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Geology
of
McMahon and Morin Townships
District of Algoma

By

F. W. Chandler

Geological Report 112

TORONTO
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Geological Map

(back pocket)

Map 2272 (coloured) — McMahan and Morin Townships, District of Algoma.
Scale, 1 inch to ½ mile.

ABSTRACT

In McMahon and Morin Townships, Huronian sedimentary rocks lie nonconformably on Archean granitic rocks. The Huronian succession, confined mainly to the south part of the map-area, may consist of the Matinenda, Ramsay Lake, Mississagi, Gowganda, and Lorrain Formations. Conglomerate outliers in Morin Township may belong to the Ramsay Lake and Gowganda Formations which have overlapped older Huronian Formations northward onto the Archean basement.

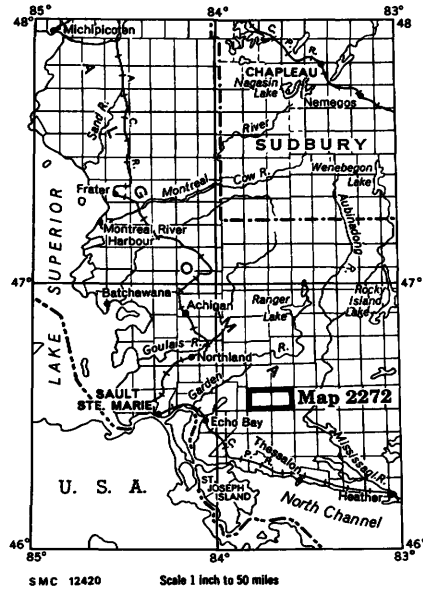


Figure 1—Key map showing location of McMahon and Morin Townships, District of Algoma.

Mafic volcanic rocks occur at the base of or within the Matinenda Formation. Quartz diabase bodies, olivine diabase dikes, and a pyroxene-biotite lamprophyre dike intrude the Huronian rocks.

The dip of the Huronian strata is moderate and essentially monoclinal to the southwest. Significant faults are few. A combination of pre-Huronian and present topography has produced a complicated outcrop pattern of the boundary between the basal Huronian and the Archean rocks. There is no evidence of regional metamorphism of Huronian rocks in the map-area.

Vertical quartz veins, some striking east-west, contain pyrite, chalcopyrite, and traces of gold and silver. Some copper-bearing quartz-carbonate veins are spatially related to quartz diabase bodies. Uranium mineralization is present in quartz-pebble conglomerate and pebbly arkose with quartz clasts in the Matinenda Formation, where the formation probably thickens in a pre-Huronian valley.

Examination of the sulphide-bearing veins commenced at the beginning of the century. Drilling for uranium started in 1956. More recently geophysical surveys have been undertaken. So far none of the mineral deposits found have proved to be worth mining.

Thick terraces of sand and gravel are present in river valleys, particularly that of the Thessalon River.

Geology
of
McMahon and Morin Townships
District of Algoma

By
F. W. Chandler¹

INTRODUCTION

Access

The map-area is 26 miles from Echo Bay via Highway 638, and 25 miles from Bruce Mines via Highway 561. Both highways are gravel roads and suitable for the average car. Within the map-area, gravel roads give access to Patten Lake and Carpenter Lake. These roads are usable except after heavy rains which cause floods and washouts. Other gravel roads in the map-area are suitable only for four-wheel-drive vehicles and are very muddy until midsummer. In McMahon Township, a road runs west from the Thessalon River valley road to the south end of Stuart Lake. A second road, difficult for four-wheel-drive vehicles, begins $\frac{1}{4}$ mile east of Stuart Lake and runs 4 miles north up the centre of the township. In Morin Township a road follows Wood Creek to Sheldon Lake. Numerous overgrown wagon roads transect the area. These are difficult to locate on air photographs and are now only suitable for travel on foot. The Solar Lake area in northwest McMahon Township is best reached by float-equipped aircraft.

Field and Laboratory Work

Geological mapping of the area was accomplished during four months of the summer of 1970 by a five-man field party. Transport was by means of truck and powered canoe. Owing to thick bush the area was covered by pace-and-compass traverses using lakes and other features as 'tie-points'. The distance between adjacent traverses was about $\frac{1}{4}$ mile and this was decreased in areas of complex geology.

¹ Geologist, 1971, Ontario Department of Mines and Northern Affairs. Manuscript accepted for publication by the Chief Geologist 26 November 1971.

McMahon and Morin Townships

Field data were in part recorded on transparent overlays attached to black and white air photographs with a scale of 1 inch to ¼ mile (1:15,840). The photographs were supplied by the Ontario Division of Forests, Ministry of Natural Resources. The data were transferred from the overlays by means of a sketch master for scale corrections, to base maps of the same scale that were prepared by the Cartography Section, Ontario Division of Lands, Ministry of Natural Resources.

Some clusters of small outcrops, less than 100 feet (30m) across, were generalized to permit reduction of the map to the publication scale of 1 inch to ½ mile (1:31,680). All outcrops shown on the map were visited by the writer or his senior assistant, P. R. Teal.

Chemical analyses, X-ray defraction, and assays were by the Mineral Research Branch of the Ontario Division of Mines except where stated otherwise. Modal analyses were made by the writer and 400 points were counted on each thin section. Except for micaceous sedimentary rocks, potassic feldspars were stained.

Previous Geological Work

The area has been mapped by Collins and Emmons (Collins 1925) and Frarey (1959). The geology has been summarized in a regional map by Giblin and Leahy (1967). The two townships are included in Ontario Department of Mines-Geological Survey of Canada aeromagnetic map 2213G (1963).

A record of work, filed for assessment work credit, that was carried out in the map-area by the mining industry is kept by the Ontario Ministry of Natural Resources in the regional office at Sault Ste. Marie and at Toronto in the Assessment Files Research Office.

Mineral Exploration

Since the beginning of the century, copper prospects have received attention. Early mineral exploration is discussed in the section on Economic Geology. Since discovery of the Blind River uranium deposits, interest has been focussed on uranium. The following accounts of exploration by the mining industry are taken from the assessment work files of the Ontario Ministry of Natural Resources at the Resident Geologist's office in Sault Ste. Marie.

In 1956, Romar Mines Limited carried out ground self-potential and magnetometer surveys in the vicinity of the Romar prospect (8) in McMahon Township. Diamond drilling was undertaken to test a weak self-potential anomaly approximately 1,300 feet west of the prospect. In 1956, Romar Mines Limited also drilled seven diamond drill holes, the longest being 464 feet, to test this copper prospect in McMahon Township. Analyses show copper percentages up to 0.18 over a core length of 12 inches (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie).

In 1968, magnetometer surveys in the south part of McMahon Township were flown by the British American Oil Company Limited. W. D. Sutherland and associates, also in 1968, ran airborne magnetometer and radioactivity surveys in the southeastern part of Morin Township. According to Sutherland's maps, higher

values of radioactivity in general were confined to Huronian sedimentary rocks as opposed to the granitic basement.

In 1955, McIntyre Porcupine Mines Limited diamond drilled four holes in the Matinenda Formation in property number 13, Morin Township. The deepest hole (325 feet) passed through two quartz-pebble conglomerate beds which are 2 and 3 feet thick. Analyses of drill cores from these beds indicate U_3O_8 values of 0.014 percent over 1.2 feet for one bed and 0.018 percent over 3.0 feet for the other (Figure 6) (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie).

In 1968, W. D. Sutherland and associates drilled six holes, mostly started in the Mississagi Formation on property number 14 in Morin Township (Figure 6). A quartz-pebble conglomerate several feet thick and lying between two units of volcanic rocks was found to contain concentrations of uranium. Insufficient proved areal extent prevented development.

In the summer of 1970, Gulf Minerals Canada Limited were mapping in the southern part of McMahan Township. In 1971, at the outlet of Hugli Lake in McMahan Township, they diamond drilled 1,503 feet (460m) to basement through the Matinenda Formation. No uranium mineralization was encountered (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie).

Acknowledgments

The senior assistant P. R. Teal, who provided much of the data for the report from his B.Sc. thesis (Teal 1971), and the junior assistants, B. Patten, N. Zuckerman, and D. Dupak are thanked for their enthusiasm and services. The detailed local knowledge of Jack Stevenson was invaluable in tracing some of the older workings.

R. Rupert, Resident Geologist of the Ontario Ministry of Natural Resources at Sault Ste. Marie afforded much cooperation. M. J. Frarey of the Geological Survey of Canada kindly lent the writer some of his field data and discussed stratigraphic problems.

GENERAL GEOLOGY

The northern and greater part of the area is underlain by granitic rocks of Archean age. Banded gneiss occurs in the northern part of the map-area but most of the Archean terrain is underlain by massive granitic rocks, large parts of which are porphyritic.

The stratigraphic nomenclature used in this report is a modified version (Robertson *et al* 1969) of a scheme devised by Collins (1925). Where the Mississagi (quartzite) Formation, in Collins' sense is referred in the text, the term 'Mississagi (Collins)' Formation is used. The above two systems of nomenclature and a stratigraphic column applicable to McMahan and Morin Townships are shown in Figure 3.

Sedimentary rocks were classified according to a scheme shown in Figure 2. The classification of granitic rocks follows that described by Ayres (1972).

McMahon and Morin Townships

Huronian sedimentary rocks rest nonconformably upon the dissected and weathered Archean surface. They occur as outliers in northern and eastern Morin Township and occupy large areas in the southern parts of both townships. The lower part of the succession, dominantly feldspathic sandstone with subordinate ortho- and paraconglomerates, has been placed by earlier workers in several stratigraphic positions (Collins 1925; Frarey 1959; Giblin and Leahy 1967). Recognition of a previously unmapped, continuous unit of massive sandy paraconglomerate in the lower sandstones permitted separation of these hitherto undivided rocks into lower and upper sandstone units. The order of stratigraphic succession, field appearance of these sandstones, and the presence of an enclosed conglomerate permit tentative correlation with the Matinenda, Ramsay Lake, and Mississagi Formations of the Elliot Lake area (Robertson *et al* 1969). These rocks are succeeded by the mixed clastic assemblage of Gowganda Formation and sandstone of the Lorrain Formation; these two correlations are also tentative.

In southwestern McMahon Township, mafic to intermediate amygdaloidal volcanic rocks have been faulted up against rocks of the Gowganda Formation which lie to the northeast. In Morin Township, small outcrops of mafic volcanic rocks occur intermittently at or near the base of the Matinenda Formation.

Large irregular bodies of Nipissing-type quartz diabase are concordant or discordant intrusions within Huronian and Archean rocks. Many small mafic dikes trend west-northwest. A few olivine diabase dikes occur in the map-area and one lamprophyre dike cuts the Gowganda Formation. Though pyrophyllite has been observed locally in aluminous sandstones (Chandler *et al* 1969) the effects of regional metamorphism were not detected in the field.

The overall dip of Huronian rocks is moderate and toward the south or southwest, but the Archean topography locally influences the attitude of the strata. A combination of Archean and present topography and the relatively gentle dip of the Huronian rocks has produced an outcrop distribution complicated by outliers and inliers and sinuous boundaries. Faulting has affected the area to a minor extent. West-northwest-striking foliation occurs in the Archean rocks, particularly in the north. Some argillaceous rocks of the Gowganda Formation and mafic volcanic rocks are sheared in the southern part of the map-area.

ARCHEAN ROCKS

Although metasediments and metavolcanics underlie a significant part of the Quirke Lake Syncline (Robertson 1961; Roscoe 1969), the pre-Huronian basement along the North Shore of Lake Huron is largely composed of granitic rocks (Giblin and Leahy 1967). The granitic rocks were grouped as Algoman by Robertson (1961 *et seq.*). Like those of the Superior Province as a whole (Stockwell *et al* 1970), those underlying the Huronian rocks immediately north of Lake Huron are mainly granodiorite, quartz diorite, and quartz monzonite (Pienaar 1963; Roscoe 1969).

Massive or gneissic, pink to grey, porphyritic granitic rocks are generally thought to be older than red, potassic, equigranular to porphyritic granitic rocks (Stockwell



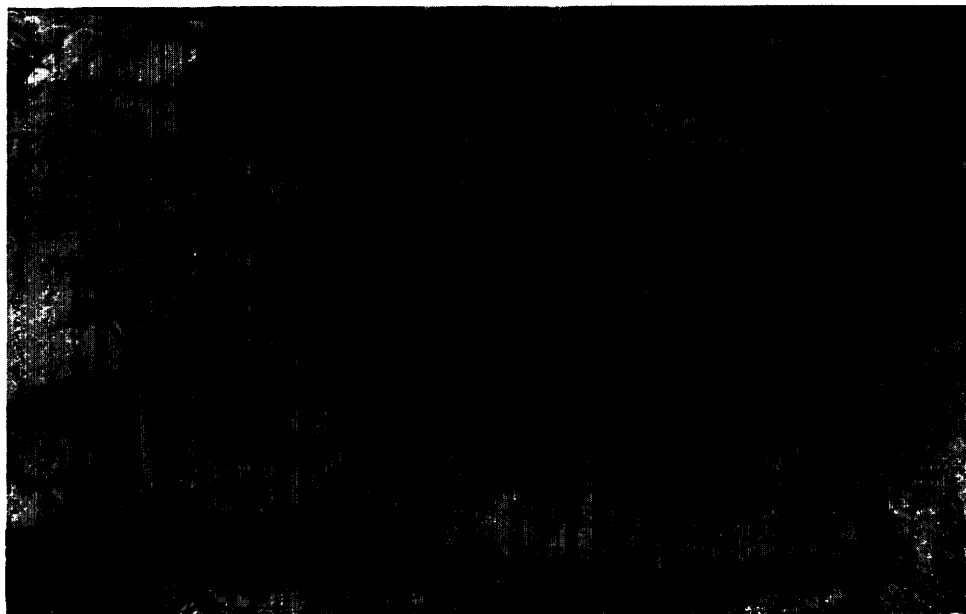
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Photo 1—Archean mafic dike (2) in andesine quartz-monzonite (1c) central McMahon Township (83°46.3'W, 46°38.8'N). Dark agmatitic fragments are massive amphibolite. The monzonite has been remobilised after intrusion of the dike.

et al 1970; Roscoe 1969; McConnel 1926). Robertson (1963) has divided pre-Huronian granitic rocks of the Elliot Lake area into two general groups: (1) a 'grey phase' consisting of variable, grey to pink, gneissic, sodic granodiorite with numerous mafic inclusions, and (2) a younger 'red phase' of uniform equigranular to porphyritic quartz monzonite with fewer pegmatite and aplite dikes than the grey phase. The two phases have a similar mineralogy but the 'grey phase' rock is more highly altered and the 'red phase' is more radioactive. The writer was able to map three granitic lithologies in McMahon and Morin Townships. These are banded quartz diorite gneiss, porphyritic quartz diorite, and red quartz monzonite. The banded quartz diorite gneiss may correspond to Robertson's 'grey phase' granitic rocks and the red quartz monzonite and porphyritic quartz diorite may correspond to Robertson's 'red phase' granitic rocks. The age relationships of the three lithologies could not be determined.

Archean granitic rocks, cut by small mafic dikes and sills, underlie the northeast half of McMahon Township and are dominant in all but the south part of Morin Township.

In the granitic terrain are outcrops of fine grained sericite schist, chlorite schist, massive coarse-grained amphibolite (Photo 1) (amphibole feldspar rock), and hornblendite (amphibole rock with grain size up to 2 cm) occur. They may be the metamorphosed equivalents of felsic volcanic rocks, mafic volcanic rocks, and mafic intrusive rocks, respectively.



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Photo 2—Archean banded gneiss (1a), northwest Morin Township, andesine quartz-monzonite with subordinate bands and pods of amphibolite (dark).

BANDED QUARTZ DIORITE GNEISS

Quartz diorite gneiss occurs almost exclusively in a lenticular area of high ground in the northernmost part of the map-area, mainly in Morin Township between Mink Creek and Carpenter Lake. The rock is banded with individual layers up to 2 inches (5cm) thick and either linear and hundreds of feet in length or strongly contorted in such a manner as to indicate that they suffered plastic deformation. Grain size is about 1 mm-5 mm and dominant pale pink-grey to greenish quartzofeldspathic layers alternate with subordinate darker layers rich in biotite and hornblende. In some outcrops mafic material is more abundant or may be present as schlieren or agmatic fragments of paleosome. Pegmatite bodies with crystals up to 2 cm long, aplite dikes, and quartz veins are abundant. Small scale faulting and brecciation also has occurred. An examination of two thin sections (Table 2) showed the banding to reflect in part a variation in the grain size of quartz and feldspar, and in part a concentration and alignment of mafic minerals which include green (ferric) biotite, sphene, pistacite (epidote), and black iron oxides. Feldspar is subhedral and mainly has the composition of sodic andesine. It is heavily sericitized with bent multiple twinning. Small rare microcline grains are less altered. Quartz is clear and strained and is present as anhedral grains that are either granular or lenticular in shape. Compared with the quartz monzonite and quartz diorite, plagioclase, sericite, and pistacite (epidote) are abundant, and potassic feldspar is not abundant in this rock type.

Table 2

MODAL ANALYSES OF ARCHEAN GRANITIC ROCKS, McMAHON AND MORIN TOWNSHIPS

Sample No.	Red Quartz Monzonite			Porphyritic Quartz diorite			Quartz diorite Gneiss	
	B4C2	C7C4	D10C1	A2C1	A4C1	B11C1	A8T1	A10C5
Apatite					0.25			
Biotite		2.20		9.85			4.75	1.44
Black Iron Ore	0.25	tr	0.50	tr	tr	tr	0.25	tr
Carbonate		0.24					0.25	
Chlorite	3.50	0.24	1.00	2.46	2.90	2.25		tr
Epidote (pistacite)			0.75	1.00	0.8		3.25	1.67
Hematite	0.25 ²	tr ³	tr					tr
Hornblende				0.50	2.75			
K-Feldspar	43.85	39.94	23.75	8.54	25.05	18.00	6.75	0.25
Leucoxene	tr		0.25			tr		
Muscovite	tr			0.74	0.50	0.50	1.50	2.63
Plagioclase ⁴	30.75	24.83	45.00	54.19	47.50	41.25	53.00	57.41
Quartz	21.50	32.42	28.75	22.70	20.25	37.75	29.75	36.60
Sphene	tr			1.00	0.50	0.25	0.50	
Totals	100.10	99.87	100.00	100.98	100.50	100.00	100.00	100.00

(1) For locations of samples see Figure 4.

(2) Dust in cracks in K.Feldspar.

(3) Dust in K.Feldspar.

(4) Sodic andesine.

(r = noted in thin section, did not register on 400 point count.)

PORPHYRITIC QUARTZ DIORITE

Porphyritic quartz diorite is well developed in northwest and central McMahon Township, where pink perthitic feldspar phenocrysts or porphyroblasts are euhedral and up to 3 cm long. In central and east Morin Township, the phenocrysts are usually less than 1 cm in length and are often subhedral to anhedral. The boundaries between the porphyritic quartz diorite and the red quartz monzonite are ill-defined and in field mapping were taken where phenocrysts cease to stand out clearly from the groundmass.

The grain size of the matrix of the porphyritic quartz diorite is usually 1 mm to 3 mm, rarely 4 mm. The pale pink or pale green colour of the rock is probably due to varying amounts of hematite which occur in potassic feldspar, and sericite which formed at the expense of plagioclase. The rock usually weathers pale pink. The feldspar phenocrysts may be preferentially or randomly oriented. Pegmatite, quartz, and some aplitic veins reminiscent of the red quartz monzonite are present.

The porphyritic quartz diorite was also identified by the presence of hornblende. More detailed sampling may show that it contains more mafic minerals than the quartz diorite gneiss and the quartz monzonite, and more sphene than the quartz-monzonite. The phenocrysts are slightly sericitized, poikilitic microcline

McMahon and Morin Townships

Table 3

CHEMICAL ANALYSES OF THE ARCHEAN GRANITIC ROCKS OF MCMAHON AND MORIN TOWNSHIPS

Sample No.	Major components, percent			Minor elements p.p.m.		
	C6C2*	A4C1	A10C5	C6C2	A4C1	A10C5
SiO ₂	74.46	65.44	71.51	Ag	—	—
Al ₂ O ₃	13.56	15.86	14.63	As	6	11
Fe ₂ O ₃	1.68	3.37	1.90	Ba	400	2000
FeO	0.36	1.43	0.84	Be	—	—
MgO	0.32	1.75	0.68	Co	3	8
CaO	0.27	1.47	2.43	Cr	10	20
Na ₂ O	3.79	3.98	5.00	Cu	9	20
K ₂ O	4.66	3.52	1.09	Ga	10	29
H ₂ O ⁺	0.58	1.16	0.62	Li	—	—
H ₂ O ⁻	0.18	0.37	0.18	Mn	—	—
CO ₂	0.12	0.11	0.15	Mo	—	—
TiO ₂	0.02	0.51	0.20	Ni	20	30
P ₂ O ₅	0.04	0.10	0.06	Pb	10	15
S	0.01	0.01	0.01	Sb	4	4
MnO	0.01	0.04	0.03	Sc	—	—
Totals	100.06	99.12	99.33	Sn	—	—
				Sr	200	400
				Ti	—	—
				V	10	40
				Y	—	—
				Zn	10	40
				Zr	30	150

* C6C2 Red quartz-monzonite
 A4C1 Porphyritic quartz-diorite
 A10C5 Quartz-diorite gneiss
 For location of samples see Figure 4.
 Analyses by the Mineral Research Branch, Ontario Division of Mines.

or perthite. The perthite is dispersed in microcline phenocrysts which are irregular, bent subparallel lenticles usually less than 1 mm long. The phenocrysts are set in a granular to foliated quartzofeldspathic groundmass. The groundmass feldspars are sodic andesine in composition. They have been highly sericitized and show simple or polysynthetic twinning. A few subhedral, ragged patches of hornblende grains are cut by thin veinlets of brown sericite(?) and are associated with patches or irregular veins made up of pistacite, allanite(?), rhombic sphene, chlorite, and iron oxides.

QUARTZ MONZONITE

Red quartz monzonite is best exposed along the road running east from the southeast end of Stuart Lake. It consists of about 70 percent pink (hematite-dust stained) potassic feldspar with quartz and very minor dark minerals (for modal analyses see Table 2). The rock varies from a rich red to pink and weathers red, pink, or less often grey. Grain size is usually 2 to 3 mm. The quartz monzonite locally is agmatitic with angular amphibolite fragments or, less commonly, banded; in places it is cut by veins of pegmatite, quartz, and aplite. The rock is massive

equigranular or in places foliated. Feldspars are generally subhedral. Potassic feldspar is either featureless, crosshatched as in microcline, or perthitic. Plagioclase (sodic andesine) locally displays bent albite twinning and has been more highly sericitized than the potassic feldspar. Quartz grains are clear, strained, and anhedral with sutured boundaries. Chlorite, epidote, black iron oxide, hematite, and leucocoxene occur in places.

PROTEROZOIC

HURONIAN SUPERGROUP

Regolith

The boundary between the Matinenda Formation and the underlying Archean rocks is sharp in some places, gradational in others. Gradational boundaries are best developed where sericitic arkosic sandstone rests on a mantle of altered granite (Collins 1925; McConnell 1926). Slight alteration of the granite resulted in removal of mafic materials, sericitization of plagioclase, and whitening of the rock. More intense alteration higher up in the regolith resulted in sericitization of potassic feldspar (Pienaar 1963). Still further alteration resulted in the final development of a greenish rock containing quartz grains and relatively few smaller grains of microcline 'floating' in a structureless mass of sericite, i.e. mica-illite (Roscoe 1969). This alteration has been attributed to pre-Huronian weathering (Roscoe 1969). Loss of iron during alteration relative to the underlying granitic rocks has been cited as evidence for a reducing atmosphere during early Huronian time (Pienaar 1963).

A rock similar to the green regolith described above was seen in Morin Township under arkosic sandstone at the base of the Matinenda Formation and generally lying on pink Archean granitic rocks. It was traced intermittently along the northern edge of the Matinenda Formation. In one place (Longitude 83°36.6'W, Latitude 46°33.8'N) it lies between the Ramsay Lake Formation and Archean granitic rocks. In McMahan Township, ¼ mile northeast of the east end of Hugli Lake, although no green regolith was seen on the surface, a gradational contact between granitic rocks and sandstone occurs.

A chemical study was not made of regolith development in McMahan and Morin Townships. The regolith is waxy and has a pale green to yellow, locally grey to buff appearance. Outcrops generally appear to be made up of quartz and sericite, but some contain feldspar. One thin section (C10T1, Table 5), contains angular, embayed polycrystalline fragments of clear quartz with unoriented undulose extinction. These fragments 'float' in a matrix of subparallel greenish white mica flakes about 0.03 mm long. The grain size of the quartz approximates that of the underlying granitic rocks. More or less oblong areas similar in size to those largely occupied by sericite, but showing weaker birefringence, may be ghosts of potassic feldspar crystals. The results of modal analysis of this thin section are: quartz, 39.5 percent; sericite, 60.5 percent; and accessory sphene, zircon, and leucocoxene. Following the classification scheme for sedimentary rocks used in this report (Figure 2) the above rock would be a quartz-wacke.

McMahon and Morin Townships

Orientation and distribution of lenticular quartz grains in the quartz-sericite regolith were found in one outcrop to be similar to those in the underlying foliated quartz monzonite, which implies alteration in place. Some granitic rocks in southwest Morin Township with altered feldspars possessed wedge-shaped cracks containing regolith.

Elliot Lake Group

Mafic Volcanic Rocks

Volcanic rocks at the base of the Huronian Supergroup are exposed along the North Shore of Lake Huron. These volcanic rocks are mostly mafic and are exposed in Duncan and Aberdeen Townships (Duncan and Aberdeen Volcanics: McConnell 1926; Hay 1961), near Thessalon (Thessalon Volcanics: Frarey 1962), in the Elliot Lake area (Bottrill 1971), near Spragge (Pater Volcanics: Robertson 1970a), and near Massey (Salmay Lake Volcanics: Robertson 1970b). The areal distribution of the volcanic rocks south of the Sudbury Basin (Stobie Formation and others) is illustrated on the map by Card (1969).

The volcanic rocks at the base of the Huronian Supergroup were previously classified as Keewatin (pre-Huronian) by Collins (1937), but their better state of preservation than local Archean volcanic rocks (McConnell 1926), and conformable and sometimes interbedded relations with strata of the Elliot Lake Group (Bottrill 1971; Hay 1961; Frarey 1959; 1961; 1962) indicate a lower Huronian age. General accounts of the Huronian volcanic rocks are given by Roscoe (1969) and Robertson (1971).

Part of a belt of volcanic rocks in Aberdeen Township included in the Thessalon Formation by Roscoe (1969) outcrops as parallel, southeast-trending, high ridges in the southwest corner of McMahon Township. On the basis of a 35°SW dip of amygdaloidal layers, a maximum thickness of 2,800 feet (850 m)¹ is likely. East toward McMahon Lake lie sheared paraconglomerate, argillite, and laminated argillite (with dropped stones) of the Gowganda Formation. Because no Huronian volcanic rocks have been found which are younger than the Matinenda Formation, and because of the southeast-striking, steeply dipping deformation surfaces west of McMahon Lake, it is probable that the volcanic rocks have been faulted up against the Gowganda Formation (McMahon Lake Fault). Nipissing-type diabase north of the volcanic rocks may have been intruded along this line of weakness.

Volcanic rocks similar in appearance to those of McMahon Township outcrop in the east half of Morin Township, at or near the base of the Matinenda Formation. Just west of St. Onge Lake, volcanic rocks with an apparent thickness of nearly 400 feet (120 m) were found in diamond drill holes of W. D. Sutherland and Associates (Figure 6). These rocks occur near the top of the Matinenda Formation. They thin markedly northward, and 1,500 feet north of mineral occurrence number 14 they appear to have pinched out.

¹ Metric equivalents are given approximately.

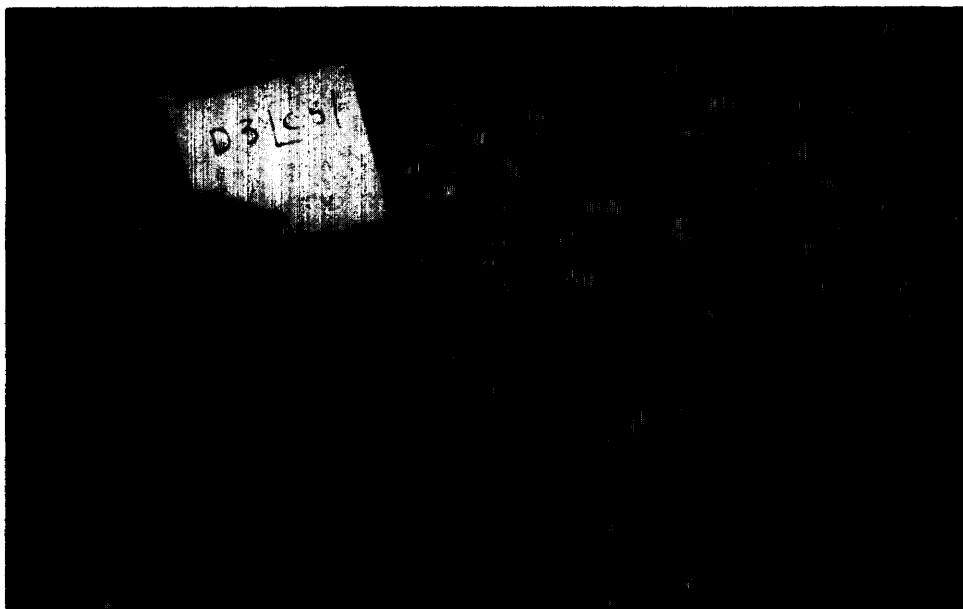
1		2		3		
Collins 1925		Federal-Provincial Committee 1969 (Robertson et al.) (Radioactive Age Dates in Millions of Years)		McMahon-Morin Townships		
Keweenawian	Olivine diabase	Olivine diabase	1,225	Olivine diabase		
	Granite	Granite	1,750	Lamprophyre		
	Diabase (incl. Thessalon Greenstone)	Diabase dikes		Nipissing Diabase	Nipissing Diabase	
			Nipissing Diabase		2,155	
Cobalt Series	Upper white quartzite and cherty quartzite	Bar River	Not present	Eroded?	Cobalt Group	
	Banded cherty quartzite	Gordon Lake				
	Lorrain quartzite	Lorrain		Lorrain Fm.		
	Gowganda	Gowganda	Members	Gowganda Fm.		
Bruce Series	Serpent quartzite	Serpent		Mississagi Fm.	Hough Lake Group	
	Espanola	E.L.	E.L.			Mississagi Fm.
		E.G.	E.G.			
		B.L.	B.L.			
	Bruce conglomerate	Bruce				
	Mississagi quartzite (Ramsay Lake locally in Quirke Lake area, as basal member)	Mississagi	Mississagi			Ramsay L. Fm.
			Pecors			* Matinenda Fm.
			Ramsay Lake			
		McKim		Volcanic Rocks		
		Local volcanic units		Matinenda		
Pre-Huronian	Granite	Matinenda	Members	Volcanic Rocks	Elliot Lake Group	
		Diabase		Diabase		
	Sudbury Series	Algonian Granite	2,500	Granitic rocks and Mafic intrusives		Archean
	Schist Complex	Metavolcanics				

* For discussion of other probably equivalent local formational names, see Roscoe 1969, p. 31-33.

SMC 12422

Figure 3—Comparison of stratigraphic nomenclatures for Huronian rocks (Southern Province of the Canadian Shield—North Shore of Lake Huron).

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Photo 3—Lower Huronian "greenstone" (4b) with amygdules rimmed by or filled with drusy quartz. South end of McMahon Lake, Aberdeen Township (83°48.6'W, 46°3.16'N).

The volcanic rocks are mostly massive and in places are sheared. Cleavage in southwest McMahon Townships dips 55-65°SW and amygdaloidal and vesicular layers dip 30-35°SW. Grain size is rarely more than 1/2 mm except at two localities west of McMahon Lake where phenocrysts of feldspars, 2 cm by 3 mm in size, were found. The volcanic rocks are usually dark green but sometimes dark to mid grey and weather buff to pale buff. Curved joint patterns resembling pillow structures were seen in two localities 1/4 mile (400 m) northeast of the southwest corner of Morin Township.

Amygdules and vesicles are abundant in some localities and absent in others. They can occur in bands. Amygdules and vesicles may be spherical, oval, or lenticular, and are usually 1 to 2 cm in length, rarely 5 cm. The long axes of the oval and lenticular amygdules and vesicles are parallel to the banding. Vesicle fillings appear to be white or drusy quartz (Photo 3), chlorite, and calcite. The writer, as well as McConnell (1926), noted that some bands of quartz amygdules strikingly resemble beds of quartz pebble conglomerate. Interbedded quartzite, grit, and quartz-pebble conglomerate were reported by Frarey (1959, 1961, 1962) however the writer only saw one bed of pink weathering dark grey medium-grained sandstone 5 feet (1.5 m) thick. Study of one thin section of amygdaloidal lava showed a possible paragenesis of the vesicle filling materials to be angular to drusy quartz succeeded in turn by chlorite, green (Fe³⁺rich) biotite, a mixture of chlorite and green biotite, and finally calcite. In sample D2C1 (Table 4) the amygdules are enclosed in a matrix comprising quartz, chlorite, sphene, green biotite, and epidote (identified optically). Minor

Table 4

CHEMICAL ANALYSES OF LOWER HURONIAN MAFIC VOLCANIC ROCKS,
MCMAHON TOWNSHIP

Sample No.	Major components, percent			Minor elements p.p.m.	
	D2C1*	D2C3		D2C1	D2C3
SiO ₂	58.81	49.96	Ag	—	—
Al ₂ O ₃	12.35	15.43	As	7	7
Fe ₂ O ₃	4.48	2.85	Ba	2000	200
FeO	6.04	10.0	Be	—	—
MgO	3.75	6.87	Co	35	50
CaO	2.62	5.61	Cr	10	150
Na ₂ O	1.39	3.30	Cu	20	20
K ₂ O	4.22	0.56	Ga	15	15
H ₂ O ⁺	3.03	3.58	Li	—	—
H ₂ O ⁻	0.67	0.19	Mn	—	—
CO ₂	0.21	0.10	Mo	—	—
TiO ₂	1.50	1.02	Ni	40	150
P ₂ O ₅	0.37	0.09	Pb	15	15
S	0.01	0.01	Sb	4	4
MnO	0.15	0.21	Sc	—	30
Totals	99.60	99.78	Sn	—	—
			Sr	300	400
			Ti	—	—
			V	200	300
			Y	30	30
			Zn	120	110
			Zr	300	200

* For location of samples see Figure 4.
Analyses by the Mineral Research Branch, Ontario Division of Mines.

plagioclase, potassic feldspar, muscovite, and possible epidote were identified by X-ray diffraction. The amygdaloidal lava is equigranular and the grain size is about 0.03 to 0.05 mm. In a thin section of sample D2C3 (Table 4) patches (about 1 mm across) of amphibole needles, with interstitial chlorite, occur in a matrix of chlorite, epidote, and leucoxene with a grain size of 0.03 mm. X-ray diffraction showed quartz, plagioclase, amphibole, muscovite, chlorite, and epidote also to be present. These two samples of lava were analyzed chemically by the Mineral Research Branch, Ontario Division of Mines and were found to be tholeiitic basalt (Table 4).

One outcrop of amygdaloidal lava immediately southwest of Osawomick Lake contains angular cobbles of granite, similar to that of the Archean basement exposed to the southwest. It also contains wisps of dispersed arkosic grit particles. The rock is succeeded stratigraphically by the Matinenda Formation. The field relations indicate that the amygdaloidal lava is post-Kenoran in age and was extruded contemporaneously with or earlier than the beginning of Matinenda sedimentation.

Mineralization associated with rocks of the volcanic sequence includes uraniferous interflow quartz-pebble conglomerate and some pyritization (W. D. Sutherland, personal communication).

Matinenda Formation

During earlier work along the North Shore of Lake Huron, Collins (1925), Emmons (1927), and McConnell (1926) recognized the presence at the base of the Huronian succession of a sedimentary sequence comprising interbedded conglomer-

McMahon and Morin Townships

ate, feldspathic sandstone, and argillite. The sequence was named by Winchell (1887) the Mississagui (sic) quartzite after the occurrence at the mouth of the Mississagi River. Collins (1925) accepted this name but changed the spelling to Mississagi.

Recent discovery of uranium at the base of the sequence in the Elliot Lake area (Pronto Mine) led to intensive investigation of the formation. As a result of this investigation, Roscoe (1957a) subdivided the Mississagi Formation (Collins 1925) into five units, now known as the Matinenda, McKim, Ramsay Lake, and Pecors and Mississagi Formations (Robertson *et al* 1969). The term 'Matinenda Formation' is restricted to a unit made up of feldspathic sandstone grit and uraniumiferous quartz-pebble conglomerate. Detailed accounts of this formation have been published by Pienaar (1963) and Roscoe (1969). The Matinenda Formation is thought to have been deposited under fluvial conditions on a dissected Archean surface which was modified during sedimentation by faulting and volcanism (Roscoe 1969). Studies of crossbedding by McDowell (1957) and Pienaar (1963) indicate a southeasterly paleocurrent direction.

The Mississagi Formation (Collins 1925) has not been subdivided in the Sault Ste. Marie area (Hay 1961, 1964; Frarey 1962), although possible correlatives with the Matinenda Formation in that area are the Livingstone Creek (Frarey 1967) and Driving Creek (McConnell 1927) Formations (Roscoe 1969).

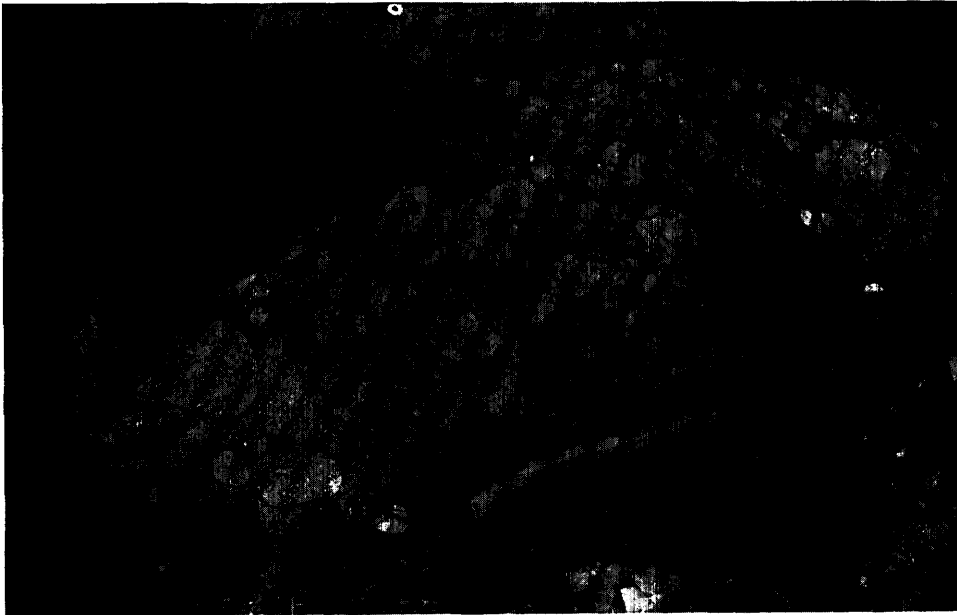
In the Blind River and Spragge areas, Abraham (1956) and Robertson (1970a) called the rocks, now considered to make up the Matinenda Formation, the Lower Mississagi Quartzite or Formation. The Matinenda Formation has been traced east from the present map-area to south of Sudbury where Collins (1925, 1936) considered the Ramsay Lake Formation to be the basal unit of the Huronian succession. Collins' inference places the Matinenda Formation within the pre-Huronian succession. Recent work in that area, summarized by Young and Church (1966), shows that the Matinenda Formation can be traced east to Denison Township (Card 1969), where it has been correlated with Ginn's (1961, 1965) 'Quartzite No. 3' and Card's (1965, 1968) 'Lower Quartzite'. To the north of the Sudbury Basin, Meyn (1969), and Card *et al* (1970) have been unable to subdivide the Huronian rocks beneath the Bruce Formation and have retained the term Mississagi Formation for them.

In McMahon and Morin Townships the Matinenda Formation consists of feldspathic sandstone with subordinate orthoconglomerate and paraconglomerate. Apart from a small outcrop area on the north shore of Hugli Lake in McMahon Township, the formation is confined to southern Morin Township where it lies with nonconformity upon an irregular surface of the Archean granitic rocks. Although in Morin Township a regolith (4a) was seen to rest on Archean rocks, grey feldspathic sandstone also occurs in this position northwest of Hugli Lake.

Except where the boundary is obscured by diabase intrusive bodies, the Matinenda Formation is succeeded by the Ramsay Lake Formation, but at the east end of Hugli Lake paraconglomerate of the Gowganda Formation overlies the Matinenda with a sharp contact (see 'Cobalt Group').

Formational thickness may be up to 1,400 feet (430 m) and may be influenced by Archean topography and intercalated volcanic rocks (Figure 6).

Granite cobble-boulder ortho- to paraconglomerate (Photo 4) and fine- to medium-grained feldspathic pyritic grey sandstones (5b) are prominent in the lower part of the Formation. Coarse-grained pale feldspathic sandstones and grits (5c) are well developed toward the upper part. Also in this upper part are beds of pebble-poor quartz-pebble conglomerate (5d) and minor mid-grey feldspathic coarse sand-



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Photo 4—Granite cobble-boulder conglomerate at the base of the Matinenda Formation (5a) Morin Township (83°37.3'W, 46°33.3'N). Matrix is pale green to pink arkosic grit.

stones and grits. Toward the top of the formation a paraconglomerate is exposed in the bed of Wood Creek (83°37.6'W, 46°32.6'N). The conglomerate is about 40 feet (12 m) thick and it appears to be laterally discontinuous. It may be the result of a mud flow channelled down on Archean valley. A modal analysis of the matrix and a count of the megaclast lithologies (Tables 8, 9, 10, 11) indicate that it cannot be correlated with conglomerates in the Ramsay Lake and Gowganda Formations.

BASAL CONGLOMERATE (5a)

A basal conglomerate facies of the Matinenda Formation, at least 30 feet thick, is well developed immediately east of Camp I Lake (local name, not on map) in Morin Township (83°37.5'W, 46°33.3'N). Megaclasts are in the 10 to 20 cm range and are almost entirely of pink granitoid rock; they are well rounded and have a high sphericity (Photo 4). The megaclasts may be tightly packed (orthoconglomerate) or dispersed (paraconglomerate). The locally crossbedded matrix commonly consists of pale green or pink coarse arkosic sandstone or grit. Some grit beds contain dispersed megaclasts of granitic rock or quartz pebbles. Some of the interbedded sandstones are fine grained, laminated or crossbedded, and dark grey with grey to brown weathered surfaces. An outcrop of regolith was seen to underlie the conglomeratic rocks.

The basal conglomeratic facies is best developed in a northward extended embayment of the lower boundary of the Matinenda Formation between two Archean

McMahon and Morin Townships

Table 5

MODAL ANALYSES AND CLASSIFICATION. MATINENDA FORMATION
SANDSTONES, MORIN TOWNSHIP

Sample No. Facies	C10T1 4a	C12C7 4	C14C4 4c	C14C5 4c	D13T3 4c	C13C4 4d	C14C1 4d
Quartz							
Quartz	39.50	42.25	77.00	82.00	81.00	56.00	55.00
Quartzite-chert		1.75	1.25		0.50		0.75
Feldspar				15.25 ⁴			
Granitoid		26.25	0.75		0.75	9.75	3.00
Microcline		3.25	2.25			3.00	2.50
Perthite		5.75	4.25		0.25	5.50	2.00
Plagioclase		5.25	0.50			4.00	4.75
Orthoclase		9.25	11.75		1.25	10.75	15.75
Labile Fragments							
Sericite?							0.25
Basal volcanic		0.75					
Matrix							
Sericite	60.50	0.50	2.25	1.00	15.75	3.75	10.25
Chlorite		6.00		1.75	0.25	tr	3.25
Leucoxene							2.25
Carbonate						7.25	
Pyrite					0.25		(+0.25 others)
Total	100.00	101.00	100.00	100.00	100.00	100.00	100.00
Texture							
Grain size ⁵	2-3 mm	Very coarse	Fine	Coarse	Medium	Medium	Fine- medium
Sphericity ¹		0.70	0.76	0.8	0.84	0.76	0.7
Roundness ²		A ²	S ²	S ²	SR ²	SA ²	SA ²
Matrix %	60.5	6.5	2.3	2.8	16.3	11.0	16.0
Classification (Fig. I)	Quartz wacke	Arkose	Sub- arkose	Sub- arkose	Quartz wacke	Arkose	Arkosic wacke

Notes

- (1) Rittenhouse (1948).
- (2) Powers (1953).
A = Angular
S = Sutured
SR = Subrounded
SA = Subangular
- (3) Too low to measure.
- (4) Too altered to distinguish varieties.
- (5) Wentworth size classes.

topographic highs which are in the centre of, and in the extreme southeast of Morin Township. This facies may have been deposited by vigorous fluvial action in the Archean valley, and it may be significant that the two uranium discoveries in the area lie immediately south and approximately 1 mile southeast. A relationship between southeast-trending Archean valleys, the conglomeratic facies in the Matinenda Formation, and uranium mineralization has been demonstrated in the Blind River area (Pienaar 1963). A local paraconglomerate may be the result of a mudflow channelled by this postulated valley.



ODM8811

Photo 5—Pale green arkosic grit with white quartz pebbles, Matinenda Formation (5d) Morin Township (83°37.7'W, 46°33.1'N). Bedding plane surface.

SANDSTONE (5b)

The basal conglomerate of the Matinenda Formation is overlain by a fine- to medium-grained, grey to dark grey sandstone. The sandstone commonly contains specks of limonite less than 1 mm across. It weathers grey to buff and is thinly bedded to laminated. On the basis of 2 modal analyses (C13C3, C14C1) the rock is an arkose or arkosic wacke (Table 5).

FELDSPATHIC SANDSTONES (5c)

The grey sandstone (5b) grades upward into medium-grained, pale, pink to grey, pale pink weathering (pink feldspar clasts) arkose, subarkose, or quartz wacke. These sandstones make up a large part of the Matinenda Formation in the area. The transition is marked by an increase in quartz content and a decrease in feldspar and matrix (Table 5).

Thus these sandstones have a higher textural and mineralogical maturity than the grey sandstone (5b). They are generally thicker bedded (several inches to several feet) than the grey sandstone and contain abundant crossbeds and some ripple marks.

A medium grey feldspathic grit (arkose, C12C7, Table 5) also occurs in the upper part of the formation. It is distinguished by its uniform dull grey colour and the angularity of its abundant granitic or feldspar clasts.

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ODM8812

Photo 6—The Ramsay Lake Formation (6) McMahon Township (83°38'W, 46°32.8'N). Typical massive paraconglomerate in which granitic (few of which are pink) and vein-quartz megaclasts are sparsely dispersed in a sericitic matrix of subarkosic-wacke.

QUARTZ-PEBBLE CONGLOMERATE (5d)

Some beds of feldspathic sandstone, up to 15 cm thick, contain dispersed pebbles of white quartz (Photo 5). The white quartz pebbles are up to 6 cm across and vary in roundness. Arcuate lumps of pale green sericitic mudstone also occur as clasts in the feldspathic sandstone matrix. More details of the distribution and geometry of these beds may be had from Figure 6.

No radioactivity was discovered in samples taken from outcrops.

Hough Lake Group

Ramsay Lake Formation

The Ramsay Lake Formation was named by Coleman (1905) after Ramsay Lake which is immediately southeast of Sudbury. It has not been recognized south and west of the present map-area (Frarey 1962) or north of Sudbury (Meyn 1970). In the Elliot Lake area, Roscoe (1957a) and Pienaar (1963) referred to the formation as the 'boulder conglomerate of the base of the Whiskey Formation' or 'the Whiskey conglomerate'. Abraham (1956), Robertson (1961; 1970a), and McDowell (1957) used the term "Middle Mississagi Conglomerate". In Harrow Township, Chandler (1969) used the term 'Whiskey Formation'.

Collins (1936) equated the Ramsay Lake Formation southeast of Sudbury with the basal formation of the Huronian sequence, thus he considered the rocks of the Matinenda and McKim Formations to be pre-Huronian in age. The geology of this area has been studied more recently by Ginn (1965) who correlated the 'lower conglomerate' in Nairn and Lorne Townships with the Whiskey (Ramsay Lake) Formation. His polymictic conglomerate, '2b' (Ginn 1961), Card's conglomerate (1965), and conglomerate 'unit' (1968) in Porter Township, Hyman and Drury Townships, and the Denison-Waters areas, respectively, are correlatives of the Ramsay Lake Formation.

The Ramsay Lake Formation is usually a massive paraconglomerate and is regarded by Roscoe (1957a) as the most useful stratigraphic marker in the lower Huronian sequence. Bedding is known in some localities, e.g. Flying Goose Lake (Roscoe 1957a) and Whiskey Lake (Chandler 1969). The thickness is variable (Robertson 1964) and increases toward the south (Robertson 1961). The formation appears to be the thinnest over thick ore-bearing facies of the Matinenda Formation (Roscoe 1969). It consists of pebbles of granitic rocks, quartz, and 'greenstone' in a sandstone matrix. Several writers, e.g. Card (1965), Ginn (1961), and Robertson (1961) have noted that the matrix of the conglomerate has a high quartz content, is pale in colour, and contains sericitic mica. Robertson (1963) has noted that the matrix tends to be chloritic where the conglomerate overlies Archean 'greenstones' and sericitic where it rests on granitic rocks.

Both glacial (McDowell 1957; Young and Chandler 1968) and mudflow (Pienaar 1963) origins have been postulated for the Ramsay Lake Formation.

Though Chandler (1969) suggested that the formation may have been derived from the west in the Elliot Lake area, the possibility that clast fabric may be in part of tectonic derivation should not be overlooked.

In the map-area, the Ramsay Lake Formation can be traced intermittently west from the southern corner to the south-central part of Morin Township. Outliers of paraconglomerate with properties similar to, (see Conglomerates, Huronian Stratigraphy) and probably forming a part of the Ramsay Lake Formation overlie Archean granitic rocks north and east of Osawomick Lake in southeast Morin Township. The thickness of the Ramsay Lake Formation, as indicated by one diamond drill hole (Figure 6), is up to 125 feet. A thickness of 40 feet was measured by the author in lot 2, concession 8 of Morin Township and at Woods Creek (83°37.6'W, 46°32.6'N).

The Ramsay Lake Formation is a homogeneous structureless paraconglomerate. The matrix is sandy to gritty in texture, quartz rich, and is pale grey to green, which reflects the presence of sericite. It weathers pale grey, green, or buff. The matrix of the formation is subarkosic wacke in composition. Details of matrix petrography and chemistry are presented in Tables 9 and 12. Megaclasts from 10 to 20 cm in size, but rarely up to 0.5 m across, are sparsely distributed in the matrix. One boulder of porphyritic granitoid rock was found to be 1.5 m in size. The megaclasts are of massive or foliated granitoid rocks, pink, red, or white banded gneiss, white vein quartz, and 'greenstone' (Table 11). The proportions of these lithologies vary from outcrop to outcrop.

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The lower boundary of the Ramsay Lake Formation where it rests on the Matinenda Formation is either knife sharp and wavy or gradational. Where the lower boundary of the formation is gradational the matrix of the lower 60 cm to 1 m of the paraconglomerate is a pale green weathering sandstone. A concentration of sandstone clasts does not occur in the basal part of the Ramsay Lake Formation.

Immediately northwest of Osawomick Lake the lower boundary of the paraconglomerate is knife sharp, with no alteration of the underlying quartz monzonite or alteration of the succeeding paraconglomerate. At the north end of the outlier north of Osawomick Lake, however, 5 to 10 feet of regolith (arkosic sandstone) was found between the paraconglomerate and the quartz monzonite. The regolith (sandstone) grades up into paraconglomerate very rich in vein quartz pebbles 1 cm to 5 cm across and 10 to 30 cm apart.

The Ramsay Lake Formation is overlain conformably by the Mississagi Formation. The Pecors Formation which is present between these two formations in an area to the southeast of the map-area is absent in McMahon and Morin Townships.

Mississagi Formation

The term Mississagi Formation was originally used for rocks of the Elliot Lake and Hough Lake Groups but as the result of refinement of Huronian stratigraphy it has been restricted to the feldspathic sandstone formation at the top of the Hough Lake Group (Figure 2).

In the Elliot Lake area Roscoe (1957a) referred to the Mississagi Formation (restricted sense) as the Ten Mile Formation, and Robertson (1961, et seq.) referred to it as the Upper Mississagi Quartzite. In the Bruce Mines area, it was included with the rest of the Hough Lake and Elliot Lake Groups in the Mississagi (Collins) Formation by Hay (1961, 1964) and Frarey (1962). East of the Elliot area, between Spragge and Sudbury, the Mississagi Formation has been referred to as the Wanaipitei Quartzite (Coleman 1914), the Upper Quartzite Unit (Card 1965, 1968b) and Middle Quartz Unit (Ginn 1965). In the Espanola area, Chandler (1969) and Casshyap (1967) refer to it as the Mississagi Formation.

The formation thickens southeast across the Elliot Lake area to about 2,700 feet. East of Harrow Township, Chandler (1969) found a thickness of 7,800 feet; Ginn (1965) found a thickness of 10,700 feet in the Nairn-Lorne Township area. Sedimentary structures include ripple marks (Photo 7), megaripple marks (Ginn 1965), and crossbeds. Depositing currents flowed southeast and east (McDowell 1957), and sedimentation was fluvial-deltaic (Card 1968, 1969).

In the map-area the Mississagi Formation is confined to the south-central and southeast parts of Morin Township. It is a pale pink to pale grey, rarely pale green subarkose, with red or pink feldspar clasts up to 1 cm across. It weathers to pale tints of pink grey or buff. Some exposures exhibit alternating pink-white and greyish blue laminae $\frac{1}{4}$ to $\frac{1}{2}$ cm thick as noted elsewhere (Chandler 1969). The sandstone varies from fine to coarse grained with medium and coarse grained being predominant.

Table 6MODAL ANALYSES AND CLASSIFICATION. MISSISSAGI FORMATION
SANDSTONES, MORIN TOWNSHIP

	C11C5 ²	C11C10	D10C2	D11C5	D11T2
Quartz					
Quartz	89.75	78.25	84.00	80.50	73.25
Quartzite-chert		2.25	1.25	1.25	3.25
Feldspar					
Granitoid	0.50	1.75	0.25	1.50	0.75
Microcline	0.75	2.00	0.50	1.75	2.50
Sericite assoc. with Orthoclase		+ .75		+ .50	+ 1.50
Orthoclase	3.75	6.50	3.75	7.00	6.75
Perthite	1.00	2.75	0.25	3.00	1.00
Plagioclase		1.75	0.25	0.25	0.25
Matrix					
Sericite	4.25	4.00	9.75	4.25	10.25
Zircon	tr				0.25
Oraques			tr		0.25
Totals	100.00	100.00	100.00	100.00	100.00
Texture					
Grain size					
Sphericity	0.88	0.86	0.80	0.85	0.84
Roundness ¹	S	SR	SR	SR	SA
Matrix %	4.3	4.0	9.8	4.3	10.9
Classification	Sub-arkose	Sub-arkose	Sub-arkose	Sub-arkose	Sub-arkose

Notes

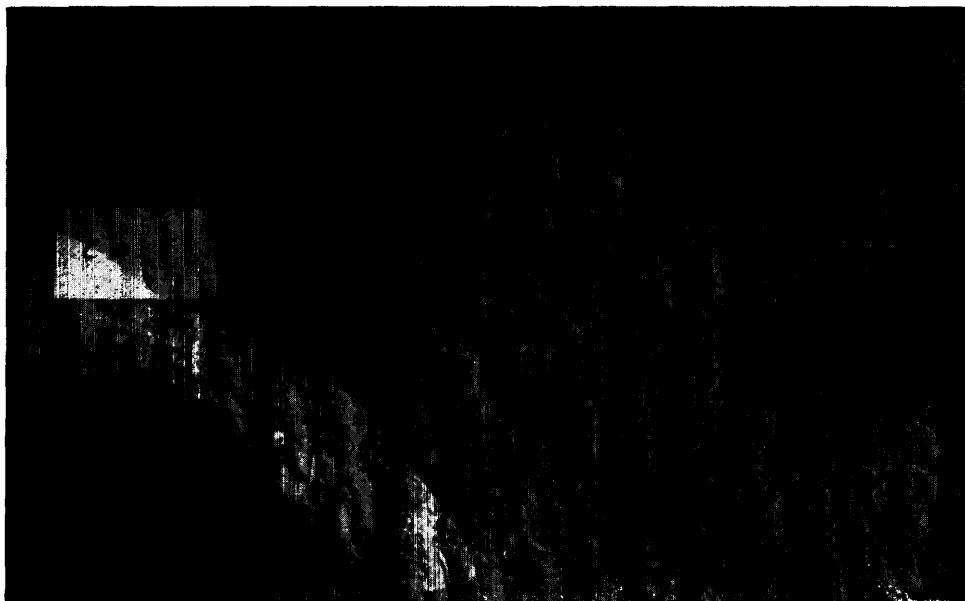
- (1) For explanation of symbols see Table 5.
(2) For location of samples see Figure 4.

The Mississagi Formation could not be subdivided into members in the map-area. Five modal analyses (Table 6) show a composition similar to that found in other areas (Chandler 1969; Casshyap 1967). Compositional and textural homogeneity and maturity are superior to those of the arenites of the Matinenda Formation (Table 3). Other differences which might serve to distinguish the sandstones from the two formations include a lower content of feldspar of the Mississagi Formation.

Sedimentary structures include the laminations, abundant crossbedding, current ripple marks (Photo 7), and bedding at a scale of 1 foot to several feet.

The thickness of the Mississagi Formation estimated from diamond drill core (Figure 6) is over 400 feet but in McMahan Township and further north in Morin Township its absence indicates that either the formation was removed by erosion prior to deposition of the Gowganda Formation or that here its paleolimit has been reached.

Because the Pecors Formation is missing in the map-area, the Mississagi Formation must overlie and, on the basis of attitude, be conformable with the Ramsay Lake Formation. The Quirke Lake Group of sedimentary rocks (Figure 2) is also missing. The Gowganda Formation, therefore, must succeed the Mississagi Formation in the stratigraphic succession in southeast Morin Township.



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Photo 7—Asymmetrical ripple marks in subarkose of the Mississagi Formation (7). (83°39.1'W, 46°32.7'N). Morin Township. Ripple wavelength 3 cm, amplitude 0.8 cm.

Cobalt Group

Gowganda Formation

The Gowganda Formation stretches from Sault Ste. Marie to the Cobalt-Gowganda area. Possible correlatives in Wyoming, Michigan, and Quebec (Chibougamau) have been suggested by Young (1970). The formational thickness varies from 2,000 to 4,000 feet north of Bruce Mines and north of Lake Temagami (Roscoe 1969; Simony 1964). The formation approximately doubles in thickness farther south near Lake Wanapitei (Grant 1964).

The formation rests with regional unconformity on older Huronian formations and overlaps northward on to Archean rocks (Giblin and Leahy 1967). It is a variable succession of clastic sedimentary rocks with a basal granitic orthoconglomerate that occurs particularly where the formation rests on Archean granitic rocks. The formation consists of massive paraconglomerate, plagioclase-rich feldspathic sandstone, siltstone, and laminated argillite, the last often found with dropped clasts. Though there is much lateral facies variation (Collins 1925; Card *et al* 1970) individual members can sometimes be traced several miles (Chandler 1969). Conglomerates are more apparent in the lower part of the formation near Elliot Lake (Robertson 1968a) and south of Whitefish Falls. This tendency, well developed in the Cobalt area, prompted Thomson (1957) to subdivide the formation into a lower conglomerate-sandstone Coleman Formation and an upper argillite-rich Firstbrook Formation. Collins (1925), however, had already pointed out that the term Gow-

ganda is linked with a glacial genesis and should be retained as the formational name. On account of this last point the writer regards Coleman and Firstbrook as members of local significance.

The Gowganda Formation is well known on account of Miller's (1905 in Wilson, 1913) and Coleman's (1905, 1908) proposal of a glacial origin. Recently Crowell (1957) and Dott (1961, 1963) pointed out that sediments similar to those of the Gowganda Formation could be formed by mudflow and similar mass transport mechanisms. This triggered many recent studies which have supported the glacial hypothesis. Among these are studies by Casshyap (1969), Chandler (1969), Lindsey (1969), Ovenshine (1965), Schenk (1965a, b), Young (1970), and Young and Chandler (1968). A regional paleocurrent pattern for the Gowganda Formation has been presented by Young (1968).

The Gowganda Formation is widely distributed in the southeast half of McMahon Township where it is intruded by extensive Nipissing-type quartz-diorite sills. It is present along the southern boundary of Morin Township and as an outlier about 2 square miles in area extending 2 miles west of Shelden Lake. A southeastern extension of the outlier is poorly exposed south of Shelden Lake. No reliable thickness data are available, though in the Stuart Lake-Hugli Lake area of McMahon Township the Gowganda Formation is probably over 400 feet thick. Because it overlaps older Huronian Formations, the Gowganda Formation rests directly on the Archean granitic rocks throughout much of its extent in McMahon Township and west of Shelden Lake. In places in the map-area, the Gowganda Formation also lies directly upon the Matinenda and Mississagi Formations but it was not found resting on the Ramsay Lake Formation.

Where 'muddy'¹ paraconglomerate overlies Archean pink granitic rocks, the trace of the base of the Gowganda Formation is sharp and may be either undulose or straight at outcrop scale. Where the matrix of the basal conglomerate is pink-red and arkosic, and clasts are of pink granitic material, the boundary with pink granitic rocks is difficult to observe particularly under lichen.

At the east end of Hugli Lake (83°45.9'W, 46°33.2'N) paraconglomerate (7c) overlies, with a sharp wavy boundary, the pale green weathering, pale grey, massive, medium-grained sandstone of the Matinenda Formation. The base of the conglomerate is rich in red granitoid megaclasts but sandstone megaclasts were not seen. It is likely that the Matinenda Formation was not lithified during deposition of the Gowganda Formation.

The upper boundary of the Mississagi Formation, where it is overlain directly by the Gowganda Formation, may be sharp or gradational across a zone of 5 to 20 cm thick. Foliation of the transition zone rock may indicate tectonic disturbance, i.e. bedding plane slip.

An unconformable relation with the underlying Mississagi Formation is suggested by the following data: (a) strike and dip directions differ in the two formations in southeast Morin Township; (b) a rippled bedding surface in the same area is at an angle to the local base of the Gowganda Formation (Longitude 83°33'W, Latitude 46°32'N).

A soft sediment boundary with the underlying Mississagi Formation is suggested by the following data from southeast Morin Township. Above a channel-like depression of the base of the Gowganda Formation, in to the Mississagi Formation, the matrix of the paraconglomerate is unusually sandy. Pebbles, including some possibly

¹ Textural terms in quotation marks refer to consolidated sediments.

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of quartzite, appear to have been pressed down into the underlying Mississagi Formation sandstone prior to lithification of the sandstone.

As discovered elsewhere, the Gowganda Formation in this area is a varied, commonly interbedded assemblage of clastic sedimentary rocks ranging from boulder conglomerate to mudstone. Even though exposure is poor, there appears to be a tendency for conglomerate to occur lower and sandstone and argillite higher in the Formation.

CONGLOMERATES

The conglomerates range from an orthoconglomerate of close-packed megaclasts of red granitic rocks in an arkosic matrix (8a) through a transitional phase (8b) in which the ratio of matrix to megaclasts is relatively high, to a paraconglomerate (8c) of massive mudstone with sparse megaclasts.

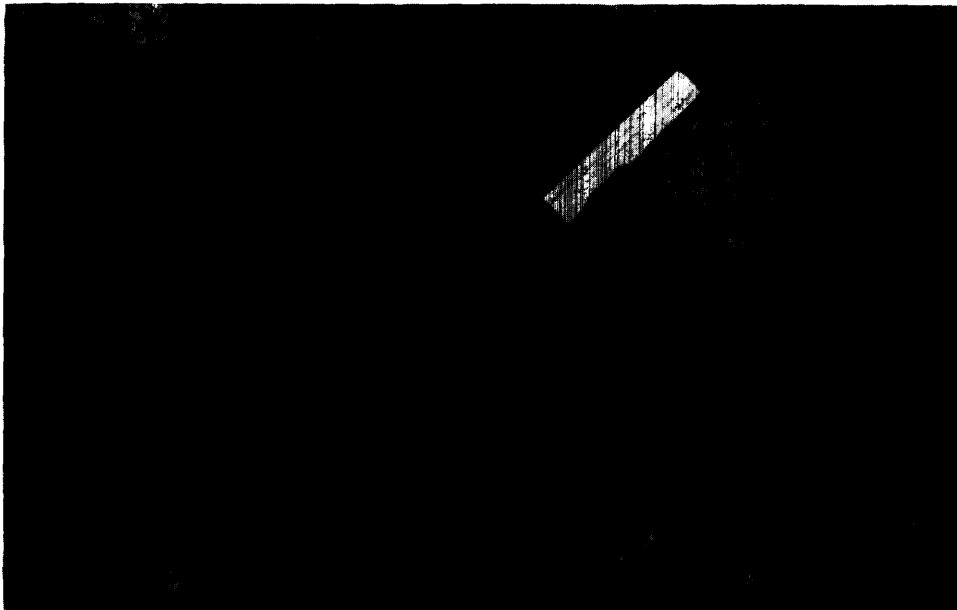
Orthoconglomerate (8a) occurs mainly at the base of the formation where it overlies the Archean granitic rocks, and in a few places other Huronian formations, e.g. in the southeast part of Morin Township. It is particularly well developed in the west and south parts of the outlier west of Shelden Lake. The orthoconglomerate varies from units over 500 feet (150 m) thick to 6 inches (15 cm) thick. The thinnest units are graded beds of coarse sandstone with pebbles up to 2½ cm across. It also is locally interbedded with argillite, paraconglomerate, and fine-grained sandstone, particularly in the southern part of the map-area.

Most megaclasts consist of pink to red massive granitic rocks; some of foliate or porphyritic granitic rocks; a few of diabase, vein quartz, and felsic, mafic, massive, and schistose metavolcanics (Table 11). The megaclasts vary from pebble to boulder size. One megaclast of foliated granitic rock was found to measure 55 cm across. The megaclasts are angular to subrounded with generally high sphericity and good sorting. The more angular megaclasts occur at or near the base of the formation. The matrix is generally a coarse-grained, pale, pink weathering, dark red to grey arkose to arkosic grit. Modal analyses of matrix and counts of megaclast lithologies are given in Tables 7 and 9.

In some exposures the conglomerate possesses characteristics intermediate between the orthoconglomerate (8a), and the paraconglomerate (8c) described below. This transitional conglomerate (8b) (Photo 8) occurs near the base of the formation and may be the result of a mixture of partly weathered granitic mantle (talus and other large fragments) and fluvial gravel incorporated into a tillite or a mudflow conglomerate.

Paraconglomerate (8c) is prominent in the lower part of the formation but is less common northwest, southwest, and south of Stuart Lake in McMahon Township. Generally it is massive in outcrops but may be interbedded with all other facies of the Gowganda Formation. The matrix varies from dark grey or green mudstone or wacke to pink grit and is generally arkosic in composition (Table 9). The coarse-grained matrix which has a more feldspathic sand-size fraction (0.03 mm) tends to occur where the paraconglomerate is close to or lies directly upon Archean granitic rocks.

Megaclasts in the paraconglomerate vary in size from 1.43 metres downward and are extremely variable in abundance. In places they are concentrated in ill-defined beds. Sandstone schlieren also occur in the matrix. The megaclasts are of all degrees



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Photo 8—Basal granitic conglomerate of the Gowganda Formation, centre of McMahon Township (83°46.5'W, 46°34.0'N). Facies (8b) transitional between ortho- and paraconglomerate. Scale is 15 cm long.

of roundness and consist predominantly of red to pink granitic rocks. The dominance of granitic megaclasts has been used to distinguish between paraconglomerates of the Gowganda and Bruce Formations in the Elliot Lake area (Robertson 1968). This criterion does not seem to hold southeast of Massey (Chandler 1969; K. D. Card 1971, personal communication). Minor quantities of other megaclasts also occur (Table 11).

SANDSTONES

Clastic sedimentary rocks finer than conglomerate are particularly well developed southwest of Stuart Lake and east of Patten Lake in McMahon Township and in the southwest corner of Morin Township.

Sandstones are divisible into two facies: greywacke¹ (8d) and feldspathic sandstone (8e). Greywacke (8d) is fine to medium grained, poorly sorted, dark grey, and weathers pale buff to red. It is usually found interbedded with other facies particularly siltstone and argillite. Feldspathic sandstone (8e) is generally medium- to fine-grained arkose (Table 7) and better sorted than 8d. It is also more thickly bedded and has a lesser tendency to be interbedded with other facies. It is abundant northwest and northeast of Lamothe Lake in McMahon Township and on the

¹ Used here as a field term. Modal analyses of this rock type were not made.

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Photo 9—Laminated to thinly bedded argillite and sandstone of the Gowganda Formation, (8c,d,k) McMahon Township. Starved ripples of sandstone and ripple sandstone beds are paler than argillaceous laminae. Dropped clasts up to boulder size (95 cm, centre of photo) are abundant (83°46.1'W, 46°32.9'N).

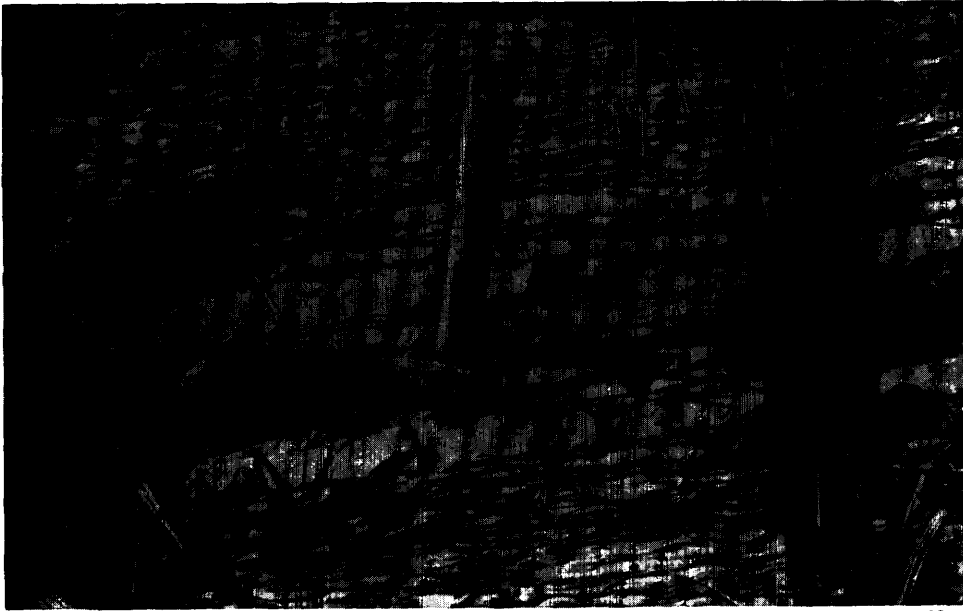
islands in the northern part of McMahon Lake. It is dark red, purple, chocolate or grey, and weathers chocolate, buff, orange, or grey. Bedding is 2 inches (several cm) to more than 3 feet (1 m) thick. Ripples and slumped bases (into interbedded argillite) occur. Many outcrops are characterized by limonite specks resulting from oxidation of disseminated pyrite and chalcopyrite.

ARGILLITES

Argillites may be massive (8h), laminated (8j), or laminated with dropped clasts (8k).

Rocks identified in outcrops as massive argillite may be pebbly mudstone in which pebbles have escaped notice. Laminated argillite (8j) is banded (varved?) on a scale down to less than 1 mm. It is dark grey to green and weathers rusty buff or grey. The laminae may be undisturbed or recumbently folded as a result of soft-sediment deformation. Open folds of tectonic origin occur at the boundary between McMahon and Morin Townships. The facies occurs in units of at least 30 feet (10 m) in thickness. The argillite may be interbedded with fine-grained feldspathic sandstone beds which are up to 1 foot (30 cm) thick, paraconglomerate, and orthoconglomerate. At some localities in McMahon Township it rests directly upon the Archean rocks.

Another laminated argillite (8k) is characterized by contemporary deposition of coarser clastic detritus, in particular boulders which only up warp and down



ODM8816

Photo 10—Rippled fine-grained purple feldspathic sandstones transitional between the Gowganda and the Lorrain Formations, McMahon Township (83°50.3'W, 46°35.5'N). Interbedded argillite contains abundant fine sandstone and siltstone starved ripples.

warp the surrounding laminae. One boulder (centre of Photo 9) is 95 cm long. In general, dropped megaclasts are pebbles and cobbles of red granitic rock. Included with the laminated argillite (8k) are thin gritty paraconglomerate beds about 4 inches (10 cm) thick (mudflows?); pebble and granule layers; dark grey, orange to pink weathering sandstone beds $\frac{1}{4}$ inch to 4 inches (1 cm to 10 cm) thick, with slumped bases and starved sand ripples. It is likely that this facies (8k) is the result of deposition of unsorted detritus by mudflows and turbidity currents, and from floating ice in gently moving waters.

Lorrain Formation

The Lorrain Formation consists of 5,000 to 7,000 feet of upward maturing sandstone. It is well developed north of Bruce Mines (Collins 1925). Though almost completely removed by erosion in the Elliot Lake area, it is preserved farther north in the Flack Lake depression (Harding 1939; Wood 1968a, b). Tightly folded into the La Cloche Syncline, it forms a line of hills that stretch east from the mouth of the Spanish River and curve southwest around the MacGregor Anticline and other structures (Young 1966). The formation is unconformably overlain by Paleozoic rocks at the northeast end of Manitoulin Island. The formation is widely present north of Sudbury (McIlwaine 1970; Card *et al* 1970).

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Table 7

MODAL ANALYSES AND CLASSIFICATION, GOWGANDA AND LORRAIN FORMATION SANDSTONES, McMAHON AND MORIN TOWNSHIPS

Formation	Gowganda			Lorrain		
	7f	7f	8a	8b	8c	8c
Sample No.	A12T4*	B4T1	B2C6	B1C1	B2C8	B1C3
Quartz						
Chert Quartzite	1.50	0.50	0.50	0.25	5.00	
Jasper						0.25
Quartz	40.25	53.50	45.25	86.25	79.25	84.00
Feldspar						
Granitic	5.50	3.75	1.25	0.25	—	—
Microcline	2.25	2.25	2.00	—	—	—
Orthoclase	28.50	21.50	29.75	4.00	—	—
Perthite	2.75	3.25	0.75	6.00	—	—
Plagioclase	9.50	12.00	3.00	—	—	—
Labile Fragments (Mafic volcanic)	—	0.25	—	—	—	—
Matrix						
Carbonate	1.00	—	3.00	—	—	—
Chlorite	7.75	0.50	12.75	—	—	—
Hematite	0.25	—	—	—	0.25	0.50
Ilmenite	0.50	0.25	—	—	0.25	—
Leucoxene	0.25	0.25	1.00	—	—	—
Magnetite	—	0.25	—	—	1.50	— ¹
Sericite	—	1.75	0.75	3.25	13.75	15.25
Total	100.00	100.00	100.00	100.00	100.00	100.00
Classification	Arkose	Arkose	Arkosic wacke	Sub- arkose	Quartz wacke	Quartz wacke

(1) Occurs in large patches of fine grained crystals, possibly derived from diagenesis of feldspar clasts.
* For location of samples see Figure 4.

The boundaries with the underlying Gowganda and succeeding Gordon Lake Formations are conformable. Several writers have subdivided the formation (Frarey 1962; Chandler 1969; Casshyap 1967; Card *et al* 1970). Regional subdivision is into basal feldspathic sandstone, middle quartz pebbly sandstone and upper quartz arenite. In the Bruce Mines area, jasper clasts are common in the middle part. Aluminous minerals, kaolinite, diaspore, pyrophyllite, andalusite, and kyanite have been observed at various localities in the middle and upper parts (Church 1967; Chandler *et al* 1969; Card *et al* 1970).

The sedimentology of the formation has been described by Hadley (1968). According to Casshyap (1969) there was a change from a fluvial to a beach environment during deposition. Around Flack and Rawhide Lakes, thorium radioactivity in black sandstone of placer origin (Roscoe 1969) provides a geophysical marker unit.

Only the lower part of the Lorrain Formation is exposed west of Stuart and Lamothe Lakes in west McMahon Township. The facies is transitional from the Gowganda Formation (Photo 10) and passes upward into fine- to medium-grained, purple to grey sandstone which weathers buff, rust, or chocolate (9a).

With increasing grain size, thickening bedding, and the appearance of trough crossbeds, the fine- to medium-grained sandstone is succeeded by coarse-grained, pale, purple to pink feldspathic (9b) or jasper bearing (9e) sandstones. Jasper begins as rare specks 1 mm to 2 mm long and at the top of the section several may be present to the square inch and up to 7 mm in length. The appearance of jasper, upon which the formation is subdivided in the map-area, is regarded as a 'forerunner' of the Jasper Conglomerate (Collins 1925; Frarey 1962).

Modal analyses (Table 7) indicate upward increasing maturity. The less marked textural maturity trend (Folk 1951) as represented by sericite, which causes the most mature rocks to be classified as wackes, may be due to diagenetic breakdown of potassic feldspar.

Huronian Stratigraphy

Two stratigraphic problems exist in the map-area. The first arises because of the presence of sandstones lying between the Archean basement rocks and the overlying Gowanda Formation in south Morin Township. The second concerns the presence of some outliers of paraconglomerate (Bodies A-G, Figure 3), mainly in east Morin Township.

Previous Work

McMahon and Morin Townships lie at the northern limit of the area mapped by Collins and Emmons (Collins 1925). Allowing for differences in access and scale of mapping, lithological boundaries in this report broadly reflect those presented by Collins. Collins, however, did not recognize the presence of volcanic rocks (Aberdeen Volcanics) in the southwest part of McMahon Township, and of the Lorrain Formation in western McMahon Township. Major differences between Collins' map and Map 2272 (back pocket) lie in interpretation. Collins (1925, p. 32) observed that:

"There is a remarkable development of the basal member of the Mississagi [Collins] Formation in the northern part of the Bruce Mines map-area. It approaches near to the north and northeast part of Echo Lake and was seen there by the writer; but although it was evidently the Mississagi quartzite, [Mississagi Formation, Robertson *et al* 1969] its strong resemblance to the Gowanda Formation caused some uncertainty regarding its identity . . .".

"In the district north of Patten Lake and east of Stuart Lake much of the conglomerate is lithologically indistinguishable from a very common rock type in the Gowanda Formation".

Thus it is not surprising that Collins, working without the knowledge of Huronian stratigraphy derived from the exploration for uranium in the Elliot Lake area, should have confused the various conglomerates of the area.

In 1959, McMahon and Morin Townships were included in the Echo Lake area mapped by Frarey (1959). Apart from recognition of the volcanic rocks in the southwestern part, and of the Lorrain Formation in the western part of McMahon Township, Frarey's changes were mainly interpretive. The most fundamental of these were: (a) all paraconglomerates and orthoconglomerates were grouped into the

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Table 8

AVERAGE MODAL ANALYSES OF HURONIAN PARACONGLOMERATE MATRICES
NORTH SHORE OF LAKE HURON⁽¹⁾

Formation	Ramsay Lake		Bruce		Gowganda	
	Harrow Township	Bruce Mines-Elliot Lake	Harrow Township	Bruce Mines-Elliot Lake	Harrow Township	Bruce Mines-Elliot Lake
No. of specimens	10	3	5	3	6	3
Quartz	64.6	61.7	42.7	47.9	31.2	35.5
Feldspar	3.1	4.8	8.6	8.3	6.2	11.7
Sericite	25.1	29.3	35.5	39.5	24.0	11.7
Chlorite	1.4	3.6	1.0	1.5	0.2	40.7
Biotite	4.0		10.2	0.2	36.3	
Carbonate	0.3		1.2	1.3	0.4	tr
Accessory Minerals	0.6	0.6	0.8	1.0	1.9	0.1
Total	99.1	100.0	100.0	99.7	100.2	99.7
Feldspar Analyses						
No. of specimens	9	3	5	3	5	3
Microcline	0.5		0.9	0.5	0.5	0.1
Orthoclase	1.1	3.2	6.0	5.4	3.5	7.3
Perthite	1.0	1.0		tr		
Plagioclase	0.3	0.6	1.7	2.4	1.2	3.7
Total	2.9 ²	4.8	8.6	8.3	5.2 ²	11.1 ²

(1) After Chandler (1969).

(2) Feldspars analysed separately.

Gowganda Formation; and (b) the sandstones in Morin Township (including the Ramsay Lake paraconglomerate Formation) were reassigned to the Serpent Formation. Some sandstones west of McMahon Lake remained in the 'Mississagi [Collins] Formation'.

In 1967 further changes were made in the interpretation of the stratigraphy (Giblin and Leahy 1967). Although most paraconglomerates were considered by Giblin and Leahy to belong to the Gowganda Formation, an outlier of paraconglomerate ½ mile (0.8 km) north of Osawomick Lake was assigned to the Bruce Formation and the sandstones in Morin Township were reassigned to the 'Mississagi [Collins] Formation'.

Roscoe (1969, p. 23) was also aware of the difficulties in correlating these "isolated outcrop areas of quartzite . . . surrounded by the Gowganda Formation" and returned to Collins' (1925, p. 24) view that "some quartzites may be correlatives of the Livingstone Creek and Matinenda Formations".

In view of the occurrence of economic concentrations of uranium in the Matinenda Formation in the Elliot Lake and Quirke Lake areas (Robertson 1961, 1968a, b; Roscoe 1969), the stratigraphic position of the sandstones in the map-area is of particular importance. It was for this reason and uncertainties regarding the stratigraphy of the area that the writer's field party mapped McMahon and Morin Townships.

Sandstones

The sandstones of Morin Township contain a continuous conformable unit of paraconglomerate. The sandstones beneath the paraconglomerate lie on regolith and contain intercalated volcanic rocks and quartz-pebble conglomerate beds with uranium mineralization. The paraconglomerate has the pale sericitic gritty matrix, relative maturity, and white quartz pebbles characteristic of the Ramsay Lake Formation (Tables 8, 9, 11, 12, Photo 6).

This correlation indicates that the McKim Formation is absent in the map-area. The absence of this formation is not surprising for according to Roscoe (1969) the McKim Formation in the Elliot Lake area was deposited in a river estuary or drowned Matinenda valley which opened southeastward into the McKim sea, but terminated near the northwestern corner of Township 161. Similarly, to the east in Denison Township (Card *et al* 1968), the McKim Formation dies out westward with interdigitations into the Matinenda Formation.

Overlying the Ramsay Lake Formation is a pale subarkose. Roscoe (1969) has pointed out that the Pecors Formation, which thins northward, is probably absent in Aberdeen Township (south of McMahan Township). Assuming this to be valid the subarkose above the Ramsay Lake Formation in the map-area can be correlated with similar rocks of the Mississagi Formation.

Rocks of the Quirke Lake Group do not outcrop in the map-area. This may be because they were not deposited about a topographic high formed of Archean granitic rocks in the Haughton Township area. In Gould Township, east of the high, the Gowganda Formation has been shown by diamond drilling (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) to lie directly on Archean basement. Drilling also shows that on the west side of the topographic high the Espanola Formation is absent. Paraconglomerate of the Gowganda Formation on a small island in the northeast corner of Cummings Lake in Gould Township was identified by Frarey (1961) as belonging to the Bruce Formation. Thus it would seem likely that the present northern unit of the Quirke Lake Group about the Haughton topographic high may run from the southeast corner of Galbraith Township through Bridgland and Wells Townships to where it is exposed in Parkinson Township. The limit may run thence north, obscured beneath the Gowganda Formation through Grasset Township to the eastern margin of Township 182. Diamond drilling northwest of this arcuate boundary (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) has not revealed the presence of limestones similar to those of the Espanola Formation.

The absence of Quirke Lake Group rocks may be due to non-deposition or erosion following incipient uplift of a structure possibly continuous westward from the Chiblow Anticline and the Parkinson Dome. This event preceded deposition of the Gowganda Formation.

The absence of pelitic formations such as the McKim and Pecors, and of rocks of the Quirke Lake Group indicates that the map-area, during part of the Huronian period, may have been in an environment closer to terrestrial than those areas farther southeast.

McMahon and Morin Townships

Conglomerates

Previous work in the North Shore of Lake Huron region has indicated differences in textural (Folk 1951) mineralogical and chemical (Pettijohn 1957) maturity between the Huronian paraconglomerates (Table 8). The differences have been explained in terms of decreasing availability of supracrustal materials, particularly partly mature sediments, in the source areas of the three successive paraconglomeratic formations (Chandler 1969). A source material of some significance might be the quartz-sericite regolith developed between the Kenoran orogeny and the onset of Huronian sedimentation (Modal analysis C10T1, Table 5). It may be that this mantle of weathered material supplied much of the sericite that is diagnostic of the Ramsay Lake Formation where it does not overlie mafic volcanic rocks. On the basis of megaclast lithologies (Chandler 1969), mineralogy (Table 8), and chemistry (Table 10), it would seem that the Bruce and Gowganda Formations depended on increasing proportions of unweathered crystalline granitic rocks as a sediment source.

The above differences occur also between the conglomerate identified as the Ramsay Lake Formation and the Gowganda Formation in the present map-area (Tables 9, 11, 12).

Outliers of paraconglomerate in McMahon and Morin Townships (Figure 4) have been assigned to the "Mississagi [Collins] Formation" and the Bruce and Gowganda Formation by Collins (1925), Frarey (1959), and Giblin and Leahy (1967).

The rocks of these outliers were compared by the author to the Ramsay Lake, Bruce, and Gowganda Formations on the basis of megaclast lithology (Table 11), mineralogy of matrix (Tables 8, 9, 10), and chemistry of matrix (Table 12). Results are as follows:

CONGLOMERATE A

Laminated argillite, and paraconglomerate with abundant red granitic rock clasts are characteristic of the Gowganda Formation. Low K-feldspar/plagioclase ratio, abundance of sand-size granitic and labile fragments, chloritic matrix, and low aluminum/sodium ratio of the paraconglomerate matrix also indicate affinity with the Gowganda Formation.

CONGLOMERATE B

A sericitic matrix may indicate this conglomerate to be of the Ramsay Lake Formation but the high feldspar content could indicate the rock to be a part of the Gowganda Formation.

Table 9

MODAL ANALYSES AND CLASSIFICATION OF PARACONGLOMERATE MATRICES, RAMSAY LAKE AND GOWGANDA FORMATIONS, MCMAHON AND MORIN TOWNSHIPS

Formation	Ramsay Lake							Gowganda						
	C11C3 ²	C11C6	C13-2C4	D12T1	D13T2	Average	A13C1	B4C1	B11C3	B13C4	C4TC	D6C1	D12T1	Average
Quartz	54.00	51.00	44.00	62.75	50.61	52.5	25.5	28.3	24.5	20.8	10.0	10.0	30.0	21.3
Feldspar and Granitic fragments														
Micoclase ¹	2.25	1.00	0.75	0.25		0.9	0.7		0.3	0.3	0.3		1.0	0.4
Orthoclase ¹	0.50	2.00	3.25	6.00	3.42	3.0	4.1	3.8	6.0	3.3	1.8	1.5	7.3	4.0
Perchite	1.75	0.75		0.75	1.00	0.9		0.3	0.5	0.5				0.2
Plagioclase						0.1	1.9	4.0	1.9	1.3	0.5	1.3	3.8	2.0
Granitic	0.50	0.25	11.00	0.25	1.00	2.6	5.1	3.0	15.5	1.5	0.5	1.5	22.5	7.1
Labile fragments														
Micaceous Sst, Schist							1.0	9.3	8.1	0.6		1.1	1.5	2.2
Basic Volc.-Diabase								0.5		0.3		0.5		0.2
Labiles	1.25	0.25			1.25	0.3								2.4
Matrix														
Sericite(s) or Chlorite(c)	39.50(s)	44.75(s)	41.00(s)	30.00(s)	42.3(s)	39.5(c)	60.7(c)	51.3(c)	44.0(c)	71.5(c)	87.0(c)	84.0(c)	33.8(c)	61.8(c)
Carbonatite														
Ilmenite						tr	0.5							0.4
Leucoxene														
Magnetite														
Pyrite														
Totals	100.00	100.00	100.00	100.00	99.83	100.4	100.0	100.5	100.11	100.4	100.1	100.2	100.2	99.6
Maturity indices														
Quartz/Feldspar and Granite														
K. Feldspar/Plag.						7.2								1.6
Classification	Sub-arkosic wacke	Sub-arkosic wacke	Arkosic wacke	Sub-arkosic wacke	Sub-arkosic wacke	Sub-arkosic wacke	Arkosic wacke	Arkosic wacke	Lithic arkosic wacke	Sub-arkosic wacke	Arkosic mud-stone	Arkosic mud-stone	Sub-arkosic wacke	Arkosic wacke

(1) Unwinned Feldspar.
 (2) For location of samples see Figure 4.

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Table 10

MODAL ANALYSES OF MISCELLANEOUS PARACONGLOMERATE MATRICES
MCMAHON AND MORIN TOWNSHIPS

Sample Number ¹ Conglomerate Body	B12-2C2 B	C13-C4 C	C13-2T1 C	C13-2T3 C	Average of C	C13-C3 C	C12-T1a E
Quartz, quartzite	33.50	77.50	60.50	31.50	56.5	35.25	39.00
Feldspars + Granitic fragments	(27.00)	(6.75)	(8.75)	(17.25)	(11.0)	(3.50)	(6.50)
Microcline	0.25		0.25	0.75	0.4	0.50	
Orthoclase	4.25	2.50	4.00	2.50	3.0	0.75	1.00
Perthite		0.25	0.50	1.00	0.6	0.50	0.25
Plagioclase						0.25	
Granitic fragments	22.50	4.00	4.00	13.00	7.0	1.50	5.25
Labile fragments							
Micaceous Sst, Schist							
Mafic volc., Diabase	2.75		1.00	0.25	0.4		1.00
Matrix							
Sericite (s)	36.00S	15.50S	29.75S	51.00S	32.0S	61.25S	53.50S
Chlorite (c)							
Carbonate							
Ilmenite							
Leucoxene							
Magnetite		0.25			0.1		
Pyrite							
Total	100.00	100.00	100.00	100.00	100.0	100.0	100.00
Qtz/Feldspar + Gran. Kspar/Plagio.	1.2 5.8:1.0				5.1 4.0:0	9.8 6.0:0	5.9 1.3:0
Classification	Arkosic wacke	Sub- arkosic wacke	Sub- arkosic wacke	Arkosic wacke	Sub- arkosic wacke	Sub- arkosic wacke	Sub- arkosic wacke

(1) For location of conglomerate bodies and samples see Figure 4.

CONGLOMERATE C AND D

The lithology of the megaclasts, matrix modal analyses, and chemistry indicate that conglomerates C and D are similar to the Ramsay Lake Formation. White quartz megaclasts and a pale green (sericitic) gritty matrix are characteristic features of the Ramsay Lake Formation.

Pebble fabric studies (Teal 1971) in McMahon and Morin Townships indicate that the paraconglomerate pebble-fabric maximum in the Matinenda Formation (1 sample) points southeast; in the Ramsay Lake Formation (1 sample), it points east-northeast; and in the Gowganda (1 sample), it points southeast. Maxima of two fabric analyses from outlier "D" point east-northeast, indicating that this body may belong to the Ramsay Lake Formation.

Table 11

LITHOLOGY OF MEGACLASTS IN HURONIAN PARACONGLOMERATES (AFTER TEAL 1971, TABLE 2A)

Formation	Gowganda			Gowganda			Ramsay Lake			Mati-nenda			Outliers			Bruce								
	a	b	c	d	e	f	g	h	i	j	k	m	y	Ave	n	p	q	r	x	e	t	v	Ave	
Lithologies																								
Acid Igneous																								
Granitoid																								
pink	80 ²	66.7	73.3	100	81.0	75.0	79.3	100	100	23.0	27.3	57.1	66.7	29.0	83.3	35	60	19						
white		33.3			12.5	7.6				30.8	27.3	33.4	7.2	16.5	20	80	33.4	61.9	39.1					
Gneiss (pink)	20		26.7		4.8	8.6				30.8		7.2	22.2	10.0	16.7	25	33.4	11.7						
Mafic Igneous																								
Intrusive											9.1	22.2		5.2										
Volcanic					9.4	1.6				75.0	9.1			14.0										
Holes*					12.5	2.1				25		11.1		6.0										
Sedimentary Chert																								
Vein quartz										7.7	18.1	22.2	7.2	11.1										
Quartzite					4.8	0.8				7.7		14.2		3.7										
Argillite											9.1	7.1		2.7										
Number of Clasts	5	3	15	13	21	8				13	4	11	9	14	9									
Location ¹	a	b	c	d	e	f	Ave	s	u	g	h	j	k	m	y	Ave	n	p	q	r	x	e	t	v

(1) For location of samples s-v inclusive from Bruce Mines area see Teal (1971, p. 8). For other sample locations McMahon and Morin Townships see Figure 4.
 (2) Figures represent area percentages of megaclast lithologies based on counts of 100 points spaced evenly on a 1 m square grid. Clasts below 1 cm diameter were rejected. For details of method and raw data see Teal (1971, p. 21, 71).
 (3) *Holes are listed under mafic igneous... because these [mafic igneous clasts] are the softest pebbles and frequently remains of mafic rocks were found at the bottom of holes.' (Teal 1971, p. 22.)

Stratigraphic Unit Sample No.	Outlier C		Outlier B		Ramsay Lake Formation		Gowganda Formation											
	C13-2T1 ¹	C13-C4	C13-C3	B12-2C2	C11-C4	D12-T2	D12-T1	B11-C2	C4-T6									
Ni	60 A	30 A	40 A	40 A	60 A	40 A	40 A	70 A	70 A									
Pb	10 S	10 S	15 S	15 S	15 S	15 S	— S	10 S	15 S									
Sb	4 C	4 C	4 C	4 C	4 C	4 C	4 C	4 C	4 C									
Sc	— S	— S	— S	— S	— S	20 S	20 S	— S	— S									
Sn	— S	— S	— S	— S	— S	— S	— S	— S	— S									
Sr	200 S	150 S	200 S	300 S	30 S	50 S	10 S	150 S	600 S									
Tl	— S	— S	— S	— S	— S	— S	— S	— S	— S									
V	30 S	20 S	50 S	20 S	50 S	40 S	40 S	150 S	100 S									
Y	— S	— S	— S	— S	— S	— S	— S	— S	20 S									
Zn	10 A	20 A	20 A	10 A	10 A	30 A	8 A	40 A	80 A									
Zr	200 S	150 S	150 S	100 S	200 S	100 S	40 S	100 S	200 S									
B. Formation																		
		SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	MgO	CaO	Na ₂ O	K ₂ O	H ₂ O	CO ₂	TiO ₂	Zr ₂ O	P ₂ O ₅	Total Al ₂ O ₃ / Na ₂ O			
		82.23	7.96	0.53	2.40	1.02	0.34	1.33	2.01	1.37	0.17	0.29		0.70	2.93	5.93	0.04	
Whiskey (Ave)		72.02	12.01	1.13	2.76	2.10	0.92	3.17	2.80	1.84	0.36	0.51		0.12	3.89	3.78	0.03	
Bruce (Ave)		65.14	14.80	3.68	3.69	3.56	1.50	4.39	1.72	2.73		0.60		0.16	7.37	3.37	0.08	
Gowganda (Ave)		61.98	17.20	1.42	4.49	3.27	1.00	5.27	2.04	2.80		0.60			5.91	3.26	0.10	
Gowganda (Collins, 1925)																		
C. Canadian Shield																		
Archean (Condie, 1967)		64.43	15.48	6.54	3.12	2.22	2.22	3.74	2.44			0.62			6.54	4.2		
Precambrian (Shaw et al., 1967)		64.93	14.63	1.36	2.75	2.24	4.12	3.46	3.10	0.92	1.28	0.52		0.15	4.11	4.23		
Archean (Fahrig and Eade, 1968)		65.10	16.00	1.50	3.00	2.30	3.40	4.10	2.70	0.70	0.20	0.50		0.15	4.50	3.9		

(1) For location of samples see Figure 4. Analyses for Table 12A performed by the Mineral Research Branch, Ontario Division of Mines.

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CONGLOMERATE E

This conglomerate was only seen to outcrop in the valley of Woods Creek. It rests on the Matinenda Formation and is succeeded by quartz-pebbly arkose of Matinenda Formation type. It has megaclast lithology unique in the area (Location (n), Table 11). The sericitic matrix and other features indicative of maturity and similar to those of the Ramsay Lake Formation (Table 10), may be the result of incorporation of pre-Huronian sediments and regolith. The body may be the result of a valley mudflow.

CONGLOMERATE F, G, H

Lithologies of megaclasts and facies similar to 8a, 8b, 8c, indicated an affinity with the Gowganda Formation.

Paleocurrents

Paleocurrent indicators found in the map-area, corrected where necessary (Potter and Pettijohn 1963), are listed below. Location of these sedimentary structures are shown in Figure 3.

- Matinenda Formation
 - Location C12T1a, Assymetrical ripples, transport to 230°E.
- Mississagi Formation
 - Location C11C3, Planar crossbeds, dip 63° transport to 75°E
 - dip 24° transport to 200°E
 - dip 19° transport to 343°E.
 - Location D10C1, Assymetrical ripples, transport to 291°E.
 - Oscillation ripples, strike 115°E.
- Gowganda Formation
 - Location C2-2C4, Oscillation ripples, strike 55°E.

Paraconglomerate fabrics studies (Teal 1971) show some difference in orientation of clasts between the Ramsay Lake and Gowganda Formations, but too few stations were sampled to draw conclusions.

These few Huronian paleocurrent indicators may be the result of local westward transport from the Houghton Township topographic high.

POST-HURONIAN IGNEOUS ROCKS

More than 20 diabase dike swarms occur in various parts of the Canadian Shield. They are assumed to have intruded fractures resulting from 'elastic rebound of the crust after a period of crustal compression' (Fahrig and Wanless 1965) or from

tensional forces due to motions of the mantle (Clifford 1968). The post-Huronian dikes were referred to in older reports as Keweenawan (Roscoe 1969).

The sequence of intrusion of these diabase and related dike rocks along the North Shore of Lake Huron is as follows:

- (1) Nipissing diabase and Sudbury gabbro, dated at 2.1 BY¹ (Lowden *et al* 1963; Van Schmus 1965), and 2.17 BY (Kanasevich and Farquhar *in Hriskevich* 1968);
- (2) Lamprophyres, dated at 1.53 BY (Van Schmus 1965), 1.4 BY (Lowden *et al* 1963);
- (3) Sudbury dikes, dated at 1.28 BY (Fahrig *et al* 1956; Van Schmus 1965); and
- (4) Abitibi dikes, dated at 1.23 BY (Fahrig *et al* 1956), 2.1 BY (Gates 1970).

The Nipissing tholeiitic diabase was named by Miller (1913). The diabase occurs as dikes, subconcordant sills (Roscoe 1957a) up to 1,000 feet thick (McIlwaine 1970; McConnell 1927); and cone sheets (Card *et al* 1970). The usual lithology is a greenish, altered quartz diabase. Although Collins (1925) reported little regional lithological variation, norite also occurs in places and magmatic differentiation in thicker bodies has resulted in the settling and concentration of olivine and hypersthene (Card *et al* 1970; Hriskevich 1968). Copper mineralization occurs at Bruce Mines and silver-cobalt mineralization at Gowganda and Cobalt. According to Card *et al* (1970), the two types of mineralization are mutually exclusive, with a regional boundary line (approximately 47°45'N) occurring north of Sudbury. Some effects of sodic metasomatism occur but contact metamorphic effects are slight (Bowen 1910; Pienaar 1963). Associated aplite, pegmatite, and granophyre ("redrock") are regarded as primarily the result of magmatic differentiation (Collins 1925; Hriskevich 1968; Card *et al* 1970), though Bowen (1910, p. 664) states that 'altered sediment has been influential in the production of this granophyric material'.

Little is known about the origin, distribution, or trend of lamprophyre dikes including some of alnoite and minette (Roscoe 1969; Robertson 1970a) along the North Shore of Lake Huron. Some may have resulted from differentiation of Nipissing diabase magma (Robertson 1963). They cut (Robertson 1962) or postdate Nipissing-type diabase (Pienaar 1963).

The Sudbury dikes are known along the North Shore of Lake Huron as 'olivine diabase dikes'. They mostly trend northwest (Fahrig *et al* 1965) and may be traced as magnetic 'highs' on aeromagnetic maps. They cut the Nipissing diabase (Card and Meyn 1969; Ginn 1965) and the Cutler granite, which Van Schmus (1965) has dated 1.7 BY. They consist of black olivine diabase, are unaltered, and may be porphyritic. They weather out from the outcrop as rusty ellipsoidal masses (Collins 1925).

The Abitibi dikes also appear as strong magnetic anomalies on aeromagnetic maps but trend northeast (Fahrig *et al* 1965). Though these dikes may be slightly younger than the olivine diabase dikes they are less alkaline. This runs counter to the general statement that younger Precambrian dikes in the Canadian Shield are more alkaline. Further work is needed to clarify the status of these intrusions.

¹ BY = 10⁹ years.

Nipissing-Type Quartz Diabase

Nipissing-type quartz diabase is well represented in the map-area. It is present as abundant subconcordant sills and as dikes. The sills are up to 400 feet thick. A sill of sinuous outcrop pattern crosses the Thessalon River just north of the centre of the map-area. In a hill just west of the river the attitude of this intrusion changes from horizontal at the north end of a dip of 65°S at the south end of the hill. A northeast-trending dike, coarser grained (0.4 to 0.6 cm) than typical diabase (0.2 to 0.4 cm), merges imperceptibly with the above sill about 1 mile north-northwest of the Rising Sun Mine shaft (89°40.6'W, 46°33.4'N). This dike is parallel to a major regional fracture direction in the Archean granitic rocks. The steeply dipping part of the sill where it crosses the Thessalon River and the northeast-trending dike may have been feeders that supplied magma to the sills at the sub-Huronian unconformity and within the Huronian sedimentary rocks.

The diabase generally has a grain size of 0.2 to 0.4 cm, is medium to dark grey or green, and weathers pale brown to orange. Finer grained samples have a pepper-and-salt appearance.

The rock is made up of roughly two-thirds labradorite and one-third augite, with minor quartz and granophyre, interstitial chlorite, biotite, pyrite, and magnetite. The texture is subophitic. The plagioclase occurs as randomly oriented sub-hedral laths with albite and carlsbad twinning. Most grains are fresh but some are saussuritized and contain abundant zoisite. Others are zoned. The pyroxene is anhedral and generally fresh, but some crystals are clouded and others appear to have been in part chloritized.

Granophyre ('red rock') is well developed south of Stuart Lake and has been mapped as a separate unit by Frarey (1959). A tendency for granophyre to occur in the upper parts of the diabase sills is exemplified in outcrops along the northeast shore of McMahon Lake. Presumably magmatic differentiation by gravity separation was significant in the development of this granophyre. Every gradation exists from normal quartz diabase to phases indistinguishable from the local red Archean quartz monzonite. Relative to the quartz diabase, the granophyre is characterized by abundant (sometimes over 50 percent) hematite-stained feldspar, a coarser grain size (1/2 cm to 1 cm) and randomly oriented amphibole laths.

Lamprophyre

A vertical dike 3 feet (1 m) wide outcrops in the bed of the creek drains Lamothe Lake (83°50.3'W, 46°33.3'N). The dike strikes N70W and cuts fine-grained, purple sandstone of the Gowganda Formation, but does not appear to have penetrated a sandstone bed, jutting out from the hillside 5 feet (1 1/2 m) above the stream.

Pebble size, rounded fragments of black aphanitic rocks, making up 20 percent of the surface, stand out from the weathered rocks, and some have acquired a red patina. X-ray diffraction analysis of five fragments showed four to be comprised mainly of serpentine and talc. The fifth was comprised of plagioclase. The matrix of the rock, in hand specimen, is dark green, massive, and contains phenocrysts of dark mica flakes up to 1 mm in size.

Table 13

(MAJOR ELEMENT) CHEMISTRY OF KIMBERLITES, NON-FELSIPATHIC LAMPROPHYRES AND OTHER IGNEOUS ROCKS

	Fourchite, McMahon Twp. ¹	Kimberlite 2	Kimberlite 3	Ultra- basic Rocks 4	Basic Rocks 5	Inter- mediate Rocks 6	Felsic Rocks 7	Syenite 8	Alnoite 9	Monchiquite 10
SiO ₂	31.89	27.56-44.08	29.56-46.83	40.6	51.3	55.6	69.2	62.2	32.31	45.17
TiO ₂	5.28	0.60-1.48	0-2.34	0.05	1.5	1.3	0.4	0.58	1.41	1.90
Al ₂ O ₃	8.13	3.60-8.55	0.69-6.16	0.85		16.7	14.5	16.6	9.50	14.78
Fe ₂ O ₃	6.72								5.42	5.10
Cr ₂ O ₃	8.50	3.17-5.18	2.21-4.84	12.6	10.9	7.5	3.5	4.7	6.34	5.05
MnO	17.89	0-0.09	0-0.01	0.19	0.26	0.15	0.7	0.12	0.01	
MgO		15.12-34.13	10.80-39.70	42.9	7.4	3.6	0.93	0.96	17.43	6.26
CaO	8.03	3.64-15.96	2.42-10.40	1.0	9.4	6.5	2.3	2.5	13.58	11.06
Na ₂ O	0.19	0-2.72	0.11-2.55	0.77	2.6	4.1	3.7	5.4	1.43	3.69
K ₂ O	0.97	0-2.72	0.26-4.32	0.04	0.99	2.8	4.0	5.4	2.70	2.73
H ₂ O ⁺	6.20	2.82-10.13	4.82-10.19	—					7.50	
H ₂ O ⁻	2.46	0.64-5.80	0.25-7.95	0.04	0.04	0.07	0.10		—	3.40
CO ₂	2.60	0.64-2.26	0.20-7.65	0.04	0.32	0.36	1.6	1.8	—	0.86
P ₂ O ₅	0.43	0-1.80	0.41-2.15	0.04						
S	0.22	—								

(1) Sample C2-2C4, location shown on Figure 4. Analyses by the Mineral Research Branch, Ontario Division of Mines.
 2, 3, 9 From Brown *et al.* (1967).
 4-8 From Dawson (1967).
 10 From Hatch *et al.* (1956).

Table 14 MINOR ELEMENT CHEMISTRY OF KIMBERLITES AND OTHER IGNEOUS ROCKS MODIFIED FROM DAWSON (1967)

	Fourchite McMahon Twp. ¹	Ultra- basic Rocks	Basic Rocks	Inter- mediate Rocks	Felsic Rocks	Syenite	Carbonate Kimberlites	Yakutia Kimberlites	Yakutia Kimberlites	Basutoland Kimberlites	South West Africa Kimberlites
Al/Ga	2870	2250	4866	4425	3850	2700				3100 ⁺	
As	5										
Sb	8										
Ba	400	1	300	650	830	1600	2240			740	1000
Be	3										
B		1	5	15	15	9			149		
Cs		0.1	1	0.6	5	0.6			12		
Ce/Sr	57.4	700	153	58	53	90	99			72 ⁺	
Cr	800	2000	200	50	25	2		1500		1440	1000
Cr/Ni	1.1	1	1.2	1.4	3.1	0.5		3.1		1.2	
Co	80	200	45	10	5	1	17	40		77	50
Cu	80	20	100	35	20	5	2.5	60		100	
Ga	15	2	18	20	20	30	1			9	10
Ge		1	1.5	1.5	1.4	1			0.5		
La		0*	15*	45*	55*	70	284			370	
Li		0.5	15	20	40	28			34	16	20
Ni	520	2000	160	35	8	4	8	450		1140	1200
Ni/Co	6.5	10	3.6	5.5	1.6	4		11		15	
Nb	200	1	20	20	20	35	1690	70		240	200
Rb		2	45	100	200	100			160	200	
Sc		5	24	2.5	3	3	10		11	21	250
Sr	1000	1*	465*	440*	100*	200	2450	200	10	25	15
Ta		0.018	0.48	100	3.5	2.1			8.6	445	600
V	250	40	200	100	40	30		170	120	120	160
Y	600	0*	21*	35*	40*	20	96		97	46	40
Zr	190	30	100	260	200	500	83	200		445	190
Zn											
Pb	15	0.1	8	15	20	12				9	30

(1) Sample C2-2C4, location shown on Figure 4. Analyses of sample No. 1 by the Mineral Research Branch, Ontario Division of Mines.
* Footnotes in Dawson (1967)

One thin section of the matrix of the rock indicated the presence of phenocrysts of pyroxene (18.0 percent) and biotite (11.5 percent) with abundant granular opaque minerals (12.8 percent). Patches of sparitic calcite (8.3 percent) similar in size to pyroxene grains (identified by X-ray diffraction analysis by the Mineral Research Branch, Ontario Division of Mines), and chlorite crystals (1.3 percent) also are set in a finer grained (0.03 mm) groundmass (48.3 percent) which contains chlorite, acicular apatite, and calcite. According to Harker (1962), chlorite, apatite, and calcite are common alteration products of pyroxene in lamprophyre. Pyroxene, white mica, serpentine, anatase(?), perovskite, talc, and fine-grained opaque minerals (magnetite, pyrite, and ilmenite) were also found by X-ray diffraction analysis to be present in the groundmass.

The pyroxene is present as subhedral to rounded phenocrysts, 0.1 mm to 2 mm long, veined by a network of irregular cracks. Alteration to serpentine and inclusions of magnetite(?) occur in variable amounts.

The biotite occurs as well formed laths up to 1 mm long. It is red brown, possibly indicative of a high titanium content (Deer *et al* 1962). The larger crystals are bent, kink-banded, and contain concordant interlayer, exsolved(?) lenticles of magnetite and hematite.

The opaque minerals occur as euhedral to anhedral equant grains, usually 0.05 mm in size, and are mostly birefringent leucoxene and ilmenite.

The porphyritic texture, the presence of xenoliths (probably of altered olivine) and bent biotite crystals with exsolved magnetite and other minerals are present in kimberlite (Dawson 1967; Mitchell 1970). The contents of TiO_2 , Al_2O_3 , K_2O , volatiles (Table 13) and trace elements (Table 14) indicate kimberlitic or lamprophyric affinity. In contradistinction, high pressure minerals were not identified by the author. The low silica content and probably altered olivine in the rock in the map-area (Table 13) indicate similarity to alnoite. Absence of feldspar in the groundmass suggests alnoitic or monchiquitic affinity, but the rock is unlike either alnoite or monchiquite in that melilite and analcime are absent.

Olivine Diabase

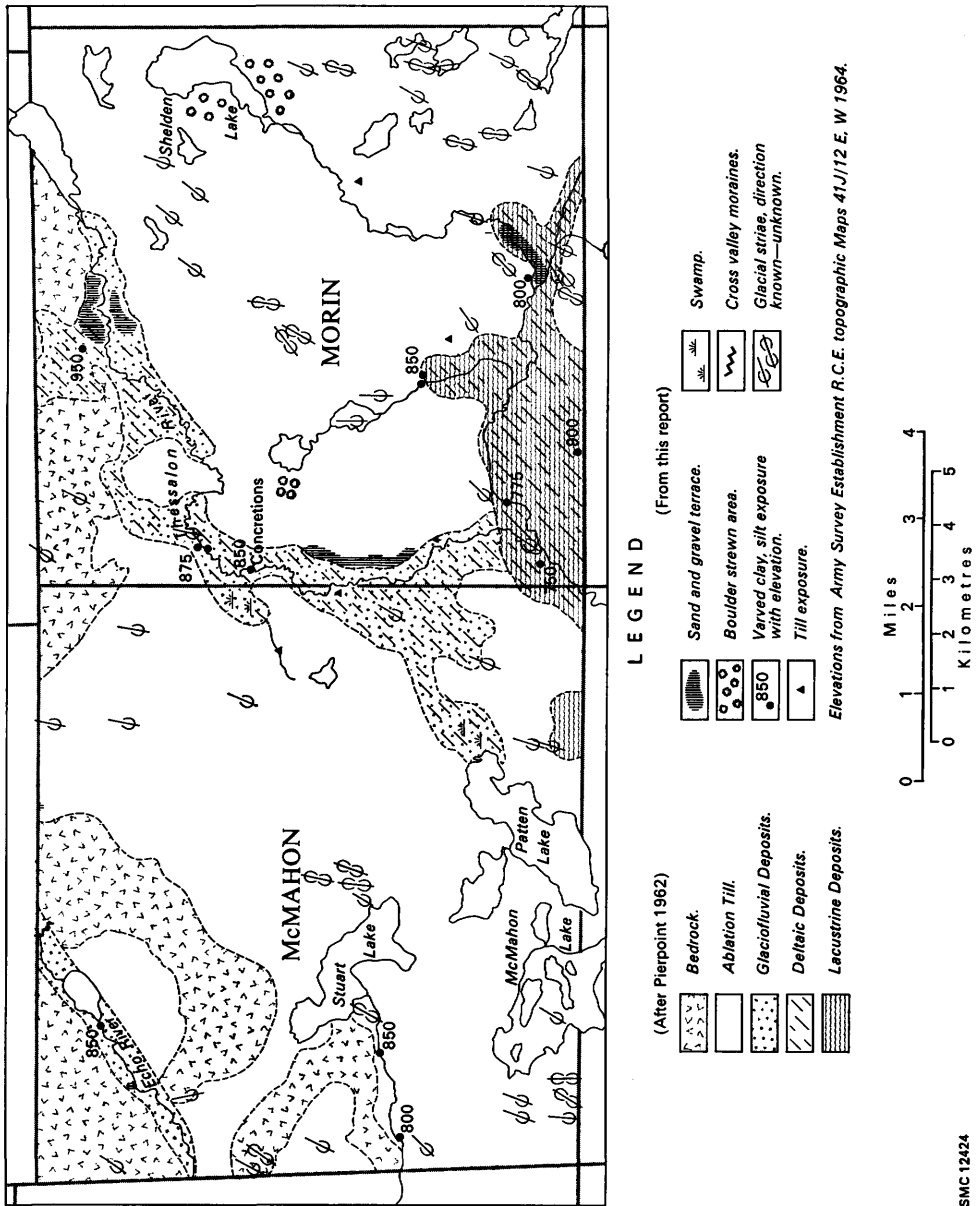
Olivine diabase is exposed in two places in the map-area, immediately east of Stuart Lake and 1 mile south of Shelden Lake.

At Stuart Lake a 50-foot wide vertical dike trends N80W. It cuts paraconglomerate of the Gowganda Formation.

South of Shelden Lake a small isolated exposure of olivine diabase was found within Nipissing-type quartz diabase.

The olivine diabase is black and acquires a rusty 'skin' on weathering. Thin section study of one sample (B13-C2) indicated that the rock consists of about two-thirds decussate subhedral labradorite laths, unaltered subophitic pyroxene, granular olivine heavily altered to iddingsite, and minor chlorite and magnetite.

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SMC 12424

Figure 5—Quaternary Geology of McMahon and Morin Townships superimposed on a land-type map by Pierpoint.

CENOZOIC

QUATERNARY

Those parts of the Sault Ste. Marie area underlain by Paleozoic rocks contain mostly constructional Pleistocene features, whereas those underlain by Precambrian rocks are characterized by glacial erosion features (Kemp 1966).

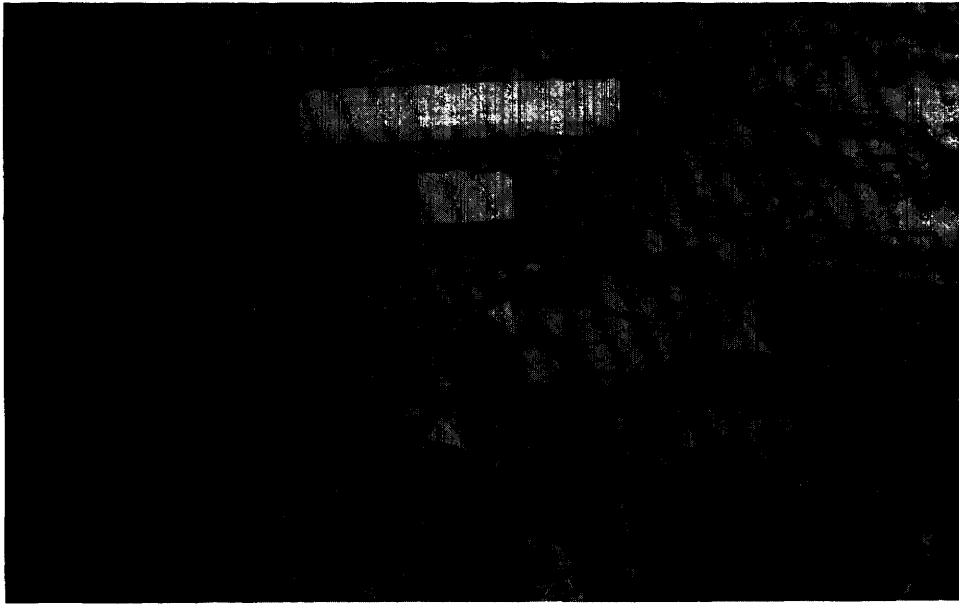
McMahon and Morin Townships lie within larger regions studied by both Pierpoint (1962) and Boissonneau (1965, 1968). Pierpoint (1962) prepared a Forest Management Survey map showing land types (soil types), bedrock and superficial geology (Figure 4), and vegetation. His areas of bedrock correspond to certain lithologies, i.e. to diabase and porphyritic quartz diorite in McMahon Township and banded gneiss and migmatite in Morin Township.

The glacial history of McMahon and Morin Townships may be interpreted from Boissonneau (1968) as follows: during the last glaciation a spreading ice lobe moved south across the area north of Lake Huron. Ice moved across McMahon and Morin Townships, which were under the western part of the lobe, toward the south-southwest. The interpolated line of the Whiskey Lake terminal moraine trends approximately N80W across the south parts of these two townships. To the north of this line (Boissonneau 1965) lies a deposit of sandy to silty till. To the south of this line, which was the ice front 9.5 to 10.5 thousand years ago, stood proglacial Lake Algonquin that reached a level of 1,015 feet above sea level at Root River (Leverett and Taylor *in* Boissonneau 1968). Beneath this lake, at elevations between 790 and 890 feet above sea level, massive and varved clay and silt were deposited.

The writer's survey bore out Boissonneau's earlier findings. High ground was found to be either bare or covered by thin sandy till. River valleys are partly filled with terraces of sand and gravel. In places varved clay and silt were found beneath the coarser deposits. Glacial striae are best preserved on diabase, mafic volcanic rocks, and massive pebbly mudstone, and poorly preserved on granitic rocks. In McMahon and Morin Townships, striae indicate a unique direction of glacial ice movement. Rarely two sets are visible with deviations in the order of 10 to 15 degrees. Stoss and lee relationships, crescentic fractures, and gouges (Dreimanis 1956) indicate a direction of ice movement to the south-southwest (Chandler 1970a, b). The orientation of some south-trending striae may have been controlled by local topography.

Glacial depositional landforms are rare. The Whiskey Lake moraine (Boissonneau 1968) was not identified by the author. A single saddle-shaped bouldery ridge between Patten and McMahon Lakes and a series of parallel ridges across the line of the Echo River valley may be cross-valley moraines (Figure 5, this report) (Prest 1968).

Thin, massive, arkosic, sandy gravels (probably tills) with granitic boulders are best exposed in undercut stream banks. Boissonneau's (1968) northern limit of glaciolacustrine features corresponds with that of Pierpoint (1962). Though varved clays and silt were noted by this writer north of the limits shown on Figure 4, they are at an elevation consistent with deposition in Lake Algonquin.



ODM8817

Photo 11—Calcite concretions in situ in varied silty clay, on Thessalon River west Morin Township (83°42.4'W, 46°34.8'N). Apices of small white triangles point to round bodies. Scale is 16.3 cm (about 6½ inches) long.

The varved silt at one locality contains calcite concretions. Similar concretions near Espanola were interpreted by Quirke (1917) to be the result of dehydration and calcite cementation of a syn-depositional clay-water slurry rather than as early post-depositional structures. Those found in the Thessalon valley vary from irregular (see Pettijohn 1957, plate 7, top) to sub-spherical (Photo 11) with the radial symmetry axis normal to the plane of deposition. Some concretions extend into the depositional plane of the enclosing sediment. Sedimentary laminations continue through one sectioned concretion and intersect an internal concentric lamination. The concretion is composed mainly of calcite (identified by X-ray diffraction) and subordinate detrital silicates.

The concretions probably resulted from post-depositional growth in localized alkali micro-environments which developed about decaying organic matter. The alkali conditions would favour solution of silica, thus creating room for carbonate deposition.

Prominent sand and gravel terraces occur in the valleys of Echo and Thessalon Rivers (Photo 12) and of Wood Creek. The clasts in gravels are granitic and the sands are arkosic. Orientation of crossbedding in these sediments fits the present drainage pattern.

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ODM8818

Photo 12—Dissected remnants of fluvial terraces, looking northwest along the Thessalon River valley, at Poplar Dale, McMahon Township (83°42.6'W, 46°31.8'N).

STRUCTURAL GEOLOGY

Folds are gentle and open north of Sudbury and in the Bruce Mines and Elliot Lake areas (Roscoe 1969) but in the Espanola wedge (area of Huronian rocks south of the Sudbury Basin and stretching west from the Grenville Front to the town of Cutler on the North Shore of Lake Huron) vertical isoclinal folds are a result of considerable north-south compression. Northeast- and southeast-trending faults occur in both Huronian and Archean rocks in all three areas (Giblin and Leahy 1967).

Folding is not prominent in the map-area. Huronian strata and quartz diabase sills within these strata dip moderately southwest. Horizontal to gently undulose bedding occurs west of Shelden Lake.

A west-plunging syncline west of Stuart Lake is preserved in the lower part of the Lorrain Formation.

The role of Archean topography in determining present attitudes of Huronian strata is emphasized by the quaquaversal dips of Matinenda Formation sandstones about the Archean basement knoll in southeast Morin Township, adjacent to the southwest shore of Wakegijig Lake.

Penetrative deformation has not affected Huronian rocks except for argillaceous rocks of the Gowganda Formation that were folded on a small (several cm) scale locally at the boundary of the two townships and exhibit a distinct cleavage. West of McMahon Lake a south-east-striking cleavage, which dips steeply southwest, characterizes Huronian volcanic and sedimentary rocks. This southeast-striking cleavage, accompanied by faulting and hematite staining, has rendered stratigraphic interpretation difficult in that area.

FAULTING AND FRACTURING

A regional fracture system is indicated by northeast- and northwest-trending lineaments and diabase dikes in the Archean granitic rocks north of Lake Huron (Ayles *et al* 1971). In McMahon and Morin Townships, the granitic Archean rocks have been eroded to a peneplain-like surface transected by steep-sided linear north-east- and northwest-trending valleys which have developed on this fracture pattern. The similarly oriented McMahon Lake and Echo Lake Faults may indicate movement along the fractures after Huronian time. Dike-like parts of post-Huronian quartz diabase bodies also may have been localized by the fractures.

The quartz diorite gneiss (1a) in the north part of the map-area is separated from other Archean crystalline rocks by a southeast-trending lineament along Mink Creek, and by a northeast-trending lineament west of Carpenter Lake. Gneissic structure and banding (which dip steeply northwest) and dikes of uncertain age (9) which cut Archean rocks are oriented east to east-southeast.

East-west structures include the Stuart Creek Fault, some quartz diabase dikes (9) in northern McMahon Township, and several vertical quartz-carbonate vein systems localized along faults.

METAMORPHISM

In the Espanola wedge, several phases of regional metamorphism have produced kyanite and andalusite in the Lorrain Formation (Church 1967). Pelitic rocks have been metamorphosed under middle greenschist facies conditions, but in some localities almandine-amphibolite facies mineral assemblages are present (Card 1964). North of Sudbury (Card *et al* 1970), north of Elliot Lake (Wood 1970), and in the Bruce Mines area (Chandler *et al* 1969) pyrophyllite in quartz arenite and wacke of the middle and upper Lorrain Formation indicates that these rocks were metamorphosed under greenschist facies conditions.

Contact metamorphism by quartz diabase sills in the map-area is insignificant. Regional metamorphic effects are not apparent in the fine-grained chloritic matrix of pelites, nor was pyrophyllite identified in the Lorrain Formation by X-ray diffraction (analysis by the Mineral Research Branch, Ontario Division of Mines).

ECONOMIC GEOLOGY

In the region along the North Shore of Lake Huron, copper mineralization is mainly associated with Nipissing diabase. The mineralization in the Massey and Hermina Mines however (Shklanka 1969) appears to be related to volcanic rocks (Robertson, Geologist, Ontario Division of Mines, 1970, personal communication). Silver-cobalt mineralization which occurs in an environment similar to the copper mineralization in the Cobalt-Gowganda area (Miller 1913) is poorly represented. Uranium occurs in the Matinenda Formation of the Elliot Lake Group. In the map-area, pyrite is disseminated in sandstones in the lower part of the Matinenda Formation and in the Gowganda Formation.

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Terraces of gravel and sand and some varved clay are present in river valleys particularly that of the Thessalon River.

COPPER MINERALIZATION

Copper ore deposits are the most numerous and most widespread of all metallic deposits in the North Shore [of Lake Huron] district. Old mines, prospect pits and undeveloped veins are scattered in extraordinary number all the way from Sault Ste. Marie to the Sudbury nickel district [Collins 1925, p.125].

The most famous copper mine of the region was situated at Bruce Mines which was discovered in 1846 (Knight 1915). Between 1848 and 1916 it produced ore valued from 3½ to 7 million dollars (Collins 1925) and production ceased in 1921 (Shklanka 1969).

Another important copper deposit in the region was the Rock Lake Mine situated in lot 2, concession 1, Aberdeen Township, just north of Rock Lake. Operations were carried out here between 1898 and 1903 (Collins 1925).

Copper mineralization in the map-area occurs in chalcopyrite-bearing quartz-carbonate-specularite veins which are either in or close to diabase intrusions.

At the turn of the century, shafts were sunk by the Copper Queen Mining Company Limited (Copper Queen Mine, Morin Township) and by the Sault Gray Copper Company Limited (lot 5, concession 1, McMahon Township) to examine several of these copper-bearing veins. A later discovery (1956) was the Bruce Mines prospect of Romar Mines Limited in McMahon Township.

SILVER-COBALT MINERALIZATION

In Gowganda and adjoining districts, typical silver-cobalt veins grade into quartz veins mineralized chiefly with chalcopyrite (Card *et al* 1970). Cobaltite veins have been found in Otter Township (Burrows 1913) and on the shore of Lake Huron opposite Desbarats (Miller and Knight 1915). Cobalt occurrences associated with diabase are also recorded north of Desbarats (83°58'W, 46°28'N) and south of Echo Lake (83°35'W, 46°35'N) (Giblin and Leahy 1967).

An occurrence of cobalt bloom in McMahon Township is described by Knight (1915) as follows:

In McMahon Township, which is two townships to the west of Otter, cobalt bloom occurs in small quantities on the north half of lot 6 in the second concession. The vein in which it is found has been stripped 125 feet and is very irregular. At its widest point it is five feet across, and consists of eighteen inches of quartz and three and one-half feet of pure white calcite. Cobalt bloom was noted in small quantities, and also copper and iron pyrites. The vein occurs in the Nipissing diabase, and is cut at right angles by a decomposed dike in which mica seems to be the only original constituent remaining.

Traces of cobalt were found at mineral occurrence No. 7 in McMahon Township. The occurrence is close to a prominent east-striking lineament, the Stuart Creek Fault, in a part of McMahon Township in which mineral occurrences appear to be concentrated. Southwest of Hugli Lake (mineral occurrence No. 4) a quartz vein contains silver but no cobalt.

GOLD-SILVER MINERALIZATION

Quartz veins bearing pyrite and minor chalcopyrite in the map-area were found to contain traces of gold and a little silver. These veins were the sites of many small exploratory excavations. A grab sample taken from one vein located ¼ mile southwest of Hugli Lake, McMahon Township, was assayed by the Mineral Research Branch, Ontario Division of Mines, and found to contain 0.4 ounce silver per ton.

URANIUM MINERALIZATION

Uranium mineralization is associated with quartz-pebble conglomerate of the Matinenda Formation in the Elliot Lake and Agnew Lake areas. For a general discussion of the ore-bearing conglomerate see Roscoe (1969). The geological reports of Robertson (1970a, 1961, 1968b) provide details of the mining activity in the Elliot Lake area. In the map-area, uranium was discovered in 1955 by McIntyre Porcupine Mines Limited and in 1968 by W. D. Sutherland and Associates.

DESCRIPTIONS OF MINERAL OCCURRENCES

CHIPMAN LAKE OCCURRENCE (1)

The mineralization lies at Longitude 83°46.5'W and Latitude 46°32.8'N on the north shore of Chipman Lake. It may be reached by way of a portage between Patten and Chipman Lakes or a portage connecting the northwest end of Chipman Lake with Stuart Lake.

The occurrence lies in a southwest-dipping sill of Nipissing-type diabase which has intruded clastic rocks of the Gowganda Formation.

An abandoned water-filled pit about 5 feet across is surrounded by fragments of diabase. These contain quartz veins mineralized with pyrite and magnetite.

HUGLI LAKE OCCURRENCE (2)

The occurrence lies between Chipman and Hugli Lakes and may be reached by walking south from the Stuart Lake road.

East-striking vertical quartz veins cut paraconglomerate of the Gowganda Formation. The occurrence is surrounded on three sides by a sill of quartz diabase of Nipissing type.

Quartz veins up to 6 inches (15 cm) wide occur in a 60-foot (20 m) wide sheared zone. A 4-foot thick vertical east-striking milky quartz vein occurs ¼ mile (400 m) east on strike at the south end of Hugli Lake. Analysis by the Mineral Research Branch, Ontario Division of Mines, of a selected grab sample from the western occurrence showed a content of 0.01 percent Cu, 0.4 oz/ton Ag, traces of Au, Cr,

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Pb, Mn, Ni, and Ti. This vein system has features in common with that of mineral occurrence on the property of J. Krupp and Associates (occurrence No. 11).

In both cases, extensive vertical east-trending quartz vein systems cut sheared Gowganda Foundation. Both occurrences are close to the Archean granitic basement and to post-Huronian quartz diabase intrusions.

J. KRUPP AND ASSOCIATES (11)

The prospect is comprised of 960 acres. Mineralization is reported to occur in east-striking quartz veins along the margin of a 'trap eruption', which extends at least 400 feet north. Granitic rocks occur to the south (Carter 1904) and are capped with patches of Gowganda conglomerate (Shklanka 1969). Several parallel quartz veins occur over a width of 50 feet and have been traced 2,000 feet east-west. The main vein is 4 to 20 feet wide (Shklanka 1969).

Veins form stockworks in brecciated greenstone. A small percentage of chalcopryite occurs in nodules surrounded by considerable amounts of specularite. Mineralization is mostly poor (Collins 1925). However in 1925, J. Krupp announced favourable results from diamond drilling on the property (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie).

The workings, once of considerable magnitude (Collins 1925) and now so collapsed and overgrown as to be difficult to locate, were begun in 1902 by the Copper Queen Mining Company. The prospect is now owned by J. Krupp and Associates of Milwaukee, Wisconsin. Two shafts were sunk in 1904 (Thomson *et al* 1957). An eastern shaft, 140 feet deep, was sunk in Gowganda conglomerate on the east side of a hill. One hundred and fifteen feet to the east of this shaft, an adit was driven to intersect the shaft at a depth of 80 feet in the shaft. A second (western) shaft, 85 feet deep, was in Gowganda conglomerate at a point 2,000 feet east of the first shaft.

Pits were sunk and the surface stripped in several places to examine the many east-striking vertical quartz veins and stringers exposed between the two shafts.

Mapping by the writer showed the occurrence to be within an outlier of paraconglomerate of the Gowganda Formation. No diabase or 'trap' was found to the immediate north, but a 400-foot (120 m) thick northeast-striking diabase dike lies at the edge of the outlier immediately east of the eastern shaft.

Immediately north of the western shaft, paraconglomerate with sandy textured matrix is brecciated and contains abundant east-striking anastomosing white quartz veins with chalcopryite, bornite, brown weathering carbonate, and abundant specularite. At the north of the adit, intersecting the eastern shaft, a 4-foot wide vertical sheared quartz vein strikes N80E and contains local high grade concentrations of chalcopryite.

LAMOTHE LAKE EAST OCCURRENCE (3)

The occurrence lies at Longitude 83°49.1'W and Latitude 46°32.7'N between McMahon and Lamothe Lakes. It may be reached by landing an aeroplane on McMahon Lake. A portage connects the extreme south end of McMahon and Patten Lakes.

Chalcopyrite is disseminated in sheared granophyre in a north-west-facing cliff in the side of a sill of Nipissing-type diabase.

Apart from its occurrence in situ, chalcopyrite is also found in scree(?) blocks about 300 feet (100 m) northwest. Vertical quartz veins, ½ inch to 2 inches (1½ to 5 cm) thick and striking N70E, are also associated with the mineralization in the granophyre. A grab sample of the host rock analyzed by the Mineral Research Branch, Ontario Division of Mines, was found to contain 0.02 percent of Cu, 0.16 oz/ton Ag, and traces of Cr, Mn, Ni, and Ti.

A grab sample of sheared chalcopyrite-bearing diabase several feet from the above sample was found to contain 0.01 percent Cu and traces of Ag.

LAMOTHE LAKE NORTH OCCURRENCE (4)

The occurrence is about 300 yards northwest of Lamothe Lake at Longitude 83°45.9'W and Latitude 46°33.2'N. Access is similar to that for mineral occurrence No. 3.

The occurrence lies in southwest-dipping fine-grained feldspathic sandstone, probably of the Gowganda Formation. Large intrusive sheets of Nipissing-type diabase cut rocks of the area.

Mineralization in the sandstone is disseminated pyrite and minor chalcopyrite.

McINTYRE PORCUPINE OCCURRENCE (12)

This occurrence is situated on claim SSM87518 in lot 4, concession 2 (subdivision now annuled). A dirt road to Sheldon Lake, usable by four-wheel-drive vehicles in dry weather, passes within ¼ mile of the west side of the property. Feldspathic sandstone, some of which contains white quartz pebbles, and granite orthoconglomerate of the Matinenda Formation dip 25 to 45 degrees south. The sedimentary rocks rest nonconformably on Archean granitic rocks which outcrop about 600 yards to the northeast.

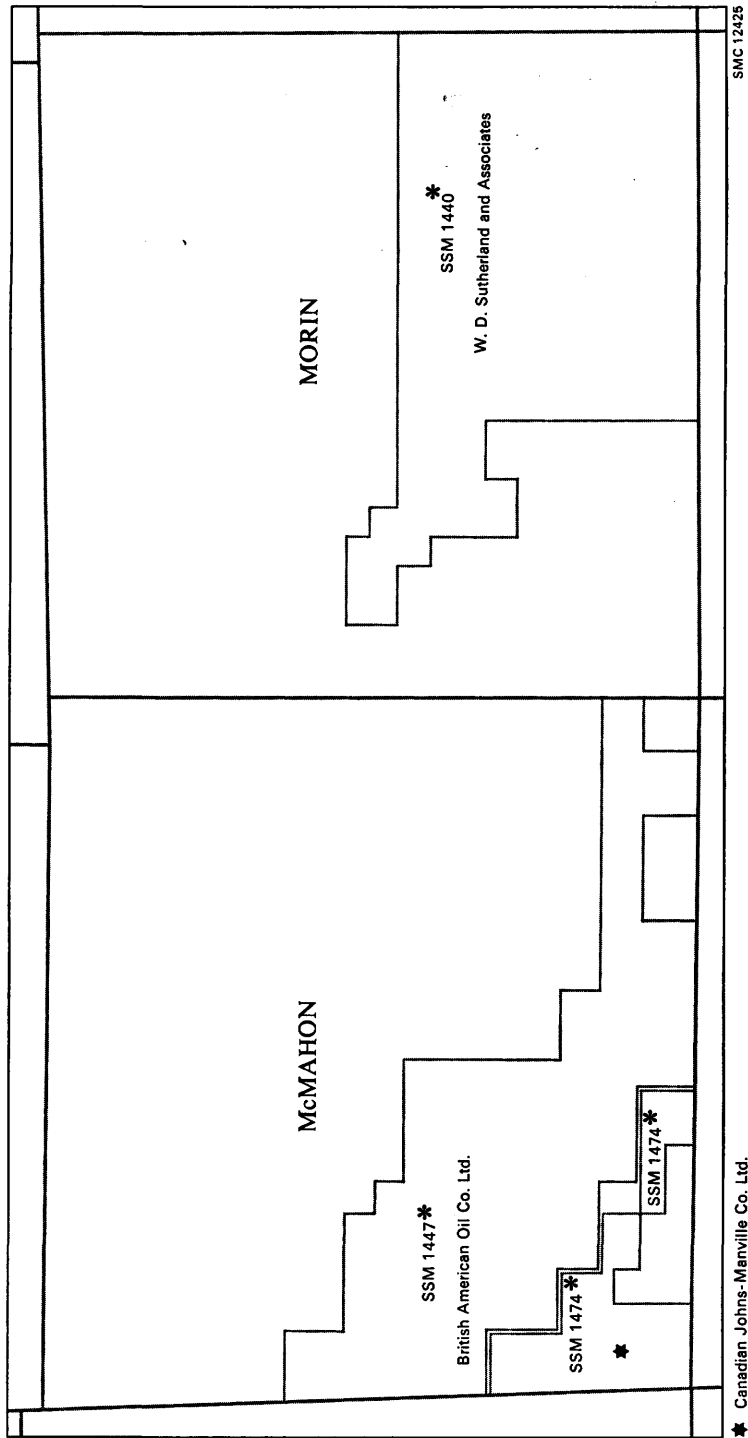
A large diabase body cuts the above rocks ¼ mile west of the property.

Uranium mineralization, 0.018 percent U₃O₈ over 3 feet and 0.014 percent U₃O₈ over 1.2 feet, was found in drill core from diamond drill hole 2.1 put down on the west side of Wood Creek (Assessment Files Research Office, Ontario Division of Mines, Toronto).

Four diamond drill holes were bored on the claim in 1955 by McIntyre Porcupine Mines Limited. Stratigraphic and mineralization data from the core logs (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie, File 83) are presented on Figure 6.

Core was reported in 1965 to be stored in a building owned by Mr. Schultz of Poplar Dale in the southeast corner of the southwest half of lot 9, concession 1 of Morin Township. This is on the south boundary of the township about 100 feet east of the road in an open field. A visit by the author in 1970 to the above storage location showed the core to have been bulldozed east down a bank and to have been scattered and mostly covered with earth.

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★ Canadian Johns-Manville Co. Ltd.

* Sault Ste. Marie Resident Geologist's Files.

Figure 6—Areas covered by commercial geophysical surveys (airborne electromagnetic, magnetic, radioactivity).

McMAHON LAKE OCCURRENCE (5)

The occurrence lies at the northeast end of the 300-yard (275 m) long egg-shaped island in southeast McMahon Lake. Access is similar to occurrence No. 3.

A northeast-trending carbonate vein cuts the quartz diabase which makes up the island.

An associated parallel 3-foot wide vertical sheared zone is mineralized by dark red weathering carbonate and chalcopyrite. A selected grab sample was found by the Mineral Research Branch, Ontario Division of Mines, to contain 0.72 percent Cu and between 0.05 and 0.5 percent Mn, Ti, and traces of Ni.

PATTEN LAKE EAST OCCURRENCE (6)

The occurrence is situated on summer resort parcel No. 41 on the east shore of Patten Lake. It may be reached by boat from a public landing that is ¼ mile southwest along the shore or by way of a dirt road 100 yards back from the shore. The road leaves the Patten Lake road ¼ mile east of the landing.

Mineralization is chalcocite, chalcopyrite (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie), malachite, tetrahedrite (Carter 1902), pyrite (Collins 1925), and bornite. The minerals occur in two east-striking nearly vertical quartz veins, with minor carbonate, which are 50 feet apart (Carter 1902). The veins lie in the Gowganda Formation and the host rock has been described as "fine sandy material with a few angular fragments of red granite, slightly schistose and striking 81 degrees from north" (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) and as "fine grained schistose trap" by Carter (1902). Mapping indicated that the host rocks are paraconglomerate, argillite, siltstone, and fine-grained pale buff weathering sandstone. The paraconglomerate is stratified with minor red granite pebbles and is laminated to bedded at a scale of 4 inches (10 cm).

Mining activity was carried out by the Sault Gray Copper Company between 1901 and 1902. The northern vein (above) is about 4 feet wide and has been trenched along an east-west line for 150 feet and is mineralized for 60 feet (20 m) (Collins 1925). A 50-foot (15 m) shaft, now covered by an 'A frame' cottage, was sunk on this vein 25 feet (7½ m) south from the shore. Fifty feet east from the shaft, a shallow pit was sunk. The south vein is also trenched for 100 feet (30 m) (Carter 1902). A chip sample across 8 inches (20 cm) of the more richly mineralized material, about 25 feet (7½ m) from the water's edge, yielded 1.35 percent Cu (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault St. Marie, File 693).

PATTEN LAKE WEST OCCURRENCE (7)

The occurrence is on the east-facing cliff formed by a sill of Nipissing-type diabase on the southwest shore of Patten Lake.

An east-southeast-trending cleft in the face of the cliff dips 70 degrees south. To the south of the cleft, the cliff is of Nipissing-type diabase and to the north of

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granophyre. Argillite of the Gowganda Formation, which may form the base of the sill or be a large xenolith, was seen just to the south of the occurrence.

Deformation of the argillite indicates that the cleft may be the site of a fault which has its up thrown side to the south.

Mineralization is in veins usually less than 6 inches (15 cm) wide and parallel to the cleft. The veins are mainly in the granophyre and are composed of white quartz, carbonate, and chalcopyrite. Limonite and unidentified green minerals coat blocks in the scree below the veins. A selected grab sample, analyzed by the Mineral Research Branch, Ontario Division of Mines, was found to contain 0.16 percent Cu, a low concentration of Mn, and traces of Cr, Co, Pb, Ni, and Ti.

RISING SUN MINE OCCURRENCE (13)

The Rising Sun prospect, reported by Collins (1925) to be a working of considerable magnitude, is situated on lot 9, concession 2.

It lies in metavolcanics in the southern fringe of the granitic rocks (Carter 1904, p. 78-80) between two large diabase bodies. The shaft lies in an area of thick drift. Eight feet (2½ m) of gravel were observed by the writer above the timbering.

Outcrops of quartz diabase occur 100 feet (30 m) east of the shaft and pink quartz monzonite occurs 120 feet (35 m) southeast.

Mineralization is poor (Collins 1925). Fragments of brecciated 'greenstone' and angular fragments of granitic rock lie in a small heap immediately north of the shaft. The granitic rock contains a network of quartz veinlets in which 1 mm to 2 mm blebs of pyrite and chalcopyrite are sparsely scattered.

Work on the prospect was started in 1903 by the Copper Queen Mining Company. The shaft, 53 feet (16 m) deep in 1904, was planned to reach a depth of 100 feet (30 m) (Carter 1904, p. 80-81). Work was reported by Collins (1925) to have been abandoned.

ROMAR MINE OCCURRENCE (8)

The occurrence lies at the extreme east edge of the township at Longitude 83°42.8'W and Latitude 46°33.6'N. A partly overgrown dirt road connects the occurrence with the all-weather gravel road following the Thessalon River valley. The dirt road runs northeast from the gravel road approximately 1,200 feet (365 m) north of the Stuart Lake road turnoff.

The occurrence is on the west side of the Thessalon River valley. The valley is filled with thick deposits of sand and gravel. Diabase dikes cut fine-grained massive pink Archean quartz monzonite. Outcrops of 'greenstone' also occur.

The deposit has been tested by a pit and a trench. The pit, about 15 feet (4½ m) across and 4 feet (1.2 m) deep, lies on the north side of a jointed diabase body. The joints strike N68W and are vertical.

Thirty feet south of the pit, another diabase body more than 50 feet (15 m) wide is exposed. The trench extends west-northwest from the pit along a near vertical fault. In the pit a vertical white quartz vein lies in sheared 'greenstone'. The vein

strikes N50W and carries minor carbonate and patches, several inches across, of chalcopyrite and bornite. A white quartz vein with minor chalcopyrite occurs in the trench 40 feet (12 m) northwest of the pit.

The mineralized zone has been traced for 300 feet (92 m). In 1956, 2,207 feet (675 m) of diamond drilling was done in seven holes by Romar Mines Limited.

Forty-seven assays over widths of 1 foot to 5 feet ($\frac{1}{3}$ m to $1\frac{1}{2}$ m) showed copper values up to 0.18 percent (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie, File 82).

Ground magnetometer and self-potential surveys were carried out near the showing by Romar Mines Limited.

The magnetic survey indicated the possibility of some minor mafic intrusive rocks. Drilling was recommended on a self-potential anomaly (possibly sulphide mineralization) occurring 1,300 feet (400 m) west of the showing (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie, File 84).

STUART LAKE OCCURRENCE (9)

The occurrence lies by the side of an old north-trending lumber road $\frac{1}{4}$ mile (400 m) northeast of the east end of Stuart Lake at Longitude $83^{\circ}46.5'W$ and Latitude $46^{\circ}33.7'N$. It may be reached on foot or by four-wheel-drive vehicle from the Stuart Lake Road.

The deposit lies in paraconglomerate of the Gowganda Formation. Quartz monzonite of the underlying Archean basement outcrops 300 yards (275 m) east. These rocks are cut locally by Nipissing-type diabase bodies.

The following reference by Knight (1915) may refer to this deposit:

On lot 6, in the third concession a vein of quartz has been exposed for about 300 feet (92 m) or more by cross-trenches; in addition a 20-foot (6 m) shaft has been sunk. The occurrence consists really of a system of quartz veins which branch and unite in a most complex manner. Chalcopyrite and pyrite occur very sparingly, but specularite is found in masses one to four inches (10 cm) in diameter. The interesting point about the deposit is that it is intersected by a dike of fresh diabase less than 100 feet (30 m) in width. The vein occurs in greywacke of Animikean age, containing pebbles and boulders of granite, and both the greywacke and quartz veins are cut by the diabase dikes.

In the test pit, a quartz vein about 2 feet (60 cm) wide, vertical, and striking N80E is mineralized with abundant pyrite, and locally sandstone contains hematite and bornite.

A 9-inch (25 cm) vertical quartz vein with a strike of N70E occurs $\frac{1}{4}$ mile (400 m) west of the pit.

Float of vein quartz in paraconglomerate similar to that found locally in the Gowganda Formation was found also $\frac{1}{4}$ mile west of the pit. Analysis by the Mineral Research Branch, Ontario Division of Mines, yielded 0.21 percent Cu, 0.02 oz/ton Ag, and traces of Au, Cu, Pb, Mn, Ni, and Ti.

STUART LAKE ROAD OCCURRENCE (10)

The occurrence lies at the base of a south-facing diabase cliff on the north side of a creek just north from the Stuart Lake road at Longitude $83^{\circ}45.9'W$ and Latitude $46^{\circ}33.7'N$.

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The occurrence was described by Knight (1915, p. 239) as follows:

... on the north corner of the same lot [lot 6, concession 2] a vein of snow-white calcite two feet in width occurs cutting the Nipissing diabase, but cobalt bloom was not noted in it. The upper two-thirds of the cliff in which the vein occurs is diabase, which rests in sill-like fashion on pink granite. The vein could not be traced downwards into the granite on account of debris.

A trench strikes 100 feet (30 m) southeast from the cliff and is 3 to 6 feet (1 m to 2 m) wide and 6 to 10 feet (2 to 3 m) deep. It ends at a 6-foot (2 m) adit into the cliff. Two downward widening veins each at least 3 feet (1 m) across dip steeply east. The western one is of white carbonate. The eastern one is of quartz with an 18-inch (50 cm) border of iron-stained carbonate. The veins possibly fill wedge-shaped tension gashes.

The western vein contains patches of quartz, chalcopyrite, and green minerals. Seventy feet (21 m) southeast along the trench from the cliff, a 6-foot (2 m) thick quartz vein with minor chalcopyrite dips 60 to 65 degrees east.

W. D. SUTHERLAND AND ASSOCIATES (14)

The occurrence is situated in the southeast corner of the township 1/2 mile (0.8 km) north of the west end of Skookum Lake. It may be reached on foot from Skookum Lake or by walking 1 mile (1.6 km) east from the dirt road running up Woods Creek to Shelden Lake.

At the locality, rocks of the Matinenda Formation are overlain by rocks of the Ramsay Lake and Mississagi Formations. The sedimentary rocks dip 15 to 20 degrees southwest at the end of a southwest-pointing prominence in the Archean basement which is composed of pink quartz monzonite. At the base of and within the Matinenda Formation scattered outcrops of mafic volcanic rocks occur (Map 2272, back pocket). A steeply dipping dike of quartz diabase, about 300 feet (92 m) across, transects the other rocks.

In 1968, W. D. Sutherland and Associates drilled 6 vertical holes in the pattern shown on Map 2272 (back pocket) (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie, File 1246) (see also Figure 6). Interflow quartz-pebble conglomerate was found to contain significant quantities of uranium. It was not possible to decipher the distribution of the mineralized zone (W. D. Sutherland, personal communication).

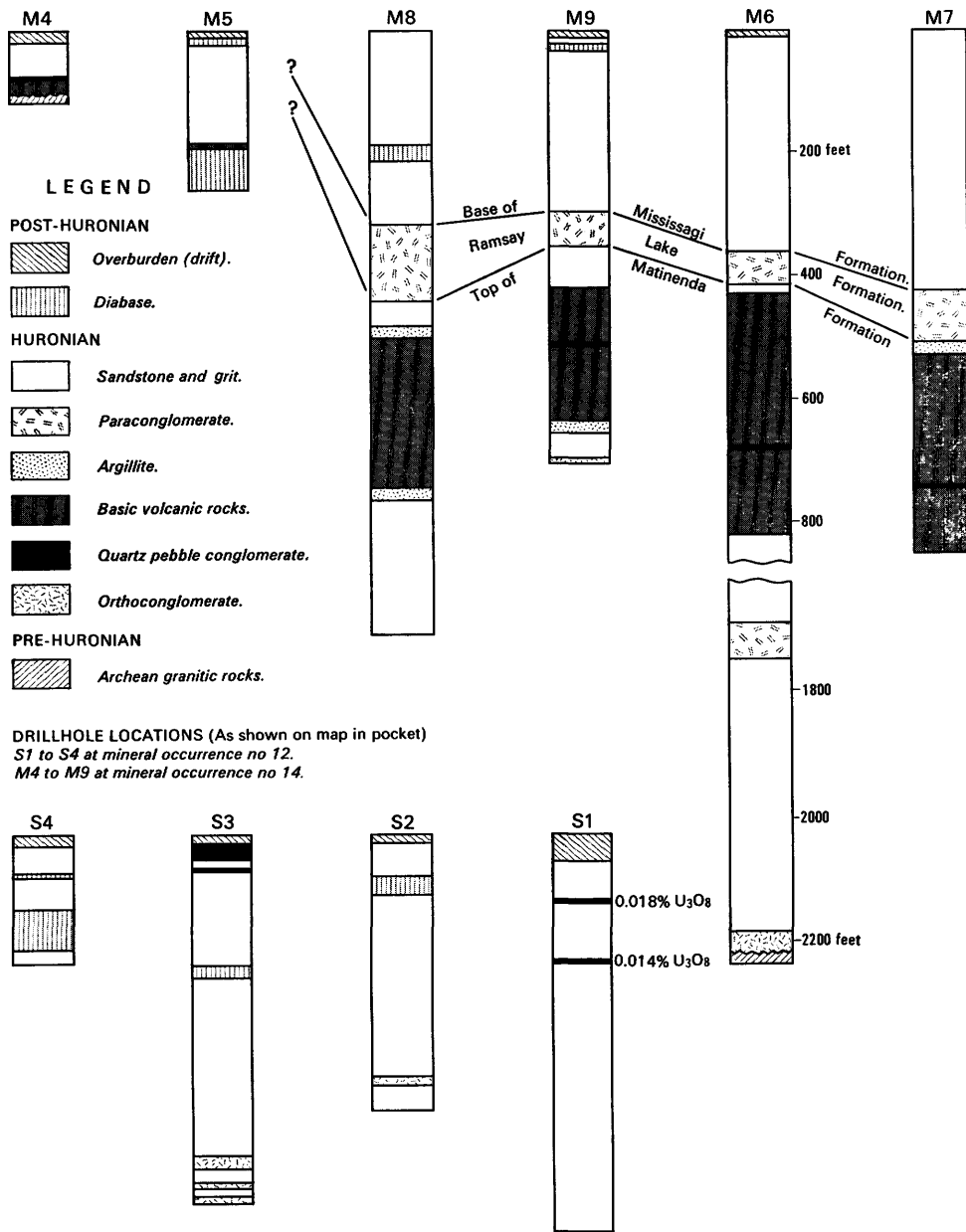
THESSALON RIVER OCCURRENCE (15)

A chalcopyrite-bearing vein occurs at the base of an east-facing cliff overlooking the Thessalon River at Longitude 83°42.5'W and Latitude 46°34.5'N.

The cliff is of Nipissing-type quartz diabase and caps a hill of massive pink Archean quartz monzonite. The diabase sheet is horizontal in the north but curves downward to dip 65 degrees south at the south end of the hill.

A more or less horizontal vein 6 inches to 1 foot (15 to 30 cm) wide is traceable

← NORTHEAST TOWARDS BASEMENT



SMC 12426

Figure 7—Interpretation of diamond drill logs, Morin Township (S1-S4, SSM file 83; M4-M9, SSM file 1246).

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for a distance of 20 yards (18 m). It is made up mainly of white carbonate, subordinate quartz, and patchy chalcopyrite mineralization.

A selected grab sample of chalcopyrite analyzed by the Mineral Research Branch of the Ontario Division of Mines contained 30 percent copper and traces of silver, nickel, and zinc.

WOOD CREEK OCCURRENCE (16)

The showing is located on the northeast side of a tree-covered granite hill at Longitude 83°37.4'W and Latitude 46°33.7'N. The Sheldon Lake road comes within 200 yards (180 m) of the locality. A vertical 20-foot wide quartz vein trends northwest in a 40-foot high northeast-facing cliff of pink quartz monzonite which is sheared parallel to the vein. Several yards (metres) southwest a diabase dike and several small knobs of 'greenstone' outcrop through the drift.

The vein is sparsely mineralized with chalcopyrite and malachite. It is composed of pale grey quartz with associated specularite, carbonate, and minor brecciated diabase.

There are no signs of prospecting at the outcrop. A selected grab sample was analyzed by the Mineral Research Branch, Ontario Division of Mines, and found to contain 0.08 percent Cu and traces of Cr, Pb, Mn, Ti, Ag, and Au.

GEOPHYSICAL SURVEYS

Airborne geophysical surveys as listed below have been carried out over the Huronian sedimentary rocks and parts of the post-Huronian diabase of McMahon and Morin Townships (Figure 5). A land based survey was carried out over Archean rocks in the vicinity of the Romar Mines Limited prospect.

THE CANADIAN JOHNS-MANVILLE COMPANY LIMITED (McMAHON TOWNSHIP)

Surveys were carried out in November and December of 1968. The electromagnetic survey showed four poor conductors. Ground checking was advised for one anomaly over Lamothe Lake. Another anomaly ¼ mile (400 m) west of the west end of McMahon Lake coincides with a magnetic high. The airborne magnetic survey indicated positive anomalies that coincide with diabase and a negative one that coincides with volcanic rocks west of McMahon Lake.

BRITISH AMERICAN OIL COMPANY LIMITED (McMAHON TOWNSHIP)

Surveys were performed in 1968. A coincidence exists between electromagnetic anomalies and quartz diabase. One highly conductive zone or anomaly occurs on

the east shore of Patten Lake near the tourist camp. High magnetic readings between Patten and McMahon Lakes were related to high ground underlain by quartz diabase and to an olivine diabase dike and associated sulphide mineralization where the Gowganda Formation overlies Archean granitic rocks east of Stuart Lake (mineral occurrence No. 9). One radioactive anomaly coincides with the above magnetic anomaly. A second occurs at the west end of Stuart Lake where quartz diabase overlies sandstones and argillites of the Gowganda Formation.

ROMAR MINES LIMITED (McMAHON TOWNSHIP)

A ground geophysical survey carried out by the above company was discussed in the section on Mineral Occurrences (mineral occurrence No. 8).

W. D. SUTHERLAND AND ASSOCIATES (MORIN TOWNSHIP)

A strong electromagnetic anomaly (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) lies close to mineral occurrence No. 14. Pyrite mineralization was noticed by the writer in mafic volcanic rocks stained at the outflow of the small lake immediately northwest of the anomaly (Longitude $83^{\circ}36.4'W$, Latitude $46^{\circ}32.4'N$). Higher magnetism is connected with larger diabase bodies. The presence of many northeast-trending faults was inferred from the magnetic map (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie). Though no discrete radioactive anomalies were found which might be attributable to uraniferous formations (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie, File 1440), higher radioactivities tend to lie over feldspathic sandstones of the Matinenda and Mississagi Formations as opposed to Archean granitic rocks.

SUGGESTIONS FOR FUTURE EXPLORATION

Copper mineralization appears to be limited to east-striking chalcopyrite-bearing quartz-carbonate veins which are associated spatially with mafic intrusive rocks.

Uranium mineralization in the map-area is limited to the more or less southwest-dipping Matinenda Formation. Therefore the Ramsay Lake Formation might be considered in mapping projects as a marker unit to diminish exploration targets in nearby areas underlain by unsubdivided Huronian rocks older than the Bruce Formation. Areas of interest are shown coloured grey on Ontario Division of Mines Map 2108 and lie in Duncan, Jarvis, Kehoe, and Aberdeen Townships and between Bruce Mines and Thessalon. Similarly, rocks underlying Indian Reserve No. 14, west of Echo Lake formerly placed in the Serpent Formation, are now believed to consist mainly of older Huronian sandstones (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie).

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Between Longitudes $83^{\circ}15'$ and $83^{\circ}45'$ extensive overlap of older Huronian Formations by the Gowganda Formation has hindered exploration for uranium. Examination by the writer of deep diamond drill cores (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) indicates a saddle shaped ridge of Archean rocks stretching from Haughton Township to the Chiblow-Matinenda Lakes area over which Huronian rocks have been draped.

Mapping by the writer in the Wakomata Lake area in 1971 suggested that north of this saddle shaped basement ridge the Quirke Lake Syncline may terminate as an east-plunging syncline. The axis of this fold would lie between Wakomata and Jobammageeshig Lakes. Thus the Quirke Lake Syncline might be regarded as an elongate structural basin. Huronian strata to the south of the ridge and obscured by the unconformable Gowganda Formation may dip southwest. In other words, the Elliot Lake 'Z' structure is mirrored in the west by an 'S' structure herein called the 'Wakomata Lake S structure'. The latter structure has been downthrown by the Little White River Fault. Uplift of the axial zone of the Chiblow Anticline on this fault has exposed the Mississagi Formation where plunge is to the east in Parkinson Township. Downward drag of strata of the Mississagi Formation as a result of the movement of the above fault may have given the Parkinson Township structure the appearance of a dome.

Deep drilling has shown that the Quirke Lake Group is absent west of Parkinson Township and over the Haughton Township-Chiblow Lake basement ridge. It is possible that rocks previously identified as belonging to the Bruce Formation in Cummings Lake (Gould Township: Frarey 1961) and in Morin, Otter, Haughton, and Galbraith Townships (Giblin and Leahy 1967) belong in the first case to the Gowganda Formation and in the second case to the Ramsay Lake Formations or are in part paraconglomerates within the Mississagi Formation. If the above basement high has restricted the distribution of Huronian rocks particularly during deposition of the Matinenda Formation and effusion of penecontemporaneous volcanic rocks it might be important in restricting location of the associated uranium deposits. Stratigraphic and sedimentological studies would help clarify the significance of the Chiblow Anticline.

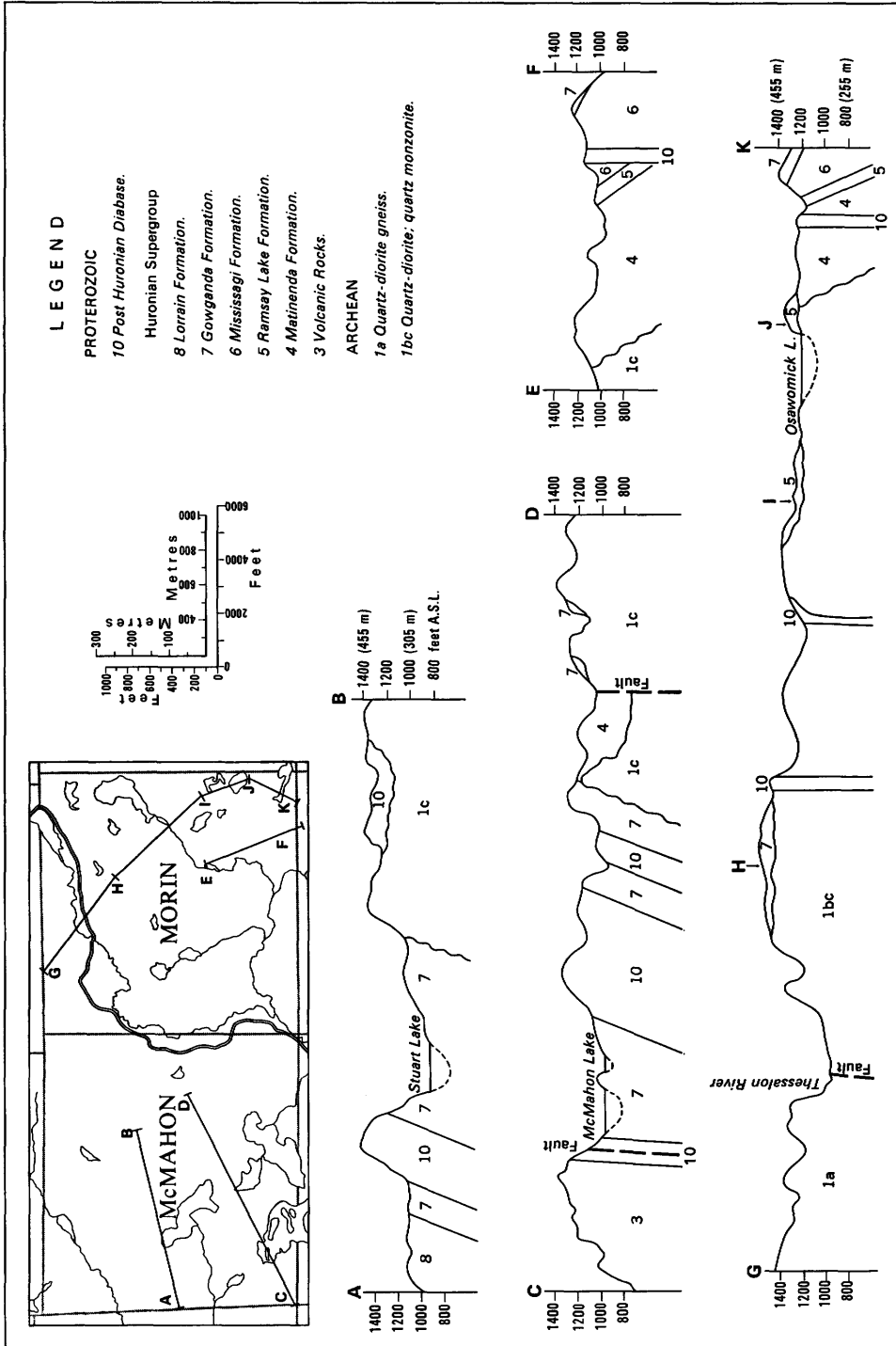


Figure 8—Four sections across McMahon and Morin Townships map-area.

SMC 12427

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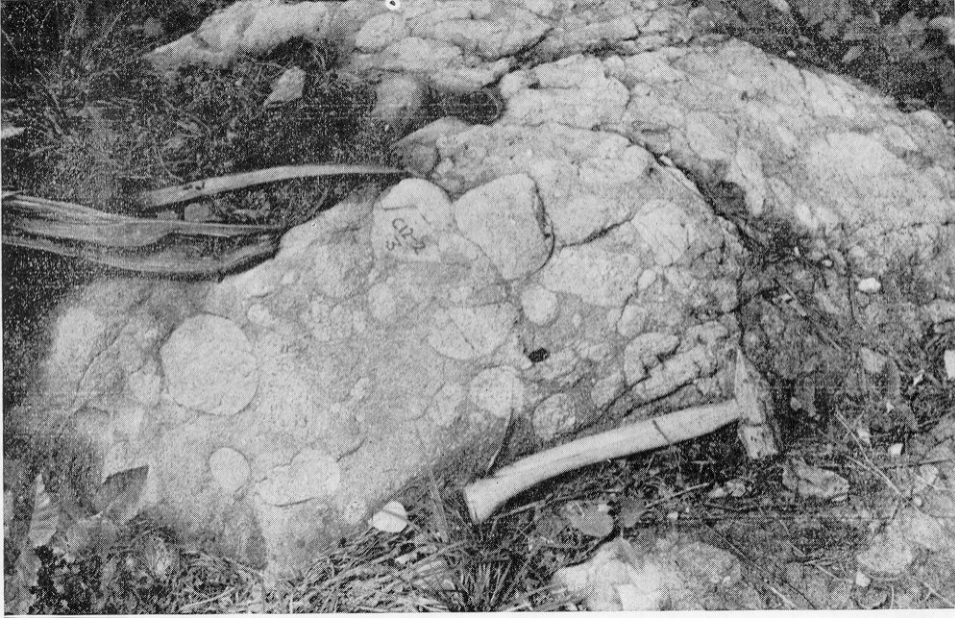
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A black and white photograph showing a hammer lying on a dark, gravelly surface. A small, light-colored rectangular label is attached to the hammer's head, with the handwritten text "D3 LC51" on it. The hammer is positioned vertically on the left side of the frame, with its head pointing upwards. The gravel consists of numerous small, light-colored stones and pebbles of various sizes scattered across a dark background. The lighting is somewhat uneven, with the hammer and label being brighter than the surrounding gravel.

D3 LC51







C10. F1





B4-2

NRZ

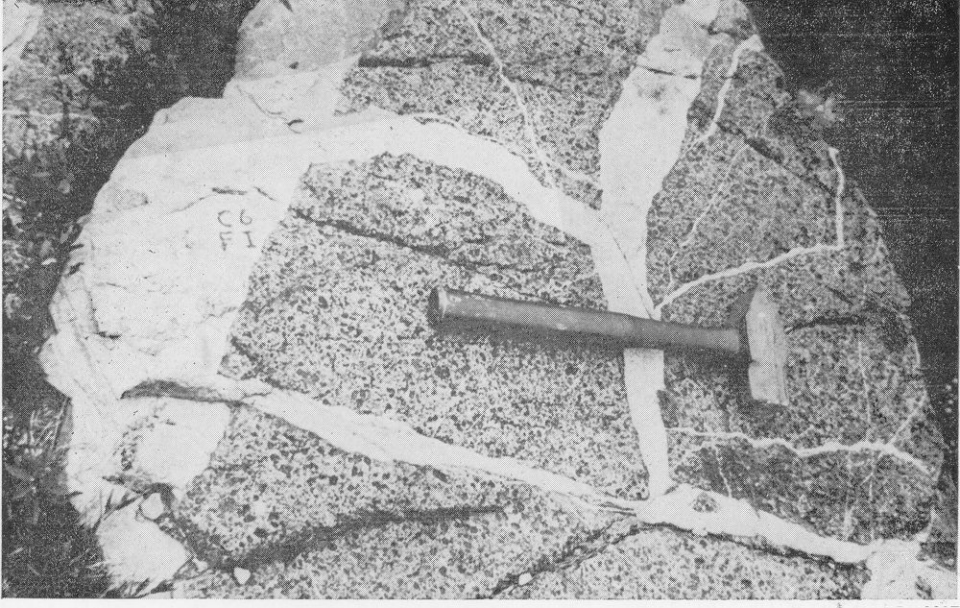




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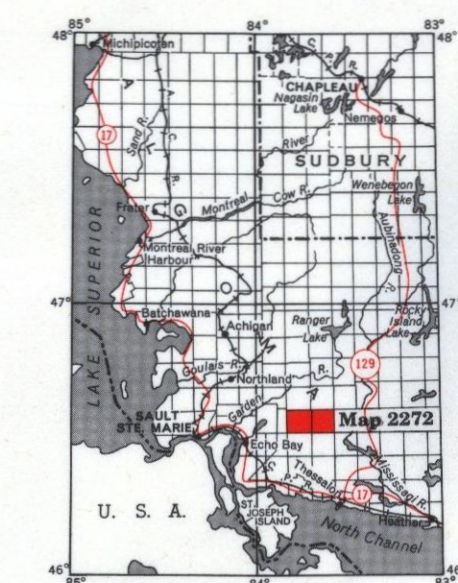






C6
F1





- SYMBOLS**
- Glacial stria.
 - Small bedrock outcrop.
 - Area of bedrock outcrop.
 - Bedding, horizontal.
 - Bedding, (inclined, vertical).
 - Gneissosity, (horizontal, inclined, vertical).
 - Foliation; (horizontal, inclined, vertical).
 - Geological boundary, observed.
 - Geological boundary, position interpreted.
 - Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.
 - Lineament.
 - Jointing; (horizontal, inclined, vertical).
 - Anticline, syncline, with plunge.
 - Drill hole; (vertical, inclined).
 - Vein. Width in feet.
 - Swamp.
 - Motor road.
 - Other road.
 - Trail, portage, winter road.
 - Building.
 - Township boundary, approximate position only.
 - Property boundary, approximate position only.
 - Surveyed line, approximate position only.
 - Location of mining property; (Surveyed, unsurveyed). See list of properties.

SOURCES OF INFORMATION

Geology by F. W. Chandler and assistants, 1970.
Geology is not tied to surveyed lines.

Map Publication No. 1989, Geological Survey of Canada
Memoir 145, 1929
Map 23—1959, Geological Survey of Canada.

Aeromagnetic Map 2213G, O.D.M.-G.S.C., 1963.

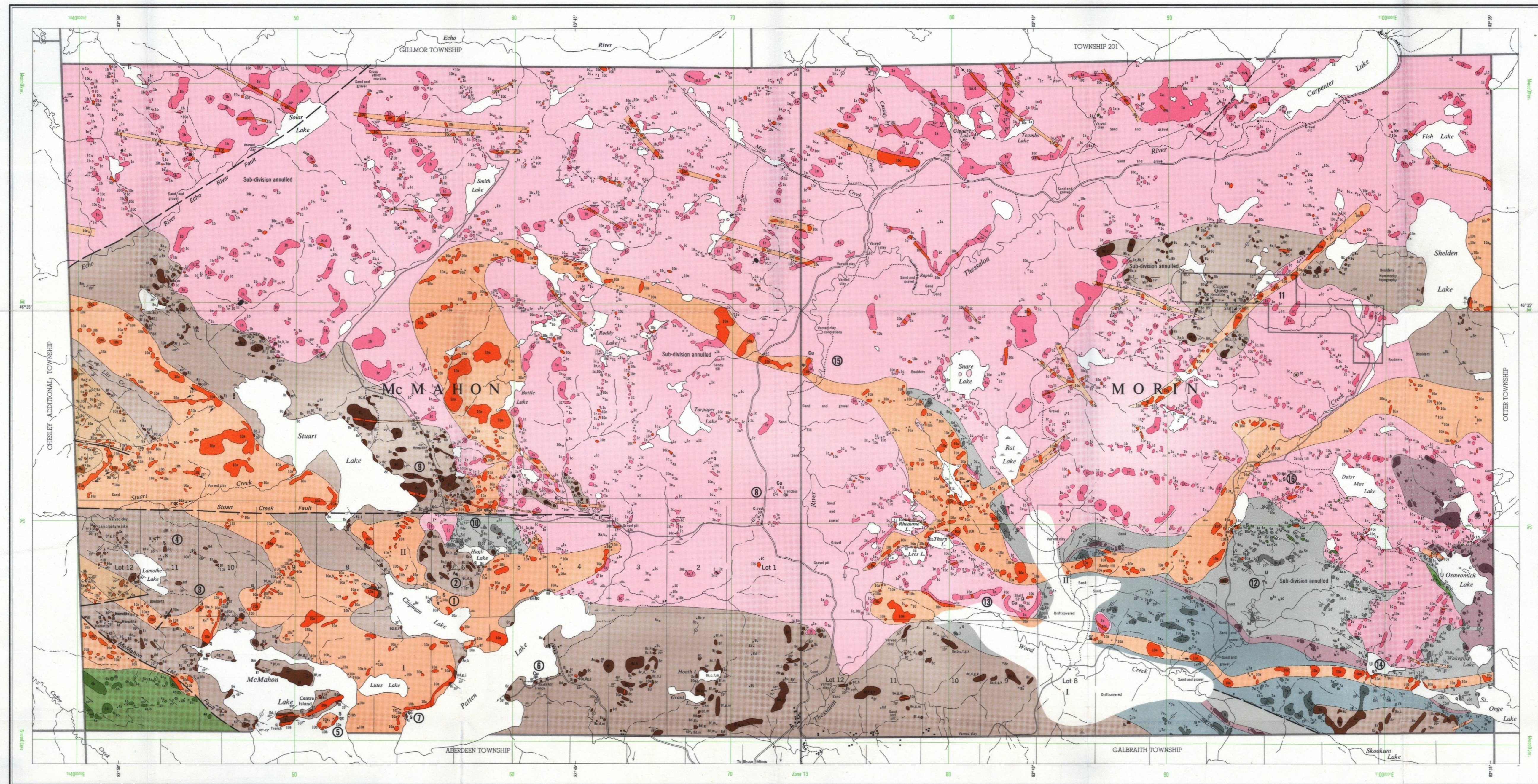
Preliminary maps, P. 650 McMahon Township and P. 621 Morin Township, scale 1" to 1/4 mile, issued 1970.

Cartography by M. G. Sifton and assistants, Ministry of Natural Resources, 1972.

Basemaps derived from maps of the Forest Resources Inventory, Ministry of Natural Resources, with additional information by F. W. Chandler.

Magnetic declination in the area was approximately 5°20' W, 1970.

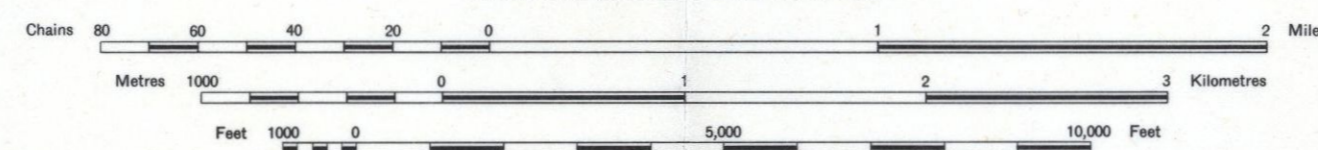
- LIST OF PROPERTIES**
(Information prior to December 31st, 1970)
- McMAHON TOWNSHIP**
1. Chipman Lake occurrence.
 2. Agill Lake occurrence.
 3. Lamothe Lake, East occurrence.
 4. Lamothe Lake, North occurrence.
 5. McMahon Lake occurrence.
 6. Patten Lake, East occurrence.
 7. Patten Lake, West occurrence.
 8. Romar prospect.
 9. Stuart Lake occurrence.
 10. Stuart Lake road occurrence.
- MORIN TOWNSHIP**
11. Krupp, A. J. and associates.
 12. McIntyre Porcupine occurrence.
 13. Ring Lake occurrence.
 14. Sutherland occurrence.
 15. Theissen River occurrence.
 16. Wood Creek occurrence.



- LEGEND**
- CENOZOIC**
- QUATERNARY**
- Sandy till, fluvial gravels and sands, varved clays, sandstone deposits.
- UNCONFORMITY**
- PRECAMBRIAN**
- PROTEROZOIC**
- MAFIC INTRUSIVE ROCKS**
- 10 Unsubdivided.
 - 10a Quartz diabase, Nipissing-type.
 - 10b Granodiorite, Nipissing-type (Red Rock).
 - 10c Quartz diabase of uncertain age.
 - 10d Lamprophyre.
 - 10e Oligine diabase (possibly later than 10a, 10b).
- INTRUSIVE CONTACT**
- HURONIAN SUPERGROUP**
- COBALT GROUP**
- LORRAIN FORMATION**
- 9 Unsubdivided.
 - 9a Sandstone (fine-grained, purple to grey).
 - 9b Sandstone (coarse-grained, feldspathic).
 - 9c Orthoquartzite (coarse-grained, jas-per-bearing).
- GRADATIONAL BOUNDARY**
- GOWANDA FORMATION**
- 8 Unsubdivided.
 - 8a Orthoconglomerate (massive to bedded with granitic clasts).
 - 8b Conglomerate transitional between 8a, 8c.
 - 8c Paraconglomerate (massive with granitic megacrysts).
 - 8d Greywacke.
 - 8e Sandstone (feldspathic).
 - 8f Sandstone (fine-grained, purple feldspathic).
 - 8g Siltstone.
 - 8h Argillite (massive).
 - 8i Argillite (laminated).
 - 8k Argillite (laminated with dropped clasts).
 - 8m Argillite unsubdivided.
- UNCONFORMITY**
- HOUGH LAKE GROUP**
- MISSISSAUGI FORMATION**
- 7a Sandstones (medium- to coarse-grained feldspathic).
 - 7b Paraconglomerate with siliceous matrix and quartz, granitic and angular volcanic megacrysts.
- CONFORMABLE BOUNDARY**
- RAMSAY LAKE FORMATION**
- 6 Paraconglomerate (polymictic, sandy matrix).
- UNCONFORMITY**
- ELLIOT LAKE GROUP**
- MATHENDEA FORMATION**
- 5 Sandstone unsubdivided.
 - 5a Orthoconglomerate, granitic clasts.
 - 5b Sandstone (fine-grained, grey feldspathic, pyritic).
 - 5c Sandstone (feldspathic).
 - 5d Sandstone (coarse-grained, feldspathic, quartz pebbles).
 - 5e Paraconglomerate (polymictic).
- VOLCANIC ROCKS**
- 4 Unsubdivided.
 - 4a Massive.
 - 4b Mafic, vesicular and (or) amygdaloidal.
 - 4c Felsic.
- BURIED LANDSCAPE NONCONFORMITY**
- REGOLITH**
- 3 Quartz-sericite rock.
- ARCHEAN**
- MAFIC INTRUSIVE ROCKS**
- 2 Amphibolite.
- INTRUSIVE CONTACT**
- FELSIC INTRUSIVE AND METAMORPHIC ROCKS**
- 1 Unsubdivided.
 - 1a Banded quartz diorite gneiss.
 - 1b Porphyritic quartz diorite.
 - 1c Massive quartz monzonite.
 - 1d Aegirite.

Map 2272
McMAHON AND MORIN TOWNSHIPS
 ALGOMA DISTRICT

Scale 1:31,680 or 1 Inch to 1/2 Mile



Ag Silver
Cu Copper
Q Quartz
cc Quartz-carbonate
S Sulphide mineralization
U Uranium

a Unconsolidated deposits. Cenozoic deposits are represented by the lighter coloured and uncoloured parts of the map.
 b Bedrock geology. Outcrops and inferred extensions of each map rock 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 block.
 c Found cutting only Archean rocks. Some or all of these dikes may be pre-Huronian in age.
 d Mostly Lower Huronian or pre-Matheneia in age. Some of these volcanic rocks may be Archean in age.