p. 161). Beds range in thickness from very thin-bedded to very thick-bedded but are generally thick-bedded to very thick-bedded (2 to 10 feet). Grain gradation is common, but visible gradation is restricted to the basal several inches where very fine to fine pebbles are locally present and to the upper 1 inch to 3 inches where the metagreywacke rapidly grades into metasiltstone and rare slate; the bulk of the bed appears to have a homogeneous texture. Metasiltstone, other than that which

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Photo 6—Interbedded amphibole-bearing (dark-grey to grey) and biotite-bearing (light-grey to white) metagreywacke and metasiltstone at the rapids at the east end of Muskrat Dam Lake. Note flow folding in some beds.

forms part of the graded beds, is rare in the muscovite-bearing metagreywacke members. Primary flowage structures and load casts were locally found in thin metasiltstone and slate units beneath very thick metagreywacke beds. Tabular metashale fragments, which range in length from ½ inch to 6 inches, were rarely found in this type of metagreywacke.

Biotite-bearing metagreywacke and metasiltstone weather pale-grey to grey and are grey on fresh surfaces. This type predominates in all metasedimentary formations and is not genetically associated with felsic metavolcanics. In general, it is finer-grained, thinner-bedded, and contains less sand-size rock fragments and more metasiltstone interbeds than muscovite-bearing metagreywacke.

The average size of the sand fraction is very fine to coarse sand. Bedding is well preserved, and beds range in thickness from thinly laminated to thick-bedded but are generally very thin-bedded (about ½ inch). Metasiltstone forms at least 25 percent of these members as discrete beds and as part of graded beds. In most outcrops medium- to coarse-grained metagreywacke beds alternate with fine-grained metagreywacke and metasiltstone beds; graded bedding was found only locally. Some of the thicker beds contain rare fine to very fine pebbles. Three modal analyses are presented in Table 3.

Satterly (1938, p. 26) reported andalusite in the lower metasedimentary formation along the Severn River at the southwest corner of the Muskrat Dam Lake belt. This occurrence was not verified, but andalusite, in association with cordierite and staurolite, was found in the formation south of Fox Bay. Fine-grained biotite-bearing metagreywacke and metasiltstone at Satterly's locality, however, do contain ¼-inch to 1-inch long ovoid pale-grey knots that are preferentially developed in certain beds where they form as much as 10 percent of the rock. The

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Photo 7—Pebble metaconglomerate along the Severn River, 9 miles west of Sandhill Crane Island. Note the slight stretching of the dolomite (dark-grey) and metachert (white) pebbles and the intense stretching of some of the other pebbles. Glacial striae, parallel to the pencil, are poorly developed in the right-central part of the photo.

knots contain more plagioclase and less biotite and potassic feldspar than the host metagreywacke which is quartz-poor and appears to be potassic rather than sodic. The origin of the knots is not known.

Amphibole-bearing metagreywacke and metasiltstone contain 5 to 50 percent amphibole and 5 to 30 percent biotite; they weather grey, pale-green, green, or dark-green, are grey to green on fresh surfaces, and are generally interbedded with biotite-bearing metagreywacke. In bedding thickness and grain-size, amphibole-bearing metagreywacke is similar to biotite-bearing metagreywacke, but minor crenulations and small-scale flow folds are common (Photo 6); these structures are rare in the other types of metagreywacke.

Amphibole-bearing metagreywacke is most abundant in the almandine amphibolite and hornblende hornfels facies zones of the lower metasedimentary formation and the metasedimentary formation at the east end of Muskrat Dam Lake. It is sometimes associated with calc-silicate gneiss (Blackwater Bay) and with intermediate metavolcanics (east end of Muskrat Dam Lake). Most of the amphibole-bearing metagreywacke, especially where tremolite(?) is present, probably represent metamorphosed calcareous sandstone and siltstone, but some may represent eroded intermediate volcanic rocks.

Slate

In the greenschist facies part of the upper metasedimentary formation, grey slate, which was derived from fine-grained siltstone and claystone, is interbedded with muscovite-bearing and biotite-bearing metagreywacke and coarse-grained metasiltstone. The slate is most abundant in an 1,100-foot thick member along the Severn

River where individual slate units are at least 20 feet thick and form about 50 percent of the member. Bedding is only rarely preserved in the slate units and is defined by thin metagreywacke and coarse-grained metasiltstone beds. The slate has a well developed pervasive cleavage along which it can be readily split into thin smooth-sided slabs; the cleavage is generally only slightly discordant to bedding. Many slate outcrops along the Severn River are frost-heaved and slumped.

Black locally pyritic slate is interbedded with highly schistose felsic flows and breccia in the upper part of the felsic metavolcanic formation along the Severn River. Fine-grained metagreywacke beds (analysis 88, Table 3) as much as 1 inch thick occur in the slate and are commonly crenulated. The cleavage is parallel to the axial plane of the crenulations, but the cleavage was itself crenulated by a later stage of deformation. The close association with felsic metavolcanics suggests that this black slate may have been derived from a tuff.

Metaconglomerate

Beds and lentils of polymictic pebble metaconglomerate, which range in thickness from less than 1 foot to 1,000 feet, were found in the three metasedimentary formations and locally in the upper mafic metavolcanic formation near Axe Lake and Munekun Lake. The metaconglomerate has a metagreywacke matrix and locally contains cobbles and rare boulders; the average primary diameter of the pebbles was about 1 inch and the largest observed boulder was 1 foot in diameter. Bedding is commonly absent and, where present, is defined by 1-foot to 2-foot thick layers containing fine pebbles and by metagreywacke and metasiltstone interbeds. Thin units locally show graded bedding.

Table 4 | ESTIMATED FRAGMENT POPULATIONS OF THE MAJOR METACONGLOMERATE UNITS

FRAGMENT TYPE	1	2	3	4	5	6
Equigranular felsic metavolcanics	A	P	..	A	P	P
Porphyritic felsic metavolcanics	P	..	..	..	x	..
Fine-grained, equigranular mafic metavolcanics	x	..	..	A	A	..
Medium-grained, equigranular, mafic metavolcanics or metagabbro	..	..	..	..	..	P
Porphyritic mafic metavolcanics	..	..	..	..	x	..
Felsic metatuff or muscovite-bearing metagreywacke	..	P	..	..	P	A
Biotite-bearing metagreywacke and metasiltstone	..	A	A	..	..	P
Dolomite	..	..	..	..	A	P
Metachert	P	A	A	..	P	P
Ferruginous metachert	..	P	P	..	x	..
Granite	..	x	..	P	..	x
Medium-grained quartz	..	..	..	x	x	P

Location
1. Metasedimentary formation, eastern part of Muskrat Dam Lake.
2. Upper metasedimentary formation, island in western part of Muskrat Dam Lake.
3. Upper metasedimentary formation, Sandhill Crane Island.
4. Upper metasedimentary formation, north of Severn River, 1.5 miles west of Sandhill Crane Island.
5. Upper metasedimentary formation, Severn River, 9 miles west of Sandhill Crane Island.
6. Upper metasedimentary formation (2-foot thick beds in muscovite-bearing metagreywacke), Severn River, 2.3 miles downstream from southwest edge of Muskrat Dam Lake belt.

Code

A-abundant (greater than 10%)
P-present (1 to 10%)
x-trace (less than 1%)

Fragment populations are heterogeneous and vary from unit to unit (Table 4). Most fragments are highly stretched, but quartz, metachert, dolomite, granite, and muscovite-bearing metagreywacke fragments either retain their primary subrounded shape or are only slightly stretched (Photo 7). Brown weathering siliceous dolomite pebbles and cobbles are common in the unit along the Severn River, 9 miles west of Sandhill Crane Island (Photo 7), but the dolomite has no equivalent in the exposed part of the stratigraphic sequence. Granitic pebbles, cobbles, and boulders were found in several units in the upper metasedimentary formation (Table 4). The only granitic fragment examined in thin section (Table 3) was from the almandine amphibolite facies and has an abnormal composition (quartz gabbro).

Massive pyrrhotite and pyrite occur in the matrix of the metaconglomerate units on Sandhill Crane Island and at the east end of Muskrat Dam Lake (see "Economic Geology" section).

Marble and Calc-Silicate Gneiss and Granofels

An 800-foot thick marble and calc-silicate gneiss and granofels member forms the basal part of the upper metasedimentary formation at the south end of Fox Bay and is also present near the Severn River at the southwest corner of the Muskrat Dam Lake belt. Minor calc-silicate gneiss and granofels were also found interbedded with hornblende-bearing metagreywacke in the lower metasedimentary formation at the mouth of Blackwater Bay and near the Severn River at the southwest corner of the Muskrat Dam Lake belt.

Marble, which by definition contains more than 50 percent carbonate, is white to pale-grey on both fresh and weathered surfaces and forms less than half of the member in the upper metasedimentary formation. Calc-silicate rocks contain less than 50 percent carbonate, contain abundant calcium-magnesium-silicate minerals such as tremolite, biotite, and diopside, and vary in colour from pale-grey to dark-green on both fresh and weathered surfaces. Foliation is rare.

The mineralogy of these rocks is highly variable and changes from bed to bed. In the greenschist facies, the common minerals are carbonate, tremolite, quartz, and phlogopite. In the hornblende hornfels facies, diopside, carbonate, potassic feldspar, epidote, quartz, scapolite, biotite, andesine, and hornblende are present in varying proportions.

At Fox and Blackwater Bays bedding is well developed, and beds range in thickness from a fraction of an inch to 3 inches; contortion is rare. Differential erosion of the carbonate-rich beds has produced an irregular outcrop surface.

Near the Severn River at the southwest corner of the Muskrat Dam Lake belt, bedding is rare, and many outcrops are brecciated. Breccia fragments are composed of relatively pure bedded marble and rare meta-arkose(?); and the fragments are lenticular, have a preferred orientation, range in length from a fraction of an inch to 2 feet, and form 10 to 50 percent of the breccia. The matrix ranges in composition from silicate-rich marble (Photo 8) to carbonate-poor calc-silicate granofels (see Satterly 1938, photograph on p. 26).

On the Severn River at the southwest corner of the Muskrat Dam Lake belt, dark green massive "greenstone" overlies brecciated marble (Photo 8) and contains marble fragments (Satterly 1938, p. 27 and photograph on p. 26). This greenstone is composed of approximately equal amounts of diopside and potassic feldspar, minor tremolite and epidote, and accessory scapolite, carbonate, andesine, sphene, pyrrhotite, iron-titanium oxide, and chalcopyrite; it is thus a calc-silicate granofels.

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Photo 8—Brecciated marble on the Severn River at the southwest corner of the Muskrat Dam Lake belt. Fragments are relatively pure, bedded marble, and the matrix is silicate-rich marble.

Metamorphosed Iron Formation and Ferruginous Metasediments

By definition (Gross 1965, p. 83) metamorphosed iron formation contains more than 15 percent iron. Layered iron-rich rocks that contain less than 15 percent iron but that texturally resemble metamorphosed iron formation are here called ferruginous metasediments or ferruginous metachert.

Metamorphosed iron formation units range in thickness from 2 inches to more than 100 feet and were found in the Rottenfish River mafic metavolcanics, the upper mafic metavolcanic formation east of the Windigo River fault, and the upper metasedimentary formation north of the Severn River fault. The thickest layers are at Munekun Lake (50 feet) and in the northern part of the Rottenfish River belt (30 to 100 feet) and are overlain and underlain by mafic flows. Metamorphosed iron formation layers in the upper metasedimentary formation are less than 1 foot thick. Aeromagnetic data (O.D.M.-G.S.C. 1966d; 1967a, b, d, e) suggest that many iron-rich units either do not outcrop or were not found. The lateral extent of the mapped layers could not be determined because of poor exposure.

Ferruginous metasediments are associated with metamorphosed iron formation and also form separate units as much as 750 feet thick in the felsic metavolcanic

ODM8128

Photo 9—Metamorphosed iron formation on Munekun Lake unconformably overlain by mafic metavolcanic flow (dark-grey). Layering in the iron formation is at a slight angle to the bottom of the photo.

formation. In the units north of the Severn River fault, magnetite content is highly variable and the units range in composition from iron-poor metachert to rare metamorphosed iron formation.

The iron-rich rocks have been metamorphosed to the greenschist and almandine amphibolite facies, and many units are contorted. The units are well layered, and in general white to pale-grey metachert layers alternate with grey to black magnetite layers; white to dark-green iron silicate mineral layers are locally present. In several units metachert is rare, and iron-silicate mineral layers alternate with magnetite layers. Metachert layers range in thickness from a fraction of an inch to 6 inches but average ½ to 1 inch thick; many of the thicker layers have a fine internal lamination. Magnetite layers are as much as 1 foot thick but average ¼ inch. Iron silicate mineral layers, which contain grunerite, actinolite, biotite, and several unidentified minerals, are generally less than ½ inch thick. Rare pyrite layers were found near the base of the unit at Munekun Lake.

At the south end of Munekun Lake, metamorphosed iron formation is unconformably overlain by a mafic flow (Photo 9). The contact is irregular and truncates layers in the metamorphosed iron formation. A 5-inch thick metasiltstone layer was found 10 feet below the top of this 50-foot thick iron formation unit.

The 750-foot thick ferruginous metasedimentary unit at the base of the felsic metavolcanic formation south of Fox Bay has an unusual composition. The metachert layers are alumina-rich and contain 20 percent andalusite, 10 percent chloritoid, and 4 percent iron oxide in a granular quartz matrix. Silicate mineral layers contain loosely packed ellipsoidal 0.5 millimetre long granules composed of a non-magnetic opaque mineral, chlorite, and chloritoid. The matrix between the granules is very fine-grained quartz, muscovite, and chloritoid.

Unusual gneissic rocks that contain about 55 percent garnet, 30 percent cummingtonite, 15 percent quartz, and minor iron-titanium oxide and apatite, form thin units in biotite-bearing metagreywacke northeast and northwest of the intersection of the Severn River and Rottenfish River faults. Gneissic layers have an average thickness of a half inch, and alternate layers are composed of garnet-quartz-cummingtonite and garnet-cummingtonite. Crenulations and drag folds are common in these units but are absent in the adjacent metagreywacke. Similar rocks were described by Lumbers (1962, p. 17) north of Lake Abitibi. A partial chemical analysis (Table 5) shows that the rock is an aluminous iron formation and that the garnet is almandine. Silica is probably the only major undetermined oxide.

The rarity of primary textures and the association with metavolcanics and metagreywacke suggest that most of the metamorphosed iron formation is the Algoma type of Gross (1965).

Non-Ferruginous Metachert

Narrow layers of thinly laminated white to pale-grey non-ferruginous metachert, which are generally less than 6 inches thick, were rarely found in metagreywacke and between mafic metavolcanic flows.

Table 5 | PARTIAL CHEMICAL ANALYSIS OF GARNET-CUMMINGTONITE ROCK. (ANALYSIS BY THE LABORATORY BRANCH, ONTARIO DEPT. MINES.)

Al_2O_3	12.2
Total iron as Fe_2O_3	32.9
MgO	2.92
CaO	1.65
MnO	0.32
TiO_2	0.3 (qualitative analysis)
Cr_2O_3	$<$0.1 (qualitative analysis)
V_2O_3	$<$0.1 (qualitative analysis)

STRATIGRAPHY

Muskrat Dam Lake Belt

Because of a lack of outcrop in many parts of the belt and the limited time available for examining those outcrops that were found, the fold pattern is not completely known. Thus, because the stratigraphy is dependent on the structural interpretation (e.g. see Billings [1950]), the sequence of formations shown in (Figure 3, and Figure 4 on Chart A, back pocket) and Table 1 is tentative, and detailed work may lead to major revisions. For example, scanty data along the southwest edge of the belt suggest that the axis of an anticline occurs within intermediate metavolcanics south of Fox Bay. If this is true, then the lower half of column 1 in Figure 3 is reversed and is equivalent to the upper part of the column. The tentative stratigraphy, however, provides a framework for the history of the Muskrat Dam Lake belt.

Because the stratigraphy is tentative, formal formation names are not used.

Contacts between formations are poorly defined but appear to be conformable and to vary from sharp to gradational; interfingering and interlayering of units are

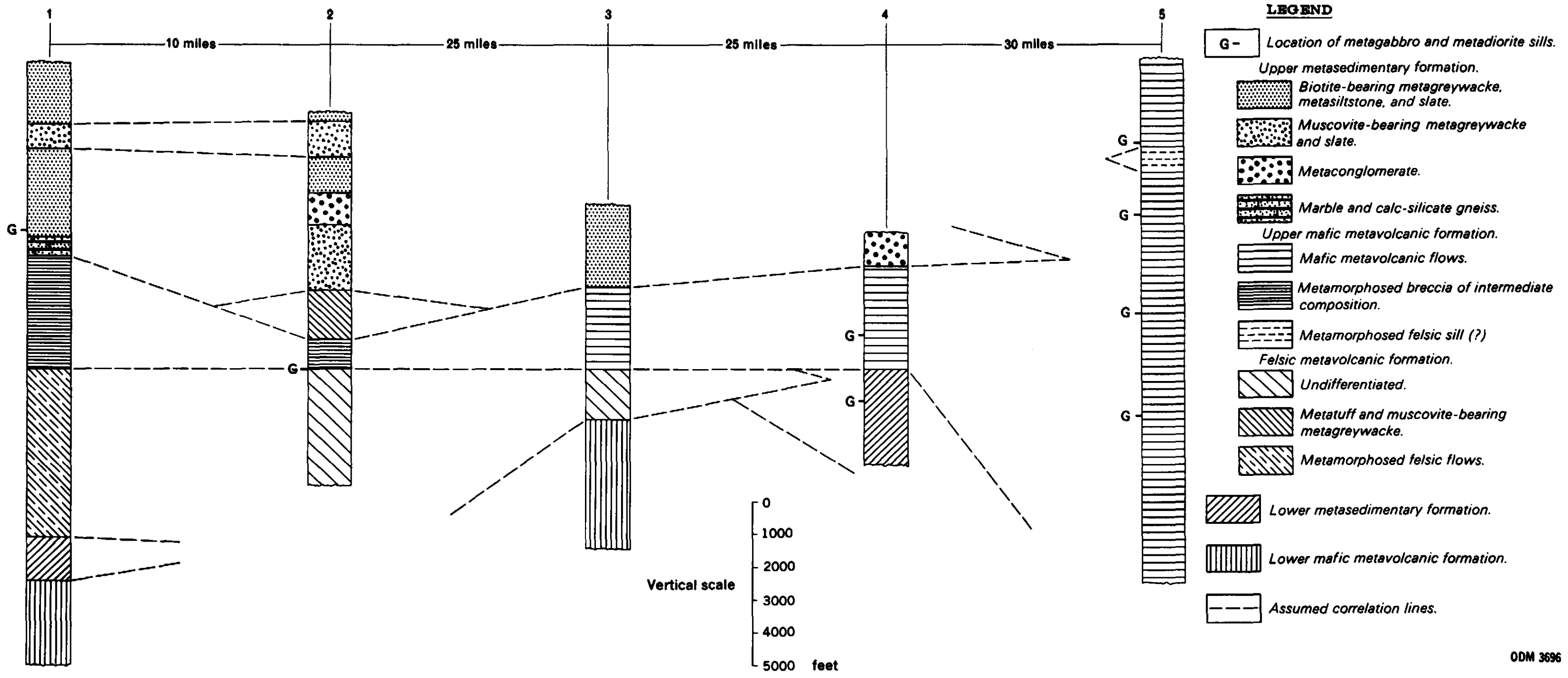

Figure 3—Generalized columnar sections in the Muskrat Dam Lake belt. Section No. 1 represents the south limb of the Fox Bay syncline and contains a 4,500-foot thick metagabbro sill. Section No. 2 represents the north limb of the Fox Bay syncline and contains a 600-foot thick metagabbro sill. Section No. 3 represents the northwest side of the Severn River fault. Section No. 4 represents the north limb of the syncline in the west part of Muskrat Dam Lake and contains two metagabbro sills which, from bottom to top, are 1,200 and 750 feet thick. Section No. 5 represents the Munekun Lake syncline near Munekun Lake and contains four metagabbro sills which, from bottom to top are 1,100, 1,000, 5,300, and 1,550 feet thick.

common. On the south limb of the Sandhill Crane anticline, a gradational contact between the felsic metavolcanic and the upper metasedimentary formation appears to reflect a gradual decrease in the intensity of explosive felsic volcanism and a concomitant increase in the amount of reworking and transport of felsic detritus by sedimentary agents.

Each formation contains many different rock types (Table 1), and in some formations the detailed lithology varies from place to place. The gross composition or lithology, however, is relatively constant, and generally each formation is distinctly different from adjacent formations.

Correlation between the eastern and western parts of the belt is hampered by the Windigo River fault which appears to be a major structural break. A metagreywacke formation at the east end of Muskrat Dam Lake cannot be traced into other metasedimentary formations but appears to occupy the same stratigraphic position as the upper metasedimentary formation.

In the Muskrat Dam Lake belt the maximum thickness of the metasedimentary-metavolcanic sequence is 18,500 feet (Figure 3). The earliest recorded activity was extrusion of a sequence of mafic flows (lower mafic metavolcanic formation) with concomitant greywacke sedimentation in the north-central part of the belt (lower metasedimentary formation). Pillows, which indicate subaqueous extrusion, are rare (or rarely preserved) in the lower mafic metavolcanic formation, and its environment of deposition is unknown.

In the west, cessation of volcanism was followed by expansion of greywacke sedimentation, and in many places the lower metasedimentary formation overlies the lower mafic metavolcanic formation. Greywacke sedimentation was ended by a second volcanic episode that was initiated by extrusive and explosive felsic volcanism (felsic metavolcanic formation). This felsic volcanism either did not reach the extreme west end of the belt or its products were removed from here before deposition of the upper mafic metavolcanic formation.

Felsic volcanism was concentrated in the west-central part of the belt and reached the margins only during the early stages. In these early stages, quiescent periods at the margins of the belt allowed chemical precipitation of thick sequences of ferruginous metachert. During the later stages of felsic volcanism, mafic and intermediate flows and pyroclastic breccia (upper mafic metavolcanic formation) accumulated at the margins of the belt. Felsic and mafic volcanism were thus coeval. Pillows are rare in the upper mafic metavolcanic formation on the west side of the Windigo River fault.

Mafic volcanism apparently ceased before felsic volcanism and was replaced by subaqueous greywacke sedimentation (upper metasedimentary formation). Local deposition of limestone, which was probably chemically precipitated, indicates a quiescent period between the cessation of mafic volcanism and the beginning of clastic sedimentation. In the central part of the belt, felsic pyroclastic activity gradually gave way to greywacke sedimentation, and early greywacke in this part of the belt was derived from the felsic volcanic terrane. The derivation of later greywacke and of most of the greywacke at the margins of the belt is unknown.

Local development of conglomerate during the transition from felsic volcanism to sedimentation probably represents tectonic activity in the volcanic terrane.

In the east, pillowed mafic flows appear to have been extruded subaqueously during the entire period represented by the complex facies changes in the west; interbedded iron formation and greywacke represent local cessation of volcanism. Along the north-central part of the belt, the development of thick greywacke formations reflects local absence of volcanism and the presence of depositional basins. It may also indicate nearby source areas.

Quartz is abundant in the greywacke (Table 3) and could not have been derived from a mafic volcanic terrane. Possible source areas are a plutonic-metamorphic complex, a felsic volcanic terrane, or an older sedimentary formation (Donaldson and Jackson 1965). As previously shown, some of the greywacke was derived from a felsic volcanic terrane, but the source area for most of the greywacke is unknown. Granitic fragments in the upper metasedimentary formation indicate some pre-existing granitic intrusions.

In northeastern Manitoba, about 125 miles west-northwest of the map-area, an unconformity of considerable hiatus separates a dominantly metavolcanic group from an overlying dominantly metasedimentary group that contains abundant granite pebble metaconglomerate (Quinn and Meinert 1959; Barry 1961; Davies *et al.* 1962; Godard 1963). Similar relationships were not recognized in the map-area and have not been recognized elsewhere in this part of northwestern Ontario (Satterly 1937b; 1938).

Rottenfish River Belt

The structure and stratigraphy of this belt are poorly known. The sequence appears to be about 6,000 feet thick and is composed dominantly of pillowed, probably subaqueous, mafic flows. A 1,550-foot thick felsic metavolcanic formation occurs within the mafic sequence on the west side of the belt. Numerous interbedded iron formation units indicate quiescent periods in the mafic volcanism.

Garrett Lake Belt

Mafic metavolcanic and biotite-bearing metagreywacke outcrops along the Makoop River in the northeast corner of the map-area were mapped by P. P. Hudec (unpublished map on file with Geological Branch, Ontario Department of Mines) in 1961. Hudec (1964, p. 24) stated that these outcrops were part of "a presumably small sharply curving sedimentary and volcanic belt" which he named the Garrett Lake belt. These outcrops were not examined by the author, and contacts with granitic rocks could not be determined because of lack of data.

Age

No isotopic age determinations are available from the map-area. However, on the basis of regional structural synthesis and age determinations from nearby areas, Stockwell (1965) assigned the metavolcanic-metasedimentary sequences in the map-area to the Archean.

At Weagamow Lake, about 35 miles south of the map-area, biotite from a granitic gneiss gave a potassium-argon age of 2,505 million years (Lowdon 1961, p. 58). At Big Trout Lake, about 65 miles northeast of the map-area, biotite from paragneiss and migmatite gave a potassium-argon age of 2,630 million years (Lowdon 1963, p. 80).

INTRUSIVE ROCKS

EARLY PORPHYRITIC FELSIC DIKES AND SILLS

Porphyritic to rarely equigranular felsic dikes and sills intrude both metavolcanic-metasedimentary assemblages but are rare. They can be divided into four types: (1) metamorphosed dikes that are intruded by metagabbro; (2) metamorphosed dikes that intrude metagabbro; (3) unmetamorphosed dikes that are spatially associated with granitic batholiths (p. 33); and (4) unmetamorphosed dikes that are not spatially associated with granitic batholiths (p. 32-33).

Metamorphosed dikes were only rarely identified. Along the Severn River at the southwest corner of the Muskrat Dam Lake belt, a 6-inch wide pale-grey plagioclase porphyry dike was intruded into marble and was intruded in turn by a 1-foot wide metagabbro dike. North and northwest of Lookout Lake, recrystallized white to pale-grey, fine- to coarse-grained equigranular garnetiferous potassic muscovite granite forms sills, dikes, and pods in metagabbro and locally in adjacent formations; the sills pinch and swell. The granite is composed of 35 percent microcline, 30 percent quartz, 24 percent albite (An_5), 10 percent muscovite, and 1 percent garnet.

Pre-gabbro dikes are probably related to volcanism. Metamorphosed, post-gabbro dikes appear to be spatially associated with metagabbro and may be a felsic differentiate of the gabbro magma.

At Munekun Lake a concordant layer of plagioclase-quartz porphyry, which has a maximum thickness of 800 feet, has been traced laterally for 11 miles. The porphyry weathers pale grey-green, is grey to dark-grey on fresh surfaces, has been metamorphosed to the greenschist facies, and is overlain and underlain by pillowed mafic flows. Phenocrysts are fine- to medium-grained. Quartz phenocrysts predominate, have rounded to square outlines, and are locally corroded; plagioclase phenocrysts (An_4) are subhedral, equant to tabular, randomly oriented, and locally concentrated in glomeroporphyritic aggregates. The groundmass is a recrystallized mozaic of biotite, quartz, and albite.

The upper contact was observed in the western part of Munekun Lake. The contact is sharp, and, adjacent to the mafic flow, quartz porphyry layers alternate with plagioclase porphyry layers. Elsewhere the porphyry is massive and appears to have a uniform composition. No fragments were found.

The origin of the porphyry is uncertain; it may be a sill, a flow, or an ash-flow tuff. An intrusive origin appears to best fit the features described above. East of Munekun Lake in the axial zone of the Munekun Lake syncline, the porphyry appears to be intruded by metagabbro.

URALITIZED AND METAMORPHOSED GABBRO AND DIORITE

Prior to the regional metamorphism, concordant to locally discordant bodies of gabbro and diorite were intruded into the metavolcanic-metasedimentary assemblage in both belts. The sill-like bodies range in thickness from 1 foot to 7,800 feet, and several sills have been traced laterally for more than 15 miles.

The sills texturally resemble the fine- to medium-grained interiors of thick mafic flows; but (1) the sills are coarser-grained (2 to 3 millimetres); (2)

recrystallization is less intense and the texture is well preserved; (3) primary plagioclase is commonly preserved and primary clinopyroxene is locally preserved; (4) foliation is poorly developed and many sills are massive; and (5) the sills have sharp, locally discordant contacts with adjacent units; the chilled zone is narrow. Some thin sills, especially in the mafic metavolcanic sequences, may have been mistaken for thick mafic flows. The sills weather green to dark-green and are dark-green to black on fresh surfaces.

In the Muskrat Dam Lake belt, the sills have an average thickness of about 2,500 feet. Between Munekun Lake and the west end of the belt, one major sill and locally one or two minor sills were mapped. Near Munekun Lake, however, four major sills were found. The west end of the Fox Bay sill and an irregularly shaped body on the north side of the Severn River fault are distinctly discordant.

Sills are difficult to distinguish in the Rottenfish River belt, but there appear to be two or three sills that have an average thickness of 1,000 feet.

Eight modal analyses are presented in Table 6. The plagioclase is tabular andesine-labradorite that has normal and locally oscillatory zoning and that, in many samples, is highly altered and is locally pseudomorphously replaced by albite. Most of the primary pyroxene is pseudomorphously replaced by pale-green actinolite(?). Quartz is common but forms less than 10 percent of most samples. In the almandine amphibolite facies (Figure 5 on Chart A, back pocket), thin sills and the margins of thick sills are recrystallized to mineral assemblages that are identical to those in the previously described almandine amphibolite facies mafic metavolcanics.

The texture is generally isogranular (Oppenheim 1964), but gabbro with subophitic to ophitic texture forms thin zones in the lower part of some sills[1].

Table 6 MODES OF URALITIZED GABBRO AND METAGABBRO

	121	326	1131	414	425	448	832	1122
Plagioclase + alteration products	43.1	69.3	91.3	63.3	48.8	50.0	37.4	44.6
Quartz	7.0	...	0.1	14.3	...	0.8	0.2	45.7
Clinopyroxene	...	...	...	...	...	6.8	...	...
Actinolite	33.6	30.0	...	19.2	45.0	33.4	59.7	...
Chlorite	1.2	0.4	2.8	0.2	2.3	0.1	0.2	4.0
Biotite	14.1	...	...	...	0.9	...	2.0	4.9
Muscovite	...	...	0.2	...	...	...	...	0.4
Pistacite	...	...	...	0.2	...	6.2	...	trace
Carbonate	0.4	...	4.4	...	...	...	...	...
Opaque minerals[1]	0.4	0.1	1.0	0.2	3.0	2.6	0.3	0.2
Others[2]	0.2	0.2	0.2	2.6	trace	0.1	0.2	0.1
Plagioclase composition	67→30	80→65	4[3]	41→22	56→35	8[3]	74→47	3

Location of samples

121, 326, 1131	Fox Bay sill
414, 425, 448	Upper Munekun Lake sill
832, 1122	Unnamed sill 10 miles west of Sandhill Crane Island

Notes
In Tables 6, 7, and 8, plagioclase composition is given in percent anorthite component. When plagioclase is zoned (→), both core and rim composition are given with core composition stated first.

[1] Iron-titanium oxide, leucoxene, minor pyrite, rare pyrrhotite
[2] Apatite, sphene, and zircon
[3] Composition is secondary

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[1] Definitions of these textures, as used in this report, can be found in Ayres (in press).

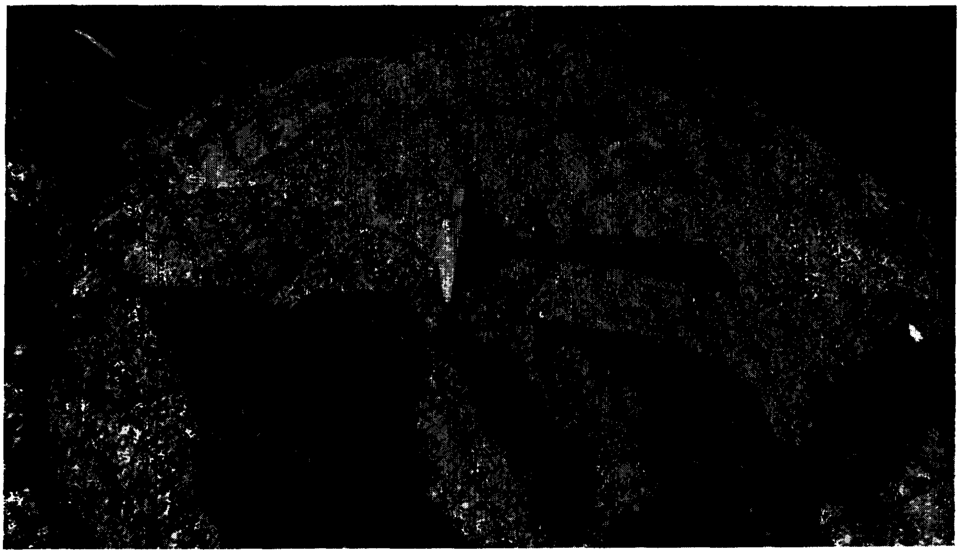

Photo 10—Fine-grained, mesocratic uralitized gabbro intruded by medium-grained, leucocratic uralitized tonalite at top of upper Munekun Lake sill, west part of Munekun Lake. There appear to be several periods of intrusion.

Most sills contain about 50 percent mafic minerals, but leucocratic, anorthositic gabbro (22.5 to 35 percent mafic minerals) is locally present, especially in the Fox Bay sill. Rare 6-inch to 10-foot thick lenses and layers of porphyritic anorthosite (analysis 1131, Table 6) are found in the anorthositic gabbro; a 4-inch to 6-inch wide gradational contact zone separates the two phases. Serpentinized peridotite was found near the top of the sill on the north limb of the Sandhill Crane anticline.

With one exception, differentiation appears to be minor. Neglecting the uppermost early crystallized zone, there seems to be a slight increase in quartz content and a decrease in mafic mineral content from bottom to top of the sills. No systematic variation in plagioclase composition was found. In the upper Munekun Lake sill, leucocratic tonalite dikes (analysis 414, Table 6) locally intrude the upper early crystallized zone (Photo 10) and rarely penetrate the overlying rocks. These dikes appear to represent the final stage of differentiation.

North of the Severn River about 10 miles west of Sandhill Crane Island, the upper 500 feet of a 1,400-foot thick sill is composed of quartz-rich albite granite (analysis 1122, Table 6). Its texture is granitic and no granophyre was found. The contact between gabbro and granite is gradational and is marked by a 100-foot to 200-foot thick hybrid zone. Rarely granite intrudes gabbro. Rare narrow discontinuous syenite dikes were found in the granite. The granite and gabbro are probably genetically related but the sill appears to be a composite intrusion.

Metamorphosed potassic granite, which intrudes gabbro northwest of Lookout Lake, might be a felsic differentiate of the gabbro.

In the central part of most sills, dioritic pegmatite forms ovoid to locally irregular masses that have an average length of 9 inches and are in sharp contact with the adjacent gabbro (Photo 11). The pegmatite has an average grain-size of

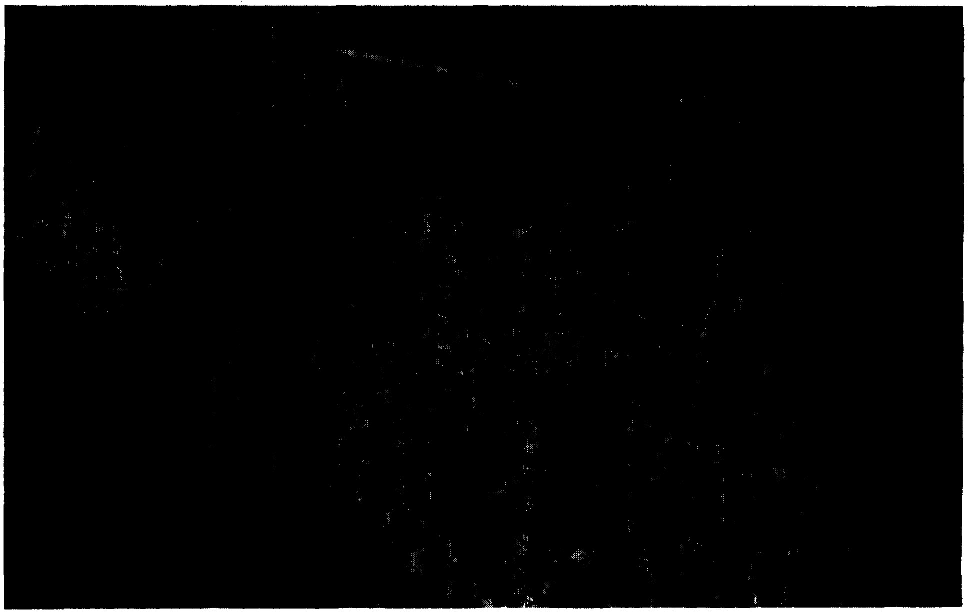

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Photo 11—Dioritic pegmatite in uralitized gabbro of upper Munekun Lake sill, west part of Munekun Lake. Note sharp contact and blade-like, radiating hornblende.

1 inch and contains about 45 percent oligoclase-andesine, 20 percent uralitized clinopyroxene, 20 percent primary green hornblende, 10 percent iron-titanium oxide and leucoxene, and 5 percent biotite, quartz, and apatite. The hornblende commonly forms radiating blade-like grains as much as 4 inches long (Photo 11). In many of the pegmatite pods, plagioclase has been completely replaced by epidote, and the pods are pale-green.

The upper Munekun Lake sill also contains 1-inch to 6-inch diameter medium- to coarse-grained rusty-weathering spheroids in which mafic minerals and iron-titanium oxides are more abundant than in the adjacent medium-grained gabbro.

Contacts with country rocks were only rarely observed, and primary textures and structures in contact zones are preserved only in the greenschist facies. On the Severn River, the Fox Bay sill has a 2-foot wide chilled zone against metasiltstone. The metasiltstone weathers white instead of grey in a 1-foot wide zone adjacent to the sill, but in thin section no contact metamorphic effects were observed.

The sills predate the regional metamorphism, and the trend of the faint differentiation, the concordant habit, and the great lateral extent suggest that the gabbro was inruded into an essentially horizontal sequence. Local cross-cutting relations, however, show that some, if not all, of the sills were intruded into a moderately folded sequence. This is best documented at the west end of the Fox Bay sill where the sill discordantly intrudes both limbs of the Fox Bay syncline.

LATE PORPHYRITIC FELSIC DIKES

Near Munekun Lake, grey to dark-grey unmetamorphosed porphyritic tonalite dikes and sills have intruded uralitized gabbro and mafic metavolcanics. The tonalite contains 5 to 20 percent oscillatory zoned, subhedral plagioclase phenocrysts (oligoclase to labradorite), 3 to 10 percent altered subhedral to euhedral, hornblende phenocrysts, rare quartz and biotite phenocrysts, 55 to 70 percent groundmass quartz and plagioclase (oligoclase-andesine), 10 to 15 percent groundmass biotite, and minor iron-titanium oxide, pyrite, pyrrhotite, chalcopyrite, sphene, zircon, and apatite.

The dikes range in width from a few feet to 50 feet and have sharp chilled contacts. At the dike margins, the groundmass is cryptocrystalline, and phenocrysts range in diameter from 1 millimetre to 5 millimetres. In the centre of the wider dikes, the groundmass grain size is 0.1 millimetre, and phenocrysts range in diameter from 2 to 10 millimetres. Phenocrysts are absent in a 2-inch to 3-foot wide zone at the margins of some dikes.

The dikes are probably genetically related to the granitic batholiths, but the reason for their localization near Munekun Lake, 3 miles from the nearest batholith, is unknown.

Similar dikes were rarely found in the Rottenfish River belt.

Rare narrow unmetamorphosed porphyritic trondhjemite and sodic granite dikes were found in the metavolcanic-metasedimentary-metagabbroic assemblages near the granitic batholiths and are probably genetically related to the batholiths. The dikes contain fine- to medium-grained plagioclase and rare quartz phenocrysts in a very fine-grained plagioclase-quartz-microcline-biotite-muscovite groundmass. These dikes are much less abundant than equigranular granitic dikes which occur in the country rock adjacent to the batholiths.

QUARTZ MONZONITE STOCK

The only granitic stock within the metavolcanic-metasedimentary-metagabbroic belts is north of the east end of Muskrat Dam Lake. The stock appears to be approximately circular in plan and underlies an area of about 0.3 square mile; its contacts are not exposed. It is composed of pale-pink, foliated, medium-grained, equigranular quartz monzonite; a modal analysis is given in Table 7 (sample 246). The plagioclase has discontinuous normal and rare oscillatory zoning.

GRANITIC BATHOLITHS

Granitic rocks underlie about 70 percent of the map-area (1,200 square miles) and completely encompass the metavolcanic-metasedimentary-metagabbroic belts except for about 10 miles at the north and south ends of the Rottenfish River belt and the east end of the Muskrat Dam Lake belt. Except for a small area on the west side of the Rottenfish River belt, all granitic rocks appear to belong to one composite, intrusive batholith.

The granitic rocks have a wide range in composition, texture, and structure, but one mafic phase and eight felsic phases were distinguished during the reconnaissance mapping (Table 1; Figure 4 on Chart A, back pocket). Each of these phases has a wide range in soda to potassia ratio but was differentiated from other phases by mafic mineral content and texture.

The classification of granitic rocks used in this report has been previously described by the author (Ayres, in press, Table 2).

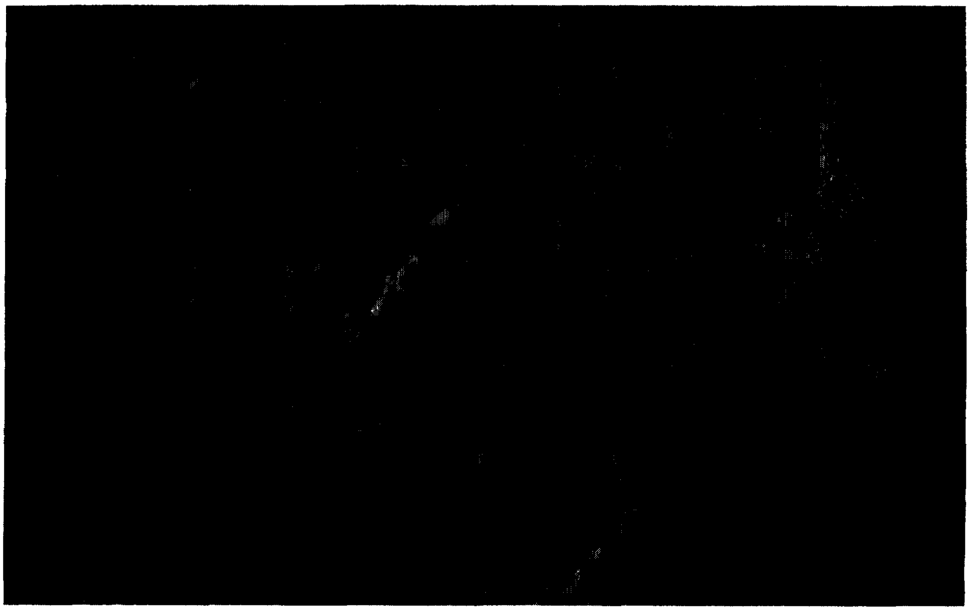

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Photo 12—Diorite inclusions in equigranular to porphyritic granodiorite, 15 miles north of Sandhill Crane Island. Note hybrid patches in the granodiorite beneath hammer.

Early Mafic Phase

East of Rottenfish Lake, equigranular diorite, quartz-bearing diorite (5 to 10 percent quartz), syenodiorite, and quartz-poor mafic trondhjemite form a stock-like body which is elliptical in plan. The stock has an area of about 4.5 square miles and is bounded on the east by the Hill Lake fault. Two textural types were mapped: a predominant medium-grained massive to poorly foliated phase with uniformly distributed mafic minerals (Table 7, analysis 1012), and a coarse-grained phase in which plagioclase is oriented and mafic minerals are concentrated in oriented, lenticular clots. The relationship between the two phases is unknown.

Clinopyroxene, which is partly to completely replaced by pale-green amphibole, forms as much as 35 percent of the stock. Plagioclase is highly strained, fractured, and locally recrystallized. The mafic mineral content appears to decrease and the quartz content to increase toward the margin of the stock, and the stock may grade into adjacent hornblende tonalite and trondhjemite. Contacts with adjacent rocks are not exposed.

The stock contains rare hornfelsed mafic metavolcanic inclusions and was intruded by rare narrow pink leucocratic, locally recrystallized quartz monzonite dikes.

North of the Muskrat Dam Lake belt, rare, diorite inclusions were found in equigranular and porphyritic felsic phases (Photo 12).

The incipient recrystallization and inclusions in felsic phases suggest that the mafic-rich phase is older than the granitic phases.

Granitic Phases

The eight granitic phases are discussed below in order of apparent decreasing age. The intrusive history, however, is not completely known and is probably complex; some phases probably have several ages. Except where otherwise specified, the granitic rocks are medium-grained (1 millimetre to 3 millimetres) and are grey, pale-grey, white, or pink on both fresh and weathered surfaces.

Foliation is common in the granitic rocks and appears to be a primary flow structure. It is generally parallel to contacts between the major phases and to the contact with the metavolcanic-metasedimentary-metagabbroic belts.

The granitic rocks near Rottenfish Lake were briefly described by Satterly (1938, p. 32).

Equigranular Hornblende-Biotite Phase

Equigranular foliated hornblende-biotite granodiorite, trondhjemite, and tonalite form a distinctive but minor phase which is most abundant north of Rottenfish Lake and north of the western part of the Muskrat Dam Lake belt (Table 7, analyses 286, 401, and 134). Trondhjemite is the predominant rock type; granodiorite is rare. Quartz-poor tonalite locally forms a contaminated(?) marginal zone adjacent to mafic metavolcanics along the south edge of the Muskrat Dam Lake belt, but its contacts with mafic metavolcanics are sharp.

Hornfelsed mafic metavolcanic inclusions are present in many outcrops but are generally not abundant. Eleven miles north-northwest of Sandhill Crane Island, however, mafic inclusions are abundant, and the granitic rock (probably tonalite) has a highly variable hornblende content because of contamination; the foliation is contorted. In the equigranular biotite phase, described below, a narrow contaminated hornblende-bearing zone locally surrounds mafic inclusions, especially where inclusions are abundant.

Porphyritic Hornblende-Biotite Phase

Porphyritic foliated hornblende-biotite granodiorite and minor trondhjemite underlie a small area about 18 miles north-northwest of Sandhill Crane Island (Table 7, analysis 798). This unit is characterized by ½-inch to 1-inch long, subhedral perthitic microcline phenocrysts which have a random or locally preferred orientation. Phenocrysts form as much as 20 percent of the rock but average between 5 and 10 percent; groundmass microcline forms less than 10 percent of most samples. With the disappearance of phenocrysts this unit appears to grade into equigranular hornblende-biotite rocks. Inclusions are rare.

Fine-Grained Trondhjemite Dikes

Narrow dikes of fine-grained (0.5 to 1 millimetre) equigranular massive biotite trondhjemite (Table 7, analysis 792) have intruded the equigranular hornblende-biotite phase about 15 miles north-northwest of Sandhill Crane Island. The dikes form as much as 15 percent of some outcrops. Although they could not always be distinguished from later fine-grained granodiorite dikes, the trondhjemite dikes

Table 7 MODAL ANALYSES OF GRANITIC ROCKS

	1012	286	401	134	934	769	792	798	791	827	1152	905	47	893	246	1146	370
Plagioclase	53.9	57.1	39.1	54.2	55.9	59.2	58.9	48.7	46.4	40.1	43.9	43.0	35.2	24.9	33.0	28.6	22.7
Quartz	7.2	21.1	34.7	21.4	35.1	27.1	30.2	31.2	34.8	36.4	30.7	31.3	35.5	38.8	30.3	32.3	32.2
Microcline	2.1	...	1.5	...	4.0	1.1	1.4	12.0	10.0	18.9	16.1	18.8	23.0	35.2	31.5	36.5	42.3
Clinopyroxene	0.1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hornblende	22.9	10.5	14.7	3.3	...	...	...	1.2	...	...	...	...	...	...	...	...	...
Biotite	12.4	9.5	9.4	17.4	4.6	11.2	5.9	5.5	7.8	3.3	7.1	5.2	5.0	0.1	3.8	1.5	1.6
Chlorite	0.1	0.1	...	...	trace	0.2	0.6	0.1	trace	0.3	0.2	0.1	0.2	0.6	...	0.4	0.2
Muscovite	...	...	...	...	trace	0.4	...	0.1	0.1	0.5	0.2	0.3	0.7	...	1.0	0.2	0.1
Pistacite	0.2	1.3	0.4	2.4	trace	trace	1.4	0.5	0.8	...	0.2	0.7	0.2	0.3	...	0.3	0.2
Opaque minerals[1]	0.1	trace	trace	0.3	0.4	0.4	1.2	0.1	trace	0.4	1.0	0.4	0.1	0.1	0.3	0.2	0.7
Others[2]	1.0	0.4	0.2	1.0	trace	0.4	0.4	0.6	0.1	0.1	0.6	0.2	0.1	trace	0.1	trace	trace
Plagioclase composition	40→27	29→36	28	31→25	28→18	24→23	30→21	23→21	25→22	21→19	27→24	35→19	27→23	17→16	23→15	18	24→20
$\frac{\text{Microcline}}{\text{Total feldspar}}$	0.04	0	0.04	0	0.07	0.02	0.02	0.20	0.18	0.32	0.27	0.30	0.39	0.59	0.49	0.56	0.65

Description of Samples

1012-Quartz-bearing diorite, east of Rottenfish Lake
286-Tonalite
401, 134, 934-Trondhjemite
769-Porphyritic trondhjemite
792-Fine-grained trondhjemite dike
798-Porphyritic hornblende-biotite granodiorite
791, 827-Granodiorite
1152-Porphyritic granodiorite
905-Fine-grained granodiorite dike
47, 893-Quartz monzonite
246-Quartz monzonite from small stock north of Muskrat Dam Lake
1146, 370-Fine-grained, leucocratic quartz monzonite

Notes

[1] Fe-Ti oxide and rare pyrite

[2] Apatite, sphene, allanite, and zircon

appear to be rare or absent in, and to thus predate, the medium-grained biotite phases. Near Pike Lake, however, similar fine-grained trondhjemite dikes have intruded the equigranular biotite phase, and there are thus two ages of these trondhjemite dikes.

Equigranular Biotite Phase

Most of the batholith is composed of equigranular biotite trondhjemite, granodiorite, and quartz monzonite (Table 7, analyses 934, 791, 827, 47, and 893). On the south side of the Muskrat Dam Lake belt, this phase, where mapped, comprises 60 percent trondhjemite, 25 percent granodiorite, and 15 percent quartz monzonite. On the north side of the belt, the mapped part of the phase consists of 35 percent trondhjemite, 25 percent granodiorite, 40 percent quartz monzonite, and rare sodic syenite. On the west side of the Rottenfish River belt only granodiorite was found. The relationship between the various rock types in the phase could not be determined. In some places the phase has a relatively uniform composition over a large area, but in other outcrops trondhjemite, granodiorite, and quartz monzonite are intimately interlayered.

Two rare varieties of the phase are: (1) porphyritic trondhjemite (Table 7, analysis 769) in which the phenocrysts are 5-millimetre to 10-millimetre long subhedral plagioclase; and (2) coarse-grained (5 millimetres to 10 millimetres) granodiorite. These varieties appear to grade into the medium-grained equigranular rocks.

Foliation defined by oriented biotite flakes and aggregates and locally by oriented quartz lenses is common and is generally slightly wavy although contortion is rare. Lineation was found in a few well foliated outcrops. Quartz monzonite is locally massive. Gneissic varieties are locally present, and three main types of gneissosity have been distinguished.

(1) *Intimately interlayered sodic and potassic phases.* Grey sodic layers are generally 1 inch to 2 feet thick, and pink potassic layers, which are locally pegmatitic, have an average thickness of 1 inch; layers pinch and swell and are locally contorted. This type is best developed south of Pike Lake and on the east side of the Rottenfish Lake fault. Mafic metavolcanic and metasedimentary inclusions are abundant in gneissic outcrops south of Pike Lake.

(2) *Migmatite.* Migmatite composed of alternating granitic sills and metasedimentary or mafic metavolcanic layers is locally found adjacent to the metavolcanic-metasedimentary-metagabbroic belts.

(3) *Mafic schlieren.* Hornblende- and biotite-rich schlieren are common in areas where mafic metavolcanic inclusions are abundant, such as south of Pike Lake, and may be modified mafic metavolcanic inclusions. In migmatite, metasedimentary layers locally grade into biotite-rich schlieren. Schlieren are generally less than 2 inches thick.

Angular, round, and lenticular hornfelsed mafic metavolcanic inclusions are ubiquitous and range in length from several inches to hundreds of feet (Photo 13). South of Pike Lake some inclusions are highly stretched and appear to pass into mafic schlieren. The amount of mafic inclusions is highly variable, and there are distinct zones in which inclusions form 10 to 50 percent of the outcrop; these zones resemble intrusion breccias. The granitic phase in these zones is generally trondhjemite which has a variable biotite content and appears to be contaminated. Metasedimentary inclusions are rare and, in general, were found only near metasedimentary formations. Rare angular equigranular, hornblende-biotite trondhjemite

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Photo 13—Poorly layered, hornfelsed, mafic metavolcanic inclusions in equigranular biotite trondhjemite west of Sick Lake. Note variable mafic content of trondhjemite, lenticular mafic clots, and leucocratic granitic phase which forms sills and dikes in, and locally surrounds, inclusions. Narrow, late, aplite dikes are present in the photo.

inclusions as much as 500 feet long were found in biotite trondhjemite. Inclusions which have planar structure have locally been rotated (Photo 13).

At the edges of some equigranular hornblende-biotite trondhjemite units and at the south end of Misquamaebin Lake, hornblende-biotite trondhjemite and biotite trondhjemite are interlayered; the layers have gradational contacts. The presence elsewhere of equigranular hornblende-biotite trondhjemite inclusions in biotite trondhjemite indicates, however, that the biotite phase is slightly younger. Biotite trondhjemite has also intruded porphyritic hornblende-biotite granodiorite.

Porphyritic Biotite Phase

Porphyritic biotite granodiorite and quartz monzonite (Table 7, analysis 1152) underlie large areas which are elongated parallel to the foliation in the adjacent phases. Quartz monzonite is about twice as abundant as granodiorite. The phase is characterized by subhedral randomly oriented perthitic microcline phenocrysts which have an average length of ½ inch but which locally are as much as 3 inches long; in some outcrops phenocrysts are aligned. Phenocryst abundance is highly variable and ranges from locally absent to 25 percent; the average content is 10 percent. Quartz monzonite in this phase and in the equigranular biotite phase locally contains euhedral magnetite crystals as much as 5 millimetres in diameter.

The phase is massive to poorly foliated with foliation defined by oriented biotite and locally by aligned phenocrysts. A rare gneissosity is produced by alternation of layers containing abundant large phenocrysts with layers containing sparse small phenocrysts. Inclusions are rare

About 15 miles north-northwest of Sandhill Crane Island, massive porphyritic biotite quartz monzonite was found in sharp discordant contact with, and is thus younger than, foliated equigranular hornblende-biotite trondhjemite. The relationship between the porphyritic and equigranular biotite phases was not directly observed, but the porphyritic phase appears to distort the foliation in the equigranular phase (Figure 4 on Chart A, back pocket) and is probably younger.

Fine- to Medium-Grained Granodiorite Dikes

Fine- to medium-grained massive granodiorite dikes (Table 7, analysis 905) have intruded the equigranular and porphyritic hornblende-biotite phases and the equigranular and porphyritic biotite phases in a 15 square mile area north-northwest of Sandhill Crane Island (Figure 4 on Chart A, back pocket). The dikes range in width from a few feet to more than 100 feet and locally underlie entire outcrops. The dikes are in sharp contact with the granitic country rocks and locally contain angular country rock inclusions.

The plagioclase has discontinuous oscillatory zoning and is thus distinctly different from the plagioclase in the other granitic phases that has continuous normal or continuous oscillatory zoning or is locally unzoned.

Hornblende-Biotite Trondhjemite Dike

A 50-foot wide fine-grained foliated hornblende-biotite trondhjemite dike appears to intrude porphyritic biotite quartz monzonite north of the west end of the Muskrat Dam Lake belt. Contacts are not exposed. The approximate composition of the dike is 57 percent normally zoned oligoclase-andesine, 25 percent quartz, 3 percent microcline, 9 percent biotite, 3 percent hornblende, and minor pistacite, chlorite, sphene, iron-titanium oxide, pyrite, apatite, and allanite.

The relationship between this dike and the fine- to medium-grained granodiorite dikes is unknown.

Pegmatite and Aplite

Pink pegmatite and fine- to medium-grained leucocratic granodiorite and quartz monzonite (aplite) (Table 7, analyses 1146 and 370) dikes are ubiquitous and have intruded all other granitic phases except possibly the fine- to medium-grained granodiorite and the hornblende-biotite trondhjemite dikes.

Aplite dikes are massive, range in width from a fraction of an inch to more than 200 feet, and have an average width of 3 inches. Contacts are subvertical, sharp, slightly chilled, and straight to curved. Dikes commonly occupy several joint sets but only rarely do dikes in one joint set intrude those in another joint set; the younger aplite is generally grey rather than pink. Aplite varies in abundance from rare to more than 50 percent but generally forms less than 1 percent of the outcrop. When aplite is abundant, dikes are less than 10 feet wide and country rock between the dikes is not rotated.

Pink pegmatite dikes are associated with, but are generally less abundant than, aplite dikes, and the two locally form composite dikes with either an aplite core and pegmatite rim or a pegmatite core and aplite rim. In some outcrops pegmatite intrudes aplite, but in other outcrops pegmatite is intruded by aplite. Pegmatite dikes are straight to curved, have a maximum grain size of 2 feet, have sharp contacts with narrow, fine- to medium-grained chilled zones, and are generally composed of perthitic microcline, albite, quartz, and biotite; graphic intergrowth of quartz and feldspar is common. The dikes locally contain muscovite and accessory magnetite. Dikes are subvertical, have an average width of 3 feet, but are locally as much as 300 feet wide. Pegmatite forms less than 1 percent of most outcrops, but in some areas it is the dominant rock type. When pegmatite is abundant, dikes are narrow and country rock is not rotated. Dikes are locally zoned with a quartz-rich core and feldspar-rich wall zones; rarely the wall zones have an outer albite-microcline zone and an inner microcline zone.

In rare outcrops both aplite and pegmatite form narrow lenses parallel to the foliation of the host rock.

Pink pegmatite also forms irregular patches within, and gradational with, medium-grained quartz monzonite. In some outcrops, large microcline grains, which resemble phenocrysts, have a highly irregular distribution throughout quartz monzonite and locally form aggregates. The larger aggregates have associated coarse-grained quartz and are pegmatitic. In the porphyritic biotite quartz monzonite previously described phenocrysts have a relatively uniform distribution and aggregates are rare. The irregularly distributed and aggregated microcline grains thus appear to be porphyroblasts which formed during the pegmatite stage of crystallization.

In several aplite dikes a similar gradation was observed from single microcline grains to small pegmatite patches.

White pegmatite which contains albite-oligoclase, quartz, muscovite, and accessory tourmaline, garnet, magnetite, molybdenite, and apatite forms rare sills, lenses, and dikes in metasediments and metavolcanics. It is most abundant along the north edge of the Muskrat Dam Lake belt between Axe Lake and the Morrison River. The pegmatite has a maximum grain size of 6 inches, and, on a small island in the Severn River at the entrance to Axe Lake, it contains fractured black tourmaline crystals as much as 4 inches long (Photo 14).

Rare narrow white pegmatite sills and lenses were found in the granitic rocks, and several of these contain concentrations of magnetite. A 2-foot thick sill about 14 miles north-northwest of Sandhill Crane Island contains about 15 percent magnetite.

Pistacite Veins

Rare pale-green to green pistacite (epidote) and quartz-pistacite veins as much as a half inch wide fill joints in many granitic outcrops and appear to postdate all of the granitic phases.

Contacts with Metavolcanic-Metasedimentary-Metagabbroic Belts

The contacts between the granitic batholiths and the metavolcanic-metasedimentary-metagabbroic belts were observed at several localities and are generally subvertical. In small outcrops the contact appears to be concordant, but over large areas contacts are distinctly discordant, and vary from sharp to gradational. Gradational contacts are migmatitic with layers of country rock ranging in width from a few inches to more than 100 feet alternating with granitic sills of similar width; contacts between the two phases of the migmatite are sharp. Discordant granitic dikes are rare in the migmatite zones. Intrusion breccia consisting of angular country rock

ODM8133

Photo 14–White pegmatite containing black tourmaline crystals, island in Severn River at entrance to Axe Lake.

fragments in a granitic matrix was not observed at the contact but forms zones of unknown origin within the equigranular biotite phase.

Foliation in the granitic rocks is generally parallel to the contact, but distinctly discordant foliation was found on the west side of the Rottenfish River belt, north of the west end of the Muskrat Dam Lake belt, and west of Lookout Lake.

Sharp contacts were observed at the following locations: adjacent to metagabbro on the west side of the Rottenfish River belt (locality 1); adjacent to mafic metavolcanics along part of the northeast edge of the Rottenfish River belt (locality 2), north of the west end of the Muskrat Dam Lake belt (locality 3), at Nekence Lake (locality 4), and on the Schade River (locality 5); and adjacent to metasediments on the Windigo River (locality 6). At these localities, country rock inclusions are rare in the granitic rocks, which are generally unchilled, and granitic sills are rare and dikes are absent in the country rocks. Near Pike Lake abundant granitic sills and dikes were found in the mafic metavolcanics adjacent to the granitic rocks at two flexures in the contact. At localities 3, 5, and 6, the granitic rocks adjacent to the contact are locally sheared; the shear zone is as much as 500 feet wide and muscovite is common in the sheared granitic rocks (compare with Table 7). A chilled 50-foot to 100-foot wide zone of porphyritic tonalite was found at the Windigo River contact.

The Rottenfish Lake fault forms the southeast contact of the Rottenfish River belt. Contact relations along the fault are described in detail under "Structural Geology".

Migmatitic contacts were observed adjacent to mafic metavolcanics: (1) along part of the northeast contact of the Rottenfish River belt (1,500+ feet wide); (2) at the west end of the Muskrat Dam Lake belt (4,000 feet wide); (3) near Wapesi Lake (500 feet wide); and (4) about 8 miles west of Sandhill Crane Island (1,500+

feet wide). They were observed adjacent to metasediments (5) at the northwest corner of the Muskrat Dam Lake belt (500 feet wide); (6) northeast of Sandhill Crane Island (3,000 feet wide); and (7) north and east of Axe Lake (500 to 1,000 feet wide). At the northwest corner of the Muskrat Dam Lake belt, metasediments contain as much as 30 percent granitic sills, but a metagabbro sill within the metasediments contains only rare granitic dikes. The mica in the granitic sills is muscovite rather than biotite. This migmatite is in relatively sharp contact with the batholith in which biotite is common and muscovite is rare.

West of Lookout Lake, mafic metavolcanics between the batholith and the quartz monzonite stock contain about 20 percent granitic and pegmatitic sills and rare dikes.

Origin

On the basis of reconnaissance mapping, Donaldson (1961) and Duffell (1963) postulated that many of the granitic rocks immediately south of the map-area were formed by "large-scale granitization". Moxham (1965) further suggested that many of the granitic rocks were regionally metamorphosed to the epidote-amphibolite facies.

In the map-area, many features such as (1) the intrusive relationships between many of the granitic phases, (2) the lack of recrystallization except in the early mafic phase, (3) the igneous-like textures, (4) the rotation of inclusions, (5) the universal but commonly sparse occurrence of angular hornfelsed mafic metavolcanic inclusions which have sharp contacts but locally narrow contaminated zones, (6) the locally sharp contacts with the metavolcanic-metasedimentary belts, (7) the lack of gradational contacts, other than migmatite, and (8) the contact metamorphism of the belts, suggest that the granitic rocks crystallized from a magma although the origin of the magma is not known. No evidence of large-scale metasomatism within the granitic terrane was found although minor metasomatism is indicated by a change in composition of some of the inclusions, local development of feldspar porphyroblasts in felsic inclusions, and local development of microcline porphyroblasts in quartz monzonite during pegmatite formation. These features, however, are consistent with a magmatic derivation of the granitic rocks.

Detailed mapping (Ayres 1967) 75 miles west-southwest of the map-area within the area considered by Donaldson (1961) and Moxham (1965) has shown that the granitic batholiths are composed of many discrete plutons, each of which, except the oldest, has intrusive contacts against older granitic rocks. These batholiths thus resemble other large batholiths of orogenic regions, such as the Sierra Nevada (Bateman *et al.* 1963).

LATE MAFIC DIKES

Lamprophyre(?)

Several fine-grained grey to black mafic dikes which range in width from 4 inches to 5 feet have intruded granitic rocks and are called lamprophyre although some are not noticeably porphyritic. These dikes were found along the Severn River south of the west end of the Muskrat Dam Lake belt, at Namaybin Lake, north of Sandhill Crane Island, and east of the Windigo River. A similar dike was found in mafic metavolcanics southeast of Munekun Lake.

The dikes are compositionally different from diabase, and the approximate composition is 15 percent blue-green hornblende, 15 to 25 percent biotite, 0 to 20 percent quartz, 40 to 60 percent zoned oligoclase-andesine, and minor pistacite, sphene, pyrite, pyrrhotite, iron-titanium oxide, chalcopyrite, and apatite. Phenocrysts, where present, are medium-grained hornblende or biotite.

Diabase

Four north-northeast-trending, three west-northwest-trending, and one north-northwest-trending, post-granitic, diabase dikes were found. The north-northeast-trending dikes have been traced intermittently across the map-area. The west-northwest-trending dikes were found only in the northwest and southeast parts of the area and could be traced for only short distances along strike. However, a weak aeromagnetic anomaly joins the dike in the southeast corner with one of the dikes in the northwest corner. The other dike in the northwest corner appears to have an *en échelon* relationship to the first dike. A 3-foot wide, east-northeast-trending dike was found at the mouth of Blackwater Bay and is probably a subsidiary dike to the west-northwest-trending dike. The north-northwest-trending dike was found only in one outcrop but can be extended for about three miles on aeromagnetic data.

Most of these dikes are between 50 and 200 feet wide, but subsidiary dikes which are generally less than 3 feet wide were found near, and parallel to, the main dikes. Contacts are sharp, chilled, and straight, curved, undulating, or slightly irregular; in several outcrops the strike of the contact changes more than 30 degrees within a distance of 1 mile. The chilled zone is generally less than 2 feet wide and locally contains thin flow layers. Rare stoped granitic blocks were found near the margins of the dikes east of Cable Lake (Photo 15).

The dikes are dark-grey to black on fresh surfaces and weather grey or brown. Four modal analyses are presented in Table 8. Quartz is present in all samples but always forms less than 10 percent of the dike. Plagioclase has oscillatory zoning and clinopyroxene has normal zoning.

Table 8 MODES OF DIABASE DIKES

	440	550	559	768
Plagioclase + alteration products	54.2	54.0	47.8	57.5
Quartz	4.9	5.4	6.6	2.1
Olivine + alteration products	..	...	...	2.5
Clinopyroxene	23.5	27.0	26.0	27.4
Amphibole	6.0	6.4	9.8	0.6
Biotite	6.3	2.6	3.4	4.9
Chlorite	0.4	0.5	1.9	trace
Opaque minerals[1]	4.3	4.0	4.2	5.0
Apatite	0.4	0.1	0.3	trace
Plagioclase composition	60→33	63→44	68→45	68→40
Granophyre	5.7	4.0	6.0	1.2

Location of samples
440, 550, 559-easternmost, major, north-northeast-trending dike
768 -west-northwest-trending dike

Note
[1] Fe-Ti oxide, minor pyrite, rare pyrrhotite

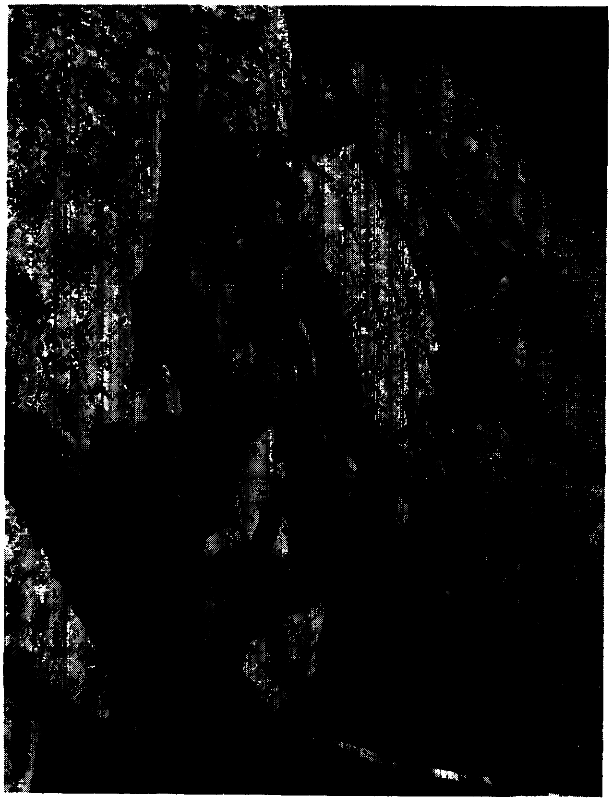

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Photo 15—Stoped, granitic block in diabase dike east of Cable Lake.

The two major dike sets are distinctly different in composition and texture. North-northeast-trending dikes have isogranular texture (see p. 30) and contain accessory pigeonite and rare orthopyroxene. Zoning in plagioclase is locally discontinuous, and medium-grained plagioclase phenocrysts were found in the chilled margin of several dikes. West-northwest-trending dikes have subophitic to ophitic texture and contain minor olivine; about twenty-five percent of the clinopyroxene is pigeonite.

East of Cable Lake rare 6-inch wide white fine-grained granophyre dikelets are present in the diabase and trend perpendicular to the dike contact. The granophyre contains 70 percent albite (An_0), 20 percent quartz, 2 percent clinopyroxene, 1 percent hornblende, 2 percent pistacite, and rare sphene, allanite, and iron-titanium oxide; granophyric intergrowth forms about 20 percent of the dikelets.

Diorite

On the west side of a creek about 4 miles east of Moose Lake, several pale-grey to grey fine-grained (0.5 millimetre) north-trending diorite dikes were observed in the granitic rocks. The dikes have a maximum width of 6 inches and their approximate composition is 60 percent normally zoned andesine (An_{41}–An_{36}), 17 percent clinopyroxene, 10 percent quartz, 4 percent pistacite, 3 percent microcline, 2 percent sphene, 1 percent dark-green hornblende, 2 percent devitrified glass(?), and minor apatite, allanite, and pyrite. The dikes have a mineralogical layering parallel to contacts.

The glass(?) generally has a partial or complete pistacite rim and is devitrified to an orange, locally fibrous, birefringent aggregate which has a mean refractive index of 1.529. Rare curved (perlitic?) fractures were observed in the altered glass.

The presence of devitrified glass indicates that the dikes must have been emplaced much closer to the earth's surface than the granitic rocks in which they occur. The dikes are thus much younger than the granitic batholith.

METAMORPHISM

The metavolcanic-metasedimentary-metagabbroic belts have been regionally metamorphosed, and the grade of metamorphism ranges from the middle greenschist to the middle almandine amphibolite facies (as defined by Fyfe *et al.* 1958). The approximate position of the greenschist and almandine amphibolite facies is shown in Figure 5 (on Chart A, back pocket). This figure is based on only 190 thin sections, and detailed work would probably result in considerable revision.

The almandine amphibolite facies zone has a highly variable width and is narrowest west of Fox Bay. In many places, the boundary between the greenschist and almandine amphibolite facies appears to occur within a metagabbro sill and near the side of the sill which faces the almandine amphibolite facies. The coincidence of this facies boundary and metagabbro sills may reflect a lag in metamorphic reaction rates within the coarser-grained parts of the sills. The greenschist facies part of these sills generally retains primary grain size while, in the almandine amphibolite facies part, the primary grains, especially plagioclase, have been recrystallized to aggregates of smaller grains.

On the southeast side of the Rottenfish River fault, upper greenschist facies rocks which occur adjacent to granitic rocks (Figure 5 on Chart A, back pocket) are separated from the batholith by the Rottenfish Lake fault, a major structural break. Part of this greenschist facies zone may have been formed by retrograde metamorphism related to the fault.

The granitic batholiths superimposed hornblende hornfels facies, contact metamorphic aureoles as much as 1 mile wide on the almandine amphibolite facies zone. These two facies could not always be differentiated, but in mafic metavolcanics the contact aureole is characterized by: (1) a deepening in the colour from green or dark-green to dark-grey-green or black; (2) a decrease in the intensity of foliation and partial development of a granular hornfels texture; (3) a slight increase in grain size;(4) local development of gneissosity produced by metamorphic differentiation (p. 12); and (5) an increase in the number of narrow concordant quartz veins. Gneissosity (Figure 5 on Chart A, back pocket) is best developed where granitic rocks adjacent to the belt are sheared or where large flexures occur in the contact. At the northwest corner of the Muskrat Dam Lake belt, a metagabbro sill in migmatitic metasediments has gneissic border zones but a massive to foliated interior.

Clinopyroxene locally occurs in hornblende hornfels facies mafic metavolcanics along the north edge of the Muskrat Dam Lake belt and in inclusions in the granitic batholith north of this belt.

PLEISTOCENE

DIRECTION OF ICE MOVEMENT

Glacial striae are present on most outcrops, and in most of the map-area have a relatively consistent southwest trend (Figure 6 on Chart A, back pocket), but in the southeast corner of the area they trend west-southwest and locally west. The gently sloping northeast sides and steeply sloping plucked southwest sides of many outcrops (*roches moutonnées*) indicate that the last movement of the ice was in a southwesterly direction. Glacially polished surfaces are preserved on a few metavolcanic and granitic outcrops.

Straight to rarely curved drumlins and drumlinoid ridges which have the same trend as nearby striae (Figure 6 on Chart A, back pocket) indicate either a southwest or a northeast ice movement direction. They are found in most parts of the area and form an extensive field near, and northwest of, Muskrat Dam Lake. The ridges were located by examination of aerial photographs and were only locally examined on the ground. They range in length from 1,300 to 8,000 feet and in width from 200 to 2,100 feet; their average length is about 2,500 feet and average width about 400 feet. They are seldom more than 20 feet high, and the highest part is near the centre of the ridge rather than at the stoss end as in most drumlins. Most of the ridges have a length-to-width ratio between 3:1 and 5:1 and are drumlins (Reed *et al.* 1962). A few have a length-to-width ratio of 10:1 and approach drumlinoid ridges in shape (Dean 1953). The surface of the ridges is composed of cobbles and boulders which were probably concentrated by wave washing of boulder clay.

Older south-southeast-trending striae which are partly obliterated by the southwest-trending striae were found in hollows on a few outcrops in the eastern part of the area (Figure 6). The ice movement direction could not be determined. Similar older striae have been reported from Fawn River and Big Trout Lake by Tyrrell (1913) and Hudec (1964). These authors found that the older ice sheet or lobe moved in a northwesterly direction.

South-trending to south-southeast-trending striae also occur on the west side of the Sachigo interlobate moraine (Satterly 1937a and b) but are younger than the southwest-trending striae (Derry and MacKenzie 1931). None of these striae was mapped.

MORAINES

A thin layer of drift mantles much of the bedrock but only the upper surface, which is composed of boulders, cobbles, pebbles, and minor sand, is exposed. This upper part of the drift is probably a concentrate formed by Pleistocene wave washing of the original till. Similar concentrates which are found in rapids and along lake shores are probably Recent wave-washed drift. In the western part of the area where lacustrine varved clay overlies drift (Figure 6 on Chart A, back pocket), the drift, where exposed, is wave washed and composed of pebbles, cobbles, and boulders. It forms a thin layer, generally less than 1 foot thick, between bedrock and overlying clay.

Drift is rare on most outcrops; it was probably originally present but was removed by Pleistocene lacustrine wave action. Some rock hills were apparently protected from wave action and still have a drift cover. On these hills outcrop is best exposed on the northeast (stoss) side and the hills are probably crag-and-tail. Some outcrops, especially south of Axe Lake, are surrounded by a wide boulder and cobble apron which has the same elevation as the outcrop and is probably wave modified ground moraine.

At three localities, boulders and cobbles form definite beach ridges near the top of outcrop hills (Figure 6 on Chart A, back pocket). North of Rain Lake, a series of ridges which have a difference in elevation of 3 to 10 feet and are composed of angular to subrounded cobbles and boulders form the crown of a granitic outcrop. When traced along strike the beach ridges pass into extensive boulder fields. All outcrop on the hill is below the lowest beach ridge. East of Cable Lake, narrow beach ridges composed of subrounded pebbles and cobbles rest on outcrop and are separated from adjacent ridges by bare outcrop.

Most of the cobbles and boulders in the drift are angular to subrounded and granitic in composition. Diabase boulders are abundant southeast of Moose Lake near the postulated intersection of two dikes. Fossiliferous Paleozoic limestone and dolomite pebbles and cobbles are locally present.

Thick deposits of ground moraine which have a hummocky knob-and-kettle upper surface are locally present and underlie a large area east of Rottenfish Lake. The kettles are invariably occupied by small swampy ponds.

A low end moraine, which is generally covered by muskeg, was found by aerial photograph interpretation in the northeast corner of the area (Figure 6) but was not examined on the ground. The moraine appears to have been wave modified, has a maximum width of 3,500 feet, and, along the west shore of Makoop Lake where muskeg is locally absent, appears to have a maximum local relief of 50 feet. Several eskers on the northeast side of the moraine terminate at the moraine.

On preliminary maps P. 219, P. 221, and P. 222 (Ayres 1964g, j, and k), this moraine was tentatively correlated with the Kawagami moraine which was described by Tyrrell (1913) east of Makoop Lake. Recent air photograph interpretation by the author east of Makoop Lake suggests, however, that the Kawagami moraine is a ground moraine which cannot be correlated with the moraine in the map-area. The moraine mapped by the author is equivalent to the end moraine mapped by Prest (1963) southwest of Wunnummin Lake although there appears to be a 15-mile long gap in the moraine between the south end of Makoop Lake and the Nekikamog River.

Several east-trending sand and gravel hills east of Rottenfish Lake (Figure 6 on Chart A, back pocket) may be part of the Agutua end moraine first described by Tyrrell (1913) near Windigo Lake. Prest (1963) has traced this moraine northwestward to latitude 53° north, longitude 92° west where it consists of a series of isolated hills rather than a continuous ridge. One of the hills east of Rottenfish Lake is more than 100 feet high[1], and poorly developed beaches near the top of the hill indicate that the hill was completely covered by Pleistocene lakes.

A large north-trending interlobate moraine which is 150 to 200 feet higher than the surrounding terrain was mapped at the west edge of the area (Figure 6). This moraine was first described by Satterly (1937a and b) and was called the Sachigo moraine by Elson (1961). The moraine was not examined on the ground, but well developed beaches were identified on aerial photographs. The distribution of the beaches shows that, at one time, most of the moraine was below lake level (Figure 6 on Chart A, back pocket). The moraine is an asymmetric ridge with the east side

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[1] Relief taken from the Opasquia 1:250,000 topographic sheet, Canada Department of Mines and Technical Surveys, Ottawa.

having a steeper slope than the west side. In the Sachigo Hills north of the map-area, the highest beach on the west side of the moraine is at a higher elevation than the highest beach on the east side.

Large kettle holes are locally preserved along the top of the moraine. At one locality a series of kettles occurs along the prolongation of a major negative lineament in the bedrock and probably formed by melting of ice which had been trapped in the valley and covered by the moraine.

The interlobate moraine appears to have formed between an eastern stagnant lobe of ice behind the Agutua moraine and a later western lobe. These lobes were respectively called Sachigo and Ponask by Satterly (1937a and b). The asymmetric shape of the moraine and the distribution of the beaches in the Sachigo Hills suggest that the western lobe retreated before the eastern lobe. The western lobe built a prominent east-trending end moraine north of Sandy Lake at latitude 53°20′ north. Elson (1961) included this end moraine with the Sachigo moraine, but the author believes that it should be given a separate name.

GLACIOFLUVIAL DEPOSITS

The drainage pattern of rivers beneath the waning ice is shown by the eskers which are plotted in Figure 6 (on Chart A, back pocket). The convergence of the eskers towards the south edge of the map-area and the tributary pattern indicate a southwesterly river flow.

The eskers are long, locally discontinuous ridges which generally have a relatively uniform crest line and a maximum height above adjacent terrain of 50 feet. They are composed dominantly of sand and pebble gravel and contain about 10 percent subrounded cobbles and boulders. The boulders are generally less than 1.5 feet in diameter but some are as much as 6 feet in diameter.

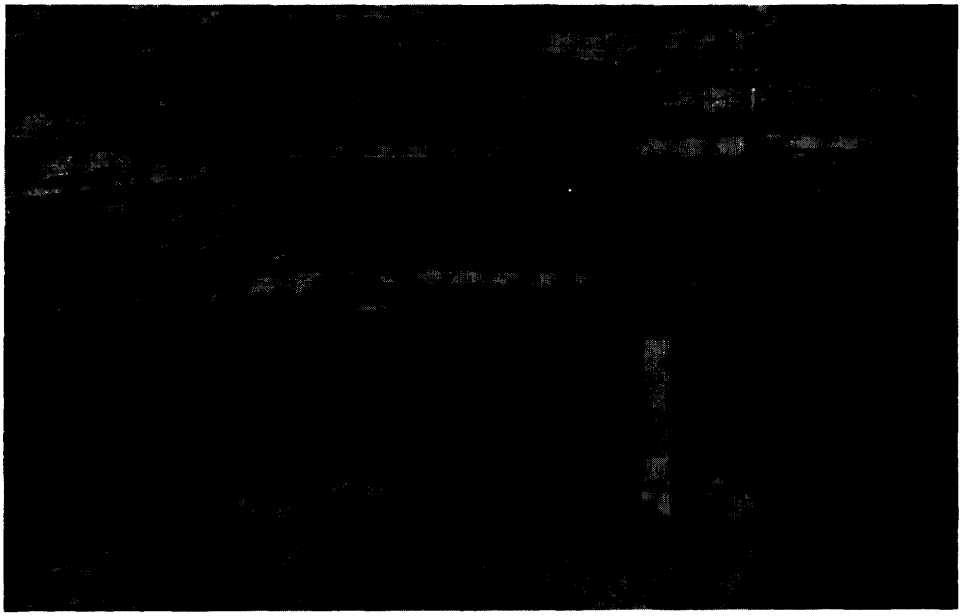
Two sand and silt deltas which probably represent brief halts in the retreat of the ice were found along one esker. The deltas occur at the south end of an esker ridge and are separated from the southerly continuation of the esker by a short gap. Narrow sand and gravel aprons locally flank the main esker ridge and appear to have two origins (Figure 6):–outwash from the glacier, and lacustrine wave modification of the esker. Linear depressions which might be kettles are found in the esker and outwash deposits between Clear Lake and the Windigo River.

In the southwestern part of the area eskers have been modified by Pleistocene wave action (Figure 6). The less modified eskers retain their ridge shape and locally have beaches. The more highly modified eskers form low linear sand and gravel mounds which have a local relief of only a few feet.

A large pit which might be a pothole was found in a granitic outcrop about 18 miles north-northwest of Sandhill Crane Island. The pit is circular in plan, has vertical walls, is 8 feet in diameter and at least 6 feet deep, and is filled with debris. No water was found in the pit, which probably indicates subterranean drainage.

GLACIOLACUSTRINE DEPOSITS

The presence of abandoned beaches, wave modification of eskers and interlobate moraine, winnowing of ground moraine, and removal of drift from most outcrops indicate that most, if not all of the map-area was subjected to Pleistocene lacustrine wave action. It is not known, however, if the entire area was simultaneously



ODM8135

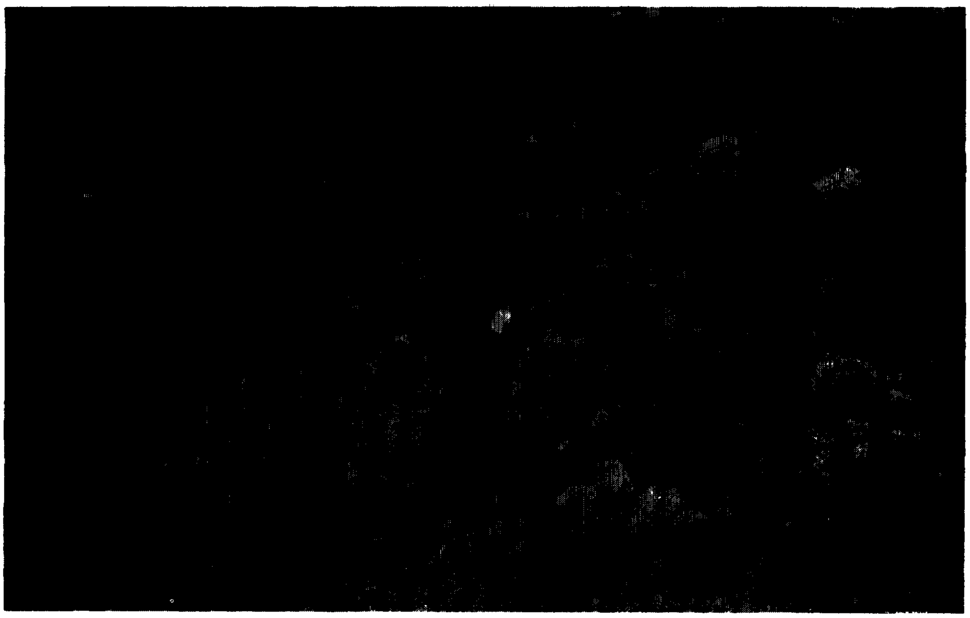
Photo 16—Varved clay at base of varved clay bank on south side of Sandhill Crane Island. Note thickness of varves and fine lamination in light-coloured silt layers.

covered by a Pleistocene lake. Because beaches extend almost to the top of the Sachigo interlobate moraine, the lake near the moraine must have been at least 200 feet deep. The abrupt transition from highly wave-modified esker to unmodified esker on the west side of the Windigo River and north of Sandhill Crane Island indicates the eastern ice shore of a former lake. This shoreline approximately coincides with the eastern limit of thick varved clay outcrops.

Calcareous varved clay, which was deposited in a relatively long-lived glacial lake, is generally restricted to the western part of the area (Figure 6) although it is locally found elsewhere. Elson (1961) and Rutford (1962) consider that the varved clay was deposited in glacial Lake Agassiz.

Varved clay forms banks as much as 20 feet high along the Severn River, but good exposures were found only in the lowermost several feet of the bank where it had been subjected to wave and ice erosion. Varves in the lower part of the section have an average thickness of 2 inches (Photo 16) while varves near the top of the bank appear to be about ¼ inch thick. Each varve comprises a white to pale-brown lower layer which is composed of calcareous silt and clay and is thinly laminated (0.5 millimetre to 1 millimetre) and a dark-brown upper layer which is composed of calcareous clay and is not laminated. The pale-brown layers form between ⅔ and ¾ of the varves and have a greater variation in thickness than the dark-brown layers (Photo 16). The contact between layers is always sharp, but the contact between the dark-brown and overlying pale-brown layers is locally scalloped; rare dark-brown clay chips were found in the lower part of some pale-brown layers.

Brown spherical, ovoid, or pancake-shaped mudstone concretions which are more highly indurated and more calcareous than the adjacent clay and silt were found in the pale-brown layers at three localities near the eastern limit of varved clay



ODM8136

Photo 17—Top view of concretions in light-coloured layer of varved clay, south side of Sandhill Crane Island. Note central hole and concentric layering about hole.

outcrops (see Figure 6 and Photo 17). The concretions were only found in the lowermost well exposed parts of the varved clay banks but may occur elsewhere.

The concretions are generally circular in plan, have a flat to rounded base and top, are 1 inch to 2 inches in diameter, although one concretion is 6 inches in diameter, and generally occupy the entire thickness of the pale-brown layers. The laminae in the pale-brown layers extend through the concretions, and the concretions also have vertical concentric growth layers which are emphasized by slight variations in the brown colour (Photo 17).

Extending through the central part of most concretions is a 0.5-millimetre to 1-millimetre diameter vertical tube which is generally surrounded by a 3-millimetre to 5-millimetre diameter cylinder of grey reduced silt and clay. The tube is commonly hollow and in the centre of the concretion it rarely contains a fragile dark-grey to black carbonized(?) plant stem. Locally the tube is partly filled by silica. Rarely the tube is parallel to, or at a low angle to, the bedding, and the concretion is oval in plan.

Concretions do not occur in the dark-brown layers, but locally the tube extends through this layer and connects a concretion in one pale-brown layer with a concretion in the overlying pale-brown layer. The maximum concentration of concretions is about 10 per square foot of bedding surface. Nearby concretions locally coalesce.

The concretions are cemented by calcite and hydrous ferric oxide which appear to have been deposited around the stem of an aquatic plant. The concretion localities are near the eastern limit of varved clay outcrops and thus were probably near the edge of Lake Agassiz where the water may have been relatively shallow.

These concretions differ in colour, amount of calcite cement, shape, and internal structure from concretions which are locally found elsewhere in varved clay deposits (e.g. see Tarr [1935]).

Low gravel ridges which have a maximum height of 3 feet were found on top of three high relatively flat outcrop hills and on one high relatively flat ground moraine hill in the southeast part of the map-area (Figure 6 on Chart A, back pocket). Only one ridge is present on each hill, and on the moraine hill the gravel ridge overlies angular to subrounded boulders and cobbles from which the matrix has been winnowed by wave action. The ridges are composed of subangular to rounded pebbles and cobbles in a fine to coarse sand matrix; the largest cobble observed was 4 inches in diameter.

The ridges resemble abandoned beach deposits, but their location suggests that they were formed by bottom currents rather than by surface wave action.

RECENT

Recent deposits comprise lacustrine and fluvial clay, silt, and sand which are being deposited in the rivers and lakes, and organic mud which is being deposited in swamps and muskegs. Recent streams and lakes have also formed boulder and cobble deposits by winnowing of Pleistocene drift. Recent sand beaches are rare and have apparently formed only on Pleistocene outwash deposits.

The Severn River and some of its tributaries have a high content of suspended clay and silt because of erosion of Pleistocene varved clay. This clay and silt is probably being deposited in lakes and on the mud flats which flank the river (see "Physiography" section). Small silt and clay deltas are locally found at the mouth of tiny rivulets which flow into the Severn River.

Recent swamp and muskeg cover most of the map-area but are best developed on the impermeable Pleistocene clay deposits in the western part of the area (see "Physiography" section). Many of the outcrop areas shown on the geological maps, especially within areas underlain by granitic rocks, consist of several low outcrops which are separated by muskeg. For mapping purposes, the organic deposits have been subdivided into two types—open swamp and muskeg and treed swamp and muskeg; contacts shown on the geological maps are generalized.

Open swamps and muskegs are distinctive topographic features because they are flat relatively open areas in which trees are sparse and are less than 10 feet high. The three main types are: (1) wet areas in which tamarack is the dominant tree species; (2) string bogs; and (3) relatively open, slightly hummocky areas in which spongy Sphagnum moss, Labrador-tea, black spruce, and tamarack are the dominant plant life and small pools of water occur at the surface.

Treed swamps and muskegs are generally drier, have a greater relief and higher trees, and are characterized by variability in density of tree growth, tree type, tree height, and wetness; they are not distinctive topographic features. The main types are: (1) relatively dry and open, slightly hummocky areas in which spongy Sphagnum moss, Labrador-tea, and scrub black spruce are the dominant plant life and small pools of water are rare; (2) knob-and-kettle ground moraine in which the knobs are dry and the kettles contain swampy ponds; and (3) relatively wet areas with a dense, variable growth of alder, black spruce, tamarack, and birch.

CORRELATION OF GEOLOGY WITH AEROMAGNETIC DATA

The map-area was included in an airborne magnetometer survey flown by Lockwood Survey Corporation Limited in 1965 and 1966 for the Ontario Department of Mines and the Geological Survey of Canada. The resulting aeromagnetic maps were issued in 1966 and 1967 at a scale of 1 inch to 1 mile. Data for the map-area are shown on the following thirteen maps: 3670G, 3671G, 3678G, 3679G, 3680G, 3686G, 3687G, 3688G, 3698G, 3699G, 3700G, 3710G, and 3711G (O.D.M.-G.S.C. 1966a, b, c, d, e, f, g; 1967a, b, c, d, e, f). These maps were not available when the geological survey was carried out.

The two major metavolcanic-metasedimentary-metagabbroic belts are easily recognized on the aeromagnetic maps. However, in most parts of the area, aeromagnetic data cannot be used to locate the contacts between the belts and adjacent granitic batholiths.

A positive anomaly with a maximum relief of 16,000 gammas occurs over most of the Rottenfish River belt and is flanked by complementary negative anomalies except at the southwest corner and along the southeast side of the belt. With the exception of the north end and west-central part of the belt, the positive anomaly extends into the adjacent granitic rocks. It thus masks any aeromagnetic reflection produced by the contact of the belt. The highest aeromagnetic reading over the belt was obtained 3 miles south-southwest of Osaokass Lake in an area devoid of outcrop.

During the geological survey, it was observed that compass readings throughout most of the belt and over granitic rocks adjacent to the belt were affected by a magnetic body. Compass deviations over the belt ranged from 15 to 180 degrees; deviations were observed as much as 1 mile east and ½ mile northwest of the belt. In the northern part of the belt two zones of maximum attraction were found and are shown on the geological map (No. 2162, back pocket) by the symbol MA. In part these two zones can be recognized on the aeromagnetic map (O.D.M.-G.S.C. 1967b). No outcrop was found at points of maximum compass deflection.

Seven metamorphosed iron formation units ranging in width from 2 inches to 100 feet were found in the northern part of the belt, but most of these units are on the flanks of the positive aeromagnetic anomaly. The highest aeromagnetic readings generally occur over areas in which no outcrop was found. The only high aeromagnetic readings which were recorded over large outcrops are 2 miles north-northeast of Osaokass Lake. One 20-foot thick metamorphosed iron formation unit was found here, and other units may have been overlooked because only cursory examination could be given the outcrops.

The author believes that the large positive aeromagnetic anomaly over the Rottenfish River belt reflects metamorphosed iron formation which is largely buried by Pleistocene and Recent deposits. The anomaly could be produced by either a thick metamorphosed iron formation unit or by numerous thin units. At the east end of the Sandy Lake belt, a 20,000-gamma anomaly (O.D.M.-G.S.C. 1966a) appears to reflect numerous thin metamorphosed iron formation units separated by mafic metavolcanic layers; the average thickness of the metamorphosed iron formation units is 20 feet (Satterly 1938, p. 16). A similar sequence probably occurs in the Rottenfish River belt.

Several other major conclusions about the Rottenfish River belt can be made from the aeromagnetic data:

1. The narrow, metavolcanic belt west of Otay Lake is a southwestward extension of the Rottenfish River belt.

2. The Rottenfish River belt does not appear to join the Sandy Lake belt mapped by Satterly (1938) southwest of Rottenfish Lake.
3. A narrow metavolcanic unit occurs between Rottenfish and Hill Lakes on the east side of the Rottenfish Lake fault. This unit is separated from the main belt by the fault.
4. Northward extension of the belt beyond the most northerly outcrop found on the Rottenfish River is not justified.

In general the Muskrat Dam Lake belt has a low magnetic intensity which is modified by the presence of many small but high, linear to rarely circular, positive anomalies. The magnetic intensity of most of the belt is about 200 gammas lower than that of the northern granitic batholith and 0 to 100 gammas lower than that of the southern batholith. The positive anomalies have a relief of as much as 15,000 gammas and appear to reflect metamorphosed iron formation and rarely metagabbro.

Isomagnetic lines over the belt are broadly parallel to the contacts between the belt and adjacent batholiths. However, because of the slight but variable difference in intensity between granitic and adjacent metavolcanic or metasedimentary rocks and the distortion produced in the isomagnetic lines by the positive anomalies, aeromagnetic data generally cannot be used to locate the contacts of the belt in areas of low outcrop density. In areas of abundant outcrop it was found that contacts drawn on the basis of aeromagnetic data are as much as 1½ miles in error: along the southern edge of the belt the aeromagnetic contact varies from 1 mile north to 1½ miles south of the defined contact.

Aeromagnetic data (O.D.M.-G.S.C. 1966c; 1967b) suggest that a narrow metavolcanic-metasedimentary belt occurs on the east side of the Windigo River about 14 miles south of Muskrat Dam Lake; this area was not mapped. This assumed belt is separated from the mapped part of the Muskrat Dam Lake belt by the Windigo River fault and appears to extend east-southeast to join the North Caribou Lake belt mapped by Satterly (1939). The anomaly associated with the assumed belt has a maximum width of 1½ miles.

Table 9 | OPAQUE OXIDE CONTENT OF THE MAJOR ROCK TYPES

Rock type	Opaque Oxide Content	
	Greenschist Facies	Amphibolite Facies
Mafic metavolcanics	2%	2%
Felsic metavolcanics	trace	0.3%
Metasediments	trace	1.5%
Metagabbro	1.5%	. . . .
Granitic rocks	0.2%	
Diabase	4.5%	

The estimated mean opaque oxide content of the major lithologic groups is shown in Table 9. If all of the oxide is magnetite, the Muskrat Dam Lake belt should have a higher magnetic intensity than the adjacent granitic rocks. The actual distribution of magnetic intensities indicates that (1) much of the opaque oxide in the metavolcanic, metasedimentary, and metagabbroic rocks is not magnetite, and (2) a member of the ilmenite-hematite series must form a major part of the opaque oxide content of these rocks (see Balsley and Buddington [1958] for further explanation).

This interpretation is supported by the observed association of sphene and leucoxene with the opaque oxide in some rocks in this belt.

In most of the Muskrat Dam Lake belt it is impossible to differentiate aeromagnetically between felsic metavolcanics, mafic metavolcanics, metasediments, and metagabbro. The only major exception to this rule is the eastern part of the Fox Bay metagabbro sill which has a 500 to 1,500 gamma positive anomaly (O.D.M.-G.S.C. 1967a and d). The western part of the sill is essentially non-magnetic although one small anomaly occurs where the sill crosses the Severn River. Two samples from that part of the sill covered by the anomaly contained only 0.5 percent opaque oxides; by comparison the average opaque oxide content of metagabbro in the map-area is 1.5 percent (Table 9). The cause of the anomaly is not known; it may reflect concentrations of iron-titanium oxides within the sill. In the Big Trout Lake area Hudec (1964) reported concentrations of iron-titanium oxides in an anorthosite complex. By comparison the Fox Bay sill is the most leucocratic of the metagabbro sills in the map-area (p. 31) and is partly anorthositic gabbro.

At Fox Bay there is a half-mile wide gap in the anomaly. The east and west parts of the anomaly have an *en échelon* arrangement (O.D.M.-G.S.C. 1967a): the east end of the western part is north of the west end of the eastern part. The east end of the western part of the anomaly occurs over an area in which no outcrops were found although nearby outcrops are metasediments. The anomaly may reflect a bifurcation of the Fox Bay sill.

Serpentinized peridotite on the Severn River, 2 miles west of Sandhill Crane Island, has an 1,100 gamma positive anomaly.

Metamorphosed iron formation units probably produce most of the other positive anomalies in the Muskrat Dam Lake belt. The highest anomaly is between Axe and Willow lakes (O.D.M.-G.S.C. 1966d; 1967e) where several outcrops of metamorphosed iron formation were found. Near Rain Lake aeromagnetic and ground magnetic data indicate two metamorphosed iron formation units, one west and the other north of the lake. The western unit has the higher anomaly and one 20-foot thick exposure of metamorphosed iron formation was found here; the total thickness of the unit was not exposed. No outcrop was found north of the lake, but the anomaly can be traced east-southeast to Munekun Lake where metamorphosed iron formation with an observed thickness of 50 feet was found on the south shore of the lake. The total thickness was not observed. East-southeast of Munekun Lake the anomaly is slightly discordant to the inferred position of the metagabbro sill at Willow Lake. Ground magnetometer readings taken across the anomaly along the Tobogan River by N. Firth (oral communication, 1963) disclosed two positive magnetic anomalies which cannot be differentiated on the aeromagnetic map.

The six major types of granitic rocks in the batholiths (Figure 4 on Chart A, back pocket) have similar magnetic intensities, and the aeromagnetic maps cannot be used to differentiate the intrusive phases of the batholiths. The trend of the isomagnetic lines over the batholiths, however, parallels structural trends within the batholiths. Magnetite-bearing white pegmatite does not have any aeromagnetic expression.

The west-northwest-trending and north-northwest-trending diabase dikes produce small linear aeromagnetic anomalies. The anomaly over the west-northwest-trending dike has a relief of as much as 150 gammas. Part of the north-northeast-trending dike near Beaverskin Lake produces a small anomaly, but the north end of the dike near Cable Lake and the other north-northeast-trending dikes have no aeromagnetic reflection.

As discussed previously (under "Diabase") the west-northwest-trending and north-northeast-trending dikes have distinctly different compositions. Both dikes, however, contain about 4.5 percent iron-titanium oxide, and the aeromagnetic properties suggest that the west-northwest-trending dike has a higher magnetite and a lower hematite-ilmenite content than the north-northeast-trending dikes.

Two 400- to 500-gamma positive anomalies occur over areas where no outcrop was found but which are presumably underlain by granitic rocks. The anomalies are on the north shore of Misiwaweya Lake (O.D.M.-G.S.C. 1966e) and on the Schade River, 2½ miles southeast of Misquamaebin Lake (O.D.M.-G.S.C. 1966g). The cause of the anomalies is not known.

STRUCTURAL GEOLOGY

FOLIATION, SCHISTOSITY, AND CLEAVAGE

Most of the metavolcanic and metasedimentary rocks have a well developed metamorphic foliation which is produced by subparallel orientation of amphibole, chlorite, biotite, and white mica, and by the stretching of fragments. Foliation is poorly developed in the hornblende hornfels facies and is rare or absent in inclusions in granitic rocks and in mafic metavolcanics in the cross syncline north of the Munekun Lake syncline. Metamorphic foliation is rare in metagabbro except in the almandine amphibolite facies (Figure 5 on Chart A, back pocket).

Many of the granitic rocks are also foliated, but the foliation, which is produced by subparallel orientation of hornblende, biotite, and locally plagioclase, quartz, and microcline, appears to be a primary flow structure.

Schistosity is rare and is most common in greenschist facies felsic metavolcanics. Along the south shore of Munekun Lake in the axial zone of the Munekun Lake syncline, however, mafic metavolcanics are schistose and contain abundant carbonate. This schist zone may be a locus along which shearing and flowage were concentrated during folding.

East of the Windigo River fault in the Muskrat Dam Lake belt, metamorphic foliation is generally parallel to primary structures such as bedding and flow contacts. In many places west of the fault, however, especially south of Fox Bay and northwest of the Severn River fault, the foliation is discordant to primary structures. The discordance is as much as 90 degrees, and the discordant foliation appears to be parallel to the axial plane of the major folds. Discordant foliation was also locally found in the Rottenfish River belt.

In many of the rocks the discordant foliation is a pervasive structure, but in thick-bedded muscovite-bearing metagreywacke, the discordant foliation comprises closely spaced cleavages along which there has been a small amount of movement; muscovite is aligned parallel to the cleavages. In some metasediments two foliations are present: (1) an early foliation which is parallel to bedding and (2) a later, discordant foliation.

Slate units have a well developed slaty cleavage (see "Slate" section).

GNEISSOSITY

Gneissosity was found in hornblende hornfels facies mafic metavolcanics (see "Mafic Metavolcanics" section), in some granitic rocks (see "Granitic Phases"; "Equigranular Biotite Phase" section), and rarely in metasediments and felsic metavolcanics. In the mafic metavolcanics, the gneissosity is a secondary structure related to intrusion of the granitic batholiths, and, on the northwest side of the Severn River fault, it postdates the discordant foliation. In the granitic rocks most of the gneissosity appears to be a primary igneous structure, but, on the east side of the Rottenfish Lake fault, gneissosity seems to have been formed in the granitic rocks by movement along the fault.

LINEATION

Secondary lineations which comprise minor fold axes, crinkles in foliation, intersection of foliation and bedding, stretching of fragments and amygdules, and preferred orientation of amphibole, mafic mineral aggregates, and quartz aggregates are common in the metasediments and metavolcanics but are rare in metagabbro and granitic rocks (Figure 4 on Chart A, back pocket). Secondary lineations which are parallel to lineations in adjacent mafic metavolcanics were found in sheared granitic rocks along the north side of the west end of the Muskrat Dam Lake belt. Primary flow lineations were rarely found in the granitic rocks.

Except for minor fold axes, lineation types are not differentiated on the geological maps. Minor folds are best developed in amphibole-bearing metagreywacke and in quartz-cummingtonite-garnet iron formation.

Many lineations plunge steeply at an angle that appears to be greater than the plunge of the axis of the enclosing fold. Some of these lineations may be *a* lineations which represent major flowage or movement directions during folding.

JOINTS

Joints are a ubiquitous, secondary structure throughout the map-area, but only a few strongly developed joint sets were recorded because of lack of space on aerial photographs and basemaps. Granitic rocks south of the Muskrat Dam Lake belt appear to have fewer joints than those north of the belt. In granitic rocks early joints are occupied by pegmatite and aplite dikes; later joints cut these dikes and locally contain epidote, chlorite, and quartz veins. Some of the late joints are stained by hematite.

On the east side of the Rottenfish Lake fault, strongly developed joints are found in many granitic outcrops and are parallel to east-trending faults.

MAJOR FOLDS

The trace of the axial planes of the major folds, as interpreted from available structural and stratigraphic data, are shown in Figure 4 (Chart A, back pocket); some of the folds are well documented but others are based on scanty data. Two main groups of folds were recognized: (1) upright to slightly overturned, isoclinal folds that trend parallel to the axis of the metavolcanic-metasedimentary belt and are the dominant structural element; and (2) isoclinal cross folds that trend approximately perpendicular to the first group of folds. The first group was locally warped about subvertical axes, possibly during intrusion of the granitic batholiths.

In the Muskrat Dam Lake belt the first group of folds comprises a syncline on the east side of the Windigo River fault and an anticline and two flanking synclines on the west side of the fault. An isoclinal anticline appears to be the dominant structure in the Rottenfish River belt. Only two major cross folds were recognized, both in the Muskrat Dam Lake belt. It is not known whether the cross folds are the same age as, or are younger than, the large isoclinal folds.

The large isoclinal folds appear to have a variable plunge. At the east and west ends of the Muskrat Dam Lake belt they plunge steeply, but elsewhere in the belt the plunge appears to be relatively gentle.

Flowage must have been a major factor in formation of the isoclinal folds, and evidence of flowage includes stretched fragments in metaconglomerate and metavolcanic breccia, well developed lineation, flattened pillows, and a schist zone along the axis of the Munekun Lake syncline. There is no evidence of flowage, however, in the isoclinally cross-folded syncline at Munekun Lake; there, mafic metavolcanics and metagabbro are massive with locally well preserved primary textures, and pillows in the mafic metavolcanics are not distorted (Photo 3).

The major folds apparently began to form before intrusion of the Fox Bay metagabbro sill (see "Intrusive Rocks"; "Uralitized and Metamorphosed Gabbro and Diorite" section); major fold movement must have ceased before intrusion of the youngest granitic rocks because the discordant axial plane(?) foliation is obliterated at the edges of the belts by gneissosity which was produced by the granitic batholiths.

FAULTS

Many faults were recognized, but others were probably overlooked because of the low outcrop density in many parts of the area. Most of the faults are subvertical and have diverse trends; the largest amount of movement, however, seems to have been along faults which trend between north-northeast and north-northwest (Figure 4 on Chart A, back pocket). Fault movement ranges from a few inches to many hundreds of feet, but the maximum amount of movement is not known.

The following criteria were used to identify faults: (1) negative lineaments, (2) scarps, (3) stratigraphic or structural offset, (4) strongly developed joint sets, (5) subsidiary faults including schist and mylonite zones, (6) schistose wallrock, (7) granulated and recrystallized wallrock, (8) quartz veins along, or parallel to, the fault and in tension joints near the fault, and (9) wallrock alteration including epidotization, hematitization, and silicification. Not all negative lineaments are the surface expression of faults.

The north-northwest-trending Windigo River fault has cut the Muskrat Dam Lake belt into two segments which are distinctly different in structure and stratigraphy (Figure 4). Two sheared and silicified outcrops on the Windigo River must be close to the fault, but elsewhere the fault cannot be precisely located because of paucity of outcrop. The vertical component of movement along the fault appears to have been greater than the horizontal component, and the east side apparently moved up relative to the west side.

The northern 8 miles of the north-northeast-trending Rottenfish Lake fault forms part of the eastern boundary of the Rottenfish River belt, but the southern part of the fault is entirely within granitic rocks. The northern part of the fault ends against the west-northwest-trending Rottenfish River fault. Granitic rocks adjacent to the fault are highly sheared, granulated, and recrystallized, and at Rottenfish Lake, the sheared zone is at least 2,000 feet wide on each side of the fault. The sheared zone decreases in width northward, and, adjacent to the Rottenfish River belt, it is about 500 feet wide. Shearing is less pronounced in the mafic metavolcanics and metagabbro of the belt and is restricted to a 200-foot wide highly foliated and locally schistose zone; quartz veins are common in this zone and rare talc and serpentine veins were found. Adjacent to the Rottenfish River belt, the sheared granitic rocks generally form a prominent scarp which is as much as 100 feet high. The shearing at Rottenfish Lake was first recognized by Satterly (1938, p. 32).

At the fault, the granitic rocks have been completely granulated and recrystallized to a granular mozaic of 0.1-millimetre grains and are locally thinly layered. A few feet away from the fault, the rock is only partly granulated, and granulation is concentrated along foliation planes and microscopic fractures; non-granulated grains are highly strained and fractured. Rocks containing abundant microcline are more highly granulated than those lacking microcline. Phenocrysts in porphyritic granitic rocks have been sheared into ovoid augens.

On the east side of the Rottenfish River belt, the sheared granitic rocks are gneissic with quartz-rich, microcline-rich, plagioclase-rich, and mafic mineral-rich layers, and range in composition from tonalite to quartz monzonite; the various rock types are intimately interlayered. The gneissosity and interlayering appear to be the result of differentiation which was caused by movement along the fault. At the exit from Rottenfish Lake, the sheared granitic rocks have a more uniform composition although the mafic minerals have been concentrated into very thin crenulated layers and lenses. Highly lenticular mafic metavolcanic inclusions are common in all of the sheared granitic rocks.

The north-trending Hill Lake fault is a branch of the Rottenfish Lake fault and has also produced a similar wide sheared zone in its granitic wallrocks. Several 2-foot to 3-foot wide north-trending shear zones within the early mafic granitic phase appear to be related to this fault.

The wide recrystallized granulated zone and the differentiation of the granitic wallrocks within this zone suggest that both the Rottenfish Lake and Hill Lake faults are relatively early, deep-seated faults. All granitic phases adjacent to the faults are sheared, but because a higher proportion of aplite dikes are concordant to the foliation than elsewhere in the batholiths, shearing may have been initiated during intrusion. Shearing probably continued for a long period of time, and late movement along the Rottenfish Lake fault is suggested by the presence of the scarp. The greenschist facies zone in the Rottenfish River belt adjacent to the Rottenfish Lake fault (Figure 5 on Chart A, back pocket) may be a retrograde zone related to movement along the fault.

The Rottenfish Lake fault is offset by several east-trending faults which appear to have brittle movement. The wallrock is altered, hematitized, and locally epidotized but is not granulated. Strong joints, which locally contain quartz and epidote veins parallel the faults, and 1-foot to 3-foot wide layered mylonite zones were found near, and parallel to, several faults.

Other than the schistose zone in mafic metavolcanics in the axial zone of the

Munekun Lake syncline, no major orogenic shear zones were recognized within the metavolcanic-metasedimentary belts. During granitic intrusion, however, some shearing apparently occurred along the Rottenfish Lake and Hill Lake faults and locally along the margins of the batholiths (p. 41). Most of the faults which were recognized have post-orogenic, brittle movement.

ECONOMIC GEOLOGY

There are no known economic mineral concentrations in the map-area although quartz veins are abundant and 22 sulphide mineral concentrations were found (Figure 7 on Chart A, back pocket). Metamorphosed iron formation was found at several localities, and aeromagnetic data suggest that iron formation is more abundant than the few outcrops that were found would indicate. Prospecting is hampered by the paucity of outcrops, the thick drift cover, the lack of aeromagnetic maps prior to 1966, and the great distance from existing roads and railways.

Prospectors have been active in the area since at least 1937, and, during the 1963 and 1964 field seasons, twelve prospectors worked in the area. The only evidence of exploration which was found, other than surface prospecting, are two pits of unknown age at the west end of Muskrat Dam Lake. In 1964, 19 claims were staked on the east side of the Windigo River but these have since lapsed. There are currently (1966) no claims in the map-area, and no data has yet been submitted for assessment work.

Because of the reconnaissance nature of the survey, sulphide mineral concentrations and mineralized quartz veins could not be examined in detail and thus cannot be properly evaluated. As an aid to future prospecting, however, most observed sulphide concentrations and some mineralized quartz veins are described even though the majority contain only trace amounts of economically important elements.

QUARTZ VEINS

Concordant and discordant quartz veins are present in all rock types but are rare in late mafic dikes.

Concordant veins are generally lenticular; their average width is less than 1 inch, but some veins are as much as 3 feet wide. In the Muskrat Dam Lake belt, they are most abundant in the contact metamorphic aureole adjacent to the granitic batholiths, especially in the gneissic mafic metavolcanics north of Pike Lake and in the metasediments along the north edge of the belt. In the Rottenfish River belt, they appear to be most abundant near the Rottenfish Lake fault. On islands in the western part of Muskrat Dam Lake, pillowed mafic metavolcanics contain lenticular quartz pods that are as much as 6 feet long and range in width from 6 inches to 3 feet. A grab sample collected by the author from one pod gave upon assay 0.01 ounces of gold per ton (Figure 7 on Chart A, back pocket). Many of the concordant veins appear to be genetically related to contact metamorphism.

In the Muskrat Dam Lake belt discordant quartz veins are most abundant near faults, in felsic metavolcanics south of Fox Bay, and in the Munekun Lake metagabbro sills in the axial zone of the Munekun Lake syncline; they are rare in the Rottenfish River belt. Discordant veins pinch and swell but can generally be traced for long distances along strike. The veins are generally less than 1 foot wide and, near the faults, locally form stockworks. Rare *en échelon* vein systems were found.

Both types of veins are generally white or pale-blue, transparent to translucent, and fine- to coarse-grained. The quartz is commonly anhedral, but euhedral crystals were found in one vein in granitic rocks about 3 miles northwest of Blackwater Bay. Rusty-weathering veins which contain minor pyrite and rare chalcopyrite are locally found.

Grab samples were collected by the author and his assistants from 99 quartz veins (Figure 7). These samples were fire assayed for gold and were tested for 29 other elements by qualitative spectrographic analysis. Most samples contained trace amounts of gold, but only three samples contained as much as 0.01 ounces of gold per ton (Figure 7). Each of these three veins is in a different host rock, but all are in the Muskrat Dam Lake belt near the boundary between the greenschist and almandine amphibolite facies (compare Figure 5 and Figure 7 on Chart A, back pocket).

The qualitative spectrographic analyses showed trace amounts of copper, manganese, and titanium in 40 percent of the samples and trace amounts of chromium, lead, nickel, vanadium, and zirconium in several samples. One sample from a rusty-weathering vein in mafic metavolcanics in the Rottenfish River belt contained 0.1 percent copper (Figure 7). Veins within metagabbro appear to contain a higher concentration of trace elements than veins in other rock types.

On the north bank of the Severn River near its outlet into Muskrat Dam Lake, an 8-foot by 8-foot pit had been sunk through 4 feet of clay to expose the contact between a black quartz vein and metagabbro. The quartz vein is at least 5 feet wide, trends N30°W, and contains disseminated pyrite. Two grab samples collected by the author gave upon assay trace amounts of gold, copper, and lead. Twenty feet west of the pit, a 15-foot long by 3-foot wide trench had been sunk to a depth of 4 feet in clay; no bedrock is exposed in the trench.

Quartz veins formed throughout a long period of time. Fragments from early veins are found in some of the metaconglomerate units. Late veins are found in granitic rocks and diabase dikes and along some of the late brittle faults.

GOLD

In 1937, J. O. Lingman prospected in the Rottenfish River belt and panned gold from several quartz veins east of the river (written communication to J. Satterly, 1937). In an unsuccessful attempt to find these gold-bearing quartz veins, the author and his assistants collected grab samples from 22 veins within this belt (Figure 7). These samples contained only trace amounts of gold, but a grab sample collected by the author from a chalcopyrite-pyrite-rich quartz lens in metagabbro gave upon assay 0.02 ounces of gold per ton (Figure 7 on Chart A, back pocket). As previously mentioned three veins in the Muskrat Dam Lake belt contained 0.01 ounces of gold per ton.

SULPHIDE MINERAL CONCENTRATIONS

Trace amounts of pyrite, pyrrhotite, and rarely chalcopyrite are found in most rocks within the metavolcanic-metasedimentary-metagabbroic belts, but concentrations of sulphide minerals, dominantly pyrite and pyrrhotite, are rare (Figure 7 on Chart A, back pocket). Rocks containing between 1 and 10 percent sulphide minerals were found at 17 localities, and rocks containing more than 10 percent sulphide minerals were found at only five localities (Figure 7). Most of these sulphide mineral concentrations are within the greenschist facies zone (compare Figures 5 and 7), and the greatest density of sulphide mineral concentrations is along the north side of the eastern part of Muskrat Dam Lake.

Felsic metavolcanics locally contain 1 to 2 percent disseminated subhedral pyrite and have rusty weathered surfaces. These occurrences are not plotted in Figure 7 but are most abundant north of the Severn River about 10 miles west of Sandhill Crane Island. The black slate unit along the Severn River about 7 miles west of Sandhill Crane Island also locally contains disseminated pyrite and rare narrow pyrite veins.

In the following sections, the sulphide mineral concentrations plotted in Figure 7 are described in geographic order, beginning at the west side of the area.

ROTTENFISH RIVER BELT

The northern occurrence is a narrow rusty-weathering felsic metavolcanic unit that occurs between two thick mafic flows and contains about 5 percent disseminated pyrite. A grab sample collected by the author from this occurrence gave upon assay trace amounts of gold and copper.

The central showing is a rusty-weathering mafic metavolcanic flow which contains 1 to 5 percent pyrrhotite as disseminations and narrow veins; no sample was collected for assay.

The southern locality is in a metagabbro sill where a 2-inch to 3-inch wide quartz lens contains 5 to 10 percent pyrite and rare chalcopyrite; disseminated sulphides also occur in the metagabbro adjacent to the lens. As previously mentioned, a grab sample collected by the author from this lens gave upon assay 0.02 ounces of gold per ton and also contained 0.2 percent copper and trace amounts of nickel.

NORTH OF THE SEVERN RIVER FAULT

A sheared felsic dike which intruded metagabbro north of the Severn River fault contains about 5 percent disseminated pyrite. A grab sample collected by the author from this dike was assayed but contained no precious or base metal elements.

FOX BAY

At the west end of Fox Bay, an amygdaloidal metavolcanic flow of intermediate composition contains 2 to 3 percent pyrite and rare chalcopyrite; the pyrite is concentrated near the quartz amygdules. A grab sample collected by the author from this flow contained 0.1 percent copper and trace amounts of gold and nickel.

On the south shore of the bay, disseminated pyrite, pyrrhotite, and rare chalcopyrite were found in calc-silicate rocks and marble adjacent to a 1-foot wide unmineralized discordant quartz vein which trends N55°W. Three grab samples collected from the quartz vein and mineralized wallrock by V. A. Jones, the author's senior assistant, gave upon assay trace amounts of gold and copper.

Between Fox Bay and the Severn River, disseminated pyrite and rare chalcopyrite were observed in interbedded felsic metavolcanics and muscovite-bearing metagreywacke. No samples were collected for assay.

SANDHILL CRANE ISLAND

The matrix and rarely the pebbles of metaconglomerate exposed at the northwest corner of Sandhill Crane Island have been replaced by disseminated to massive pyrrhotite and by concordant lenses of massive pyrite as much as 2 inches wide; rare chalcopyrite is associated with both the pyrite and pyrrhotite. The amount of sulphide minerals is highly variable, but the mineralized zone is exposed along strike for at least 300 feet. The surface of the outcrop is only locally rusty, and the rust appears to be related to ferruginous chert pebbles rather than to the sulphide mineralization. Three grab samples collected by the author from the metaconglomerate contained trace to 0.1 percent copper and trace amounts of gold and nickel.

SEVERN RIVER

On the south side of the Severn River east of Sandhill Crane Island, metagabbro of the Muskrat Dam Lake sill contains 2 to 3 percent disseminated pyrite and rare chalcopyrite. No samples were collected for assay.

WINDIGO RIVER

Two sulphide mineral concentrations were found in a metagabbro sill east of the Windigo River. At the north locality, 5 to 10 percent disseminated pyrite, sparse 1-millimetre to 2-millimetre wide pyrite veins, and rare chalcopyrite are associated with numerous poorly mineralized quartz lenses as much as 2 feet wide in a sheared phase of the sill. The mineralized zone was traced along strike for several hundred feet. Two grab samples collected by the author from this zone gave upon assay trace to 0.1 percent copper and trace amounts of gold and nickel.

About 2 miles south of the above locality, rare lenses of massive pyrite and chalcopyrite as much as 6 inches long were found in the sill. A grab sample collected by the author from one lens contained 1.22 percent copper and a trace amount of gold.

Pillowed mafic metavolcanics in an isolated outcrop between Red Sucker Lake and the Windigo River locally have a rusty weathered surface and contain about 5 percent disseminated pyrite and rare chalcopyrite. No samples were collected for assay.

BLACKWATER BAY

Near the mouth of Blackwater Bay, a 2-foot thick rusty-weathering metasedimentary unit, which is interbedded with hornblende-bearing metagreywacke, contains 5 to 10 percent pyrite as thin concordant lenses. A grab sample collected by the author from this unit gave upon assay trace amounts of gold and copper.

EASTERN PART OF MUSKRAT DAM LAKE

Numerous sulphide mineral concentrations occur along or near the north shore of the eastern part of Muskrat Dam Lake (Figure 7 on Chart A, back pocket) in a cross folded area characterized by rapid vertical and lateral changes in lithology.

The western occurrence is a garnetiferous mafic metavolcanic flow on the lakeshore which contains 1 to 2 percent disseminated arsenopyrite. A grab sample collected by the author from this flow contained trace amounts of cobalt, copper, lead, nickel, and zinc.

Also on the lakeshore but 600 feet east of, and stratigraphically above this flow, a metavolcanic breccia outcrop of intermediate composition contains about 5 percent disseminated pyrrhotite and pyrite. A grab sample collected by the author from this unit gave upon assay trace amounts of cobalt, copper, lead, and nickel.

Five hundred feet east of, and four hundred feet stratigraphically above the breccia, a porphyritic felsic metavolcanic outcrop on the lakeshore contains 2 to 3 percent disseminated pyrite. A grab sample collected by the author from this outcrop contained trace amounts of copper, lead, and nickel.

Interbedded felsic metavolcanic flows and pyroclastic rocks, which occur about 3,500 feet northeast of the previous locality and are part of the same felsic unit, locally weather rusty and contain trace to 10 percent disseminated pyrite and pyrrhotite. The mineralization occurs throughout the felsic metavolcanic part of the outcrop but is most abundant in pyroclastic breccia. No samples were collected for assay.

On a point about 1.5 miles east of the previous lakeshore occurrence, mineralized locally rusty-weathering metaconglomerate forms units as much as 20 feet thick within unmineralized interbedded metagreywacke and slate. The matrix and rarely the pebbles of the metaconglomerate were replaced by disseminated to massive pyrite and rare pyrrhotite; concordant lenses of massive pyrite as much as 2 inches wide and 1 foot long are locally present. Mineralized metaconglomerate units are exposed for about 1,500 feet along the shore of the lake, but the amount of mineralization is highly variable. Five grab samples collected by the author and his assistants from the metaconglomerate gave upon assay trace amounts of gold, cobalt, copper, lead, nickel, and zinc. Except for the higher pyrite to pyrrhotite ratio and the more varied trace element content, this mineralized metaconglomerate resembles the previously described occurrence on Sandhill Crane Island.

On the south shore of the eastern part of Muskrat Dam Lake, a small isolated rusty weathering metaconglomerate outcrop contains 10 to 20 percent disseminated pyrite and pyrrhotite, rare chalcopyrite, and possibly galena. A grab sample collected from this outcrop by V. A. Jones, the author's senior assistant, gave upon assay trace amounts of gold, silver, copper, and nickel; no lead was found.

RAIN LAKE

About half a mile east of Rain Lake, minor disseminated pyrite and rare chalcopyrite were found in mafic metavolcanics near the contact with a diabase dike. No samples were collected.

Two miles northeast of Rain Lake, small irregular areas in a garnetiferous biotite-bearing metagreywacke and metasiltstone outcrop weather rusty. These areas contain 1 to 3 percent disseminated pyrrhotite and rare pyrite while the rest of the outcrop contains only trace amounts of sulphide minerals. No samples were collected.

MUNEKUN LAKE

On a small mafic metavolcanic island in the western part of Munekun Lake, massive pyrite was found in the interstices between pillows and in a 6-inch wide vein which trends N50°E. No samples were collected.

SUMMARY

The greatest density of sulphide mineral concentrations is in the greenschist facies zone in the eastern part of Muskrat Dam Lake where a major syncline is complicated by a synclinal cross fold. This area is characterized by rapid lateral and vertical changes in lithology, and within an area of 2 square miles the following rock types were found: metaconglomerate, metagreywacke, metasiltstone, slate, felsic metavolcanic flows and pyroclastic rocks, intermediate metavolcanic pyroclastic breccia, and mafic metavolcanic flows. Sulphide mineral concentrations are most abundant in felsic metavolcanics and metaconglomerate but contain only trace amounts of economically important elements.

In comparison with sulphide mineral concentrations elsewhere in the map-area, those in the eastern part of Muskrat Dam Lake have a greater variation in trace element content (Figure 7 on Chart A, back pocket).

The greenschist facies zone in this area of complex lithology in the eastern part of Muskrat Dam Lake warrants detailed prospecting. Prospecting would be hampered, however, by lack of outcrop on many of the islands and along the south shore of the lake.

COPPER

Of 99 quartz veins and 14 sulphide mineral concentrations sampled, only one quartz vein and two sulphide mineral concentrations contained more than 0.1 percent copper (Figure 7), and only one of these contained more than 0.2 percent copper.

An assay of 1.22 percent copper was obtained from a 6-inch long massive pyrite-chalcopyrite lens in a well exposed, metagabbro sill on the east side of the Windigo River (see "Sulphide Mineral Concentration"; "Windigo River" section). Several of these small massive sulphide lenses were found during a rapid examination of this part of the sill, and detailed prospecting might lead to the discovery of larger lenses.

LEAD AND ZINC

In 1938, S. Staunton (written communication to J. Satterly, 1938) found a 1-foot to 2-foot wide vein containing galena and sphalerite at a portage on the Severn River near the east end of Muskrat Dam Lake. The vein was reported to be 60 feet long. Portages at the east end of Muskrat Dam Lake are no longer in use, and neither the portages nor the vein were found during a short search. Trace amounts of lead and rarely zinc, however, were found in the sulphide mineral concentrations in the eastern part of Muskrat Dam Lake.

IRON

Concentrations of iron, in the form of magnetite, were found in metamorphosed iron formation and in white pegmatite sills.

Metamorphosed iron formation units were described in a previous section. No assays were made, but the thickest and most iron-rich units were found at the north end of the Rottenfish River belt (30 to 100 feet thick) and on the south shore of Munekun Lake (50 feet thick) and appear to contain about 20 percent iron; iron content is highly variable within each unit. Iron formation in the Rottenfish River belt has been metamorphosed to the almandine amphibolite facies and iron formation at Munekun Lake has been metamorphosed to the upper part of the greenschist facies.

Aeromagnetic and ground magnetic data suggest that extensive metamorphosed iron formation units are buried beneath glacial drift between Willow and Axe lakes (p. 54).

Several narrow white pegmatite sills within the granitic batholiths contain concentrations of magnetite (see "Granitic Phases"; "Pegmatite and Aplite" section). The largest observed concentration was in a 2-foot thick sill about 14 miles north-northwest of Sandhill Crane Island; this sill contains about 15 percent magnetite.

SAND AND GRAVEL

Concentrations of gravel occur in the Pleistocene eskers and end and interlobate moraine, but concentrations of sand are restricted to large outwash areas near eskers (Figure 6 on Chart A, back pocket).

Because a large part of the map-area is covered by swamp and muskeg, any future road construction will be difficult unless the roads trend northeast along one of the eskers or north along the Sachigo interlobate moraine.

CLAY

Extensive deposits of Pleistocene varved clay which are as much as 20 feet thick occur in the western part of the area (Figure 6 on Chart A, back pocket). No samples were collected for testing, but a sample which was collected by Hurst (1929) from similar deposits on the north side of the West Arm of Sandy Lake was tested by R. J. Montgomery of the Ceramics Department, University of Toronto who reported (in Hurst [1929, p. 84]; also in Satterly [1938, p. 39]) that "unless it [the clay] is near some centre of population it would have very little economic value".

RECOMMENDATIONS FOR FUTURE MINERAL EXPLORATION

Only minor amounts of gold were found by the author, but, because the three veins and one sulphide mineral concentration which were found to contain more than trace amounts of gold occur within the greenschist facies zone, this zone should be examined for other, possibly richer, gold-bearing veins. The greenschist facies zone in the Rottenfish River belt, especially near the Rottenfish Lake fault should be examined in detail because of the reported occurrence of gold in this belt. Other areas which may be favourable loci for gold mineralization are the schistose axial zone of the Munekun Lake syncline along the south shore of Munekun Lake and the sheared nose of this fold which is exposed six miles east of Munekun Lake.

As previously mentioned the most favourable area for sulphide mineralization appears to be the greenschist facies zone in the eastern part of Muskrat Dam Lake. The reported galena-bearing vein in this area should be sought and examined for possible silver content. Another favourable area appears to be the thin gabbro sill on the east side of the Windigo River.

The large aeromagnetic anomalies in the Rottenfish River and Muskrat Dam Lake belts reflect buried iron formation. It was impossible to determine, however, whether the anomalies were caused by thick iron formation units or by a large number of thin units such as cause the large anomaly in the Sandy Lake area (p. 52).

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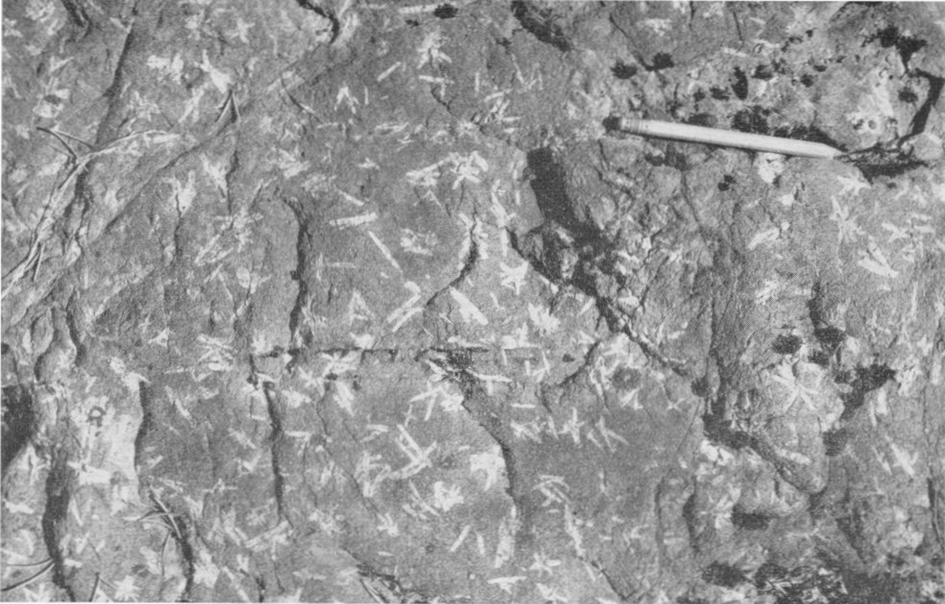

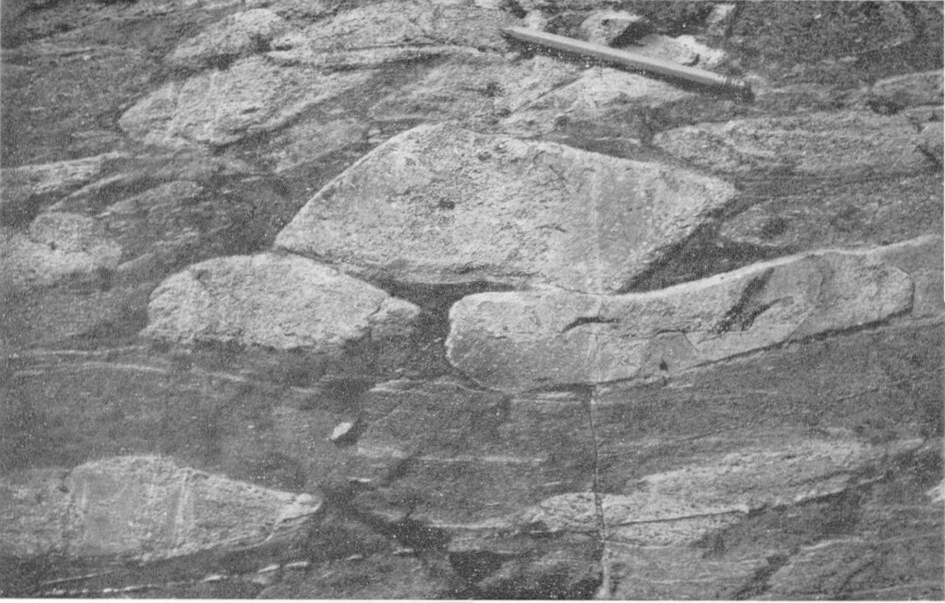

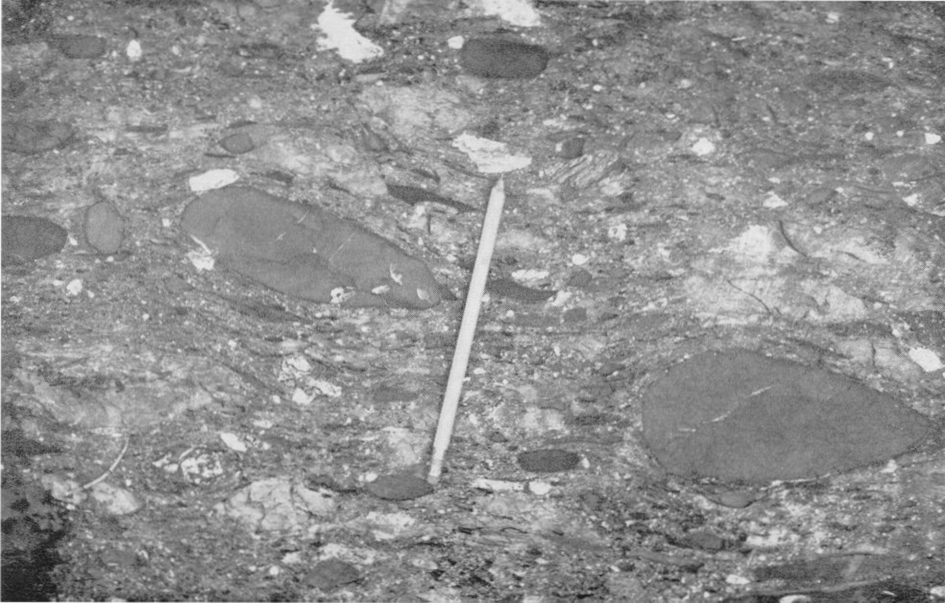

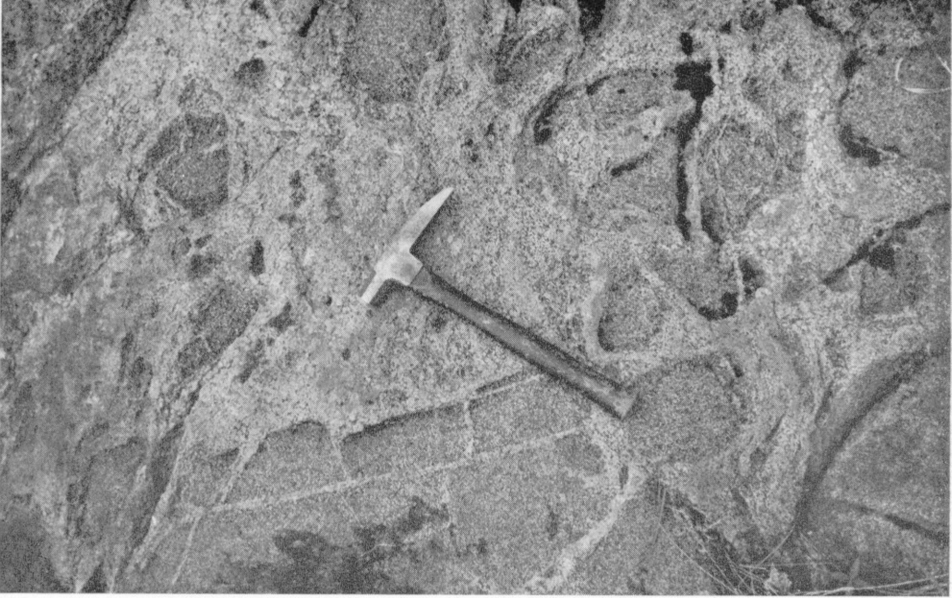

Muskrat Dam Area Report
Chart A
Figures 4 to 7

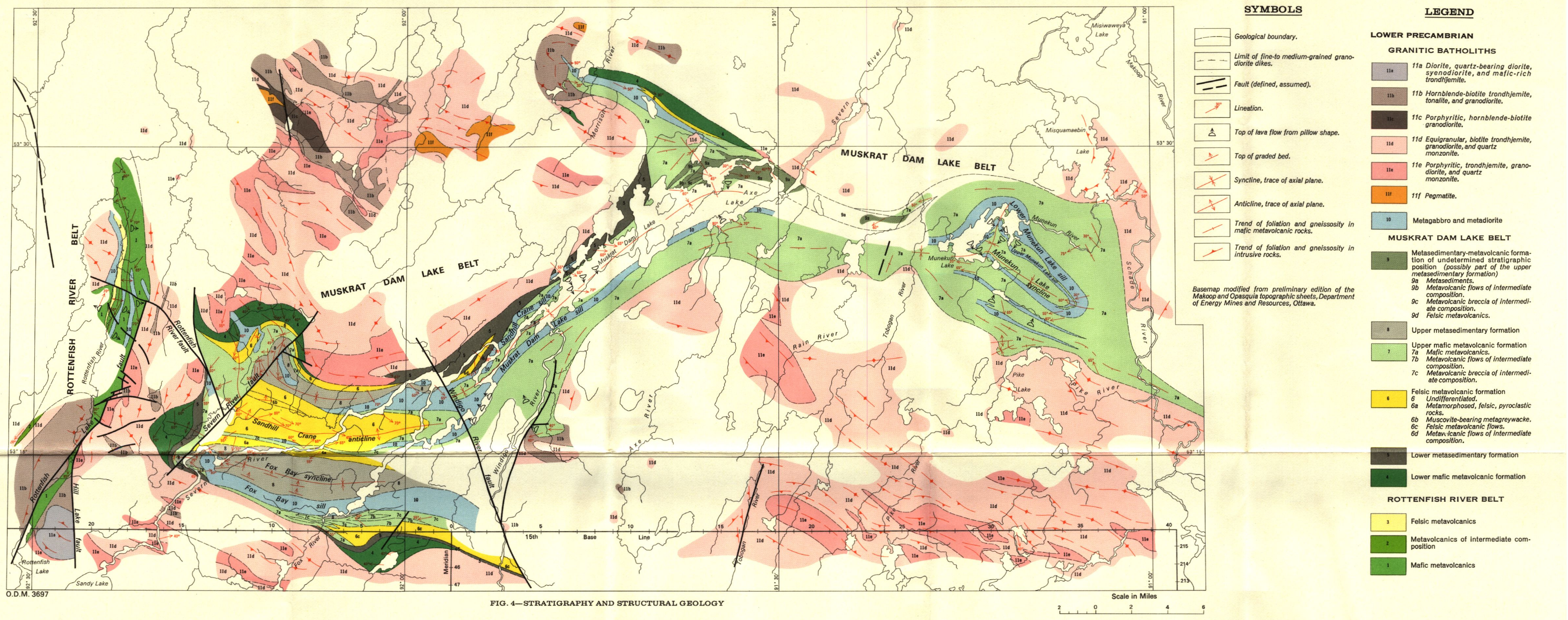

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FIG. 4—STRATIGRAPHY AND STRUCTURAL GEOLOGY

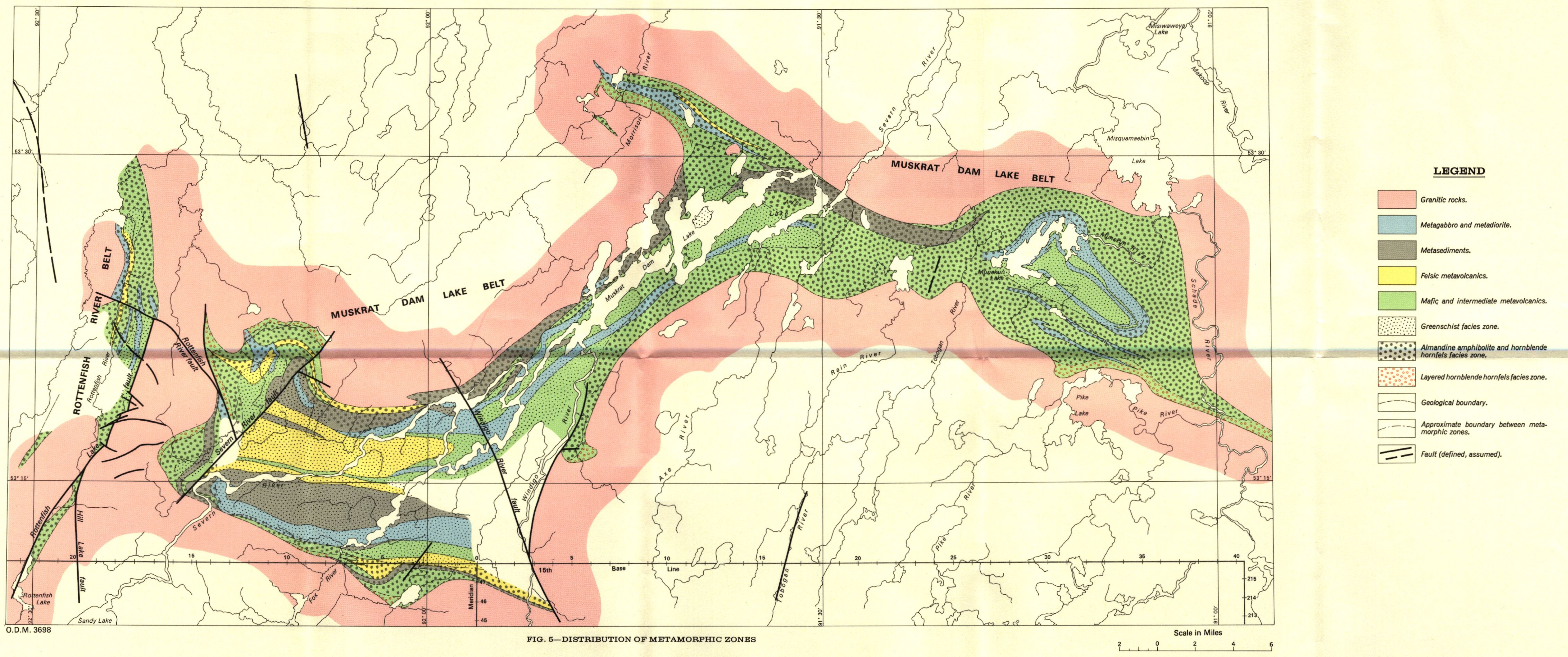

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FIG. 5—DISTRIBUTION OF METAMORPHIC ZONES

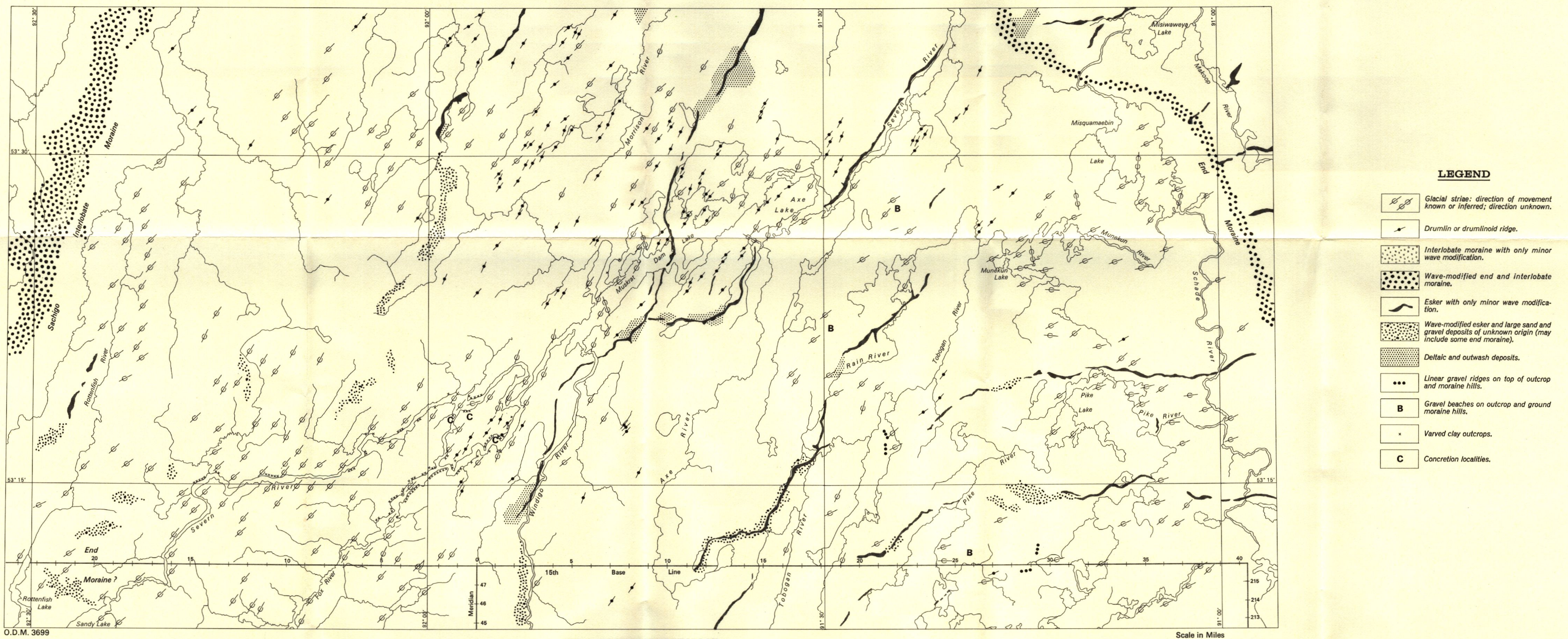

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FIG. 6—PLEISTOCENE GEOLOGY

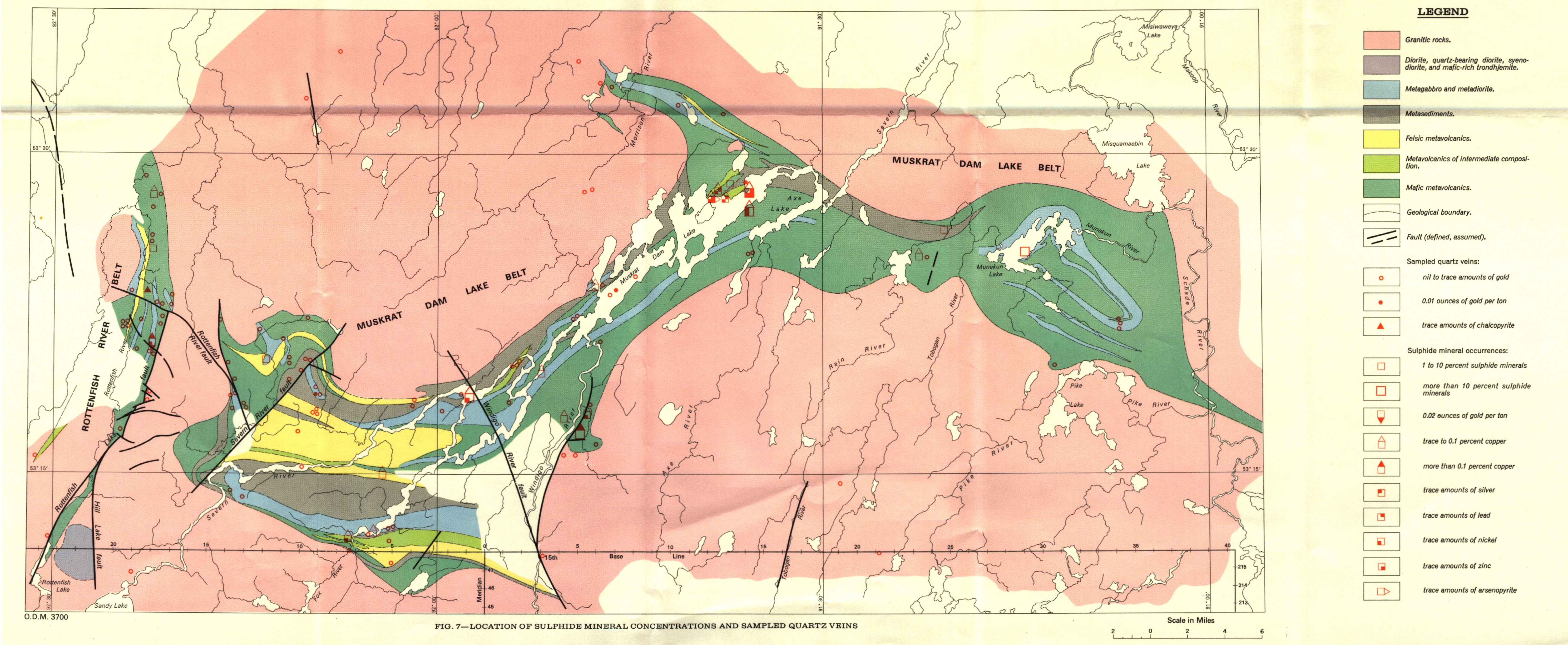

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FIG. 7—LOCATION OF SULPHIDE MINERAL CONCENTRATIONS AND SAMPLED QUARTZ VEINS

LEGEND

CENOZOIC*

RECENT

Organic mud; lacustrine and fluvial clay, silt, and sand.

PLEISTOCENE

Till, lacustrine varved clay and silt, fluvial sand and gravel, beach sand and gravel.

UNCONFORMITY

PRECAMBRIAN (?)**

13 *Diorite.†*

INTRUSIVE CONTACT (?)

PRECAMBRIAN**

DIABASE

12a *Diabase (lacks olivine).*
12b *Olivine diabase.*
12c *Granophyre.†*

INTRUSIVE CONTACT (?)

LAMPROPHYRE

11 *Lamprophyre.*

INTRUSIVE CONTACT

GRANITIC BATHOLITHS

Granitic phases

10 *Undifferentiated.*[a]
10a *Equigranular, hornblende-biotite tonalite, trondhjemite, and granodiorite.*
10b *Quartz-poor, hornblende-biotite tonalite and trondhjemite (contaminated phase of 10a).†*
10c *Porphyritic, hornblende-biotite trondhjemite and granodiorite.*
10d *Fine-grained, trondhjemite dikes.†*
10e *Equigranular, medium-grained, massive to foliated, biotite trondhjemite, granodiorite, and quartz monzonite.*
10f *10e with 10 to 50 percent mafic metavolcanic inclusions.*
10g *Gneissic phase of 10e.*
10h *Coarse-grained phase of 10e.†*
10j *Porphyritic biotite trondhjemite.*
10k *Porphyritic biotite grandiorite and quartz monzonite.*
10m *Fine-to-medium-grained granodiorite dikes.†*
10n *Late, hornblende-biotite trondhjemite dike.*
10p *Aplite and fine-to-medium-grained, leucocratic granodiorite and quartz monzonite.*
10q *Pink pegmatite.*
10r *White pegmatite.*
10s *Sodic syenite.*

INTRUSIVE CONTACT

Early mafic phase

9a *Medium-grained diorite, quartz-bearing diorite, syenodiorite, and mafic-rich trondhjemite.*
9b *Coarse-grained phase of 9a.*

INTRUSIVE CONTACT (?)

LATE (UNMETAMORPHOSED), PORPHYRITIC FELSIC DIKES

8a *Porphyritic tonalite.*
8b *Porphyritic trondhjemite and sodic granite.*

INTRUSIVE CONTACT

URALITIZED AND METAMORPHOSED GABBRO AND DIORITE

7a *Gabbro and diorite.*
7b *Anorthositic gabbro, gabbroic anorthosite, and anorthosite.*
7c *Serpentinized peridotite.†*
7d *Albite granite.*

INTRUSIVE CONTACT

EARLY (METAMORPHOSED) FELSIC INTRUSIONS[b]

6a *Pre-gabbro, plagioclase porphyry.*
6b *Post-gabbro, equigranular, garnetiferous, potassic muscovite granite and pegmatite.*
6c *Plagioclase-quartz porphyry sill (?).†*

INTRUSIVE CONTACT

METAMORPHOSED IRON FORMATION

5a *Metamorphosed iron formation.*
5b *Ferruginous metasediments.*
5c *Aluminous iron formation and ferruginous metasediments.*

METASEDIMENTS[c]

4 *Undifferentiated.*
4a *Muscovite-bearing metagreywacke and metasiltstone.*
4b *Biotite-bearing metagreywacke and metasiltstone.*
4c *Amphibole-bearing metagreywacke and metasiltstone.*
4d *Garnetiferous metagreywacke and metasiltstone.*
4e *Cordierite-, andalusite-, and staurolite-bearing metagreywacke and metasiltstone.*
4f *Grey slate.*
4g *Black slate.*
4h *Polymictic pebble metaconglomerate.*
4j *Marble.*
4k *Calc-silicate gneiss and granofels.*
4m *Non-ferruginous metachert.*

FELSIC METAVOLCANICS

3 *Undifferentiated.*
3a *Felsic flows.*
3b *Metatuff and fine-grained metalapillistone.*
3c *Coarse-grained metalapillistone and metamorphosed pyroclastic breccia.*
3d *Felsic rocks of possible ash-flow tuff origin.†*

METAVOLCANICS OF INTERMEDIATE COMPOSITION

2 *Undifferentiated.*
2a *Flow rocks, commonly amygdaloidal.*
2b *Metamorphosed pyroclastic breccia and coarse-grained metalapillistone: matrix more felsic than fragments.*
2c *Metamorphosed pyroclastic breccia and coarse-grained metalapillistone: matrix more mafic than fragments.*
2d *Metatuff and fine-grained metalapillistone.*

MAFIC METAVOLCANICS[c]

1 *Undifferentiated.*
1a *Thick mafic flows (contain metagabbro-like central parts).*
1b *Pillowed, mafic metavolcanic flows.*
1c *Porphyritic, mafic metavolcanics.*
1d *Mafic metavolcanic breccia.*
1e *Mafic metatuff.*
1f *Garnetiferous mafic metavolcanics.*
1g *Gneissic mafic metavolcanics.*
1h *Coarse-grained clinopyroxene-microline layer.†*

---

mag *Magnetite.*
q *Quartz vein or lens.*
S *Sulphide mineralization.*

**Unconsolidated deposits. In general, Cenozoic deposits are represented by the lighter coloured and uncoloured parts of the map. Some special Pleistocene deposits are stippled.*

***Bedrock geology. Outcrops and inferred extensions of each rock map unit are shown respectively in deep and light tones of the same colour. Where, in places, a formation is too narrow to show colour and must be represented in black, a short black bar appears in the appropriate colour block. Uncoloured parts of the map represent (a) unmapped areas (labelled on map face), and (b) areas in which outcrop is rare or absent (see report for explanation).*

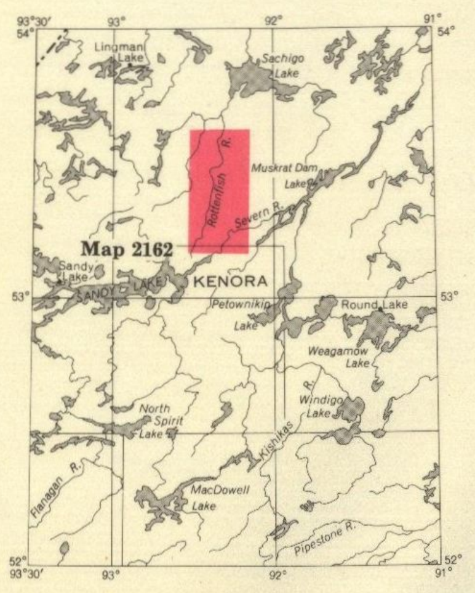
[a] *Marks outcrops which were not examined on the ground but were located by aerial observation or by aerial photograph interpretation.*

[b] *Includes intrusions of several ages.*

[c] *Forms two formations in the Muskrat Dam Lake belt.*

†Occurs on some of the adjoining sheets (see index) of the Muskrat Dam Lake Area.

Map 2162
Rottenfish River Sheet



Scale, 1 inch to 50 miles

N.T.S. reference 53F

SYMBOLS

Glacial striae, direction of ice movement known or assumed.
Eskers, deltas and other outwash deposits, and sand and gravel deposits of unknown origin.
End and interlobate moraine.
Drumlins.
Small bedrock outcrop.
Area of bedrock outcrop.
80° *Bedding, top unknown; (inclined, vertical).*
80° 80° *Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned).*
Lava flow; top (arrow) from pillows shape and packing.
80° *Schistosity; (inclined, vertical).*
75° *Gneissosity; (inclined, vertical).*
75° *Foliation; (inclined, vertical).*
35° *Lineation with plunge.*
Geological boundary, observed.
Geological boundary, position interpreted.
Geological boundary, deduced from geophysics.
Fault; (observed, assumed).
Lineament.
75° *Jointing; (inclined, vertical).*
80° 80° *Drag folds with plunge.*
Anticline, syncline.
MA *Magnetic attraction.*
Treed swamp and muskeg.
Open swamp and muskeg.
Trail, portage, winter road.
15 *Base line and meridian with mile posts, approximate position only.*

SOURCES OF INFORMATION

Geology by L. D. Ayres and assistants 1963 and 1964. Outcrops along the Makoop River from unpublished mapping by P. P. Hudec and assistants 1961.

O.D.M.-G.S.C. - aeromagnetic maps 3670G, 3671G, 3678G, 3679G, 3680G, 3686G, 3687G, 3688G, 3698G, 3699G, 3700G, 3710G, and 3711G.

Preliminary maps P214, Martyn River Area; P215, Gruneau Lake Area; P216, Kippen Lake Area; P217, Muskratdam Lake Area; P218, Hillis Lake Area; P219, Munekun Lake Area; P220, Cooney Lake Area; P221, Misquamaebin Lake Area; and P222, Pike Lake Area issued in 1964 and P214, Fox River Area and P295, Rottenfish River Area issued in 1965. Scale 1 inch to ½ mile.

Cartography by B. Jackson, Ontario Department of Mines, 1968.

Basemap derived from preliminary editions of the Makoop and Opasquia topographic sheets, Department of Energy, Mines and Resources, Ottawa, with additional information by L. D. Ayres.

Geology is only locally tied to surveyed lines.

Magnetic declination in centre of map-area was 2° E, 1964.

Index to the adjoining maps of the
MUSKRAT DAM LAKE AREA

Map 2162 Rottenfish River Sheet	Map 2163 Sandhill Crane Island Sheet	Map 2164 Axe Lake Sheet	Map 2165 Munekun Lake Sheet

ONTARIO
DEPARTMENT OF MINES
HON. ALLAN F. LAWRENCE, *Minister of Mines*
D. P. Douglass, *Deputy Minister* J. E. Thomson, *Director, Geological Branch*

Map 2162

ROTTENFISH RIVER SHEET

KENORA DISTRICT

Scale 1 : 63,360 or 1 Inch to 1 Mile

Chains 80 40 0 1 2 3 4 5 Miles
Feet 10,000 0 10,000 20,000 Feet
Metres 1000 0 1 2 3 4 5 6 Kilometres

Published 1969

Published 1969

LEGEND

CENOZOIC*

RECENT

Organic mud; lacustrine and fluvial clay, silt, and sand.

PLEISTOCENE

Till, lacustrine varved clay and silt, fluvial sand and gravel, beach sand and gravel.

UNCONFORMITY

PRECAMBRIAN (?)**

13 *Diorite.†*

INTRUSIVE CONTACT (?)

PRECAMBRIAN**

DIABASE

12a *Diabase (lacks olivine).*
12b *Olivine diabase.*
12c *Granophyre.†*

INTRUSIVE CONTACT (?)

LAMPROPHYRE

11 *Lamprophyre.*

INTRUSIVE CONTACT

GRANITIC BATHOLITHS

Granitic phases

10 *Undifferentiated.*[a]
10a *Equigranular, hornblende-biotite tonalite, trondhjemite, and granodiorite.*
10b *Quartz-poor, hornblende-biotite tonalite and trondhjemite (contaminated phase of 10a).*
10c *Porphyritic, hornblende-biotite trondhjemite and granodiorite.*
10d *Fine-grained, trondhjemite dikes.*
10e *Equigranular, medium-grained, massive to foliated, biotite trondhjemite, granodiorite, and quartz monzonite.*
10f *10e with 10 to 50 percent mafic metavolcanic inclusions.*
10g *Gneissic phase of 10e.*
10h *Coarse-grained phase of 10e.†*
10j *Porphyritic biotite trondhjemite.*
10k *Porphyritic biotite grandiorite and quartz monzonite.*
10m *Fine-to-medium-grained granodiorite dikes.*
10n *Late, hornblende-biotite trondhjemite dike.†*
10p *Aplite and fine-to-medium-grained, leucocratic granodiorite and quartz monzonite.*
10q *Pink pegmatite.*
10r *White pegmatite.*
10s *Sodic syenite.†*

INTRUSIVE CONTACT

Early mafic phase

9a *Medium-grained diorite, quartz-bearing diorite, syenodiorite, and mafic-rich trondhjemite.*
9b *Coarse-grained phase of 9a.†*

INTRUSIVE CONTACT (?)

LATE (UNMETAMORPHOSED), PORPHYRITIC FELSIC DIKES

8a *Porphyritic tonalite.*
8b *Porphyritic trondhjemite and sodic granite.†*

INTRUSIVE CONTACT

URALITIZED AND METAMORPHOSED GABBRO AND DIORITE

7a *Gabbro and diorite.*
7b *Anorthositic gabbro, gabbroic anorthosite, and anorthosite.*
7c *Serpentinized peridotite.*
7d *Albite granite.†*

INTRUSIVE CONTACT

EARLY (METAMORPHOSED) FELSIC INTRUSIONS[b]

6a *Pre-gabbro, plagioclase porphyry.†*
6b *Post-gabbro, equigranular, garnetiferous, potassic muscovite granite and pegmatite.†*
6c *Plagioclase-quartz porphyry sill (?).†*

INTRUSIVE CONTACT

METAMORPHOSED IRON FORMATION

5a *Metamorphosed iron formation.*
5b *Ferruginous metasediments.*
5c *Aluminous iron formation and ferruginous metasediments.*

METASEDIMENTS[c]

4 *Undifferentiated.*
4a *Muscovite-bearing metagreywacke and metasiltstone.*
4b *Biotite-bearing metagreywacke and metasiltstone.*
4c *Amphibole-bearing metagreywacke and metasiltstone.*
4d *Garnetiferous metagreywacke and metasiltstone.*
4e *Cordierite-, andalusite-, and staurolite-bearing metagreywacke and metasiltstone.*
4f *Grey slate.*
4g *Black slate.*
4h *Polymictic pebble metaconglomerate.*
4j *Marble.*
4k *Calc-silicate gneiss and granofels.*
4m *Non-ferruginous metachert.*

FELSIC METAVOLCANICS

3 *Undifferentiated.*
3a *Felsic flows.†*
3b *Metatuff and fine-grained metalapillistone.*
3c *Coarse-grained metalapillistone and metamorphosed pyroclastic breccia.*
3d *Felsic rocks of possible ash-flow tuff origin.*

METAVOLCANICS OF INTERMEDIATE COMPOSITION

2 *Undifferentiated.*
2a *Flow rocks, commonly amygdaloidal.*
2b *Metamorphosed pyroclastic breccia and coarse-grained metalapillistone: matrix more felsic than fragments.*
2c *Metamorphosed pyroclastic breccia and coarse-grained metalapillistone: matrix more mafic than fragments.*
2d *Metatuff and fine-grained metalapillistone.†*

MAFIC METAVOLCANICS[c]

1 *Undifferentiated.*
1a *Thick mafic flows (contain metagabbro-like central parts).*
1b *Pillowed, mafic metavolcanic flows.*
1c *Porphyritic, mafic metavolcanics.*
1d *Mafic metavolcanic breccia.*
1e *Mafic metatuff.†*
1f *Garnetiferous mafic metavolcanics.*
1g *Gneissic mafic metavolcanics.*
1h *Coarse-grained clinopyroxene-microline layer.†*

Cu	*Copper.*
mag	*Magnetite.*
q	*Quartz vein or lens.*
S	*Sulphide mineralization.*

**Unconsolidated deposits. In general, Cenozoic deposits are represented by the lighter coloured and uncoloured parts of the map. Some special Pleistocene deposits are stippled.*

***Bedrock geology. Outcrops and inferred extensions of each rock map unit are shown respectively in deep and light tones of the same colour. Where, in places, a formation is too narrow to show colour and must be represented in black, a short black bar appears in the appropriate colour block. Uncoloured parts of the map represent (a) unmapped areas (labelled on map face), and (b) areas in which outcrop is rare or absent (see report for explanation).*

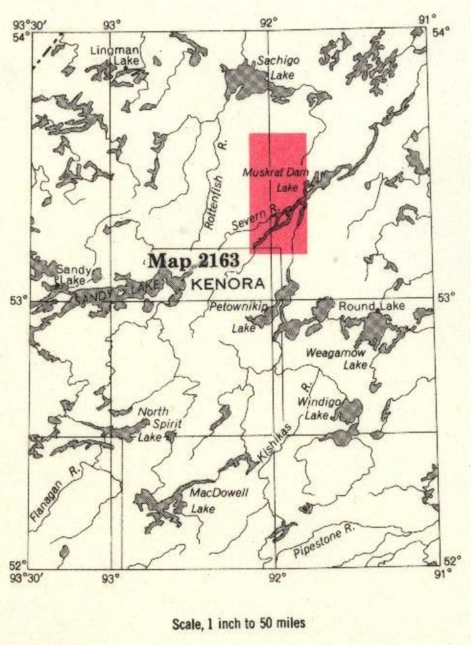
[a] *Marks outcrops which were not examined on the ground but were located by aerial observation or by aerial photograph interpretation.*

[b] *Includes intrusions of several ages.*

[c] *Forms two formations in the Muskrat Dam Lake belt.*

†Occurs on some of the adjoining sheets (see index) of the Muskrat Dam Lake Area.

Map 2163
Sandhill Crane Island Sheet



Scale, 1 inch to 50 miles

N.T.S. reference 53F, 53G

SYMBOLS

- *Glacial striae, direction of ice movement known or assumed.*
- *Glacial striae, direction of ice movement unknown.*
- *Eskers, deltas and other outwash deposits, and sand and gravel deposits of unknown origin.*
- *Drumlins.*
- *Small bedrock outcrop.*
- *Area of bedrock outcrop.*
- *Bedding, top unknown; (inclined, vertical).*
- *Bedding, top (arrow) from grain gradation; (vertical).*
- *Lava flow; top (arrow) from pillows shape and packing.*
- *Schistosity; (inclined).*
- *Gneissosity; (inclined, vertical).*
- *Foliation; (inclined, vertical).*
- *Lineation with plunge.*
- *Geological boundary, observed.*
- *Geological boundary, position interpreted.*
- *Geological boundary, deduced from geophysics.*
- *Fault; (observed, assumed).*
- *Jointing; (inclined).*
- *Drag folds with plunge.*
- *Anticline, syncline.*
- MA *Magnetic attraction.*
- *Treed swamp and muskeg.*
- *Open swamp and muskeg.*
- *Trail, portage, winter road.*
- *Base line and meridian with mile posts, approximate position only.*

SOURCES OF INFORMATION

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O.D.M.-G.S.C. - aeromagnetic maps 3670G, 3671G, 3678G, 3679G, 3680G, 3686G, 3687G, 3688G, 3698G, 3699G, 3700G, 3710G and 3711G.

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Cartography by B. Jackson, Ontario Department of Mines, 1968.

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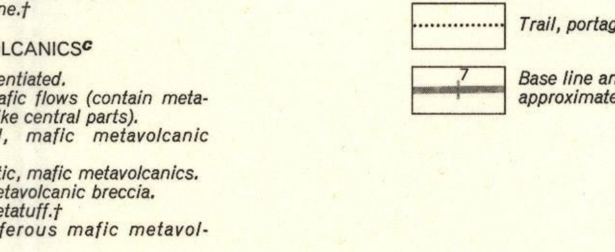
Index to the adjoining maps of the
MUSKRAT DAM LAKE AREA



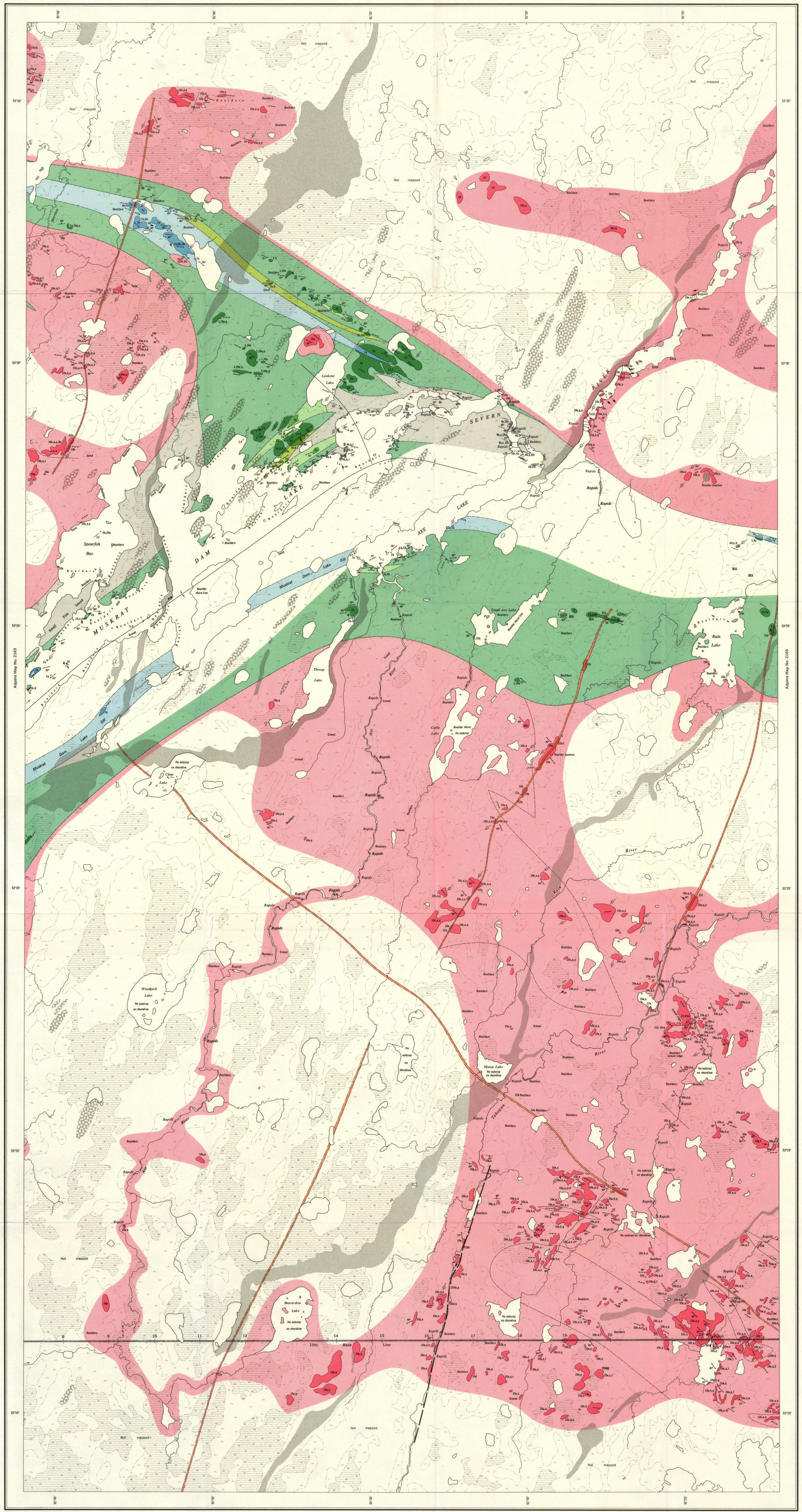
ONTARIO
DEPARTMENT OF MINES
HON. ALLAN F. LAWRENCE, *Minister of Mines*
D. P. Douglass, *Deputy Minister* J. E. Thomson, *Director, Geological Branch*

Map 2163

SANDHILL CRANE ISLAND SHEET

KENORA DISTRICT

Scale 1 : 63,360 or 1 Inch to 1 Mile



Published 1969

LEGEND

CENOZOIC*

RECENT

Organic mud; lacustrine and fluvial clay, silt, and sand.

PLEISTOCENE

Till, lacustrine varved clay and silt, fluvial sand and gravel, beach sand and gravel.

UNCONFORMITY

PRECAMBRIAN (?)**

13 *13 Diorite.*

INTRUSIVE CONTACT(?)

PRECAMBRIAN**

DIABASE

12
- *12a Diabase (lacks olivine).*
- *12b Olivine diabase.*
- *12c Granophyre.*

INTRUSIVE CONTACT(?)

LAMPROPHYRE

11 Lamprophyre.†

INTRUSIVE CONTACT

GRANITIC BATHOLITHS

Granitic phases

10
- *10 Undifferentiated.**a***
- *10a Equigranular, hornblende-biotite tonalite, trondhjemite, and granodiorite.*
- *10b Quartz-poor, hornblende-biotite tonalite and trondhjemite (contaminated phase of 10a).†*
- *10c Porphyritic, hornblende-biotite trondhjemite and granodiorite.†*
- *10d Fine-grained, trondhjemite dikes.†*
- *10e Equigranular, medium-grained, massive to foliated, biotite trondhjemite, granodiorite, and quartz monzonite.*
- *10f 10e with 10 to 50 percent mafic metavolcanic inclusions.*
- *10g Gneissic phase of 10e.*
- *10h Coarse-grained phase of 10e.*
- *10j Porphyritic biotite trondhjemite.†*
- *10k Porphyritic biotite grandiorite and quartz monzonite.*
- *10m Fine-to-medium-grained granodiorite dikes.†*
- *10n Late, hornblende-biotite trondhjemite dike.†*
- *10p Aplite and fine-to-medium-grained, leucocratic granodiorite and quartz monzonite.*
- *10q Pink pegmatite.*
- *10r White pegmatite.*
- *10s Sodic syenite.†*

INTRUSIVE CONTACT

Early mafic phase

9
- *9a Medium-grained diorite, quartz-bearing diorite, syenodiorite, and mafic-rich trondhjemite.*
- *9b Coarse-grained phase of 9a.†*

INTRUSIVE CONTACT(?)

LATE (UNMETAMORPHOSED), PORPHYRITIC FELSIC DIKES

8
- *8a Porphyritic tonalite.†*
- *8b Porphyritic trondhjemite and sodic granite.*

INTRUSIVE CONTACT

URALITIZED AND METAMORPHOSED GABBRO AND DIORITE

7
- *7a Gabbro and diorite.*
- *7b Anorthositic gabbro, gabbroic anorthosite, and anorthosite.†*
- *7c Serpentinized peridotite.†*
- *7d Albite granite.†*

INTRUSIVE CONTACT

EARLY (METAMORPHOSED) FELSIC INTRUSIONS***b***

6
- *6a Pre-gabbro, plagioclase porphyry.†*
- *6b Post-gabbro, equigranular, garnetiferous, potassic muscovite granite and pegmatite.*
- *6c Plagioclase-quartz porphyry sill (?).†*

INTRUSIVE CONTACT

METAMORPHOSED IRON FORMATION

5
- *5a Metamorphosed iron formation.†*
- *5b Ferruginous metasediments.*
- *5c Aluminous iron formation and ferruginous metasediments.†*

METASEDIMENTS***c***

4
- *4 Undifferentiated.*
- *4a Muscovite-bearing metagreywacke and metasiltstone.†*
- *4b Biotite-bearing metagreywacke and metasiltstone.*
- *4c Amphibole-bearing metagreywacke and metasiltstone.*
- *4d Garnetiferous metagreywacke and metasiltstone.*
- *4e Cordierite-, andalusite-, and staurolite-bearing metagreywacke and metasiltstone.†*
- *4f Grey slate.*
- *4g Black slate.†*
- *4h Polymictic pebble metaconglomerate.*
- *4j Marble.†*
- *4k Calc-silicate gneiss and granofels.†*
- *4m Non-ferruginous metachert.†*

FELSIC METAVOLCANICS

3
- *3 Undifferentiated.*
- *3a Felsic flows.*
- *3b Metatuff and fine-grained metalapillistone.*
- *3c Coarse-grained metalapillistone and metamorphosed pyroclastic breccia.*
- *3d Felsic rocks of possible ash-flow tuff origin.†*

METAVOLCANICS OF INTERMEDIATE COMPOSITION

2
- *2 Undifferentiated.*
- *2a Flow rocks, commonly amygdaloidal.*
- *2b Metamorphosed pyroclastic breccia and coarse-grained metalapillistone: matrix more felsic than fragments.*
- *2c Metamorphosed pyroclastic breccia and coarse-grained metalapillistone: matrix more mafic than fragments.*
- *2d Metatuff and fine-grained metalapillistone.†*

MAFIC METAVOLCANICS***c***

1
- *1 Undifferentiated.*
- *1a Thick mafic flows (contain metagabbro-like central parts).*
- *1b Pillowed, mafic metavolcanic flows.*
- *1c Porphyritic, mafic metavolcanics.*
- *1d Mafic metavolcanic breccia.*
- *1e Mafic metatuff.†*
- *1f Garnetiferous mafic metavolcanics.†*
- *1g Gneissic mafic metavolcanics.*
- *1h Coarse-grained clinopyroxene-microline layer.*

---

mag	*Magnetite.*
q	*Quartz vein or lens.*
S	*Sulphide mineralization.*

**Unconsolidated deposits. In general, Cenozoic deposits are represented by the lighter coloured and uncoloured parts of the map. Some special Pleistocene deposits are stippled.*

***Bedrock geology. Outcrops and inferred extensions of each rock map unit are shown respectively in deep and light tones of the same colour. Where, in places, a formation is too narrow to show colour and must be represented in black, a short black bar appears in the appropriate colour block. Uncoloured parts of the map represent (a) unmapped areas (labelled on map face), and (b) areas in which outcrop is rare or absent (see report for explanation).*

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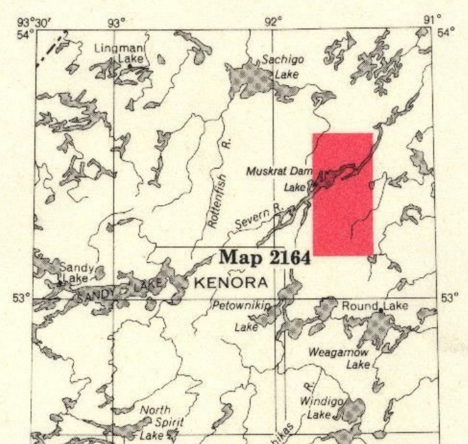
b *Includes intrusions of several ages.*

c *Forms two formations in the Muskrat Dam Lake belt.*

†Occurs on some of the adjoining sheets (see index) of the Muskrat Dam Lake Area.

Map 2164
Axe Lake Sheet



Scale, 1 inch to 50 miles

N.T.S. reference 53G

SYMBOLS

- *Glacial striae, direction of ice movement known or assumed.*
- *Glacial striae, direction of ice movement unknown.*
- *Eskers, deltas and other outwash deposits, and sand and gravel deposits of unknown origin.*
- *Drumlins.*
- *Small bedrock outcrop.*
- *Area of bedrock outcrop.*
- 70° *Bedding, top unknown; (inclined, vertical).*
- *Lava flow; top (arrow) from pillows shape and packing.*
- 45° *Gneissosity; (inclined, vertical).*
- 65° *Foliation; (inclined, vertical).*
- 30° *Lineation with plunge.*
- *Geological boundary, observed.*
- *Geological boundary, position interpreted.*
- *Geological boundary, deduced from geophysics.*
- *Fault; (assumed).*
- 45° *Jointing; (inclined, vertical).*
- *Syncline.*
- MA *Magnetic attraction.*
- *Treed swamp and muskeg.*
- *Open swamp and muskeg.*
- .... *Trail, portage, winter road.*
- ▪ *Building.*
- 9 *Base line and meridian with mile posts, approximate position only.*

SOURCES OF INFORMATION

Geology by L. D. Ayres and assistants 1963 and 1964. Outcrops along the Makoop River from unpublished mapping by P. P. Hudec and assistants 1961.

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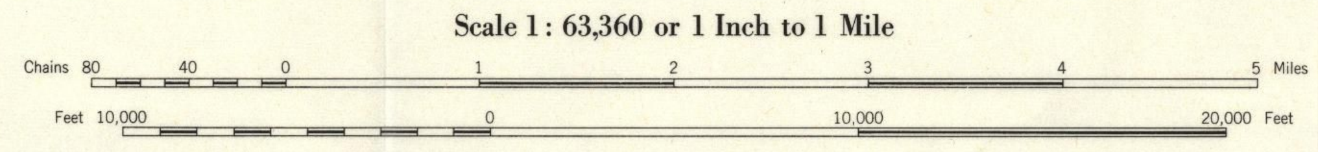
Index to the adjoining maps of the
MUSKRAT DAM LAKE AREA

Map 2162 Rottenfish River Sheet	Map 2163 Sandhill Crane Island Sheet	Map 2164 Axe Lake Sheet	Map 2165 Munekun Lake Sheet

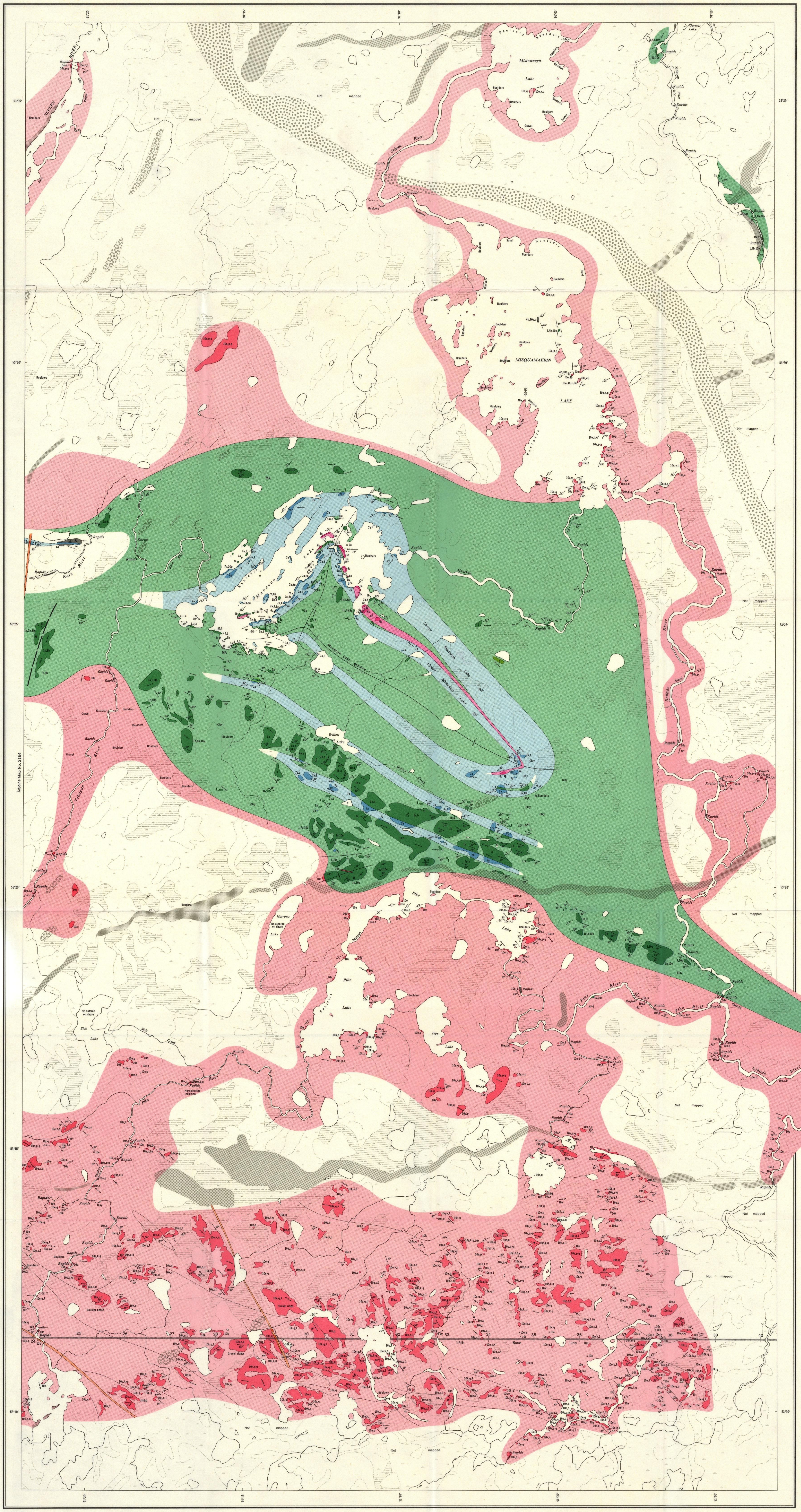
ONTARIO
DEPARTMENT OF MINES
HON. ALLAN F. LAWRENCE, *Minister of Mines*
D. P. Douglass, *Deputy Minister* J. E. Thomson, *Director, Geological Branch*

Map 2164
AXE LAKE SHEET
KENORA DISTRICT

Scale 1 : 63,360 or 1 Inch to 1 Mile



Map 2165
Munekun Lake Sheet



Published 1969

LEGEND

CENOZOIC*

RECENT

Organic mud; lacustrine and fluvial clay, silt, and sand.

PLEISTOCENE

Till, lacustrine varved clay and silt, fluvial sand and gravel, beach sand and gravel.

UNCONFORMITY

PRECAMBRIAN (?)**

- ☐ 13 *Diorite.†*

INTRUSIVE CONTACT(?)

PRECAMBRIAN**

DIABASE

- 🟧 12
  - 12a *Diabase (lacks olivine).*
  - 12b *Olivine diabase.*
  - 12c *Granophyre.†*

INTRUSIVE CONTACT(?)

LAMPROPHYRE

- ☐ 11 *Lamprophyre.*

INTRUSIVE CONTACT

GRANITIC BATHOLITHS

Granitic phases

- 🟥 10
  - 10 *Undifferentiated.*[a]
  - 10a *Equigranular, hornblende-biotite tonalite, trondhjemite, and granodiorite.*
  - 10b *Quartz-poor, hornblende-biotite tonalite and trondhjemite (contaminated phase of 10a).*
  - 10c *Porphyritic, hornblende-biotite trondhjemite and granodiorite.†*
  - 10d *Fine-grained, trondhjemite dikes.*
  - 10e *Equigranular, medium-grained, massive to foliated, biotite trondhjemite, granodiorite, and quartz monzonite.*
  - 10f *10e with 10 to 50 percent mafic metavolcanic inclusions.*
  - 10g *Gneissic phase of 10e.*
  - 10h *Coarse-grained phase of 10e.*
  - 10j *Porphyritic biotite trondhjemite.*
  - 10k *Porphyritic biotite grandiorite and quartz monzonite.*
  - 10m *Fine-to-medium-grained granodiorite dikes.†*
  - 10n *Late, hornblende-biotite trondhjemite dike.†*
  - 10p *Aplite and fine-to-medium-grained, leucocratic granodiorite and quartz monzonite.*
  - 10q *Pink pegmatite.*
  - 10r *White pegmatite.*
  - 10s *Sodic syenite.†*

INTRUSIVE CONTACT

Early mafic phase

- ☐ 9
  - 9a *Medium-grained diorite, quartz-bearing diorite, syenodiorite, and mafic-rich trondhjemite.*
  - 9b *Coarse-grained phase of 9a.†*

INTRUSIVE CONTACT(?)

LATE (UNMETAMORPHOSED), PORPHYRITIC FELSIC DIKES

- ☐ 8
  - 8a *Porphyritic tonalite.*
  - 8b *Porphyritic trondhjemite and sodic granite.*

INTRUSIVE CONTACT

URALITIZED AND METAMORPHOSED GABBRO AND DIORITE

- 🟦 7
  - 7a *Gabbro and diorite.*
  - 7b *Anorthositic gabbro, gabbroic anorthosite, and anorthosite.†*
  - 7c *Serpentinized peridotite.†*
  - 7d *Albite granite.†*

INTRUSIVE CONTACT

EARLY (METAMORPHOSED) FELSIC INTRUSIONS[b]

- 🟪 6
  - 6a *Pre-gabbro, plagioclase porphyry.†*
  - 6b *Post-gabbro, equigranular, garnetiferous, potassic muscovite granite and pegmatite.†*
  - 6c *Plagioclase-quartz porphyry sill (?).*

INTRUSIVE CONTACT

METAMORPHOSED IRON FORMATION

- ☐ 5
  - 5a *Metamorphosed iron formation.*
  - 5b *Ferruginous metasediments.†*
  - 5c *Aluminous iron formation and ferruginous metasediments.†*

METASEDIMENTS[c]

- ⬛ 4
  - 4 *Undifferentiated.*
  - 4a *Muscovite-bearing metagreywacke and metasiltstone.†*
  - 4b *Biotite-bearing metagreywacke and metasiltstone.*
  - 4c *Amphibole-bearing metagreywacke and metasiltstone.*
  - 4d *Garnetiferous metagreywacke and metasiltstone.*
  - 4e *Cordierite-, andalusite-, and staurolite-bearing metagreywacke and metasiltstone.†*
  - 4f *Grey slate.†*
  - 4g *Black slate.†*
  - 4h *Polymictic pebble metaconglomerate.*
  - 4j *Marble.†*
  - 4k *Calc-silicate gneiss and granofels.†*
  - 4m *Non-ferruginous metachert.†*

FELSIC METAVOLCANICS

- 🟩 3
  - 3 *Undifferentiated.*
  - 3a *Felsic flows.†*
  - 3b *Metatuff and fine-grained metalapillistone.†*
  - 3c *Coarse-grained metalapillistone and metamorphosed pyroclastic breccia.†*
  - 3d *Felsic rocks of possible ash-flow tuff origin.†*

METAVOLCANICS OF INTERMEDIATE COMPOSITION

- 🟩 2
  - 2 *Undifferentiated.†*
  - 2a *Flow rocks, commonly amygdaloidal.†*
  - 2b *Metamorphosed pyroclastic breccia and coarse-grained metalapillistone: matrix more felsic than fragments.†*
  - 2c *Metamorphosed pyroclastic breccia and coarse-grained metalapillistone: matrix more mafic than fragments.*
  - 2d *Metatuff and fine-grained metalapillistone.*

MAFIC METAVOLCANICS[c]

- 🟩 1
  - 1 *Undifferentiated.*
  - 1a *Thick mafic flows (contain metagabbro-like central parts).*
  - 1b *Pillowed, mafic metavolcanic flows.*
  - 1c *Porphyritic, mafic metavolcanics.†*
  - 1d *Mafic metavolcanic breccia.*
  - 1e *Mafic metatuff.†*
  - 1f *Garnetiferous mafic metavolcanics.†*
  - 1g *Gneissic mafic metavolcanics.*
  - 1h *Coarse-grained clinopyroxene-microline layer.†*

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mag	*Magnetite.*
q	*Quartz vein or lens.*
S	*Sulphide mineralization.*

**Unconsolidated deposits. In general, Cenozoic deposits are represented by the lighter coloured and uncoloured parts of the map. Some special Pleistocene deposits are stippled.*

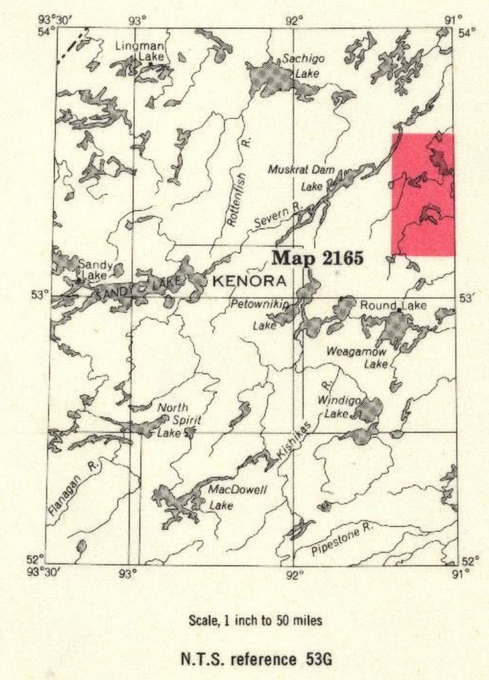
***Bedrock geology. Outcrops and inferred extensions of each rock map unit are shown respectively in deep and light tones of the same colour. Where, in places, a formation is too narrow to show colour and must be represented in black, a short black bar appears in the appropriate colour block. Uncoloured parts of the map represent (a) unmapped areas (labelled on map face), and (b) areas in which outcrop is rare or absent (see report for explanation).*

[a] *Marks outcrops which were not examined on the ground but were located by aerial observation or by aerial photograph interpretation.*

[b] *Includes intrusions of several ages.*

[c] *Forms two formations in the Muskrat Dam Lake belt.*

†Occurs on some of the adjoining sheets (see index) of the Muskrat Dam Lake Area.



Scale, 1 inch to 50 miles

N.T.S. reference 53G

SYMBOLS

⌀	*Glacial striae, direction of ice movement known or assumed.*
⌀	*Glacial striae, direction of ice movement unknown.*
▨	*Eskers, deltas and other outwash deposits, and sand and gravel deposits of unknown origin.*
●	*End and interlobate moraine.*
○	*Drumlins.*
×	*Small bedrock outcrop.*
◯	*Area of bedrock outcrop.*
75°	*Bedding, top unknown; (inclined, vertical).*
▷	*Lava flow; top (arrow) from pillows shape and packing.*
▷	*Lava flow; top in direction of arrow.*
80°	*Schistosity; (inclined, vertical).*
70°	*Gneissosity; (inclined, vertical).*
70°	*Foliation; (inclined, vertical).*
80°	*Lineation with plunge.*
―	*Geological boundary, observed.*
‒ ‒	*Geological boundary, position interpreted.*
- -	*Geological boundary, deduced from geophysics.*
▬ ▬	*Fault; (assumed).*
✦	*Jointing; (vertical).*
60°	*Drag folds with plunge.*
✕	*Anticline, syncline.*
MA	*Magnetic attraction.*
◯	*Treed swamp and muskeg.*
◯	*Open swamp and muskeg.*
⋯⋯	*Trail, portage, winter road.*
35	*Base line and meridian with mile posts, approximate position only.*

SOURCES OF INFORMATION

Geology by L. D. Ayres and assistants 1963 and 1964. Outcrops along the Makoop River from unpublished mapping by P. P. Hudec and assistants 1961.

O.D.M.-G.S.C. - aeromagnetic maps 3670G, 3671G, 3678G, 3679G, 3680G, 3686G, 3687G, 3688G, 3698G, 3699G, 3700G, 3710G, and 3711G.

Preliminary maps P214, Martyn River Area; P215, Gruneau Lake Area; P216, Kippen Lake Area; P217, Muskratdam Lake Area; P218, Hillis Lake Area; P219, Munekun Lake Area; P220, Cooney Lake Area; P221, Misquamaebin Lake Area; and P222, Pike Lake Area issued in 1964 and P214, Fox River Area and P295, Rottenfish River Area issued in 1965. Scale 1 inch to ½ mile.

Cartography by B. Jackson, Ontario Department of Mines, 1968.

Basemap derived from preliminary editions of the Makoop and Opasquia topographic sheets, Department of Energy, Mines and Resources, Ottawa, with additional information by L. D. Ayres.

Geology is only locally tied to surveyed lines.

Magnetic declination in centre of map-area was 2° E, 1964.

Index to the adjoining maps of the
MUSKRAT DAM LAKE AREA

Map 2162 Rottenfish River Sheet	Map 2163 Sandhill Crane Island Sheet	Map 2164 Axe Lake Sheet	Map 2165 Munekun Lake Sheet

ONTARIO
DEPARTMENT OF MINES
HON. ALLAN F. LAWRENCE, *Minister of Mines*
D. P. Douglass, *Deputy Minister* J. E. Thomson, *Director, Geological Branch*

Map 2165

MUNEKUN LAKE SHEET

KENORA DISTRICT

Scale 1 : 63,360 or 1 Inch to 1 Mile