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Geology of the
Wakomata Lake Area
District of Algoma

By
K.M. Siemiatkowska

1977

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ABSTRACT

The Wakomata Lake Area in the District of Algoma consists of Jackson Township (formerly Township 182) and parts of Casson Township (formerly Township 188), and Gould and Grasett Townships. The map-area is situated approximately 36 miles (58 km) north of Thessalon. The area, located at the contact between the Superior and Southern Provinces of the Canadian Shield, is underlain by felsic intrusive rocks, mafic intrusive rocks and sedimentary rocks of the Huronian Supergroup.

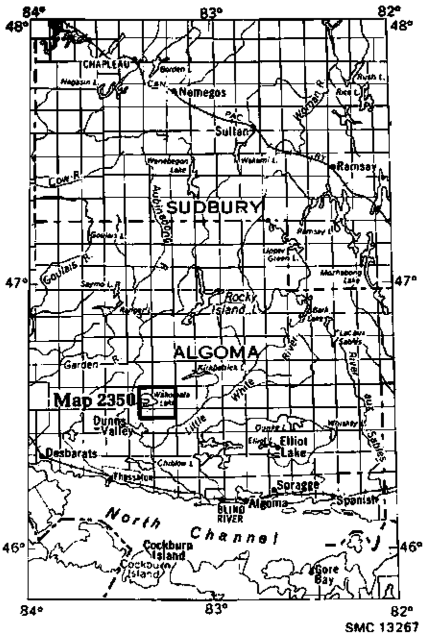


Figure 1—Location map of Wakomata Lake area. Scale 1:3,168,000 (1 inch to 50 miles).

The felsic intrusive rocks are Early Precambrian in age, and range from trondhjemite to granodiorite and contain xenoliths of amphibolite, orthogneiss and paragneiss.

The Huronian Supergroup exposed in the map-area consists of sedimentary rocks of the Cobalt and Hough Lake Groups. These sedimentary rocks comprise the following: sandstone, argillite, siltstone, orthoconglomerate, and paraconglomerate of the Gowganda Formation; sandstone, conglomerate and quartzite of the Lorrain Formation; and sandstones of the Mississagi type. The rocks of the Gowganda and Lorrain Formations represent a continuous depositional sequence with no major breaks. The rocks of the Gowganda Formation show characteristics of a regressive marine sequence. The lower part of the Lorrain Formation was deposited mainly in a fluvial (braided stream) environment, but a change to a beach environment occurred towards the top of the formation. Possibly, a change from a frigid to a tropical climate occurred during the deposition of the upper part of the Gowganda Formation and the lower part of the Lorrain Formation. This change is possibly indicated by the disappearance of feldspars and the appearance of aluminous minerals, such as diaspore, kaolinite, and pyrophyllite.

Wakomata Lake Area

There are four ages of mafic intrusive rocks in the area. The earliest dikes occur only in the Early Precambrian granitic basement, and consist of Matachewan-type porphyritic diabase dikes and fine-grained amphibolitic dikes. The most abundant mafic rocks consist of Nipissing Diabase bodies which usually are very magnetic. A few lamprophyre and olivine diabase dikes of the Sudbury Swarm are present in the area.

The Huronian rocks are not greatly deformed or metamorphosed. The dominant structure is an eastward-plunging open syncline which is probably a continuation of the major Quirke Syncline to the east. The Flack Lake Fault System, a major regional tectonic feature crosses the area in the northeast corner.

Mineralization in the form of chalcopyrite, and malachite with specularite-magnetite-bearing quartz-carbonate veins occurs in fault zones associated with Nipissing Diabase.

Geology

of the

Wakomata Lake Area

District of Algoma

by

K. M. Siemiatkowska[1]

INTRODUCTION

The Wakomata Lake Area consists of Jackson Township (formerly Township 182), the eastern half of Casson Township (formerly Township 188), and the northern parts of Gould and Grasett Townships. The present work is a continuation of the project initiated by Chandler (1973) in the Saunders Lake Area. The map-area is approximately 50 air miles (80 km) northeast of Sault Ste. Marie, and is 36 miles (58 km) north of Thessalon on Highway 129 which connects Thessalon with Chapleau. The area covers about 70 square miles (180 km^2) and is bounded by Latitudes 46°30′ to 46°37′N and Longitudes 83°23′ to 83°12′W.

Highway 129 and numerous public and private gravel roads provide access to Wakomata, Chub, and Jobammageeshig Lakes. These lakes provide boat access to most of the western part of the area. The eastern part can only be reached conveniently by float-equipped aircraft via East Caribou, Pearl and Skirl Lakes. The northern part can be reached by means of four-wheel-drive vehicle to Two Camp Lake (just north of the northern edge of the map-area). The southern part is accessible from a gravel road which extends north from Highway 129 at a point just north of Cummings Lake to Pickerel Lake in Grasett Township. Hartem and McEarchen Lakes and the power line of the Hydro-Electric Power Commission of Ontario can be reached from this gravel road. During the summer of 1973, Midway Lumber Company constructed numerous roads from Kynoch via Grasett Lake to Highland Lake in Jackson Township.

Mapping was carried out in four months during the summer of 1973. Mapping was done by pace-and-compass traverses on land, and shoreline traverses on most of the lakes and streams. Traverses were spaced at varying intervals to give the geologists maximum

[1]Geologist, Ontario Division of Mines, Toronto. Manuscript approved for publication by the Chief, Precambrian Section, 30 December 1974.

coverage of outcrops. Two geologists and three assistants gathered data which were plotted directly in the field on acetate overlays on aerial photographs at a scale of 1 inch to ¼ mile (1:15,840). The information was transferred by means of a sketchmaster to base-maps of the same scale prepared by the Cartography Section of the Ontario Division of Lands from maps of the Forestry Resources Inventory of the Ontario Division of Forests. A preliminary geological map of Wakomata Lake (East Half), P.914, was issued by the Ontario Division of Mines in 1973 (Siemiatkowska and Douglas 1973).

Physiography

The area is rugged with elevations ranging from approximately 800 feet (240 m) to 1,800 feet (550 m) above mean sea level. The topography is controlled by the rock formations of the area. The granitic rocks in the northern part of the area form rounded hills with a moderate exposure of bedrock. The eastern half of the area, underlain by Huronian sandstone, consists of rugged cliffs and cuestas formed by differential erosion. Bedrock exposure is generally excellent in the eastern part of the area. The western part of the area is flat and heavily forested. Pleistocene till and sand deposits form plains in the area. Numerous faults and lineaments throughout the area give rise to vertical cliff faces reaching about 500 feet (150 m) in height.

Resources and Development

The area was prospected in the past for copper, and in the late 1960s for uranium. Numerous copper occurrences have been found in the four townships forming the area. Private cottages and tourist camps are located on Wakomata, Chub, Jobammageeshig and East Caribou Lakes. Lumbering has been carried out in the region since the turn of the twentieth century; the central, western, and southern parts of the map-area constitute a timber resource. Tree species present include poplar, birch, and pine, and in swampy areas, spruce, cedar, and balsam. Hunting and fishing draw a number of tourists to the area. Game species present include grouse, moose, deer, black bear, and snowshoe rabbit. The lakes and streams are well stocked with brook, lake and rainbow trout, pickerel, northern pike, bass and perch.

Previous Work

The area has not been mapped previously in its entirety. In 1926, Emmons mapped parts of the area (Emmons 1927), and Hadley (1968) collected some samples from the Lorrain Formation around Lake Wakomata. The area is included on a regional Preliminary Map P.304 (Robertson 1971). The area to the west was mapped by Chandler (1973), to the east by Robertson (1969), and to the south by Frarey (in press).

In 1956, the Ontario Department of Mines issued aeromagnetic maps at a scale of 1 inch to ¼ mile (1:15,840) of Grassett and Gould Townships (ODM 1955, 1956). The magnetic characteristics of the map-area are shown on Aeromagnetic Map 2227G, the

Wakomata Lake Sheet (ODM-GSC 1963). Records of work done by the mining industry in the area are kept in the Assessment Files Research Office in Toronto and the Regional Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie.

Acknowledgments

The author was capably assisted in the field by G.B. Douglas, G.J. Winter, A.P. Fleming, D.F. Baker, and Janet Martin. Douglas and Winter were responsible for part of the geological mapping.

The author would like to thank the following: Mr. and Mrs. A. Clinton for providing accommodation and many helpful services; Mr. Doug Sprague, Mine geologist at the Quirke Mine, Elliot Lake for information about some parts of the map-area; fellow staff members, Dr. K.D. Card and Mr. Roy Rupert for helpful discussions about the geology in the area, and Mr. W.D. Hicks, Mineral Research Branch, Ontario Division of Mines, for X-ray diffraction analyses of the sandstones of the Lorrain Formation.

GENERAL GEOLOGY

Precambrian rocks in the map-area, located at the contact between the Superior and Southern Provinces of the Canadian Shield (Card *et al.* 1972), can be subdivided into five major subdivisions shown in Table 1.

The Early Precambrian felsic intrusive rocks of the Superior Province form the basement on which the Huronian supracrustal rocks of the Southern Province were deposited A Rb-Sr whole rock radiometric age of 2,500 m.y. was obtained for the Early Precambrian granitic rocks (Van Schmus 1965). However, this is possibly a minimum age because the granites are cut by porphyritic diabase dikes similar in appearance and strike to the Matachewan Diabase in the Matachewan area dated at 2,690± 93 m.y. (Gates and Hurley 1973). The Huronian sedimentary rocks were deposited after 2,500 m.y. ago, the minimum Rb-Sr radiometric age of the Early Precambrian basement rocks, and before 2,150 m.y. ago, the radiometrically determined age of the Nipissing Diabase (Gates and Hurley 1973) which intrude the Huronian rocks. The Southern Province rocks were mildly deformed and metamorphosed in the map-area during the Penokean Orogeny some 1,900 to 1,600 m.y. ago (Goldich 1968).

The youngest Precambrian rock unit known in the area is a northwest-trending diabase dike of the Sudbury Swarm. The age of this swarm has been established by the Rb-Sr whole rock method as 1,460±30 m.y. (Gates and Hurley 1973).

The Precambrian rocks are partly covered by a thin discontinuous mantle of sandy till; the deposits of continental glaciation that occurred during the Pleistocene. Two sets of glacial striae are present, indicating ice movement from the north and northeast.

Table 1 | TABLE OF LITHOLOGIC UNITS FOR THE WAKOMATA LAKE AREA.

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT

Glacial, glaciofluvial, glaciolacustrine, swamp, lake and stream deposits

Unconformity

PRECAMBRIAN

LATE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS

Olivine diabase, lamprophyre

Intrusive Contact

MIDDLE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS (NIPISSING DIABASE)

Diabase, gabbro, diorite, amphibolite, granophyre, porphyritic metadiabase

Intrusive Contact

HURONIAN SUPERGROUP

COBALT GROUP

LORRAIN FORMATION

Orthoquartzite, pebbly sandstone, sandstone, conglomerate

GOWGANDA FORMATION

Feldspathic sandstone, siltstone, argillite, conglomerate

Nonconformity

HOUGH LAKE GROUP

Unclassified sandstone

Arkose, pebbly arkose, regolith

Nonconformity

EARLY PRECAMBRIAN (ARCHEAN)

MAFIC INTRUSIVE ROCKS

Porphyritic diabase (Matachewan type), amphibolitic diabase

Intrusive Contact

FELSIC INTRUSIVE ROCKS

Trondhjemite, granodiorite, quartz monzonite, pegmatite, aplite

Table 2 MODAL ANALYSES OF THE EARLY PRECAMBRIAN (ARCHEAN) FELSIC INTRUSIVE ROCKS; WAKOMATA LAKE AREA.

<table>
<tr><th>GRANITIC ROCKS</th><th>S8-73-33</th><th>S2-73-143</th><th>P2-73-155</th></tr>
<tr><td>Quartz</td><td>32.5</td><td>27.2</td><td>26.9</td></tr>
<tr><td>Plagioclase</td><td>57.1</td><td>58.8</td><td>55.3</td></tr>
<tr><td>Orthoclase</td><td>2.3</td><td rowspan="2">5.4</td><td>....</td></tr>
<tr><td>Microcline</td><td>....</td><td>....</td></tr>
<tr><td>Biotite</td><td>....</td><td>....</td><td rowspan="2">17.4</td></tr>
<tr><td>Chlorite</td><td>7.0</td><td>2.6</td></tr>
<tr><td>Epidote</td><td>....</td><td rowspan="2">3.8</td><td>....</td></tr>
<tr><td>Carbonate</td><td>....</td><td>....</td></tr>
<tr><td>Heavy Minerals</td><td>1.1</td><td>....</td><td>0.4</td></tr>
<tr><td>Number of points counted</td><td>1000</td><td>500</td><td>1000</td></tr>
</table>

S8-73-33 – Trondhjemite
S2-73-143 – Trondhjemite
P2-73-155 – Trondhjemite

Abbreviation:
.... Not detected

Early Precambrian (Archean)

Felsic Intrusive Rocks

Granitic rocks are exposed in the northern part of the map-area. The southern limit of these rocks is a steep escarpment marked by Caribou Creek. North of this escarpment the relief over the granitic terrane is more subdued. Bedrock exposure, mainly in the form of small scattered outcrops, constitutes about 30 percent to 50 percent of the surface area, except in the northeast corner of Jackson Township where exposure is about 70 percent.

The granitic rocks are pink to grey, equigranular, fine to coarse grained, and consist of trondhjemite, quartz monzonite and granodiorite (Table 2). The most abundant rock type, grey trondhjemite is medium to coarse grained and leucocratic with an average mafic mineral content of about 5 percent. Chlorite and biotite which formed at the expense of primary hornblende are the most common mafic minerals.

Wakomata Lake Area

Pink-coloured granitic rocks are most commonly associated with faults, shear zones, and zones of contact alteration adjacent to mafic intrusions. In the southern part of the granitic terrain, pink granitic rocks are host to amphibolite, orthogneiss, and paragneiss xenoliths ranging in maximum dimension from 1 foot (0.3 m) to 5 feet (1.5 m). Xenolithic fragments compose about 15 to 20 percent of the rock around the north shore of Wakomata Lake and Caribou Creek, and decrease northward to about 1 to 5 percent.

A weak cataclastic foliation trending N50°E and dipping 70 degrees northwest was noted in the granitic rocks between the north shore of Wakomata Lake and Shingwak Lake, and north of Papineau Lake.

Late-stage aplitic and pegmatitic dikes, ranging from ½ inch (1.3 cm) to 2 feet (0.6 m) in width, cut the granitic rocks. The aplite and pegmatite consist essentially of variable amounts of quartz, microcline, and plagioclase.

Mafic Intrusive Rocks

The rocks of the map-area are intruded by many thin diabase dikes and metagabbro bodies. These have been classified into four groups. Two of these groups are: 1) a northwest- to north-trending set of porphyritic metadiabase dikes, and 2) a predominantly northwest-trending but anastomosing set of fine-grained amphibolite dikes. Dikes of the first two groups intrude only the Early Precambrian basement rock and are considered to be of Early Precambrian age. The third and fourth groups, Nipissing Diabase and olivine diabase dikes of the Sudbury Swarm (Card *et al.* 1972) are described in a later section.

PORPHYRITIC DIABASE

The prophyritic diabase dikes resemble the dikes of the Matachewan type (R. Rupert, personal communication 1972). They occur only in Early Precambrian rocks and were not seen cutting Huronian sedimentary rocks. Most dikes dip steeply and have an average thickness of about 300 feet (90 m). The dikes have two types of contact with the country rocks; a fine-grained chilled contact, or a coarse-grained sharp contact, where plagioclase phenocrysts are aligned parallel to the margins of the dike. The dikes contain greenish, cream or red coloured euhedral to anhedral, fresh to altered plagioclase phenocrysts up to 2 inches (5 cm) in diameter set in a groundmass of dark green, fine- to medium-grained amphibolite. The percentage of phenocrysts in the rock varies and can be as high as 70 percent by volume of the rock. Larger phenocrysts as well as some of the smaller phenocrysts are generally euhedral and show good zoning whereas most of the smaller phenocrysts tend to be anhedral and show diffuse grain boundaries. The distribution of phenocrysts in some dikes is irregular. The phenocrysts tend to be concentrated in patches; the remaining areas resemble medium-grained equigranular amphibolitic dikes. In areas of sparse outcrop it was difficult to map these intrusions consistently.

Thin section examination reveals that the plagioclase phenocrysts are mainly 3 to 4 mm in diameter. These phenocrysts are completely saussuritized to epidote and talc. The surrounding matrix is similar to an altered Nipissing Diabase and consists of saussuritized plagioclase laths, chlorite, uralitized amphibole, minor interstitial quartz, and zoned and skeletal leucoxene.

AMPHIBOLITIC DIABASE

The amphibolitic diabase dikes and altered Nipissing Diabase dikes are very difficult to distinguish in the field. Since the amphibolitic diabase dikes are Early Precambrian in age and cut only the granitic rocks of the basement, some attempt was made to separate them from altered Nipissing Diabase dikes. However, more detailed mapping is required. In comparison with the Nipissing Diabase, the amphibolitic dikes are finer grained, more mafic, commonly weather brownish, and may display foliation at the edges.

However, these criteria were not always very reliable to use in the field, because many dikes mapped in the Early Precambrian basement could either be Nipissing Diabase or Early Precambrian dikes. The dikes average approximately 200 feet (60 m) in thickness, trend northwest and east-west, and dip steeply like the Nipissing Diabase.

The amphibolitic dikes contain disseminated pyrite and pyrrhotite, and some dikes have metasomatically altered the country rocks which they intrude. Most of the alteration is to albite and iron oxides which produce a deep red colour in the country rock. A few fine-grained well jointed, massive, rusty weathering dikes which are black on the fresh surface, were observed to range in thickness from a few feet to 100 feet (30 m). These could be a different generation of dikes.

Middle Precambrian

HURONIAN SUPERGROUP

Hough Lake Group

REGOLITH

An unconformity between the Early Precambrian granitic basement rocks and the Huronian sedimentary rocks was observed in the terrain between the junction of the East Caribou Fault and the Pearl Lake Fault, southeast of Triple Isle Lake in Jackson Township. The unconformity is well exposed as an undulating weathered surface developed upon Early Precambrian quartz monzonite. Lying upon this weathered surface is a regolith consisting of immature, coarse-grained pink arkose derived directly from the underlying quartz monzonite. The weathered surface is an altered, coarse-grained leucocratic quartz monzonite composed of fresh microcline, plagioclase almost completely altered to sericite, and quartz exhibiting sutured grain boundaries. In places, the quartz is cataclastically granulated. The overlying regolith resembles the quartz monzonite, but in thin section it can be seen that the rock is made up of granulated grains of quartz and fresh microcline with fine-grained sericite filling the interstices between grains and cracks in quartz and feldspar. No trace of plagioclase can be seen.

UNCLASSIFIED SANDSTONE

Pink arkosic sandstone of the Huronian Supergroup occurs in two places in the map-area. This rock cannot be assigned to a specific Huronian formation because it occurs in fault-bounded blocks and its contact with the Gowganda Formation is not exposed. Lithologically, the sandstone resemble rocks of the Mississagi Formation. At the southeastern end of Pearl Lake in Jackson Township, on both sides of the lake, a fine-grained pink arkose overlies the granitic basement which is exposed to the north. The sandstone is sheared, brecciated, and mylonitized as a result of movement along both branches of the Pearl Lake Fault. Maping to the east in 1974 (Siemiatkowska *et al.* 1975) determined the stratigraphic position of this sandstone to be in the Mississagi Formation.

The second occurrence of unclassified sandstone directly overlies the regolith described in the subsection "Regolith". The sandstone comprises green pebbly arkose and pink arkose. The pebbly green arkose is the product of further weathering and reworking of the regolithic material. The arkose is a coarse-grained feldspathic sandstone with 5 to 10 percent white quartz pebbles, pink granitic pebbles and pink potassic-feldspar clasts in a coarse-grained, poorly sorted green arkosic matrix. This rock shows evidence of formation by sedimentary transport because it exhibits poorly defined bedding and contains small flattened mud balls. In thin section, clasts of quartzite and granite and some degree of rounding and sorting of grains are visible. Matrix composed of sericite with minor opaque minerals and muscovite forms 40 percent of the rock and occurs interstitially to fresh microcline and quartz. This rock resembles the green pebbly feldspathic sandstone of the Mississagi Formation in the Endikai Lake area. The pink, fine-grained arkose overlying the green pebbly arkose shows moderate sorting and is composed of subangular grains. Sorting and rounding, although minor, indicate that the sediments were transported, and the presence of bedding indicates deposition. The beds are generally about 2 feet (0.6 m) thick, massive, and show little internal sedimentary structure. An average modal analysis of the sandstone, given in Table 3, is about 70 percent quartz, 25 percent potassic feldspar, 1 percent plagioclase, a minor amount of chert grains and 5 percent sericitic matrix. The quartz grains are flattened and deformed where these rocks are in close proximity to the East Caribou Fault.

Cobalt Group

GOWGANDA FORMATION

The Gowganda Formation is the basal formation of the Cobalt Group, the thickest and most widespread of the Huronian groups. The Gowganda Formation, 700 to 9,000 feet (200 to 2,700 m) thick is a heterogeneous assemblage of paraconglomerate, orthoconglomerate, feldspathic standstone, and laminated argillite extending from Sault Ste. Marie to the Cobalt-Gowganda area (Frarey in press; Card *et al.* 1972). In most areas, the formation can be subdivided into a lower polymictic cobble to boulder conglomerate and an upper well-stratified sequence of (non-conglomeratic) laminated argillite and sandstone (Frarey in press; Thomson 1957; Wood 1973).

Only the upper well stratified sequence consisting of conglomerate, argillite, and sandstone occurs in three parts of the map-area: 1) at Chub Lake in the southwestern part of the area; 2) along Caribou Creek; and 3) as an outlier west of Rogers Lake along the northwestern edge of the area. The best exposures of this formation are seen along the lakeshores, especially those of Wakomata, Jobammageeshig, and Chub Lakes. Inland, the Gowganda Formation is exposed as small scattered outcrops in heavily drift-covered and wooded areas.

Table 3 MODAL ANALYSES OF UNCLASSIFIED SANDSTONE OF THE MIDDLE PRECAMBRIAN HURONIAN SUPERGROUP; WAKOMATA LAKE AREA.

UNCLASSIFIED SANDSTONE	S2-73-205	S2-73-206	S2-73-207	S2-73-208	S2-73-209
Quartz	36.4	35.2	30.6	41.3	69.5
Plagioclase	....	26.9	....	....	1.8
Microcline	32.5	33.4	37.5	8.9	24.0
Muscovite	3.6	4.5	....	1.6	....
Sericite	....	....	1.0	....	4.7
Matrix Sericite—	27.5	....	31.0	41.3	....
Heavy Minerals	....	....	....	0.8	....
Pebbles	....	....	....	6.3	....
Number of points counted	1000	1000	1000	1000	1000

S2-73-205 – regolith
S2-73-206 – regolith
S2-73-207 – regolith
S2-73-208 – pebbly green sandstone
S2-73-209 – pink sandstone

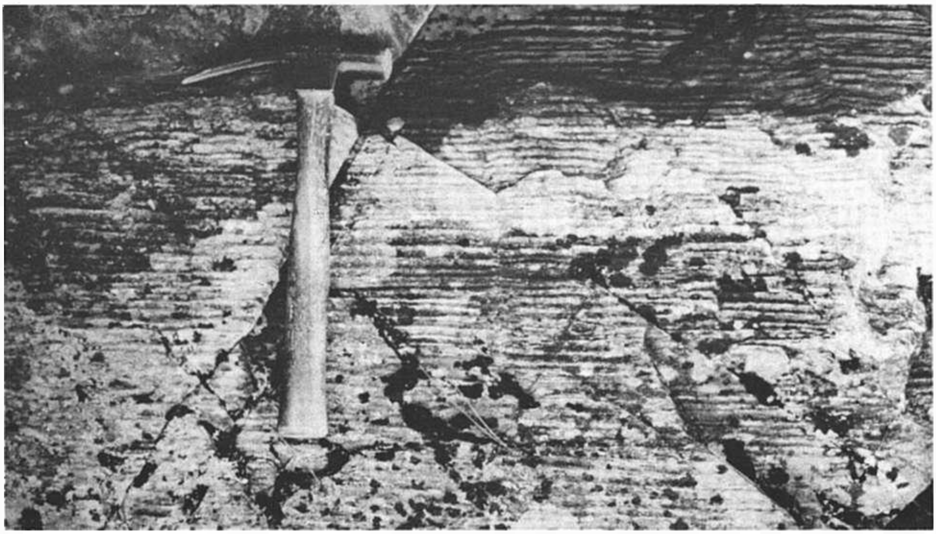
Abbreviation:
.... Not detected

In the map-area, the Gowganda Formation can generally be subdivided into five stratigraphic members on the basis of lithology: 1) a *Lower Conglomeratic Member (4a),* followed successively upward by; 2) a *Rhythmically Laminated Argillite Member (4b)*; 3) a *Slumped Siltstone Member (4c)*; 4) a *Purple Siltstone Member (4d)*; and 5) a *Feldspathic Sandstone Member (4e).* Contacts between these members are conformable and gradational.

In this report, separate descriptions are given for each area in which the Gowganda Formation is exposed.

Chub Lake Area

In the Chub Lake area, the lowest exposed member of the Gowganda Formation is the *Rhythmically Laminated Argillite Member (4b)* at least 250 feet (76 m) thick. Member (4b) is best exposed at the east end of Chub Lake. The rock, a fine-grained argillite, weathers buff to light grey and is dark grey to greenish black on fresh surfaces. Fine laminations from 0.1 mm to 1 mm thick form rhythmically repeated couplets consisting of alternating dark grey and light, greenish grey argillite (Photo 1). Upward



ODM9404

Photo 1–Gowganda Formation, Rhythmically Laminated Argillite Member (4b) on the shore of Chub Lake, Rhythmic couplets of alternating dark grey and greenish grey argillite from 0.1 mm. to 1 mm. thick.

ODM9405

Photo 2–Gowganda Formation, Slumped Siltstone Member (4c) on the shore of Jobammageeshig Lake. Note slump balls of fine sand in siltstone.

in the member, silty material forms lenses interlaminated with argillite, also, the argillite couplets increase in thickness to about 1 cm to 2 cm until the rock is massive with no internal laminations. The proportion of siltstone and fine sandstone interbeds increases upward into the overlying *Slumped Siltstone Member (4c)* (Photo 2). The fine sandy laminations become 2.5 cm or more thick and form convolute laminations in the siltstone. As the laminations become progressively thicker, they appear to have slumped, and form prominent ball and pillow structures. This member is mappable, is about 150 feet (45 m) thick, and has been traced by Chandler (1973) into Casson Township.

The overlying member, the *Purple Siltstone Member (4d)* consists of pink to buff fine-grained greywacke to arkosic sandstone interbedded with purple and green argillite and siltstone. This member is best exposed on the shore of the southwest bay of Wakomata Lake. Argillite is dominant in the lower part of the member and occurs as cyclicly repeated units 2 cm to 13 cm thick (Photo 3). These cycles show flaser bedding consisting of interlaminated argillite and siltstone with fine- to medium-grained graded sand lenses which vary in thickness from approximately 1 mm to 7 mm (Photo 4). The sand lenses show well-developed ripple marks, ripple-cross-laminations, load casts, sole marks, flame structures (Photo 4) and microsedimentary dikes of fine sand in silt. As the thickness of the sandy lenses increases to about 1 foot (0.3 m), it can be seen that they represent sand waves. These structures appear as asymmetrical swells with an amplitude of 1 to 2 feet (0.3 to 0.6 m) in the bedding plane, and are internally cross-stratified. Towards the top of the member, the sandstone is feldspathic greywacke, also, the siltstone lenses become thinner until they form interbeds about 15 cm to 8 cm thick.

Pyrite, either as fresh cubes or weathered out pits around ½ to 2 mm in diameter, is disseminated throughout the member. No chalcopyrite was observed in the map-area, although Chandler (1973) and Frarey (1973) reported its presence in adjacent areas. Brown weathering or rusty calcareous spots or pits about 1 to ½ cm appear throughout the upper portion of the member. The greywacke becomes richer in hematite, and grades upward into the coarser grained *Feldspathic Sandstone Member (4e)*. Bedding increases in thickness to about 2 to 4 feet (0.6 m to 1.2 m) as the contact with the Lorrain Formation is approached. The feldspathic sandstone ranges from an arkose to a subarkose. It is pink, red, and grey, and weathers pinkish grey. Fine laminations accentuated by detrital hematite, sand waves, and ripples are observed towards the top of the member. The fine-grained sandstone is massive, and generally lacks sedimentary structures other than bedding.

Petrography

In thin sections of the *Rhythmically Laminated Argillite Member (4b)*, it can be seen that the clay laminae, ranging from 0.4 mm to 2.0 mm in thickness, consist of sericite and chlorite, and are interlaminated with 0.1 mm to 1 mm thick quartz-rich silt laminae. The clay laminae are massive, but the silt laminae commonly show grading from fine sand (0.2 mm) to silt (0.006 mm). The quartz grains are angular, and make up 40 percent of the silt lenses, with 10 to 15 percent feldspar. The remaining matrix is composed of sericite, chlorite, minor calcite and opaque minerals. Penecontemporaneous faulting can be seen in some thin sections.

The grain size in the *Slumped Argillite Member (4c)* ranges from silt (0.006 m) to fine sand (0.22 mm). The dark fine-grained massive argillite has more chlorite than the slump balls of pink fine sand.

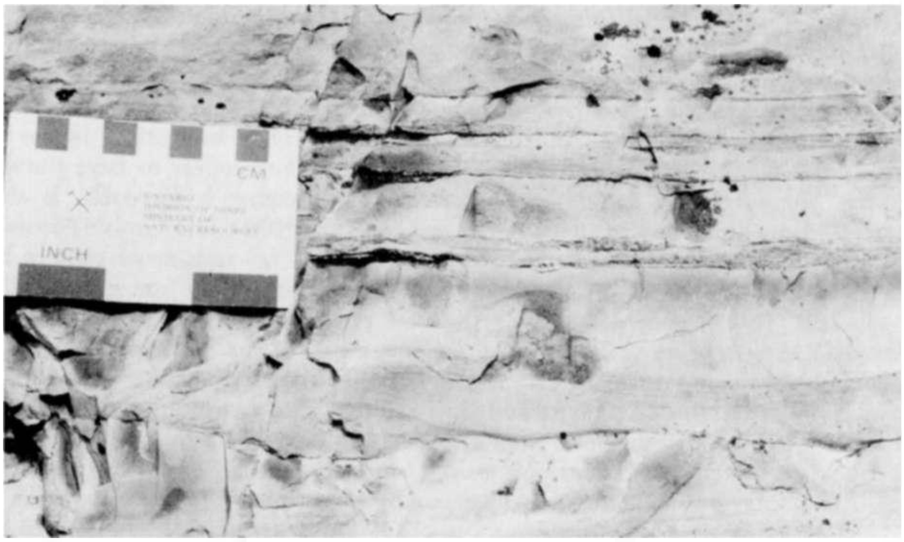


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Photo 3—Gowganda Formation, Purple Siltstone Member (4d) on the shore of Wakomata Lake. Interlaminated argillite and siltstone showing fine to medium grained sand lenses with well-developed ripple marks and ripple cross-laminations. The rock is bleached by water.

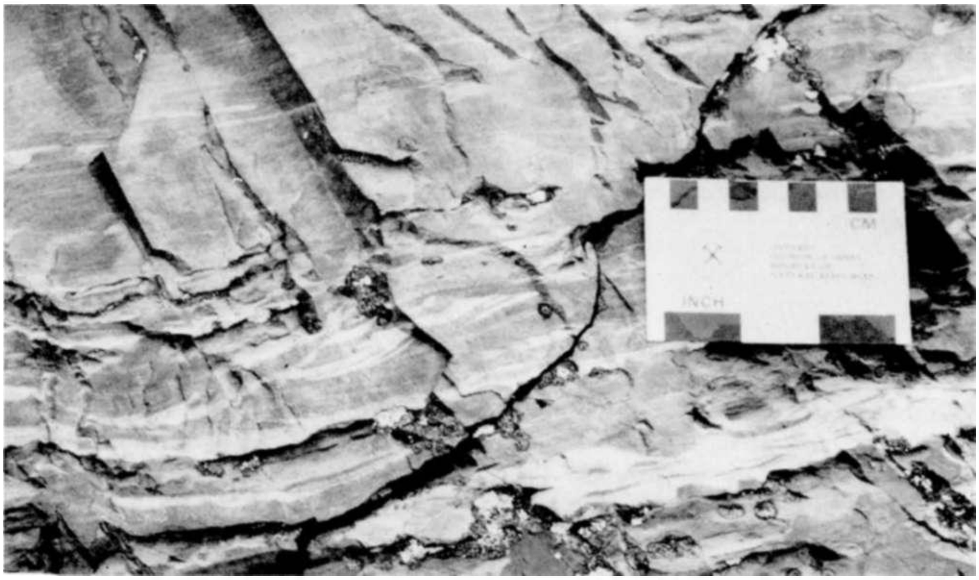

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Photo 4—Gowganda Formation, Purple Siltstone Member (4d) on the shore of Wakomata Lake. Load casts, ripples, and ripple cross-laminations can be seen in the sand lenses which are cut off by siltstone.

In the *Purple Siltstone Member (4d)*, the siltstone laminations range from 0.4 mm to 2 mm in thickness with grain size ranging from 0.01 mm to 0.2 mm. The fine sand layers contain angular to subrounded grains from 0.4 mm to 0.2 mm in size. Contacts between silt and sand layers are sharp. A few calcareous aggregates are present in these layers. The sandy layers tend to be discontinuous and graded. Detrital hematite grains become concentrated in laminations in the sandy layers. Ripple-drift cross-laminations show good grading in their individual foresets. Compositionally the rocks range from subarkose to arkose with a predominance of potassic feldspar over plagioclase. The matrix, forming about 10 percent of the fine sand layers, consists of sericite, chlorite, opaque minerals and minor carbonate. The greywacke is spotted with aggregates of carbonate, probably calcite, associated with chlorite. The rock is fairly well sorted with grain size ranging from silt (0.01 mm) to medium sand (0.5 mm) and averaging fine sand (0.2 mm).

The *Feldspathic Sandstone Member (4e)* is a fine-grained to medium-grained arkose with a grain size which varies from 0.08 mm to 0.05 mm, and averages 0.2 mm. The arkose is moderately sorted with subangular to subrounded grains. In some areas it is rich in detrital hematite. Typical modal analyses are given in Table 4. Plagioclase, which is less abundant than potassic feldspar, is often saussuritized. The sand is well cemented with sutured boundaries on the quartz grains. The matrix, composed mainly of sericite, forms about 10 to 15 percent of the rock. In some thin sections apatite was observed as an accessory mineral.

Caribou Creek Area

In the small fault block west of East Caribou Lake in the northern part of the map-area, a polymictic boulder orthoconglomerate, about 4 feet (1.2 m) thick consists of granitic boulders up to 1½ feet (0.4 m) in maximum dimension to pebble size about 1 inch (2.5 cm) across. The orthoconglomerate grades upward into a sequence consisting of paraconglomerate 4 feet (1.2 m) thick with poorly sorted clasts ranging from 1 foot (0.3 m) to 1 inch (2.5 cm) set in a massive mudstone matrix. The paraconglomerate contains discontinuous lenses up to 1 foot (0.3 m) thick of fine-grained argillite. Overlying the paraconglomerate is a 2-foot (0.6 m) thick laminated argillite sequence which grades upwards into a fine-grained pink feldspathic sandstone unit 3 feet (0.9 m) thick. This succession is repeated three times and the cumulative thickness is in the order of 30 feet (9 m). The contacts between sandstone units and the overlying orthoconglomerate units are erosional, and show prominent scour channels. The sequence is very similar to a modern point bar sequence of a meandering stream (Blatt *et al.* 1972).

In thin section, the conglomerate near the contact with the Early Precambrian granitic basement consists of a "debris" of mainly plutonic rock fragments and a lesser amount of volcanic rock fragments. The fragments and grains are subangular to subrounded and are coated with iron oxides. The matrix forms 40 to 60 percent of the rock and consists of sericite, chlorite, quartz, plagioclase, potassic feldspar, and opaque minerals. Plagioclase and potassic feldspar, are present in approximately equal proportions.

The overlying pink feldspathic sandstone is an arkosic greywacke composed of 40 percent feldspar, 20 to 30 percent matrix, and 40 percent quartz. Bedding in the

Table 4 MODAL ANALYSES OF THE ROCKS OF THE GOWGANDA FORMATION; WAKOMATA LAKE AREA.

SAMPLE NO.	S8-73-53	S6-73-98	D2-73-179	D2-73-180	D2-73-185	S8-73-63
Quartz	49.0	57.6	22.9	79.4	57.9	52.0
Plagioclase	36.1	11.0	3.8	....	....	11.3
Microcline	9.1[1]	16.8[1]	5.8	5.9	14.0	....
Orthoclase	....	....	....	12.4	24.3	15.0
Muscovite	....	0.3	....	tr	....	....
Sericite	....	....	....	2.3	....	....
Matrix	2.2	14.2	59.0	....	4.6	21.1
Heavy minerals	3.7	0.1	0.7	....	....	3.7
Pebbles	....	....	7.0[2]	....	....	....
Sorting	Poor	....	Very Poor	....	....	....
Roundness	Ang.	Subang.	Ang. Subang. Subrou.	Subrou.	....	....
Number of points counted	1000	1000	1000	1000	1000	1000

S8-73-53 – Arkose (4e) (Chub Lake Area)
S6-73-98 – Feldspathic sandstone (4e) (Chub Lake Area)
D2-73-179 – Feldspathic sandstone (Two Camp Creek Area)
D2-73-180 – Feldspathic sandstone (Two Camp Creek Area)
D2-73-185 – Arkose (Two Camp Creek Area)
S8-73-63 – Feldspathic sandstone (4e) (Chub Lake Area)

Abbreviations:
Ang – angular
Subang – subangular
Subrou – subrounded
.... Not detected
tr trace amount
Footnotes:
[1]Microcline or orthoclase
[2]Rock fragments

sandstone is 3 to 4 feet (0.9 to 1.2 m) thick with coarse-grained lenses alternating with very fine grained silty lenses. The matrix consists of feldspar, quartz, sericite and chlorite. Potassic feldspar, microcline and orthoclase, dominate plagioclase which tends to be more altered than the potassic feldspar.

Two Camp Creek Area

The Huronian outlier west of Rogers Lake consists of a sequence of paraconglomerate and sandstone. The paraconglomerate consists of poorly sorted, angular to subangular granitic and volcanic fragments in a greywacke matrix. The arkosic sandstone is composed of 40 percent microcline and orthoclase, 55 percent quartz and 5 percent sericite matrix. A modal analysis of the rock is given in Table 4.

LORRAIN FORMATION

The Lorrain Formation is 5,000 to 8,000 feet (1500 m to 2400 m) thick, composed of sandstone, and is widely exposed throughout the eastern part of the Southern Province in the North Shore of Lake Huron and in the Cobalt-Gowganda area (Card *et al.* 1972). Although the formation displays some lithological variations from one area to another, the general stratigraphic subdivision proposed by Young (1973, p.101-102), is generally applicable throughout the map-area. The scheme consists of: a) a lower sequence of varicoloured feldspathic and sericitic planar and crossbedded argillite siltstone and sandstone; b) a middle sequence of quartz and jasper granule and pebble conglomerate; and c) an upper sequence of pure orthoquartzite with subordinate quartz pebble conglomerate. The boundary with the underlying Gowganda Formation is conformable in all areas (Young 1973).

During the mapping project, no definite contact could be established as has been proposed by previous workers in other areas (Frarey in press; Young 1973; Wood 1969a and b; and Hadley 1968). The thin argillite unit, found in the Whitefish Falls area and used by Card (1969) and Chandler (1969) as the contact between the Gowganda Formation and the Lorrain Formation, is missing from the present map-area. Instead, a complete gradation exists upward in the succession from siltstone through interbedded siltstone and sandstone to feldspathic sandstone of the Gowganda Formation and sandstone of the Lorrain Formation over a stratigraphic interval about 100 feet (30 m) thick. Placement of the contact within this transition zone is quite arbitrary.

A thick coarse-grained arkose occurs in the basal member of the Lorrain Formation to the east and northeast in the Flack Lake and Rawhide Lake area, Robertson (1970) and Wood (1971). This arkosic unit has a maximum true thickness of 20 feet (6 m) in the map-area. Thin sections and X-ray diffraction analyses show that there is a drastic decrease in feldspar content from 30 percent in the arkose of the Gowganda Formation to 3 percent in the overlying sandstone of the Lorrain Formation (Tables 4 and 5). This decrease in feldspar is recognizable in the field, and is associated with a distinct colour change in the rock from the pink sandstone of the Gowganda Formation to the deep purple sandstone in the Lorrain Formation. The decrease in feldspar content and change in colour are considered by the author to indicate a change in depositional environment which will be discussed in a later part of the report. Mineralogical data are shown in Tables 5 and 6.

Since the arkosic part of the basal member is relatively thin, the author placed the contact between the two formations at the position where feldspar grains disappear and where there is a marked colour change in the rocks.

In the Wakomata Lake map-area the Lorrain Formation can be subdivided into six conformable lithostratigraphic members on the basis of different colour and pebble content. With some exceptions these members are similar to those of other workers (Frarey in press; Young 1973) in the region. The six members are in ascending stratigraphic order: *Basal Purple Sandstone Member (5a); Pink Hematitic Pebbly Sandstone Member (5b); Quartz, Jasper Pebble Conglomerate (Puddingstone) Member (5c); Fine-Grained Hematitic Sandstone Member (5d); Pink to Buff Pebbly Sandstone Member*

Table 5 MODAL ANALYSES OF THE ROCKS OF THE

Sample Number	SGr-73 223	SGr-73 224	SGr-73 225	SGr-73 227	SGr-73 228	SX-73 241	SX-73 242	SX-73 244
	5a	5a	5a	5a	5a	5c	5c	5c
Quartz	34.7	32.7	84.9	82.2	53.3	92.6	63.9[1]	89.0
Matrix (sericite-chlorite-kaolinite-pyrophyllite)	56.9	59.5	10.0	13.7	41.5	7.3	15.5	11.0
Chert	....	....	2.3	1.3	....	....	....	....
Muscovite	....	4.3	....	....	4.7	....	....	....
Heavy Minerals	6.5	3.5	....	....	0.5	....	....	....
Feldspar[2]	....	....	2.8[2]	2.8[2]	....	....	....	....
Diaspore	....	....	....	....	....	....	....	....
Pebbles	1.9	....	....	....	....	....	....	....
No. of points	1000	1000	1000	1000	1000	1000	1000	1000

Abbreviation:
.... Not detected

(5e); White Orthoquartzite Member (5f). Frarey (in press) combined members (5a) with (5b) and members (5d) with (5e). In this study (5d) was kept separate by the author because it is quite distinct. The rock is fine grained, contains no pebbles, and shows the development of liesegang rings. This member was used as a marker horizon by the author.

Stratigraphic sections of the Lorrain Formation were measured between Blinko Lake and Skirl Lake, and in the Grasett Lake area. The vertical cliff-faces of the cross section were measured by means of an 8-foot (2.4 m) long Jacob's staff divided into ¼-foot (7.6 cm) long intervals. The lengths on horizontal and sloping outcrop surfaces were measured by pacing, and the surface measurements were recalculated to vertical true thicknesses. In the Blinko Lake-Skirl Lake section a true thickness of some 3,000 feet (900 m) was recorded from near the top of member (5b) to member (5f) (Photo 5). The top of the formation was not reached. In the Grasett Lake section, a true stratigraphic thickness of some 300 feet (90 m) was measured in members (5a) and (5b). The true thickness of (5b) could not be measured because of poor exposure.

Basal Purple Sandstone Member (5a)

The lowermost member of the Lorrain Formation consists of red and purple sandstone, and has a thin arkosic sandstone at its base. A true thickness of 180 feet (55 m) was measured in the cross section at Grasett Lake. The contact with the underlying

LORRAIN FORMATION; WAKOMATA LAKE AREA

SX-73 246	SX-73 247	SX-23 248	SX-73 250	SX-73 252	SX-73 257	SX-73 259	SX-73 260	S2-73 186	S2-73 201
5d	5d	5d	5e	5e	5e	5e	5e, f	5f	5f
74.9[1]	71.0	83.3	81.3	77.0	86.0	86.5	90.0	89.0	79.8
24.4	29.0	16.9	18.1	14.6	10.6	8.2	9.3	11.0	20.2
....	....	....	....	....	3.4	....	....	....	....
....	....	....	....	....	....	....	0.7	....	....
....	....	....	0.6	0.6	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....
0.7	....	1.2	....	2.4	....	3.1	....	....	....
....	....	....	....	5.5	....	....	....	....	....
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Footnotes:
[1]Quartz, jasper, and chert
[2]Feldspar is undetermined

Gowganda sandstone was placed at the sharp colour change from pink to purple as discussed earlier in the report. The colour of the sandstone in this member varies from deep red to deep purple at the base to a pinkish red at the top. Sorting is poor and grain size ranges from coarse at the bottom to medium at the top. Massive beds range the thickness from 1 foot (0.3 m) at the bottom of the member to 4 feet (1.2 m) at the top; the average bedding thickness is about 2 feet (0.6 m).

The basal portion of this member contains up to 30 percent fresh pink feldspar grains in association with the coarse-grained fraction of the beds. The feldspar disappears rapidly over a maximum horizontal distance of 100 feet (30 m).

The sandstone is interbedded at irregular intervals with red and green, fine-grained sandy siltstone interbeds about ½-foot (15 cm) to 1-foot (0.3 m) thick. Graded crossbedding in individual foresets, small and large scale troughs, and ripple marks form some of the sedimentary structures observed. Pebbles which occur only in the coarser part of the beds do not form layers, but are scattered throughout the beds, and can be described as 'floating'. The pebbles are small (½ to 1 cm; 0.2 to 0.4 inch) and consist mainly of white quartz and less than 1 percent jasper.

Pink Hematitic Pebbly Sandstone Member (5b)

This member is medium-grained to coarse-grained pebbly sandstone and was measured to be at least 120 feet (37 m) thick. The contact with the underlying member (5a) was

Table 6 GRAIN SIZE ANALYSES OF THE SANDSTONES OF

LORRAIN GRAIN SIZE		SX-73 260	SX-73 259	SX-73 257	SX-73 252	SX-73 250	SX-73 248	SX-73 247
Range (mm)	Min.	0.04	0.10	0.10	0.02	0.10	0.10	0.10
	Max.	1.60	1.60	1.20	8.00	2.00	3.80	2.40
Average Size (mm)		0.54	0.61	0.43	0.52	0.43	0.58	0.39
Maximum No. of grains of a given size		13 0.3 mm	17 0.5 mm	29 0.2 mm	11 0.3 mm	20 0.2 mm	23 0.2 mm	30 0.2 mm
Distribution		Unimodal	Polymodal	Unimodal	Bimodal	Unimodal	Polymodal	Bimodal
Number of Grains		100	100	125	82	96	110	100
Formation		5e, f	5e	5e	5e	5e	5d	5d
Classification (Wentworth) on basis of range and average		Med.-Cse. Sand	Med. Sand	Med. Sand	Med. Sand-Cse. Sand	Med. Sand-Cse. Sand	Med.-Cse. Sand	Med.-Cse. Sand
Sorting		Poor	Fair	Moderate	Poor	Moderate	Poor	Fair
Roundness		Subrou.-Subang.	Subrou.-Subang.	Subrou.-Subang.	Ang.-Subang.	Subang.	Subrou.-Well Rou.	Subrou.-Subang.

Abbreviations:
Subrou.—Subrounded; Subang.—Subangular; Ang.—Angular; Rou.—Rounded; Cse.—Coarse; Med.—Medium; No.—Number.

placed at the base of the first pebble layer which coincides approximately with a change in colour of the sandstone from deep red to pink. The colour of the sandstones of this member varies from pink to greyish white at the top. Bedding ranges in thickness from 2 feet (0.6 m) to 4 feet (1.2 m), with some beds near the top reaching 6 feet (1.8 m). Some beds show graded bedding; others show prominent trough (Photo 6) and planar crossbedding. Ripple laminations, some of which are accentuated by detrital hematite concentrations, convolute laminations, and scour channels are present throughout this member. Crossbeds are about ½-foot (15 cm) thick and are best developed in the upper part of the member. Interbeds of medium- to fine-grained greenish to red, gritty, muscovitic sandstone still persist in the lower half of the member. These interbeds range in thickness from ½-foot (15 cm) to 1 foot (30 cm) and exhibit a sugary texture reflecting their relatively good sorting.

Pebble layers appear for the first time in this member (Photo 7). In the middle and upper parts of the member the pebble layers range in thickness from ½-inch (1.2 cm) to ½-foot (15 cm) and are repeated about every vertical foot. Floating pebbles occur in the sandstone isolated from pebble layers. Pebbles in the layers are subrounded to subangular and range from ½ cm to 6 cm, averaging around 3 cm. The pebbles of these layers consist of 90 percent white quartz with up to 10 percent jasper and minor

THE LORRAIN FORMATION; WAKOMATA LAKE AREA.

SX-73 246	SX-73 244	SX-73 242	SX-73 241	SGr-73 210	SGr-73 232	SGr-73 228	SGr-73 225	SGr-73 224
0.10	0.10	0.10	0.20	0.05	0.1	0.02	0.1	0.02
0.80	0.70	6.40	0.90	11.40	2.8	0.76	1.6	0.56
0.39	0.35	0.58	0.42	1.04	0.85	0.23	0.54	0.08
22	35	22	35	7	11 11	13	17	30
0.3 mm	0.3 mm	0.3 mm	0.4 mm	0.2	0.8 1.2	0.08	0.6	0.08
Unimodal	Strongly Unimodal	Polymodal	Strongly Unimodal	Weak Polymodal	Polymodal	Bimodal	Weak Polymodal	Polymodal
100	100	100	100	40	100	100	100	100
5d	5c	5c	5c	5c	5b	5a	5a	5a
Med. Sand	Med. Sand	Med.-Cse.-Very Cse. Sand	Med. Sand	Med. Sand-Pebbly Sandstone	Cse. Sand	Fine Sand	Med. Cse. Sand	Fine Sand
Good	Good	Poor	Well Sorted	Very poor (none)	Poor	Well Sorted	Fair	Fair
Subrou.-Well Rou.	Subrou.-Subang.	Subang.-Well Rou.	Subrou.	Subang.-Subrou.	Subang.-Well Rou.	Ang.-Well Rou.	Subrou.-Subang.	Ang.

pebbles of iron formation, black chert, sandstone, and argillite. The jasper pebble content increases from 1 percent at the bottom of the member to 10 percent at the top, averaging generally 5 percent. Chert pebbles are more rounded than quartz pebbles. In some locations such as on the east shore of Wakomata Lake, the chert and jasper pebbles are weathered out in the centres. Frarey (in press) identified kaolinite in these alteration patches. A typical cross section is shown in Figure 2.

Quartz-Jasper Pebble Conglomerate (Puddingstone) Member (5c)

This member which contains abundant jasper pebble conglomerate (Photo 8), is probably best known for its ornamental beauty, and has the local name of Puddingstone. It is exposed around Deadtree Lake, Swamp Island Lake, Puddingstone Lake, and west of McGrath Lake. The exposure on top of the hill west of McGrath Lake is the only easily accessible area from Wakomata Lake. The contact zone between members (5b) and (5c) is gradational and consists of interbedded sandstone and conglomerate over a true thickness of 50 to 100 feet (15 to 30 m). The lower contact of (5c) was arbitrarily placed at the base of the appearance of the first white sandstone bed. The thickness of this member was measured at 210 feet (64 m). The sandstone of member (5c) is pre-

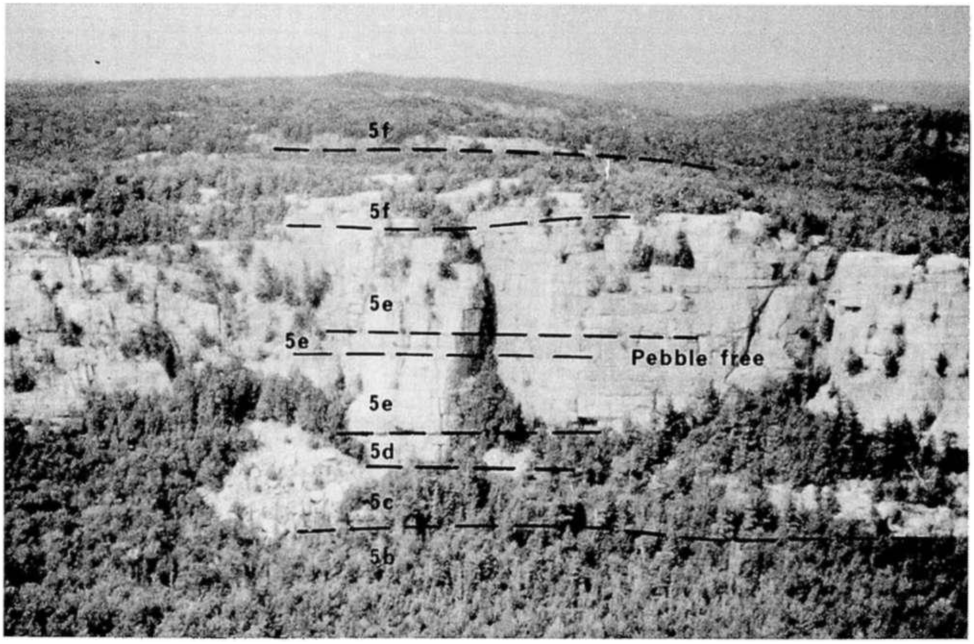

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Photo 5–Cliff composed of Lorrain Formation at Blinko Lake where detailed stratigraphic section was measured. Contacts between the different members of the Formation from 5b to 5f are shown.

dominantly white, but ranges from greenish pink to white to slightly pink. Sandstones in the lower 80 feet (24 m) of the member are commonly pinkish white, those in the central part are greenish white to white, and the upper part are slightly pink. The member is notably conglomeratic, although in the lower part the pebble content is rather low. The main conglomerate part, about 55 feet (17 m) thick, occurs in the upper half of the member. Pebbles in the lower part of the member are arranged in single pebble layers from ½ inch (1.3 cm) to 1 inch (2.5 cm) thick. In the conglomeratic part, the pebble layers range in thickness from 3 inches (8.6 cm) up to 3 feet (0.9 cm). These layers consist of poorly sorted angular to subrounded pebbles ranging from ½ inch (1.3 cm) to 2½ inches (6.35 cm) in maximum dimension and average approximately 1 inch (2.5 cm). Where distinct conglomeratic layers are absent, the pebbles either form a paraconglomerate composing 5 to 10 percent of the bed, or if they form 1 percent to 2 percent of the sandstone bed then they are considered to be 'floating'. Most of the pebbles are quartz with jasper pebble content ranging from 1 percent to 10 percent. However, the conglomeratic layers consist of: 10 to 40 percent angular to rounded jasper pebbles; 5 to 10 percent subrounded iron formation pebbles; 10 to 15 percent subrounded black and pink chert pebbles; subrounded white quartz, and minor amounts of pebbles of smoky quartz, agate, pink sandstone and argillite. Some conglomeratic beds display size grading with larger pebbles at the bottom to smaller pebbles at the top.

Bedding thickness ranges from 1 foot (0.3 m) to 6 feet (1.8 m), and averages approximately 4 feet (1.2 m). Bedding is lenticular and discontinuous. Green gritty

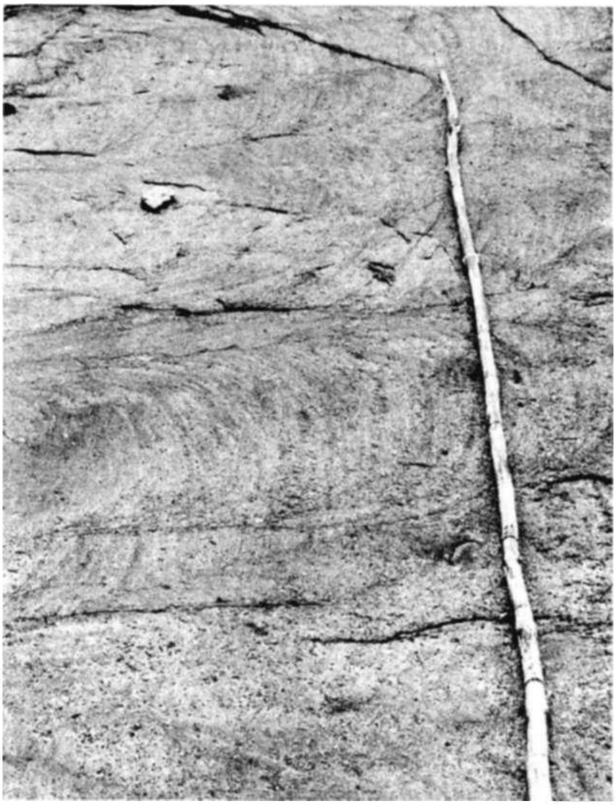

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Photo 6–Lorrain Formation, Pink Hematitic Pebbly Sandstone Member (5b). Photo shows prominent trough crossbedding shown in the photo from the upper part of the member.

sandstone partings up to 1 inch (2.5 cm) thick occur irregularly in the lower part of this member. Sedimentary structures include crossbedding at the bottom and the top of the member as well as ripple marks and scour and fill channels. Graded beds are present throughout the sequence. Matrix to pebble ratio varies from 80:20 in the lower part of the member to about 30:70 in the middle conglomeratic part, and back to 80:20 at the top. In the upper 45 feet (13.7 m) of the member, the sandstone is better sorted and finer grained. Discrete conglomerate layers are present. The beds are wedge shaped and display coarse parallel laminations and crossbedding. A typical cross section is shown in Figures 3 and 4.

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Photo 7–Lorrain Formation, Pink Hematitic Pebbly Sandstone Member (5b). Quartz pebbles are arranged in irregular layers interbedded with hematite-rich layers.

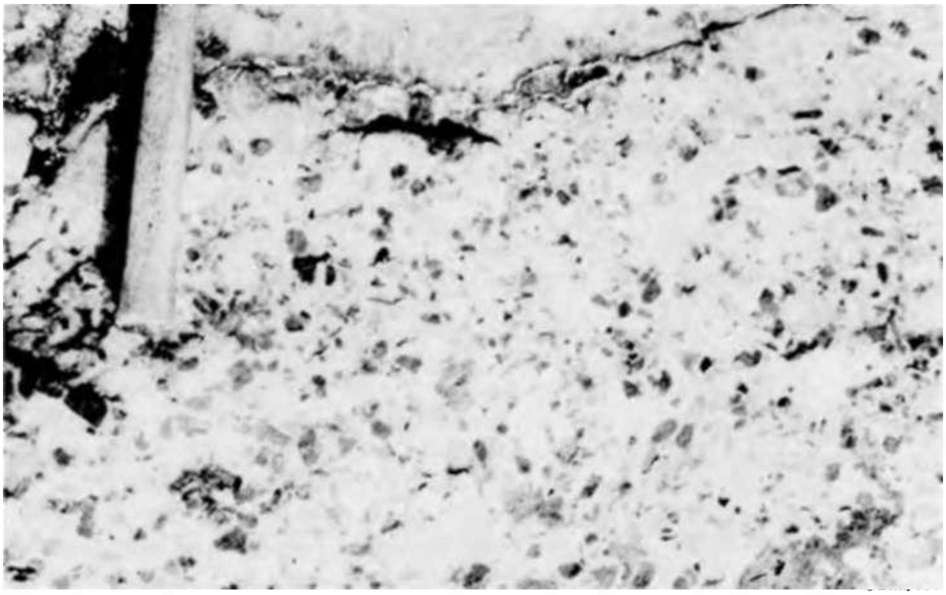


Photo 8–Lorrain Formation, Jasper Pebble Conglomerate Member (5c). Typical conglomeratic bed of Puddingstone with about 25% Jasper and 75% Quartz pebbles.

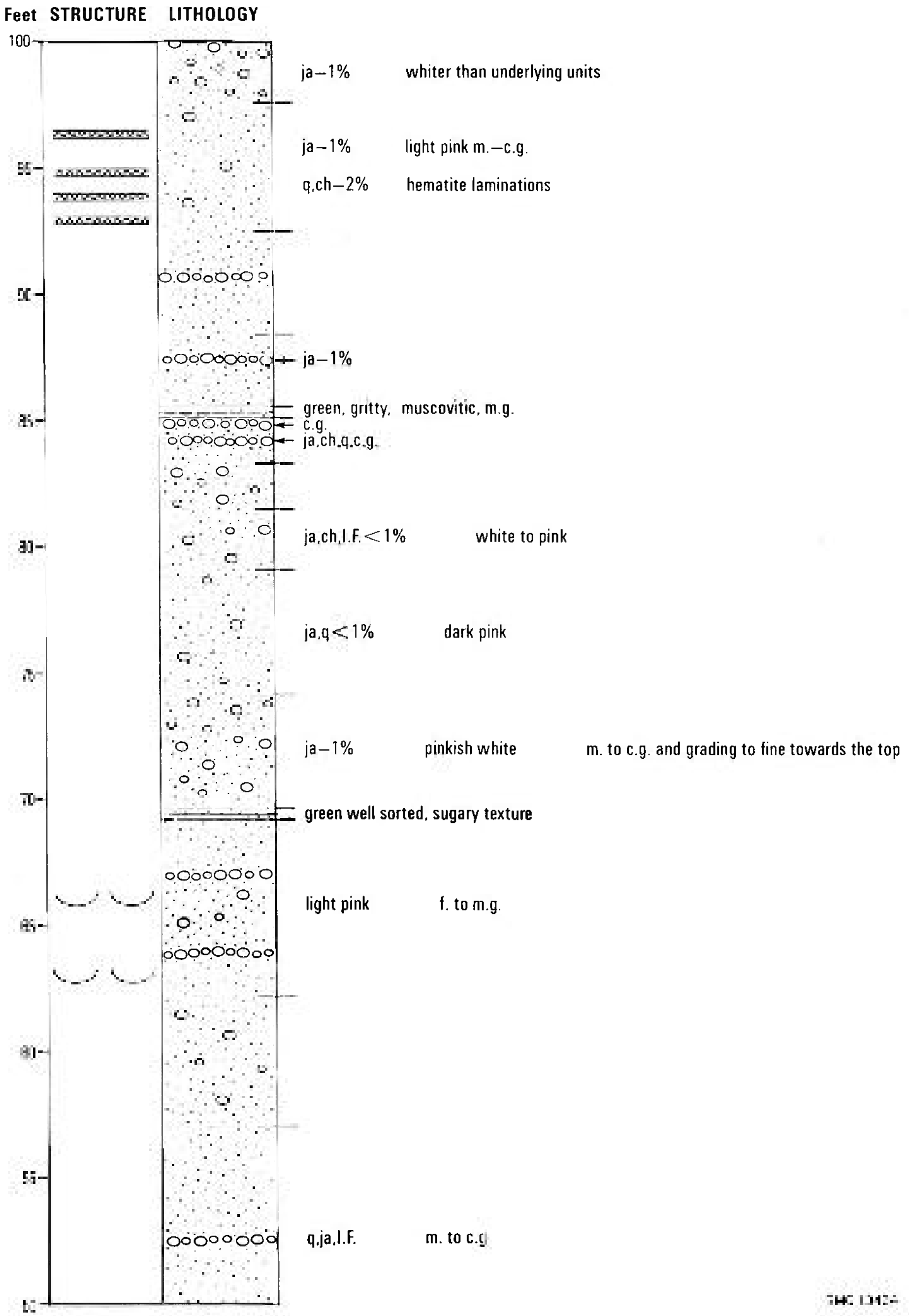


Figure 2–A representative measured cross-section of Member (5b) of the Lorrain Formation, Wakomata Lake Area. For symbols see Legend on page 41.

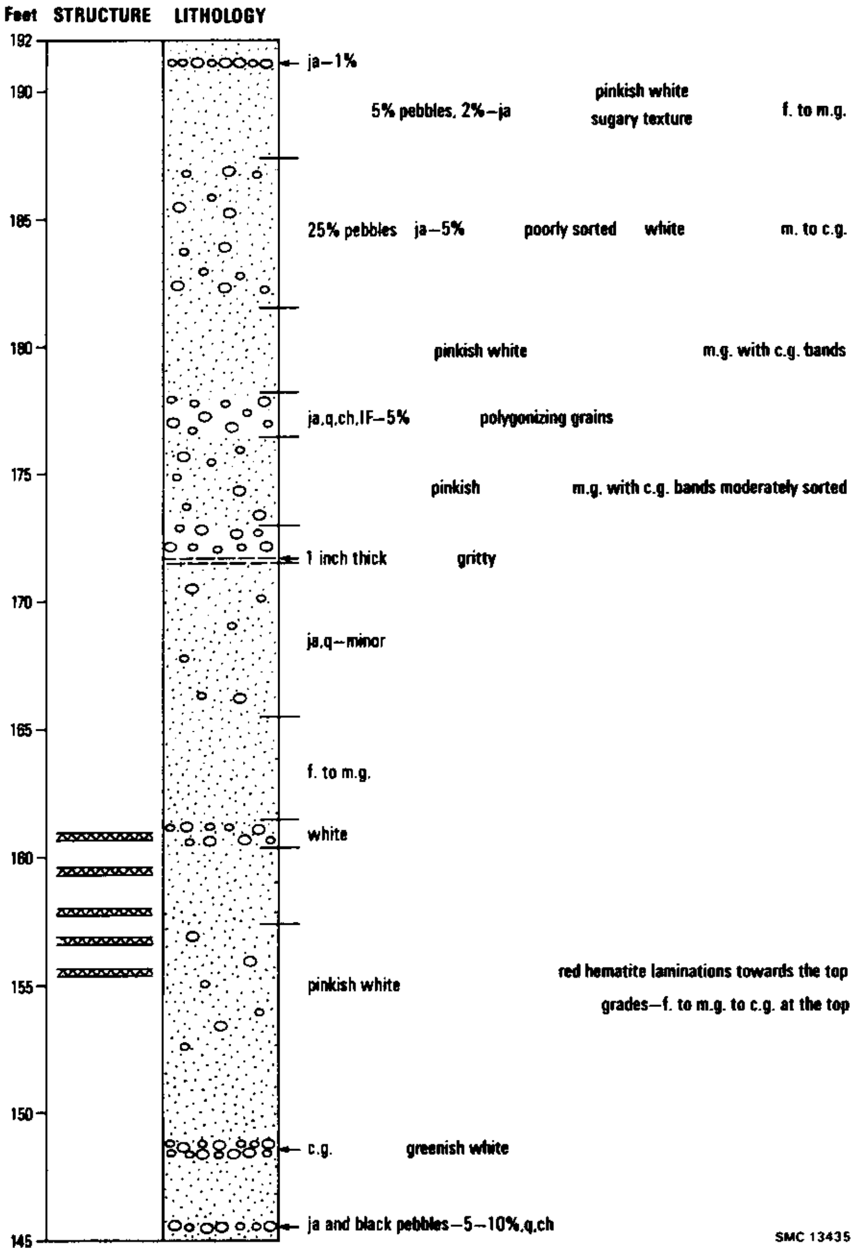


Figure 3–A representative measured cross-section of Member (5c) of the Lorrain Formation, Wakomata Lake Area. For symbols see Legend on page 41.

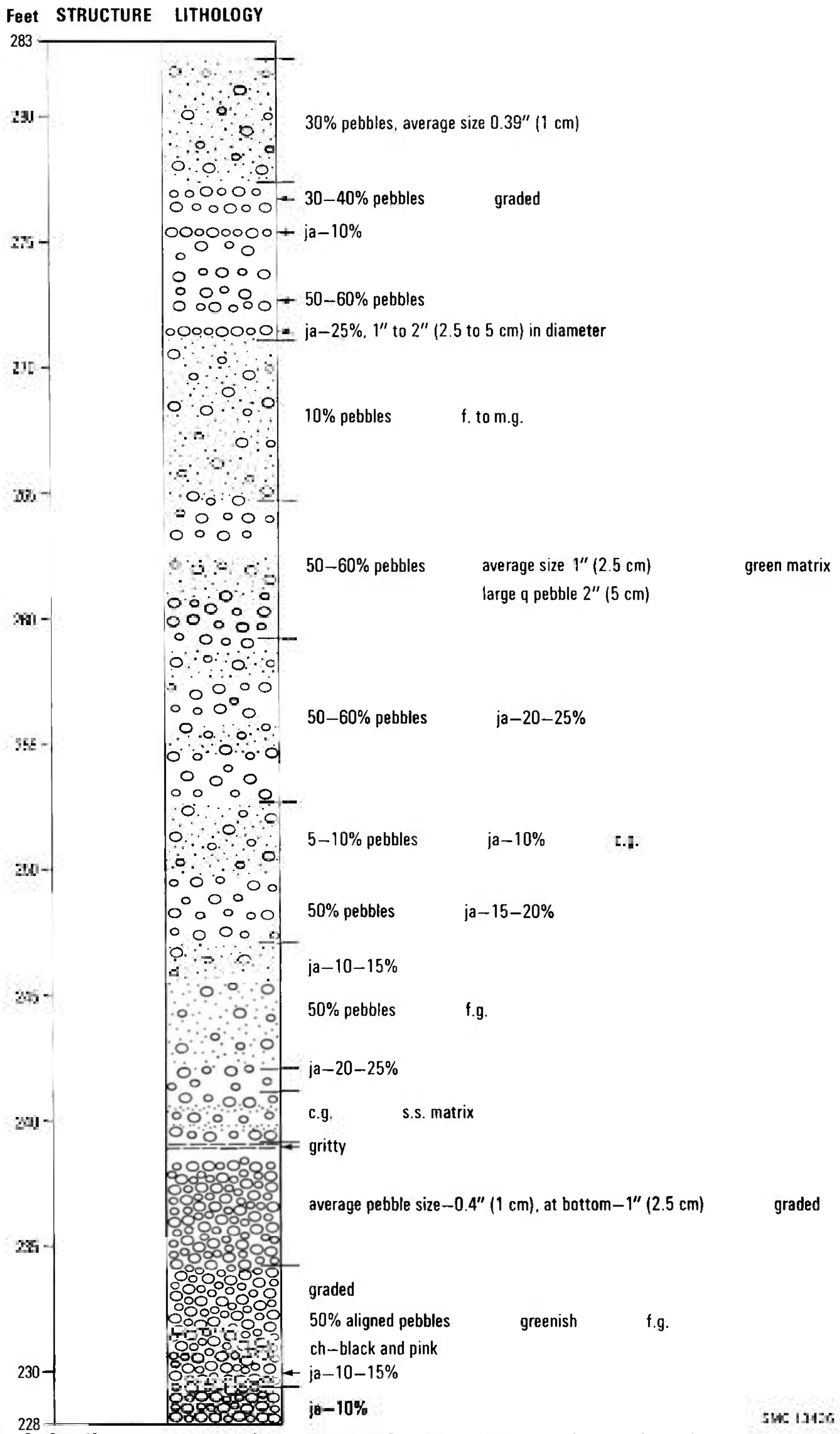


Figure 4–Another representative measured cross-section of Member (5c) of the Lorrain Formation, Wakomata Lake Area. For symbols see Legend on page 41.

Fine-Grained Hematitic Sandstone Member (5d)

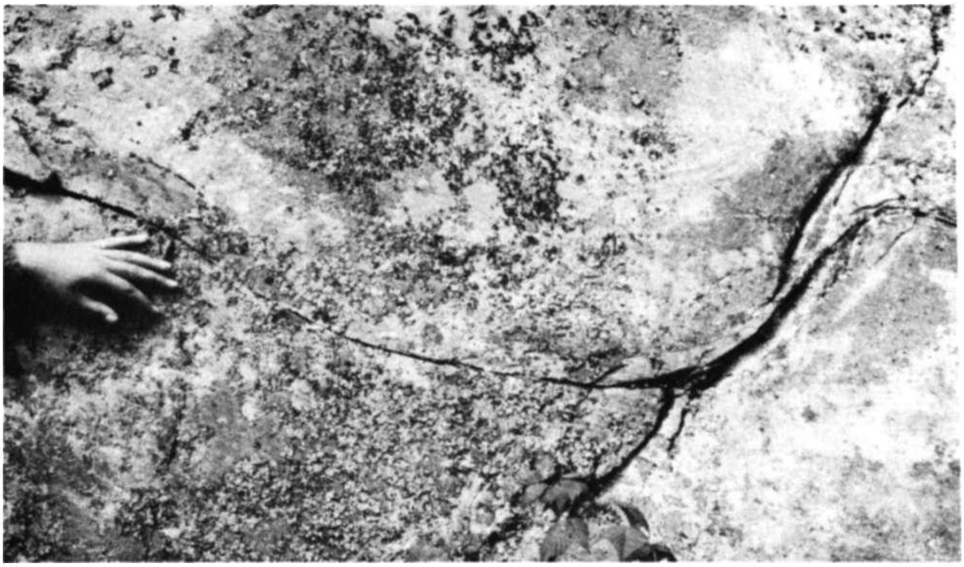
This member is characterized by the almost complete absence of pebbles and is useful as a marker horizon. It is approximately 100 feet (30 m) thick and consists of sandstone variously coloured in shades of pink, red, orange, creamy buff, and white. The sandstone is fine grained to medium grained, and has a sugary texture with moderate to well-sorted grains. Beds tend to be wedge shaped and discontinuous. Some interbeds in the lower part of the member contain 1 percent 'floating pebbles' of jasper and quartz which are absent in the rest of the member. The sandstone is mostly massive, but in some beds structures such as trough crossbedding, ripple laminations accentuated by hematite concentrations, scour and fill channels (Photo 9) and leisegang rings (Photo 10) are present. In some areas, strange concentric features were noted that resemble 'stromatoforms' (Photo 11). Hematite is abundant and is concentrated in layers, or in purple coloured patches, or as coating on quartz grains. A few 1 inch (2.5 cm) gritty sandstone interbeds are still present. A typical cross section of the member is shown in Figure 5.

Pink to Buff Pebbly Sandstone Member (5e)

This member is similar to member (5b) except that it is coarse grained and has a lower amount of jasper pebbles. The contact between members (5e) and (5d) was placed at the base of the reappearance of the first pebble layer. Member (5e) is approximately 1,400 feet (430 m) thick, and in consequence is the second thickest member of the Lorrain Formation in this area [map-area]. The sandstone is pink, buff, grey, cream, and white at the top. The member is relatively coarse grained except at the bottom where it is interbedded with pebble-free hematite-rich crossbedded sandstone. The bottom 70 feet (20 m) of the member consists mainly of sandstone with 'floating' quartz granules about 1 cm (0.4 inches) in diameter. The next 60 feet (18 m) comprises pebble free, very hematite rich, crossbedded sandstone. Crossbeds are from 1 to 2 feet (0.3 to 0.6 m) thick and both festoon and planar types are present. The rest of this member consists of sandstone some of which has pebble layers, black hematitic laminations, and 'floating' quartz and jasper pebbles.

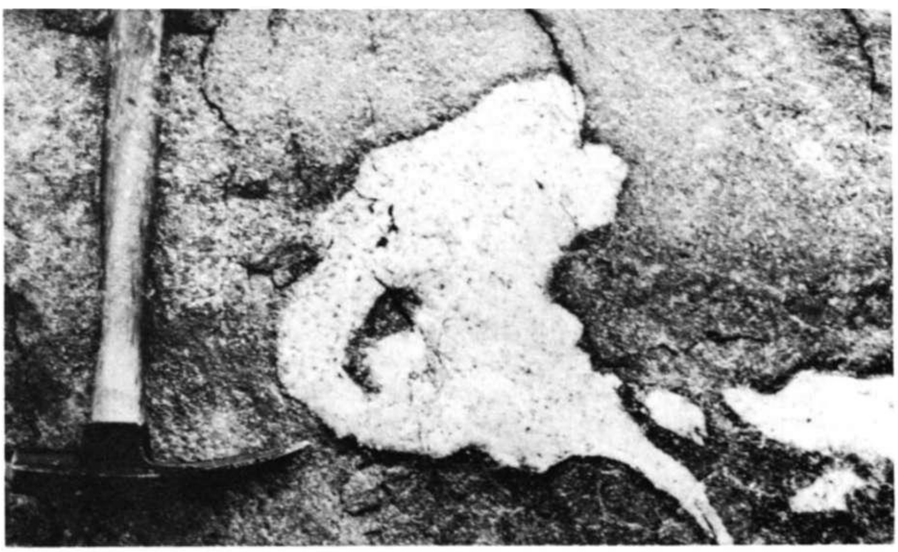
Bedding thickness ranges from 2 (0.6 m) to 6 feet (1.8 m) and averages about 4 feet (1.2 m). Trough crossbedding with graded foresets, festoon and planar crossbedding, and ripple laminations are some of the sedimentary structures observed in the field. Gritty sandstone interbeds 1 to 2 inches (2.3 cm to 5.1 cm) thick are still present. The pebble layers range in thickness from ½ foot (15 cm) to 3 feet (0.9 m) in the middle and upper parts of the member. Most pebbly layers are lensoid and discontinuous. 'Floating' quartz and jasper pebbles are present throughout the sequence where no discrete pebble layers are present.

Pebbles are concentrated in the coarse-grained fraction of the beds, or are associated with black hematite laminations (Photo 12). The overall pebble content averages about 30 percent and the pebbles consist mainly of 90 percent white quartz with as much as 5 percent pink chert. Jasper pebbles are present in amounts of 1 percent to 5 percent, and locally up to to 10 percent in some areas. The pebbles range from 1 inch (2.5 cm) to 5 inches (12.7 cm) in diameter and average about 3 inches (7.6 cm). Floating pebbles are a minimum of 4 mm (0.2 inch) in diameter and average about 1 cm (0.4 inch).



ODM9412

Photo 9–Lorrain Formation, Fine-grained Hematitic Sandstone Member (5d). Note scour and fill channel.



ODM9413

Photo 10–Lorrain Formation, Fine-grained Hematitic Sandstone Member (5d). Note Liesegang Ring.

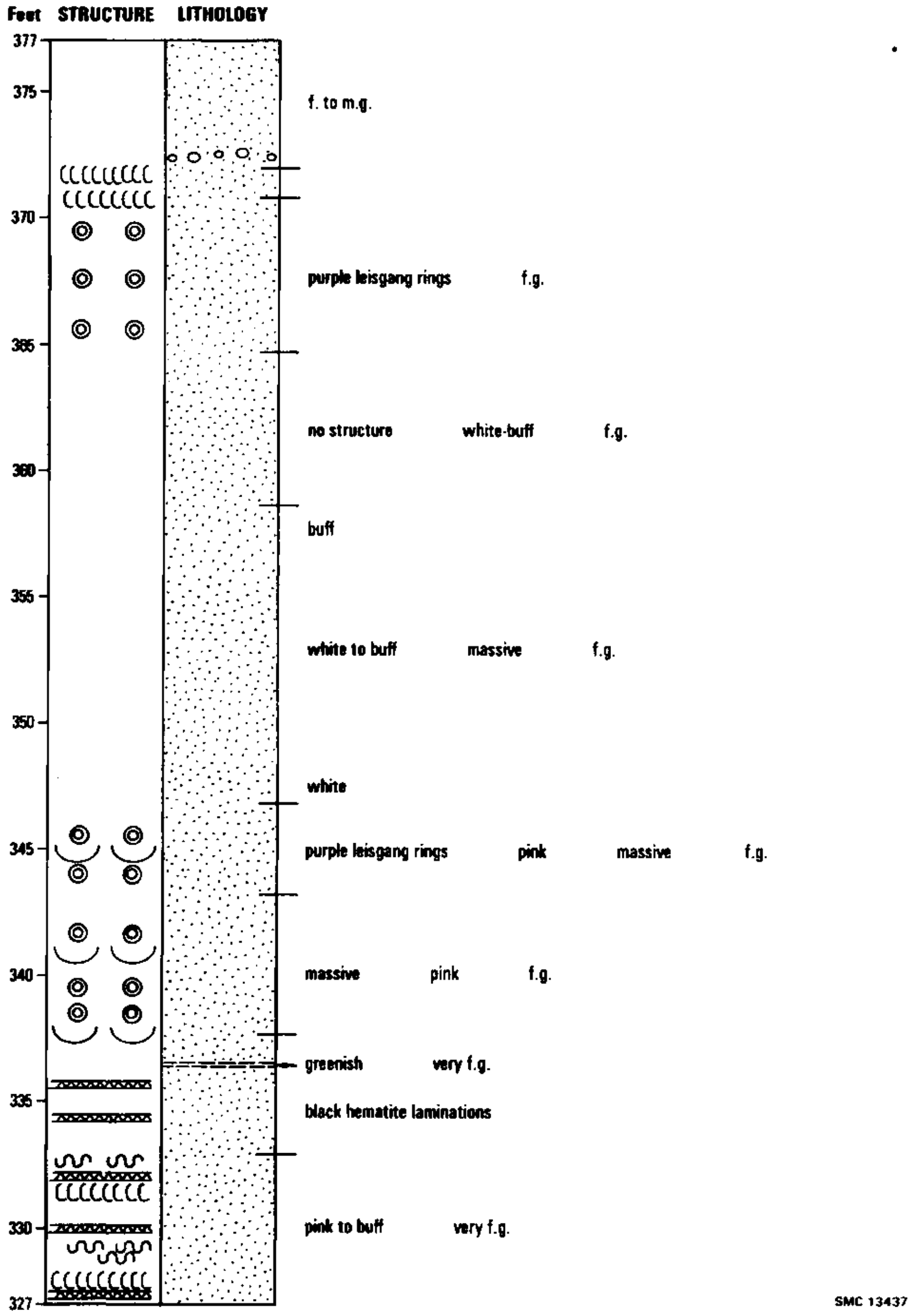


Figure 5—A representative measured cross-section of Member (5d) of the Lorrain Formation, Wakomata Lake Area. For symbols see Legend on page 41.

ODM9414

Photo 11–Lorrain Formation, Fine-grained Hematitic Sandstone Member (5d). Note concentric features on bedding plane surface resembling 'stromato forms'.

Jasper pebbles disappear towards the top of the member and only white quartz pebbles remain. A typical cross section is shown in Figure 6.

White Orthoquartzite Member (5f)

The white orthoquartzite member, the uppermost member of the Lorrain Formation exposed in the map-area, has a minimum thickness of 1,500 feet (460 m) as measured in the Skirl Lake area. This member can be distinguished from member (5e) on the basis of colour, which is white to creamy white, and the minor (less than 1 percent) jasper pebble content. Three distinct units were noted in this member; a lower conglomeratic submember, a middle pebble free submember, and an upper conglomeratic submember.

The pebble free member is fine to medium grained with a sugary texture. In some areas, beds are sheared and slicken sides can be observed on bedding plane surfaces. A greasy, dull, talc-like mineral coats these surfaces. X-ray diffraction analysis identified this mineral as a mixture of pyrophyllite and kaolinite.

The conglomeratic submembers consist of pebble layers ranging in thickness from approximately 3 inches (7.6 cm) to 1 foot (0.3 m). These layers consist predominantly of rounded white quartz pebbles with less than 1 percent jasper pebbles, and up to 5 percent cherty quartz pebbles. Iron formation pebbles were rarely observed. The pebble layers are lensoid, discontinuous, and consist of 50 to 60 percent pebbles which are well sorted and rounded and range in diameter from 1 cm (0.4 inch) to 1½ inches (3.8 cm), and average about ½ inch (1.3 cm). Bedding thickness averages 3 feet (0.9 m) with maximum thickness of 8 feet (2.4 m). Where pebbles are absent, good crossbedding

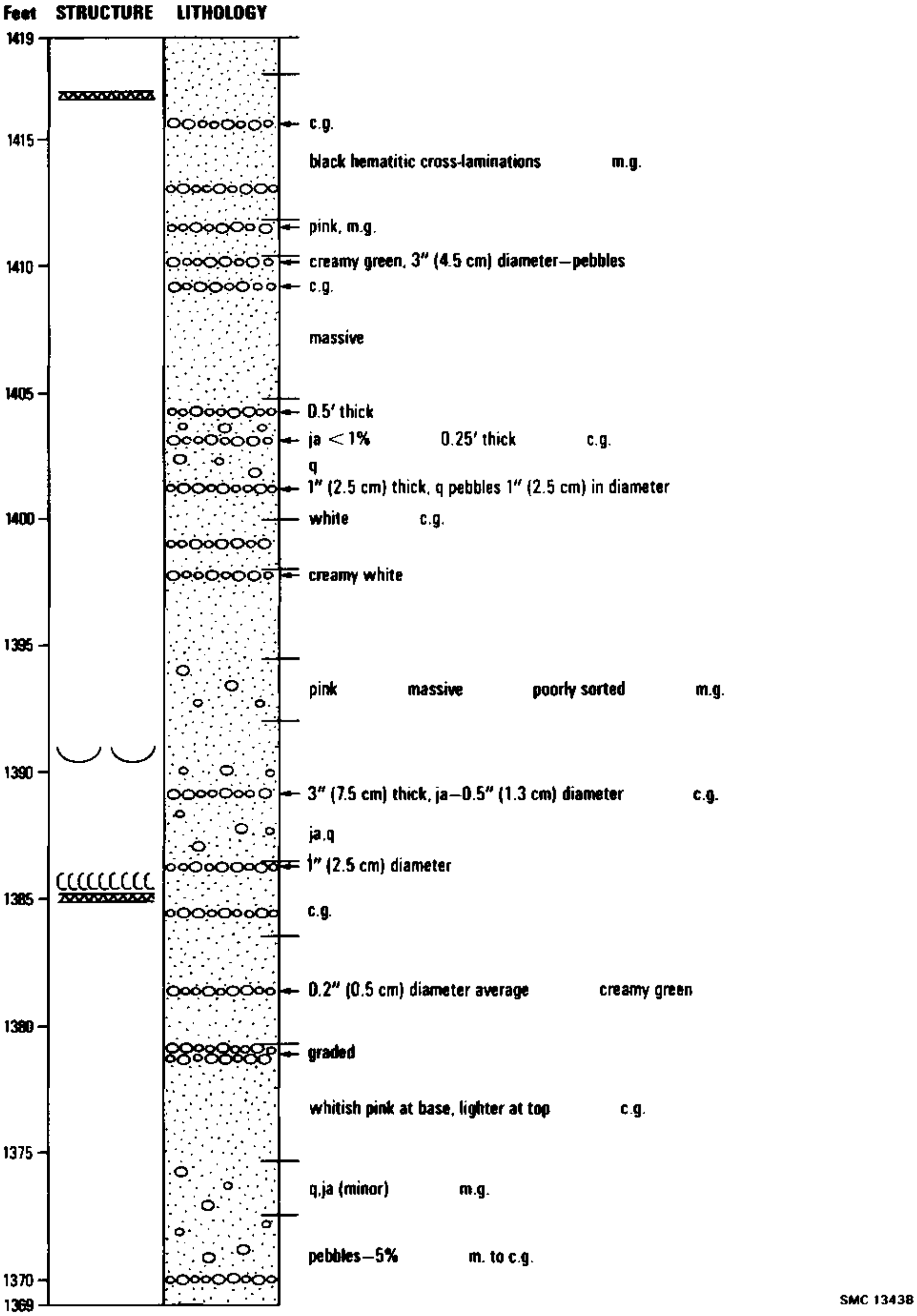
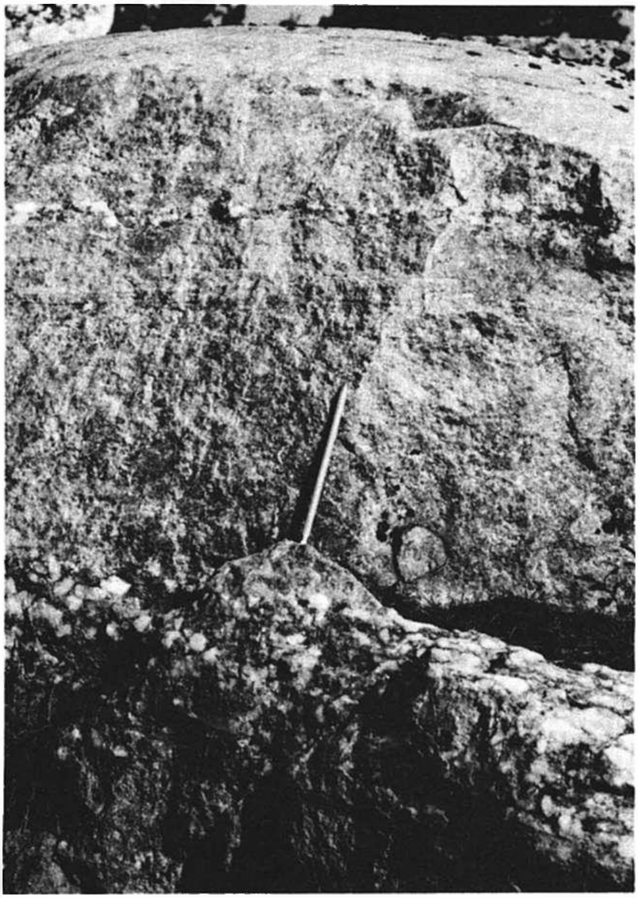


Figure 6–A representative measured cross-section of Member (5e) of the Lorrain Formation, Wakomata Lake Area. For symbols see Legend on page 41.



ODM9415

Photo 12–Lorrain Formation, Pink to Buff Pebbly Sandstone Member (5e). Photo shows a tranverse bar with fining upward bed. Sharp contact can be seen between the coarse pebbly layer and the underlying fine-grained sandstone with planar laminations.

(festoon and planar) is present. Minor amounts of hematite form faint purple layers, and are still present in some areas as are ripple marks and scour and fill channels. A typical cross section is shown in Figure 7.

Petrography

In thin section, the sandstones of the Lorrain Formation show a progression in textural maturity from the bottom to the top of the formation (Table 6). Sandstones of the lower members (5a), (5b), and (5c) have open frameworks. Sorting and rounding of the grains

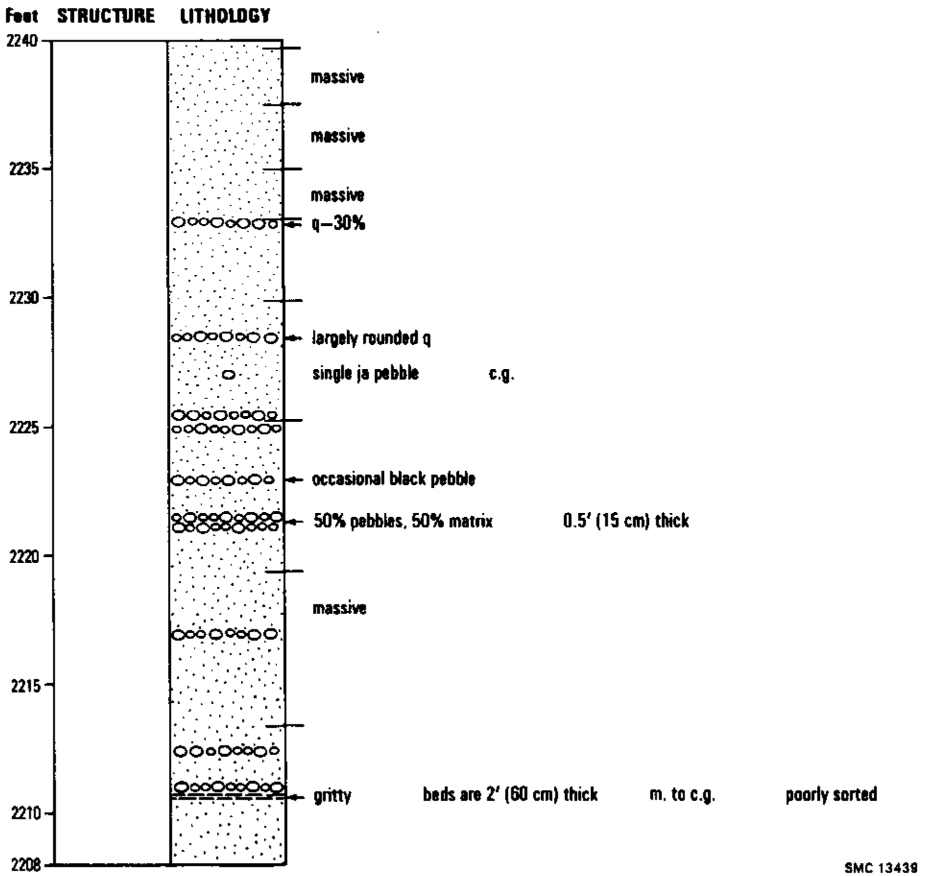


Figure 7—A representative measured cross-section of Member (5f) of the Lorrain Formation, Wakomata Lake Area. For symbols see Legend on page 41.

are better as the matrix decreases in amount from a maximum of 56 percent in the basal member to 7 percent in the top member. Grain size varies from member to member (Table 6) and distribution patterns range from unimodal, bimodal, and multimodal. The sandstone is composed mostly of quartz grains displaying prominent overgrowths except in the top member (5f). Smaller quartz grains with no overgrowths are more angular than the larger grains. Hematite is present throughout the sequence either as detrital grains in the matrix, or as a coating on individual quartz grains, giving the sandstone its characteristic red to pink colour. The matrix consists mainly of sericite, kaolinite and quartz. Chlorite occurs only in member (5a) where individual foresets in crossbeds are graded, the coarse-grained fraction contains more matrix than the fine-grained portion. The fine-grained fraction shows a higher degree of sorting and rounding than the coarse-grained fraction. Chert pebbles and grains are partially altered to kaolinite. In members (5a) and (5b), a few grains of feldspar and mineral pseudomorphs after feldspar can be observed. The feldspar is altered to sericite and kaolinite. Pyrophyllite and diaspore, identified by an X-ray diffraction method, first appear at the bottom of member (5d) and disappear at the bottom of member (5f). These aluminous minerals occur in interstitial patches between the quartz grains. Diaspore occurs as porphyroblasts partly altered to pyrophyllite and in places rims quartz grains. Pyrophyllite forms lath-shaped patches interstitial to quartz grains, and forms from the reaction of diaspore and kaolinite with quartz under conditions of low greenschist facies metamorphism. It can be associated with diaspore, kaolinite, or can occur by itself. The diaspore and kaolinite are probably authigenic as is discussed later in the report. Chandler (1969), Young (1973) and Wood (1970) give detailed discussions of these minerals.

Mafic Intrusive Rocks (Nipissing Diabase)

The Nipissing Diabase forms dikes, irregular bodies and sills. Nipissing Diabase is erosion resistant and the larger bodies form prominent ridges. The bodies are irregular in outline and average about 1 mile (1.6 km) in diameter. All of the bodies are magnetically responsive, especially the intrusion around Rowe Lake which gives rise to a circular aeromagnetic anomaly (Aeromagnetic Map 2227G; ODM-GSC 1963). The dikes are generally fine grained, about 100 feet (30 m) thick, and can be traced for only short distances. Exceptions are, the dikes passing through Blinko Lake and the dike north of Threecorner Lake which are about 400 feet (120 m) thick, coarse grained, and can be traced for several miles. The dike passing through Blinko Lake has a distinct positive aeromagnetic anomaly. Two sill-like bodies occur in the area, at Harten Lake in Gould Township and Rowe Lake at the western edge of Jackson Township. A porphyritic variety was observed on the west end of the large unnamed island on Wakomata Lake and around Baird Lake. This dike contains zones rich in phenocrysts of saussuritized plagioclase.

The dikes commonly have sharp contacts with the country rocks; most of the larger intrusions have chilled contacts. Some dikes have amphibolitic off-shoots. South of Highland Lake, xenoliths of Lorrain sandstone are present in the dike. These xenoliths are pink, showing some metasomatic effects from the dike.

The Nipissing Diabase is generally greenish, mottled grey, black, green, and greenish pink, fine to coarse grained and equigranular. Nipissing Diabase consists dominantly of quartz metagabbro, fresh two pyroxene-bearing gabbro, granophyre, diabase, and amphibolite. The larger bodies display differentiation trends from two-pyrozene (orthopyroxene and clinopyroxene) gabbro, to one-pyrozene (clinopyroxene) gabbro, to granophyric gabbro and granophyre. A typical differentiation sequence is shown by the body at Boot Lake, where, at the southwest margin an amphibolitic fine-grained gabbro grades into a fresh two-pyroxene gabbro towards the centre. The grain size increases, the gabbro becomes more felsic, and granophyre is present towards the northeast contact where a breccia occurs. At Aikens Lake a pink granophyre was observed with bladed amphibole crystals up to 2 inches (5 cm) long. The granophyric sections commonly occur as irregular zones throughout the bodies.

Other dikes do not show these compositional trends except for the dike passing through Blinko Lake where gabbroic, dioritic, and granophyric phases were seen. The smaller dikes are usually altered and amphibolitized and no fresh textures can be observed.

Some are rich in pyrite and pyrrhotite, and have vugs filled with quartz crystals, magnetite, specular hematite, carbonate and epidote.

One fine-grained dike between Delaney and Dyment Lake contains veinlets of epidote about 1 cm thick (0.4 inch) and ½ inch apart (1.3 cm). Several areas have a gossan rich in weathered pyrite cubes. Associated with the gossan are vugs filled with quartz and acicular crystals of epidote up to 2 inches (5 cm) long.

In thin section, the amphibolitic parts of the large Nipissing Diabase bodies display the same texture and mineralogy as the diabase dikes. They are all altered gabbros with 0 to 15 percent quartz which appears as micrographic intergrowths with plagioclase in the more felsic parts, and as anhedral interstitial grains in the more mafic gabbros. Plagioclase as bladed crystals is commonly altered to epidote, sericite, and talc. Chlorite and amphibole are interstitial to the plagioclase crystals. The opaque minerals, ilmenite and magnetite, show skeletal textures. Accessory minerals include apatite, rutile and sphene. In the fresh pyroxene-bearing gabbro, plagioclase (An_{50} to An_{60}), appears as fresh euhedral laths which are normally zoned; some are slightly saussuritized. Pyroxene present includes orthopyroxene (enstatite) and clinopyroxene (augite and pigeonite), or clinopyroxene only. The orthopyroxene has exsolutions of augite. The platy pyroxene crystals partly enclose plagioclase forming a subophitic texture. In places the pyroxene is altered to chloritie and hornblende. Typical modal analyses of Nipissing Diabase are given in Table 7.

Several fine-grained grey to black mafic dikes cut the Gowganda Formation on the shore of the west bay of Wakomata Lake. One of the dikes is 1 foot (0.3 m) wide with 1.5 cm (0.2 inch) thick pyrite veinlets and specks of specular hematite, carbonate and epidote. A similar dike 3 feet (0.9 m) wide was found cutting Early Precambrian basement rocks at Chain Lake has vugs filled with pyrite, chalcopyrite, magnetite, epidote, and carbonate. Malachite staining was observed throughout this exposure. Some xenoliths of granite were included in the dike.

Late Precambrian

Mafic Intrusive Rocks

On the south shore at the east end of Chub Lake there are pinkish, fine-grained dikes containing plagioclase and biotite phenocrysts. These dikes resemble the lamprophyre dikes described by Robertson (1963, p.38) near Iron Bridge.

The youngest dikes in the map-area are two olivine diabase dikes of the Sudbury Swarm. A small 50-foot (15 m) thick dike occurs just south of Wakomata Lake, while

Table 7 MODAL ANALYSES OF MAFIC INTRUSIVE ROCKS; WAKOMATA LAKE AREA.

Sample Numbers	S8-73-14	S2-73-125	S2-73-126
Quartz	....	4.9[1]	2.8[1]
Plagioclase	58.1	40.2	51.5
Augite	20.3[2]	10.0	22.6
Orthopyroxene	....	....	13.4
Olivine	5.8	....	....
Uralite	....	27.4	....
Chlorite	1.2	1.0	....
Biotite	....	0.7	0.7
Sericite	....	....	3.2
Epidote	....	....	5.3
Saussurite	tr	10.6[3]	....
Heavy Minerals	14.6	5.2	0.5
Plagioclase Composition	An_{55}	An_{56}	An_{65}
Number of points	1000	1000	1000

S8-73-14 – Fine-grained olivine diabase dike
S2-73-125 – Amphibolite (metagabbro) (Nipissing Diabase)
S2-73-126 – Pyroxene bearing diabase (Nipissing Diabase)

Abbreviations:
.... Not detected
tr trace amount

Footnotes:
[1]Quartz and granophyre
[2]Titaniferous augite
[3]Saussurite and sericite

the other at Highland Lake is about 200 feet (60 m) thick, and trends northwest for about ½ mile (0.8 km). The dikes, fine- to coarse-grained rocks, weather to a characteristic brown to rusty colour, and consist of olivine, clinopyroxene, orthopyroxene and laths of plagioclase (Table 7). They are rich in magnetite producing a magnetic response (ODM-GSC 1963).

STRUCTURAL GEOLOGY AND METAMORPHISM

The Wakomata Lake area lies partly within the Superior and Southern Structural Provinces of the Canadian Shield (Stockwell *et al.* 1970). The southern part of the Superior Province consists of Early Precambrian (Archean) granitic plutons, migmatites, and remnants of metavolcanic-metasedimentary 'greenstone' belts which have been faulted and folded and intruded by granitic rocks during the Kenoran Orogeny about 2,500 m.y. ago (Card *et al.* 1972; Stockwell *et al.* 1970). Rocks of the Superior Province are exposed in the northern part of the map-area, and are largely represented by massive to gneissic felsic intrusive rocks. At the end of the Early Precambrian or during the early part of the Middle Precambrian, some 2,300 m.y. or more ago, faulting and downwarping of the Superior Province craton initiated the Huronian depositional basin. This deformation was probably accompanied by emplacement of mafic dike swarms (Card *et al.* 1972).

The Southern Province consists of an early Middle Precambrian linear orogenic belt that developed along the southern boundary of the Superior Province (Card *et al.* 1972). The Southern Province can be subdivided into a number of subprovinces including the Penokean Fold Belt, the Port Arthur Homocline, and the Lake Superior Basin (Stockwell *et al.* 1970). The eastern part of the Penokean Fold Belt consists of supracrustal rocks of the Huronian Supergroup, a sequence of dominantly sedimentary rocks which unconformably overlie the Early Precambrian Basement (Stockwell *et al.* 1970).

The eastern part of the Penokean Fold Belt is further subdivided into three tectonic subdivisions: Sault Ste. Marie-Elliot Lake; Sudbury-Espanola; and Sudbury Basin (Card *et al.* 1972). The Sault Ste. Marie-Elliot Lake Subdivision comprises relatively thin, little deformed and metamorphosed Huronian rocks deposited upon a relatively stable cratonic basement. The tectonic structure pattern in the Southern Province has been attributed to deformational forces concentrated in the south thrusting a plate of supracrustal rocks northward against a relatively stable cratonic block now represented by the Superior Province (Card *et al.* 1972). The Huronian rocks of the Wakomata Lake area form part of the Sault Ste. Marie-Elliot Lake tectonic subdivision and are consequently little deformed and metamorphosed.

FOLDS

The dominant structure in the Huronian rocks of the map-area is an open syncline with a generally shallow (5 degree) east-plunging axis. The north limb of the fold in proximity to the basement contact dips south, at angles of up to 60 degrees. The beds on the south limb dip gently to the north at about 10 degrees to 15 degrees. East of Wakomata Lake the axial trace of the fold, which strikes east-west on the southern shore of the lake, is successively displaced northward by the northwest-striking, Blinko and Skirl Lake Faults.

Slickenside lineations and quartz coatings are present on sheared bedding planes on both limbs of the syncline. Stereonet plots of these lineations show that they are generally normal to the axial plane of the fold and are consequently 'a' lineations (Figure 8) formed by interstratal slip during flexural folding (Whitten 1969). The fold axis appears to undulate, plunging east and west. More mapping to the east is required to determine the direction of plunge. The syncline, named in this report the Wakomata Lake Syncline, is probably the westward continuation of the Quirke Syncline which shows a variably plunging axis (Robertson 1971, 1963).

Bedding in the Lorrain sandstone dips mainly at low angles (average 10 degrees). Prominent ridges and cuestas dominate the topography. The horizontal expression of the members of the Lorrain Formation gives rise to patterns on the map which appear to be caused by folding, but are actually an effect of topography and the low dip of the strata.

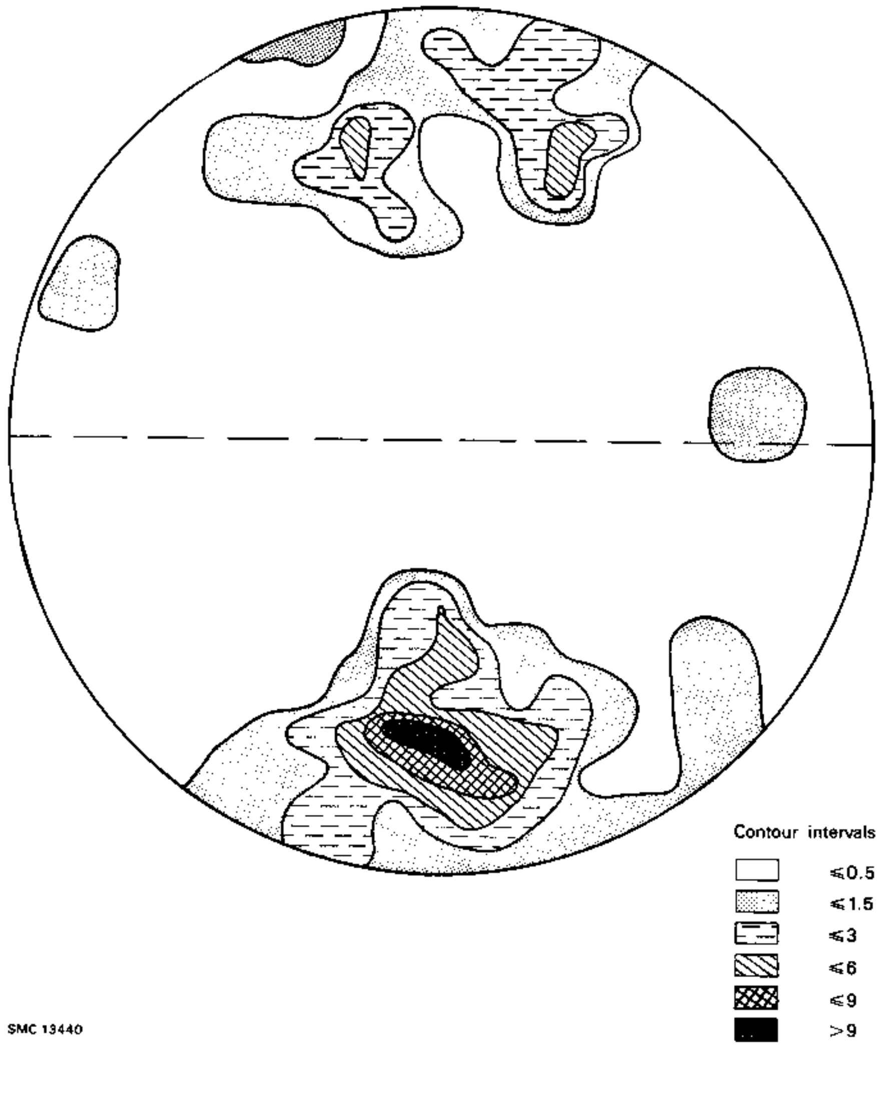


Figure 8–Stereonet plot of slickenside lineations from sheared bedding planes in the sandstone of the Lorrain Formation, Wakomata Lake Area.

FAULTS

Prominent northwest- and east-west trending fracture patterns occur in the map-area and are expressed as faults and trends of mafic dikes. The northwest-trending Flack Lake Fault which crosses the map-area in the northeast corner is the most important fault in the region. The Flack Lake Fault was described by Robertson (1963) as a system of faults, rather than a single fault, which forms an east-west trending curvilinear structure extending for approximately 96 miles (154 km). In the Rawhide Lake Area, Wood (1971) described the Flack Lake Structure as a reverse fault dipping 72 degrees to the south.

The Pearl Lake Fault in the northeast part of the map-area is part of the Flack Lake Fault System. The apparent right-hand horizontal offset of the Gowganda-basement contact and of the mafic bodies on this fault is approximaely 1¾ miles (2 km). The rocks within the fault zone are sheared, brecciated and injected with carbonate and specularite-bearing quartz veins. The faults split into two branches at Pearl Lake and continue eastward into Varley Township (formerly Township 176).

The Blinko and Skirl Lake Faults, inferred from surface geology, are northwest-trending structures which displace the Huronian strata. Displacements of the contacts between the Lorrain members suggest that these structures are strike-slip faults with left-hand horizontal offsets of approximately ½ mile (0.75 km) for the Blinko Fault and 1 mile (1.6 km) for the Skirl Lake Fault.

A few minor northeast-trending faults and lineaments can be seen in the map-area. In the sedimentary rocks of the Lorrain Formation, lineaments are accentuated by deep gulleys. Copper mineralization is associated with the Frobel Lake and East Caribou Faults. This mineralization will be discussed in some detail in the Economic Geology section of this report.

METAMORPHISM

The rocks of the Southern Province have been altered during Middle to Late Precambrian orogenic events under conditions ranging from diagenesis to almandine-amphibolite facies of regional metamorphism (Card *et al.* 1972). In the Sault Ste. Marie-Elliot Lake part of the Penokean Fold Belt, alteration ranges from diagenesis to low greenschist facies of regional metamorphism (Card *et al.* 1972).

In the map-area, megascopic evidence for metamorphism is apparent only in the metagabbro bodies and dikes. The original pyroxenes have been altered to chlorite, biotite, amphibole, and feldspars have been altered to sericite and epidote. The presence of muscovite in the Gowganda and Lorrain Formations indicates lower greenschist facies of regional metamorphism. The Lorrain Formation also contains clay minerals like kaolinite, diaspore and pyrophyllite. Kaolinite and diaspore are considered to be diagenetic, while pyrophyllite forms as a reaction of diaspore or kaolinite with quartz in the lowest zone of the greenschist facies.

DEPOSITIONAL ENVIRONMENT OF THE GOWGANDA AND LORRAIN FORMATIONS

The Gowganda Formation has been studied by many authors such as Lindsey (1971), Casshyap (1969), and Young (1968), most of whom concluded that deposition of this formation was connected with glaciation. The conglomerates of this formation have been equated with glacial till and the laminated siltstone and argillite interpreted as deposits formed in a proglacial lake environment (Young 1968). In the Whitefish Falls area, the Lorrain Formation has been interpreted as a shallow marine-beach deposit (Card 1969; Hadley 1969; Chandler 1969), but in the Elliot Lake-Bruce Mines area a fluvial environment for this formation is favoured by Young (1973), Wood (1970), and Frarey (in press).

DEPOSITIONAL MODEL

A depositional model for the Gowganda and Lorrain Formations is given in Figure 9. The gradational contact between these two formations indicates continuous deposition with no major breaks. If the interpretation that the Gowganda conglomerates are tillites is correct, then, as the glaciers began to melt and recede isostatic rebound probably occurred resulting in crustal uplift and attendant gradual marine or lacustrine regression. The silty and sandy sediments of the Upper Gowganda Formation show characteristics of a regressive sequence. Continued emergence of the land by isostatic rebound resulted in continued regression and rapid erosion by streams of the glacially dumped detritus and of the freshly scraped bedrock surfaces. The lower and middle part of the Lorrain Formation exhibit characteristics of braided stream deposits. During a later gradual transgression the upper part of the Lorrain Formation was deposited in a beach environment.

DETAILED DESCRIPTION OF MODEL

The members of the Gowganda Formation exposed at and near Chub Lake display characteristics similar to a typical deltaic regressive marine sequence such as that described by Visher (1965). The lower part of the sequence, a fine-grained laminated siltstone-argillite member was formed by settling of fine-grained sediments from suspension in water, possibly in a distal pro-delta type of environment. Upward in the sedimentary sequence, a progressive increase in the admixture of fine sand and the presence of ripples and climbing ripples indicate deposition near wave base and suggest possibly a more proximal pro-delta environment of deposition. Deposition of the above rocks took place as the uplift, infilling, and emergence of the sedimentary basin continued. Slumping of interbedded sands and silts to form ball and pillow structures, and penecontemporaneous faulting indicate instability of the depositional basin. With further regression the upper sandy member of Gowganda Formation was deposited. The relatively well sorted sedimentary rocks form graded beds about 2 to 3 feet (0.6 to 0.9 m) thick

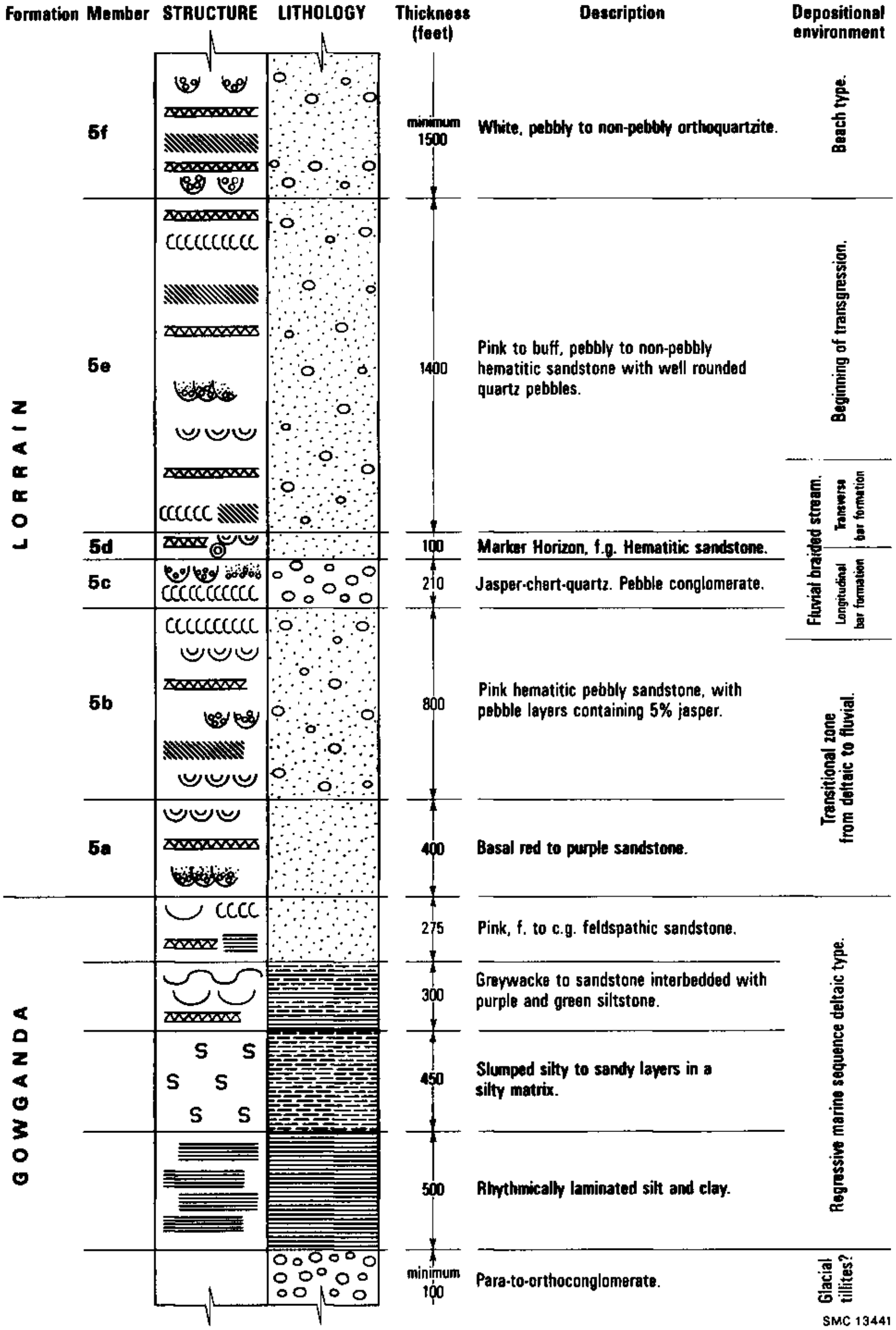
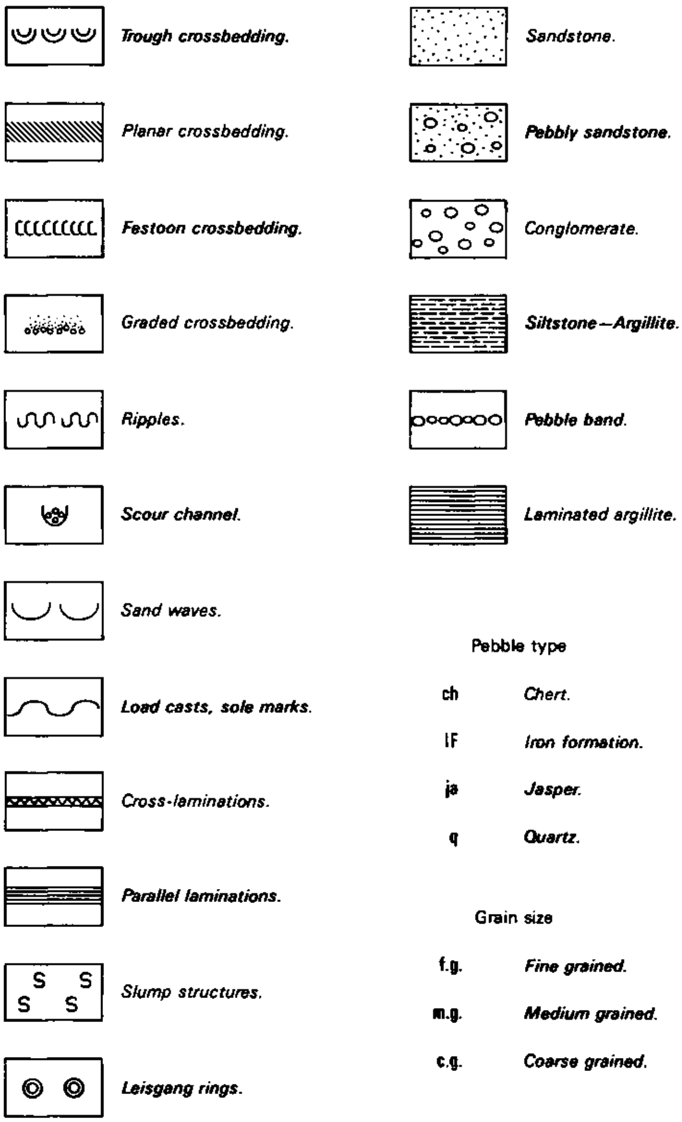


Figure 9–Depositional Model for the Gowganda and Lorrain Formations, Wakomata Lake Area.

LEGEND



Metrication: to determine thickness in metres multiply feet by 0.3048.

Legend for Figures 2, 3, 4, 5, 6, 7, 9.

with small scale crossbedding, sand waves, and irregularly distributed thin silty lenses. These characteristics are typical of a pro-delta sequence (Visher 1965).

The sedimentary rocks of the transitional zone between the Gowganda and Lorrain Formation represent the change from a pro-delta to a fringe delta or fluvial facies. Smith (1970) outlined the physical characteristics typical of braided stream deposits as follows: lenticular beds, unimodal paleocurrent direction, admixture of angular and rounded pebbles, cut and fill structures, irregular bedding contacts, rapid and extreme vertical and lateral grain size variations, sand waves, ripples, and large scale trough cross-stratification. These characteristics can be observed in the lower and middle parts of the Lorrain Formation.

The change from the Gowganda Formation to the Lorrain Formation is also marked by the disappearance of feldspars and increase in the hematite content. Terrigenous red-beds, normally non-marine are deposited rapidly in well-drained basins in warm and humid climates (Heckel 1972). The disappearance of feldspars might indicate a change from a frigid to a tropical climate (Chandler 1969; Frarey, in press) or a rapid change of depositional environment for example an emergence from water and weathering in a tropical climate. The sandstone of the lower part of the Lorrain Formation is coarse grained, poorly sorted, and contains silty or fine sand interbeds which are horizontally laminated. Higher in the stratigraphic sequence pebbles appear as well as trough cross-beds which show unimodal paleocurrent direction (Figures 10c and 10d). These sedimentary rocks form the transition from deltaic to fluvial conditions of sedimentation. A further uplift of the basin was followed by the deposition of the conglomeratic member of the Lorrain Formation. These coarse, poorly sorted conglomeratic rocks were deposited in a high energy environment, probably representing the bed load of turbulent traction currents of braided streams. Abundant interbeds of sand and the occasional presence of silty interbeds indicate frequent and extreme changes in flow conditions (Smith 1970). These conglomeratic units show characteristics of longitudinal bars formed in a braided stream. A longitudinal bar is essentially an accumulation of gravel with a mixture of sand; the proportion of sand increases downstream where trough cross-bedding is developed. Cut and fill structures, lenticular bedding, poor sorting of material, mixture of angular and rounded pebbles, extreme variations in grain size, sand waves, and trough crossbeds are all typical of fluvial braided stream deposits as mentioned earlier.

Upward in the sequence, the longitudinal bars give way to transverse bars which form further downstream away from the source. The sediments of member (5d) and the lower part of Member (5e) show characteristics of transverse bars. Sharp contacts can be observed between each bar where the basal unit is coarse grained and shows festoon and trough crossbedding. The top part consists of tabular sets of planar cross-strata. Commonly, each foreset is graded (Photo 2) (Smith 1970).

The sediments of the upper part of the Lorrain Formation show polymodal grain size distribution and bimodal to polymodal paleoccurrent directions (Figures 10a and 10b). Where pebble layers occur, they consist of sorted well-rounded quartz pebbles. The sandstones are well-sorted mature orthoquartzites and are white in colour. Loss of red colour can be attributed to deposition of the sandstone in a marine environment (Heckel 1972). The maturity of orthoquartzite indicates deposition under high energy conditions, probably in a mixture of fluvial and beach environments. Reworking by waves on a beach of sediments previously deposited by fluvial processes would produce a very mature orthoquartzite.

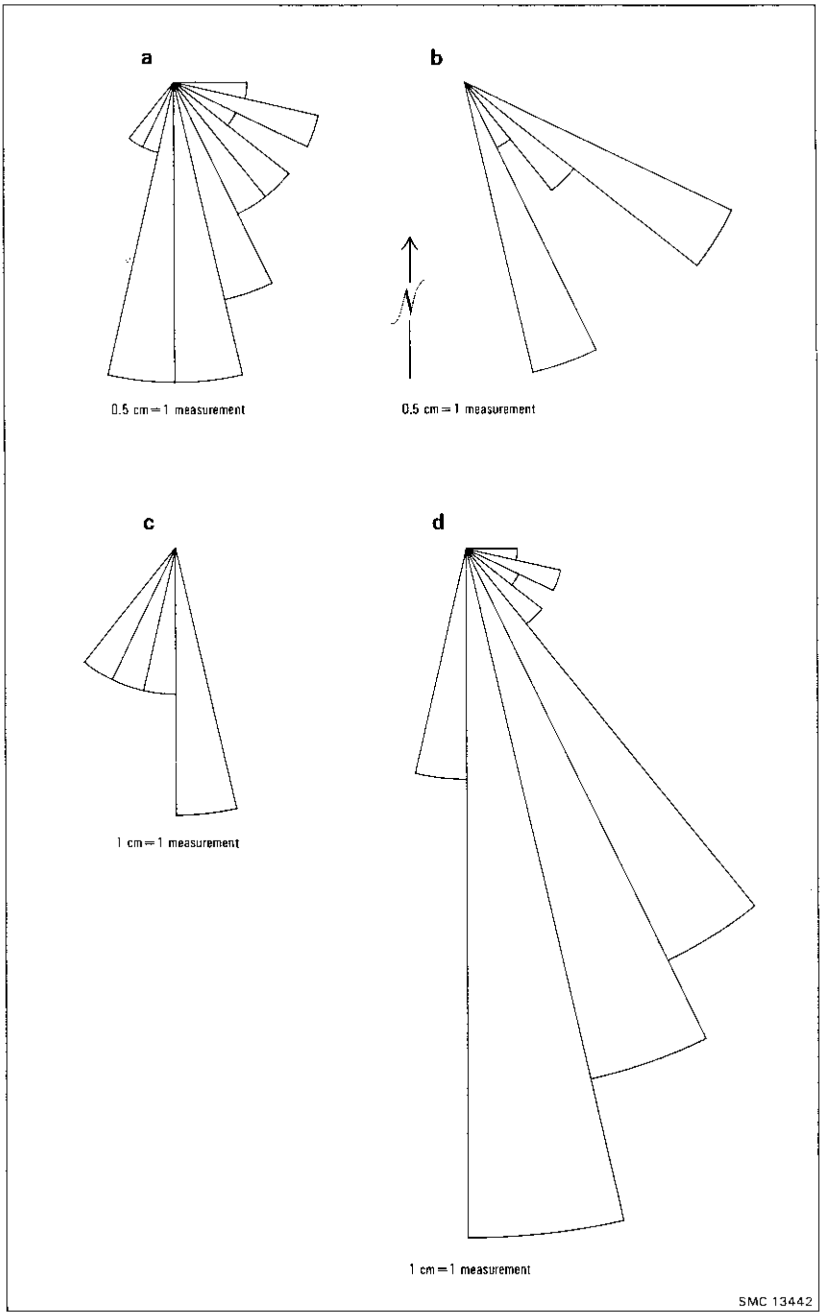


Figure 10–Paleocurrent directions from trough crossbedding, Lorrain Formation, Wakomata Lake Area: a) in Member (5b); b) in Member (5c); c) in Member (5d); d) in Member (5e).

ORIGIN OF ALUMINOUS MINERALS IN THE LORRAIN FORMATION

Samples collected from the measured cross section were analysed by X-ray diffraction methods to determine their content of pyrophyllite, diaspore, and kaolinite. In the field, concentrations of these minerals were noted to occur as certain stratigraphic horizons. Although the occurrence of these aluminous minerals could not be correlated with any physical characteristics of the rock, as observed in thin sections and hand specimens, their presence is probably controlled by changes in the depositional environment. Diaspore and kaolinite are probably authigenic minerals. Pyrophyllite is a metamorphic mineral appearing in the greenschist facies and can be produced by reactions such as:

$$\text{Kaolinite} + \text{quartz} = \text{pyrophyllite} + H_2O$$

or

$$\text{Diaspore} + \text{quartz} = \text{pyrophyllite} + H_2O$$

(Winkler 1965). Kaolinite and diaspore form by the breakdown of feldspars or clay minerals. However, diaspore forms in laterite-type conditions in a tropical climate (Deer, Howie and Zussman 1967). Diaspore is most abundant in samples that contain a considerable amount of pyrophyllite and minor kaolinite (Table 8). The amount of pyrophyllite is, therefore, controlled by the presence of diaspore and kaolinite. Where absent, diaspore and kaolinite must have broken down completely to form pyrophyllite. In order for diaspore to form, the sediments must have been exposed to air. It has been postulated earlier in this report that the Lorrain Formation formed in a braided stream environment. The 'Puddingstone' Member (5c) was formed in longitudinal bars where deposition was rapid, and changes in flow conditions were frequent and extreme; and as a result only minor diaspore, kaolinite, and pyrophyllite occur in the 'Puddingstone' Member (5c). However, where transverse bars are formed in a braided stream, the flow conditions are quieter and there are periods of emergence from water. It is postulated that during such emergences the diaspore formed, and the amount of diaspore was controlled by the time the transverse bar was above water. The sediments of the upper part of the Lorrain Formation were deposited in a high energy beach environment where sediments were seldom, if ever exposed to subaerial weathering. Therefore, the aluminous minerals did not have the chance to form.

ECONOMIC GEOLOGY

The map-area has been prospected for copper since the beginning of the twentieth century. Along the North Shore of Lake Huron copper occurs in fault zones associated with Nipissing Diabase. In the area, chalcopyrite and malachite occur at several localities, in association with specularite-magnetite-bearing quartz-carbonate veins which are also associated with shear zones and Nipissing-type diabase intrusions. The copper mineralization occurs in pods, which although commonly rich, are mainly small, and do not appear to have great economic potential.

Since the discovery of uranium at Blind River in the early 1950s exploration for uranium in the form of prospecting and diamond drilling has been carried out in the map-area. No radioactivity was noted in the rocks of the area.

Table 8 ABUNDANCE OF CLAY MINERALS SANDSTONE OF THE LORRAIN FORMATION AS SHOWN BY X-RAY DIFFRACTION ANALYSES; ANALYSES BY MINERAL RESEARCH BRANCH, ONTARIO DIVISION OF MINES.

Sample Number	Member	Pyrophyllite	Kaolinite	Muscovite	Diaspore
SX-73-243	5c	–	–	D	–
SX-73-244	5c	–	–	–	–
SX-73-245	5c	–	–	C	–
SX-73-241	5c	B	–	–	–
SX-73-247	5d	B	–	D	–
SX-73-248	5d	A	D	–	D
SX-73-249	5d	D	–	–	–
SX-73-250	5d	B	–	D	–
SX-73-251	5e	A	–	–	D
SX-73-252	5e	A	D	–	D
SX-73-253	5e	D	–	B	–
SX-73-254	5e	–	–	C	–
SX-73-256	5e	B	–	C	–
SX-73-258	5e	A	D	C	D
SX-73-259	5e	B	D	D	–
SX-73-260	5ef	B	D	D	–
SX-73-261	5f	–	–	C	–
SX-73-262	5f	–	C	D	–
SX-73-263	5f	B	–	D	–
SX-73-264	5f	A	–	D	–
S2-73-201	5f	–	–	C	–
S2-73-203	5f	–	–	C	–
S2-73-204	5f	D	–	C	–

Abbreviations:
A = abundant
B = major
C = moderate
D = present in minor amounts

Geophysics

In 1968, airborne radiometric and magnetic surveys were carried out over parts of the area for Canadian Johns-Manville Company Limited and for D.J. Happy. In 1970, airborne magnetic-electromagnetic surveys were carried out over parts of the area for David S. Robertson and Associates Limited, and for Radex Uranium Syndicate (Assessment Files Research Office, Ontario Division of Mines, Toronto).

Property Descriptions

CARIBOU CREEK OCCURRENCE (2)

In Jackson Township (formerly Township 182), about 1 mile (1.6 km) east of Wakomata Lake along Caribou Creek and 1,000 feet (300 m) north of Caribou Creek, malachite, pyrite, and magnetite occur in quartz veins associated with a shear zone of the Frobel Lake Fault near a diabase dike. Three grab samples taken by the writer assayed 0.42 percent copper; 1.36 percent copper, and 0.02 ounce of gold per ton; and 0.56 percent copper and 0.01 ounce of gold per ton (Mineral Research Branch, Ontario Division of Mines).

Two other occurrences of the same type were found in Jackson Township but not sampled: one is on the southern shore and the other is on the northern shore of East Caribou Lake.

CHUB LAKE OCCURRENCE (3)

On the southern shore of Chub Lake between lots 3 and 4 of concession V, Gould Township, a quartz vein about 10 feet (3 m) long and 3 feet (0.9 m) wide striking approximately east-west containing disseminated chalcopyrite was observed cutting a lamprophyric dike. A grab sample taken by the writer assayed 0.20 percent copper (Mineral Research Branch, Ontario Division of Mines).

FROBEL LAKE PROPERTY; C.W. ARCHIBALD (1), AND PROCESS MINERALS LIMITED (6)

The Frobel Lake Property consists of 19 unsurveyed contiguous mining claims. In the spring of 1974, the seven northern claims (SSM346828 to SSM346833 inclusive and SSM104227) were registered in the name of C.W. Archibald and the remainder (SSM104222 to SSM104224 inclusive and SSM105675 to SSM105680 inclusive and SSM105682, SSM269703) in the name of Process Minerals Limited. The claims are situated between Snowshoe and Frobel Lakes and are accessible by foot along a logging road from Highway 129, by a trail from Wakomata Lake, or by float-equipped aircraft via Frobel or Snowshoe Lakes.

Previous Work

F.M. Jowsey Limited reported that the area around Frobel Lake was underlain by greenstone, granite, diabase and quartz breccia (Regional Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie). In 1968, a diamond-drill hole 588 feet (179.2 m) in depth, adjoining claim SSM91288, intersected spotty chalcopyrite in stringers of carbonate and carbonate-barite. Also in 1968, a reconnaissance geophysical survey was conducted over a small part of the area northwest of Frobel Lake. In 1969, a second diamond-drill hole drilled to a depth of 1,200 feet (370 m) on claim SSM91291 showed much disseminated chalcopyrite. In 1970, Aggressive Mining Limited carried out a ground electromagnetic survey using a Crone Radem ULF instrument which revealed five conductors. In 1971, the claims were transferred to Process Minerals Limited and C.W. Archibald, and at that time four diamond-drill holes totalling 1,758 feet (535.8 m) were drilled in claims SSM105675 to SSM105678 to test the conductors. Hole 71-2, 701 feet (213.7 m) deep proved to be the most interesting, revealing 0.30 percent copper, 0.13 ounce of silver per ton and 3.91 percent barite over a length of 7 feet (2.1 m) (Northern Miner 1972) along with widely disseminated chalcopyrite in diorite between the depths of 192 to 305 feet (58.5-93.0 m) before encountering a fault zone. Below the fault zone (305 to 701 feet; 93.0-213.7 m) chrysotile asbestos slip fibre and tremolite was intersected in widths up to 3/4 inch (19.1 mm) (see Regional Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie). Diamond drilling was continued for 1,253 feet (381.9 m) during the summer of 1972 to further test conductors and a barite showing in the area. This diamond drilling had disappointing results and some claims are no longer held. No further work was done during the summer of 1973. Two grab samples of diamond-drill core taken from this hole by the author assayed 1.62 percent and 1.94 percent copper and 0.01 ounce of gold per ton respectively with traces of silver, nickel and cobalt (Analyses by the Mineral Research Branch, Ontario Division of Mines).

Geology

The claim groups are underlain by Early Precambrian granitic rocks which are intruded by a Nipissing Diabase body. The host rock to the mineralization is a medium- to coarse-grained amphibolitized metagabbro with granophyric phases. Two faults, the Frobel Lake Fault striking northwest-southeast and the Arthur Lake Fault striking northeast-southwest, intersect on the south shore of Frobel Lake. Subsidiary fractures trending east and northwest form shear zones between the east end of Snowshoe Lake and the south shore of Frobel Lake. Sulphide minerals are found along or near shear zones within the main faults or along smaller subsidiary fractures.

A carbonate vein in a shear zone which strikes N60°W, dips 85 degrees in a southwesterly direction, and extends for 2,000 feet (600 m) fills and cements the breccia of the Frobel Lake Fault. A small stream cuts through the vein exposing a fairly good section in two caves formed by downcutting of the stream. In the northwestern part of the Frobel Lake Fault, the carbonate vein is approximately 200 feet (60 m) wide thinning to about 25 feet (7.6 m) in width 900 feet (270 m) to the east. Rhombs of carbonate (probably calcite or siderite) more than ½ inch (12.7 mm) in diameter are typical, with colours ranging from pink, grey, beige and white to colourless. The wall rock breccia is often heavily chloritized and vuggy. The breccia is fine grained, friable and medium dark green to dark green.

Subsidiary veins pass into the country rock along fractures for distances up to 20 feet (6 m) in length often showing bleaching, chloritization, and epidotization.

In the metagabbro, east of the intersection of the faults, quartz veins making up 10 percent of the exposed rock fill joints with orientations striking N50°E and dipping 80° to the southeast and N80°W and dipping 60° north. Lenses of quartz measuring 6 to 8 inches long by 4 inches wide (15.3 to 20.3 cm by 10.2 cm) and slickensides plunging 10 degrees in a direction of S50°W are quite common in the area. Generally, the quartz veins are 1/16 inch to 1 inch (1.6 mm to 2.5 cm) thick with a few veins up to 2 feet (0.6 m) thick. One 4-inch (10.2 cm) thick vein showed a 3/4 inch (19.1 mm) thick core of specular hematite flanked by white quartz.

The carbonate veins carry specks and blebs of chalcopyrite up to ½ inch (12.7 mm) in length and cubes of pyrite about ¼ inch (6.3 mm) in diameter. The sulphide minerals are generally associated with either quartz-rich zones or granitic inclusions. Malachite is exposed on the weathered surface in these areas. Specks of specular hematite are present throughout, and rusty weathering is evident on some fracture surfaces of the metagabbro near the vein. Northwest of the 'caves' in the small stream of barite-rich zone of limited extent about 15 feet (4.6 m) thick appears to overlie the carbonate vein.

HARICO MINING AND DEVELOPMENT COMPANY [1956] (4)

In 1956, Harico Mining and Development Company Limited reported very slight radioactivity in pegmatite dikes north of East Caribou Lake. The area is underlain by granite, granodiorite, and diabase. Pink granite pegmatites and barren quartz veins cut the granitic rocks. Narrow fractures in the pegmatites are radioactive, but are too small to have any commercial value. Some copper sulphide minerals were found on the property (Regional Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie).

PACIFIC PETROLEUMS LIMITED (MISSISSAGI SYNDICATE, [1968] (5)

In 1968, Pacific Petroleums Limited (Mississagi Syndicate) drilled a diamond-drill hole to a depth of 3,211 feet (978.7 m) in Grasett Township, in claim SSM86699, southeast of Wawiyay Lake (Last Lake). The hole cut through the Gowganda Formation and passed into Early Precambrian basement rocks in the last 42 feet (12.8 m) of the hole. No mineralization was reported (Regional Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie).

RENNER OCCURRENCE (7)

The occurrence, located at the eastern end of Triple Isle Lake, was discovered, pitted and sampled, in 1970 by Mr. Lawrence Renner and his brother G. Renner. The showings are associated with the Pearl Lake Fault Shear Zone and its subsidiary fractures. Quartz-calcite veins ranging anywhere from 1/16 inches to 2 inches (1.6 mm to 5.1 cm) in width occur in sheared metagabbro and granite in a narrow shear zone. The veins carry minor amounts of chalcopyrite, erythrite, and hematite. The average copper content as reported by the Regional Geologist's Office is 0.1 percent or less, 'high grade' areas may have values as high as 3 percent (Regional Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie).

ROTHSAY MINES LIMITED (8)

In Gould Township, two patented claims, located on lots 6 and 4, concession V, are part of the Cheney Copper Mine claim group that has been intermittently worked since 1929. Before 1915, an inclined shaft was sunk to a depth of 45 feet (13.7 m) where 45 feet (13.7 m) of drifting was done (Knight 1915).

In 1955, Headvue Mines Limited put down two diamond-drill holes on lot 6 and three diamond-drill holes on lot 4, concession V, Gould Township. The three holes have lengths of 146, 147 and 369 feet (44.5, 44.8, 112.5 m). In 1959, Rothsay Mines Limited acquired the two claims as part of a property consisting of 856 acres (345.8 ha) of patented claims.

On lot 4, concession V, Gould Township, four pits and trenches exposed a 4-foot (1.2 m) wide quartz-carbonate vein striking northwest and dipping 50 degrees south, for a length of 140 feet (43 m) in laminated argillite of the Gowganda Formation (Regional Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie). The vein, consisting of quartz and carbonate with massive to disseminated chalcopyrite and malachite, occurs in a small shear zone about 10 feet (3m) wide and is well exposed in a 20-foot (6 m) long, 10-foot (3 m) wide and 10-foot (3 m) deep pit. A grab sample of high grade material taken by the author yielded 26.5 percent copper upon assay (Mineral Research Branch, Ontario Division of Mines). On lot 5, concession V, three pits exposed quartz veins striking approximately east, containing carbonate patches with blebs and disseminations of chalcopyrite, malachite and specularite. Three grab samples taken by the writer assayed 1.54 percent copper; 0.62 percent copper and 0.01 ounce gold per ton; and, 3.14 percent copper (Mineral Research Branch, Ontario Division of Mines).

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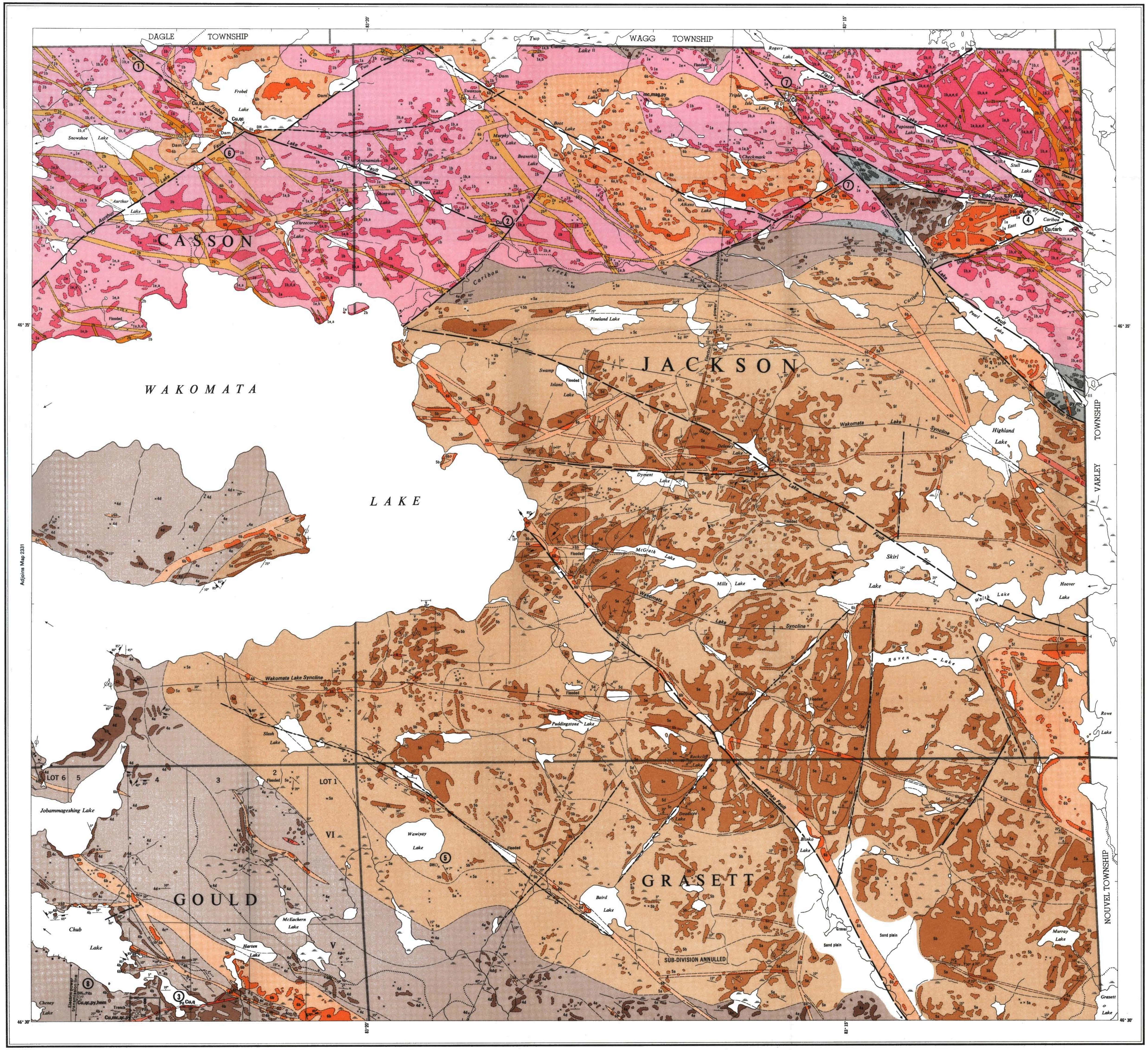


LEGEND

CENOZOIC[a]

QUATERNARY

PLEISTOCENE AND RECENT

Sand, till, gravel, clay.

UNCONFORMITY

PRECAMBRIAN[b]

LATE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS

8 *Olivine diabase.*

7 *Lamprophyre.*

INTRUSIVE CONTACT

MIDDLE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS (NIPISSING)

6a *Diabase, gabbro, diorite.*
6b *Metadiabase, metagabbro, amphibolite.*
6c *Granophyre.*
6d *Porphyritic metadiabase.*

INTRUSIVE CONTACT

HURONIAN SUPERGROUP

COBALT GROUP

LORRAIN FORMATION

5f *White orthoquartzite.*
5e *Pink to buff pebbly sandstone.*
5d *Fine-grained hematitic sandstone.*
5c *Quartz, jasper pebble conglomerate. (Puddingstone).*
5b *Pink hematitic pebbly sandstone.*
5a *Basal purple sandstone.*

GOWGANDA FORMATION

4e *Feldspathic sandstone.*
4d *Purple siltstone.*
4c *Slumped siltstone.*
4b *Laminated argillite.*
4a *Conglomerate.*

UNCONFORMITY

HOUGH LAKE GROUP

UNCLASSIFIED SANDSTONE

3a *Pink arkose.*
3b *Green pebbly arkose.*
3c *Regolith.*

NONCONFORMITY

EARLY PRECAMBRIAN (ARCHEAN)

MAFIC INTRUSIVE ROCKS

2a *Porphyritic diabase (Matachewan type).*
2b *Amphibolitic diabase.*

INTRUSIVE CONTACT

FELSIC INTRUSIVE ROCKS

1a *Xenolithic trondhjemite, quartz monzonite and granodiorite.*
1b *Grey trondhjemite, quartz monzonite and granodiorite.*
1c *Gneissic granite trondhjemite, quartz monzonite and granodiorite.*
1d *Pegmatitic granite.*
1e *Pink aplite and granitic rocks*

Breccia.

ba	*Barite.*
carb	*Carbonate.*
Co	*Cobalt.*
Cu	*Copper.*
hem	*Hematite.*
mag	*Magnetite.*
mc	*Malachite.*
py	*Pyrite.*
q	*Quartz.*
qc	*Quartz-carbonate.*

[a] *Unconsolidated deposits. Cenozoic deposits are represented by the lighter and uncoloured parts of the map.*

[b] *Bedrock geology. Outcrops and inferred extensions of each rock map unit are shown respectively in deep and light tones of the same colour. Where in places a formation is too narrow to show in colour and must appear in black a short black bar appears in the appropriate block.*

SOURCES OF INFORMATION

Geology by K. M. Siemiatkowska and assistants, Geological Branch, 1973.
Geology is not tied to surveyed lines.

Unpublished maps, plans, and drill logs of mining companies.

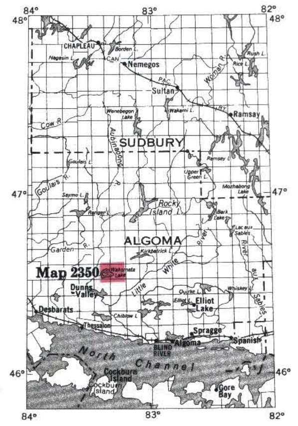
Aeromagnetic map 2227G, ODM-GSC.

Preliminary map (ODM) P. 914, Wakomata Lake Area (east part), scale 1 inch to ¼ mile, issued 1973.

Cartography by P. A. Wisbey and assistants, Surveys and Mapping Branch, 1975.

Base maps derived from maps of the Forest Resources Inventory, Surveys and Mapping Branch, with additional information by K. M. Siemiatkowska.

Magnetic declination in the area was approximately 5°30′ West in 1973.



Scale 1 inch to 50 miles

N.T.S. Reference 41J/11

SYMBOLS

Glacial striae.

Small bedrock outcrop.

Area of bedrock outcrop.

Bedding, horizontal.

Bedding, top unknown; (inclined, vertical).

Bedding, top (arrow) from cross bedding; (inclined, vertical, overturned).

Foliation: (horizontal, inclined, vertical).

Lineation with plunge.

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).

Swamp.

Other road.

Trail, portage, winter road.

Township boundary with milepost, approximate position only.

Mining property, surveyed, approximate position only.

Mineral deposit; mining property, unsurveyed.

Surveyed line, approximate position only.

PROPERTIES, MINERAL DEPOSITS

1. *Archibald, C. W.*
2. *Caribou Creek occurrence.*
3. *Chub Lake occurrence.*
4. *Harico Mining and Development Co. [1956].*
5. *Pacific Petroleums Ltd. Mississagi Syndicate [1968].*
6. *Process Minerals Ltd.*
7. *Renner occurrences.*
8. *Rothsay Mines Ltd.*

Information current to December 31st, 1973.

Only former properties on ground now open for staking are shown where exploration information is available—a date in square brackets indicates last year of exploration activity. For further information see report.

ONTARIO
DIVISION OF MINES

HONOURABLE LEO BERNIER, *Minister of Natural Resources*
DR. J. K. REYNOLDS, *Deputy Minister of Natural Resources*
G. A. Jewett, *Executive Director, Division of Mines* E. G. Pye, *Director, Geological Branch*

Map 2350

WAKOMATA LAKE

ALGOMA DISTRICT

Scale 1:31,680 or 1 Inch to ½ Mile

Chains 80 60 40 20 0 1 2 Miles
Metres 1000 0 1 2 3 Kilometres
Feet 1000 0 5,000 10,000 Feet

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