MANITOBA

DEPARTMENT OF MINES, NATURAL RESOURCES AND ENVIRONMENT

MINERAL RESOURCES DIVISION

REPORT OF FIELD ACTIVITIES 1979

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GEOLOGICAL SERVICES BRANCH

**Funding for this programme was provided under the Canada/Manitoba Northlands Agreement.*

MINES BRANCH — AGGREGATE RESOURCES SECTION

GEOLOGICAL SERVICES BRANCH

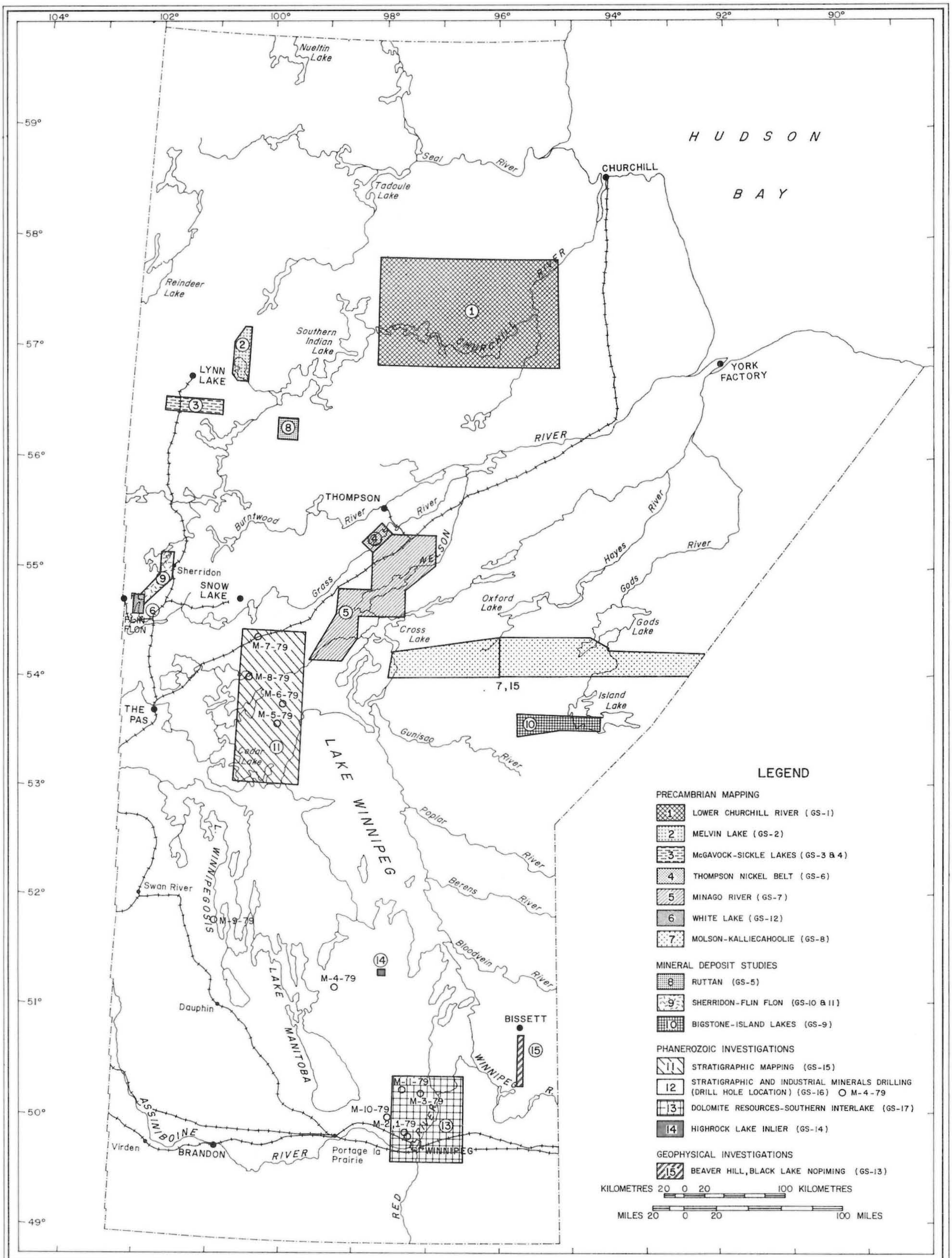

FIGURE GS-1: Location of Field Projects 1979.

INTRODUCTION

The recent restructuring of the Mineral Resources Division has led to the incorporation, within the Geological Services Branch, of Mineral Deposit, Industrial Mineral and Geophysical Programmes in part initiated under the auspices of the previous Mineral Evaluation and Administration Branch. The main thrust of the programmes conducted by the Geological Services Branch continues to be directed toward the delineation of the Province's geological framework and its rock and mineral resources through regional mapping, and mapping in progressively greater detail those areas in which significant concentrations of exploitable minerals are thought to occur.

Funding provided under the 1976/81 Federal/Provincial Northlands Sub-agreement facilitated the implementation of Regional Mapping programmes in which the large areas to be covered dictate a heavy reliance on fixed wing and helicopter air support. Similarly, Mineral Deposit investigations and regional uranium follow-up surveys were also funded under the Northlands Mineral Initiatives Sub-agreement.

A total of 18 Preliminary geological maps were prepared, together with 8 Geophysical/geochemical maps relating to uranium follow-up programmes and 12 Overburden thickness, Geology and Bedrock Topography maps outlining the potential Dolomite Resources of the Southern Interlake area.

This year's spectrum of activities ranged from Regional Mapping Programmes in the Lower Churchill River and Molson-Kalliecahoolie Lakes region, through conventional 1:50 000 scale mapping in the Melvin Lake, Barrington Lake, McGavock Lake, Sickle Lake and Minago River areas to detailed 1:25 000 and 1:15 000 scale mapping on Paint Lake and around White and Mikanagan Lakes. Several thousand square kilometres of highly varied granitic terrain were mapped in the Chipewyan Batholith and in the Uhlman and Baldock Lakes area. The large horseshoe-shaped greenstone occurrence between Gauer and Partridge Breast Lakes was confirmed and has provided new keys to the stratigraphic unravelling of the supracrustal units of the Churchill Province. The stratigraphic analysis of the greenstone belts and their flanking sedimentary gneiss terrains has played an important part in the unravelling of the structural complexes and this focus was maintained this year in the mapping of the McGavock, Sickle, Melvin and Barrington Lakes areas.

Near White Lake well preserved and superlatively exposed flows have been found to display primary internal organization of structures from a massive basal zone, upwards through pillows, to uppermost pillow breccias and hyaloclastites. Facing directions are consistent throughout the western half of the area and provide a coherent stratigraphy in which the base metal deposits can readily be positioned.

The work, that has recently led to a revised interpretation of the relationships between the Pikwitonei region and the Superior Province, was continued into the Minago River and Black Duck Lake area. The southern limit of the orthopyroxene-bearing Pikwitonei gneisses and the position of the Hudsonian orogenic front are now better defined as is the Kenoran age of the granulite facies metamorphism that has affected the western arm of the Cross Lake Greenstone Belt.

The first year of mapping in the Molson and Kalliecahoolie project revealed a prominent plutonic granitoid terrain, lying between the Cross Lake-Red Sucker Lake greenstone belt and the Stevenson Lake-Island Lake greenstone belt, that in many respects resembles the Winnipeg River Plutonic Complex of the English River Gneiss Belt. An older mainly tonalitic plutonic and gneissic complex is intruded by small yet widespread stocks and dykes of late Kenoran granites. The major URP anomalies appear related to even younger felsic alaskitic dykes.

Mineral Deposit studies in the Leaf Rapids area augmented the ongoing 1:20 000 scale mapping, initiated in the Lynn Lake area (1976, 1977 & 1978) and at Barrington Lake (1979), and provided detailed information on the structure and stratigraphy of the greenstones and the setting of the base metal deposits at Ruttan. Similar investigations integrated with the survey work near Wabishkok and Mikanagan Lakes, will focus specifically on the setting and mode of origin of the copper/zinc mineral occurrences and/or deposits. This year the broader aspects of the regional metallogeny were examined through an inspection of the Ideal and Sherridon deposits which have been compared to the purportedly similar deposits at Broken Hill, Australia. The study revealed several common features between the setting of the Broken Hill and Sherridon deposits, and highlighted the need for the development of consistent and reliable lithologic maps as the starting point for any subsequent investigation of ore bodies that might have a stratigraphically controlled mode of occurrence.

In the Island Lake and Bigstone Lake areas a brief review of the ultramafic occurrences was made as part of a longer-term programme which will investigate the stratigraphic setting of these bodies and their potential for nickel mineralization.

The latest, and possibly the last, of the Geological Survey of Canada's high sensitivity gamma-ray spectrometer surveys, flown under the joint Federal/Provincial Uranium Reconnaissance Programme, was implemented in 1978 and the results released in May 1979 for over 88 400 km^2 in NTS areas 63N,O,P; 62A,B and parts of 63J & K. The in-house geophysical programmes were mainly related to follow-up the URP anomalies in the Molson-Kalliecahoolie regions and in southeast Manitoba. Reports relating to geophysical and geochemical surveys implemented over the past several years are in the final stages of preparation and their release is anticipated early next year.

In southwest Manitoba a total of 11 holes were drilled as part of the combined Stratigraphic and Industrial Minerals programme and the occurrence of near surface deposits of carbonate bedrock was investigated in the southern Interlake area and detailed depth-to bedrock and geological maps were prepared.

A brief inspection of the Highrock Lake Precambrian inlier, near Riverton, resulted in the discovery of several new exposures of Paleozoic strata and a slightly greater extent of granite than had previously been recorded. The area displays several anomalous features such as structurally disturbed, steeply dipping (up to 40°) Paleozoic strata and extensive calcite veining in the granite; however, shock-metamorphic structures have not as yet been discovered and the origin of the structure remains controversial.

The gathering of data for the new Geological Map of Manitoba necessitated complete revision of the existing Phanerozoic maps and the boundaries now depicted on the 1:1 000 000 map will, where feasible, indicate a bedrock or "subcrop" geology rather than a surface or outcrop geology. Field checks resulted in a verification of much of the extrapolated data even though projections of over 40 km were necessary in the poorly or unexposed Cedar and Moose Lake areas north of Grand Rapids. At the time of writing the 1:1 000 000 Geological Map of Manitoba has been compiled and draughted with printing anticipated in October or November of this year. The data illustrated on the new map present a comprehensive and stimulating new synopsis of the Province's geological framework that reflects the collective effort of the Branch's geologists over the last 15 years.

W.D. McRitchie
Director
Geological Services Branch

Winnipeg
September 1979

GS-1 LOWER CHURCHILL RIVER PROJECT

(Regional Mapping)

(64H, 54E west)

by M.T. Corkery and P.G. Lenton

INTRODUCTION

Geological mapping was conducted along the lower Churchill River system from Southern Indian Lake to Portage Chute (54E/14). Helicopter-supported operations covered the surrounding areas of 64H and 54E west half. This work represents the first year of a two-year project intended to complete mapping at a scale of 1:100 000 for 64H, 54E, 64A and 54D (Fig. GS-1-1). Ground traverse mapping in the Baldock, Uhlman and south Gauer Lakes area was started with completion scheduled for 1980. The field work has been an enhancement of the regional picture established by McRitchie (1978) and Corkery (1978).

Exposures of bedrock are restricted mainly to the Churchill River and riverine lakes system including Partridge Breast, Missinipi, Northern Indian, Fidler and Billard Lakes. Lowering of the water levels by the Churchill River Diversion has increased the number and size of rock exposures along the Lower Churchill River. Most of the remaining area, with the exception of the Little Beaver River, has widely scattered exposures of bedrock, restricted mainly to major lakes and drainage channels. Extensive areas of sand plains and eskers occur in the northwest around the Waddie River and south and east from Etawney Lake to the limit of Paleozoic cover.

GENERAL GEOLOGY

The map-area can be divided into three major belts: the Chipewyan batholith in the north and the Baldock batholith in the south, separated by a belt of gneisses and schists of the Reindeer Lake-Southern Indian Lake sedimentary gneisses (McRitchie, 1977; Corkery, 1978). The Chipewyan and Baldock batholiths are very similar in rock types and textures and probably represent phases of contemporaneous intrusive bodies. They are referred to as two separate bodies because of the spatial separation present between them. The Chipewyan batholith has a greater diversity of rock types and is generally more inhomogeneous than the Baldock batholith.

Supracrustal rocks are exposed on Partridge Breast, Gauer, Thorsteinson and Northern Indian Lakes. They range from diatexitic gneisses on Northern Indian Lake to lower grade unmobilized metasedimentary and metavolcanic rocks on Partridge Breast Lake and south to Gauer Lake. The Partridge Breast-Gauer-Thorsteinson area is a wedge of dominantly supracrustal rocks. Beyond this area the belt of gneisses can be followed as a series of inclusion trains in the batholiths. Northern Indian Lake is dominantly an injection complex with supracrustal rocks limited to a belt of diatexites through the central and eastern part of the lake and bounded by a variety of granitoid rocks.

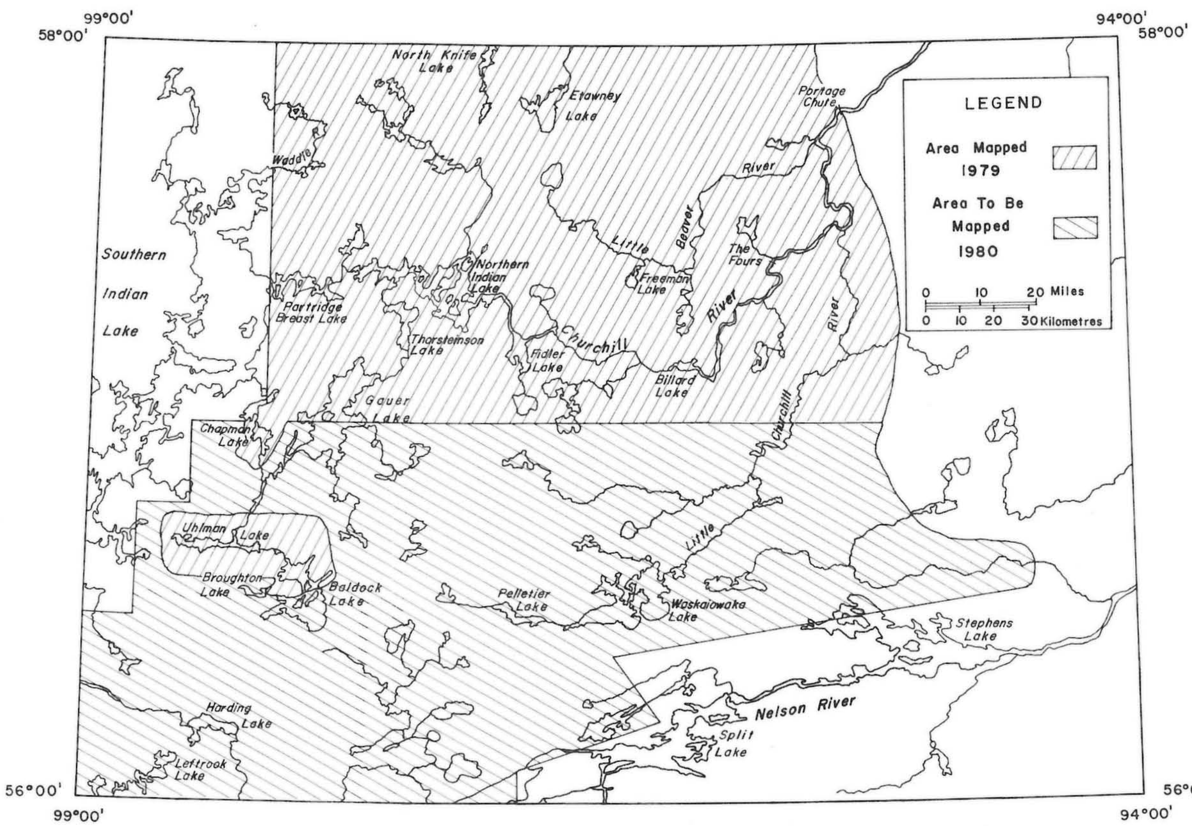

FIGURE GS-1-1: Lower Churchill River Project Map Area.

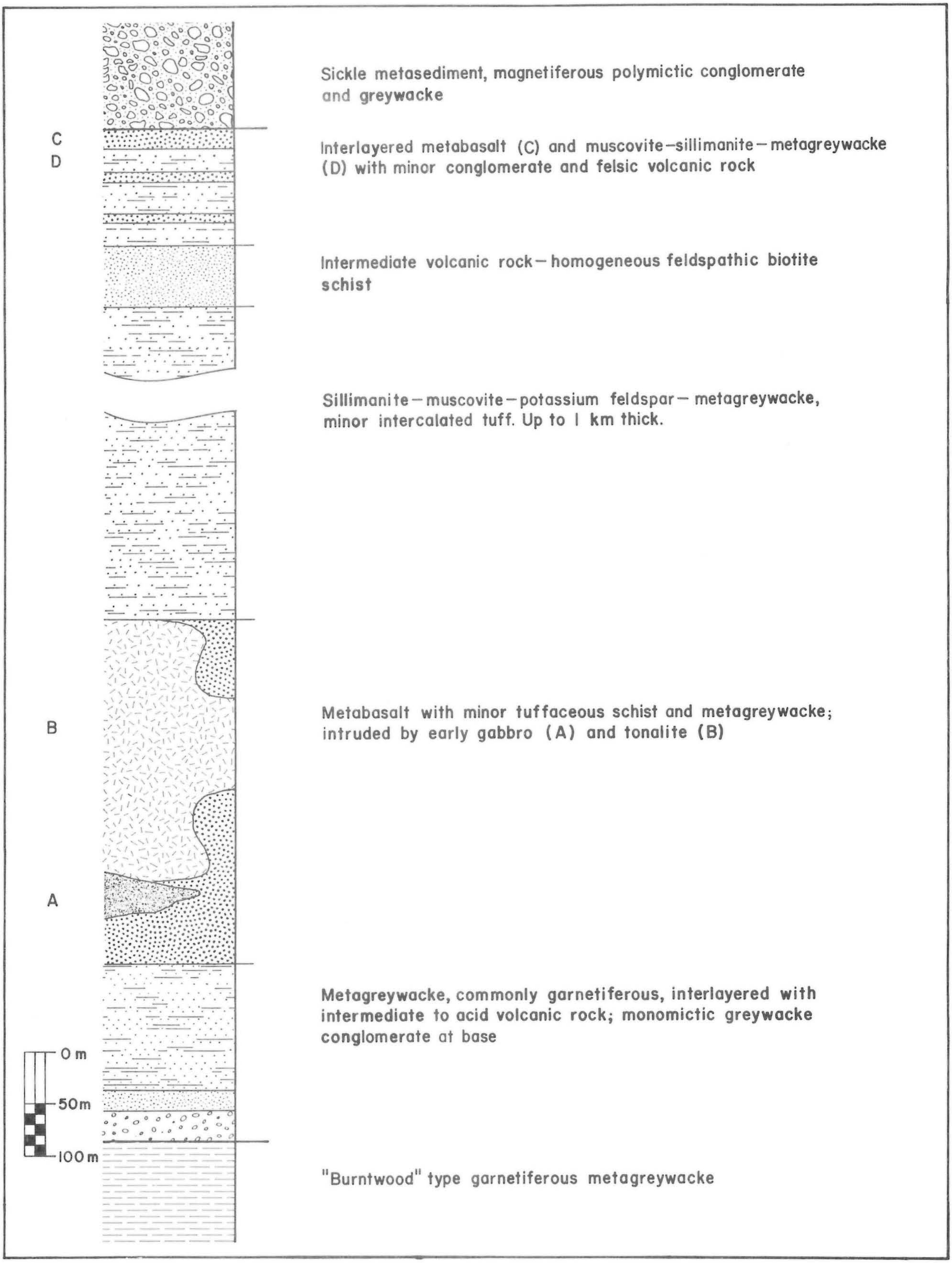

FIGURE GS-1-2: Composite stratigraphic section for the sedimentary-volcanic sequence exposed on Partridge Breast Lake.

SUPRACRUSTAL ROCKS

McRitchie (1978) observed the "generalized threefold subdivision of supracrustal rocks into metagreywacke, meta-arkose and metavolcanic associations, as used elsewhere in the Churchill Structural Province", as being "equally relevant to the Northern Indian Lake area". Supracrustal xenoliths composed of schists, metatexites, diatexites and recognizable anatectic derivatives are observed as isolated rafts in many outcrops. Belts up to several kilometres thick, rich in relict supracrustal xenoliths, commonly occurring as trains of inclusions, crop out on a section of the Churchill River from Fidler Lake to Kirkness rapids, on the Churchill River at The Four rapids, and on the Churchill River downstream from the confluence of the Churchill and Little Beaver Rivers.

More extensive zones of well preserved supracrustal rocks, described by McRitchie (1978), form a 1 km by 15 km belt of metatexites which trend eastward then swing to the southeast through the centre of Northern Indian Lake (Preliminary Map 1979 M-1).

PARTRIDGE BREAST LAKE

Extensive exposures of well preserved low mobilizate supracrustal rocks crop out along the south and east shores of Partridge Breast Lake. This block of generally east trending metasedimentary and metavolcanic rocks can be traced through sporadic exposures for approximately 25 km south of Partridge Breast Lake to an area of no outcrop. Further outcrops of metavolcanic rocks and metasedimentary rocks occur on the northern half of Gauer Lake southward to the contact of the Baldock batholith. To the east on Thorsteinson Lake, a few exposures of supracrustal rocks persist and are terminated by a large granitic intrusive. This belt comprises the eastern extension of the Southern Indian Lake sedimentary gneiss belt (Cranstone, 1972).

The general sequence of rocks observed on Partridge Breast Lake consists of a lower greywacke, a 1 to 2 km thick sequence of interlayered metagreywacke and mafic to acid volcanics, and a thick overlying sequence of "Sickle-type" meta-arkoses.

The lowermost unit of greywackes consists of interlayered psammites and pelites. These are typical "Burntwood style" metagreywackes containing pinhead garnets in the psammites, 1 to 2 cm garnets in the pelites, minor graphite and abundant calc-silicate boudins.

A complexly interlayered sequence of greywacke, volcaniclastic rocks and volcanic flows approximately 1 km thick overlies the garnetiferous greywackes (Fig. GS-1-2).

The lowest unit in the sequence comprises 300 m of psammitic greywacke and greywacke conglomerate interlayered with intermediate flows 1 to 15 m thick and several thin fragmental units. This is overlain by a sequence of mafic flows ranging from 15 to 50 m thick, composed dominantly of massive equigranular and aphyric basalts. This, in turn, is overlain by several hundred metres of sillimanite-muscovite-potassium feldspar-psammites and pelites. The sequence is generally more pelitic at the base gradually increasing in the psammitic fraction up section. Several tuffaceous schists 10 to 50 cm thick occur as discrete layers within the greywackes.

The upper 300 m is composed of interlayered psammites, pelites, minor greywacke conglomerates with numerous andesite flows, tuffaceous schists and basaltic flows. The top 30 m is dominated by a series of 1 to 2 m amygdaloidal basalts, feldspar-phyric basalts and a possible pillow breccia. Within this zone intercalated muscovite-rich pelites are generally magnetiferous.

The top of the exposed sequence is marked by a thick section of conglomerates and psammites grading upwards into biotite and sillimanite arkoses.

The base of the conglomeratic section comprises thickly bedded clast-supported polymictic conglomerates with a pelitic to semi-pelitic matrix and a few 10 to 20 cm thick semi-pelite beds, many of which contain a grit fraction. These beds contain numerous 0.5 to 2 cm muscovite blasts, 0.5 to 1 cm grey microcline blasts and magnetite.

The upper half of the conglomeratic sequence consists of a distinctly psammitic section of 20 cm to several metre thick polymictic pebble conglomerates, commonly graded or internally cross-bedded, with up to 4 m thick cross-bedded light grey psammites.

Several outcrops of interlayered biotite and sillimanite arkoses form the top of the exposed sequence.

INTRUSIVE ROCKS

The Chipewyan and Baldock batholiths are best referred to as intrusion complexes. There are several phases of intrusive rocks associated with the complexes that range in composition from quartz diorite to quartz syenite. The major rock type for both batholiths is a pink magnetite-bearing porphyroblastic granite. This coarse inequigranular rock can contain from 5% to 60% of subhedral microcline blasts.

The Baldock batholith contains several phases that tend to form discrete homogeneous bodies with fairly sharp contacts. The Chipewyan batholith by way of contrast is far more complex in its internal structure, and consists of sheet-like layering of intrusive phases. There is a general tendency for the most potassic phases to occur in the eastern part of the area along the Churchill River from Fidler Lake to the junction with the Little Beaver River. The rock exposed in this area is a quartz-poor (5 to 15%) red porphyroblastic quartz syenite. In the west the porphyroblastic unit has a granite to granodiorite composition.

From Partridge Breast Lake to Northern Indian Lake the intrusive phase most commonly found in contact with the supracrustal rocks is a grey coarse grained gneissic granodiorite to tonalite.

The sequence of intrusive rocks, from oldest to youngest, observed in the area is:

(a) Diorite and quartz diorite plugs occurring on Northern Indian, Partridge Breast and Gauer Lakes. These salt-and-pepper textured hornblende diorites with 0% to 10% quartz are usually found in the proximity of supracrustal rocks.
(b) Tonalite and leucotonalite. The felsic intrusion breccia described by McRitchie (1978) is a border phase of the tonalite. These two units (i.e. a and b) appear to predate the Sickle sediments.
(c) Narrow diabase dykes, never exceeding 1 m in width, cut across the diorite and tonalite bodies but occur as inclusions in the latter intrusives.
(d) Extensive bodies of gneissic hornblende granodiorite are the first major intrusions in the area. They contain inclusions of all the supracrustal rocks observed in the area.
(e) Porphyroblastic granite to quartz syenite comprises the bulk of the Chipewyan and Baldock batholiths.
(f) Quartz-poor potassic pegmatites are found throughout the area cutting all preceding phases.
(g) Porphyritic leucogranite (anatectic granite) plugs occur mainly in the area south of Northern Indian Lake.
(h) Diabase dykes up to 10 m thick, commonly with gabbroic to ultramafic compositions occur sporadically throughout the area. They trend 300° to 320°.
(i) Grey fine-grained magnetiferous granite occurs as dykes and small bodies throughout the area, but is particularly abundant in the area between Partridge Breast and Northern Indian Lakes.
(j) Quartz-rich potassic pegmatites, commonly zoned and differentiated, occur as bodies ranging from dykes a few centimetres thick up to plug-like bodies 200 m by 500 m. They are commonly associated with, and in some locations cut by, networks of pink aplite dykes.

In addition to the above units, there are small bodies of gabbroic to ultramafic rocks noted on Northern Indian Lake for which the age sequence is not certain, although they definitely precede the porphyroblastic granite.

ECONOMIC CONSIDERATIONS

The 1 to 1.5 km sequence of interbedded metasedimentary and metavolcanic rocks observed over an extensive area on Partridge Breast Lake and extending southward to Gauer Lake contain volcanic rocks ranging from basaltic to acid fragmental. Locally these contain minor sulphide phases consisting of pyrite, pyrrhotite and rare chalcopyrite. Massive chalcopyrite occurs as lenses up to 0.5 by 5.0 cm in amphibolitic clots in an andesitic unit on the western part of Partridge Breast Lake. Traces of malachite reported by McRitchie (1978) in a muscovite conglomerate were confirmed and further occurrences of malachite were found at the same horizon.

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GS-2 MELVIN LAKE PROJECT

(64C/16, 64F/1)

by H.P. Gilbert

INTRODUCTION

The objectives of six weeks' field work in the Melvin and Barrington Lake areas were:

(1) Investigation of the stratigraphic relationship between the volcanic rocks of the Lynn Lake greenstone belt and metasedimentary rocks to the north, and

(2) Structural and stratigraphic investigation of the volcanic section at southern Barrington Lake; comparison of this section with the Wasekwan Group stratigraphy established in the area to the west (Gilbert, Syme and Zwanzig, 1976, 1977, 1978); and evaluation of the potential for base metal mineralization in this area.

MELVIN LAKE-NORTHERN BARRINGTON LAKE AREA

The oldest rocks identified comprise greywacke-derived schist and gneiss occurring in *lit-par-lit* structure with several tonalitic phases (unit 4, Table GS-2-1). These rocks occur in three east-trending zones separated by granitoid intrusions (Fig. GS-2-1); polymictic cobble/boulder conglomerate (unit 8) of the Sickle Group occurs on Melvin Lake at the south margin of the northern metasedimentary zone. Remnants of the paragneisses also occur within the dominantly granitoid areas. Continuity between the three zones in the area east of Melvin Lake is indicated by the mapping of Hunter (1952). Amphibolite of possible volcanic origin occurs as rare interlayers within the paragneiss at Melvin Lake and comprises remnants within a quartz diorite zone in tonalite-granodiorite (6) at northern Barrington Lake (Fig. GS-2-1). Polymictic cobble/boulder conglomerate (8) occurs within the quartz diorite; this represents an extension of the conglomerate at the northern margin of the Lynn Lake greenstone belt which has been mapped from Zed Lake to Hughes River (Gilbert and Syme, 1977; Syme and Gilbert, 1977). The latter conglomerate has been interpreted as overlying both the greywacke-derived paragneiss to the north, and the greenstone belt to the south in the keel of a synclinal structure (Gilbert, 1976). The mafic volcanic unit north of the conglomerate between Zed Lake and Hughes River is represented at Barrington Lake by the quartz diorite zone within the tonalite-granodiorite intrusion (6). It is interpreted as the product of contamination by a former mafic volcanic section. The local occurrence of greywacke-derived paragneiss (4) within the quartz diorite zone at Barrington Lake is interpreted as an infolded or faulted body derived from the metasedimentary terrain north of the quartz diorite (Fig. GS-2-1). A late, layered gabbronorite intrusion (10) at central Melvin Lake is largely undeformed. Minor granitoid intrusions in the gabbronorite and massive granitic and pegmatitic dykes (11) throughout the area are the youngest phases recognized.

PARAGNEISS AND SCHIST; TONALITE (4)

Greywacke-derived rocks commonly display pale to dark grey 1 to 30 cm thick layering (reflecting variable biotite content), or comprise massive units up to 50 cm thick. Turbidite units were identified at one location (lower slightly graded unit → parallel-laminated unit → upper fine-grained unit). The metasedimentary rocks are generally semipelitic, but pale grey to beige, relatively more psammitic lithologies also occur in the section. Pink arkosic gneiss with thin (1 to 3 cm) micaceous laminae occurs 2.5 km southeast of the island of conglomerate (8) at western Melvin Lake. Rare pebble-conglomerate layers occur within metagreywacke east of Melvin Lake; the clasts, which are highly attenuated, include felsic, intermediate, and dark micaceous lithologies. Epidote-rich pods with hornblendic rims occur within paragneiss near the southern extremity of Melvin Lake.

Table GS-2-1 TABLE OF FORMATIONS, Melvin Lake — Barrington Lake Area

PRECAMBRIAN

Intrusive Rocks

11 Tonalite, granodiorite, granite, pegmatite

10 Gabbronorite, gabbro, amphibolite

9 Diabase, porphyritic diabase

Sickle Group

8 Cobble/boulder conglomerate with minor feldspathic greywacke interlayers

Intrusive Rocks

7 Quartz-plagioclase porphyry

6 Tonalite, granodiorite, granite, pegmatite; quartz diorite, diorite

Probable Wasekwan Group age

5 Amphibolite

4 Paragneiss and schist derived from feldspathic greywacke and arkose intruded by tonalite

Wasekwan Group

3 Feldspathic greywacke, argillite, conglomerate

2 Porphyritic and aphyric dacite and rhyolite flows and related intrusive rocks; intermediate to felsic pyroclastic breccia and lapilli-tuff

1 Porphyritic and aphyric basalt and minor andesite flows, related breccia, and minor gabbro; mafic to intermediate tuff, crystal and lapilli-tuff, and pyroclastic breccia

W Undifferentiated volcanic and sedimentary rocks (Wasekwan Group) after Milligan (1960)

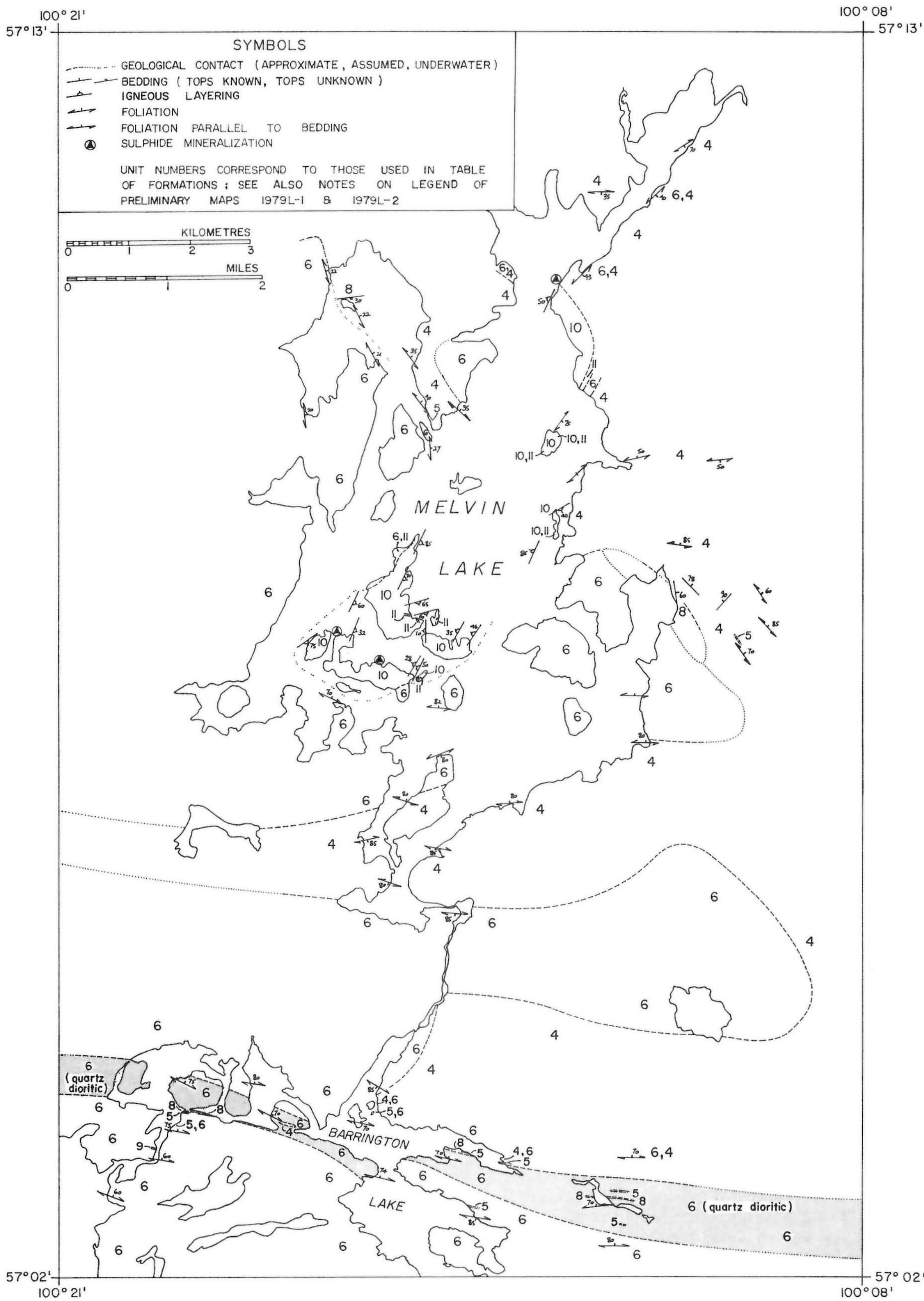

FIGURE GS-2-1: General Geology of the Melvin Lake — Northern Barrington Lake area.

Tonalitic *lits* and dykes in the metasedimentary section include at least two pre-tectonic and one post-tectonic phase. The earlier *lits* are isoclinally folded and disrupted by moderate to vertically plunging folds. The metasedimentary rocks are partly assimilated by the tonalite, and are locally reduced to thin micaceous screens within the latter. Sporadic porphyroblasts of garnet and hornblende and muscovite-sillimanite knots within metagreywacke at east-central Melvin Lake are possibly related to the intrusion of tonalite.

AMPHIBOLITE (5)

Several units of fine-grained, gneissoid amphibolite, 1 to 2 m thick, are interlayered with garnetiferous paragneiss east of Melvin Lake. A thicker amphibolite unit (at least 5 m thick) occurs at an equivalent stratigraphic position at western Melvin Lake.

Massive medium-grained amphibolite comprises a 20 m thick unit within quartz diorite east of northern Barrington Lake. Fine-grained pyritiferous amphibolite at least 2 m thick occurs immediately south of the conglomerate (8) at northwestern Barrington Lake. The amphibolite units are interpreted as part of the original stratigraphic sequence, derived from flows or calcium-rich sediments.

COBBLE/BOULDER CONGLOMERATE WITH MINOR FELDSPATHIC GREYWACKE INTERLAYERS (8)

The conglomerate at Melvin Lake contains a diverse assemblage of cobbles and boulders which include felsic and mafic volcanic rocks, felsic porphyry, quartz, tonalite, and possible feldspathic greywacke. The unit is generally strongly foliated and clasts are attenuated, but angular and rounded fragments are locally well preserved at the east-central shore of Melvin Lake. The matrix is hornblendic greywacke. Minor feldspathic greywacke interlayers occur within the conglomerate, which is at least 150 m thick at western Melvin Lake. Graded bedding in one greywacke interlayer at eastern Melvin Lake indicates a northeastward direction of facing; the overlying conglomerate unit displays reverse to normal graded bedding.

At least 25 m of polymictic conglomerate at northern Barrington Lake is similar to the conglomerate at Melvin Lake in both clastic components and matrix-type. The unit is strongly foliated and clasts are highly attenuated (e.g. 10 cm x 4 mm). Epidotic alteration is characteristic.

SOUTHERN BARRINGTON LAKE AREA

The dominantly mafic volcanic section at southern Barrington Lake comprises the eastern extension of the greenstone belt which has been mapped for approximately 45 km from the area southwest of Lynn Lake east to the vicinity of Auni Lakes. The section south of Barrington Lake provides the best and most accessible exposure of the eastern end of the belt; the mapping conducted in this area will provide a basis for further work in the area between Barrington and Auni Lakes.

A volcanic belt (approximately 2700 m wide) trends southeasterly between White Owl and Larson Lakes (Fig. GS-2-2); the section consists largely of mafic volcanic flows and related breccia (1). Felsic volcanic rocks (2) comprise minor fragmental interlayers and thicker flows and sills (up to 140 m) which are most extensive in the vicinity of Barrington River (Fig. GS-2-2). Mafic tuff and crystal tuff occur sporadically within the volcanic flows, and are well developed in the northern part of the section north of Nickel Lake; a unit of mafic tuff also occurs between Nickel and Larson Lakes. Major gabbro intrusions (10) occur south of the volcanic rocks at Nickel and Larson Lakes; the age of these gabbros is uncertain; the intrusions were considered to be pre-Sickle Group by Milligan (1960). The section thins eastwards towards Spider Lake and extends a further 24 km to the Macbride-Magrath Lakes area (Kilburn, 1956). A north-trending section of volcanic rocks extends from the vicinity of Webb Lake along the eastern shore of Barrington Lake to the area south of Star Lake. Felsic volcanic interlayers are relatively more abundant in this section than in the White Owl Lake-Larson Lake section, and a large body of rhyolite occurs just west of Webb Lake.

An anticlinal structure has been mapped in the northern part of the White Owl-Larson Lakes section; it is uncertain whether the section south of this structure is monoclinal or synclinal, as indicated by limited structural data. The Webb Lake-Star Lake section follows the margin of an ovoid granitoid body comprising part of the major granitoid intrusion east of Barrington Lake. Pillow-tops indicate this section faces west, away from the granitoid body.

Sulphide occurrences are numerous within the volcanic section at southern Barrington Lake; the majority, which occur in narrow (10 to 50 cm) silicified zones within the mafic volcanic flows, consist of pyrite ($\pm$ pyrrhotite); chalcopyrite and malachite are relatively rare. Earlier mapping (Crombie, 1948) also reported sphalerite, and molybdenite and gold showings associated with granitic intrusions; chalcopyrite associated with gabbro was also reported. Some felsic volcanic and/or fragmental interlayers are associated with sulphide mineralization. An occurrence of pyrite, pyrrhotite and chalcopyrite was found in fine-grained hornblendite (1) interlayered with tuff at the margin of a quartz-plagioclase porphyry body (7) at the northern end of the Webb Lake-Star Lake section. This mode of occurrence may provide good potential for further work in the area, but no conductors are shown in this section on the Questor INPUT Survey map (1977) with one exception, which is associated with an old showing reported by Norman (1933). However, conductors are common in the section between Spider Lake and Nickel Lake, and between White Owl and Auni Lakes.

MAFIC METAVOLCANIC FLOWS AND FRAGMENTAL ROCKS; MINOR RELATED GABBRO (1)

Mafic volcanic rocks are dominantly plagioclase-phyric; hornblende (after pyroxene phenocrysts) is common, generally subordinate to plagioclase, but basalt containing only hornblende is also present (approximately 2% of the section). Aphyric basalt occurs as flows and minor intrusions in the porphyritic rocks. Amygdaloidal rocks are widespread, and are locally associated with the segregation of irregular bodies containing up to 75% quartz amygdales. Flow-top breccias consist of concentrations of these bodies (originally vesicular, and now generally altered to epidote). Metamorphism of the breccias results in zones of epidote and quartz stringers and veins. Epidosite bodies also occur sporadically in the flows, and are commonly accompanied by enclaves of several mafic lithologies defined by various porphyritic textures. These "flow-breccias" are locally gradational with massive flows in contrast to pyroclastic breccias which are associated with the tuffaceous rocks. Flow-trends are locally indicated by diffuse zones defined by variable content of plagioclase or quartz amygdales and by finely laminated aphyric units within some porphyritic flows. Some flow-contacts display several zones related to chilling, brecciation and alteration. Pillows are rare in the White Owl-Larson Lakes section, but a well preserved unit of pillowed, amygdaloidal basalt occurs northwest of Webb Lake. Some flows in the Webb Lake-Star Lake section contain vesicles filled with hornblende, and rare hornblende and pyrite or quartz and pyrite.

Gabbro and andesite are subordinate lithologies within the mafic volcanic section ($<5\%$). Pale grey, felsic andesite comprises a 350 m thick unit at the southeastern shore of Barrington Lake; the unit contains minor porphyritic interlayers and numerous concordant gossaned zones (up to 5 m thick) containing disseminated pyrite and pyrrhotite. Felsic andesite, which locally contains pyrite ($\pm$ chalcopyrite and malachite), also comprises minor concordant units (50 cm to 1 m thick) within basalt. The andesite is characterized by green hornblende stringers, aggregates and sporadic prisms; some andesite units may represent silicified basalt. The basalts are recrystallized to green hornblende-andesine assemblages. Flow-

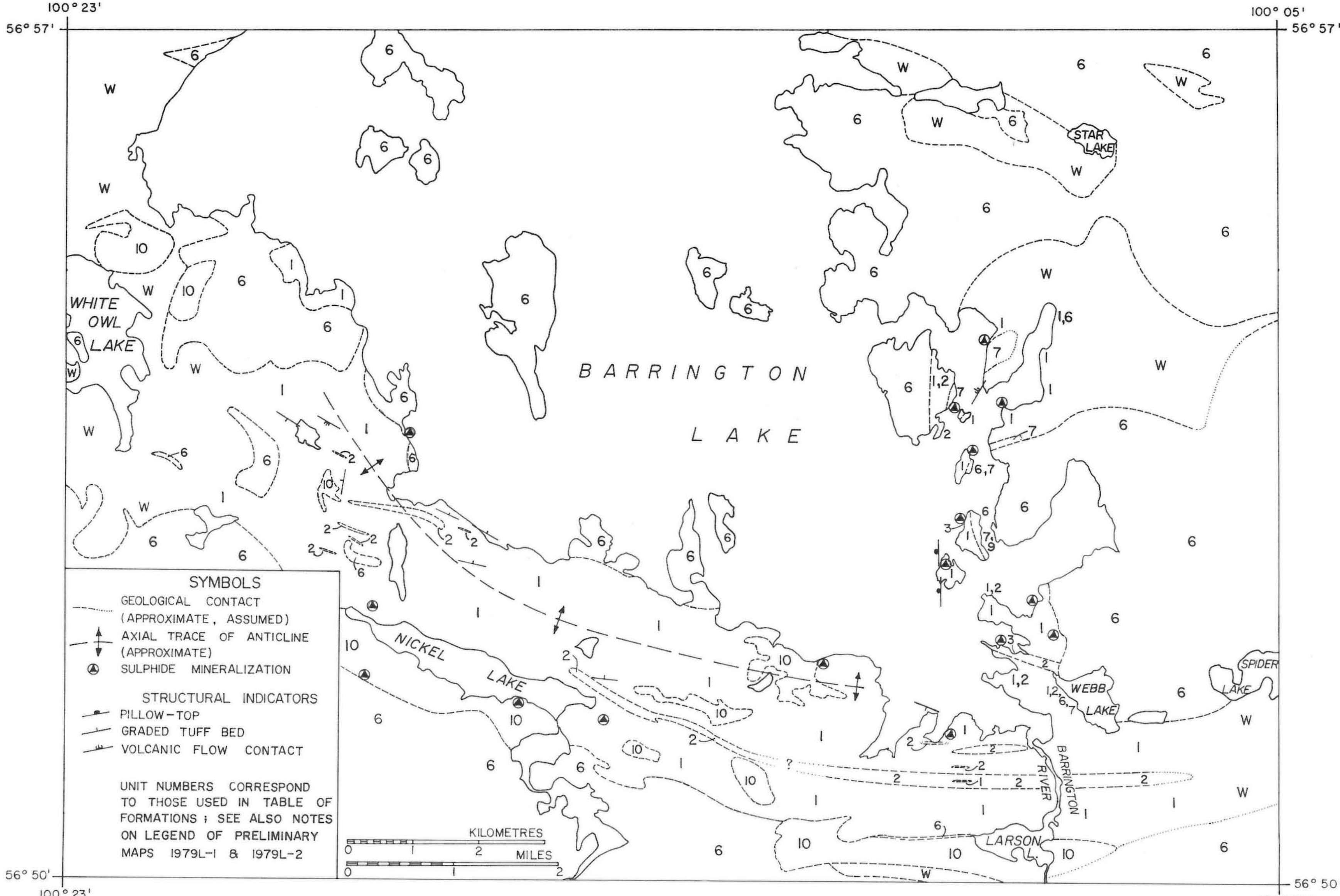

FIGURE GS-2-2: General Geology of the Southern Barrington Lake area.

breccias in the southern part of the White Owl Lake-Larson Lake section are altered to strongly-foliated gneiss with alternating feldspathic/hornblendic laminae derived from the original fragments and matrix respectively.

Mafic tuffs occur as massive units (up to several m thick) or bedded sequences (1 to 30 cm thick layers) which locally display grading of plagioclase and/or lapilli. Bedding is locally preserved at the south shore of Barrington Lake, but the tuffaceous unit between Nickel and Larson Lakes consists of a strongly foliated very fine grained amphibolite devoid of bedding. Fine metamorphic laminae (alternating pale and dark green) parallel to bedding occur in some units. Subordinate lapilli-tuff interlayers within the aphyric and crystal-tuffs are similar to the coarser pyroclastic breccias which comprise less than 5% of the section. Fragment-types are predominantly aphyric and porphyritic felsic and intermediate lithologies; basaltic clasts are subordinate or absent. The pyroclastic rocks are generally distinguished from breccias related to mafic flows by the detrital texture of the matrix.

INTERMEDIATE TO FELSIC METAVOLCANIC FLOWS; RELATED INTRUSIVE AND VOLCANIC FRAGMENTAL ROCKS (2)

Intermediate to felsic volcanic units, which comprise approximately 10% of the volcanic sections at southern Barrington Lake, include extrusive and shallow intrusive bodies. The units in the southern part of the Webb Lake-Star Lake section are largely extrusive, whereas intrusive bodies are predominant in the north. Porphyritic plagioclase (± quartz) dacite to rhyolite is the most common lithology, whereas aphyric rocks comprise a minor part of the section. The rocks are very fine grained to aphanitic, and contain micaceous lenticles (± hornblende prisms ± garnet). Several flows contain vesicles filled with quartz (± hornblende). Concordant hornblendic stringers occur in some felsic flows, and some units display streaky, micaceous zones which are probably the result of contamination. Fragmental structure within the flows is very rare. Quartz-porphyry bodies (7) in the marginal part of the tonalite-granodiorite intrusion east of Barrington Lake are more coarsely porphyritic than the majority of the syn-volcanic porphyries (2), but there is a possible genetic relationship between the two types. Distinction between these units is not always clear, especially in the Webb Lake-Star Lake section.

Intermediate to felsic pyroclastic breccia contains aphyric and porphyritic felsic and subordinate mafic fragments in a tuffaceous matrix; these units are locally associated with massive felsic volcanic flows. The breccias are relatively rare in the Webb Lake-Star Lake section; the thickest units (up to 85 m) occur east of Nickel Lake and north of the west end of the lake.

FELDSPATHIC GREYWACKE, ARGILLITE AND CONGLOMERATE (3)

Metasedimentary rocks were observed at only two locations in the southern Barrington Lake area. Feldspathic greywacke and well laminated argillite units (0.5 to 1 m thick) occur within porphyritic rhyolite northwest of Webb Lake. Fragmental volcanic rocks further north in this section include a conglomerate characterized by mixed volcanic fragments in a pyrite-bearing siltstone matrix.

INTRUSIVE ROCKS (6,7,9,10 & 11)

The oldest intrusive rocks identified in the Melvin Lake-Barrington Lake area comprise disrupted, concordant tonalitic *lits* within paragneiss and schist (4). These massive to gneissoid, leucocratic phases are probably coeval with the major tonalite-granodiorite intrusion which wedges out across central Melvin Lake towards the east. Porphyritic phases of the intrusion south of Melvin Lake occur as *lits* within the greywacke-derived gneiss to the north. The quartz diorite zone within this intrusion at northern Barrington Lake may correspond to a former mafic volcanic section now represented by remnant amphibolite bodies within the quartz diorite. The granitoid rocks in this vicinity contain sporadic hornblende and/or biotite-rich xenoliths which are partly altered, with development of plagioclase porphyroblasts.

Massive gabbronorite (10) comprises an ovoid intrusion in the south-central part of Melvin Lake. Rhythmic igneous layering is well-preserved, dipping more steeply at the margins of the body. The intrusion is undeformed, and alteration of primary plagioclase and pyroxenes is generally minimal. Pegmatitic gabbro occurs at the margins of the intrusion and contamination has resulted in the development of coarse garnetiferous phases at a few places. Fine-grained tonalite-granodiorite and granitic pegmatite (11) intrude the gabbronorite in minor and major dykes (up to 30 m thick); these are generally massive, but cataclastic deformation has affected some pegmatite.

The major granitoid intrusion east of Barrington Lake consists of massive to slightly gneissoid tonalite, granodiorite, and granite (6). Enclaves of more gneissoid granitoid rocks reported by Hunter (1952) indicate a young age for this intrusion at northern Barrington Lake. The intrusion east of southern Barrington Lake is of uncertain age; correlation of related porphyritic phases with synvolcanic porphyries suggests an older age for this intrusion, possibly contemporaneous with the granitoid rocks (6) at Melvin Lake. The intrusion north of Webb Lake is invaded by massive aphyric and porphyritic diabase (9) which also intrudes the volcanic rocks in this vicinity.

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GS-3 SICKLE LAKE (South Half)

(63C/10)

by H.V. Zwanzig

INTRODUCTION

Selected areas southeast and southwest of Sickle Lake were mapped during six weeks in 1979 at a scale of 1:50 000, with the assistance of T. Shklanka (Preliminary Map 1979L-3). The terrain is largely granitic but attention was directed to outliers of metavolcanic and metasedimentary rocks of the Wasekwan Group and to the stratigraphy of the unconformably overlying metasedimentary rocks of the Sickle Group.

The most important findings include Wasekwan dacite and rhyolite, with trace mineralization at one locality, and with associated cordierite-anthophyllite schist and iron formation at another locality.

GENERAL GEOLOGY

Granitic plutons containing large screens of Wasekwan Group rocks occur in an uplifted block between Amy Lake and McGavock Lake (Fig. GS-3-1, see also Cameron, this volume). The Sickle Group sandstones and conglomerates occur in a large synclinorium that is curved around the granitic block on the northeast. Plutons separated by narrow belts of Wasekwan Group rocks occur on the east limb of the synclinorium.

The metamorphic grade is medium to low in much of the area, such that the intrusive relationship of granite into the Wasekwan Group, and the unconformable relationship of the Sickle Group is preserved at several localities. However, west of Finch Lake (Fig. GS-3-1) the metamorphic grade is high and all the rocks are injected by pegmatite and leucogranite. The western plutons are strongly foliated and screens of Wasekwan Group gneiss lie parallel to their margins. Belts of high-grade gneiss of the Sickle metamorphic suite are concordant with the older rocks: presumably unconformable relationships have been destroyed by post-Sickle deformation. Within the sillimanite-bearing rocks, vestiges of basal conglomerate are preserved only for a short distance on the south shore of Finch Lake.

The structural style of the granitic terrain is typified by a small dome at Hunter Lake (Preliminary Map 1979L-3). The domal granodiorite core is mantled with Wasekwan amphibolite which is overlain in turn by muscovite schist in which basal Sickle conglomerate is locally preserved. The granodiorite was domed during post-Sickle deformation.

WASEKWAN GROUP

Amphibolite (unit 1) occurs in a 300 m thick mantle on the Hunter Lake dome and as rafts to the south and east. It is fine grained and is interpreted as metabasalt. Porphyritic varieties occur at Lasthope Lake and southeast of Black Trout Lake.

A mafic to felsic volcanic succession extends for 5 km in a large screen south of Lasthope Lake. Felsic rocks (unit 3) lie north of the intermediate (unit 2) and mafic volcanics. Massive dacite and rhyolite (3a) occur with breccia (3b) containing angular fragments of dacite in an intermediate, porphyritic matrix. The breccia locally contains traces of pyrrhotite and chalcopyrite. Felsic tuff (3c) may be present in dacite interlayered with iron formation southeast of Black Trout Lake. This body of dacite contains breccia with staurolite porphyroblasts, and along strike there is cordierite-anthophyllite schist (3d).

Amphibolite interlayered with felsic gneiss (unit 4) occurs in 1 km thick limbs of a syncline northeast of Finch Lake. Alternating hornblende-rich and hornblende-poor layers 2 cm to 10 m thick resemble mafic mudstone-felsic siltstone successions found elsewhere in the Lynn Lake volcanic belt.

Iron formation (unit 5) up to 1 300 m thick occurs with dacitic rocks southeast of Black Trout Lake. Banded cherty magnetiferous rocks, layered and massive amphibolite (± garnet), and pyrrhotite-bearing amphibolite are interlayered with each other and locally with dacitic rocks.

Felsic sedimentary rocks (unit 6) are rich in biotite ± garnet and occur with the felsic volcanic rocks. Siltstone is grey, massive or laminated; conglomerate contains pebbles of dacite and iron formation with which it is interlayered.

SICKLE GROUP

A 3 000 m thick section between Amy Lake and Chicken Lake is typical of the Sickle Group and includes most units found in the region south of Lynn Lake (Table GS-3-1). The section contains numerous east-facing crossbeds and ripples.

The Sickle Group contains disseminated hematite or magnetite, and concentrated hematite placers. Unit 9 contains pseudomorphs of dolomite rhombs (0.1 mm long) and fine graphite laminations south of Black Trout Lake. The basal 400 to 1 000 m of the group consists of interfingering lenses of conglomerate and sandstone, none of which persist along strike more than 2 km. At Lasthope Lake there is a 500 m thick lens of basal conglomerate overlain by 500 m of conglomerate interbedded with micaceous arkose. The conglomerate pinches out towards the west where changes in the strike of the unconformity may be related to a pre-Sickle topography.

INTRUSIVE ROCKS

A majority of the plutons were intruded and partly eroded before the deposition of the Sickle Group. They mainly comprise granodiorite (unit 14) which occurs in several distinctive phases. Tonalite and quartz diorite (unit 13) occur mainly in narrow bodies along the margins of the granodiorite plutons. Pre-Sickle granite (unit 15) comprises about 15% of the intrusive rocks. Black Trout diorite (unit 16), pegmatite and pegmatitic granite (unit 17) are the only rocks which intrude arkose.

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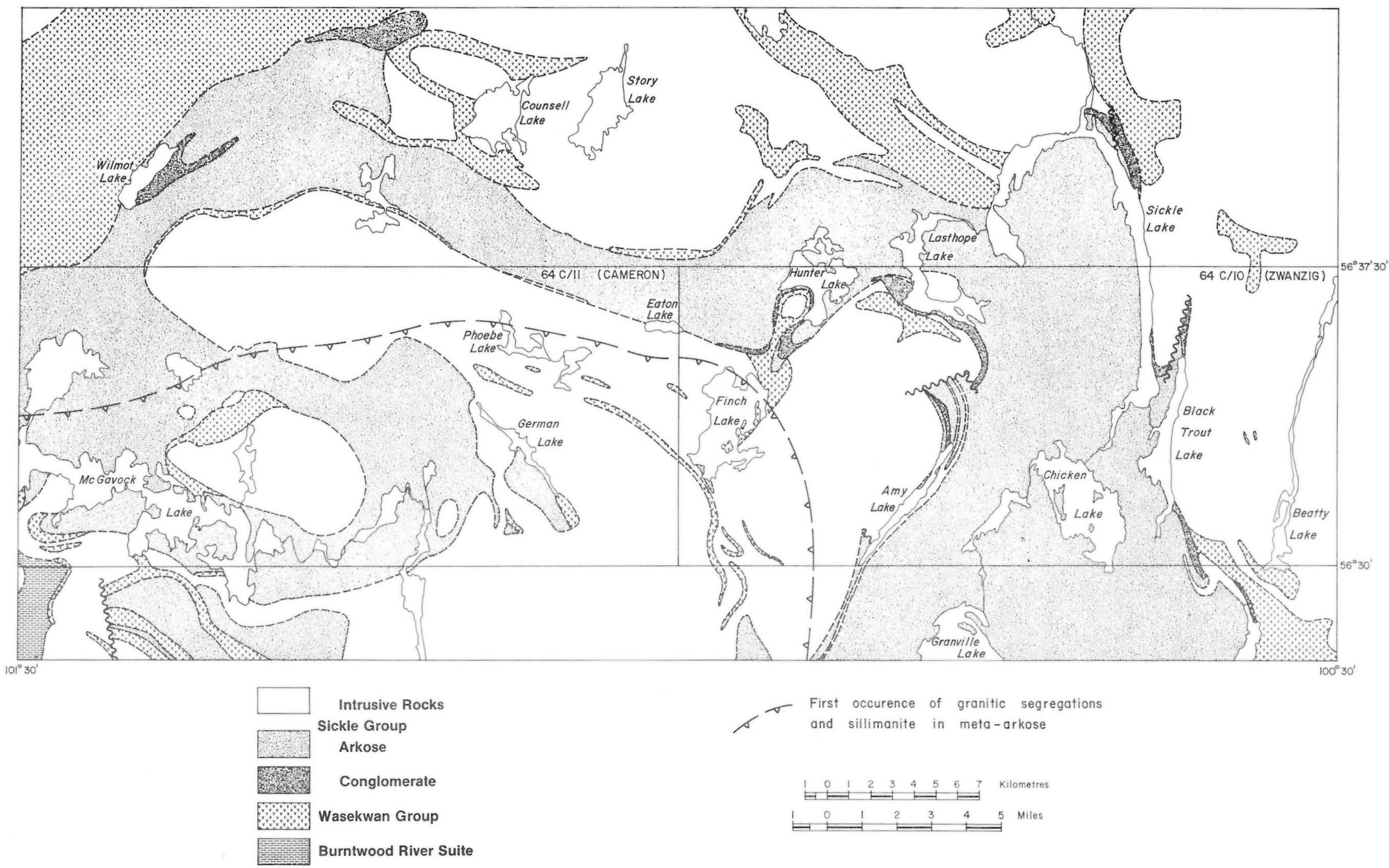

FIGURE GS-3-1: Simplified geology of Sickle Lake (south half) and McGavock Lake (south half).

TABLE GS-3-1. SICKLE STRATIGRAPHIC SECTION

Thickness	Unit	Description
1 100 m	10	Fine, grey, muscovite-bearing sandstone, massive, crossbedded or ripple laminated, commonly with rip-ups of shaly siltstone.
1 100 m	9	Pink, grey and greenish; fine-grained sandstone, massive and laminated, commonly containing secondary amphibole, epidote or carbonate.
200 m	10a	Crossbedded arkose, fining upwards to dense reddish arkose.
200 m	8a	Conglomerate and grey sandstone; fine-grained pink pebbly arkose.
100 m	8	Conglomerate, rounded clasts comprising felsic volcanics, porphyries, granites, quartz and fine-grained sediments.

GS-4 McGAVOCK LAKE (South Half)

(63C/11)

by H.D.M. Cameron

INTRODUCTION

Mapping was undertaken at a scale of 1:50 000 at McGavock Lake and in the German Lake-Finch Lake area as part of the ongoing revision program in the Lynn Lake region. The stratigraphy of the Wasekwan and Sickle Groups and the nature of the intervening granitic rocks were investigated.

GENERAL GEOLOGY

A body of grey tonalitic gneiss, containing screens of Wasekwan amphibolite and metagreywacke up to 200 m wide, dominates the area between German and Finch Lakes. From German Lake west to McGavock Lake the area is underlain by arkosic gneisses of the Sickle Group, intruded by small plutons of granite and pegmatite.

The metamorphic grade is high at German Lake and on southern McGavock Lake where sillimanite-bearing arkose is common. The grade decreases northeast across Finch Lake and northwest across McGavock Lake where muscovite-bearing schists are prevalent. The change in metamorphic grade represented by the first occurrence of sillimanite knots and granitic segregation is delineated by a line running from the west shore of McGavock Lake across the map-area and down to the south shore of Finch Lake (Fig. GS-3-1).

WASEKWAN GROUP

Layered amphibolite (unit 1) occurs as narrow screens and smaller rafts in the grey tonalitic injection gneiss (unit 7a) between Phoebe and Finch Lakes in the eastern part of the area, and between the Sickle meta-arkose and the granitic plutons at McGavock Lake. The amphibolite commonly contains thin hornblende-rich and garnetiferous layers and is locally interlayered with garnetiferous metagreywacke and biotite gneiss (unit 2). Small ultramafic bodies (unit 5) were found on the south side of the amphibolite south of Phoebe Lake and northwest of Finch Lake.

Rafts of a medium-grained leucodiorite (unit 6) occur with amphibolite in the tonalite north of German Lake.

SICKLE GROUP

Arkosic gneisses of the Sickle Group extend from the south shore of German Lake across the area to McGavock Lake. The major unit contains abundant sillimanite knots (unit 4a) and rarely contains magnetite. At German Lake the sillimanite gneiss has been intruded and rafted by dykes of pegmatite extending from a large body of pegmatitic granite (unit 10) northwest of the lake. At McGavock Lake the sillimanite gneiss is better preserved although veins and dykes of younger granite and pegmatite are common on most outcrops.

On the north arm of McGavock Lake the arkose is a fine-grained muscovite-bearing schist (unit 4b). It has a distinctive reddish hematite stain but contains no magnetite.

Very fine-grained arkosic gneiss containing hornblende (unit 3) is found at several locations on southern McGavock Lake. It is characterized by delicate hornblende-bearing layers alternating with feldspathic and siliceous material on a 1 mm to 5 cm scale. Magnetite is abundant in all exposures of this unit and epidote is common in the feldspathic layers.

INTRUSIVE ROCKS

Tonalite (unit 7) and tonalitic gneiss (unit 7a) vary from massive white tonalite to a grey injection gneiss cut by veins of aplite and pegmatite. Amphibolite boudins and smaller schlieren are common in the foliated tonalite north of German Lake. Tonalite also intrudes the amphibolite south of McGavock Lake.

Pink gneissic granite and granodiorite (unit 8) occurs northwest of Finch Lake and in a pluton northeast of McGavock Lake. It is generally free of inclusions and is deeply weathered with a pronounced red hematite stain.

Aplitic granite (unit 9), south of Eaton Lake, is a homogeneous sugary pink unit with fine quartz veining and distinctive 3 mm clots of magnetite. The aplite contains rafts of unit 8 along its southern margin.

Two large bodies of pegmatitic granite are found in the area, one northwest of German Lake and the other on the southwest shore of McGavock Lake. These are massive perthitic bodies commonly showing graphic textures, and contain rafts of units 1, 2 and 3 along their margins. Smaller veins and dykes of pink pegmatite intrude all the other units in the map-area.

GS-5 RUTTAN LAKE, KARSAKUWIGAMAK LAKE, EAGLE LAKE PROJECT

(Parts of 64B/5, 6, 11, 12)

by D.A. Baldwin

INTRODUCTION

A ten week geological mapping program was conducted to collect field data on the physical stratigraphy, volcanic environments and massive sulphide metallogeny in the Ruttan Lake, Karsakuwigamak Lake, Eagle Lake area of the Rusty Lake greenstone belt (Fig. GS-5-1).

The objectives of the investigation are to define:

i) vertical and lateral facies changes;
ii) position of volcanic and exhalative centres;
iii) nature of the volcanoes and their vents;
iv) the stratigraphic position and areal distribution of stratabound massive sulphide mineralization;
v) variations of major elements and metals (primarily Cu-Zn) in lavas both vertically and laterally in stratigraphic sections both proximal and distal to volcanic centres;
vi) the geological environment in which the volcanic rocks and stratabound massive sulphide mineralization were deposited.

The realization of these objectives will result in a documentation of the structural geology, regional stratigraphy, history of volcanism and sedimentation, the number and the nature of sulphide horizons, depositional environments, metal distribution patterns and timing of the mineralization in relation to volcanism: phenomena of prime importance to the development of an exploration strategy for future exploration in the Rusty Lake greenstone belt.

In this report the volcanic rock units outlined on preliminary maps 1979R-1 and 2 are described simply as mafic flows, felsic flows, volcaniclastic rocks and volcanogenic sediments. The areal distribution of rock types, lateral continuity of lithostratigraphic units, facies changes and structural geology are now better defined. The stratigraphic position of stratabound massive sulphide mineralization is not resolved except for the Ruttan Mine (Baldwin, 1978) mainly because of insufficient outcrop where the mineralization occurs. Nevertheless, it can be demonstrated that the mineralization occurs at or close to contacts between volcaniclastic rocks and volcanogenic sediments and in a few cases is associated with exhalite.

Prior to the 1980 field season, stratigraphic petrographic and geochemical analyses will be conducted. The results of these studies will indicate what additional geologic data is required to fulfill the objectives of the investigation. Further field investigations will be carried out in the 1980 field season.

Figure GS-5-1, shows the geographic location of the Rusty Lake greenstone belt, its boundaries and the limits of the project area.

GENERAL GEOLOGY

The volcanic rocks in the Rusty Lake greenstone belt comprise metamorphosed mafic to felsic volcanic flows and derived fragmental and sedimentary rocks. Intrusive rocks include quartz monzonite, tonalite, diorite and diabase.

Steeves and Lamb (1972) defined the Lower and Upper Wasekwan Group. Gilbert (1974) subdivided the Lower Wasekwan Group into an older volcanosedimentary sequence and a younger largely volcanic succession. Due to flooding along the Rat River system the older volcanosedimentary sequence is not exposed.

The exposed part of the Lower Wasekwan Group is 8 000 m thick, consists of mafic and felsic volcanic flow rocks, derived breccias and subordinate volcaniclastic rocks and mafic volcanic derived sedimentary rocks.

The Upper Wasekwan Group has an exposed thickness of almost 5 700 m and consists of mafic to felsic volcanic derived sedimentary rocks, volcaniclastic rocks, debris flows and subordinate mafic and felsic flow rocks and associated breccias.

Contrary to interpretations made from limited observations during the 1978 field season (Baldwin, 1978) more complete data now reveals that there is no geologic indication that repetition of lithologic units results from folding.

The metamorphic mineral assemblage in the greenstone belt is middle greenschist facies. There is a zone of amphibolite facies metamorphism around the periphery of the greenstone belt accompanied by a strong schistosity. This zone varies in width from 300 m to 700 m.

All the metavolcanic rocks in the area have a schistosity. This fabric is best developed in fine-grained mafic flow rocks, in the matrix of volcaniclastic rocks and in the metasedimentary rocks. It is poorly developed in porphyritic mafic flow rocks and felsic flow rocks.

STRUCTURAL GEOLOGY

Reliable younging directions and the absence of major isoclinal folding indicate that the geological structure in the area is a steeply dipping, northerly facing monocline, except for the stratigraphic succession in which the Ruttan Mine occurs; the "Ruttan Block" (Fig. GS-5-2). Here, younging directions and the dip of the strata, are southeast and south. Its stratigraphic position relative to the rest of the belt is now known.

In the north, the "Ruttan Block" is in fault contact with the Upper Wasekwan. In the south its contact with the Lower Wasekwan is obscured by plutonic rocks. In the east the fault appears to terminate against the plutonic rocks and the Lower and Upper Wasekwan Groups are in stratigraphic continuity.

A schistosity parallel to the east-west trend of the belt is present throughout the area. It is commonly parallel to bedding, however, locally it is at small angles to the bedding.

LITHOLOGIES

MAFIC FLOW ROCKS

Two textural varieties of mafic flow rocks have been recognized in the area; porphyritic and aphanitic.

The porphyritic mafic flow rocks consist of phenocrysts of hornblende and/or plagioclase set in an aphanitic matrix. Hornblende is euhedral to subhedral, 2 to 6 mm in diameter and generally forms short stubby crystals. Plagioclase occurs as euhedral to subhedral crystals generally 2 to 3 mm in diameter but locally lath shaped crystals up to 3 mm in width by 7 mm in length are present. The porphyritic mafic flow rocks are greenish-black to greyish-black depending upon the variation in hornblende and plagioclase content. The aphanitic rocks are black or dark green.

Flows are massive, differentiated or pillowed. Massive plagioclase-phyric flows are commonly amygdaloidal. Differentiated flows generally comprise hornblende-phyric rock that grades stratigraphically upward into plagioclase-phyric rock followed by breccia and/or fine-grained, thinly laminated mafic rock that has a clastic appearance. Pillow lavas have been observed in the plagioclase-phyric mafic rocks and in the aphanitic mafic rocks. The aphanitic mafic rock generally forms massive flows that are typically amygdaloidal. Epidote alteration in the mafic rocks, where it

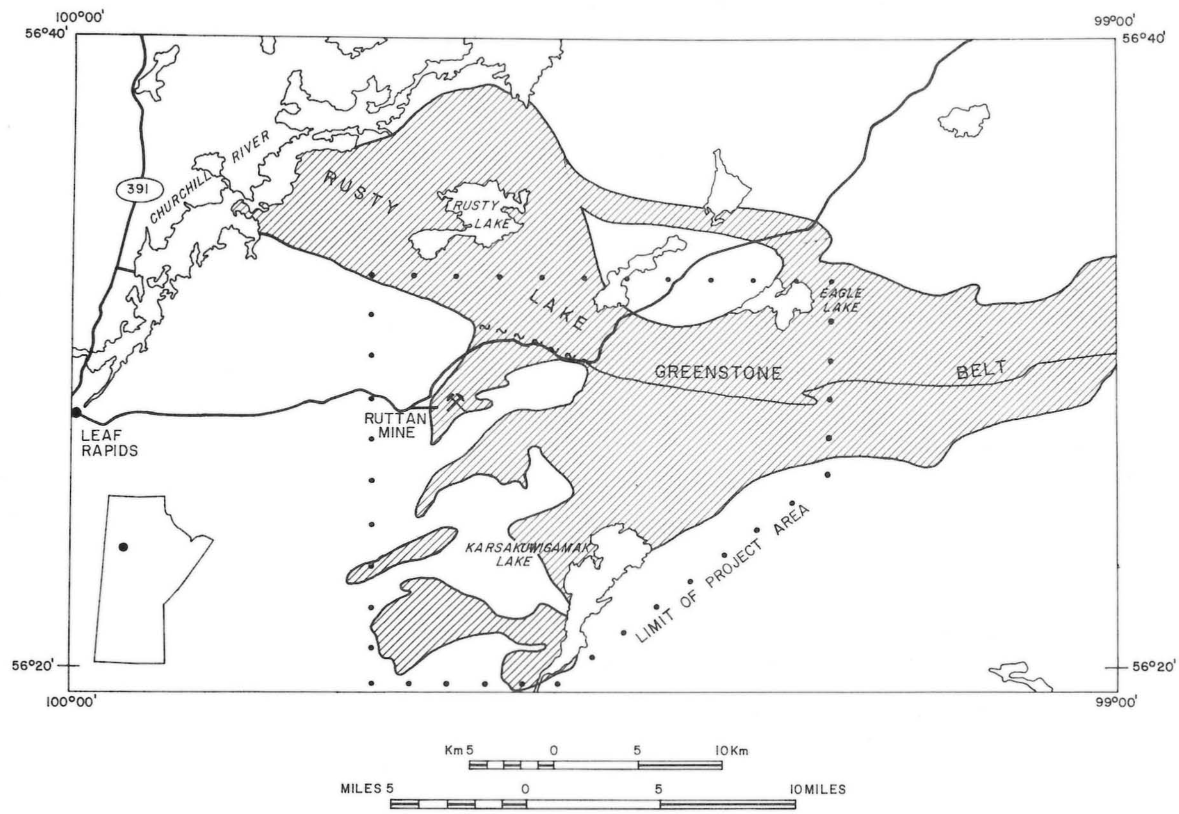

FIGURE GS-5-1: Geographic location of the Rusty Lake greenstone belt, its boundaries and the limits of the project area.

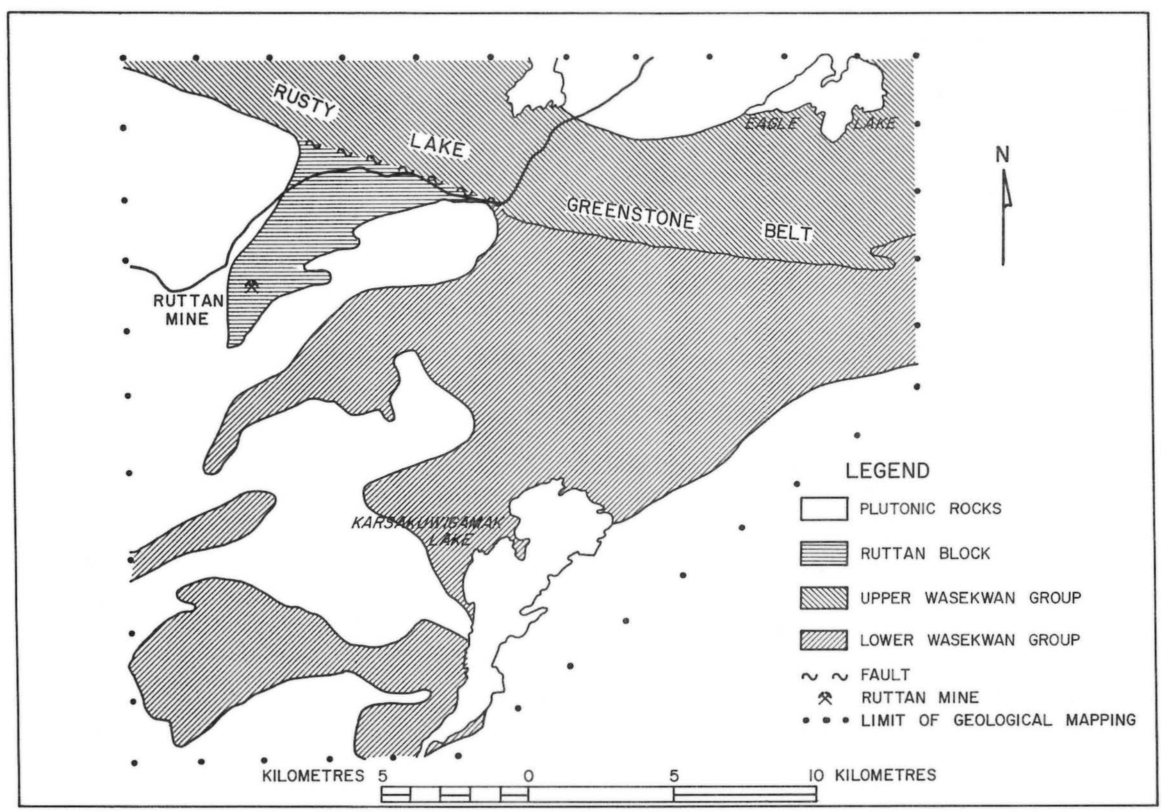

FIGURE GS-5-2: Generalized map of the project area showing the distribution of the Upper Wasekwan Group, Lower Wasekwan Group and the Ruttan Block.

is concentrated and stratigraphically continuous, may represent seawater alteration of flow tops and flow top breccia. The mafic flows vary in thickness from less than 1 m thick up to about 40 m.

FELSIC FLOW ROCKS

Felsic flows in the area are massive flow banded, and autobrecciated and have aphanitic and porphyritic textures. Flow banding is less than 1 cm and is distinguished on weathered surface by faint color variations giving the rock a layered appearance. In autobrecciated rocks the fragments and matrix have the same composition and in many examples the matrix appears to be flow banded. Fragments can be angular to subrounded in shape and are generally greater than 5 cm in diameter. At any one locality the shape and size of the fragments in the breccia is uniform. Autobrecciation and flow banding are best observed in the aphanitic felsic rocks.

Porphyritic felsic rocks form massive flows. Phenocrysts of plagioclase and quartz approximately 1 to 2 mm in diameter are embedded in a matrix with a grain size barely visible to the unaided eye.

Flow thicknesses have not been documented in detail but some are probably about 100 m thick.

VOLCANICLASTIC ROCKS

Included in this unit are all of the fragmental rocks within the area, not identified as flow breccia, which contain volcanic rock fragments greater than 2 mm set in a fine-grained volcanic derived matrix regardless of an epiclastic or pyroclastic origin. The rock may be monolithic (fragments and the matrix have the same composition), or heterolithic (fragments and matrix have different compositions, or there is more than one fragment composition in the rock). The division of heterolithic volcaniclastic rocks into felsic, intermediate and mafic is based on fragment composition regardless of the composition of the matrix.

Most of the heterolithic volcaniclastic rocks in the area are of the type in which there are fragments that have more than one composition. The fragments in the rocks are generally matrix supported and are angular to subrounded in shape, although in many cases tectonic flattening has destroyed the fragment shapes. Bedding is usually not developed and little sorting of the fragments has taken place. These deposits form units that vary in thickness from 15 m to greater than 250 m that can be traced along strike for up to 7 km.

The heterolithic volcaniclastic rocks that contain fragments of more than one rock type probably represent debris flows. To date, pyroclastic rocks have not been positively identified. Nevertheless, it is recognized that some of the monolithic volcaniclastic rocks and heterolithic volcaniclastic rocks with one composition of fragments may be pyroclastic in origin or have a pyroclastic component.

By the definition of volcaniclastic rocks employed in this report the unit also contains rocks that may be called lapilli agglomerate, lapilli breccia and lapilli tuff.

VOLCANOGENIC SEDIMENTARY ROCKS

This unit comprises all bedded fine-grained volcanic derived rocks deposited by sedimentary processes. They vary in composition from felsic to mafic. Graded bedding, rip-ups, scours, bedding imbrication and flame structures are common. Bedding varies in thickness from about 2 mm to 3 m, but most beds are less than 1 m thick. Felsic volcanogenic sediments are typically more thinly bedded than mafic volcanogenic sediments.

Rock types in this unit are tuffs, argillite, greywackes, carbonate-rich thinly bedded rocks and exhalites.

PLUTONIC ROCKS

These rocks have not been examined except to identify the rock types.

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GS-6 THOMPSON NICKEL BELT PROJECT

(Parts of 63 0/8,9; 63P/5, 12)

by R. Charbonneau, R.F.J. Scoates and J.J. Macek

INTRODUCTION

The geological mapping of Paint Lake, initiated in 1978 (Macek and Russell, 1978), is now complete. Rock types encountered in the northern and southern portions of the lake are similar to those observed by Macek and Russell (1978), and consequently field descriptions of those rock types will not be included here. Instead, attention will be directed to new rock units and to additional features not previously described.

METAGABBROIC COMPLEX (1)

Two outcrops of metapyroxenite (1a) were found which consisted of brown-weathering, very coarse-grained (1 to 5 cm) orthopyroxene in a fine-grained matrix of hornblende + clinopyroxene. In part of one outcrop, the large orthopyroxene grains have plumose or fan-like terminations (Fig. GS-6-1). Other metapyroxenite exposures display enormous (15 to 30 cm) interlocking poikiloblastic orthopyroxene crystals.

Layered metagabbro (1b) occurs as isolated outcrops and also forms a few larger bodies, but never more than 1 km long. Layering, interpreted as originally igneous in origin is well preserved in some outcrops. A coarse-grained plagioclase-quartz-orthopyroxene-garnet-cordierite rock is associated with the large metagabbro body in the southwest part of the lake.

RETROGRESSED ENDERBITIC GNEISS (2)

This rock type occurs as small scattered bodies, mainly along the western shore of the lake. In places it grades into a biotite-rich rock which splits readily along the foliation surface.

MIGMATITES (3)

Rocks of the migmatite complex underlie by far the largest part of the map-area. The principal components of the migmatite are:

(1) a grey, felsic, quartz-feldspar-biotite ± hornblende ± garnet rock with gneissic structure;

(2) mafic to ultramafic anorthosite inclusions of various sizes, commonly lens-shaped, but often forming long layers parallel to the foliation in the rock; and

(3) fine-grained to pegmatitic, white or pink granitoid veins, dykes and layers often very folded, and showing pinch and swell structures in various stages of development.

A few exposures of layered quartz-rich rocks, some containing minor graphite, occur within the migmatite.

GRANITOID ROCKS (5)

Dykes and small bodies of pink pegmatite and aplite are common. The composition of these rocks is quartz-potassium feldspar ± plagioclase-biotite. Magnetite occurs as grains that can be 1 cm or more in size. In some pegmatites a black radioactive mineral forming euhedral crystals, the largest exceeding 5 cm in length was observed. Garnet is rare. Most of these granitoid rocks show little deformation, but some of them display a weak fabric.

A fine-grained quartz-feldspar-hornblende-garnet ± magnetite rock, associated with pegmatite, is exposed on a string of islands in the southeast part of the lake (unit 5b). Its homogeneous and massive character combined with its elongate shape suggests an intrusive, igneous origin. Alternatively, it could be a highly migmatized rock that has been thoroughly rehomogenized, thus acquiring a granitoid appearance.

OTHER FEATURES

One of the most intriguing rock types in the area is found in the southwestern bay of the lake. It is a brownish-to-reddish-weathering rock forming a knobbly outcrop surface (Fig. GS-6-2). The rock consists of a large number of twinned orthoclase crystals 2 to 3 cm long, having a roughly rectangular shape, but with rounded corners, set in a fine-grained matrix of quartz-feldspar-biotite-clinopyroxene (orthopyroxene?) ± hornblende. The orthoclase crystals are a dark grey, have their long axes preferentially aligned, and stand out in positive relief because of weathering. Folded, clinopyroxene-bearing, pink granitoid dykes are commonly associated with this unit. Godard (1966) refers to this unit as "microcline-quartz-plagioclase-biotite augen gneiss". As the matrix of this unit is quite mafic, the rock is tentatively classified as belonging to the metagabbro complex (unit 1).

Garnet is common, but its distribution appears to be sporadic. The garnets in the rocks of the metagabbroic complex are orange or red-orange. Those in the grey, felsic components of the migmatite complex are often a pale pink or mauve colour, but orange ones are also present. The garnets fall into the almandine-rich field on the basis of their unit cell dimensions (11.53 - 11.63°A) and high refractive indices.

Molson dykes, which are known to occur elsewhere in the Thompson Nickel Belt (for example on Wintering Lake, as reported by Hubregtse, 1978), are difficult to recognize on Paint Lake. Very strong deformation has either reoriented the dykes parallel to the foliation, or dismembered them.

STRUCTURAL GEOLOGY

The rocks are folded and the dominant folds have shallowly plunging axes to the northeast and southwest at angles up to 35° (Fig. GS-6-3). The folds become disharmonic in the vicinity of major fault zones. Ptygmatic folds are commonly developed in early pegmatites and aplites.

Major faults are marked by well-developed mylonite zones. The presence of narrow (5 to 25 cm) pseudotachylite layers within the mylonite zones indicates extreme mylonitization. Feldspar and quartz porphyroclasts and fluxion structure characterize the pseudotachylite layers. Mylonite zones, across which pseudotachylite layers are developed are up to 15 m wide. The major fault zones can be traced for tens of kilometres on the basis of well-defined topographic lineaments.

Boudinage of competent layers in the migmatite is common and most units can be found in a boudinaged state depending on the relative competancy of adjacent units.

Reorientation of the dominant northeasterly (~ 0.45°) trend of layering and foliation into more northerly trends (0° to 20°) is sporadically developed (Fig. GS-6-4). Other manifestations of this late event include fractures which slightly offset layering and foliation and late pegmatite dykes both of which are oriented in a more northerly direction (0 to 20°). A number of late faults trend in this direction (Fig. GS-6-3).

ECONOMIC GEOLOGY

Sulphide minerals are rare, although pyrite and pyrrhotite grains are sometimes seen in gossan zones which are sporadically distributed throughout the migmatite. Of particular interest are the few localities where small flakes of molybdenite were discovered. The molybdenite is contained within the grey felsic component of the migmatite, in places close to granitoid veins. The largest piece found is a 3 cm long stringer.

The radioactive mineral associated with late pegmatite dykes, mentioned previously, has no X-ray pattern, indicating the crystal structure has been totally destroyed by radiation damage. Optical and chemical investigations will be attempted to determine the identity of the mineral.

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FIGURE GS-6-1: Orthopyroxene porphyroblasts with plumose or fan-like terminations in metapyroxenite (1a). Tape width 2.5 cm.

FIGURE GS-6-2: Mafic gneiss containing strongly oriented orthoclase porphyroblasts (6) which render a characteristic rough, knobbly outcrop surface.

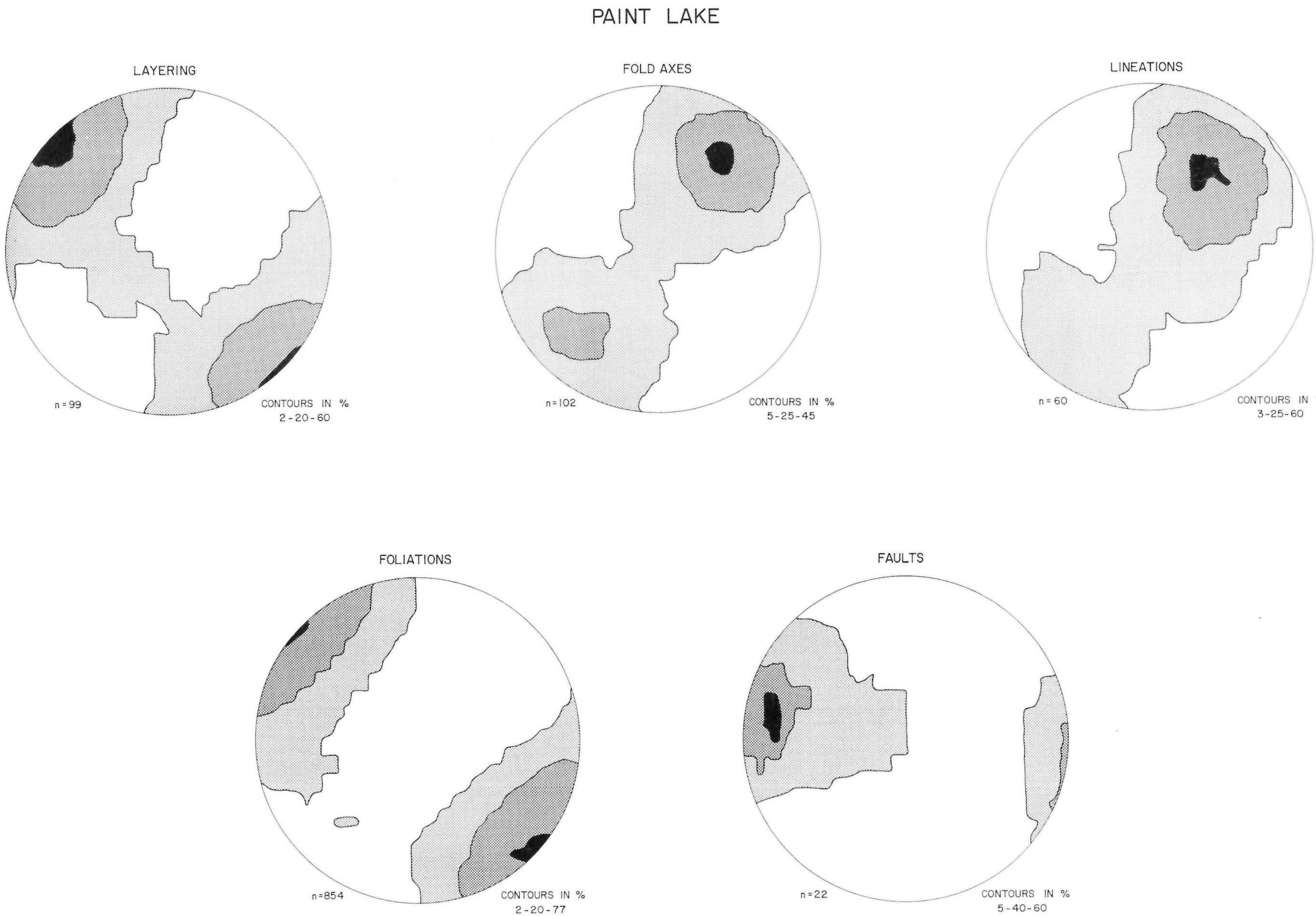

FIGURE GS-6-3: Stereograms of structural elements, Paint Lake.

FIGURE GS-6-4: Truncation of 045° layering and foliation by later penetrative deformational event. New direction ranges from 0 to 020°. Tape width is 2.5 cm.

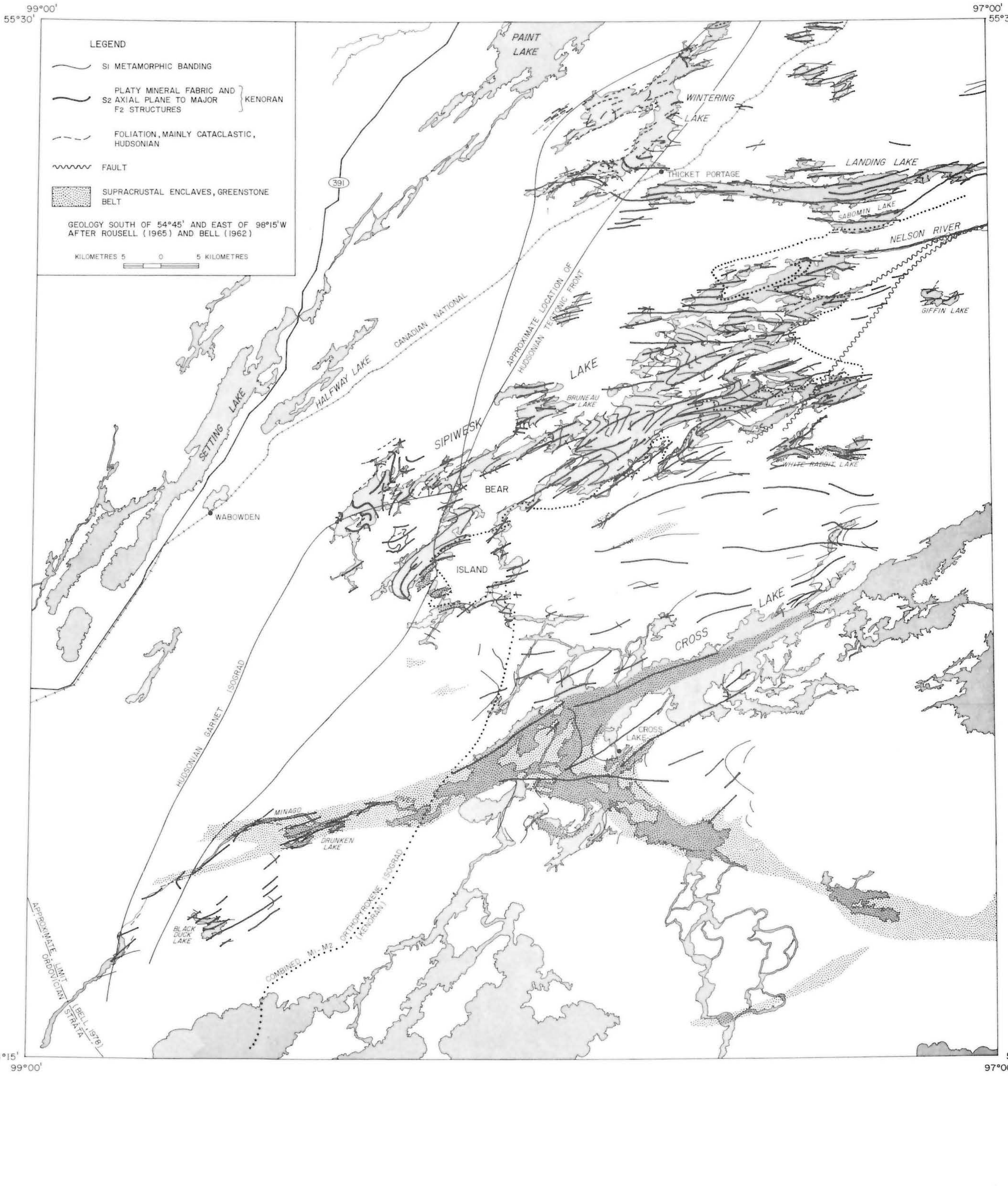

FIGURE GS-7-1: Structural map of the Wintering Lake-Sipiwesk Lake-Cross Lake-Minago River area.

GS-7 MINAGO RIVER-BLACK DUCK LAKE AREA

(Parts of 63J/7,8,9 & 10)

by J.J.M.W. Hubregtse

INTRODUCTION

This summer's field work was directed towards the completion of the mapping project in the Wintering, Landing and Sipiwesk Lakes area (Hubregtse, 1977, 1978) and some preliminary investigations were carried out in the southern part of the Pikwitonei region west of Cross Lake (Fig. GS-7-1) (Hubregtse, 1979). The objectives of the projects were to identify the origin of the granulite facies rocks of the Pikwitonei region and their relationship with the greenstone belt-tonalite gneiss terrain of the northwestern Superior Province to the east and the Thompson belt and Churchill Province to the west. It was discovered that the Pikwitonei granulites of the Wintering, Landing, and Sipiwesk Lakes area represent a high-grade part of the Superior Province and that the granulites did not form a basement for the greenstone belts of the Superior Province. The Pikwitonei region and the northwestern Superior Province are separated by an isograd and not by an unconformity (Bell, 1971). Granulite facies greenstone enclaves occur within the Pikwitonei granulite facies gneisses. The age of the granulite facies metamorphism is interpreted as Kenoran. For detailed discussions on the regional geology, geological history and lithologies the reader is referred to Hubregtse (1977 and 1978), Weber (1976, 1977 and 1978) and Weber and Scoates (1978). Only this year's findings will be discussed in this report. The geological history of the entire project area is given in Table GS-7-1, which refers also to events discussed earlier (Hubregtse, 1977 and 1978).

GRANULITE FACIES METAMORPHISM IN THE CROSS LAKE GREENSTONE BELT

The southern limit of orthopyroxene-bearing Pikwitonei gneisses is now better defined in the Duck Lake-Cross Lake area (Fig. GS-7-1). The southern limit of orthopyroxene occurrences is not a true isograd related to a single metamorphic event, since it reflects the M_1 and M_2 Kenoran events of metamorphism, which were both locally in granulite facies (Hubregtse, 1978). Late-M_2 retrograde action and late-M_2 widespread granitization (Hubregtse, 1978), particularly in the area between Cross Lake and Sipiwesk Lake, caused a shift of the orthopyroxene limit towards the north. At White Rabbit Lake and Giffin Lake, however, isolated domains of granulites occur within the zone of retrograde granulite facies gneisses. The southern limit of orthopyroxene occurrences transects the Cross Lake greenstone belt east of the mouth of the Minago River (Fig. GS-7-1). The metamorphic grade of the western arm of the Cross Lake greenstone belt in the Minago River area varies from granulite facies to upper amphibolite facies. This finding differs from previous reports that the Cross Lake greenstone belt was not involved in granulite facies metamorphism (Rousell, 1965; Bell, 1971 and 1978). Moreover, it confirms a late-Archean age for the granulite facies metamorphism and precludes the interpretation that granulites formed a basement for the greenstone belts of the Superior Province. A preliminary Rb-Sr whole-rock isochron age of 2475 Ma was recently determined for rocks that intruded during the late-Kenoran M_2 granulite facies event (Charbonneau and Brooks, pers. comm.). The exact trace of the southern orthopyroxene limit needs to be mapped in the western Cross Lake area.

MINAGO RIVER-DRUNKEN LAKE-CROSS LAKE PARAGNEISS-SHEAR BELT

Drunken Lake and the eastern part of the Minago River are underlain by a layered granulite facies and amphibolite facies gneiss sequence. The mainly felsic orthogneisses include garnet-biotite ± sillimanite gneisses, amphibole-biotite ± clinopyroxene gneisses, amphibolites and garnet amphibolite, which are considered to have a supracrustal origin since they are extremely variable in composition on outcrop scale. The gneisses are situated on strike with the Cross Lake greenstone belt, but primary sedimentary features have not been preserved. Rocks near the east end of the Minago River, shown as conglomerates on maps by Rousell (1965) and Bell (1978) are amphibolite facies and granulite facies migmatite gneisses, that display a compositional metamorphic layering S_1 with a superimposed mineral fabric S_2, and oval inclusions that were formed as a result of boudinaging of pre-S_1 mafic xenoliths and syn-M_2 felsic mobilizate veins. The paragneisses are interlayered with tonalitic and enderbitic orthogneisses which are similar to those that underlie most of the Sipiwesk, Landing and Wintering Lakes area (Hubregtse, 1977, 1978). The paragneiss component decreases in a westerly direction along the Minago River. The Minago River-Drunken Lake zone is a shear belt that formed during the second Kenoran deformational event D_2. The general, northwesterly-trending older metamorphic layering S_1 is almost completely transposed into the younger west-southerly-trending S_2 foliation throughout the shear belt, which must have been active during and after the M_2 metamorphic event because of the presence of late-M_2 blastomylonite and post-M_2 mylonite and augen gneiss. The Minago River-Drunken Lake shear belt was reactivated during the Hudsonian orogeny (see below).

BLACK DUCK LAKE ORTHOPYROXENE-SILLIMANITE GNEISSES

Black Duck Lake (Fig. GS-7-1), southwest of Cross Lake, is underlain by sporadically garnet-bearing and locally hornblende-poor enderbitic gneisses and mafic granulites, that are similar to the high-grade rocks that underlie the Wintering, Landing and Sipiwesk Lakes area. The granulites at Black Duck Lake comprise in part rusty-brown garnet-plagioclase-quartz gneisses, which may have a supracrustal origin. Rare orthopyroxene-sillimanite gneisses were mapped at central Black Duck Lake. Similar gneisses occur associated with mafic sapphirine-cordierite-orthopyroxene-spinel gneisses in west-central Sipiwesk Lake (Hubregtse, 1978; Hubregtse, Kusmirski and Charbonneau, 1978). The stable association of orthopyroxene and sillimanite indicates metamorphic conditions of 10 to 11 kb and 900° to 1000°C (Hensen and Green, 1973) for the M_2 Kenoran event.

HUDSONIAN FRONT D_3-M_3 EVENTS

Late-Hudsonian tectono-metamorphic activity (D_3-M_3) in the western part of the Archean Pikwitonei region, which adjoins the Churchill Province, resulted in the formation of the north-north-easterly-trending Thompson belt (Hubregtse, 1977 and 1978). The late-Hudsonian orogenic events were preceded by the emplacement of the Molson dyke swarm, subsequent intrusion of tonalitic and pegmatitic phases and associated metasomatism that also affected the Molson dykes. A preliminary Rb-Sr whole-rock isochron age of 1720 Ma has been determined for metasomatically altered Archean gneisses of the Thompson belt (Charbonneau and Brooks, pers. comm.). The Molson dyke swarm forms an excellent marker in the structural history, since it has been affected only by the younger Hudsonian event M_3-D_3. The Hudsonian orogenic front can be subdivided from west to east into three zones which respectively enclose garnet-bearing and deformed Molson dykes, garnet-free deformed Molson dykes, and non-deformed but metasomatized Molson dykes (Fig. GS-7-1). The three zones of the Hudsonian front transect the late-Kenoran Minago shear belt west of Drunken Lake. A garnet-bearing Molson dyke occurs 8 km northeast of the overlying Ordovician limestone strata at Hill Lake.

The late-Hudsonian front strikes generally in a north-northeasterly direction but Hudsonian mylonite and shear zones are deflected along older, more easterly-trending Kenoran structures east of the main Hudsonian tectonic front (Fig. GS-7-1). Molson dykes in such reactivated Kenoran shear belts are deformed and commonly metasomatized. The Minago River and Sabomin Lake are underlain by major reactivated Kenoran shear belts. Minor zones of Hudsonian deformation east of the main Hudsonian front occur at Bruneau Lake, near Bear Island, at northern Sipiwesk Lake and east-northeast of Thicket Portage (Fig. GS-7-1).

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TABLE GS-7-1

ORDER OF EVENTS, WINTERING, LANDING AND SIPIWESK LAKES AREA

MINAGO RIVER WINTERING LAKE — WESTERN SIPIWESK LAKE		LANDING LAKE — EASTERN AND CENTRAL SIPIWESK LAKE — BEAR ISLAND — BULGER LAKE — CROSS LAKE		
— emplacement of granite and pegmatite				
— formation of rare pseudotachylyte		— formation of pseudotachylyte		
D_{3B} — renewed shearing within S_3 tectonite zones		— northeast trending faults and mylonites		
M_3: — greenish-grey lamprophyre	HUDSONIAN FRONT			HUDSONIAN OROGENY
M_3: D_{3A} — intense shearing and (blasto) mylonitization; formation of well-layered gneisses (S_3 — tectonites), profound reworking of Archean gneisses	HUDSONIAN FRONT	— reactivation of D_2-shear belts, sporadic deformation of Molson dykes; weak metamorphism noticeable in Molson dykes only	M_3: amphibolite facies metamorphism in the Wintering and western Sipiwesk Lakes area only	HUDSONIAN OROGENY
M_3: — formation of M_3-migmatites	HUDSONIAN FRONT			HUDSONIAN OROGENY
M_3: — metasomatism of Archean gneisses	HUDSONIAN FRONT			HUDSONIAN OROGENY
— pegmatite, tonalite and granodiorite				

— emplacement of Molson diabase swarm

— local anatexis of older migmatites

— north-northwest trending mylonites

D_{2B}	— formation of east-northeast trending late D_2 shear belts, augen gneisses and mylonites, attenuation of S_2 fabric		KENORAN OROGENY
	— granitization and recrystallization of migmatites between Sipiwesk Lake and Cross Lake	M_2: (hornblende) granulite facies and amphibolite facies metamorphism, lower grade metamorphism in the Cross Lake area	KENORAN OROGENY
	— growth of post-S_2 garnet and local retrogression	M_2	KENORAN OROGENY
D_{2A}	— formation of planar and planolinear quartz fabric (S_2)	M_2	KENORAN OROGENY
	— formation of M_2-migmatites	M_2	KENORAN OROGENY
	— intrusion of quartz-monzonite, pegmatite, granite, minor tonalite and monzo-diorite	M_2	KENORAN OROGENY
	— intrusion of (leuco-)gabbro — leuco-enderbite — opdalite dykes and sills (central Sipiwesk Lake)	M_2	KENORAN OROGENY
	— derivation of quartz-feldspar (-orthopyroxene/hornblende) mobilizate from pre-M_1 migmatites	M_2	KENORAN OROGENY
	— intrusion of hornblendite dykes	M_2	KENORAN OROGENY
D_{1B}	— local isoclinal folding of S_1	M_1: amphibolite facies and possibly hornblende granulite facies metamorphism, lower grade metamorphism in the Cross Lake area	KENORAN OROGENY
D_{1A}	— formation of metamorphic banding S_1	M_1	KENORAN OROGENY
	— derivation of K-feldspar-rich felsic mobilizate	M_1	KENORAN OROGENY
	— plagioclase-phyric mafic dykes (Bulger Lake dykes)		KENORAN OROGENY
	— formation of pre-M_1 migmatites		KENORAN OROGENY
	— intrusion of tonalite, granodiorite and minor quartz diorite (enderbite ?)		
	— emplacement of layered gabbro-pyroxenite-peridotite (northwestern part of map area)		
	— intrusion of hypabyssal plagioclase-phyric gabbro and anorthosite in the greenstones		
	— deposition of greenstones (massive and pillowed basalts, sediments, iron formations, dacites and porphyries (southern part of map area))		

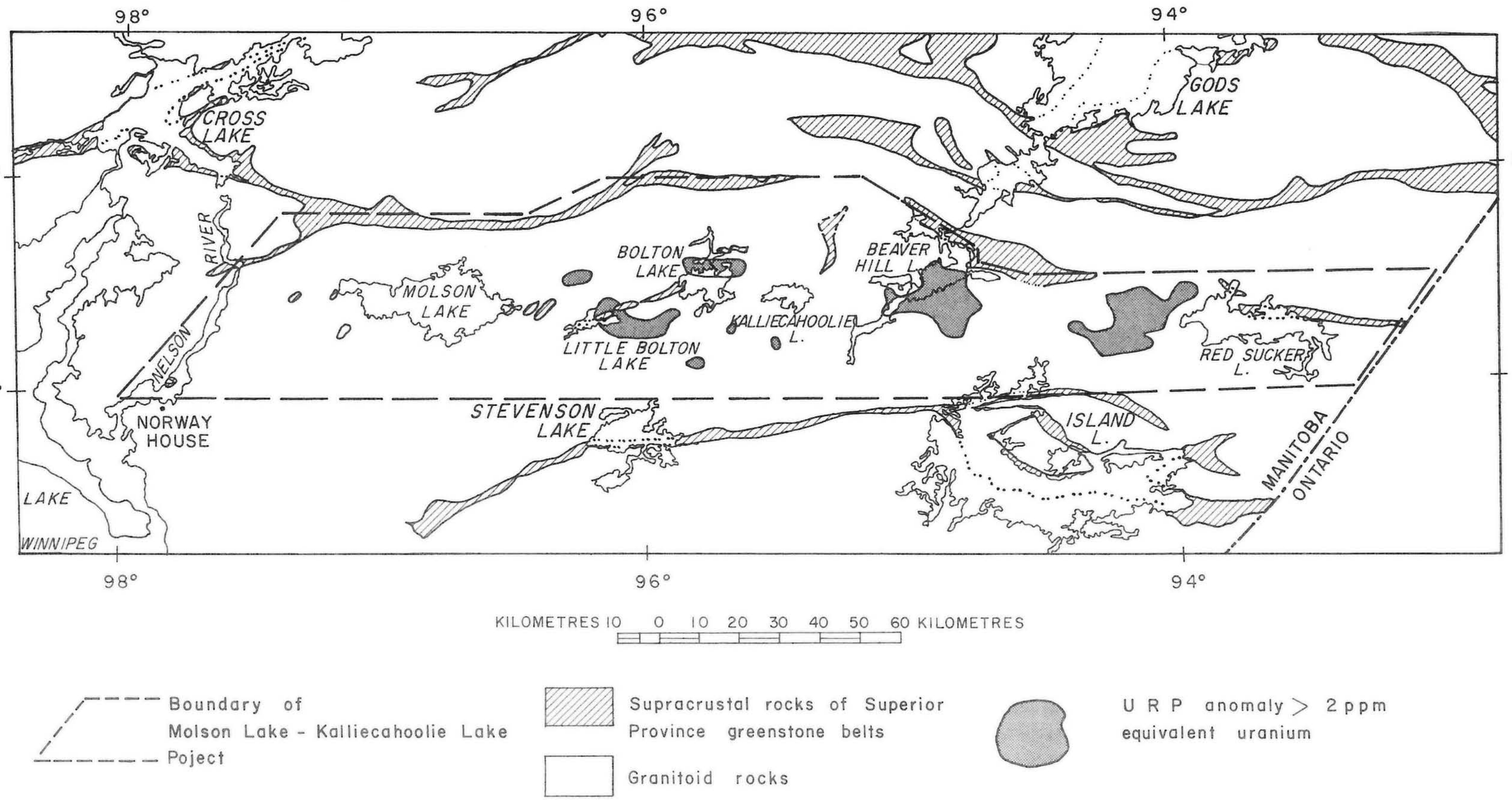

FIGURE GS-8-1: Outline of the Molson Lake-Kalliecahoolie Lake Project, URP anomalies, and regional geology.

GS-8 MOLSON LAKE-KALLIECAHOOLIE LAKE PROJECT

(63 I/1 to 4, 6 to 8; 53L/1 to 8 and 53K/3,4)

by W. Weber and D.C.P. Schledewitz

INTRODUCTION

The Molson Lake-Kalliecahoolie Lake Project was initiated this year as a two-year programme funded under the cost-shared Federal/Provincial Northlands Subagreement. The objective of the project is to upgrade, at the scale of 1:100 000, the geological mapping in this poorly explored granitoid terrain and to evaluate a chain of uranium anomalies which were detected during the 1977 URP airborne gamma-ray spectrometer survey*. Geophysical surveys form part of this evaluation (Soonawala, this volume).

The uranium anomalies lie in a belt of granitoid rocks between Molson Lake and Red Sucker Lake (Fig. GS-8-1). The belt is flanked to the north by a narrow and apparently discontinuous greenstone belt which extends from Cross Lake to the north end of Beaver Hill Lake and thence to the north shore of Red Sucker Lake. To the south the granitoid terrain is flanked by the Stevenson Lake-Island Lake greenstone belt.

The area is covered by 1:250 000 Geological Survey of Canada reconnaissance maps (Bell, 1961; Currie, 1961; Downie, 1936), and by more detailed maps along the northern fringe of the project area (Elbers et al. 1971, 1972, 1973). Some sections of the belt had never been mapped.

SUMMARY OF GEOLOGICAL FIELD WORK

This year W. Weber and J.J.M.W. Hubregtse mapped the section of the belt between 96° and 98° longitude. D.C.P. Schledewitz and his senior assistant, R. Kusmirski covered the belt between 93° and 96°. The majority of the project area was mapped in 1979, although some areas were covered only by widely spaced helicopter stops (See Preliminary Maps 1979K-1 to 5). Mapping will be completed in 1980.

The oldest rocks appear to be metasedimentary, metavolcanic and associated intrusive rocks which are preserved (a) in the greenstone belts along the margin of the granitoid belt, (b) in a newly discovered highly discontinuous belt through the granitoid terrain from Aswapiswanan Lake towards Molson Lake, and (c) in isolated lenses within granitoid rocks. These supracrustal rocks are intruded and migmatized by tonalitic to granodioritic rocks. The early period of intrusion is followed by the emplacement of mafic dykes in a northerly direction and subsequently by the formation of granodiorite, partly (through metasomatism of earlier tonalitic rocks. The metasomatism seems to be associated with a period of ubiquitous granitic intrusions which form dykes and small stocks throughout most of the area. Felsic pegmatite, alaskite and aplite dykes represent the latest granitic intrusions. The youngest magmatic event is represented by mafic Molson dykes.

The older tonalitic rocks are similar to 2.7 to 2.8 Ga intrusions in other parts of the northwestern Superior Province whereas the younger granitic rocks are syn- to post-tectonic intrusions and are comparable to 2.5 Ga old intrusions elsewhere in the Superior Province of Manitoba. The character of the granitic intrusions, their occurrence as small bodies and their wide distribution supports their derivation as mobilizates of older crustal material. Metamorphism has affected mainly the supracrustal and tonalitic rocks and took place before the emplacement of the younger granites.

Spectrometer readings carried out during geological mapping indicate that the younger potassic alaskite dykes give the highest uranium values. These dykes appear to be the cause of the URP anomalies (> 2ppm equivalent uranium). Similar conclusions were derived from detailed helicopter-borne scintillometer surveys and ground checking (Soonawala, 1978) and from a more detailed spectrometer grid survey and rock sampling programme (Soonawala, this volume).

A) MOLSON LAKE AREA

(63 I/1 to 4, 6 and 8)

by W. Weber

During 1979 geological mapping was concentrated on the outcrops around the larger lakes and the uranium anomalies near Little Bolton Lake. Most of the remaining terrain was covered by a 20-hour helicopter survey designed to provide a preliminary interpretation of the geological history of the area by the end of the first field season.

J.J.M.W. Hubregtse mapped the western and northern part of Molson Lake during part of the field season whereas the remainder was mapped by the author.

An outline of this year's mapping compiled from Preliminary Maps (1979K-1, 2) is presented in Figure GS-8-2. The major findings are:

- discontinuous lenses of greenstones are found within the granitoid rocks flanked by the Cross Lake and Stevenson Lake greenstone belts.
- the granitoid rocks comprise mainly tonalitic to granitic plutonic rocks; gneisses are subordinate.
- a suite of metamorphosed mafic (to ultramafic) dykes which is older than the Molson dyke swarm strikes in a northeasterly direction.
- the highest uranium values appear to be related to young alaskite dyke intrusions.

GENERAL GEOLOGY

Table GS-8-1 lists the main rock types according to observed age relationships.

Fine-grained amphibolite (1f), locally with preserved pillow structure remnants, forms a discontinuous belt between the falls east of Robinson Lake and towards the Echimamish River (Preliminary Map 1979K-1; Bell, 1961). Bell's transition rocks comprise sheared and mylonitic granitic rocks with less than 5% amphibolites. They should not be regarded as part of the Hayes River Group of supracrustal rocks, as suggested by Bell. Similarly, the "conglomerate" (unit 2c) previously indicated adjacent to these transition rocks (Bell, op. cit.) is a tectonic breccia or tectonic conglomerate formed by boudinage of the layered mylonitic zone with subsequent partial rotation of the boudinaged segments. An even younger fault separates this zone of tectonic fragmentation from foliated tonalites to the north.

Amphibolite similar to the greenstones near Robinson Lake occurs in lenses between Molson Lake and Little Bolton Lake. It

*Federal/Provincial Uranium Reconnaissance Program, Geophysical Series, Maps 35963G, 36153G, 36253G published by the Geological Survey of Canada, 1978.

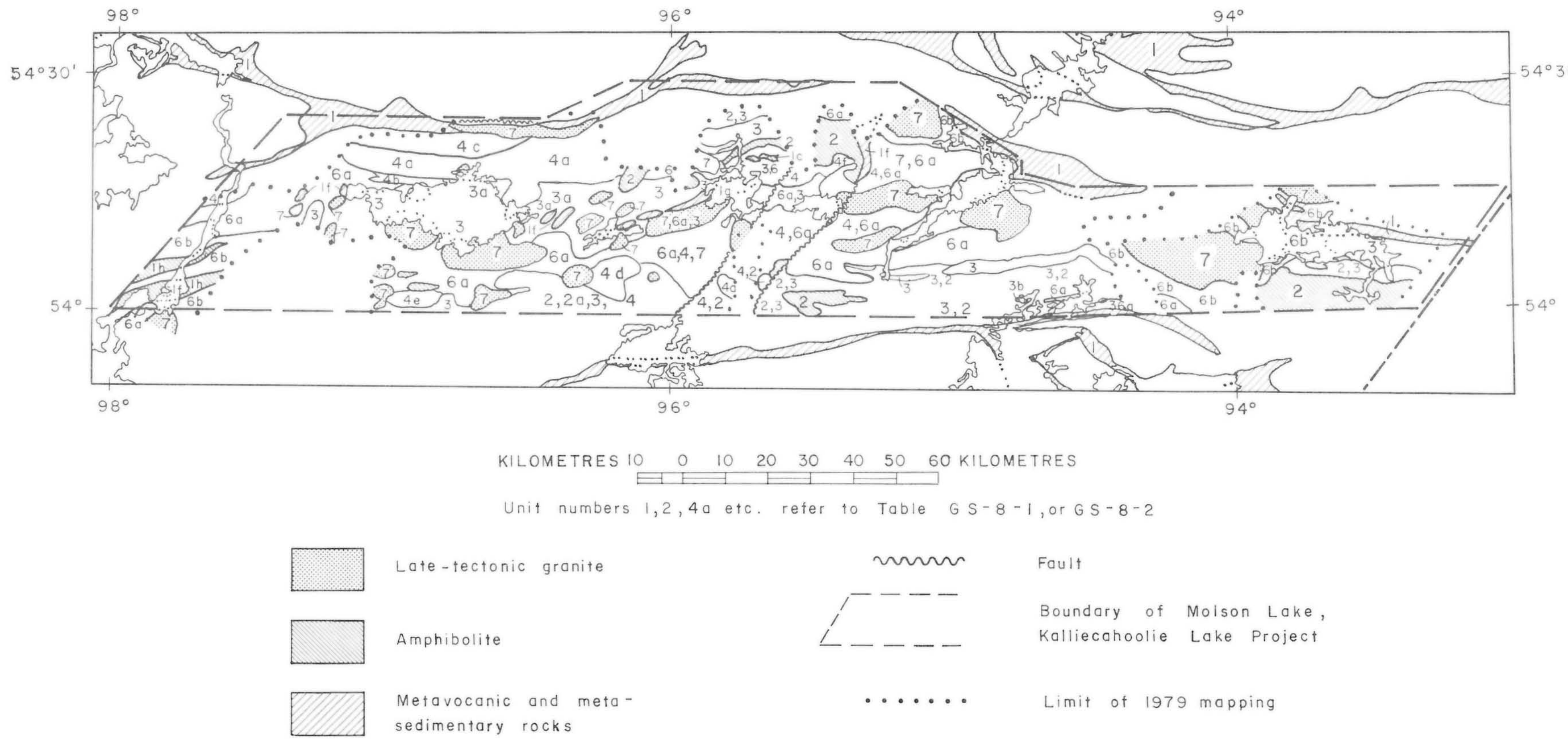

FIGURE GS-8-2: Geological compilation of the Molson Lake-Kalliecahoolie Lake Project.

becomes more abundant towards the eastern edge of the map sheet. At Little Bolton Lake faint pillow structures are preserved. Associated garnet-biotite schists (1g) probably represent metasedimentary rock. A lens of amphibolite facies porphyritic metapillow basalt with a hydrothermal alteration zone occurs in the Norway House area.

Amphibolites containing porphyroblastic plagioclase and relatively massive metagabbroic to dioritic rock (1h) are typical for the Norway House area. Most of the finer grained mafic rocks are probably metavolcanic in origin whereas the coarser grained metagabbroic rocks are intrusive.

Amphibolites interlayered with tonalitic gneiss (2a) occur in the southeastern part of the map-area. These rocks probably represent a sequence of metavolcanic rocks which was migmatized by tonalitic rocks.

Foliated, biotite±hornblende-bearing, coarse grained tonalite and minor granodiorite (3) is aerially widespread, particularly in the central part of the belt. It represents the plutonic component of the oldest granitoid intrusive event. Good exposures of this major unit occur on the southern shore of Molson Lake. This foliated tonalite is similar to tonalites found elsewhere in the Superior Province of Manitoba, as plutons within and marginal to greenstone belts.

Medium grained, foliated tonalite (3a) is less common, but appears to represent part of the same intrusive event. It may be a marginal phase, since it is locally gneissic.

TABLE GS-8-1: Table of Formations, Molson Lake Area

(equivalent to Legend of Preliminary Maps 1979K-1 to 5)

PRECAMBRIAN

Proterozoic

9		Gabbro to diabase dykes (Molson swarm)

Archean

8		Pegmatite, inequigranular alaskite, aplite
7		Granite, pink, medium to coarse grained, massive, locally porphyritic
6		Metasomatic and related granitic rocks
	6a	porphyroblastic granodiorite, locally gneissic, with minor pink, fine grained granite
	6b	hybrid granodiorite gneiss; porphyroblastic granodiorite and tonalitic gneiss with mafic inclusions; minor pink, fine grained granite
	*6c	hornblende monzodiorite
5		Metamorphosed mafic dyke
	5a	hornblendite, metapyroxenite and metagabbro
	5b	hornblende porphyroblastic amphibolite to metagabbro-diorite
4		Granodiorite, weakly foliated to massive
	4a	porphyritic biotite granodiorite
	4b	gneissic to porphyroclastic granodiorite
	4c	augen gneiss
	4d	medium to coarse grained granodiorite
	4e	fine to medium grained granodiorite to tonalite

Archean (Cont.)

4		
	*4f	white pegmatite
3		Tonalite, foliated, biotite ± hornblende-bearing, medium to coarse grained, locally porphyritic
	3a	medium grained biotite tonalite
	*3b	medium to coarse grained leucogranodiorite to diorite
2		Tonalitic gneiss, minor amphibolite (up to 20%)
	2a	tonalitic gneiss interlayered with amphibolite (20 to 50%)
1		Metavolcanic and metasedimentary rocks
	*1a	metabasalt; massive to pillowed, local biotite-hornblende schist
	*1b	intermediate tuffaceous rocks, layers of acicular amphibole, quartzofeldspathic layers and muscovite-biotite quartz feldspar schist ± garnet ± cordierite
	*1c	metagabbro, ultramafic rocks
	*1d	grey green metagreywacke (sporadic graded bedding)
	*1e	meta-arkose to subgreywacke
	1f	metabasalt, fine grained amphibolite, sporadically interlayered with pale green diopside plagioclase layers
	1g	garnet-biotite schist
	1h	plagioclase porphyroblastic amphibolite-metagabbro-metadiorite

*These subunits do not occur in the map-area.

Porphyritic granodiorite (4a) forms a large belt in the northern part of the map-area. It is very homogeneous except along its southern sheared margin and therefore is regarded as a plutonic body rather than part of the similar unit 6 metasomatic rocks. Its southern margin, along the north shore of Molson Lake, is characterized by a cataclastically layered and porphyroclastic granodiorite (4b). Towards the northern margin of the pluton cataclastic augen gneiss (4c) and related rocks (4b) coincide with the east-west lineaments defined by the Hayes River in that area.

Medium to coarse grained non-porphyritic granodiorite (4d) was mapped south of Little Bolton Lake. Relatively massive, fine-to-medium-grained granodiorite to tonalite (4e) occurs mainly as dykes in much of the map-area, and is probably part of the same intrusive event.

Mafic to ultramafic dykes (5), 0.2 to 200 metres wide, intrude the granodiorite (4), generally in a northeasterly direction. Although the dykes are metamorphosed, weakly foliated and deformed, the contrast is preserved between the fine grain size of chilled margins or narrow dykes and the coarser grain size of more central portions of wider dykes. Fine-grained mafic dykes commonly contain hornblende porphyroblasts (pseudomorphs after pyroxene?) in a foliated amphibolitic groundmass. The medium to coarse grained hornblende±biotite-bearing dyke rocks are relatively massive and vary in composition from gabbroic to dioritic; local hornblendite and metapyroxenite have also been observed. The best exposed metamorphosed dykes are found in the northern part of Molson Lake and along the larger lakes south of Little Bolton Lake.

Metasomatic rocks (6) occur mainly in the southern half of the map-area. They range in composition from tonalite to granodiorite on outcrop scale and/or over a larger area. Typical exposures are found between Norway House and Pine Creek, and south of Molson Lake. Pink to beige, fine-grained, massive granitic dykes are commonly associated with the metasomatic rocks and apparently represent a magmatic fraction of the metasomatic event. However, they are not restricted to the metasomatic rocks and can be found throughout much of the map-area. Small stocks of granite (7) compositionally identical to the pink dykes occur throughout the central part of the map-area.

The late felsic dykes comprise pegmatite, inequigranular alaskite, and aplite. In contrast to the generally straight-walled pegmatite and aplite, alaskites tend to form more irregular dykes. Hematite staining is common in the alaskites.

Several dykes of the Molson swarm (unit 9) were encountered. Dykes over 5 m wide usually have a gabbroic texture except the chilled margins which have a diabase textures, as do the narrower dykes. The "dyke" at the type locality, in the eastern half of Molson Lake, is exposed on a few islands over a maximum width of 20 metres. These outcrops might be part of an *en echelon* set of Molson dykes rather than part of a single dyke. The dykes (9) are slightly altered (pyroxene to hornblende). In a few places fine-grained plagioclase dykelets, up to 10 cm wide, intrude the Molson dykes along fractures. These dykelets may represent an aplitic stage of a younger magmatic differentiate. Ultramafic Molson dykes common in the Pikwitonei granulite domain, were not observed in the Molson Lake area.

OBSERVATIONS RELATED TO THE URP ANOMALIES

A URP usually $>$ 2 ppm equivalent uranium detected over part of Little Bolton Lake and another over an area about 10 miles to the north were covered by a helicopter scintillometer survey (Soonawala, 1978). These, and other localities yielding similarly high individual readings on the recorded flight lines, were checked during geological mapping with an Exploranium GR 310 calibrated digital gamma-ray spectrometer. Alaskite and to a lesser extent pegmatite, aplite and the fine-grained, pink granite dykes showed the highest values ranging from 0.02 to 0.04 cps in the U channel. The other rock types yielded values of below 0.015 cps uranium. These felsic dykes were present, among other rock types, in all the localities coinciding with URP anomalies ($>$ 2 ppm U). However, the same felsic dykes are present in areas not yielding URP anomalies. It is likely that the URP anomalies reflect a high abundance of these late felsic dykes, since no secondary uranium concentration was detected. An exception are small fractures within these felsic dykes which locally yielded values of over 0.05 cps U. It is at present not known how extensive these slightly more radioactive fractures are developed and whether they might contribute to the anomalies. At Little Bolton Lake, it was noted that an esker remnant comprising coarse boulders runs in a north-south direction and coincides with the peak of the URP anomaly. It is thus possible that the increased rock surface along this border train might contribute to the anomaly in this area. No uranium mineralization or secondary alteration products have been detected in the map-area.

b) BOLTON LAKE-RED SUCKER LAKE AREA

(52L/1 to 8, 53K/3,4)

by D.C.P. Schledewitz and R. Kusmirski

INTRODUCTION

Regional geologic mapping at a scale of 1:100 000 was started in the south half of the Oxford House Map area (NTS-53L, Prelim. Maps 1979K-3 and K-4), and the southwest quarter of the Stull Lake Map area (NTS-53K, Prelim, Map 1979K-5). The southern limit of the project is 54° while the northern limit of the project overlaps slightly the southern extent of the Greenstone Projects initiated in 1971 to examine the greenstone belts of the Oxford House map area and their relationship to the surrounding granitoid rocks (Elbers et al 1971, 1972 and 1973).

The geology of the Oxford House area was previously described by Currie (1961) at a scale of 1:250 000 and the geology of the Stull Lake area by Downie (1936) at a scale of 1 inch to 4 miles.

Both these areas are covered by the Federal/Provincial airborne Uranium Reconnaissance Program published in 1978 as the geophysical series 36153G, (NTS-53K) and 36253G, (NTS-53L). A ground survey was conducted by Smith et al. (1977) to investigate a uranium anomaly at the northwest corner of Red Sucker Lake (NTS-53K).

Cassiterite bearing pegmatites at Red Sucker Lake were examined by Bannatyne (1973) as part of the province-wide "Pegmatite Project".

GENERAL GEOLOGY

The oldest rocks in the area comprise a sequence of intercalated metavolcanic rocks and volcanogenic sedimentary rocks in part overlain by metasedimentary rocks. These rocks were intruded by mafic to ultramafic dykes and sills, Scoates et al. (1971 and 1972). This sequence of rocks forms a discontinuous narrow zone from 2-3½ km wide extending from the western boundary of the Oxford House map area east to Aswapiswanan Lake where it swings southeast to the Beaverhill and Goose Lake area, (Elbers et al, 1972, 1973). The belt strikes east southeast at the east end of Goose Lake but continuity is interrupted by a 60 km wide zone of little or no exposure. However a similar belt of metavolcanic rocks and intercalated volcanogenic sediments outcrops along strike on the north shore of Red Sucker Lake and continues east to Pierce Lake in Ontario.

The other rock types in the area are tonalitic gneisses with variable amounts of amphibolite lenses and intrusive rocks which range in composition from leucotonalite to granodiorite intrusive rocks. Both the tonalitic gneiss and the extrusive rocks are cut by

TABLE GS-8-2

Table of Formations, Bolton Lake-Red Sucker Lake Area

Unit	Subunit	Description	Scintillometer Reading (counts per sec.)
		PRECAMBRIAN	
		PROTEROZOIC	
9		Diabase dykes (Molson swarm)	25
		ARCHEAN	
8		Pegmatite to aplite, pink hematite, stained, dykes and/or irregular shaped bodies graditional with granite (7)	170-210 high 320
7		Granite, medium- to coarse-grained, locally porphyritic	220-230 high 320
6		Metasomatic rocks and related granitic rocks	
	6a	porphyroblastic granodiorite, large porphyroblasts of mottled pink and buff microcline in a medium- to coarse-grained plagioclase matrix, plagioclase-chalk white with pin points of orange feldspar	190
	6b	hybrid granodiorite gneiss pale greyish pink. Tonalite gneiss altered by potassium metasomatism, hematization and injected by granite *lit*	100
	6c	hornblende monzodiorite, coarse-grained, mottled white, pink to orange and black, hornblende 10-35%, microcline 10-30%	50-70
5		Metamorphosed mafic dykes	
	5a	hornblendite, metapyroxenite and metagabbro, fine- to coarse-grained, massive to weakly foliated	30
4		Granodiorite, weakly foliated to massive, medium- to coarse-grained; locally porphyritic, white feldspar phenocrysts; white on fresh and weathered surfaces, biotite 5-8%, hornblende 0-2%	170-190
	4a*	porphyroblastic biotite granodiorite	
	4b*	gneissic to porphyroblastic granodiorite	
	4c*	augen gneiss	
	4d	medium- to coarse-grained granodiorite	
	4e	granodiorite to tonalite, fine- to medium-grained, grey, occurs as narrow dykes	150-250
	4f	white pegmatite gradational to medium-grained zones	200-320
3		Tonalite medium- to coarse-grained	70-110
	3a	medium-grained biotite tonalite, grey, weakly foliated	90-110
	3b	leucodiorite to diorite medium- to coarse-grained, weakly foliated	40
2		Tonalite gneiss, minor amphibolite, (up to 20%) agmatitic amphibolite, interblock material is a white granodiorite to trondhjemite mobilizate	90-110
	2a	tonalite gneiss, interlayered with amphibolites, (20-50%) agmatitic amphibolites as in unit 2	70-90
		Metavolcanic and metasedimentary rocks	

*These units do not appear in the Bolton Lake-Red Sucker Lake area.

	ARCHEAN (Cont.)	**Scintillometer Reading (counts per sec.)**
1a	metabasalt massive to pillowed, pillows flattened, locally a biotite-hornblende-plagioclase schist	60
1b	intermediate tuffaceous rocks, layers of acicular olive green amphibole interlayered with quartzo-feldspathic layers and muscovite-biotite-quartz-feldspar schist ± garnet ± cordierite	No Reading
1c	metagabbro, ultramafic rocks	
1d	metagreywacke, grey green, thick to thinly bedded, sporadic graded bedding	25 CPS
1e	meta-arkose to subgreywacke, locally quartzitic, preserved scour channels, trough crossbedding, outcrops at north end of Beaverhill Lake	
1f	metabasalt, fine-grained amphibolite, sporadic interlayers of pale green diopside plagioclase layers	No Reading
1g	garnet-biotite schist and biotite psammite	No Reading
1h	plagioclase-porphyroblastic amphibolite-metagabbro-metadiorite	30-50

intermediate to basic dyke rocks. The youngest rocks in the area are granite to granite pegmatite and aplite cut by younger gabbro to diabase dykes of the "Molson swarm".

PHASE I (Deformation and Intrusion)

The tonalitic gneisses (units 2 and 2a) with variable content of agmatitic amphibolites form a continuous zone across the south half of the project area. Tonalitic gneisses also occur in the northwest corner of the Oxford House map area (SW) in the region of Bolton Lake to Joint Lake. These areas of tonalitic gneiss are separated by an east trending intrusive complex of leucotonalite (3) to mainly grey granodiorite (4), 17 to 20 km wide, extending from the south half of Bolton Lake east to Beaverhill Lake. Multiple intrusion of tonalite into the volcanic and volcanogenic sediments can be demonstrated in the Beaver Hill Lake area. The multiple intrusions and subsequent migmatization and deformation, related to the emplacement of the large intrusive complex of leucotonalite to granodiorite, produced the tonalite gneisses.

At Beaver Hill Lake inclusions of volcanic and/or volcanogenic rocks, metamorphosed to amphibolite facies occur within a foliated to gneissic mesocratic tonalite. The inclusions are surrounded by a corona of cream colored leucodiorite, and similar material forms *lits* and veins within the inclusion blocks. This complex of foliated mesotonalite and inclusion blocks has been intruded by a light grey medium- to coarse-grained leucotonalite which forms large irregular bodies which have engulfed and form *lits* within the dark grey mesotonalite. This complex has been deformed about easterly axial planes and a white coarse-grained granodiorite to trondhjemite has been injected along the axial planar foliation.

Enclaves or remnants of the metamorphosed supracrustal rocks (1f, 1g), and their associated mafic to ultramafic rocks (1c), within the tonalitic gneisses in the area of Bolton Lake and the Joint River 25 km east of Bolton Lake (Oxford House SW) indicate the regional extent of the associations observed at Beaver Hill Lake.

The emplacement of the leucotonalite to granodiorite as a batholithic zone, extending from Bolton Lake east to Red Sucker Lake, marks the culmination of the Phase I deformational and intrusive event. The character of the D_1 structures is uncertain. The end of Phase I is punctuated by the emplacement of medium-grained granodiorite to quartz diorite dykes.

PHASE II (Deformation and Intrusion)

The second phase of deformation is marked by a regional variation in both the style and trends of the deformation. The style of deformation displayed by the tonalitic gneisses on the north side of the batholith differs from that in the tonalitic gneisses on the south side. The D_2 structures in both areas are defined by the S_1 gneissosity and parallel metamorphic layering defined by lenses of amphibolite (Figure GS-8-3).

The folds within the zone north of the batholith are asymmetric with maximum amplitudes of 2 to 3 km and northeast trending axial planes. The D_2 folds have open to moderately tight closures. The S_2 fabric is a schistosity and realignment of quartz into a platy fabric. Narrow zones of intense fracture cleavage are also developed along the NE trend. A weak and sporadic SE trending fracture cleavage is present. The D_2 folds appear to refold moderately tight D_1 folds.

In contrast the structures in the tonalitic gneiss south of the intrusive complex are isoclinal upright folds trending east. These tight fold structures are intersected by narrow shear zones trending 065° to 075°. Deformation within these narrow zones is intense, with augen development, cataclastic foliation, and locally the development of a gneissosity. Subsiduary or second order directions of schistosity development are 045° and 110°. A persistent fracture cleavage and sporadic cataclastic foliation is developed in the area of Beaverhill Lake and persists as a narrow zone 2-3 km wide into the SE corner of the Oxford House Map Area (SE).

The intrusion of the granite (7) stocks and sills postdates the main phase of D_2 folding and related high grade shearing but predates the last period of cataclasis, mylonite zones and faulting. The emplacement of the granite bodies is centered along the same zone of intrusion as the older tonalite (3) and granodiorites (4).

Widespread potassium metasomatism is correlated (associated) with the emplacement of the granite (7). The porphyroblastic granodiorite (6a), the hybrid granodioritic gneiss (6b) and hornblende monzodiorite (6c) are derived from tonalite (3), tonalite gneiss (2) and the leucodiorite to diorite (3b) respectively by a process of potassium metasomatism.

The late Phase II deformation is marked by a network of fault zones which trend 340°, 000°, 015° and 025°. Mylonite zones are developed along previously established planar trends of 065° to 075°. Bright salmon-orange potassium feldspar and pale green

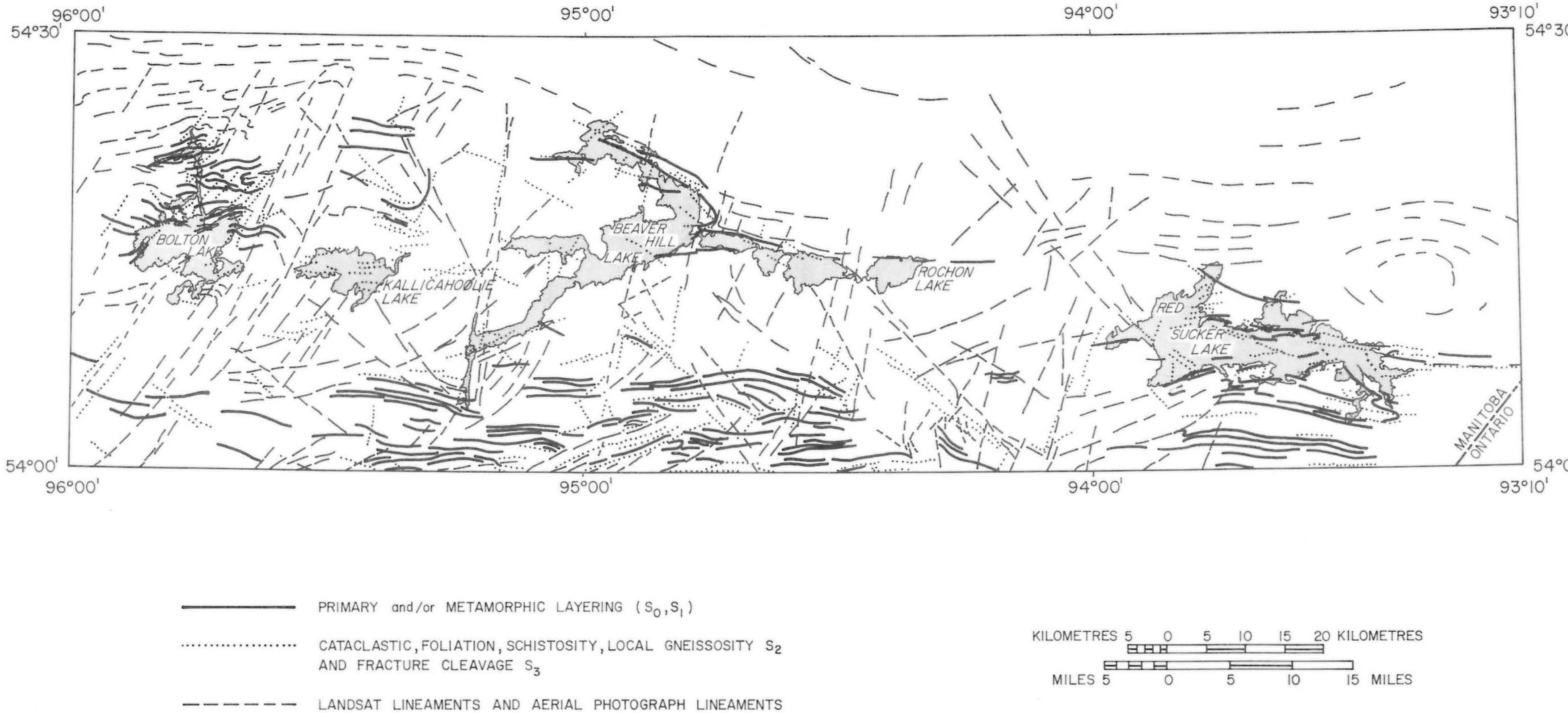

FIGURE GS-8-3: Structural interpretation of foliation trends, combined with preliminary interpretation of lineaments from ERTS imagery.

epidote are commonly deposited along microfractures with the above trends (Fig. GS-8-3).

PHASE III (Molson Dyke Swarm)

The basic dykes, mainly of diabase composition, are undeformed and show only minor alteration along cross-cutting fractures. These dykes occupy fractures with azimuths corresponding to the late fault and fracture zones between 340° to 025°.

OBSERVATIONS REGARDING AIRBORNE URP SURVEY

The search for potential uranium mineralization was a major objective in the regional mapping of the project area. Readings were taken at waist level for all stations with a Scintrex BGS-1 scintillometer. An Exploranium GR-310 digital gamma-ray spectrometer was used to ground truth anomalous areas outlined on the Federal/Provincial airborne Uranium Reconnaissance Program. The cut-off for airborne URP anomalies was 2 ppm equivalent Uranium (Fig. GS-8-1).

The overall scintillometer survey and spectrometer survey indicated that the young granite (7) and aplite (8) and the older white porphyritic granodiorite (4) and white pegmatite (4f) have the highest background values for uranium.

Detailed examination of bedrock exposures and boulders in the areas outlined to be anomalous were not reproduceable for airborne URP anomalies below 3 ppm equivalent uranium.

MINERALIZATION

SULPHIDE MINERALIZATION

Traces of pyrite and minor traces of chalcopyrite are ubiquitous in the metamorphosed layered mafic to ultra-mafic rocks (1c).

A minor alteration zone was observed within the pillowed metabasalt rocks on Red Sucker Lake. The zone 0.5 m wide comprises dark green chlorite, garnet, acicular amphibole and disseminated blebs and seams of pyrite.

CASSITERITE

Disseminated cassiterite occurs in sucrosic albite dykes on the north side of Red Sucker Lake. White albite pegmatites bearing tourmaline are also abundant in this area.

The distribution of the cassiterite is very spotty and has been previously prospected (Bannatyne, 1973).

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TABLE GS-8-3

Table of Geologic Events in the Bolton Lake-Red Sucker Lake Region

	PHASE III	
Diabase to gabbro dykes of the Molson dyke swarm		
	PHASE II	
Late kinematic granites, pegmatites and aplites	D_2	— Open to moderate fold closure, asymmetric Isoclinal upright folds — Resultant narrow shear zones in areas of tight folding
	M_2	— Amphibolite facies — Potassium metasomatism — Contact metamorphism
	S_2	— Gneissosity in narrow shear zones — Cataclastic foliation — Platy quartz fabric and biotite realignment
Intrusion of basic dykes		
Intrusion of grey med. grd. granodiorite dykes		
	PHASE I	
Intrusion of leucotonalite to granodiorite and locally leucodiorites, synkinematic to late D_1	D_1	— Structure and style unknown
	M_1	— Greenschist facies in supracrustal rocks — Amphibolite facies in tonalitic gneiss zones — Contact metamorphism
	S_1	— Gneissosity and metamorphic layering
Intrusion of gabbroic to ultramafic rocks		
Deposition of volcanogenic sedimentary rocks		
Extrusion of basaltic rocks		

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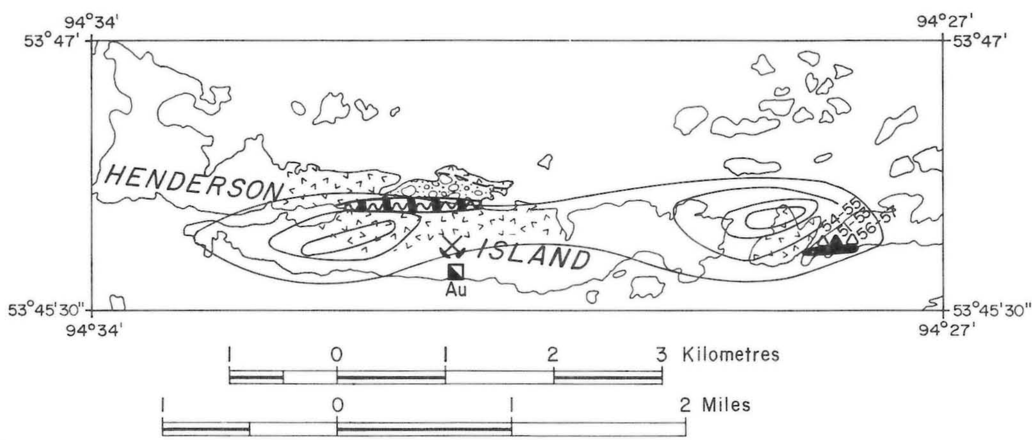

LEGEND

Quartz pebble conglomerate (Island Lake "Series")

Ultramafic rocks (known, inferred)

Mafic volcanic rocks (Hayes River Group)

SYMBOLS

Geological boundary (defined, approximate)

Fault (defined)

Aeromagnetic anomaly interpreted to reflect ultramafic rocks

Cluster of drill holes and holes numbers (intersecting ultramafics, not intersecting ultramafics)

Mine shaft

FIGURE GS-9-1: Geology of Henderson Island (Island Lake area).

GS-9 ULTRAMAFIC OCCURRENCES AND STRATIGRAPHIC RELATIONSHIPS IN THE ISLAND LAKE AND BIGSTONE LAKE AREAS

(53E/10, 11, 12, 15, 16)

by P. Theyer

INTRODUCTION

In order to clarify the stratigraphic relationship between the ocurrence of ultramafic lavas and the unconformity between the Hayes River Group and the Island Lake "series" (Theyer, 1978) a two week field program was carried out in the Island Lake and Bigstone Lake area.

Traverses were made in the vicinity of Wapus Bay (53E/10, southern Island Lake), the area south of Picket Lake (53E/11) and Bigstone Lake (53E/12) to identify and study ultramafic occurrences reported by earlier workers: Ames (1975), Ermanovics et al (1975), Park and Ermanovics (1978).

Most of the results of this program have been incorporated in Economic Report 79/2 (in prep.).

ISLAND LAKE AREA

HENDERSON ISLAND (Fig. GS-9-1)

Exploration drilling by Phelps Dodge Ltd. in 1960 revealed the existence of an ultramafic lens underlying the second island east of Henderson Island (Fig. GS-9-1). This lens is indicated by a prominent magnetic anomaly (Federal-provincial aeromagnetic map series #4041, Island Lake).

A second aeromagnetic high is inferred to be also caused by an ultramafic body that is thought to underly an east striking trench, approximately 150m in width, situated in the northern half of Henderson Island (Fig. GS-9-1). The southern wall of this trench is composed of mafic tuffs which locally have a gabbroic appearance due to feldspar metasomatism which has obliterated the tuffaceous layering. The northern wall of the trench is an oligomictic quartz pebble conglomerate which has undergone intensive tectonic stress to form a quartzite sericite schist, with a peculiar knotty surface. This oligomictic quartz pebble conglomerate underlying a part of northern Henderson Island (Fig. GS-9-1) is petrographically similar to other oligomictic conglomerate of the Island Lake "series".

The observation of clastic sediments occurring in the northern part of Henderson Island, adjacent to mafic tuffs of the Hayes River group, and to an inferred ultramafic occurrence, is of great stratigraphic importance since ultramafic lenses of volcanic origin tend to occur at the interface of the Hayes River and the predominantly clastic sedimentary Island Lake "series". (Theyer, 1978).

WAPUS BAY — PICKET LAKE

Ultramafic occurrences reportedly intruded by gabbroic bodies (Ames, 1975) were not identified in the Wapus Bay area.

The search for an ultramafic occurrence, in the area south of Picket Lake, reported by Herd (pers. comm.) had similar negative results.

BIGSTONE LAKE AREA

The Bigstone Lake area is underlain by a succession of mainly mafic volcanic rocks and narrow intravolcanic sedimentary layers intruded and partially assimilated by granitic intrusions along the edges of this belt.

Geologic studies of this area revealed the possible lack of stratigraphic continuity between this belt and the Island Lake greenstone belt. Further studies will have to be carried out to ascertain whether the stratigraphic correlation between these two belts is valid. The ultramafic occurrences reported by Park and Ermanovics (1978) were found to be hornblendite pods in mafic volcanic tuffs with the exception of one occurrence of serpentinized peridotite that outcrops in the northeastern part of the lake.

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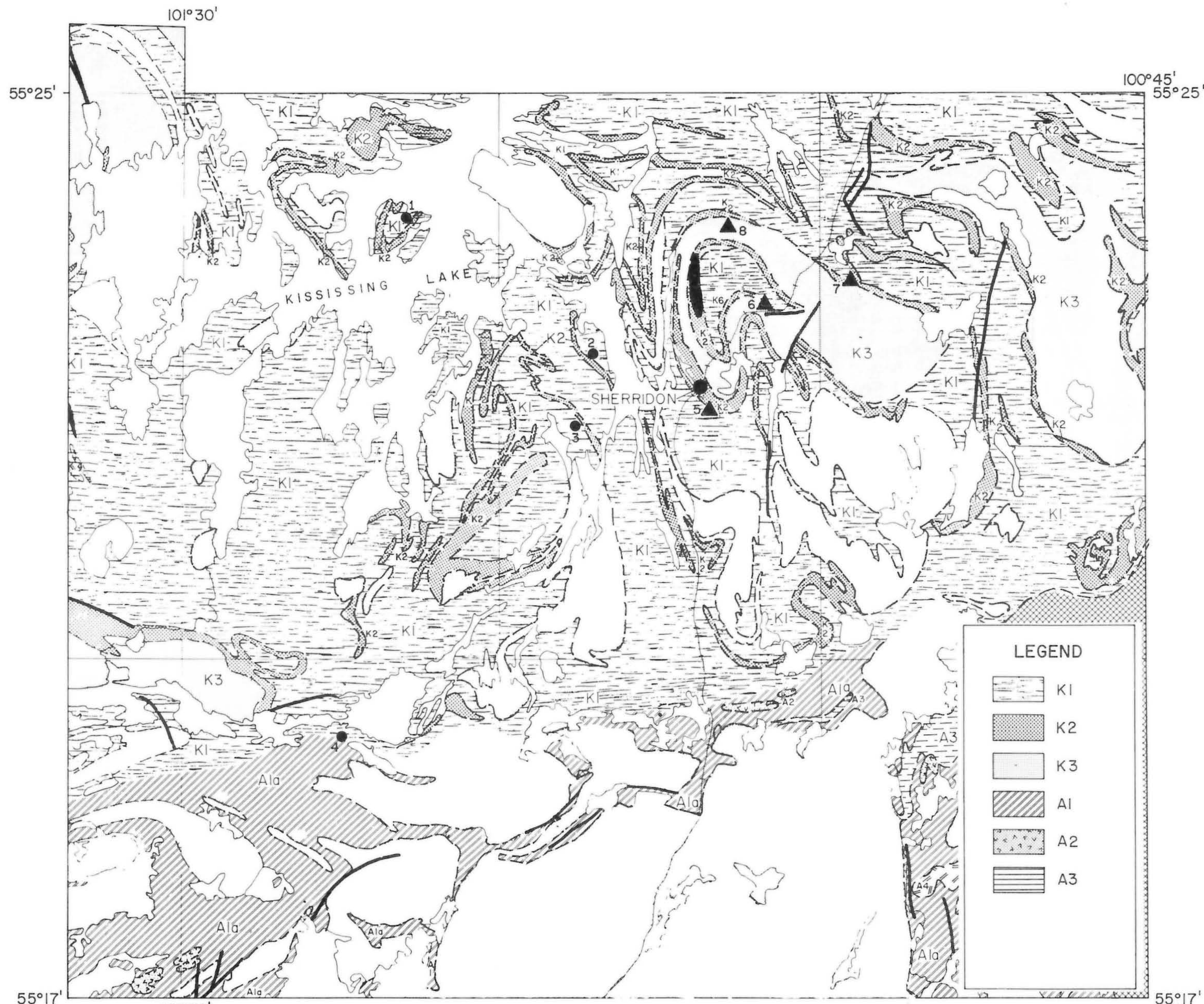

FIGURE GS-10-1: *Location of known massive sulphide occurrences in the sedimentary gneiss terrain of the Kississing area (Geology after Bailes, 1971). K1 — Intermediate garnetiferous paragneisses derived from a repetitious sequence of greywacke and argillite. K2 — Hornblende plagioclase gneiss and amphibolite. K3 — Siliceous paragneiss derived from arkosic to quartzitic sedimentary rocks. Ala — Predominantly pillowed basalt and andesite. A2 — Rhyolite, dacite and quartz porphyry. A3 — Argillite, greywacke and tuff. Deposits: 1. Yakusavich Island; 2. Ideal; 3. Maltman Lake; 4. Weldon Bay; 5. Sherridon; 6. Bob Lake; 7. Jungle Lake; 8. Park Lake. Circles represent zinc-rich deposits. Triangles represent Cu-Zn deposits.*

GS-10 RECONNAISSANCE OF THE FLIN FLON — SHERRIDON AREA

By G. H. Gale

Studies in the Flin Flon — Sherridon area included compilation of information on mineral occurrences on map sheets 63N and parts of 63K, reconnaissance of mineral occurrences in the Weldon Bay and Sherridon areas and a detailed investigation of stratigraphy and mineral occurrences in a part of Kississing Lake.

Compilations of information on mineral occurrences and past exploration history for the NTS map sheet 63N, 63K/11 and the portion of the Flin Flon greenstone belt underlying the Palaeozoic cover in map sheets 63K/1 to 8 have been completed. The information will be released as open file reports and synthesized in Economic Geology Report 79/1 (in prep.).

Reconnaissance of sphalerite-bearing massive sulphide deposits in Weldon Bay and Kississing Lake areas showed that the Weldon Bay mineralization is not fault localized (Kalliokoski, 1953) but an example of exhalative sulphide mineralization in a geological setting similar to that of the massive sphalerite mineralization at the Ideal occurrence (see Tuckwell, this volume GS-11). The rock sequence from south to north at the Weldon Bay showing is greywacke, layered amphibolite, greywacke intercalated with quartzite, quartzite (chert?), sphalerite-bearing sulphide exhalite layer, layered to massive amphibolite and thence meta-arkose (?Missi Group equivalent?). Detailed mineral deposit and structural studies are required in this area to establish the extent and stratigraphic position of this type of mineralization which appears to represent an important newly recognized deposit type of which at least four occurrences are now known, i.e. the Ideal, Maltman Lake, Weldon Bay and Yakusavich Island (Fig. GS-10-1).

The geological setting of the Sherridon Cu-Zn massive sulphide deposits, a metasedimentary gneissic terrain, is somewhat unique for a massive sulphide deposit in Canada (D.F. Sangster, pers. comm.). It was inferred (Wilson, 1979) that the Geco massive sulphide deposit may have a geological setting similar to that of the Sherridon deposit. Examination of the geological setting of the Geco Mine, during a field trip, revealed that its geological setting is similar to that of the Anderson and Stall Lake Mines in the Snow Lake Area (i.e. a mixed volcanic and sedimentary environment) rather than the sedimentary environment present at Sherridon. Consequently, although their metamorphic grades are similar, the Geco deposit cannot be used as an example of Sherridon-type massive sulphide deposits or vice versa.

Preliminary results of the detailed investigation into the stratigraphy and mineral deposits of the Kississing Lake area are contained in the report by Tuckwell (this volume).

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GS-11 STRATIGRAPHY AND MINERAL DEPOSITS OF THE SHERRIDON AREA

by Kevin Tuckwell*

INTRODUCTION

Fieldwork in the east Kississing Lake — Sherridon area of northern Manitoba was designed to determine the stratigraphic setting and structural position of stratiform sulphide mineralization in the area. The project was fairly specific and did not entail extensive remapping of the Sherridon map sheet (Bateman and Harrison, 1946), except along specific traverses which were chosen beforehand to provide the maximum amount of information for construction of stratigraphic/tectonic profiles away from the "Sherridon Group". This study will then form the basis for more detailed geological and mineral deposit investigations in this high-grade sedimentary gneiss terrain.

Good lakeshore exposure on Kississing Lake provided sections that could be mapped in detail. These sections were then augmented by traverses, where necessary, to obtain more complete structural/ stratigraphic information. The use of a Bell, Jet Ranger Helicopter kindly provided by Selco, enabled the checking and comparison of poorly accessible regions around Sing Sing Lake, Thunderhill and Piat Lakes and Duval Lake.

Many of the results presented here are interpretations based on a limited synthesis of field information, and by necessity are also generalizations of a complex stratigraphy much modified by later thrust fault and possible nappe style tectonics.

Three major rock sequences, not necessarily in stratigraphic order, are represented in the area:

(a) The Sherridon Group (per se) as described originally by Bateman and Harrison (1946) and reinterpreted by Froese and Goetz (1976).

(b) Quartz-plagioclase-biotite-garnet gneiss; probably equivalent to the Nokomis Group gneisses and characterized by strongly foliated non-layered or poorly-layered migmatized gneisses with white pegmatite or granitic segregations and veins.

(c) An intermediate or transitional sequence, here termed the Cold Lake Gneiss for convenience, consisting of hornblende-bearing gneisses often with magnetite, and characterized by some layered epidote-rich calc-silicate horizons, and pink migmatitic veins. Within this sequence are garnet + biotite gneisses which superficially resemble the Nokomis Group gneisses except that they may contain hornblende and/or magnetite and disseminated sulphides.

A simplified stratigraphy is shown in Figure GS-11-1, and although some of the complications introduced by tectonics are shown, many will not become apparent until synthesis of the field work is completed.

SHERRIDON GROUP

The Sherridon Group, which is developed in a boomerang-shaped structural basin north and east of the village of Sherridon, appears to have no identical lithological counterpart elsewhere in the Sherridon map sheet. Tectonically, it is separated from the structurally underlying Cold Lake Gneiss by a zone of intense deformation which has the geometry and style of a nappe. The "basal" amphibolite of the Sherridon Group, mapped as a gabbro by Froese and Goetz (1976), is a massive amphibolite which retains a vague mineralogical layering reminiscent of a differentiated mafic intrusive. Structurally overlying the massive sulphide horizon at Sherridon is another amphibolite. This massive and garnet free amphibolite contains an anastomosing network (lattice work) of garnet and hornblende "veins", 1 to 5 cm thick, and spaced at 5 to 30 cm intervals. These have the appearance of metamorphosed alteration fractures which have been depleted in alkalies and enriched relatively in iron and magnesium. Two inconclusive younging directions from metasediments just south of the mineralized horizon suggest that the Sherridon Group, south of the village of Sherridon may be overturned. This would place the "altered amphibolite" described above, in a primary position beneath the massive sulphide mineralization.

NOKOMIS GROUP

The type area for the Nokomis Group (on Nokomis Lake) was visited with G. Gale and W.D. McRitchie, in order to standardize nomenclature and allow definitive correlations to be established. The Nokomis Group as described by Robertson (1953) consists of vaguely layered quartz-plagioclase-biotite-garnet ± graphite gneisses, in part migmatitic, with white pegmatitic anatectic veins. Diagnostically the Nokomis Group contains no amphibolite horizons nor does it contain hornblende. As a consequence there are no Nokomis Group metasediments in contact with the Sherridon Group to the immediate west, south or east of Sherridon village. However, good Nokomis Group metasediments occur just to the west of the Ideal deposit and in what are interpreted as imbricate thrust slices, to the north of Big Island.

COLD LAKE GNEISS (Intermediate or Transitional Facies)

This unit consists of a package of rocks which occur structurally between the Sherridon Group and the garnet-biotite, migmatitic gneisses of the Nokomis Group. However, as its name suggests, the package contains rocks which possess characteristics similar to both the Nokomis and Sherridon Groups.

Typically this unit is hornblende-bearing and contains rocks varying in composition from amphibolites and garnetiferous amphibolites, through quartzitic hornblende gneisses with minor calc-silicates, skarn-like hornblende-diopside-calcite-quartz gneisses, well-layered, striped hornblende-plagioclase-biotite ± garnet gneisses to "Nokomis-like" quartz-plagioclase-biotite-garnet ± hornblende gneisses.

Immediately adjacent to the Sherridon Group, south and west of Sherridon village, is a sequence of well-layered, banded gneisses. The alternating light and dark layers vary in thickness from 5 to 25 cm and are composed of quartz + plagioclase + garnet ± biotite and hornblende ± biotite. This unit has some possible correlatives only on the western shore of Maltman Lake. In all sections mapped, this unit is invariably separated from the rest of the Cold Lake Gneiss, by a "granitoid" orthogneiss of tonalitic to granitic composition.

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Elsewhere the Cold Lake Gneiss consists of distinctive pink/green coloured quartzitic, hornblende-bearing gneisses; the colouration being due to rose quartz and hornblende respectively. These rocks may be hornblende rich, grading into garnet free amphibolites. They can also be felsic with less than 10% hornblende, in which case the pink colouration disappears and the magnetite content increases. Magnetite occurs as porphyroblasts 1 mm to 6 cm in diameter, which are typically surrounded by white plagioclase haloes or pressure shadows. Epidote rich, finely-layered calc-silicate layers and lenses, a common component of this sequence are more typically associated with the felsic horizons. There are no sulphides present in this sequence.

A complexly interlayered sequence of quartz-plagioclase-biotite ± garnet ± hornblende ± sulphide gneisses, garnet amphibolite + sulphide and hornblende-diopside-quartz-calcite ± sulphide gneisses occurs within the Cold Lake Gneiss adjacent to the quartzitic hornblende-bearing gneisses, and probably stratigraphically beneath them. These rusty weathering gneisses (due to the oxidation of pyrite and pyrrhotite) seem to be compositionally transitional between the Nokomis Group and the Sherridon Group.

STRATIGRAPHY

The preliminary stratigraphy is shown in Figure GS-11-1, and the approximate distribution of these units in the Sherridon area, in Figure GS-11-2. It should be pointed out, however, that the stratigraphy of the Cold Lake Gneiss is probably more complicated than is shown, and may well be substantially revised after compilation is completed.

Several points are immediately evident however:

(a) The "base" of the Sherridon Group does not appear to have any regional stratigraphic significance;

(b) The Cold Lake Gneiss/Nokomis Group boundary has sufficient stratigraphic and genetic significance to warrant further investigation and mapping throughout the area;

(c) Stratabound sulphide mineralization is confined to specific horizons within the Cold Lake Gneiss; and within parts of the Sherridon Group. Massive sulphide horizons within the Cold Lake Gneiss seem to be confined to rusty weathering gneisses, which may contain garnet or which may be calcareous, but typically occur in close juxtaposition with a characteristic garnetiferous amphibolite.

(d) The Sherridon Group may be equivalent stratigraphically to this part of the Cold Lake Gneiss but lithologically there is little similarity between the two sequences, other than in broad comparison and sulphide type. However, because the Sherridon Group is not in conformable stratigraphic contact with the Cold Lake Gneiss, at least in the area studied, it is preferred to not attempt the correlation.

STRUCTURE

Three major periods of folding were recognized in the area:

F_1 — characterized by tightly appressed, over-flattened highly attenuated, polyclinal isoclinal folds with a well developed axial surface foliation defined by biotite and/or hornblende.

F_2 — tight similar folds, coaxial to F_1 folds but which fold the F_1 axial surface foliation. These have a consistent E/W primary horizontal orientation, with all folds bearing a consistent vergence indicating thrusting from the north.

F_3 — Folds of this generation are rather restricted in distribution and account for such structures as the Sherridon synform, which are open NNW/SSE plunging structures which fold the earlier F_1 and F_2 folds.

It is speculated that the intrusion of granitoid sheets accompanied thrusting associated with F_1 folding and that the primary metamorphic event also took place at this time. Continued movement generated the F_2 structures but under a much reduced thermal event and developed the imbricate stacking of thrust/nappe sheets that is present in the northern part of Kississing Lake.

SULPHIDE MINERALIZATION

Most sulphide mineralization is either associated with the Sherridon Group, or with the rusty weathering garnet gneisses and/or with the hornblende-diopside-quartz-calcite gneisses on either side of a distinctive garnetiferous amphibolite within the Cold Lake Gneiss.

It is interpreted that these sediments were originally a shallow-water marine succession with some associated carbonates. The hornblende content is thought to have been derived from basic volcanism on the margins of the basin; either in the Flin Flon-Snow Lake Belt and/or the Lynn Lake Belt.

Thicker accumulations of sulphide should occur in areas of less structural attenuation (such as fold hinges), and in areas of less rapid sediment accumulation, that is, where the primary sedimentary grain-size was finer and where the rocks are probably now characterized by more aluminous assemblages.

The Sherridon Group rock assemblage is unique in the area investigated. It does not appear to have any direct stratigraphic equivalent, and its present position, straddling both the Cold Lake Gneiss and Nokomis Group suggests that it has been structurally emplaced. Thrusting directions from metasediments beneath the Sherridon Group, have been interpreted to imply that it has been emplaced from the north.

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To accompany Report GS-11: Tuckwell

Preliminary Stratigraphy in the Sherridon-Kississing Lake Area

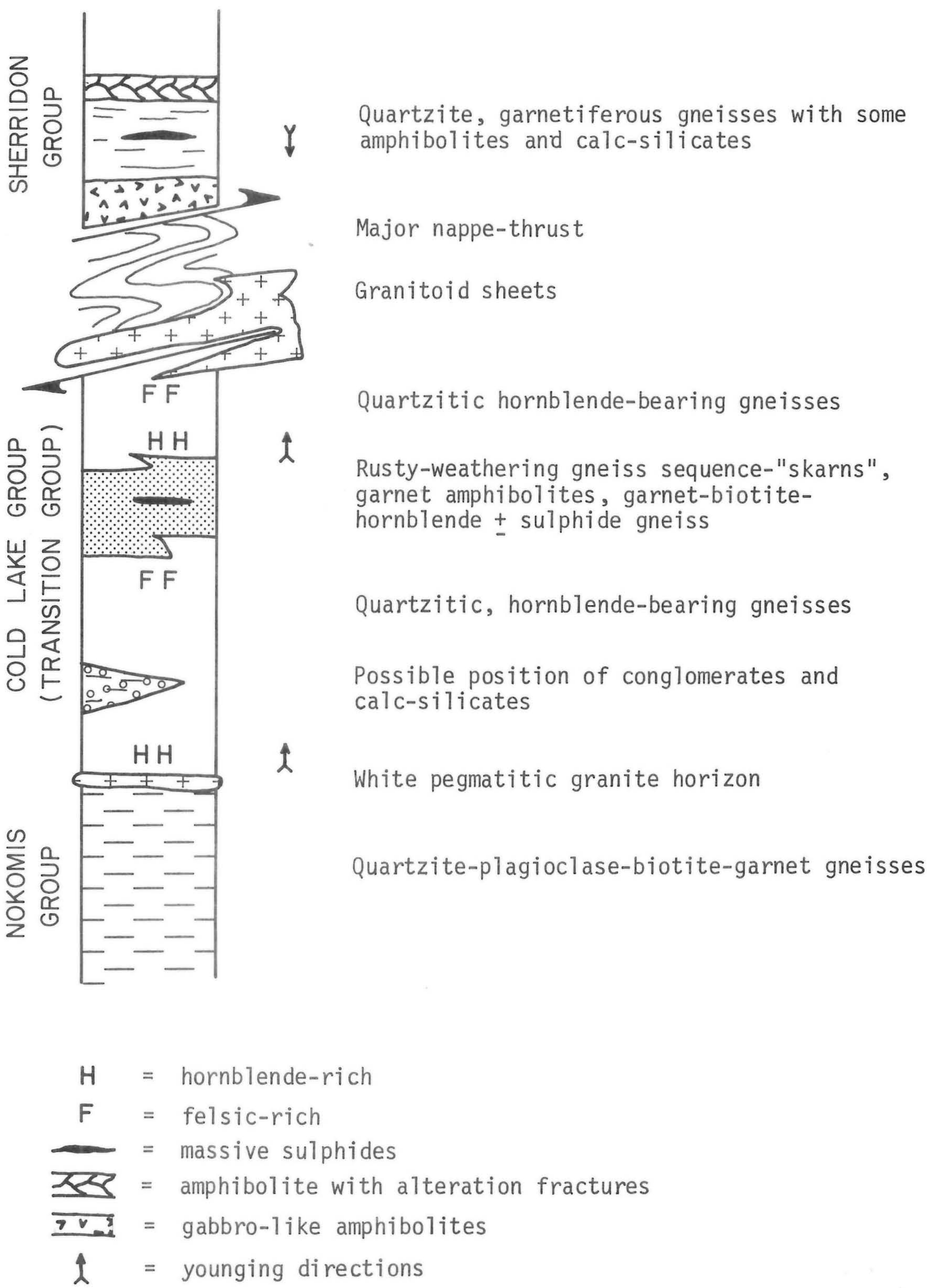

FIGURE GS-11-1: Preliminary Stratigraphy in the Sherridon-Kississing Lake Area.

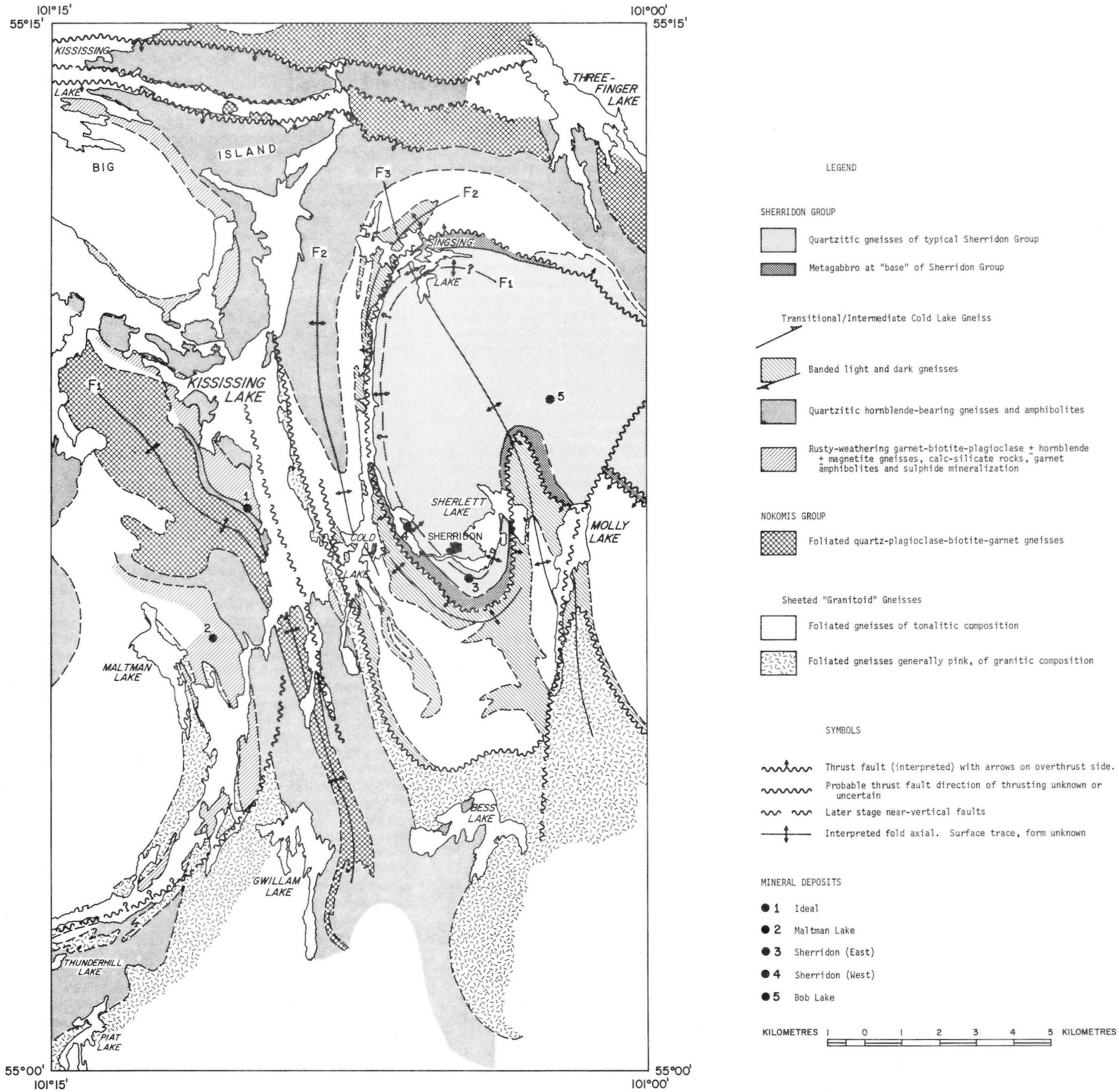

Figure GS-11-2: Outline geology — Sherridon area.

GS-12 WHITE LAKE-MIKANAGAN LAKE PROJECT

(Parts of 63K/12 and 13)

by Alan H. Bailes and Eric C. Syme

INTRODUCTION

A need for detailed mapping and interpretation of the Aphebian Flin Flon volcanic belt has arisen with the development of modern models for the genesis of volcanogenic massive sulphide deposits. This project was undertaken to provide a sound geological base for future mineral exploration in the White Lake-Mikanagan Lake area. Three volcanogenic massive sulphide deposits, the White Lake, Cuprus and Centennial Mines, are located in the project area.

During 1979, mapping at a scale of 1:15 840 was completed for approximately half of the project area (Fig. GS-12-1), Preliminary Map 1979W-1). This report includes an outline of the structural setting, a brief description of the rock units (unit numbers correspond to Preliminary Map 1979W-1), and a summary of the volcanic stratigraphy (Fig. GS-12-2).

STRUCTURAL SETTING

There are two major structural blocks in the map area: (1) an east-facing sequence between Manistikwan Lake and Schist Lake; and (2) a west-facing sequence between Pineroot River and Schist Lake. These blocks are separated by a major fault, referred to here as the Schist Lake fault, which follows the west shore of Schist Lake. A north-plunging, tight syncline west of Schist Lake is the only other major structure in the area.

The Schist Lake fault trends at approximately 020° and has a steep dip. It truncates large parts of units 7 and 8, and juxtaposes these against rocks of unit 16. Mudstones of unit 16 are tightly folded, foliated, and veined by quartz and carbonate in a zone adjacent to the fault, but where observed the fault plane is only a few millimetres wide.

The syncline west of Schist Lake has an axial plane which strikes at 025° and an axis which plunges between 10° and 40° at 015°. A regional schistosity is parallel to the axial surface. The west limb of the syncline comprises at least 4100 m of east-facing strata, whereas the east limb consists of only 300 m of west-facing strata. The short east limb of the syncline is truncated by the Schist Lake fault. This fold was recumbant during intrusion of a series of differentiated gabbro sills because in the west limb of the fold these intrusions top opposite to bedding in the host volcanic rocks.

The close association of a major, short-limbed fold with the Schist Lake fault suggests that this fault may have been a thrust plane.

DESCRIPTION OF UNITS

Supracrustal rocks in the map area belong to the Amisk Group of the Flin Flon volcanic belt. They are intruded by large gabbro sills and small bodies of tonalite and melatonalite.

Metamorphic grade is approximately middle greenschist facies. Primary structures and textures are generally well preserved, except west of White Lake, west of Sleep Lake, and immediately west and north of Schist Lake, where a strong regional foliation is present.

The stratigraphic section west of Schist Lake (Fig. GS-12-2) comprises units 1 to 9; the section east of Schist Lake (Fig. GS-12-2) includes units 10 to 16.

WEST OF SCHIST LAKE

INTERMEDIATE FLOWS AND RELATED INTRUSIONS (Unit 1)

More than 3200 m of east-facing intermediate flows and related intrusive rocks are exposed between Manistikwan Lake and White Lake. Zones of pillow-fragment breccia, up to 300 m thick, occur locally in the upper one-third of the unit. The pillow-fragment breccias are lateral facies equivalents of thick, highly vesicular, commonly pyroxene-phyric, pillowed flows. Massive flows and flows with massive divisions occur in the upper part of the section, predominantly in the immediate Bear Lake-Sleep Lake area. Highly altered (epidotized) pillowed flows occur in the White Lake-Sleep Lake area.

Flows

Flow thickness ranges from less than 1 m to over 80 m depending on flow type and organization; most flows are between 5 and 10 m thick. Pillowed flows are generally the thickest. Chilled basal and top parts of massive flows are locally preserved.

The flows are organized in a manner comparable to that described by Dimroth *et al.* (1978). Individual flows comonly consist of several divisions distinguished by their structure. They are, from base to top: massive lava, pillowed lava, isolated-amoeboid-pillow breccia, and stratifield hyalotuff. One or more of these divisions may be absent from any flow. Figure GS-12-3 shows flow organization in three well exposed localities in the Bear Lake area.

Total vesicularity increases upwards in flows, and is greatest in the amoeboid pillows in flow-top breccias. Vesicularity also varies between flows, from 0 to 60%. Vesicles are commonly filled with quartz and locally contain minor carbonate, epidote, or chlorite.

Gas cavities up to 25 cm long by 4 cm wide, some with cupola shapes, occur at the top of massive divisions of flows and at the tops of pillows. These cavities parallel the flow or pillow top and are filled with vuggy quartz or quartz and feldspar.

Pyroxene phenocrysts occur in some flows; they are 1 mm to 1 cm in diameter and comprise 1 to 20% of the rock. They are locally concentrated at the base of massive divisions and in the lower halves of pillows. Aphyric and pyroxene-phyric flows are intercalated and differ only by the absence or presence of pyroxene phenocrysts. It is probable that aphyric and pyroxene-phyric flows are cogenetic.

Pillows vary in size and shape in a manner similar to that described by Dimroth *et al.* (1978). Selvages are less than 5 mm thick, and weather rusty brown. Spherulites, less than 1 mm to 1 cm in diameter, locally occur within the margins of pillows, adjacent to the selvage. Best preserved spherulites are composed of fibro-radial feldspar. Amygdales up to 1 cm in diameter occur at some pillow margins and in pillow cores. Pipe vesicles, 2 to 5 cm long, occur around the margin or at the upper margin of some pillows. Zoned pillows, megapillows with re-entrants of pillow crust, and budded pillows indicate movement of lava through these structures, and suggest they may have been tubes (Dimroth *et al.*, 1978). Pillow size decreases upwards in some individual pillowed flows. Flows with southerly components of flow direction, and others with northerly components, are indicated by pillow imbrication and the lateral transition from pillowed flow to pillow-breccia.

Flow-top breccias occur on many massive and pillowed flows. The breccias consist of amoeboid pillows, small pillow fragments, and hyaloclastite. The amoeboid pillows are highly irregular in shape, have complete selvages, and are characterized by high vesicularity. They range from 10 cm to 4 m long, and are elongate parallel to flow contacts.

Thermal contraction cracks occur within pillows and at the margin of some massive flows. The quartz-filled cracks are paper thin, parallel and spaced 1 to 5 mm apart. In pillows the cracks are parallel to the rim and occur in the outer margin or outer part of the

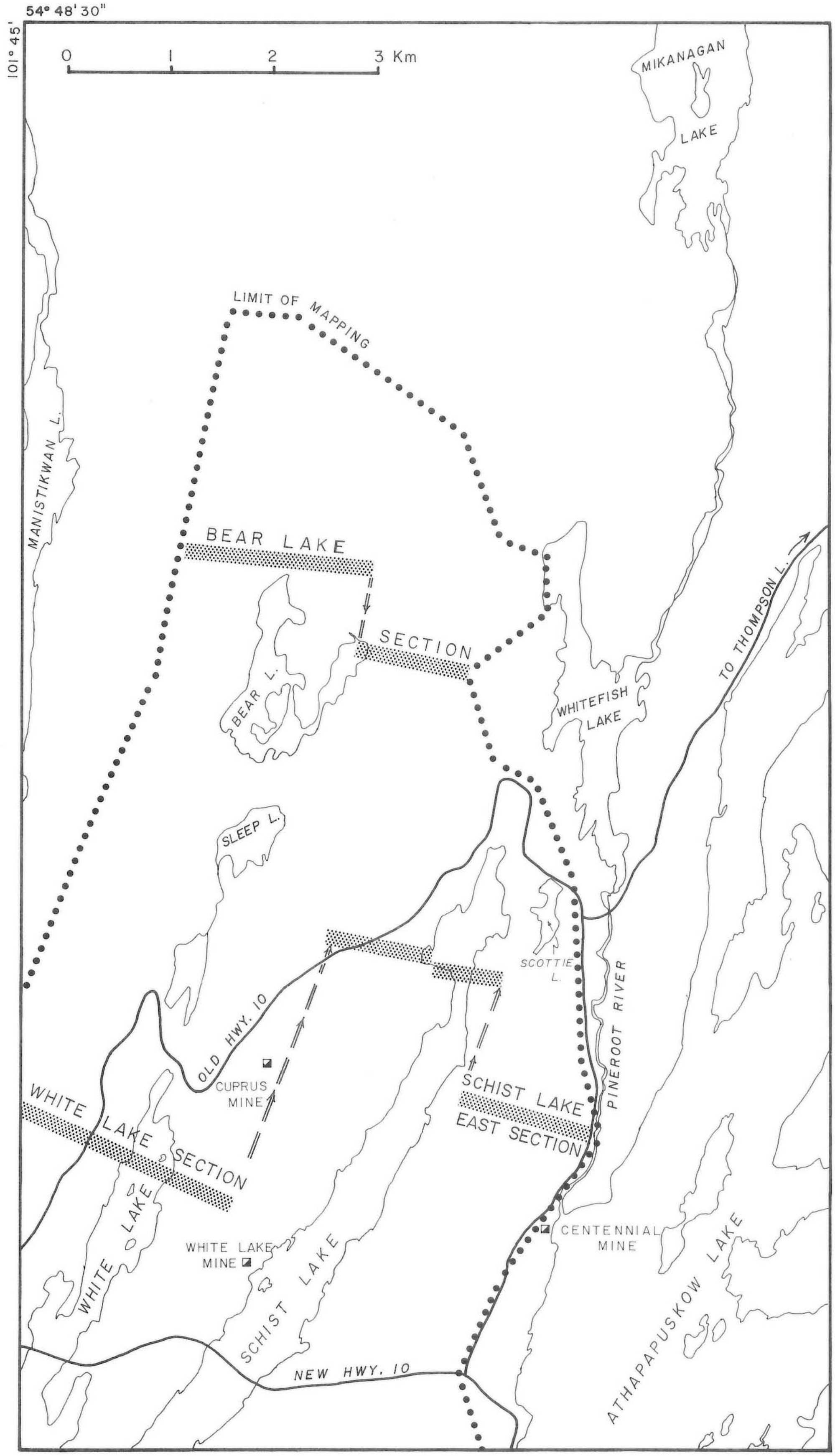

FIGURE GS-12-1: Location map of the White Lake-Mikanagan Lake project area, showing the area mapped in 1979, the location of stratigraphic sections (Fig. GS-12-2), and the location of mines.

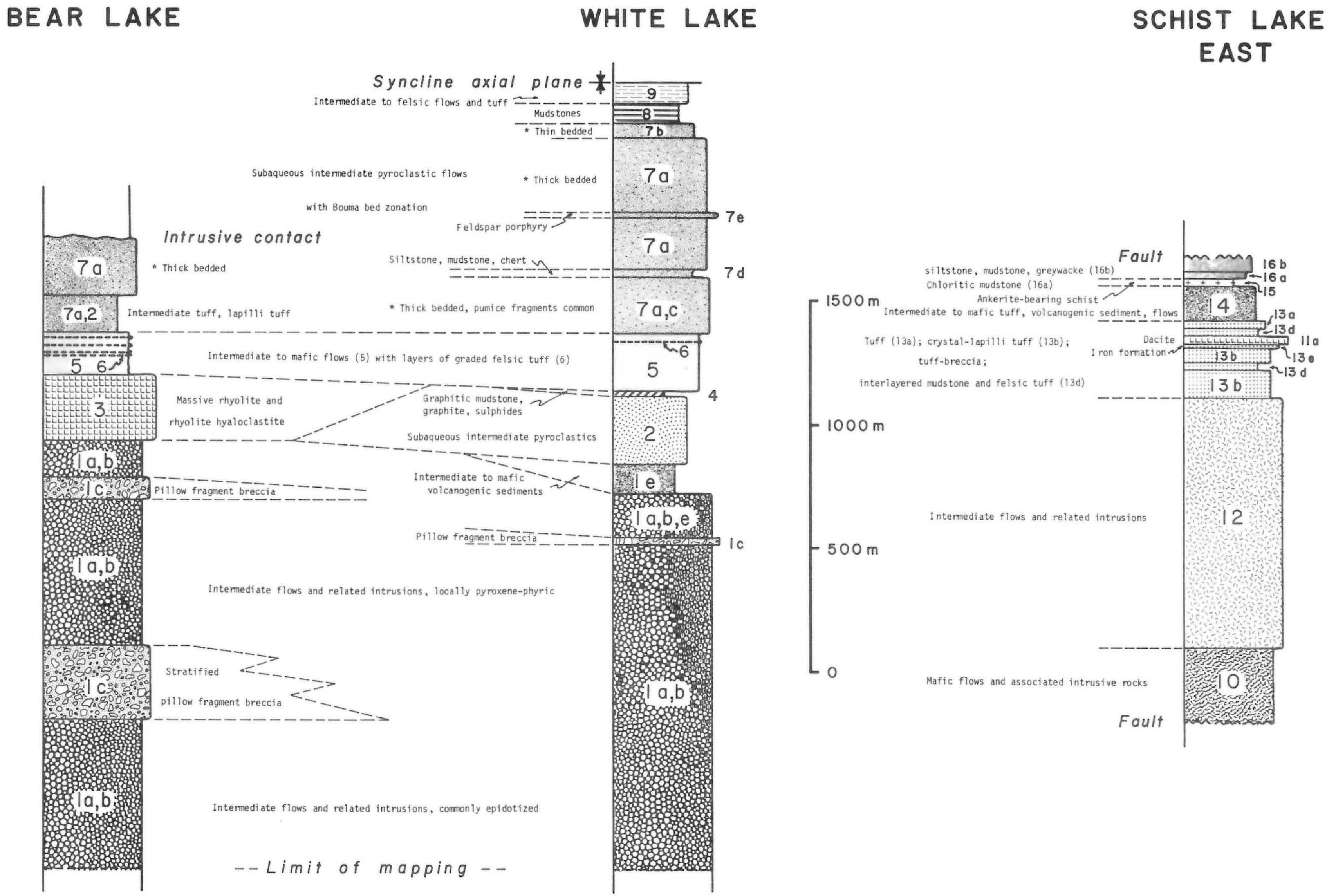

FIGURE GS-12-2: Representative stratigraphic sections (see Fig. GS-12-1 for locations). Gabbro sills have been omitted.

pillow core. Thermal contraction cracks are developed only in weakly vesicular or non-vesicular portions of massive flows or pillows.

Feeder dykes are common throughout unit 1. They are typically 50 cm to 3 m wide, but are locally several metres wide. They range from straight-walled dykes to irregular bodies which wind through pillowed flows or pillow-breccias without cross-cutting the pillows or fragments. Margins of the dykes are commonly layered; the layers are 5 to 15 cm thick and are interpreted as chilled phases deposited by successive pulses of magma. Some dykes are amygdaloidal, and some of the marginal layers are weakly amygdaloidal. Lava tubes are rare; one tube in the Bear Lake area, 2 by 10 m in section is concentrically zoned and contains a core of collapse-breccia.

Pillow-fragment breccias

Stratified pillow-fragment breccias are demonstrably the lateral facies equivalents of some strongly vesiculated pillowed flows. Thin (2 to 3 m) intercalations of pillowed lava occur in the thick pillow-breccia unit north of Bear Lake.

The breccias consist of angular pillow fragments in a brown-weathering matrix of small fragments and granules derived primarily from pillow selvages. Shapes of the larger fragments are consistent with *in situ* brecciation of pillows along concentric and radial contraction cracks; fragments of pillow margins complete with selvages and radial pipe vesicles are diagnostic. Complete pillows occur in some beds, and not necessarily at the base of beds. The fragments are commonly epidotized, and contain more than 30% quartz amygdales.

The breccias are organized into beds ranging from 1 m to over 21 m thick. Bed contacts are defined by abrupt changes in fragment size and the proportion of fragments to matrix. Most beds are graded, but grading is obvious only in the top portion. Basal portions of beds are coarsest, with fragments up to 30 cm long. Upper parts of beds consist of small (less than 10 cm) fragments and granules, with abundant fine-grained matrix.

SUBAQUEOUS INTERMEDIATE PYROCLASTICS (Unit 2)

Subaqueous intermediate pyroclastic rocks comprise a wedge-shaped deposit with a maximum thickness of 400 m east of White Lake. The unit is characterized by variability in composition, bed form, fragment size, and proportion of pumice. The three major rock types are lapilli tuff, tuff, and pumice-bearing tuff.

Lapilli tuff is buff to light-brown weathering and light to medium green-gray on fresh surface. Stratification, although present, is typically poor defined. Beds vary in fragment size and proportion of matrix; some beds are graded. Typical fragments are intermediate in composition, light grey, and aphyric. Pumice fragments or rhyolite fragments or both are present in some beds. The unit occupies the same stratigraphic interval as the rhyolite flows (unit 3), and may be in part derived from the rhyolite.

Tuff is characteristically rusty-brown weathering and dark green on fresh surface, and locally contains oval to irregular-shaped epidosite replacement bodies. The tuff is very fine-grained, with crude stratification ranging from a few centimetres to 3 m thick. Beds are defined by variations in the abundance of 0.25 to 0.5 mm quartz grains.

Pumice-bearing tuff and laminated tuff with large exotic pumice blocks, up to 2 m long, occur northeast of White Lake. The pumice fragments are epidotized and silicified; primary vesicularity is only locally preserved.

RHYOLITE (Unit 3)

Rhyolite forms a wedge-shaped unit, a maximum of 300 m thick, which terminates south of Bear Lake. It overlies portions of both units 1 and 2. It consists of aphanitic, aphyric, white-weathering, massive rhyolite, light brown-weathering rhyolite hyaloclastite, and rhyolite breccia with hyaloclastite matrix. These lithologies are interpreted to be part of subaqueous rhyolite flows by analogy to structures described by Dimroth and Rocheleau (1979).

Rhyolite occurs as pods, lobes, and tongues of massive lava enveloped by breccia and hyaloclastite. Contacts between massive rhyolite and hyaloclastite are commonly sharp, but are locally diffuse over approximately 5 cm. Massive lava with *in situ* brecciation grades into rhyolite breccias composed of subangular rhyolite fragments and granules set in a hyaloclastite matrix. The hyaloclastite is composed of small (less than 1 to 5 mm) rhyolite granules and a very fine-grained, felsic, green matrix. Both the breccia and hyaloclastite are locally stratified where these lithologies are not directly associated with massive rhyolite lobes or tongues.

MUDSTONES (Unit 4)

In the White Lake area 25 m of sulphide-bearing fine-grained sediments occur at the contact between intermediate pyroclastics (unit 2) and overlying intermediate to mafic flows (unit 5). The unit was not observed in the Bear Lake area but its stratigraphic position is equivalent to the contact between rhyolite (unit 3) and intermediate to mafic flows (unit 5).

Rock types which outcrop include highly gossaned graphitic mudstone, graphite, minor chert, and sulphide zones. Two massive sulphide deposits (White Lake mine, Cuprus mine) occur within this formation. Footwall chloritic alteration zones are associated with both massive sulphide deposits.

INTERMEDIATE TO MAFIC FLOWS (Unit 5)

A unit of intermediate to mafic flows, 150 to 210 m thick, overlies intermediate pyroclastics (unit 2) and graphitic sediments (unit 4) west of Schist Lake, and rhyolite flows (unit 3) east of Bear Lake.

Both massive and pillowed flows, which vary in composition from intermediate (light brown-weathering) to mafic (dark grey-weathering) occur in unit 5. Mafic varieties include massive microgabbroic-textured flows which are difficult to distinguish from shallow intrusions where flow contacts are not exposed. At Bear Lake, where individual massive mafic flows are locally defined by felsic crystal tuff layers (unit 6), the flows are up to 20 m thick and have chilled margins and weakly vesicular tops. Intermediate varieties locally contain pillows with poorly defined selvages; mafic pillowed flows have well defined bun-shaped pillows. The entire suite is characterized by the near absence of amygdales or vesicles.

FELSIC CRYSTAL TUFF (Unit 6)

Felsic crystal tuff layers occur throughout the intermediate to mafic flow unit (unit 5); they are thickest and most abundant in the Bear Lake area. The layers vary from 30 cm to 7 m thick; most are 1 to 2 m thick. Each layer is a single depositional unit. All the felsic tuffs are at least weakly gossaned and are locally overlain by sulphide-bearing cherty or graphitic material. A 7 m thick tuff, overlain by 15 m of gossaned cherty material, occurs at the top of the unit 5 flow sequence east of Bear Lake.

The tuff beds are graded, with a crystal-rich base characterized by quartz crystals up to 3 mm in size. The tuff also contains feldspar crystals, and locally contains aphanitic felsic fragments up to 5 cm in size. Chert layers occur in the upper parts of beds and the topmost portions are locally parallel laminated. Bed organization suggests deposition from subaqueus density currents, probably pyroclastic flows.

SUBAQUEOUS INTERMEDIATE PYROCLASTIC FLOWS (Unit 7)

Up to 825 m of subaqueous intermediate pyroclastic flows overlie unit 5. They characteristically weather light buff and are light grey on fresh surface. These rocks were previously mapped as sediments (Buckham, 1944), but the following features indicate deposition from subaqueous pyroclastic flows:

(1) The beds have a 'Bouma' internal zonation of structures; this indicates subaqueous deposition from turbid density flows.
(2) Pumice fragments and pumice-fragment layers are common

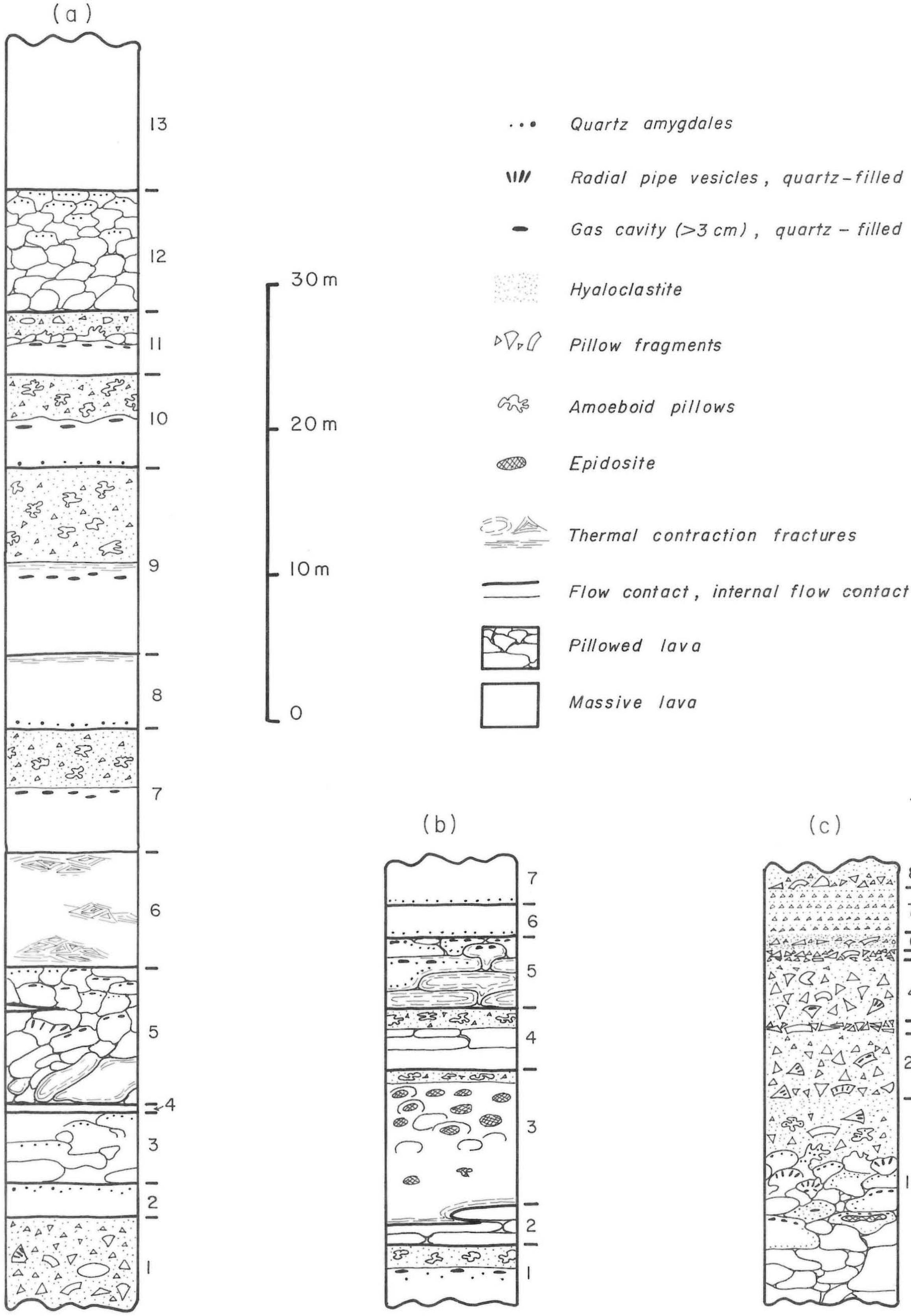

FIGURE GS-12-3: Sections showing organization and vertical sequence of unit 1 subaqueous intermediate flows (a and b) and stratified pillow-fragment breccia (c), Bear Lake. Numbers identify individual flows and beds.

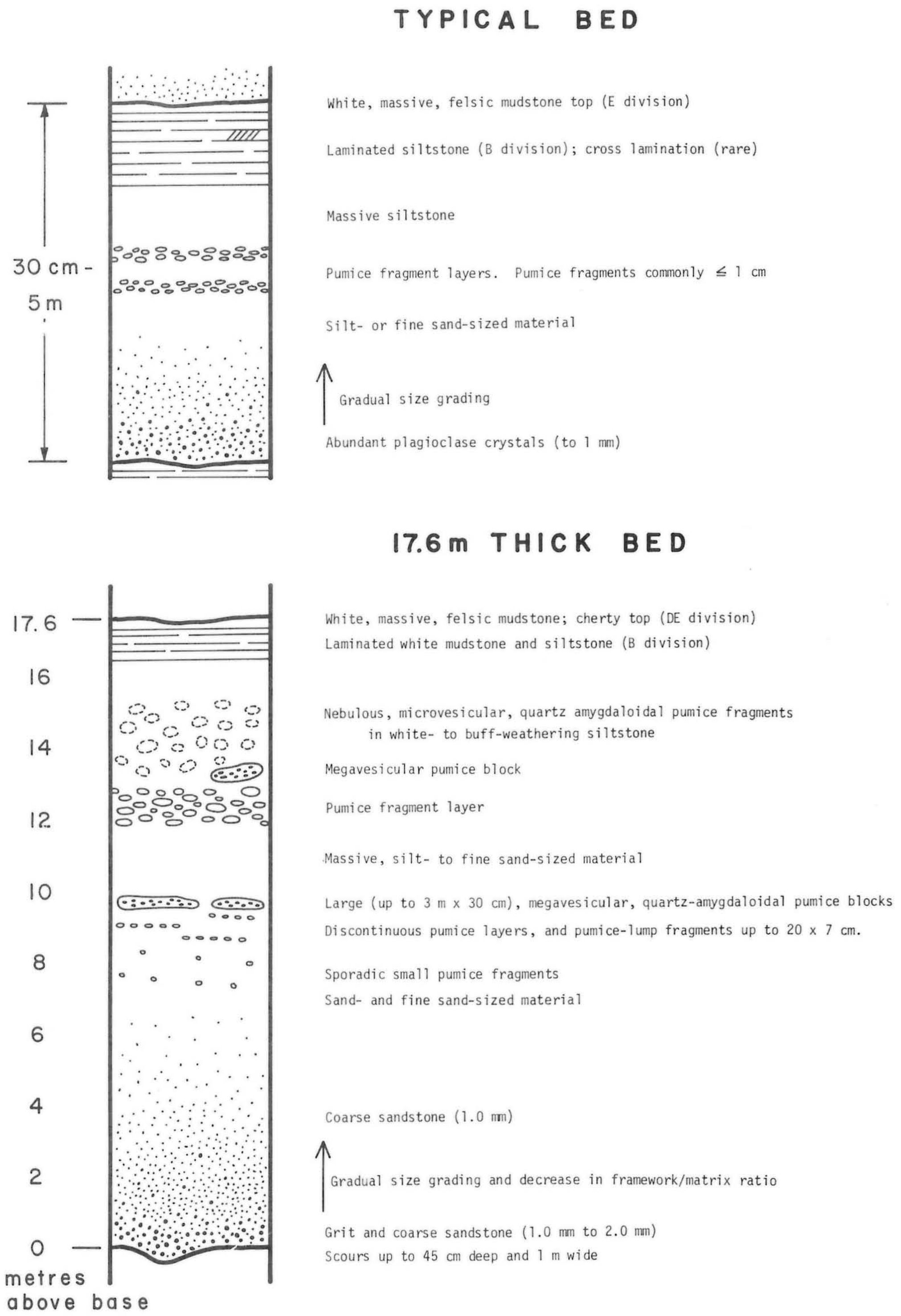

FIGURE GS-12-4: Sections showing the sequence of structures in intermediate, subaqueous pyroclastic flows (unit 7); (a) a typical bed, (b) a measured, 17.6 m thick bed.

(see below); the presence of pumice demonstrates that these rocks are either pyroclastic or slumped pyroclastic deposits (Fiske, 1969).

(3) The beds are all similar in composition, the clast population is homogeneous, and non-volcanic clasts are absent. This indicates a homogeneous, volcanic source terrain.

(4) There is no systematic sequence of bed types, for example, the upward-fining cycles of deep-sea fan systems (Walker, 1976). This favours a pyroclastic rather than sedimentary origin (Dimroth and Rocheleau, 1979).

Similar deposits, interpreted to be subaqueous pyroclastics, have been described by Niem (1977). Although the deposition of unit 7 was subaqueous the tuff could have been erupted in either a subaqueous or subaerial environment.

Bed thickness ranges from 5 cm to 17.6 m, and averages approximately 1 m. Contacts between beds are defined by grain size contrast. Beds are graded, with feldspar crystals up to 2 mm at the base and a silt- or mud-sized fraction at the top. Scours up to 45 cm deep occur at the base of some beds. White-weathering, very fine-grained tuff occurs at the top of many beds.

Beds display a 'Bouma' zonation of internal structures (Fig. GS-12-4), namely graded division (A), parallel laminated division (B), ripple laminted division (C), and white weathering tuff (DE?). Beds rarely contain all the divisions; AB(E) beds predominate. In contrast to sedimentary turbidites, beds of unit 7 are characterized by exceptionally thick A divisions and only minor development of upper divisions.

Fragments greater than 5 mm and fragment-bearing strata typically occur within the upper part or at the top of the A division, never at the base (Fig. GS-12-4). The fragments are interpreted to be pumice because (1) their position in the upper part of the A division indicates a low primary density, and (2) their primary vesicularity is locally preserved.

MUDSTONE AND INTERMEDIATE VOLCANICS (Units 8, 9)

Approximately 150 m of mudstone, chert, intermediate and felsic flows, and tuff overlie unit 7. They are poorly exposed and occur in the nose of the fold west of Schist Lake. Fine-grained sediments in this sequence are locally pyrite-bearing and strongly gossaned.

EAST OF SCHIST LAKE

MAFIC FLOWS AND ASSOCIATED INTRUSIONS (Unit 10)

Up to 180 m of mafic flows and associated intrusions occur above the faulted base of the west-facing stratigraphic section east of Schist Lake. The massive and pillowed flows occur as screens in a predominantly mafic intrusive complex. Flows weather dark green and are grey-green to black on fresh surface. Intrusive phases include microgabbroic and diabase dykes, plagioclase-phyric and pyroxene-phyric mafic to intermediate dykes, quartz diorite and aplite, as well as intrusive phases related to the overlying intermediate flows (unit 12).

FELSIC VOLCANICS (Unit 11)

Felsic volcanic rocks, mainly dacite, are rare in the section east of Schist Lake. Massive varieties occur locally at the base and at the top of the rusty-brown intermediate volcanics (unit 12). Layers of felsic tuff occur sporadically within both the intermediate flows (unit 12) and overlying pyroclastics (unit 13). West of the Flin Flon airport, just south of the map-area, a felsic, phreatic explosion breccia is associated with massive rhyolite flows.

INTERMEDIATE FLOWS AND RELATED INTRUSIONS (Unit 12)

Immediately south of the new Highway 10 between Athapapuskow and Schist Lakes intermediate flows comprise a 1520 m thick sequence which thins northward to 820 m west of the Pineroot River. The unit has no identified internal stratigraphy and comprises massive and pillowed flows riddled with related intrusions. Up to 60 m of fine-grained, thin-bedded, intermediate volcanogenic sediments occur within the upper 150 m of the unit.

The flows weather rusty-brown and are plagioclase-rich. They range from 3.5 m to greater than 40 m thick, and are commonly between 5 and 10 m thick. Massive flows predominate; pillowed flows are abundant west and south of Scottie Lake and at the base of the unit on new Highway 10.

A typical flow is depicted in Figure GS-12-5. It is characterized by a thick massive division with a chilled base, a randomly oriented plagioclase microlite texture in the centre of the flow, and a thin flow-top facies composed of isolated-pillow breccia, or hyaloclastite, or both. Other flow types are rare, in contrast to the highly variable organization of flows in unit 1.

Pillowed flows are generally not significantly vesicular. Pillows have rusty-brown selvages approximately 5 mm thick. Feldspar spherulites are locally well preserved within the margin of some pillows.

Unit 12-type intrusions are intermediate in composition and include feldspar-porphyry, feldspar-pyroxene porphyry, and fine-grained (0.5 to 1 mm) equigranular quartz diorite. These intrusions are a genetically related suite, as indicated by gradation of one type to another and the absence of these intrusions in the overlying pyroclastics of unit 13. Thickness of individual dykes ranges from a few centimetres to 200 m; many outcrops are almost completely composed of cross-cutting intrusive bodies.

The fine-grained equigranular dykes are difficult to distinguish from massive flows. In general the intrusive rocks can be recognized by their equant plagioclase crystals, whereas flows contain microlitic lath-shaped plagioclase crystals. These criteria can be best employed in the least-deformed rocks and are of limited use in rocks containing a well-developed schistosity.

INTERMEDIATE PYROCLASTICS (Unit 13)

Up to 335 m of intermediate pyroclastic rocks are poorly exposed along the east shore of Schist Lake. In the section at the northeast end of Schist Lake, the base of unit 13 comprises 110 m of lapilli tuff, followed by 30 m of interlayered felsic tuff and mudstone, 60 m of lapilli-and crystal-tuff, 15 m of chert-magnetite iron formation, 30 m of dacite, 30 m of locally pyritic tuff and crystal tuff, 30 m of interlayered felsic tuff and mudstone and 30 m of interlayered felsic tuff and intermediate tuff.

The pyroclastics weather light to medium brown and are light bright-green on fresh surface. Plagioclase crystals, 1 to 2 mm in diameter, are the main component of the crystal tuff and dominate the matrix of lapilli tuff. Lapilli are intermediate in composition, vesicular, and commonly feldspar-phyric. Bedding is locally well developed, and some lapilli tuff beds are normally graded.

INTERMEDIATE TO MAFIC VOLCANICS (Unit 14)

A total of 140 m of mafic volcanogenic sediments and minor pillowed mafic flows overlie the pyroclastics of unit 13. The volcanogenic sediments are thinly layered (4 to 30 cm). Best preserved beds are graded and have laminated mudstone tops; the graded portions contain feldspar crystals. Chert occurs at the top of some beds. Thin concordant intrusions of gabbro (less than 3 m thick) are common and locally boudinaged.

ANKERITE-SERICITE-CHLORITE-CHERT SCHIST (Unit 15)

A 30 m thick unit of red-brown weathering ankerite-rich schist directly overlies unit 14. Small-scale chevron kink folds are characteristic of this unit.

MUDSTONE, SILTSTONE, GREYWACKE (Unit 16)

Approximately 30 m of dark green chloritic mudstone directly overlie unit 15. It is followed by 60 m of siltstone, mudstone, and minor feldspar crystal-bearing greywackes; alternating grey and red-brown weathering layers characterize the siltstone and

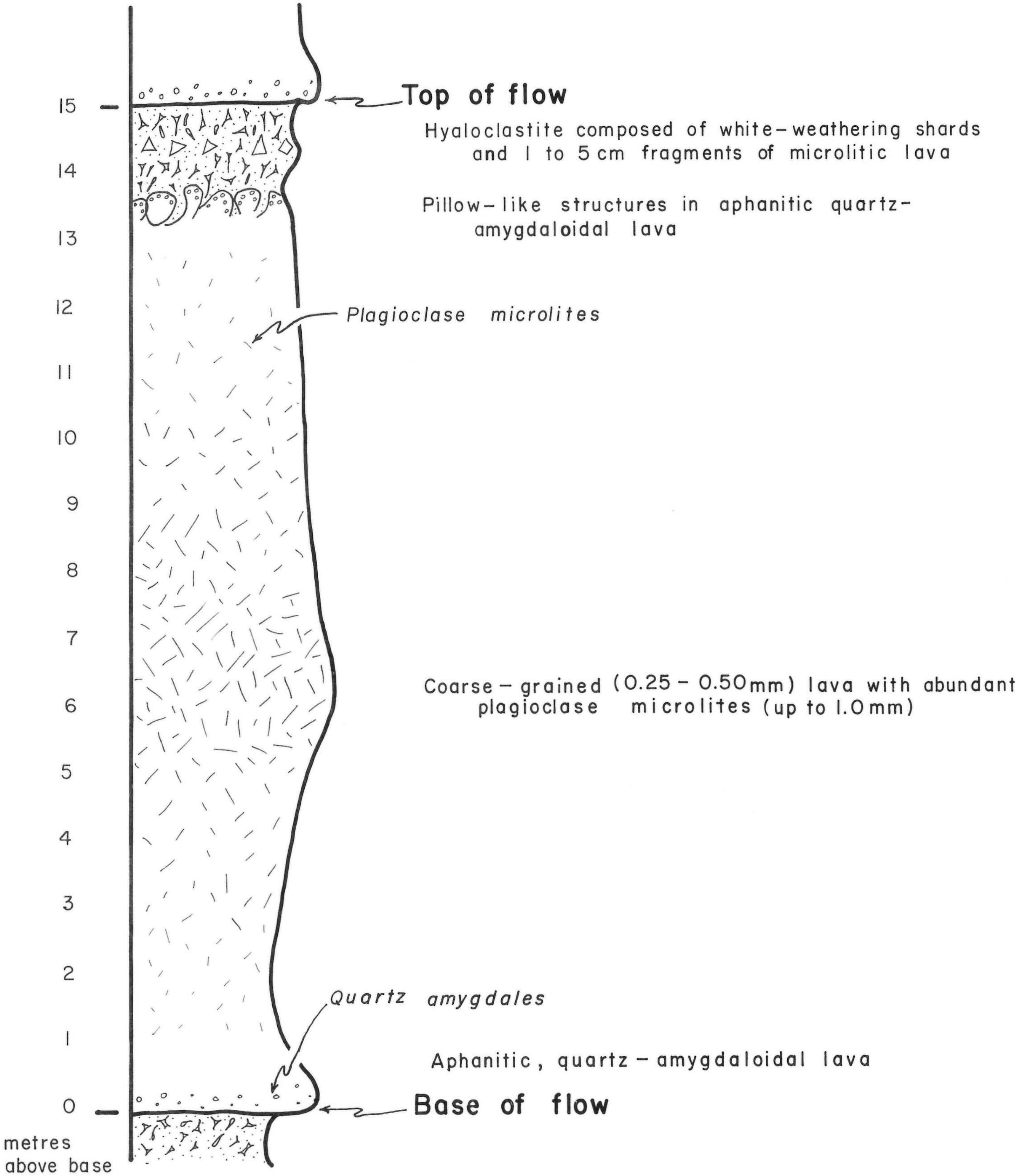

FIGURE GS-12-5: Section showing flow organization and variation in plagioclase grain size in a typical intermediate flow of unit 12.

mudstone. The greywacke beds weather grey and are locally graded. Tight folding, an intense schistosity, and quartz and carbonate veining characterize this unit adjacent to the Schist Lake fault.

INTRUSIVE ROCKS

GABBRO (Unit 17)

Three sills, ranging in thickness from 30 m to 330 m, and one podiform body 550 m in diameter comprise unit 17. The sills are differentiated and zoned. Four zones have been identified:

(1) 'Green' gabbro: medium grained, dark green to black weathering, with up to 60%, equant, 1 to 2 mm amphibole and 40 to 50% strongly hematized plagioclase.
(2) 'Brown' gabbro: medium grained, brown-weathering, with 50% equant, 1 to 2 mm amphibole, and 50% light brown-weathering epidotized plagioclase.
(3) Melagabbro: medium-grained, dark green to black-weathering, with 80 to 90%, 1 to 2 mm amphibole and 10 to 20% light brown-weathering plagioclase.
(4) Quartz diorite.

The sill just west of White Lake is the largest. It has an established strike length of over 10 km, is a maximum of 330 m wide, and thins to the north. Up to 120 m of 'brown' gabbro occurs along the west side of the sill. Igneous layering in the brown gabbro, at or near its contact with the 'green' gabbro, indicates that the sill tops to the west. Quartz diorite occurs at or near the base of the sill and bears an uncertain relationship to the major gabbro lithologies; it is locally intrusive.

The west-facing White Lake sill is emplaced in east-facing pyroclastic rocks of unit 2; this indicates that the sill was probably intruded after recumbant folding. Folds in the sill at the south margin of the map-area indicate the recumbant folding probably continued after intrusion of the sill.

FINE-GRAINED DIORITE AND QUARTZ DIORITE (Unit 18)

This unit includes two sills in the White Lake area, one of which is probably equivalent to a similar sill in the Bear Lake area. Zoning is not prominent in these intrusions. Narrow layers of quartz diorite occur on the west, and locally the east, margin of the Bear Lake intrusion. Layers of 'brown' gabbro and quartz diorite (units 17d and b) occur on the west margin of one of the sills in the White Lake area. Both intrusions locally include coarse (1 to 2 mm) phases, but a grain size of 0.5 mm is most common.

GABBRO, LEUCOGABBRO, ANORTHOSITE (Unit 19)

Two large, concordant, zoned gabbro bodies occur in the area west of Whitefish Lake. Incomplete mapping of these bodies indicates that they are composed predominantly of white to light buff weathering leucogabbro and minor anorthosite. Igneous layering is developed locally. A red-brown gabbro is present on the eastern margin of the sill at Whitefish Lake. Gabbros of unit 19 are characterized by a relatively coarse-grain size (1 to 3 mm), excellent gabbroic textures, and only weak recrystallization.

GABBRO, PYROXENITE (Unit 20)

A gabbro sill 120 m thick, with a central 30 m thick pyroxenite zone, occurs at the north end of Schist Lake. Primary gabbroic textures are well preserved. This intrusion may be genetically related to intrusions of unit 19.

TONALITE (Units 21 and 22)

Several small bodies of strongly foliated, white to pink weathering tonalite (unit 21) occur north and west of Schist Lake. They are composed of 20 to 30% quartz megacrysts (2 to 10 mm) and 70 to 80% epidotized plagioclase.

Two bodies of tonalite and melatonalite (unit 22), probably related to a large pluton south of the map-area, occur on Schist Lake and just west and north of the Flin Flon airport. The tonalite is white to buff weathering, coarse-grained (2 to 3 mm), and consists of 30% quartz, 65% plagioclase, and 5% biotite. The melatonalite is darker coloured and consists of 30% quartz, 20% amphibole, and 50% plagioclase.

QUARTZ-FELDSPAR PORPHYRY (Unit 23)

Dykes of fine-grained quartz-feldspar porphyry occur widely but are most abundant in the axial zone of the fold west of Schist Lake. The dykes weather white, pale green, or buff, and are light grey on fresh surface. Quartz and feldspar phenocrysts (1 mm) together comprise 10% of the rock. The dykes are axial planar to the fold west of Schist Lake and are unfoliated.

CONCLUSIONS

Mapping completed in 1979 has identified the main volcanic stratigraphy, established that the area is not structurally complex, and demonstrated the stratigraphic position and probable stratigraphic equivalence of the White Lake and Cuprus Cu-Zn sulphide deposits.

All of the volcanic and sedimentary units were deposited in a subaqueous environment. The generally high vesicularity of flows and the abundance of large gas cavities indicates deposition in moderate to shallow water. The pyroclastic flows must have been deposited below storm wave base (Walker, 1976) because they contain well-preserved turbidite-type structures. The large volume of pyroclastic material in the section suggests shallow water to subaerial eruption (Ayres, 1978).

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GS-13 GEOPHYSICAL INVESTIGATIONS

by N.M. Soonawala

INTRODUCTION

During the 1979 field season geophysical investigations were undertaken to locate and evaluate anomalies resulting from the airborne high-sensitivity gamma-ray spectrometer surveys done under the auspices of the Federal/Provincial Uranium Reconnaissance Program over the past four years. In order to evaluate a prominent URP anomally near Beaver Hill Lake (53L/2), gamma-ray spectrometer, magnetic and VLF-EM surveys were implemented over a geophysical grid of approximately 1 km by 1 km. Gamma-spectrometer readings were also taken near Black Lake and Shoe Lake (52L/11), and near the town of Rennie (52E/13). A helicopter-borne scintillometer survey was implemented in the vicinity of Mistuhe Lake (53L/1) in order to better define the location of a prominent URP anomaly in the area. A car-borne scintillometer survey was implemented in the Nopiming Provincial Park and vicinity, where several URP anomalies are located. Table GS-13-1 lists the above activities and Figure GS-13-1 indicates the locations.

Results of a high-sensitivity URP gamma-ray spectrometer survey implemented in 1978 over NTS areas 63N, O, P; 64A, B and parts of 63J and K were released in May 1979. This survey embraced an area of about 88 400 km^2 (Soonawala, 1978).

Three reports relating to geophysical and geochemical surveys implemented over the past several years are in the final stages of preparation, and their release is expected early next year. The reports deal with an aeromagnetic survey in the Lynn Lake area, and lake-sediment geochemistry and helicopter-scintillometer surveys in the Kasmere-Munroe area.

EVALUATION OF URP ANOMALIES BY GAMMA-SPECTROMETER AND OTHER GROUND GEOPHYSICAL METHODS

The usefulness of URP-type aerial gamma-ray surveys lies not in their ability to directly locate economic grade uranium mineralization but rather in locating relatively large areas which can be considered as 'source areas', containing 'fertile rocks' from which uranium might be mobilized for eventual economic-grade concentration by subsequent processes. Thus it can be expected that a URP anomaly would reflect bedrock whose uranium content is more than the universal average value (about 5 ppm for granites), but significantly less than that of low-grade deposits, i.e., about 100 ppm. The quantitative determination of this uranium content of possible source rocks can be very significant in evaluating an area for its potential for uranium mineralization, and for area selection for detailed exploration surveys.

With this in view, a program has been initiated for the systematic sampling of URP anomalies by calibrated digital gamma-ray spectrometers, which can rapidly determine *in situ*, the potassium, uranium and thorium content of rocks. The location of a selected URP anomaly is first accurately determined by a helicopter-borne scintillometer or other means, and then up to several hundred spectrometer readings are taken, usually with the stations spaced at 25 m on survey lines 50 m apart. For every such survey grid, the following eighteen statistical parameters are computed; the range, arithmetic mean, geometric mean and standard deviation for each of the three radio elements, the three possible coefficients of correlation and the three possible ratios. Histograms are also drawn for each of the three radio elements in order to illustrate their distribution and grouping tendencies.

In the vicinity of URP gamma-ray anomalies, information of secondary importance can also be obtained from magnetic, VLF-EM and magnetic susceptibility measurements. At about 10% of the stations where gamma-spectrometer readings are taken, rock samples are also collected for laboratory assay for the three radio-elements, in order to check the accuracy of the spectrometer results.

BEAVER HILL

A prominent URP gamma-ray anomaly located south of Beaver Hill Lake at about 54°11'N; 94°48'W in NTS area 53L/2 was investigated in detail. The URP survey, implemented in 1977, had indicated an anomaly with amplitude exceeding 4 ppm equivalent uranium. The location of the anomaly was determined precisely by a helicopter-scintillometer survey of line spacing 0.5 km in 1978 (Soonawala, 1978).

A geophysical grid of lines spaced at 50 m was established over an area of about 1 km by 1 km. Readings were taken at stations 25 m apart on the survey lines on an Exploranium GR-310 digital gamma-ray spectrometer which has a sensor volume of about 100 cm^3. The spectrometer was placed directly on outcrop or a suitable boulder

TABLE GS-13-1: SUMMARY OF GEOPHYSICAL INVESTIGATIONS, 1979.

Name of Area	NTS	Approx. Coordinate	Type of Survey	Descriptive Statistic
Beaver Hill Lake	53L/2	54°11'N 94°48'W	Gamma Spectrometer Magnetic VLF-EM	270 readings 5.8 line-km 5.8 line-km
Black Lake	52L/11	50°41'20"N 95°24'30"W	Gamma Spectrometer	23 readings
Shoe Lake	52L/11	50°38'30"N 95°27'20"W	Gamma Spectrometer	19 readings
Rennie	52E/13		Gamma Spectrometer	30 readings
Mistuhe Lake	53L/1		Helicopter Scint.	400 line-km
Nopiming	52L/11/14		Car scint.	125 line-km

and the following counting intervals were employed; total count 1 sec, potassium 10 sec, uranium and thorium 100 sec.

About 270 readings were taken, and Figures GS-13-2 to 4 indicate the areal distribution of the radio elements. Assay equations supplied by the manufacturer were used to convert field readings to radio element content. Table GS-13-2 indicates the statistics obtained from this data. The majority of the readings were taken on boulders of pink inequigranular granite to aplite (Schledewitz, this volume). The diagrams indicate the homogeneous nature of the populations, e.g., in the case of equivalent uranium there are only four readings in excess of mean plus three standard deviations, and the maximum is only 68.9 ppm. Thus it can be concluded that there are no significant 'hot spots', at least none detectable on a grid spacing of this size, and the radiation field over this anomaly is quite uniform. Figure GS-13-5 is a contour map of the total magnetic field over the grid, the readings were taken with a Scintex MP-2 proton precession magnetometer. The magnetic relief is quite low, ranging from 61 300 to 61 550 gammas. Comparison of Figures GS-13-3 and 5 strongly suggests that there is a correlation between magnetic and radioactive highs. Such an association can be noted at the following points on the grid: 1+50W, 2+00S; 1+50W, 1+00N; 1:50W & 0+50W, 2+50N and at about 1+75E, 6+50N. Several *in situ* susceptibility determinations were made with an Abem Kappameter, but this set of data has yet to be processed. Figure GS-13-6 shows the results of a VLF electromagnetic survey done with a Geonics EM-16 instrument. It can be noted that the only true cross-overs are located only at the extreme north and the south extremities of the grid, the implication being that the anomalous radiation is caused by a granitic block which stands out from low ground both to the north and the south of it.

Figure GS-13-7 shows the histograms for the three radio-elements and total count of the spectrometer readings over the Beaver Hill grid. The potassium distribution is unimodal and appears to be normal. It may be noted from Table GS-13-2 that its arithmetic mean is 3.64% K and the standard deviation is 5.86%. The uranium distribution, on the other hand, is distinctly bimodal with the two modes being at about 8 ppm and 25 ppm. The shape of the histogram very strongly suggests that there is a 'background' population below the 18 ppm level and an 'anomalous' population occupying the region from 18 to 35 ppm. The parameters of the 'background' population correspond to what would be normally expected for granitic rocks, e.g., mean uranium content of about 8 ppm. Thus it may be concluded that it is the 'anomalous' population which is responsible for the URP anomaly, it being caused by a significant volume of rock having an average uranium content of about 25 ppm. The thorium histogram is basically unimodal with the primary grouping around 35 ppm. However, there is a suggestion of a second mode at about 65 ppm. Table GS-13-2 indicates that the uranium-thorium coefficient of correlation at 0.370 is small but still significant.

JOHNSTON LAKE

During the 1978 field season a URP gamma-ray anomaly was investigated along a 50 m by 50 m grid with a Scintex GAD-1 gamma-ray spectrometer in the Johnston Lake area (NTS 52L/6) of the Whiteshell Provincial Park (Soonawala, 1978). Results of the statistical analysis are shown in Figure GS-13-8 and listed in Table GS-13-2. It is interesting to note that the uranium histogram in this case is similar to that for the Beaver Hill area, i.e., it is bimodal with grouping tendencies around about 9 ppm and 24 ppm. The potassium distribution is more complex than at Beaver Hill and it appears to be multimodal. The thorium population seems to be grouped around the 15 and 38 ppm levels. There is a strong correlation amongst all the three radio elements.

BLACK LAKE

During the current field season 23 readings were taken with a Scintex GAD-1 instrument on a 50 m by 25 m grid on an area about 1.7 km north of Black Lake in the Nopiming Provincial Park, where an URP anomaly of amplitude in excess of 4 ppm equivalent uranium has been located. The uranium histogram (Figure GS-13-9) indicates only one prominent mode, around the 21 ppm level. This would correspond to the 'anomalous' population of the previous two cases, but the 'background' population is missing. Probably this is the result of the small population sampled, and it would appear that all the 23 points sampled were in one subdivision of the overall population. Therefore, additional sampling is warranted in this area to verify if the 'background' population centered around 8 ppm exists. Statistics from a small sampling program at Shoe Lake in the Nopiming Provincial Park (52L/11) are also listed in Table GS-13-2.

RENNIE

The three distributions presented so far, i.e., from Beaver Hill, Johnston and Black Lakes were all from areas indentified as anomalous by the URP surveys. Therefore, it was decided to gather data from granitic rocks which are not anomalous according to the URP. Thirty readings were taken with the Scintex GAD-1 instrument along a 50 m by 25 m grid from such an area 16.6 km east of the intersection of Provincial highways 11 and 44 and about 13 km west of the town of Rennie. Figure GS-13-10 indicates the distinctly unimodal character of the uranium distribution grouped around the 5 ppm level. These observations confirm that for granitic rocks from an area identified as non-anomalous by the URP surveys, only the postulated 'background' population exists, and the 'anomalous' population centered at around 25 ppm is missing.

The quantitative investigations from the four abovementioned areas show that certain granitic rocks have an appreciable volume of material containing about 25 ppm uranium, which is approximately three to six times the universal average for such rocks. The investigations also show that rocks of this type are responsible for the URP gamma-ray anomalies. This conclusion warrants mineralogical and petrological studies to determine the nature of this excess uranium, and also to determine to what extend it is leachable. It can be speculated that the eighteen statistical factors listed in Table GS-13-2 would certainly form distinctive patterns for different granites; patterns which have not been recognized yet but would become apparent when more data has been gathered. Such a classification of granites on the basis of their 'radiometric signatures' would be highly significant in assessing their relative importance as possible source rocks for supergene uranium mineralization. It should be noted that similar statistical analyses would also be possible on the basis of the high-quality airborne digital data accumulated during the course of the URP aerial gamma-ray surveys.

HELICOPTER-BORNE SCINTILLOMETER SURVEY:

Two hundred square kilometres were surveyed by a helicopter-scintillometer near Mistuhe Lake (NTS 53L/1) in order to better define the location of a prominent URP gamma-ray anomaly. Four hundred linear kilometres were surveyed at line spacing 0.5 km at a speed of about 110 km/hr and altitude of 50 m. The sensor volume was 1.8 litres and it was used in the broad-band mode. The analogue record was hand digitized at 2189 points. Statistical analyses indicate that the range is 50 to 1475 counts per second (cps), the arithmetic mean is 516 cps and the standard deviation is 284 cps. Figure GS-13-11 is the histogram of this population. The prominent grouping in the 150-200 cps class reflects the radiation level over thick overburden and wet ground. The histogram peaks in the 400 to 800 cps range reflect outcrop with background radio-element content. On Preliminary Map 1979UR-7 which shows the results of the survey, all points exceeding 800 cps, the mean plus one standard deviation level, are indicated. No outstanding amplitudes are noted, and in fact only one point exceeds the mean plus three standard deviations level.

CAR-BORNE SCINTILLOMETER SURVEY:

A car-borne scintillometer survey was implemented in the Nopiming Provincial Park (NTS 52L/11, 14) over 125 km extending from the intersection of Provincial Roads 315 and 314 to Gold Creek, which is about 20 km west of the town of Bissett. A 1.8 litre sensor was mounted on the roof of a van, and it was used in conjunction with an analogue recorder and a spectrometer console operated in the broad-band mode. Figure GS-13-12 shows the results of the survey. The route passed through three URP anomalies with uranium amplitudes in excess of 2 ppm eU. As may be noted from the figure all three have been detected. The background radiation was about 450 counts per second, and readings as high as 1330 cps were recorded.

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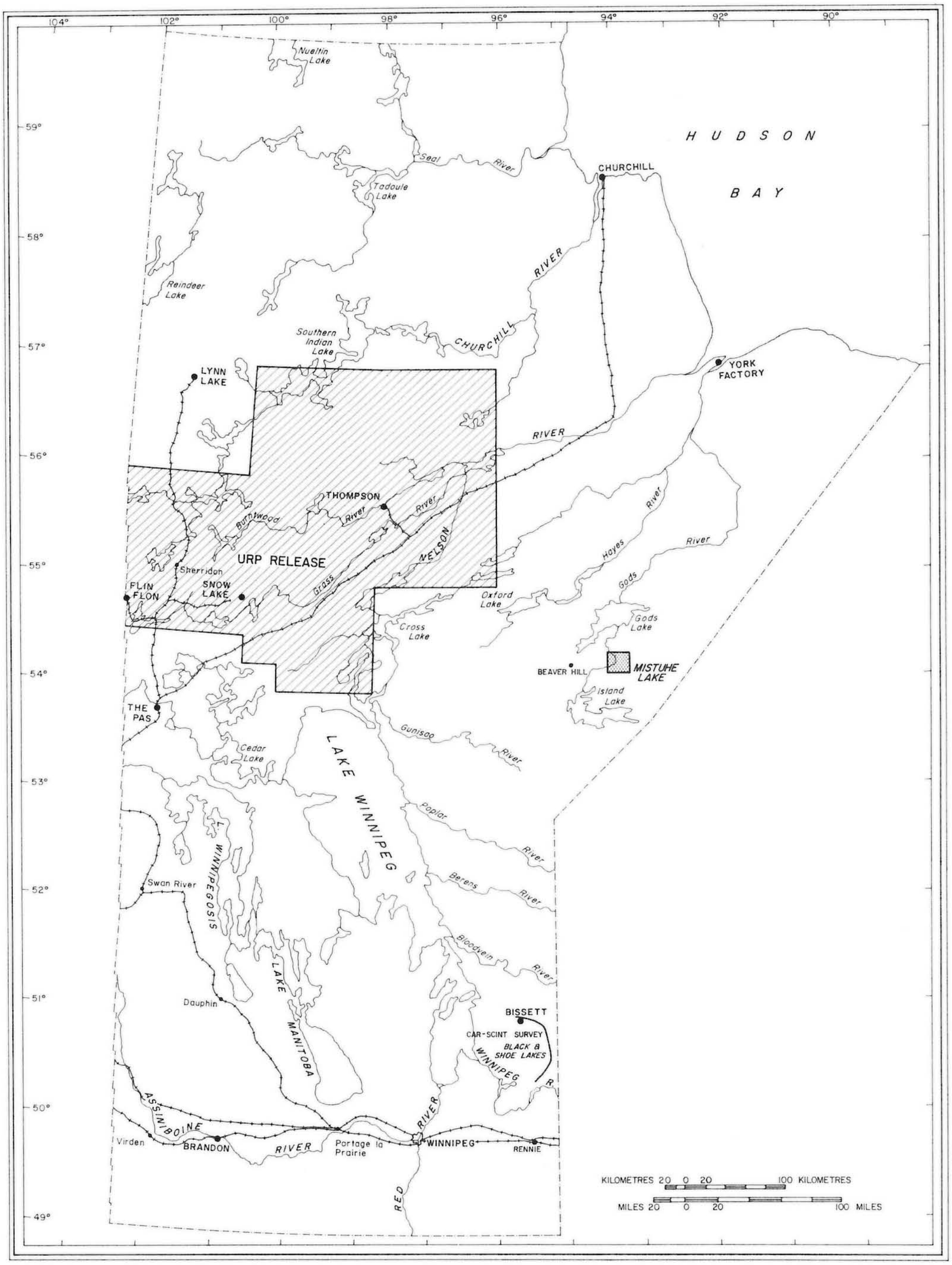

FIGURE GS-13-1: Index Map; Geophysical Investigations, 1979.

TABLE GS-13-2: RADIO ELEMENT STATISTICS OF GRANITIC ROCKS

NAME OF AREA	POPU-LATION	SAMPLE DENSITY (m² per sample)	RANGE			ARITH. MEAN			GEOM. MEAN			STD. DEV.			CORRELATION(r)			AVERAGE RATIO		
			K	U	Th	K	U	Th	K	U	Th	K	U	Th	U-Th	U-K	K-Th	U/Th	U/K	Th/K
Beaver Hill	253	1250	.13 5.76	2.45 68.9	6.86 87.3	4.15	17.3	37.5	3.61	14.2	35	5.86	11.67	13.67	.370	.012	.133	.497	6.54	10.53
Johnston Lake	63	2500	.03 5.54	1.08 64.16	.75 61.4	2.77	20.0	24.9	2.28	14.9	19.4	1.34	13.4	15.38	.652	.567	.665	.901	7.58	10.7
Black Lake	23	1250	.98 4.13	4.57 65.68	5.27 13.94	3.19	23.6	8.52	3.09	20.3	8.19	0.7	14	2.54	-.493	.218	.116	3.24	7.5	2.91
Shoe Lake	19	350	.48 4.34	.91 20.2	3.33 118	3.09	6.5	22.0	2.88	4.97	15.7	.906	4.66	24.85	.812	-.23	.029	.434	2.73	8.01
Rennie	30	1250	.73 5.54	.07 12.85	8.05 61.3	2.87	7.04	20.1	2.64	5.9	18.5	1.08	2.82	11.98	-.039	-.085	.53	.421	3.087	7.89

UNITS: U and Th readings in ppm; K readings in %. Multiply indicated U/K and Th/K ratios by 10^{-4} to obtain true value.

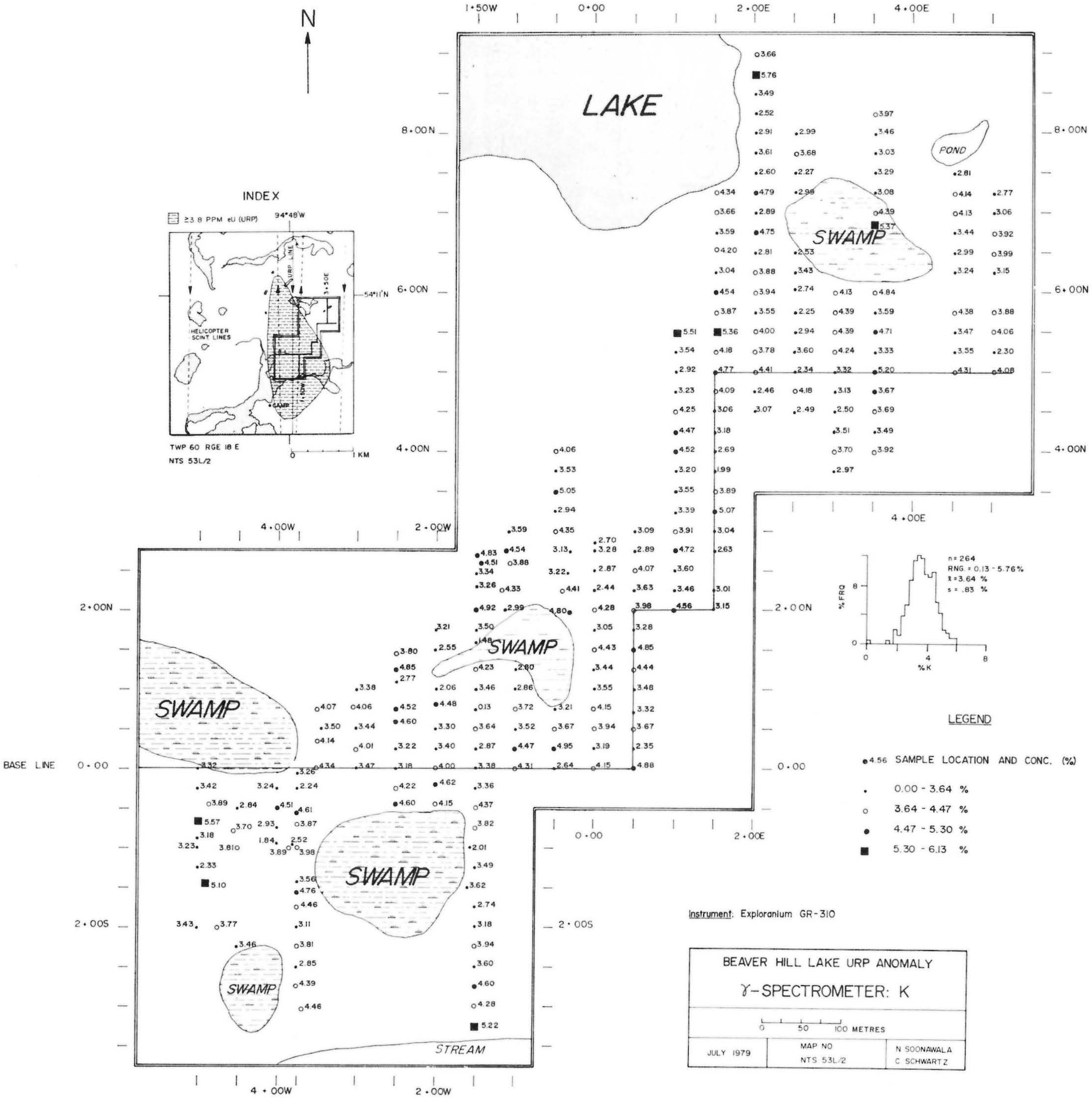

FIGURE GS-13-2: Beaver Hill Lake; potassium distribution.

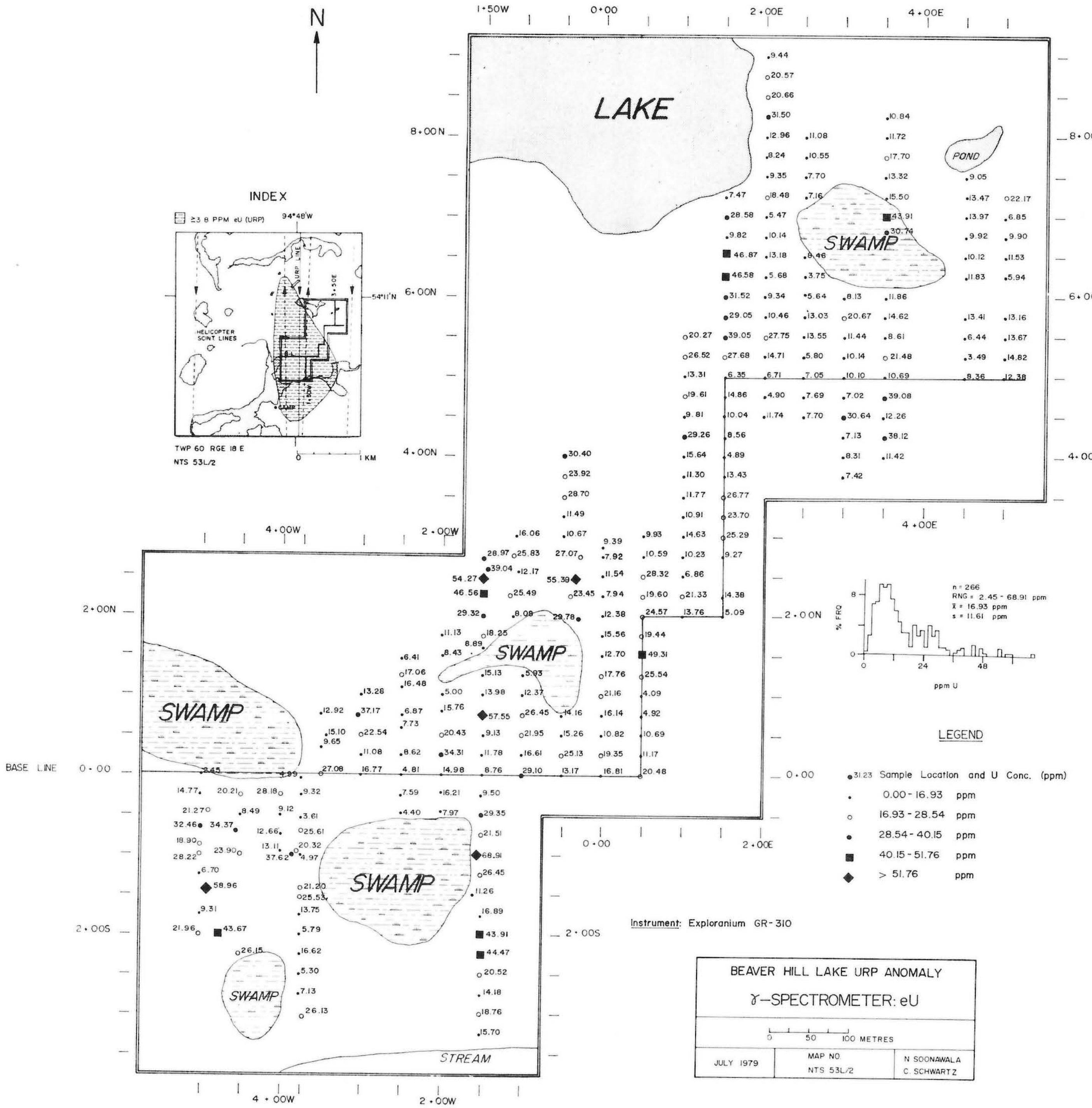

FIGURE GS-13-3: Beaver Hill Lake; equivalent uranium.

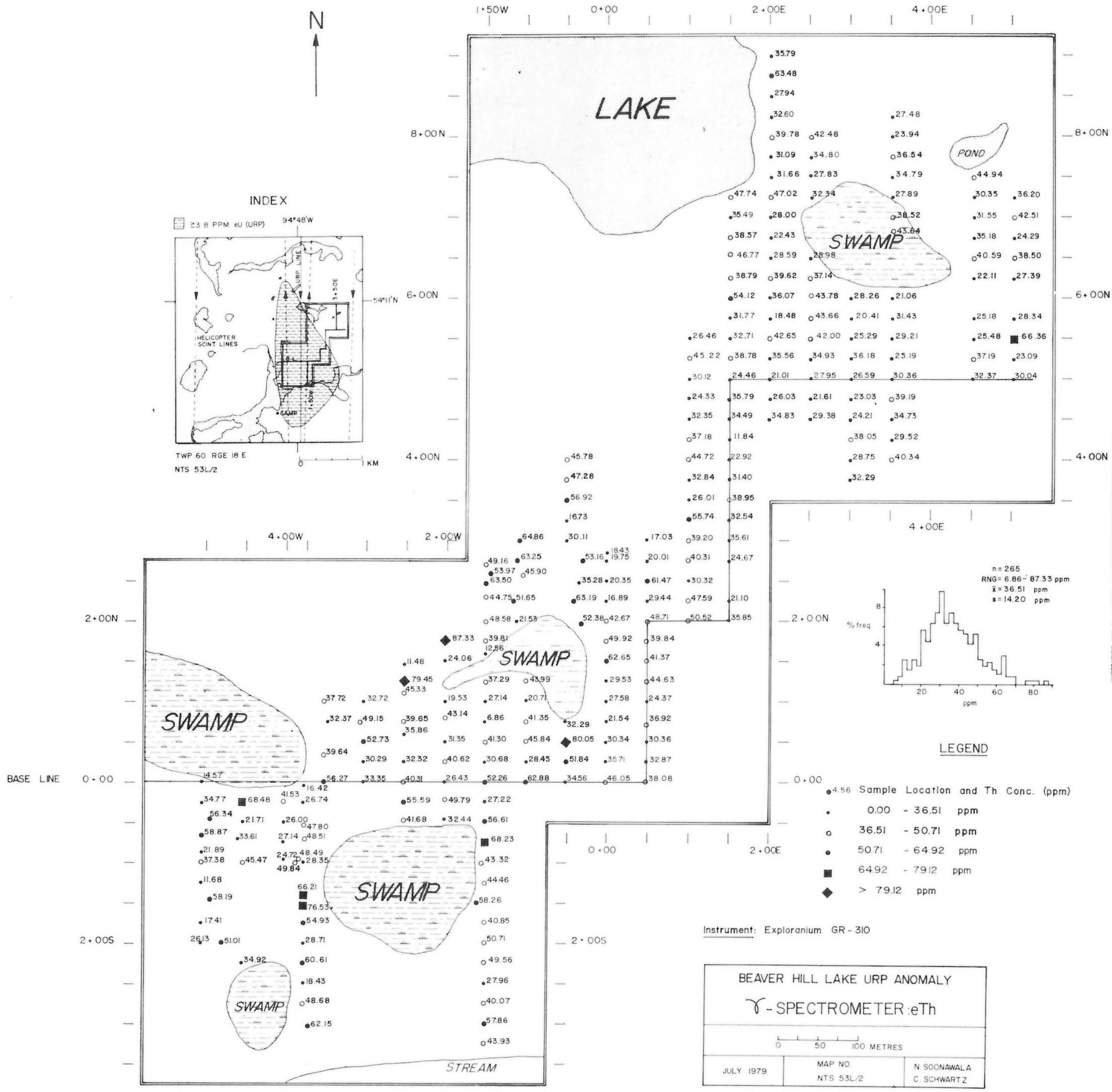

FIGURE GS-13-4: Beaver Hill Lake; equivalent thorium.

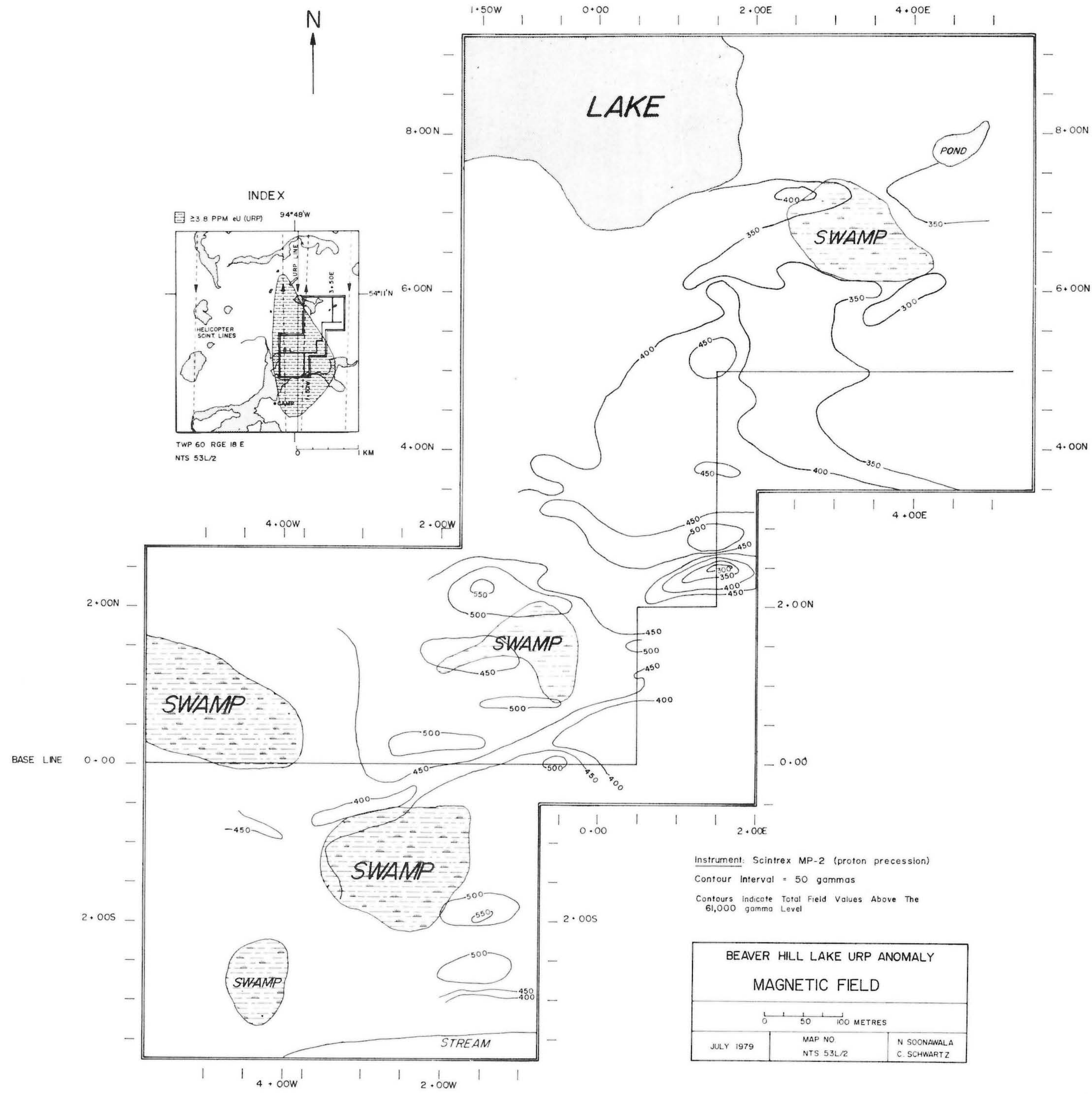

FIGURE GS-13-5: Beaver Hill Lake; magnetic field.

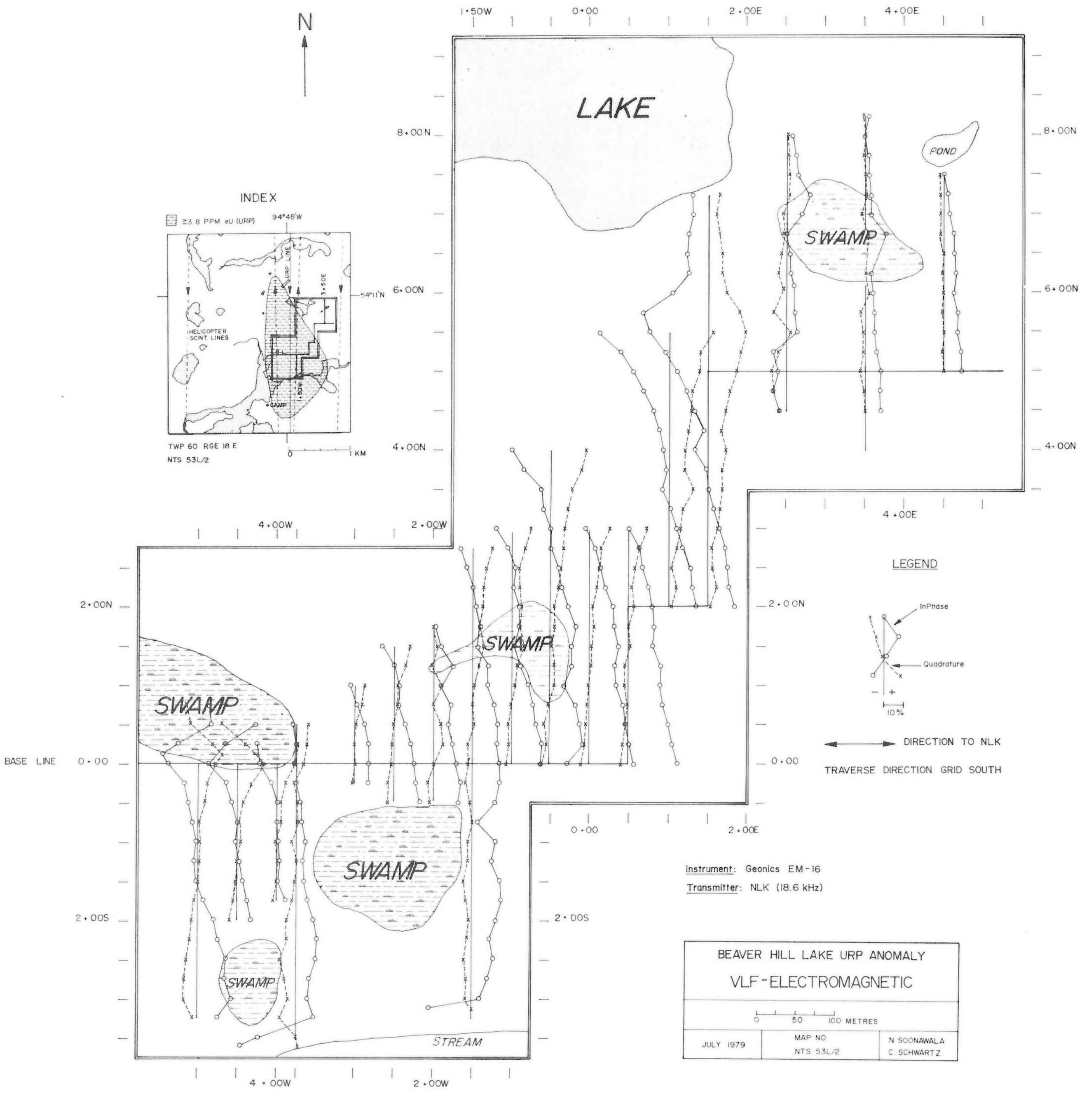

FIGURE GS-13-6: Beaver Hill Lake; VLF-EM survey.

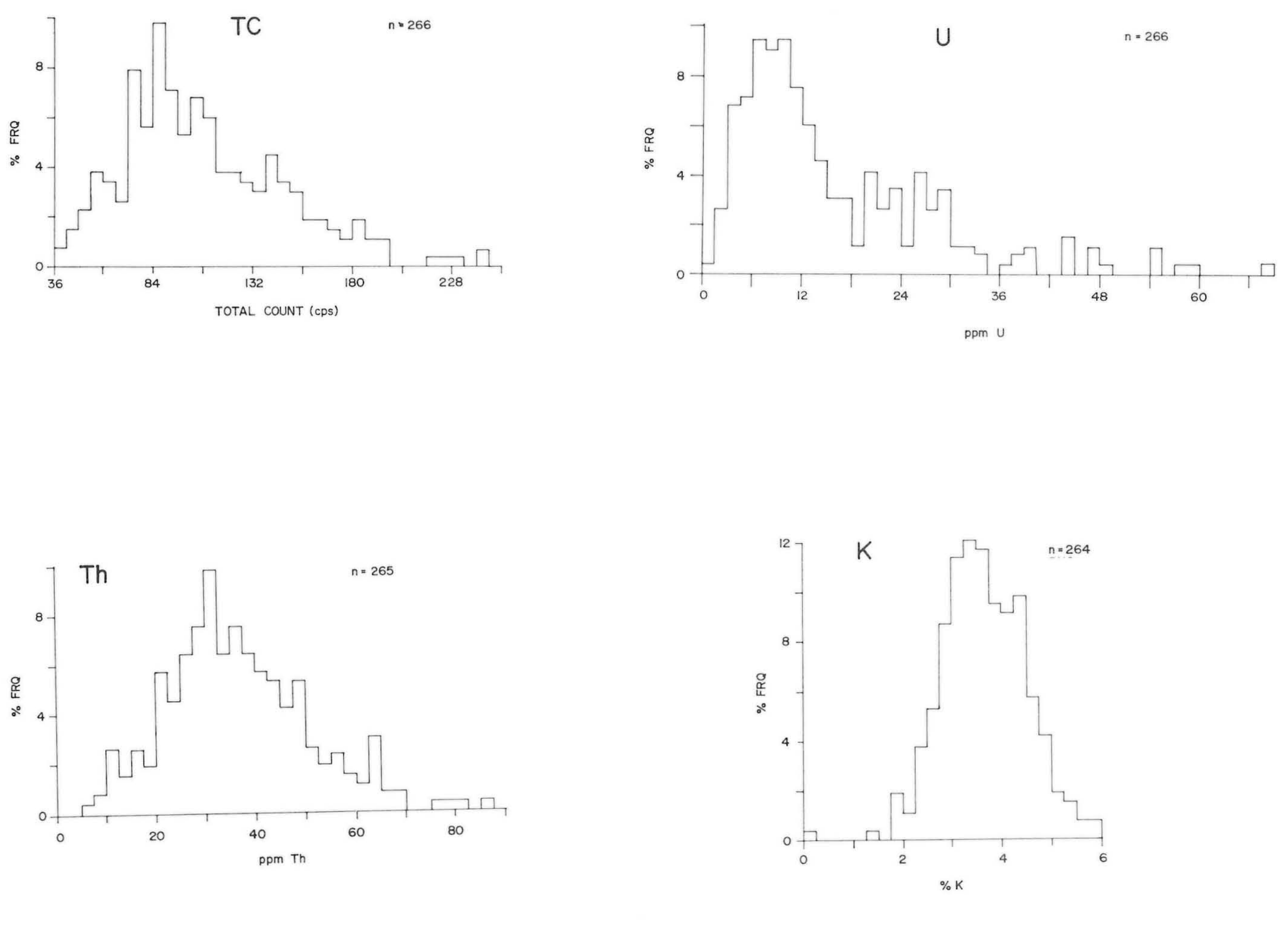

FIGURE GS-13-7: Beaver Hill Lake; gamma-spectrometer histograms.

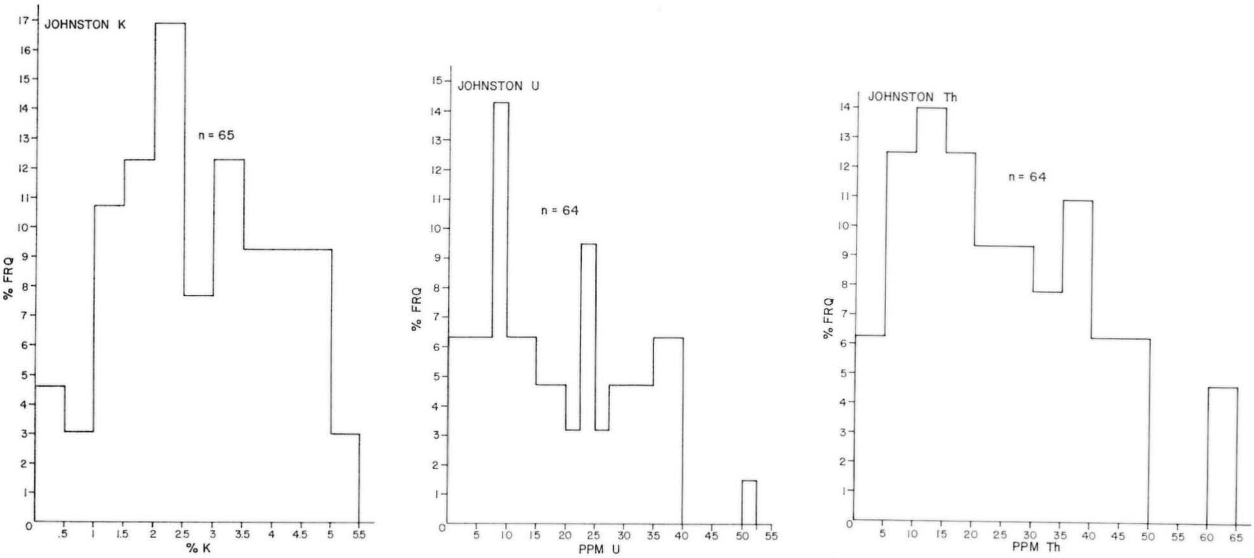

FIGURE GS-13-8: Radio element histograms; Johnston Lake.

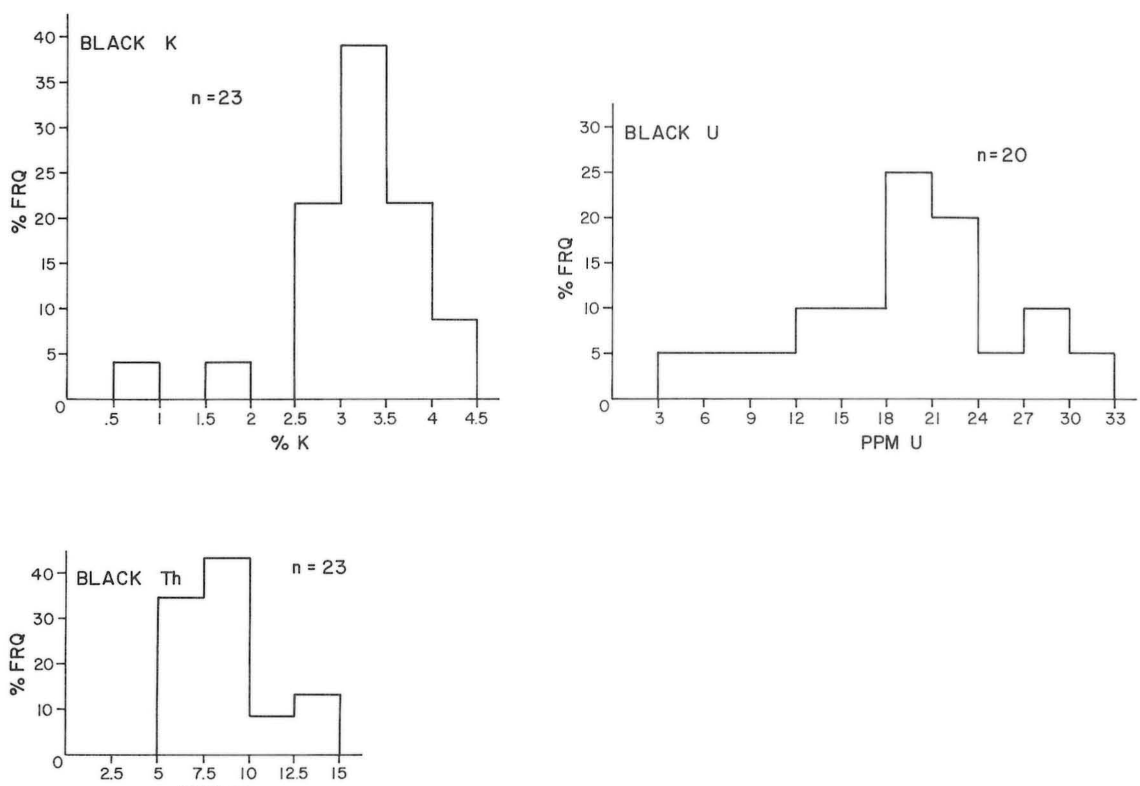

FIGURE GS-13-9: Radio element histograms; Black Lake.

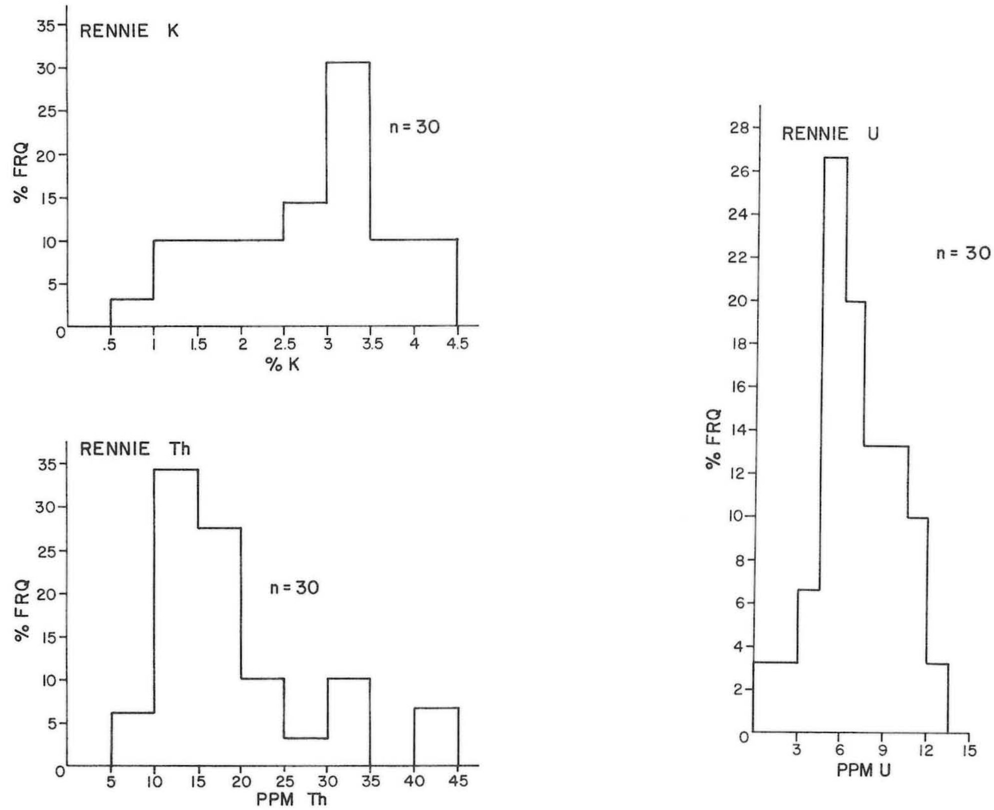

FIGURE GS-13-10: Radio element histograms; from near Rennie.

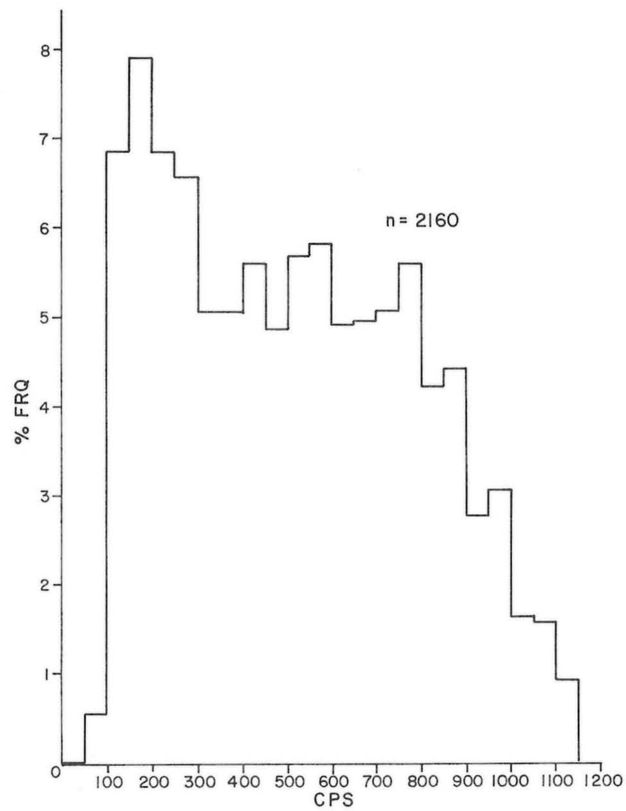

FIGURE GS-13-11: Histogram of digitized helicopter-scintillometer readings Mistuhe Lake area.

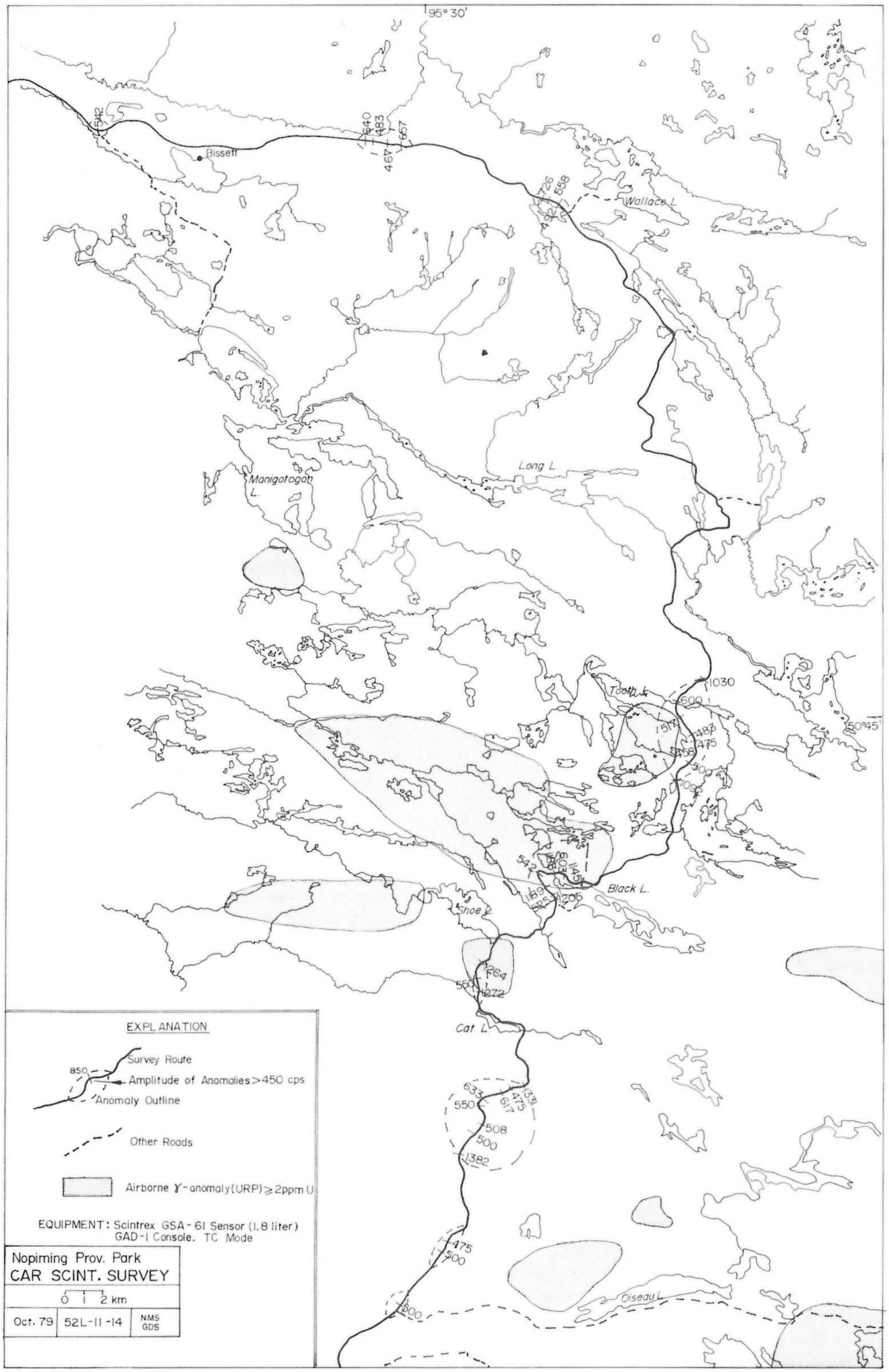

FIGURE GS-13-12: Car-borne scintillometer survey; Nopiming Provincial Park.

GS-14 HIGHROCK LAKE STRUCTURE

(62P/5; 4-29-2WPM)

by H. McCabe, B.B. Bannatyne and W.D. McRitchie

INTRODUCTION

The occurrence of a granitic outlier in the vicinity of Highrock Lake, within the Paleozoic outcrop belt and 65 km downdip from the Precambrian Shield (Fig. GS-14-1), has been known for many years. The origin of this feature has been the subject of considerable speculation. Regional data indicate the Precambrian rocks are a minimum of 152 metres above their expected elevation for this area (Strat. Map Series PC-1). The initial interpretation was that the granite represented a monadnock or remnant erosional high on the Precambrian erosion surface, which was subsequently buried by later Paleozoic sediments. A somewhat similar granitic high was known in the Lake St. Martin area, but subsequent studies (McCabe and Bannatyne, 1970) have shown the Lake St. Martin granite to be associated with a cryptoexplosion crater (meteorite impact structure?) of approximate Permian age. Furthermore, regional stratigraphic data have shown the Precambrian erosion surface to be a uniformly flat, low-relief surface with no evidence of remnant erosional highs. The possibility thus arose that the Highrock Lake Structure could also represent a post-Precambrian crater structure. A reconnaissance helicopter survey was therefore carried out in an attempt to clarify the nature and extent of the Highrock Lake Structure.

The following discussion is more detailed than usual for the Report of Field Activities because it is uncertain that the data will provide the basis for a more extended geological report in the immediate future.

PREVIOUS WORK

Although the presence of the Highrock Lake inlier has been known for many years (Dawson, 1939), the first detailed information was obtained in 1976 by Bannatyne (Unpublished notes) when samples of the granite were obtained together with dolomite samples from two nearby locations (Fig. GS-14-1). (The samples were obtained incidentally during a helicopter survey of peat deposits). Although winter trails provide near access to the Highrock Lake Structure, the location is 11 km from the nearest roads, and is reasonably accessible only by helicopter.

The main occurrence of granite comprises two large, roughly arcuate and concentric ridges separated by a sharply defined medial gorge. The ridges rise more than 20 metres above the surrounding terrain. Bannatyne noted that the granites were cut by numerous aphanic carbonate (calcite) veinlets bordered by sharply defined reddish rims.

Examination of several thin sections showed the granite to be for the most part normal textured (hypidiomorphic-allotriomorphic) with no petrographic evidence of shock-metamorphic effects such as observed in the central uplift of the Lake St. Martin Crater. It must be noted, however, that the granites comprising the uplifted rim of the Lake St. Martin Crater also show no appreciable shock-metamorphic effects. The carbonate veinlets are unusual in that they consist of very fine-grained calcite showing, both on the weathered surface and in thin sections, a coarse sub-radial, interlocking, polysynthetically-twinned mosaic overprinting a microcrystalline aggregate of calcite.

Also associated with the carbonate veinlets are patches of microbreccia consisting of angular fragments of quartz, feldspar and biotite ranging down to micron size. In places the extremely fine-grained, almost cryptocrystalline matrix could represent a devitrified glass. Recrystallization and/or "overgrowths" of euhedral feldspar grains are evident along the calcite veinlets.

The dolomite outcrop (HR-8-79) approximately 2.2 kilometres northeast of the granite ridges is anomalous for the area. The strata are disturbed, with beds dipping 10° to the west, and consist of highly fossiliferous (coral-brachiopod) porous dolomite which is not lithologically correlatable with the Stony Mountain Formation, the stratigraphic unit expected in this area.

A further oddity was the occurrence of a 25 cm piece of float consisting of poorly consolidated sandstone with rounded and frosted sand grains, lithologically correlatable with the basal Ordovician Winnipeg Formation. It was found on an outcrop of flat-lying dolomite 1.9 km southeast of the granite ridges.

These factors, when taken together, suggested that the Highrock Lake Structure may not be a simple Precambrian monadnock, but could represent another crater structure. The current reconnaissance helicopter survey was undertaken in an attempt to obtain sufficient additional information to define more accurately the nature and extent of the Highrock Lake structure.

PRESENT STUDY

Prior to the field survey, which involved only 2 one-day helicopter trips out of Winnipeg, photomosaic and aeromagnetic maps were studied in an attempt to determine the configuration of a possible crater structure, and to determine areas to be spot checked. The arcuate configuration of the granite outcrops and the occurrence of a small but well defined coincident magnetic low (Fig. GS-14-1) appeared compatible with the occurrence of a small crater structure three to six kilometres in diameter and centred approximately in NE4-29-2WPM. Several areas of outcrop or near outcrop were determined in the vicinity of this postulated structure.

The granitic outcrops noted previously were examined in more detail, and samples obtained for age determination. The outcrops were found to be relatively uniform throughout, consisting of a massive to very slightly foliated coarse-grained homogeneous, equigranular to weakly porphyritic brownish red biotite granite. Grain size ranges from 0.4 to 0.8 cm, the largest crystals being prominent yet subhedral Carlsbad-twinned, randomly oriented potassium feldspar. Biotite is the other most visible mineral and occurs in dispersed 0.6 to 1.0 cm equant cleavage flakes, also with an almost random orientation. The overall uniformity of the granite is quite striking, as is the virtual absence of xenolithic schlieren, and, but for one occurrence, cross cutting pegmatite or aplite dykes. Local thin irregular and anastomosing hematized fracture sets resemble late tectonic micro-faults. Their orientation is inconsistent, however, and does not appear to be related to either the faint foliation (316°/50°) or the strike of the main medial gorge. The granite is quite similar to the rocks of the Lac du Bonnet pluton, exposed in the Shield area 180 km to the southeast, except for the occurrence of the numerous carbonate (calcite) veinlets noted previously. The carbonate veinlets were found to occur throughout the outcrop area, with a possible slight increase, to the northeast in abundance, and in intensity of the associated alteration/microbreccia zones. The vertical to sub-vertical veinlets generally are thin, in the order of 1 to 2 cm, but in places swell to as much as 15 cm.

The medial gorge was found to be faced, in part, by cliffs representing vertical joint faces. Most joint blocks exhibit a weakly spheroidal form with rounded to subrounded corners. Though much of the calcite has locally been removed by recent erosion, the carbonate veinlets with their associated red borders persist to the base of the vertical cliff face 12 to 18 m below the crest of the ridge. No evidence is seen of any appreciable change in lithology towards the gorge and it is concluded that the gorge may represent a structural separation (slumping?) along a fracture system, within a single granite body.

A second, but much smaller granite outcrop (HR-7-79) was found on the postulated northern rim of the structure, approximately 2.5 km northeast of the previously described granite. Lithologically the granites are similar, but the degree of surface alteration (oxidation and microbrecciation) locally appears much higher in this second outcrop. Extensive 2-4 cm thick reddish "rinds" are present in much of the outcrop, and sandstone and/or microbreccia veinlets are common. Carbonate veinlets, however, are rare or lacking. The sand grains appear well rounded and frosted, and, in hand specimen, are similar to sands of the Winnipeg Formation. Petrographic studies will be necessary to determine the nature of these sandy veinlets, but initial examination suggests the material may have been injected into the granite rather than being a normal sedimentary infilling of a fractured, weathered granite. The reddish alteration rinds resemble a spheroidal weathering, but appear to be associated with a high degree of microbrecciation. In places the "sandy" veinlets show a "vesicular?" porosity. The relatively high degree of alteration described above may be a local phenomenon because another portion of this outcrop area, 40 m to the east, showed much less alteration and no trace of the sandstone veinlets or thick rinds.

Although no other granite outcrops were observed, 5 additional outcrop areas of sedimentary rocks (dolomite) were discovered and sampled. All outcrops show a considerable degree of (structural) disturbance with dips ranging from 0 degrees to almost 40 degrees, and strikes from almost north-south to east-west (Fig. GS-14-1). Although the indicated strikes are erratic, there is a tendency for the strikes to be circumferential to the postulated rim of the structure. Dips are noted both towards and away from the structure, and, in places, appear to change abruptly over distances of a few metres. These outcrops generally fall just outside, or along the postulated rim of the structure, except for stations 8 and 9 which appear to fall well within the rim.

All of the outcrops of sedimentary strata, except station 8, are lithologically similar, consisting of dolomite and argillaceous dolomite. The dolomites are pale yellowish buff, massive to thick-bedded, hard, finely crystalline, dense to moderately granular, and variably fossiliferous and porous. Despite the structural (?) disturbance, these massive beds show little or no evidence of fracturing or brecciation. The argillaceous dolomites are thin, platy bedded, mottled and streaked shades of medium grey to purplish red, and in places show definite burrow structures.

As to stratigraphic correlation, the argillaceous dolomites are lithologically similar to the dolomitized facies of the lower part of the Stony Mountain Formation (i.e. Gunn-Penitentiary Members), and the massive dolomites resemble the upper Stony Mountain Gunton beds. This correlation, however, is tentative, and will be checked if possible by microfossil determination. As noted previously, the biostromal dolomite of station 8 does not appear lithologically correlatable with known Ordovician strata. Microfossil study will also be required to date these beds, but a possible lithologic correlation with the Silurian Fisher Branch Formation could be suggested.

In summary:

a) all of the sedimentary rocks in the immediate vicinity of the Highrock Lake Structure, appear to be structurally (?) disturbed.
b) granitic rocks show "disturbance" in the form of calcite veinlets and sandy (?) veinlets with associated sporadic yet locally intensive microbrecciation.
c) the attitude and configuration of the Paleozoic and granitic outcrops is erratic but not incompatible with a circular structural configuration.

CONCLUSIONS

Although no firm hypothesis can be put forward, the general impression is that the feature may represent a crater structure, similar in some respects to the Lake St. Martin Crater, but much smaller in size and with no evidence of shock-metamorphic features or central uplift. A normal sedimentary origin cannot, however, be ruled out. The "disturbed" structures observed in the Paleozoic could possibly result from differential compaction, contemporaneous slumping and/or primary dips on the flank of a granitic erosional high. Similarly, the carbonate veinlets, sandy inclusions and microbreccia could represent an unusual type of sedimentary infill. These sedimentary interpretations, however, are difficult to reconcile with the regional structure/stratigraphic setting. On the other hand, if the feature is a crater (impact?) structure, uplifted lower Paleozoic strata of the Red River Formation should be expected flanking the uplifted granites. No strata correlative with the Red River were seen, and the outcrop distribution leaves barely enough room for occurrence of such strata between the granites and the nearby Stony Mountain (?) strata. However, the sample of sandstone float, apparently derived from the Winnipeg Formation, suggests that uplifted basal Paleozoic strata may be present in the area, even though they are not observed in outcrop.

Although much new information was collected in the present study, and although most if not all of the available outcrops were examined, the origin of the structure remains as yet unclear. Drilling and/or geophysical studies may provide the answers, but the remote location of the site precludes ready access, unless the drilling and/or geophysical programmes were to be conducted during the winter or with helicopter assistance.

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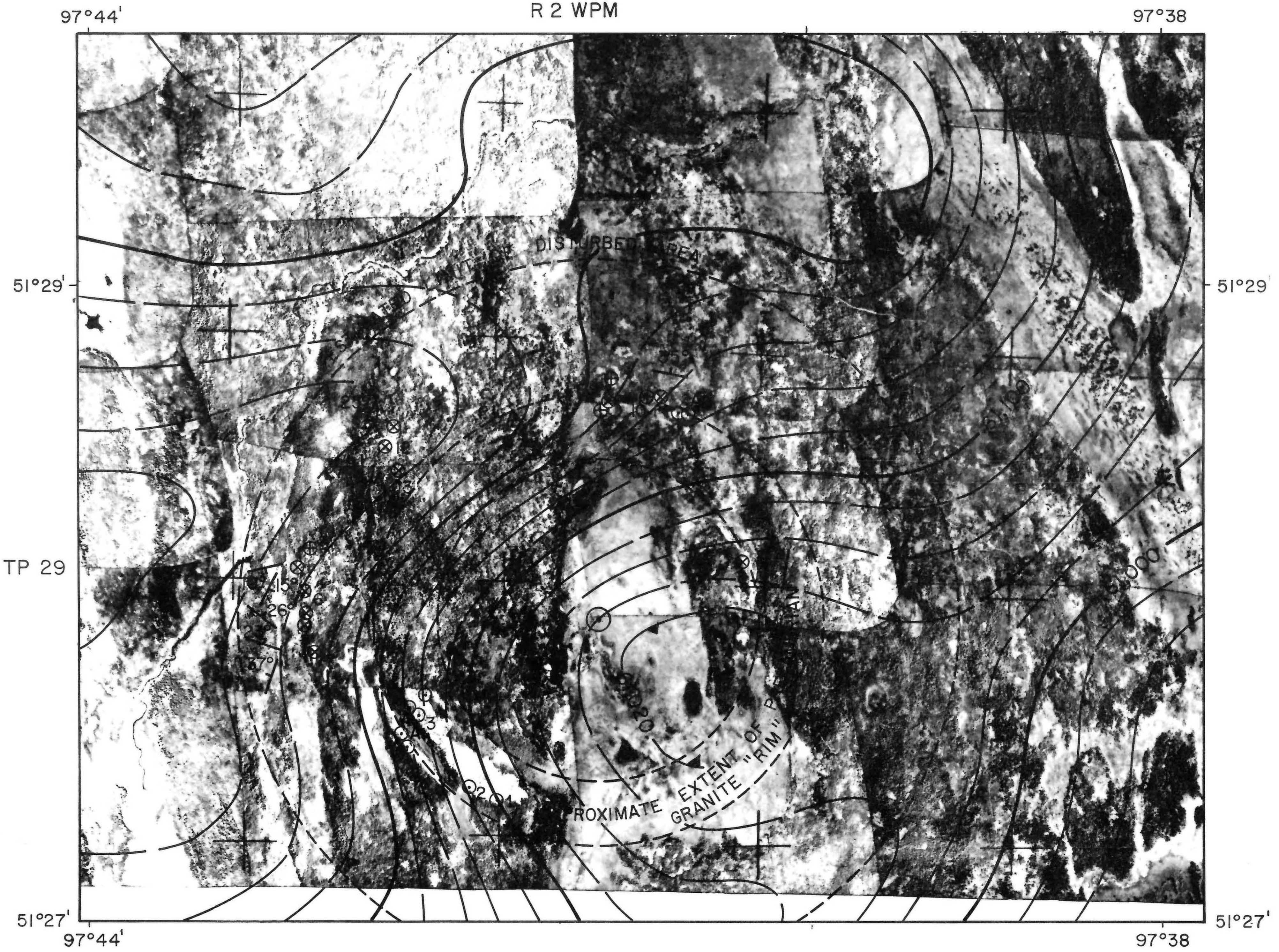


FIGURE GS-14-1: Geology of the Highrock Lake area.

LEGEND

⊗1 Paleozoic outcrop, attitude determined, station number (=HR-79-1).

⊕ Paleozoic outcrop, pavement, approximately flat-lying.

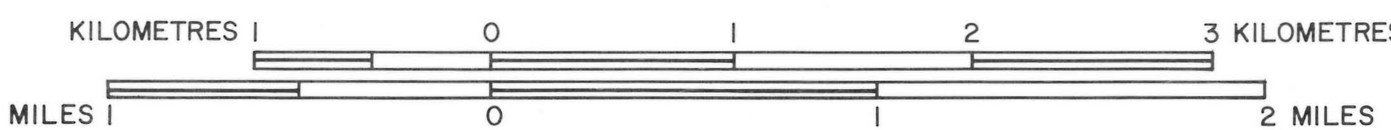
⊗ Paleozoic outcrop, pavement, attitude indeterminate.

⊙A Precambrian outcrop (A = sample for age determination).

Aeromagnetic contours, contour interval 20 gammas. From: Geophysics Paper 4166, Harwill, Manitoba, sheet 62P/5; Geological Survey of Canada and Manitoba Department of Mines and Natural Resources.

Estimated centre of disturbed area, and possible configuration *if* structure is crypto-explosion (impact?) crater. Actual configuration probably irregular (faulted?).

Section corners.



GS-15 STRATIGRAPHIC MAPPING PROGRAM

by H.R. McCabe

The stratigraphic mapping program for 1979 involved a number of projects: updating and revision of the Phanerozoic portion of the Geologic Map of Manitoba; reconnaissance field mapping in the area north of Grand Rapids; continuation of the stratigraphic core hole programme; and mapping in the Highrock Lake area. The latter two projects are discussed elsewhere in this report. In addition consolidation and cataloguing of all oil well core was completed. All core available for oil wells drilled in Manitoba is now in Departmental storage in Winnipeg, and the revised list of core and sample storage will be issued shortly. Supplementary oil well and core hole data were incorporated into the Stratigraphic Map Series and subsurface data tables, and the revised versions will be available by year end.

GEOLOGIC MAP OF MANITOBA — PHANEROZOIC PORTION

Revision of the Phanerozoic geology portion of the Geological Map of Manitoba involved not only compilation of all new geologic data, but also an attempt to revise portions of the map from essentially a surface or outcrop geology map to a bedrock or "subcrop" geology map. Preparation of the "subcrop" portion of the map involved utilization of available bedrock topography maps (Klassen et al, 1970; Teller et al, 1976; Water Resources Branch, 1968-1978). These maps were supplemented, updated and modified where required. A series of structural stratigraphic cross-sections was then prepared, utilizing data from the stratigraphic core hole program as well as oil exploration test holes. Formation contacts were extrapolated to the point of intersection with the buried bedrock surface, and then extrapolated between the section lines and conformed to the bedrock topography.

Because of the highly variable topography of the eroded bedrock surface, the questionable reliability of some of the water well data used in determining the bedrock topography, and the probability of error introduced by the structural extrapolation, the resultant "subcrop" map will undoubtedly be less accurate, in a sense, than the previous maps, which were primarily "outcrop" maps based on a finite number of outcrops and a defined topographic surface. A geological outcrop map has the advantage of defining or predicting with a relatively high degree of accuracy the location of any surface exposures. It is, however, highly inaccurate in defining buried outcrops or mineral occurrences. Since regional dips are only 1.5 — 2.3 m per km, relatively small changes in bedrock relief can cause marked changed in position of formation contacts.

"Subcrop" mapping is possible only in areas of sufficient subsurface control, largely in developed areas with relatively closely spaced water wells. This applies to much of southwestern Manitoba, generally the area south of latitudes 51° — 52°, and primarily in the Manitoba Lowland area, underlain largely by Paleozoic strata.

The southwestern Upland is generally characterized by Mesozoic strata with relatively thin overburden and hence little "subcrop" topography. Nevertheless, local preglacial channels are indicated, and local thick drift occurrences are known (up to 300 m in the Duck Mountain area).

On the geologic map, those areas showing "subcrop" geology (i.e. greater than 15 m overburden) are distinguished by the use of fine dashed formation contacts. This distinction must be clearly noted in any use of this map.

Subsequent to compilation of the previous geological map of Manitoba, a large amount of detailed topographic information has become available. This information was used in revision of the map in areas where both subsurface and outcrop control are lacking. In these areas, regional structural information, again based largely on stratigraphic core hole data, was used to extrapolate formation contacts to conform to surface topography, providing a more detailed but more interpretive "outcrop" map. This procedure was followed in two principal areas, where topographic relief is sufficient to cause significant variation in outcrop pattern, and where the limited data available suggested that overburden thickness is not excessive. These two areas are the Wekusko Lake-Grand Rapids area, discussed in detail in a following section, and the northern Interlake area, between Gypsumville and Grand Rapids. In this latter area, basic geologic control is limited to a single core hole (M-3-78) in an area approaching 13 000 square km, and the geology has been extrapolated and conformed to the topography on this basis. The accuracy of such extrapolation is obviously less than desirable, nevertheless, the apparent continuity (predictability) of regional structural and stratigraphic data through the area suggests that even such large scale extrapolation may be reasonably accurate.

One other aspect of the revised geological map requires comment — the detailed outcrop pattern within the Devonian outcrop belt. Both the underlying, lower Paleozoic strata, and the overlying Mesozoic strata are characterized by structural and stratigraphic continuity, which permits regional extrapolation of limited data over large areas. The opposite holds true, however, for Devonian strata, where any extrapolation beyond the actual limits of a given outcrop are highly uncertain. The reason for this is the highly erratic local structural deformation, with relief of as much as 60 to 90 metres. This deformation, which is in large part stratigraphically limited to Devonian formations, has been superimposed on all upper Devonian strata as a result of solution of the Devonian Prairie Evaporite and collapse and draping of upper Devonian strata over the underlying Winnipegosis reefs. The regional framework within which this deformation has occurred is now well known, and some of the general features of reef size and configuration are also known (Uyeno, McCabe and Norris, in press). Despite this, the detailed pattern of reef development and hence the detailed structural configuration appears almost totally unpredictable. Extreme caution is therefore essential in any attempt to use this map, or any other Devonian map, as a basis for exploration for Devonian mineral deposits.

WEKUSKO LAKE-GRAND RAPIDS AREA (63G; 63J)

Further reconnaissance mapping was carried out in the general area north and northeast of Grand Rapids to supplement and revise previous field work (McCabe, 1971; Whiteway, 1973), and to check geological extrapolation proposed for the Geological Map of Manitoba. Mapping involved helicopter checking of the large, previously unmapped and otherwise inaccessible area southeast of Hargrave Lake, as well as spot-checking several locations east of Highway 6. In addition, shorelining and limited traversing to adjacent topographic highs was carried out on Talbot Lake, utilizing the recently opened Crossing Bay logging road which provides the first access to the lake. Additional shorelining and traversing was done on William Lake and Little Limestone Lake. All outcrop station locations for 1979 are shown in Figure GS-15-1.

Four core holes were drilled to the base of the Paleozoic carbonate sequence, to supplement the field mapping program. Only one hole (M-7-79) penetrated to Precambrian basement. The other holes were terminated at the top of the basal Ordovician Winnipeg Formation because of anticipated problems in drilling the unconsolidated sandstone. The objective of this drilling was to establish more accurate regional correlation, to determine regional isopach and lithologic variations, and to obtain more accurate structural data for extrapolation of formation contacts to remote areas where lithologic correlations are uncertain.

Correlations indicated in Table GS-16-1 are tentative. The entire Paleozoic carbonate sequence in this area consists of a relatively monotonous dolomite sequence with only a few argillaceous and/or sandy marker horizons, and even these markers are not completely consistent. Confirmation of the indicated correlations will require more detailed lithologic study, and possibly microfossil age determination. Nevertheless, several important features are evident from these preliminary data. The northward thinning of the Red River Formation, as indicated previously by regional subsurface maps (Stratigraphic Series ORR-1), is confirmed, with the thickness decreasing from about 67 m in the Grand Rapids area to only 40 m in the Wekusko area (hole M-7-79). This information aids greatly in interpreting the mineral exploration core hole data, which provides only the gross "limestone" thickness overlying Precambrian basement.

Of particular stratigraphic interest is the occurrence of the 8 to 11 m thick argillaceous, partly laminated dolomite of the Fort Garry Member. This unit occurs at the top of the Red River sequence, separating the typical (in this area) mottled Red River dolomite from the very similar mottled dolomite of the Stony Mountain Formation. Fort Garry beds have not been reported in previous mapping of the area, and almost no outcrop of these beds was noted in the present study, apparently because the unit is highly recessive. The presence of this recessive unit, however, is probably responsible for the extensive scarp development and the spectacular block slumping observed along the edge of the Stony Mountain outcrop belt at a number of locations (Figure GS-15-2). The shaly beds of the Fort Garry Member appear to have provided a zone of separation permitting extensive ice wedging. Numerous 8 to 10 cm open fractures are evident for more than 100 m back from the scarp face, indicating extensive lateral displacement. The peculiar reverse or inward slumping seen in Figure GS-15-2 possibly results from the position of groundwater level relative to the horizon of separation. Maximum ice wedging has occurred near the base of the separated blocks. Most other slumped scarps show a normal or outward tipping of the slump blocks.

Slumped scarps also occur in Red River strata, at the Precambrian contact. In this case, separation occurs at the sandy, argillaceous, and weathered zone at the Precambrian erosion surface. The weathered zone in this area appears to be very thin or absent (Hole M-7-79) as compared to more southerly areas such as Grand Rapids, where the upper 3 m of the granite is highly weathered. The decrease in thickness of the weathered zone may possibly coincide with the depositional pinchout of the Winnipeg Formation.

In sharp contrast to the Red River Formation, the Stony Mountain Formation shows little variation in thickness, ranging only from about 30 to 33 m. Data are insufficient to indicate any regional variations in thickness of Silurian strata, although they appear to thin somewhat to the north.

As noted previously, revision of the Geologic Map of Manitoba included extensive extrapolation of Ordovician or Silurian "outcrop" belts into the large and previously unmapped area southeast of Hargrave Lake. The extent of those proposed revisions necessitated the implementation of a helicopter-based survey to check the accuracy of the extrapolation. The basis for the extensive revision in this area was two-fold. Firstly, a general although irregular topographic rise of about 45 m is evident in an area where regional dips are only about 1.5 m per km. Photogeologic studies (Bell, 1978) had indicated that most topographic highs represented areas of bedrock outcrop or near outcrop, so it was known that the outcrop pattern would be closely controlled by the topography, and this would result in a pronounced northeasterly shift in the outcrop belt. Secondly, the topographically high area generally coincides with a synclinal flexure referred to as the Moose Lake Syncline (McCabe, 1967), which has the same (additive) effect of shifting the outcrop belts even farther up dip to the northeast, along the axis of the syncline.

Field mapping has shown the initial interpretation to be reasonably accurate, despite the size of the area, the uncertainty as to the exact configuration of the synclinal flexure, the effect of regional isopach variations, and the considerable effect of topographic relief. Minor alterations were incorporated into the Geological Map of Manitoba, and further revision will be possible when compilation of all new data is completed, but such revisions will be minor and should involve only extension of some subunits within the Silurian.

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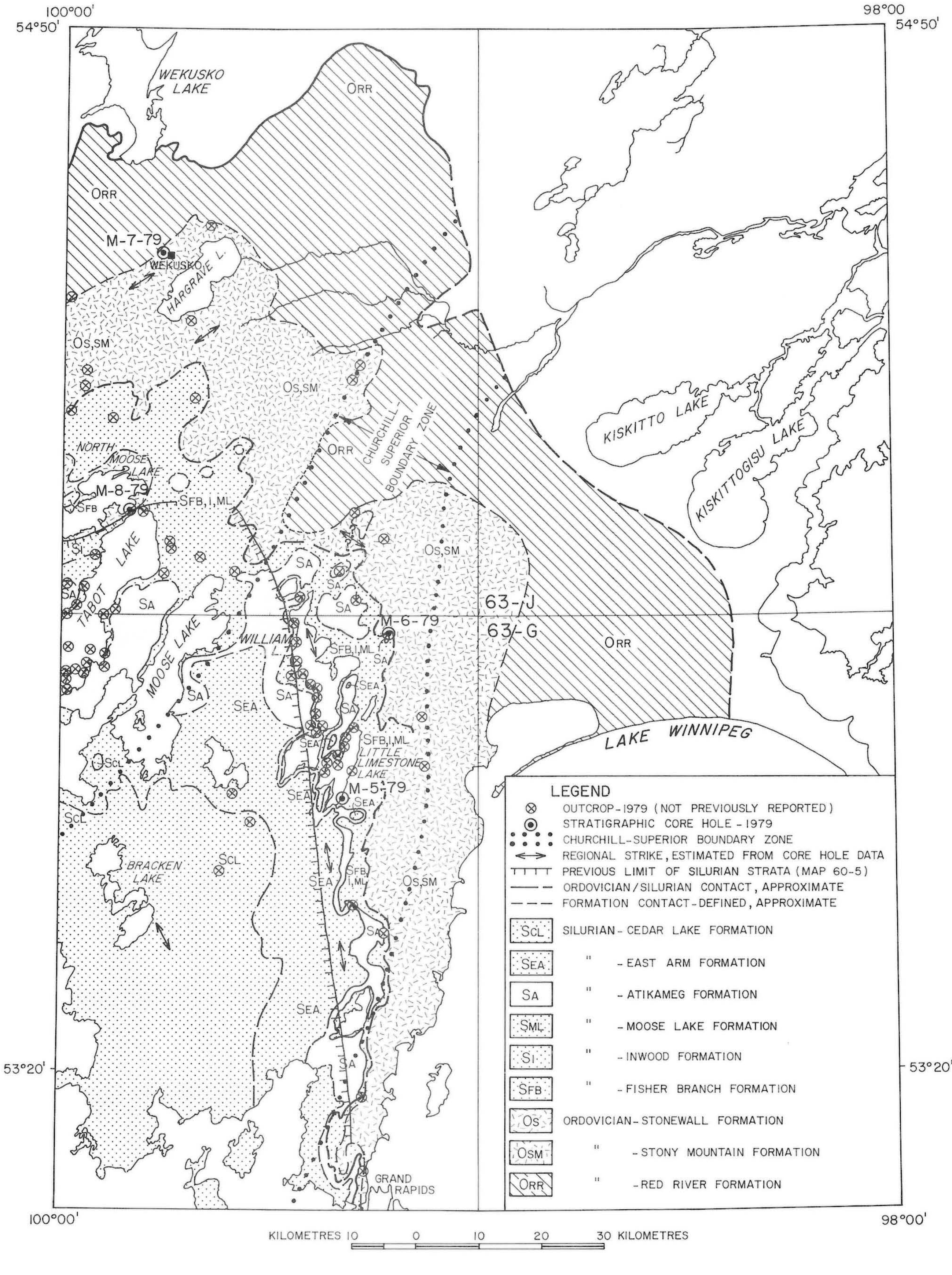

FIGURE GS-15-1: Geology of the Wekusko-Grand Rapids Area.

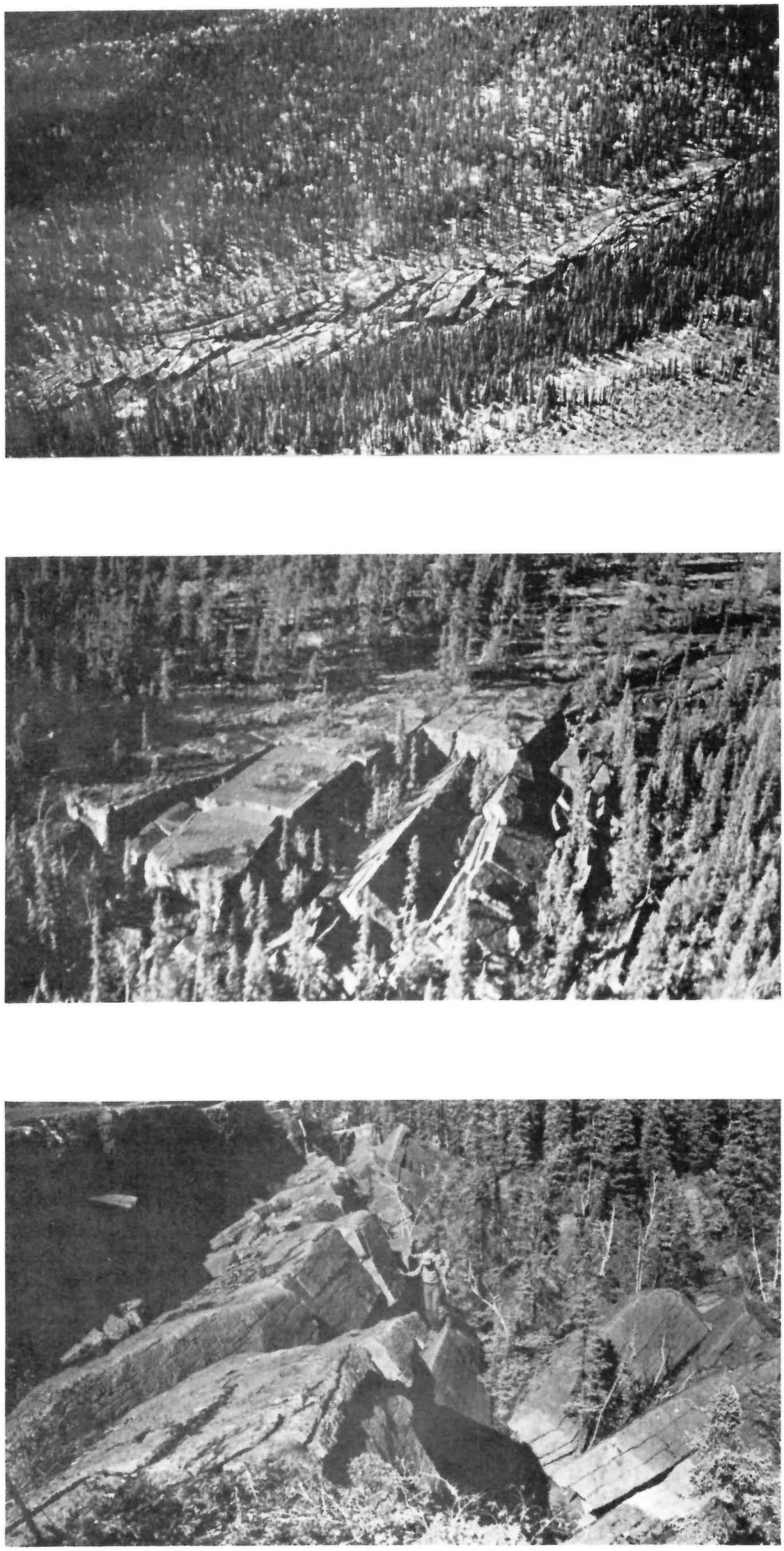

FIGURE GS-15-2: Stony Mountain Formation; slumped scarp northwest of Hargrave Lake. Note inward (reverse) dip of ***slumped*** *blocks.*

GS-16 STRATIGRAPHIC AND INDUSTRIAL MINERALS CORE HOLE PROGRAM

H.R. McCabe

The 1979 in-house core hole program represents a continuation of the previous drill program. A total of 11 holes were drilled for a total depth of 846 m, bringing the total length drilled to date to 5394 m. Well data are shown in Table GS-16-1, and hole locations in Figure GS-1. No major problems were encountered except for some difficulty in controlling an artesian flow of brackish water in hole M-9-79. A head estimated at in excess of 20 m with very high flow rates, indicative of high permeability, forced abandonment of the hole before target depth was obtained.

Holes 1, 2, 3, 10 and 11 were drilled to obtain data for the Industrial Minerals aggregate resources study in the general area north and west of Winnipeg. Results are discussed by B. Bannatyne in Section GS-17 of this report.

Holes 5, 6, 7 and 8 were drilled in support of the stratigraphic mapping program, and the results are discussed in Section GS-15 of this report.

Hole M-4-79 was intended to be a deep test hole (proposed T.D. ± 270 m) to provide a complete section of Ordovician and Silurian strata to the top of the Winnipeg Formation. However, extremely poor drilling conditions were encountered and the hole was abandoned at only 118 m while still in Silurian.

The reason for the difficult drilling is development of a sporadic but extensive karst (?) solution and infill. The Devonian section was mainly as expected with a thin dolomite zone occurring below the high-calcium quarry beds of the Elm Point Formation. The basal Devonian Ashern Formation is well developed, somewhat thicker than expected, and consists almost entirely of shale/dolomite breccia.

In the underlying Silurian Interlake beds, extensive development of relatively small, clay-infilled cavities was encountered to a depth of 71 m below the top of the Silurian. The number and size of cavities decrease with depth. The clay infill is dominantly red to a depth of 40 m below the top of the Silurian, and the surrounding dolomites show extensive reddish coloration. Below this depth the infill is grey to green. This extensive development of clay-filled solution cavities in the upper Silurian beds probably represents incipient karst development during the late Silurian — early Devonian erosional interval.

Although the hole was drilled deep enough to have intersected at least the middle Silurian marker beds (i.e. East Arm sandy dolomites), no sign of any marker beds was seen, and no reliable correlation is possible within the Silurian sequence. In order to obtain the desired structural and stratigraphic data, it will be necessary to carry out additional drilling, possibly relocating in the vicinity of Mulvihill, where previous drilling (M-6-69) indicates relatively solid bedrock.

Hole M-9-79 is located at a recently opened Department of Highways quarry exposing high-calcium brachiopod biomicrite beds of Devonian age. Initial lithologic correlation suggested that these beds comprise part of the Souris River Formation. The flat-lying nature of the quarry beds was believed compatible with this correlation. An inter-reef section of Winnipegosis beds was expected, and the objective of the hole was to drill to the base of the Devonian for structural data to permit regional estimates of reef thickness etc. It was also noted, however, that the quarry beds are lithologically similar to lower Dawson Bay beds, but since all other known Dawson Bay occurrences in this area are located on structural/topographic domes indicative of underlying Winnipegosis reefs, the Souris River correlation was preferred.

Drill results proved the initial correlations to be incorrect. The quarry beds are lower Dawson Bay, and porous reefal Winnipegosis dolomites were intersected at a depth of only 21 m, accompanied by a strong artesian flow. The flow increased with depth to the point where drilling had to be terminated. Unfortunately no accurate estimate of Winnipegosis reef thickness can be made for this hole, but regional extrapolation suggests a possible thickness of 90 m or more, which would mark this as the thickest reef known in this portion of the outcrop belt. The apparently flat-lying nature of the overlying Dawson Bay beds is unusual. It suggests that the underlying reef is flat-topped, unlike most other reef-associated occurrences. Possibly the extent of the quarry is insufficient to show development of the typical domal structures.

The numerous natural salt springs in the area indicate the presence of a number of reefs, or a reef complex. Further drilling is anticipated, to provide the structural and isopach data necessary for regional extrapolation. It will be necessary, however, to pick an inter-reef location so as to avoid the problem of artesian water.

TABLE GS-16-1 SUMMARY OF CORE HOLE DATA

Hole No.	Location and Elevation (est.)	System/Formation/Member	Interval (metres)		Summary Lithology
M-1-79	NW 13-33-11-2E	Overburden		- 5.05	Clay, till, gravel
(Moore)	(+242.7 m)	Ordovician — Stony Mountain —			
		Gunton	5.05	- 6.35	Dolomite, mottled, slightly argillaceous
		Penitentiary	6.35	-10.3	Argillaceous dolomite
		Gunn	10.3	-32.5	Argillaceous limestone
		Red River — Fort Garry	32.5	-48.05	Limestone, laminated; dolomite, cherty
M-2-79	SW 12-17-12-2E	Overburden	0	- 5.7	Clay, till
(Lilyfield)	(+243.9 m)	Ordovician — Stony Mountain —			
		Gunton	5.7	- 9.3	Dolomite, mottled, vuggy
		Penitentiary	9.3	-11.7	Argillaceous dolomite
		Gunn	11.7	-34.6	Argillaceous limestone
		Red River — Fort Garry	34.6	-45.9	Limestone, laminated; dolomite,
M-3-79	SE 3-25-16-3E	Overburden	0	- 3.0	Clay, some till
(Netley)	(+233.2 m)	Ordovician — Red River —			
		Fort Garry	3.0	- 5.2	Dolomite
		Selkirk	5.2	-52.75	Limestone and cherty banded dolomitic limestone to 13.6 m; mottled dolomitic limestone.
		Cat Head	52.75	-60.15	Dolomite, mottled
M-4-79	NE 2-22-27-7W	Devonian — Elm Point	0	- 3.0	Limestone, thin basal dolomite
(Spearhill Quarry)	(+287 m)	Ashern	3.0	-10.0	Breccia, shale/dolomite, shades of red and brown
		Silurian — Interlake Group	10.0	-98.7	Dolomite, variable, aphanitic to granular and vuggy; shale-filled cavities upper 70 m.
M-5-79	16-10-55-13W	Silurian — Moose Lake	0	- 4.6	Dolomite, aphanitic, stromatolitic
(Little Limestone Lake)	(+273 m)	Inwood	4.6	-12.7	Dolomite, calcarenitic
		Fisher Branch	12.7	-15.7	Dolomite, fossiliferous
		Ordovician — Stonewall	15.7	-33.5	Dolomite
		Stony Mountain — Williams	33.5	-37.3	Dolomite, dense, slightly argillaceous
		Gunton	37.3	-50.9	Dolomite, nodular bedded
		Penitentiary/Gunn	50.9	-66.7	Dolomite, slightly argillaceous, fossiliferous
		Red River — Fort Garry	66.7	-77.5	Dolomite, dense, partly shaly
		Selkirk etc.	77.5	-118	Dolomite, mottled, sandy at base
M-6-79	6-32-57-12W	Winnipeg	(118 est.)		
(Minago River microwave tower)	(+297 m)	Total Depth	117.95		
		Silurian — Atikameg	0	- 3.4	Dolomite, vuggy, granular
		Moose Lake	3.4	- 5.2	Dolomite, alphanitic, stromatolitic
		Inwood	5.2	-10.5	Dolomite, calcarenitic
		(sandy marker)	10.5	-17.5	Sandy dolomite breccia
		Fisher Branch	17.5	-19.0	Dolomite, fossiliferous
		Ordovician — Stonewall	19.0	-34.3	Dolomite
		Stony Mountain — Williams	34.3	-37.9	Dolomite, dense, slightly argillaceous
		Gunton	37.9	-51.9	Dolomite, nodular
		Penitentiary/Gunn	51.9	-65.7	Dolomite, slightly argillaceous, burrowed
		Red River — Fort Garry	65.7	-75.5	Dolomite, dense, shaly interbeds
		Selkirk etc.	75.5	-109.9	Dolomite, mottled
		Winnipeg	109.9	-111.9	Sandstone

TABLE GS-16-1 SUMMARY OF CORE HOLE DATA (continued)

Hole No.	Location and Elevation (est.)	System/Formation/Member	Interval (metres)		Summary Lithology
M-7-79 (Wekusko Stn.)	2-2-64-16W (+282 m)	Overburden	0	- 6.6	Sand and gravel
		Ordovician — Stony Mountain — Penitentiary/Gunn	6.6	-13.5	Dolomite, slightly argillaceous, fossiliferous
		Red River — Fort Garry	13.5	-21.5	Dolomite, dense, shaly interbeds
		Selkirk etc.	21.5	-52.17	Dolomite, mottled
		Winnipeg	—		(not present)
		Precambrian	52.17	-53.8	Granite, slightly weathered
M-8-79 (Talbot Lake Portage)	NW 15-32-59-16W (+259 m)	Ordovician — Stonewall	0	- 7.7	Dolomite, fine-grained dense
		Stony Mountain — Williams	7.7	-10.1	Dolomite, slightly argillaceous
		Gunton	10.1	-26.5	Dolomite, nodular
		Penitentiary	26.5	-38.1	Dolomite, slightly argillaceous
		Red River — Fort Garry	38.1	-47.5	Dolomite, shaly interbeds, reddish
		Selkirk etc.	47.5	-81.7	Dolomite, mottled
		Winnipeg	81.7	-84.6	Sandstone
M-9-79 (Camperville South Quarry)	NW 16-31-33-19W (+258 m)	Devonian — Dawson Bay	0	-11.3	Limestone, biomicrite; dolomite
		Second Red	11.3	-21.0	Shale, dolomitic, red
		Winnipegosis	21.0	-38.45	Dolomite, excellent porosity, reefoid
M-10-79 (Warren)	NW 13-31-13-1W (+249.7 m)	Overburden	0	- 5.0	Clay, till
		Silurian — Interlake Group	5.0	-40.3	Dolomite, dense, fossiliferous and porous
		Ordovician — Stonewall	40.3	-54.05	Dolomite; red shaly interbeds
		Stony Mountain — Williams	54.05	-59.1	Dolomite, shaly and sandy interbeds
		Gunton	59.1	-69.9	Dolomite, mottled
		Penitentiary	69.9	-72.35	Argillaceous dolomite, pale green and purple
M-11-79 (Teulon)	NW 14-35-16-1E (+271.3 m)	Overburden	0	- 4.45	Clay, till
		Silurian — Interlake Group	4.45	-12.0	Dolomite, yellowish, fossiliferous
		Ordovician — Stonewall	12.0	-23.55	Dolomite, mottled; clayey bands
		Stony Mountain — Williams	23.55	-29.1	Dolomite, argillaceous, sandy
		Gunton	29.1	-39.7	Dolomite, mottled
		Penitentiary	39.7	-50.7	Dolomite, argillaceous
		Gunn	50.7	-62.85	Limestone, argillaceous, fossiliferous
		Red River — Fort Garry	62.85	-97.15	Limestone; dolomite, cherty and dense; clay at 78.2 m
		Selkirk	97.15	-112	Limestone, cherty; mottled dolomitic limestone

GS-17 DOLOMITE RESOURCES OF THE SOUTHERN INTERLAKE AREA

(63H/14, 15; 63 I/2, 3, 6, 7)

by B.B. Bannatyne

Dolomite and dolomitic limestone in the Ordovician and Silurian strata of southern Manitoba are sources of raw material for crushed stone, lime, and decorative building stone. Continuous quarrying of these rocks since the early days of settlement in the Red River Valley has led to depletion or near-depletion at some quarry sites. Continued development of the area, and particularly the building of new homes, subdivisions, and plant sites in the Winnipeg-southern Interlake region has made necessary a more precise knowledge of the abundant quarriable resources of these rocks.

During 1979, work was concentrated in the area extending from St. Norbert north to Winnipeg Beach, and from Warren east to Beausejour, including six 1:50 000 NTS sheets (the Winnipeg, Dugald, Selkirk, Stonewall, Teulon, Red River Delta sheets). Maps showing the depth to bedrock, topography of the bedrock surface, and the projected geological contacts of Ordovician and Silurian strata are being concurrently released as Preliminary Maps 1979DR-1 to 12 inclusive.

The information has been of use in compiling mineral resource maps for Municipal Planning Districts, under 'Policy 13', and it is hoped the maps will be useful to producers in identifying areas where bedrock is sufficiently close to surface to be quarriable. Several previously unknown sites have been identified, many near major transportation routes. Additional work in the Municipality of Rockwood is currently being done under contract by F.J. MacLaren Ltd. to identify near-surface bedrock.

The examination of recently acquired drill core, and of core in storage from previously drilled holes, has resulted in a better delineation of the geology and geological contacts in the area. The results of the 1979 drilling are listed in Table GS-16-1.

Drill holes M-1-79 and M-2-79 were drilled in the Moore and Lilyfield area to determine the thickness of the Gunton Member and to outline an anomalous structure in the unit. In M-1-79, 1.3 m of dolomite was intersected below 5.05 m of glacial till. In M-2-79, 3.6 m of Gunton dolomite was intersected below 5.7 m of overburden. However, compared with the results from hole M-5-77, drilled 1.3 km to the southeast, the dip of the Gunn Member appears to be about twice the regional amount in this location.

Projections of regional structure suggested the possibility of outliers of the Fort Garry Member as bedrock highs along Highway 8 between St. Andrews and Melnice. This was confirmed in hole M-3-79, where 2.2 m of Fort Garry dolomite was intersected at a depth of 3.0 m, overlying beds of the Selkirk Member.

Holes M-10-79 and M-11-79 were drilled to provide stratigraphic control for the Stonewall and Teulon map sheets. The former hole, near Warren, provided 35.3 m of core of the lower part of the Silurian Interlake Group which, because of the 100 percent recovery, has provided excellent control for this part of the section for which good drill core has been unavailable. Hole M-11-79 provided basic geological control for the northern part of Rockwood Municipality.

LIST OF PRELIMINARY GEOLOGICAL AND GEOPHYSICAL MAPS — 1979

PRECAMBRIAN MAPPING:

1979K-1	Molson Lake, East Half (63 I/1,2,7,8) by W. Weber and J.J.M.W. Hubregtse	
1979K-2	Molson Lake, West Half (63 I/3,4,6) by W. Weber and J.J.M.W. Hubregtse	1:100 000
1979K-3	Oxford House, Southwest Half (Parts of 53L/3,4,5,6) by D.C.P. Schledewitz and R.T. Kusmirski	1:100 000
1979K-4	Oxford House, Southeast Half (Parts of 53L/1,2,7,8) by D.C.P. Schledewitz and R.T. Kusmirski	1:100 000
1979K-5	Stull Lake, Southwest Half (Parts of 53K/3,4) by D.C.P. Schledewitz	1:100 000
1979L-1	Barrington Lake area (64C/16) by H.P. Gilbert	1:50 000
1979L-2	Melvin Lake area (64F/1) by H.P. Gilbert	1:50 000
1979L-3	Sickle Lake, South Half (64C/10) by H.V. Zwanzig	1:50 000
1979L-4	McGavock Lake, South Half (Part of 64C/11) by H.D.M. Cameron	1:50 000
1979M-1	Northern Indian Lake (64H) by T. Corkery, P. Lenton, G. Werniuk and A. Wilson	1:250 000
1979M-2	Herchmer, West Half (54E) by T. Corkery and P. Lenton	1:250 000
1979M-3	Northern Indian Lake, Southwest (64H/3,4,5,6) by T. Corkery, P. Lenton, G. Werniuk and A. Wilson	1:100 000
1979N-1	Minago River-Black Duck Lake (Parts of 63J/7,8,9,10) by J.J.M.W. Hubregtse	1:50 000
1979R-1	Pemichigamau Lake and Opachuanau Lake (Parts of 64B/5,12) by D.A. Baldwin	1:20 000
1979R-2	Earp Lake and Issett Lake (Parts of 64B/6,11) by D.A. Baldwin	1:20 000
1979T-1	Paint Lake, North Part (Parts of 63O/9 east half; 63P/12 west half) by R. Charbonneau and S. Sutherland with information by J.J. Macek and J.K. Russell Supercedes Preliminary Map 1978T-2	1:25 000
1979T-2	Paint Lake, South Part (Parts of 63O/8 east half; 63P/5 west half) by R. Charbonneau and S. Sutherland with information by J.J. Macek and J.K. Russell Supercedes Preliminary Map 1978T-2	1:25 000
1979W-1	White Lake-Bear Lake area (Parts of 63K/12,13) by A.H. Bailes and E.C. Syme	1:15 840

URANIUM FOLLOW-UP PROGRAMME:

1979UR-1	Beaver Hill Lake URP Anomaly: Gamma Spectrometer Total Count (53L/2) by N.M. Soonawala	
1979UR-2	Beaver Hill Lake URP Anomaly: Gamma Spectrometer: Potassium (53L/2) by N.M. Soonawala	1:2 500
1979UR-3	Beaver Hill Lake URP Anomaly: Gamma Spectrometer: Equivalent Uranium (53L/2) by N.M. Soonawala	1:2 500
1979UR-4	Beaver Hill Lake URP Anomaly: Gamma Spectrometer: Equivalent Thorium (53L/2) by N.M. Soonawala	1:2 500
1979UR-5	Beaver Hill Lake URP Anomaly: Magnetic Field (53L/2) by N.M.Soonawala	1:2 500
1979UR-6	Beaver Hill Lake URP Anomaly: VLF-Electromagnetic (53L/2) by N.M. Soonawala	1:2 500
1979UR-7	Helicopter Scintillometer Survey — Mistuhe Lake (53L/1) by N.M. Soonawala	1:31 680
1979UR-8	Car Scintillometer Survey: Nopiming Provincial Park (52L/11 & 14) by N.M. Soonawala	1:126 720

DOLOMITE RESOURCES OF THE SOUTHERN INTERLAKE AREA:

1979DR-1	Winnipeg: Overburden thickness (62H/14) by B.B. Bannatyne and C. Jones	1:50 000
1979DR-2	Winnipeg: Geology and bedrock topography (62H/14) by B.B. Bannatyne and C. Jones	1:50 000
1979DR-3	Dugald: Overburden thickness (62H/15) by C. Jones and B.B. Bannatyne	1:50 000
1979DR-4	Dugald: Geology and bedrock topography (62H/15) by C. Jones and B.B. Bannatyne	1:50 000
1979DR-5	Selkirk: Overburden thickness (62 I/2) by C. Jones and B.B. Bannatyne	1:50 000
1979DR-6	Selkirk: Geology and bedrock topography (62 I/2) by C. Jones and B.B. Bannatyne	1:50 000
1979DR-7	Stonewall: Overburden thickness (62 I/3) by B.B. Bannatyne and C. Jones	1:50 000
1979DR-8	Stonewall: Geology and bedrock topography (62 I/3) by B.B. Bannatyne and C. Jones	1:50 000
1979DR-9	Teulon: Overburden thickness (62 I/6) by B.B. Bannatyne and C. Jones	1:50 000
1979DR-10	Teulon: Geology and bedrock topography (62 I/6) by B.B. Bannatyne and C. Jones	1:50 000
1979DR-11	Red River Delta: Overburden thickness (62 I/7) by C. Jones and B.B. Bannatyne	1:50 000
1979DR-12	Red River Delta: Geology and bedrock topography (62 I/7) by C. Jones and B.B. Bannatyne	1:50 000

MANITOBA GEOLOGICAL SURVEY

993 Century Street, Winnipeg, Man. R3H 0W4

Position:	**Staff:**	**Area of current involvement:**
Director:	Dr. W.D. McRitchie	Churchill Structural Province
Senior Precambrian Geologist:	Dr. W. Weber	Superior Structural Province (north to south)
Precambrian Geologists:	D.C.P. Schledewitz	North of 58°, and Molson-Kalliecahoolie belt
	M.T. Corkery	Lower Churchill River
	P.G. Lenton	Lower Churchill River
	Dr. H.V. Zwanzig	Lynn Lake region
	H.P. Gilbert	Lynn Lake/Barrington Lake
	H.D.M. Cameron	Lynn Lake/McGavock Lake
	Dr. R.F.J. Scoates	Thompson belt and Fox River region
	J.J. Macek	Thompson belt
	Dr. J.J.M.W. Hubregtse	Landing, Wintering and Sipiwesk Lakes
	Dr. A.H. Bailes	Flin Flon and Snow Lakes
	E.C. Syme	Flin Flon and Lynn Lake
Mineral Deposit Geologists:	Dr. G.H. Gale	Flin Flon, Snow Lake; Manitoba
	D.A. Baldwin	Ruttan and Churchill Province
	Dr. P. Theyer	Island and Bigstone Lakes, Superior Province
Geophysicist:	Dr. N.M. Soonawala	Manitoba
Phanerozoic Geologists:	Dr. H.R. McCabe	S.W. Manitoba
	J. Malyon	
Industrial Minerals Geologist:	B.B. Bannatyne	Manitoba
Secretarial:	B. Thakrar	
	L. Chudy	
	D. Navitka	

ACKNOWLEDGEMENTS

This year's production of the Report of Field Activities was pursued by the staff with what has now become a customary though nonetheless highly appreciated verve and industry. The field programme in many instances began late, what with the extensive spring flooding in the Red River Valley and the late passing of winter ice. Such a postponement of schedules inevitably leaves less time at the end of the field season for the preparation of manuscripts and subsequent printing, and accordingly the timing of the Meeting with Industry was set back to November 20th, one week later than usual.

The editors are indebted to the geological staff for the prompt manner in which the manuscripts were submitted and to Barbara Thakrar, Leah Chudy and Debbie Navitka for transforming the initial drafts into highly readable typed reports.

The new 1:1 000 000 Geological Map of Manitoba is currently scheduled for joint release with the 1979 Report of Field Activities and the completion of this project cannot be allowed to pass without special acknowledgement to the staff who have been involved in the preparation of the map. The need for such a map was recognized several years ago and data gathering required for regional correlation was initiated in addition to, yet as part of, each year's field investigations. Consequently, many of the staff have been indirectly involved with the project for the last 4-5 years. The final compilations resulted from an intensification of activities early in 1979 and the subsequent drafting was undertaken in the period May to September under the guidance of a production team comprising P. Buonpensiere, L. Franceschet, R.J. Sales, H.R. McCabe, W. Weber, R.F.J. Scoates and W.D. McRitchie. The final product presents considerably more geological information than was available to the compilers of its predecessor 15 years ago, nevertheless the visual impact and readability of the map have been greatly enhanced through the careful and thorough cartographic skills of P. Buonpensiere and L. Franceschet.

W.D. McRitchie

MINES BRANCH

Aggregate Resources Section

INTRODUCTION

The activities of the Aggregate Resources Section have continued to reflect increasing concern for resource management pressure brought about by impending shortages of high quality gravel in the vicinity of urban centres in Manitoba. The requirement is still particularly acute in the Winnipeg region, and steps have been undertaken to proceed with detailed mapping of gravel and near surface limestone sources both to the east of Winnipeg and in the southern Interlake. Results of the latter work are not yet available as fieldwork is ongoing by James F. MacLaren Ltd.

Regional planning concerns have influenced the activities of the Section to the extent that mapping in the Neepawa area, for instance, was undertaken both in response to resource planning needs and to localised aggregate shortages. The integration of potential industrial mineral resource extraction areas into Development Plans and the initiation of procedures designed to protect granular resources in terms of the formulation of Aggregate Resources Management proposals have been undertaken. Two such proposals are currently being considered by the Selkirk and District and Morden, Stanley, Thompson, Winkler District Boards.

Susan Ringrose, Head,
Aggregate Resources Section.

Winnipeg,
October, 1979.

QUATERNARY GEOLOGY AND SAND AND GRAVEL RESOURCES OF THE MUNICIPAL SURVEYS AREA

by Gaywood Matile and Glenn Conley

Field mapping, resistivity and backhoe work was conducted in the Rural Municipalities of Ste. Anne, Springfield, Tache and Hanover. The Bird's Hill Region is excluded from the study area. The purpose of this study was 1) to delineate sand and gravel deposits to serve as a reference for land use planning and 2) to obtain a better knowledge of the Quaternary stratigraphy. In the area, glaciofluvial gravel deposits are associated, in classical Wisconsin time, with either the Labradoran lobe which is derived from the north or northeast or the Keewatin lobe which is derived from the west or northwest.

LABRADORAN GLACIOFLUVIAL SAND AND GRAVEL

A topographical high area, located three kilometres south southeast of Giroux is considered to be the only sand and gravel deposit associated with the Labradoran ice advance (Figure AR-1-1). At the base of a 15 metre deep excavation on the ridge, 4 to 6 metres of sandy till is exposed. Overlying the till is a sand and gravel unit in which sandy till also appears as stringers. Analysis of the till indicates a sand content of 73 percent, suggesting a correlation with the Senkiw Till as described by Fenton (1974). The sand and gravel unit is severely folded and faulted, suggesting deposition in an ice contact environment and subsequent overriding by Keewatin ice from the northwest. This conclusion is further supported by a carbonate-rich till, containing 46 percent sand, exposed along the flanks of the deposit which is correlated with the Marchand Till (Fenton, 1974; Teller and Fenton, 1979, in press).

KEEWATIN GLACIOFLUVIAL SAND AND GRAVEL

A dissected moraine ridge comprised partially of Keewatin sand and gravel extends for approximately 30 kilometres in the south centre of the area passing through the town of Blumenort (Figure AR-1-1). The southern portion of the ridge which is partially buried by lacustrine clay, consists of sand and gravel, along the northwest flank of a till high. Paleocurrent directions in the gravel run consistently parallel to the ridge, in a northeasterly direction. The presence of extensive tabular and trough cross-stratification and clast supported gravel, suggests deposition within an open channel. The feature is therefore considered to be a kame terrace, deposited when the Keewatin lobe was stationary along the line of the "Blumenort moraine".

The northern portion of the moraine is more complex. Current directions are highly variable over short distances. In several sections two tills are exposed, an upper thin till which contains 38 percent sand and a lower till which contains 56 percent sand. Tentatively the upper till is correlated with the Steinbach Till which overrode an earlier recessional moraine formed by the Marchand ice advance. The diversity of paleoflow directions is attributable to the two or more phases of glaciofluvial activity.

Other notable sand and gravel deposits within the area include six eskers believed to be associated with Keewatin ice because of their orientation, till association and paleocurrent direction (Figure AR-1-1). Other glaciofluvial and deltaic sand and gravel deposits, which generally form isolated hills, are also believed to be deposited contemporaneously with the overall retreat of the Keewatin ice. Many of these are overridden by a thin carbonate-rich till (Fenton, 1974).

ECONOMIC GEOLOGY

The glaciofluvial sand and gravel deposits are mostly composed of high quality aggregate and are frequently over 10 metres thick. The actual thickness of many is unknown due to the high water table. That portion of the eskers which is overlain by fine lacustrine sediments tends to be depleted. However, where they crop out on the till plain further east they are not so readily recognized and have good potential for future sand and gravel exploration and extraction. Sand and gravel quantities are presently unknown due to this lack of exposure.

The beach ridges of the area shown on Figure AR-1-1 represent a very small proportion of the economical sand and gravel. One large ridge (located 6.5 kilometres east of Ste. Anne) is among several sufficiently extensive for sand and gravel extraction.

Local demands on sand and gravel, primarily for highway construction and maintenance, are low with respect to the reserves of the area. However, as the present reserves in the Bird's Hill complex are quickly diminishing, the larger, untapped deposits in the study area are proving attractive sites for more detailed exploration.

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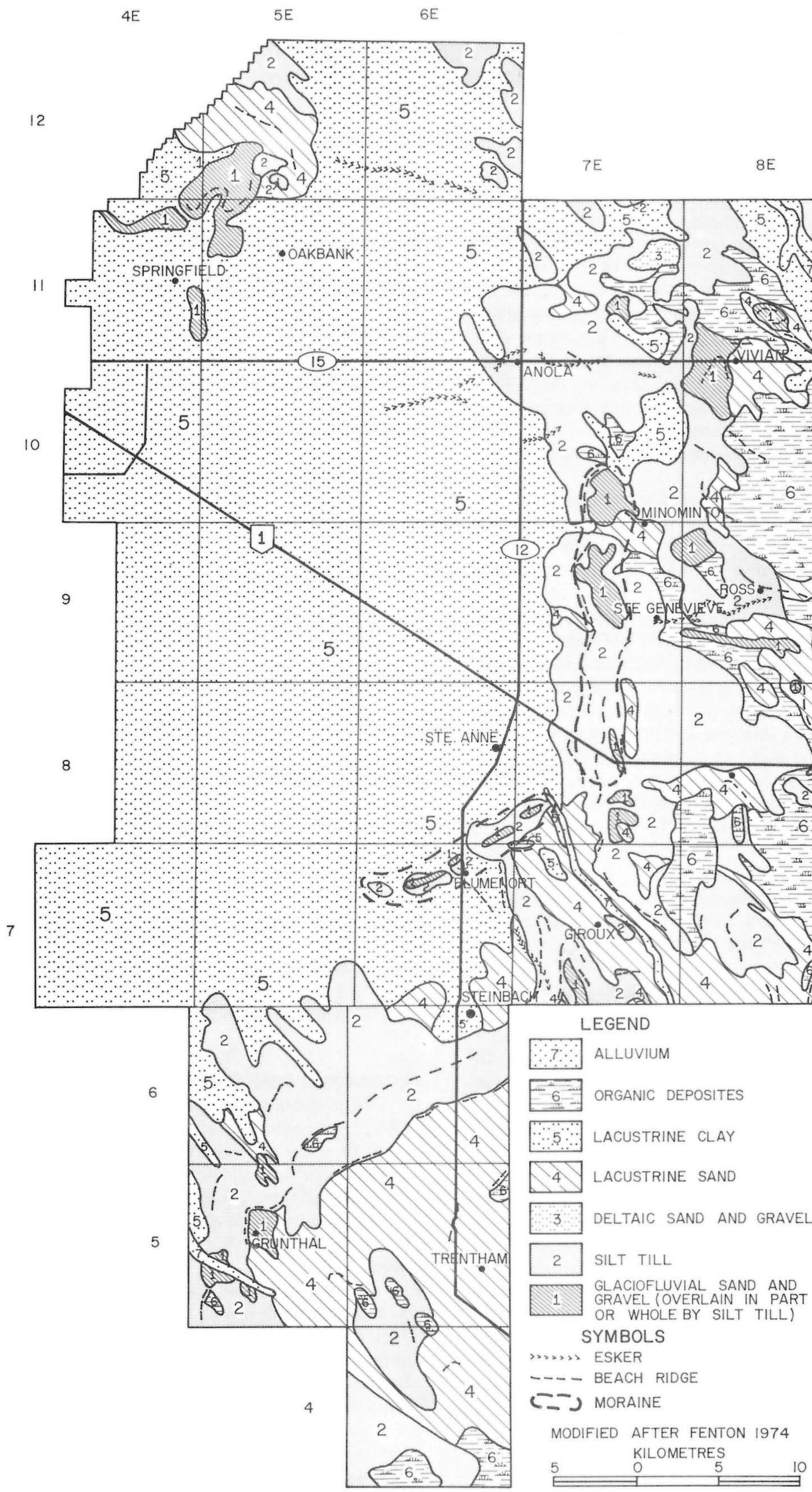


FIGURE AR-1-1: Surficial Geology of the Municipality Surveys Area.

QUATERNARY GEOLOGY AND AGGREGATE RESOURCES OF THE NEEPAWA AREA

by M.A. Mihychuk and H. Groom

The Neepawa study area consists of the whole of the Rural Municipalities of Rosedale and Langford and adjacent areas as found on NTS sheets 62J/2 to 6 and 62J/11. It can be conveniently divided into two parts: the Neepawa area in the north and the Brookdale area in the south. The Neepawa area extends westwards from 99° 15'W to 99° 45'W and northwards from 50° 15'N to 50° 45'N. Riding Mountain National Park extends into the northwest corner of the area but was not mapped for this study. The Brookdale area, contained within latitudes 50° 00'N and 50° 15'N and longitudes 99° 00'W and 99° 45'W, was previously mapped as part of the Brandon Region by Underwood, McLellan and Associates in 1976. The present study undertook supplementary field work in this area.

The objectives of the field study were to:

(a) map the surficial geology and determine the Quaternary stratigraphy of the area;

(b) provide background aggregate resource information for the Neepawa and Area Planning District.

Preliminary map sheets at a scale of 1:50 000 are available showing the surficial geology and delineating the aggregate deposits (series 1979P-N-1 to 4).

The Neepawa study area covers approximately 3300 sq. km. It includes two major physiographic regions: the Western Uplands (Second Prairie Level) in the west and the Manitoba Lowlands in the east. They are separated generally by the Manitoba Escarpment (Figure AR-2-1). Bedrock underlying the Manitoba Lowlands is composed of Jurassic shales, sandstones and limestones, while the foot of the Escarpment and the adjacent Uplands are of Cretaceous shales and sandstones. The Cretaceous bedrock exposed in incised stream valleys along the escarpment edge is the Odanah Member of the Riding Mountain Formation (Bannatyne, 1970).

SURFICIAL GEOLOGY

The stratigraphic and areal relationships of the surficial units are shown in Figures AR-2-1 and AR-2-2. Each unit is briefly discussed in generally chronological order from the oldest to youngest.

The assumed earliest Quaternary deposit occurs in a pit, 3 km east of Bethany, which contains unusually high percentages of quartzite and chert. In this regard it is similar in lithologic composition to a deposit described by Nielsen and Matile (1978) in the Swan River area and to the Souris sand and gravel. These deposits may be early Pleistocene in age.

Two lithologically distinct tills are found in the area. To the west a dark brown till containing 40-98% shale by weight (Unit 2a), referred to by Klassen (1966) as the Lennard Till, comprises the hummocky topography of the Uplands area. The shale content decreases in the area between the Escarpment and the Campbell strandline between Arden and Birnie. Here the till contains 1-20% shale and shows signs of water modification. The till to the east of the Campbell strandline is silty with no shale clasts, and is referred to on Figure AR-2-1 as the Interlake Till (Unit 2b).

Two types of outwash occur: linear outwash deposits and extensive outwash plains. Linear outwash deposits occur as terraces along the valley of the McFadden Spillway. There are two major outwash plains, one at Bethany and the other 6 km west of Neepawa. These deposits (Unit 3) are mainly of shale rich gravel.

Sand deposits associated with the Assiniboine Delta (Unit 4a) extend southwards from approximately 13 km north of Neepawa and cover an area of more than 500 sq. km. Much of this sand has been reworked into dunes which have for the most part been stabilized by vegetation.

Deposits of glacio-lacustrine clay (Unit 4b) are found along the Escarpment, in the vicinity of Brookdale, north of Neepawa and west of Arden. These are believed to result from local ponding above the Campbell beach level in association with ice recession. East of the Escarpment localized clay beds are found within the till, beach ridges and littoral sands.

Two major series of Lake Agassiz beach levels (Unit 5b) are found in the area. One occurs along the Escarpment west of Neepawa at 410 m above sea level. These are tentatively ascribed to the Herman strandline. The Upper Campbell strandline 324 m above sea level is extremely well developed in the Neepawa area and is composed of well sorted, normally graded, horizontally bedded, sandy pebble gravel. At Kelwood the strandline is a well pronounced scarp composed of till and bedrock. The Lower Campbell strandline is also very prominent and can be traced through the area paralleling the Upper Campbell 10 m — 15 m below it. Numerous small discontinuous beach ridges are found east of the Campbell beach level recording sequential, lower levels of the receding glacial lake.

Littoral sands (Unit 5a) which were deposited in a near shore environment of the lake are found close to the beach ridges. These sands are generally medium fine textured and show no distinct bedding.

Minor deposits of alluvium (Unit 6), composed usually of sand, silt and clay, occur in the flood plains of present day streams. Numerous alluvial fans flank the Escarpment where the change in slope results in a reduction of stream energy and thus its capacity to carry sediment. The material in the fans is generally coarse, shaley, pebble gravel at the apex but becomes finer distally.

One and one half kilometres east of Birnie, a stream section shows three distinct fossiliferous paleosols suggesting three periods of deposition and subaerial modification of the fan. Subsequent headward erosion by the Birnie Creek has led to the stream capture of the water flowing in the McFadden Spillway.

Organic deposits (Unit 7b) are found in the lowlands. They generally occur between ridges and are most frequent to the east of the Campbell strandline.

ECONOMIC GEOLOGY

High quality aggregate resources occur in the Upper and Lower Campbell beaches, locally known as the Arden Ridge. This source is ideal for concrete, requiring very little modification. For this reason aggregates from the Arden ridge are used extensively within a 100 km radius of the study area. Much of this valuable resource is made unavailable by roadways, utility lines and buildings. However, the accessible supply should be sufficient to meet immediate future needs.

An outwash fan 6 km west of Neepawa contains moderate quality aggregate which has been used extensively for local needs. This deposit is an important local source of sand and gravel and should continue to be used in the future. Outwash deposits at Bethany and Scandinavia (outside the study area) are also used to meet the local demand for sand and gravel.

In general, the beach ridges contain the higher quality sources; the outwash plains contain moderate quality gravel, while the outwash terraces comprise lower quality sources. The estimate of quality is inversely proportional to the shale clast content.

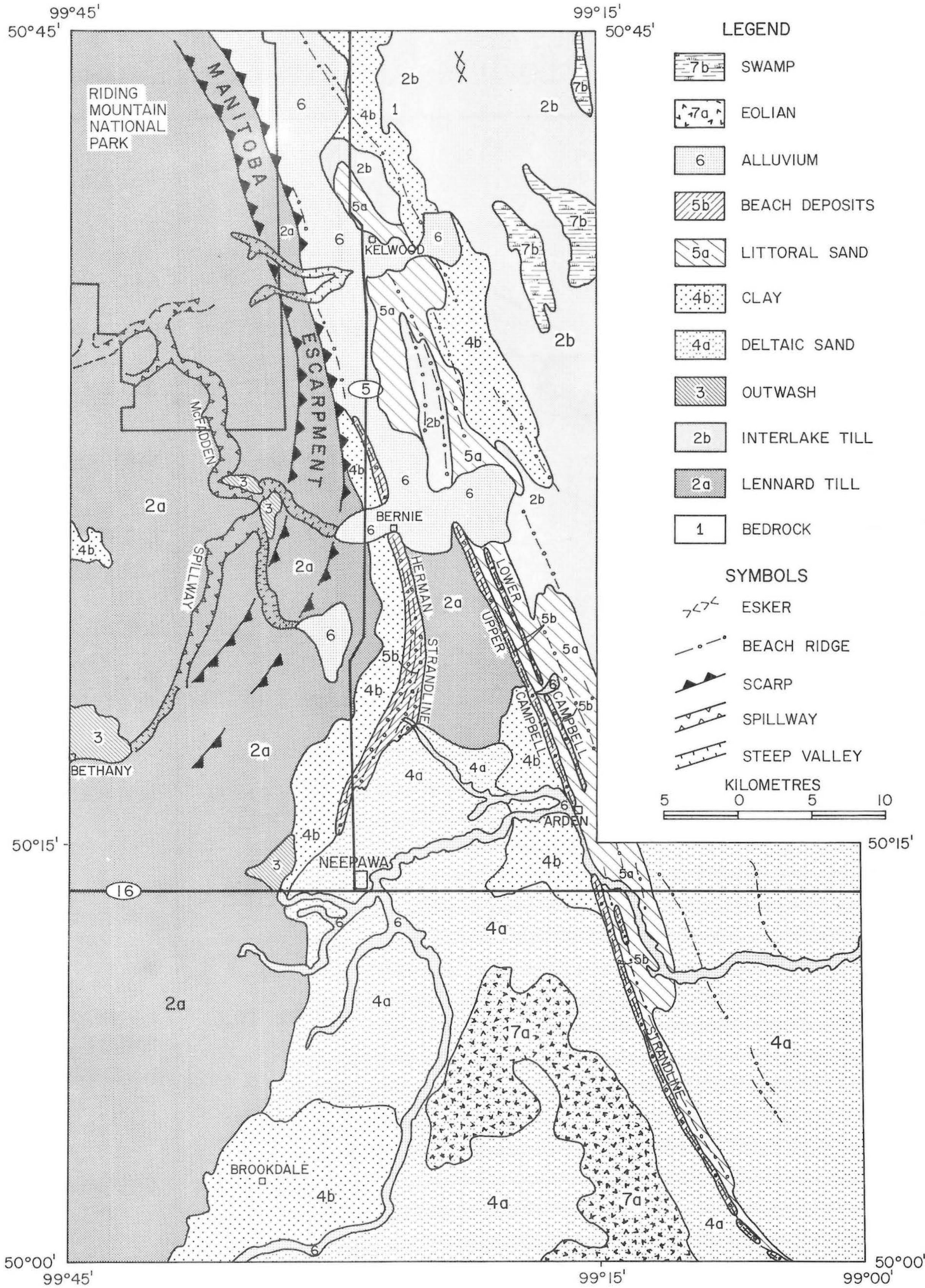


FIGURE AR-2-1: Surficial Geology of the Neepawa Study Area.

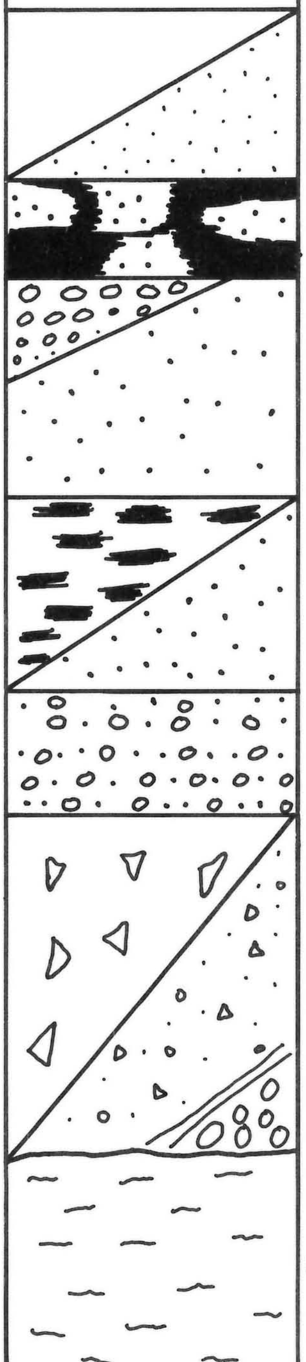
THICKNESS	UNIT NO.	COLUMN	MATERIAL	ORIGIN
0 - 2 m.	7b		MUCK and PEAT	ORGANIC ACCUMULATION
0 - 3 m.	7a		SAND	EOLIAN
0 - 2 m.	6		SAND, SILT and CLAY	ALLUVIUM
0 - 4 m.	5b		SAND and GRAVEL	SHORELINE
0 - 3 m.	5a		SAND	LITTORAL
0 - 2 m.	4b		SILT and CLAY	GLACIOLACUSTRINE
0 - 4 m.	4a		SAND	DELTAIC
0 - 4 m.	3		SAND GRAVEL, MINOR TILL	OUTWASH
0 - 6 m.	2b		CALCAREOUS TILL	INTERLAKE ICE SHEET
0 - 10m	2a		SHALEY TILL	LENNARD ICE SHEET
			GRAVEL	UNKNOWN
	1		SHALE BEDROCK	CRETACEOUS

FIGURE AR-2-2: Schematic Stratigraphic Column of the Neepawa Study Area.

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AGGREGATE RESOURCES MANAGEMENT

by Peggy Large

The aggregate resources management program has been designed to address two recognized needs: firstly, the need for an assured supply of sand and gravel for present and future construction; and secondly, the need for an integrated resource data base for regional land use and development planning activities.

The program involves initially the selection of areas for sand and gravel inventory. Detailed survey work is required in Municipalities which are actively involved in land use and development planning and in which there is a deficit of sand and gravel and other industrial mineral resource data. Emphasis is also placed on regions facing an impending shortage of sand and gravel reserves.

Inventory data are compiled in standard format and are filed in the computer storage system called PLSTCNG. The computerized data base has been designed to provide information to gravel users as well as resource planners and is keyed to parameters such as location, deposit type, material quality, and reserves.

For each inventory region, mineral data are synthesised into a form useful for resource management and land use planning activities. Application of this information typically takes one of three forms: Firstly the data are used in the review of Basic Planning Statements written for each Municipality or Planning District to ensure the concern for aggregate resources planning, particularly in areas where the supply of these resources is limited or where the demand is high. In other locations, the significance of the aggregate extraction industry requires integration of resource data into basic planning proposals. Secondly, information is used to provide resource data and resource management proposals to planning agencies dealing with both private and Crown land. These take the form of an information package in response to requests from Planning Boards. The resource management proposal deals with resource inventory, future demand for aggregate, regional integration of supply and demand with recommendations for protection of certain valuable deposits, and specific proposals for sequential land use and after-mining rehabilitation. Thirdly, subdivision applications are reviewed to ensure that areas with good aggregate or industrial mineral potential are not inadvertently built upon or otherwise rendered unexploitable.

Much of the aggregate resource and planning activity has revolved around the development and emplacement of a minerals oriented land use policy. The policy, one of thirteen used as guidelines to land use planning and development, aims to protect aggregate and industrial mineral resources from land uses which will preclude their future exploitation.

These activities which have gained considerable momentum over the past year comprise:

- review of twenty-five Basic Planning Statements (see Figure AR-3-1)
- compilation of sand and gravel resource data for eight planning areas
- presentation of three aggregate and industrial minerals resource management proposals for inclusion into Development Plans
- inventory and data compilation of aggregate resources in ten regions in southern Manitoba and six northern areas
- review of approximately fifteen hundred applications for land subdivision, ten percent of which required detailed investigation and recommendation regarding aggregate resources.

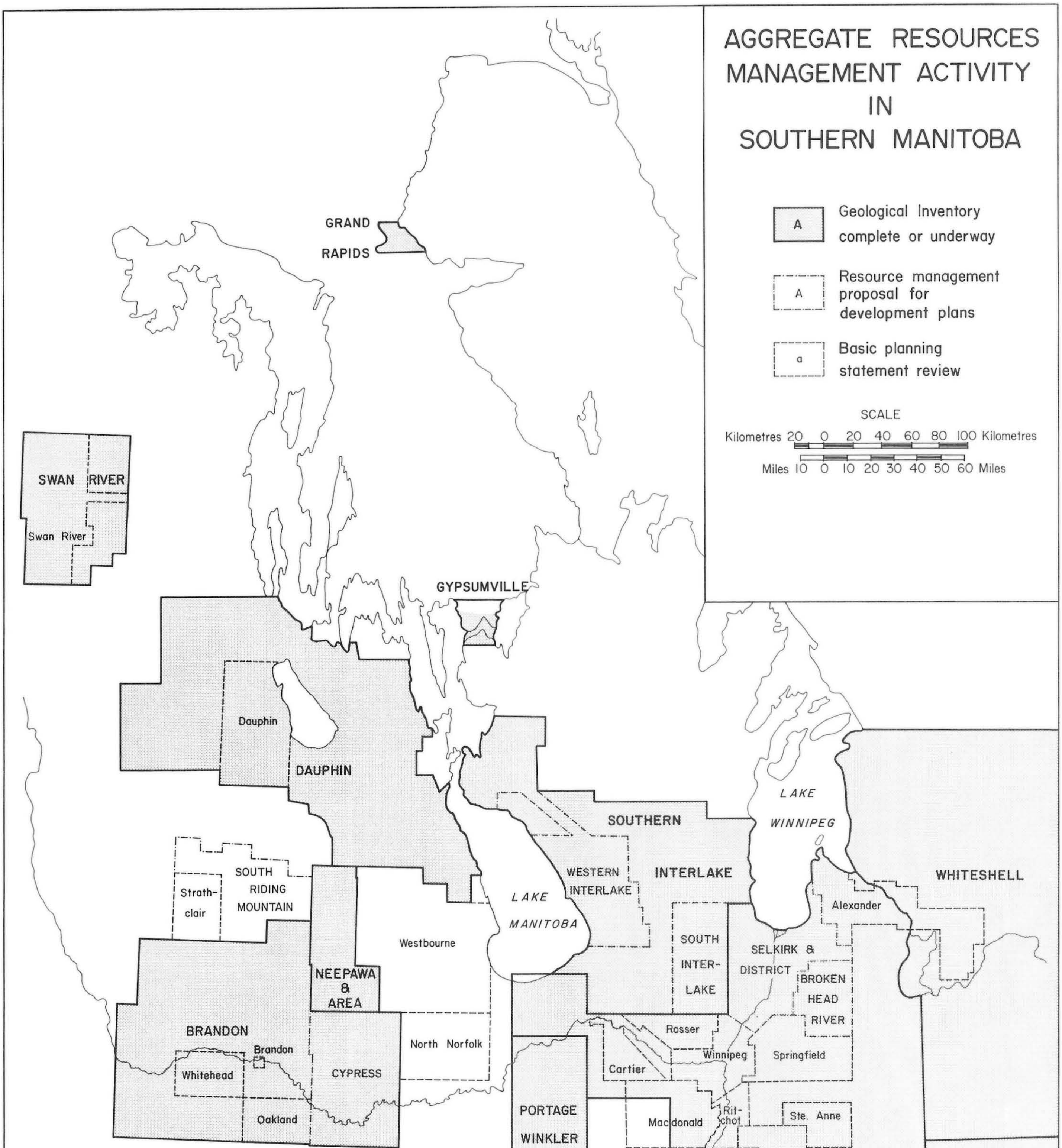

FIGURE AR-3-1: Aggregate Resources Management Activities in Southern Manitoba.

PRELIMINARY MAPS, QUARTERNARY GEOLOGY OF THE NEEPAWA AREA

1979PN-1	Glenella, (62J/11 West Half and 62J/12 East Half) by Maryann Mihychuk and Heather Groom	1:50 000
1979PN-2	Arden, (62J/5 East Half and 62J/6 West Half) by Maryann Mihychuk and Heather Groom	1:50 000
1979PN-3	Moorepark, (62J/4 East Half) by Maryann Mihychuk and Heather Groom	1:50 000
1979PN-4	Neepawa, (62J/3) by Maryann Mihychuk and Heather Groom	1:50 000