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DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT

MINERAL RESOURCES DIVISION

REPORT OF FIELD ACTIVITIES 1978

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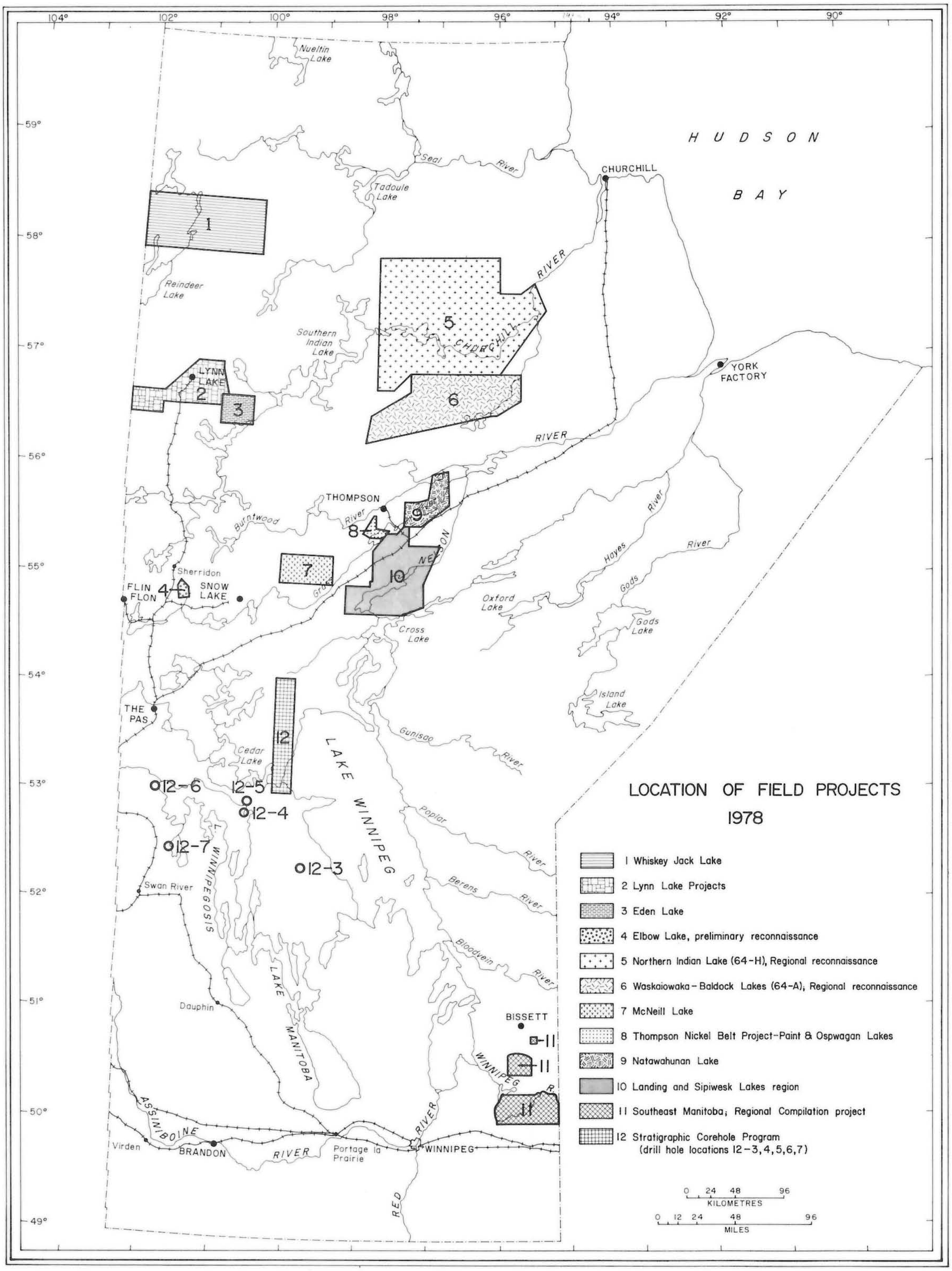


Figure GS-1: Location of Field Projects 1978.

INTRODUCTION

The 1978 field program of the Geological Survey Section was moderated in comparison to previous years as efforts were redirected from new mapping projects to a consolidation of outstanding reports and a completion of long-term projects. This year's undertakings saw the completion of the Churchill Structural Province inspection conducted as part of the Regional Correlation Program. The information now available is being compiled into a new geological map of Manitoba at a scale of 1:1 000 000 which will present a standardized and coherent interpretation of the geology based to a large extent on the staff's first hand experience over the last 8 years.

Five of the 12 parties fielded this year comprised regular 1:50 000 and 1:20 000 scale mapping programs in the McNeill, Eden, Paint, Natawahunan and Sipiwesk regions, and five were short-term Regional correlation and/or feasibility projects in the Whiskey Jack, Northern Indian, Baldock and Elbow Lakes regions and in Southeast Manitoba. The remaining projects entailed a final review of the newly developed stratigraphic framework in the Lynn Lake greenstone belt, and diamond drilling conducted jointly under the Stratigraphic core hole program and the GDA funded Industrial Minerals drilling program.

Marked advances have been achieved in relating and better defining the geology of the Pikwitonei and Thompson belt regions, and the identification of hitherto unrecorded greenstone occurrences in the Partridge Breast and Northern Indian Lake region lends new base metal exploration potential to this relatively unexplored segment of the Churchill Structural Province.

W.D. McRitchie
Director
Geological Services Branch

Winnipeg
September, 1978

GS-1 GEOLOGY OF THE WHISKEY JACK LAKE AREA (South Half)

(64K-1 to 8)

by D.C.P. Schledewitz

Introduction

Mapping of the Whiskey Jack Lake (south half) area completes regional mapping at a scale of 1:100 000 of Manitoba north of 58° (Fig. GS-1-1). The mapping of the south half of the Whiskey Jack Lake area was conducted as a southward extension of the Kasmere Project (Weber et al., 1975). The geologic units are consistent with those used in the Kasmere Project.

Mapping was carried out using fixed wing support for access into areas of abundant outcrop, helicopter traverses were used to fill in the ground traverses and for access into areas of isolated outcrop. On-rock scintillometer readings were carried out at each station using a McPhar TV-1 scintillometer. The geological traverses were located to provide a more detailed breakdown and expansion of the existing map coverage as defined on the Geological Survey of Canada Map (G.S.C. Map 52-1960) at a scale of 1:250 000.

The percentage of bedrock outcrops in the region is variable. To the west and along the Cochrane River exposure ranges from 0.5% to 2%. In the southwest corner of the area along the north shore of Reindeer Lake, Perch Bay and Zangeza Bay are exceptional with 50% to 60% exposure along the shorelines. To the east of Cochrane River exposure is less than 0.5% and in the southeast of the region the area is covered by drift with scattered occurrences of frost shattered material and minor boulder trains.

General Geology

The Whiskey Jack Lake area (south half) is dominated by intrusive rocks of granite to quartz monzonite composition. These acid intrusive rocks contain discontinuous bodies of metasedimentary gneisses and bodies of granodiorite to quartz diorite (Fig. GS-1-2).

The metasedimentary gneisses at the north end of Whiskey Jack Lake are a southward extension of similar rocks in the area of Lac Brochet (Kasmere Lake Project, 1975). These metamorphosed sedimentary rocks form a narrow zone, 8 km wide, at the northwest end of Whiskey Jack Lake. This zone of metasedimentary rocks becomes narrower to the east and at a point 22 km east of Whiskey Jack Lake they form a zone of widely spaced highly metamorphosed inclusions in the quartz monzonite.

The metasedimentary sequence comprises a lower psammite to semi-pelitic gneiss with pelitic laminations and minor calc-silicate layers, and an upper unit of arkosic gneiss.

The psammite layers comprise biotite (8%), quartz and feldspar (± garnet). The quartz content varies from 35 to 60%. The more aluminous laminations are defined by concentrations of biotite, cordierite and sillimanite (± garnet). The absence of muscovite and the presence of the assemblage biotite + cordierite + sillimanite ± garnet indicates low pressure and high temperature conditions of the upper amphibolite facies of metamorphism.

The psammite-pelite sequence is overlain by an arkosic gneiss containing calc-silicate, albite — pyroxene and/or quartzite lenses. Diopside and hornblende are common accessory minerals in the rocks of arkosic composition with rare andradite garnet and epidote in the quartzite lenses.

The bodies of metadiorite occur within the quartz monzonite to granite complex and form discontinuous zones ranging in size from several km square to bodies 5 km wide and 15 km in length (Fig. GS-1-3). The aeromagnetic maps indicate a broad inhomogeneity for the region outlined by the limited bedrock geology as mainly rocks of quartz monzonite composition. Areas of magnetic highs of 2900 to 4500 gammas correspond to areas mapped in the field as magnetite-bearing biotite-hornblende-plagioclase-quartz granoblastites, gneisses and schists. Clinopyroxene-bearing less altered metadiorite occurs as zones within the larger areas of metamorphosed basic rocks. These basic rocks are best exposed in the southwest corner of the map-area along the southern shoreline of Whiskey Jack Lake, 12 km south of Whiskey Jack on "Tricky Lake", and further east along the southern extent of the Cochrane River. These zones of basic rocks range in size from 7 km square to areas 5 km x 15 km. The degree of alteration in the basic rocks is related directly to the intensity of intrusion by aplite and quartz monzonite dykes. The formation of a magnetite + chlorite + hornblende + epidote + plagioclase + microcline schist defines the most intensely altered areas of the basic rocks. Epidote coated fractures with an associated marginal bright salmon coloured feldspar occur in both the quartz monzonite and in the basic inclusions within the areas of contact metamorphism.

Two structural trends are apparent in the region,

(i) an easterly trend,

(ii) a northeasterly trend.

East-trending layering and faults are prominent in the area of Whiskey Jack Lake. The easterly trend is overprinted by northeast-trending shear zones, 20 km east of Whiskey Jack Lake. The younger northeast-trend is well defined along the Cochrane River. Elsewhere in the region the two trends are defined by the presence of a weak to pronounced foliation in the intrusive rocks or by well defined but narrow zones of cataclasis. Both structural trends are also apparent on the four-mile airborne magnetic map of the area (Map 7147G).

Mineralization

The south half of the Whiskey Jack Lake area was covered by the airborne Gamma Ray Spectrometer and Lake Sediment Geochemical Reconnaissance program conducted by the Geological Survey of Canada in 1975. The results of these surveys were released in 1976.

The survey outlines a cluster of well defined anomalies between the southeast end of Lac Brochet and the intersection of latitude 58°20' and the Cochrane River (Fig. GS-1-4). This grouping of anomalies defines a zone 18 km x 32 km which is elongated to the northeast. Common featues to this zone are,

i) a well defined northeast structural trend,

ii) a less well defined easterly structural trend, and

iii) isolated moderate to highly metamorphosed and digested inclusions of meta-sedimentary rocks.

The enveloping zone of 2.0 ppm uranium equivalents contains 6 anomalous areas which display greater than 3.0 ppm uranium equivalents. The two southernmost anomalies A and B (Fig. GS-1-4) are the highest and the largest in areal extent.

Anomalies A and B were examined by ground follow-up during the 1978 mapping program. Anomaly A lies in an area of poor exposure and a distinct radioactivity peak was not defined. On-rock scintillometer readings ranged from 10,000 to 17,000 cpm within this area.

Anomaly B occurs within a zone of outcrop. The main rock type is a pink to greyish pink biotite bearing (5% — 8%) well foliated quartz monzonite. Porphyritic to coarsely porphyritic zones of quartz monzonite to granite occur within this area and are gradational in their contacts.

On-rock scintillometer readings were taken starting within the background region to the northeast of the anomaly. Readings at these stations ranged from 8,000 to 10,000 cpm (stations 21 and 22, Fig. GS-1-4). At stations 23 and 24 readings ranged from 13,000 to 16,000 cpm. The highest on-rock readings were recorded within the peak zone of the airborne anomaly and the area of a corresponding geochemical lake sediment anomaly. Readings of 40,000 cpm (station 180) were recorded on pale greyish green biotite (3% — 5%), plagioclase and quartz bearing veins. The veins up to 1 cm thick are of variable strike length, the longest observed being 3 m. The host rock is a grey to pink medium granined well foliated quartz monzonite which produced background readings of 6,000 to 8,000 cpm.

Autoradiographs and X-ray analysis confirm the presence of uraninite. Examination of thin sections indicates the mineral assemblage uraninite-allanite-magnetite. Uraninite occurs as disseminated grains either within plagioclase or interstitially. Biotite grains within the veins are almost opaque due to metamictization possibly indicating inclusions of uranium-bearing elements are also present in the biotite. Plagioclase is heavily altered to epidote, calcite and sericite within the veins. The host rock is altered at its contact with the veins. Chloritization of the biotite, the formation of epidote in the plagioclase and sericitization of microcline are abundant. Epidote and fluorite also occur as lenses within altered biotite grains.

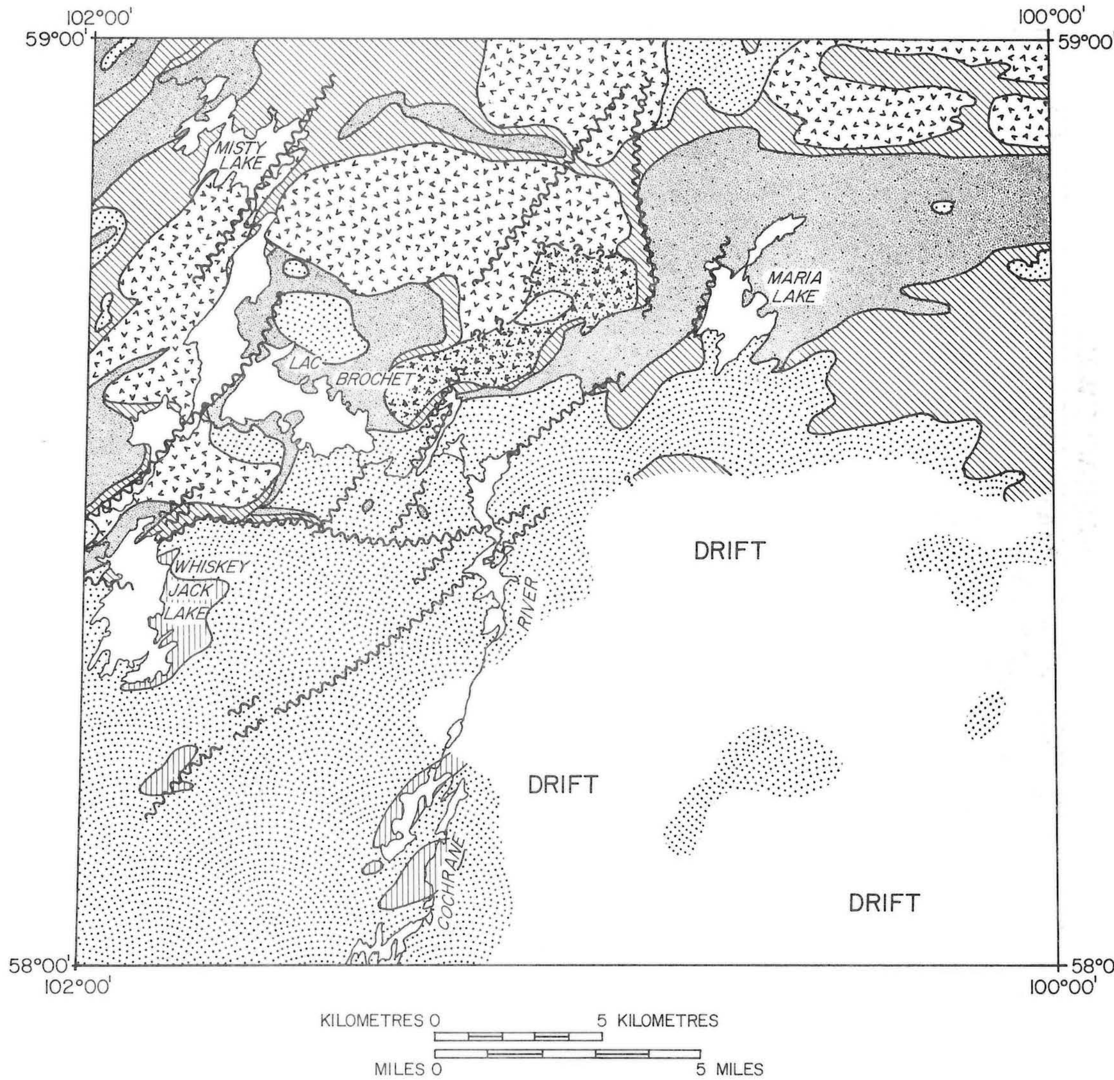
References

Currie, K.L.
1960: Whiskey Jack Lake, Manitoba; *Geol. Surv. Can.*, Map 52-1960

Weber, W. *et. al.*
1975: Geology of the Kasmere Lake-Whiskey Jack Lake (north half) Area (Kasmere Project); *Man. Min. Res. Div.*, Publ. 74-2

Resources Geophysics and Geochemistry Division
1975: Airborne Gamma-Ray Spectrometry Survey, Open Files 317 & 318.

Figure GS-1-1: Location of Regional Map Projects for Northern Manitoba (1971-1978).



LEGEND

- COMPLEX OF HUDSONIAN QUARTZ MONZONITE & ARCHEAN GRANITIC ROCKS
- HUDSONIAN QUARTZ MONZONITE, MEDIUM GRAINED TO PORPHYRITIC
- META-ARKOSE, CALC-SILICATE, CONGLOMERATE, BIOTITE PSAMMITE
- SEMI-PELITIC TO PELITIC GNEISS
- METADIORITE UNCERTAIN AFFINITY
- ARCHEAN GRANITIC ROCKS, IN PART HYPENSTHENE BEARING

SYMBOLS

- FAULT, ASSUMED
- GEOLOGIC BOUNDARY (APPROXIMATE, ASSUMED)

Figure GS-1-2: Simplified geology of the Whiskey Jack Lake area (64K).

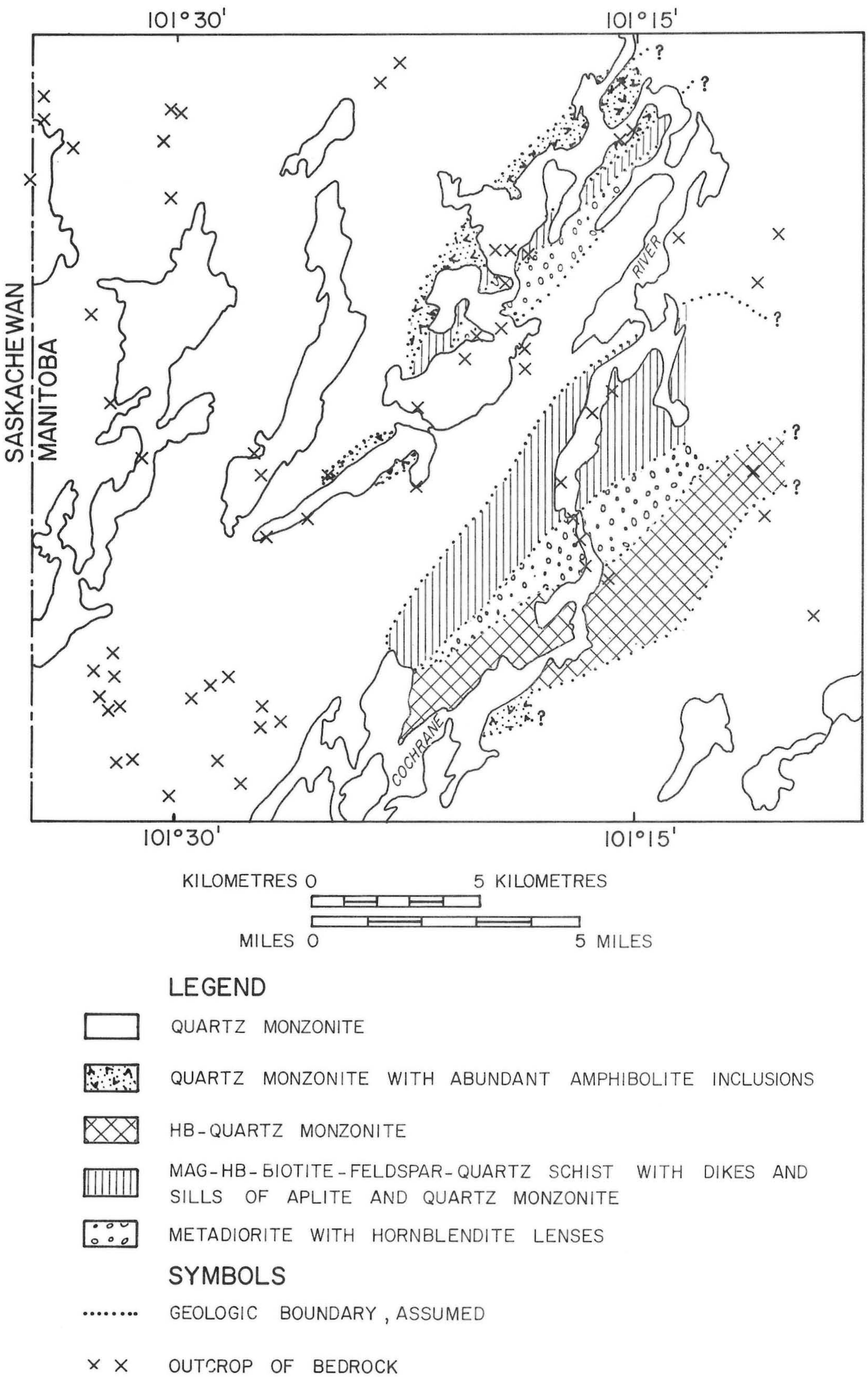


Figure GS-1-3: Detailed geology of metadiorite (unit A).

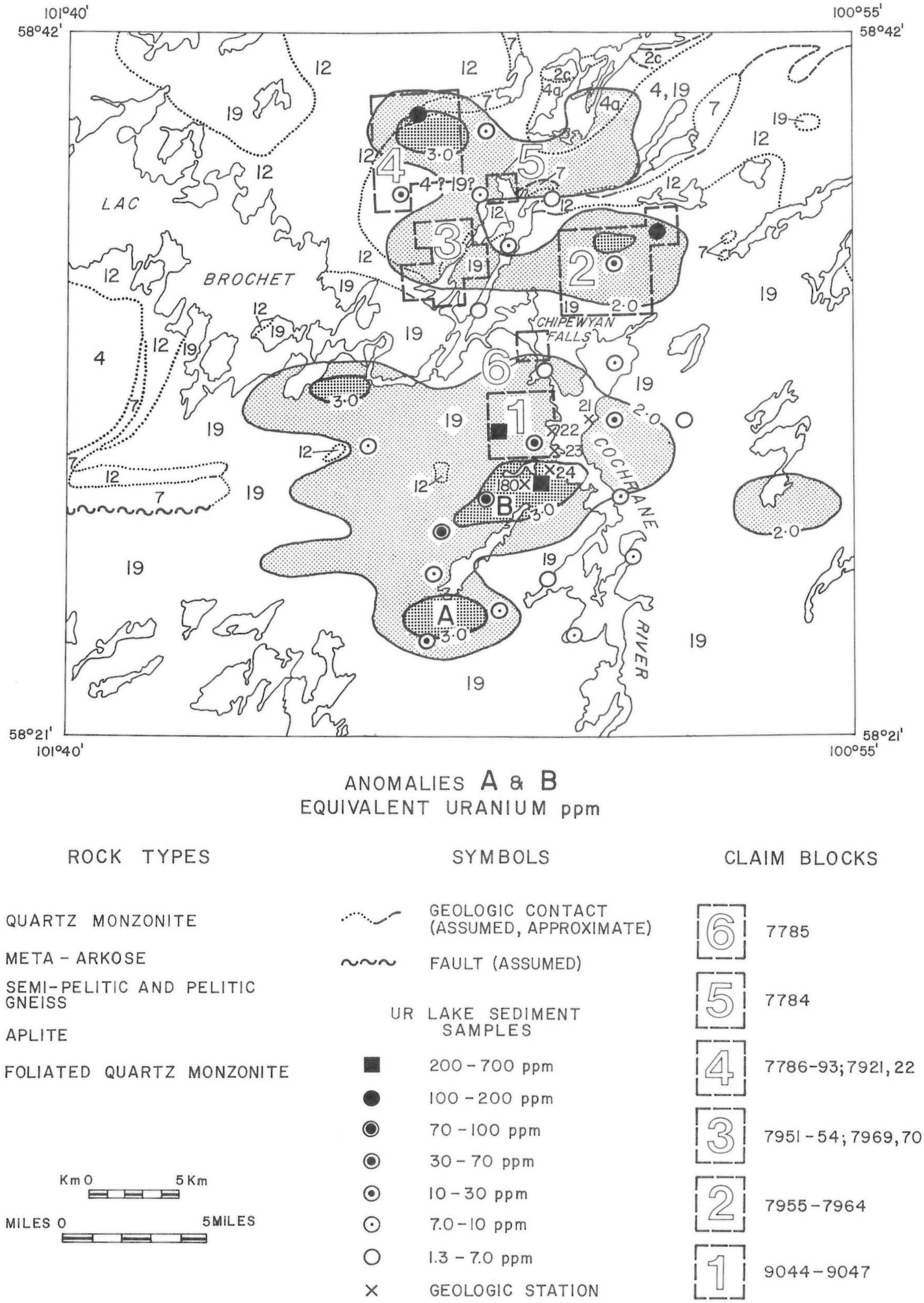


Figure GS-1-4: Radiometric anomalies A and B in the south half of the Whiskey Jack Lake area.

GS-2 LYNN LAKE PROJECT

(64C-12, 14 and Parts of 10, 11, 13 and 15)

a) Regional Correlation

by H.V. Zwanzig

A brief field programme was conducted by H.P. Gilbert, E.C. Syme and H.V. Zwanzig to compare exposures of similar lithology throughout the Lynn Lake greenstone belt and to solve problems in details of mapping. A compilation map (1978L-1) was prepared at 1:100 000, showing major units and selected minor units in the Lynn Lake area. The map includes data from preliminary maps 1976L-1 and 1977L-1 to 7 pertaining to the Wasekwan Group, Sickle Group and the adjacent gneisses. Data for plutonic rocks was taken from earlier publications. (See Milligan, 1960 for a bibliography).

Correlations in the southern and western part of the Lynn Lake belt support the preliminary subdivision of the Wasekwan Group into two volcanic divisions (A and C after Gilbert, 1976 p. 37) separated by a sedimentary division (B). However, in the northeastern part of the belt the sedimentary rocks lens out and there is no clear distinction between the upper and lower parts of the volcanic succession.

Several preliminary correlations can be made among bodies of similar lithology. There are large areas of porphyritic metabasalt shown on the compilation map as unit 3. They are in the area of McVeigh Lake, Miskwa Lake and Fox Lake (Map 1978L-1 and Fig. GS-2-1). The correlation between these areas is based on the criteria that the porphyritic basalt contains similar types of phenocrysts everywhere. These consist of pyroxene (replaced by hornblende), commonly 5 mm in diameter, and plagioclase up to 1 mm long. The structure of the basalt is dominated by autoclastic breccia. Differentiated flows with cumulate pyroxene occur in the Miskwa Lake and Fox Lake bodies.

The three bodies of porphyritic basalt occupy a similar stratigraphic position. They interfinger with aphyric basalt (compilation unit 2) and are probably underlain by it. Part of each body of porphyritic basalt is overlain by metasedimentary rocks.

The sediments provide additional data for correlation. They occur in two successions:

1) a unit of fine-grained biotite greywacke (unit 1) that underlies the mafic volcanics and mafic sediments on the north and south flanks of the greenstone belt;
2) a higher succession of diverse sedimentary rocks (units 8 and 9) that lies within the volcanic pile. It consists of lenticular bodies of hornblende greywacke, biotite greywacke, conglomerate, siltstone and basaltic mudstone.

On the south flank of the greenstone belt the lower greywackes belong to the Burntwood River "Supergroup" (Zwanzig, 1976). They underlie a thin, distal facies of the volcanic rocks. Several exposures on the north flank near the Hughes River (Fig. GS-2-1), where moss was stripped in 1977, provided reliable top indicators. In the north, the facing directions define an anticline developed in the greywacke. On the southern limb of the anticline the greywacke is overlain by a thin unit of mafic volcanic and volcaniclastic rocks, followed by conglomerate of probable Sickle age to the south. The mafic rocks face south and they are considered to be a distal facies of the Wasekwan volcanic rocks in the main part of the Lynn Lake belt. The greywackes are probably equivalent to the Burntwood River "Supergroup" because of their similar composition, fine grain-size, turbidite structure and identical stratigraphic position. The greywackes are considered to be of Wasekwan age because of their conformable contact with the distal volcanic rocks.

The correlation of the diverse metasedimentary rocks along the greenstone belt is constrained by the lensoid shape of the individual bodies. Evidence for their correlation is provided by the long-strike length of the whole sedimentary succession and by their consistent stratigraphic position above the porphyritic basalt (unit 3). The sediments lens out to the northeast where the volcanic succession remains undivided.

The succession of diverse Wasekwan metasedimentary rocks is directly underlain by felsic volcanic rocks in several localities. Moreover, some of the sediments are lateral equivalents of the felsic rocks. They can be useful in tracing felsic horizons and associated mineralization.

b) Arbour Lake Project — Revisions

by H. Paul Gilbert

One month's field work was directed to improving the accuracy of the earlier mapping and attempting to resolve related problems. No extension was made to the map-area (the volcano-sedimentary belt between Wilmot Lake and Eagle Lake, N.T.S. sheets 64C-11, 14 and 15). Revisions incorporated in the compilation map (1978L-1) include the mapping of a felsic volcanic unit in the area immediately north of Motriuk Lake (Fig. GS-2-2) and the recognition of predominant fine-grained mafic tuff and lapilli-tuff in the Wasekwan section between Wilmot and Gemmell Lakes (Preliminary Map 1977L-3) which was formerly considered to be largely a flow sequence with related breccia (Gilbert, 1977). Several minor felsic volcanic units have been added, e.g., northeast of Counsell Lake, and northeast of Auni Lakes; porphyroblastic schists are locally developed where the felsic rocks are associated with mafic tuffs, and some zones correspond to linear electromagnetic anomalies (Questor INPUT Surveys 1976, 1977).

A review of the structure of the conglomerate/staurolite schist body at Gemmell Lake indicates the presence of two or more fold axes in the body, supporting the concept that these rocks are infolded remnants of younger rocks within the Wasekwan section (Gilbert, 1977). Mafic volcanic rocks at Betty Lake (21b) between conglomerate to the south and fine-grained sediments to the north (units 19b and 21a, respectively, Preliminary Map 1977L-4) are probably of Wasekwan age. The mafic volcanics or derived amphibolite have been mapped northeastwards to the area on the Hughes River, where they are considered to be equivalent to Wasekwan rocks south of the conglomerate (Zwanzig, this report). At Ralph Lake,gabbro within the mafic volcanic unit apparently intrudes the greywacke to the north (21a) suggesting the fine-grained sediments are relatively older. This is consistent with the earlier suggestion that these sediments, which extend from Zed Lake to the area east of Dunsheath Lake, are of Wasekwan age (Gilbert, 1976).

References

Gilbert, H.P.

1976: Lynn Lake Area; *in*: *Man. Min. Res. Div.*, Geol. Surv. Report of Field Activities 1976, pp. 33-37.

1977: Lynn Lake Area; *in*: *Man. Min. Res. Div.*, Geol. Surv. Report of Field Activities 1977, pp. 37-46.

Milligan, G.C.

1960: Geology of the Lynn Lake District; *Man. Mines Br.*, Publ. 57-1.

Zwanzig, H.V.

1976: Laurie Lake Area; *in*: *Man. Min. Res. Div.*, Geol. Surv. Report of Field Activities 1976.

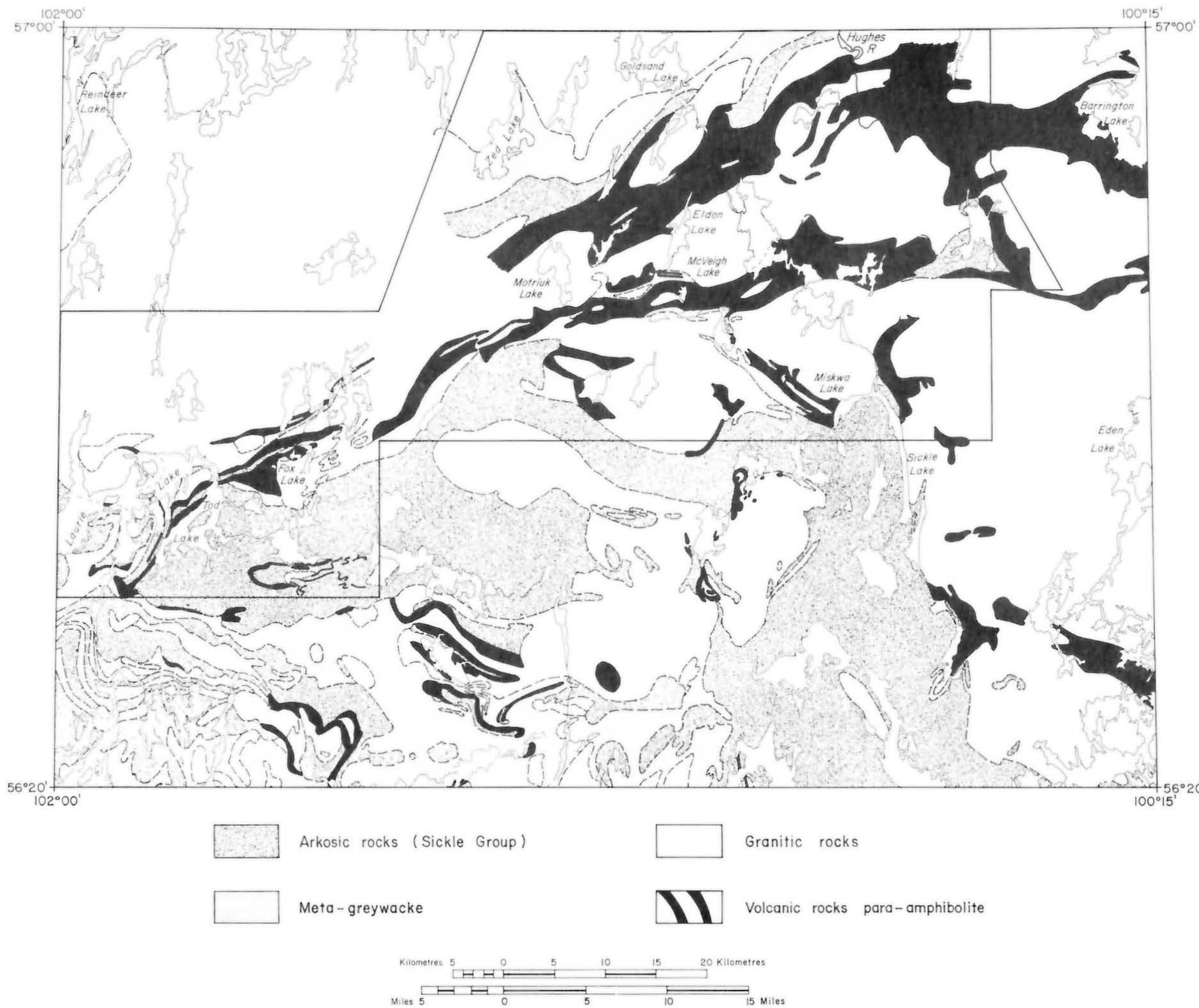


Figure GS-2-1: Outline of the Lynn Lake Project area and general geology.

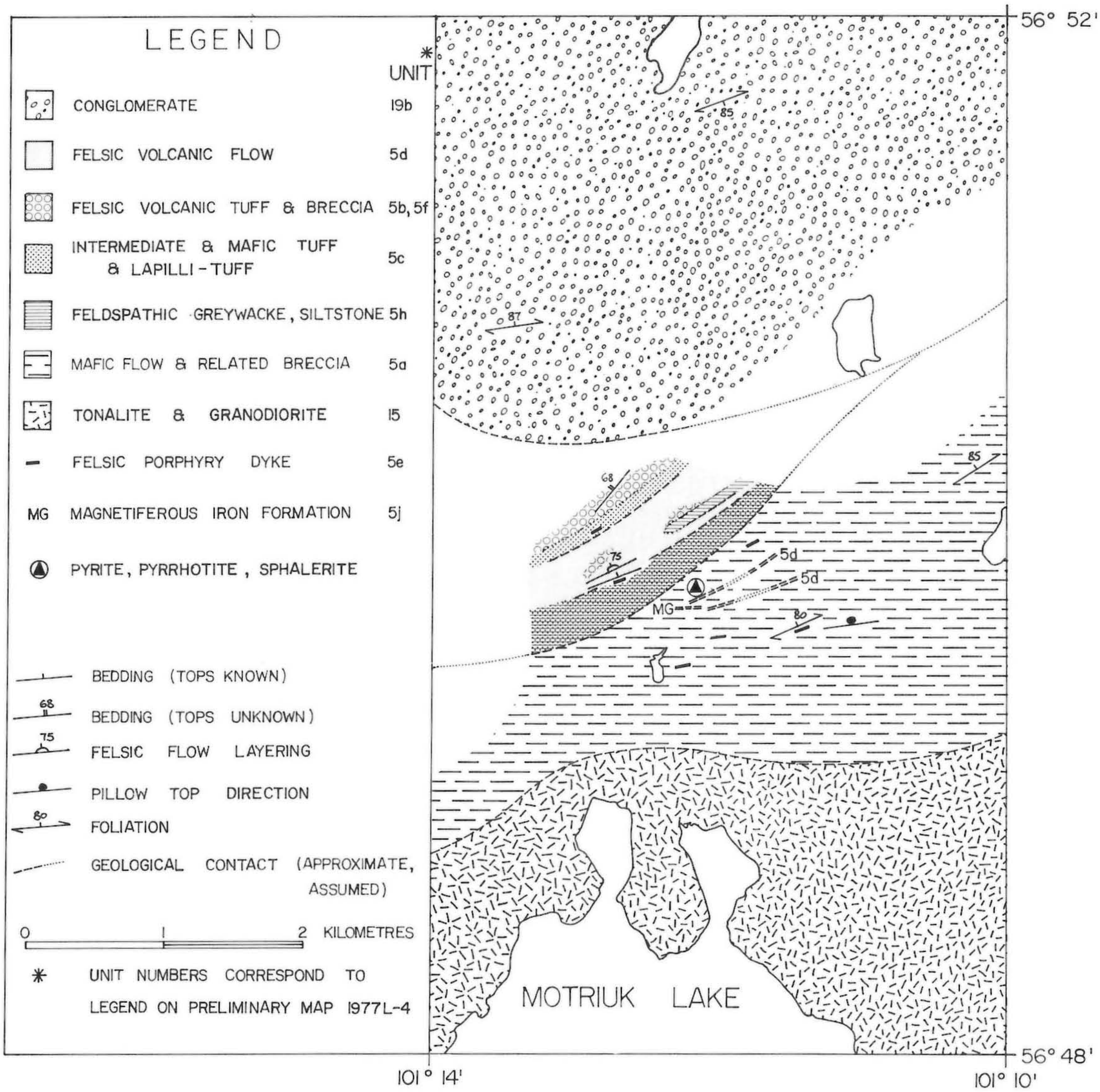


Figure GS-2-2: Geology of the area north of Motriuk Lake, Lynn Lake area (N.T.S. 64C-14)

GS-3 EDEN LAKE

(64C-9)

by H.D.M. Cameron

Introduction

Mapping at a scale of 1:50 000 was carried out in the Eden Lake area (64C-9) to complete the geologic coverage of the unmapped area between Barrington Lake and Turnbull Lake sheets.

Previous work by McRitchie (1976) in the Outlaw Bay region, outlined a section of quartz monzonite containing rafts of metasedimentary and metavolcanic gneisses.

General Geology

The map-area is underlain by granitoid intrusives, some of which contain rafts of metasedimentary and metavolcanic rocks.

The dominant rock type is a foliated grey granodiorite which covers most of the southern half of the map sheet. A train of rafts of metasedimentary and metavolcanic gneisses can be traced through the granodiorite south of Eden Lake from Outlaw Bay in the east to Stag Lake in the west (Fig. GS-3-1). A coarse porphyroblastic quartz monzonite stretches northward in an arc from Outlaw Bay to the northeast corner of the map sheet and down to the northeast shore of Eden Lake. A fine-grained massive pink granite lies within the centre of the quartz monzonite body, east of Eden Lake. Late pegmatites and aplites in the east half of the area are assumed to be related to a massive red granite centered on Eden Lake. Several intrusive bodies of quartz monzonite to granite composition lie along the west boundary of the area. These are weakly foliated and free of inclusions of gneisses and veins of the younger pegmatite.

Two areas near the northern boundary contain large rafts of metasedimentary and metavolcanic rocks related to the greenstone belt to the north.

Gneisses and associated Migmatites (unit 1)

A complex of siliceous metasedimentary and amphibolite gneisses is found along the shoreline of Outlaw Bay, in the southern part of the area, extending westward as far as Stag Lake. These generally occur as large rafts in the main granodiorite body (unit 2a) ranging in size from 10 to 1,000 m. It is not possible to establish any consistent stratigraphic relationships between the sub-units in the gneisses.

The most common inclusions consist of fine grained, light grey weathering psammitic gneisses. These occur throughout the granodiorite south of Eden Lake. Locally the psammite is garnetiferous and in some locations resembles the metagreywackes of the Burntwood River "Supergroup". Fine grained amphibolite and a biotite gneiss which is slightly more mafic than the psammite, are associated with these rocks. Rare occurrences of arkosic gneiss similar to some of the Sickle arkoses were observed.

A fine grained, layered amphibolite occurs sporadically and is locally interlayered with fine grained tuffaceous material. These are found on both the Outlaw Bay shoreline and further west near the southern end of Eden Lake. More massive mafic fragmental rocks were also noted on Outlaw Bay.

At two locations near the north end of Eden Lake the porphyroblastic quartz monzonite (unit 3a) contains abundant rafts of metasedimentary and metavolcanic rocks. The volcanic rocks have been tentatively identified as mafic to intermediate flow and fragmental rocks whereas the majority of the sedimentary material comprises a fine grained, light grey meta-arkose.

The gneisses also occur as more highly assimilated inclusions throughout the granodiorite (unit 2a) and the porphyroblastic quartz monzonite (unit 3a).

Granodiorite and Tonalite (unit 2); Foliated Granodiorite (unit 2a)

Medium to coarse grained grey granodiorite is the most common rock type in the southern part of the area. It is generally well foliated, weakly porphyroblastic and contains schlieren and small inclusions of biotite gneiss. It has been locally agmatized by younger granite along the western shore of Eden Lake. In the eastern half of the area it is cut by numerous intersecting veins of pink to brick red pegmatite and buff to pink aplite.

The granodiorite is white to buff weathering and contains plagioclase, feldspar, quartz, biotite and hornblende. In most locations it contains small amounts of magnetite.

Massive Granodiorite (unit 2b)

In the Stag Lake area and west of Eden Lake the granodiorite is more massive, weakly foliated, and free of inclusions. It is not intruded by the pegmatite and aplite that is common in the eastern part of the area.

Tonalite (unit 2c)

Bodies of coarse grained hornblende tonalite, composed of plagioclase, quartz, hornblende and biotite, are found on Stag Lake, on the eastern arm of Outlaw Bay and at the north end of Eden Lake. The tonalite is white weathering and has a coarsely pitted surface due to preferential weathering of the hornblende megacrysts. It is well foliated and intruded by a network of white aplitic veins which are most resistant to weathering than the tonalite.

Granite and Quartz Monzonite (unit 3); Porphyroblastic Quartz Monzonite (unit 3a)

A large horseshoe-shaped outcrop belt of distinctive porphyroblastic quartz monzonite lies in the northeast corner of the map-area. It stretches from the northern end of Outlaw Bay up the eastern boundary of the area and down through the northern part of Eden Lake. In some locations on the west shore of Eden Lake the quartz monzonite contains inclusions of the granodiorite (unit 2a).

The quartz monzonite is very coarse grained, buff to pink weathering and contains numerous 1 to 3 cm rectangular blasts of pink feldspar. The blast size decreases to the southwest and the composition becomes more granitic. Generally the rock contains potassium-feldspar, some plagioclase, quartz, biotite and hornblende. Magnetite is usually abundant, giving the unit a high aeromagnetic signature.

The rock is well foliated and contains numerous small inclusions of psammitic gneiss, amphibolite and biotite gneiss (unit 1). It is cut by numerous intersecting veins of pegmatite, aplite and massive pink granite.

Massive fine grained Granite (unit 3b)

A fine to medium grained pink granite occupies the centre of the quartz monzonite body (unit 3a). The granite is non-foliated, homogeneous, equigranular and contains little or no magnetite. It is intruded by veins of younger pegmatite and aplite and contains few inclusions or schlieren.

Typically it contains potassium-feldspar, plagioclase, quartz, and biotite. The central part of the body lacks hornblende and magnetite but both of these are present in the granite ridges near the east shore of Eden Lake.

Massive red Syenogranite (unit 3c)

A dark pink to brick red granite, assumed to be the source of the late pegmatites and aplites throughout the area, is centered on Eden Lake. The composition varies from coarse grained pink granite to red syenogranite. It is non-foliated and contains no inclusions. In some locations on the west shore and on some of the islands on Eden Lake, large angular blocks of the grey granodiorite (unit 2a) are rafted and agmatized by the granite.

Massive medium grained Granite and Quartz Monzonite (unit 3d)

Several bodies of medium grained intrusive rocks occur along the southern half of the western boundary of the area. These vary in composition from granite to quartz monzonite. They are medium grained, grey to pink weathering, massive, and poorly foliated. No gneissic inclusions, schlieren or pegmatitic veins occur in these bodies. The granites contain minor chlorite in addition to plagioclase, potassium-feldspar, quartz and biotite, but magnetite is not as common as in the granites further east.

Economic Geology

Radiometric anomalies detected during the Federal/Provincial Uranium Reconnaissance Program (1977) outline an area centered on the porphyroblastic quartz monzonite (unit 3a) and the massive fine grained granite (unit 3b) in the northeastern part of the map sheet. Fluorite and andradite have been noted in the late pegmatites within these units. Fluorite, while not a common accessory mineral in granites, is known to occur in similar granitic regions elsewhere in Manitoba.

The only sulphide minerals noted in the area were sporadic occurrences of pyrite and pyrrhotite in rafts of amphibolite on Outlaw Bay, Stag Lake, and northwest of Eden Lake. These rafts locally contain small sulphide-bearing gossan zones. The granodiorite (unit 2a) and quartz monzonite (unit 3a) near these inclusions also contain traces of pyrite and pyrrhotite.

References

Geological Survey of Canada
1977: Uranium Reconnaissance Program Map 35364G.

McRitchie, W.D.
1976: Paskwachi-Waskaiowaka Regional Compilation; *Man. Min. Res. Div.*, Geol. Surv. Report of Field Activities 1976 GS-2.

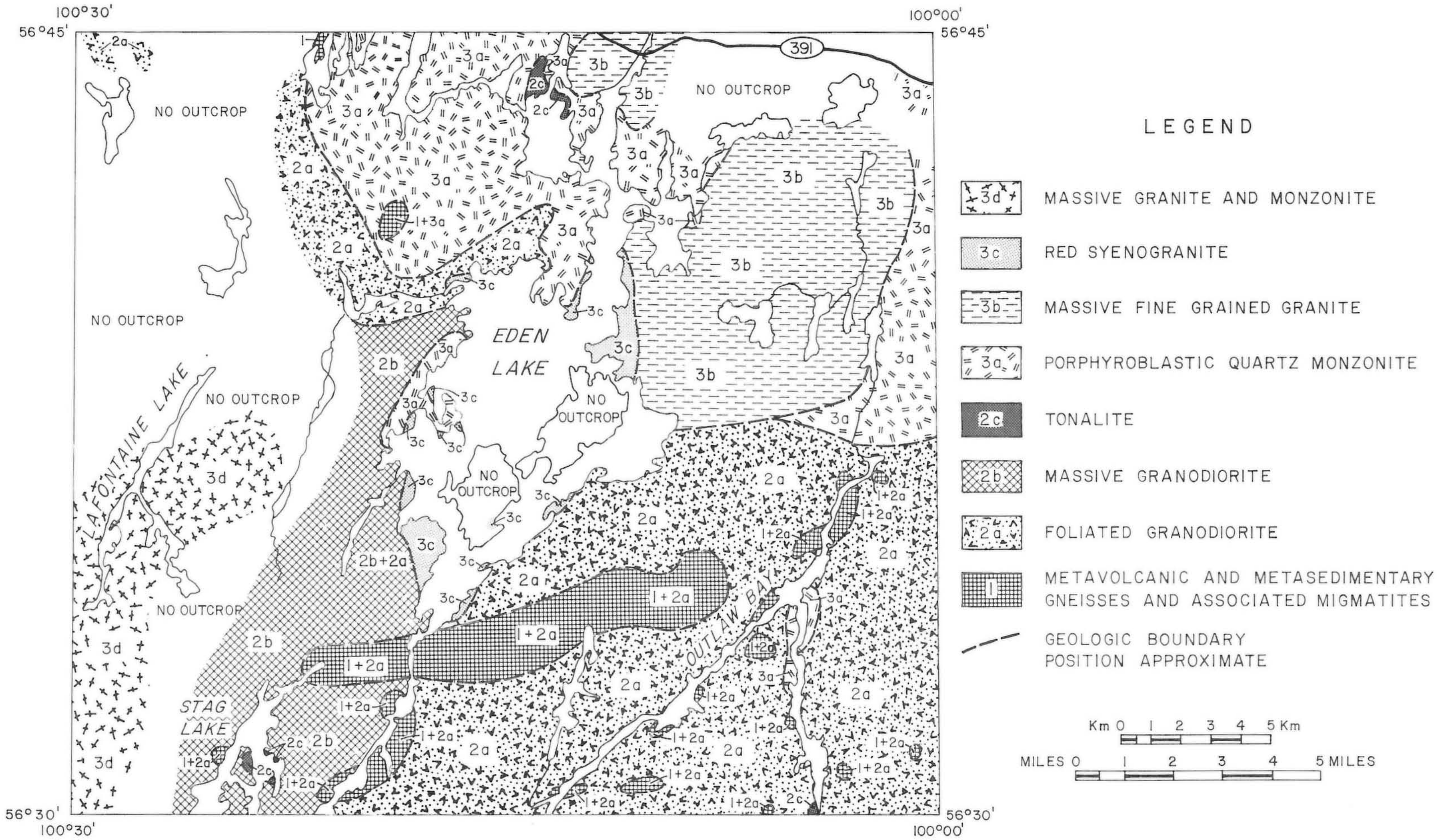


Figure GS-3-1: General Geology of the Eden Lake Area.

GS-4 ELBOW LAKE RECONNAISSANCE

(63K-15W)

by E.C. Syme

A brief examination of the Aphebian Amisk Group metavolcanic and metasedimentary rocks in the Elbow Lake-Webb Lake area was conducted to determine the feasibility of proceeding with a 1:50 000 or 1:20 000 mapping program in the area in 1979. The existing map of Elbow Lake (McGlynn, 1959) does not distinguish separate volcanic lithologies, and recent information coming out of the area has indicated that there is considerably more lithologic variation than reported. This work identified the existence of limited compositional variation in the metavolcanics and outlines a tentative stratigraphy. However, detailed mapping of the entire map sheet appears neither feasible nor warranted since the compositional variation is limited and inland outcrops, although abundant, are very poorly exposed due to heavy moss and lichen cover.

Structure

The rocks on Elbow Lake are deformed by tight, upright, northeast to northwest trending folds (Fig. GS-4-1). The largest of these folds, a north-northeast trending syncline cored by intermediate flows, is defined by numerous pillow-top determinations. Structure in the Webb Lake area is complex, but major folds could not be defined due to insufficient facing indicators. Minor folds at Webb Lake trend northeast and plunge steeply southwest.

A very strong schistosity, developed locally in the lavas on central Elbow Lake, may be due to north-northeast trending strike-faults. McGlynn (1959) noted mylonites along a north-northeast trending fault zone near the entrance of the Grass River into Elbow Lake.

Lithology

Elbow Lake

Ninety percent of the exposures on central Elbow Lake are mafic to intermediate subaqueous flows and derived sediments. Rhyolite flows and breccias occur in a narrow zone at the northeast end of the lake. A tentative stratigraphic sequence at Elbow Lake, based on limited mapping, comprises:

Approximate maximum thickness	Lithology
2250 + m	Intermediate flows
600 m	Rhyolite flows and breccias, associated sediments
3500 m ?	Mafic flows and related sediments

Mafic flows and related sediments occur prominently on eastern Elbow Lake, and extend to the large granodiorite batholith to the east. The mafic flows are medium to dark green weathering, vary from uniformly aphyric to weakly plagioclase-phyric, and include both massive and pillowed varieties. The pillows are bun-shaped to ovoid, 20 cm to 1 m in maximum dimension, with narrow selvages and few vesicles. Pillowed flows are interlayered with, or grade upward from, massive flows. Individual flows range from 30 cm to over 3 m thick.

Thin interflow units of mafic volcanogenic sediments occur throughout the entire lower mafic pile. The sediments are fine grained, weather shades of medium grey-green, and are characterized by a well-developed lamination or fine layering defined by contrasting proportions of amphibole and feldspar and by rare cherty layers. Greywacke interlayers are extremely rare.

Felsic rocks on Elbow Lake comprise massive pale buff rhyolite flow units 3 — 12 m thick and intercalated monolithologic rhyolite fragmental units 2 — 12 m thick. The rhyolites contain sporadic 1 mm diameter quartz phenocrysts. Two varieties of fragmental rhyolites are recognized: autoclastic breccias with close packed, lensoid fragments (up to 25 cm in maximum dimension) enclosed in a light green fine grained matrix, and bimodal breccias in which the rhyolite fragments are enclosed in a mafic, chlorite-rich matrix. The matrix of both breccia types contains 1 — 2% pyrite crystals.

Interflow units of mafic and felsic volcanogenic sediments occur in the rhyolite flow breccia unit at the northeast end of Elbow Lake, and also as along-strike, possible facies-equivalent units on central Elbow Lake. The sediments are fine grained, strongly foliated, and comprise 1 — 10 cm thick interlayers grey-green mafic and light buff felsic beds. Individual beds are internally laminated. Pyrite occurs in some units associated with felsic extrusives. The volcanogenic sediments locally contain heterolithic debris flows.

Brownish-buff to light green intermediate flows occur along the entire western side of Elbow Lake, in the centre of a large-scale synclinal structure. The top of the unit is not exposed. The intermediate lavas are fine grained, medium grey-green on fresh surface, and aphyric to weakly plagioclase-phyric. Pillowed flows dominate, with ovoid to bun-shaped pillows averaging about 40 cm in maximum dimension. The pillows have very narrow selvages, and are non-vesicular to weakly amygdaloidal. Some flows grade from a massive base through a pillowed central division to an isolated pillow breccia top. Very little interflow volcanogenic sediment occurs within the intermediate unit compared to the lower mafic volcanic unit to the east.

Along the north shore of Century Island a unit of mafic flows and breccias occurs within the upper intermediate volcanic unit. The massive mafic facies weathers a distinctive bright medium green, and is intercalated with amoeboid-pillow breccias. In exceptional exposures the complete association of massive basal division, pillowed central division, and isolated pillow breccia flow top is exposed: one such flow is at least 20 m thick.

Webb Lake

Mafic flows and related sediments outcrop along the southeast shore of Webb Lake and a suite of rhyolite flows, hypabyssal rhyolite intrusions and pink granite outcrop on the northwest shore and inland to the north.

The mafic unit is similar to the lower mafic unit on Elbow Lake, except it is more completely recrystallized, contains higher metamorphic grade (lower amphibolite facies) mineral assemblages, and is more strongly deformed. The flows include both massive and pillowed varieties, locally accompanied by minor mafic volcanogenic sediments and greywacke. Epidosite segregations, in parallel vein-like and elongate lensoid structures, are common in the mafic flows.

Felsic extrusives on Webb Lake are white to light buff on weathered surfaces, dark grey on the fresh surface, and very fine grained. Massive flows commonly grade to autoclastic breccias in which lensoid fragments up to 30 cm long are enclosed in a slightly darker weathering felsic matrix. The individual felsic flows are distinguished by contrasting proportions of quartz and plagioclase phenocrysts.

Two possible alteration zones, approximately 20 m wide and trending parallel to the foliation, were observed on Webb Lake. They contain pseudo-breccia zones where interconnecting rhyolite "fragments" are set in a "matrix" of (or are alternatively veined by) green amphibole + garnet ± muscovite. Massive rhyolite within the alteration zones contains varying amounts of amphibole-rosette blasts. Trace amounts of pyrite, pyrrhotite, and chalcopyrite occur within the alteration zones.

North of Webb Lake, units mapped as metasediments and granitized mafic volcanics by McGlynn (1959) were found to be mainly light buff to salmon weathering, fine grained felsic hypabyssal rocks. No primary structures were observed in the felsic rocks but this may have been, in part, a consequence of very poor exposure.

Basaltic and rhyolitic dykes and sills abound on Webb Lake. They have been folded with the enclosed volcanic rocks and are probably feeders to Amisk volcanism rather than related to felsic plutons. The post-Amisk intrusive porphyritic rhyolite and rhyolite (unit 9) of McGlynn (1959) was found to comprise two entirely different suites: the body north of Elbow Lake is probably a quartz-plagioclase-phyric hypabyssal intrusion or massive flow, whereas the body north of Webb Lake is a pink weathering, medium grained, equigranular to quartz-phyric granite. The granite is in part enveloped by a chaotic breccia in which angular blocks of rhyolite, greywacke, mafic and felsic dyke lithologies, and "quartz-eye granite" are admixed with very minor amounts of matrix (quartz and finely granulated material). The blocks measure up to 1 x 2 m and were foliated *prior* to incorporation in the breccia.

Metamorphism

The grade of metamorphism in Amisk Group metavolcanic rocks increases from south to north. On Elbow Lake the rocks are within the greenschist facies; upper greenschist to lower amphibolite facies is encountered as the granitoid plutons are approached. Six miles to the north, at Webb Lake, all the rocks are within upper greenschist or lower amphibolite facies. A precise field identification of grade is difficult in the absence of pelitic beds and attendant indicator minerals.

References

McGlynn, J.C.
1959: Elbow-Heming Lakes area, Manitoba; *Geol. Surv. Can.* Mem. 305, 72 pp.

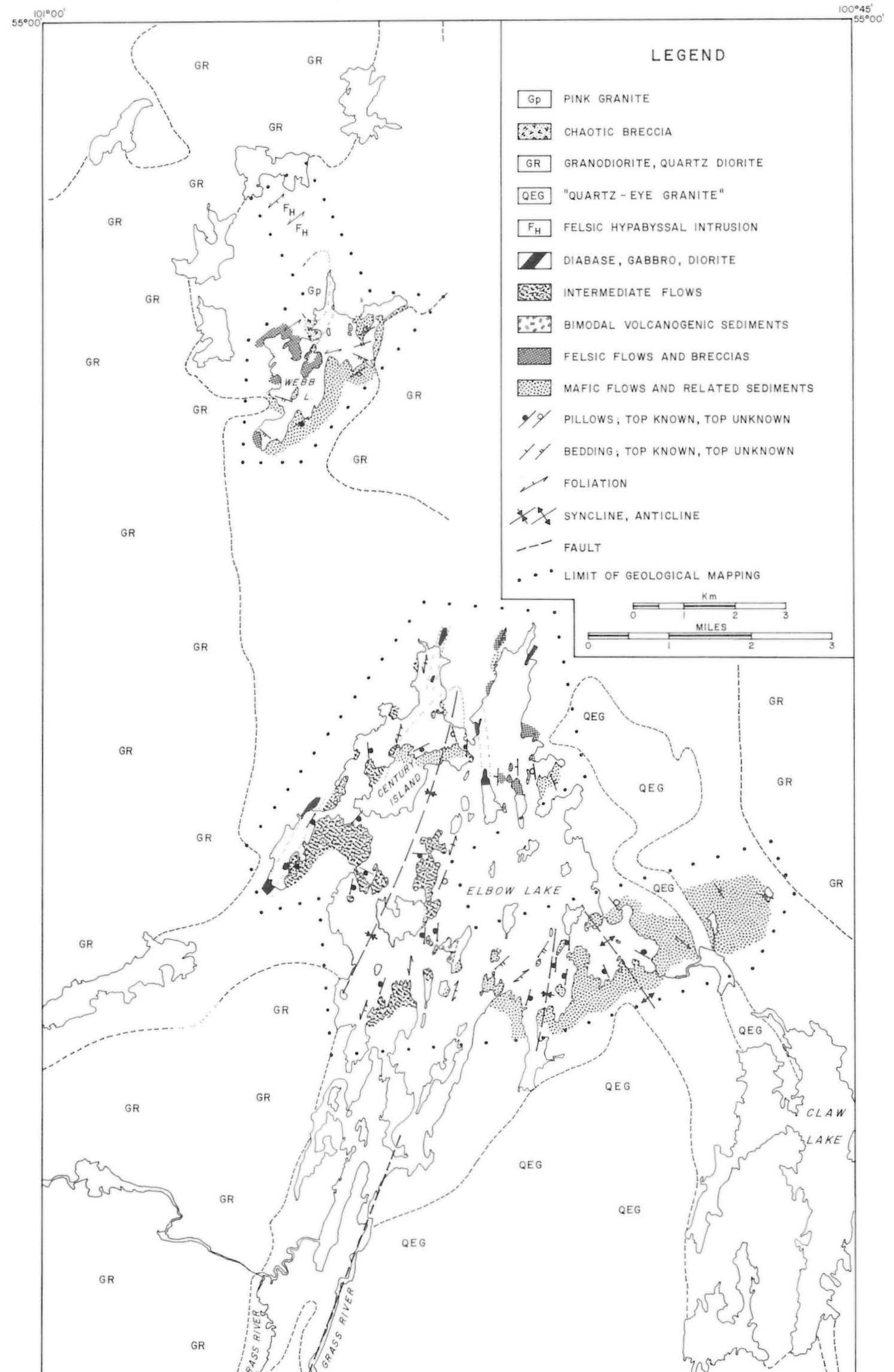


Figure GS-4-1: Geological sketch-map of the Elbow Lake — Webb Lake area. Outlines of the greenstone belt are after McGlynn (1959).

GS-5 NORTHERN INDIAN LAKE

(Regional correlation program)

(64H)

by W.D. McRitchie

Introduction

A three-week reconnaissance survey of the Northern Indian Lake region was conducted

a) to effect a correlation between the geology of this area and the rest of the Churchill Structural Province in Manitoba and

b) to assess and develop a logistical base in anticipation of future mapping programs.

This inspection extended down the Little Beaver and Churchill Rivers to their junction (54-E) and encompassed shoreline outcrops on southern Gauer Lake (64-A) as a contribution to the contemporaneous reconnaissance of the Baldock and Waskaiowaka region conducted by T. Corkery (Report GS-6, this volume).

Since much of the area is covered by extensive surficial deposits ground traverses were focused on the major lakes and rivers, the inland areas being traversed with the aid of a De Havilland Beaver aircraft and Alouette II turbine-powered helicopter

The extent of the outcrop belts is now better defined and a paragenetic and correlative re-interpretation of the geology has led to the identification of hitherto unreported metavolcanic units on Partridge Breast, Thorsteinson, Northern Indian and Gauer Lakes which may be laterally correlative with the Lynn Lake Greenstone belt (McRitchie & Peters, 1978). The greater proportion of the area is underlain by a wide variety of granitic bodies and injection complexes. The northern two-thirds of the map sheet (Fig. GS-5-1) are occupied by porphyritic granite of the Wathaman-Chipewyan batholith. South of the 110° regionally trending contact of the batholith, thin paragneiss and metavolcanic belts lie between four irregularly ellipsoidal granitic bodies which are interpreted as the surface expression of phacolithic rather than diapiric structures. The metamorphic grade is generally Lower Amphibolite facies but increases gradually to Uppermost Amphibolite facies towards and adjacent to the Chipewyan batholith, some phases of which contain widespread orthopyroxene which is thought to represent relicts of an extensive granulite association.

A descriptive listing of formations is presented in Table GS-5-1. The following comments are directed primarily to the supracrustal rocks, their stratigraphy, and correlative significance. It should be emphasized that the conclusions presented here are preliminary and tentative representing impressions gained through a limited number of observations made during the brief reconnaissance.

Supracrustal Rocks

The generalized threefold subdivision of supracrustal rocks into metagreywacke, meta-arkose and metavolcanic associations, as used elsewhere in the Churchill Structural Province, is equally applicable and relevant to the Northern Indian Lake area. The metagreywacke gneisses comprise a 5 km wide belt of diatexites and metatexites flanking the southern contact of the Chipewyan porphyritic granite, and a lower grade lobe centered on Partridge Breast Lake. The gneisses and schists on Partridge Breast Lake lie in conformable juxtaposition with the Sickle-type conglomerates and arkosic gneisses and are interlayered with and in part overlain by metavolcanic units. The generalized sequence from metagreywacke through amphibolites (metavolcanic) to arkosic gneisses is encountered on both Partridge Breast and Northern Indian Lakes and is presented in Table GS-5-2 for comparison.

Metagabbro and metavolcanic rocks are best exposed on Partridge Breast and Northern Indian Lakes and the north ends of Gauer and Thorsteinson Lakes (Figs. GS-5-2, GS-5-3). Sporadic and more dispersed higher grade metabasalt and metagabbro occur as major formational belts and xenolith trains in sparsely exposed injection complexes along the Churchill River between Kirkness Rapids and Billard Lake.

Metasedimentary Rocks

On Northern Indian Lake the thinly layered and delicately laminated metatexitic semipelitic greywacke gneisses, containing sporadic amphibolite layers and a prominent 2.5 m thick porphyritic metabasalt flow, are overlain by a thin gossan zone and 20 m of thinly interlayered chert, diopside-carbonate rock, diopside-bearing granofels, hornblendite and a local coarse grained grossular-rich horizon. Layering ranges from 2 mm to 10 cm in thickness. Above this possible silicate iron formation a 70 m thick unit of interlayered hornblende-plagioclase gneiss and metabasalt (30 - 80 cm thick layers) is topped by delicately laminated layers of pink magnetite-bearing "Sickle-type' arkosic gneiss. The 'silicate iron formation' persists to the south where it is represented by a 30 m wide unit of delicately laminated and interlayered (1 mm — 5 cm) amphibolite and diopside-bearing granofels with sporadic scapolite and carbonate segregations, thin gossan zones and garnet concentrations (Fig. GS-5-4).

This sequence closely resembles that observed on Partridge Breast Lake where the metagreywacke sequence grades upwards from a psammitic unit with thin grit interlayers, into a blastic muscovite and sillimanite-bearing pelite, semipelite and psammite transition (20 m) with sporadic 1 m thick amygdaloidal flows. The section is topped by a finely layered 1 m thick gossan and quartz zone which is in turn overlain by a 1/2 m thick unit of thinly interlayered medium grained garnetite, hornblendite and quartz, a 1 m thick diopside and garnet-bearing marble and the main locally pillowed metabasalt. Near the outlet of the lake the metabasalt is represented by thinly interlayered hornblendite and diopside-bearing granofels with local carbonate segregations. The top of the exposed sequence is marked by a thick conglomerate unit which ranges from several interlayered pebble conglomerate and psammite members upwards into a coarse arkosic, near clast supported, conglomerate into magnetite-bearing conglomerate and thence arkosic gneiss. Prominent malachite staining was observed in the central layers of the strongly foliated arkosic conglomerate (UTM 6 357 250 N 560 600E). The highly stretched and lineated clasts are both angular and rounded and range in compositon from granite through massive quartz, and felsite/rhyolite to greywacke and semipelite. Scour structures and cross-bedding were locally observed in the more prominent psammitic units interlayered with the pebble conglomerate.

Metavolcanic Rocks

On Partridge Breast and Northern Indian Lakes the metavolcanic rocks exhibit a wide range in composition from melabasalt through basalt and andesite to dacite. Typically, the layers are from 50 cm to 2 m in thickness and lie in compositionally and texturally similar or contrasting juxtaposition. Textures range from microporphyritic to coarsely porphyritic and glomeroporphyritic with widely varying phenocryst contents within and between layers (Figs. GS-5-5, GS-5-6). Phenocrysts are generally feldspar but hornblende and hornblende after pyroxene are also prominent (Fig. GS-5-7). Most units are amygdaloidal (5 mm to 5 cm) with a local tendency for the amygdales to concentrate consistently on one side of successive layers (Figs. GS-5-8, GS-5-9). Where such hypabyssal and/or extrusive top indications were observed the facing directions agreed with the stratigraphic interpretation based on the lithological sequence. Pillow structures were best observed on Partridge Breast Lake (Figs. GS-5-10, GS-5-11) where the units are transected by thin hornblendic alteration networks that obscure and locally mimic the more readily identifiable selvedges. The pillows locally exhibit a radial fracturing and peripheral bleaching with a tendency for calc-silicate and epidosite pod concentrations in the interstices. Chalcopyrite was observed as a dissemination in porphyritic andesite near the centre of the south shore of Partridge Breast Lake (UTM 6 355 350N 564 600E).

On Thorsteinson Lake the layers of basalt and leucobasalt are from 30 — 50 cm in thickness and exhibit amygdales and strongly lineated plagioclase phenocrysts up to 3 cm in length. Some thicker layers show a prominent parallel vertical jointing that may represent original cooling cracks.

The basaltic and leucobasaltic units on Northern Indian Lake form a narrow (40 m) band that exhibits variable composition, epidote pods up to 1 metre in length, sporadic 20 — 100 cm amygdaloidal layers with amygdales ranging from 5 mm — 5 cm in length, and metasedimentary 'wackes' which may represent ash layers. To the south and structurally beneath the basalts, finely layered and laminated hornblendic and felsic tuffs are interpreted as a facies variant of the silicate iron formation observed to the north. Thin pink weathering (20 cm) siliceous and feldspathic layers approach a rhyolitic composition and are distinct from the later intrusive flow-textured aplite dykes. The hornblendic and felsic schists and phyllites (tuffs) are prominent to the south where they form a 600 m wide belt that contains several clast-bearing layers. The clasts (1 — 25 cm) range in composition from hornblendite through gabbro to andesite and together with the andesitic to dacitic matrices comprise polymictic fragmental units. The southern contact of the tuffaceous zone is marked by the occurrence of a 20 m thick coarse grained layered (1 — 2 m thick) polymictic diorite breccia containing large rounded and angular inclusions of coarse grained metabasalt and meta-andesite, up to 1.5 m in length (Fig. GS-5-12). Local more leucocratic phases with inclusions (1 — 50 cm) of hornblendite define a vague layering. Many of the larger fragments are characterized by pitted weathering of biotite blasts developed in association with small amygdales. Though some fragments in this unit may approach a dacitic composition the unit as a whole is basaltic to andesitic. The structural base of the sequence is marked by well layered fine-grained phyllitic tuffs.

Tuffaceous schists and phyllites form a persistent band which can be traced intermittently from Partridge Breast Lake east to the north shore of Thorsteinson Lake. The compositional layering in this unit (5 — 50 cm thick layers) exhibits a sharp alternation between siliceous, hornblendic and feldspathic layers which is only in part a result of tectonic transposition. Pyrite and pyrrhotite are prominent in the more siliceous layers which may represent ash deposits. A nearby light felsic unit exhibits a strong foliation which in part transposes an anastomosing network of darker coloured 1 — 5 cm hornblendic veins which are either the vestigial remnants of early diabase dykes or alteration fractures related to magnesium metasomatism.

Elsewhere observations of volcanic rocks included fine- and coarse-grained metabasalts on the north shore of Gauer Lake and to the east on the Gauer River, phyllitic and porphyritic dacitic 'tuffs' on small islands near the centre of the lake and a porphyritic and possibly amygdaloidal metabasalt on the extreme southwest shore of the same lake.

Diabase intrusions occur prominently on the south shore of Partridge Breast Lake where 1 metre thick, parallel sided dykes cut obliquely across the other metavolcanic units.

A unique intrusion breccia was encountered on Partridge Breast Lake. The host intrusion is fine-grained, pale buff-cream coloured and granitic (felsitic-rhyodacitic) with a local prominent flow layering. 1 — 10 m thick segments of the intrusion appear intermittently along the south shore for over 3 km as dykes penetrating the earlier metagabbros and metabasalts. Along the southern flank of the intrusion at the east end of the lake (UTM 6 363 700N 567 700E) large raft trains of relatively undistorted gabbro and basalt are incorporated within the fine-grained, locally heterogeneous and micro-fractured margins of the leucocratic intrusion. North of a 40 m 'clean' zone a sharp transition is observed into the intrusion breccia which is characterized by a randomly oriented and unsorted, close packed, association of heterolithic angular and rounded fragments ranging in composition from ultramafic through hornblendite, gabbro, blastic diorite, basalt, porphyritic basalt, andesite and dacite to felsite (Fig. GS-5-13). Fragments are both massive and layered and range in size from 10 — 30 cm with larger bodies up to 1.5 m across. The brecciated zone is a minimum of 20 m thick and is open along strike for 50 m. The xenoliths display sharp contacts with local alteration haloes around the more mafic fragments. The entire association is cut by a 1 metre thick 108° trending diabase dyke.

Regional Considerations

The Chipewyan batholithic domain extends continuously as a relatively unbroken massif from the Saskatchewan border east to the Churchill River and the boundary of the overlying Paleozoic strata (Fig. GS-5-1). Strong northeast-trending aeromagnetic linears within the body are possibly related to mafic raft zones preserved along the axes of relatively late northeast-trending shallow plunging folds. 'Fingerprint' anomalies, with intensities over 7000 gammas, on the South Knife River and east-southeast of Buckland Lake, remain unexplained but are generally associated with arcuate aeromagnetic highs which are at least in part orthopyroxene-bearing phases of the porphyritic granites (for comparison see the Attridge Lake gabbro and pyroxene monzonite west of Big Sand Lake 64-G and 64-F, McRitchie, 1977).

The generalized stratigraphy elsewhere in the Churchill Structural Province appears to continue into the Northern Indian Lake region with lowermost greywackes grading up through greywackes with sporadic amphibolite layers (metavolcanic) into the transitional amphibolite group (also partly metavolcanic in the Northern Indian Lake region) and thence through a local conglomerate into the overlying arkosic gneisses referred to as 'Sickle type' on Southern Indian Lake.

The apparent absence of the greywacke group in the region to the south of the Churchill River would appear to indicate a progressive eastward narrowing and wedging out of the Reindeer Lake-Southern Indian Lakes metasedimentary domain. The metamorphic gradient increases towards the Chipewyan batholith, the contact of which is oblique to the regional trend of the contact between the main metasedimentary and metavolcanic domains. Transitionally, lower metamorphic grades are apparent on Partridge Breast Lake where the faserkiesel-bearing pelites and semipelites exhibit no or minor mobilizate in contrast to the metatexites to the west and north of the lake. The low metamorphic grade is even more apparent throughout the southwestern one-third of the map sheet where lower amphibolite facies metavolcanic belts persist between the weakly porphyritic granite bodies on Thorsteinson and Gauer Lakes. Somewhat higher grade hornblendic metasediments on Gauer Lake appear to have developed as contact diatexites or partially assimilated roof pendants in direct response to the emplacement of the early hornblende granodiorities in this region.

The existence of metavolcanic strata in the Northern Indian Lake region appears to correlate westwards through the minor and poorly exposed metavolcanics on Long Point, "Whyme Bay" and Pukatawagan Bay (Frohlinger, 1972), with the northernmost belts of metavolcanic strata in the Barrington and Lynn Lake regions. Extensive granitoid batholithic domains dominate the sparsely exposed region south of Gauer Lake from the Gauer River through Baldock to Harding Lake where once again a dominantly metagreywacke association is encountered with transitional amphibolites and calc-silicates and an overlying group of arkosic gneisses.

Economic considerations

The occurrence of hitherto unreported metavolcanic rocks in this little explored region has potential significance viewed in the context of the proven association of base metal mineralization with metavolcanic rocks elsewhere in the Churchill Structural Province. Minor copper mineralization was encountered during this brief reconnaissance as malachite staining in the central foliated section of the conglomerate on Partridge Breast Lake (Cu 0.4%), and as a chalcopyrite dissemination in a thin andesite flow on the south shore of the same lake. Reports from the cancelled assessment files of the Mineral Resources Division relate to an airborne geophysical survey of the region in 1961-1962, an airborne geophysical survey of the Currie Lake area in 1972 and ground geophysical surveys with limited diamond drilling follow-up on two relatively small claim groups north and south of Partridge Breast Lake. Most of the site-specific work was conducted in areas outside of those in which greenstones might be expected to occur.

On Partridge Breast Lake and Northern Indian Lake the intimate interlayering of thin predominantly mafic volcanic flows with the metagreywacke sedimentary group might well indicate a distal character for the volcanism in this section with the possibility of more proximal and felsic volcanics to the south in the poorly and unexposed regions around Gauer and Thorsteinson Lakes. More detailed mapping is planned for this area in the immediate future.

References

Cranstone, J.R.
1972: Geology of the Southern Indian Lake Area, northeastern portion; *Man. Mines Br.*, Publ. 71-2J.

Frohlinger, T.G.
1972: Geology of the Southern Indian Lake Area, central portion; *Man. Mines Br.*, Publ. 71-2I.

Kretz, R.
1958: Geology of Northern Indian Lake, Manitoba; *Geol. Surv. Can.*, Preliminary Map 2-1959.

McRitchie, W.D.
1977: Reindeer Lake-Southern Indian Lake (Regional correlation program) *in* Report of Field Activities, 1977, *Man. Min. Res. Div.*, Geol. Paper GS-2.

McRitchie, W.D. & Peters, J.
1978: Northern Indian Lake (64-H); *Man. Min. Res. Div.*, Preliminary Compilation Map 1978 M-1.

TABLE GS-5-1

TABLE OF FORMATIONS, NORTHERN INDIAN LAKE REGION

Intrusive Rocks

18 Aplite-pegmatite; pink inequigranular, parallel sided dykes of microcline, albite, quartz, and muscovite with local and sporadic graphic intergrowths
   a) tourmaline-bearing on Partridge Breast Lake

17 Quartz monzonite; pale cream alaskitic homogeneous equigranular fine to medium grained weakly foliated dykes and intrusions

16 Granite-quartz monzonite; coarse grained, pink dominantly porphyritic and inequigranular hornblende and biotite-bearing granite with local lineated fabric; extensive near horizontal dykes between Fidler and Billard Lakes
   a) hypersthene-bearing phase with weak brown colouration

15 Hornblende syenite and granite; vivid pink inequigranular intrusive rock with prominent stubby green black hornblende and minor retrogressive biotite

14 Quartz monzonite-granodiorite; pink and grey inequigranular homogeneous medium to coarse grained weakly foliated unit forming relatively large phacolithic intrusions with associated marginal pink pegmatites

13 Gneissic granodiorite-leucodiorite; medium to coarse grained homogeneous equigranular weakly foliated medium grey hornblende and biotite-bearing gneissic granodiorite with characteristic strongly developed rectangular jointing and ovoid or lenticular xenoliths of dioritic gneiss

12 Gabbro-diorite; massive, coarse grained equigranular locally foliated hornblende-bearing gabbro with rare relict pyroxene crystals and ophitic textures

11 Hornblende monzonite and monzodiorite; coarse grained, massive heterogeneous intrusive unit with cross-cutting network of feldspathic veinlets

10 Ultramafic; very coarse grained blastic hornblende pyroxenite and local gabbronorite with minor scattered sulphides

Metasedimentary and Metavolcanic Rocks

9 Felsite-leucogranite; fine grained microfractured pale buff and cream coloured locally flow textured intrusive rock with local agmatic phases
   a) intrusion breccia with abundant close packed heterolithic randomly oriented fragments of ultramafic, basalt, andesite, and dacite and felsite

8 Arkosic gneiss; finely layered and laminated pink feldspathic gneiss with abundant magnetite; layers range from 3 cms to 2 metres with sporadic interlayered amphibolite
   a) thinly interlayered arkosic and hornblendic gneisses verging on diatexite with abundant sills of associated intrusive hornblende-bearing granodiorite

7 Metaconglomerate and metaconglomeratic gneiss; thickly bedded foliated and lineated gniessic conglomerate with 10 — 60% clasts in generally arkosic and micaceous matrix Magnetite prominent near top of unit. Clasts up to 50 cms range in composition from granite through, quartz, to greywacke, semipelite, felsic volcanic and andesite
   a) interlayered matrix supported pebble conglomerate and psammite with local cross bedding and scour structures

6 Amphibolite-hornblende plagioclase gneiss; well layered medium to coarse grained gneisses with sporadic massive more mafic metabasaltic layers Local associated hornblende-bearing mobilizate on Northern Indian Lake

5 "Silicate Iron Formation"; thinly interlayered hornblendite and diopside-bearing granofels with local chert, layers, grossular-bearing layers, diopside carbonate layers and carbonate lenses; sulphides sporadic throughout
   a) interlayered garnetite and quartz with overlying coarse grained diopside marble

4 Mafic and intermediate tuffs; schistose and locally phyllitic interlayered hornblendic and felsic tuffs with local delicate laminations, blastic hornblende-bearing layers, siliceous wackes and minor dacitic crystal tuff. Sporadic fragmental layers with andesitic clasts and matrix
   a) felsic gneiss with discordant mafic fracture set

3 Metabasaltic rocks; fine to medium grained massive generally homogeneous melabasalt, basalt, leucobasalt, andesite and minor dacite, gabbro, diorite and diabase dykes. Units generally form thin layers 50 cms — 2 metres with microporphyritic, porphyritic, glomeroporphyritic, amygdaloidal and pillowed textural variations. Epidote and epidosite pods common as are thin interlayered units of mafic tuff and or wacke

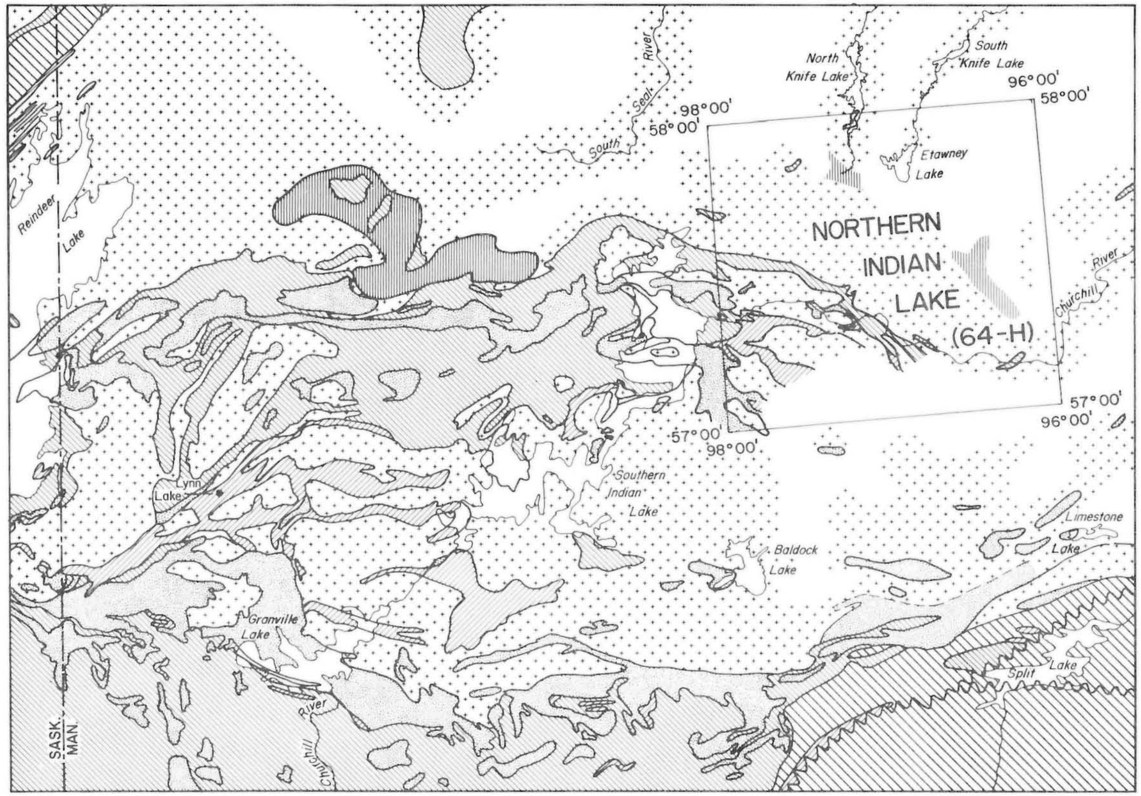
2 Diorite breccia; large angular and rounded heterolithic fragments of basalt, andesite and gabbro in generally homogeneous coarse grained dioritic hornblende plagioclase and quartz-bearing matrix. Weak layering defined by slight variations in matrix and clast compositions, clast size and abundance

1 Metagreywacke Group; strongly foliated grey and brown weathering interlayered psammite semipelite and blastic pelite containing small/or large faserkiesel (quartz-sillimanite knots) and microcline poikiloblasts. Local grit lenses interlayered with psammite on Partridge Breast Lake
   a) metatexite with up to 60% white quartzofeldspathic mobilizate as conformable *lit* or cross-cutting stringers and veinlets
   b) diatexite and highly complex and commonly schlieric association of paragneiss and subordinate amphibolite rafts and raft zones, quartzofeldspathic mobilizate, pegmatite aplite and cross-cutting dykes of porphyritic granite

TABLE GS-5-2

Comparison of Lithologic sequences between Northern Indian Lake and Partridge Breast Lake

Thickness	Northern Indian Lake	Thickness	Partridge Breast Lake
	Thinly layered and laminated magnetite-bearing arkosic gneiss		Magnetite-bearing conglomerate with large clasts and 40-70% matrix. Coarse grained muscovite and sillimanite-bearing heterolithic conglomerate with large clasts. Pebble conglomerate with interlayered psammite
70 m	Interlayered hornblende plagioclase gneiss with subordinate mafic and amygdaloidal metabasaltic layers; minor arkosic gneiss interlayers near top	5-20 m	Pillow basalt, pillow breccia, and massive thin basalt flows
20 m	Interlayered chert, hornblendite, diopside marble and diopside-bearing granofels with garnet-rich layers near base. Carbonate segregations and pods throughout. Gossan zone near base	1 m 1 m	Diopside-marble and minor garnetiferous semipelite Interlayered medium grained garnetite, hornblendite and minor thin quartz layers with basal gossan zone and thick quartz pods
	Semipelitic thinly layered and laminated metagreywacke gneisses with sporadic minor amphibolite layers and 260 cm thick porphyritic metabasalt flow 4-5 metres below contact with overlying amphibolite group		Interlayered semipelite, blastic muscovite and sillimanite-bearing pelite, and psammite with several subordinate thin basalt and leucobasalt flows exhibiting local phenocrysts and flow-top amygdale development
			Interlayered thick units of psammite with subordinate grit layers and minor semipelite



LEGEND

Granitic rocks	Major faults
Orthopyroxene-bearing phases of the Chipewyan Batholith	"Greywacke" gneisses and derived migmatites — includes mixed greywacke and diorite of uncertain affinity in the Attridge, Big Sand, North Knife Lakes regions and on the Little Beaver River
"Arkosic" gneisses and derived migmatites — includes hb-bo gneisses of uncertain affinity in the Waskaiowaka region	Metavolcanic rocks and mafic hb-rich gneisses of uncertain origin — probable extent of metavolcanic rocks indicated in the exposed part of the Northern Indian Lake sheet (64H) where the observed occurrences have been linked by aeromagnetic correlation and extrapolation
Archean and inferred Archean gneisses, granites, etc.	

Figure GS-5-1: The Northern Indian Lake Region in relation to other major tectonic and lithostructural belts in north-central Manitoba. Includes data from the 1978 reconnaissance of the Waskaiowaka region (Corkery this volume GS-6).

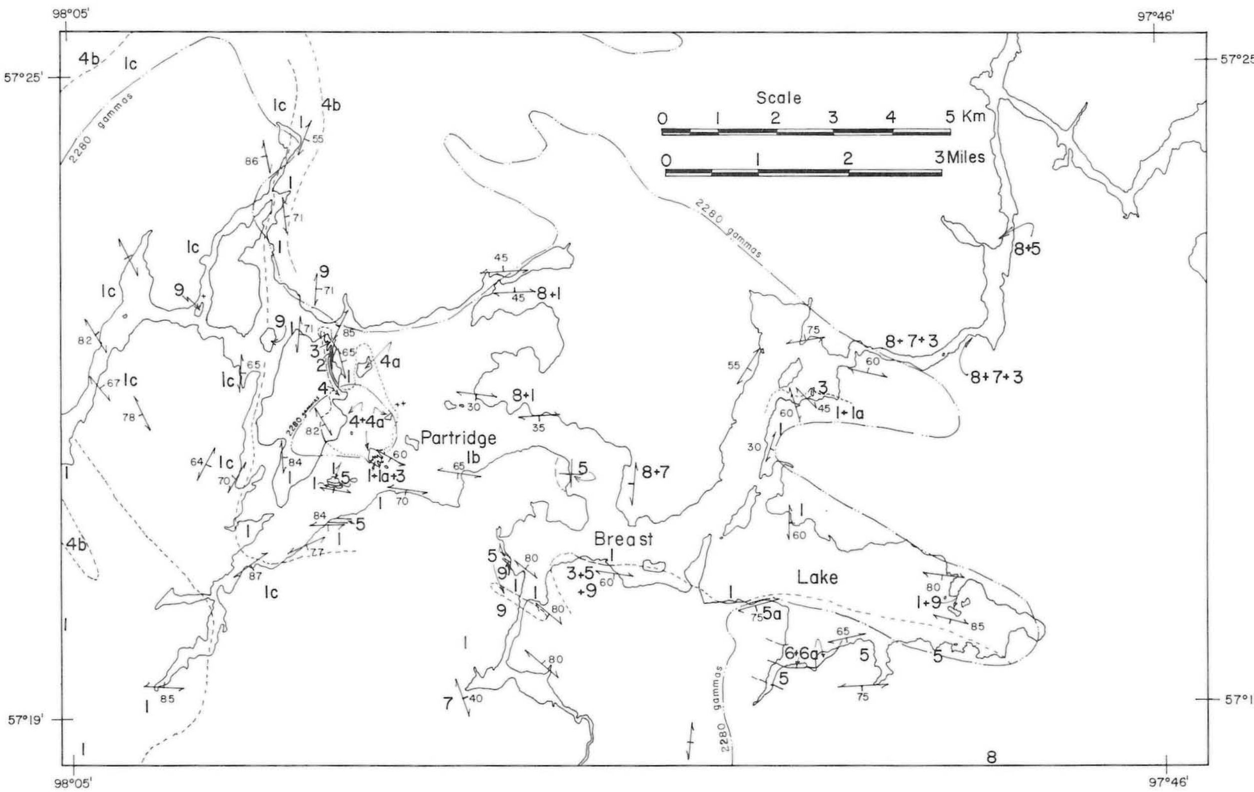
LEGEND

15	Aplite-pegmatite
14	Quartz monzonite - fine to medium grained
13	Quartz monzonite-granite porphyritic
12	Quartz monzonite - inequigranular locally porphyritic
11	Gneissic granodiorite-leucodiorite
10	Gabbro-diorite
9	Hornblende monzonite-monzodiorite
8	Ultramafic
7	Arkosic gneiss a) arkosic diatexite
6	Amphibolite-hornblende plagioclase gneiss
5	Interlayered hornblende gneiss, diopside granofels and chert layers with minor diopside-bearing carbonate and garnet-quartz layers (silicate iron formation?)
4	Mafic and intermediate tuffs and breccias
3	Metabasalt; amygdaloidal and massive flows a) with numerous thin siliceous and felsic interlayers
2	Diorite breccia
1	Metagreywacke; minor amphibolite a) metatexite b) diatexite diorite and gabbro layers

SYMBOLS

- Geological boundary (approximate)
- Geological boundary (gradational)
- Layering (inclined, vertical)
- Foliation (inclined, vertical)
- Foliation and layering parallel (inclined, vertical)

Figure GS-5-2: Outline Geology of Northern Indian Lake.



LEGEND

9	Aplite and pegmatite; locally tourmaline-bearing	
8	Granite-quartz monzonite	
7	Gneissic granite	
6	Hypabyssal granite/rhyodacite/felsite	a) intrusion breccia
5	Gabbro-diorite	a) with cross cutting diabase dykes
4	Metaconglomerate	a) pebble conglomerate and interlayered psammite; b) arkosic gneiss
3	Metabasalt - thin flows locally porphyritic, glomeroporphyritic, amygdaloidal pillowed and/or massive. Generally interlayered with andesitic and more rarely dacitic flows with similar textural variations	
2	Garnet amphibole rock; with associated quartz layers and overlying metre-thick diopside-bearing marble	
1	Metagreywacke; interlayered psammite and blastic pelite with abundant quartz sillimanite and/or microcline blasts: minor interlayered thin amphibolite and/or metabasalt layers;	a) interlayered grit and psammite; b) greywacke, argillite and siltstone; c) metatexite

SYMBOLS

Geological boundary (defined, approximate)

60 Foliation and/or layering (inclined, vertical, horizontal)

2280 gamma aeromagnetic contour

Garnet-amphibole rock

Figure GS-5-3: Outline Geology of Partridge Breast Lake

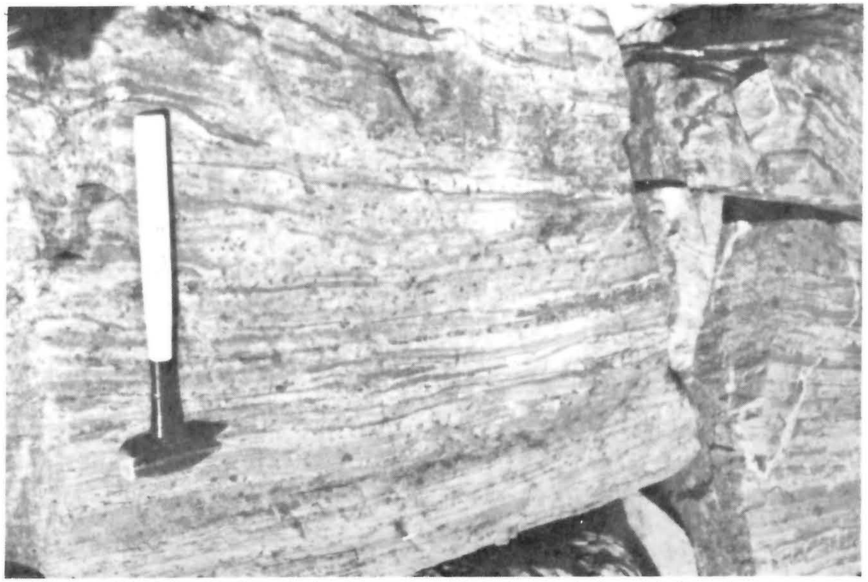


Figure GS-5-4: Delicately laminated and interlayered diopside-bearing granofels, hornblendite and carbonate-bearing layers- "silicate iron formation"? Northern Indian Lake

Figure GS-5-5: Hornblende (after pyroxene) and feldspar phenocrysts in weakly amygdaloidal andesite — Partridge Breast Lake

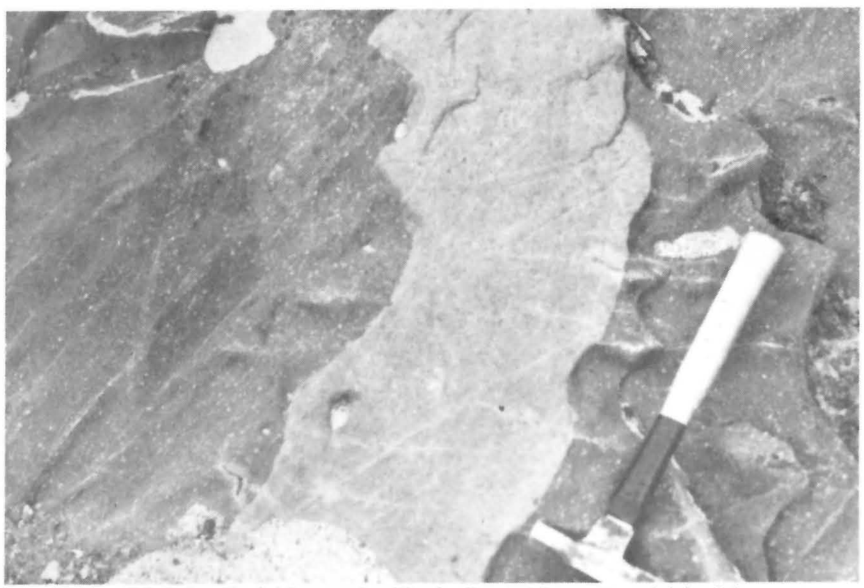


Figure GS-5-6: Variably porphyritic dacite, cut by narrow felsic dyke — Partridge Breast Lake

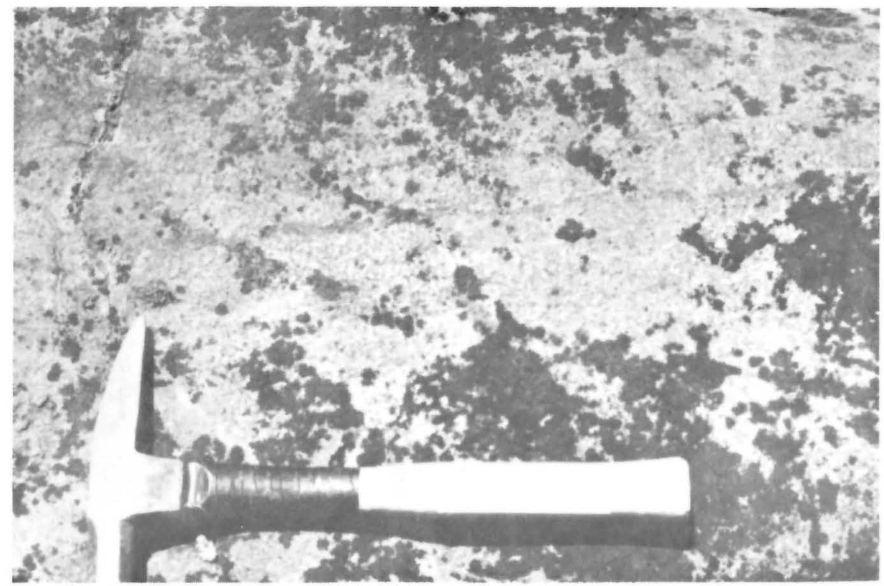


Figure GS-5-7: Coarse grained feldsparphyric basalt on Thorsteinson Lake

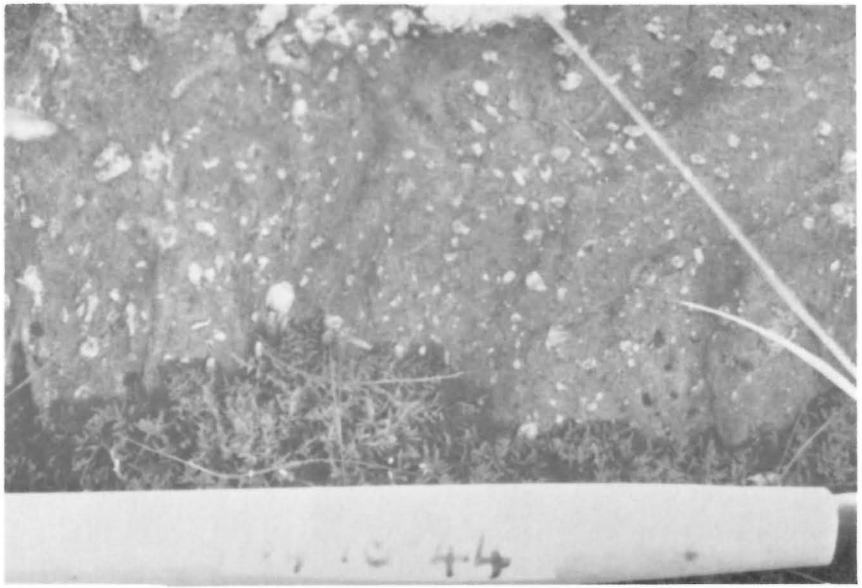


Figure GS-5-8: Coarsely amygdaloidal basalt — Northern Indian Lake

Figure GS-5-9: Vesicular/amygdaloidal flow-top in narrow basalt layer within paragneissic sequence on Partridge Breast Lake

Figure GS-5-10: Contact between massive basalt layer (cross-latticed by narrow hornblendic alteration cracks), and pillow basalt with characteristic radial contraction fractures — Partridge Breast Lake

Figure GS-5-11: Close-up of pillows in basaltic unit on Partridge Breast Lake — note peripheral bleaching, radial fractures and selvage development

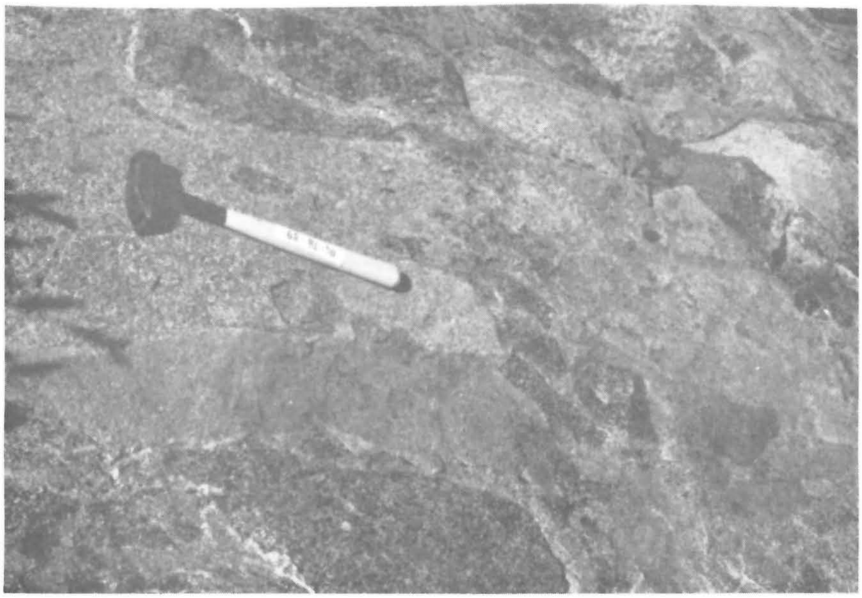


Figure GS-5-12: Diorite breccia — Northern Indian Lake — angular heterolithic fragments of variable dimension, grainsize and texture set in hornblende-bearing matrix of intermediate composition

Figure GS-5-13: Intrusion breccia containing angular and rounded fragments of randomly oriented, unsorted ultramafic, basalt, andesite, dacite and felsite in fine to coarse grained foliated felsite/granite matrix

GS-6 BALDOCK-WASKAIOWAKA LAKES REGION

(64A-9 to 16 and Parts of 64B-8, 9 and 54D-12, 13)

by M.T. Corkery

Preliminary investigations were carried out during a three-week field program in the Baldock Lake-Waskaiowaka Lake region in conjunction with the Northern Indian Lake regional reconnaissance program (W.D. McRitchie GS-5, this volume) to facilitate planning of a major regional mapping program to be initiated in 1979. This information, in addition to Geological Survey of Canada Map 10-1956 by Mulligan, and Manitoba MREM mapping by Haugh (1965), McRitchie (1976, 1977, 1978), Weber (1977) and Corkery (1976, 1977a, 1977b) provides a geologic basis for the compilation of the Split Lake map sheet (Preliminary Map 1978 M-2) and a framework for the compilation of the Geological Map of Manitoba. Field checks within the area of low bedrock exposure north of Baldock, Pelletier and Waskaiowaka Lakes were made using an Alouette II helicopter. More detailed investigations of shoreline exposures were made by boat traverses on Baldock Lake and the Little Churchill River from Hale Lake to Recluse Lake (64A-9) (54D-12, 13).

A simplified geological map of the sedimentary-derived gneisses and migmatites on southwestern Baldock Lake is shown in Figure GS-6-1. A preliminary compilation map at 1:250 000 scale of the Split Lake sheet 64A is also available.

The "Baldock Batholithic Complex"

The major portion of the map-area is occupied by the "Baldock Batholithic Complex" which has been traced from Southern Indian Lake eastward beyond Waskaiowaka Lake. The complex is widely exposed on Baldock Lake and areas to the north and west. East of Baldock Lake the frequency of outcrop is very low with scattered exposures limited to small lakes and rivers with the exception of good exposures on the shoreline of Waskaiowaka Lake.

The batholith varies in composition from hornblende-biotite-quartz monzonite, and hornblende-quartz monzonite to biotite granite.

The quartz monzonite weathers pink to pinkish grey and varies from medium to coarse grained. It is characteristically porphyritic with pink weathering phenocrysts of potassium feldspar, varying in size from 5 mm to 5 cm, within a medium grained groundmass of plagioclase, quartz, hornblende and/or biotite and magnetite. The larger phenocrysts are observed predominantly in marginal phases where they are euhedral and oriented parallel to a foliation and are enhanced by blastic growth.

Inclusions within the batholith of granodiorite, diorite, arkosic-derived gneisses and amphibolite gneisses are common.

Southwestern Baldock Lake

Exposures in the southwestern arm of Baldock Lake (Fig. GS-6-1) comprise an enclave of dominantly arkose-derived gneisses and migmatites. These are in contact on the east with highly folded amphibolites and minor garnetiferous greywackes. The gneisses are truncated by the major quartz monzonite intrusion on the north and east.

References:

Corkery, M.T.

1978: Preliminary Compilation of the Split Lake Area (64A); *Man. Min. Res. Div.*, Prelim. Map 1978 M-2.

1977a: Northeast Split Lake Area; *Man. Min. Res. Div.*, Rept. of Field Activities 1977 GS-12.

1977b: Waskaiowaka Lake Area; *Man. Min. Res. Div.*, Rept. of Field Activities 1977 GS-13.

1976: Assean Lake-Crying Lake Area; *Man. Min. Res. Div.*, Geol. Surv., Rept. of Field Activities 1976 GS-9.

Haugh, I.

1969: Geology of the Split Lake Area; *Man. Mines Br.*, Publ. 65-2.

McRitchie, W.D.

1978: Northern Indian Lake Area; *Man. Min. Res. Div.*, Rept. of Field Activities 1978 GS-5.

1977: Harding-Rock Lakes Region; *Man. Min. Res. Div.*, Rept. of Field Activities 1977 GS-9.

1976: Paskwachi-Waskaiowaka Regional Compilation; *Man. Min. Res. Div.*, Geol. Surv., Rept. of Field Activities 1976 GS-2.

Mulligan, R.

1956: Split Lake, Manitoba; *Geol. Surv. Can.*, Prelim. Series, Map 10-1956.

Weber, W.

1977: Burntwood River Region; *Man. Min. Res. Div.*, Rept. of Field Activities 1977 GS-10.

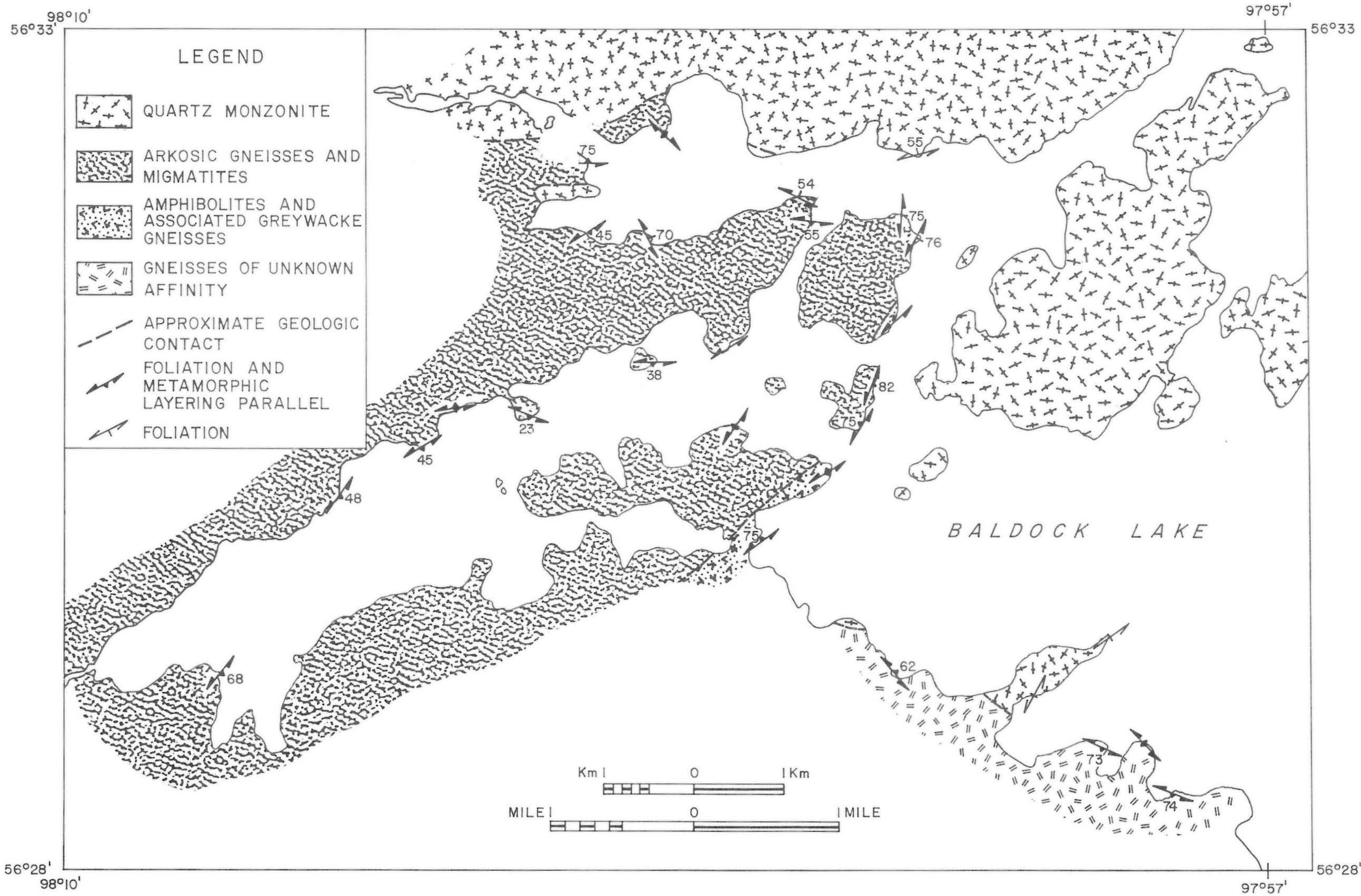


Figure GS-6-1: Southwestern Baldock Lake (64A-5, 12 and 64B-8, 9)

GS-7 GEOLOGY OF THE McNEILL LAKE-PISTOL LAKE (WEST HALF) AREA

(630-3 and 630-2W)

by P.G. Lenton

Introduction

Geological mapping in the McNeill-Pistol Lakes area was initiated at a scale of 1:50 000 to complete the mapping of the Kisseynew sedimentary gneiss belt and to examine the relationship of the Kisseynew gneisses with the metasedimentary gneisses of the Thompson belt.

The physiography of the region presents extreme problems of logistics for field operations. Rock exposure is distributed in two belts at the eastern and western ends of the map-area. The central region is an extensive area of swamp on Pleistocene clay deposits with little or no rock exposure. The only practical means of access to the area is by helicopter.

Completion of the mapping program in this area is planned for the summer of 1979.

General Geology

The Aphebian age rocks of the McNeill-Pistol area lie in the Churchill geologic province. The rocks can be divided into three general groups (Figure GS-7-1).

Metamorphosed mafic volcanic rocks
Metasedimentary gneisses and migmatites
Granitoid gneisses and intrusive rocks

The large areas of overburden are mainly Lake Agassiz lacustrine clay deposits.

Rock Unit Descriptions

Metavolcanic rocks

A narrow belt of mafic volcanic rocks terminates in the southwest corner of the McNeill Lake area. These rocks, previously mapped to the south by Bailes (1976), are primarily metamorphosed flow basalts and pillow basalts with minor amounts of mafic volcanic breccia. Pillow structures are easily recognized as the volcanic rocks are preserved better than the sedimentary rocks in the area.

The volcanic rocks commonly contain thin interbeds of mafic and intermediate fine grained sediments. These hornblende-biotite-plagioclase-quartz $\pm$ garnet sediments are well laminated and probably represent volcanic tuffs. The sediments appear to become more siliceous northward along strike.

Although the belt of volcanic rocks terminates in the southwest corner of the area there is one small area of mafic metavolcanic rocks to the northeast at the edge of the clay belt (Figure GS-7-1). Its relation to the country rock cannot be determined, but it is probably a raft caught up in the predominantly intrusive country rocks.

Metasedimentary rocks

Adjacent to the metavolcanic rocks is a layer of white protoquartzite. The rock consists of quartz with minor plagioclase and traces of biotite, garnet and magnetite. The protoquartzite is massively bedded (1 to 3 m) and contains sporadic 1 m layers of biotite-hornblende-plagioclase-quartz gneiss. Coarser grained and more siliceous than the sediments associated with the volcanic rocks, the mesocratic gneiss is probably a greywacke interbedded with the quartzite. The protoquartzite, though generally fine grained and massive, contains local sporadic pebbly beds.

The majority of the metasedimentary gneisses in the area are migmatites of greywacke composition of the Kisseynew metasedimentary gneiss belt. This metamorphosed greywacke and mudstone sequence has been correlated to the west with the Nokomis Group (Bailes, 1975) and to the north with the Burntwood River "Supergroup" (Baldwin, *et. al.*, in preparation).

The degree of partial anatexis is highly variable in the migmatites, ranging from 10% to extensive areas of nebulitic diatexites with more than 70% anatectic fraction. The graphitic greywackes are highly garnetiferous and commonly contain cordierite and sillimanite.

Intrusive rocks and granitoid gneisses

Much of the area mapped is dominated by a variety of granitoid gneisses and granitic intrusives. All the bodies are strongly foliated and deformed except unit 11 which exhibits only a weak schistosity. Many of the bodies show evidence of metasomatic blastic growth.

Units 4 and 5 are the only mafic intrusive rocks. Unit 4 is variable in composition. North of McNeill Lake it is a homogeneous coarse grained metagabbro with plagioclase crystals up to 2 cm long in a hornblende and biotite matrix. East of Ferguson Creek a similar body is finer grained and contains pods of hypersthene-bearing ultramafic. In the eastern locality a penetrative shear fabric found throughout the surrounding granite (unit 8) is not evident in the gabbro.

West of McNeill Lake a large body of mesocratic hornblende tonalite (unit 5) maintains a high degree of homogeneity with no visible variation either across or along the body. Inclusions of siliceous gneiss are common in the southwest portion of the body but absent in the north.

Units 6, 7 and 8 are granitoid gneisses characterized by extensive areas in which a weakly developed layering is evident. The layering is nebulous, and is mainly defined by variations in the content of mafic minerals. South of McNeill Lake unit 6 shows extensive areas where layers of hornblende-biotite granite alternate with layers of biotite granite. These areas of layered gneiss may represent large rafts of granitized sediments.

Units 9 to 13 are granitic rocks with a strictly intrusive character. The contacts with the surrounding bodies are sharper than the gradational contacts characteristic of the granitoid gneisses. Each body is homogeneous with little variation in texture or composition.

Structure and Metamorphism

All the rocks examined have developed penetrative fabrics to varying degrees. The foliations are generally consistent in a northeast direction. Minor structures indicate a regional plunge at shallow angles to the northeast except in the metavolcanic rocks in the southwest corner where the plunge of minor structures is at a steep angle to the southwest.

Minor cataclasis is a common feature throughout the area but is particularly common in the east along Ferguson Creek. Shearing is parallel to the regional foliation.

Mineral assemblages representative of upper amphibolite grade metamorphism are developed throughout the area. Garnet is ubiquitous, and partial anatexis prominently developed in most of the metasedimentary gneisses. It is likely that metasomatism was an important factor in the development of the granitoid gneisses. Cranstone and Toogood (1969) report a gradational metasomatic change from arkosic gneisses into granitoid gneisses in the Pakwa Lake-Pistol Lake (east) area.

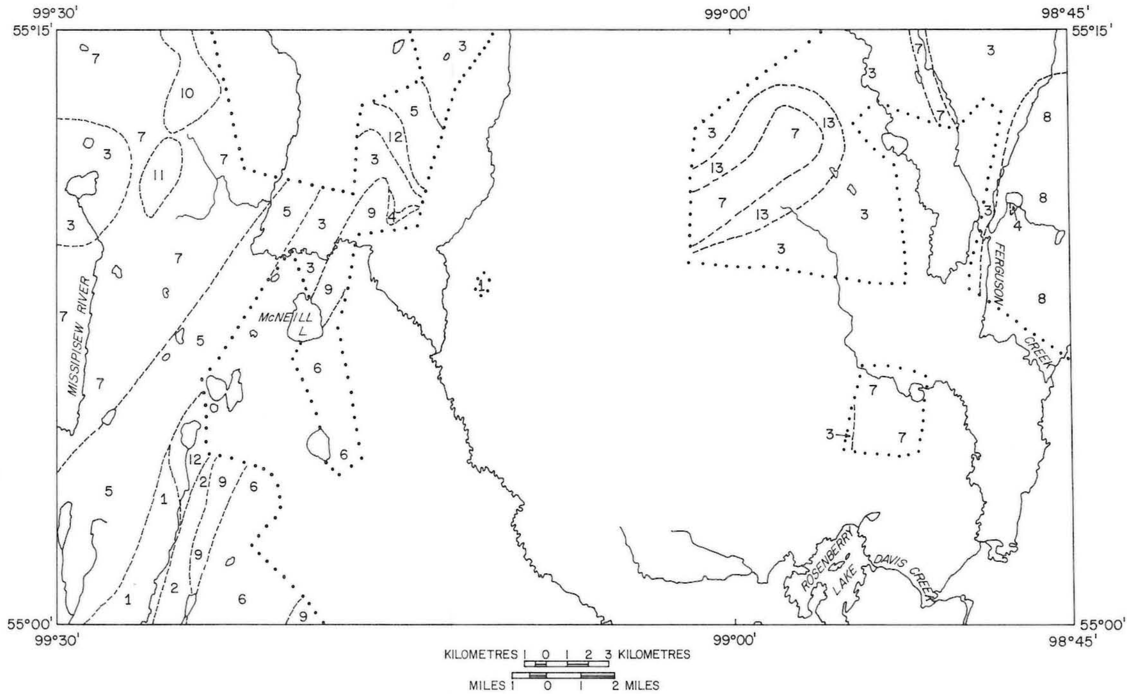
References

Bailes, A.H.
1975: Geology of the Guay-Wimapedi Lakes area; *Man. Min. Res. Div.*, Publ. 75-2.

1976: Saw Lake Area (Grass River Project); *In*: *Man. Min. Res. Div.*, Geol. Surv. Rept. of Field Activities 1976 GS-8.

Baldwin, D.A., Frohlinger, T.F., McRitchie, W.D., Zwanzig, H.V.
in prep.: Geology of the Nelson House-Pukatawagan Region (Burntwood Project).

Cranstone, D.A. and Toogood, D.J.
1969: Pakwa Lake and Pistol Lake (east half) areas; In: *Man. Mines Br.*, Geol. Pap. 4/69, pp. 80-83.



LEGEND

Intrusive Rocks and Granitoid Gneisses

13	Pegmatitic granite: coarse white granite with 50% pegmatite clots: contains abundant inclusions of unit 3 metagreywacke
12	Grey granite; homogeneous biotite granodiorite containing minor amounts of red garnet
11	Leuco-granite-granodiorite; weakly to non-foliated; in places contains garnet
10	Pink garnetiferous granodiorite; contains red garnets and equant porphyroblasts of microcline
9	White porphyroblastic tonalite to granodiorite; weakly foliated leucocratic biotite granite with equant porphyroblasts of plagioclase
8	Red gneissic granite; highly magnetiferous
7	Granodiorite to granite; local garnet, sillimanite or muscovite; commonly contains inclusions of unit 3 metagreywacke
6	Biotite-hornblende granite; white to pink magnetiferous granite
5	Hornblende tonalite; commonly gneissic
4	Metagabbro and ultramafic

Metasedimentary Rocks

3	Metagreywacke; garnetiferous migmatites derived from greywacke
2	Protoquartzite; massive siliceous white paragneiss; contains thin pebbly beds and layers of mesocratic biotite gneiss

Metavolcanic Rocks

1	Mafic metavolcanic rocks and associated mafic metasedimentary rocks; chiefly basalt, pillow basalt and mafic volcanic breccia with thin interbeds of more siliceous hornblende-bearing sediments

.... Limit of mapping

Figure GS-7-1: General geology, McNeill-Pistol Lakes area.

GS-8 THOMPSON NICKEL BELT PROJECT

(Parts of 630-8, 9; 63P-5, 12)

by J.J. Macek and J.K. Russell

A geological examination of rocks on Ospwagan Lake was completed. New investigations were undertaken on Mid, Middle, and Liz Lakes and on the central part of Paint Lake. The area mapped on Paint Lake forms a strip approximately 14 km long and 4 km wide.

Ospwagan Lakes

The 1978 fieldwork on Upper and Lower Ospwagan Lakes complemented the 1977 investigations (Scoates, Macek and Russell, 1977) and was in part directed toward defining the Churchill-Superior boundary in this area. The contact itself was not observed due to the lack of outcrop in the critical area. However, the outcrops that were observed indicate that the contact is faulted and in places occupied by a fine- to medium-grained, pinkish red, poorly foliated granitoid rock. The rest of the work was directed toward determining the extent of several lithologic units.

Mid and Middle Lakes

Poor outcrops of limited extent, due to high water levels, were found on Mid and Middle Lakes. As a result of the limited exposure, our tentative interpretation is that the lakes are underlain almost entirely by migmatites and folded, garnet-bearing amphibolites. This conclusion may be changed in the future.

Liz Lake

Rocks of metavolcanic association (4) occupy most of the north and northwest shorelines. Strongly deformed metabasalts (4b) (Fig. GS-8-1) form approximately 80 percent of the outcrops and have structures which probably developed from pillows, flows and interflow breccias. The rest of the north and northwest shorelines consist of layered, folded and metamorphosed ultramafic rocks (4b) derived from massive to porphyritic picrites similar to those of Ospwagan Lakes. The preserved texture of a porphyritic picrite is shown in Figure GS-8-2.

Metabasaltic rocks (4a) of the southwest shoreline are injected by a grey, medium-grained granitoid rock. The amount of injected material increases to the east grading into a two-component migmatite (3c) (Figure GS-8-3) in which agmatitic and schollen structures are developed on the south end of the lake.

Multicomponent migmatites (3a) with folded and stromatitic structures (Figure GS-8-4) were found on the poorly exposed southeastern shoreline. A strong cataclastic overprint on some outcrops suggests the presence of a major fault nearby.

Paint Lake

The central part of Paint Lake was chosen for mapping since a well exposed section perpendicular to the structural trend is accessible on many islands and shorelines.

The eastern portion of the mapped area is underlain by migmatites and the western part contains, in addition, rocks of a metagabbroic complex and large areas of a retrograded enderbitic gneiss.

Small dykes, sills and irregular bodies of aplite, pegmatite and other granitoids occur within the rocks of the area.

The metagabbroic complex (1) includes metapyroxenite (1a), layered metagabbro (1b), layered anorthositic metagabbro (1c) and associated layered amphibolites (1d).

Metapyroxenites (1a) are buff to brown weathering, coarse grained, massive to layered rocks with weak foliation. Other metapyroxenites are recrystallized to coarse grained, glittering black amphibolites which retain remnants of the original texture. Outcrops are seldom larger than 25 m^2.

Layered metagabbro (1b) comprises medium to coarse grained, two pyroxene-(hornblende)-plagioclase gneiss interlayered with medium-grained, garnet-hornblende-plagioclase gneiss. Garnets form subhedral to euhedral porphyroblasts ranging from 1 to 2.5 cm in size. Layers range from 30 to 60 cm in thickness.

Layered anorthositic metagabbro (1c) is found as a leucocratic, fine- to medium-grained, delicately banded, garnet-hornblende-plagioclase gneiss with minor amounts of quartz and clinopyroxene. Garnet porphyroblasts (usually with poikiloblastic or symplectic textures) are variable in size and abundance.

Associated layered amphibolites (1d) are glittering black, fine-grained, well foliated plagioclase amphibolites with a wispy layering. Garnet and clinopyroxene are rarely found. Minor bands or layers of coarse grained, two pyroxene-plagioclase-gneiss, similar to 1b, are found sporadically in these layered amphibolites.

Retrograded enderbitic gneiss (2) forms large bodies with a characteristic light olive-green to green-brown weathered surface. The rocks are medium to coarse grained biotite-plagioclase-quartz gneisses with pyroxene relicts. Pegmatites and/or aplites occur as 10 — 18 cm thick, folded sheets within the enderbitic gneiss. Mafic to ultramafic inclusions are rare. Rusty weathering equivalents of the enderbitic gneiss are common. The enderbitic gneiss is modified by feldspar blastesis in several outcrops. Two varieties of enderbitic gneiss are distinguished on the basis of relative abundance of biotite and hornblende.

Migmatites (3a, 3b) are the most common, variable and complex rocks on Paint Lake. Their appearance differs from outcrop to outcrop according to the number of rock components, their composition and their relative size, form and abundance. Stromatitic, folded, nebulitic and ophthalmitic structures are common, agmatites are rare (Mehnert, 1968). Mafic to ultramafic inclusions of differing compositions and sizes are present as lenses, deformed blocks or boudins. The common minerals of migmatitic components are plagioclase, quartz, biotite, hornblende, potassium-feldspar, garnet, orthopyroxene and clinopyroxene. Sillimanite, carbonate, cordierite sulphides and magnetite are relatively rare, but are concentrated in a few outcrops which are usually not far from a fault or a shear zone. Many outcrops have a rusty, decayed appearance due to the weathering in the presence of the sulphides, biotite, garnet and/or shearing.

Statistical treatment of the basic structural elements collected from Paint Lake is given in Figure GS-8-5, together with the average angular co-ordinates of the main maxima. It is necessary to stress that in this preliminary form the structural data represents almost entirely only the attitudes resulting from the major deformational event which involved both tight folding and faulting in migmatites. Some outcrops preserve evidence that his major deformational event has overprinted two earlier events and was followed by at least two later periods of brittle deformation. One set of faults strikes from 010° to 025°.

It is likely that the geological history in the Paint Lake area was similar to that in the Wintering Lake area (Hubregtse, 1977), although the intensities and regional extent of the geological events may have differed.

References

Scoates, R.F.J., Macek, J.J. and Russell, J.K.
1977: Thompson Nickel Belt Project; *in*: *Man. Min. Res. Div.*, Geol. Surv. Report of Field Activities 1977 GS-8.

Mehnert, H.R.
1968: Migmatites and the Origin of Granitic Rocks; *Elsevier Publishing Company*, New York.

Hubregtse, J.J.M.W.
1977: Sipiwesk Lake-Wintering Lake Area; *in*: *Man. Min. Res. Div.*, Geol. Surv. Report of Field Activities 1977 GS-14.

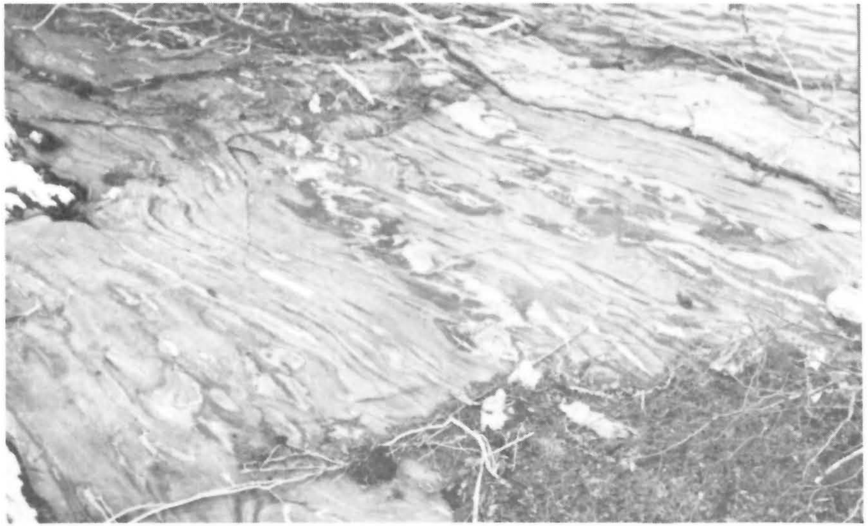


Figure GS-8-1: Deformed matabasaltic rocks (unit 4a). Liz Lake.

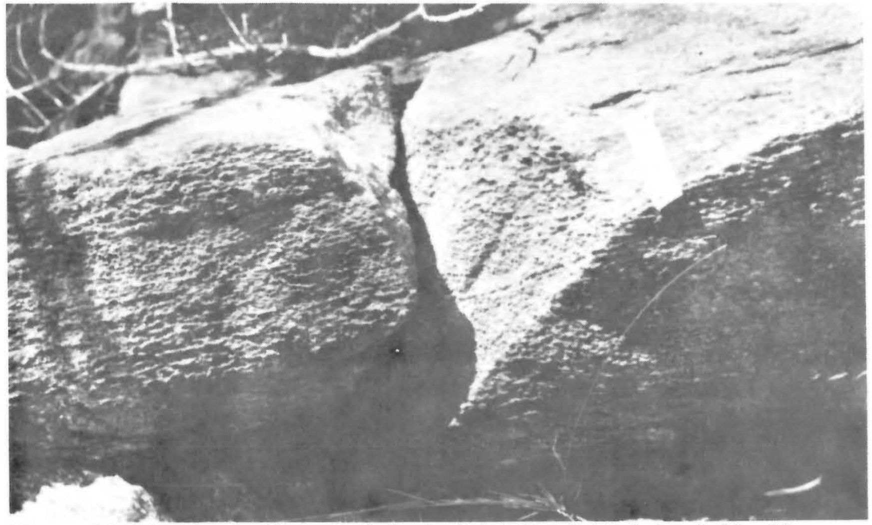


Figure GS-8-2: Porphyritic metapicrite (unit 4a). The field of view is 20 x 30 cm.

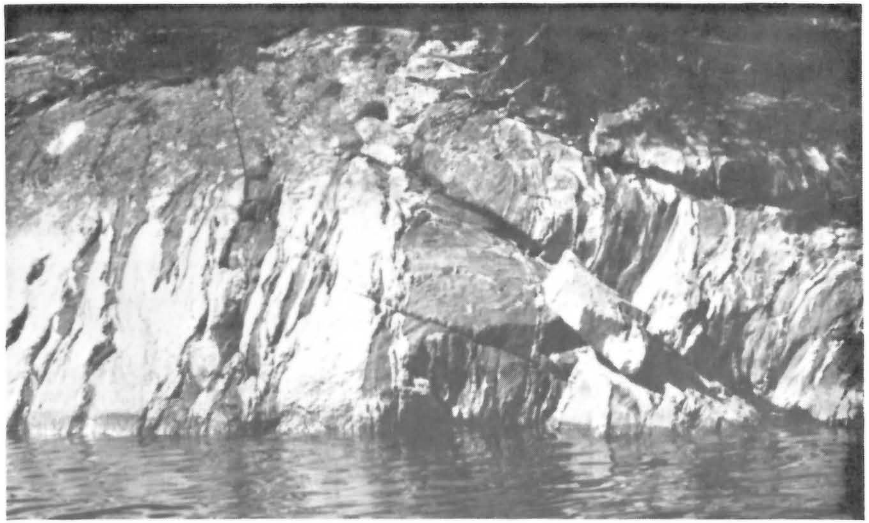


Figure GS-8-3: A two-component migmatite (unit 3c) with schollen agmatitic structures. Liz Lake.

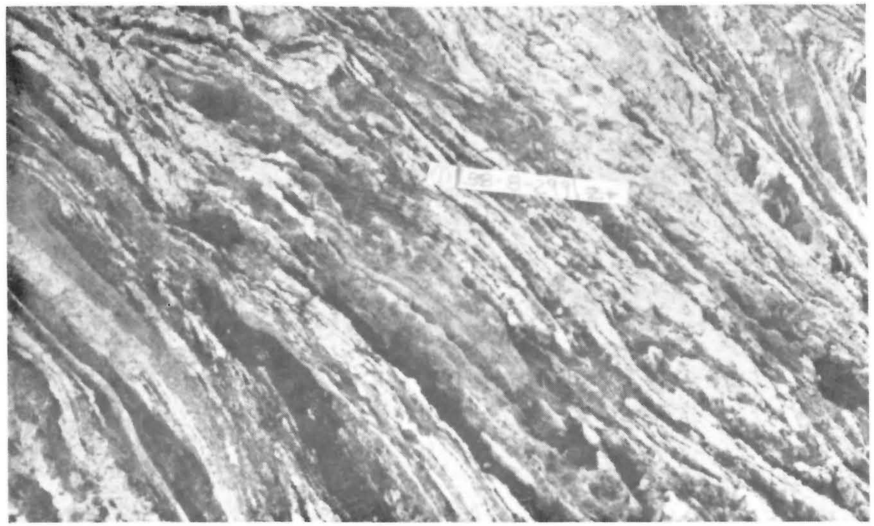


Figure GS-8-4: A multicomponent migmatite (unit 3a) with folded structure. Liz Lake. The width of the tape is 2.5 cm.

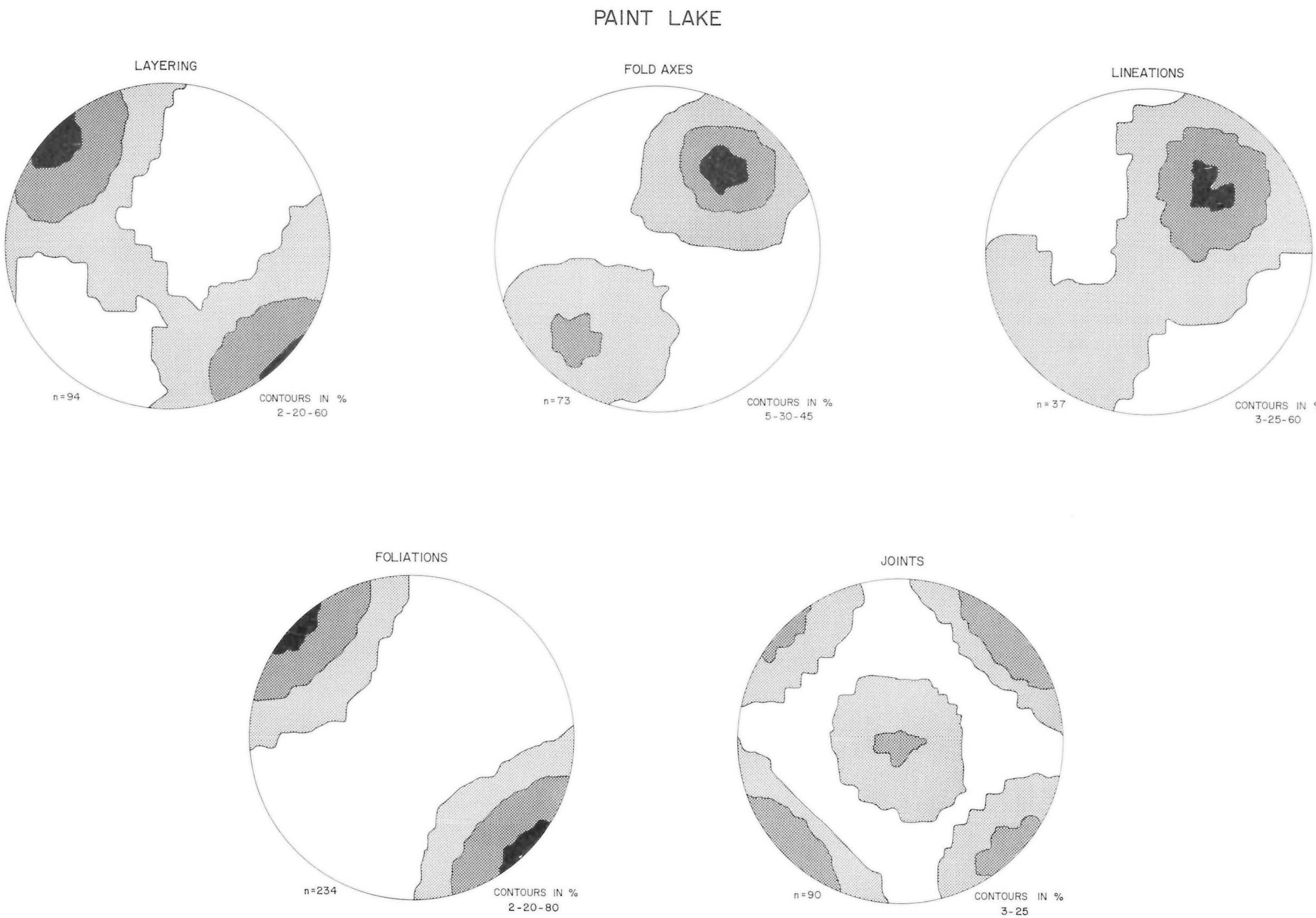


Figure GS-8-5: Stereograms of the basic structural elements with a record of angular co-ordinates of the main maxima.

Structural Elements
Paint Lake

Metamorphic layering	**224/82**	**Joints**	**135/90**
Fold Axes	**040/37**		**180/02**
Lineation	**045/46**		**225/85**
Foliations	**225/88**		

GS-9 NATAWAHUNAN LAKE

(63P-10, 11, 15 and Parts of 63P-12, 14, 64A-2)

by W. Weber

Shoreline exposures along the Grass River system, from Partridge Crop Lake to Witchai Lake, and Armstrong Lake, were mapped during the 1978 field season with the assistance of J. Malyon.

The territory covered is one of the few areas in which the major lithologies of the northern portion of the granulite facies Pikwitonei region are exposed.

The objective of the survey was to map the lithologies, particularly the supracrustal rocks, and to compare these rocks with those of other parts of the Shield, in order to provide a better basis for mineral evaluation.

The findings are presented in Preliminary Maps 1978U-1, 2 and 3 which also include data collected during the 1976 and 1977 field seasons. A synthesis and review of the regional geology in this part of the Shield has recently been published by Weber and Scoates (1978).

An outline of this year's findings is presented in Tables GS-9-1, 2 and Figure GS-9-1. Among the most important highlights was the discovery that the banded magnetite/chert and silicate facies iron formation is the best preserved supracrustal assemblage in the granulite facies terrain. This iron formation is similar to that developed in greenstone belts of lower metamorphic grade (i.e. Utik Lake greenstone belt) to the south. The spatial association between sulphide-bearing gossan zones and the banded iron formation indicates the existence of similar mineralization processes to those found in the Superior Province greenstone belts to the south.

General Geology

Table GS-9-1 lists the mapped rock types according to observed or inferred age relationships. The distribution of metamorphic grades is illustrated in Figure GS-9-1. The granulite facies rocks occur east of line A. Granulite facies rocks and their partially or completely retrogressed amphibolite facies equivalents occur between lines A and B. Amphibolite facies rocks of the Thompson Nickel belt which have been derived from granulite facies rocks through a Hudsonian metamorphic and tectonic overprint (Weber and Scoates, 1978) occur west of line B.

The succession of geological events in the map-area (Table GS-9-2) is similar to that observed in the Sipiwesk and Wintering Lakes area (Hubregtse, 1977, 1978).

Units 1 — 7 most likely represent supracrustal rocks with the exception of unit 3 and possibly some rocks included in unit 1. These supracrustal rocks form irregular belts or rafts within enderbitic rocks (10).

Pyroxenite (1) is usually associated with mafic rocks (2), e.g. at the east end of Partridge Crop Lake and at Buckingham Lake. Locally, the contacts of the ultramafics are sharp and intrusion-like. Elsewhere gradational changes in composition from ultramafic to mafic point toward an origin as differentiated flows or sills.

Mafic rocks (2) are noritic in composition and are generally massive or weakly layered. The layering is caused by variations in the plagioclase and pyroxene contents or by thin discontinuous garnet-bearing layers. Garnet $\pm$ clinopyroxene-rich lenses may represent original intra-pillow material. In several places mafic rocks (2) are associated with iron formation (7). By analogy with the mafic flow/iron formation association in the less metamorphosed Utik Lake greenstone belt (Weber, 1974) it would appear that most of unit 2 probably represents mafic flows.

Garnet-bearing gabbroic rocks (3) are commonly more strongly layered than unit 2. The layering is caused mainly by a variation in garnet content, but also by local leucogabbroic layers, 10 cm to over 1 m wide. An intrusive origin for the gabbroic rocks (3) is supported by the mineralogy of unit 3 and its similarity with layered gabbroic intrusions in the Wintering Lake area (Hubregtse, 1977).

Garnet-bearing gneisses (4) are either quartz-rich or "pelitic" containing biotite, hypersthene $\pm$ sillimanite, and local cordierite. The origin of these gneisses is uncertain. Generally, garnet-bearing gneisses (4) appear to be related to mafic rocks (2) which occur as inclusions or interlayers. From this it may be inferred that the garnet gneiss was derived from unit 2 either through diagenetic fumarolic (?) alteration of basalt (see Utik Lake, Weber, 1974),

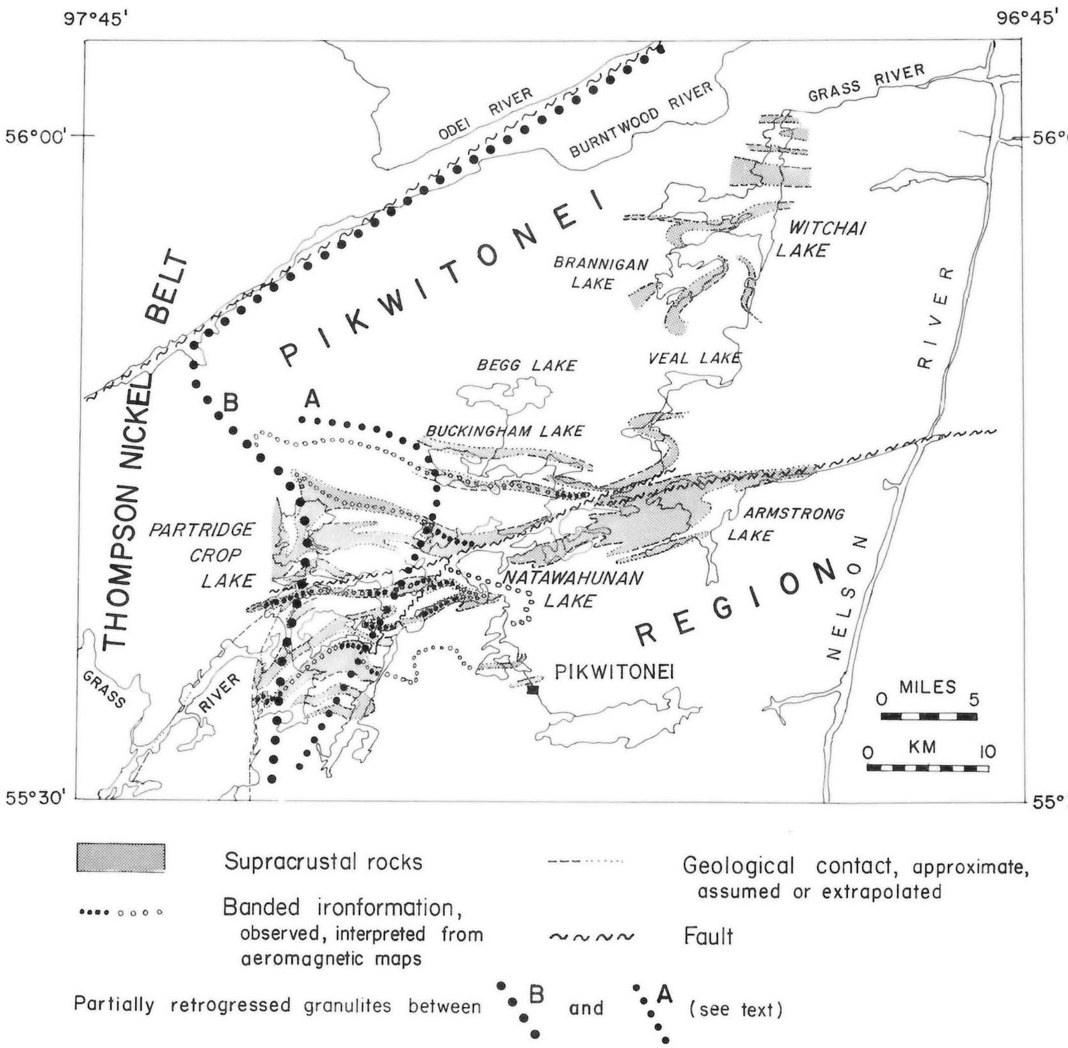


Figure GS-9-1: Geological sketch map of the Partridge Crop-Natawahunan-Witchai Lakes area.

TABLE GS-9-1

TABLE OF FORMATIONS

Pikwitonei Region (Granulite Facies)		Thompson Nickel Belt (Amphibolite Facies)	
		PROTEROZOIC	
		15	granodiorite
		14	monzonite
		13	augen gneiss
		12	migmatite
11	diabase, gabbro and ultramafic dykes of the Molson swarm	11a	fine to medium-grained amphibolite
		ARCHEAN	
10	enderbite, gneissic, and/or with mafic and ultramafic inclusions	10a	tonalite, retrogressed enderbite, gneissic, and/or with mafic and ultramafic inclusions
9	porphyritic opdalite		
8	anorthosite		
7	banded oxide facies to silicate facies iron formation (magnetite/quartzite to garnet-pyroxene ± quartz/quartzite interlayers)	7a	banded oxide facies to silicate facies iron formation (magnetite/quartzite to grunerite ± garnet-pyroxene/quartzite interlayers)
6	quartzite ± garnet gneiss (4), mafic rocks (2) and calc-silicate marble (skarn)		
5	garnet-pyroxene ± magnetite-bearing ultramafic rocks, generally associated with banded iron formation (7)	5	garnet-hornblende ± magnetite-pyroxene-bearing ultramafic rocks
4	felsic to intermediate garnet ± biotite-sillimanite gneiss, commonly with mafic rocks (2) and/or quartzites (6)	4a	garnet-biotite-sillimanite-hornblende gneiss, biotite schist
3	layered gabbroic rocks, commonly garnet-bearing	3a	layered, garnet-bearing amphibolite
2	mafic rocks (metabasalt ?)	2a	amphibolite
1	pyroxenite (ultramafic flows ? or sills ?)	1a	hornblendite

TABLE GS-9-2

TABLE OF GEOLOGICAL EVENTS IN THE PARTRIDGE CROP — NATAWAHUNAN — WITCHAI LAKES AREA

Events		Processes
PROTEROZOIC		
— pegmatite intrusion		
— granodiorite intrusion		
— intrusion of granodiorite sills and pegmatite	M_3	metamorphism: amphibolite facies
— migmatite, augen gneiss	D_3	deformation: SSW axial traces
— intrusion of mafic and ultramafic dykes (Molson swarm)	S_3	fabric development
ARCHEAN		
— generation of quartz-diorite to diorite mobilizate, pegmatite	M_2	metamorphism: granulite facies
	D_2	deformation; WSW axial traces
	S_2	fabric development
— migmatite formation	M_1	metamorphism: amphibolite facies
— intrusion of tonalite and granodiorite	D_1	deformation
	S_1	fabric development
— ? deposition of volcanic muds?		
— fumarolic (?) alteration of mafic and ultramafic rocks, associated sulphide mineralization, carbonatization of supracrustal rocks		
— deposition of chemical sediments, iron formation, quartzites		
— intrusion of gabbro and anorthosite sills		
— extrusion of basic magma and formation of mafic and differentiated mafic/ultramafic flows (?) and sills (?)		

or through metasomatism during intrusion of the granitoid rocks (9, 10). Alternatively, a sedimentary origin may be inferred from the association of pelitic garnet gneisses with rocks resembling psammitic greywacke as at Witchai Lake. Biotite schist in the south bay of Partridge Crop Lake appears to have been derived through alteration of ultramafic rocks (1, 1a).

Garnet-pyroxene ± magnetite-bearing ultramafic rocks (5) are commonly part of a layered sequence comprising mafic rocks (2), iron formation (7) and/or quartzite (6). Rocks of unit 5 locally contain thinly layered chert-magnetite bands which may be discontinuous. Elsewhere they may be interlayered with quartzite in the iron formation (7). In both cases ultramafic rocks (5) are interpreted as part of a silicate (-oxide) facies iron formation.

Quartzite (6) may be up to several metres thick. In many cases it is thinly layered. "Pure" quartzite locally grades into "dirty" quartzite containing mafics or plagioclase. Commonly, quartzite (6) is associated with mafic rocks (2) and/or iron formation (7) and/or calc-silicate rocks which may be calcareous. The calc-silicate rocks appear to have formed through calcium metasomatism leading to carbonatization oblique to primary lithologic boundaries and layering.

Banded iron formation (7) is the only unit which can be identified with certainty as supracrustal in origin. Oxide facies (Fig. GS-9-2), silicate facies and many intermediate facies were observed. Most iron formation is more thinly layered (Fig. GS-9-3) than typical iron formation of the Superior Province greenstone belts in Manitoba. In many places gossan zones (Weber, 1978; Weber and Malyon, 1978) containing disseminated to semi-massive sulphides are immediately associated with iron formation and locally the iron formation itself contains fine-grained sulphides.

Oxide facies iron formation contains magnetite-rich (90%) layers, up to 5 cm thick, interlayered with quartzite of the same width. The quartzites are interpreted as recrystallized chert layers.

The silicate facies iron formation comprises garnet + pyroxene ± quartz, and biotite with variable amounts of magnetite as interlayers between the quartzite layers.

Outcrops containing oxide facies iron formation coincide with positive anomalies in the Federal/Provincial aeromagnetic maps. These anomalies generally form linear trends which aid in the extrapolation of some of the supracrustal rocks on the Preliminary Maps.

Anorthosite (8) forms small sills (0.5 m wide) in mafic rocks (2) and isolated outcrops several metres wide.

Porphyritic opdalite (9) occurs at Witchai Lake and is similar to the opdalite exposed on the Burntwood River (Weber, 1977).

Enderbite and enderbitic gneiss (10) are similar to the schollen enderbite and enderbitic gneisses in the Cauchon Lake area (Weber, 1976).

The Natawahunan Lake area contains numerous dykes of the Molson Swarm (10). The dykes strike north-northeast and are mafic to ultramafic in composition. Most are less than 5 km long. One to three sets of ultramafic dykes which strike along Cuthbert Lake and through Partridge Crop, Natawahunan and Buckingham Lakes ("Cuthbert dykes") apparently define a major zone of dyke emplacement. These dykes appear to be deflected and displaced (right laterally) by west-southwest striking cataclastic zones on Partridge Crop and Natawahunan Lakes.

In the granulite facies terrain the Molson dykes are fresh, whereas in the area between lines A and B (Fig. GS-9-1) the dykes contain a recrystallized greenschist facies mineralogy but retain much of their primary igneous texture. West of line B, in the Thompson Nickel belt, the Molson dykes are recrystallized to amphibolites, and are intruded by granodiorite (15) and younger pegmatite.

Migmatite (12) in the large south bay of Partridge Crop Lake formed through injection of tonalitic and granodioritic mobilizates, (derived from rocks of unit 10) into amphibolite (2a).

Augen gneiss (13) along the Grass River at the west margin of th granodiorite (15) was formed through complete recrystallization and potassium metasomatism of rocks of unit 10. Similar augen gneisses are associated with concordant granodiorite intrusions at Apussigamasi Lake (Weber, 1976).

Monzonite (14) is strongly foliated and most likely resulted from recrystallization and potassium-metasomatism of mafic rocks (2).

Granodiorite (15) is the northern extension of the post-tectonic granite body at Wintering Lake (Hubregtse, 1977).

Relation of Pikwitonei region supracrustal rocks to Superior Province greenstone belts

The supracrustal remnants in the Natawahunan area are highly metamorphosed and primary textures and structures are exceedingly rare. Nevertheless, it may be inferred from their association that they represent part of a succession containing mafic volcanic flows, possible partly differentiated mafic/ultramafic flows and/or sills, and chemical and, perhaps, clastic sediments. These rafts of supracrustal rocks are similar in lithology and composition to the supracrustal rocks in the Utik Lake and High Hill greenstone belts (Weber, 1974, 1975). The High Hill belt and a similar belt at Cauchon Lake are oblique to and cut by the orthopyroxene isograd (Weber and Scoates, 1978) as are the supracrustal rocks northeast of the Cross Lake belt (Hubregtse, 1978). Accordingly, it would seem that the granulite facies supracrustal rocks in the Pikwitonei region represent more highly metamorphosed equivalents of the Superior Province greenstone belts in the Utik-High Hill Lakes area. The absence in the Utik Lake and Pikwitonei region of felsic volcanic and associated sedimentary rocks similar to those in the greenstone belts to the south, e.g. the Oxford Lake-Knee Lake greenstone belt, may indicate that the mafic (to ultramafic) supracrustal rocks lie stratigraphically below the bimodal, differentiated greenstone belt succession.

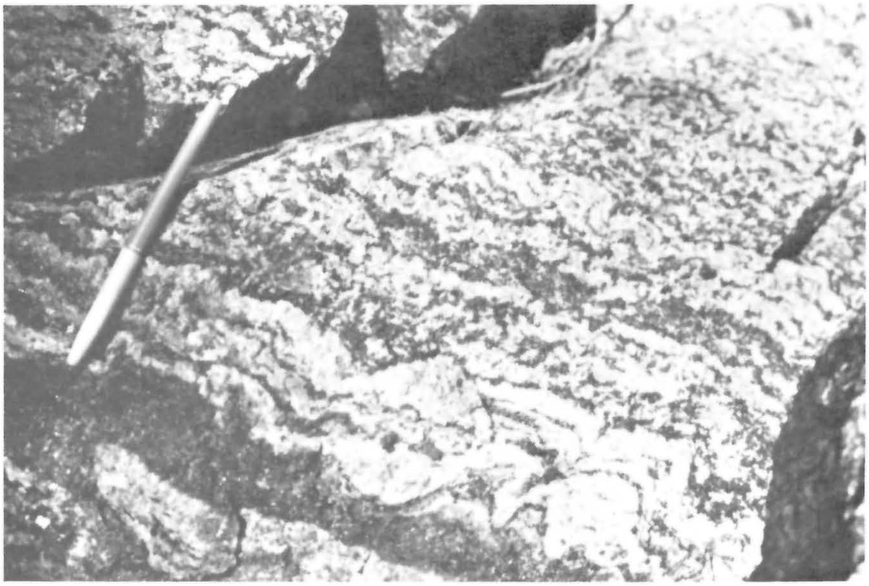


Figure GS-9-2: Granulite facies magnetite/quartzite iron formation, west end Natawahunan Lake.

Figure GS-9-3: Thinly layered granulite facies iron formation, east end Partridge Crop Lake.

References

Hubregtse, J.J.M.W.

1977: Sipiwesk Lake-Wintering Lake area; *In*: *Man. Min. Res. Div.*, Report of Field Activities 1977, pp. 73-79.

Weber, W.

1974: Utik-Bear Lake Project; *In*: Summary of Geological Fieldwork 1974; *Man. Min. Res. Div.*, Geol. Paper 2/74, pp. 27-32.

1975: High Hill-Utik Lake area; *In*: Summary of Geological Fieldwork 1975; *Man. Min. Res. Div.*, Geol. Paper 2/75, pp. 24, 25.

1976: Cauchon, Partridge Crop and Apussigamasi Lakes area; *In*; *Man. Min. Res. Div.*, Report of Field Activities 1976, pp. 54-57.

1977: Odei-Burntwood Rivers Region; *In*: *Man. Min. Res. Div.*, Report of Field Activities 1977, pp. 58-59.

Weber, W. and Scoates, R.F.J.

1978: Archean and Proterozoic Metamorphism in the northwestern Superior Province and along the Churchill-Superior Boundary, Manitoba; *In*: Metamorphism in the Canadian Shield, Ed. J.A. Fraser and W.W. Heywood, Geol. Surv. Can. Paper 78-10.

GS-10 SIPIWESK LAKE-LANDING LAKE-WINTERING LAKE AREA

(63P-3, 4, 5 & 6S1/2, 63J-16, 63I-13 & 14W1/2)

by J.J.M.W. Hubregtse

Introduction

A mapping program was initiated in the summer of 1977 in the area between Paint Lake and Cross Lake (Fig. GS-10-1). After this year's field season, mapping of the following lakes has been completed: Wintering, Landing, Sipiwesk, Bulger, Duck, White Rabbit, Bruneau, Dugas, Scatch, McLaren and Sabomin Lakes, and some smaller lakes south of Sipiwesk Lake. Mapping of the Nelson River in the Bear Island area has been completed north of Redrock Rapids and west of Little Manitou Rapids. A helicopter survey was carried out in the area between Sipiwesk Lake and Cross Lake (Hubregtse *et. al.*, 1978 a-g).

The age and structural position of the granulite facies rocks of the Pikwitonei region have been a matter of contention over the last decade (see Bell, 1971; Weber, 1976 and 1977; Hubregtse, 1977). The initial objectives of this project, therefore, were to identify the origin of the granulite facies rocks underlying much of the map-area (southern Pikwitonei region) and their relationship with the greenstone belt-gneiss terrain of the Superior Province to the southeast and the Thompson Nickel Belt-Churchill Province to the northwest. A basic description of the lithologies and metamorphism of the area was given by Hubregtse (1977), and only this year's findings will be discussed in this paper.

The main results of this year's survey are:

- Supracrustal rocks as found in "classical" greenstone belts, with well-preserved primary structures, were documented in the southwestern part of the map-area. These rocks occur as large enclaves in the migmatite gneisses and are situated across the orthopyroxene isograd (M_2).
- The only difference between the migmatite gneisses of the southern Pikwitonei region and those underlying the northern shore of Cross Lake is their grade of metamorphism. The gneisses underlie a continuous migmatite terrain in which lithologies, structure and rock fabrics can be traced from Sipiwesk Lake to northern Cross Lake. There is no unconformity (Bell, 1971; Cranstone and Turek, 1976) between the Cross Lake area and the Sipiwesk Lake area.
- Sapphyrine-bearing mafic rocks were documented in central Sipiwesk Lake, among "dry" orthopyroxene granulite facies (M_2) migmatites. A younger enderbite suite intruded the older pre-M_1 migmatite gneisses in the same zone of intense metamorphism.
- The undeformed Molson diabase dykes and the metamorphosed and tectonized Wintering Lake diabase dykes (Hubregtse, 1977) belong to the same swarm. The dykes provide an excellent structural marker as they separate Kenoran from post-Kenoran orogenic events.
- The position and nature of the post-Kenoran (Thompson Nickel belt trend), Hudsonian overprint of the southern Pikwitonei region is now better defined. This orogenic event decreases in intensity in a southeasterly direction, and its southeastern limit can be subdivided into metasomatic, tectonic and metamorphic fronts, which are locally accompanied by the addition of post-Kenoran magmatic phases. This complicated pattern of overprinting makes the location of the Superior-Churchill boundary increasingly difficult to define and rather arbitrary.
- Although we agree with Cranstone and Turek's (1976) thesis that the gneisses of the Wabowden region* have formed by metamorphism of the Pikwitonei granulities, we cannot support their view that this event was Kenoran. The tectonic overprint is clearly post-Kenoran and it is restricted to the margin of the northwestern Superior Province. Our findings support Rance's (1966) concept that the gneisses of the Wabowden region represent Hudsonian tectonites derived from Archean gneisses.

Geological History

The order of geological events (Table GS-10-1) is basically similar to the previously published version (Hubregtse, 1977) and, therefore, only amendments and additions will be discussed here.

*Bell's (1971) Wabowden subprovince of the Superior Province

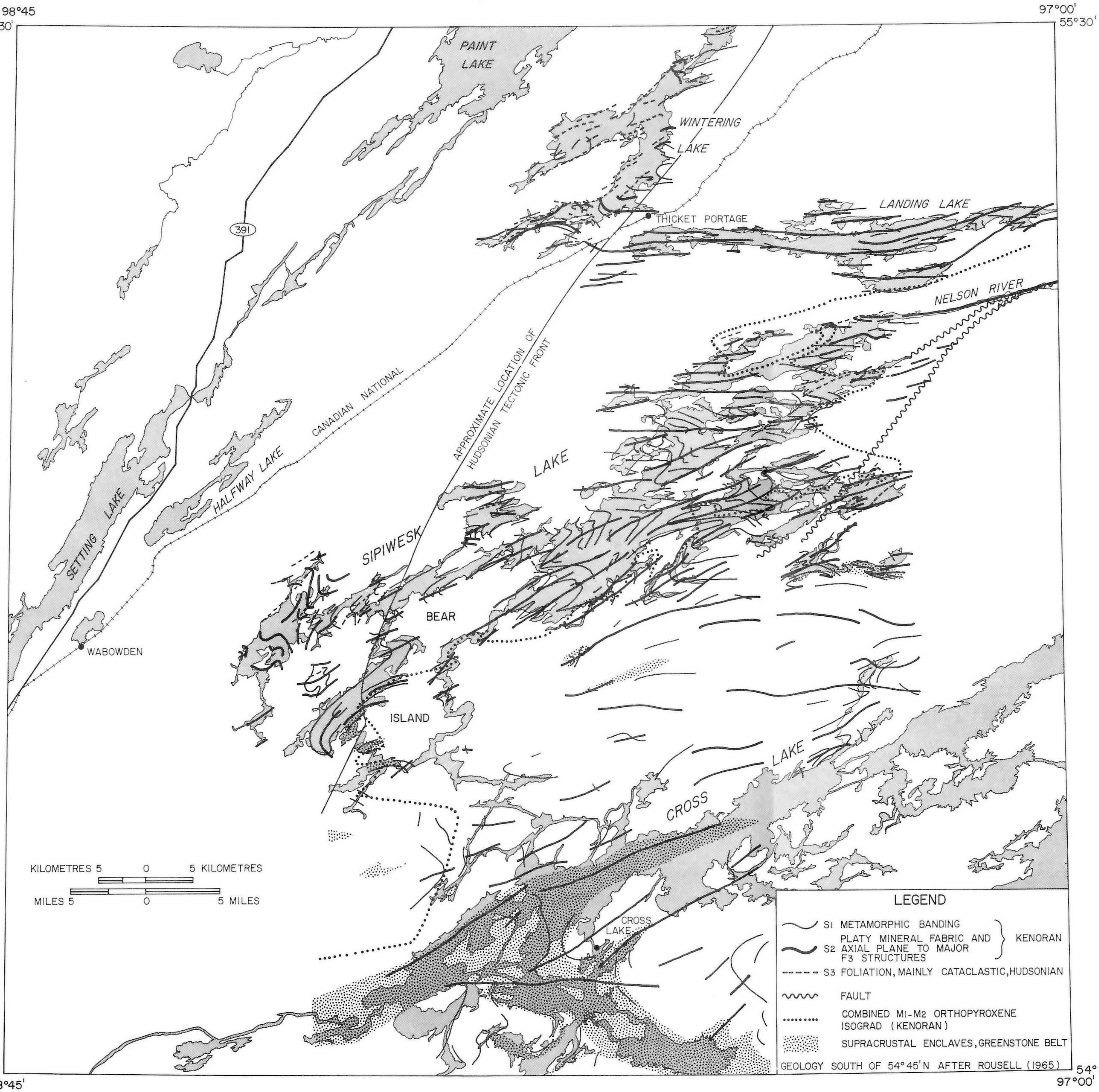


Figure GS-10-1: Structural map of the Wintering Lake-Sipiwesk Lake-Cross Lake area.

TABLE GS-10-1

ORDER OF EVENTS

	WINTERING LAKE-WESTERN SIPIWESK LAKE		LANDING LAKE-EASTERN AND CENTRAL SIPIWESK LAKE-BEAR ISLAND-BULGER LAKE-CROSS LAKE	Metamorphism	Orogeny
	— emplacement of granite and pegmatite	HUDSONIAN FRONT			HUDSONIAN OROGENY
	— formation of rare pseudotachylyte		— formation of pseudotachylyte		
D_{3B}	— renewed shearing within S_3 tectonic zones				
M_3	— greenish-grey lamprophyre		— northeast-trending faults and mylonites		
M_3, D_{3A}	— intense shearing and (blasto) mylonitization formation of well-layered gneisses (S_3 tectonites), profound reworking of Archean gneisses		— 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	
M_3	— formation of M_3 migmatites				
M_3	— metasomatism of Archean gneisses				
	— pegmatite, tonalite and granodiorite				

— emplacement of Molson diabase swarm

	WINTERING LAKE-WESTERN SIPIWESK LAKE	LANDING LAKE-EASTERN AND CENTRAL SIPIWESK LAKE-BEAR ISLAND-BULGER LAKE-CROSS LAKE	Metamorphism	Orogeny
	— local anatexis of older migmatites			KENORAN OROGENY
		— 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		
		— granitization and recrystallization of migmatites between Sipiwesk Lake and Cross Lake	M_2 (hornblende) granulite facies and amphibolite facies metamorphism	
		— growth of post-S_2 garnet and local retrogression	M_2	
D_{2A}		— formation of planar and planolinear quartz fabric (S_2)	M_2	
		— formation of M_2 migmatites	M_2	
		— intrusion of quartz-monzonite, pegmatite, granite, minor tonalite and monzo-diorite	M_2	
		— intrusion of (leuco-) gabbro — leuco-enderbite — opdalite dykes and sills (central Sipiwesk Lake)	M_2	
		— derivation of quartz-feldspar (-orthopyroxene/hornblende) mobilizate from pre-M_1 migmatites	M_2	
		— intrusion of hornblendite dykes	M_2	
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	
D_{1A}		— formation of metamorphic banding S_1	M_1	
		— derivation of K-feldspar-rich felsic mobilizate	M_1	
		— plagiophyric mafic dykes (Bulger Lake dykes)		
		— formation of pre-M_1 migmatites		
		— intrusion of tonalite, granodiorite and minor quartz diorite (enderbite?)		
		— emplacement of layered gabbro-pyroxenite-peridotite (northwestern part of map-area)		
		— intrusion of hypabyssal plagiophyric gabbro and anorthosite in the greenstones		
		— deposition of greenstones (massive and pillowed basalts, sediments, iron formations, dacites and porphyries (southern part of map-area))		

Pre-M_1 Supra and Infracrustal Rocks and Their Structural Position

Supracrustal sequences with well-preserved primary features were documented at southern Duck Lake, Redrock Rapids and southern Sipiwesk Lake southwest of Bear Island and at "Pillow" Lake (Fig. GS-10-2). The greenstone successions include metamorphosed equivalents of pillowed and massive basalt, banded magnetite iron formation, dacite or quartz-feldspar porphyry, conglomeratic or pyroclastic deposits and metasedimentary biotite-quartz-feldspar, garnet-biotite and sillimanite-potash feldspar gneisses. The supracrustal rocks were invaded by intra-volcanic plagiophyric gabbro-anorthosite sills. The supracrustal belts may be as wide as 2 km and occur also as outcrop-scale rafts in the migmatite gneiss complex. Although they are largely in amphibolite facies, granulite facies mineral assemblages have been observed too. Metabasalts and metamorphosed plagiophyric gabbro have been traced into mafic granulites along strike, west of Little Manitou Rapids. Similarly, the supracrustal rafts could be traced into the compositional banding (S_1) of the surrounding migmatite-gneiss. There are clear intrusive relationships between the greenstones and the enclosing tonalites and enderbites. Marbles only occur in association with strongly assimilated supracrustal rafts. A belt of amphibolite and biotite gneiss, extensively invaded by tonalite and granodiorite, at White Rabbit Lake, is interpreted to be of supracrustal origin although no primary features were observed. This belt has been affected locally by granulite facies metamorphism (M_2).

Layered metagabbros and metapyroxenite, as mapped at Wintering Lake (Hubregtse, 1977) were documented at Bruneau Lake, at the Nelson River, north of Duck Lake and at Landing Lake. It is interesting to note that enclaves of well-preserved supracrustal rocks occur in the area southwest of the line through northern Duck Lake-southern Bruneau Lake-Sabomin Lake. Both areas enclose a terrain in which the origin of the mafic enclaves is uncertain. This distribution may well have a bearing on the overall stratigraphy of the southern Pikwitonei region.

The supracrustal assemblages are not different from those documented in "classical" greenstone belts such as the Cross Lake belt (Rousell, 1965) and the Oxford Lake belt (Hubregtse, 1973). The amphibolite facies migmatite gneisses at northern Cross Lake* and the granulite-amphibolite facies gneisses at Sipiwesk Lake** (Pikwitonei region) belong to the same migmatite gneiss complex. The only boundary that separates both areas, is the M_2 granulite facies isograd. Lithologies, including the greenstone succession, structures and fabrics can be traced across the orthopyroxene (M_2) isograd. Linear structures (L_2) within the area mapped, including northern Cross Lake, strike parallel to similar linear structures mapped by Rousell (1965) within and north of the Cross Lake greenstone belt. Rousell shows that the lineations are parallel to the axes of the major structures of the Cross Lake greenstone belt, and that they are likely to be coeval. Rousell (1965) also concluded that the tonalite (and granodiorite) gneisses of the migmatite complex are younger than the supracrustal rocks of the Cross Lake greenstone belt. On the basis of this year's work and Rousell's (1965) findings the following conclusions can be drawn:

— there is no evidence for the existence of an unconformable relationship between the Cross Lake area and the Sipiwesk Lake area, as proposed by Bell (1971). Moreover, Bell's (1971) "unconformity" has been field checked in five localities and no structural breaks were observed (Fig. GS-10-1).

— there is no reason to assume that all of the Sipiwesk Lake gneisses (Pikwitonei area) and the granulite facies metamorphic events are older than the Archean rocks of the Cross Lake area and the Kenoran orogeny.

M_2 — Related Intrusive Rocks

A younger enderbite suite and rare hornblendite dykes were mapped in addition to the M_2-related mobilizate phases and intrusive rocks previously reported (Hubregtse, 1977). The hornblendite dykes intrude prior to M_2 or early during M_2. The younger syn-orogenic enderbite suite is generally leucocratic and commonly porphyritic, but ranges from opdalitic to leuco-gabbroic compositions, including the previously reported clotty dykes (Hubregtse, 1977). This suite forms dykes and sill-like bodies at central Sipiwesk Lake where they include older pre-M_1 migmatite gneisses.

* Bell's (1971) Cross Lake subprovince of the Superior Province

** Bell's (1971) Pikwitonei Province

Figure GS-10-2a: Fragmental deposit at "Pillow Lake".

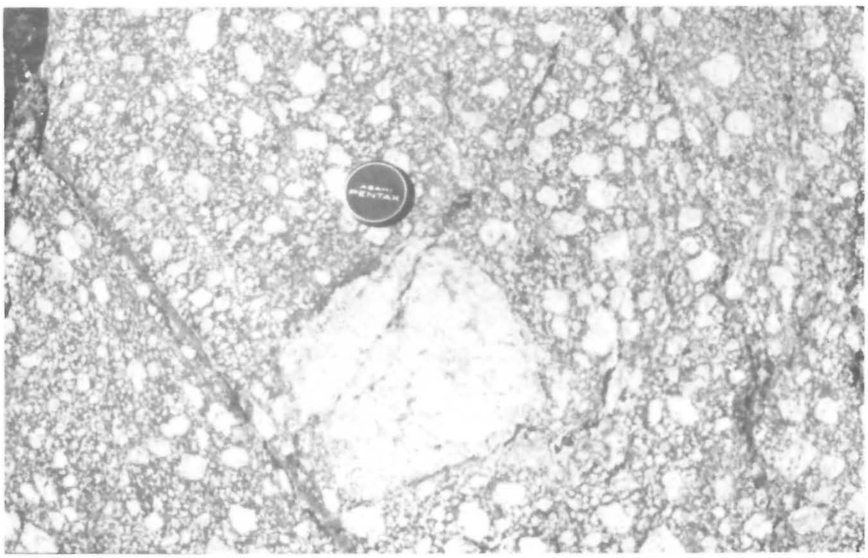


Figure GS-10-2b: Intravolcanic anorthositic gabbro at Redrock Rapids

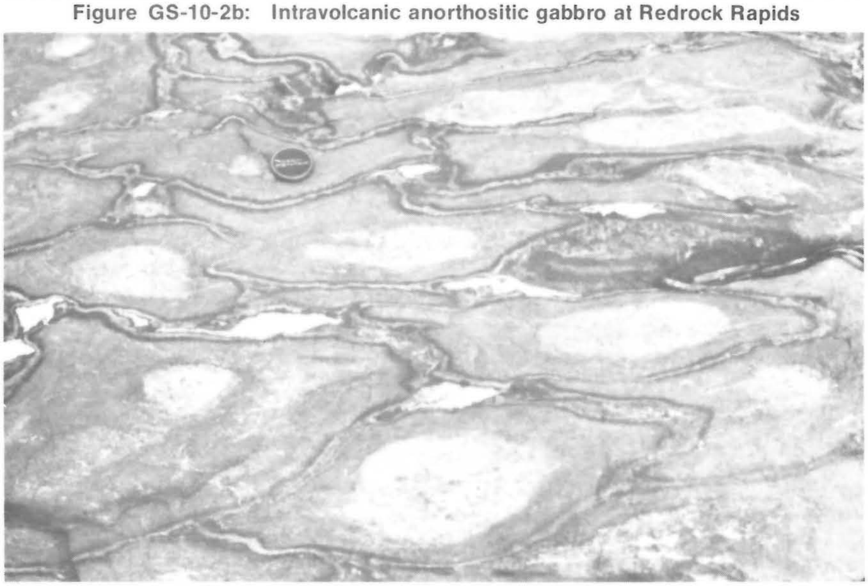


Figure GS-10-2c: Pillow basalt at Redrock Rapids.

M_1 and M_2 Metamorphic Events

The nature and grade of M_1-metamorphism is not yet fully understood because of the M_2-granulite facies overprint. It seems, however, that M_1 was commonly amphibolite facies grade, since pre-M_1 migmatites are always in amphibolite facies at the M_2-orthopyroxene isograd. The hornblende granulite and granulite facies assemblages in pre-M_1 rocks have been shown to be related to the overprinting M_2-metamorphism and in many instances, simply reflect a more advanced "drying-out" stage (breakdown of hornblende) of the M_1-amphibolites by intense "dry" (orthopyroxene + plagioclase) M_2-granulite facies metamorphism. This is obvious in the field, where hornblende-free haloes have developed around M_2 orthopyroxene-plagioclase-quartz mobilizates in hornblende granulite facies and amphibolite facies pre-M_1 migmatites. A progressive sequence as shown in Figure GS-10-3 was observed at White Rabbit Lake. On the other hand, mafic xenoliths in migmatites, commonly exhibit recrystallized "dry" granulite facies (M_2) margins around coarser hornblende granulite facies M_1 cores, that contain an older S_1 fabric. Therefore, the possibility of the M_1 event being locally in hornblende granulite facies should not be ruled out.

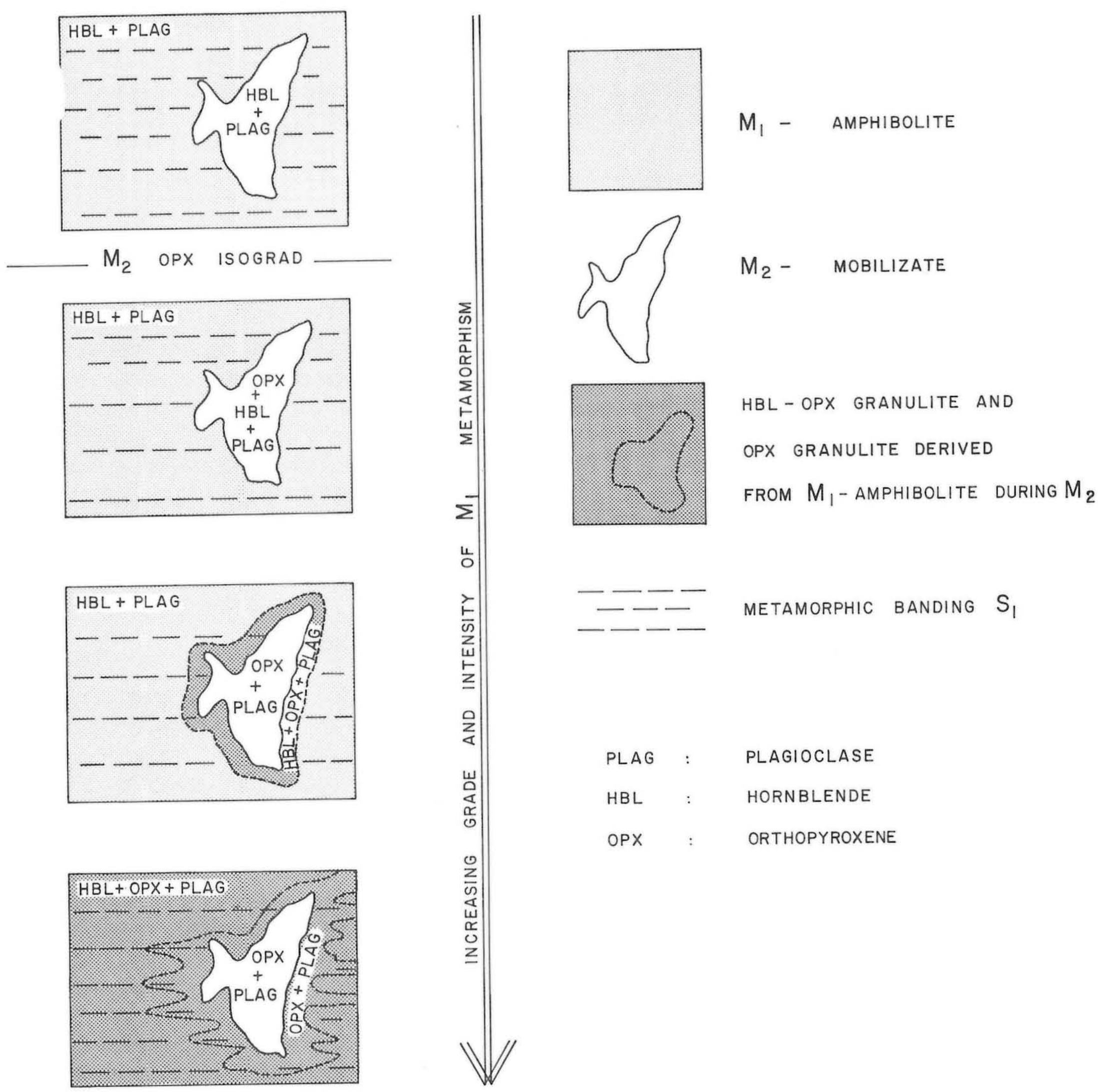


Figure GS-10-3: Schematic representation of development of M_2 metamorphic mineral assemblages in M_1 amphibolite.

The conditions of M_2 varied from amphibolite facies to "dry" granulite facies. Very coarse M_2-related orthopyroxene-plagioclase mobilizates (grain sizes over 5 cm) occur commonly in central Sipiwesk Lake south of The Narrows, indicating that this area was effected by the most extreme conditions of the M_2-metamorphism. Rare sapphyrine-bearing and cordierite-bearing rocks occur in this area.

Sapphyrine is present in mafic rocks with orthopyroxene, cordierite, biotite and either spinel and corundum or feldspar. Cordierite-bearing gneisses of intermediate composition occur along strike. Both the sapphyrine and the cordierite-bearing rocks are associated with the commonly found pre-M_1 mafic and ultramafic orthopyroxene granulite layers, which occur enclosed in pre-M_1 enderbitic migmatite gneiss.

Another significant M_2-related event is the widespread granitization of the amphibolite facies pre-M_1 migmatite gneisses in the area between Sipiwesk Lake and Cross Lake. This process of recrystallization and introduction of pegmatitic and granitic phases takes place between tectonic phases D_{2A} and D_{2B}. It may result in the complete obliteration of earlier D_2 and D_1 structures and assimilation of pre-M_1 mafic components of the migmatite gneisses. The process yields featureless, weakly foliated granodiorite and granite gneisses with faint, slightly more mafic, ghost schlieren, outlining earlier structures. This process of granitization is thought to be related to the M_2 "dry" granulite facies event that affected deeper crustal levels presently situated at Sipiwesk Lake. It seemingly resulted in the extraction of volatile and potassium-rich components and subsequent transfer of these components towards higher crustal levels. The ultimate product may have been a generally "dry" and potassium-depleted deeper crustal granulite facies complex overlain by an amphibolite facies complex, enriched in volatile and potassium-rich granitic and pegmatitic components.

D_1 and D_2 Tectonic Events

A phase of isoclinal folding locally affected the oldest structural element, the metamorphic banding S_1, prior to the formation of S_2. This newly recognized folding phase is only rarely visible in zones of low D_2 strain, where the isoclinally folded S_1 bands are cut at a high angle by the S_2 foliation.

The trend of S_1 is northwesterly on a regional scale and S_2 trends northeasterly (Fig. GS-10-1). A westerly trend of both S_1 and S_2 is characteristic for the Landing-Sabomin Lakes area. The S_1 structure is overprinted by alternating zones of low and high D_2 strain, which have resulted in a characteristic megascopic pattern of moderately and northeasterly dipping pseudoconcentric, gentle to open F_2 antiforms which alternate with isoclinal to tight similar F_2 synforms. There is a complete transposition of S_1 into the S_2 planes in the high strain D_2 zones. The megascopic structures described here are also perfectly visible at outcrop scale.

Pronounced shear belts, underlain by augen gneiss and mylonite, developed late during D_2, particularly in the eastern part of the map-area.

Post-Kenoran Rocks and the Hudsonian Orogenic Event (M_3-D_3)

The post-Kenoran lithologies are best exposed at Wintering Lake and at western Sipiwesk Lake. A brief description was given by Hubregtse (1977). The correlation between undeformed Molson diabases at Sipiwesk Lake and deformed diabases at Wintering Lake has been established in the field. The term Wintering Lake dykes for deformed diabases (Hubregtse, 1977) will therefore be dropped.

The Molson dyke swarm provides an excellent tool for the separation of earlier, Kenoran (M_1, D_1 and M_2, D_2) and later, Hudsonian (M_3, D_3) events, since the Molson dykes are deformed by the younger event only. The dykes are undeformed in the eastern half of the map-area. They generally trend in a northeasterly direction, dip subverticaly and are straight-walled. Large dykes and en-echelon sets of dykes occur in the central Sipiwesk Lake and Landing Lake region where they may be as wide as 250 m and as long as 8 km. The largest Molson dyke in the area was mapped between White Rabbit Lake and northern Cross Lake. It is at least 14 km long and reaches a width of 600 m just north of Cross Lake. This dyke may be part of the Nelson River dyke, which is "believed to underlie the north-northeast flowing part of the Nelson River" (Bell, 1971).

The transition from undeformed to deformed and metamorphosed Molson diabases is abrupt and marks the position of the Hudsonian tectonic front (Fig. GS-10-1). The tectonic front can be traced roughly from Thicket Portage in a southwesterly direction, west of Dugas

Lake, through the Nelson River north of Duck Lake, and from there in a southerly direction through Duck Lake. Discrete, chiefly cataclastic D_3 shear zones occur, however, east of the Hudsonian tectonic front at Bruneau Lake, east of Bear Island and as far east as Bulger Lake and Sabomin Lake, where the D_3 structures trail off along pre-existing older D_2 structures. The D_3 shear zone at Sabomin Lake is actually a re-activated D_2 augen gneiss belt, in which Molson dykes were folded during the D_3 movement. The Hudsonian D_3 activity increased in intensity in a westerly direction, west of the tectonic front. Sporadic tilting and gentle warping of S_2 on a regional scale, east of the front, may have been caused by D_3.

The M_3 metamorphic front reaches much farther eastwards into the Superior Province, as witnessed by slightly metamorphosed but undeformed Molson dykes that occur throughout the eastern part of the map-area. The position and configuration of the metamorphic front needs to be determined in detail. The M_3 metamorphism reaches amphibolite facies grade in the western part of the map-area.

A third Hudsonian (M_3) feature, superimposed on the Archean rocks of the Sipiwesk Lake area, is a pre-D_3 metasomatic event that is associated with the intrusion of post-Molson dyke, aplitic and pegmatitic phases. These felsic phases and similar metasomatic processes have been described previously in the Wintering Lake and western Sipiwesk Lake area as part of the M_3 event (Hubregtse, 1977). The metasomatism has resulted in textural and mineralogical changes in the Archean granulites and amphibolites along strike within one and the same compositional layer, centered around post-Molson dyke aplite and pegmatite. The metasomatic changes are only readily visible in partially affected areas where the process was incomplete. The mineralogical change is best seen in granulites since the metasomatic action produces amphibole. The "metasomatic" amphibolites contain felted aggregates of amphibole. They are also easily distinguished from amphibolites with older granoblastic textures. It should also be stressed that the felted metasomatic textures only survived in areas of low D_3-M_3 activity.

The youngest major tectonic event is the widespread development of pseudotachylyte, particularly at Sipiwesk Lake.

Mineralization

Gossan zones are not at all uncommon in the Pikwitonei region. They commonly occur associated with garnet gneisses and mafic granulites and amphibolites, and with banded iron formations in the high grade supracrustal rocks. There are numerous gossan and mineralized zones (pyrite and graphite) in the White Rabbit Lake supracrustal belt. A zone of massive pyrite and pyrrhotite was mapped at southern Landing Lake.

Messrs. R. Charbonneau, N.G. Culshaw, and R.T. Kusmirski rendered excellent assistance in the field during the course of the two-year project. They contributed to the development of the concepts presented above and are responsible for part of the mapping.

References

Bell, C.K.
1971: Boundary Geology, upper Nelson River Area, Manitoba and Northwestern Ontario; Geol. Assoc. Spec. Pap. No. 9, pp. 11-40.

Cranstone, D.A. and Turek, A.
1976: Geological and geochronological relationships of the Thompson nickel belt, Manitoba; *Can J. Earth Sci.*, Vo. 13, pp. 1058-1069.

Hubregtse, J.J.M.W.
1977: Sipiwesk Lake-Wintering Lake Area; *in*: *Man. Min. Res. Div.*, Geol. Surv. Report of Field Activities 1976, pp. 73-79.

Hubregtse, J.J.M.W., Kusmirski, R.T. and Charbonneau, R.
1978a: Bulger Lake; *Man. Min. Res. Div.*, Prelim. Map 1978N-1.

1978b: Sipiwesk Lake; *Man. Min. Res. Div.*, Prelim. Map 1978N-2.

Hubregtse, J.J.M.W., Charbonneau, R. and Culshaw, N.G.
1978c: Wintering Lake; *Man. Min. Res. Div.*, Prelim. Map 1978N-3.

Hubregtse, J.J.M.W. and Charbonneau, R.
1978d: Landing Lake, south half; *Man. Min. Res. Div.*, Prelim. Map 1978N-4.

Hubregtse, J.J.M.W., Culshaw, N.G. and Kusmirski, R.T.
1978e: Duck Lake; *Man. Min. Res. Div.*, Prelim. Map 1978N-5.

Hubregtse, J.J.M.W. and Kusmirski, R.T.
1978f: Hill Rapids; *Man. Min. Res. Div.*, Prelim. Map 1978N-6.

Hubregtse, J.J.M.W.
1978g: White Rabbit Lake, west half; *Man. Min. Res. Div.*, Prelim. Map 1978N-7.

Rance, H.
1966: Superior-Churchill structural boundary, Wabowden, Manitoba; Unpubl. Ph. D. thesis, *Univ. of Western Ottawa*, London, Ontario.

Rousell, D.H.
1965: Geology of the Cross Lake Area; *Man. Mines Br.*, Publ. 62-4.

Weber, W.
1976: Cauchon, Partridge Crop and Apussigamasi Lakes Area; *in*: *Man. Min. Res. Div.*, Geol. Surv. Report of Field Activities 1976, pp. 54-57.

1977: Cauchon Lake Region; in: *Man. Min. Res. Div.*, Geol. Surv. Report of Field Activities 1977, pp. 60-61.

GS-11 SOUTHEASTERN MANITOBA

(Parts of 52E and 52L)

by D.A. Janes

Mapping of the Precambrian outcrops of Southeast Manitoba was carried out by one party under D. Janes. Several weeks were spent south of the Winnipeg River in defining unit boundaries of the areas mapped in 1977. The balance of the field season was spent north of the Winnipeg River in the Tooth Lake, Maskwa Lake and Cat Creek-Maskwa River areas.

The area between Round and Anson Lakes was traversed to augment the previous coverage. The area is underlain by the "Great Falls" quartz diorite which in this region contains minor but significant enclaves of mafic metavolcanic and felsic metasedimentary rocks. These enclaves are related to the Bird Lake and Cat Lake metavolcanic terrains.

The Maskwa River leuco-monzogranite was traversed and it appears that portions of the area originally assigned to the Black River porphyroblastic suite should be included in the monzogranite unit.

The Maskwa River monzogranite now extends east to Cat and Euclid Lakes and southeast in a narrow band to the Ontario border. Monzogranites of the Maskwa River unit are similar to the Turtle-Tooth bodies but lack the green apatite and toumaline found in the Moose Lake body.

A limited amount of chemical and petrographic work is planned on the rocks of the region between the Manigotagan and Winnipeg Rivers to compare with similar studies completed on the Manigotagan region and in progress south of the Winnipeg River.

References

Janes, D.A.

1977: Southeastern Manitoba; *in*: *Man. Min. Res. Div.*, Geol. Surv. Report of Field Activities 1977 GS-17.

1976: Southeastern Manitoba; *in*: *Man. Min. Res. Div.*, Geol. Surv. Report of Field Activities 1976 GS-13.

Lamb, C.F.

1974: *Southeastern Manitoba; in*: Summary of Geological Fieldwork, 1974; *Man. Min. Res. Div.*, Geol. Papter 2/74.

1975: Southeastern Manitoba; *in*: Summary of Geological Fieldwork, 1975; *Man. Min. Res. Div.*, Geol. Paper 2/75.

McRitchie, W.D.

1971: The Petrology and Environment of the Acid Plutonic Rocks of the Wanipigow-Winnipeg Rivers region, Southeastern Manitoba; *in*: Geology and Geophysics of the Rice Lake Region, Southeastern Manitoba (Project Pioneer) Ed. W.D. McRitchie and W. Weber; *Man. Mines Br.*, Publ. 71-1.

GS-12 STRATIGRAPHIC CORE HOLE AND MAPPING PROGRAMME

by H.R. McCabe

The Division's in-house drilling programme continued this summer as a joint stratigraphic and industrial minerals mapping and evaluation project. The stratigraphic holes were directed primarily to provide new structural and lithofacies data in areas of poor outcrop control. These data are required for the forthcoming revision of the Geological Map of Manitoba, and are summarized in Table GS-12-1. Hole locations are shown in Figure GS-1. The industrial minerals portion of the programme is covered by B. Bannatyne in a separate section of this report. The results of the programme are presented here in some detail since the objectives of the stratigraphic mapping programme are directed toward a progressive and ongoing refinement of the existing data base, and a final report is not intended for the near future. However, all drilling data and all core are on file and available for examination.

Attempts to test and utilize the deep drilling capacity of the J.K.S.-300 drill were frustrated by local drilling problems and time limitations. Nevertheless, hole M-3-78 was drilled to a depth of 203 m (665 feet) (the deepest hole drilled to date), and holes to the rated drill capacity of 300 m should be attainable elsewhere in Paleozoic carbonates.

Hole M-3-78 was located in the approximate centre of the Interlake region to provide stratigraphic control in a very large area where outcrop is almost non-existent. A previous shallow core hole at this location (M-6-73) provided only inconclusive data as to correlation of Silurian strata, and did not reach the Ordovician. Hole M-3-78 was drilled to the top of the Ordovician Winnipeg Formation, but no attempt was made to reach Precambrian basement because of the potential problems in drilling the unconsolidated sandstone beds. The results of this hole will aid in detailed correlation of Silurian strata from the northern outcrop area, north of Grand Rapids, to the south Interlake area. Several marker horizons occur in the section, but some local omission of marker beds also seems to occur. This causes considerable uncertainty in correlation, so the reported Formation tops (Table GS-12-1) should be considered tentative pending compilation of all available data. Correlation of upper Ordovician strata is somewhat uncertain, and several additional core holes in this area may be required to establish firm correlations.

Hole M-3-78 also provided new data as to facies changes within the Ordovician strata. In particular, almost complete dolomitization of Red River strata is evident in this hole, in sharp contrast to the predominantly limestone sequence in the Lake St. Martin area, 56.3 km to the southeast. This extensive dolomitization virtually precludes any possibility of subdividing the Red River Formation into the three members defined for the southern part of the Province, namely, Dog Head, Cat Head and Selkirk.

Hole M-4-78 was located on Denbeigh Point, at the northeast end of Lake Winnipegosis. Silurian outcrop at this location is stratigraphically the highest known in the northern portion of the outcrop belt, and this hole provides structural and stratigraphic data for essentially the complete Silurian section. Hole M-4-78 was drilled deep enough to overlap the Cominco Denby No. 1 core hole, located 22 km to the northwest, so that the two holes together provide a complete stratigraphic section from uppermost Silurian to Precambrian. The argillaceous, sandy marker beds used to subdivide the upper Ordovician and Silurian section are well developed in these holes, but precise correlation with data from other areas, such as hole M-3-78, is somewhat uncertain because of cyclical repetitions in lithology, and the apparent omission of some marker beds.

Denby 2 Anomaly: *Hole M-5-78* was intended to test the major structural/stratigraphic anomaly intersected by the Cominco Denby No. 2 core hole, drilled in 1971. This anomaly has not specifically been referred to in any published reports, although the anomalous data have been shown in the Stratigraphic Map Series issued by the Department. Consequently, a brief outline of this anomalous structure will be presented, even though the M-5-78 core hole did not materially aid in interpreting the feature.

According to company logs, the Cominco Denby No. 2 core hole intersected, below glacial till, a "deep layered soil section (91.4 m thick) consisting of a red, blue, and grey clay containing a thick layer of uniformly sorted fine sand. In the layered complex, sheets of limestone (which may or may not have been boulders) about 3 to 4 m thick were found. Large marcasite concretions were found in the blue and grey clay and a large amount of marcasite was found in the limestone boulders".

In view of somewhat similar, but thinner occurrences known to occur elsewhere in southwestern Manitoba, it seems probable that the above sequence of sediments is Mesozoic

(Cretaceous?) in age and represents some type of channel or karst deposit.

Below the sand-clay-limestone sequence, the Denby No. 2 hole intersected a thin section of Paleozoic dolomite from 114 to 130.1 m, and passed directly into Precambrian serpentinite at 130.1 m. The elevation of the Precambrian surface in this hole is approximately 106.7 m above that indicated by regional data, and by data from the Cominco Denby No. 1 core hole, located only 10 km to the northwest. The Denby No. 1 hole intersected a completely normal Paleozoic sequence, with Precambrian (ultrabasic) rocks at a depth of 208.5 m.

Examination of Paleozoic core for the Denby No. 2 hole indicates that the Paleozoic strata are Ordovician, probably basal Red River Formation, and are normal dolomites, although somewhat fractured and weathered in appearance. The basal Paleozoic Winnipeg (sandstone) Formation was either not present or very thin in this hole. The suggested Paleozoic correlations indicate that the Precambrian high cannot be a simple erosional high (monadnock) on the Precambrian erosion surface, and that 80 to 105 m of local post-Ordovician, probably pre-Mesozoic, structural uplift has occurred in the vicinity of the Denby 2 location (15-30-46-16W).

The origin of the Denby 2 structure is highly problematical. It was hoped that hole M-5-78 would provide further data as to the extent and nature of the structure, but the hole had to be abandoned in heavy glacial till (The Pas Moraine) at a depth of 25 m. The only other local Precambrian structural anomalies in any way comparable to the Denby 2 structure, are associated with known or postulated crypto-explosion (meteorite impact?) features (e.g. Lake St. Martin). The Denby 2 structure may thus represent still another ancient impact crater — possibly the fifth such structure in Manitoba. Unfortunately, further data will be extremely difficult to obtain, since the anomaly area is completely covered by a thick mantle of glacial till, and surface access to the site, which was visited this summer, is extremely difficult due to very soft muskeg. The poor ground conditions rule out the possibility for further drilling in the immediate area of the anomaly, unless all-terrain tracked vehicles are used, or winter drilling is undertaken. Both of these alternatives are beyond the present scope of the drill programme. Redrilling at the M-5-78 location could possibly provide data as to the extent of structural deformation, and ground gravity and/or eletromagnetic surveys could possibly aid in determining the nature of this feature.

Hole M-6-78 and *M-6A-78* were located on the flank of a large Devonian (Winnipegosis) reef complex immediately north of the Overflowing River on Dawson Bay. A number of Devonian outcrops occur on and flanking several prominent, reef-controlled topographic highs. A previous Winkie core hole (M-7-72) located near the highest point of the reef exposure was drilled to a total depth of 64 m, but had to be abandoned before reaching the base of the reef. Hole M-6-78 was located so as to determine reef thickness, to obtain data as to near reef-flank facies, and to provide structural data to define more accurately the Silurian-Devonian contact northwest of Dawson Bay. No outcrops are known to occur in this area and structural data were not sufficient to delimit the position of the contact with any degree of accuracy.

The original site chosen for this drill hole was immediately adjacent to a flat-lying outcrop ledge beside Highway 10. However, to facilitate drilling procedures, the location was moved approximately 60 m north so as to be closer to the available water supply. Unexpectedly, over that limited distance, glacial till thickened to 20.5 m and beneath this, hole 6A intersected a red to white sand and shale, believed to be of Mesozoic age, and probably a channel or karst infill. Because of the difficulty in drilling and uncertainty as to thickness of the Mesozoic deposits, it was decided to abandon this location and move back to the original drill site, where a normal, section of Upper Winnipegosis mixed inter-reef and reef flank facies was encountered. By extrapolation, the minimum Winnipegosis reef thickness, based on the elevation of the partly eroded reef crest, is approximately 70 m, surprisingly high considering that this is the closest occurrence of Devonian strata to the erosional edge of the unit in this area.

Hole M-7-78 was located on the western shore of Swan Lake, immediately southwest of several Devonian (Souris River and Dawson Bay) outcrops that represent the most southwesterly occurrences of Devonian strata in this area. The purpose of the hole was to obtain regional structural data, to determine the possible reef thickness, and to clarify correlation of upper Devonian strata. The prognosis as to regional structure in the area, and the estimate of overburden thickness (based on a hammer seismic survey) proved to be reasonably accurate. "Bedrock", however, consisted of 88.9 m of monomict to polymict dolomite-shale-limestone breccias overlying a "normal" inter-reef Winnipegosis sequence. The breccia fragments are generally identifiable as belonging to either Souris River or Dawson Bay units, and the sequence of breccias comprises a reasonably "normal" and complete stratigraphic sequence, with only a moderate degree of mixing of adjacent lithologies. The section is, however, more than an in-situ breccia of these upper Devonian beds. The mixing of lithologic types strongly suggests a true collapse brecciation, almost certainly the result of solution of the Prairie Evaporite beds, with formation of an open solution void prior to collapse. This type of salt collapse mechanism contrasts markedly with the almost total lack of brecciation effects in some outcrop areas farther north that have undergone an almost equal amount of collapse (e.g. Point Wilkins and Mafeking Quarry outcrops).

The total Winnipegosis thickness intersected in hole M-7-78 is only about 24 m, the thinnest inter-reef sequence cored to date in the outcrop belt. The Upper Winnipegosis beds consist of 9.9 m of both limestones and dolomites that range from argillaceous/bituminous laminates to granular vuggy dolomites and breccias. The Lower Winnipegosis platform beds consist almost entirely of limestone and comprise one of the few occurrences of this "Elm Point Facies", outside of the southern part of the outcrop belt.

The above-described core holes that intersected Mesozoic channel or karst deposits, or Devonian collapses breccias, show the considerable uncertainty involved in extrapolating Paleozoic outcrop data into areas of overburden cover. To date most core holes not located directly on Paleozoic outcrop have intersected anomalous channel fill or breccia sequences. This points out the possibility, or probability, that a considerable portion of the area of "no outcrop" may be underlain by such deposits, which are relatively soft and recessive and would not be expected to occur in outcrop. Compilation of all available water well data and exploration drilling data is presently underway to attempt to define the extent of such anomalous deposits. It is hoped to incorporate much of the resulting data in the forthcoming revision of the Geological Map of Manitoba. In large areas, however, no subsurface data are available, and the possibility of intersecting such anomalous features should be considered in any type of exploration or evaluation programme.

In addition to the core hole programme, a one-week field project was carried out in the Grand Rapids area to check data previously issued in Preliminary Map 1973M-1. New, more detailed topographic data are now available, and the recent core hole drilling has assisted in establishing regional correlations. Considerable revision of map 1973-M-1 will be required, and these data also will be incorporated into the revision of the Geological Map of Manitoba. Bedrock control of topography is prominent in the area, with at least 4 or 5 scarp forming units in the section, giving rise to almost 100 feet of local topographic relief in places. Repetition of lithologic sequences, and facies changes, coupled with the complex topography and the thinness of the formations pose considerable problems in defining accurately the formational contacts.

The 1979-80 core hole program hopefully will continue to obtain geological data in areas of sparse outcrop control, and to provide basic geological data for the industrial minerals inventory. Additional drilling may be undertaken in the area of the Lake St. Martin crater (vic. Tp. 32, Rge. 8W) to supplement geophysical studies (gravity and magnetic) carried out this summer by the Gravity and Geodynamics Division, Ottawa.

Table GS-12-1 Summary of Core Hole Data

Hole No.	Location and Elevation (est.)	Formation/Group/Member	Interval (metres)	Summary Lithology
M-3-78 (Devils Lake)	12-7-40-10W (• 259 1 m)		0 — 2 3	Gravel
		Interlake Group		
		Cedar Lake	2 3 — 17 3	Dolomite, dense and fragmental
		East Arm	17 3 — 24 8	Dolomite, algal, oolite, calcarenite
			24 8 — 31 3	Dolomite, sandy and argillaceous
		Atikameg	31 3 — 35 9	Dolomite, vuggy, fragmental
		Moose Lake/Inwood	35 9 — 57 0	Dolomite, stromatolitic
		Fisher Branch	57 0 — 61 6	Dolomite, fossiliferous
		Stonewall	61 6 — 73 6	Dolomite, sandy, argillaceous; breccia at top
		Stony Mountain		
		— Williams	73 6 — 79 7	Dolomite, shaly interbeds
		— Gunton	79 7 — 104 3	Dolomite, vuggy nodular
		— Gunn	104 3 — 117 4	Dolomite, slightly argillaceous, burrow-mottled
		Red River-Fort Garry	117 4 — 120 9	Dolomite, porous, bituminous(?) laminations
			120 9 — 124 1	Dolomite and limestone, laminated, breccia argillaceous
			124 1 — 129 3	Dolomite, laminated, silicified, breccia
			129 3 — 141 0	Dolomite, dense, mottled, slightly argillaceous
		— Selkirk	141 0 — 165 0	Dolomite, cherty, mottled
		— Cat Head	165 0 — 172 0	Dolomite, massive, slightly cherty
		— Dog Head	172 0 — 201 0	Dolomite, slightly mottled
		Winnipeg	201 0 — 202 8	Shale, grey, massive, silty
M-4-78 (Denbeigh Point)	SW12-19-45-16W (• 254 5 m)	Interlake Group		
		Cedar Lake	0 — 28 5	Dolomite, sublithographic and fragmental
		East Arm	28 5 — 36 9	Dolomite, algal, fragmental
			36 9 — 45 8	Dolomite, algal, breccia, sandy
		Atikameg	45 8 — 50 5	Dolomite, granular, vuggy
		Moose Lake/Inwood	50 5 — 58 9	Dolomite, aphanitic/fragmental
			58 9 — 60 0	Dolomite, sandy, silty; breccia
			60 0 — 68 0	Dolomite, earthy, argillaceous
		Fisher Branch	68 0 — 74 3	Dolomite, fossiliferous
		Stonewall	74 3 — 74 5	Dolomite, argillaceous, silty
			74 5 — 79 0	Dolomite, fossiliferous, laminated, conglomeratic
			79 0 — 80 9	Argillaceous dolomite; sandy breccia at base
			80 9 — 90 0	Dolomite, nodular
		Stony Mountain		
		— Williams	90 0 — 90 7	Argillaceous dolomite; breccia
		— Gunton	90 7 — 93 5	Dolomite, nodular
M-5-78 (Denbeigh North)	NC7-33-46-16W (• 280 4 m)		0 — 24 4	Boulder till (The Pas Moraine)
M-6-A-78 (Overflowing River)	5-7-48-25W (• 259 m)		0 — 20 5	Till
		Mesozoic (Cretaceous?)	20 5 — 29 7	Sandy shale and sandstone
			29 7 — 31 0	Variegated shale, minor sand
M-6-78 (Overflowing River)	5-7-48-25W (• 258 m)		0 — 2 8	Till
		Dawson Bay	2 8 — 5 0	Limestone, biomicrite
		Second Red	5 0 — 14 5	Dolomitic shale, brecciated
		Winnipegosis (reef flank facies)	14 5 — 14 8	Limestone, dense, stylolitic
			14 8 — 30 2	Dolomite and limestone, massive
			30 2 — 53 6	Dolomite, massive, vuggy, fossiliferous
			53 6 — 59 7	Dolomite, interbedded bituminous and fragmental
		(platform)	59 7 — 70 5	Dolomite, massive, vuggy
		Ashern	70 5 — 74 8	Shale, dolomitic, grey-brown
M-7-78 (Swan Lake)	NE2-21-41-24W (• 259 m)		0 — 7 1	Till
		Breccia	7 1 — 96 2	Limestone/shale/dolomite breccia with fragments from Souris River and Dawson Bay (collapse breccia)
		Winnipegosis (Inter-reef facies)	96 2 — 97 3	Dolomite, vuggy
			97 3 — 102 5	Limestone, laminated, breccia
			102 5 — 106 1	Limestone and dolomite
		(platform)	106 1 — 119 9	Limestone, massive, mottled
		Ashern	119 9 — 124 2	Shale, dolomitic, grey to brown

Note Data for core holes M-1-78, M-2-78, M-8-78, M-9-78 and M-10-78 are presented by B Bannatyne in the industrial mineral evaluation section of this report

LIST OF PRELIMINARY GEOLOGICAL MAPS — 1978

1978B-1	McNeill Lake (630-3) by P.G. Lenton	1: 50 000
1978B-2	Pistol Lake, West Half (630-2 W1/2) by P.G. Lenton	1: 50 000
1978F-1	Geology of the West Part of Kenora Sheet (52E) by D.A. Janes	1:250 000
1978F-2	Geology of the West Part of Pointe du Bois Sheet (52L) by D.A. Janes	1:250 000
1978F-3	Geology of the West Part of Carroll Lake Sheet (52M) by D.A. Janes	1:250 000
1978L-1	Preliminary Compilation of the Lynn Lake Area (64C-12, 15 and Parts of 10, 11, 14, 16) by H.V. Zwanzig, H.P. Gilbert and E.C. Syme)	1:100 000
1978L-2	Eden Lake (64C-9) by M. Cameron	1: 50 000
1978M-1	Preliminary Compilation of the Northern Indian Lake Area (64H) by W.D. McRitchie and J. Peters	1:250 000
1978M-2	Preliminary Compilation of the Compilation of the Split Lake Area (64A) by M.T. Corkery	1:250 000
1978N-1	Bulger Lake (63P-3) by J.J.M.W. Hubregtse, R.T. Kusmirski and R. Charbonneau	1: 50 000
1978N-2	Sipiwesk Lake (63P-4) by J.J.M.W. Hubregtse, R.T. Kusmirski and R. Charbonneau	1: 50 000
1978N-3	Wintering Lake (63P-5) by J.J.M.W. Hubregtse, R. Charbonneau and N.G. Culshaw	1: 50 000
1978N-4	Landing Lake (63P-6) by J.J.M.W. Hubregtse and R. Charbonneau	1: 50 000
1978N-5	Duck Lake (63J-16) by J.J.M.W. Hubregtse, N.G. Culshaw and R.T. Kusmirski	1: 50 000
1978N-6	Hill Rapids (63I-13) by J.J.M.W. Hubregtse and R.T. Kusmirski	1: 50 000
1978N-7	White Rabbit Lake, West Half (63I-14 W1/2) by J.J.M.W. Hubregtse	1: 50 000
1978S-1	Preliminary Compilation of the Whiskey Jack Lake Area (64K) by D.C.P. Schledewitz	1:250 000
1978T-1	Ospwagan, Middle and Mid Lakes (Parts of 630-9 and 63P-12) by J.J. Macek and J.K. Russell	1: 25 000

1978T-2	Paint Lake (Central Part) and Liz Lake (Parts of 630-8, 9; 63P-5,12) by J.J. Macek and J.K. Russell	1: 25 000
1978U-1	Armstrong Lake (63P-10) by W. Weber	1: 50 000
1978U-2	Pikwitonei (63P-11 and Parts of 63P-12 and 63P-14) by W. Weber and J. Malyon	1: 50 000
1978U-3	Arnot (63P-15 and Parts of 64A-2) by W. Weber and J. Malyon	1: 50 000

GS-14 REGIONAL GEOPHYSICAL SURVEYS

by N. Soonawala

URANIUM RECONNAISSANCE PROGRAM

During the summer of 1978, about 88 400 km², were surveyed by the Geological Survey of Canada's high sensitivity airborne spectrometer system under the joint Federal-Provincial Uranium Reconnaissance Program, bringing to about 347 000 km² the total area covered to date by this system in Manitoba. The first surveys under the URP were flown in the Province in 1975, and the progress since then has been as follows:

Survey Year	Location	NTS Reference	Approx. Survey Area (km²)	Release Date
1975	Kasmere Lake region	64 N, O, K, J, F	60 000	March 24, 1976
1976	Churchill region	64 P, I, G 54 M(W½), 54 L(W½)	50 000	March 28, 1977
1976	East of Lake Winnipeg	52 E(W½), 52 L(W½) 52 M(W½), 53 D(W½) and parts of 62 I, 62 P and 63 A	45 000	August 24, 1977
1977	Lynn Lake area	64 C	13 500	June 15, 1978
1977	Gods Lake area Northeast Manitoba	63 H, I, 53 L, M, N, E, F, K	90 000	July 26, 1978
1978	Central Manitoba	63 N, O, P, 64, A, B, and parts of 63J and K	88 400	mid 1979

Figure GS-14-1 indicates the coverage.

All the above surveys were flown at a line spacing of 5 km, sensor altitude of 120 m and aircraft speed of 190 kph. The high sensitivity spectrometer system used thallium activated sodium iodide sensors totalling 50 litres in volume. The digitized pulses are summed to produce counts in the following four windows: total count, 0.41 — 2.81 MeV; potassium — 40, 1.37 — 1.57 MeV; bismuth — 214, 1.67 — 1.87 MeV; and thallium — 208, 2.41 — 2.81 MeV. The counts from these windows are recorded on digital tape along with altimeter and navigational data for computer processing. All surveys except those flown in 1975, also included a total field magnetic survey. Data processing of the radiometric data include corrections for background, deviation from planned altitude and spectral scattering. The gamma flux in every channel is converted to equivalent concentration of the radioelement. The data, in the form of contour maps and stacked profiles, are presented at a scale of 1:250 000. For each area the following seven contour maps are produced: total count, equivalent uranium (eU), equivalent thorium (eTh), equivalent potassium (eK), eU/eTh, eU/K and eTh/K. Profiles are presented for the same seven parameters and where applicable, the total magnetic field. The radiometric profiles are based on gamma flux gathered over 2.5 seconds for the total count. The contour maps are based on data points averaged from seventeen such counting intervals.

As indicated in Figure GS-14-1, over areas north of the 58th parallel the URP also included a concurrent geochemical survey. Organic-rich sediments from the deepest parts of suitable lakes were used. Surface lake waters were also analyzed for uranium. The average sample density was one sample per 13 km². Uranium in waters was determined by fluorometry. The sediment after being dried and sieved at minus 80 mesh was analyzed for U, Zn, Cu, Pb, Ni, Co, Ag, Mn, Fe, Mo, As, Hg and loss on ignition. Uranium concentration was determined by the delayed neutron activation method. Data were plotted on maps of scale 1:250 000 using symbols to represent selected concentration ranges, determined by computer-assisted statistical analysis.

The Uranium Reconnaissance Program for 1977 also included an aeromagnetic gradiometer survey over a 2 000 square kilometre area in the Kasmere Lake sheet (64 N)

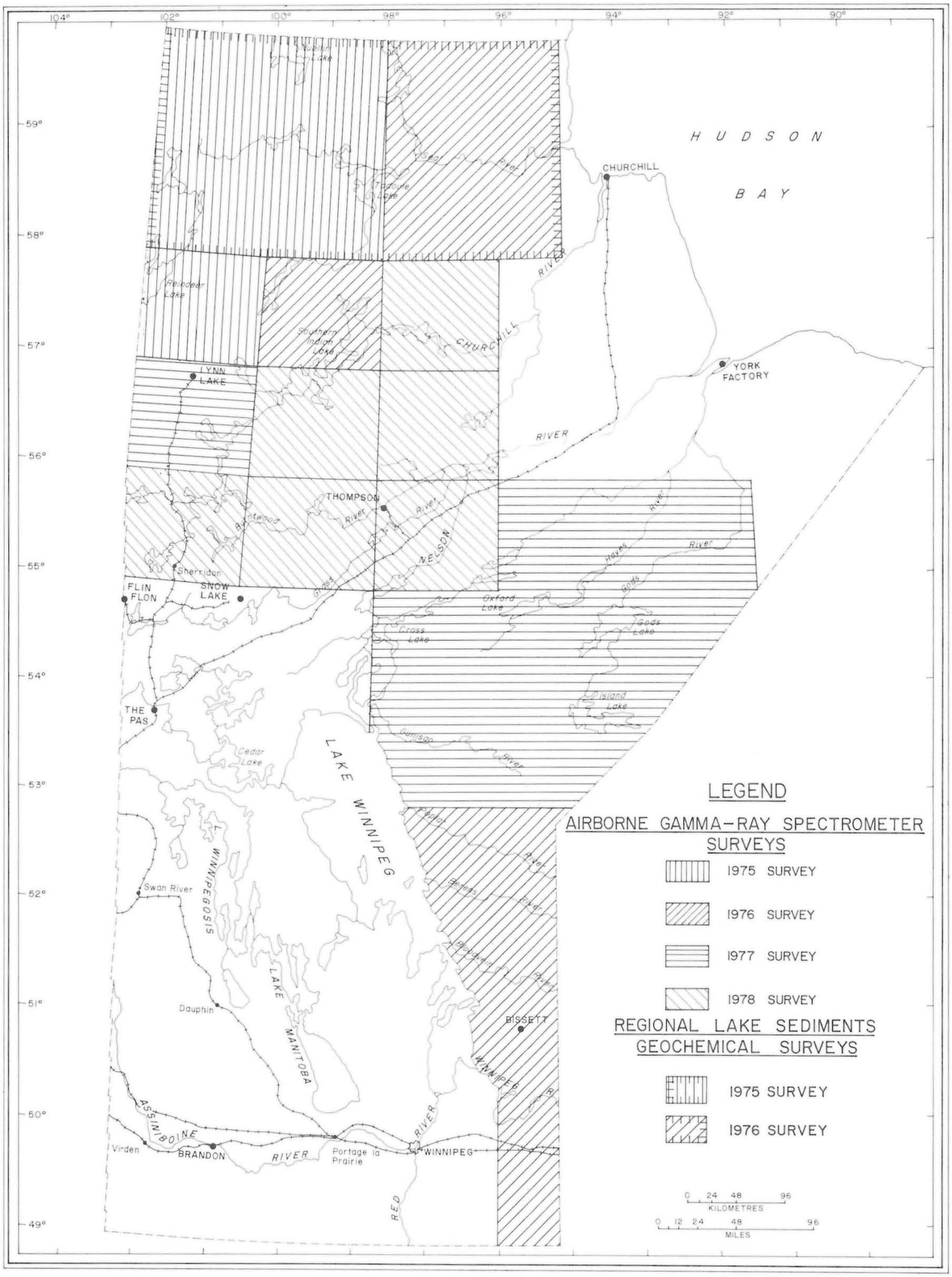


Figure GS-14-1: Uranium Reconnaissance Program Surveys in Manitoba.

Correction: Sheet 64H (Northern Indian Lake) has not been surveyed. Substantial parts of 63J and K (Wekusko and Cormorant Lake) have been surveyed.

indicated in Figure GS-14-2. The survey system was the Geological Survey of Canada's inboard vertical gradiometer, mounted on a Beechcraft B80 aircraft. The data were gathered at sensor altitude 150 m and flight line spacing 300 m. Two rubidium-vapour magnetometers at a vertical separation of 2.08 metres were employed. The preliminary maps were released on June 8, 1978.

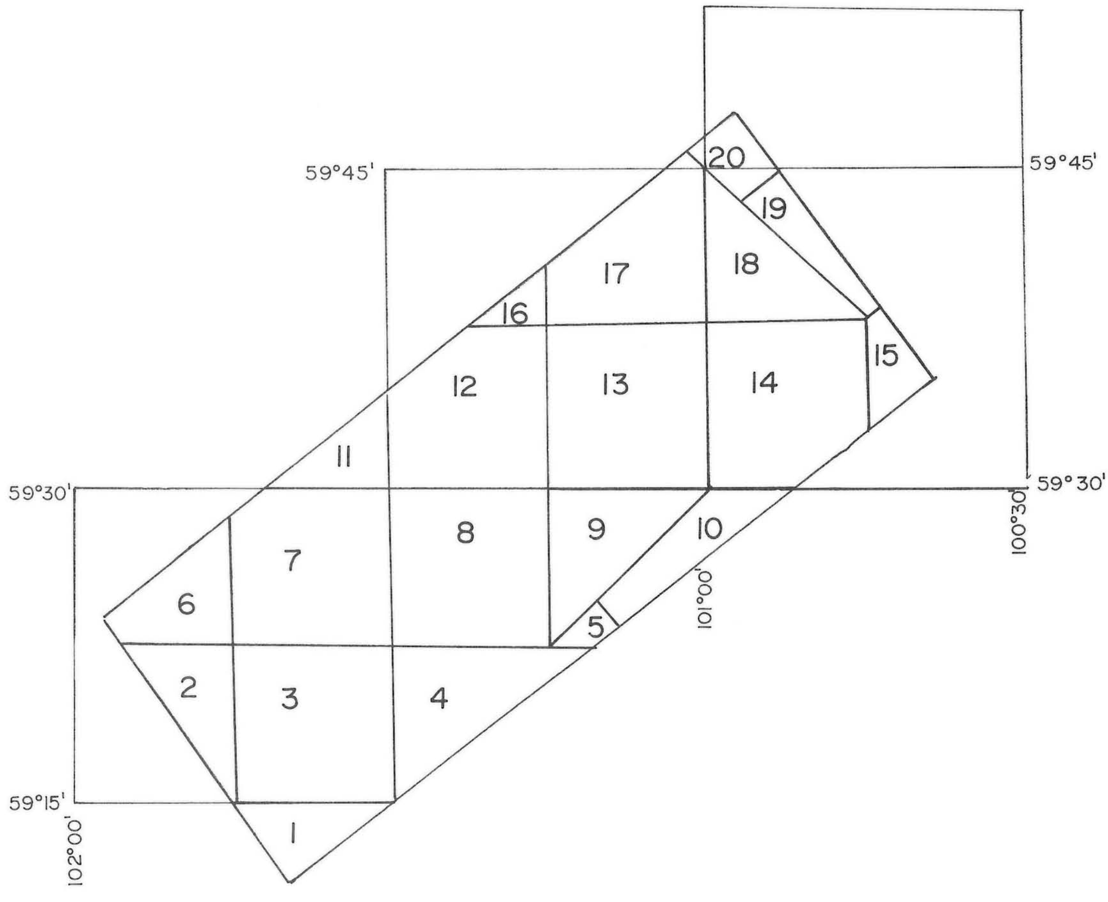


Figure GS-14-2: Aeromagnetic gradiometer survey — Kasmere Lake (64N).

EVALUATION OF URP DATA

Airborne gamma-ray spectrometer anomalies can be caused by a number of situations, of which the presence of economic uranium mineralization is only one. With this in view, preliminary evaluation has been undertaken of the URP anomalies recorded in the Province. It is a process which involves the following steps: identification of uranium-rich zones from the URP data, accurate field location of anomalous areas with the aid of a helicopter-borne scintillometer, ground examination in selected areas consisting of gamma spectrometer determinations, geological observations and sample collection, and laboratory analysis of samples to determine their radio-element content. Data gathered from the exploration-oriented surveys of the now defunct Exploration Operations Branch of the Mineral Resources Division has been extensively used for the evaluation, and additional field data was acquired during the 1978 field season from three locations in northeastern and southeastern Manitoba.

On the basis of the URP radiometric data released up to 1978, approximately six zones of uranium enrichment each of dimensions 150-200 km can be identified in the Province, in three widely separated areas. The first of these areas can be considered to be the whole of the Province north of the 58th parallel. The second area is an east-west trending zone about 150 km long, between Red Sucker and Molson Lakes, i.e., just north of the 54th parallel; and the third major area of regional uranium enrichment is in southeast Manitoba approximately in the region bounded by Winnipeg and the Wanipigow Rivers.

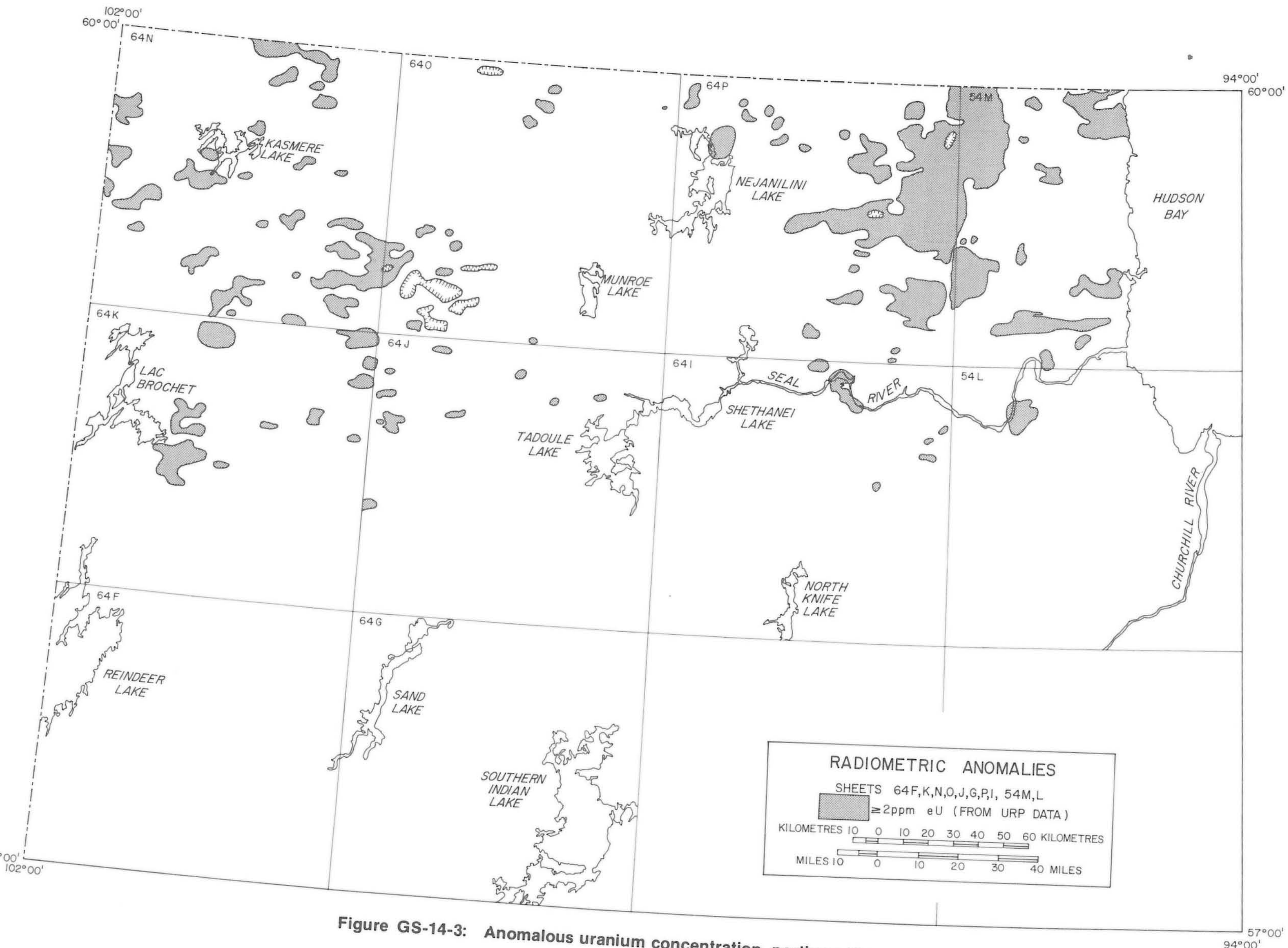


Figure GS-14-3: Anomalous uranium concentration, northern Manitoba.

Figure GS-14-3 encompasses approximately 130 000 km^2 with 80% of this area being north of 58 degrees. The shaded areas in this figure correspond to uranium enrichment equalling or exceeding 2 ppm equivalent uranium as recorded in the uranium channel of the radiometric system employed for the URP surveys. Note that this data has been extracted from the contour maps and not the profiles, i.e., it is the result of a moving average of seventeen digital measurements. Charbonneau et al. (1976) have reported that with the URP radiometric system, uranium concentration in bedrock is likely to be about 2.5 times that indicated by the airborne data. Thus a threshold of 2 ppm would correspond to about 5 ppm in bedrock, which is approximately the Clark value for granitic rocks. From Figure GS-14-3 it is evident that in the area north of 58° there are two discrete zones of uranium enrichment. One is a northeast trending feature in the western half (sheets 64 K, N and O) and the other is in the northeastern portion (sheets 64 P and 54 M). The first of these roughly corresponds to the Wollaston Fold Belt and is the extension of a zone of similar enrichment in Saskatchewan. A fair amount of detailed exploration has been done in the past few years over this zone, by both exploration companies and the now defunct Exploration Operations Branch of the Mineral Resources Division. The latter work consists of about 5000 linear kilometres of detailed helicopter scintillometer survey, detailed lake sediment sampling and ground follow-up including drilling. This work has been reported in the Divisional Reports of Field Activities for 1976 and 1977. The general conclusion which can be reached on the basis of this follow-up is that the radiometric anomalies in northwestern Manitoba correspond to the following three rock types described by Weber *et al.* (1975): (a) northeast-southwest trending belt of metasediments, within which fairly large zones of anatectic leucogranites are anomalously radioactive, (b) batholiths of Hudsonian intrusive granites, and (c) Archean granites. The anomalous zone in the northeast part of Figure GS-14-3 has not as yet been investigated in detail by geophysical or geochemical methods. However, Schledewitz (1977) has made preliminary observations which indicate that it corresponds to a zone of quartz monzonites.

Figure GS-14-4 indicates zones of uranium enrichment exceeding 2 ppm over a 90 000 km^2 area in northeast Manitoba. One 150 km long trend between Red Sucker and Molson Lakes stands out prominently in this area which has an otherwise low uranium background. Three individual areas within this trend have been investigated in some detail. Investigations northwest of Red Sucker Lake were done in 1977 and have been reported in the Report of Field Activities, 1977. In the current field season, field checking of two more areas in this trend was undertaken. Figure GS-14-5 shows the results of a total count helicopter scintillometer survey, south of Beaver Hill Lake, which utilized a 1.8 litre sensor flown at 40 m altitude at a speed of about 110 kph. Background over dry ground was about 500 cps. Amplitudes exceeding 1400 cps have been noted. Preliminary ground follow-up was done near the peak of 1375 cps about half-way down line 34. It included measurements with a calibrated digital gamma-ray spectrometer on eight stations along a 50 m by 50 m square grid. Five samples were also collected for laboratory analysis. The statistics of the radio-element measurements are as follows:

Determination	**Number of Samples**	**Range**	**Mean**	**Standard Deviation**
Spectrometer:				
eU	8	16-70 ppm	44 ppm	23 ppm
eTh	8	31-91 ppm	49 ppm	21 ppm
K	8	2-6%	4%	1.37%
Laboratory Assay:				
U	5	5.8-36.9 ppm	18.8 ppm	14.1 ppm
Th	5	23-79 ppm	50.4 ppm	26.9 ppm
K	5	2.47-7.5%	4.67%	1.93%

All the ground measurements at the Beaver Hill anomaly were made on boulders, all of which were of medium grained pink granodiorite, with varying amounts of biotite and hornblende. Several coarse pegmatitic phases of widths from a few tens of centimetres to a metre were also

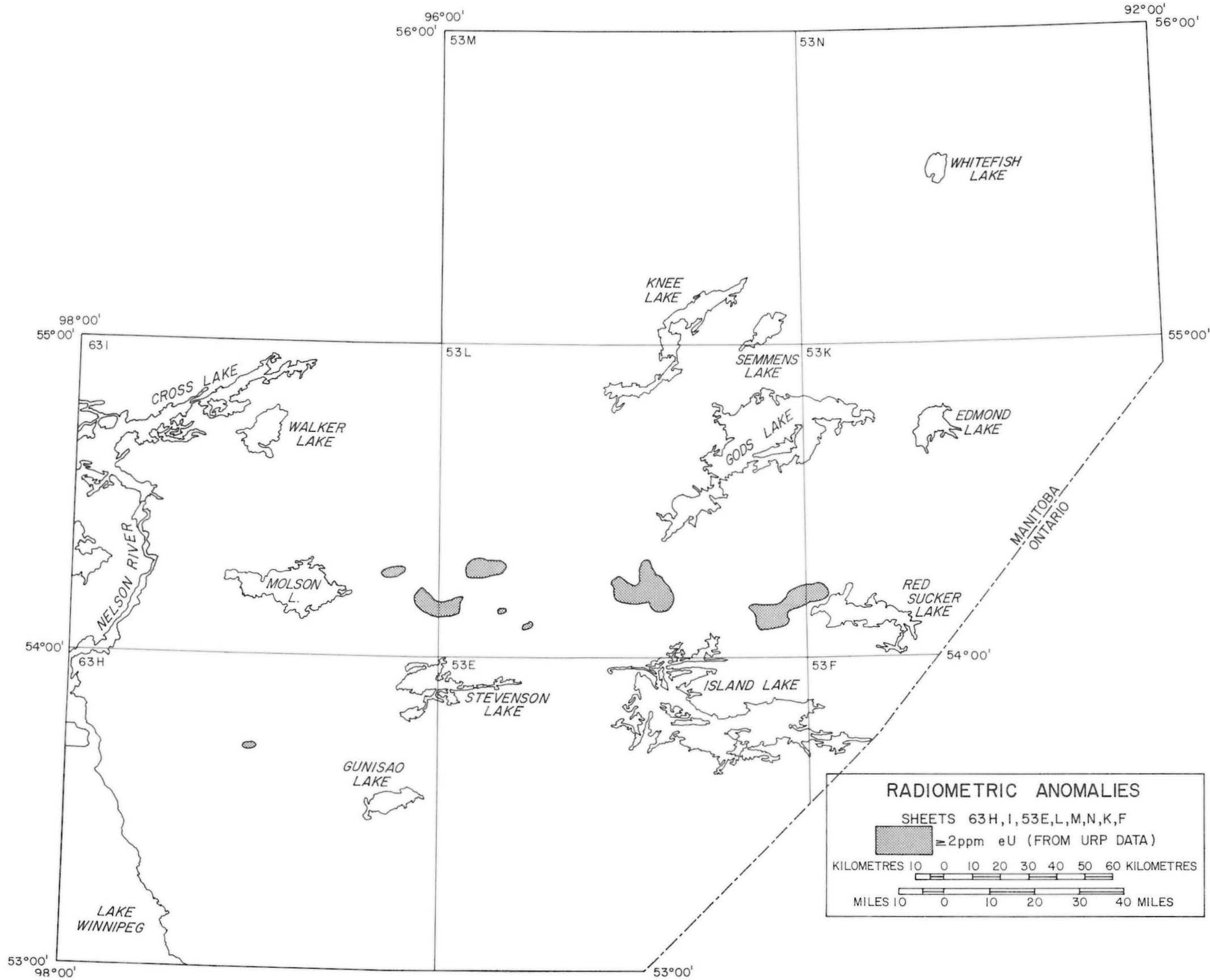


Figure GS-14-4: Anomalous uranium concentration, central Manitoba.

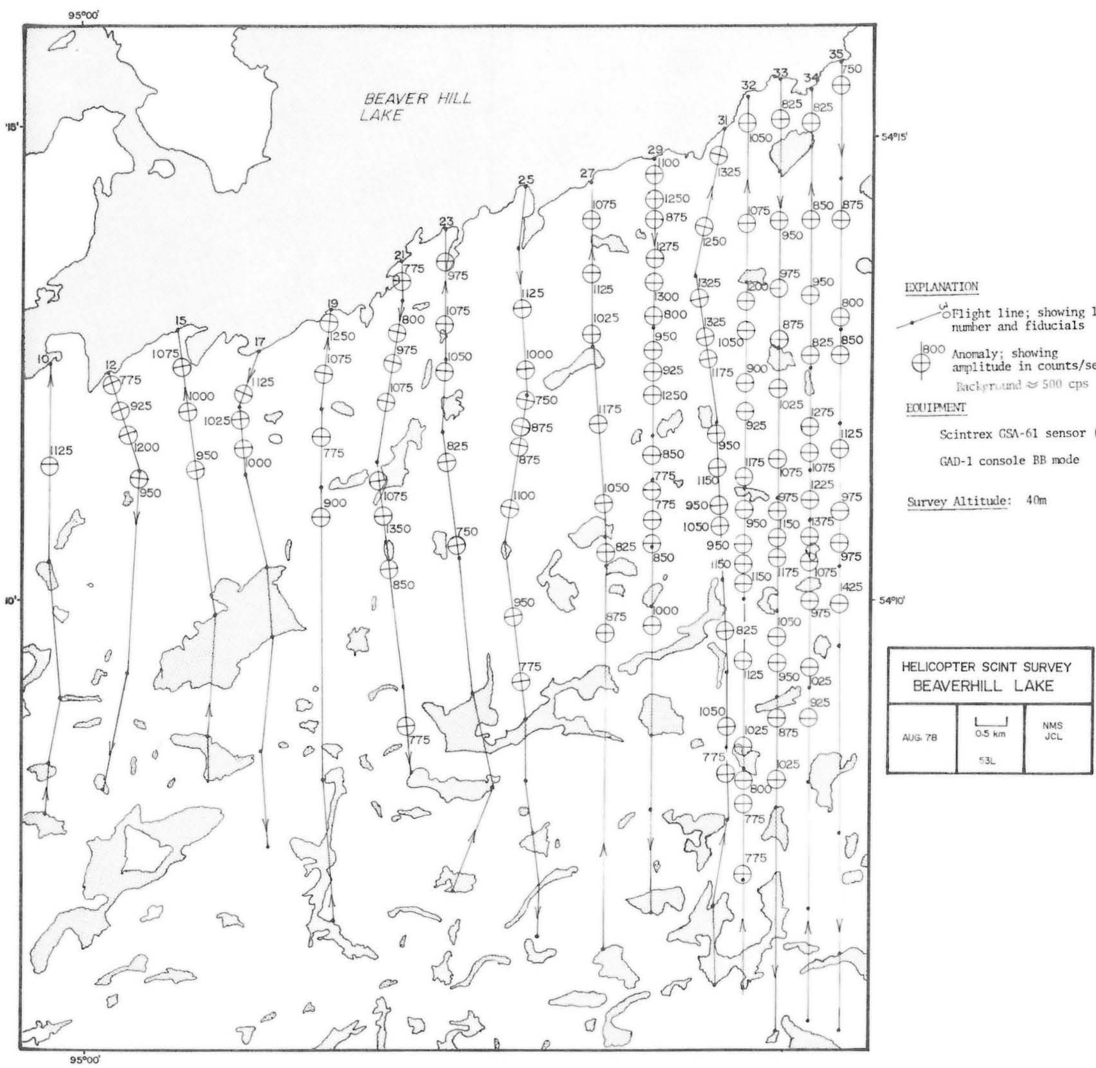


Figure GS-14-5: Helicopter scintillometer survey, Beaver Hill Lake.

observed. The boulders were angular and about a metre in length. They appeared to have been frost heaved. A uniform count of about 300 cps was observed on the Scintrex BGS-1SL broad-band scintillometer which has a sensor of volume 43 cm^3.

A helicopter-borne scintillometer survey and ground check was also done in an area north of Little Bolton Lake, about 90 km to the west of the Beaver Hill area. Figure GS-14-6 gives the results of the helicopter survey. With an approximate background of 500 cps over dry ground, peaks of amplitude 1075 cps have been recorded. A ground spectrometer check, similar to the one described for the Beaver Hill area, was done at the peak of 1050 cps about mid-way along line 9. The results were as follows:

Determination	Number of Samples	Range	Mean	Standard Deviation
Spectrometer:				
eU	8	11-61 ppm	23 ppm	16 ppm
eTh	8	29-57 ppm	38 ppm	12 ppm
K	8	2-5%	4%	1.73%
Laboratory Assay:				
U	4	5.7-14.1 ppm	11.2 ppm	3.91 ppm
Th	4	6-167 ppm	77.2 ppm	70.9 ppm
K	4	1.81-6.58%	4.2%	2.46%

The rock types were very similar to those described for the Beaver Hill area. Medium grained pink granodiorite was the predominant rock type, with several pegmatitic phases. The ground check was done in an area of outcrop. Readings of up to 600 cps on the BGS-1SL scintillometer.

Figure GS-14-7 indicates areas over which radiation equal to or exceeding 2 ppm eU was recorded in the URP radiometric survey in southeastern Manitoba. The majority of the anomalies are between 50° and 51° N. Except for a rather unusual north-south trending feature, two zones can be identified. The northern one is an extension from Ontario of the Sydney Lake zone. A part of it, in the Manigotagan-Flintstone Lakes area was investigated by a detailed helicopter-borne scintillometer survey and ground follow-up, by the Mineral Resources Division in the 1976 field season (Soonawala and Whitworth, 1977). During the current field season, a portion of the southern anomaly was investigated with a detailed helicopter survey and subsequent ground check. Figure GS-14-8 gives the results of the helicopter survey. Ground follow-up was done on the anomalies near the south ends of lines 13 and 14. Actually, the peaks marked "850" on line 14 and "1050" on line 13 were examined. Sixty-four measurements were made by a digital gamma-ray spectrometer on a 50 m by 50 m grid. Another eighteen such readings were taken at an area about 1.5 km to the northeast, i.e., the two northernmost anomalies on line 15. The statistics of the radio-element measurements (for both areas combined) are as follows:

Determination	Number of Samples	Range	Mean	Standard Deviation
Spectrometer:				
eU	82	0-63.88 ppm	18.35 ppm	14.1 ppm
eTh	82	0-67.94 ppm	23.69 ppm	16.3 ppm
K	82	0-6.43%	3.01%	1.58%
Laboratory Assay:				
U*	14	3.2-53 ppm	18.6 ppm	14.8 ppm
Th**	14	0-72 ppm	40.07 ppm	21.25 ppm
K	15	1.31-8.44%	4.84%	2.3%

* one sample assaying 210 ppm not included.
** one sample assaying 405 ppm not included.

Most of the spectrometer readings during the ground check was taken on outcrop of granitic rocks, of quartz diorite to quartz monzonite composition, and medium texture. Coarse grained potash feldspar porphyroblasts about a few centimetres across were encountered, some of which had a radiation intensity reaching 1600 cps on a BGS-1SL scintillometer, and readings on the spectrometer which would correspond to approximately 300 ppm uranium. Both anomalies were located on ridges about 20 m high, which might have had a minor effect in boosting their amplitudes.

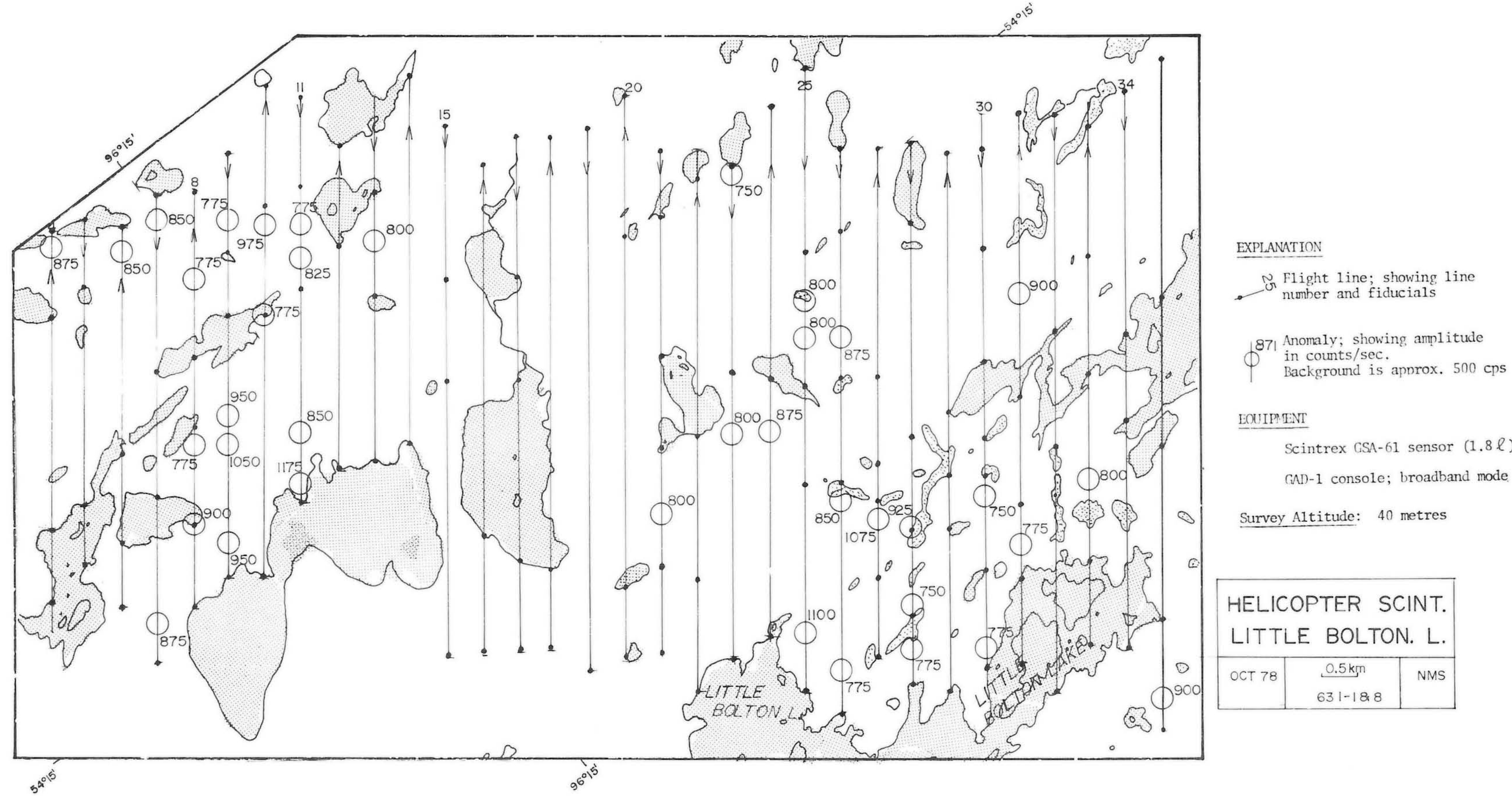


Figure GS-14-6: Helicopter scintillometer survey, Little Bolton Lake.

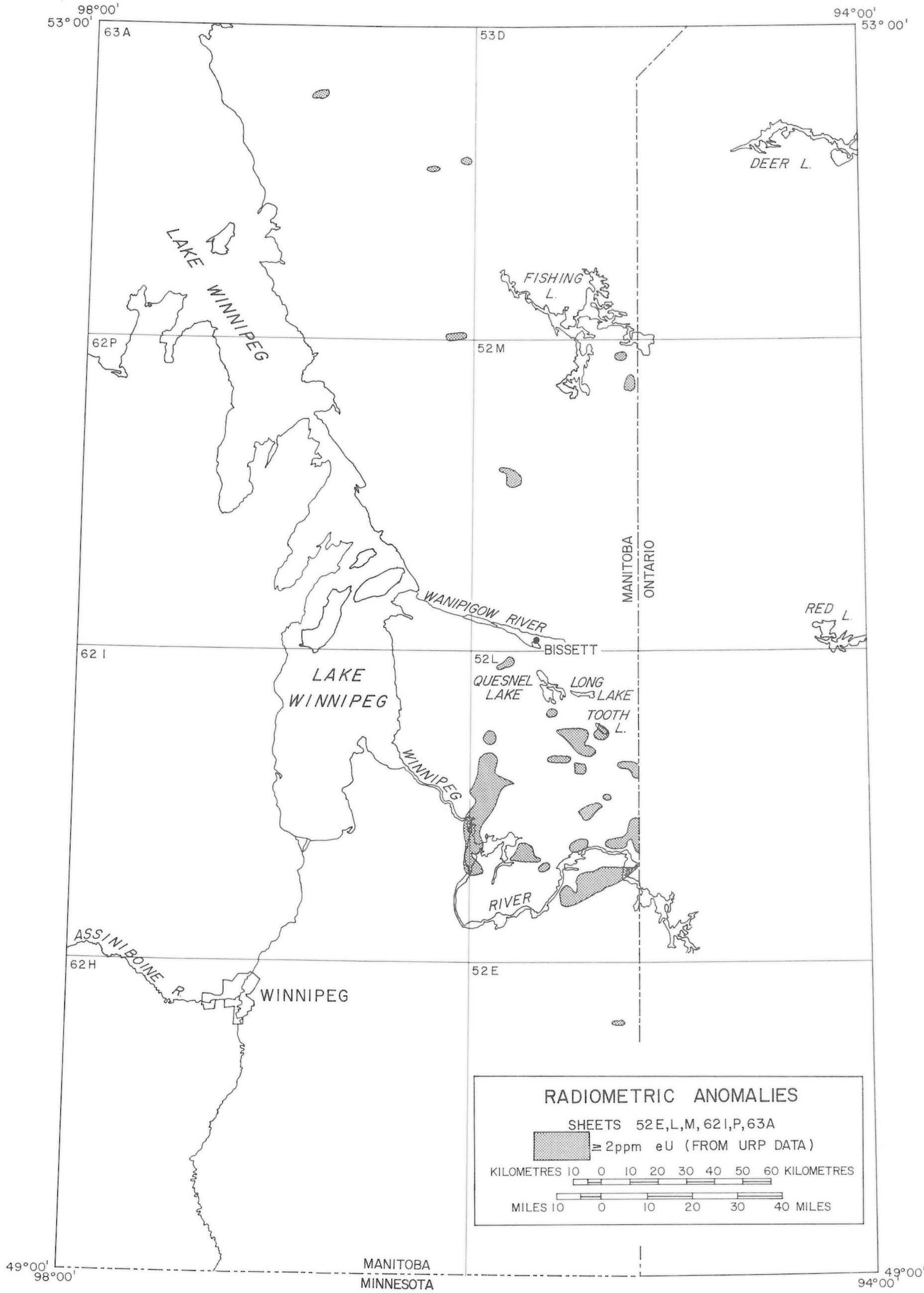


Figure GS-14-7: Anomalous uranium concentration, southeastern Manitoba.

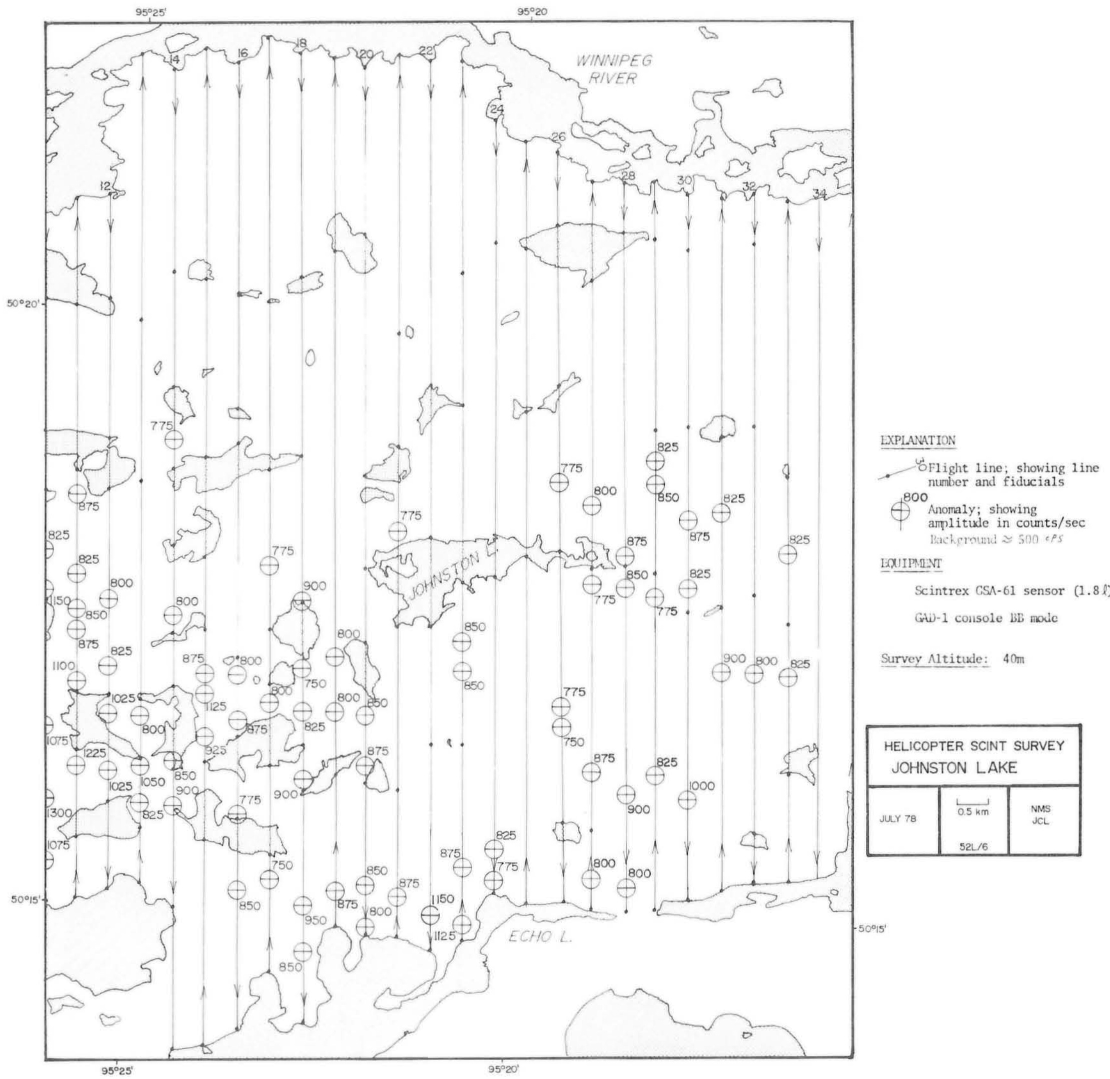
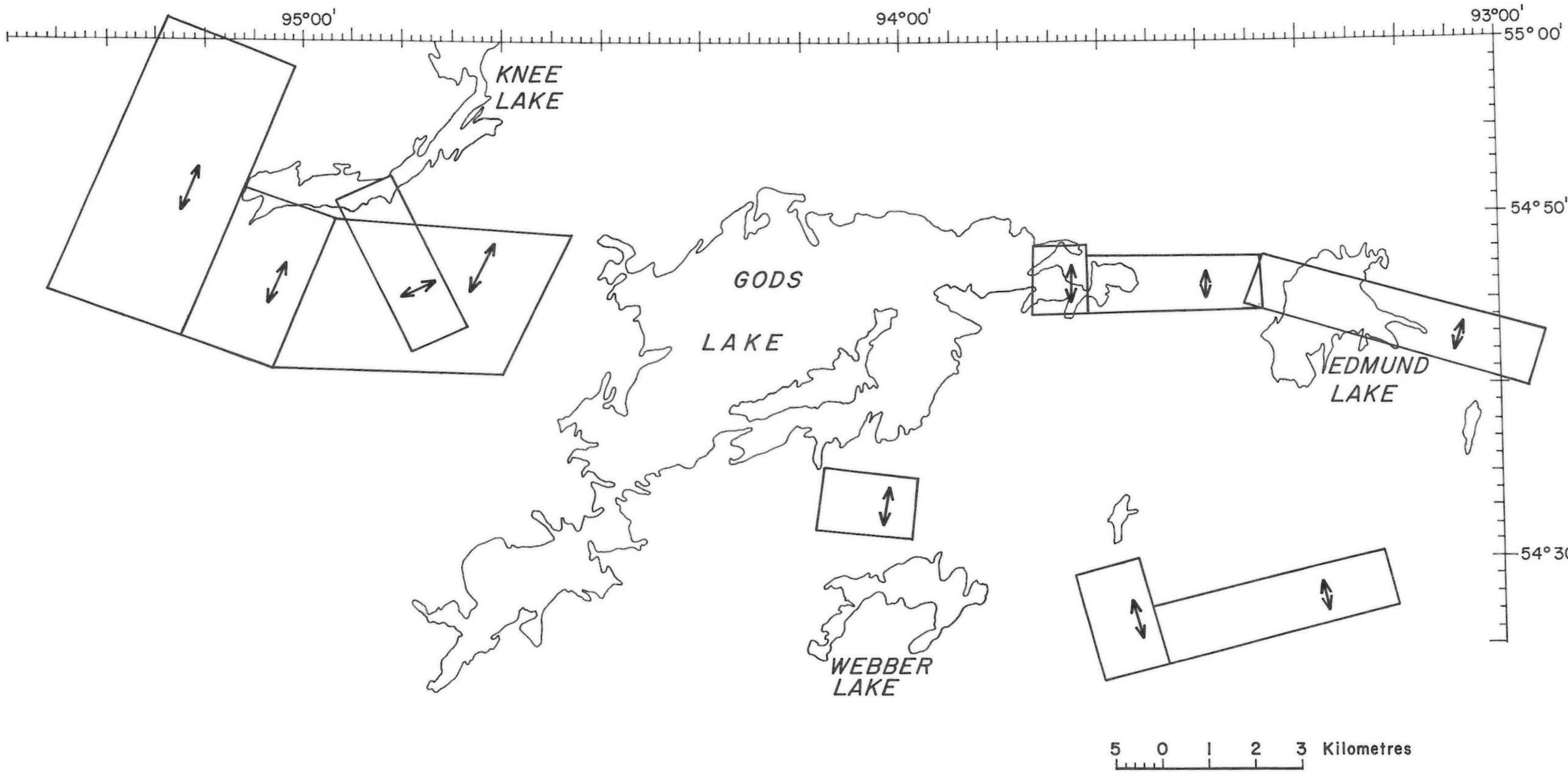


Figure GS-14-8: Helicopter scintillometer survey, Johnston Lake.

ELECTROMAGNETIC (INPUT)-MAGNETIC SURVEY

About 2000 square kilometres in NTS areas 53 K and 53 L were surveyed under contract to Questor Surveys Ltd. with the Questor INPUT system in November and December 1977 and February and March 1978. Figure GS-14-9 indicates the areas covered. It may be noted that two separate areas, i.e., Oxford-Knee and Edmund-Sharpe-Stull Lakes areas were surveyed. The results were released on June 15, 1978. The Mark VI INPUT system and Geometrics G803 proton precession magnetometer were employed. Flight line spacing was 400 m and flight altitude was 120 m for the aircraft. Data were presented on scale 1:20 000. 4703 linear kilometres were flown during the course of the survey. Computer-assisted interpretation has been done on the data, and the conductivity-thickness product has been calculated for every anomaly picked. In addition, the depth-to-the-top and the dip for certain selected conductors has been computed. In the Oxford-Knee Lakes area 51 conductive zones have been identified; and in the Edmund-Sharpe-Stull Lakes area, 33 zones.



Oxford – Knee and Edmund – Sharpe Lakes areas indicating areas of INPUT survey and flight line directions

Figure GS-14-9: Airborne electromagnetic/aeromagnetic (INPUT) surveys.

References

Charbonneau, B.W., P.G. Killeen, J.M. Carson, G.W. Cameron, and K.A. Richardson
1976: Significance of radioelement concentration measurements made by airborne gamma-ray spectrometry over the Canadian Shield, *in* Exploration for uranium ore deposits, IAEA.

Schledewitz, D.C.P.
1977: Nejanilini-Caribou Lakes projects, *in* Report of field activities, 1977, Manitoba Min. Res. Div.

Soonawala, N.M., R.A. Whitworth
1977: Uranium exploration, *in* Report of field activities, 1976, Manitoba Min. Res. Div.

Soonawala, N.M.
1977: Uranium exploration, *in* Report of field activities, 1977, Manitoba Min. Res. Div.

Weber, W., D.C.P. Schledewitz, C.F. Lamb and K.A. Thomas
1975: Geology of the Kasmere Lake-Whiskey Jack Lake area (Kasmere Project), Man. Min. Res. Div. Publ. 74-2.

ACKNOWLEDGEMENTS

As in previous years, the successful completion and presentation of this report, 10 weeks after the field season, represents an intensive effort by all authors to compile and in some instances synthesize the results of their findings within a very limited time frame. Such an undertaking is not only laudatory in that the findings are displayed rapidly to a much wider audience, but also provides a firm foundation for organizing the winter's programme of analysis and a reference base to which the writer may return for information and concepts that were fresh from the field. The editors extend their thanks and congratulations to the geological staff and to their senior assistants, acknowledgements to whom are made on the accompanying preliminary maps.

The creation of the manuscripts is but the first step in the preparation and presentation of such a report and sincere thanks are also due to Mrs. B. Thakrar and Ms. L. McKnight who typed the numerous drafts which led to the final copy, and to Mr. R. Sales and the draughting staff whose skill turned many a conceptual and technical sketch into a readable and artistically honed figure.

W.D. McRitchie

MANITOBA GEOLOGICAL SURVEY

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Senior Precambrian Geologist	Dr. W. Weber*	Superior Structural Province (north to south)
Precambrian Geologists:	D.C.P. Schledewitz*	Region north of latitude 58°
	J. Peters	Northern Indian Lake
	Dr. H.V. Zwanzig*	Lynn Lake-Ruttan belt
	H.P. Gilbert	Lynn Lake (and Gods Lake)
	E.C. Syme	Lynn Lake (and Elbow Lake)
	H.D.M. Cameron	Eden Lake
	P.G. Lenton	McCallum & McNeill Lakes
	M.T. Corkery	Waskaiowaka & Lower Nelson River
	Dr. R.F.J. Scoates*	Thompson belt & Fox River region
	J.J. Macek	Paint & Ospwagan Lakes
	Dr. J.J.M.W. Hubregtse*	Pikwitonei region
	A.H. Bailes*	Flin Flon-Snow Lake belt
	D.A. Janes*	Southeast Manitoba
Phanerozoic Geologists:	Dr. H.R. McCabe* & J. Malyon	Southwest Manitoba & Hudson Bay Lowlands
Secretarial:	Mrs. B. Thakrar & Ms. L. McKnight	

*Responsible for developing a synthesis and geological assessment of the assigned region.

MINERAL EVALUATION AND ADMINSTRATION BRANCH

INTRODUCTION

The Federal/Provincial Non-Renewable Resources Evaluation Program and the DREE Minerals Sub-Agreement are both in the final year of their agreement periods. Field activities conducted under these programs were limited during the 1978 field session as emphasis was given to the preparation of final reports.

In the uranium evaluation program, the possibility of uranium mineralization in the sandstones of the Ordovician Winnipeg Formation in southeastern Manitoba was tested by a well water analysis program. A full report with analytical results is included in the report on Phanerozoic uranium environments (MEA-1).

Field activities for base metal evaluation were carried out in the Rusty Lake greenstone belt for copper-zinc mineralization (MEA-2), and in the Island Lake greenstone belt for nickel mineralization (MEA-3). The Rusty Lake greenstone belt hosts the Ruttan mine and the present investigations form part of a longer term program to investigate the stratigraphy and metallogenesis of this part of Manitoba. The Island Lake investigations have resulted in a new interpretation of the stratigraphic control of mineralized ultramafic bodies in this part of the Superior Province.

The industrial minerals evaluation program has continued its investigations of Quaternary geology in southern Manitoba, with emphasis on the quantity and quality of available gravel resources in southern Manitoba. Gravel-poor areas such as the Portage-Winkler area, the Swan River and Gypsumville areas and an area in the southeastern corner of Manitoba have been investigated, and in each case an attempt has been made to reconstruct the glacial history of the study region and develop a stratigraphic column (Reports MEA-4 to MEA-7) as a basis for resource estimation.

Drilling for industrial minerals and stratigraphic information was carried out at twelve locations in southern Manitoba (MEA-8). The objective of this program is to provide data on the distribution and quality of industrial minerals such as dolomite, lignite, kaolin and shale in support of the industrial minerals industry of Manitoba.

Winnipeg
September 1978

F.J. Elbers
Director
Mineral Evaluation and Administration Branch

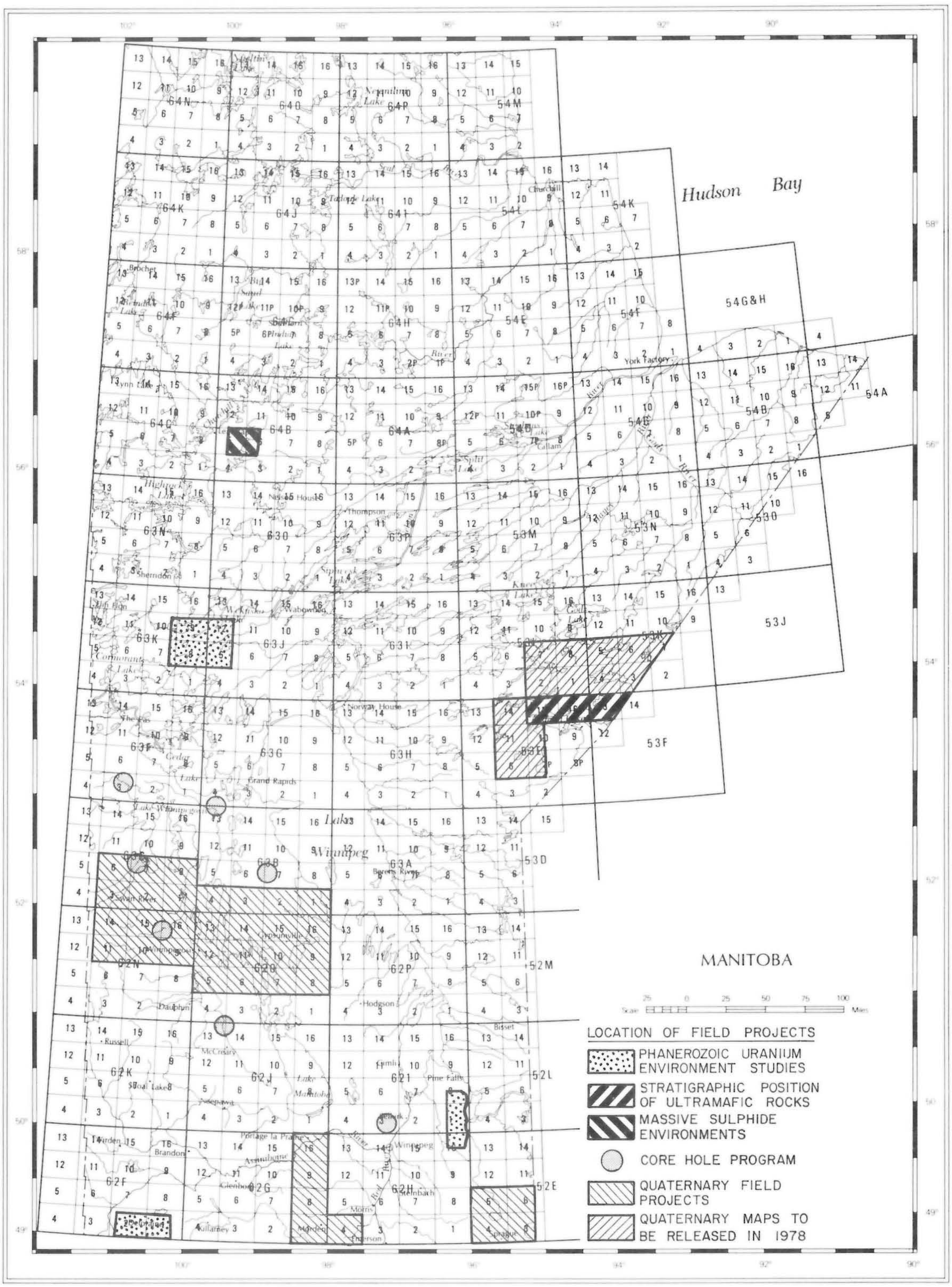

Figure MEA-1 Location of Field Projects 1978

MEA-1 PHANEROZOIC URANIUM ENVIRONMENTS

by G. Southard

Introduction:

As part of the Uranium Evaluation Program carried out under the Federal/Provincial Minerals Sub-Agreement certain Phanerozoic environments potentially favourable for the deposition of uranium were investigated during the 1978 field season.

These included:

— The Winnipeg Formation, an Ordovician sandstone — mudstone sequence;

— The Turtle Mountain Formation, a series of Paleocene shale, sandstone and lignite beds;

— The Bakken Formation, Mississippian marine black shales;

— The Paleozoic — Precambrian contact.

Winnipeg Formation

Introduction

An environment favourable for the concentration of uranium may exist within the Winnipeg Formation at or near its contact with Precambrian granites, in a zone extending south from the southern end of Lake Winnipeg into the U.S.A. (Fig. MEA-1-1).

The Winnipeg Formation is a mudstone-sandstone unit of Ordovician age that lies unconformably on rocks of Precambrian age in eastern Manitoba. The Winnipeg Formation "consists of terrigenous material transported from slightly uplifted margins into a marine depositional basin, distributed by current action and laid down in a variety of depositional environments", (Vigrass, 1971).

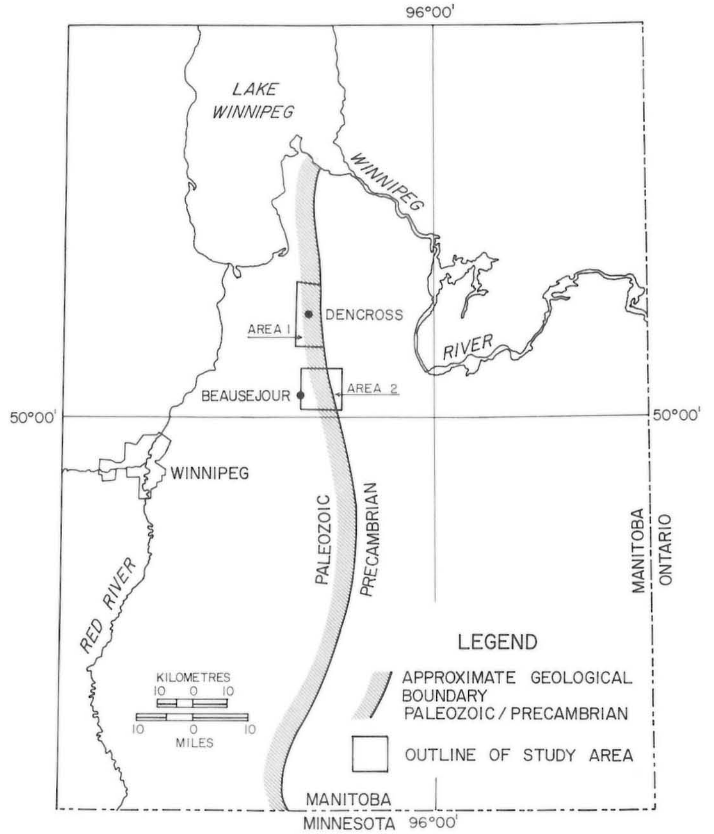

Figure MEA-1-1 Approximate contact between Paleozoic and Precambrian rocks in Southern Manitoba and location of the two study areas.

Background

Principal factors in the formation of sandstone uranium deposits (including the roll-front type) are: (i) source of uranium, (ii) porosity and permeability of the host rock, (iii) movement of an oxidizing transporting fluid, and (iv) reducing conditions in the host rock to prompt uranium deposition. Within the study area these factors measure up as follows:

i) Uranium Source Recent Federal-Provincial Uranium Reconnaissance Program airborne radiometric data (1976) show granites of the Lac du Bonnet area to possess a high background level of uranium (Fig. MEA-1-2). Ground follow-up by the Mineral Resources Division has indicated that parts of the granite area are anomalously enriched in uranium as determined by hand spectrometer. Some chemical assays are given in report GS-14. Both field and laboratory studies have demonstrated that in many cases a substantial proportion of the uranium in such granites is readily dissolved by oxidizing waters of meteoric origin.

ii) Host Rock Porosity and Permeability — The Winnipeg Formation constitutes an important and productive aquifer in the Beausejour area, therefore its past and present porosity and permeability are not in question. The direction of groundwater flow has been documented by the Water Resources Division as being from these granitic areas, i.e. south and west towards Winnipeg.

iii) Fluid Movement — Locally within the area, limited exposure and data from water well drilling show the granites to be elevated between 20 and 40 m relative to the base of the gently dipping Winnipeg Formation. The accompanying schematic cross-section (Fig. MEA-1-3) illustrates how meteoric waters would tend to flow off an elevated granite mass — in which porosity and permeability would be expected to decrease rapidly with depth — toward the adjacent porous sandstone of the Winnipeg Formation.

iv) Reducing Environment — Due to scarcity of outcrop and lack of diamond drill core the presence of reducing conditions within the Winnipeg Formation in the study area has not been established. However, elsewhere in this formation (e.g. Black Island; Lake Winnipeg; east of The Pas; the Virden-Hartney region of south-western Manitoba), disseminated pyrite is of widespread occurrence, ranging from 1 — 2% to 15 — 20% of the rock by volume. The presence of carbonaceous matter in shaley beds, which are a characteristic feature of the Winnipeg Formation, also points to reducing conditions existing within the Formation.

Model

In the proposed model, meteoric water would percolate through the granites, become progressively enriched in uranium, and eventually move into the Winnipeg Formation where a "roll-type" deposit may develop by the reaction of an oxidizing, uraniferous solution with reducing conditions prevailing locally within the Winnipeg Formation.

Methodology

To evaluate this model a program of water well sampling was carried out in the summer of 1978. Water well sampling was chosen because of the lack of outcrop (glacial drift is ubiquitous), and the large number of wells in the region.

Two areas were selected to test the model. Area #1 comprises 93 km^2 and is situated east of Beausejour, Manitoba. Area #2 comprises 89 km^2 and is an elongate N-S belt centered near Dencross, Manitoba (Fig. MEA-1-1).

A total of 176 wells were sampled and analyzed for radon 222, Eh, pH, lead, copper, zinc and iron. Location of sampled wells and radon values are shown in figures MEA-1-4, 5. Table MEA-1-1 summarizes the results.

The general procedure for sampling was that as outlined by W. Dyck, et al, 1976.

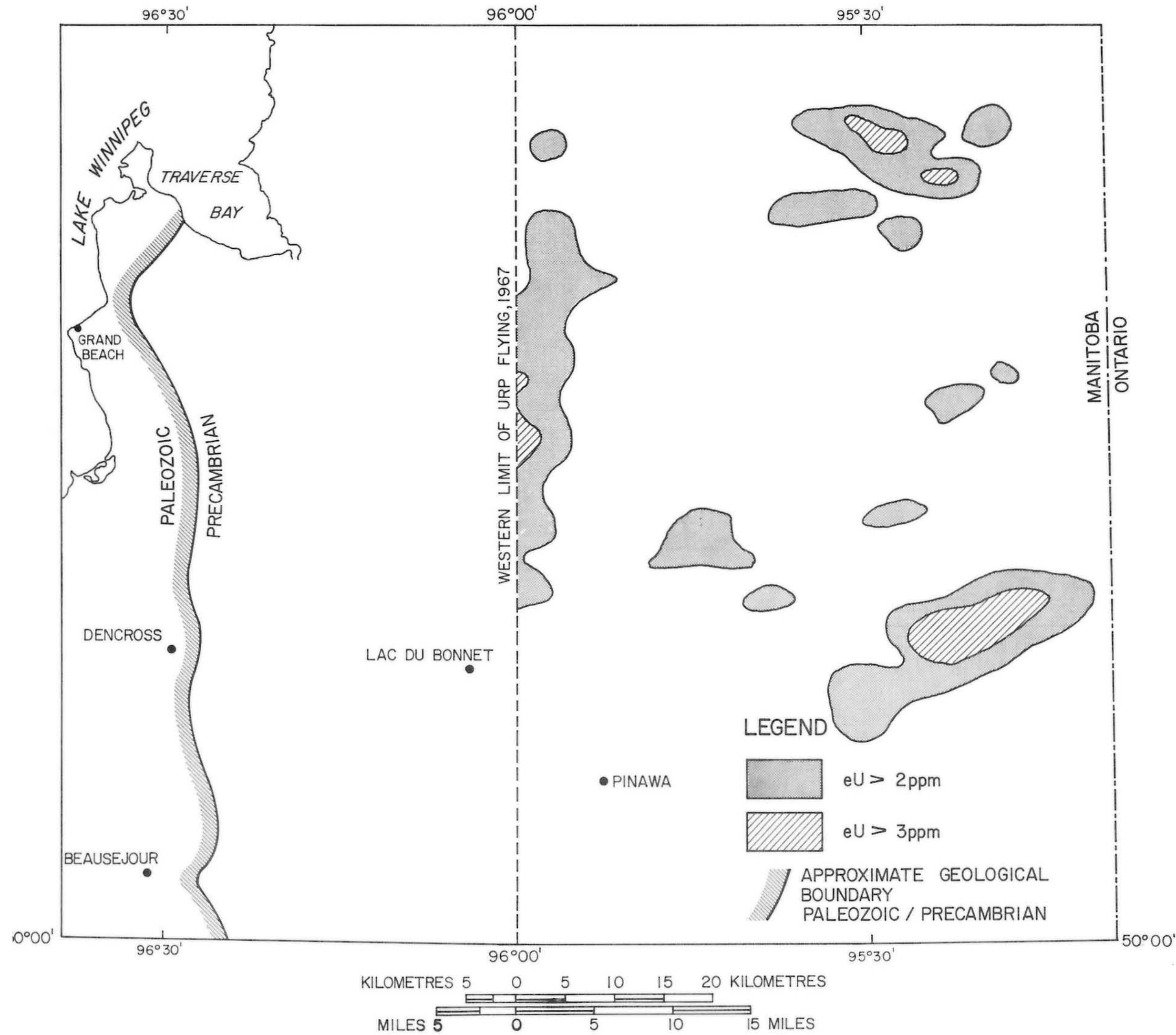

Figure MEA-1-2 Sketch map showing granite areas with elevated uranium content near the Paleozoic-Precambrian boundary.

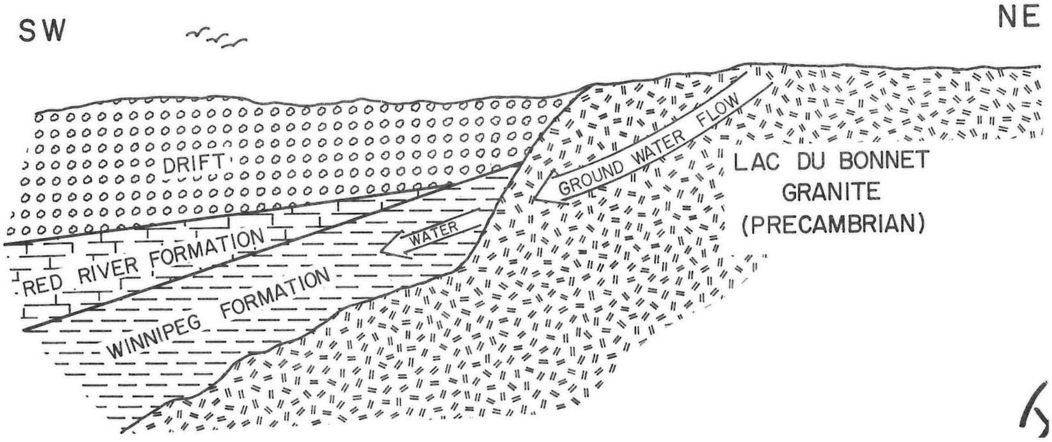

Figure MEA-1-3 Schematic cross-section of the Paleozoic-Precambrian boundary near Beausejour.

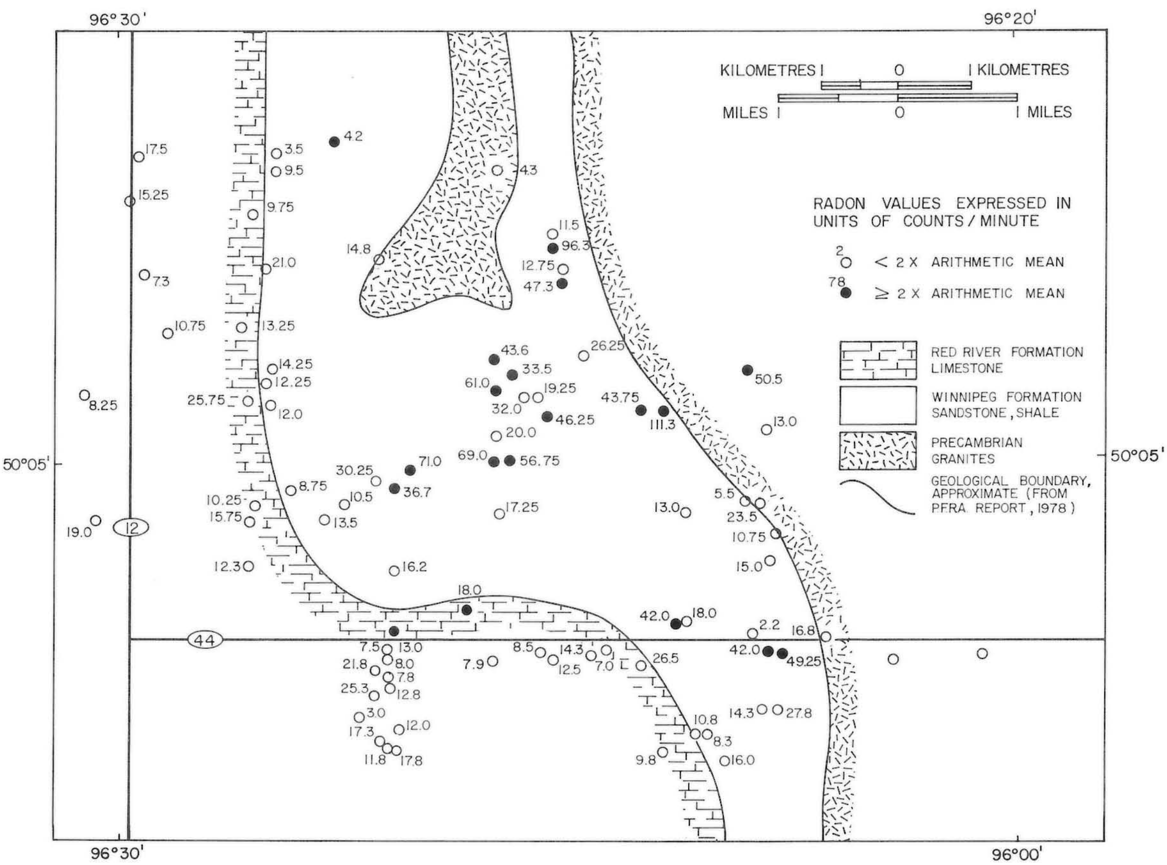

Figure MEA-1-4 Location of sampled water wells and Radon values in Area 1.

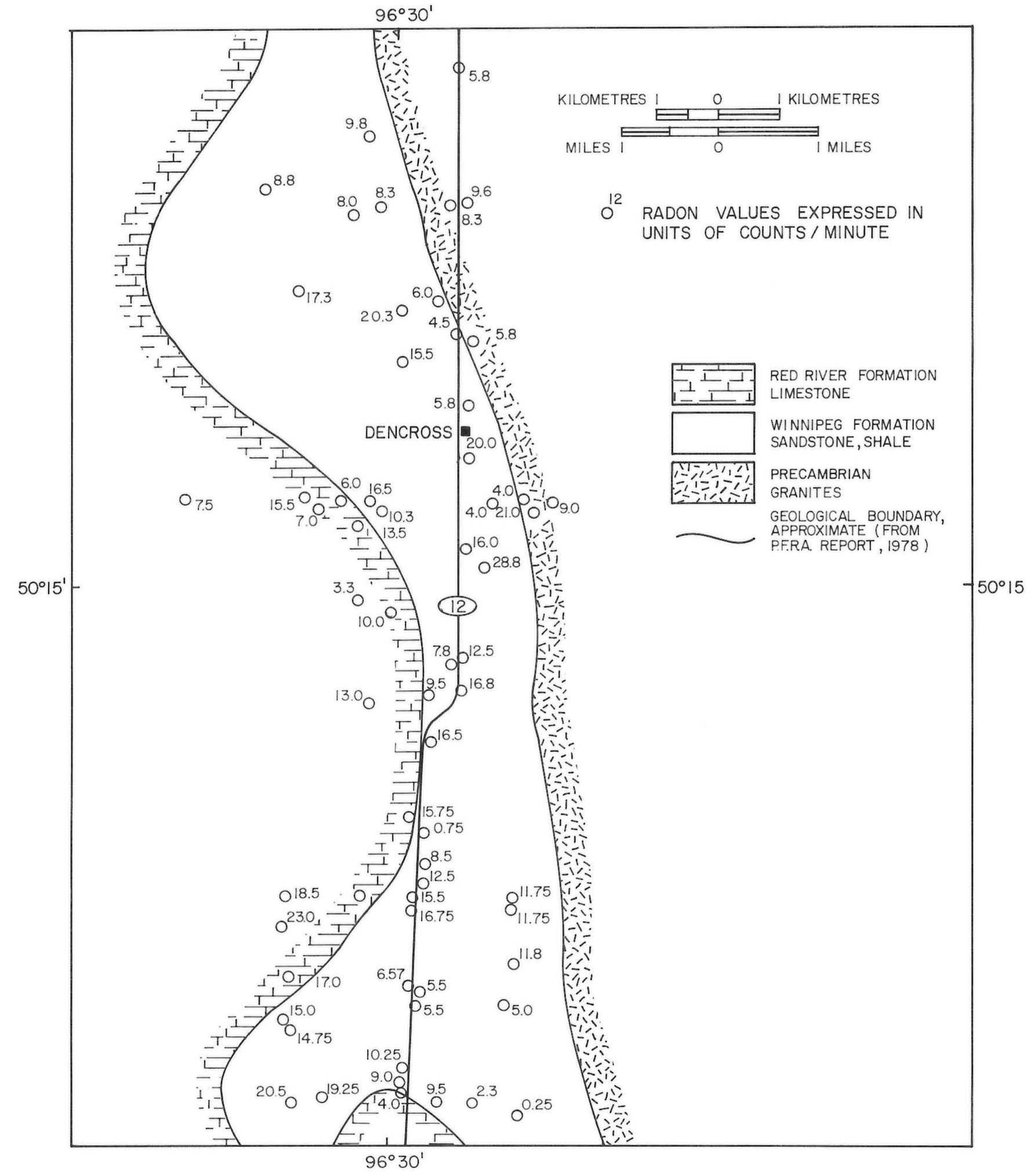

Figure MEA-1-5 Location of sampled water wells and Radon values in Area 2.

TABLE MEA-1-1

WINNIPEG FORMATION STUDY DATA

STATION NO.	RADON 222 VALUE IN CORRECTED COUNTS PER MINUTE	Eh NHE	pH	Pb (ppb)	Zn (ppb)	Cu (ppb)	Fe (ppb)
1050.1	10 3	+519	7 95	7	2400	46	70
1052.3	16 5	+481	7 82	3	10	2	310
1054.5	6	+479	7 60	5	135	1	180
1056.7	7	+509	7 78	7	1900	3	520
1058.9	15 5	+501	7 74	2	95	3	1280
1060.1	13 5	+479	7 59	3	65	2	930
1062.3	4	+478	7 81	3	385	5	1610
1064.5	4	+488	7 60	2	535	34	480
1066.7	21	+479	7 74	2	20	3	540
1068.9	9	+484	7 98	2	105	2	780
1070.1	16	+463	8 08	2	160	19	160
1072.3	28 8	+474	8 20	2	125	5	170
1074.5	10	+481	7 90	2	60	24	1450
1076.7	3 3	+489	8 00	2	1385	2	960
1078.9	12.5	+479	8 34	4	75	5	90
1080.1	7 8	+469	8 22	2	75	15	370
1082.3	16 8	+484	8 10	2	125	105	450
1084.5	9 5	+469	8 20	4	60	11	330
1086.7	13	+479	8 02	4	35	7	200
1088.9	1 5	+489	8 10	2	30	1	700
1090.1	20	+474	7 92	4	10	10	330
1092.3	5 8	+469	8 00	2	70	2	760
1093 a	8	+479	7 99				
1094.5	5 8	+265	7 99	5	1810	2	280
1096.7	9 8	+255	8 19	2	150	69	130
1098.9	8 3	+250	7 98	2	5	2	400
1100.1	9 6	+250	8 10	2	10	3	400
1102.3	8 3	+245	7 99	2	130	10	170
1104.5	6	+230	7 80	2	525	2	200
1106.7	4 5	+230	7 93	2	270	4	1280
1108.9	5 8	+225	7 92	24	210	8	240
1110.11	15 5	+225	7 78	6	385	195	560
1112.13	20 3	+230	7 96	4	220	3	340
1114.15	8	+230	8 28	4	5	3	180
1116.7	11 3	+240	7 86	4	185	2	130
1118.19	8 8	+240	7 95	2	150	16	500
1120.1	3 3	+250	7 68	2	235	96	6400
1122.3	7 5	+245	7 77	4	70	4	1280
1124.5	19 8	+240	7 64	4	450	11	520
1126.7	1 8	+250	7 90	4	1390	12	670
1128.9	26 3	+250	7 75	2	65	17	70
1130.1	16 3	+260	7 46	18350	7	150	
1132.3	4	+255	7 70	5	6700	5	130
1134.5	21 5	+454	7 82	4	320	7	260
1136.7	9 5	+454	7 69	5	35	170	40
1138.9	12 5	+454	7 47	2	2035	7	480
1140.1	17	+459	7 48	4	225	7	40
1142.3	12 75	+549	8 05	2	5	4	580
1142 a	14 0	+559	8 00				
1144.5	4 25	+569	7 35	2	20	6	2580
1146.7	9 5	+549	7 39	2	140	17	70
1148.9	5	+554	7 00	5	610	17	100
1150.1	0	+549	7 44	4	35	7	510
1150 a	1 5	+539	7 45				
1152.3	11	+549	7 46	4	35	28	280
1154.5	8 75						
1154.5	8.75	+544	7 40	5	25	57	1530
1156.7	5 25	+539	7 42	5	165	4	930
1158.9	2 0	+539	7 64	5	1235	130	3310

TABLE MEA-1-1 (cont'd)

WINNIPEG FORMATION STUDY DATA

STATION NO.	RADON 222 VALUE IN CORRECTED COUNTS PER MINUTE	Eh NHE	pH	Pb (ppb)	Zn (ppb)	Cu (ppb)	Fe (ppb)
1160,1	6.75	+534	7.60	5	70	5	920
1162,3	10.25	+534	7.53	4	435	19	340
1164,5	16.5	+499	8.40	2	20	3	240
1166,7	15.75	+494	8.63	2	30	1	240
1168,9	0.75	+509	8.02	4	240	99	160
1170,1	8.5	+524	7.72	2	285	3	920
1172,3	12.5	+509	8.05	2	55	17	340
1174,5	15.5	+504	7.65	2	285	76	430
1176,7	16.75	489	8.21	4	5	4	680
1178,9	6.75	+499	7.43	4	10	3	780
1180,1	5.5	+504	7.42	4	130	5	1040
1182,3	5.5	+509	7.50	7	55	50	40
1184,5	10.25	+509	7.31	2	50	25	1140
1186,7	9.0	+514	7.36	6	145	9	1500
1188,9	4	+409	7.22	9	2300	13	3330
1190,1	9.5	+419	7.49	23	145	363	2800
1192,3	2.3	+419	7.61	5	110	14	590
1194,5	0.25	+424	7.48	5	225	6	3180
1196,7	5.0	+429	7.58	6	415	5	5400
1198,9	11.8	+449	8.02	5	45	9	510
1200,1	7.5	+509	7.61	7	610	7	3020
1202,3	8	+469	7.38	5	10	6	4290
1204,5	21.8	+484	7.33	6	80	102	60
1206,7	7.8	+499	7.38	12	65	27	5900
1208,9	12.8	+496	7.43	5	20	20	7600
1210,11	25.3	+700	7.43	8	1245	112	1430
1212,3	3	+350	7.50	36	70	47	4500
		+500					
1214,15	12	+505	7.10	7	370	41	600
1216,17	17.3	+360	7.46	15	65	45	400
1218,19	11.8	+350	7.67	5	15	7	500
1220,1	17.8	+360	7.74	5	60	5	340
1222,3	13	+529	7.29	7	200	76	150
1224,5	18	+514	7.47	4	45	7	10200
1226,7	7.9	+579	7	160	3150	40	
1228,9	8.5	+539	7.50	7	210	68	80
1228 a	8.8	+534	7.39				
1230,1	12.5	+539	7.60	6	730	128	370
1232,3	12.5	+529	7.22	4	360	3	4950
1234,5	14.3	+519	7.50	5	10	10	760
1236,7	7	+529	7.10	5	150	8	180
1238,9	26.5	+524	7.40	5	65	6	1550
1240,1	18	+519	7.90	6	25	6	240
1242,3	42	+514	8.01	5	10	12	210
1244,5	42	+529	7.60	5	370	13	150
1246,7	49.25	+534	7.32	4	25	3	2040
1248,9	16.8	+519	7.68	4	35	12	1020
1250,1	12.5	+509	8.00	4	120	4	430
1252,3	15.8	+499	8.09	5	30	17	400
1254,5	14.3	+514	7.44	5	45	8	180
1256,7	27.8	+534	7.79	5	605	3	930
1258,9							
1260,1	10.8	+539	7.60	5	50	145	20
1262,3	8.3	+549	7.51	6	155	154	70
1264,5	16	+549	7.48	5	260	173	40
1266,7	9.8	+514	8.22	6	345	6	130
1268,9	12.3	+499	7.51	4	65	2	1200
1270,1	15.75	+504	7.55	4	65	11	1760
1272,3	10.25	+504	7.61	2	40	4	2170
1274,5	8.75	+525	7.65	5	950	15	860

TABLE MEA-1-1 (cont'd)

WINNIPEG FORMATION STUDY DATA

STATION NO.	RADON 222 VALUE IN CORRECTED COUNTS PER MINUTE	Eh NHE	pH	Pb (ppb)	Zn (ppb)	Cu (ppb)	Fe (ppb)
1276,7	12.0	+529	7.46	4	65	14	60
1278,9	25.75	+519	7.60	10	35	1	1340
1280,1	14.25	+524	7.61	2	20	3	1200
1282,3	12.25	+529	7.53	2	20	2	810
1284,5	13.25	+539	7.38	2	145	18	1110
1286,7	21.0	+559	7.38	2	170	2	2040
1288,9	9.75	+554	7.50	2	5	1	930
1290,1	3.5	+509	7.78	118	6650	28	920
1292,3	9.5	+499	7.72	47	1950	16	740
1294,5	42	+509	7.30	5	125	42	150
1296,7	14.8	+504	6.90	6	360	36	100
1298,9	24.3	+494	7.84	4	30	1	540
1300,1	11.5	+494	7.87	2	35	58	240
1302,3	96.3	+494	8.29	8	45	91	1460
1304,5	12.75	+499	8.11	2	15	2	260
1306,7	47.3	+509	8.00	2	5	1	200
1308,9	17.5	+509	7.89	2	65	2	630
1310,11	43.6	+499	8.22	4	15	19	170
1312,13	33.5	+504	8.18	2	10	2	170
1314,15	61.0	+499	8.19	2	65	3	520
1316,17	16.2	+529	7.38	2	15	64	80
1318,19	10.5	+529	7.45	2	885	2	4190
1320,1	13.5	+539	7.11	2	15	74	60
1322,3	36.7	+524	7.6	2	215	2	180
1324,5	30.25	+489	7.81	2	40	4	760
1326,7	71	+499	7.71	2	365	5	850
1328,9	17.25	+504	7.43	6	140	71	3680
1330,1	56.75	+489	8.13	2	65	6	260
1332,3	69.0	+489	8.20	6	220	20	2010
1334,5	20.0	+479	8.30	2	5	2	160
1336,7	32.0	+489	8.02	2	10	17	630
1338,9	19.25	+509	7.95	2	145	19	330
1340,1	46.25	+504	7.95	2	5	3	390
1342,3	26.25	+499	7.89	2	5	3	400
1344,5	43.75	+499	8.20	2	15	5	170
1346,7	111.3	+494	8.11	2	10	3	340
1348,9	50.5	+509	8.12	2	65	4	170
1350,1	13.0	+524	7.40	4	80	17	110
1352,3	5.5	+519	7.67	4	15	4	500
1354,5	23.5	+519	7.80	2	10	4	390
1356,7	13.0	+539	7.63	2	175	14	1380
1358,9	8.5	+529	7.91	2	10	2	280
1360,1	15	+534	7.90	2	15	3	630
1362,3	2.25	+340	7.31	2	480	5	200
1364,5	19.0	+534	7.49	2	140	14	20
1366,7	8.25	+529	7.44	2	75	1	2640
1368,9	10.75	+529	7.31	2	15	5	1020
1370,1	7.3	+529	7.30	2	60	9	5900
1372,3	15.25	+534	7.40	2	15	8	1480
1374,5	17.5	+539	7.32	2	190	6	880
1376,7	19.25	+539	7.38	2	25	4	1200
1378,9	20.5	+539	7.34	2	270	3	1780
1380,1	14.75	+539	7.35	2	105	10	3370
1382,3	15.0	+549	7.40	2	1000	43	130
1384,5	17.0	+299	7.32	2	25	1	3350
1386,7	23.0	+529	7.40	2	15	2	2680
1388,9	18.5	+529	7.38	2	385	5	40
1390,1	13.3	+549	7.29	2	15	8	2000
1392,3	11.75	+459	8.00	2	25	6	370
1394,5	11.75	+439	8.02	2	25	5340	

Radon, Eh and pH analyses were carried out in a mobile field laboratory within 24 hours of collection. Duplicate samples were taken each day as a check of field analytical procedures. Analyses were done by D. Snuggs and J. Leeson and the radon equipment used has been designed and assembled by N.M. Soonawala.

Results

Statistical programs have not yet been applied to the data for proper determination of anomalies. However, the untreated data indicate anomalous radon concentrations (up to 7 times the arithmetic mean) in a 7 km^2 area northeast of Beausejour (Fig. MEA-1-4).

To substantiate these radon anomalies 42 wells were resampled and the waters analysed for uranium. The analyses were done with the Scintrex UA-3 Uranium Analyser which measures laser-activated fluorescence, and has a sensitivity at the sub-ppb level of uranium.

Results of the uranium analyses are shown in Figure MEA-1-6. Because of the irregular distribution of sampling points the data have not been contoured, but values over 2 ppb are indicated in bolder print.

This survey indicates that some significant uranium anomalies are present in the study area. Out of 42 analyses, 13 show values greater than 2 ppb U with outstanding values being 34.5, 51.4 and 73.3 ppb U. The values, especially in the medium range, fit a log normal distribution with a mean value of 0.834 ppb and a standard deviation of ± 6.514 (D. Janes, pers. comm.).

To put these data into perspective a comparison can be made with results of similar type surveys in other terrains. Denson et al (1956) conducted a water sampling program in Wyoming and South Dakota to test the usefulness of uranium in groundwater as a pathfinder to uranium deposits. Several thousand water samples were collected; most samples contained less than 2 ppb U, however, waters from areas of known uranium deposits were found to contain as much as 10 to 250 ppb. Dyck et al (1976) tested 1706 groundwater samples from the Carboniferous basin of the Maritimes as a means of tracing uranium occurrences. Uranium values up to 52 ppb were encountered with the mode being 0.13 ppb, the mean value 1.02 ppb and the standard deviation 3.04, assuming a normal distribution; his highest values were obtained near known Cu-U showings.

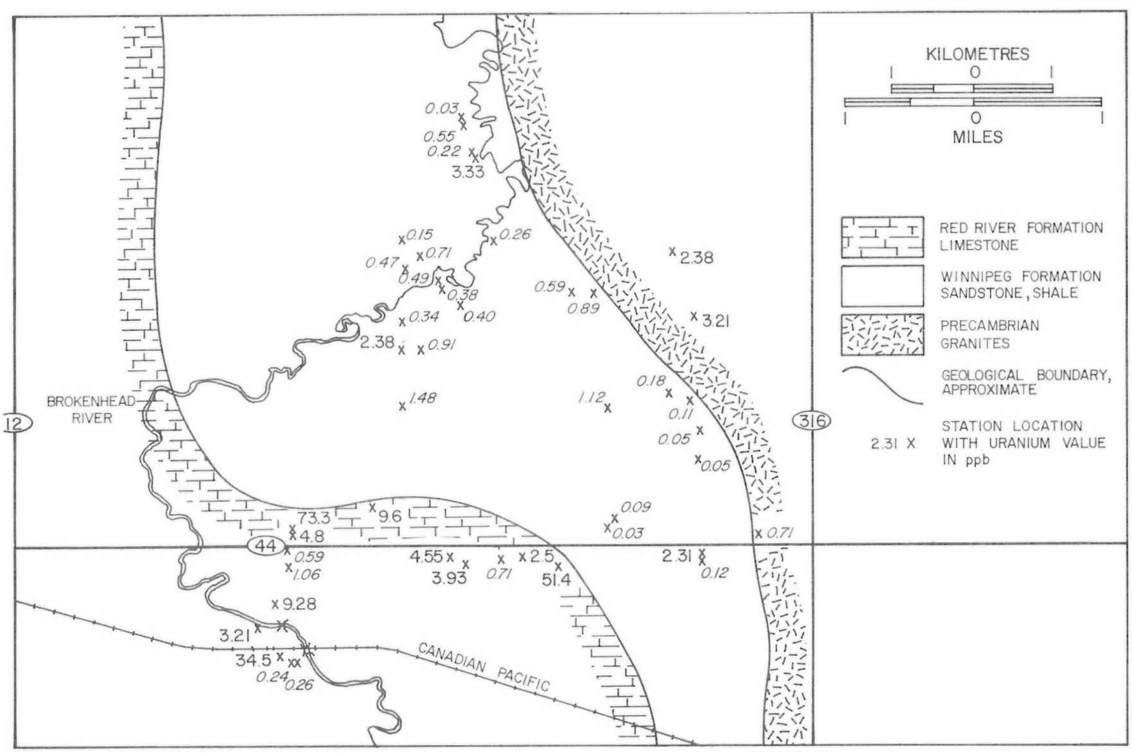

Figure MEA-1-6 Uranium values (ppb) in selected water wells in Area 1.

Thus it can be concluded that the high uranium values encountered in this survey cannot be explained simply by leaching dispersed uranium from the bordering granite terrain and that a source of concentrated uranium is probably present in the area. If the source of uranium as postulated in the model (Fig. MEA-1-3) is substantiated by further work a new uranium environment will be available for exploration in Manitoba.

Turtle Mountain Formation

Introduction

The lignite seams within the Turtle Mountain Formation (Goodlands member) are considered a favorable environment for uranium concentration.

Lignite beds are known to be an excellent scavenger of uranium. Moore (1954) has shown that low grade coal, peat and lignite extract 98% of the uranium from an aqueous solution while high grade coal (anthracite, bituminous) removes only 34% and 17% respectively.

The Turtle Mountain Formation is exposed only in southwestern Manitoba. (Fig. MEA-1-7) and is correlated with the Fort Union and Hell Creek Formations in the U.S.A. (Bamburak, 1978). These formations are known to be uraniferous and minor uranium production has been recorded from lignite seams within them (Vine, 1955).

The Turtle Mountain Formation is defined by Wickenden (1945) as the Paleocene series of shale, sandstone, and lignite bearing beds which overlie the Upper Cretaceous Boissevain Formation in the Turtle Mountain area. The lignite seams range in thickness from 0.15 m to 1.83 m and occur throughout the lower 40 m of the Turtle Mountain Formation (Goodlands member; Bamburak, 1978).

Methodology

Outcrop areas of lignite are scarce because of the extensive glacial cover, and it was decided that a geochemical approach would provide the best evaluation of the uranium potential of these beds.

A stream water and stream sediment sampling program was initiated, and all flowing streams draining the western slope of Turtle Mountain were sampled during July, 1978. The Turtle Mountain formation is generally flat lying (Bannatyne, 1978), and streams were sampled below the projected outcrop areas.

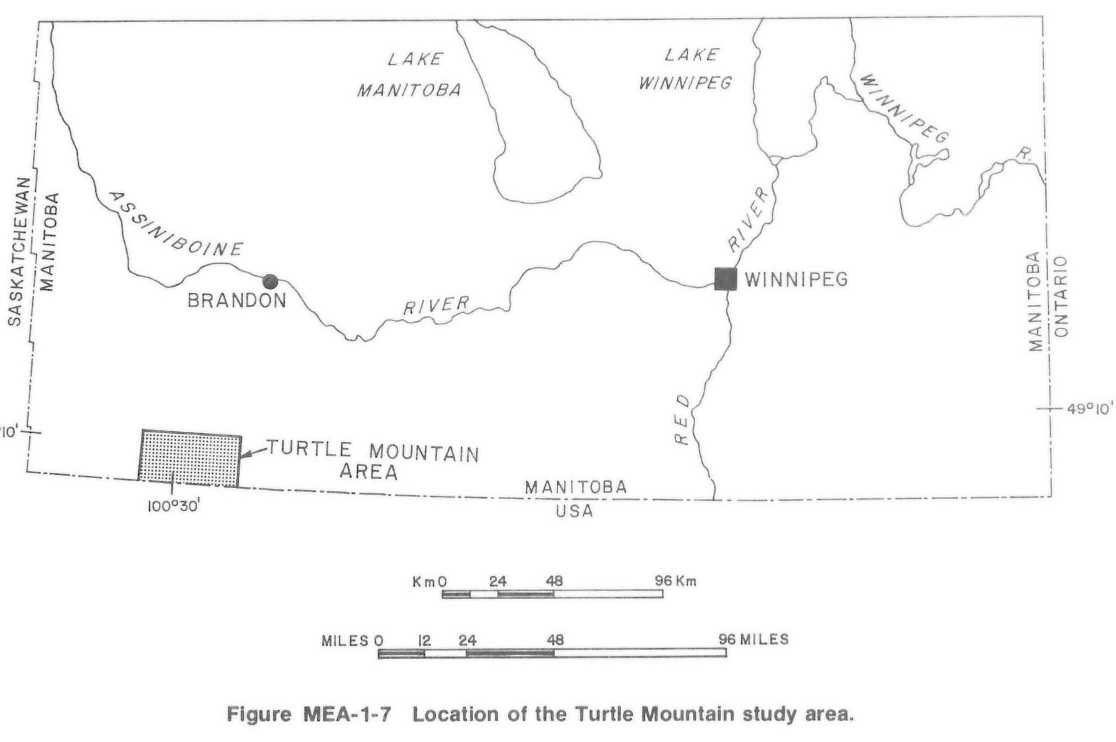

Figure MEA-1-7 Location of the Turtle Mountain study area.

Drought conditions over the past 3 years hampered sampling, as a number of streams were dry. Figure MEA-1-8 shows the distribution of the dry and flowing (sampled) streams. A total of 16 streams were sampled. Samples were taken in at least two locations along most streams, one near the lower contact and one higher up section.

Stream water samples were analyzed for Radon 222, Eh and pH. Stream sediments (-100 mesh) were analyzed for uranium by neutron activation. Results are shown in Table MEA-1-2. Sampling techniques for waters were those outlined by W. Dyck, et al (1976).

Results

Analyses showed one stream to be carrying anomalous amounts of radon. Two samples taken 1 m apart showed radon concentrations of up to 8 times arithmetic mean (Fig. MEA-1-8). This stream should be resampled with closer spacing of stations to duplicate and more fully define the anomaly.

LOCATION OF SAMPLED STREAMS DRAINING
TURTLE MOUNTAIN

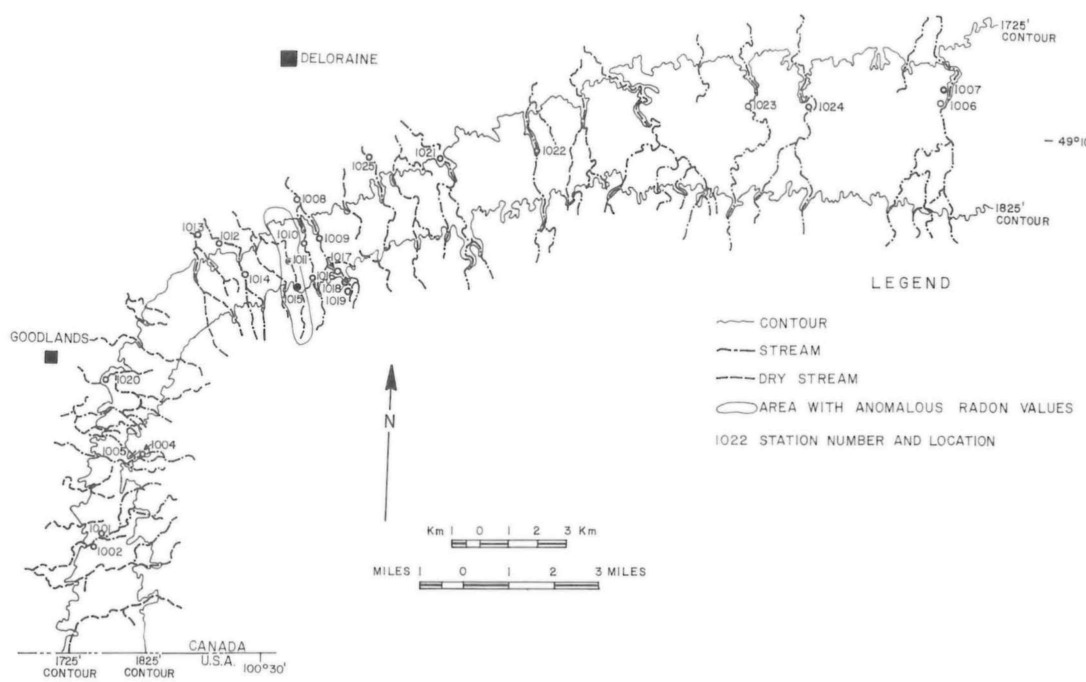

Figure MEA-1-8 Radon values of sampled streams in the Turtle Mountain study area.

TABLE MEA-1-2

TURTLE MOUNTAIN DATA

STATION NO.	RADON 222 VALUE IN CORRECTED COUNTS PER MINUTE	U (ppm) OF STREAM SEDIMENT
1001	0.75	2.0
1002	1.25	2.1
1003		2.2
1004	1.25	2.8
1005	2.75	2.9
1006	3.25	3.0
1007	0	2.4
1008	0	2.3
1009	0.3	2.2
1010	1.25	2.6
1011	9.75	2.1
1012	0.7	2.8
1013	1	2.6
1014	2	2.7
1015	18.25	2.2
1016	1.25	2.7
1017	0.25	2.7
1018	1.75	2.1
1019	2.5	2.4
1021	0.5	2.1
1022	0	2.2
1023	4.25	2.4
1024	0.25	n.d.
1025	0	2.6

Bakken Formation

Introduction

The Bakken Formation was investigated as a possible environment containing low grade uranium mineralization.

The Bakken Formation is described by Davies, et al (1962) as a series of black bituminous shales and siltstones deposited by Mississippian seas. Uranium values ranging from 40-80 ppm have been reported by Mapel (1955) from work on the U.S. correlative of the Bakken Formation: the Kinderhook shale.

Methods and Results

The Bakken Formation is not known to outcrop in Manitoba. Core, from oil well drilling, was obtained from seven locations in southwestern Manitoba and analyzed for uranium by neutron activation: results are shown in Table MEA-1-3. The black shaley sections show a noticable increase in uranium content — ranging from 41.3 ppm uranium to 61.3 ppm uranium. The siltstone sections show considerably lower values, in the 3-8 ppm uranium range.

Precambrian/Paleozoic Contact

The possibility of uranium concentrations existing at or near the Paleozoic-Precambrian unconformity was investigated.

Samples of weathered Precambrian rock were obtained from 25 diamond drill holes put down near the northern edge of the Paleozoic cover (Fig. MEA-1-9) and analyzed for uranium content by neutron activation.

A zone of intense weathering marks the unconformity and ranges in thickness from 40′ to 200′ in the holes examined. The actual contact between Paleozoic and Precambrian was not seen — it washes away during drilling. The weathered material is highly oxidized and leached, with solution cavities formed where pyrite is either completely removed or altered to marcasite. The feldspars have been completely altered to various clay minerals. The extensive oxidation, leaching, and depth of weathering point to a prolonged period of tropical weathering.

The existence of widespread and deep weathering is significant because of the amount of uranium that would be released from the Precambrian strata — particularly granites — by this means. If suitable structural and/or physiochemical traps were available at that time, and preserved, then economic concentrations may well exist.

All holes examined went into volcanic rock. Results of uranium analysis show the regolith to be uniformly low (1-6 ppm range) except where graphitic sections were encountered within the weathered material. Three sections of graphitic regolith were recovered and uranium content in each is noticeably elevated (15 ppm, 22 ppm, 35 ppm) (Table MEA-1-4).

The correlation between graphitic zones and high uranium values indicates that concentrating mechanisms were (are?) working and should be further investigated.

BAKKEN FORMATION

TABLE MEA-1-3

SAMPLE NO.	FORMATION TESTED	HOLE IDENTIFICATION	FOOTAGE	URANIUM (p.p.m.)	COMMENTS
64-78-14	Bakken shale	Cleary Calstan * 6-21-1-19	3196-3215 (19′)	8.3	Dark grey to black, fissile shale
64-78-15	Bakken shale & sandstone	Cleary Calstan 6-21-1-19	3215-3235 (20′)	3.4	Sandstone underlying upper shale of Bakken formation. Some red beds with pyrite
64-78-17	Bakken shale	H. B. South Maples	2401-2407(6′)	44.6	Black fissile shale 3x background with scintillometer
64-78-18	Bakken shale	Calstan Linklater 2-21-7-28	3068-3073(5′)	47.5	Black fissile shale 2½x background with scintillometer
64-78-19	Bakken shale	Calstan Birdtail 9-8-16-27	1695-1697(2′)	7.8	Variable coloring — Red to grey-green siltstone with very minor pyrite. 1½x background
64-78-20	Bakken shale	Calston Birdtail 9-8-16-27	1700-1705(5′)	7.4	Varied shale — siltstone soft-green to red color. Some "bleached" areas. 1½ — 2x background
64-78-21	Bakken shale	Calstan Reston 7-27-6-27	3083-3085(2′)	41.3	Black — fissile — carbonaceous shale 2½x background
64-78-22	Bakken shale	Calstan West Butler 1-31-9-29	2997-3001(4′)	61.1	Black shale as above
64-78-23	Bakken shale	Calstan West Butler 1-31-9-29	3001-3006(5′)	3.4	White to grey siltstone, sandstone with lignite fragments
64-78-24	Bakken shale	Rocanville Lazare 2-16-17-28	1626-1630(4′)	7.5	Contact between red shale and white-grey siltstone-sandstone 1½x background

*Wells are referred to by location only, using the standard location system used in western Canada. For example. 16-16-1-27, refers to the well located in l.s.d. (legal survey division) 16, section 16, township 1, range 27. All range designations are west of the principal meridian.

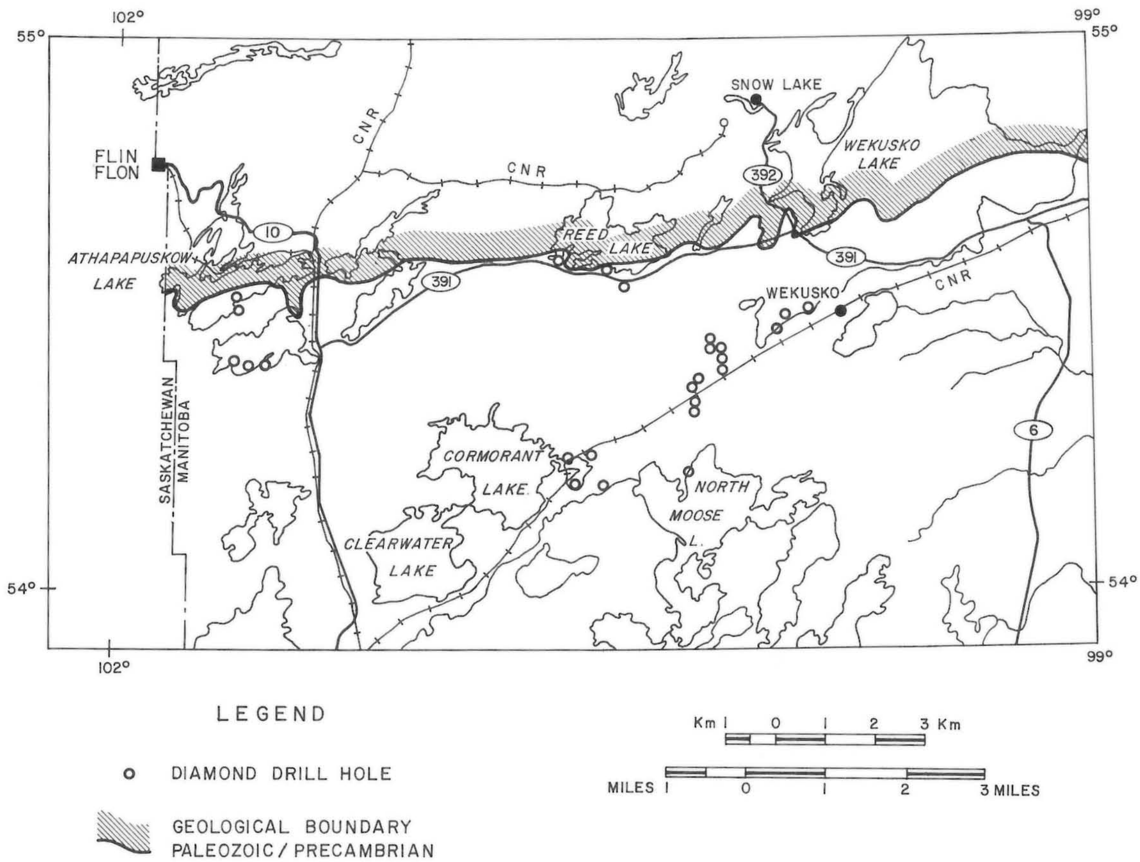

Figure MEA-1-9 Location of sampled diamond drill holes through the Paleozoic cover south of the Flin Flon — Snow Lake greenstone belt.

TABLE MEA-1-4

PRECAMBRIAN/PALEOZOIC CONTACT

SAMPLE NO.	FORMATION TESTED	HOLE NO.	URANIUM CONTENT (p.p.m.)	COMMENTS
64-78-60b	Regolith	M-42	2.7	weathered volcanic
64-78-61a	Regolith	M-105	3.5	talcose material very poorly consolidated
64-78-61b	Regolith	M-105	2.2	more indurated, talcose material
64-78-61c	Regolith	M-105	2.9	leached volcanic
64-78-61d	Regolith	M-105	35.3	graphitic horizon
64-78-61e	Regolith	M-105	3.6	oxidized but not leached volcanic
64-78-62	Regolith	M-93	0.9	volcanic? well consolidated
64-78-63	Regolith	M-92	4.9	greenish volcanic poorly consolidated
64-78-64	Regolith	M-90	0.7	very red oxidized material
64-78-65	Regolith	M-8	1.1	greenish talcose material
64-78-66	Regolith	M-11	15.3	mixture of graphite and badly weathered volcanic
64-78-67	Regolith	M-10	1.5	badly weathered greenish material
64-78-68a	Regolith	M-107	1.7	badly leached volcanic
64-78-68b	Regolith	M-107	1.1	volcanic, not as badly leached
64-78-69	Regolith	M-37	2.0	weathered greenish volcanic
64-78-70	Regolith	M-38	3.2	grey to white talc material
64-78-71	Regolith	M043	2.5	white talc-sericite material
64-78-72	Regolith	P-73-5	1.2	reddish oxidized volcanic
64-78-73	Regolith	P-73-8	2.2	very red, oxidized volcanic
64-78-77	Regolith	138-24	3.5	regolith on top of sulphide zone
64-78-78	Regolith	W-14	0.6	red oxidized material
64-78-79	Regolith	138-21	6.6	greenish volcanic weathered
64-78-81	Regolith	138-26	2.1	green to white material with pyrite
64-78-82	Regolith	7504-76-10	1.5	weathered volcanic
64-78-83	Regolith	7504-76-12	22.5	graphitic-biotite schist
64-78-84	Regolith	7504-76-11	7.6	weathered volcanic
64-78-86	Regolith	F-125	1.5	weathered volcanic
64-78-91	Regolith	F-160	1.5	weathered volcanic (green)
64-78-93	Regolith	F-104	1.5	weathered volcanic green to white — (kaolinized)
64-78-94	Regolith	F-72	1.4	green to white weathered volcanic — some kaolin

References

Bamburak, J.D.,
1978: Stratigraphy of the Riding Mountain, Boissevain and Turtle Mountain Formations in the Turtle Mountain area, Manitoba; Mineral Resources Division, Geological Paper 78-2.

Bannatyne, B.B.,
1978: Summary of Available Data on Lignite Deposits, Turtle Mountain, Manitoba; Mineral Resources Division, Economic Geology Report 77/1.

Davies, J.F., et al,
1962: Geology and Mineral Resources of Manitoba, Manitoba Department of Mines and Resources.

Denson, N.M., Zeller, H.D., and Stephens, J.G.
1956: Water Sampling as a Guide in the Search for Uranium Deposits and its use in Evaluating Widespread Volcanic Units as Potential Source Beds for Uranium; *in* U.S. Geol. Surv. Prof. Paper no. 300, p. 673-680.

Dyck, W., et al,
1976: Minor and Trace Element Contents of Well Waters, Carboniferous Basin, Eastern Canada, Federal-Provincial Uranium Reconnaissance Program, Geol. Surv. Can., Open File #340.

Federal-Provincial Uranium Reconnaissance Program Airborne Gamma-Ray Spectrometer Survey, Geophysical Series 35552G, 35652G, 36152G, 36252G, 36352G, 36452G, 36353G, 35962G, 36062G, 35163G, Geol. Surv. Can., 1976.

Groundwater Resources of the Beausejour Area, Manitoba, Canada, Department of Regional Economic Expansion, Prairie Farm Regional Authority Engineering Service, 1978.

Mapel, W.J.,
1955: Uraniferous Black Shale in the Northern Rocky Mountains, and Great Plains Regions, **in** U.S.G.S. Professional Paper No. 300.

Moore, G.W.,
1954: Extraction of uranium from aqueous solution by coal and some other materials, Econ. Geology V. 49, No. 6.

Vigrass, Lawrence, W.,
1971: Depositional Framework of the Winnipeg Formation in Manitoba and Eastern Saskatchewan, Geol. Assoc. Can., Special Paper No. 9.

Vine, J.D.,
1955: Uranium Bearing Coal in the United States, **in** U.S.G.S. Professional Paper No. 300.

Widkenden, R.T.D.,
1945: Mesozoic Stratigraphy of the Eastern Plains, Manitoba and Saskatchewan; Geol. Surv. Can. Mem. 239.

MEA-2 STRATIGRAPHIC POSITION OF ULTRAMAFIC LENSES IN THE ISLAND LAKE AREA

by Peter Theyer

During the 1978 field season two weeks were spent in the Island Lake greenstone belt to examine in detail the stratigraphic and structural setting of a quenched ultramafic body (Theyer, 1977) and related ultramafic lenses.

Thin sections of core obtained from packsack drilling of an ultramafic lens located east of Linklater Island (Fig. MEA-2-1) confirmed the existence of spinifex texture in this rock. This supports the view that the rock formed from a supercooled ultramafic flow or shallow intrusion.

Information from geological maps, drilling and magnetic surveys indicate that the ultramafic lens forms part of a series of lenses which occupy a position (Fig. MEA-2-1) that correlates over almost its entire strike length with the contact between a group of volcanic rocks (equivalent to the Hayes River Group) and a group of sediments (equivalent to the Island Lake series; Wright, 1928; Quinn, 1960; Godard, 1963).

Consistent stratigraphic relationships were found to exist along the length of this contact. These relationships are illustrated by schematic stratigraphic columns from the vicinity of Linklater Island and the area north of Loonfoot Island (Fig. MEA-2-2).

a) Linklater Island

In the vicinity of Linklater Island, massive and locally weakly pillowed mafic and acidic metavolcanic rocks underlie a conglomerate which contains altered cobbles and pebbles of quartz porphyry and subordinate clasts of granite and rhyolite. The matrix of the conglomerate is a chloritic phyllite. The conglomerate probably grades laterally into silicified grey phyllite

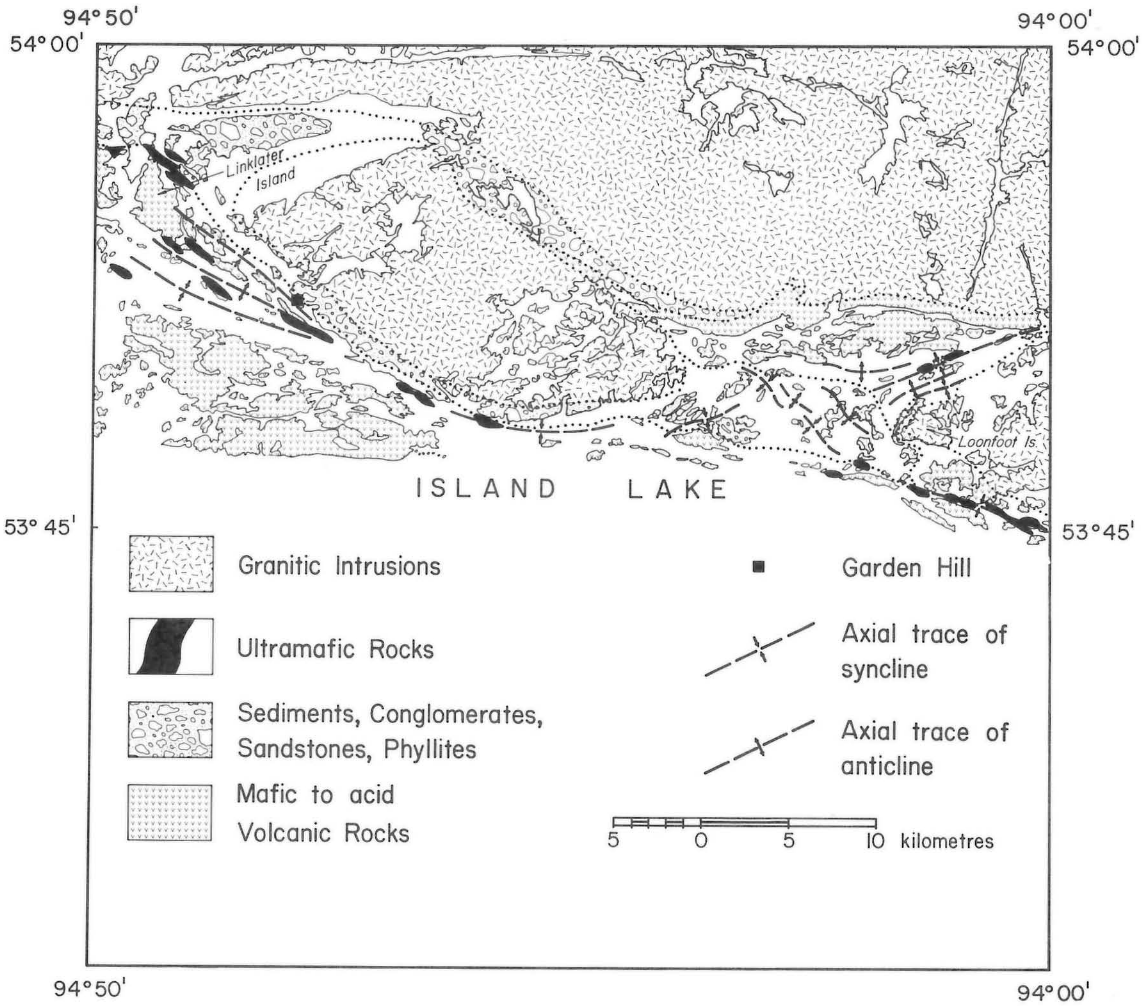

Figure MEA-2-1 Generalized geology of the Island Lake Belt in part after Godard (1963).

over a few tens of metres; however, since key areas are covered by drift and water, the exact relationship between the two rock types remains uncertain. These polymictic conglomerates are stratigraphically overlain by approximately 50 metres of quenched and weakly pillowed ultramafic flows(?). The ultramafic rocks are also overlain by conglomerates, but these conglomerates contain quartz pebbles and some cherty fragments in a quartzitic matrix. In one locality, the exposed contact between ultramafic rocks and the overlying quartz pebble conglomerates is sharp. An acicular layer of hornblende needles (5-8 mm thick) has developed in the ultramafic rock at this contact. Lateral facies changes in the quartz pebble conglomerates are abrupt, they grade into fine grained, weakly cross-bedded sandstone within a few metres.

Stratigraphically above the quartz-pebble conglomerates, there are coarse polymictic conglomerates similar to those underlying the ultramafic lenses.

b) Loonfoot Island

The second stratigraphic column (Fig. MEA-2-2) is based on the stratigraphy above and below a series of ultramafic lenses located both to the north and south of Loonfoot Island. In this area, ultramafic rocks are underlain by either rhyolite and/or a polymictic conglomerate and are stratigraphically overlain by polymictic conglomerate similar to those at Linklater Island.

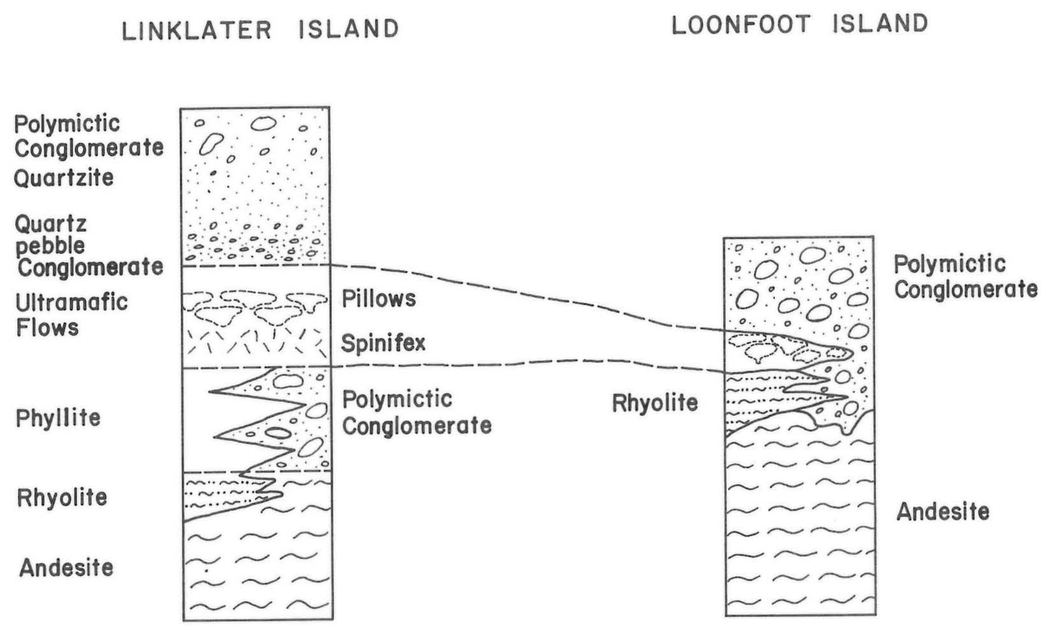

Figure MEA-2-2 Schematic stratigraphic columns of parts of the Island Lake greenstone belt.

Summary:

At least one of the ultramafic lenses (Linklater Island) is, on the basis of its quench texture, almost certainly derived from a flow or a shallow intrusion of ultramafic magma. Its position at the base of, or within a sedimentary pile, indicates that the magma was probably unrelated to that producing the other mafic volcanic rocks in the area. Almost all other ultramafic lenses in the area occur in a stratigraphic position similar to that occupied by the Linklater Island occurrence.

Both the Linklater Island and the Loonfoot Island ultramafic lenses contain significant Ni-Cu mineralization (Quinn, 1960).

In view of the well documented correlation between Ni-Cu deposits and ultramafic volcanic rocks in Australia and Canada, (Woodall and Travis, 1969; Ewers and Hudson, 1972; Pyke, Naldrett and Eckstrand, 1973; Naldrett and Arndt, 1975) the geological environment documented above appears to be of economic significance.

References:

Ewers, W.E. and Hudson, D.R.,
1972: An interpretive study of a nickel-iron sulphide ore intersection, Lunnon shoot, Kambalda, Western Australia. Econ. Geol. 67.

Godard, J.P.,
1963: Geology of the Island Lake-York Lake Area; Man. Mines Br., Publ. 59-3.

Naldrett, A.J. and Arndt, N.T.,
1975: Association of nickel sulphides with rocks of volcanic origin suggests new exploration targets. Northern Miner, March 6.

Pyke, D.R., Naldrett, A.J. and Eckstrand, O.R.,
1973: Archean ultramafic metavolcanic flows in Munro Twp., Ontario. Bull. Geol. Soc. Amer., 84.

Quinn, H.A.,
1960: Geology of Island Lake, Manitoba-Ontario, Geol. Surv. Can., Map 26-1960 (with descriptive notes).

Theyer, P.,
1977: Evaluation of Nickel Environments; Man. Min. Res. Div., Report of Field Activities 1977.

Woodall, R. and Travis, G.A.,
1969: The Kambalda nickel deposits, Western Australia. Publications, Ninth Commonwealth Mining and Metallurgical Paper No. 26.

Wright, J.F.,
1928: Island Lake Area, Manitoba; Geol. Surv. Can., Sum. Rept. 1927, Pt. B.

MEA-3 VOLCANIC ENVIRONMENTS OF MASSIVE SULPHIDE MINERALIZATION IN THE LOWER WASEKWAN GROUP IN THE RUSTY LAKE GREENSTONE BELT

by D.A. Baldwin

Introduction

The objectives of field studies carried out in the Rusty Lake greenstone belt were to:

a) investigate the environments of deposition of the volcanic and volcanosedimentary rocks; and

b) establish the stratigraphic positions, types and forms of known sulphide mineralization.

Figure MEA-3-1 shows the location of the study area. This summer's field work constitutes the first phase of a longer term, comprehensive investigation of the stratigraphy and metallogenesis of the Rusty Lake greenstone belt and therefore the entire area has not been examined in detail.

Since the first phase of this study is being carried out under the Non-Renewable Resource Evaluation Program a more detailed account of this summer's work will appear in the final NREP report.

General Geology and Stratigraphy

The lower Wasekwan Group of the Rusty Lake greenstone belt (Steeves and Lamb, 1972) comprises an older volcanosedimentary sequence and a younger volcanic succession (Gilbert, 1974). The volcanosedimentary sequence is characterized by arkose, conglomerate, greywacke, siltstone and impure quartzite intercalated with minor basalt and gabbro. The volcanic sequence comprises massive and pillowed porphyritic, mafic to intermediate flow rocks that locally alternate with gabbro with which they may be related, felsic volcanic flow rocks, various volcanic breccias, heterolithic volcaniclastic fragmental rocks that in part may be debris flows, and very fine grained, bedded and thinly laminated tuffaceous rocks.

A generalized stratigraphic column for the Wasekwan Group in the Rusty Lake greenstone belt was prepared by Gilbert (1974). Details of the stratigraphy have now been established locally where facing directions indicate a repetition of the stratigraphy in large scale isoclinal folds.

Sulphide Mineralization

Massive sulphide type mineralization in the Rusty Lake greenstone belt appears to be confined to felsic volcaniclastic and felsic tuffaceous rocks that are underlain by mafic to intermediate extrusive rocks.

Stratiform polymetallic massive sulphide deposits are found at the stratigraphic top of a volcaniclastic rock with lapilli-size felsic fragments in an intermediate matrix. This unit constitutes the base of a volcaniclastic and tuffaceous sedimentary succession which is itself overlain by mafic flow rocks (Fig. MEA-3-2). The succession, where observed is thickest at the Ruttan Mine, where it is 900 m thick and the felsic volcaniclastic member which hosts the deposit is approximately 450 m thick. In contrast, massive sulphide formations (Py, Po) are associated with fine grained felsic tuffaceous rocks that are underlain by either mafic to intermediate flow rocks or a thin (50 m) succession of volcaniclastic rocks that are directly underlain by mafic to intermediate flow rocks.

Effects of chloritization, sericitization, silicification, carbonatization and sulphidization are present in rocks that stratigraphically underlie the polymetallic deposits (Gale and Koo, 1977). In addition, extensive disseminated sulphide is present in surface exposures of the felsic volcaniclastic rocks but also occurs as small local patches in the mafic to intermediate flow rocks. Stratabound rusty zones ± sericitization are characteristic of the massive sulphide formations.

Hydrothermal alteration and stringer sulphide are present in the rocks that stratigraphically underlie the polymetallic deposits, but have not been observed below the massive sulphide formations.

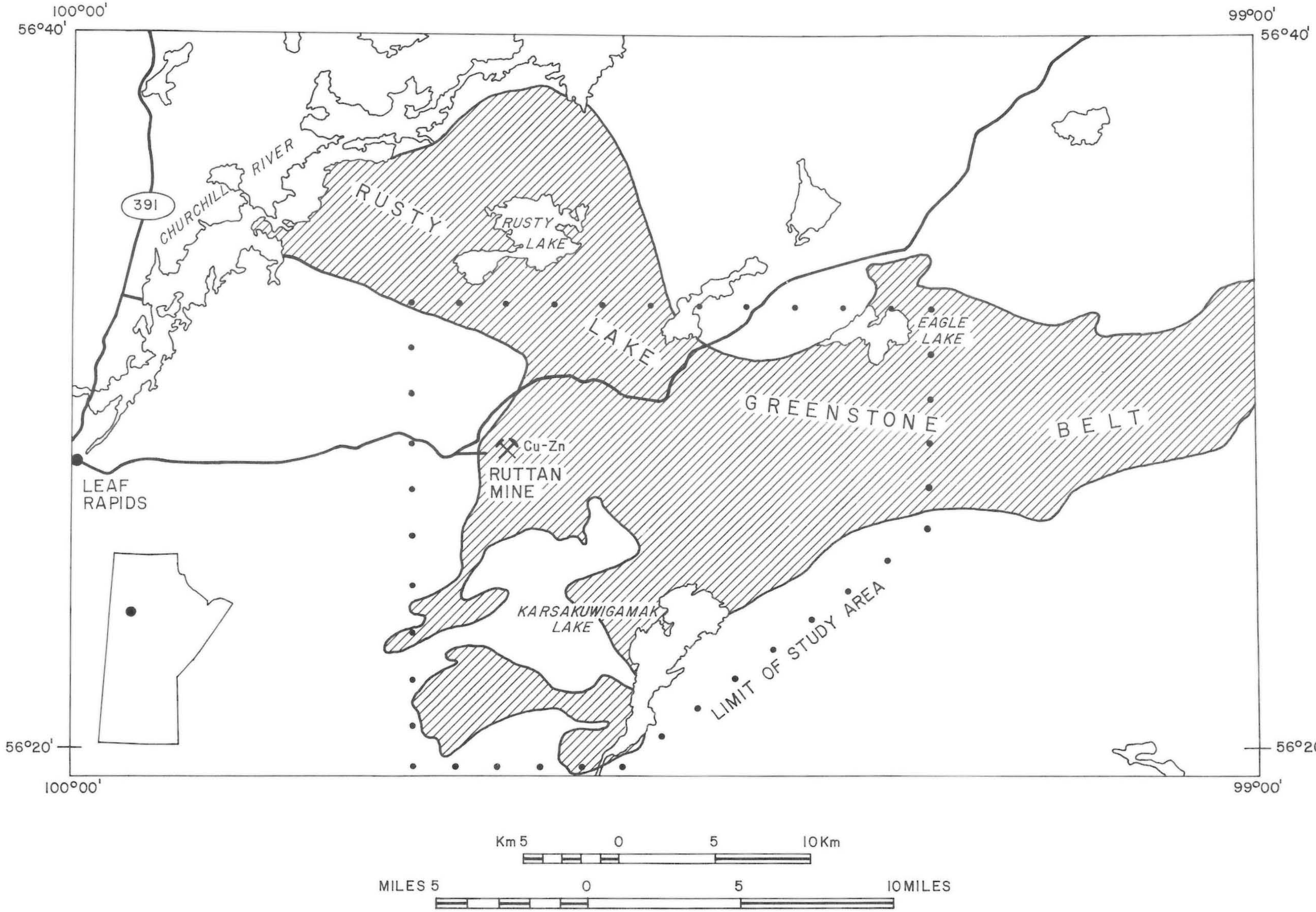

Figure MEA-3-1: Limits of study area in the Rusty Lake greenstone belt.

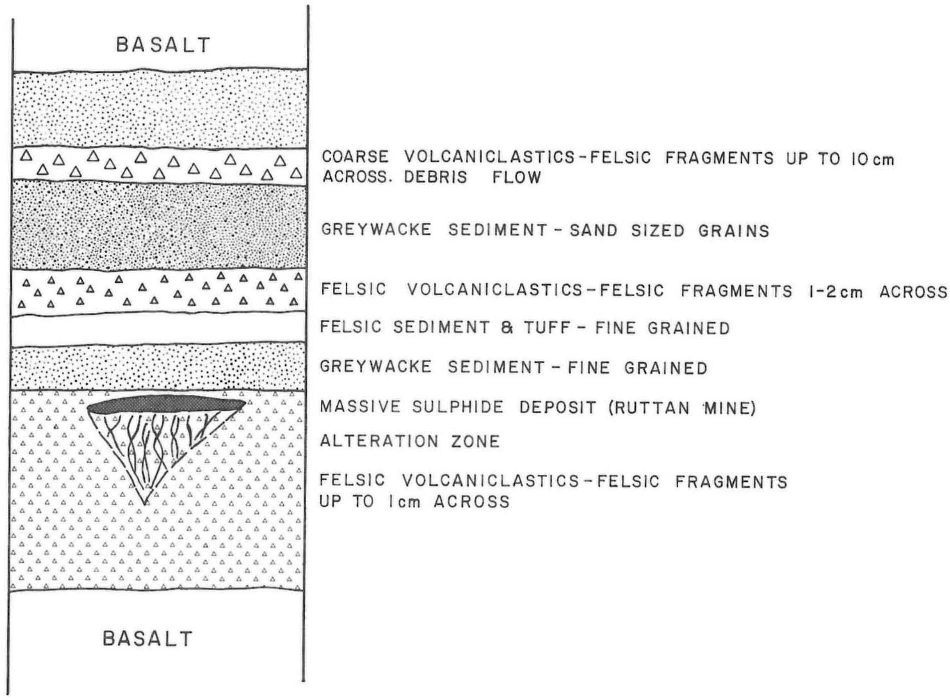

Figure MEA-3-2: Schematic stratigraphic section at the Ruttan Mine.

Massive Sulphide Environments

The polymetallic massive sulphide deposits in the Rusty Lake greenstone belt are contained in felsic volcaniclastic rocks, many of them heterolithic in character, that are thickly bedded, unsorted and contain lapilli-sized volcanic fragments that show various degrees of reworking, suggesting that the rocks were rapidly deposited, have a mixed provenance and possibly transported a considerable distance from their source.

Gale and Koo (1977) suggest that the massive polymetallic deposits were formed in a submarine environment from the precipitation of metalliferous fumarolic exhalations associated with felsic magmas proximal to exhalative vent areas. Since these deposits occur in a volcaniclastic sedimentary succession, it would appear that the exhalative vent areas were somewhat distal to an actual site of lava extrusion.

The volcaniclastic rocks which contain the massive polymetallic deposits are dominantly felsic. This association suggests a genetic relationship between felsic volcanism and mineralization; however, the absence of felsic flow rocks in the areas around the deposits renders such a relationship difficult to establish. Possibly the felsic volcanism was very explosive in nature and flow rocks did not form.

In contrast to the proximity of massive polymetallic deposits to exhalative vents it has been suggested that the massive sulphide formations were formed over a much wider area and in the Lynn Lake greenstone belt are considered to be penecontemporaneous with the massive polymetallic deposits (Gale and Koo, 1977). In the Rusty Lake greenstone belt, the environment in which the massive sulphide formations were formed is not clear, and further study is required to clarify their relationship with the massive polymetallic deposits.

References

Gale, G.H. & Koo, J.,
1977: Evaluation of Massive Sulphide Environments; **in** Non-Renewable Resource Evaluation Program, Second Annual Report 1976/1977; *Man. Min. Res. Div.*

Gilbert, H.P.,
1974: Karsakuwigamak Lake Project; **in** Summary of Geological Field Work, *Man. Min. Res. Div.*, Geol. Paper 2/74, p. 17-20.

Steeves, M.A. & Lamb, C.F.,
1972: Geology of the Issett — Opachuanau — Pemichigamau — Earp Lakes Area; *Man. Mines Br.*, Publ. 71-2F.

MEA-4 QUATERNARY GEOLOGY AND SAND AND GRAVEL RESOURCES OF THE PORTAGE — WINKLER AREA

by Susan Ringrose and Maryann Mihychuk

The Portage-Winkler area comprises a portion of south central Manitoba covered by the following N.T.S. sheets: 62G16, 62G9, 62G8, 62G1 and part of 62H4. The area was mapped in response to gravel shortages in the vicinity of Portage la Prairie and to provide background information for the Morden-Stanley-Thompson-Winkler Development Plan. The area extends from the till-covered Manitoba escarpment zone in the west to the low-lying Agassiz basin to the east (Fig. MEA-4-1). Geological relationships of beds throughout the southern portion of the area are shown in Figure MEA-4-2. In the north, the surface is characterized by extensive sand dune development.

A detailed description of mappable units is given here; detail on the distribution of these units can be obtained from the "PW series" of 1:50,000 Quaternary maps (see MEA-9).

UNIT 1: Bedrock. Much of the topography of the area is bedrock controlled. The clay basin area is underlain by Jurassic shale, sandstones and limestone, with the Cretaceous Swan River Group forming the bedrock surface towards the foot of the escarpment. The escarpment zone can be divided into two or three steps. The lower step, which corresponds to the Campbell strandline level is underlain mainly by the Ashville and Favel Formations and the Morden Member of the Vermilion River Formation. The second step is discontinuous and comprises the Boyne and Pembina Members of the Vermilion River Formation. The upper escarpment level is underlain by the Millwood and Odanah Members of the Riding Mountain Formation. The lower formations comprise calcareous or non-calcareous shale, with some bentonite (Bannatyne, 1970). The uppermost Odanah Member consists of hard, grey, siliceous shale which is excavated from numerous pits as Municipal road surfacing material, particularly in the southern portion of the area.

UNIT 2: Till:

2a: Grey till. The lowest till is visible in 1-4 m roadcuts in the southern portion of the area. The grey clast-rich till contains roughly equal proportions of Precambrian derived clasts and Phanerozoic carbonate and shale clasts in a clay-rich matrix. The beds appear contorted in some sections (possibly a secondary, slumping effect) and contain large sand inclusions towards the top of the unit, close to the contact with the overlying brown till. The clast content suggests a north or northeast origin for the till.

2b: Brown till. The brown till covers almost the entire escarpment zone, comprising about 25% of the mapped area. The till varies from 1.0 to 10 m in thickness and generally appears brown except where mottled. The brown till contains a higher proportion of Paleozoic and Precambrian clasts, relative to shale clasts, which are sub-angular to subrounded and in the medium to coarse pebble range. The matrix is a calcareous, silty clay. Sandy inclusions occur towards the base of the till. Around Morden, the till shows evidence of flow banding, with alternating relatively well sorted fine, silty sand interbedded with till containing abundant small clasts. Elsewhere, vertical jointing is characteristic. A north or northeast origin is assumed for the brown till.

UNIT 3: Eskers and Outwash. Extensive sand and sand and gravel zones, whose origin have not yet been fully determined appear related to the last ice recession from the area. Complex glaciofluvial sequences, frequently associated with ice contact depositional features occur in the vicinity of the escarpment zone, and are frequently masked by lake clay in the lower area and shoreline sand higher along the escarpment. Glaciofluvial kame ridges comprise massive silty sand, cross-laminated sand and unsorted pebble gravel. Evidence of galciofluvial activity associated with the Campbell terrace level includes large scale cross-stratified and cross-laminated sand, with paleoflow direction to the east and southeast. Outwash deposition on the escarpment appears concentrated in pre-existing valleys and includes in different areas soft sediment deformation structures, structureless fine pebble gravel containing ice rafted material and cross-stratified medium to coarse pebble gravel.

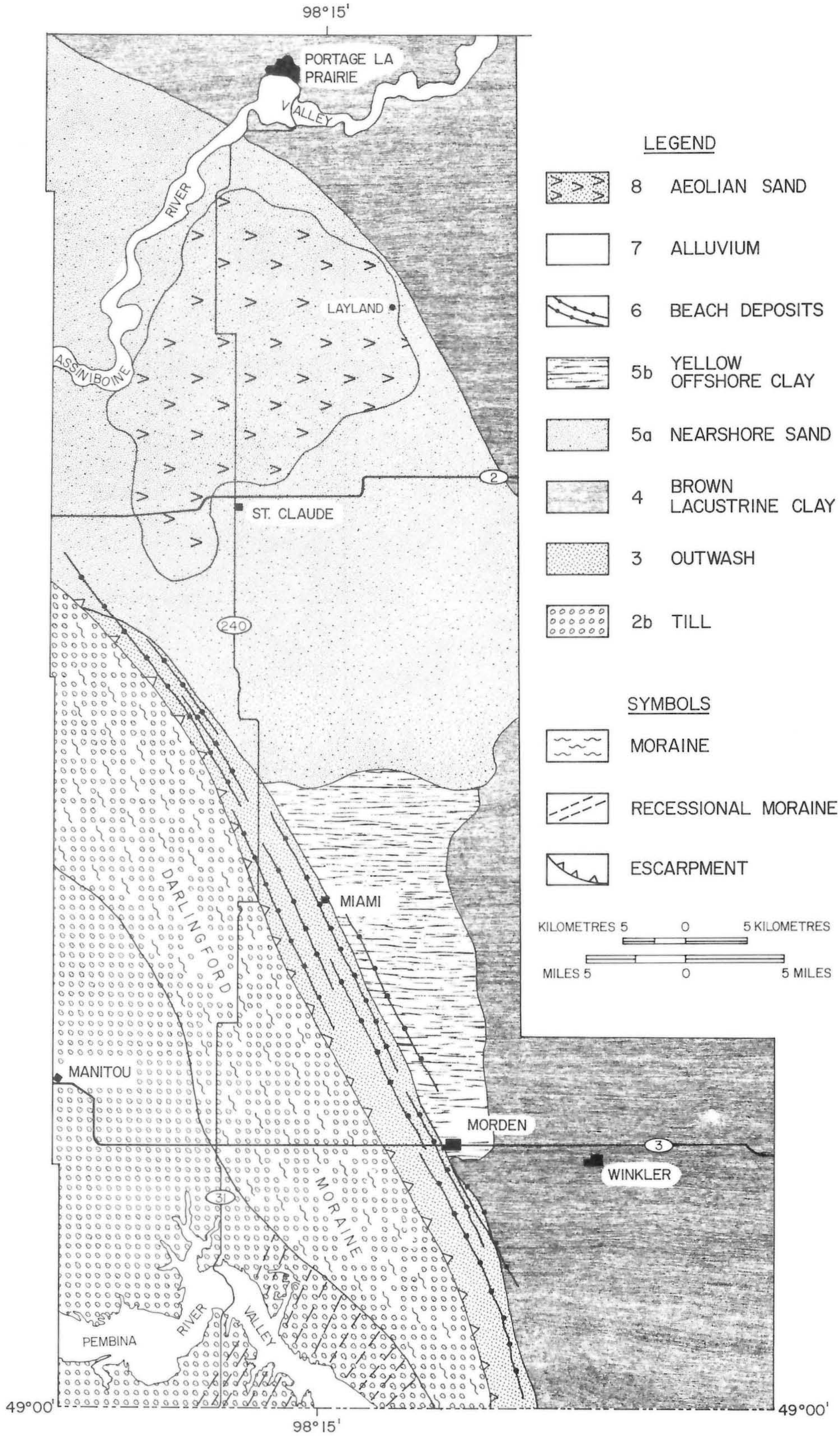

Figure MEA-4-1 Quaternary Geology of the Portage-Winkler Area

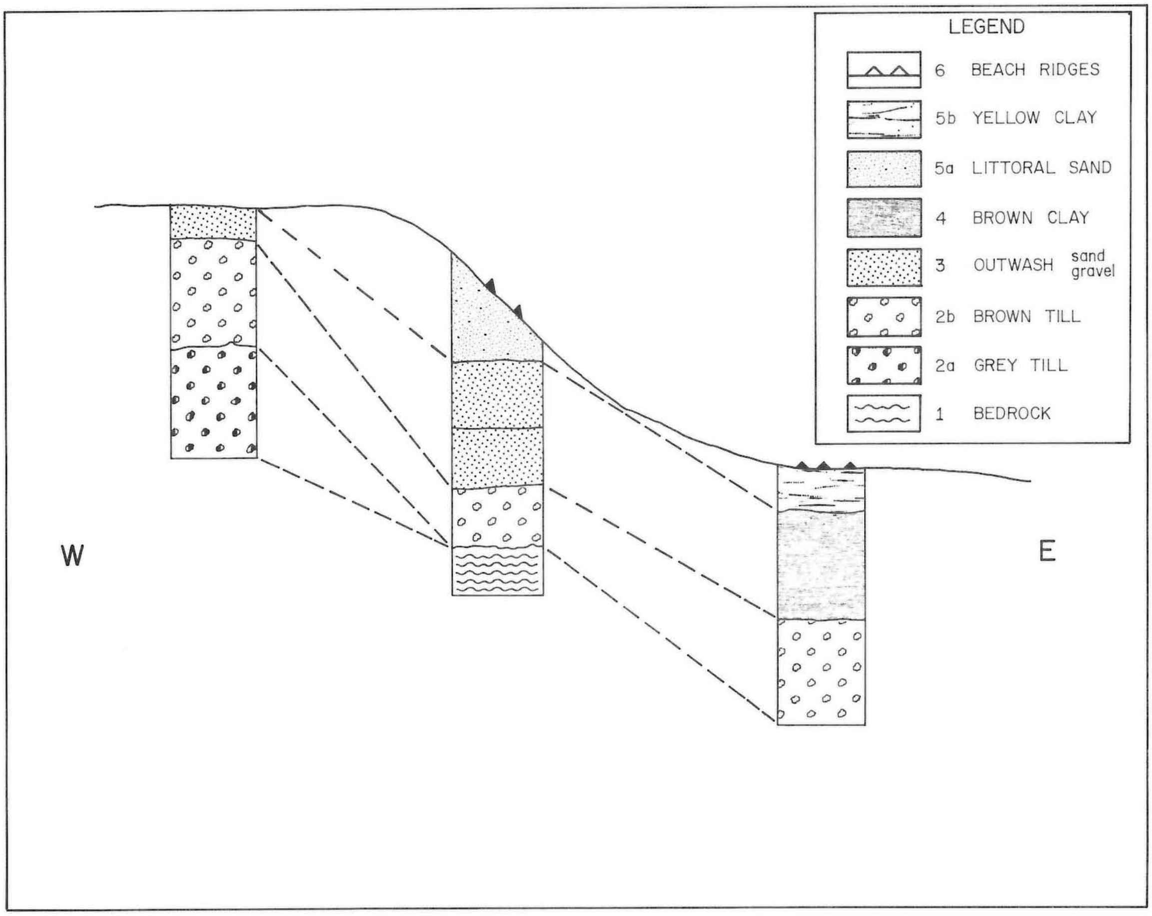

Figure MEA-4-2 Schematic stratigraphy east-west through the Manitoba Escarpment.

UNIT 4: Lacustrine Clay. Dark brown or grey, blocky lacustrine clay occurs throughout the central 10% of the area. The brown clay underlies thicknesses (0.3 — 3.0 m) of yellow silty clay which is more extensive particularly in the south. The brown clay unit is weakly calcareous, massive with numerous silt clasts, and includes dropstones. The clay is distributed throughout the Agassiz basin portion of the study area. Lacustrine silty clay deposited along the escarpment edge presumably dates from earlier periods of more extensive inundation.

UNIT 5: The sand which overlies both lacustrine clay and till on the escarpment edge is subdivided into nearshore sand and offshore very fine sand and silt. The nearshore sand is a calcareous, massive, orange, medium to fine sand. The offshore equivalent is a yellow, massive, calcareous sandy silt or clay. The unit 5 sediments are believed to have been deposited during the last phase of Lake Agassiz in the area.

UNIT 6: Comprises beach ridge sand and gravel (6a) and littoral sand (6b). The exposed beach zones extend from around 406 m to 259 m in the area, with some (aerial photograph) evidence of buried beaches below the 259 m level. The shoreline beach areas range in depth from 0.5 to 2.5 m, and are comprised of fine to coarse pebble gravel, containing clasts which show extensive iron oxidation. The beaches are composed of numerous thin beds, frequently well sorted, showing graded bedding, with occasional washover andcut and fill structures.

UNIT 7: River terrace deposits of some antiquity are grouped together as unit 7. Well defined terrace sequences are mapped in the Pembina Valley, where four distinct terrace levels are present. The Assiniboine Valley contains four less distinct terraces. Sediments in the Pembina terrace system include horizontally bedded coarse pebble gravel with contorted shale-rich grey till in the upper terraces. Cross-stratified sand and silt beds suggest that in earlier stages the Pembina flowed in the same direction as the present river. Assiniboine terrace sediments are composed mainly of fine sand, cross-laminated and massive silt, containing molluscs and plant remains.

UNIT 8: Eolian sand deposits cover the northern 25% of the study area. The sand occurs mainly in the form of longitudinal or parabolic dunes, many of which are actively shifting southeastwards in response to the prevailing winds. The sand is medium to fine grained, finely laminated or structureless, with evidence of two paleosol horizons (one location) at 2.0 m and 3.3 m.

UNIT 9: Colluvial deposits, comprising mixed debris from mud slides or rotational slumps are common in the deeply incised river valleys.

UNIT 10: Recent alluvium occupies the lower-lying river valleys and the present day floodplains of the Pembina and Assiniboine Rivers. Alluvial sediments comprise mainly friable silt.

UNIT 11: This unit represents low-lying areas presently occupied by standing water, which once covered more extensive zones. The deposits include muds and organic detritus.

As a result of the study, 106 sand and gravel deposits were identified and evaluated for quality. A preliminary demand estimate suggests that an increasing haul distance is inevitable for road construction in the R.M. of Portage while supplies in the southern portion of the study area are concentrated south of Rathwell, and along the escarpment zone. Greater use is being made of low quality, shallow beach deposits throughout the area, most of which are identified on the 1:50 000 sheets.

Reference:

Bannatyne, Barry B.,
1970: The Clays and Shales of Manitoba, Man. Mines Br., Publ. 67-1.

MEA-5 QUATERNARY GEOLOGY AND SAND AND GRAVEL RESOURCES OF SOUTHEASTERN MANITOBA

by Peggy Large

The study area, situated in the southeastern corner of Manitoba, comprises 3200 km^2 extending from Township 1 to 6 and Range 12 EPM to 17 EPM (Fig. MEA-5-1). The area was mapped because it occurs peripherally to the Winnipeg region and because highway construction and upgrading (particularly P.R. 308 and P.T.H. 12) are placing increasing demand on the sand and gravel resources of the region. The area was mapped and stratigraphy established in order to identify the sand and gravel sources (Fig. MEA-5-2).

UNIT 1: The mapped area is underlain by Precambrian granites which are heavily drift-covered (Teller et al, 1976). Outcrops of granite in the northeastern corner of the study area are the only exposures of bedrock.

UNIT 2: The earliest glacial deposit comprises part of a sandy moraine complex, known as the Bedford Hills, which crosses the southwestern corner of the area. The ridge ranges in elevation from 326 m to 388 m above sea level and offers few good sections for observation. The feature, consisting of medium to fine glaciofluvial sand, is interpreted by Fenton (1974) as a high ice contact ridge owing its origin to a depression within isolated masses of Senkiw ice into which glaciofluvial sediments collected. Glaciofluvial streams are believed to have discharged southwards then eastwards as the ice retreated northeast.

UNIT 3: Evidence of subsequent ice advance episodes following the Senkiw in the southeastern corner of Manitoba is limited to two tills believed to be correlatives of Fenton's Marchand and Steinbach tills. There is no evidence for the Roseau or Grunthal Formations although surface exposures are limited to small road cuts. The Marchand (or equivalent) is a dark brown to dark grey till with numerous medium to fine pebble clasts in a dark silty clay calcareous matrix (3a). The clasts are predominantly carbonates suggesting a northwestern origin for the till. The Marchand till is limited in areal extent within the study area. The Steinbach till (3b), the most prevalent surface till, is a light brownish-grey till comprising coarse and fine clasts in a light silty clay calcareous matrix. Most of the clasts are carbonates, again suggesting deposition from ice advancing from the northwest.

UNIT 4: Isolated patches of lacustrine clay are found throughout the southern half of the area, mainly occurring above the till. A relatively large area of this clay, east of Sprague, is characteristically dark brown, calcareous and contains silt clasts.

UNIT 5: Numerous beach ridges (5a) have been identified, not only on the margins of the Bedford Hills but also outstanding in the swamp which covers most of the low lying northern half of the area. Ridges on the upland range from the Campbell to the Blanchard levels (Fenton, 1974) and follow generally the northwest — southeast trend of the Hills. Low level ridges have no distinctive orientation on the till plain; but in the northern wetlands the beaches, bars and spits markedly define ancient Agassiz shorelines. The ridges which rarely exceed 3 m in height consist of finely bedded sand and fine to coarse pebble gravel. These ridges are the main source of aggregates in the area, and are being actively excavated. Ridges traversing low lying bog and swamp areas have been used as routeways because of their relatively good drainage. Sandy littoral fringes and near-shore sand deposits (5b) occur in association with the ridged features.

UNIT 6: Alluvial deposits of a minor nature have developed along the major river courses, mainly the Whitemouth and Powawassan Rivers and Sprague Creek. Alluvium consists of dark greyish brown silt with some clay.

UNIT 7: Organic materials ranging from dry peatlands to string bogs and reed and sedge fens cover over 65% of the area. The peat may be up to 5 m deep overlying sand, till or bedrock. Eight peat bogs in the area have been tested as part of a program to determine the potential of sphagnum bogs in southeastern Manitoba for peat moss production (Bannatyne, 1977).

In the southeastern corner of Manitoba the demand for aggregate is not high. Small quantities are used for residential construction in the towns of Piney, Middlebro and Sprague and some gravel is used by the Parks Branch to maintain the Moose Lake facility. Most of the demand for gravel comes from road construction or upgrading done by the Local Government

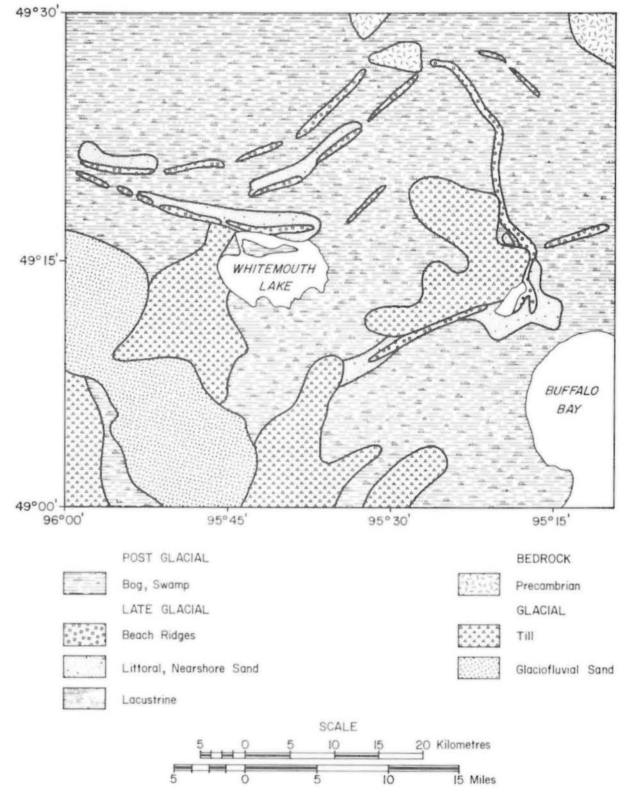

Figure MEA-5-1: Quaternary geology of the southeastern corner of Manitoba.

THICKNESS	UNIT NO.	COLUMN	MATERIAL	ORIGIN	ESTIMATED AREAL EXPOSURE
0–5m	7	b	b) dry organic material, peat	peat, swamp	25%
		a	a) wet organic material	bog, fen	40%
0–3m	6		clay, silt	alluvium	<1%
0–10m	5b		sand	littoral nearshore	5%
0–3m	5a		gravel	beach ridges	5%
0–8m	4		clay	lacustrine	2%
0–45m	3b		light till	glacial Steinbach *	10%
	3a		dark till	glacial Marchand *	1%
0–55m	2		gravel		
			sand	glaciofluvial Senkiw *	10%
			bedrock		–
				Precambrian granite	2%

* terminology of Fenton 1974

Figure MEA-5-2: Stratigraphic column of the Quaternary geology of southeastern Manitoba.

Districts or the Department of Highways. Although high quality aggregate, for instance in the Bedford Hills area, is not abundant, on the basis of this past season's field work it would appear that the immediate demand for sand and gravel can be met locally (see Fig. MEA-5-1 and PSE series of preliminary maps).

References:

Bannatyne, B.B.
1977: Peat Project; *in*: Manitoba Mineral Resources Division, Report of Field Activities 1977.

Fenton, M.M.
1974: The Quaternary Stratigraphy of a Portion of Southeastern Manitoba, Canada. Unpublished Ph. D. thesis, University of Western Ontario.

Teller, J.T., Bannatyne, B.B., Large, P., and Ringrose, S.,
1976: Geology and topography of the buried bedrock surface of southern Manitoba. Man. Min. Res. Div., Surficial Map Series, Map 76-3.

MEA-6 QUATERNARY GEOLOGY OF THE SWAN RIVER AREA

by Erik Nielsen and Gaywood Matile

Quaternary mapping at a scale of 1:50 000 was done in an area extending from Novra in the north to Garland in the south, and from Lake Winnipegosis westward to the Saskatchewan border (Fig. MEA-6-1). The area includes four major physiographic regions: Duck Mountain, Porcupine Hills, the Swan River Valley and a small portion of the Manitoba Plain. Attention was directed towards attaining a better understanding of Quaternary events in western Manitoba. Figure MEA-6-2 shows a tentative Quaternary correlation for Duck Mountain and Swan River Valley.

Early Pleistocene

The oldest Pleistocene unit is a sand and gravel deposit exposed in a pit 6.5 km east of Minitonas on the north side of Duck Mountain. The presence of agate and the westerly origin, as indicated by large scale cross-bedding, suggest that it may be equivalent in age to the 'Souris sand and gravel' described by Klassen (1969). It is therefore assigned an early Pleistocene age.

Sangamon — Wisconsin Events

One of the most complete stratigraphic sections in the area is the Roaring River section described by Klassen et al. (1967). The lowest exposed part of that section is a 9 m thick sand and gravel layer with a well developed soil horizon at the top. The 3 m thick Roaring River Clay which Klassen correlates with the Sangamon Interglacial on fossil evidence overlies the soil horizon. Correlatives of the lower sand and gravel unit and the Roaring River Clay have not been found elsewhere in the area.

The black clay till overlying the Roaring River Clay is the oldest unit found extensively throughout the area. It occurs frequently at the base of sections in the northeastern part of Duck Mountain and the adjacent lowlands to the north and east. The black colour is a result of erosion of black Cretaceous shales found to the north and east of Duck Mountain (Bannatyne, 1970).

In two sections, one less than 250 m downstream from the Roaring River section and the other in Swan River, the black till is overlain by unfossiliferous well-sorted and oxidized sand and gravel, possibly representing a substantial unglaciated interval. The underlying black till is therefore tentatively correlated with Klassen's Shell till and assigned an early Wisconsin age.

Overlying the black till in the Roaring River section and widespread on Duck Mountain are two brown tills. The lower of these two tills is sandier and more oxidized than the upper till and appears to be restricted to the southwestern part of Duck Mountain. The upper till is more widely distributed and variable in composition than the lower. These two tills are very similar to the two described by Klassen (1972) in the Deepdale Section, near Roblin. The lower brown till is correlated with the Lennard till. It is noteworthy that the lower brown till (Minnedosa till) and the black till (Shell till) rarely occur in the same exposure. This suggests they might be lateral equivalents and the Shell till may in fact not be exposed.

Late Wisconsin — Holocene Events

Hummocky disintegration moraine formed as the result of inversion of topography, is common in the central and southern part of Duck Mountain. The kames are generally composed of flow till, highly contorted glaciofluvial sand and gravel and are often capped by a layer of till of variable thickness.

Extensive lacustrine silt and clay, as well as esker deposits and spillways, indicate the presence of large lakes and rivers on Duck Mountain during the late Wisconsin and early Holocene time. Rivers have since incised the mountain and the ice-cored moraine has disappeared resulting in drainage of the large late glacial lakes.

Glacial Lake Agassiz became the dominant feature of the Swan River Valley and the Manitoba Plain after the retreat of the Lennard ice. Glaciolacustrine sedimentation was, however, soon interrupted by an advance from the north by the Interlake lobe which deposited fluted carbonate-rich till. The Interlake lobe abutted the east side of Duck and Porcupine

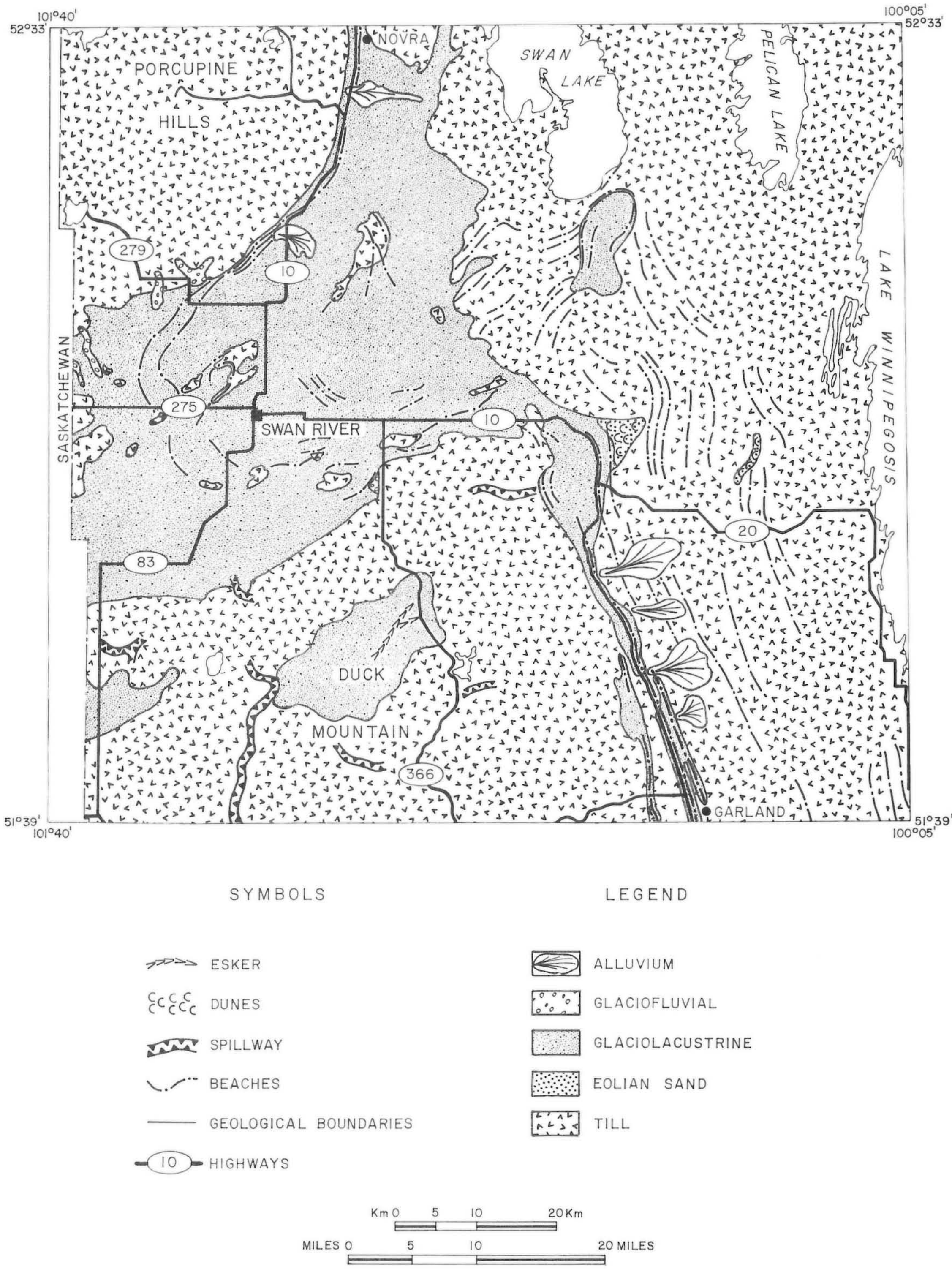

Figure MEA-6-1: Surficial geology of the Swan River area.

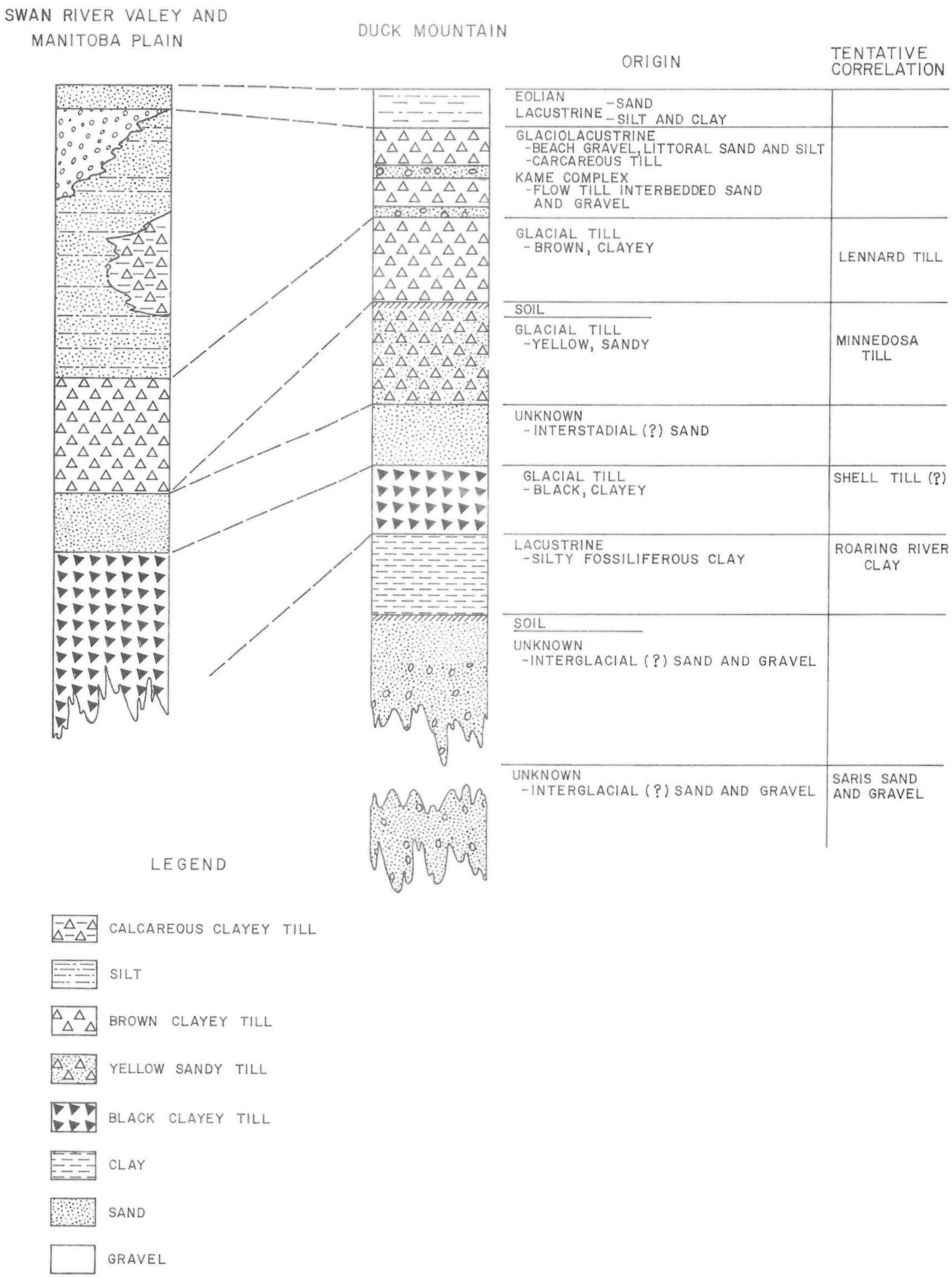

Figure MEA-6-2: Quaternary stratigraphy of the Swan River area.

Mountains, but the western limit in the Swan River Valley has not been precisely determined. Glacial Lake Agassiz was re-established at the Campbell level after the final retreat of the ice. Subsequent lake levels are recorded by the numerous beach deposits found in the Swan River re-entrant and on the Manitoba Plain to the east.

Sand dunes east of Duck Mountain, notably northeast of Cowan, were formed after the withdrawal of Lake Agassiz. The dunes are now stabilized.

Alluvial fans with high sedimentation rates are still active on the east side of Duck Mountains and the Porcupine Hills.

References

Bannatyne, B.B.
1970: The Clays and Shales of Manitoba; Man. Min. Res. Div., Publication 67-1.

Klassen, R.W., Delorme, L.D., and Mott, R.J.
1967: Geology and Paleontology of Pleistocene Deposits in southwestern Manitoba; Canadian Journal of Earth Sciences, Vol. 4, p. 433-447.

Klassen, R.W.
1969: Quaternary Stratigraphy and Radiocarbon Chronology in Southwestern Manitoba; Geol. Surv. Can. Paper 69-27.

Klassen, R.W., and Elson, J.A.
1972: *In*: Quaternary Geology and Geomorphology between Winnipeg and the Rocky Mountains: Guidebook Field Excursion C-22, International Geological Congress.

MEA-7 QUATERNARY STRATIGRAPHY AND AGGREGATE RESOURCES OF THE GYPSUMVILLE AREA

by Erik Nielsen

Surficial mapping at a scale of 1:50 000 in the Gypsumville area (Fig. MEA-7-1) was carried out for two reasons: (1) to gain stratigraphic information about part of the Interlake region and (2) to delineate and evaluate the sand and gravel resources.

Glacial History

The numerous swamps, the poor access, the low monotonous relief and the resulting poor exposure have greatly hindered our knowledge of Quaternary events in the area.

Striae directions in the area are extremely variable presumably because they were formed under thin glacier lobes in which the ice flow direction at the snout was controlled by calving and the local topography. However, glacial striae recorded on numerous bedrock exposures testify to several ice advances across the area. A few striae at 275° record the earliest ice flow. The age of this advance is unknown and there are no known deposits that can be attributed to it.

Striae and large grooves most prominent in the Waterhen area indicate ice flow from 10°. The till associated with this advance is compact and yellowish brown (Munsell colour 10YR 5/4), and has a relatively silty texture. It is moulded into drumlinoid ridges as much as 14 km long and 3 km wide. The ridges are separated by swamps of approximately the same dimensions. The maximum relief is 5 to 10 m. The swell-and-swale topography is a result of groove formation in the underlying bedrock and subsequent mantling by till.

In the central part of the area, striae and small grooves in the bedrock indicate ice flow from 325°. "Glacial" striae on bedding plane surfaces exposed on the floor of a dolomite quarry north of Fairford trend 325°. These striae indicate that dislocation of large bedrock blocks by glacier ice might have been a common form of glacier erosion in the Gypsumville area. Anomalously high topographic areas such as those southeast of Gypsum Lake and Lake St. Martin (Fig. MEA-7-1) might have formed by this method of "popping out" and stacking of bedrock slabs although field evidence in those areas is not available at present.

The till associated with the northwesterly ice advance is grey (Munsell colour 5Y 7/2) and has a clayey matrix. It is widespread in the central and eastern area and is believed to be the lateral equivalent of the silty till to the west.

Overlying the till sheet are small isolated pockets of light olive grey (Munsell colour 5Y 5/2) glaciolacustrine clay with varying quantities of dropstones. Occasionally the till and the stony lake clay are intermixed giving the impression that there are two tills. The mixing of the till and the clay is believed to be related to long narrow grooves and ridges superposed and cross-cutting the swell-and-swale topography. The grooves are orientated toward 330° (Wardlaw et al 1969) and are several tens of metres across and several kilometres long. They are generally straight but some are hairpin-shaped and often criss-cross indicating formation by iceberg scouring.

The area was completely covered by Lake Agassiz after the retreat of the ice. The almost complete absence of lake sediment, and wave washed till indicates that although the lake was at least 100 m deep at its maximum it was short lived and sediment supply was limited. Only the numerous beaches testify to the former existence of the lake (Fig. MEA-7-1). Major still stands during drainage of the lake are recorded by beaches at 242, 250, 257, 269, 290 and 307 m.

Aggregate Resources

The numerous Lake Agassiz beaches (Fig. MEA-7-1) are the principal source of sand and gravel.

The sand and gravel reserves in these beaches are in remote areas as the deposits along the major access routes have been severely depleted.

Table MEA-7-1 shows that the number of tonnes of aggregate used for construction and maintenance of roads has been highly variable over the last several years. It is however evident that crushed dolomite is of paramount importance over beach gravel as a source of aggregate. The trend will be altered only with the exploitation of beach deposits in remoter parts of the area.

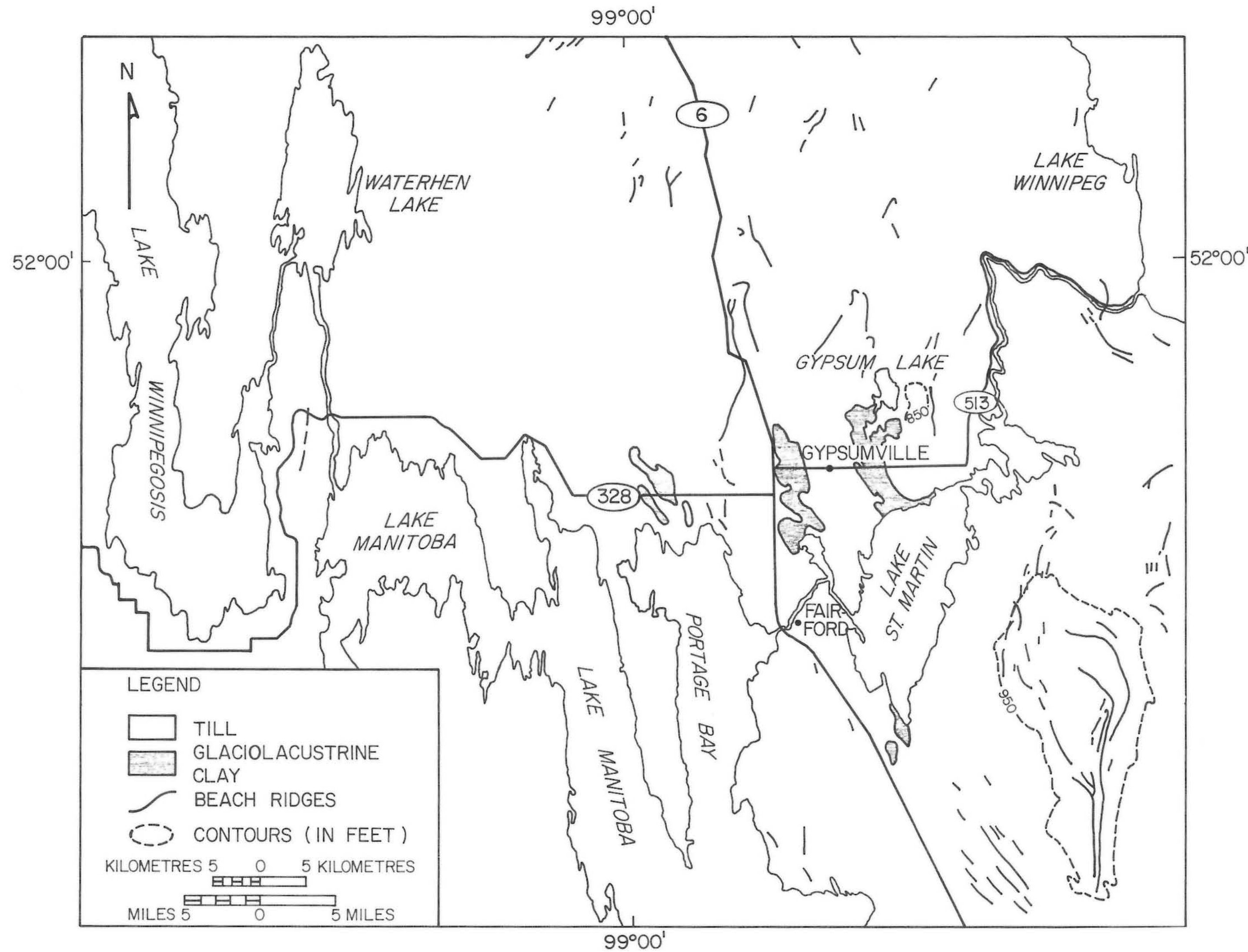

Figure MEA-7-1: Surficial geology of the Gypsumville area.

Table MEA-7-1 Tonnes of Crushed Stone and Gravel used for Road Construction in the Gypsumville Area (compiled from Mining Recording Files — Nonconfidential, Man. Min. Res. Div.)

	Tonnes Crushed Stone	Tonnes Gravel
1969	14,300	—
1970	196,340	—
1971	6,200	—
1972	1,920	—
1973	242,360	26,227
1974	—	4,872
1975	—	14,603
1976	159,400	28,785
1977	159,780	80,000

Reference

Wardlow, N.C., Stauffer, M.R., and Hoque, M.
1969: Striations, giant grooves, and superimposed drag folds, Interlake area, Manitoba; Canadian Journal of Earth Sciences, Vol. 6, p. 577-593.

MEA-8 INDUSTRIAL MINERALS DRILL PROGRAM

by B.B. Bannatyne

During the 1978 field season, 12 holes were drilled to obtain core from a variety of industrial mineral deposits and stratigraphic sections.

Holes M-1-78 and M-2-78 were drilled in the area southeast of Stony Mountain to check potential locations where dolomite suitable for crushed stone may be present under thin overburden. The locations chosen were based on results of a seismic survey (The UMA Group, 1976). Hole M-1-78 intersected bedrock, at a depth of 15.2 m, consisting of dolomite of the Fort Garry Member of the Red River Formation. The hole was deepened to intersect the high-calcium limestone bed at the top of the Selkirk Member. The limestone bed is about 2.7 m thick at this location, and may be thicker as core recovery was 67% in that interval. Hole M-2-78 was abandoned at a depth of 12.2 m in glacial lake clay (Table MEA-8-1).

Altogether, 12 locations have been drilled in the Stony Mountain-Stonewall area in the past three years (Bannatyne, 1977). In these, bedrock was intersected at less than 5 m in six holes, between 5 and 7 m in two holes, and at depths greater than 12 m in four holes (three of which were ended before bedrock was reached). Because of these results, a re-assessment of the original seismic data is being made (R. Vohra, personal communication).

Holes M-3-78 to M-7-78 were drilled in the Lower Paleozoic limestone and dolomite section of the northern Interlake-Dawson Bay-Swan Lake area, and are described by H.R. McCabe (this report). One hole, M-6A-78, intersected what is believed to be Cretaceous shales and sand deposited either in a channel or in a solution cavity in Devonian strata. However, the colour of the shales, ranging from pale green to olive and reddish brown, is somewhat similar to that of Jurassic strata, which have previously been reported only as far north as the Ethelbert-Pine River area, some 150 km to the south.

Hole M-8-78 was located to check a report of a 9 m thickness of lignite, possibly mixed with some clay, in a well drilled at Pine River school by the Water Resources Branch in 1975. The lignitic interval was reported at a depth of 85 m. Although thin lignite beds have been reported in other wells in the area, and attempts were made in 1937 and 1948 to mine lignite in sec. 7, tp. 34, rge. 20W (22 km northeast of Pine River), the school location was selected for coring because of the reported thickness of the lignite. Difficult drilling conditions, caused mainly by fine sand and silt beds in the section drilled, resulted in abandonment of the hole at a depth of 75.1 m. Core of the Ashville Formation and part of the Swan River Group was recovered.

Holes M-9-78, M-10-78 and M-11-78 were drilled in the area 10 to 12 km south of Ste. Rose du Lac, where Red River Brick and Tile have been quarrying shale since 1970. All the holes intersected kaolinitic beds of the Swan River Group (and possibly from a weathered zone of Jurassic shales), but all were stopped in sandy beds at total depths of 14 to 22 m. Thick sections of grey to white kaolinitic shales and kaolin were intersected in all three holes. These materials are known to be suitable for brick manufacture. Attempts to deepen two of the holes to intersect suspected underlying beds of high-calcium limestone of the Reston Formation and gypsum of the Amaranth Formation were unsuccessful, because of time constraints and difficult drilling conditions in the sandy beds.

Analyses for high-calcium limestone

A report on the occurrences of high-calcium limestone has been published (Bannatyne, 1975). Since that time, numerous beds of limestone have been intersected during the core hole program, and drill core of the Jurassic Reston Formation was recovered in the Tudale Neepawa drill hole. Twenty-five samples of limestone were selected from these, and the analyses are listed in Table MEA-8-2. The details of the geology of each limestone zone are described in publication 75-1.

References

Bannatyne, B.B.,
1975: High-calcium Limestone Deposits of Manitoba; *Man. Min. Res. Div.* Publ. 75-1, 103p.

Bannatyne, B.B.,
1977: Industrial Minerals Drill Program; **in** *Man. Min. Res. Div.*, Report of Field Activities, 1977, p. 150-151.

McCabe, H.R.,
1978: Stratigraphic Core Hole Programme; **in** this report.

The UMA Group,
1976: Aggregate Resources of the Winnipeg Region, prepared for *Man. Min. Res. Div.*

Table MEA-8-1 Drilling Results, 1978 Core Holes

Hole No.	Location and Elevation (est.)	Formation/Member	Interval Metres	Lithology
M-1-78 Stony Mountain	NE 16-35-12-2 EPM 234 m	Overburden	0 — 15.24	Clay (12.34 m) and till (3 m)
		Red River/Fort Garry	15.24 — 25.1	Dolomite, mottled, with chert nodules; "middle limestone zone" at 20.85 - 23.3 m
			25.1 — 41.8	Dolomite, buff to orange-buff; dense.
		Red River/Selkirk	41.8 — 48.8	"Upper limestone zone" at 41.8 - 45.3 m, cherty; remainder partially dolomitized limestone.
M-2-78 Blackdale	SE 1-29-12-3 EPM 231.7 m	Overburden	0 — 12.2	Clay
M-8-78 Pine River	4-33-32-22 WPM 347 m	Overburden	0 — 3.98	Clay; may include shale.
		Ashville	3.98 — 34.03	Shale, mainly black to grey, carbonaceous; silt lenses and laminae in lower half
		Swan River (Group)	34.03 — 75.11	Shale, light grey kaolinitic to black carbonaceous; interlayered glauconitic sandstone, pyritic sandstone, and calcareous sandstone layers (Recovered only 4 m of core between 45 and 75.11 m).
M-9-78 Ste. Rose	15-4-23-15W 283 m	Overburden	0 — 3.67 m	Clay, till
		Swan River (Group) (may include some weathered Jurassic shale at base)	3.67 — 9.42	Shale, kaolinitic, black to very light grey; minor pyrite specks, lignite fragments; in 3 repeated cycles
			9.42 — 14.38	Shale, kaolinitic, mottled light purplish grey to light grey; 0.3 m of soft red shale; sandy near base.
M-10-78 Ste. Rose	SW 4-10-23-15W 284 m		0 — 3.60	Clay, till.
		Overburden	3.60 — 6.33	Siltstone, grey; kaolin, light grey to white.
		Swan River (Group) (may include some weathered Jurassic shale)	6.33 — 7.64	Shale, variegated; red, grey, with mauve and brown patches.
			7.64 — 10.00	Shale, kaolinitic, light to dark grey; lignite fragments.
			10.00 — 11.52	Kaolin, silty, with pyrite, grading to smooth, very light grey kaolin.
			11.52 — 20.27	Siltstone, kaolinitic, and shale, kaolinitic; some kaolin and some carbonaceous shale, minor lignite fragments.
			20.27	Silt, sandy, quartzose (below 20.27 m).
M-11-78 Ste. Rose	NW 4-15-23-15W 281 m	Overburden	0 — 3.05 m	Clay, till.
		Swan River (Group)	3.05 — 21.82 m	Shale, kaolinitic, grey shades.
				Shale, carbonaceous, brownish grey to black, in places lignitic.
				Kaolin, plastic, light grey, banded medium grey and white in several layers; in part, silty.
				Sand, quartzose, near and at bottom of hole, separated by 0.8 m smooth kaolin.

Table MEA-8-2 Limestone analyses from the core-hole program, and from Tudale Neepawa

Hole	Location	Interval metres	Formation/unit	CaO	MgO	SiO_2	Al_2O_3	% Fe_2O_3	Na_2O	K_2O	P_2O_5	S	LOI
M-3-74	1-21-11-1E	55.18 — 57.32	Fort Garry Member/upper	54.23	1.33	0.55	0.15	0.22	0.01	0.05	Nil	0.02	43.73
		67.83 — 71.34	Fort Garry Member/middle	54.35	0.63								43.17
B-1A-76	1-12-13-1E	39.27 — 41.25	Fort Garry Member/upper	50.46	4.25	0.90	0.28	0.45	0.01	0.09	Nil	0.03	44.08
M-8-74	4-18-32-11W	0 — 3.05	Elm Point	54.28	0.73	1.28	0.30	0.09	0.01	0.12	Nil	0.04	43.23
		3.05 — 6.10	Elm Point	54.94	0.46	1.08	0.23	0.09	0.01	0.13	Nil	0.03	43.29
		6.10 — 9.15	Elm Point	53.66	1.07	1.52	0.48	0.39	0.02	0.19	Nil	0.04	43.14
M-2-73	9-33-43-21W	23.78 — 27.44	Elm Point	54.00	0.89								43.18
		27.44 — 32.01	Elm Point	55.69	0.15								43.50
		32.01 — 36.59	Elm Point	54.52	0.41								43.17
		36.59 — 41.16	Elm Point	55.44	0.05								43.34
M-2-74	12-29-29-17W	14.63 — 16.62	Dawson Bay/upper	54.55	1.22								44.02
		38.11 — 41.16	Dawson Bay/lower	52.72	0.68								41.84
M-5-74	1-6-30-14W	15.55 — 17.74	Dawson Bay/lower	52.79	0.94								42.30
M-9-74	9-18-30-16W	0 — 3.05	Dawson Bay/lower	53.94	0.82	1.68	0.46	0.14	0.02	0.21	Nil	0.02	43.01
		3.05 — 6.10	Dawson Bay/lower	53.43	0.53	2.44	0.71	0.15	0.02	0.36	Nil	0.04	42.39
		6.10 — 9.15	Dawson Bay/lower	51.52	0.68	4.66	1.30	0.23	0.03	0.69	0.03	0.01	40.99
M-5-76	10-22-30-16W	49.39 — 55.79	Dawson Bay/lower	52.52	1.48								42.65
D47-76-14	14-12-44-26W	34.76 — 36.89	Dawson Bay/upper	54.95	0.10								43.00
		36.89 — 39.33	Dawson Bay/upper	54.52	0.66								43.45
M-7-74	14-5-30-16W	0 — 3.20	Souris River (?)	53.87	0.72	1.73	1.36	0.17	0.01	0.09	Nil	0.05	42.62
M-3-75	8-19-30-16W	0 — 1.59	Souris River	49.85	0.46								39.43
		1.59 — 5.34	Souris River	54.38	0.97								43.56
Tudale Neepawa	5-29-14-14W	198.17 — 201.22	Reston	52.31	1.02	2.77	0.79	0.37	0.12	0.16	0.04	0.15	42.27
		201.22 — 204.27	Reston	49.39	1.43	4.86	1.45	0.64	0.20	0.34	0.04	0.36	41.17
		204.27 — 207.32	Reston	47.54	1.53	7.15	2.00	0.90	0.16	0.50	0.04	0.35	39.41

MEA-9 LIST OF PRELIMINARY MAPS, QUATERNARY GEOLOGY SERIES

Island Lake Area (1:50 000)

1978PIL-1		53L/7
1978PIL-2	Murray Lake	53L/8
1978PIL-3	Sharpe Lake West	53K/5
1978PIL-4	Sharpe Lake East	53K/6
1978PIL-5	Stull Lake	53K/7
1978PIL-6	Goose Lake	53L/2
1978PIL-7	Rochon Lake	53L/1
1978PIL-8	Red Sucker Lake	53K/4
1978PIL-9	Robson Lake	53K/3
1978PIL-10	Dobbs Lake	53E/14
1978PIL-11	Island Lake	53E/15
1978PIL-12	York Lake	53E/16
1978PIL-13	Angling Lake	53F/13
1978PIL-14	Seeber Lake	53F/14
1978PIL-15	Wass Lake	53E/11
1978PIL-16	Wapus Bay	53E/10
1978PIL-17	Benson Bay	53E/9
1978PIL-18	Hayward Lake	53F/12

Portage — Winkler Area (1:50 000)

1978PW-1	Portage la Prairie	62G/16
1978PW-2	St. Claude	62G/9
1978PW-3	Miami	62G/8
1978PW-4	Morden	62G/1
1978PW-5	Altona	62H/4

Southeastern Corner (1:50 000)

1978PSE-1	Whitemouth River	52E/5
1978PSE-2	Berry Point	52E/6
1978PSE-3	Sprague	52E/4
1978PSE-4	Buffalo Bay	52E/3

MEA-10 LIST OF MAP SHEETS COVERED BY SURFICIAL MAPPING IN 1978

Swan River Area

	Birch River	63C/6
	Lenswood	63C/7
	Magnolia Lake	63C/8
	Kircro Lake	63C/9
	Swan River	63C/3
	Renwer	63C/2
	Duck Bay	63C/1
	Durban	62N/14
	Pine River	62N/15
	Sagemace Bay	62N/16
	Childs Lake	62N/11
	Singush Lake	62N/10
	Garland	62N/9

Gypsumville Area

	Waterhen Lake North	63B/4
		63B/3
	Pine Lake	63B/2
	Clarke Point	63B/1
	Skownan	62O/13
	Proulx Lake	62O/14
	Gypsumville	62O/15
	Dauphin River	62O/16
	Winnipegosis	62O/12
	Crane Bay	62O/11
	Fairford	62O/10
	Lake St. Martin	62O/9
	Rorketon	62O/5
	Guynemer	62O/6
	Steep Rock	62O/7
	Moosehorn	62O/8

PW and PSE — as listed under Preliminary Maps