

MANITOBA

DEPARTMENT OF
ENERGY AND MINES

MINERAL RESOURCES DIVISION



Report of Field Activities 1981



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1981

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GEOLOGICAL SERVICES BRANCH

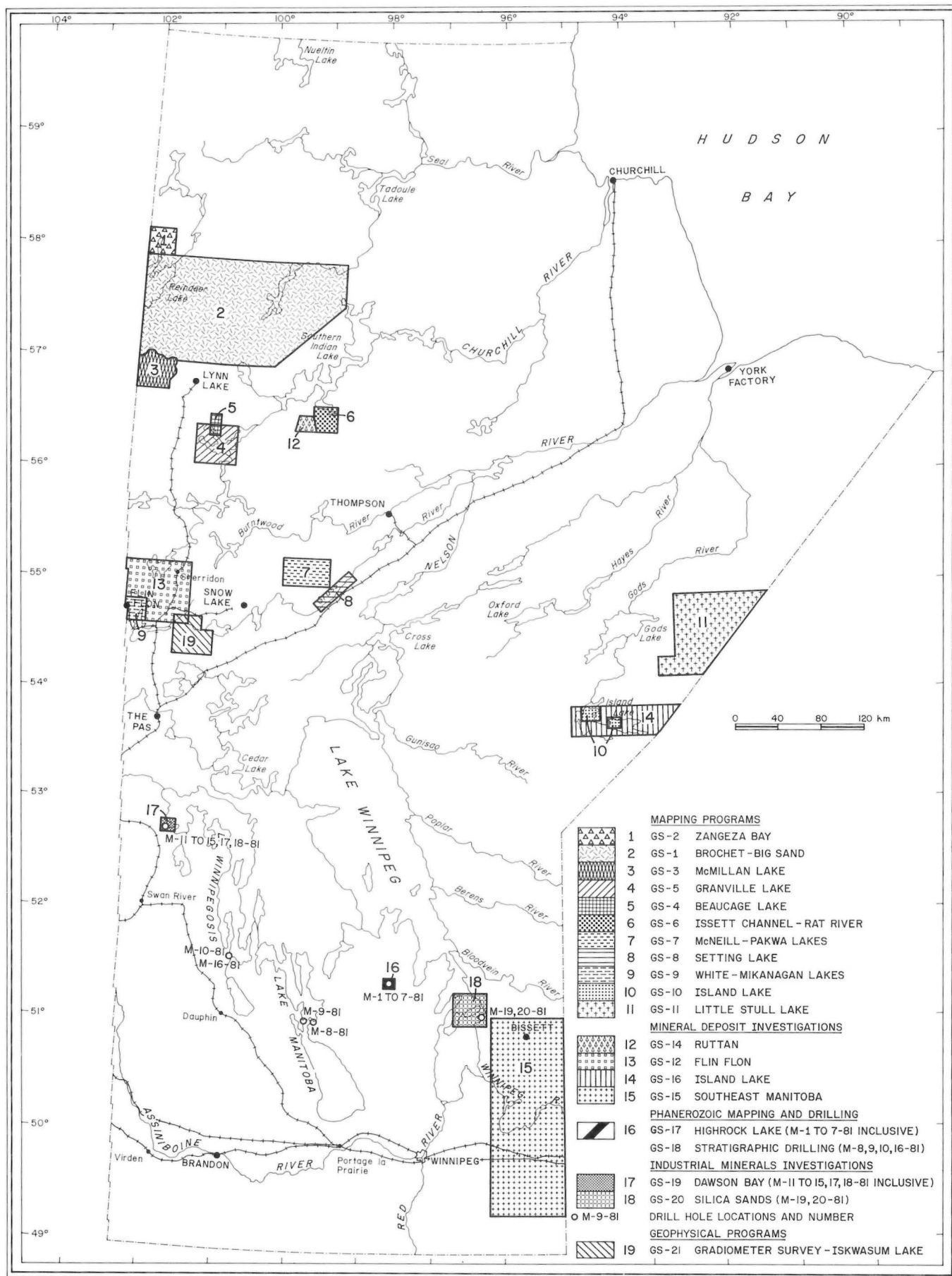


Figure GS-1: Location of Field Projects 1981.

SUMMARY

In 1981 new 1:50 000 and 1:20 000 scale mapping programs were initiated in the Island Lake area and on Setting Lake. Reconnaissance surveys were conducted on Zangeza Bay (Reindeer Lake) in the Brochet and Big Sand areas, at Flin Flon, and around Little Stull Lake, in preparation for major projects proposed for 1982. Mapping on McMillan Lake, in the McNeill Lake and Pistol Lake area, on Granville and Beaucage Lakes and east of the Issett Channel completed gaps in the coverage and/or interpretation of data stemming from earlier projects. In this context the work on Granville Lake and the Churchill River provided considerable new insight that may warrant a review of earlier stratigraphic concepts for the area.

On Setting Lake the detailed mapping of well preserved metasedimentary formations suggests a stratigraphic continuity and possible correlation between the Ospwagan group and metasediments more typical of the Churchill Province.

Mineral Deposit investigations near the Ruttan Mine focussed on the detailed mapping of felsic volcanics that appear in large part to be subaerial in origin. An Open File report on mineral occurrences in the area is currently in press.

In the Flin Flon region known mineral occurrences were mapped in detail at scales ranging from 1:100 to 1:500. Gold showings in the Tartan, Mikanagan, Alberts and Embury Lakes areas were investigated as were sulphide showings on Kississing and Kipahigan Lakes. Three hundred and fifty samples were collected from granitic intrusions in the Flin Flon area in order to investigate their base metal content.

On Island Lake the Island Lake Gold Mine and its surroundings were mapped and sampled, and the inventory of ultramafic occurrences and study of their setting completed.

In southeast Manitoba chromite layers in the Bird River Sill were mapped and sampled in detail in order to evaluate their potential for platinum group metals. A detailed investigation and documentation of the base and precious metal mineral occurrences in this part of the Province has been initiated to extend

and expand upon the descriptions contained in the present Mineral Inventory.

The limestone resources and potential of the Dawson Bay area are being re-evaluated on the basis of new drill hole information acquired as part of the Branch's stratigraphic and industrial minerals drilling program.

Industrial Minerals investigations were expanded in 1981 with the commencement of a silica resources study. Initially attention has been directed to the sandstone of the Winnipeg Formation.

In the Highrock Lake area near Red Rose, additional information on the form of the Precambrian inlier has been obtained from mapping of surface exposures and shallow drilling. A total of 122 m of core from 7 holes has provided new insights as to the nature of the cover rocks associated with this apparently circular and crater-like feature.

A summary of Rubidium/Strontium isotope work, conducted under contract to the Centre for Precambrian Studies, University of Manitoba, is contained in this volume. The results thus far show good agreement with geological field relationships.

The results of the 1980 gradiometer survey of the Weldon Bay - Goose Lake region were released on June 30th, 1981 as GSC Open File 756 and comprised 10 x 1:20 000 scale vertical gradient and 10 total field aeromagnetic maps together with multi-coloured 1:50 000 scale composites which greatly assist inspection of the survey results. The adjacent area to the east (Iskwassum Lake) was flown in June, 1981 and will be released early in 1982 using a format similar to that adopted for the Weldon Bay survey.

The assistance and cooperation received from A. Darnley and P.J. Hood (Resource Geophysics and Geochemistry Division, Geological Survey of Canada) in arranging for and implementing the surveys is gratefully acknowledged.

W.D. McRitchie

GS-1 BROCHET — BIG SAND PROJECT

(NTS 64F and 64G)

by D.C.P. Schledewitz

A sampling and limited mapping program was carried out in the Brochet (NTS 64F) and Big Sand Lake region (NTS 64G) as a preliminary phase to mapping the area at a scale of 1:100 000. These NTS areas have been mapped previously at a reconnaissance scale of 1" = 4 miles (Brochet; Gadd, 1948 and Big Sand Lake; Quinn, 1955) and a scale of 1 inch = 8 miles (Rice, 1952). A subsequent reconnaissance by the Manitoba Mineral Resources Division (McRitchie, 1976 and 1977) indicated a broad east trending lithologic continuity. Two major zones from north to south are:

- i) the Wathaman-Chipewyan batholith;
- ii) the Reindeer Lake-Southern Indian Lake gneiss belt (Fig. GS-1-1)

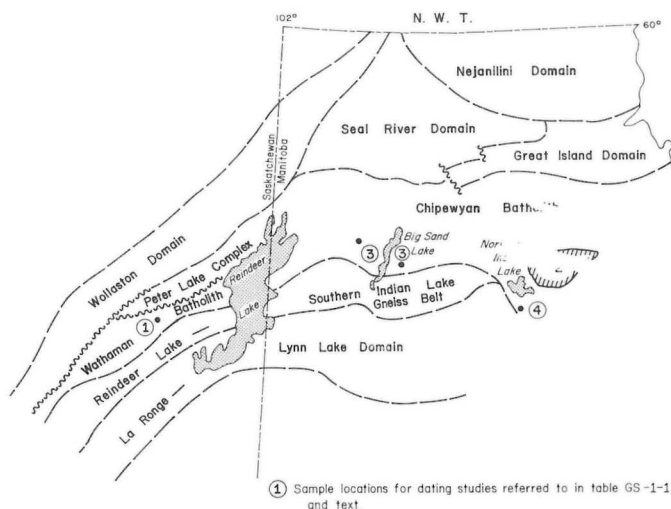


Figure GS-1-1: Reindeer Lake-Southern Indian Lake gneiss belt and Chipewyan Batholith in relation to other major tectonic units in Manitoba and Saskatchewan.

These two zones or domains lie between the Aphebian metavolcanic-sedimentary Lynn Lake belt to the south and the Wollaston-Seal River domains to the north. The Wollaston-Seal River domains are characterized by metamorphically high grade metasedimentary derived gneisses which overlie variably granitized Archean granitoid rocks.

The geological evolution of the Wathaman-Chipewyan batholithic complex, (extending 800 km from the Phanerozoic cover in Saskatchewan (Wathaman batholith, Ray and Wanless, 1980) to a region east of Northern Indian Lake, Manitoba) spanned approximately 150 million years (Table GS-1-1). The compositional heterogeneity of the batholith as presently outlined by reconnaissance mapping comprises:

- i) megacrystic monzogranite with accessory biotite and variable hornblende, (McRitchie, 1977);
- ii) quartz syenite (Corkery and Lenton, 1974) in the eastern segment of the batholith;
- iii) a granulite complex (Katimiwi River) in the south centre of the batholith, (McRitchie, 1977);
- iv) hornblende monzonite peripheral to the granulite complex;
- v) massive porphyritic granite to monzogranite occurs as stocks and dykes, intruded into the megacrystic monzogranite and granulites.

Sampling for the purpose of whole rock geochemistry, Rb/Sr dating and trace element analysis was carried out at the north end of Big Sand Lake in the biotite $\pm$ hornblende megacrystic monzogranite. This rock type is similar to rocks described by Ray and Wanless as being characteristic of the Wathaman batholith dated at 1865 ± 12 Ma (Zircon method, Table GS-1-1). Sampling for whole rock chemistry, trace element analysis, zircon dating studies and examination was also carried out in the south half of Big Sand Lake, within rocks which exhibit mineral assemblages typical of the granulite facies (Fig. GS-1-2). These rocks form part of a complex that extends from the south part of Big Sand Lake northwest to Attridge Lake. The following rock types were observed in the south part of Big Sand Lake:

- 1) translucent green (fresh surface) anorthosite to anorthositic gabbro with fine grained disseminated mafic minerals (8 to 15%) and irregular shaped clots of mafic minerals,
- 2) moderate to well foliated medium- to coarse-grained dull olive coloured biotite-hornblende-plagioclase $\pm$ quartz $\pm$ hypersthene enderbite;
- 3) fine- to coarse-grained leucocratic biotite (8%) - monzonite to quartz monzonite $\pm$ hypersthene, with irregular pegmatitic zones or isolated megacrysts of pearly grey plagioclase;
- 4) fine grained thin leucocratic quartzo-feldspathic dykes mainly in the enderbites and anorthositic rock types.

Inclusions of medium grained metadiorite to metadiabase occur within the megacrystic quartz monzonite and the hypersthene bearing monzonite to quartz monzonite indicating the presence of a pre-Chipewyan batholith country rock of intermediate to basic composition. The full areal extent and contact relationships of the granulite complex are as yet undefined. The granulite complex appears to be Hudsonian in age since samples from the Attridge Lake and the south part of Big Sand Lake (McRitchie, 1977) were dated by the Rubidium/Strontium method and yielded an age of 1815 ± 55 Ma with an initial ratio of .7034 (Table GS-1-1).

The rocks of the Reindeer Lake - Southern Indian Lake gneiss belt comprise paragneisses and migmatites which have been grouped into a garnet $\pm$ graphite metagreywacke-derived suite overlain by a magnetiferous hornblende and biotite bearing meta-arkose-derived suite, (McRitchie, 1977). Areas mapped as metagreywacke or meta-arkose gneisses also contain anatectically derived granodiorites to quartz monzonite which are characteristically white and garnetiferous in the areas of metagreywacke and pink, magnetiferous and/or hornblende-biotite-bearing in the regions interpreted as meta-arkose.

The rocks of the gneiss belt were examined along the south shores and south of Paskwachi Bay (Reindeer Lake) along the western border of the map area and in an area immediately south of Le Clair Lake along the southern margin of the granulite complex southwest of Big Sand Lake. Widely spaced stops were also made along the Hughes River (Fig. GS-1-2).

In the area of Paskwachi Bay an interlayered sequence of:

- i) Amphibolite (possibly metavolcanic in origin);
- ii) Garnet-biotite-feldspar-quartz gneiss;
- iii) Biotite-feldspar-quartz;
- iv) Magnetiferous-biotite $\pm$ hornblende-feldspar-quartz gneiss; forms discontinuous lenses, 1 km by 100 to 200 m, within a foliated biotite tonalite. The tonalite has a gneissic layering defined by lit of white quartz monzonite. These rocks are intruded by metadiorite to metabasic sills. This entire sequence has been intruded by foliated grey quartz monzonite to granodiorite and has been deformed with the resultant formation of north-trending

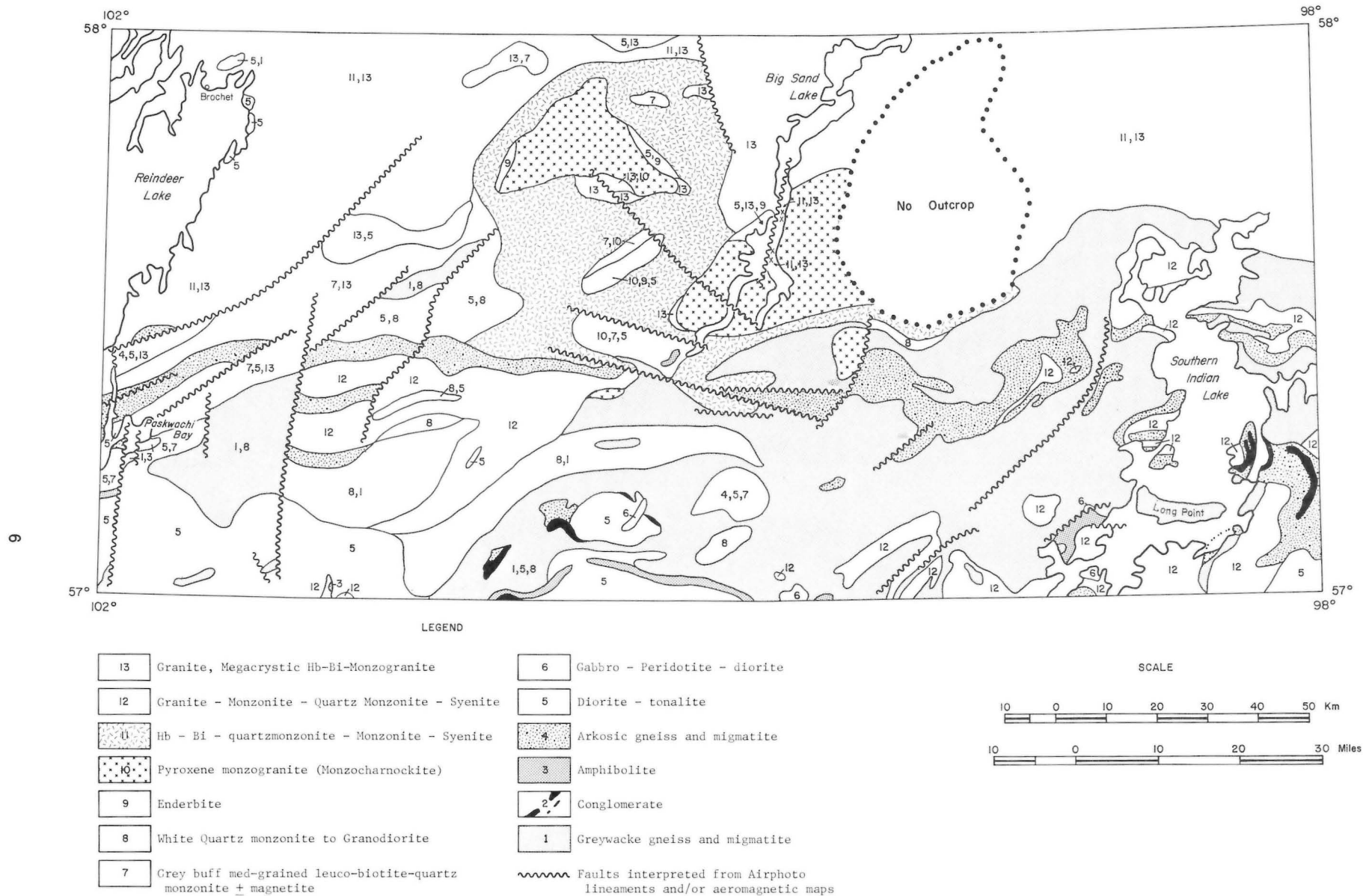


Figure GS-1-2: Outline geology of the Reindeer Lake-Southern Indian Lake region (revised after McRitchie, 1977).

zones of cataclasis and an apparent left lateral en-echelon displacement of the large scale layering. Syntectonic aplites and granite pegmatites occur along the north trending cataclastic belt.

The garnetiferous-biotite-plagioclase-quartz gneiss and interlayered biotite-feldspar-quartz gneiss with related anatectic derived rocks are found extensively along the gneiss belt as is the foliated biotite tonalite. The dominant layering trend is easterly and this has been deformed by either north trending cataclastic belts and/or easterly trending shear belts.

The garnetiferous biotite-plagioclase-quartz gneiss and anatectic derivatives outcrop on a lake south of Le Clair Lake along with areas of foliated enderbite. Inclusions of a similar biotite-plagioclase-quartz gneiss were observed within the granulite complex along the southwest shore of Big Sand Lake. The most apparent difference between the garnetiferous gneiss on the margin of the granulite and the garnetiferous gneiss inclusions in the granulite, is the formation of medium- to coarse-grained honey brown quartzo-feldspathic lenses within the garnetiferous gneisses that lie within the granulite. Preliminary observations indicate a progressive increase in the grade of metamorphism into the granulite complex.

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TABLE GS-1-1
Geochronology of the Wathaman-Chipewyan Batholith

Rock Type	Sample Location (Number refers to Figure GS-1-1)	Method	Age Ma (Note: ⁸⁷ Rb decay constant for Rb/Sr ages is 1.42 x 10 ⁻¹¹ Yr. ⁻¹ .)	Reference
Megacrystic monzogranite to granodiorite, Wathaman Batholith	1. Geike River, Saskatchewan	U-Pb Zircon	1865 ± 12	Ray, G.E. and Wanless, R.K.: 1980, Canadian Journal of Earth Sciences, Volume 17, Numbers, pp. 333-347. Clark, G.S.: 1981, In Manitoba Mineral Resources Division, Report of Field Activities, GS-22.
Coarse grained to porphyritic monzogranite, Chipewyan Batholith	2. NE of Northern Indian Lake, Manitoba	Rb/Sr	1800 ± 50 Initial ratio .7028 ± .0010	
Katimiwi River Monzocharnockite	3. Big Sand Lake and Attridge Lake, Manitoba	Rb/Sr	1815 ± 55 Initial Ratio .7034 ± .0012	
Thorsteinson Granite	4. Thorsteinson Lake, Manitoba	Rb/Sr	1710 ± 20 Initial Ratio .7046 ± .0012	

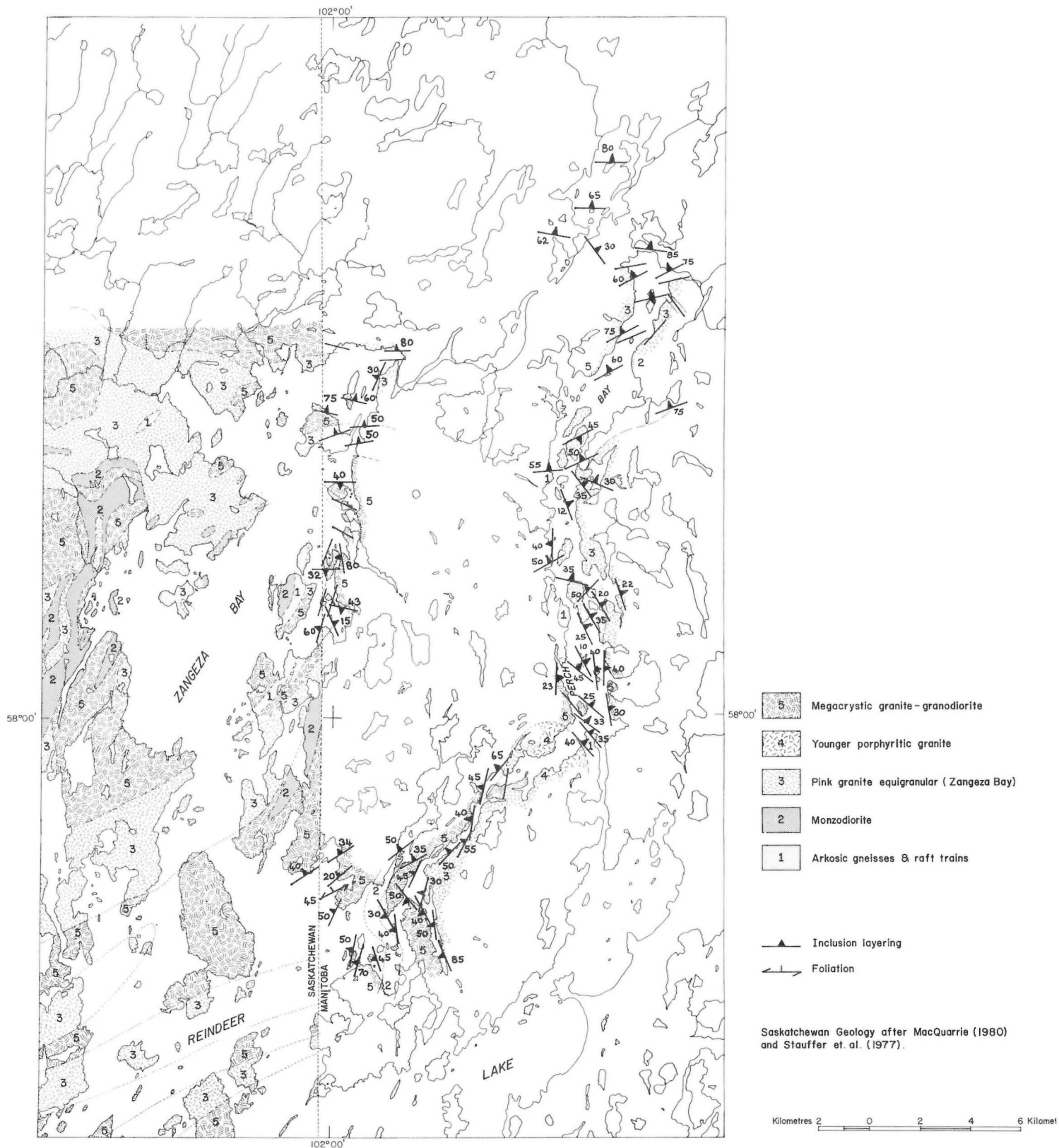


Figure GS-2-1: Outline geology of the Zangeza Bay area.

GS-2 ZANGEZA BAY

(parts of NTS 64K/4, 64L/1, 64E/16, 64F/13)

by W.D. McRitchie

INTRODUCTION

The recent publication of 1:1 000 000 scale geological compilation maps by the Provinces of Saskatchewan and Manitoba highlighted several areas in which discrepancies still persist in the scale of coverage, or in the naming or interpretation of significant rock units.

A brief investigation was therefore undertaken in the Zangeza and Perch Bay areas of Reindeer Lake with the intention of tracing units of the Peter Lake complex and Rottenstone domain in Saskatchewan (MacQuarrie, 1980; Stauffer, 1977) eastwards into the apparently equivalent Chipewyan domain of Manitoba.

GENERAL GEOLOGY

In Saskatchewan this part of the Churchill Structural Province has been subdivided into the Wollaston, Peter Lake and Rottenstone domains. The Wollaston domain comprises an Archean metasedimentary sequence folded along sub-horizontal northeast-trending axes with felsic plutonic "basement" inliers that have yielded Archean U-Pb ages. The Peter Lake domain consists almost entirely of plutonic rocks with remnants and xenoliths of supracrustal rocks which are intruded by mafic plutonic rocks and subsequent coarsely porphyritic granite similar to that of the Wathaman Batholith. A younger pink granitic suite referred to as the Zangeza Bay complex (MacQuarrie, 1980) cuts the older supracrustal complex and megacrystic granite. South and east of the Zangeza Bay complex the proportion of megacrystic granite increases and the boundary of the Peter Lake domain appears completely transitional with that of the Rottenstone domain.

On Zangeza and Perch Bay in Manitoba the plutonic complexes are overwhelmingly granitic and the supracrustal rocks mapped in Saskatchewan can be traced as discontinuous migmatitic, much intruded, strongly deformed and blastic belts and raft trains. Every variation occurs from discrete belts of supracrustal gneisses up to 1 km in width, through injection complexes, to schollen and schlieren complexes with a wide range in the abundance of supracrustal rafts and in the composition of the granitic intrusions. This older plutonic melange is further complexed by the intrusion of dykes, sills, stocks and major intrusions of younger granite, alkali, pegmatite and aplite.

The present reconnaissance confirmed the persistence into Manitoba of the older gneissic and gabbroic supracrustals of the "Archean?" Peter Lake complex mapped by MacQuarrie (1980), as well as the "Hudsonian" megacrystic granite that is probably correlative with the Wathaman and Chipewyan granites, and the younger Zangeza Bay granite that may be contemporaneous with the Nueltin Lake granites (Wanless and Loveridge) or the Thorsteinson Lake granite - 1710 Ma (Clark, pers. comm., 1981). The skeletal coverage obtained during the brief reconnaissance did not provide enough information to derive a geological map and accordingly further work is planned for the future in order to better define the major units across the Provincial boundary into Manitoba.

ROCK UNITS

Layered quartzofeldspathic biotite and biotite-hornblende gneiss

Fine- to medium-grained pink to grey quartzofeldspathic

gneisses occur in well-defined zones and belts along the southeastern shores of Zangeza Bay and as less abundant raft trains in Perch Bay. The rocks are well layered (0.5 to 15 cm thick), locally thinly laminated, magnetite-bearing and are commonly interlayered with hornblende-bearing and hornblende-rich layered and massive units. Most outcrops are strongly folded and accordingly a penetrative foliation and local lineation are typical. Quartzose, aplitic and blastic varieties were observed.

Hornblende gneisses

Layered foliated and lineated hornblende, biotite, plagioclase and quartz-bearing gneisses also occur in discontinuous belts which are parallel to and commonly interlayered with the quartzofeldspathic gneisses. Mesocratic, homogeneous, equigranular metagabbroic to metadioritic orthogneisses up to 5 m in thickness occur sporadically throughout the sequence and resemble metavolcanic units; however, no primary structures were observed. A chain of metamorphically armoured ultramafic pods, surrounded by hornblende and biotitic shells were encountered in the layered gneiss sequence in a small bay off Zangeza Bay (Fig. GS-2-1). Calc-silicate layers were notably absent.

Mafic plutonic rocks

Belts of hornblende-bearing, homogeneous, mesocratic, equigranular, coarse grained metagabbro to metadiorite up to 50 m thick form units that are large enough to trace over several kilometers. Their trend is generally parallel to that of the adjacent hornblende and quartzofeldspathic gneisses into which they appear to have been intruded as sills. Typically the units are foliated and thoroughly recrystallized and appear to have been emplaced prior to the folding which predates emplacement of the megacrystic granite. Minor pyrite and pyrrhotite mineralization is ubiquitous.

Megacrystic granite, monzogranite and syenite

The most abundant unit throughout the area is a foliated to massive very coarse grained megacrystic granite, monzogranite, quartz monzonite and/or syenite in which pink carlsbad, twinned microcline megacrysts (up to 40%) commonly attain a size of 8 cm and more typically range between 3 and 5 cms. Locally in more massive phases of the intrusion randomly oriented neutral to pink subequant 6-8 cm tablets with rounded to subrounded forms are mantled by white sodic feldspar giving a Rapikiwi texture. The matrix plagioclase, quartz, biotite and hornblende are typically 0.5-1.5 cms in size. The quartz-rich, potassic and/or quartz-poor compositional varieties form regionally persistent belts which may have resulted from magma contamination from assimilated or variably metasomatized country rock. In more foliated zones the feldspar megacrysts are flattened, pink and lineated.

Zangeza Bay granite

The Zangeza Bay granite is blocky jointed, medium grained and generally equigranular although porphyritic phases are prominent on the channel between Zangeza and Perch Bays. The most widespread occurrences of the unit are in Perch Bay. The pink, cream and locally white microcline quartz, plagioclase and biotite-bearing granite is typically leucocratic and unfoliated. The porphyritic phases superficially resemble the more ferromagnesian megacrystic granite; however, foliated xenoliths of the latter were observed in the unfoliated younger granite which commonly ex-

hibits a white plagioclase-rich matrix and fewer and smaller (1-3 cm) potassium feldspar phenocrysts. Clear-cut intrusive relationships are apparent on all outcrops with prominent dykes, sills, and stocks cutting the older complex. The younger granite suite ranges in composition from granite through alaskite and aplite to pegmatite; a weak compositional layering is evident locally. Molybdenite crystals up to 1.5 cms in size were recorded in small lenticular quartz veins in a medium grained phase of the granite also on Perch Bay.

STRUCTURE

The dominant trend of the layering and foliation appears to indicate the dominance of northeasterly-striking structures in narrow gneiss belts which flank the major granite bodies. These curve and link up to the north forming a major horse-shoe-shaped fold closure which is transected by intrusions of the younger granite. Mesoscopic structures indicate an early period of intense folding, flattening and foliation development prior to the emplacement of the megacrystic granite which itself cuts an earlier phase of more mafic intrusions. The granite is strongly foliated in zones adjacent to the gneissic belts with prominent retrogression of hornblende to biotite. This foliation and all pre-existing fabrics are repeatedly folded and crumpled into open asymmetric folds up to 10 metres in relief.

The younger, Zangeza Bay granite, aplite and pegmatite are generally fresh, unfoliated and appear to post-date most of the tectonism in the area. Narrow rectilinear fracture sets (strike 52° and 105°) locally transect the granite which exhibits minor associated pinking and retrogression.

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GS-3 McMillan Lake Project

(64C/13 and parts of 64C/14 and 64F/3 and 4)

by H.D.M. Cameron

INTRODUCTION

Four weeks of the 1981 field season were spent in the McMillan Lake area, gathering additional information to supplement the 1980 field work. Traverses and shoreline mapping were carried out in the Whitesand Bay area and at Vandekerckhove, Carswell and Tenklei Lakes. This completes the 1:50 000 scale mapping south of Provincial Road 394, east of the provincial boundary. No new rock types were encountered and the units remain as previously described (Cameron, 1980). There has been some refinement of the geologic boundaries (Fig. GS-3-1). Most changes are relatively minor and no revised maps will be issued at this time.

GENERAL GEOLOGY

Extensive glacial deposits limit exposures of bedrock in the area and many units are lost beneath the drift cover. The major portion of the area is underlain by a white magnetiferous rock of tonalitic to granodioritic composition (unit 4). Screens of meta-greywacke (unit 1) are found at Whitesand Bay and on Vandekerckhove Lake, intruded by large sills of white pegmatite (unit 8). These greywackes generally consist of interlayered psammitic gneiss and a sillimanite faserkiesel-bearing pelite. Rafts and 10 to 100 m thick layers of amphibolite (unit 2) occur within the greywacke near the contacts with the tonalite or the larger pegmatite bodies. South of Whitesand Bay the metasedimentary

section is thicker than originally assumed and appears as a series of large folds with pegmatitic cores.

The mafic iron formation (unit 3) on Vandekerckhove Lake was found to contain amphibolite and white quartz-sericite meta-sedimentary layers and sheared pegmatite veins. Further inland is a small area of metagreywacke and gneissic tonalite showing no sign of mineralization.

The porphyroblastic quartz monzonite (unit 5) in the southwest corner of the area was found to extend as far as the west shore of Tenklei Lake. On the east shore a medium grained quartz diorite (unit 6) occurs as rafts in the tonalite and as a larger body south of the lake. A similar unit is found with the tonalite near the Saskatchewan border, 7 km south of Whitesand Bay.

Southeast of Vandekerckhove Lake a medium to coarse grained pink granite (unit 7) and quartz monzonite lies between the coarse grained quartz diorite (unit 6) and Zed Lake.

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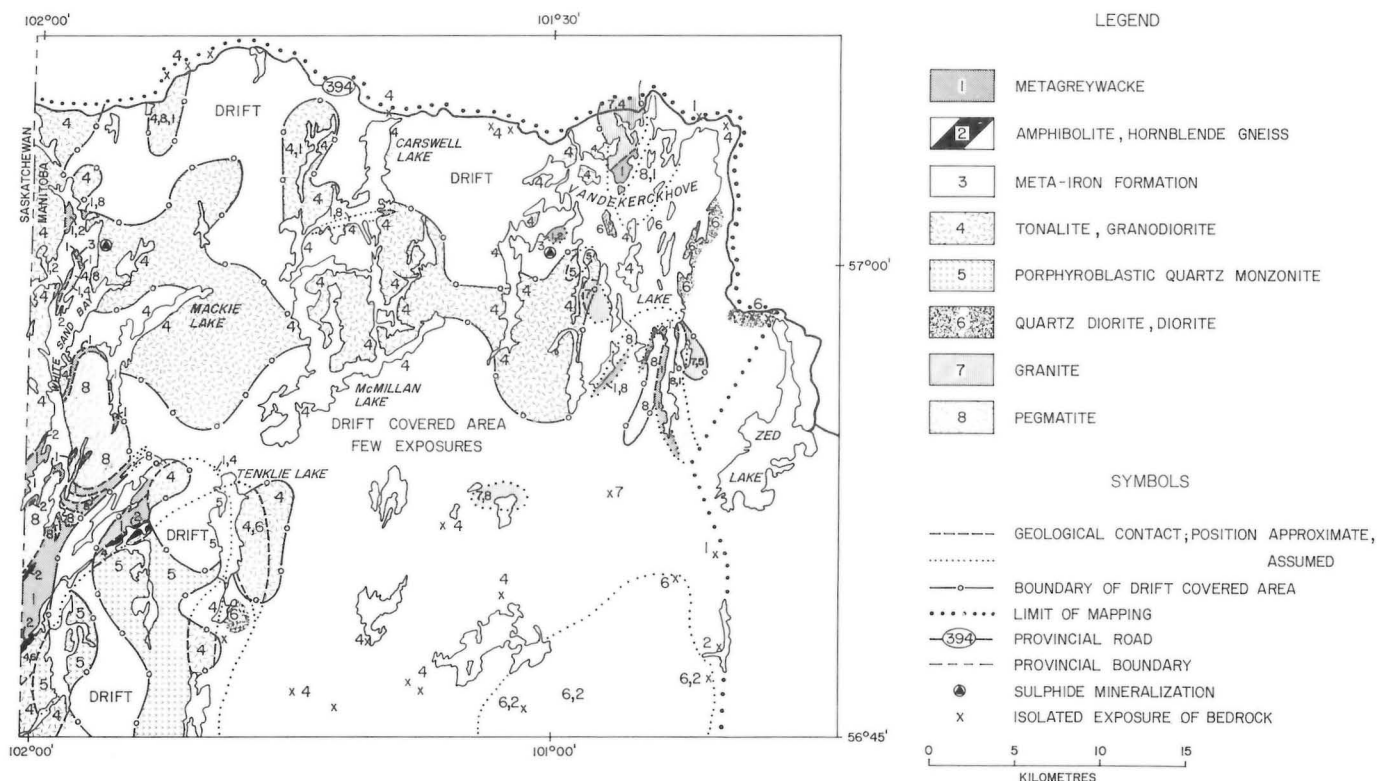


Figure GS-3-1: General geology of the McMillan Lake area.

100°30'
56°30'

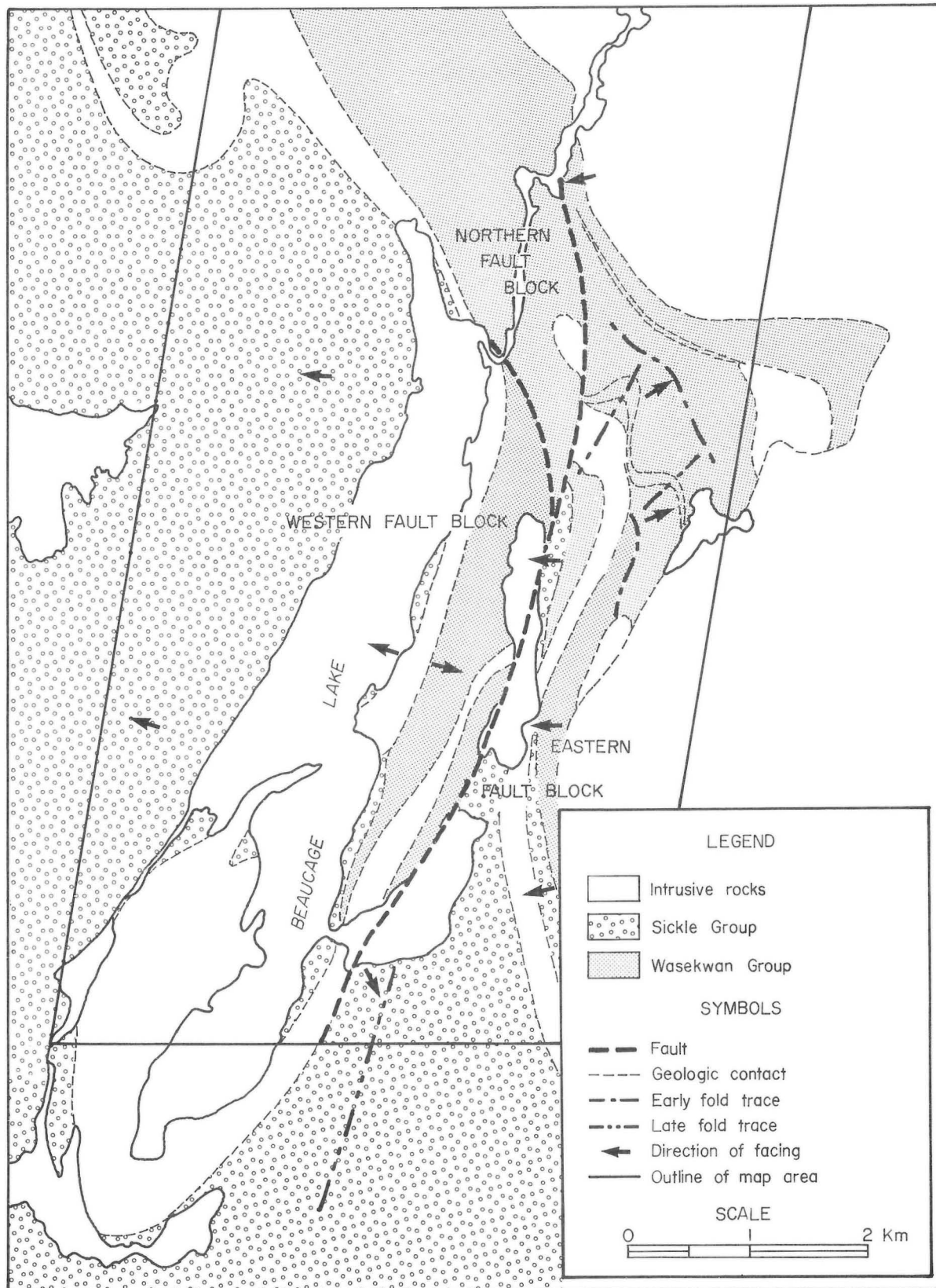


Figure GS-4-1: Major faults and outline geology of the Beaucage Lake area.

GS-4 BEAUCAGE LAKE

(part of 64C/7)

by H.V. Zwanzig

INTRODUCTION

The program of surveying outlying segments of the Lynn Lake greenstone belt was continued this year with the 1:20 000 scale mapping of the Beaucage Lake area. During four weeks of field work:

- 1) the volcanogenic sedimentary rocks of the Wasekwan Group were remapped in detail;
- 2) quartz veins associated with faults or with Black Trout diorite were sampled for assay of precious metals;
- 3) check traverses were made into the Sickle Group;
- 4) the Sickle-Wasekwan contact was examined;
- 5) granitic rocks were examined at the margins of the large plutons.

In this report the structural and stratigraphic framework of the Beaucage Lake area is discussed, and the main units are described in brief. Preliminary interpretations of depositional processes are given and major structures are discussed.

GENERAL GEOLOGY

The oldest rocks in the Beaucage Lake area belong to the Wasekwan Group. They are intruded by a suite of synvolcanic dykes and sills of quartz-feldspar porphyry, feldspar porphyry, basalt, gabbro and quartz diorite. Younger intrusive rocks including tonalite and granite form a large granitic terrane to the east.

The Wasekwan Group rocks and the oldest tonalitic and granitic rocks are unconformably overlain by the Sickle Group of moderately mature sandstones and minor conglomerate and mudstone. The Sickle Group and the adjacent Wasekwan Group are intruded by large sheets of Black Trout diorite. Pegmatite and fine grained, weakly porphyritic granite that form part of the large intrusive complex, also extend into the lower part of the Sickle Group.

The rocks in the Beaucage Lake area are complexly folded, faulted and metamorphosed to intermediate grade. However, primary lithologies and sedimentary structures are recognizable and the prefix 'meta' is not used in the descriptions.

STRUCTURAL GEOLOGY

A major northeasterly trending fault and an inferred north-west-trending splay fault cut the Beaucage Lake area into three blocks (Fig. GS-4-1).

The western block contains a west-facing succession of the Sickle Group unconformably overlying an east-facing sliver of Wasekwan Group rocks. There is a possible synclinal antiform in the Wasekwan Group in the west wall of the main fault. Apparently, the older rocks were already inverted during their erosion and subsequent burial under the Sickle Group. This early phase of folding has been found to predate the intrusion of pre-Sickle tonalites in the central part of the Lynn Lake belt (Gilbert, Syme and Zwanzig, 1980).

The relationship between bedding and foliation in the Sickle Group indicates that a major syncline lies west of Beaucage Lake. The axial planar foliation strikes 015° and dips 50° SE. The plunge is south at 20° . The syncline has the same northwesterly vergence and late relative age as Z-shaped northeast-plunging folds in the Kisseynew belt (Lenton, in prep.).

The northern fault block is wedge-shaped and contains mainly iron formation and amphibolite. Its internal structure is unknown.

The eastern fault block contains a northeasterly trending synclinal sliver of the Sickle Group unconformably overlying a succession of mainly felsic sandstone (Wasekwan) exposed in earlier, curved and northwest-trending folds. The older structures are defined by sedimentary facies and outlined by a prominent quartz-pebble conglomerate. The younger northeast-trending folds and faults have affected the older structures in the south but die out to the north within the Wasekwan Group.

The relationship between intrusive phases, foliation, the unconformity and the folds suggest that the older structures in the eastern block have a complex history involving pre- and post-Sickle deformation.

WASEKWAN GROUP

Each fault block contains different major lithologies of Wasekwan Group rocks whose stratigraphic relationship can only be inferred. The coarser grained volcanic conglomerates and possible breccias occur in the southwest whereas the finest grained epiclastic rocks occur in the northeast suggesting that successive fault blocks contain progressively more distal facies of the same overall stratigraphic succession.

WESTERN FAULT BLOCK

Quartz-feldspar porphyry

Rhyolitic quartz-feldspar porphyry occurs in pink weathering sills or sheets in the eastern fault block. The fresh porphyry has a pale grey aphanitic groundmass with 1-5 mm quartz phenocrysts and 2 mm grains of plagioclase. The thickest sill (100 m) lies directly below the Sickle unconformity. It is intruded by pre-Sickle basaltic dykes and post-Sickle Black Trout diorite.

Feldspar porphyry

Rare cross-cutting, grey weathering dykes contain up to 50 percent plagioclase phenocrysts, 2 mm long, and rare, scattered quartz eyes.

Fragmental rhyolite porphyry, conglomerate

This unit contains angular pink weathering rhyolite fragments with 1.5 - 2.0 mm quartz eyes (rarely 4 mm) and up to 2 mm feldspar grains. The largest fragments are 2 - 5 cm long and lie in a slightly darker groundmass. The rhyolite is the extrusive equivalent of the hypabyssal porphyry but the unit is interlayered with epiclastic rocks and is probably slightly reworked.

Volcanic conglomerate

Polymictic volcanic conglomerates interlayered with finer grained sedimentary rocks form a 150 m thick unit. The succession is underlain by mafic mudstones and overlain by fine grained felsic and minor mafic sedimentary rocks. The conglomerate grades into fragmental rhyolite porphyry to the south and into fine grained sedimentary rocks to the north. The conglomerate matrix consists of mafic mudstone or lithic sandstone. Fragments comprise quartz-pyritic rhyolite, dacite and minor amphibolite. They are up to 8 cm long and mostly angular. Near the base of the succession the conglomerate is weakly bedded with rare grading suggesting an easterly facing. The upper part of the succession contains sand-

stone with pebbles of quartz-eye rhyolite with thin interbeds of greywacke or mudstone.

Fine grained sedimentary rocks

The youngest rocks in the western fault block are buff and rusty weathering pyritic sandstones and mudstones. There are 160 m of thin bedded quartz-rich metasediments apparently overlain by gossan zones and pyritic biotite schist, cordierite-anthophyllite schist and minor mafic mudstone.

NORTHERN FAULT BLOCK

A wedge-shaped area northeast of Beaucage Lake is underlain by iron formation, various types of amphibolite and felsic sedimentary rock. Individual units trend northwest and extend to Black Trout Lake (Zwanzig, 1979) but the exposure is poor in the north and the stratigraphic top of the succession unknown. The block-bounding faults are inferred, mainly from abrupt changes in stratigraphy. There are several systematic changes in stratigraphy across strike within the block.

Iron formation and associated rocks

Magnetiferous and garnetiferous banded amphibolite inter-layered with coarse grained massive amphibolite form the probable base of the succession adjacent to the western fault. About 60 m of magnetite- and pyrrhotite-bearing greywacke lie to the southeast and may wedge out to the north. The greywacke contains thin beds of dark cherty iron formation, rare blue-black iron formation rich in magnetite, and blue-green iron formation rich in amphibole. Finer grained mafic sedimentary rocks and calc-silicate rocks in the northeast suggest that the greywacke was derived from the south. A 100 m belt of thin bedded oxide iron formation lies east of the greywacke but is separated from it by gabbro and fine grained amphibolite. Up to one-third of the unit consists of dark grey cherty iron formation. The rest is mainly amphibolite with local coarsely garnetiferous beds and rare blue-black magnetite-rich beds. The eastern 150 m of the northern block are exposed east of Beatty Creek; they comprise fine grained buff weathering greywacke which is locally pyritic and contains thin bands of amphibolite, dark, weakly magnetic chert, and shale. Locally, there are sandstone beds with 1 - 1.5 mm quartz eyes similar to the phenocrysts in the fragmental porphyry in the western fault block.

EASTERN FAULT BLOCK

The eastern fault block is underlain by conglomerate and sandstone belonging to the Sickle Group and by felsic volcanogenic sandstone, siltstone and quartz-pebble conglomerate belonging to the Wasekwan Group. Gabbro and fine grained intrusive or extrusive amphibolite occur in the east, adjacent to the granitic terrane. Despite the complex structure in the older sedimentary rocks, sufficient tops are known to establish a tentative stratigraphic succession. Sandstone and pebbly sandstone units exposed in an early anticline are overlain by quartz-pebble conglomerate which is overlain, in turn, by more felsic sandstone, siltstone and minor conglomerate and mudstone (Fig. GS-4-2).

Pebbly sandstone

The coarser grained rocks contain pebbles up to 3 - 5 cm long. They include sedimentary, felsic volcanic, quartz and feldspar clasts. Their shape and sorting characteristics suggest transport by mass flow as well as by traction currents. Beds are generally massive and some of the pebbly units are more than 25 m thick.

Sandstone-siltstone

Other epiclastic rocks include medium grained, buff weathering sandstone and fine grained pink weathering sandstone-siltstone. The sand is moderately sorted, ungraded and has a uniform felsic composition. Buff weathering beds are thick and massive or contain 1 - 2 cm thick partings of shale. Pink weathering beds have

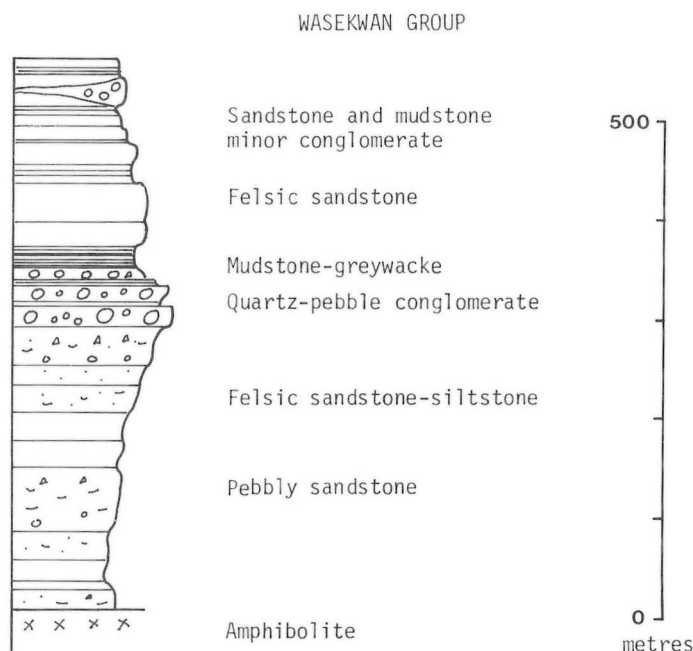


Figure GS-4-2: Schematic stratigraphic section, Wasekwan Group, eastern fault block.

a rhyolitic composition. They are internally massive and range from 10 - 100 cm in thickness. Interlayered grey and white weathering beds are 1 - 2 cm thick and internally laminated. High in the sedimentary section there are 4 cm sandstone beds alternating with 2 cm shale beds. Also present are small units of gritty sandstone and conglomerate.

Argillaceous sandstone-mudstone, biotite schist

Grey and brown weathering fine grained metasedimentary rocks rich in biotite have a composition which ranges from dacite to shale. They form schistose or finely foliated, recessive units. Argillaceous sandstone forms thick massive units throughout the succession. Thinner beds (1 - 40 cm) are massive or internally laminated. Mudstone is massive or finely laminated. Ripple laminations and grading are absent.

Quartz-pebble conglomerate

Two or three units of conglomerate occur over a 60 m section interbedded with the sandstone-siltstone formation in the eastern fault block. The conglomerate contains distinctive angular and well rounded pebbles of white quartz, chert and low-grade cherty iron formation. The conglomerate occurs in three belts, apparently repeated in the limbs of the early northwest-trending folds. The unit is underlain by gritty or pebbly volcanogenic sandstone, and overlain in the west by quartzite, in the centre by argillaceous sandstone and in the northeast by mudstone. The conglomerate matrix changes from greywacke to argillaceous mudstone and mafic mudstone upward in the succession. Pebbles consist of mainly quartz and chert at the base but there is an upward increase of rhyolite, greywacke, feldspar porphyry and quartz porphyry clasts. The maximum clast size ranges from 2 - 40 cm throughout the succession. The larger clasts are commonly well rounded, often spherical. Smaller clasts are rounded or angular. The conglomerate beds are massive and less commonly graded, locally with reversed grading at the base. There are interlayered beds of sandstone or mudstone throughout the succession.

Gabbro, amphibolite

There are several gabbro dykes and two larger mafic bodies in the eastern structural block. Fine grained amphibolite occurs in the margin of the most southerly body. The rock is amygdaloidal in one locality and may contain highly deformed pillows; however, an extrusive origin is not certain.

Granitic rocks

The western margin of the Beaucage Lake area is underlain by large granitic intrusions. They range in composition from tonalite to granite and have a complex intrusive history. Tonalite is cut by numerous faults and injected by fine grained granite and pegmatite. The tonalite is similar to pre-Sickle intrusions in the central part of the Lynn Lake belt.

Dykes which cut the Sickle Group consist of fine grained, sub-porphyrific granite, aplite or pegmatite. Similar rocks are common in the periphery of the large plutons in the east where they cut the earlier phases.

SICKLE GROUP

A thick succession of arkosic rocks unconformably overlies the Wasekwan Group rocks. On Beaucage Lake the two groups face in opposite directions, back to back across the unconformity, whereas southeast of the lake the unconformity has a slight angular discordance. Sickle lithologies range from boulder conglomerate to finely laminated mudstone and layered amphibolite interpreted as calcareous sandstone and calcareous mudstone. Sedimentary structures are moderately well preserved and include cross-bedding, parallel- and ripple-lamination and apparent, mud cracks. They indicate deposition in an alluvial environment.

In the Beaucage Lake area the Sickle Group can be divided into four gradational units. These are from the base up:

- a) conglomerate with interlayered cross-bedded and pebbly arkose;
- b) coarse- to fine-grained impure sandstone;
- c) thin bedded and laminated fine grained sandstone, siltstone, shale and calcareous sandstone;
- d) medium grained, cross-bedded sandstone.

CONGLOMERATE AND ARKOSE

In the western block polymictic conglomerate and arkose form an upward fining succession 70 m thick. The lowest beds consist of arkosic quartzite and arkose with spherical quartz pebbles. The main conglomerate is clast-supported and has an arkosic matrix. The clasts are predominantly felsic, fine grained sedimentary and volcanic lithologies. Quartz-eye rhyolite and porphyry like those in the underlying Wasekwan Group range from 15% of the clasts near the base to 90% locally at the top of the succession. Quartz clasts make up 5% and there are minor amounts of iron formation, dark chert, feldspar porphyry and fine grained granite. Most pebbles and cobbles are well rounded and have high to moderate sphericity. The maximum clast size is given as the median length of the five largest cobbles. This ranges from 10 cm in the lowest beds to 16 cm just above the base of the unit, and decreases upward to 9 cm at the top of the unit. Maximum bed thickness ranges from 1 m at the base to 3 m above the base, and decreases to 15 cm near the top. Beds are massive, ungraded and have sharp contacts rarely showing scour. Interbeds of arkose are massive, parallel laminated or cross-bedded. They become increasingly numerous upward, being dominant more than 50 m above the base.

In the eastern fault block conglomerate occurs only as a few interbeds near the base of the Sickle Group and dies out entirely towards the south.

SANDSTONE, MINOR MUDSTONE

The succession on Beaucage Lake and to the west is about 1200 m thick and comprises interbedded pink weathering coarse- to fine-grained sandstone and grey weathering mudstone. These beds are intercalated with bright green calc-silicate beds or dark green amphibolite beds derived from calcareous sandstone and mudstone. The succession consists of major sandy and muddy divisions on which are superimposed small-scale variations in calc-silicate content. Each division has a typical range of bedding thickness and of sedimentary structures. The major divisions are outlined on Figure GS-4-3.

The rocks are interpreted as red beds deposited by flash floods on a sand flat. The section is upward-fining and then passes into coarse sandstone again. These changes are probably

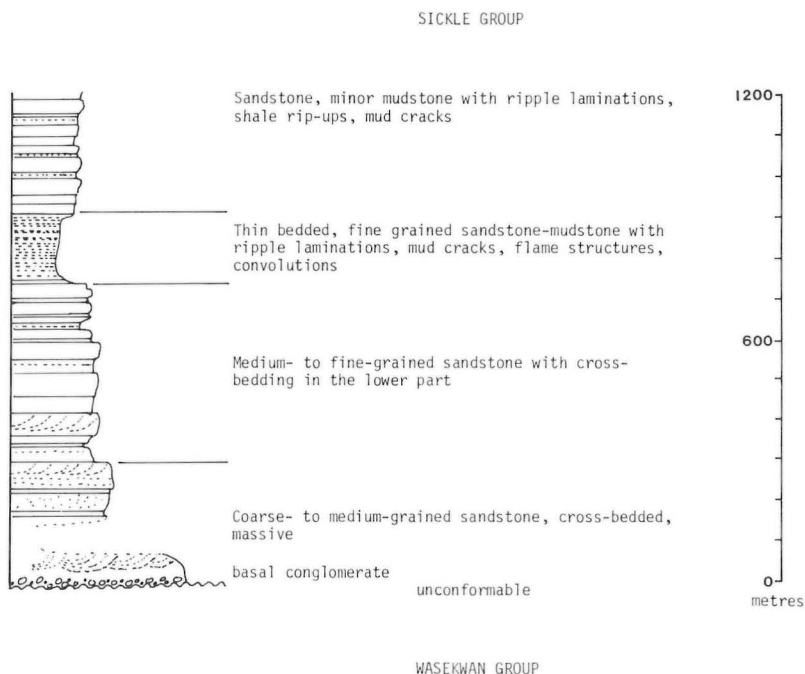


Figure GS-4-3: Schematic stratigraphic section, Sickle Group, west of Beaucage Lake.

related to the erosion of the source terrane and to tectonic cycles. Planar cross-bedding, planar ripple laminations and flame structures all indicate that sedimentary transport from the north. This is in good accordance with the general changes between Beaucage Lake and Sickle Lake to the north. The basal conglomerate tapers and dies out towards the south. The ratio of fine grained sandstone and mudstone to coarse grained cross-bedded sandstone increases towards the south. Bedding thickness decreases and delicate sedimentary structures become more common towards the south.

In the eastern structural block the lower 750 m of the Sickle Group are exposed southeast of Beaucage Lake. The section is similar to that in the northwest, but 700 m above the base of the group there is a new unit of reddish weathering cross-bedded sandstone which represents an influx of coarser sand.

This section is slightly more coarsely recrystallized than the rocks in the northwest and the stratigraphy is very similar to that of the Sickle Metamorphic Suite in the Kisseynew belt. The lower part of the succession is rich in secondary muscovite; it represents the coarse- to fine-grained basal sandstone. The central part of the succession contains interbeds rich in hornblende. It represents the calcareous part of the succession. The overlying sandstone is rich in muscovite.

DISCUSSION

A rhyolitic volcanic centre probably lay southwest of Beaucage Lake during the deposition of the Wasekwan Group in the study area. It shed predominantly felsic detritus towards the northeast. The maturity and rounding of the quartz-pebble conglomerate indicates that part of this source terrane was emergent, and that stream- and beach-activity took place. The felsic rocks are interpreted to have a predominantly epiclastic origin but pyroclastic detritus may have been present. The felsic sandstones and thick iron formation were probably deposited in a shallow basin northeast of the felsic centre.

Fine grained pyritic sedimentary rocks and magnesia-rich mudstones (anthophyllite schist) were deposited over the more proximal felsic rocks in the southwest. Traces of chalcopyrite occur with the pyrite. Oxide-facies iron formation locally overlies the felsic rocks in the south and forms a thick deposit to the north.

During the deposition of the Sickle Group the felsic volcanic terrane again acted as source. Clasts of porphyry dykes and shallow granitic intrusions indicate that the level of erosion was deeper but much of the felsic detritus consists of the fine grained Wasekwan sandstones. The deposition of the Sickle Group was apparently on an alluvial sand flat.

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GS-5a GRANVILLE LAKE PROJECT

(parts of 64C/1 and 2)

by H.V. Zwanzig

INTRODUCTION

The Granville Lake project was carried out to establish the nature and stratigraphic relationship of the narrow metavolcanic units which occur in the metasedimentary terrane on the south shore of Granville Lake. The work provides regional stratigraphic control for the massive sulphide showings in the area. The work was combined with an ongoing regional correlation program.

The author and H.D.M. Cameron devoted five weeks of field work to 1:20 000 scale mapping of an area 8 x 25 km centered on Pickerel Narrows. Exceptionally low water conditions in 1981 provided excellent shoreline exposures, suitable for structural mapping and measuring stratigraphic sections. Although the metamorphic grade is medium to high, sufficient sedimentary and pillow tops were recorded to establish a preliminary structural interpretation of the area (Fig. GS-5-1).

In this report the problems and some tentative conclusions are outlined for the area and the main units are described in local sections.

GENERAL GEOLOGY

The Granville Lake area is underlain by three major suites of metamorphic rocks:

- 1) Burntwood River metagreywacke.
- 2) Pickerel Narrows amphibolite and metasediments.
- 3) Sickle Group.

The stratigraphic relationship between these units is the focus of this study.

The Burntwood River greywacke occurs south of Granville Lake and comprises a thick succession of greywacke-mudstone-turbidite. There is a north-facing homoclinal succession at Wheatcroft Lake but the rest of the unit is tightly folded. Near the top of the succession, the greywacke contains thin but laterally extensive units of metabasalt, gabbro and diorite. Semi-massive sulphides occur in horizons between volcanic and sedimentary units.

The Pickerel Narrows amphibolite belt comprises thin units of metabasalt, metagreywacke-siltstone, chert, ultramafic rocks and minor marble. Massive sulphide deposits, generally pyrite, overlie some of the ultramafic units. Units taper out laterally due to sedimentary facies changes or structural complexities.

The major volcanic units occur along the northern side of the belt apparently in an anticline. The sedimentary rocks on the southern side of the belt may occupy a syncline.

The Sickle Group which underlies most of Granville Lake, comprises basal conglomerate, meta-arkose and calc-silicate-bearing metasediments. These rocks occupy two synclinal structures. One is a narrow faulted syncline which separates the Burntwood River greywacke from the Pickerel Narrows amphibolite and the other lies north of the amphibolite belt.

Sedimentary breccias are locally common in the metasediments below the Sickle contact, and greywacke beds in the basal Sickle conglomerate resemble the underlying Burntwood River greywacke. These features suggest that during the deposition of the Sickle Group the greywacke may have been deformed but was only partly lithified.

The Burntwood River greywacke and Pickerel Narrows suite are tentatively correlated as a turbidite basin facies and an equivalent marine volcanic facies. Each suite of rocks has pri-

mary structures of deep water marine deposits. These include pillowed flows, pillow breccia, greywacke-mudstone-turbidite, and chert. In contrast, the Sickle Group is a shallow water deposit with cross-bedding, heavy mineral placers, and apparent mud curls derived from mud cracked layers.

The structure of the Burntwood River greywacke and Pickerel Narrows suite is more complex than the structure of the Sickle Group. The older rocks are more tightly folded and contain lateral breaks in the stratigraphy. Various units pinch out along the Sickle contact. The data indicate that the Sickle Group is younger than the Burntwood River greywacke and the Pickerel Narrows suite. Apparently the Sickle contact ranges from conformable to unconformable. This can be related to synchronous deposition and deformation.

STRATIGRAPHY AND UNIT DESCRIPTIONS

BURNTWOOD RIVER GREYWACKE

A north-facing and south-dipping (40°) succession of greywacke-mudstone is exposed on Wheatcroft Lake and extends 20 km east to Granville Falls (Fig. GS-5-1). The base of the section is not exposed and the upper part of the section is tightly folded. The youngest greywacke probably occurs 6 km west of the settlement on the south shore of Granville Lake, apparently in gradational contact with Sickle conglomerate to the north. South of the settlement the upper contact seems to be unconformable or faulted and the most northerly situated greywacke beds face alternately north or south.

The section on Wheatcroft Lake is about 1 100 m thick and an additional 500 m of greywacke south of the lake probably also faces north. The lower 800 m of this section comprises coarse grained greywacke which is rich in quartz and feldspar. It is overlain by a folded succession (300 m?) of greywacke-mudstone. The coarse grained beds are pale grey and commonly up to 1 m thick. Gritty bases contain angular and rounded clasts of feldspar (up to 2.5 mm). Scoured bases, rip-ups, flame structures and calc-silicate lenses are common. Graded bedding is ubiquitous. The upper part of the beds comprises medium grey, fine grained greywacke or mudstone. Convolutions, parallel lamination and small recumbent folds occur at the top of the beds. Some beds are disrupted by syndepositional folding and small mudstone-injected faults. Flame structures suggest that sedimentary transport was towards the south.

Secondary features include muscovite and sillimanite knots which occur sporadically throughout the section. Locally there are up to 10 percent pegmatitic veins. The rock is nearly massive and minor folds are absent.

The upper part of the succession is thin bedded (2 - 20 cm) and typically contains 20 to 40 per cent medium grey argillaceous wacke or mudstone. Sillimanite knots and garnet porphyroblasts are locally abundant. The beds are planar and comprise rhythmic wacke-mudstone repetitions with well developed normal grading and parallel laminations. Soft sediment structures are locally abundant and sedimentary breccia of angular greywacke clasts in mudstone or mudstone clasts in greywacke occur near the Sickle contact. Isoclinal folding has produced an aggregate thickness of 2.4 km of the fine grained greywacke but the stratigraphic thickness is estimated at 300 to 400 m.

There is an upper, coarse grained section of quartzose grey-

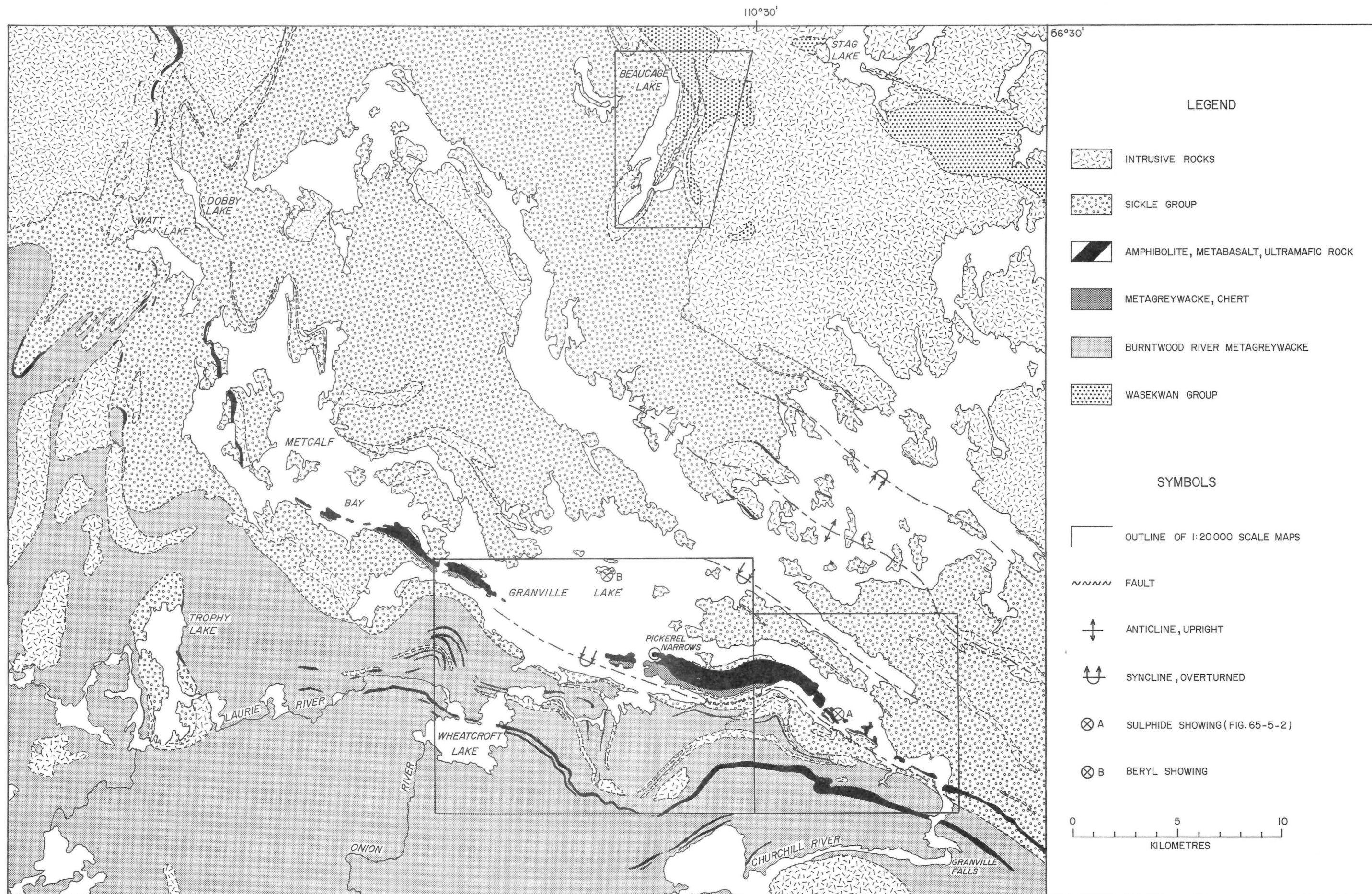


Figure GS-5-1: Location map and general geology of the Granville Lake area.

wacke 6 km west of the settlement. This part of the section is thick bedded and contains north-facing scour structures.

BURNTWOOD RIVER AMPHIBOLITE

In the upper part of the folded sedimentary pile there are thin units of amphibolite, identified on Wheatcroft Lake as pillow basalt, gabbro, diorite and ultramafic rock.

The volcanic rocks comprise sequences which grade from large to small pillows and pillow breccia, locally with massive flows at the base. Up to 10 m of gossan with semi-massive pyrite and graphite overlain by greywacke occurs at the top of some sequences. The basalt is relatively mafic and superficially resembles rocks at Pickerel Narrows. The basalt is intruded by gabbro and minor ultramafic rock and there are horizons of interstitial calcite alteration or marble.

The amphibolite belt extending along the Laurie River consists of intrusive rocks, mainly gabbro and diorite with minor ultramafic rock. Fine grained, massive amphibolite and locally breccia units are associated with a diorite unit on Granville Lake.

PICKEREL NARROWS AMPHIBOLITE AND GREYWACKE

The belt of metavolcanic and interlayered metasedimentary rocks extending through Pickerel Narrows has been considered part of the Sickie Group (Cranstone, 1968). The rocks are here interpreted to be unconformably or disconformably overlain by the Sickie Group. Volcanic rocks are most abundant on the northern side of the belt and sedimentary rocks on the southern side. Units change along strike and taper out so that no unique stratigraphic succession exists. South-facing tops determined on pillows, amygdaloidal zones and graded bedding occur on islands and peninsulas 9 to 10 km east of the settlement. They suggest that the local section comprises from the base up

- pillow basalt;
- ultramafic flows;
- ultramafic breccia;
- gossan;
- chert and greywacke with ultramafic breccia;
- calc-silicate breccia (fault?);
- greywacke-siltstone, chert.

Other ultramafic units and gossan layers occur to the south but they may face north.

Near the settlement poorly preserved, north-facing pillows suggest that there is an anticlinal axis in the pillow basalt and that the thin units of ultramafic rocks and marble that underlie the Sickie quartzite on the northern margin of the amphibolite belt face north.

The greywacke-siltstone-chert unit tapers to the west and is replaced near the settlement by a relatively thick lense of greywacke with calc-silicate breccia on the north side and greywacke breccia, grit and conglomerate on the south side. North-facing tops in the greywacke and grit suggest that the sediments occur in a syncline.

Pillow basalt, amphibolite

Much of the mafic rock consists of light and dark green banded amphibolite with diopside and hornblende-rich phases. Preserved pillows are commonly 100 x 15 cm with medium grey, veined interiors and 0.5 to 1 cm thick black garnetiferous selvages. Adjacent to the ultramafic rocks the pillows are large and locally interconnected. The triangular spaces are filled with calcite or quartz and there are alteration- or marble-layers. Units of porphyritic pillow basalt are exposed near the settlement. They contain 20 to 25 per cent 2 mm feldspar phenocrysts and poorly preserved mafic phenocrysts.

Ultramafic rock

The best preserved ultramafic succession lies 8 to 10 km east of the settlement. It comprises interlayered massive, pillowed and

fragmental units overlain by 35 m of fragmental rock. Blocks are angular, up to 3 m long and consist of fine grained dark green, apple-green and black amphibolite. The matrix comprises less than 50 per cent and contains about 20 per cent 5 mm mafic phenocrysts which are partly replaced by hematite. Near the top of the unit rounded and angular fragments are generally 2 cm long. The rock is overlain by gossan with massive pyrite followed by chert (Fig. GS-5-2).

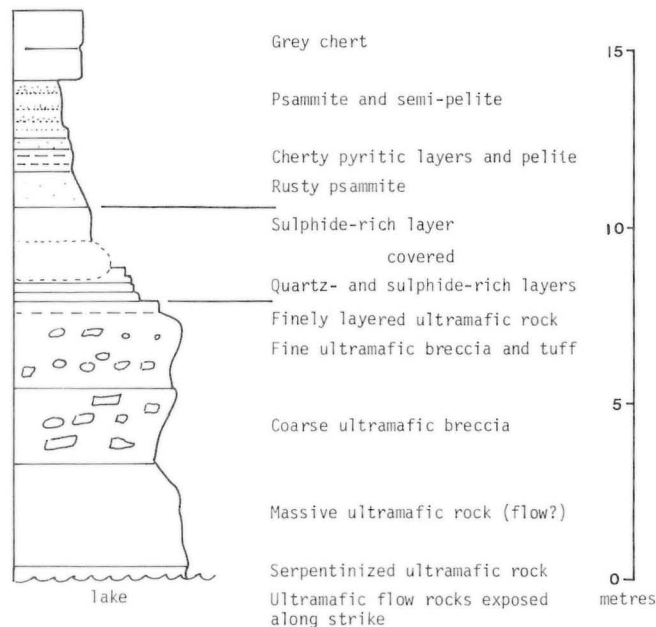


Figure GS-5-2: Section through ultramafic flow-massive sulphide-chert at location A, figure GS-5-1.

Ultramafic breccia occurs also on the margins of the Pickerel Narrows amphibolite belt underlying Sickie arkose. The phenocryst content and size varies in a few banded layers with or without fragments. The rock resembles water-laid tuff, possibly of hyaloclastic origin.

Chert

Chert and siliceous siltstone are common in the northern part of the sedimentary section overlying ultramafic rocks and locally prominent gossan zones. Chert is pale greenish grey to white with 0.5 mm laminations. It is interlayered with calc-silicate rocks and marble.

Greywacke-siltstone-mudstone

Greywacke is commonly thin bedded (2 - 10 cm) and alternates with 0.2 - 5 cm mudstone beds. Near the settlement sillimanite is a common component in thicker beds of buff weathering greywacke. The mineral occurs in the greenish core of white knots. The greywacke shows excellent graded bedding, rip-ups and lamination of high-energy turbidite. It is the best indicator of a deep marine environment incompatible with the shallow water environment of the Sickie Group.

Pale grey-green weathering hornblende greywacke-siltstone occurs east and west of the settlement. It is commonly thinly laminated and intercalated with carbonate beds and chert.

Marble

Marble occurs as a laterally continuous unit overlying amphibolite and underlying basal Sickie quartzite on the north margin of the amphibolite belt. Several beds of predominantly calcite are up to 20 cm thick. They contain laminations of diopside and other calc-silicate minerals.

Thin beds of marble are commonly associated with chert. They contain 1 mm thick quartz-rich laminations. Pale buff weathering layers of calcite locally overlie horizons of pillow basalt and some pillows contain calcite in triangular interstices. This rock is interpreted as marble.

Calc-silicate breccia

About 50 m of calc-silicate breccia separate the main volcanic and sedimentary sections. The unit is exposed near the settlement and 8 km to 10 km to the east. Breccia blocks are medium- to coarse-grained calc-silicate rock up to 3 m long and rare mafic and ultramafic rocks. The blocks are supported in a buff to rusty weathering foliated or scaley matrix of fine grained, calcareous siltstone. The unit occurs in a series of irregular lenses and may represent tectonic slide breccia. It grades locally into bedded calc-silicate rock and impure marble or altered basalt.

Feldspathic greywacke, grit

Feldspathic greywacke forms several massive white weathering units up to 5 m thick. It contains plagioclase clasts 2.5 mm in diameter. Grit contains up to 5 mm clasts and forms massive medium grey beds over 50 cm thick or it occurs at the base of graded greywacke beds. Grit also forms the matrix of sedimentary breccias with large exotic blocks. These rocks are high-energy mass-flow deposits.

Greywacke breccia and conglomerate

Several units of greywacke breccia and conglomerate extend along the south shore of the peninsula at Pickerel Narrows. The breccia occurs in 2 to 5 m thick units. Generally it contains angular clasts of greywacke up to 30 cm long and rip-ups of shale. Clasts of calc-silicate rock and amphibolite are locally present. A single 3 m long block consists of interbedded carbonate and chert. The matrix consists of greywacke or grit with 2.5 mm feldspar clasts. Breccias with a shaley matrix grade into sequences of disrupted bedding and scaley fault breccia with broken beds and loose pebbles. Greywacke beds adjacent to the breccia are commonly transposed on a large-scale strain slip cleavage. Greywacke conglomerate contains up to 40 cm long cobbles. They are subangular and occur in a shaley greywacke matrix.

Polymictic conglomerate underlies the succession of greywacke and grit on the south shore of the peninsula. It contains angular clasts of basalt, greywacke and grit up to 40 cm long.

The greywacke cobble conglomerate and breccia occupy the same stratigraphic position adjacent to hornblende arkose as Sickie conglomerate on the south shore of Granville Lake. However, the units at the Pickerel Narrows are more closely associated with the greywacke.

SICKIE GROUP

SOUTHERN SECTION

The belt of Sickie Group rocks which separates the Burntwood River greywacke from the Pickerel Narrows amphibolite and greywacke is interpreted to be a syncline with conglomerate and hornblende arkose in the limbs and cross-bedded sillimanite-bearing arkose in the core. The southern limb has a complete section and the northern limb is largely faulted out.

Greywacke cobble conglomerate

A thick formation (up to 250 m) of cobble conglomerate extends along the south shore of Granville Lake. The unit is clast-

supported, generally massive and unsorted. Near the top (north) there are horizons in which large or small clasts are concentrated. The clasts are subrounded to subangular and generally up to 20 cm long. They consist of greywacke and minor grit that range from quartz-rich to sillimanite- or biotite-rich. Their internal structure includes shaley partings, magnetite-hematite placers, cross-bedding and quartz veins. The source rock was apparently a shallow water deposit.

The conglomerate matrix consists of medium grained greywacke and locally there is greywacke interbedded with conglomerate at the base and top of the unit. The top grades into hornblende arkose and arkose-pebble conglomerate and the base has a complex relationship with the underlying Burntwood River greywacke. The lower contact is generally unconformable or faulted but 6 km west of the settlement it appears to be gradational. The basal greywacke-mudstone interbeds are laminated, lack grading and locally contain "floating" pebbles. The conglomerate interbeds have sharp contacts and are generally massive. One measured bed has normal grading (facing north) and reverse grading at the base. These features are consistent with deposition from flash floods. Elsewhere the contact is concordant, but graded bedding in the underlying greywacke faces alternately north and south immediately below the contact. These features suggest that the conglomerate was deposited on tightly folded greywacke or that much of the contact was faulted. Deposition of greywacke and conglomerate, and deformation may have overlapped in time.

Arkose pebble conglomerate

Gradationally overlying a maximum of 40 m of hornblende-bearing meta-arkose are up to 40 m of arkose-pebble conglomerate. The unit was mapped as granite-pebble conglomerate (Campbell, 1965) but such clasts were not observed. The pebbles and the matrix consist of pink weathering fine grained arkosic sandstone with small hornblende porphyroblasts. There are rare clasts of quartz and shale rip-ups. Rare pebbles of white quartzite have prominent oxidation rinds. One bed of fine grained arkose overlying the conglomerate is pyritic.

Hornblende arkose

A maximum aggregate thickness of 160 m of pink, grey and green weathering arkosic rocks are exposed along the south shore of Granville Lake. Beds are 1 to 15 cm thick. Fine grained pink sandstone, green calcareous siltstone and grey argillaceous siltstone beds alternate repeatedly. The rock resembles the less highly metamorphosed, mud-cracked unit west of Beaucauge Lake (see GS-4).

In the western part of the area the arkose tapers locally to 60 m of more schistose, relatively biotite rich grey rock. A similar rock is exposed on the south shore of the peninsula at Pickerel Narrows in the north limb of the syncline. The arkose is fine grained and grey, with lenses and bands of pale green calc-silicate rock.

Cross-bedded arkose

About 350 m of meta-arkose overlies the hornblende-bearing rock. Numerous north-facing cross-beds occur especially in the lower part of the unit. The rock consists of fine- to medium-grained metasandstone with secondary muscovite and local sillimanite-muscovite knots. Two outcrops of similar rock occur on the north limb of the syncline.

Planar and trough cross-beds are 10 cm to 5 m thick. The current direction (after structural restoration) was from the north. The upper part of the unit is coarse grained metasandstone with red and black parting laminations. Some beds contain floating pebbles and angular granules of quartz.

Sillimanite-bearing arkose-pebble conglomerate

Cross-bedded arkose is overlain by a 5 m bed of pebble conglomerate. The clasts consist of white and grey arkose and some quartzite, rarely with red oxidation rinds.

CENTRAL SECTION

An estimated 3 km thick succession of arkosic metasandstone overlies the Pickerel Narrows amphibolite belt. The rocks face north and dip towards the south. They are recrystallized and appropriate compositions contain sillimanite knots. Facing is determined from cross-bedding at the base and at the top of the succession. Differentiated gabbro in the central part also faces north.

The succession comprises from the bottom up:

- a) quartzite;
- b) cross-bedded, pink to buff weathering, medium- to coarse-grained meta-arkose with common muscovite-sillimanite knots;
- c) hard grey, fine grained, impure sandstone with calc-silicate beds and lenses;
- d) fine- to medium-grained light grey and reddish metasandstone with secondary muscovite and minor sillimanite.

Quartzite

A 15 m thick unit of basal quartzite overlies impure marble on the north side of the Pickerel Narrows amphibolite belt. Quartzite weathers grey or white with a greenish cast. Secondary muscovite forms closely spaced partings. The quartzite is concordant with the marble for 6 km east of the settlement. However, on the north shore of an island in the mouth of Metcalf Bay quartzose arkose is separated from pillow basalt by only 50 cm of biotite-rich metasedimentary rock.

There is probably a disconformity at this part of the base of the Sickle Group.

Cross-bedded arkose

Coarse grained meta-arkose gradationally overlies the quartzite. The rock weathers pink, buff or grey. Parting laminations contain muscovite and flattened knots of sillimanite low in the section; and hematite, muscovite and biotite higher in the section. Large-scale cross-bedding indicates that the unit faces north.

Hornblendic metasandstone, minor mudstone

Fine grained, hard grey rock with prominent green or white calc-silicate bands forms a unit which is estimated to be 1600 m thick. There is cross-bedding near the base of the unit; the rest

has medium to very thin bedding but recrystallization of calc-silicates has obliterated much of the primary structure to form greenish streaks and lenses. Rarely preserved 2 mm thick shaley layers are locally ripped up in structures associated with mud cracks on Beaucage Lake (see GS-4). The top of the unit is medium grey sandstone, with only rare lenses of calc-silicate, and is intruded by Black Trout diorite.

Varicoloured sandstone

Medium grained metasandstone which weathers in pale shades of grey, pink and yellow forms the upper 900 m of the exposed section. Bedding structures are typically faint and difficult to interpret. Poorly preserved cross-bedding near the top of the unit provide the only information for north facing.

The rock contains secondary muscovite and local sillimanite. Beds are 10 - 50 cm thick. Typical layers have 25 cm massive, parallel laminated or cross-bedded, pink divisions overlain by parallel laminated, grey divisions richer in muscovite.

CORRELATION

The Pickerel Narrows amphibolite is similar to the Burntwood River amphibolite. Volcanic members of each unit generally comprise non-vesicular, pillowed basalt and breccia with associated gossan zones. Interlayered metasedimentary rocks are marine turbidites with sedimentary breccias adjacent to the Sickle Group. A correlation of these units is supported by the synclinal structure of the intervening belt of Sickle Group rocks.

A narrow belt of amphibolite, sedimentary and minor ultramafic rocks with a sulphide zone is exposed on the margin of a granodiorite dome in the central part of Granville Lake (see Cameron, GS-5, part B). These rocks are also correlated with the Pickerel Narrows amphibolite and they are overlain by the basal member of the Sickle Group. The predominantly volcanic facies in the north, and the basin facies in the south, were deposited before the Sickle Group but their exact relative age is not established.

The central succession of the Sickle Group on Granville Lake is correlated with the succession west of Beaucage Lake (Zwanzig, this report). The two sections have the same subdivisions and overall stratigraphy. However, the rocks on Granville Lake are slightly finer grained and have more distal characteristics than the rocks in the north. Individual units in the central section on Granville Lake cannot be correlated with units in the Sickle Group south of Pickerel Narrows. The greywacke-cobble conglomerate is probably older than any of the arkosic rocks north of Pickerel Narrows.

GS-5b GRANVILLE LAKE PROJECT

(parts of 64C/1, 2, 7 and 8)

by H.D.M. Cameron

Six weeks were spent in the Granville Lake area mapping in conjunction with the work being done by H.V. Zwanzig (Fig. GS-5-1).

The objectives of this program were:

1. to examine the metasedimentary gneisses in the Watt Lake area, west of Metcalf Bay, in order to establish the western extent of the Sickle metamorphic suite;
2. to investigate an aeromagnetic high west of Wheatcroft Lake to see what relation it might have to the Sickle arkoses on Trophy Lake (Lenton, 1976 and in prep.);
3. to verify reports of beryl in the pegmatite dykes on central Granville Lake (Cranstone, 1968);
4. to study the nature of a zoned granodiorite body previously reported as being derived from the Sickle arkoses (Campbell, 1972, Cranstone, 1968);
5. to provide supplementary mapping and support for H.V. Zwanzig's mapping.

RESULTS

1. The units previously mapped (Godard, 1966) as granitoid gneiss, quartzofeldspathic paragneiss and quartzfeldspathic schist (Godard's units 11, 10, and 9a, b, respectively) in the Watt Lake area, were found to be sillimanite arkose of the Sickle metamorphic suite, containing faserkeisel up to 2 cm in size. Only units 1 and 7 on the previous map can be interpreted as greywackes of the Burntwood River metamorphic suite. The Sickle/Burntwood contact crosses the western boundary of the map sheet 3.6 km southwest of Watt Lake and continues west into the Kadeniuk Lake sheet (Baldwin, 1974). The granitoid gneiss and paragneiss north of Watt Lake, in the Dobbyn Lake area are also members of the Sickle metamorphic suite (Fig. GS-5-1).
2. An area southwest of Wheatcroft Lake having an aeromagnetic signature of 2500 to 2700 gammas was suspected of being associated with Sickle arkoses similar to those at Trophy Lake (Lenton, 1976 and in prep.). However, ground traversing west of the Onion River confirmed the original mapping (Pollock, 1966). The area is underlain by large pegmatite dykes and sills with rare inclusions of Burntwood River metagreywacke. No magnetite was found in either the pegmatite or the greywacke to account for the aeromagnetic expression and no Sickle arkoses are exposed in the area.
3. Several days were spent examining the pegmatite dykes on the islands in central Granville Lake in order to confirm reports of beryl in the area (Cranstone, 1968). After much searching, several small occurrences were discovered. The largest of these comprised a cluster of about a dozen pale milky green beryl crystals up to 1 by 3 cm in size. These covered an area approximately 6 cm square on the smooth surface of a dyke 500 m west of the location shown on the earlier map. An attempt to sample the crystals largely obliterated the showing.
4. A small zoned granodiorite dome located on the north shore

of Granville Lake had previously been described (Campbell, 1972, Cranstone, 1968) as consisting of Sickle-derived granitoid gneisses. No evidence could be found to support this conclusion.

Contrary to the previous reports, the grey magnetiferous granodiorite to tonalite at the core of the structure is well foliated and commonly cut by dykes of pink pegmatite. The unit strongly resembles the tonalite to granodiorite of the McMillan Lake area (Cameron, 1980).

Around the granodiorite and in sharp contact with it is a light grey to pink augen gneiss containing feldspar porphyroblasts to 3 cm in size. This coarse grained magnetiferous rock is a potassium-enriched shell of the granodiorite and is not derived from the Sickle metasediments. The augen gneiss is intruded by veins and dykes of the same granite and pegmatite which cut the granodiorite.

The granodiorite and augen gneiss are surrounded by a layered sequence which progresses from psammitic Burntwood metagreywacke, through layered amphibolite into basal units of the Sickle metamorphic suite.

The innermost layers of greywacke are intruded and rafted by veins of fine grained granodiorite from the core. They layered amphibolite is made up of interlayered amphibolite, calc-silicate rock, garnetiferous hornblende greywacke and ultramafic rock. A gossan occurs at several locations around the structure near the base of the amphibolite. Above the amphibolite, a white gritty quartz-rich sillimanite gneiss containing 5 cm rounded quartz pods, represents the base of the Sickle. The section continues outward through a layered hornblende calc-silicate arkose into faserkeisel-bearing sillimanite arkose.

This entire section is preserved around the outside of most of the dome and is represented by Campbell's unit 9 amphibolite.

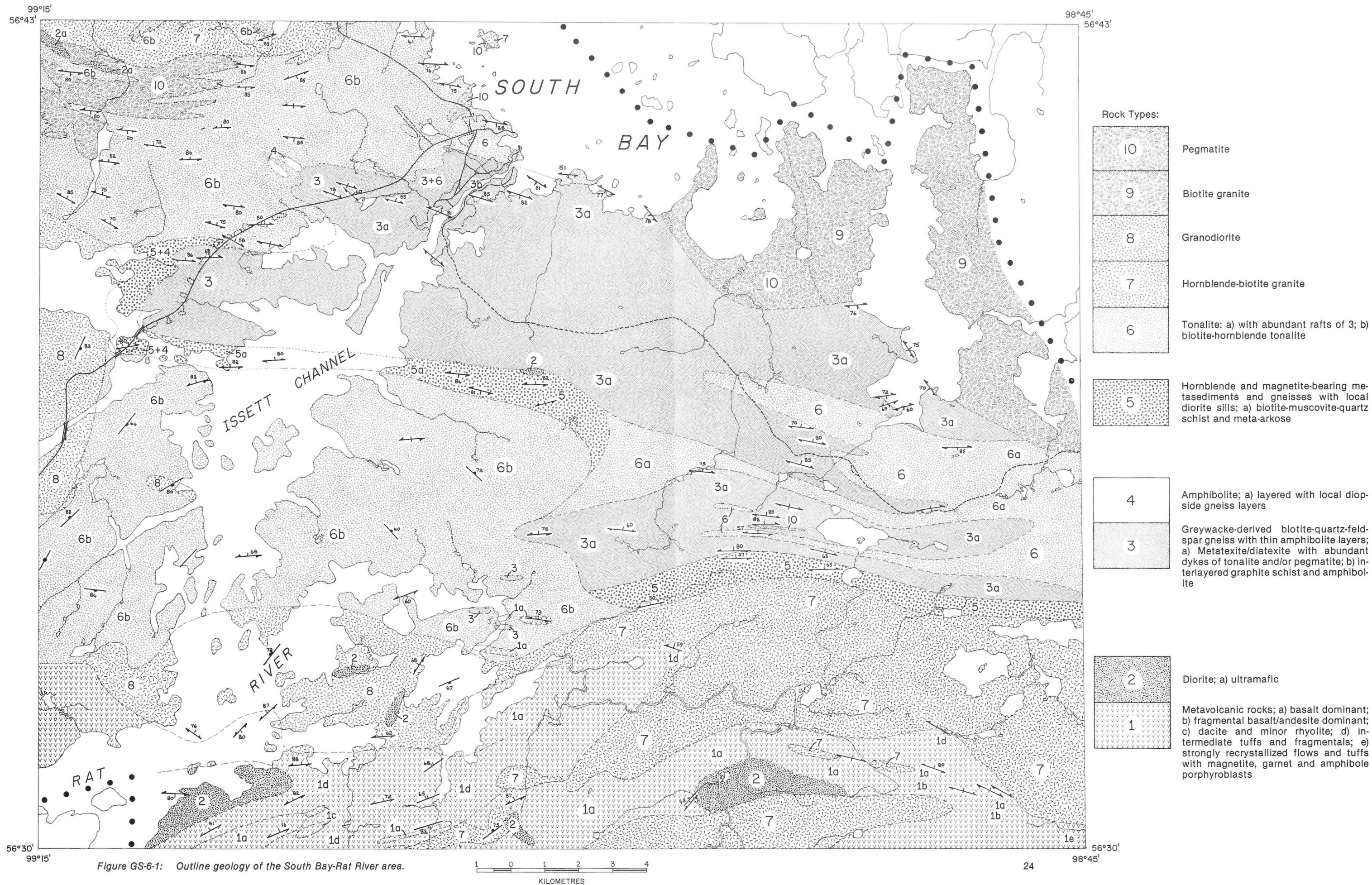
Beyond this is a zone of biotite muscovite meta-arkose cut by large dykes of pink pegmatite. Most of the pegmatite dies out away from the dome, in the main part of the Sickle, although large dykes and sills are common throughout the gneisses around Granville Lake.

Accordingly, it can be seen that there is an unbroken succession from the Burntwood metamorphic suite, in contact with the augen gneiss, into the Sickle and that the augen gneiss is derived from the granodiorite.

5. The remainder of the project involved mapping several sections in the western and central parts of Granville Lake, on Wheatcroft Lake and along the Churchill River to Granville Falls. This was done in order to verify rock types and contacts indicated on the original mapping (Barry, 1965; Barry and Gait, 1966; Campbell, 1972; Cranstone, 1968; Godard, 1966; and Pollock, 1966), to extract more detail from those units and to establish continuity with H.V. Zwanzig's more detailed work on the south shore of the lake. A description of this part of the program is given under his section of this report (GS-5a).

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GS-6 ISSETT CHANNEL - RAT RIVER AREA

(64B/10SW)

by W.D. McRitchie

INTRODUCTION

A review of geological survey work in the Ruttan, Issett Channel and Swan Bay region identified the need to upgrade coverage south of South Bay (Southern Indian Lake) where previous mapping had resorted excessively to aerial photo interpretation. Ground, shoreline and helicopter traverses were conducted over a ten-day period and significant changes made to the earlier documentation of this area (Fig. GS-6-1).

A large wedge of highly metamorphosed and deformed biotite-quartz-plagioclase gneisses, metatexites, diatexites and associated quartz diorite intrusions was identified immediately south of Swan Bay. A sharp, possibly faulted southern boundary to this block defines the northern limit of a 2.5 km wide greenstone keel in which low grade massive, amygdaloidal, locally pillowed, fragmental mafic and intermediate metavolcanic rocks predominate. This previously unrecorded occurrence appears to represent the easternmost extension of metavolcanic rocks associated with the Ruttan greenstone belt.

GENERAL GEOLOGY

The region to the immediate south of South and Swan Bays (Southern Indian Lake) can be subdivided into two contrasting belts which appear to be separated by a major tectonic break.

NORTHERN BELT

The northern belt contains a high grade association of paragneisses, metatexites, diatexites and quartz diorite intrusions that appear to have undergone repeated deep-seated deformation and metamorphism. Biotite-quartz-plagioclase gneisses predominate in layered sequences that resemble metagreywacke psammite, semipelite and pelite mapped on Southern Indian Lake (Frohlinger, 1972). These brown weathering gneisses contain ubiquitous white mobilizate *lit*, sporadic garnet and graphite and minor sillimanite and retrograde muscovite. The gneisses range from relatively fresh planar layered sequences in which the psammite and pelite are readily discernible, through metatextitic and diatextitic derivatives, to highly folded, and foliated, transposed rafts in schollen and schlieren complexes with a tonalitic hosts. Amphibolite layers are common but are generally less than 1 m thick, and highly boudinaged and segmented into discrete pods and lenses. Thick sills (up to 100 m) of strongly foliated heterogeneous grey to white inequigranular medium- to coarse-grained tonalite are intruded parallel to the regional layering and foliation. Numerous hinge zones preserved in paragneiss inclusions indicate the tonalite was emplaced parallel to and along the axial planes of early tight folds. White plagioclase, microcline, muscovite and quartz-bearing pegmatite sills up to 20 m thick were also recorded with 50 cm graphic quartz/microcline intergrowths and biotite crystals up to 1 m in length. These pegmatites cut earlier vertical, 30 cm thick diabase dykes trending 314°.

The southern flank of the migmatites is bounded by a 1 km wide belt of thinly layered and laminated hornblende, diopside and magnetite-bearing quartz plagioclase paragneisses with abundant thin amphibolite layers and local subarkosic quartz-ofeldspathic layers. Calc-silicate lenses and quartz pods are common, whereas garnetiferous layers are moderately abundant. A single medium grained homogeneous equigranular hornblende diorite sill occurs near the southern contact of the unit.

Major pink granite and granodiorite intrusions observed further north on South and Swan Bays have been described at length by Steeves *et al.* (1972).

Several east-trending linear conductors were identified by the 1969 Questor Mark V INPUT electromagnetic survey in the area. No obvious mineralization was observed in this area; however, a prominent gossan zone, along strike to the west on the west shore of the Issett Channel, exhibits high concentrations of graphite and pyrite with associated quartz veins, in close association with a 20 m thick amphibolite zone within the interlayered metagreywacke and tonalite sequence.

SOUTHERN BELT

South of the hornblende and magnetite-bearing metasediments and gneisses a 4-6 km wide east-trending pink granitic body occupies the large tract of country between latitudes 56°31' and 56°34'. The granite is medium- to coarse-grained, homogeneous, inequigranular to locally porphyritic and generally unfoliated. Compositionally the granite ranges from syenite through quartz monzonite to granodiorite. Xenoliths are vague, up to 1 m in size, and subrounded. Hornblende and biotite are the main ferromagnesian minerals. Dykes and dykelets of slightly whiter equigranular and medium grained granodiorite cut the metavolcanic and metasedimentary belt to the south.

A 10 km long east-trending belt of metavolcanics, metasediments and metadiorite ranging from 1.5 to 3 km in width was traced in a series of outcrops throughout the southcentral and south-east parts of the area. Additional exposures to the east and south have been identified by Corkery and Lenton (1981).

Toward the east end of the belt, low grade, fine grained well layered mafic metavolcanic layers predominate. Massive basaltic units are interlayered with fragmental units, amygdaloidal flows, andesitic and dacitic flows and tuffs, rare pillow basalts, feldspar phyric basalts and two thin layers (up to 5 m) of pale green high magnesian basalt. Few layers exceed 15 m in thickness, most ranging between 20 to 300 cm. Maximum amygdale size in the basaltic flows ranges up to 1.5 cm.

Many of the fragmental units are polymictic and contain fragments ranging from highly amygdaloidal basalt and dacite (up to 60% amygdales) to feldspar and hornblende-feldspar phyric varieties. Fragments are angular and up to 80 cm in length (10 cm thick). Some fragmental layers are almost oligomictic and appear autobrecciated. A 1 m thick rusty zone, with associated epidote pods flattened in the foliation, was recorded in the central part of the section. Thinly layered mafic tuffs with subhedral hornblende metacrysts are interlayered with thin felsic and intermediate tuffs near the northern flank of the belt. A vertical face at station 04-81-54a displayed repeated open folds in the volcanic sequence with near horizontal axes. The folds become progressively tighter to the north as the margin of the greenstones is approached and thin dykelets and dykes of the adjacent hornblende granite appear intruding the axial planes of the folded metavolcanic rocks. A weak fracture cleavage is apparent in less competent layers.

At the extreme east end of the greenstone belt the metamorphic grade is significantly higher and the cubic and octahedral magnetite blasts, observed elsewhere in the belt, attain sizes up to 1.0 cm. Compositional variations in the flows and tuffs are emphasized by the development of either abundant acicular amphibole needles or concentrations of ruby eye euhedral garnet

crystals up to 5 mm in size. Recrystallization appears to have been post-tectonic and related to the emplacement of the nearby hornblende granite.

At the west end of the belt a calcite-rich pod with minor associated quartz attains a size of 3.0 m x 60 cm. Quartz veins are generally more abundant in this area and the metavolcanic rocks occur as inclusions and rafts in a large hypabyssal diorite intrusion that was emplaced prior to the folding and foliation development.

No conductors were identified within the greenstone sequence by the 1969 Questor Survey.

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

(63 0/3 and 63 0/2W)

by Paul G. Lenton

INTRODUCTION

A three week period of mapping in the McNeill - Pistol Lakes area completed the 1:50 000 coverage initiated in 1978. Ground-based work concentrated on the Rosenberry Lake-Ferguson Creek area. A limited helicopter-supported program concentrated on the area south of McNeill Lake and west of Ferguson Creek.

The area comprises two belts of scattered outcrop in heavily wooded swampy terrain separated by a 15 km wide belt of Glacial Lake Agassiz lacustrine clay. Rosenberry Lake and Ferguson Creek are accessible by boat from Setting Lake. The remainder of the area is accessible only by helicopter.

GENERAL GEOLOGY

The rock units of the area are of three main associations:

- 1) Metasedimentary and metavolcanic rocks of the Amisk and Missi Groups.
- 2) Gneisses and migmatites of the Kiseynew sedimentary gneiss belt (comprising the Burntwood River and Sickie Metamorphic Suites).
- 3) Intrusive rocks of varying compositions.

Separation of the metasedimentary rocks into the Amisk-Missi association and the Burntwood River-Sickie association is an arbitrary division. Bailes (1980) has demonstrated a correlation between the metagreywackes of the Amisk Group and the greywacke derived gneisses of the Kiseynew sedimentary gneiss belt. A similar correlation of the Missi Group and the Sickie Metamorphic Suite can be inferred although it has not been proven. The McNeill Lake area lies on the boundary between the Kiseynew sedimentary gneiss belt and the Flin Flon belt. In an attempt to rationalize the terminology used to the north in the Burntwood Project (McRitchie, et al., 1979) with the current terminology for the Flin Flon belt (Bailes, 1980; in preparation) the names Amisk and Missi Groups have been restricted to rocks in the southwest of the area that are below the limits of partial anatexis. The names Burntwood River and Sickie Metamorphic Suites are restricted to the high grade gneisses and migmatites.

Supracrustal rocks

The most abundant rock type is a monotonous sequence of metamorphosed greywacke and mudstone. The Amisk greywackes in the southwest are grey fine grained silty psammities with graded bedding. Pelitic beds are rare. The greywackes are overlain by mafic volcanic rocks that have been assigned by Bailes (in preparation) to the Missi Group. These comprise pillowed and massive basalts with minor basaltic breccia and fine grained mafic sediments. Metamorphism has altered the basalts to a fine grained mixture of feldspar, quartz, green amphibole and chlorite heavily veined by quartz and calcite.

East of the basalts is a 500 m + belt of white weathering protoquartzite. Locally the unit becomes an orthoquartzite (90% quartz) and contains rare pebble horizons. On the west side of the belt 10 to 30 cm beds of garnetiferous subgreywackes are common. The contact between the basalts and quartzites lies in a swamp and was not observed in exposure. The contact between these units has been interpreted to the south by Bailes (op. cit.) as a fault. This fault has not been observed in the McNeill Lake area, although a linear swamp following the fault trend (020°) does not occur at that position.

Supracrustal rocks in the rest of the area comprise migmatite gneisses with 30 to 70 per cent of granodioritic mobilized lit. Deformation is extreme in these gneisses with little remaining of the primary textures of the sedimentary rocks. Primary layering can be recognized in some exposures based principally on variations in the contents of garnet, biotite and cordierite. Both the Burntwood River Metamorphic Suite greywacke derived gneisses and the Sickie Metamorphic Suite arkose and greywacke derived gneisses can be traced through gradational contacts into bodies of phaneritic textured anatexites. These are intrusive textured rocks of the same texture and mineralogy as the mobilized in the gneisses that contain numerous rafts and schlieren of the restite phase of the gneisses. Commonly the boundary between the greywacke-migmatite (unit 1) and its anatexitic derivative (unit 12) is arbitrarily marked at the point where the granitic component exceeds 80% of the rock. In general the felsic rocks of the Sickie Metamorphic Suite are more mobilized than the greywacke derived gneisses. The transition between migmatite and anatexite is abrupt resulting in a poorly defined subdivision of the Sickie Suite. Units identified comprise magnetiferous hornblende gneisses (commonly with an augen texture), layered biotite gneisses and magnetiferous garnet-bearing greywacke. In one location, on Rosenberry Lake, the contact between the Sickie and Burntwood River Suites is marked by a dark brown weathering interbedded layered and massive amphibolite sequence.

Intrusive rocks

Much of the area is dominated by a variety of intrusive units ranging in composition from gabbro to granite. All the intrusions are foliated to some degree with some having intense or even cataclastic foliations. All bodies are elongate in a north or northeast direction parallel to the regional foliation.

Unit 4 comprises three mafic intrusions that all occur inside bodies of granitic rocks. The bodies are isolated and their relationship to each other and to the enclosing rocks is unknown. The largest body (4a) occurs as a single large ridge north of McNeill Lake of plagioclase porphyritic quartz-diorite to quartz gabbro. It comprises 50% white zoned 1 to 2 cm plagioclase phenocrysts in a fine grained black matrix of hornblende, biotite, plagioclase and quartz. Red garnet is an accessory in some locations. The unit intruded the metagreywacke and includes it near the contact but is cut by dykes of granodiorite (unit 8). The remaining occurrences are isolated exposures of mafic gneisses for which the contacts are not exposed.

Unit 5 is a brownish-grey augen-textured tonalite. It forms a single elongate north-east trending body that appears to be folded about a broad open closure in the north. It has a uniform texture and composition throughout its 30 km strike length. Inclusions of grey siliceous gneiss similar in appearance to the psammitic greywacke of the Amisk Group are common in the southeast but were not observed north of McNeill Lake.

Unit 6 is a red quartz-rich gneissic to augen-textured granite. Magnetite is abundant in the granite. Inclusions of gneisses are present only at the margins of the body. Several minor cataclastic zones trending 020° were noted, especially along Ferguson Creek.

South of McNeill Lake an extensive complex comprises a distinctive porphyritic granodiorite (Unit 8) intruded into a multi-phase granite to granodiorite intrusion (Unit 7). The dominant

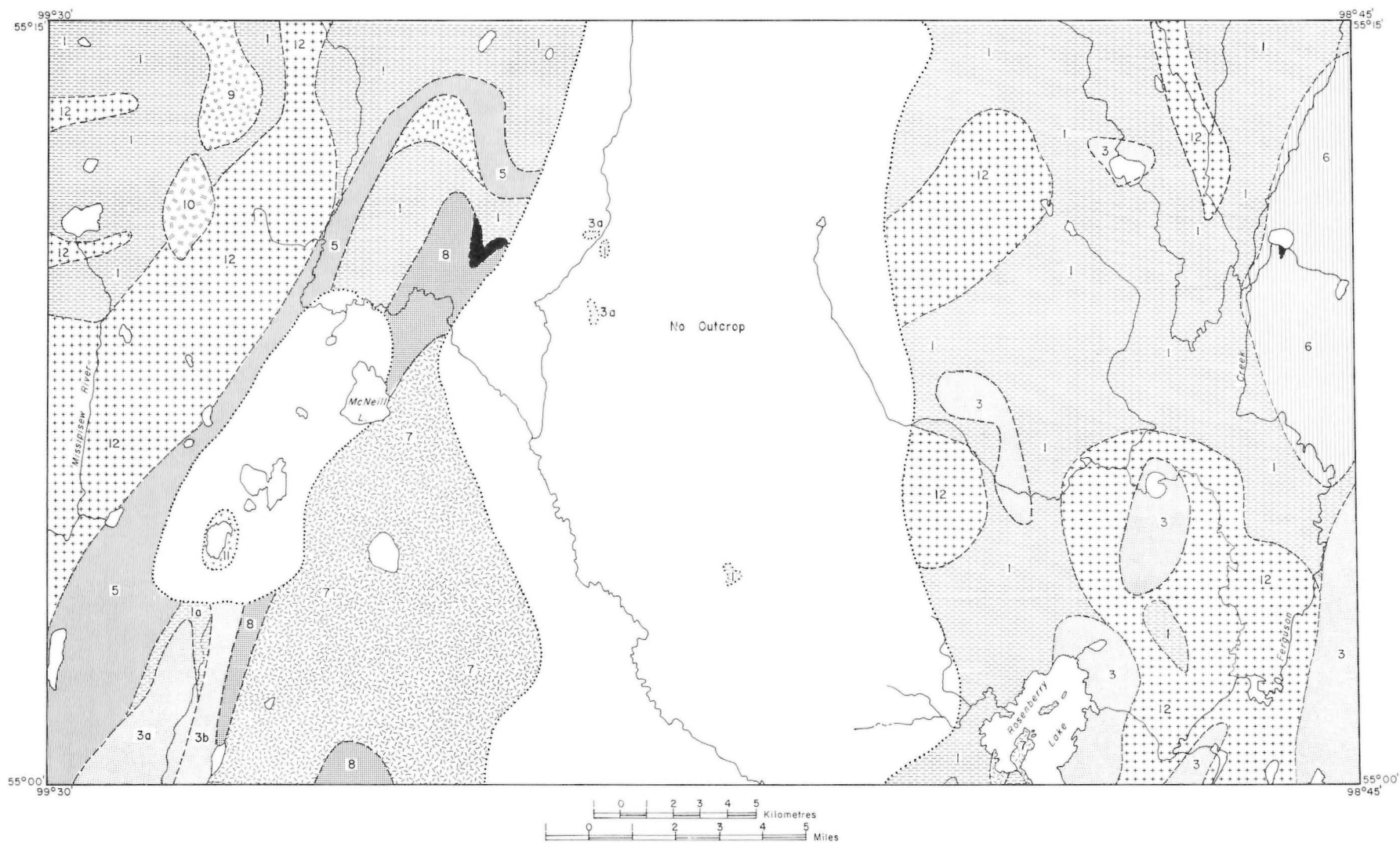


Figure GS-7-1: Geology of the McNeil Lake - Pistol Lake (West) area. Contacts have been extrapolated through areas of drift cover.

TABLE GS-7-1
Legend to Accompany
Figure GS-7-1

Precambrian Intrusive Rocks	
	Granodiorite and granite; anatectic derivative of unit 1
	Grey biotite granodiorite
	White leucogranodiorite
	Pink megacrystic granite; contains porphyroblasts of microcline and garnet
	Grey plagioclase-porphyritic granodiorite
	Biotite-hornblende granite and granodiorite
	Gneissic granite
	Hornblende tonalite
	Quartz diorite and gabbro
Metasedimentary and metavolcanic rocks	
Sickle Metamorphic Suite (in part Missi Group)	
	Undifferentiated arkosic gneisses; 3a metabasalt (Missi Group); 3b protoquartzite (Missi Group).
Burntwood River Metamorphic Suite (in part Amisk Group)	
2	Amphibolite (not shown on map)
	Greywacke-derived migmatite; 1a metagreywacke, metasiltstone (Amisk Group)

phase in Unit 7 is a pink to red homogeneous equigranular granite. In some locations ghost layering involving alternating bands of hornblende granite and biotite granite suggests the unit may contain large areas of assimilated gneisses. Other phases present include a coarse white granodiorite, a coarse quartz rich granite and a grey leucotonalite.

Units 9, 10 and 11 are each compositionally and texturally distinctive granodiorites that form discrete intrusions. They probably formed synchronous with the major mobilize producing metamorphic event. They intrude areas of highly mobilized gneisses but are themselves foliated and metamorphosed. Inclusions of gneisses are rare or absent in these intrusions.

STRUCTURE AND METAMORPHISM

All rock units encountered have penetrative foliations dominantly in a northeast direction. Minor structures indicate a uniform shallow northeast plunge. Cataclastic textures with a northeast trend are common throughout the area but are particularly prominent in the Rosenberry Lake - Ferguson Creek area. Only one zone of mylonite (on Rosenberry Lake) was encountered. A late brittle deformation in a northwest direction was encountered in the western region. This produced some offset of units but did not result in major cataclasis.

Metamorphic grade through most of this area is uppermost amphibolite grade. Partial anatexis is prominent in all of the gneisses. A characteristic reaction in the metagreywackes is the breakdown of sillimanite in the presence of biotite. This reaction denotes the "high grade B" zone of Bailes and McRitchie (1978) which is characteristic of the core of the Kiseynew belt.

The small area in the southwest of Amisk and Missi Group metasedimentary and metavolcanic rocks has a different structural and metamorphic character. The area appears to be fault bounded. The plunge of minor structures is at a moderate angle to the southwest. The metamorphic grade is upper amphibolite with the characteristic assemblage in the metagreywackes being cordierite-garnet-sillimanite corresponding to the "staurolite-out" reaction. Remnants of staurolite have been found in these rocks.

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GS-8 THOMPSON NICKEL BELT PROJECT - SETTING LAKE

(Parts of 63 0/1, 2 and 63J/15)

by K.C. Albino and J.J. Macek

INTRODUCTION

Geological mapping (1:25 000) of the Thompson Nickel Belt continued on Setting Lake as part of an ongoing study of the Churchill-Superior boundary zone. Setting Lake is approximately 45 km long and up to 6.5 km wide. It possesses long peninsulas and contains numerous islands. The quality of outcrop ranges from poor to excellent. The northwestern shoreline consists of Churchill Province gneiss which is clearly of metasedimentary origin. The southwestern shoreline is dominantly polycomponent migmatite of the Superior Province intruded by a swarm of mafic dykes. Some islands in the middle of the lake show limited exposures of metasedimentary and metavolcanic rocks that likely belong to the Ospwagan group (Scoates, Macek and Russell, 1977).

Lithological, structural, metamorphic and tectonic relationships among rock units on Setting Lake are complex and make geological investigations very rewarding. The following text concentrates on the most important aspects of Setting Lake geology only, since the wealth of collected data is too large to be evaluated fully in a short period of time. The lake was arbitrarily divided into 10 blocks (Fig. GS-8-1) in order to point out conveniently the location of geological highlights described in the following text.

SUPERIOR PROVINCE

The southeastern shoreline comprises various structural types of multicomponent migmatites similar to those described recently from Halfway Lake (Macek and Scoates, 1980) and Paint Lake (Macek and Russell, 1978). Stromatic and/or folded migmatite is the most common and invariably shows indications of cataclasis and potash metasomatism. Extensive reaches of the shoreline are medium grained, blue-grey, cataclastic and stromatic biotite-hornblende-quartz-feldspar gneiss (Moak Lake gneiss, Scoates, Macek and Russell, 1977) which is the result of intense tectonism accompanied by potash metasomatism.

Three bodies of melanocratic, medium grained biotite-hornblende-quartz-feldspar gneiss are exposed on the southeastern shoreline of Setting Lake. Both bodies are intruded by (1 - 30 cm) folded sheets of pink aplo-pegmatite in regular intervals. Their megascopic features and composition are similar to unit 2 of Halfway Lake (Macek, 1980, T-1, Halfway Lake).

However, the northern body (Block 1) is not hornblende-porphyroblastic and this may be due to recrystallization during tectonism. The larger, more southerly body (Blocks 9, 10) is hornblende-porphyroblastic but the porphyroblasts are approximately half the size of those on Halfway Lake.

The migmatites have been intruded by a swarm of diabase and plagioclase-porphyritic dykes which were tectonized and recrystallized into plagioclase amphibolites. The intensity of the tectonic fabric (segmentation, shearing, boudinage, folding, faulting) varies considerably over short distances. The best example of discordancy between dykes and migmatites has been found in the northern part of Block 7 (small bays and islands). Figures GS-8-2 and GS-8-3 show discordance in horizontal and vertical planes.

Well-preserved zoning in plagioclase porphyritic dykes was observed in the area of the Wabowden Dock in Block 7 (Fig. GS-8-4).

Migmatites on the Superior side of Setting Lake have a high ratio of hornblende to biotite which is significantly different from migmatites on Halfway and Paint Lakes. An extensive development of epidote along late fractures is also characteristic.

CHURCHILL PROVINCE

The northwestern shoreline and majority of peninsulas and islands are underlain by a sequence of metasedimentary gneisses of the Churchill structural province and their tectonic derivatives. This sequence of metasediments is locally intruded by granitoids forming schollen migmatites. Elsewhere the incipient formation of stromatic migmatites was observed.

The best stratigraphic sequence of Churchill metasedimentary gneiss is exposed in Block 2 in the extreme northwest bay of Setting Lake. The following subunits were recognized from west to east:

- light, grey, magnetite-sillimanite-biotite-feldspar-quartz gneiss (sillimanite-biotite meta-arkose) - Fig. GS-8-5.
- dark grey, magnetite-($\pm$ garnet $\pm$ hornblende)-biotite-feldspar-quartz gneiss (biotite meta-arkose) - Fig. GS-8-6.
- pinkish-grey (biotite)-hornblende-quartz-feldspar gneiss (hornblende meta-arkose) - Fig. GS-8-7.
- pinkish, dark green quartz-feldspar-hornblende gneiss (hornblende-wacke) - Fig. GS-8-8.
- greenish-grey polymictic metaconglomerate (polymictic metaconglomerate) - Fig. GS-8-9.

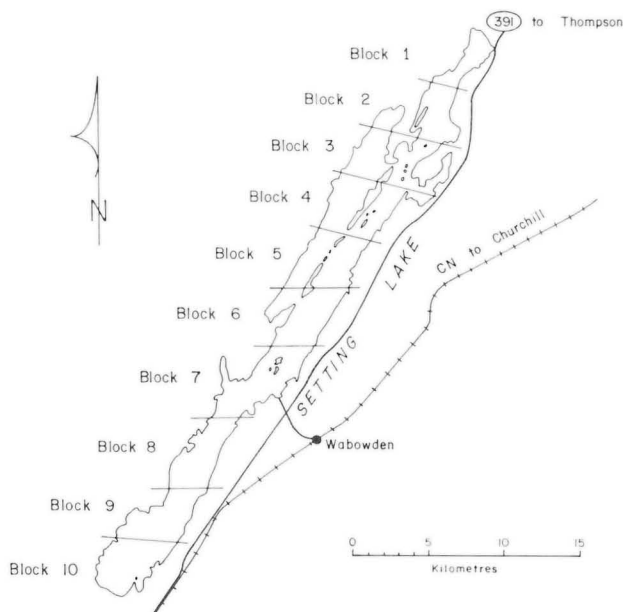


Figure GS-8-1: Setting Lake, showing subdivision into 10 reference subareas to facilitate description of geology.

This metasedimentary sequence belongs to the Sickle metamorphic suite described elsewhere in the Churchill province: (Corkery and Lenton, 1980, GS-4; Gilbert, Syme, Zwanzig, 1980, GP-81; Corkery and Lenton, 1979, GS-1; Zwanzig, 1978, GS-3; Keay and Zwanzig, 1977, GS-5; Bailes, 1977, GS-15; Zwanzig, 1976, GS-4). Rare top indicators (preserved remnants of cross-bedding) and the lithologic sequence (comparable with the above-cited references) indicate tops to the northwest.

The stratigraphic succession of the Sickle metamorphic suite in the middle of Setting Lake (Blocks 2, 4, 5) is incomplete and tectonically complicated by mega-folding associated with numerous parasitic folds and faults (strike-slip and oblique). This much broken (or disrupted) stratigraphic succession seems to top to the southeast. Dips in Block 5 indicate a large antiform with the shallow northeasterly plunging axis in close proximity to the western shore of the main islands. The presence and style of minor folds indicates the presence of an asymmetrical anticlinorium with a less deformed major limb on the northwest shore. The southeast limb is highly folded and disrupted by faults.

The core of the anticlinorium is locally intruded (Blocks 2,3) by different syntectonic granitoid rocks that are possibly related in space and time. They occur as orthogneisses, and in some places obliterate the lower part of the Sickle metamorphic suite. Orthogneisses are relatively homogeneous in the first three northern blocks and contain few inclusions or rafts of Superior-type migmatites or Churchill metasedimentary gneisses. The abundance of rafts and inclusions increases to the southwest (central parts of Blocks 4 and 5) where schollen migmatites are present. Rafts in these blocks (Blocks 4, 5) form from 30 - 70 per cent of the volume of schollen migmatites and belong almost exclusively to the metasedimentary gneisses of the Churchill Province.

Schollen migmatite structures and textures were locally considerably modified by an intense late tectonism, forming rocks of a "hybrid zone". In such instances primary features were transposed and it is often impossible to identify the original constituents.

A progressive migmatization and formation of Moak Lake-like stromatic gneiss from Sickle metasedimentary gneisses, is exposed in Block 7 on the northern shore of the bay, where Grass River enters Setting Lake. The sequence of Sickle metasediments indicates tops to the northwest in general, however, parts of the sequence are repeated a number of times due to tight folding and associated faulting. Incipient formation of quartzofeldspathic mobilizate in metasediments in the form of lenses, stringers, pinch and swell horizons can be observed in increasing amounts to the west. The original character of the metasediments can be recognized. In tectonised zones (1 - 10 m wide) cataclasis and recrystallization accompanied by potash metasomatism produced stromatic gneiss almost identical to Moak Lake gneiss. This observation supports the proposed view (Macek and Scoates, 1980) that Moak Lake gneiss is a tectonite that possesses a characteristic texture formed from rocks of variable origin. Zones of stromatic and schollen migmatites derived from Sickle metasediments suggest that the heat source was to the west. Schollen migmatites derived from Churchill metasedimentary gneiss by intrusion of granitoids also occur in the western bays of Blocks 8, 9 and 10. In Block 10 the Churchill metasediments occur almost exclusively as rafts in granitic orthogneisses. They are closely associated with amphibolites of metavolcanic and also of metasedimentary origin (para-amphibolite). Some islands (in the southwestern part of Block 10) of schollen migmatite contain rafts of Churchill metasediments in contact with para-amphibolite.

Ospwagan group

Rocks similar to those of the Ospwagan group (Scoates, Macek and Russell, 1977) on Ospwagan Lake are exposed in a few locations in Blocks 3, 4, 6 and 7 as reefs or small areas on islands

east of the main chain of islands and peninsulas in the middle of the lake.

Metavolcanic rocks are represented by pillowed and massive flows of fine- to very fine-grained, silverish-green metapelite. These are very similar in colour and texture to those on Lower Ospwagan Lake. They form two reefs in the lobe-shaped bay of the central peninsula in Block 3.

Metasediments of the Ospwagan group have been found as small areas on the eastern shore of one island, east of the main island in Block 4. These are rusty weathering, finely laminated ferruginous siltstones that display open convolute folds that contrast with the tight nearly isoclinal folds of the Churchill metasediments. Their style of deformation is similar to that on Ospwagan Lake and in the Pipe Pit. Although, detailed structural analysis is not yet available, it is apparent that the orientation of fold axes and axial planes differs from other units on the lake. These finely laminated metasiltsstones are in conformable contact with graded grits and gritty metasandstones. The contact is only slightly modified by folding. The grits and gritty metasandstone comprise folded sequences of well-graded beds (0.2 - 1.5 m thick). The bottom divisions of the beds are formed by oligomictic (quartz) pebble conglomerate grading into fine sandstone. Some layers display shale divisions that formed prior to deposition of the overlying conglomerate layers.

From excellent top indications and primary contacts, it is clear that ferruginous, finely laminated siltstones conformably underlie the sequence of graded grits and both units belong to the same stratigraphic sequence.

The metamorphic grade cannot be determined directly on finely laminated siltstones or graded grits since their composition is not suitable for formation of good indicator minerals. However, graded grits are interlayered on the neighbouring island (to the west) with beds composed almost entirely of foliated, rosettes or fan-like aggregates of anthophyllite-cordierite. Another metavolcanic-metasedimentary sequence similar to the Ospwagan group is exposed on the northern tip of the largest island in Block 7. Metavolcanics are represented by metabasalts which are folded and in places recrystallized into dark green, well-foliated actinolite schists (Fig. GS-8-10). These are in contact with finely laminated, ferruginous metasiltsstones. Both are intruded by a granitoid body (orthogneiss) and may represent a large raft. This is supported by the primary contacts (Fig. GS-8-11) and a zone of schollen migmatites on the periphery of orthogneiss containing rafts of laminated metasiltsstone (Fig. GS-8-12).

The most southerly occurrence of Ospwagan group may be found on the small island located approximately 2 km west of the Wabowden boat launch in Block 7. The exposure is however very poor.

STRATIGRAPHIC IMPLICATIONS AND RELATION TO THE CHURCHILL PROVINCE

The stratigraphic position of the "Ospwagan" graded grit sequence in relation to the Sickle metasediments is not clear. Graded grits contain rare layers of grass green metavolcanics (0.1 - 1 m thick) which are also found in metasediments assigned to the Churchill Province (central part of Block 3). They are also in close proximity to dark grey, rather homogeneous plagioclase amphibolites (massive flows or shallow sills) which are, in turn, in direct contact with typical Sickle polymictic metaconglomerate (Block 4). This would place the "Ospwagan" finely laminated siltstones at the base of the sequence overlain by graded grits containing anthophyllite-cordierite layers and grass green metavolcanics. These in turn are overlain by compositionally monotonous, but thinly layered (1 - 20 cm thick) biotite metasandstone-wacke (garnet and sillimanite-bearing) containing calc-silicate and grass green metavolcanics. Medium grained, dark grey plagioclase-amphibolite seems to be closely associated with

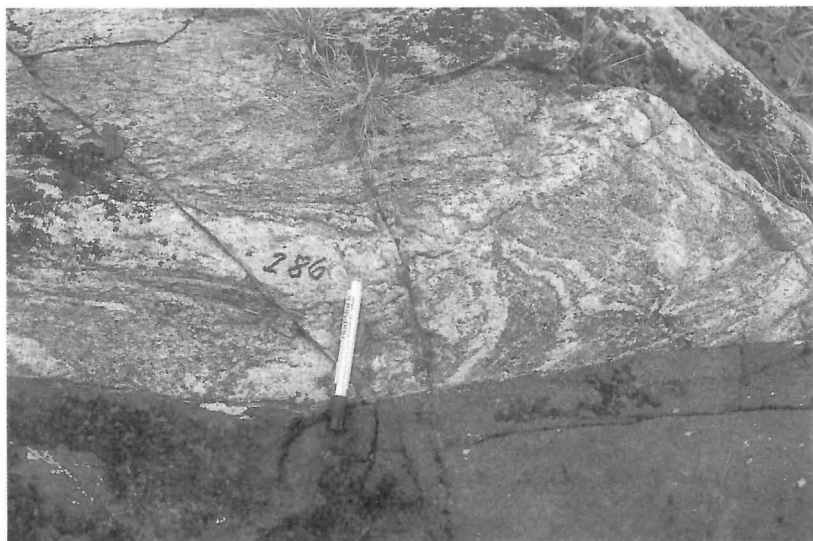


Figure GS-8-2: Discordance between stromatic, folded migmatite and plagioclase-amphibolite dyke (Molson Dyke?) in horizontal plane.

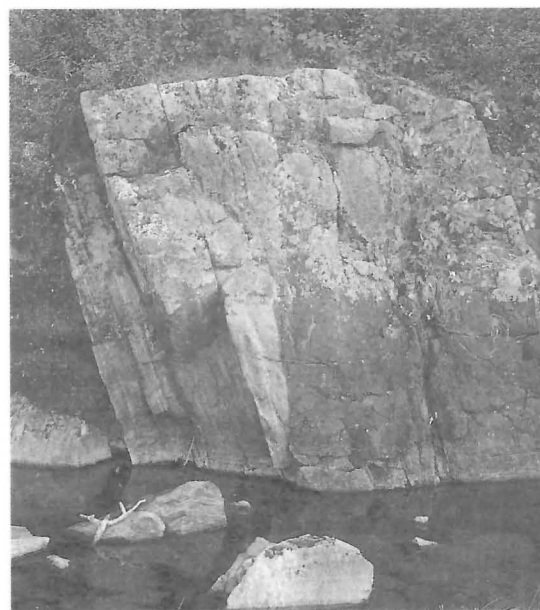


Figure GS-8-3: Discordancy between cataclastic stromatic migmatite and plagioclase-amphibolite dyke (Molson Dyke) in vertical plane.



Figure GS-8-4: Zoned plagioclase-porphyratic dyke.



Figure GS-8-5: Sillimanite-biotite meta-arkose (upper Sickie) with faserkiesel and magnetite-bearing laminae.



Figure GS-8-6: Biotite meta-arkose.



Figure GS-8-7: Hornblende arkose. Notice acicular hornblende.



Figure GS-8-8: Hornblende wacke.



Figure GS-8-9: Polymictic conglomerate (Lower Sickle). Mafic clasts are more stretched than the felsic clasts.



Figure: GS-8-10: A metabasalt of Oswagan "group" transformed into well-foliated actinolite schist.

Figure GS-8-11: An intrusive contact between granitoid (orthogneiss) and Oswagan "group."

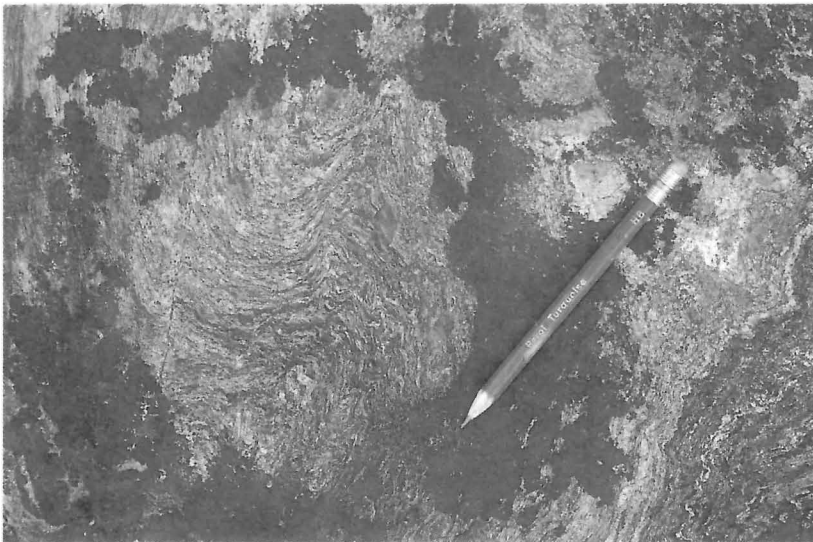
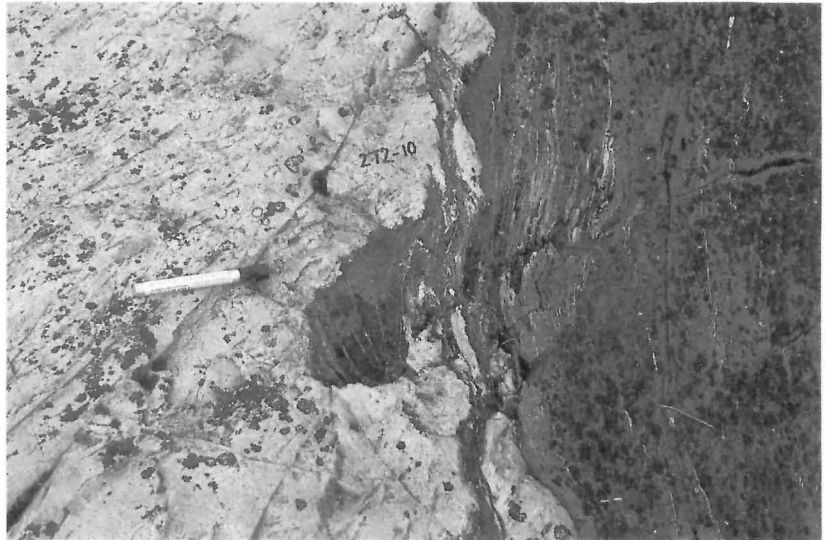


Figure GS-8-12: A detail of ferruginous, finely laminated siltstones of Oswagan "group" from the raft in schollen migmatite zone on the periphery of the orthogneiss.

BLOCK 5

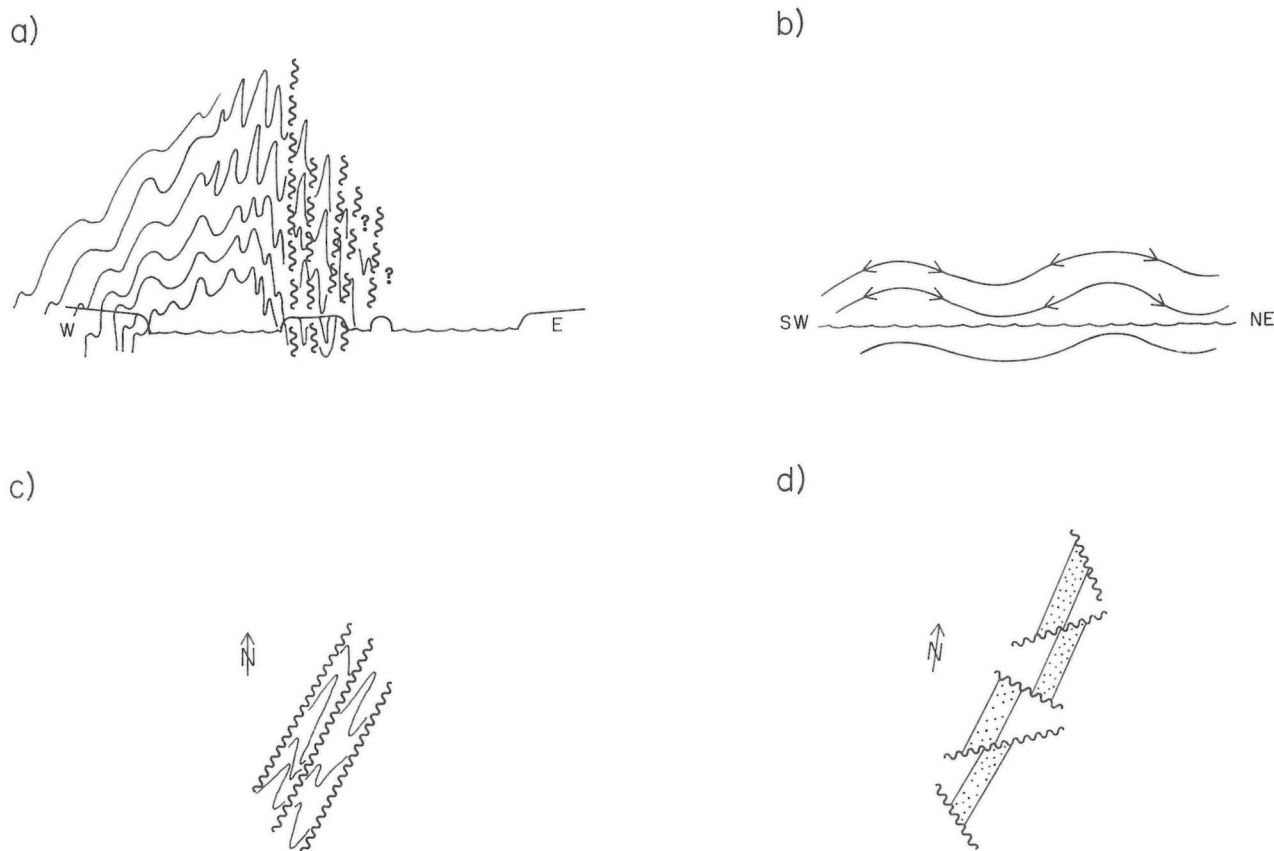


Figure GS-8-13: Basic structural features affecting geology of Setting Lake.

- a. The asymmetrical anticlinorium. The question marks indicate a possible tightly folded synform.
- b. Schematic illustrations of the changing plunge of the fold axis along the strike.
- c. Schematic illustration of strike-slip faults with parasitic folds.
- d. Oblique faults producing offsets of geological units.

graded grits and/or sillimanite, and garnet-bearing biotite metasandstone-wackes which are in direct contact with the polymictic metaconglomerate of the Sickle Group. This would appear to place the "Ospwagan" metasiltstone-graded grit sequence stratigraphically under the Sickle Group and one might expect to find this sequence to the west, on the main chain of central islands, in the core of the anticlinorium. This is not the case however and their absence, though possibly due to folding or faulting leaves the stratigraphic position of the "Ospwagan" siltstone-graded grit sequence uncertain.

STRUCTURAL GEOLOGY

A detailed structural analysis is not yet available, but the main structural features and the geological problems connected with them are evident. As mentioned above, the western and central part of the lake forms an asymmetrical anticlinorium (Fig. GS-8-13a). The eastern limb is more attenuated with numerous parasitic faults. The western limb is less deformed as is evident from minor shallow plunging folds. Shallow to steeply plunging minor folds axes and lineations in both directions indicate that

the anticlinorium is, on grand scale, gently and openly folded along northwest trending axes (Fig. GS-8-13b). This may explain why different levels of the Churchill metasedimentary sequence are exposed along strike.

The eastern limb of the anticlinorium is also tectonically modified by major strike-slip faults, coupled with parasitic folds causing repetition or absence of certain units in outcrop (Fig. GS-8-13c). The sense of movement may be in both directions. The vertical component of movement is unknown since slickensides are very rare.

The whole structure has been segmented by oblique faults with sinistral and dextral displacements from 1 - 20 m (Fig. GS-8-13d). In places, this complicates the continuity of geological units along strike over distances as short as 200 m.

The authors are grateful to our colleagues P. Lenton, W.D. McRitchie, R.F.J. Scoates and W. Weber for their valuable help and professional input during their visits to the area and also for revising this manuscript.

We also would like to thank our assistants B.D. Deverill, R.B. Kujanpaa, D.D. McNeill and F.G. Zimmer for mapping two southern blocks of the lake and for detailed collection of geological data on some outcrops.

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GS-9 WHITE LAKE - MIKANAGAN LAKE PROJECT

(parts of 63K/12 and 13)

by Alan H. Bailes and Eric C. Syme

A major objective of mapping in the White Lake-Mikanagan Lake area (Bailes and Syme, 1979, 1980) was the development of a coherent regional volcanic stratigraphy. This goal was not achieved because this part of the Flin Flon volcanic belt is characterized by a structural pattern dominated by fault-bounded blocks. Each block has a unique stratigraphic succession that cannot be correlated with the sequence in adjacent blocks.

Further mapping, in the Flin Flon-Schist Lake area (Fig. GS-9-1), will be undertaken from 1982 to 1984, with the objective of correlating stratigraphy between the major fault blocks. A comprehensive geological report on the combined White Lake-Mikanagan Lake and Flin Flon-Schist Lake project areas will be produced following completion of the mapping program.

Field work in 1981 was restricted to re-examination of critical outcrops in the White Lake-Mikanagan Lake area and to a preliminary investigation of several outcrops in the Flin Flon-Schist Lake

area. The most important outcome of the field program was the recognition of one of the major units from the White Lake area in a fault block in the Flin Flon-Schist Lake area. Correlation of stratigraphy between some fault blocks is therefore possible and further mapping in the Flin Flon-Schist Lake area should result in development of a regional volcanic stratigraphy.

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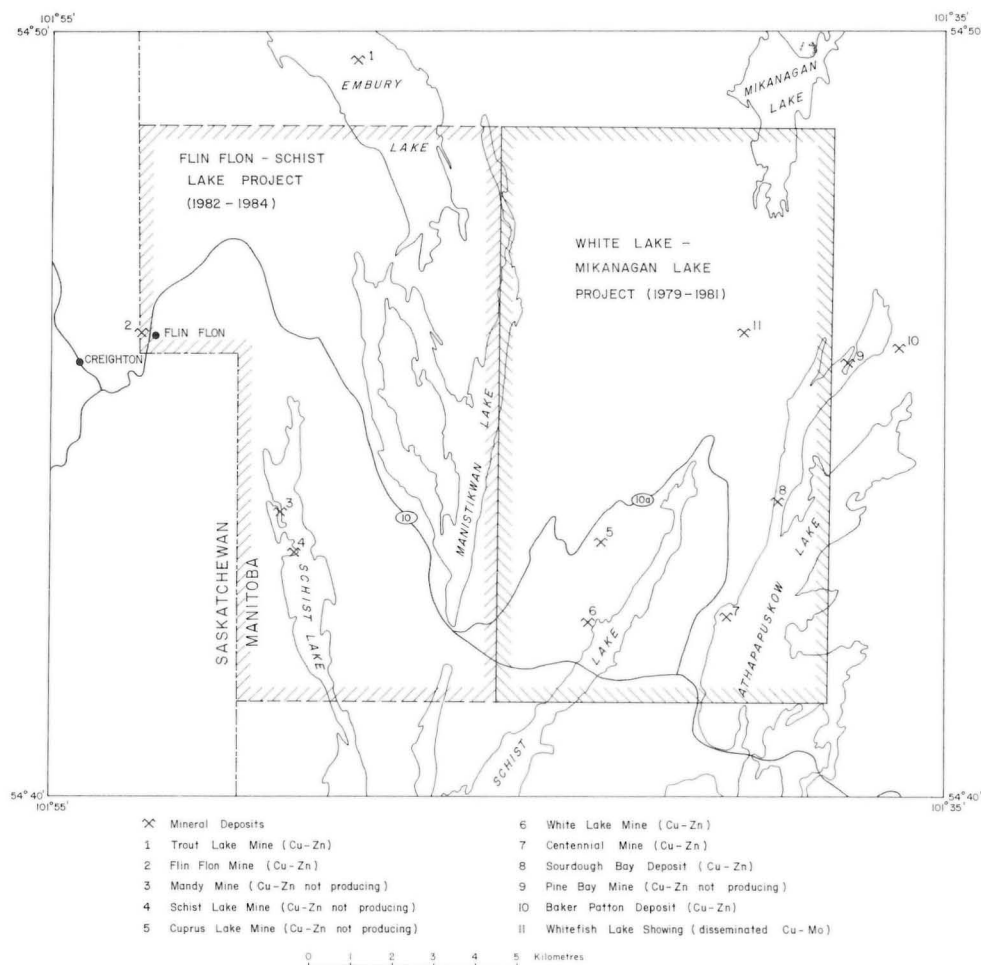


Figure GS-9-1: Location of Flin Flon-Schist Lake Project area.

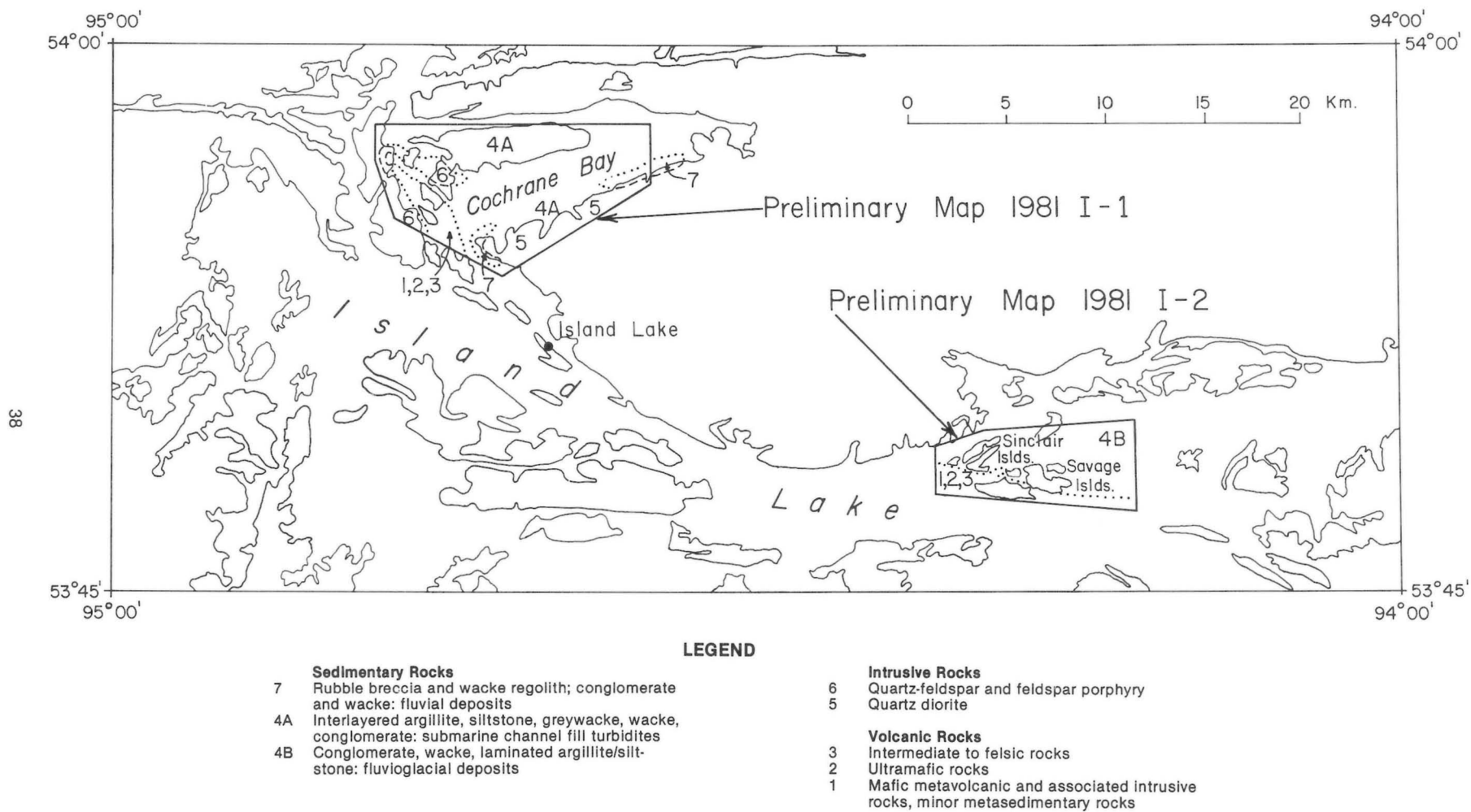


Figure GS-10-1: General Geology and Map areas 1981, Island Lake.

GS-10 ISLAND LAKE

(parts of 53E/15 and 16)

by K.L. Neale¹ and W. Weber

Field work in the Island Lake area was started this summer as part of a remapping project at a scale of 1:20 000. The area was previously mapped by Wright (1928) at 1:126 720, Quinn (1960) at 1:253 440 and Godard (1963) at 1:63 360. More recent work was undertaken by the Geological Survey of Canada (Ermanovics *et al.*, 1975; Herd and Ermanovics, 1976; Fyson *et al.*, 1978) which included mapping at the scale of 1:63 360 (not published yet). Most recently Theyer (1978, 1979, 1980a, b) conducted mineral deposit investigations in the Island Lake area.

The project was initiated to improve on the subdivision and delineation of the geological units by applying current volcanological and sedimentological concepts to the supracrustal rocks and to determine their depositional environment, composition, stratigraphy and structure.

Exploration activity in the Island Lake area has increased significantly in the last two years and the Island Lake-Stevenson Lake belt and the Bigstone belt are considered to be prime targets for gold exploration for a number of years.

The contact between the two main geological entities, the "Island Lake Series" and Hayes River Group is considered to be economically important (Theyer, 1978, 1979, 1980a, b) because ultramafic rocks occur at or near the contact, and mineralization associated with ultramafic rocks, such as nickel, copper and gold, is potentially hosted in rocks near this contact. However, the nature and position of the contact between the two main rock successions is poorly documented, mainly because of the controversy regarding the definition and extent of the Island Lake Series (Wright, 1928; Quinn, 1960; Godard, 1963).

Recent field work by Theyer (*op. cit.*) re-emphasized the need for a more definitive investigation and this new mapping project will attempt to define stratigraphic entities and their extent.

This summer's work concentrated on the sedimentary rocks of the "Island Lake Series" (Wright, 1928; Godard, 1963) and its relationship with the Hayes River Group and the granitoid rocks. Part of the "Island Lake Series" will form the topic of an M.Sc. thesis (by K.L. Neale) to determine depositional environments. The field work focussed on two areas: Cochrane Bay in north-western Island Lake (Fig. GS-10-1), and Sinclair and Savage Islands in the east central section of the lake.

RESULTS OF FIELD WORK

Three sedimentary environments are represented in the rocks mapped by Godard (1963) as "Island Lake Series".

In Cochrane Bay conglomerate and lithic greywacke mapped as "Island Lake Series" by Godard (1963), but as Hayes River Group by Wright (1928), is closely associated with graded greywacke/argillite and laminated argillite/siltstone. These lithologies are interpreted as turbidity current deposits on submarine fans.

Sedimentation was contemporaneous with, or subsequent to, felsic volcanism and related felsic intrusion. The detritus is derived largely from felsic extrusive and intrusive rocks which formed areas of high relief due to volcanism and possible upwelling of intrusive stocks and plutons. Insufficient data is available at this time to determine the nature of the contact between the Hayes River Group and the Cochrane Bay sedimentary rocks.

A younger fluvial sequence of coarse conglomerates and

quartz wackes, comprising quartz diorite detritus, overlies a regolith formed on quartz diorite. Contacts with the Hayes River Group and Cochrane Bay sequence are not exposed.

On Sinclair and Savage Islands, rocks originally defined as "Island Lake Series" by Wright (1928) comprise conglomerates, wackes, and laminated argillite and siltstone which are interpreted as fluvio-glacial deposits. The base of the metasedimentary succession overlies various lithologies of the Hayes River Group suggesting a possible erosional unconformity between the Hayes River Group and the Sinclair-Savage Islands succession.

¹Department of Geology, Carleton University, Ottawa, Ontario.

COCHRANE BAY AREA

FIELD OBSERVATIONS

Mafic volcanic rocks, including massive and pillowed flows (units 1a to 1e)*, predominate on and near the eastern shore of Linklater Island; unstratified, fine grained tuffs (1f, g) are locally exposed.

Ultramafic rocks (2a) are spatially associated with mafic flows and are possibly part of a mafic-ultramafic volcanic association. Actinolite schist and hornblende (2b) occur in a highly sheared and tectonized zone and are in contact with felsic volcanic (3c) and related intrusive (6a) rocks.

Felsic pyroclastic rocks (3a, b, c) occur in the western part of Cochrane Bay. They are spatially closely associated with felsic stocks (unit 6). Rocks of unit 4 appear to overlie felsic or mafic volcanic rocks; however, further work is required to establish age relationships.

Lithic green wacke (35 - 50 cm thick beds) interbedded with polymictic conglomerate (25 - 35 cm thick) (unit 4o, Fig. GS-10-2) is characteristic of Cochrane Island. The beds are commonly sharp based, and normal grading is locally developed. Clast lithologies for units 4j, 4n, 4o, 4p and 4s are virtually the same. They are (in decreasing abundance):

1. Quartz-feldspar porphyry, massive.
2. Quartz diorite, medium grained, massive to weakly foliated.
3. Felsic volcanic, massive.
4. Porphyritic trachyte.
5. Mafic volcanic, massive.
6. Milky quartz.

Pebbles and cobbles of dark green diorite to gabbro, fine grained mafic tuff, translucent chert and amygdaloidal basalt have a more sporadic distribution. Most clasts range from ovoid to sub-rounded, and it is only locally (e.g. north shore of Cochrane Island) that their original shape cannot be determined because of flattening due to shearing. Mafic clasts have been deformed more than felsic clasts.

In a number of localities (e.g., southeast shore and east end of Cochrane Island) unit 4o is associated with normally graded arkosic wacke (5 - 25 cm thick beds) interbedded with argillite (unit 4h). The argillite-siltstone interbeds invariably have sharp bases, and many have sharp tops. Godard (1963) mapped units 4h and 4q as Hayes River Group and unit 4o as Island Lake Series. However, the first two units are commonly stratigraphically en-

*Map units refer to Neale and Weber (1981): Preliminary Map 1981-1-1.



Figure GS-10-2: Argillite interbedded with normally graded greywacke (unit 4f); Cochrane Bay.

Figure GS-10-3: Lithic green wacke interbedded with polymictic conglomerate (unit 4o); Cochrane Bay.

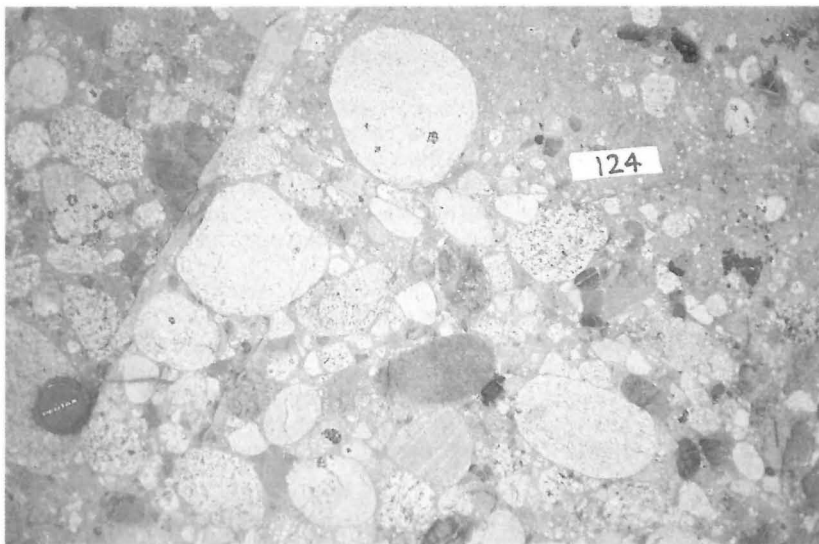


Figure GS-10-4: Sinclair Island polymictic conglomerate (4m). Note the predominance of well rounded, plutonic, clasts, gneissic and jasper iron formation clast.

closed by conglomerate-bearing beds of unit 4o, suggesting a similar environment of deposition for the three units.

On the southeast shore of Cochrane Island, and on small islands to the east, arkosic wacke (unit 4i) containing 25 cm wide scours infilled by pebbles and granules, and lithic greywacke (unit 4m) containing 20 cm wide scours infilled by granules and pebbles, are associated with one or more of units 4o, 4h, 4q. Clast composition is typically felsic.

DEPOSITIONAL ENVIRONMENT (units 4o, 4h, 4q, 4i, 4m)

The interbedded argillite and siltstone (4q), normally graded arkosic wacke and argillite (4h), together with the lithic green wacke interbedded with polymictic conglomerate (4o), are interpreted as a turbidite sequence.

The argillite-siltstone beds (4q) are thin, regular and sharp based, and the rocks themselves are fine grained and have a low sand:mud ratio. Parallel laminated argillite, overlain by argillite beds containing flame structures, are interpreted as DE Bouma divisions which would suggest deposition far from their source (distal) (Walker, 1967, 1979). However, because of the close association with thick-bedded wackes and conglomerates, unit 4q is interpreted as a deposit on levees and interchannel areas of upper submarine fans (Walker and Mutti, 1973; Nelson and Kulm, 1973). Such deposition takes place when a turbidity current "fills up" a channel and spills out over the top. Turbidity current flow over the levee is then oblique to the channel axis, and the turbidity currents are rather weak, resulting in thin, Bouma CDE, CE and DE sequences (Carson and Nelson, 1969). Relatively steep slopes on the levees and interchannel areas lead to synsedimentary deformation. Channel switching, possibly coupled with overbank deposition of sands and gravels, produces interbedding of thick, coarse sandstones and conglomerates (4h, 4o) with the siltstones and argillites (4q). In unit 4h, normally graded arkosic wacke/argillite beds ($\pm$ flame structures) represent repetitive AE Bouma divisions, indicating that the beds are close to their source (Walker, 1979). According to the turbidity current model proposed by Nelson and Kulm (op. cit.) in the uppermost fan valley, coarse grained debris is confined to the channels whereas the finer grained debris overflows the banks and spreads in a sheet-like fashion over the areas between channels.

Units 4i and 4m are interpreted as "disorganized pebbly sandstones" of "proximal exotic" deposits (Walker and Mutti, op. cit.). The arkosic and lithic greywackes of units 4i and 4m, respectively, are comparable to the disorganized pebbly sandstones in that they are composed of very coarse sand and granule-size material, lack graded bedding (grading restricted to the scours), and have irregular beds which can be as thick as 10 m. In general, proximal exotic deposits are "most prominent in the lower canyon and upper fan channels" though they may occur anywhere along fan margins that border basin slopes (Nelson and Kulm, op. cit.).

RELATIONSHIP OF INTRUSIVE ROCKS

Age relationships of porphyry stocks (6) and the enclosing metasedimentary rocks (4) have not yet been resolved. Lithic green wacke (4d) is commonly in contact with quartz-feldspar porphyry (6a) and locally seems to fill depressions in the porphyry, suggesting that the metasediments overlie the porphyry.

Quartz diorite (5e) is capped by a regolith (7a, b) in several localities along the southeast shore of Cochrane Bay. One of these is reported in Herd and Ermanovics (1976). The regolith (0.5 - 3 m thick) is a vein quartz block and quartz diorite block deposit (with blocks up to 1 m large) with a coarse grained, lithic quartz wacke matrix (7a). The matrix represents chemically weathered quartz diorite. In several places quartz wacke (7b) overlies

quartz diorite and/or underlies the block deposit and is gradational into quartz diorite at its base. The regolith (7a, b) is overlain by unstratified quartz diorite boulder conglomerate (7c) or polymictic cobble conglomerate (7d). Both units are interlayered with coarse grained lithic quartz wacke (7b). Rocks of unit 7 appear to be younger than the similar rocks of unit 4, since green lithic wacke (4d) is intruded by quartz diorite (5d, 5e) in the north-eastern end of Cochrane Bay (unless there is more than one age of quartz diorite intrusions).

Porphyry dykes (8a, b, c) and diorite dykes (8d) intrude units 4, 5 and 7. Mafic dykes (8e) intrude quartz-feldspar porphyry (6a).

SINCLAIR AND SAVAGE ISLANDS AREA

FIELD OBSERVATIONS

The polymictic, matrix-supported cobble (dominant)-boulder-pebble conglomerate (4 m, Fig. GS-10-4)* exposed on the Sinclair Islands is typically unstratified, bedding is defined by shallow dipping (45 - 50°) feldspathic wacke interbeds (0.2 - 1 m thick). Scours infilled by granule material serve as facing indicators. Clast lithologies comprise:

1. Trondhjemite, granodiorite, granite, massive or strongly foliated, constitute 70 - 90% of total clasts.
2. Mafic volcanic, fine grained, massive.
3. Quartz diorite, medium grained.
4. Gabbro, fine- to medium-grained, dark green.
5. Feldspar porphyry.
6. Quartz-feldspar porphyry, massive.
7. Carbonate, pitted appearance.
8. Siltstone, laminated (1 - 2 mm).
9. Milky quartz.
10. Black chert.
11. Amygdaloidal basalt.
12. Felsic volcanic, massive.
13. Porphyritic shoshonite.
14. Epidote (secondary).

The presence of strongly foliated plutonic clasts indicates a relatively deep level of the crust was exposed to erosion. Weathering and mechanical abrasion during transport and/or later stage reworking, are deemed responsible for the subrounded or even spherical nature of the clasts.

On East Savage Island and the second island west of it, a polymictic, matrix to (locally) clast-supported pebble-granule-cobble conglomerate (4k) is dominant. Stratification, if present, is defined by trimodal distribution of clast sizes (20 - 35 cm thick beds) or by lithic green wacke interbeds (10 - 15 cm thick). Unlike the Sinclair Island conglomerate, clast lithologies are not dominated by one particular type. They include:

1. Quartz-feldspar porphyry, medium grained, massive.
2. Mafic volcanic, strongly schistose.
3. Feldspar porphyry.
4. Diorite, fine grained, dark green.
5. Carbonate, reddish-brown.
6. Black chert, sometimes banded.
7. Jasper, reddish-orange.
8. Milky quartz.
9. Porphyritic trachyte.
10. Felsic volcanic, massive.
11. Pillowed mafic volcanic with visible selvages.
12. Fuchsite.

The smaller islands to the northwest of East Savage Island are dominated by two main types:

1. Feldspathic and lithic green wackes (4b, d) in which stratification is shown either by sporadic dark laminations (less than 1 cm) or pebble-infilled scours.

2. Laminated (1 - 2 cm) argillite and siltstone (4h, i) which are buff-coloured on weathered surface and frequently exhibit load structures.

DEPOSITIONAL ENVIRONMENT

Load structures are observed in all three sedimentary lithologies present in the Sinclair-Savage Islands area: cobble-boulder-pebble conglomerate, feldspathic and lithic green wackes, and laminated argillite and siltstone. They are most prevalent in the widely spread interlayered argillite and siltstone and, consequently, these sediments are interpreted as varves, formed in lakes during glacial outwash.

In the case of the Sinclair Islands conglomerate, long distance transport of exotic material (e.g., strongly foliated granitic clasts) is favoured by glacial processes. Post-depositional cracking of well-rounded plutonic cobbles suggests the clasts were frozen during transport. Subsequent thawing allowed widening of the fractures and filling by matrix. The presence of load structures implies vertical movement of water-charged sediments, a situation typical of retreating glaciers.

ECONOMIC GEOLOGY

Late stage carbonate veins cross-cut the metasediments in the Sinclair-Savage Islands area in several places. Most of these veins contain small quantities of sulphides and/or fuchsite. In one locality, on the west shore of East Savage Island arsenopyrite was detected. Arsenopyrite and fuchsite are typical for the locally gold-bearing carbonate zones near the volcanic-sedimentary contact further south, e.g. on Centre Island (Theyer, 1980). Consequently, the carbonate veins in the Sinclair-Savage Islands warrant prospecting for gold.

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GS-11 LITTLE STULL LAKE AREA

(part of 53K)

by M.T. Corkery

Preliminary investigations were carried out in preparation for a three-year mapping program in the Manitoba portion of the Stull Lake Map Sheet (NTS 53K) (Fig. GS-11-1). The Manitoba portion of the Stull Lake area is the only region in Manitoba with Archean greenstone belts for which GSC reconnaissance 1" = 4 mile maps are the only geological maps available. The main focus of the program will be to map, in detail, the two supracrustal belts which extend from Little Stull Lake to Edmund Lake and from Monument Bay through Sharpe Lake. This will be done in conjunction with reconnaissance mapping of the dominantly plutonic areas of the map sheet.¹

Initial investigations, carried out during a two-week field season, concentrated on the exposed greenstone belt in the Little Stull Lake, Rorke Lake, Kistigan Lake area, to facilitate planning for detailed 1:20 000 scale mapping during the 1982 field season.

GENERAL GEOLOGY

LITTLE STULL-KISTIGAN LAKES AREA

The supracrustal rocks in this area can be subdivided into two major groups: a lower mafic to intermediate volcanic sequence and an overlying sedimentary and volcanic sequence. The complex deformational patterns and the discontinuous nature of many of the units precludes any detailed interpretations based on the limited information gathered and only a brief description of some of the major groups of rock types will be attempted here.

The lower group comprises a relatively extensive suite of mafic to intermediate volcanic rocks with isolated occurrences of volcanogenic sediments. These rocks are least deformed in the Rorke Lake area and constitute a sequence of pillowed and massive flows with associated interpillow and flow top breccias. Several exposures consist of a series 1 to 2 metre thick dark olive green bedded rocks which may represent sediments or debris flows associated with the mafic volcanism.

Throughout the Little Stull Lake-Kistigan Lake area the lower sequence is highly deformed and primary textures are poorly preserved. In these areas extreme flattening of the pillows and breccias produces a centimeter scale discontinuous layering and a parallel millimeter scale metamorphic lamination. These features are cut by a later fracture cleavage.

The upper sequence comprises a heterogeneous group of sediments and volcanic rocks.

The sedimentary rocks, which dominate the sequence, are greywackes, polymictic conglomerates and feldspathic wackes. Primary structures, such as graded bedding, cross-bedding and scours are common. Typically, these sediments are composed of sand to granule sized lithic fragments with a conspicuous but variable percentage of white feldspar grains. Within restricted areas the feldspar grains become the dominant detrital material in the sediments. Pebbles are common within most of the greywacke and matrix-supported pebble conglomerates are locally developed. These conglomerates are polymictic; however, the majority of the clasts are porphyritic felsic volcanics with subordinate massive felsic volcanic, greywacke, iron formation and mafic volcanic clasts.

Interbedded with the greywackes are black, laminated argillites.

Intermediate to felsic volcanic rocks are associated with this sequence. Massive and feldspar porphyritic, light grey intermediate volcanics and pale green quartz-feldspar porphyries form the dominant volcanic units. They are associated with oligomictic breccias and possible tuffaceous layers.

This volcano-sedimentary sequence is bounded on the north side by pink granite in the Kistigan Lake area, and the Kistigan Lake dyke (Scoates and Macek, 1978) of the Molson Dyke Swarm forms a series of late northerly-trending dykes in the Rorke Lake Kistigan Lake area.

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¹This project extends the mapping of the Greenstones project (Elbers, 1973) east to the Ontario border.

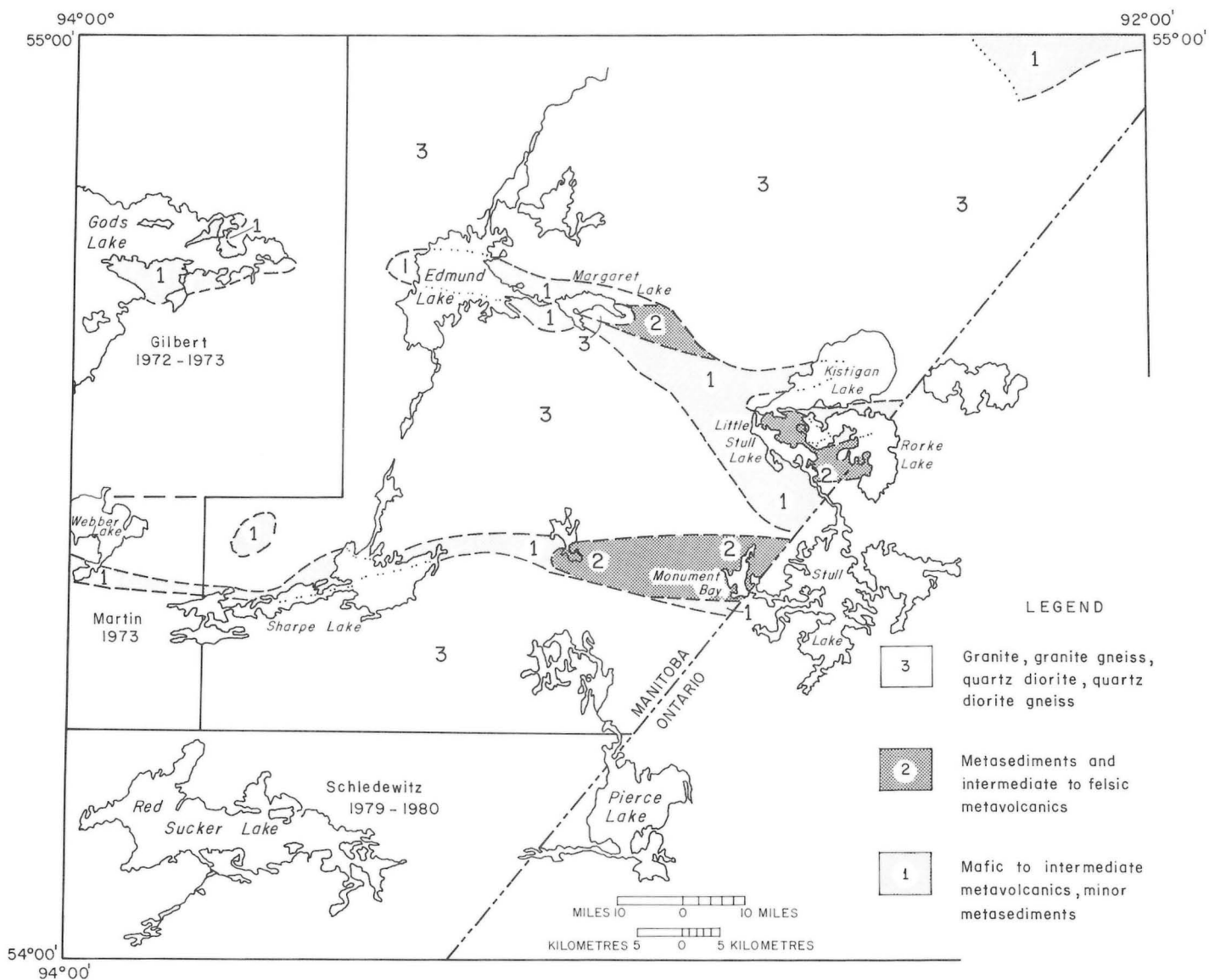


Figure GS-11-1: Distribution of major geological units in the Manitoba portion of the Stull Lake map sheet NTS 53K.

GS-12 MINERAL DEPOSIT STUDIES IN THE FLIN FLON AREA

by G.H. Gale

The 1981 field work was directed mainly towards documentation of known mineral occurrences in the Flin Flon area, map sheet 63K/13. Following the procedure established in 1980, these occurrences were mapped in detail at scales ranging from 1:100 to 1:500 as warranted. The detailed information on the individual properties is deposited in a Mineral Deposit Open File and is available upon request, consequently, only a summary of the information obtained is warranted here (see Table GS-12-1).

Gold showings were investigated in the Tartan Lake, Mikanagan Lake, Alberts Lake and Embury Lake areas and within the Cliff Lake Porphyry (Fig. GS-12-1). Two main associations are represented by these deposits (Table GS-12-1), namely: (1) in quartz veins adjacent to a gabbroic intrusive; and (2) quartz veins and silicified zones in felsic intrusions (Cliff Lake Porphyry).

Carbonitization of the hosting greenstones is a common feature of occurrence in the Mikanagan and Tartan Lake areas. In a number of the deposits, especially those in the Alberts Lake area, the quartz veins contain trace to several per cent chalcopyrite and minor pyrite and/or pyrrhotite. Several of the gold showings are associated with disseminated to solid sulphide layers.

SULPHIDE OCCURRENCES

Detailed mapping was carried out in the footwall rocks to the Flin Flon Mine, a copper showing on Embury Lake and at a number of other occurrences (Table GS-12-1).

At the Flin Flon Mine (Fig. GS-12-2) the detailed mapping revealed that the 'mill-rock' at the South Main shaft was considerably thinner than originally envisaged and in addition there is a good possibility that there is a large anticline defining the 'mill-rock' outcrop. This interpretation warrants further detailed mapping on the Saskatchewan side of the border and if correct could have a direct bearing on exploration in the immediate vicinity of the Flin Flon Mine.

Detailed mapping (1:5000) was conducted on a large area of intensive alteration on the isthmus between Embury and Manistikwan Lakes (Fig. GS-12-3). The area has undergone intensive alteration (Mg-addition, silicification, pyritization), however a preliminary interpretation of the stratigraphy was established. An overlay of previous drill holes in the area (Assessment File #90471) demonstrates the ineffectiveness of drilling without a thorough interpretation of the stratigraphy. Although the presence of a dioritic intrusion conceals the surface of exhalation over much of the strike length, it is apparent that further exploration is warranted in the area.

KIPAHIGAN LAKE AREA

A reconnaissance of this area was undertaken in order to evaluate known mineral occurrences (Pollock, 1961; 1963) and to compare the stratigraphy with that of the Kissinging Lake area. Most of the occurrences of sulphide (Figs. GS-12-4a and 4b) represent trace or minor amounts of pyrite and/or chalcopyrite (Table GS-12-1). Sulphide occurrences at the south end of the Lake include a near solid pyrrhotite layer in a graphitic mica schist (KP 9), a quartz rich layer with 5 - 10% pyrite and minor sericite that is interpreted to be a chert layer (KP 10), and a silic layer with pyrrhotite and fuchsite (KP 12) with a strike length of more than a kilometer - this is indicated as a gold occurrence (Pollock, 1961).

The general stratigraphy is similar to that in the Kissinging Lake area (Gale, 1980) and the recent forest fire in the area facilitated inspection of the contacts. In the northeast arm of Kipahigan Lake it is possible to subdivide the greywacke sequence into pelitic and psammitic subunits simply on the basis of the amounts of mobilizate present. One of the airborne electromagnetic anomalies in this area (Assessment File #90687) is located within the pelitic zone (Fig. GS12-4b).

KISSISSING LAKE AREA

Reconnaissance in the Kissinging Lake area provided additional evidence of mineralization at the same stratigraphic interval as established previously (Gale, 1980). The necessity for detailed comprehensive geological remapping of this area is exemplified by observations in the southwest corner of Moose Island where unit 6 (mapped as 'granite gneiss' by Frarey, 1961) is in part (i.e. at locality K 79), if not wholly, derived from the quartzofeldspathic sediments. On the north side of the layered amphibolite (Fig. GS-12-5) at location K 80, there are shoreline exposures of garnetiferous quartz mica schists (greywackes) that are rusty weathering and contain minor graphite and pyrite. These rocks are similar to the sulphide bearing units at Yakushavich Island and Collins Point (Gale, 1980) and indicate that this part of the Kissinging Lake area is a favourable area for sediment hosted exhalative massive sulphide deposits despite the abundance of "granitic" rocks shown on the presently available geological maps. Some of the granite rocks (e.g. unit 5 at Collins Point) are, however, massive and have intrusive relationships to the surrounding gneisses.

GEOCHEMICAL STUDIES

Disseminated copper and molybdenum in a porphyry-type setting has been proven at three centres within the Whitefish Lake Porphyry (Baldwin, 1980). One of these centres was investigated by shallow pits in the summer of 1980 and a 5 m thick zone on the edge of an overburden covered depression was uncovered. A grab sample containing chalcopyrite veins from this trench assayed up to 1.52% Cu. Other samples (M 7461 to M 7464) are chip samples that purposefully excluded any chalcopyrite veins and thus represent the minimum values for this mineralized zone (See Table GS-12-2).

During 1980 other intrusions were sampled to provide material for geochemical and petrographic analyses with the objective of establishing metal rich zones within intrusive bodies, and multi-phase intrusions that can be prospected for mineralized zones. 350 samples were collected in this reconnaissance phase of the project. All samples have been examined with an ultraviolet lamp. Major and trace elements will be determined and the results reported at a later date.

Partial chemical analyses have been determined on 150 samples from the Murray Lake and Mud Lake areas in order to document the extent of alteration associated with base metal mineralization and to characterize the nature of the alteration present in this area of extensive alteration (Area A on Fig. GS-12-1). Additional sampling has been carried out, however, the limits of the alteration have not yet been established.

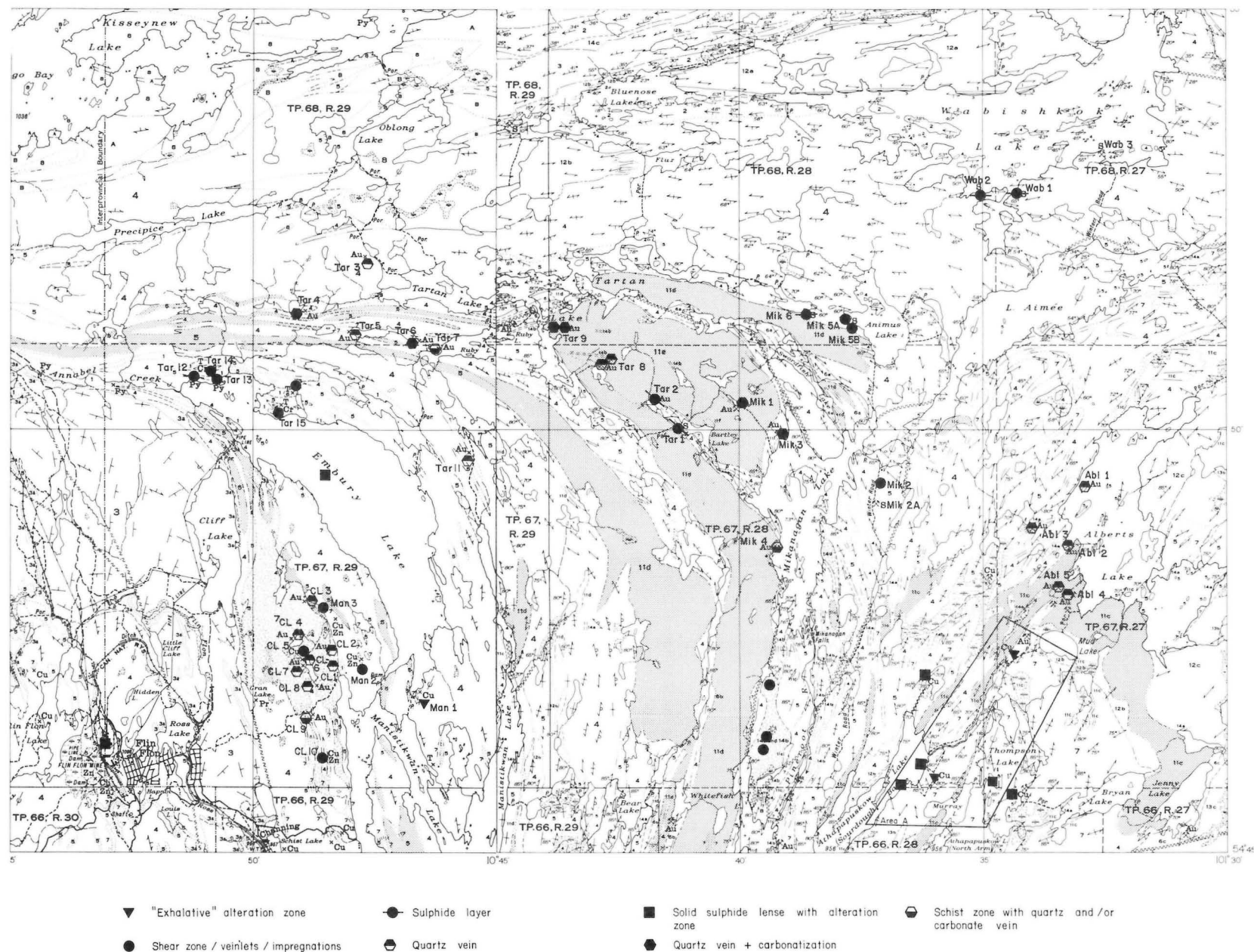


Figure GS-12-1: Classification of selected mineral occurrences in map sheet 63K/13. AbII — mineral occurrence described in Table GS-12-1 Area A — Area of detailed sampling for delineation of alteration zone associated with the Baker Patton mineral occurrence.



Figure GS-12-2: Geology of Millrock Hill, South Main Shaft area, Flin Flon. Legend: 1. Altered basaltic flow breccia; 2. Basaltic flow breccia; a) probably correlatable with 1; b) probably correlatable with 6; 3. Quartz porphyritic and basaltic rock fragments in a debris flow ('millrock'): a) less than 40% quartz porphyry fragments; b) more than 40% quartz porphyry fragments; 4. a) Massive quartz porphyry; b) massive quartz-feldspar porphyry; c) quartz porphyry flow (pyroclastic?); d) quartz porphyry pyroclastic with fragments 2 - 10 cm; e) quartz porphyry pyroclastic (tuffaceous); 5. Quartz porphyry fragmental rock with minor sulphide in matrix (may be equivalent to 4d); 6. Basaltic flow breccia and pillow lava; 7. Mafic intrusion; a) doleritic; b) boundary intrusion; 8. Fault; 9. Stratigraphic top. A. Basaltic flow unit.

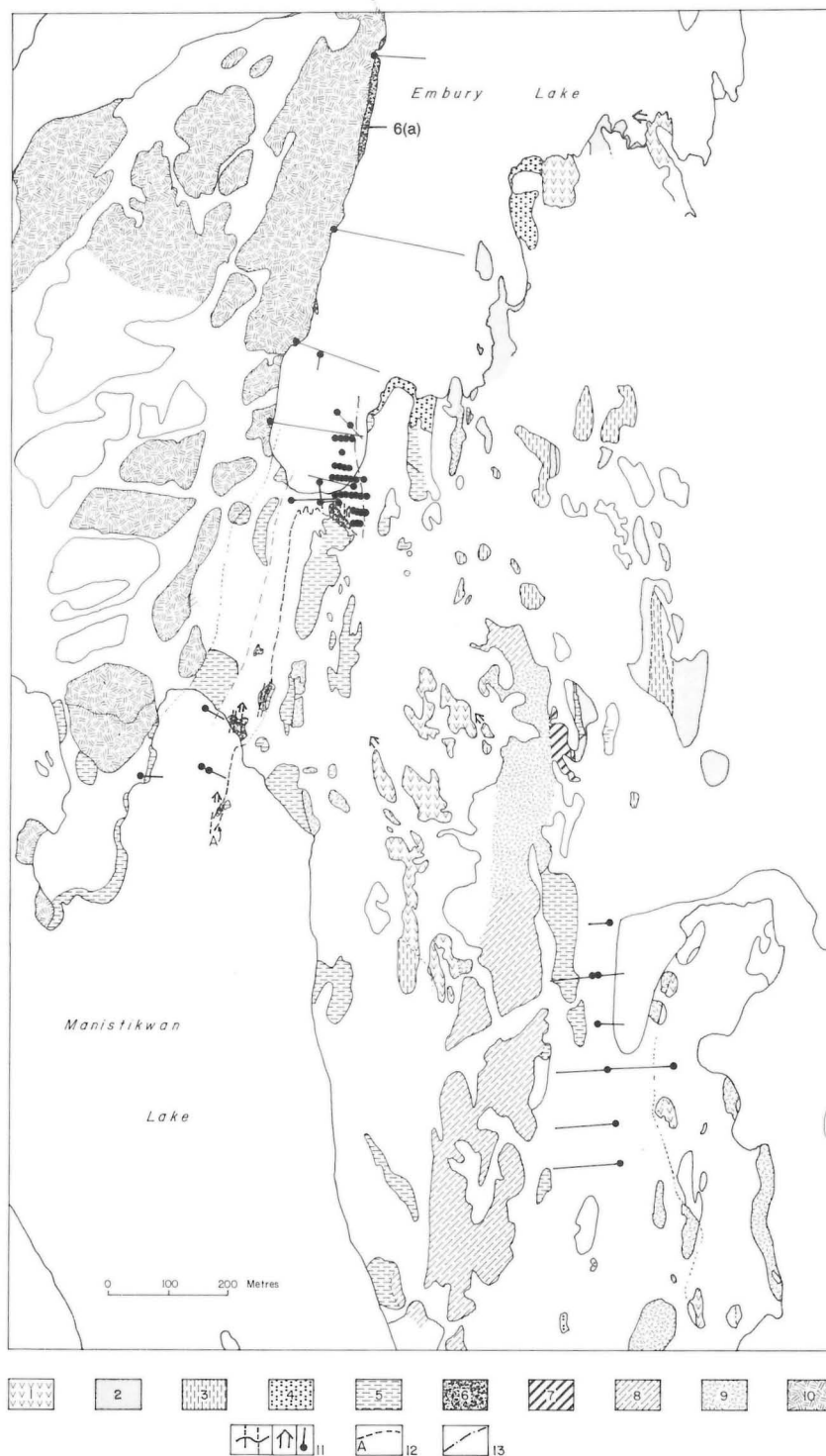


Figure GS-12-3: Preliminary geological map of the Man 1 showing, Manistikwan Lake. Geology by R. Schmidtke and G. Gale. Legend: 1. Basaltic flows, pillowed and/or vesicular; 2. Basaltic-andesitic flows and flow breccias; 3. Rhyolitic rocks: flows and volcaniclastic breccias; 4. Rhyolitic flows with weak alteration; 5. Rhyolitic rocks, hydrothermally altered with addition of magnesium, iron, sulphur and copper; 6. Sedimentary rocks, sandstone, grits, conglomerate; well developed graded beds; contains clastic sulphide fragments; 6(a) sedimentary rocks with pyrite, pyrrhotite and graphite layers; 7. Silicic feldspar porphyry intrusion; 8. Quartz-feldspar porphyry with blocks of rhyolite; 9. Intermediate intrusion; 10. Gabbro, medium grained; 11. Sedimentary layering (solid line) with axial plane cleavage (dashed line); Arrow indicates direction of stratigraphic younging. Diamond drill hole location from cancelled assessment file 90471; 12. Stratigraphic top of alteration zone; 13. Fault zone.

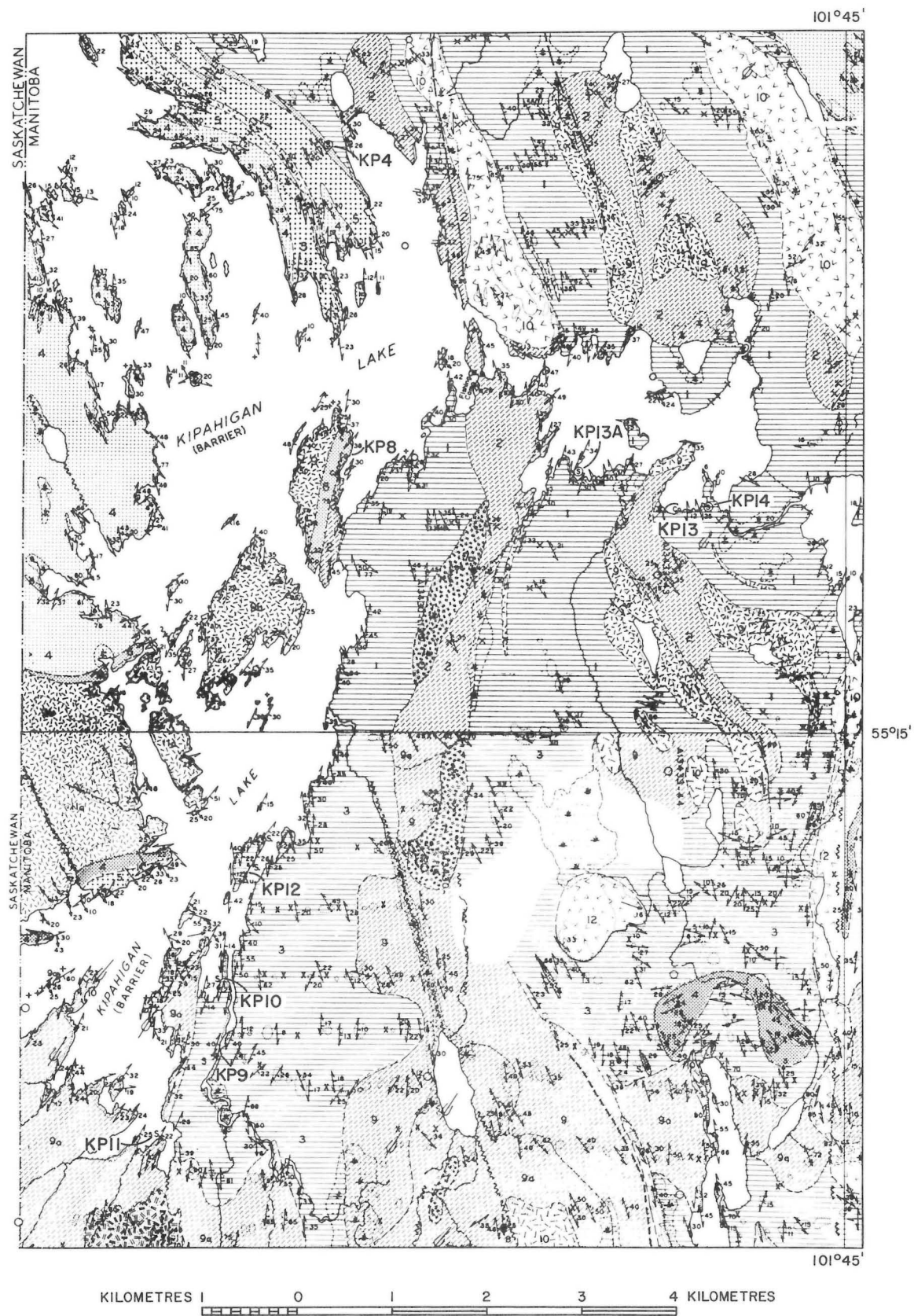


Figure GS-12-4a: Mineral occurrences in the southern part of Kipahigan Lake (Parts of 63N/4 and 63N/5), Geology base after Pollock (1961, 1963). KP4-mineral occurrence described in Table GS-12-1.

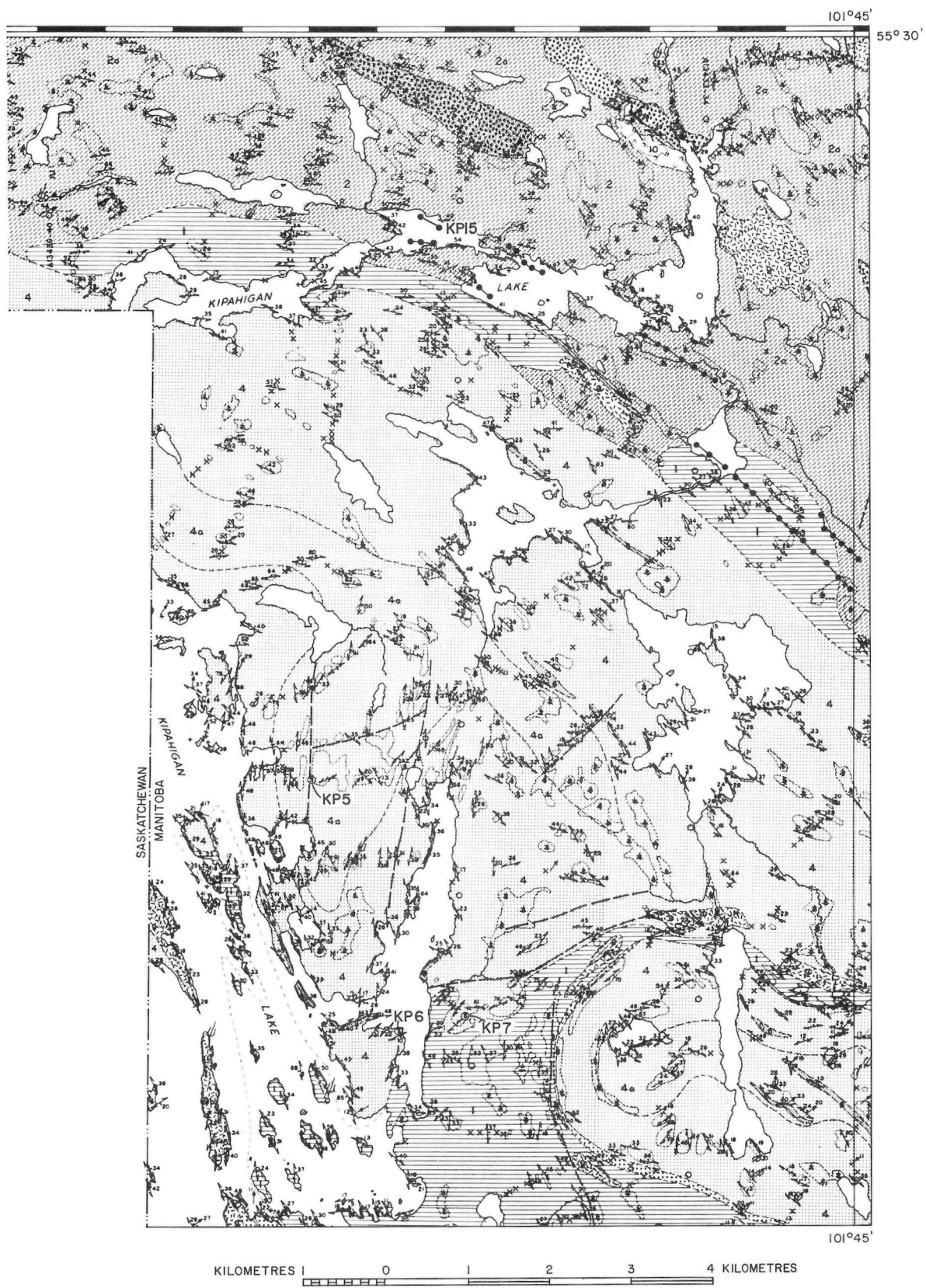


Figure GS-12-4b: Mineral occurrences in the northern part of Kipahigan Lake (Part of 63N/5). Geology base after Pollock (1963).

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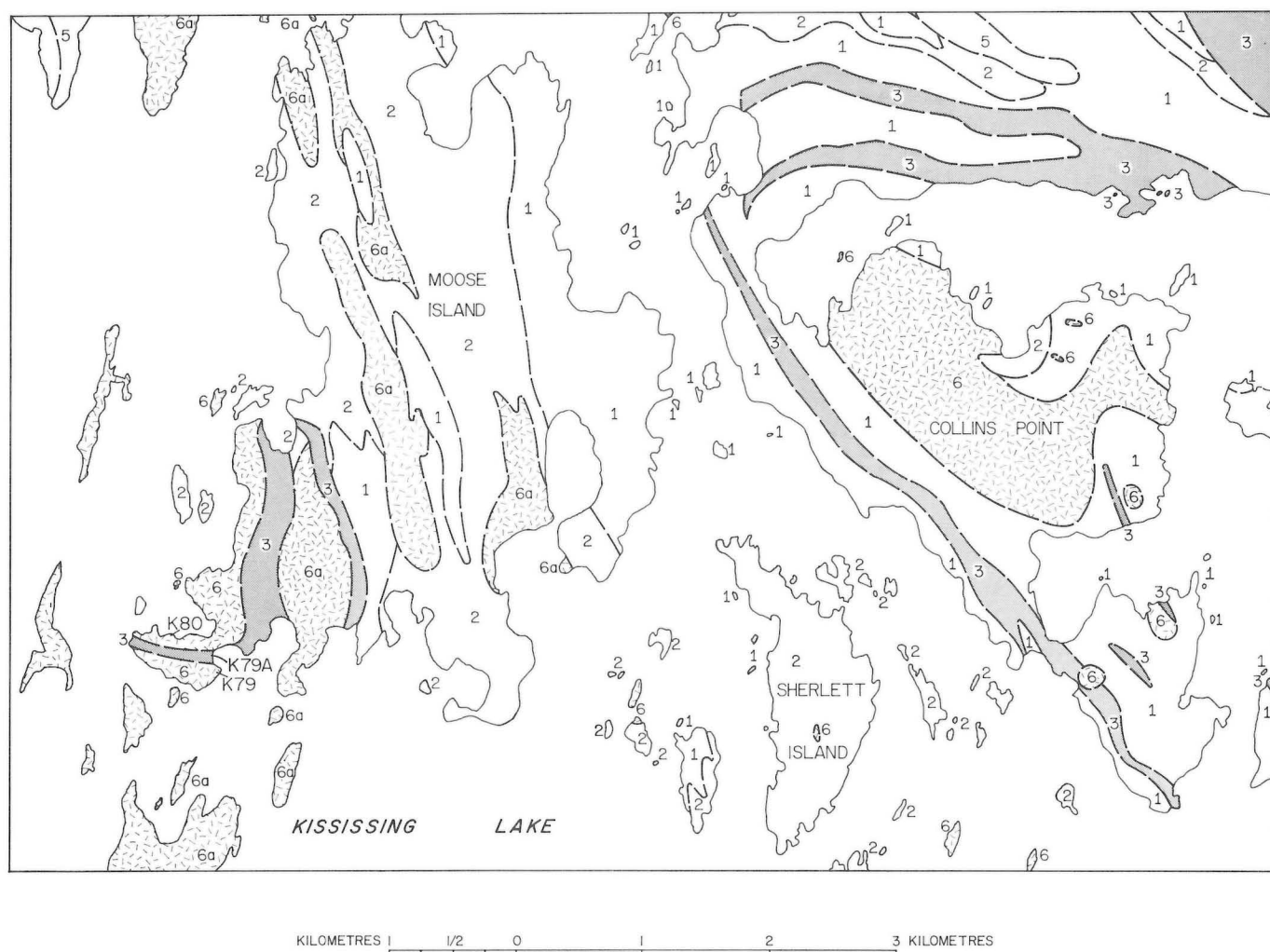


Figure GS-12-5: Geology of the Moose Island - Collins Point area, Kissinging Lake (After Frarey, 1961). Legend: 1. Quartz-plagioclase-biotite paragneiss; 2. Mixed sedimentary gneiss and narrow lit-par-lit granitic injections; 3. Amphibolite gneiss; 5. Granitoid oligoclase-quartz gneiss; 6. Granite, granite gneiss, pegmatite, 6a. Oligoclase granite. K79 - Station location.

TABLE GS-12-1
Summary of Mineral Occurrences Investigated in the Flin Flon Area (63K/13)

Locality Tartan	Type of Occurrence	Nature of Mineralization	Host Rocks	Thickness	Reference
TAR 1	Trenches: (5 x 1 x 0.5m), (2 x 1 x 0.5 m)	Disseminated Po and Py in a cherty sedimentary layer; trace Py in enclosing andesitic schists.	Andesitic schists, layered; intruded by fine to medium grained gabbro.	0.40 m	Bateman and Harrison (1945)
TAR 2	Trenches: (20 x 2 x 2 m), (10 x 2.5 x 2.5 m)	0.25 m of solid sulphide (Py); 10-30% Py as veinlets and disseminations in sulphide-bearing layer. 2 m thick sulphide-bearing silica-rich layer is composed of several sulphide-rich and several quartz-rich layers. Minor mobilization due to intrusion of gabbro into sulphide layer. Fragment of a sulphide layer enclosed by the gabbroic intrusion.	Greenstone, in part layered, now leached and oxidized. Intruded by gabbro.	2 m	
TAR 3	Trenches: (8 x 3 x 2.5 m), (2 x 2 x 2 m), Three old drill holes located.	0.60 m white quartz vein in quartz chlorite schist zone with trace Py.	Schistose andesitic volcanic rocks, minor pillow lava, several small gabbroic dikes.	0.60 m	Tanton (1941)
TAR 4	Trenches: (4 x 1 x 0.5 m), (5 x 1 x 0.5 m); old drill core at burnt cabin site.	Quartz veinlets in quartz-feldspar sericite schists; minor carbonate veining and dissemination in drill core.	Layered mafic and felsic tuffaceous and sedimentary rocks.	4 - 5 m?	Tanton (1941)
TAR 5	Trench(?) (3 x 2 x 2 m) on edge of cliffs; 25 cm thick rusty weathering layer near shoreline.	Trace Py and quartz (5 cm) in chloritic and schistose volcanic rocks, Rusty weathering sulphide zone. Contains minor (10-15%) Py.	Schistose mafic volcanic rocks intruded by a quartz-feldspar porphyry.	?	
TAR 6	Trenches: (2 x 4 x 1 m), (4 x 1 x 1 m), (2.5 x 1 x 0.5 m); and pit (2 x 3 x 2.5 m)	Minor Py in rusty weathering schistose zone with trace Mariposite in trenches; mariposite bearing quartz-carbonate-sericite schists with quartz veinlets (1 cm) in pit.	Massive and foliated greenstone.	3 m	
TAR 7	Trench: (4 x 1.5 x 1 m)	Quartz and carbonate veinlets in chloritic greenstone; trace arsenopyrite.	Massive and schistose greenstone intruded by a quartz-feldspar porphyry.	1 m	
TAR 8	Trenches: (3 x 1 x 1 m), (2 x 1.5 x 1 m) (1.5 x 1.5 x 0.5 m), (12 x 1.5 x 1 m); (6 x 0.5 x 1 m), (10 x 1.5 x 0.5 m).	Quartz veins ± carbonate.	Layered tuffaceous andesitic rocks intruded by medium to coarse grained gabbro.	0.1 - 0.5 m	
TAR 9	Trenches: (6 x 1 x 1 m), (10 x 3 x 1.5 m), (5 x 3 x 2 m), (5 x 2 x 1.5 m), (12 x 2 x 2 m), (6 x 1.5 x 1 m), (8 x 2 x 1.5 m), (4 x 2 x 1 m); and drill core.	Quartz and carbonate veins in carbonatized and sericitic quartz chlorite schists.	Greenschists inclusion within medium grained gabbroic intrusion.	1 - 10 m	
TAR 10	Trench: (not observed)	Gold bearing veins and lenses of quartz and ferruginous carbonate occur in greenstone schists (Tanton, 1941).	Greenstone and greenschists of probable tuffaceous origin; this occurrence may be the along strike continuation of Tar 9.		Trench located by A. O'Donnell
TAR 11	Trench: (not observed)	"Gold bearing quartz veins in porphyritic quartz diorite" (Tanton, 1941).	Gabbro, medium grained with widely scattered quartz veins.		Tanton (1941)

TAR 12	Trench: (10 x 3 x 2 m); and outcrop.	Minor Py in a quartz-anthophyllite-chlorite $\pm$ sericite schist layer. Exhalative sediment?	Mafic and felsic tuff and greywacke; ultramafic dyke or lava adjacent to sulphide-bearing layer.	2 m	
TAR 13	Outcrop.	Trace pyrite and carbonate in quartz-sericite schist zone.	Greenschist inclusions in gabbroic and dioritic intrusions.	2 m	
TAR 14	Outcrop.	Minor talc and chromite in veinlets and lenses.	Serpentine and peridotite.		
TAR 15	Outcrop; trench (15 x 3 x 0.5 m)	Scattered talc veins (15 cm thick) and chromite disseminations.	Serpentine.		
TAR 16	Outcrop; trench (5 x 1 x 0.25 m)	Veins and lenses of talc scattered throughout the ultramafic rock.	Serpentine and peridotite.		
Mikanagan					
MIK 1	Shaft: (2 x 2 x 4-5 m); outcrop; and old drill core.	Quartz vein is carbonatized greenschist.	Greenschist adjacent to medium grained gabbro.	0.40 m	
MIK 2	Trenches: (4 x 2 x 1.5 m); (6 x 2 x 1 m); (5 x 3 x 1.5 m); and outcrop.	Quartz and Py (10%) vein with trace Cp along margin of quartz-feldspar hornblende porphyry.	Greenstone, massive quartz-feldspar-hornblende porphyry intrusion.	0.25 - 0.40 m	
MIK 2a	Trench (not located).				Bateman and Harrison (1945)
MIK 3	Trenches: (2 x 2 x 1 m), (2 x 3 x 1 m); and outcrop.	Quartz vein in carbonatized greenschist.	Schistose greenstone with minor carbonate.	0.60 m	
MIK 4	Outcrop, trench not located.	Carbonatized greenschists.	Greenschist overlain by medium grained gabbro.	30 m	
MIK 5a	Trenches: (1 x 1 x 0.5 m), (2 x 1 x 1 m); and outcrop.	Disseminated Cp schistose basalt.	Basaltic lavas and small gabbroic dikes.	0.30 m	
MIK 5b	Trenches: (4 x 1 x 0.5 m), (2 x 2 x 2 m), (4 x 1 x 0.5 m)	Solid Py, Po; cherty Py, and disseminated Cp in greenschists adjacent to gabbro contact.	Greenschists intruded by fine- to medium-grained gabbro.		
MIK 6	Trench: (12 x 3 x 1.5 m)	Near solid Py, vein quartz, quartz-sericite-pyrite and black shale - pyrite blocks in rubble - largest block of solid sulphide is 30 cm in diameter	Basaltic lavas, massive.	?	
Wabishkok					
WAB 1	Trench: (3 x 3.5 x 2 m); and outcrop.	10-30% Py in silicic sedimentary rocks, 30% Py in 15 cm thick graphitic schists.	Greenschist, layered.	2 m	
WAB 2	Trench: (2 x 1 x 1.5 m)	10% Py in mafic schists, minor quartz mobilize.	Greenschist, layered.	2 m	
WAB 3	Outcrop, extensive (Trench not located)		Gabbro, medium grained		Bateman and Harrison (1945)
Cliff Lake					
CL 1	Trenches: (60 x 1 x 1 m), (10 x 2 x 1 m) and outcrop.	Quartz vein with minor Py, trace Cp. Hematite and chlorite alteration.	Quartz-feldspar porphyry.	0.10 - 0.30 m	
CL 2	Trenches: (15 x 1 x 0.5 m), (5 x 1 x 1 m), (5 x 1 x 1 m); and outcrop.	Quartz vein.	Quartz-feldspar porphyry.	0.40 m	
CL 3	Trench: (4 x 1 x 0.5 m) and outcrop.	Quartz vein with trace Py and Cp, minor carbonate.	Quartz-feldspar porphyry.	0.30 m	
CL 4	Trenches: (10 x 2 x 1 m), (9 x 2 x 1 m), and outcrop.	20 cm quartz vein, sheared and chloritic fine grained reddish coloured porphyry, 15 cm shear zone with quartz, chlorite and 30% Py.	Quartz-feldspar porphyry.	10 - 15 m	

CL 5	Trenches: (7 x 1 x 1 m), (4 x 1 x 1 m), (7 x 1 x 0.5 m)	Trace Cp in 30 cm quartz vein and in fine grained granitic intrusions; scattered 1 cm thick Py stringers.	Quartz-feldspar porphyry.	
CL 6	Trenches: (4 x 1 x 0.5 m), (2 x 1 x 0.5 m); and outcrop.	Quartz vein with trace Cp.	Quartz-feldspar porphyry.	0.30 m
CL 7	Trenches: (15 x 1 x 0.30 m), (4 x 2 x 1 m); and outcrop.	15 - 40 cm quartz vein and a 3 x 2 m greenstone xenolith with minor Cp and Mt.	Quartz-feldspar porphyry.	
CL 8	Trench: (2 x 1 x 1.5 m); and outcrop.	Silicified contact zone.	Quartz-feldspar porphyry and fine grained diorite.	0.15 m
CL 9	Trench: (5 x 2 x 1 m); and outcrop.	30 cm quartz veins in a quartz-sericite schist zone with minor Py.	Basaltic lavas.	
CL 10	Trenches: (5 x 1 x 0.5 m), (4 x 1 x 0.5 m), (2 x 1 x 1 m); and outcrop.	10-20% Py, trace Cp and Sp in veins adjacent to intrusion.	Basaltic lava, felsic volcaniclastic rock, quartz-eye rhyolite and diorite.	0.50 m
Alberts				
ABL 1	Trench: (5 x 2 x 0.3 m)	Quartz vein.	Quartz-feldspar porphyry intrusion and mafic volcanic schists.	2 m
ABL 2	Trench: (4 x 1 x 0.3 m); and outcrop.	Feldspar porphyry with quartz veins and minor Py.	Greenschists and gabbro.	
ABL 3	Trenches: (5 x 2 x 1.5 m), (12 x 1 x 0.5 m), (2 x 2 x 1 m); and outcrop.	Quartz veins with minor Py and Cp. Disseminated Po and Cp in a 4 - 5 m thick feldspar porphyry.	Quartz-feldspar porphyry intrusion.	0.20 - 0.60 m
ABL 4	Trenches: (2 x 1 x 2 m), (1 x 1 x 0.5 m)	Quartz vein with minor Py.	Gabbro, medium grained.	1 m
ABL 5	Trenches: (12 trenches over a strike length of 150 m).	Quartz vein.	Gabbro, medium grained Sheared adjacent to quartz vein.	0.25 - 1 m
ABL 6	Trenches: (1.5 x 1 x 0.50 m), (2 x 1 x 0.5 m), (5 x 2 x 1 m), (8 x 1 x 1 m).	Quartz vein in sheared volcanic rock.	Gabbro	0.5 - 1.5 m
Manistikwan				
MAN 1	Outcrop, extensive; several trenches; drill records	Extensive area of felsic volcanic rocks with disseminations and veinlets of pyrite and chalcopyrite; locally small centres with vein network of magnesium alteration.	Basaltic and rhyolitic flow rocks, felsic pyroclastic rocks and volcanogenic conglomeratic sediments. Minor structures indicate the fold and the mineralization face northwards on the axial plane cleavage.	
MAN 2	Trenches: (2 x 0.5 x 0.3 m), (1 x 0.5 x 0.25 m), (13 x 1 x 2 m).	Py (10-20%) bearing quartz-sericite-chlorite schist zone cuts across stratigraphy.	Andesitic to basaltic schists with disseminated Py. Basaltic pillow lava.	Old drill setup in area.
MAN 3	Trench (not located).	Veins and impregnations of Py and traces of Cp scattered over area of several hundred metres square, ? alteration zone ?	Basaltic pillow lavas.	
KIPAHIGAN				
KP 4	Outcrop.	Trace Cp in garnet-hornblende lenses.	Amphibolite.	Pollock (1963)
KP 5	Outcrop.	Small lenses of rusty weathering gneisses several tens of cms in diameter associated with a feldspar-biotite pegmatite.	Quartzofeldspathic gneiss.	Pollock (1963)
KP 6	Outcrop.	Wisps and lenses (several tens of cms in diameter) of rusty weathering (pyritic) gneiss.	Quartz-feldspar-biotite-garnet gneiss.	Pollock (1963)
KP 7	Outcrop	Widely scattered Cp disseminations.	Near contact between quartzofeldspathic gneiss and garnetiferous psammite.	Pollock (1963)

KP 8	Outcrop.	Cp + Po veinlet and rusty weathering associated with quartz mobilize.	Hornblende-rich greywacke.		Pollock (1963)
KP 9	Trenches: (9 x 2 x 2.5 m), (6 x 0.5 x 0.5 m); and outcrop.	30% to near solid Po in silicic layer within graphitic sediments.	Quartz-feldspar-biotite-graphite schists.	0.70 m	Pollock (1963)
KP 10	Outcrop.	5-10% Py in a layered quartzitic rock with minor sericite. Probably a cherty sediment.		1.5 m	
KP 11	Outcrop.	Minor Py and Po (3-5%), trace graphite and fuchsite in inter-layered quartz-rich pelitic layers.	Psammite.	4 m	Pollock (1961)
KP 12	Outcrop.	Minor Po and Py, trace fuchsite in a 10-20 cm thick quartz-biotite layer. Trace Po in silicic sediments (chert?)	Quartz-feldspar-biotite gneiss.	0.80 m	Pollock (1961)
KP 13a	Outcrop.	No sulphide located.	Psammite.		
KP 13	Outcrop	No Cp located.	Grey psammite with scattered semipelitic and pelitic layers.		Pollock (1963)
KP 14	Outcrop.	No sulphide located. Trace graphite present in 1-30 cm pelitic layers.	Biotitic psammite.		Pollock (1963)

TABLE GS-12-2

Laboratory No.	Sample Identification	Gold ounces per ton	Silver ounces per ton	Cu %	Mo %	Sample Weight in lbs.
M 7457	42-0-WF1	0.01	—	0.04	nil	1 ½
M 7458	42-0-WF2	0.01	—	0.44	nil	2
M 7459	42-0-WF3	tr	—	0.20	nil	1
M 7460	42-0-WF(pyrite)	tr	—	0.74	nil	2 ¾
M 7461	42-0-WF(0-2m)	tr	—	0.37	nil	3 ¼
M 7462	42-0-WF(2-3m)	tr	—	0.27	nil	4 ¾
M 7463	42-0-WF(3-4m)	tr	—	0.51	nil	4 ¾
M 7464	42-0-WF(4-5m)	tr	—	0.36	nil	4 ¼
M 7465	42-0-WF(high grade)	tr	—	1.52	nil	4

GS-13 MINERAL DEPOSIT STUDIES IN PHANEROZOIC ROCKS OF SOUTHERN MANITOBA

by G.H. Gale, E. Nielsen and H.R. McCabe

INTRODUCTION

A galena pebble discovered on Doan's farm in the vicinity of Balmoral yielded lead isotopes, indicating a Phanerozoic source for the galena (McCabe, 1969). Several exploration companies, in searching for the source of this pebble, have carried out investigations that include examining fields and rock piles for mineralized boulders, analyses of oilwell cuttings by XRF, and geochemical surveys of soils. The results of these programs do not appear to have been encouraging.

In order to establish whether the galena pebble has a Manitoba source, a multi-discipline project is being undertaken. The first year's activities have included:

- 1) analysis of the Pleistocene geology in the vicinity of the galena pebble find;
- 2) heavy mineral study of glacial tills from the Balmoral area;
- 3) examination of base metal contents of Phanerozoic drill core.

STRATIGRAPHY OF THE SURFICIAL DEPOSITS

In October, 1980, 61 backhoe pits were put down in a 36 km² area around Balmoral (Fig. GS-13-1). The backhoe pits ranged in depth from less than 1 m, where hard till was intersected near the surface, to a maximum of 6 m. As the average thickness of overburden for most of the area sampled is about 7 m, the bottom of the backhoe pits was close to the rock interface.

Four distinct stratigraphic units were recognized in the backhoe pits: basal till, waterlain till, stony lake clay and Lake Agassiz sand and silt. The lowest unit is a hard compact pinkish grey (5YR 8/1) till, which was encountered at the bottom of 41 holes (Fig. GS-13-2). The thickness of this till is not known, however, it probably directly overlies bedrock through most of the area. The hard till is homogeneous and generally displays the characteristics of till deposited by basal lodgement.

A thin sand or sand and gravel bed, generally less than 10 cm thick, was found overlying the hard till in a number of pits. Over-

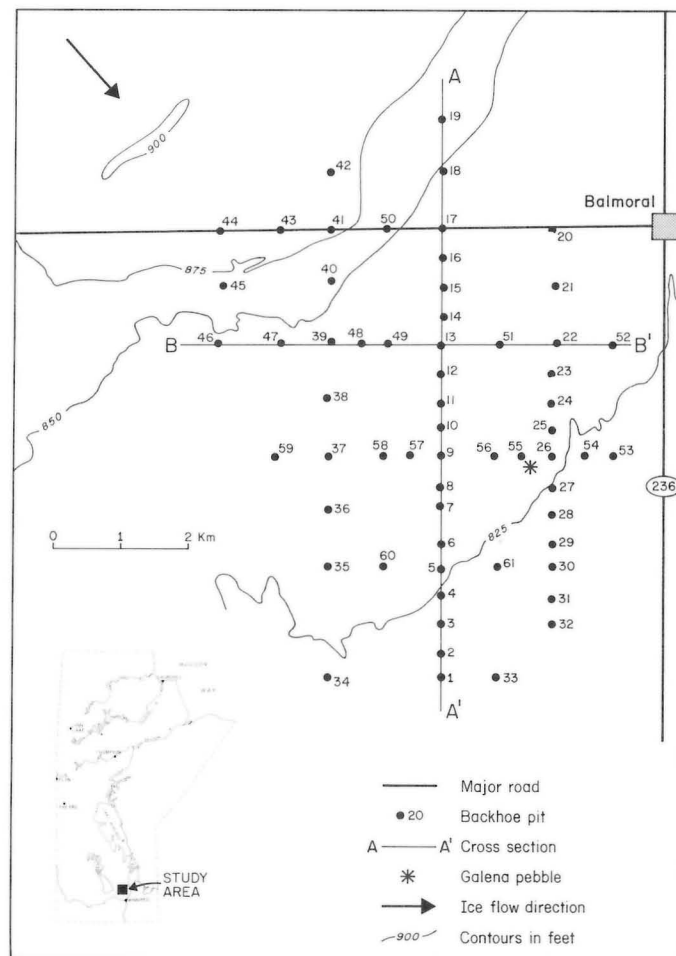


Figure GS-13-1: Geographic location of samples collected in the Balmoral area.

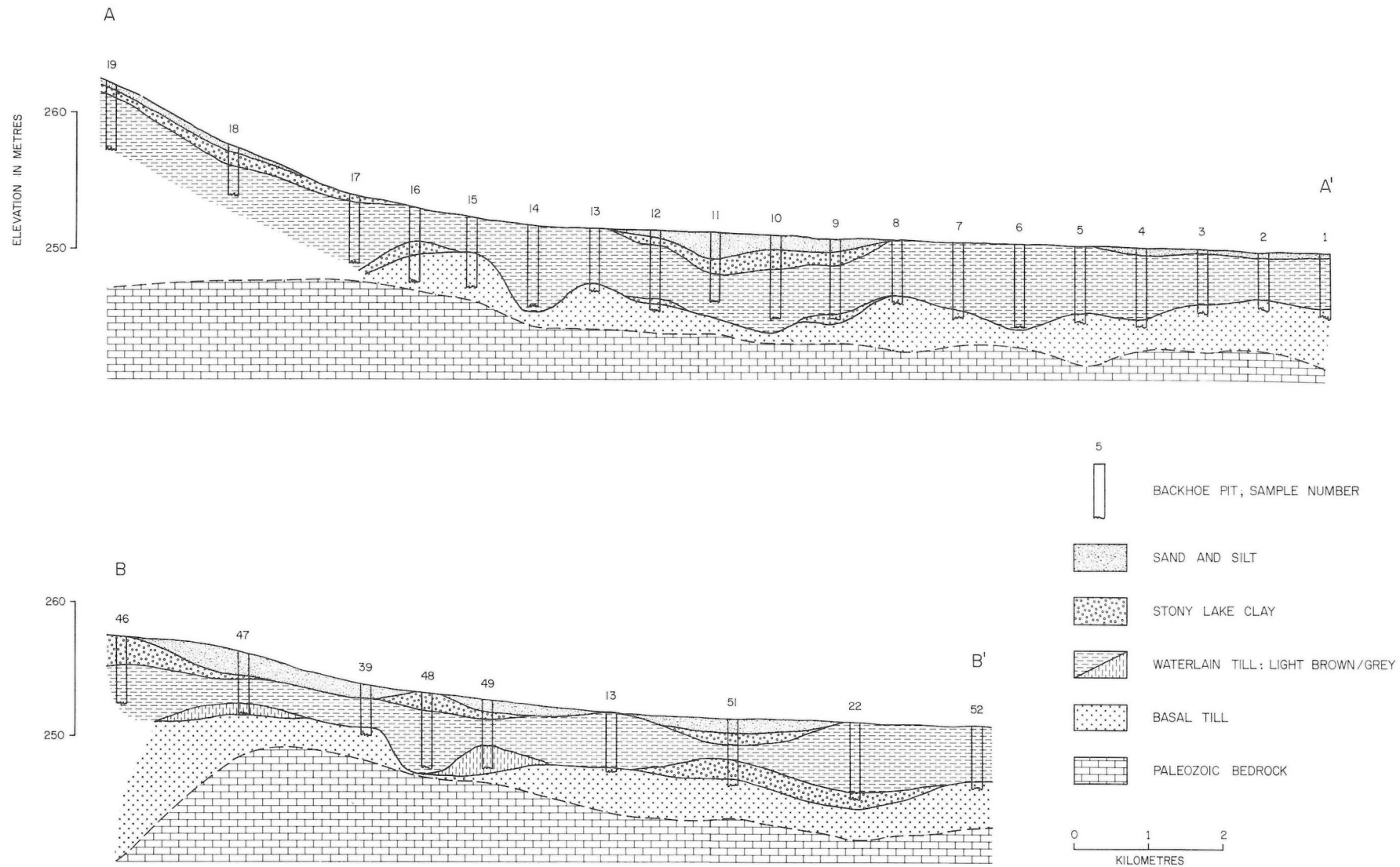


Figure GS-13-2: Stratigraphic cross-sections of surficial deposits in the Balmoral area.

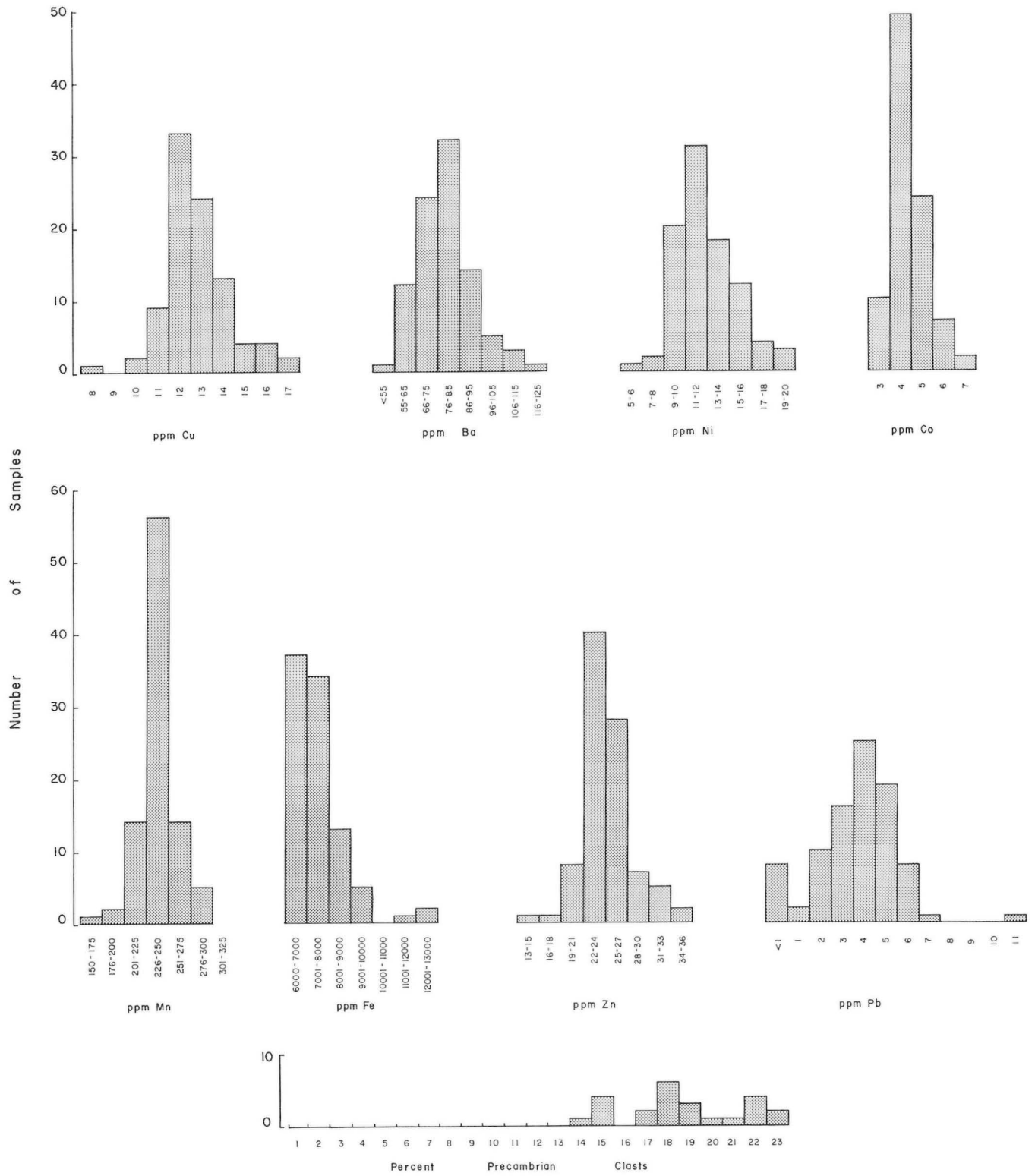


Figure GS-13-3: Histograms of trace element concentrations in the minus 250 micron fractions and Precambrian rock content of the 4-16 mm size clast fractions from samples indicated on Figure GS-13-1.

lying this bed or directly overlying the basal till is a thick unit of uncompacted till with clay interbeds. It was from this unit that the galena pebble was recovered. The thickest and most widely distributed facies of this unit is usually pinkish grey (5YR 8/1), and locally light blue grey (5B 7/1) in colour. It exhibits the same properties as the basal till except that it is soft and interbedded with clay laminae approximately a centimetre thick. In some pits the clay interbeds are absent and the till more compacted, making it difficult to differentiate from the underlying basal till. The clay interbeds indicate that deposition of the till was cyclic and interrupted by deep basin, lacustrine sedimentation. The unit is interpreted to be waterlain till deposited by icebergs in glacial Lake Agassiz, proximal to a retreating ice front.

The waterlain till is overlain and in places also underlain, by a soft massive olive grey (5Y 4/1) clay with dropstones. This is also interpreted as an iceberg deposit but the colour suggests it was deposited distal to the ice front, thereby incorporating more deep basinal clay. Shallow water sand and silt deposits of Lake Agassiz are widely distributed at the surface throughout the area.

Grain size analysis and pebble counts have been carried out on 24 selected samples and trace element geochemistry has been completed on the less than 63 micron fraction of all 92 samples. The samples were analyzed for Cu, Pb, Zn, Fe, Mn, Co, Ni, and Ba. Results of the geochemical analysis are shown in Figure GS-13-3. Although a geochemical anomaly is not apparent, the lead content is slightly higher in the Balmoral samples than in samples from the Gypsumville area (Fig. GS-13-4) which is directly up ice from Balmoral (Nielsen, 1978). Although part of this variation is the result of textural differences in the less than 250 mesh fraction (Fig. GS-13-5) the Precambrian clast content of the two areas is also markedly different (Fig. GS-13-4). These unexplained variations in the data indicate that the ice flow patterns and the provenance of glacially transported material in the Interlake are still poorly understood.

HEAVY MINERAL STUDIES OF GLACIAL TILL SAMPLES

If the galena pebble found at Balmoral had a source in Manitoba then there should be other erratics in the glacial deposits. This aspect of the program is designed, not to find a deposit, but to identify a likely source area by determining if a glacial dispersion fan exists in order to facilitate exploration for Pb-Zn deposits in the carbonate rocks of this Province.

Till samples from the Balmoral area were disaggregated and sieved. The sand sized portions (less than 1 mm) of 50 samples were used to obtain a heavy mineral concentrate on a shaker table at the University of Manitoba. The material will be examined microscopically and geochemically and the results reported at a later date.

Till samples collected in 1981 as part of Pleistocene studies in the Interlake district will also be processed for their heavy mineral contents.

BASE METAL CONTENTS OF PHANEROZOIC DRILL CORE

Several grains of sphalerite were noted in Devonian Upper Winnipegosis beds in drill core M-6-80. In order to determine which segments of Phanerozoic rocks may be potential host rocks for lead and zinc, selected drill cores are being sampled and analyzed for Pb, Zn, Cu and Mn. Other elements are to be analyzed in the near future. Five drill holes (Fig. GS-13-6) have been sampled by sawing a thin slab from each piece of core over a 30 cm interval throughout the drill hole. Lead values of up to 25 ppm were obtained relative to background values of less than 1 ppm. In addition, a preliminary investigation of the data indicates a depletion in manganese in some sections. The data are currently being assessed and the significance of the 'anomalies', which could be due solely to lithological changes, will be reported in November, 1981.

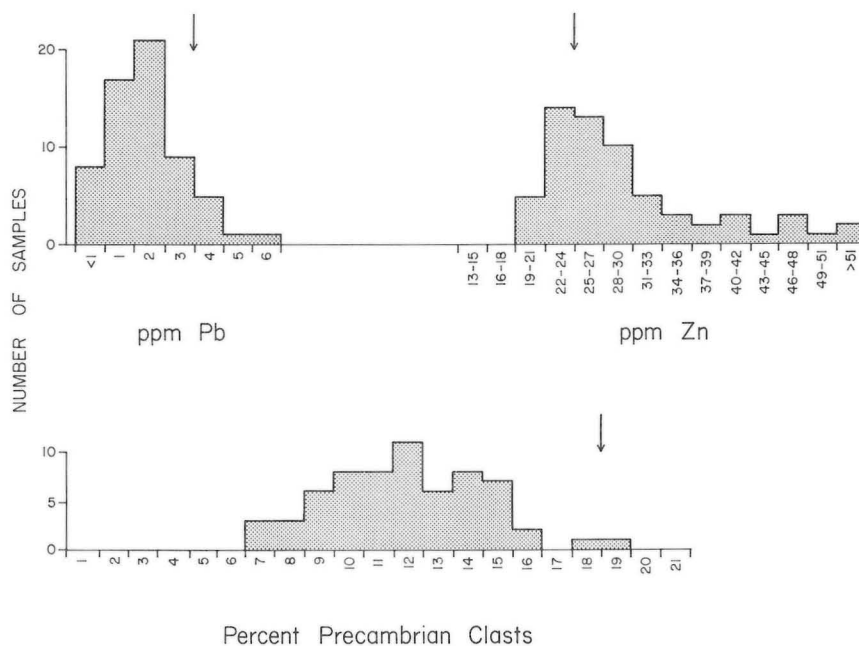


Figure GS-13-4: Histograms of trace element concentrations in the minus 250 micron fractions and Precambrian clast content of the 4-16 mm size fractions from samples collected in the Gypsumville area. The corresponding means for the Balmoral samples are indicated by arrows.

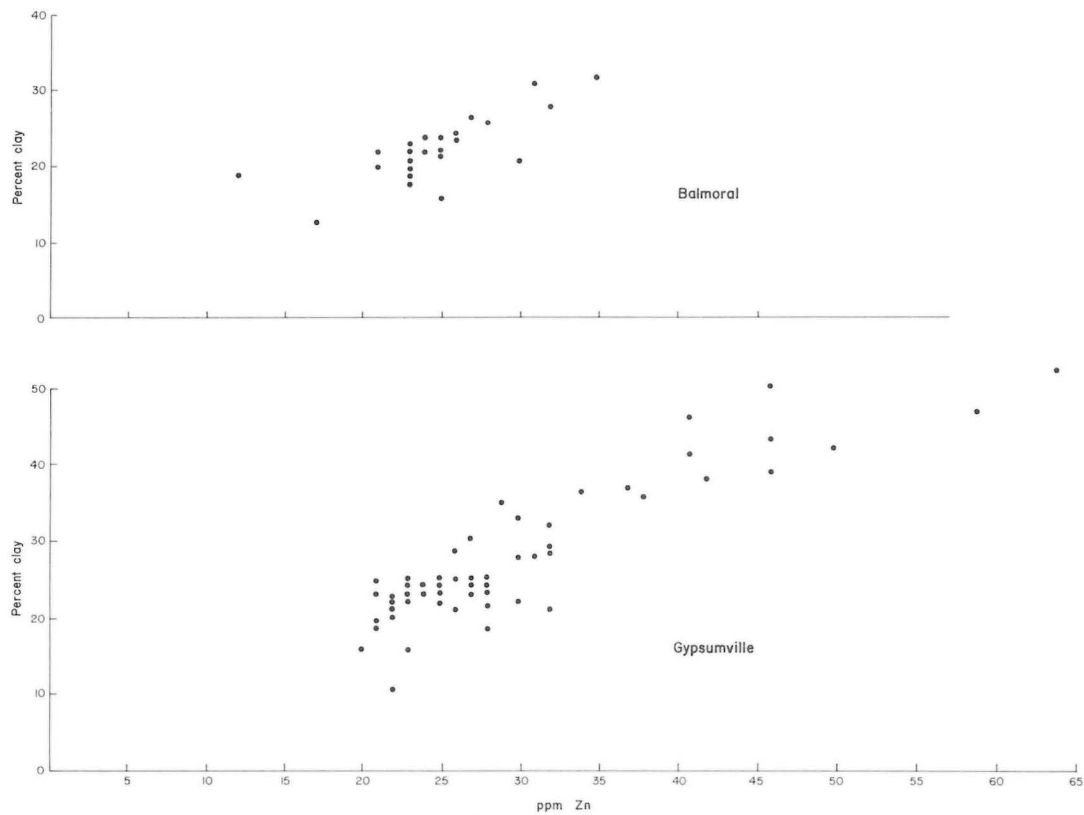


Figure GS-13-5: Relationship between clay contents and concentrations of trace elements in till samples from Balmoral and Gypsumville areas.

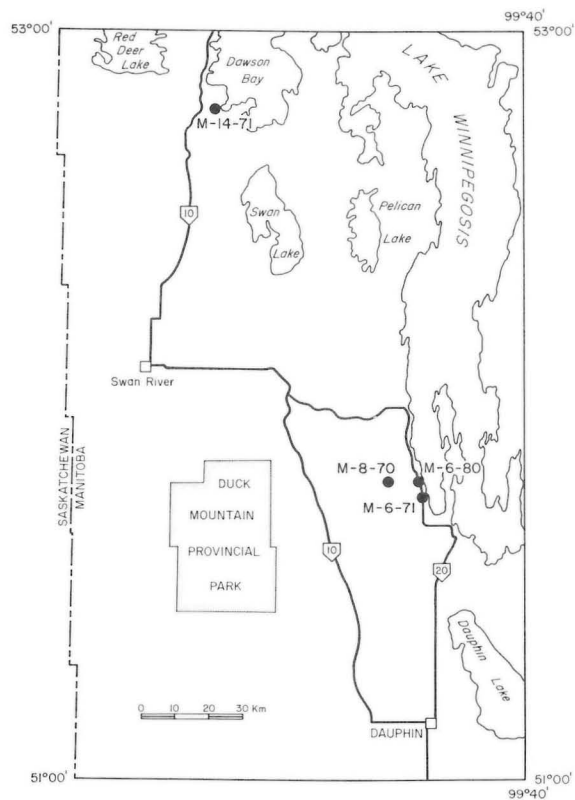


Figure GS-13-6: Location of diamond drill cores analyzed for base metal contents of Paleozoic rocks.

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GS-14 RUTTAN LAKE, KARSAKUWIGAMAK LAKE, *MUSKAYK LAKE PROJECT

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

by D.A. Baldwin

A twelve-week geological mapping program was conducted in felsic volcanic rocks of the Karsakuwigamak Block to refine earlier maps (Baldwin, 1979, 1980). The main thrust of the investigation was to delineate stratigraphy, morphology of flow units and the relationship between felsic volcanic flow rocks and derived volcaniclastic rocks. Five areas within the Karsakuwigamak Block were selected for detail investigation at 1:1200 scale. Flow units were sampled for the analysis of chemical and textural variations both within the flow units and across different flow units.

The felsic volcanic rocks in the Karsakuwigamak Block (Unit 3; Baldwin, 1980) comprise rhyolite flows, pyroclastic deposits and derived volcaniclastic rocks.

Internal structures in the pyroclastic deposits interpreted to be pumice, fiamme, lithic fragments and accretionary lapilli indicate that the felsic volcanism in the area was subaerial and that the associated deposits consist mainly of ash flow tuff (ignimbrite) and air fall tuff. The presence of spherulites, representing devitrification of dense volcanic glasses, indicates that the ash flow tuffs are welded. In addition, debris flows have been identified on the basis of their bedding characteristics, clast types and the ratio of matrix to clasts.

Etched slabs and thin sections will be examined in the near future to document the microscopic features of the felsic volcanic rocks and verify the identification of fiamme, accretionary lapilli, pumice, spherulites and other textural features. A re-evaluation of field data will result in a refinement to the geological map (Baldwin, 1980, Maps 1980 R-1 and 1980 R-2).

Following the re-evaluation of field data and the compilation of laboratory data the geological map will be revised and a report prepared detailing the geology and depositional environments in the Ruttan Lake, Karsakuwigamak Lake, Muskyak Lake area.

A report on the mineralization in the Ruttan Lake, Karsakuwigamak Lake, Muskayk Lake area is near completion and release of the publication is expected in the near future.

Future undertakings in this project will be concentrated in the Lynn Lake greenstone belt. The emphasis of the program will be on a detailed investigation and documentation of mineral deposits.

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*Muskayk Lake in previous reports on this project (Baldwin, 1978, 1979, 1980) was called Eagle Lake.

GS-15 MINERAL DEPOSIT STUDIES

SUPERIOR PROVINCE - SOUTHEASTERN MANITOBA

by M.A.F. Fedikow

INTRODUCTION

The 1981 field season marked the expansion of the Mineral Deposit program to include Southeastern Manitoba. Field work was undertaken in the Beresford Lake-Wallace Lake-Rice Lake/Gold Lake area and in the Falcon Lake-Star Lake-West Hawk Lake area (Fig. GS-15-1). The main objectives of the field work were:

- 1) detailed examination of mineral occurrences to provide a sound geological data base for further mineral deposit studies; and
- 2) the initiation of bedrock sampling programs in the vicinity of a variety of known mineral deposit types as a first step towards the compilation of geochemical case histories to assist exploration in Manitoba.

In addition, detailed mapping and the collecting of bedrock and muck-pile samples for assay purposes was undertaken from selected mineral occurrences. This information will be located in a Mineral Deposit Open File and will provide detailed geological and geochemical information on mineral occurrences that will be made available to the public upon request.

AREA 1: FALCON LAKE-STAR LAKE-WEST HAWK LAKE

The main objectives of the field work in this area were:

- 1) The detailed examination of the mineral occurrences and the geological rock units as mapped by Springer (1950) and Davies (1953); and
- 2) the initiation of a bedrock sampling program in the vicinity of the Sunbeam-Kirkland gold deposit.

A summary of observations resulting from the examination of the mineral occurrences is presented in Table GS-15-1 and their locations shown, with respect to regional geology, on Figure GS-15-2.

Mineralization in the area can be classified into three main groupings:

- a) Gold-bearing quartz veins filling shears and fractures;
- b) Sub-vertical pipes of silicification and sericite alteration characterized by disseminated pyrite, chalcopyrite, sphalerite, galena, pyrrhotite, arsenopyrite, tennantite and molybdenite, as exemplified by the Sunbeam-Kirkland deposit;
- c) Disseminated, thin (1 - 5 mm) banded pyrrhotite, pyrite $\pm$ chalcopyrite layers associated with interbedded argillites, siltstones and greywacke.

Gold-bearing quartz veins were observed in shears and fractures in

- i) massive and pillowed andesites and basalts (Unit 1; Davies, 1953) and
- ii) a polymodal fragmental unit mapped as a basic agglomerate (Unit 3; Davies, 1953).

The genesis of the gold-bearing quartz veins may be attributed to the fracturing and shearing of the andesite and basalt by the intrusion of the Falcon Lake Stock and the porphyritic granite followed by the subsequent mobilization of gold out of the intermediate and mafic volcanic rocks and into the shears and fractures.

The Sunbeam-Kirkland gold deposit is a sub-vertical pipe of silicification, sericite alteration and disseminated mineraliza-

tion. The pipe is located in the felsic core of the composite Falcon Lake Stock and is associated with similar styles of mineralization in the general vicinity. Coarse grained aggregates (1 - 5 cm) of pyrite, chalcopyrite, arsenopyrite, sphalerite and galena as well as fine disseminated pyrite were observed in bedrock samples taken from trenches on the Moonbeam claims, located approximately 275 m northwest of the Sunbeam-Kirkland deposit. A possible faulted extension of the Sunbeam-Kirkland deposit, tentatively called "Sunbeam Southwest," occurs approximately 150 m southwest of the main Sunbeam-Kirkland pipe and is characterized by disseminated pyrite, chalcopyrite and arsenopyrite. All three of these occurrences are associated with faulted, bleached and mineralogically reconstituted host rock which suggests the development of leakage-type anomalies or mineralization-related alteration haloes. A suite of bedrock samples were collected from the Sunbeam-Kirkland deposit, the Moonbeam occurrence and the Sunbeam Southwest occurrence for multi-element geochemical analysis with the aim of identifying a group of potential indicator elements associated with this type of "porphyry-style" gold deposit. The pathfinder elements will then be used in a bedrock sampling program in the Falcon Lake Stock in order to outline and define the extent of alteration haloes related to known mineralization. The determination of diagnostic pathfinder elements combined with an indication of the extent of mineralization-related alteration would provide a useful exploration tool for porphyry-style gold mineralization in Manitoba.

Disseminated, thinly banded (1 - 5 mm) pyrrhotite, pyrite $\pm$ chalcopyrite was observed in association with interbedded argillites and siltstones of Davies' Unit 5 (1953). These mineral occurrences are often associated with extensive iron-oxide staining as a result of the weathering of pyrite and pyrrhotite that occur as coatings on fractures and joint planes and as disseminations and podiform masses in quartz veins within shear zones. The mineralized units are commonly silicified with discontinuous pods and/or lenticular masses of quartz along the bedding planes. These quartz masses are invariably iron stained and contain pyrite $\pm$ pyrrhotite and chalcopyrite in fresh surfaces. The bedding plane silicification may be related to strike-slip faults associated with many of the mineralized zones. Individual sulphide horizons can have strike lengths of up to 2 km but commonly average 100 to 200 m.

Altered basalts and tuffs (Unit 6; Davies, 1953) exposed along the north shore of Falcon Lake and the east shore of West Hawk Lake were examined to determine the nature of the alteration as well as to observe the cherts described in this area (Davies, 1953). The West Hawk Lake occurrence of Unit 6 appears to be a sheared and silicified basalt with barren, white quartz veins. The exposures of Unit 6 on Falcon Lake appear to be a mixture of sheared and silicified basalt and a thin, siliceous rhyolite/dacite unit with well defined and non-gradational contacts. Sections of uni-modal silicic fragments with maximum dimensions of 50 x 25 cm and characterized by 0.5 by 1 cm reaction rims are present within this siliceous unit as well as bedded, tuffaceous sections with sulphide-bearing sections. The cherts described by Davies (1953) were not located.

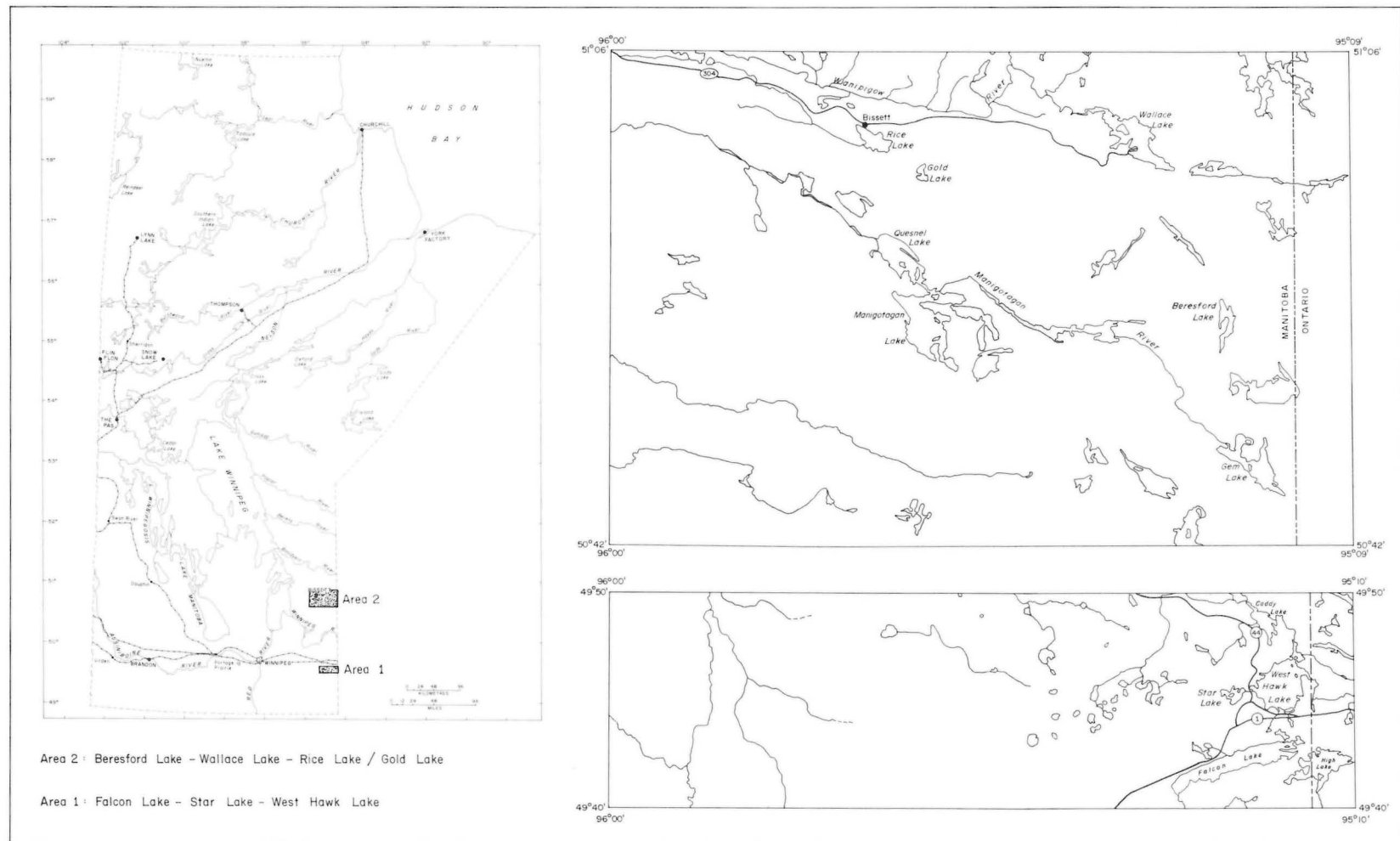


Figure GS-15-1: Location map of field areas 1981.

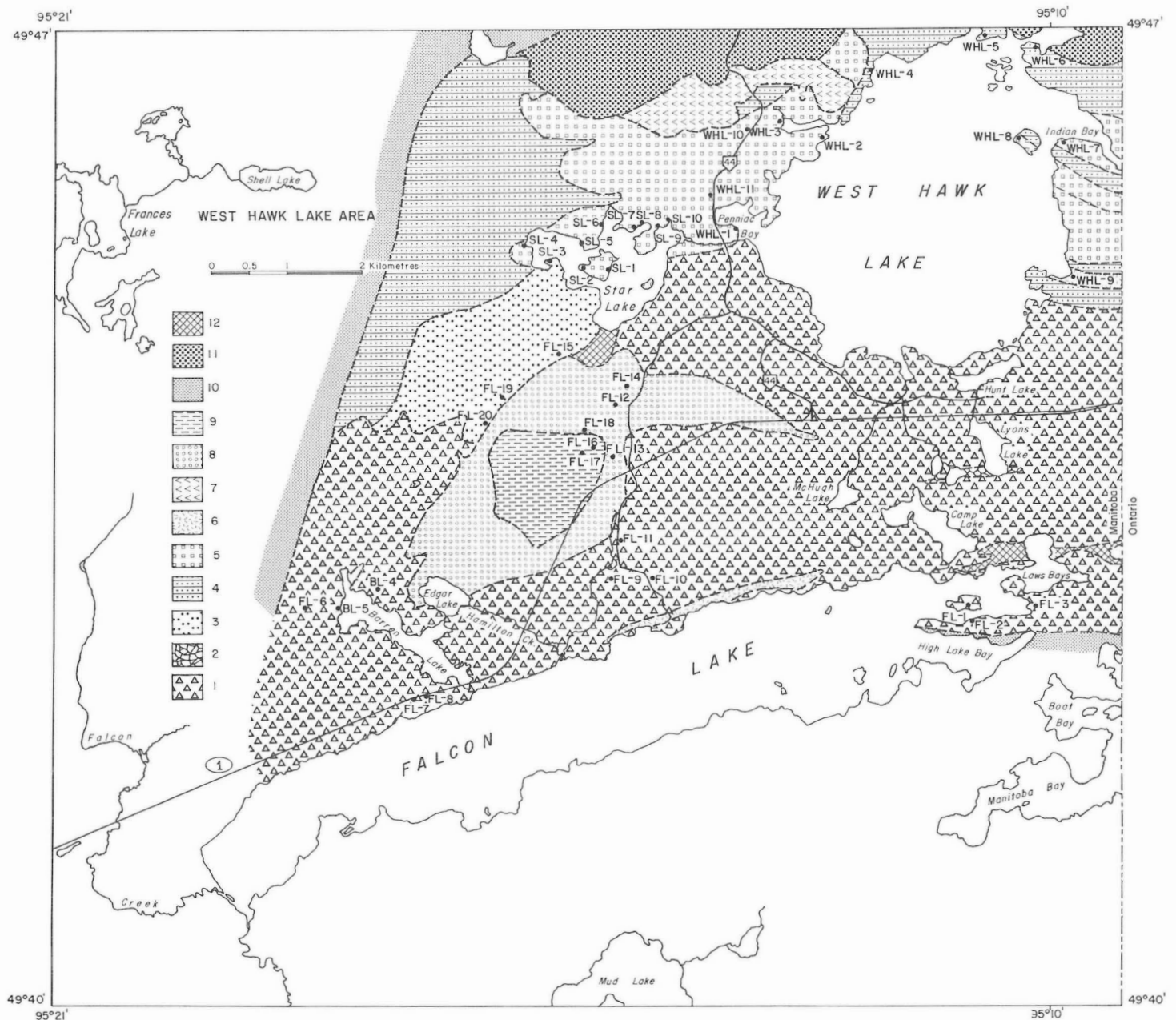


Figure GS-15-2: Location of field stations with respect to regional geology in the Falcon Lake - Star Lake - West Hawk Lake Area. Geology modified after Davies (1953). Legend: 1. Andesite and basalt; 2. Slate; 3. Basic agglomerate; 4. Basic tuff; 5. Clastic sedimentary rocks - argillites and siltstones; 6. Silicified basalt and tuffs; 7. Mixed pegmatite and clastic sedimentary rocks; 8. Diorite and gabbro; 9. Quartz monzonite; 10. Pink, porphyritic granite; 11. Grey, gneissic granite; 12. Quartz-feldspar porphyry.

AREA 2: BERESFORD LAKE-WALLACE LAKE-RICE LAKE/GOLD LAKE

Six weeks of field work were devoted to the detailed examination of the geology and nature of mineralization in and around gold-bearing properties of the area and also to the sampling of the Wallace Lake-Siderock Lake magnetite-chert banded iron formation. The general characteristics of the gold properties examined and their locations in relation to regional geology are presented in Table GS-15-2 and Figure GS-15-4, respectively.

The majority of the gold properties examined are clearly related to quartz and quartz-carbonate veins associated with faulting that accompanied intrusive activity late in the geological history of the area. The diverse range of host rocks in which gold mineralization has developed, includes: quartz diorite, gabbro, diabase, massive and fragmental volcanic rocks and siliceous sedimentary rocks. This suggests that the control on mineralization is structural rather than lithological. The most productive gold properties are hosted by the mafic intrusive and extrusive rocks and other competent extrusive and intrusive rocks that were conducive to the development of extensive shearing.

Alteration and accompanying mineralogical reconstitution of the host rocks were observed to be restricted to within 20 m of the zone of shearing. The presence of weakly developed pyritic haloes around some of the quartz-diorite hosted gold deposits (e.g. Ogama and Rockland; Table 2 Fig. 4), however, suggests that in specific cases the mineralization-related alteration aureoles may, in fact, be more extensive than previously considered. An example of the extent and nature of alteration related to gold-mineralization in a quartz-filled shear zone has been presented by Bailes, (1971). More specific investigations regarding mineralogy and genesis of the gold mineralization in the Rice Lake-Beresford Lake Greenstone Belt has been dealt with by Stephenson (1971).

The possibility of exhalative-type gold mineralization in the Beresford Lake-Wallace Lake area has been discussed briefly by Stewart (1977) with reference to the Kitchener Gold Mine (Table GS-15-2 and Fig. GS-15-4). This deposit is associated with a gabbro sill, greywacke and minor tuffs and chert (Stephenson, 1971) with mineralization essentially confined to the gabbro and greywacke. The gabbro sill is coarse grained and sheared, commonly with white carbonate filling the shear zone. The sill also contains subrounded to rounded, 1 - 5 mm blue quartz eyes. The most abundant sulphide mineralization is located in the sheared, bleached and silicified zone within the sill and the mineralization is characterized by disseminated and veinlet pyrrhotite, chalcopyrite and pyrite-associated with 1 - 5 cm long pods of clear to milky white quartz that probably represent disrupted quartz veins. The greywacke occurs as a massive, grey-green unit with an exposed thickness of approximately 12 m. It contains zones of weakly disseminated pyrite and chalcopyrite accompanied by dark green to black chlorite(?) wisps (1 - 3 mm long) in the matrix as well as 1 - 2 mm rounded, clear quartz grains. Mineralization in the greywacke is related to a blue quartz-filled shear zone that occurs approximately 1 m below the contact with the gabbro. The shear zone parallels this contact and is rusty-weathered in part, due to the presence of disseminated pyrite and chalcopyrite. The blue quartz within the shear also contains disseminated pyrite and chalcopyrite. In proximity to the Kitchener Mine the greywacke becomes increasingly rusty-weathered; this suggests an increase in sulphide content. A series of 22 trenches along the gabbro-greywacke contact trace the shear zone, and associated blue quartz, along strike for approximately 120 m until it was covered by a swamp. The greywacke can be traced intermittently for a fur-

Growler shaft and workings (Table GS-15-2, Figure GS-15-4) occurs along the greywacke-gabbro contact where disseminated pyrite and chalcopyrite occur within sheared silicified rock as well as throughout the matrix of the greywacke. The contact between gabbro and greywacke at the Growler shaft and at the Kitchener Mine is marked by a 15 to 20 cm thick zone consisting of interbanded, light grey to greenish-grey siliceous chert and tuffaceous-looking units 0.5 to 2 cm thick. Rock of this description is abundant on the muck-piles of the Kitchener Mine and it is unclear whether the banding represents silicification along the gabbro-greywacke contact accompanying the shearing and mineralization event in the greywacke or whether the banding represents the deposition of primary chert with a minor tuffaceous component. A schematic section of the gabbro-greywacke contact and associated mineralization is present in Figure GS-15-5. Further studies will be undertaken in the vicinity of the Kitchener Mine.

The magnetite-quartz banded iron formation that outcrops along the north shore of Wallace Lake and Siderock Lake (Map 71-1/6; McRitchie, 1971) was examined in detail along its entire strike length. The thickness of this unit varies from 5 - 65 m and bifurcates along the north shore of Siderock Lake to form 2 - 5 m intervals separated by 10 to 20 m of greywacke. The thickness (1 - 2 cm) of the individual magnetite and quartz (chert) bands is relatively consistent along strike. North of Wallace Lake the iron formation is associated with quartzites and greywackes and with metamorphosed argillites and basic volcanic rocks in the Siderock Lake area. Manitoba Mines Branch Non-Confidential Assessment Files indicates mineralized zones consisting of pyrite stringers and interlayered chlorite schist and "mica schists" up to 100 m thick are associated with the iron formation. The association of stringer pyrite and chlorite and mica schists with banded chert and magnetite is suggestive of a volcanic-exhalative affiliation and for this reason samples of the banded iron formation were collected along its exposed strike length. The samples will be analyzed to determine if a characteristic trace element assemblage or pattern exists in the banded iron formation with proximity to the mineralized zones. Further studies of this banded iron formation must await the results of multi-element geochemical analysis.

CONCLUSIONS

Mineral occurrences in the Falcon Lake - Star Lake - West Hawk Lake area include:

- i) gold-bearing quartz veins related to late intrusive activity;
- ii) porphyry-type gold mineralization within the Falcon Lake Stock that may be associated with either extensive major and trace element leakage haloes or mineralization-related alteration haloes; and,
- iii) stratiform pyrrhotite, pyrite $\pm$ chalcopyrite layers within argillites and siltstones and disseminated to podiform pyrrhotite and pyrite on joints and fractures.

Mineralization in the Beresford Lake-Wallace Lake-Rice Lake/Gold Lake area includes:

- i) gold-bearing quartz veins related to late intrusive activity; some of these are associated with weakly developed pyrite haloes;
- ii) possible exhalative-type gold mineralization;
- iii) volcanic-exhalative iron formation that may contain anomalous concentrations or patterns of trace elements related to associated mineralization.

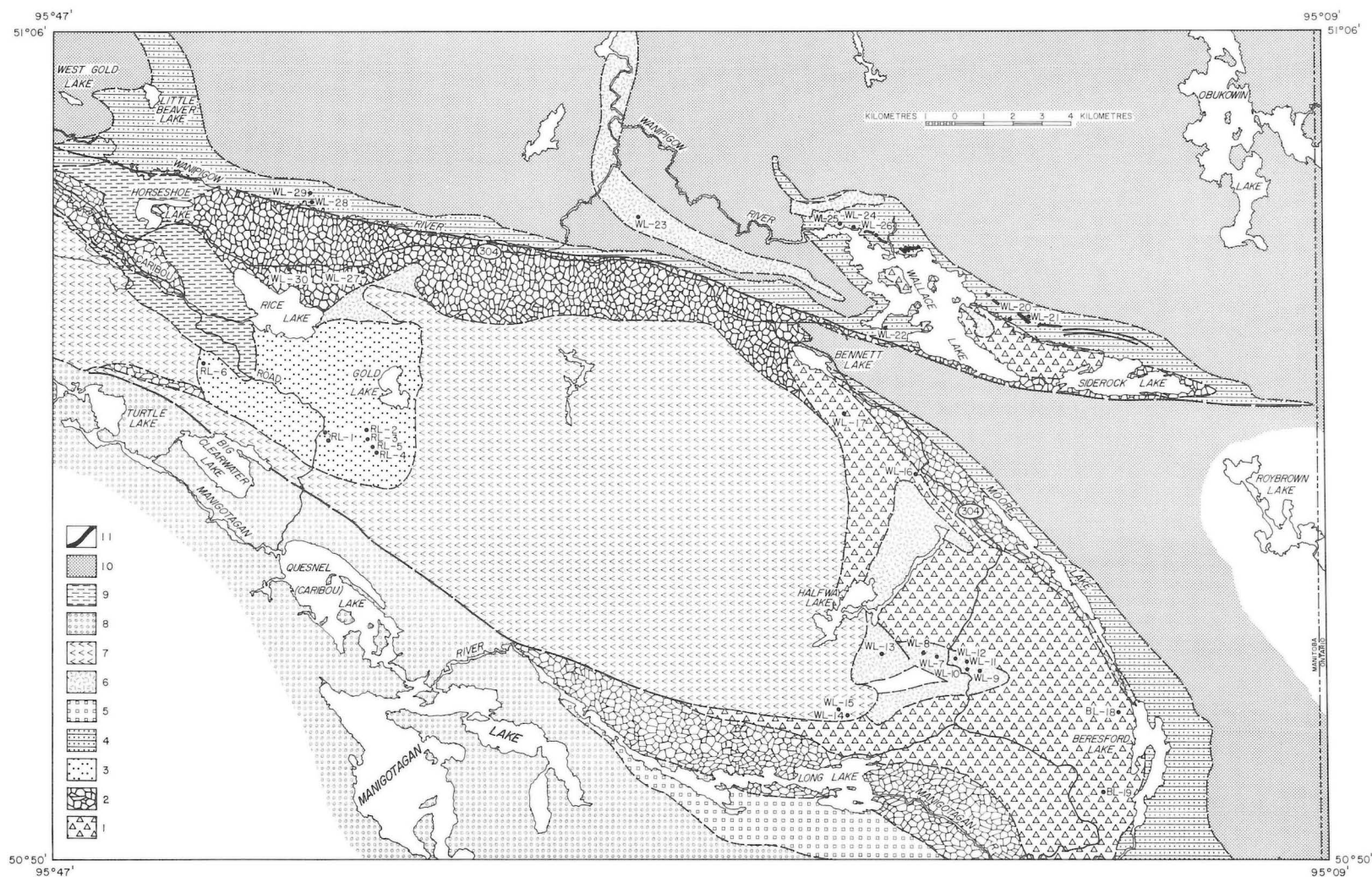


Figure GS-15-3: Location of field stations with respect to regional geology in the Beresford Lake - Wallace Lake - Rice Lake/Gold Lake Area. Geology modified from Map 71-1/4, — Project Pioneer. Legend: 1. Pillowed and massive basalt, basalt breccia; 2. Tuff breccia, crystal tuff, lapilli tuff and gabbro; 3. Massive and fragmental siliceous volcanic rocks; 4. Argillite with interlayered greywacke, some chert and iron formation; 5. Greywacke with minor argillite; 6. Gabbro; 7. Hornblende-quartz diorite and biotite-quartz diorite; 8. Metasedimentary gneisses and schists with tonalite and monzonite intrusive rocks; 9. Arkose with minor slate; 10. Biotite trondhjemite, hornblende-quartz diorite and derived gneisses; 11. Magnetite-chert banded iron formation.

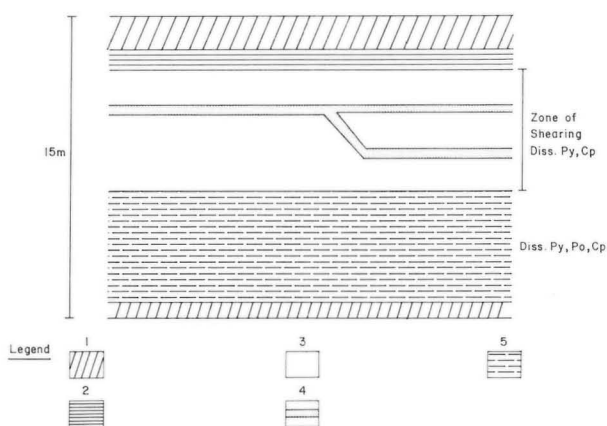


Figure GS-15-4: Schematic section illustrating the gabbro-greywacke contact and associated mineralization at the Kitchener Gold Mine. Legend: 1. Gabbro; 2. Banded cherty and tuffaceous sediments; 3. Sheared silicified sediments; 4. Blue quartz vein; 5. Greywacke.

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TABLE GS-15-1
Summary Data for Mineral Occurrences in the Falcon Lake (FL),
Star Lake (SL), and West Hawk Lake (WHL) Areas.

Locality	N.T.S.	Type of Occurrence	Nature of the Mineralization	Host Rocks	Thickness	Comment
WHL 1	52E/SE14	2 trenches: 4m x 3m x 0.5m 2m x 1m x 0.5m	Diss. and thin bedded Py, diss. AsPy	Argillites and siltstones	3 m	Davies (1953)
WHL 2	52E/SE14	Outcrop	Diss. Po, Py	Silty argillites	200 m	Davies (1953)
WHL 3	52E/SE14	2 trenches: 10m x 5m x 4m 7m x 4m x 2m outcrop	Quartz veins with diss. Py, diss. and veinlet Po in quartz	Argillite-siltstone	3 m	Davies (1953)
WHL 4	52E/SE14	Outcrop	Diss. Py	Intermediate/basic tuffs	2 m	Davies (1953)
WHL 5	52E/SE14	Outcrop	Diss. Py	Intermediate/basic tuffs	15 m	Davies (1953)
WHL 6	52E/SE14	1 trench: 5m x 3m x 8m outcrop	Diss. Po	Intermediate/basic tuffs	50 m	Davies (1953)
WHL 7	52E/SE14	Outcrop	Diss. Py	Argillites and siltstones	2 m	Davies (1953)
WHL 8	52E/SE14	Outcrop, adit: 2m x 2m x 15m	Diss. Po, minor Py	Argillites and siltstones	5 m	Davies (1953)
WHL 9	52E/SE14	Outcrop, 1 trench: 8m x 1.5m x 5m	Diss. Py, Po, tr. Cp	Argillites and siltstones	3 m	Davies (1953)
WHL 10	52E/SE14	Outcrop	Diss. Po, SS Py as joint and fracture fillings	Siltstones, minor argillite	35 m	Davies (1953)
WHL 11	52E/SE14	Outcrop	Diss. Py, Po, assoc with quartz veins	Siltstones	40 m	Davies (1953)
SL 1	52E/SE14	Outcrop	Py bands 5mm in argillite, SS - Py along joints	Siltstone, sandstone and argillites	30 m	Davies (1953)
SL 2	52E/SE14	Outcrop	Diss. Py	Siltstones, argillite clasts	5 m	Davies (1953)
SL 3	52E/SE14	Outcrop	Diss. Py	Argillites, sandstones	10 m	Davies (1953)
SL 4	52E/SE14	Outcrop, 2 trenches: 2m x 1m x 0.3m 1m x 1m x 0.3m	Diss. Py, Py bands 2 - 5mm - discon- tinuous	Siltstones and argillites	2 m	
SL 5	52E/SE14	Outcrop, 3 trenches: 3m x 1m x 0.5m 2m x 1m x 0.5m 2m x 1.5m x 0.2m	Diss. and veinlet 2-5mm Po; some NSS Po; tr. Cp; malachite staining	Siltstones with sugary quartz pods	50 m	Davies (1953)
SL 6	52E/SE14	Outcrop, 4 trenches: 8m x 1m x 1m 3m x 1m x 1m 3m x 2m x 1m 0.5m x 0.5m x 0.1m	Py bands (5mm) in argil- lite; diss. Py in cross- cutting quartz veins. diss. Po in siltstones; malachite staining	Argillites and siltstones	10 m	Davies (1953)
SL 7	52E/SE14	Outcrop, 2 trenches: 2m x 1m x 1m 2m x 1m x 1m	Py bands (5mm) in argillite; diss. Py in garnet. argillite	Argillite	2 m	
SL 8	52E/SE14	Outcrop	Diss. Py	Garnet-quartz- feldspar schist	2 m	
SL 9	52E/SE14	Outcrop	Py bands 5mm paral- lel to bedding	Argillite	5 m	Davies (1953)
SL 10	52E/SE14	Outcrop	Diss. Py	Siltstones, quartzites	30 m	
FL 1	52E/NE11	Outcrop, 1 trench: 1m x 1m x 2m	Diss. Py in quartz veins	Andesite	6 m	Springer (1950)
FL 2 (Falnora)	52E/NE11	Outcrop, 15 trenches dumps	Diss. Cp, Po, Py in quartz veining and sheared wallrock	Andesite	250 m	Springer (1950)
FL 3	52E/NE11	1 trench: 7m x 2m x 1m	Diss. Po, Py, along shear; silicification	Andesite	1 m	Davies (1953)
BL 4 (Thomas Boyes)	52E/NE11	Outcrop, 1 trench: 20m x 2m x 2m	Diss. Py in quartz- filled shear, minor Cp, AsPy	Andesite/basalt	1 m	Davies (1953)
BL 5 (Boyes No. 2)	52E/NE11	Outcrop, 1 trench: 2m x 1.5m x 2m	Diss. sulphides Py(?) in quartz vein	Andesite/basalt	0.5 m	Davies (1953)

FL 6 (Jewel)	52E/NE11	Outcrop, 1 pit: 1.5m x 1.5m x 3m	Diss. Py, Po, AsPy in sheared wallrock; diss. Py in quartz vein	Pillow basalts/andesites	1 m	Davies (1953)
FL 7	52E/NE11	Outcrop	Diss. Po.	Massive andesite/ basalt	1 m	Davies (1953)
FL 8	52E/NE11	Outcrop Wallrock	Diss. Py(?) in sheared	Intermediate/basic tuffs	20 m	Davies (1953)
FL 9	52E/NE11	Outcrop	Diss. Py, Po in sheared wallrock; diss. Py in quartz veins	Andesite	1 m	Davies (1953)
FL 10	52E/NE11	Outcrop	Diss. Py in quartz- filled joints	Andesite	3 m	Davies (1953)
FL 11	52E/NE11	Outcrop	Diss. Py along shears and joints	Andesite with inter- bedded tuffs	40 m	Davies (1953)
FL 12	52E/NE11	5 trenches	Diss. Py along shears	Granodiorite	1 m	Davies (1953)
FL 13 (Waverly)	52E/NE11	Outcrop	Minor diss. Py along shears	Granodiorite	?	Davies (1953)
FL 14	52E/NE11	Quarry	Diss. Py, Cp	Granodiorite	1 m	Davies (1953)
FL 15 (Moore)	52E/NE11	6 trenches 1 shaft, dumps outcrop	Diss. Py, Cp, cross- cutting Po veinlets; quartz veined shears	Agglomerate	2 m	Davies (1953)
FL 16 (Sunbeam)	52E/NE11	Outcrop	Diss. Py, minor Cp in silicified and faulted host rock	Quartz monzonite	10 m	Davies (1953)
FL 17 (Sunbeam- South- west)	52E/NE11	Outcrop, 3 trenches: 7m x 5m x 2m 5m x 3m x 3m 7m x 2m x 2m dumps	Diss. Py, Cp, AsPy(?); veinlet Py in faulted outcrop	Quartz monzonite	3 m	Davies (1953)
FL 18 (Moon- beam)	52E/NE11	Outcrop, 9 trenches dumps	Diss. Py, 1-3cm Ga, Cp, Py, AsPy, Sph aggre- gates in sheared and bleached wallrock	Granodiorite	5 m	Davies (1953)
FL 19	52E/NE11	Outcrop, 1 trench: 2m x 1m x 2m	Diss. Py, Po, Cp along shears and fractures; veinlet Po (1mm)	Andesite/basalt	2 m	Davies (1953)
FL 20	52E/NE11	Outcrop, 6 trenches, dumps	Diss. Po along quartz- filled shears	Andesite/basalt	2 m	Davies (1953)

Abbreviations: Py = pyrite, AsPy = arsenopyrite, Po = pyrrhotite, Cp = chalcopyrite, Sph = sphalerite, Ga = galena, Mo = molybdenite, m = millimetre, cm = centimetre, m = metre; Diss. = disseminated, SS = solid sulphide, NSS = near solid sulphide, eu = euhedral, subh. = subhedral, occas. = occasional.

Note: Trench dimensions are reported in terms of length by width by depth.

TABLE GS-15-2
**Summary data for Mineral Occurrences in the Beresford Lake (BL),
Wallace Lake (WL), and Rice Lake - Gold Lake (RL) Areas**

Locality Designation	N.T.S.	Type of Occurrence	Nature of the Mineralization	Host Rocks	Thickness	Comment
RL 1 (Pilot/ Gold Lake)	52L/NE13	2 shafts, dumps, outcrop and 12 trenches	Diss. and 1 cm veins of Py in white quartz; malachite-azurite staining	Sheared, porphyritic and fragmental dacite	1 m	Bailes (1971)
RL 2 (Gold Pan X)	52L/NE13	2 shafts, dumps and outcrop	veinlets of Py, diss. Py, Cp, Au	Sheared, porphyritic and fragmental dacite	1 m	Davies (1953)
RL 3 (Gold Pan)	52L/NE13	1 shaft, d.d. core outcrop, dumps	Diss. Py, Cp, Sph.	Fragmental and porphyritic dacite; diabase	1 m	Stephenson (1971)
RL 4 (Gold Seal)	52L/NE13	1 shaft, dumps and outcrop	Diss. Py and Cp; occas. veinlet Py	Porphyritic dacite; in part fragmental	1 m	Stephenson (1971)
RL 5 (Gold Shear)	52L/NE13	1 shaft, dumps and outcrop	Diss. Py, occas. Cp	Porphyritic dacite	1 m	
RL 6 (Packsack)	52L/NE13	1 shaft, dumps outcrop and 1 trench: 5m x 1m x 1m	Diss. Py and discontinuous Py bands assoc. with shearing and quartz-carbonate veining	Porphyritic dacite; diabase	3 m	Stephenson (1971)
WL 7 (Kitchener-Central Manitoba Mine)	52L/NW14	22 trenches, outcrop and d.d. core, 2 shafts	Diss. Py, Cp, Po	Sheared, laminated siliceous sediments; cherty, tuffaceous and rusty weathered in part; blue quartz veins	1 m	Stephenson (1971)
WL 8 (Growler)	52L/NW14	1 shaft, 1 trench: 15m x 7m x 3m	Diss. Py, Cp	Sheared, siliceous sediments, cherty and laminated in part	1 m	Stephenson (1971)
WL 9 (Hope)	52L/NW14	Dumps and outcrop	Diss. Py, Cp in blue and grey quartz veins; eu. Py in sheared rock	Sheared gabbro	1 m	Stephenson (1971)
WL 10 (Roger)	52L/NW14	Dumps and outcrop	Diss. Py, minor Cp in blue quartz. eu. Py in sheared rock	Sheared siliceous sediments and gabbro	0.5 m	Stephenson (1971)
WL 11 (Tene Shaft)	52L/NW14	Dumps and outcrop	Diss. Py, Cp in blue quartz, diss. Py in sheared rock	Sheared gabbro	2 m	Stephenson (1971)
WL 12 (Tene Stope)	52L/NW14	Dumps and outcrop	Heavily diss. Po, Cp	Sheared gabbro	5 m	Stephenson (1971)
WL 13 (Walton)	52L/NW14	Dumps and outcrop	Diss. Py, Cp, Po along fracture and joint planes; Po, Cp diss. through matrix	Quartz diorite; in part rusty weathered	2 m	Wright (1932)
WL 14 (Ogama)	52L/NW14	Dumps and outcrop	Diss. Py, Cp in shears and throughout matrix	Quartz diorite; sheared and iron stained in part	0.5 m	Stephenson (1971)
WL 15 (Rockland)	52L/NW14	Dumps and outcrop	Diss. Py, Cp in matrix and along shears; Mo as veinlets and disseminations; AsPy needles along shears	Quartz diorite; sheared and iron stained in part	0.5 m	Stephenson (1971)
WL 16 (Moore Lake)	52L/NW14	4 trenches: 25m x 10m x 0.5m 10m x 1.5m x 1m 7m x 3m x 1m 4m x 1m x 1m	Diss. eu. Py in chlorite schist, white quartz and brown/white carbonate veinlets	Sheared, massive basalt	1 m	Stephenson (1971)
WL 17 (Cryderman)	52L/NW14	Dumps, d.d. core and outcrop	Diss. Cp, Po, Py in white quartz veins; Py in sheared wallrock	Sheared massive and pillowed andesite	1 m	Wright (1932)
BL 18 (Oro Grande)	52L/NW14	Dumps and outcrop	Diss. Py in white quartz veins; eu. Py in sheared wallrock	Sheared diorite/ gabbro	2 m	Wright (1932)
BL 19 (Gunnar)	52L/SW14	1 shaft, outcrop and d.d. core	Minor diss. Py in white and blue quartz veins and white carbonate veins	Massive and pillowed andesites and basalts	2 m	Wright (1932)
WL 20 (Wanipigow River)	52M/SW3	Outcrop and 3 trenches: 2m x 1m x 1m 2.5m x 1m x 1m 2.5m x 1m x 1m	Diss. Py; diss. and 1 cm bands of magnetite	Meta-argillite, chert	15 m - 20 m	McRitchie (1971)

WL 21 (B.I.F.)	52M/SW3	Outcrop	Banded chert and magnetite	Quartzite	30 m - 40 m	McRitchie (1971)
WL 22 (Conley)	52M/SW3	Outcrop and 11 trenches	Diss. to NSS of Py along joint and fault planes; diss. Py in blue quartz and quartzites; 1mm bands, diss. Py and malachite-azurite staining in graphitic shale	Siliceous and graphitic sediments	1 - 5 m	Stephenson (1971)
WL 23 (Jeep)	52M/SW3	1 shaft, outcrop, d.d. core and 2 trenches: 65m x 7m x 4m 6m x 3m x 1m	Diss. Py in blue/white quartz and white carbonate veins	Sheared gabbro	1 m	Russell (1948)
WL 24 (Gatlan)	52M/SW3	2 shafts, d.d. core and 14 trenches	Massive to diss. As Py needles and rosettes; diss. eu. to subh. Py in blue quartz	Sheared siliceous quartzites	5 m	Russell (1948)
WL 25 (East of Gatlan)	52M/SW3	Outcrop and 2 trenches: 6m x 2m x 3m 4m x 4m x 1.5m	Minor diss. Py	Rusty weathering, garnetiferous meta-argillites	1 m	
WL 26	52M/SW3	Dumps, outcrop and 1 trench: 20m x 5m x 2.5m	Diss. Py in white quartz vein; fuchsite	Quartzite	2 m	McRitchie (1971)
RL 27 (San Norm)	52M/SE4	1 shaft, dumps, outcrop and d.d. core	Minor diss. Py in white quartz vein	Dacitic tuffs, diabase, sericite schist	10 m	Wright (1932)
RL 28 (Vanson)	52M/SE4	1 shaft, outcrop, dumps and 2 trenches: 6m x 3m x 1m 6m x 2m x 1m	Diss. Py in fine-grained white quartz vein	Siliceous sediments-greywacke, mafic sill	1 m	Davies (1950)
RL 29 (North of Vanson)	52M/SE4	Outcrop and 4 trenches: 6m x 3m x 0.7m 3m x 1m x 0.7m 0.7m x 0.7m x 0.2m 0.1m x 0.1m x 0.1m	Diss. Py in fine-grained quartz veining	Siliceous and sheared sediments; mafic sill; fuchsite	1 m	
RL 30 (Gold Cup)	52M/SE4	1 shaft, dumps and outcrop	Diss. Py in white quartz, eu. Py in sheared wallrock	Porphyritic, tuffaceous dacite; diabase	1 m	

Abbreviations: Py = pyrite, AsPy = arsenopyrite, Po = pyrrhotite, Cp = chalcopyrite, Sph = sphalerite, Ga = galena, Mo = molybdenite; mm = millimetre, cm = centimetre, m = metre; Diss = disseminated, SS = solid sulphide, NSS = *near solid sulphide*; eu = euhedral, subh. = subhedral; occas. = occasional.

GS-16 MINERAL DEPOSIT STUDIES - SUPERIOR PROVINCE

a) Island Lake; b) Bird River Sill

by P. Theyer

INTRODUCTION

Most of the 1981 field season was spent in the Island Lake area in order to:

- I) Remap the Island Lake Gold Mine and its surroundings at a scale of 1: 5000 in order to define the geology, stratigraphy and tectonic controls of mineralization.
- II) Map the extension of rock units hosting the Island Lake Gold Mine, since they have a potential to contain stratabound gold deposits.
- III) Grab sample those parts of the Island Lake "Series" that are considered to be of fluvial origin, and investigate for fossil placer gold deposits.
- IV) Mapping and sampling of ultramafic occurrences in the Island Lake Greenstone Belt.

- V) Investigate known mineral occurrences in the Island Lake Greenstone Belt.

Chromite layers in the Bird River Sill, southeastern Manitoba, were mapped and sampled in detail in order to evaluate their potential to contain platinum group elements.

ISLAND LAKE

1) Island Lake Gold Mine:

Remapping of the Island Lake Gold Mine confirmed that this is a stratabound deposit, as proposed by Stewart (1980) and Theyer (1980a). The gold mineralization occurs at the interface between rocks of mainly volcanic origin and those of mainly sedimentary origin (Theyer, 1980a). This interface also hosts an array of ultramafic bodies, at least one of which is extrusive (Theyer, 1978; 1979; 1980; 1980a).

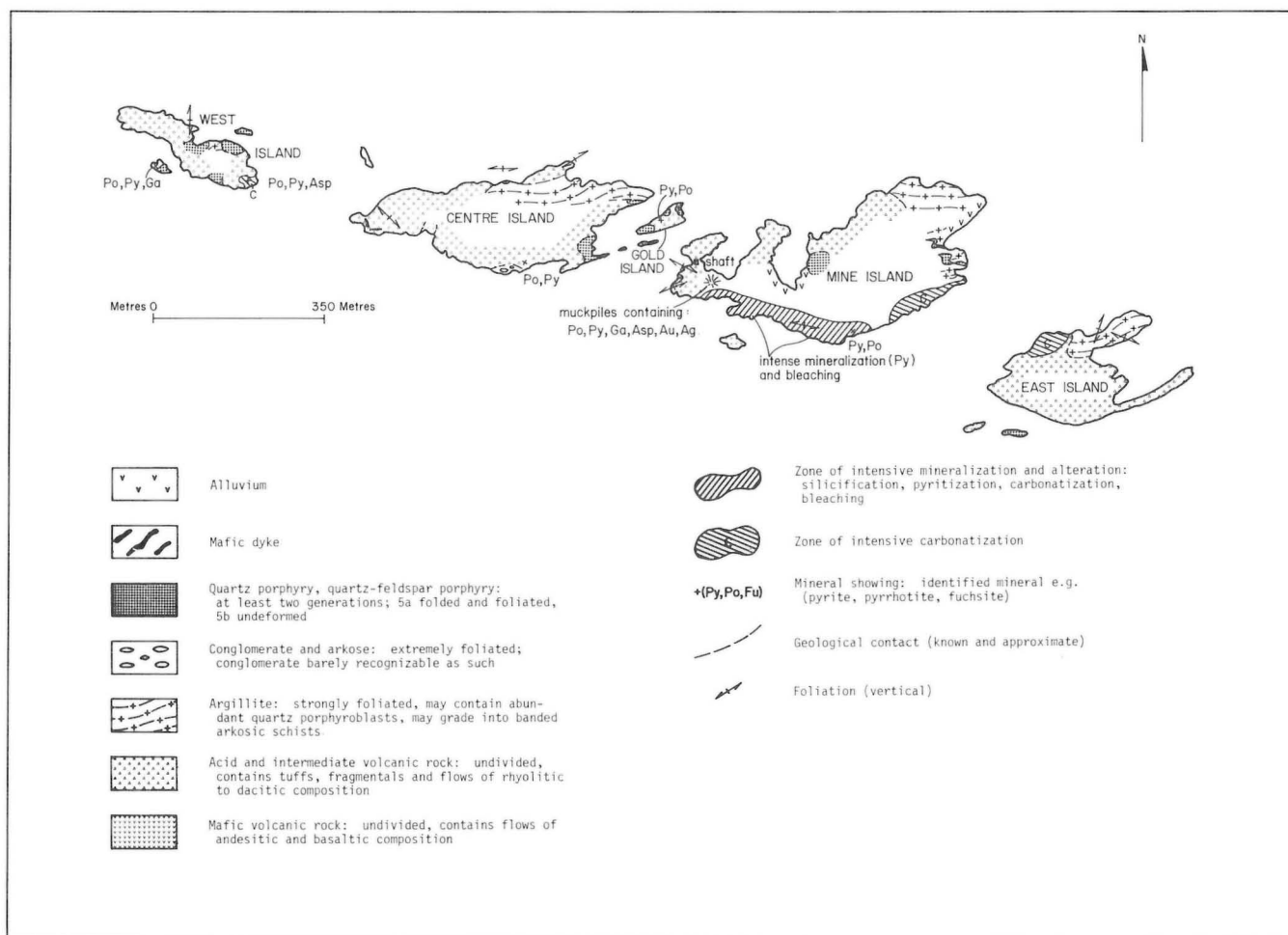


Figure GS-16-1: Geology of the Island Lake Gold Mine and its surroundings.

GEOLOGY

The area around the Island Lake Gold Mine is underlain by sheared rocks of volcanic and sedimentary origin that have been intruded by at least two separate intrusions of quartz porphyry and quartz-feldspar porphyry. (Fig. GS-16-1). Most of these intrusions are dykes, however, large massive stocks are also present. Abundant, undeformed mafic dykes are considered to be the youngest intrusions. The volcanic rocks are in order of decreasing abundance; intermediate, acid and mafic in composition. They occur as tuffaceous, fragmental, and flow rocks.

Sedimentary rocks are represented by black argillites and conglomerates. The conglomerates are extremely foliated and have been reduced to a gritty sericitic schist showing occasional faint outlines of the rock fragments.

Carbonatization and pyritization are ubiquitous, alteration products are especially intense along a shear zone on the south shore of Mine Island.

STRUCTURE

Tight folds and a strong axial planar foliation striking at approximately 100° are the dominant structural features in the area and obliterate many of the primary structures and textures. Foliation was most intense in the incompetent black slates and argillites which absorbed most of the strain.

Disruption of layering by these structures may also be the reason for the small size of the orebody, however, the nature of the host rock and the exact configuration of the orebody are not certain. It is speculated that the gold was concentrated within steeply plunging quartz veins located in the hinges of the folds.

- II) Extension of rock units hosting the Island Lake Gold Mine and their potential to contain other stratabound gold deposits:

A unit consisting predominantly of argillitic rocks shown on Figure GS-16-2 is considered to have a high potential to contain other stratabound gold deposits in addition to the Island Lake Gold Mine. This unit is characterized by:

- 1) occupying the interface between the mainly volcanic rocks of the Hayes River Group and the mainly sedimentary rocks of the Island Lake "Series";
- 2) hosting stratabound ultramafic rocks;
- 3) containing zones of intense carbonatization; and,
- 4) containing important gold showings.

Carbonatization and other types of alteration are especially intense in the area between Mine Island and Heart Island, and in an area northwest of Loonfoot Island. On the basis of this observation and the structural disruption caused by the intrusion of the Loonfoot Island granodiorite pluton, it is assumed that there is a high potential for gold mineralization in these areas. Other segments of this unit of argillitic rocks should not be discounted, particularly in the vicinity of Linklater Island even though this area exhibits less evidence of carbonatization and mineralization.

- III) Sampling of parts of the Island Lake "Series" fossil placer gold sampling program:

Grab sampling of suspected fluvial sediments, belonging to the Island Lake "Series" has been initiated to test for fossil placer gold. These samples are to be assayed by neutron activation analysis.

- IV) Ultramafic rocks

Mapping and sampling of ultramafic rocks in the eastern part of Island Lake and the Sagawitchewan Bay area concludes this project. A final report containing the results of this project will be prepared as an open file. Some parts of this year's work are relevant to the proposed gold bearing stratum and thus are reported on here.

Spinifex textures providing evidence of extrusive ultramafic rocks, were found in two ultramafic bodies. A third possible oc-

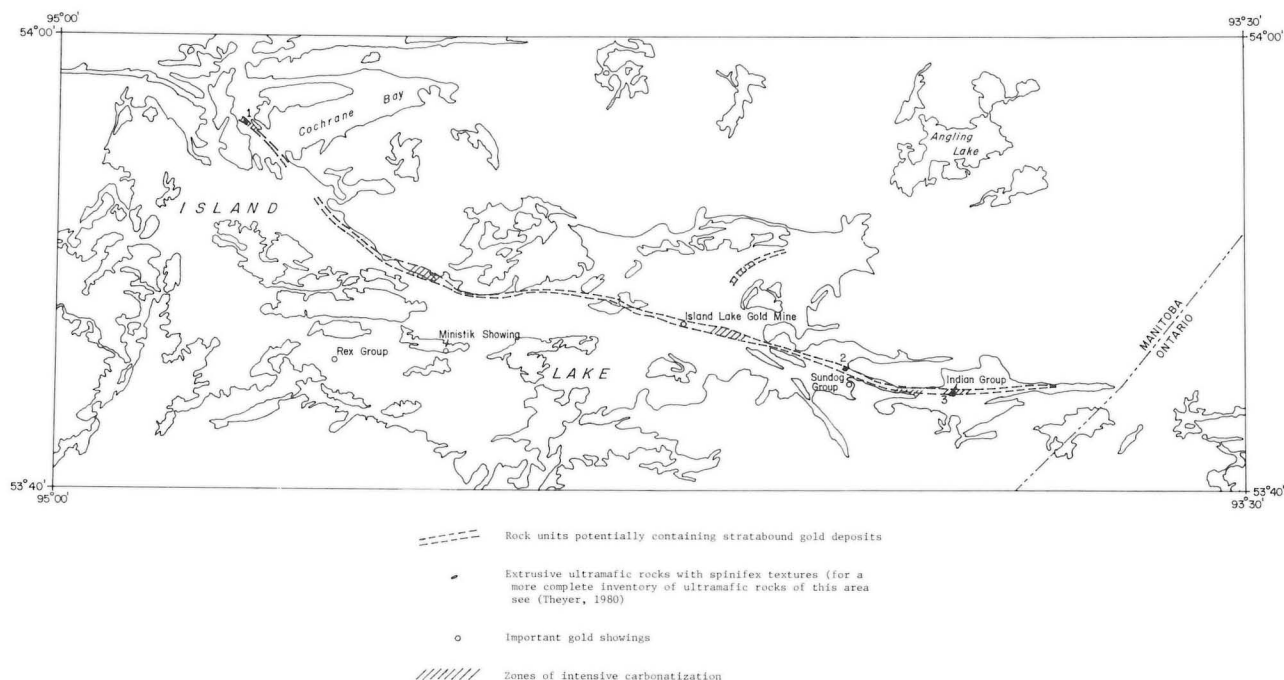


Figure GS-16-2: Extension of rock units potentially containing stratabound gold deposits and position of extrusive ultramafic rocks containing spinifex textures.

currence of spinifex textures needs confirmation by thin sections. All presently known outcrops of ultramafic rocks containing spinifex textures are shown on Figure GS-16-2.

At Location 2 (Sandy Bar Narrows) a primary, undisturbed contact between an ultramafic flow and its substratum - gabbro is exposed. This contact is unique in this belt since all other contacts between the ultramafic rocks and adjoining rocks are of a tectonic nature.

At Location 3 spinifex textures are enhanced by the foliation. These textures are spectacular both in the size and clarity of the blades (Fig. GS-16-4). This outcrop also contains abundant flow breccia.

Figure GS-16-3 shows at least sixteen discrete ultramafic bodies over a strike length of approximately 5 kilometers. These bodies occupy both a northern and a southern belt that are no less than 300 metres apart. Deformation patterns and stratigraphic observations, suggest that the ultramafic bodies occur in the hinges of folds within a single layer of rocks consisting of argillites, cherts and intermediate to acid volcanic rocks.

V) Other mineral occurrences:

All major mineral showings in the Island Lake area were visited and mapped. Grab samples were taken from most of these properties. The data accumulated will be used in future metallogenic studies. Results of this work are available in a preliminary form on request.

BIRD RIVER SILL (SOUTHEASTERN MANITOBA)

Platinum Group Elements

Since Platinum Group Elements are concentrated in their primary form in mafic to ultramafic igneous rocks, sampling of chromite and chromitite layers within the Bird River Sill was initiated. Sampled areas include the Mayville, Euclid Lake, Page, Chrome and the National-Ledin areas. Fire assaying of samples is presently being undertaken in the Department of Energy and Mines Assay labs.

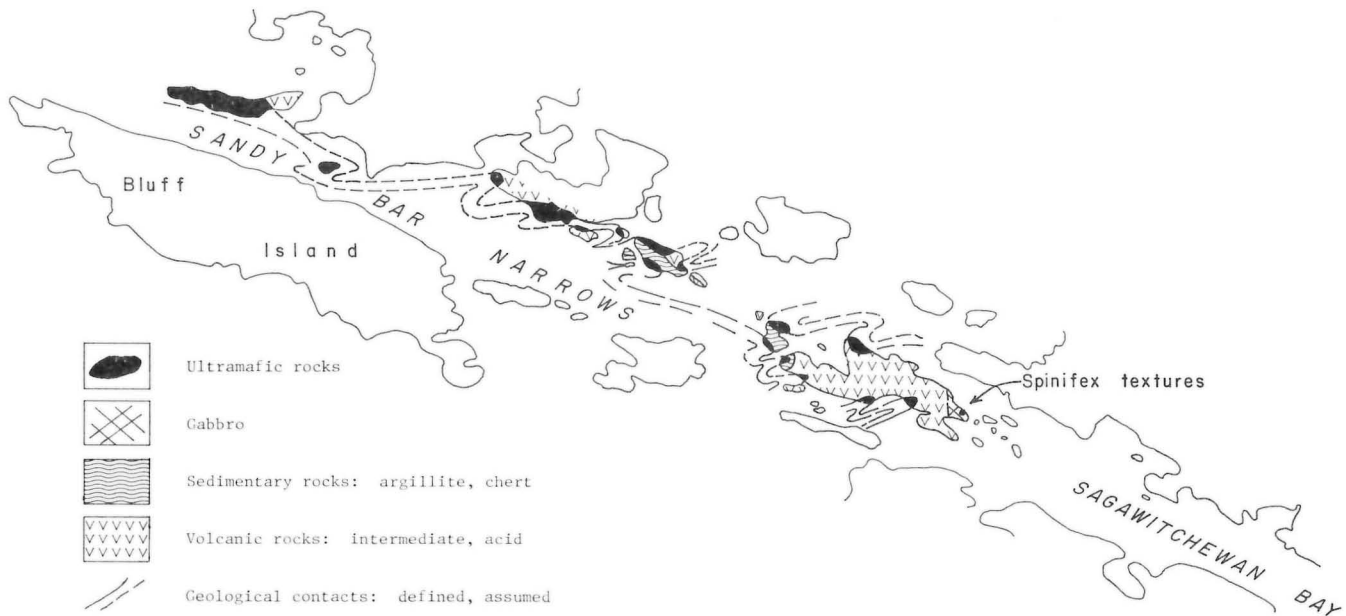


Figure GS-16-3: Stratabound ultramafic bodies of the Sandy Narrows area (Island Lake).



Figure GS-16-4: Spinifex textures in ultramafic rocks (Sagawitchewan Bay).

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GS-17 HIGHROCK LAKE STRUCTURE

by H.R. McCabe

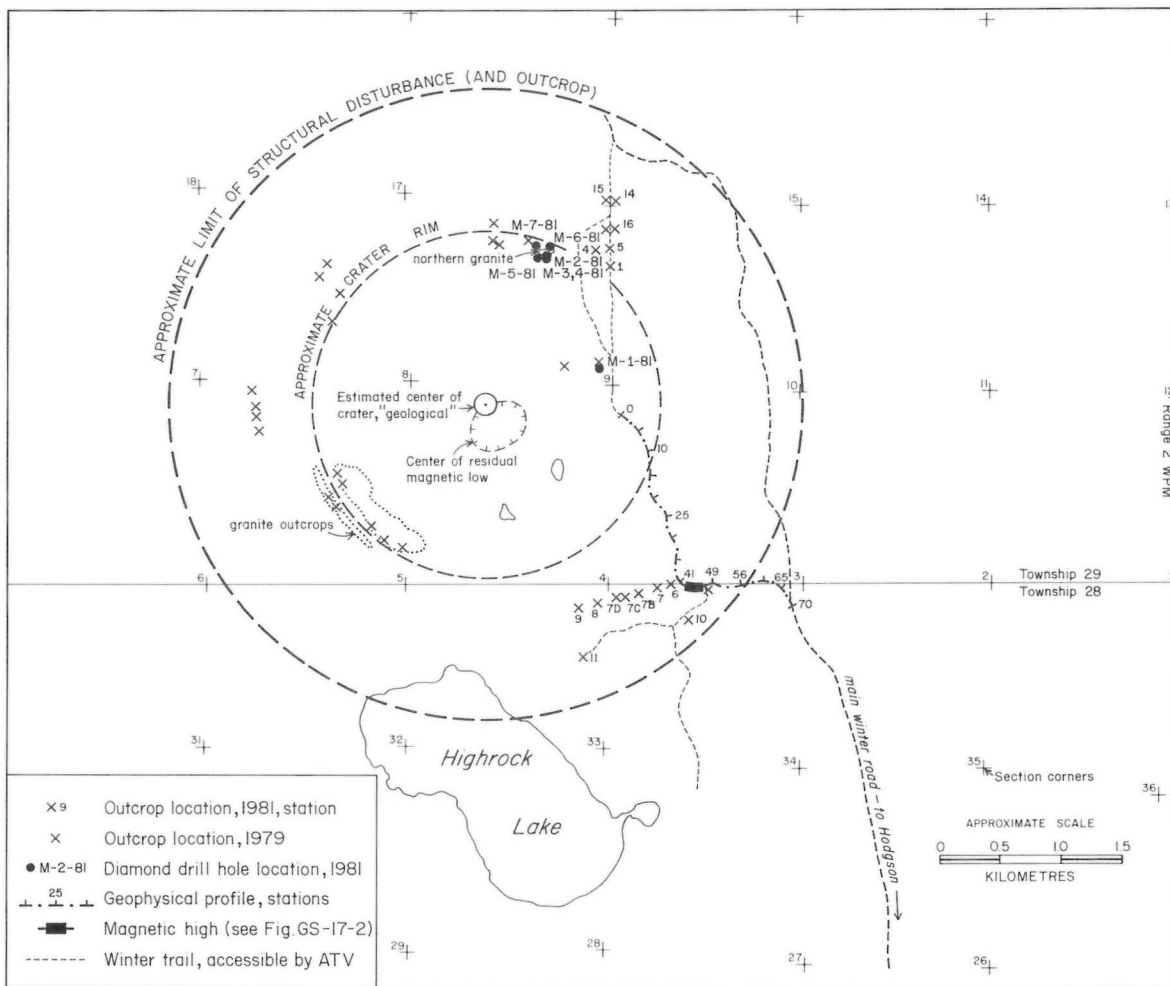
(In collaboration with B.B. Bannatyne and W.D. McRitchie)

The limited amount of surface mapping in the Highrock Lake area (Tp. 28-29, Rge. 2W) was described in the 1979 Report of Field Activities (GS-14). That study indicated the presence of a highly disturbed area, possibly comprising a crypto-explosion or meteorite impact structure. Two Precambrian granite inliers were mapped in an area where their presence indicates that they are approximately 180 m above their expected regional structural position. In addition, a number of structurally disturbed outcrops of Paleozoic carbonates were mapped north and west of the granite outcrops; those beds showed irregular attitudes, with dips of up to 45°. The granitic basement rocks themselves were found to be unusual in that they are cut by a profusion of white microcrystalline calcite veinlets and, in places, by irregular veinlets of sandy, dolomitic, and granitic microbreccia. The structurally disturbed area was shown to be coincident with a well-defined aeromagnetic low (160 gammas).

Inasmuch as there are no immediate plans to publish the results of this study pending acquisition of additional data, the

following discussion provides more detail than normally presented in the Report of Field Activities.

In order to define the structure more accurately, additional ground mapping was carried out (Fig. GS-17-1), a ground magnetometer profile was run, and a total of 121.8 m of core hole drilling was completed (Table GS-17-1). Although previous access to the area has been by helicopter, or by extended ground traverse for the earliest work, it was found that a number of winter trails could provide access to the eastern part of the structure by means of an all-terrain vehicle. Equipment was moved in by a J-5 tracked vehicle, obtained on loan from the City of Winnipeg, and the use of this vehicle is hereby gratefully acknowledged. Although access was extremely difficult due to soft wet trail conditions at the time of the operation, a total of 7 holes were drilled, one within the structure and the remaining 6 in the vicinity of the northeastern granite outcrop. A considerable number of new outcrops were examined on the northeastern and southeastern flanks of the structure.



MAGNETIC STUDIES

In order to clarify the nature of the aeromagnetic anomaly, a residual magnetic anomaly map was prepared using simple graphic methods. The reasonably well defined regional magnetic pattern was extended through the structurally disturbed anomalous area; residual anomaly values were derived by determining the difference between the reconstructed regional magnetic values and the actual observed magnetic values. The resultant residual anomaly (Fig. GS-17-2) is almost circular in nature, shows a negative value of 160 gammas, and conforms very closely to the previously postulated circular configuration indicated by the outcrop geology.

It is apparent from the residual map that there is no evidence of any magnetic high coincident with the areas of structurally high basement (crater rim?). Inasmuch as a 180 m basement high

would be expected to have some magnetic expression, a ground magnetometer profile was run along the main access trail (Fig. GS-17-1). The results are shown in Figure GS-17-2. A small, sharply defined high is indicated for stations 42-45, and a gradual but irregular drop-off is evident towards the central part of the structure. The magnetic high may reflect the position of an uplifted granitic rim, but no outcrops are present in the immediate area, and it was not possible, with the available time, to check the location with a drill hole. Additional ground profiling is planned, particularly in the vicinity of the known granite outcrops, and drilling eventually will be undertaken to determine if the uplifted granitic rim conforms to the proposed circular symmetry of the structure. The position of the magnetic high is anomalous in that it occurs approximately 600 m southeast of the estimated rim position. The sharp definition of the magnetic high suggests that the rim could consist of a series of fault-defined blocks (horsts).

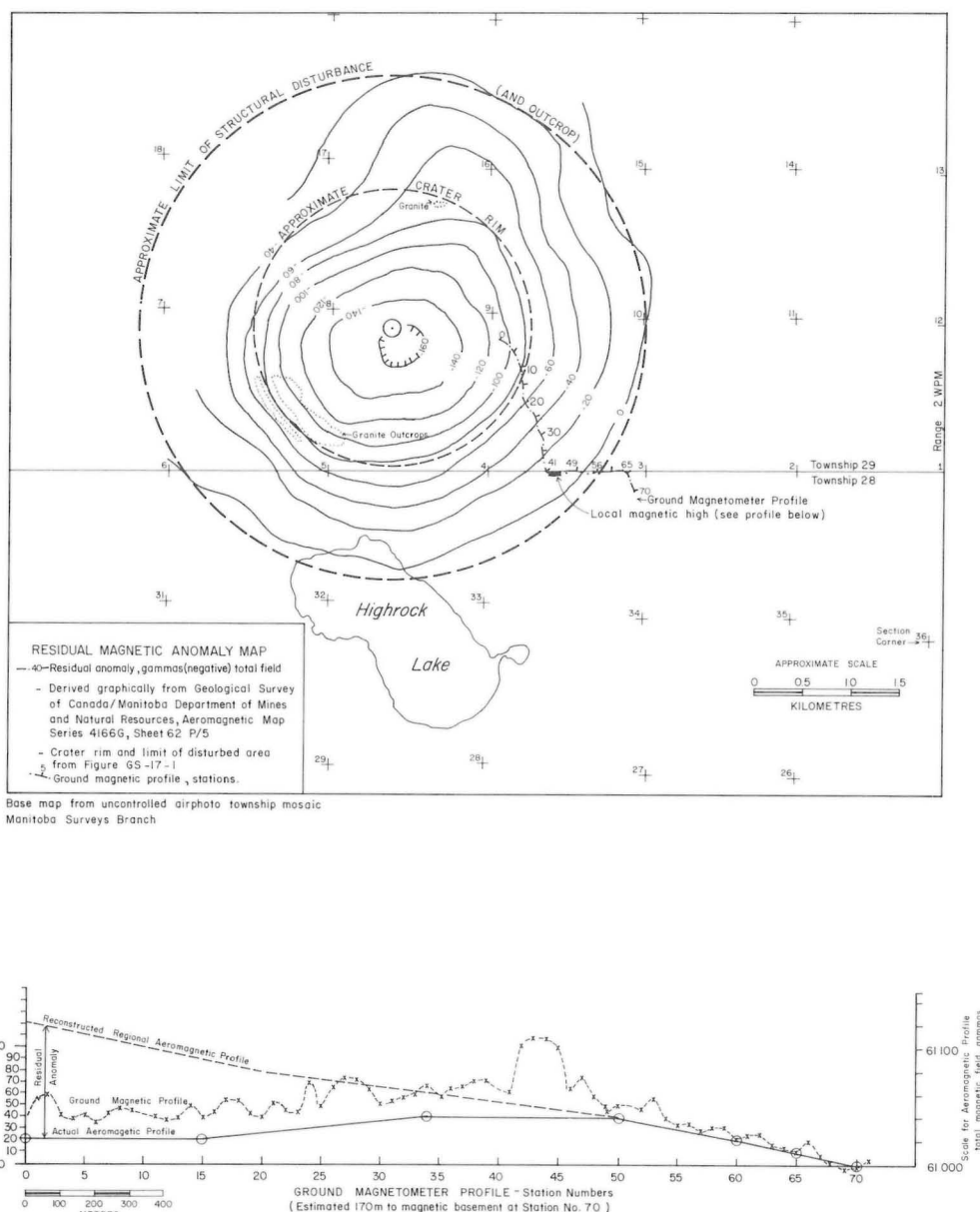


Figure GS-17-2: Ground magnetometer profile — Highrock Lake area.

GEOLOGICAL MAPPING

Ground access to the eastern part of the structure permitted more detailed, but still preliminary mapping of two areas of fairly extensive outcrop, one on the northeastern flank of the structure and the other on the southeastern flank. Although a considerable number of new stations are noted (Fig. GS-17-1), and large areas were found to consist of bedrock pavement or near bedrock, good exposures are rare. Most outcrops consist of yellowish-buff mottled dolomites that are not sufficiently distinctive to be correlated with any specific formation. (Microfossil correlation will be attempted.) Several occurrences, however, (Stations 2A, 3) resemble Upper Red River strata (Fort Garry Member).

Structural attitudes for the above outcrops, where determined, are extremely erratic, with dips as high as 52°. In much of the area of thin drift cover, the topography has a markedly irregular or hummocky character, unlike most Paleozoic outcrop areas, which are relatively flat. This topographic irregularity probably reflects the underlying structural irregularity. The presence of highly disturbed Stony Mountain strata indicates that the oldest possible age for the crater structure is post-Stony Mountain (post-Upper Ordovician).

In addition to the above "normal" Paleozoic carbonates, numerous occurrences of completely unsorted polymictic dolomite breccia were noted, in places intimately associated with, and difficult to distinguish from, the mottled dolomites. These breccia occurrences are particularly abundant, and in places predominant, on the southeastern rim of the crater, an extent to the southeastern limit of outcrop occurrence (Station 10). These breccias appear identical to the carbonate breccia intersected at depth in hole M-1-81, and could possibly represent breccia derived by crater excavation. They could also result from in-situ brecciation of the country rocks, but the polymictic nature of some of the breccia seems to argue against this.

CORE HOLE DRILLING

Data from the 7 core holes in the Highrock Lake area are shown in Table GS-18-1, and the locations are indicated in Figure GS-17-1. Hole M-1-81 was located in the only known outcrop area occurring within the postulated crater rim. It was anticipated, based on the Lake St. Martin crater as a model, that the hole would intersect a section of "crater fill," probably collapse breccia and slump blocks from the crater rim. Such was not entirely the case.

Hole M-1-81 could not be drilled to basement because of the limited drill capacity, but it did intersect at depth a thick 18 m sequence of angular unsorted polymict carbonate breccia (Fig. GS-17-4). Near the base of the breccia section some "floating" sand grains are present along with several fragments of poorly consolidated sandstone. The sand is very well rounded and frosted, medium grained, and well sorted in the fragments; it appears identical to the sands of the basal Paleozoic Winnipeg Formation. An 8 cm inclusion of grey silty shale, also comparable to the Winnipeg Formation, was noted near the bottom of the core, and a single 2 cm fragment of granite was seen. Otherwise, all fragments consist of various types of dolomite, the most distinctive of which is grey-buff micro-crystalline and dense. Most fragments are yellowish-buff, angular, and appear to grade downward in size to a granular microbreccia matrix. No evidence was seen of any sedimentary reworking of the breccia material, but "floating" sand grains, which are absent at the top of the breccia, become common in the matrix near the bottom of the hole. The breccia shows fair to good pinpoint to medium vuggy porosity. The occurrence near the bottom of the core of disseminated sand, sandstone and shale fragments suggests possible proximity to basement, based on comparison with core from subsequent drill holes.

Overlying the basal (?) breccia unit is a 23 m interval of grey to buff to red sandy argillaceous dolomite and dolomitic shale. The sequence is relatively uniform lithologically, with no evidence of any structural disturbance. Bedding was indeterminate, although there is a suggestion of banding at 0° to 20°. This unit appears to be a normal sedimentary succession, but no comparable sandy sequence of this thickness is known anywhere in the Paleozoic succession of southwestern Manitoba. The lithology, however, is similar to the thin sandy/argillaceous marker beds that occur in the Upper Ordovician and Silurian strata, and are used as a basis for subdividing these strata.

Above the sandy argillaceous unit is a mixed dolomite sequence in which the core is badly broken and a number of soft grey clay seams interrupt the dolomite sequence. The dolomite lithologies are non-descript but somewhat variable, grey to buff, fine grained, partly mottled, partly argillaceous and partly intraclastic, with a few scattered grey chert nodules. Several pieces showed distinctive fine blade-like pores believed to have resulted from evaporite solution. The lithologies are not uncommon in the Paleozoic and especially Ordovician succession. Faint banding was evident in places at 0° to 20°. It was not possible to ascertain if this sequence is a normal stratigraphic succession or a series of Paleozoic slump blocks.

The uppermost core unit consists of approximately 10 m of massive, highly porous fossiliferous dolomitic calcarenite. In outcrop these beds trend 340° and dip gently to the west at 10°; the outcrop can be traced for more than 100 m along strike. This unit also appears to be a normal sedimentary sequence with no evidence of structural disturbance other than the gentle westerly dip. However, caution must be used in suggesting that these beds represent normal sedimentary infill, because, in the Lake St. Martin crater, sections of apparently normal Devonian strata up to 60 m in thickness occur as major slump blocks immediately inside the crater rim. Lithologically, this unit is somewhat unusual, and it is not correlatable with any specific Paleozoic unit, although it is not unlike some biostromal units in the Silurian Interlake Group.

In summary, the "crater fill" in hole M-1-81 consists of a basal, crater-related breccia incorporating fragments of lower Paleozoic carbonates along with minor sandstones and shales (but none of the dolomitic limestones characteristic of lower Ordovician strata of the Interlake area). The breccia is overlain with apparent conformity by normal-appearing sedimentary strata of Paleozoic aspect, but not as yet directly correlatable with any portion of the normal Paleozoic succession.

The other six Highrock Lake holes were drilled in the vicinity of the northern granite outcrops in an attempt to determine the attitude of the Precambrian surface, the nature of the marginal crater fill, the nature of the uneroded Precambrian basement, and the lithology and structure of sedimentary strata outside the granite rim. The results are plotted in Figure GS-17-3.

The Precambrian surface is seen to dip (surprisingly) gently and uniformly towards the centre of the crater at about 28° to 30°, and the granite is cut profusely by veinlets of white microcrystalline calcite and sandy dolomitic and granitic breccia, as reported previously for the outcrop. A weathered zone at the top of the Precambrian was not evident, but some alteration occurs marginal to some of the veinlets.

The Precambrian within the crater rim is overlain by a very sandy polymict dolomite breccia ranging from 2.4 to more than 4.3 m in thickness. This breccia is similar to the breccia intersected at a depth of 44.5 m in hole M-1-81, except that the sand grains are much more abundant in the matrix. Grey to red shale and silty shale fragments, similar in lithology to parts of the Winnipeg Formation, occur at or close to the Precambrian contact. The top of the breccia blanket appears to dip inward at about 28° - 30°, parallel to the basement.

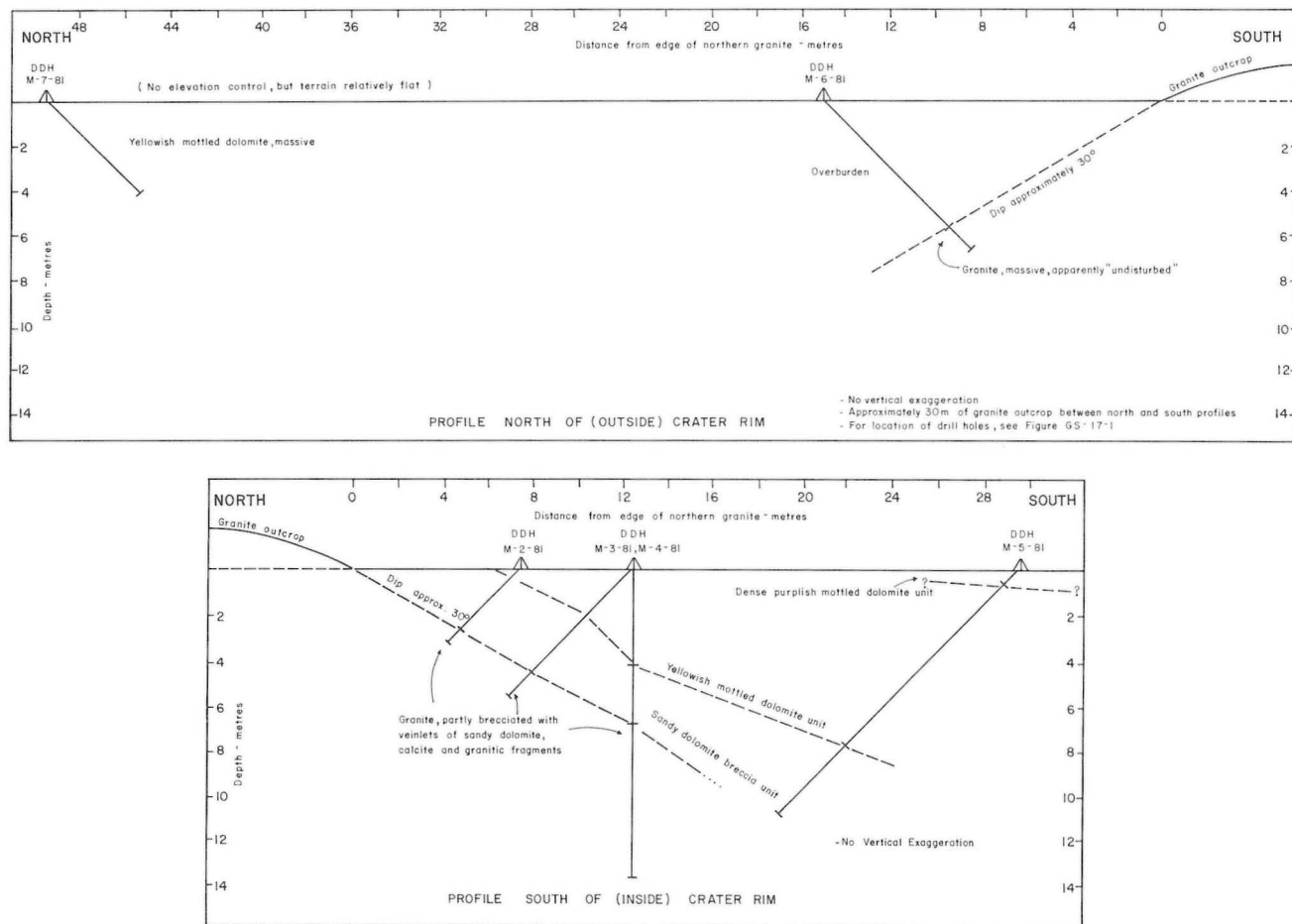


Figure GS-17-3: Structural cross-sections, northern granite — Highrock Lake area.

Overlying the breccia, in relatively sharp but irregular contact, is a 10 m sequence of massive, light grey to yellowish-buff strongly mottled, very finely crystalline dolomite with scattered crinoid fragments and a few chert nodules. Bedding is indeterminate, but there is a slight suggestion of horizontal banding, and no evidence of any structural disturbance or brecciation. (Lithologically, these beds are similar to some of the mixed dolomites of hole M-1-81, but correlation with the M-1-81 hole is very uncertain except for the basal breccia).

The stratigraphically highest unit inside the crater in this northern area consists of a thin 1 m section of purplish-red mottled, dense microcrystalline dolomite. These beds appear to be relatively flat-lying with estimated dips of 0° to 20°. Lithologically, these beds are similar to the lower part of the Fort Garry Member of the Red River Formation, but such correlation seems unlikely. There is no evidence to suggest that these beds and the underlying yellowish mottled dolomite are not normal sedimentary units deposited within the crater.

Time and weather permitted only two short holes outside of the granite rim, and only one intersected Precambrian basement. Neither hole intersected the Paleozoic-Precambrian contact. The apparent outward dip on the Precambrian surface is approximately 30°, the same as inside the crater. There is no evidence of any veinlets cutting the granite in this hole, but the intersection is

too short to permit any inferences as to the degree of "disruption" of Precambrian basement outside of the crater rim. Hole M-1-81 intersected approximately 6 m of yellow-grey, mottled, cherty dolomite that appears identical to the mottled dolomite overlying the dolomite breccia inside the crater rim. Here again, the section is uniform, and although the core is badly broken, there is no evidence of structural disturbance of these strata. An outcrop approximately 30 m northwest of hole M-7-81 consists of purplish-red mottled dense dolomite identical to that found inside the crater at the top of hole M-5-81. This apparent correlation of stratigraphic sequence inside and outside the granitic rim may have important implications with respect to the crater hypothesis.

SUMMARY AND SUGGESTIONS

The data collected to date are insufficient to allow any definite conclusions to be made, although some implications or suggestions can be drawn from the above discussion. Considerably more ground mapping, geophysical profiling, and especially drilling will be required. The limited data seem to be consistent with the suggestion that the Highrock Lake disturbed area is a crater (meteorite impact?) structure, but some peculiarities must be noted.



Figure GS-17-4: Breccia samples — Highrock Lake area.

- a) The uplifted "granitic rim" probably is not a continuous feature, but rather may be an irregular series of uplifted basement blocks. This is suggested by the occurrence, a short distance west of the norther granite, of beds believed correlative with the Stony Mountain Formation. These beds occur at a location where granite would be expected if the uplifted rim is uniform and symmetrical. The nature of the ground magnetic profile also suggests an irregular, structurally complex "rim uplift."
- b) The crater-fill breccia contains almost no basement derived material, and the dolomitic limestone lithology characteristic of the lower Paleozoic succession also is not identifiable as a breccia component (possibly the limestone component has been dolomitized?).
- c) The crater fill, other than the basal breccia, seems to consist of a "normal" sedimentary sequence of dolomite and sandy argillaceous dolomite, suggestive of Paleozoic infill, as contrasted with the Mesozoic clastic/evaporite infill of the Lake St. Martin crater. The sandy argillaceous component of the fill could possibly represent redeposition of the sandy argillaceous material expelled from the crater (i.e. Winnipeg Formation), or it could possibly represent local thickening of a lower Paleozoic (post-Stony Mountain) sandy argillaceous marker bed.
- d) The occurrence of apparently undisturbed yellowish mottled dolomite and purplish-red mottled dolomite both inside and outside the crater, and with no appreciable reworking of the underlying crater breccia suggests that little or no post-

crater erosion has occurred, other than relatively recent erosion. This is supported by the presence of dolomite breccia outside the crater rim on the southeastern flank; such breccia, if crater-derived rather than formed in-situ, would have been quickly eroded if appreciable post-crater erosion had occurred.

From the above, it seems reasonable to suggest, on a tentative basis, that the Highrock Lake structure is an early Paleozoic crater feature, possibly Silurian in age. However, the investigations thus far have not encountered any evidence of *diagnostic* impact criteria, such as shock-metamorphic fabrics/structures, melt rock, or breccias of undisputed impact origin. Such features can be expected only in the deeper, central portions of the structure, and can be determined only by additional core hole drilling, provided the depth of crater excavation does not exceed the drill capacity.

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1980: Lake St. Martin Crypto-Explosion Crater and Geology of the Surrounding Area; Manitoba Mineral Resources Division, Geological Paper 3/70.

GS-18 STRATIGRAPHIC MAPPING AND CORE HOLE PROGRAM

by H.R. McCabe

The stratigraphic mapping and core hole program involves a number of ongoing projects. This year, a total of 20 holes were drilled for a total of 672 m. Seven of the holes were drilled in support of the Highrock Lake study, which is covered separately in this report (GS-17). Seven were drilled in Devonian limestones in the Dawson Bay area (Fig. GS-19-1) in support of the industrial minerals high-calcium limestone study, and also in an attempt to define more accurately the Devonian structure and stratigraphy, particularly with respect to reef distribution. Additional ground mapping also was carried out in this area. Two deep holes were drilled in Upper Devonian limestones in the Winnipegosis Quarry, one in a salt collapse "breccia plug," to acquire additional stratigraphic information and to define the mechanics of Devonian salt solution and collapse. Two holes were drilled in the Narrows area of Lake Manitoba to determine Winnipegosis reef thicknesses and facies relationships, and two holes were drilled east of Lake Winnipeg, near Manigotagan, on an outlier of Winnipeg Formation to obtain data for the industrial minerals silica sand survey.

DAWSON BAY PROJECT

The stratigraphic purpose of the core holes was primarily to establish correlation for several occurrences of stromatoporoidal limestones. The economic significance of the results is discussed separately by B.B. Bannatyne (GS-19, this report).

Several isolated occurrences of highly fossiliferous stromatoporoidal limestone had been mapped in the Dawson Bay area, adjacent to outcrops of known Point Wilkins strata. Their location was such that the limestone appeared to overlie Point Wilkins beds. It was suspected, however, that some occurrences could result from structural uplift of lower, Dawson Bay limestones as a result of draping over buried Winnipegosis reefs. All of the questionable occurrences were drilled, and all turned out to be Upper Dawson Bay (Table GS-18-1).

Further ground checking along several cut lines and trails turned up a number of additional occurrences of Upper Dawson Bay limestones in areas previously thought to be underlain by

Point Wilkins strata. As noted by Bannatyne (op. cit.) this has considerably reduced the area of occurrence of economically exploitable high-calcium limestone deposits, and points out the importance of detailed mapping and core hole drilling in defining the complex geology of this area.

The newly-noted occurrences of reef-supported Upper Dawson Bay domes indicate the Winnipegosis reefs are more common in the area between the Steeprock and Red Deer Rivers than previously thought. Although current mapping and drilling show the extreme local complexity that can be expected, the new occurrences of Upper Dawson Bay domes are seen to fit well with the regional pattern (Uyeno, McCabe and Norris, in press.) of a strike belt of reef-supported Upper Dawson Bay domes immediately downdip from a strike belt of reef-supported Lower Dawson Bay domes, which in turn lie downdip from the outcrop belt of Winnipegosis reefs proper. Inter-reef occurrences commonly are Point Wilkins Limestone. The approximate positions of these belts are shown in Figure GS-19-1.

The occurrence of a series of relatively uniform belts of reef-supported structural domes results from several factors:

- the relative uniformity of Winnipegosis reef heights (± 55 m above platform)
- the uniformity of true structure (dip of ± 1.7 m/km on base of Winnipegosis)
- the occurrence of soft recessive shaly beds overlying the resistant carbonate units, which has resulted in preservation of the domal configuration at the present day erosion surface.

Some of the apparent scatter of outcrops relative to their proposed belts is due to the effect of present day topographic relief rather than variation in the above factors, although some true structural and stratigraphic variation undoubtedly occurs.

One deep hole, M-17-81, was drilled at the west end of the Steeprock River campground. The test confirmed that the small river-bank outcrop consists of Souris River strata, and reflects a structurally low inter-reef position. (Because the site is topographically low, the outcrop consists of First Red Beds

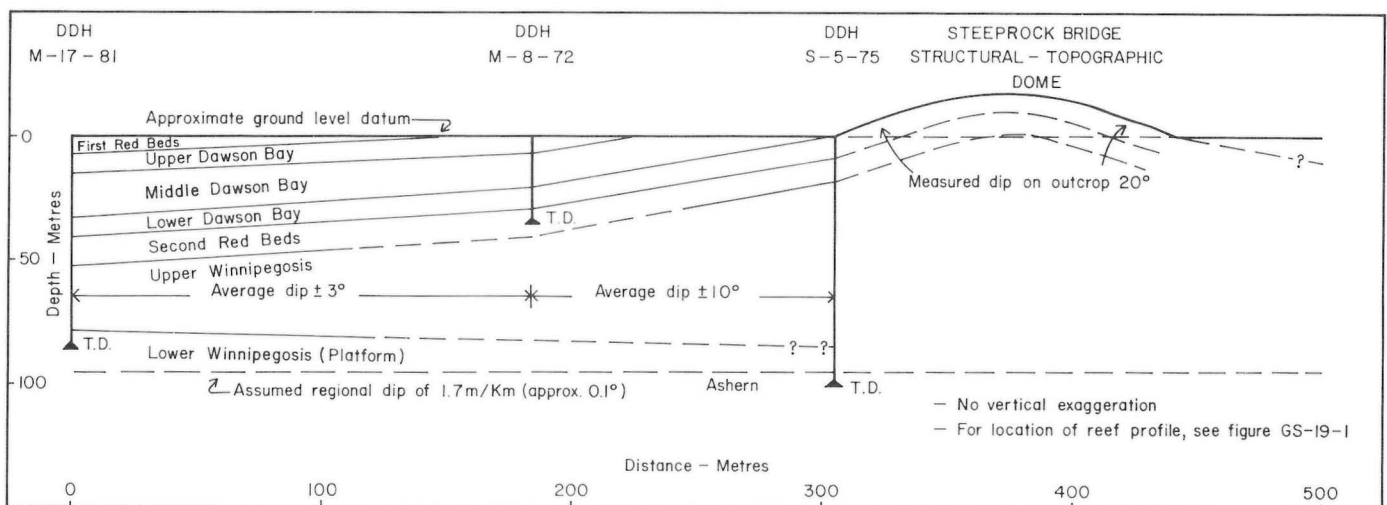


Figure GS-18-1: Winnipegosis reef profile — Steeprock River reef.

rather than Upper Point Wilkins). This hole is the third drilled on the flank of the prominent, reef-supported Lower Dawson Bay dome located just past the Steeprock River bridge. Figure GS-18-1 shows a true-scale structural profile across the reef. Because of heavy artesian flow from the Winnipegosis beds, it was not possible to drill to the base of the Winnipegosis section, and the base had to be estimated by extrapolation from the S-5-75 hole. The Upper Winnipegosis strata in hole M-17-81 show a mixture of fine bituminous laminite, typical of inter-reef locations, and coarser-grained interbeds of carbonates and carbonate breccia believed to represent detritus derived from the adjacent reef.

WINNIPEGOSIS QUARRY - SALT COLLAPSE PROJECT

Mapping of the Winnipegosis quarry had shown a small area of chaotic mega-breccia surrounded on three sides by normal, flat-lying to gently undulating limestones of the Devonian Souris River Formation (Sagemace Member). Regional studies had indicated that the quarry beds are structurally low and are located in an area of salt collapse. Because the Souris River stratigraphy is not too well defined in this area, it was decided to drill 2 holes, one in the "breccia plug" and a second in the adjacent normal quarry beds. The normal hole was intended to provide detailed structural and stratigraphic correlation for the breccia hole.

The normal hole, M-16-81, correlates well with other holes in the area, except for a zone of Winnipegosis (?) breccia which is discussed later. The post-Winnipegosis section shows some minor fracturing and brecciation, but no prominent brecciation is noted except in proximity to the basal Sagemace shale, the First Red Beds and the Second Red Beds. These breccia zones all occur at horizons where salt beds are present in the deeper parts of the basin, and represent stratigraphically confined breccias

directly related to solution of the specific evaporite beds.

In hole M-10-81, located on the breccia plug, brecciation is seen to extend from surface to the top of the Winnipegosis, but with extreme differences in the degree of brecciation. Some intervals appear relatively normal, flat-lying and undisturbed, whereas others are totally brecciated. In general, however, the overall stratigraphic succession is well preserved, as shown by correlation with hole M-16-81 (Fig. GS-18-2). Although the extent of brecciation is much greater in this hole than in M-16-81, it is nevertheless not as great as suggested by the chaotic nature of the out-crop section.

The most notable anomaly in hole M-10-81 is a basal "mega-breccia" occurring below the Second Red Beds and above the Winnipegosis. As expected, the Winnipegosis consists of a thin sequence of laminated inter-reef carbonates overlying Lower Winnipegosis platform beds. By comparison with reefal sections in the same general area, a minimum of about 90 m of evaporite (possibly much more) has been dissolved. At this former salt horizon, in the M-10-81 hole, we find a 15.2 m thick breccia zone consisting of blocks up to 1.5 m thick of identifiable Dawson Bay lithologies. Intervals of finer polymict breccia, and other blocks not correlatable to specific stratigraphic horizons also are present. This zone represents a true collapse breccia. Its occurrence as a distinct unit below a relatively coherent stratigraphic succession suggests that it represents collapse and infill of an open solution cavern beneath a still intact sedimentary cover. This earliest collapse breccia moved laterally beneath the adjacent sedimentary cover, partly filling the open cavern, and then the overlying unsupported sediments also collapsed. Formation of the breccia plug thus appears to have been a progressive series of events involving development of open solution caverns and subsequent collapse.

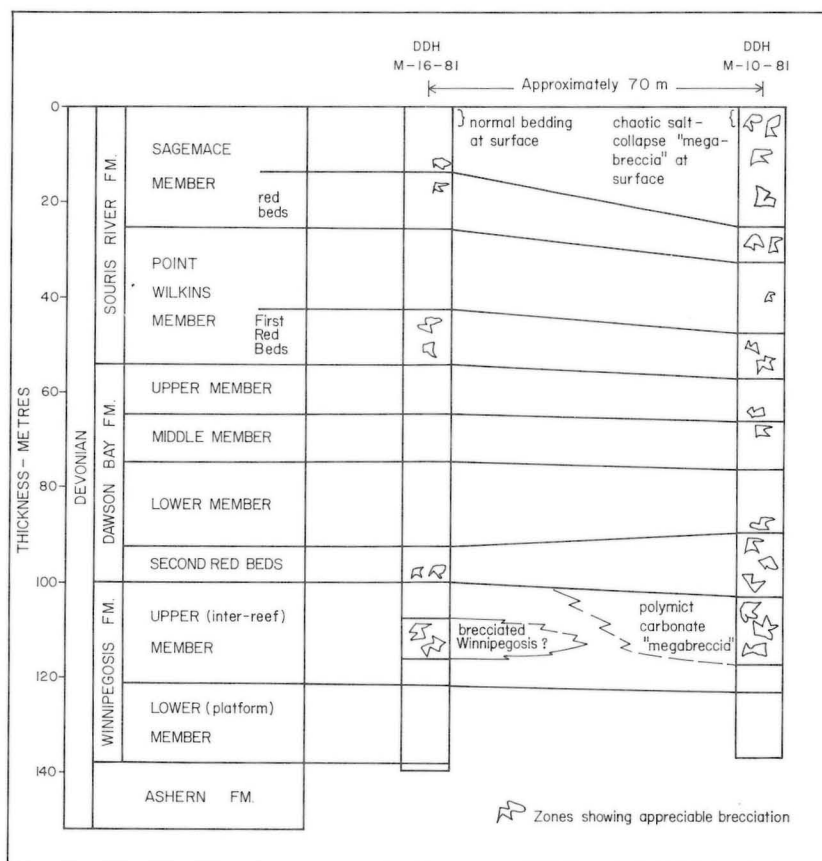


Figure GS-18-2: Devonian correlation profile — Winnipegosis quarry.

Collapse of the surrounding area, the presently "normal" sedimentary succession, must have resulted from a different process and probably occurred at a much later time. The relative integrity of the stratigraphic succession suggests that little or no open cavern collapse occurred, but rather that regional solution of evaporite took place over a wide area, probably as a result of regional flow through the Winnipegosis aquifer, permitting relatively uniform subsidence of overlying strata rather than collapse.

The localized nature of the breccia plug suggests control by fracturing, possibly analogous to the linear, fracture-controlled(?) salt collapse lows evident in Mississippian strata of the Virden producing area (McCabe, 1963).

The occurrence of the Upper Winnipegosis Breccia in hole M-16-81, the "normal" hole, poses a new problem that cannot presently be resolved. The breccia apparently occurs within the Upper Winnipegosis inter-reef laminite facies, and appears to consist largely of brecciated Winnipegosis type material, but not reef-flank breccia. The lower part of the breccia, however, is very mixed and includes some possibly rounded fragments. Below the breccia is a sequence of fine shaly laminated beds showing local convolute bedding, and dips inclined $\pm 20^\circ$ to the core axis. The high argillaceous content of these beds is unlike any known Upper Winnipegosis lithology, and suggests post-Winnipegosis sedimentary infill.

The brecciation of the Winnipegosis suggests the possibility of solution of an evaporite bed within the Upper Winnipegosis sequence, but no similar occurrences are known. Some type of karsting also is a possibility.

The closely spaced core holes provide a unique opportunity to evaluate the complex processes involved in Devonian salt solution and collapse. Additional drilling, will be carried out and further comparisons, will be made with other core holes intersecting collapse breccias.

THE NARROWS - WINNIPEGOSIS REEF PROJECT

Hole M-8-81 is located in a new Winnipegosis quarry near Overton. In previous drilling of numerous Winnipegosis localities in this area, only one hole, M-1-72, had penetrated to the base of the Devonian section. All other holes had intersected a zone of caving and sandy infill that had caused severe drilling problems and premature abandonment of the holes. Sandy cavern fill (Jurassic or Cretaceous?) noted at several places in the Overton Quarry suggests that the quarry beds are the problem zone. Approximately 13.3 m of vuggy, in part brecciated dolomite were

intersected above a 7.6 m zone referred to as atypical Elm Point Formation. These beds consist of mottled dolomitic limestone, with the dolomite content ranging from about 20% to 80%, and generally increasing downward. The basal one metre is totally dolomitized. This occurrence contrasts markedly with the type Elm Point beds, which are high-calcium limestones showing only slight traces of dolomitization. The total Devonian thickness of only 20.9 m is less than the Elm Point thickness reported in hole M-1-72, suggesting that the entire succession may be stratigraphically equivalent to Elm Point.

Hole M-9-81 was located on the southwestern flank of the Narrows West reef. A previous hole, M-5-69, had been drilled in a quarry located in the central part of the reef, but the hole had to be abandoned at a depth of 42 m, where a zone of caving was intersected. It was hoped that drilling conditions would be better in the reef-flank location, but the same zone of sandy caving was intersected at approximately 39 m, causing abandonment of the hole. The Winnipegosis section consists of uniform, massive to thick bedded, vuggy, fossiliferous to intraclastic dolomite with some faint bedding inclined at about 15° .

WINNIPEG FORMATION - SILICA SAND PROJECT

Holes M-19-81 and M-20-81 were drilled to obtain material for the industrial minerals silica sand study (Watson, GS-20, this report). The holes are located near Seymourville, east of Lake Winnipeg, in newly opened borrow pits comprising outliers of sandstone of Winnipeg Formation. These occurrences may have considerable structural and stratigraphic implications. They represent the only known Paleozoic outliers along the eastern edge of the Paleozoic section of southwestern Manitoba, and their existence is surprising in view of the soft recessive nature of the Winnipeg sands, and the apparent lack of a protective cap of Red River limestones.

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TABLE GS-18-1 SUMMARY OF CORE HOLE DATA

Hole No.	Location and Elevation	System/Formation/Member	Interval (metres)	Summary Lithology
M-1-81	SE1-9-29-2W	(Highrock Lake crater fill)	0 - 9.7	Fossiliferous dolomitic calcarenite.
		(Paleozoic? Silurian?)	9.7 - 21.5	Mixed dolomites, minor shale.
			21.5 - 44.5	Sandy argillaceous dolomite and dolomitic shale.
			44.5 - 62.3	Polymict carbonate breccia, trace sandstone and granite fragments.
M-2-81*	NE10-9-29-2W	(Highrock Lake crater fill)	0 - 0.64	Yellowish mottled dolomite, microcrystalline.
		Precambrian	0.64 - 3.9	Sandy dolomite breccia, polymict.
			3.9 - 4.67	Granite, partly brecciated; veinlets of calcite and sandy dolomite.
M-3-81*	NE10-9-29-2W (+ 244 m est.)	(Highrock Lake crater fill)	0 - 2.2	Yellowish mottled dolomite, microcrystalline.
		Precambrian	2.2 - 4.7	Sandy dolomite breccia, polymict.
			4.7 - 5.7	Granite, as above.
M-4-81	NE10-9-29-2W (+ 244 m est.)	(Highrock Lake crater fill)	0 - 4.3	Yellowish mottled dolomite, microcrystalline.
		Precambrian	4.3 - 6.9	Sandy dolomite breccia, polymict.
			6.9 - 13.9	Granite, as above.
M-5-81*	NE10-9-29-2W (+ 244 m est.)	(Highrock Lake crater fill)	0 - 0.8	Dolomite, fine grained, dense, mottled purplish-red.
			0.8 - 7.9	Yellowish mottled dolomite.
			7.9 - 11.0	Sandy dolomite breccia, polymict.
M-6-81*	NE10-9-29-2W (+ 244 m est.)	Precambrian	0 - 5.6	Overburden.
			5.6 - 6.6	Granite, massive.
M-7-81*	NE10-9-29-2W (+ 244m est.)	Paleozoic - ?	0 - 4.3	Yellowish mottled dolomite.
M-8-81	46-23-7W (+ 259 m)	Devonian-Winnipegosis Elm Point	0 - 13.3	Dolomite, vuggy, granular.
			13.3 - 20.95	Dolomitic limestone grading downward to calcareous dolomite and dolomite.
		Ashern	20.95 - 22.3	Dolomitic shale and argillaceous dolomite, buff to reddish grey.
M-9-81	SE1-20-24-10W (+ 259 m est.)	Devonian-Winnipegosis	0 - 39.7	Dolomite buff, massive to faintly bedded, dipping to 15°, fossiliferous.
M-10-81	NW15-9-31-18W (+ 257.6 est)	Devonian-Souris River-Sagamace	0 - 24.9	Limestone, minor dolomite, variable brecciation.
		Point Wilkins	24.9 - 32.2	Dolomitic shale, highly brecciated.
			32.2 - 47.5	Limestone and dolomite, some breccia.
			47.5 - 56.8	First Red Beds, highly brecciated.
		Dawson Bay	56.8 - 66.1	Dolomite, minor limestone, moderately brecciated.
			66.1 - 76.0	Calcareous shale, medium grey, highly brecciated at top with dolomite inclusions.
			76.0 - 89.5	Fossiliferous limestone grading to dolomite, brecciated towards base.
		(Second Red Beds)	89.5 - 102.8	Shale, brownish-red, brecciated.
		(collapse breccia)	102.8 - 117.0	Mixture of blocks of above lithologies.
		Winnipegosis	117.0 - 123.0	Dolomite, finely laminated, bituminous (inter-reef facies).
			123.0 - 136.5	Dolomite, massive, vuggy (platform).
M-11-81	NE3-6-45-25W (+ 283.5 m est.)	Devonian-Dawson Bay	0 - 4.15	Limestone and dolomite, coarsely crystalline.
			4.15 - 14.5	Grey calcareous shale, fossiliferous.
M-12-81	SW9-6-45-25W (+ 282 m est.)	Devonian-Dawson Bay	0 - 5.35	Dolomite, brown, granular.
			5.35 - 11.45	Grey calcareous shale, fossiliferous.
M-13-81	NE2-21-44-25W (+ 282 m est.)	Devonian-Dawson Bay	0 - 2.64	Limestone, buff.
			2.64 - 11.45	Grey calcareous shale, fossiliferous.
M-14-81	NW1-5-45-25W (+ 274.3 m est.)	Devonian-Dawson Bay	0 - 6.8	Limestone and dolomite.
			6.8 - 17.55	Grey calcareous shale, fossiliferous.
M-15-81	SE3-8-45-25W (+ 275.8 m est.)	Devonian-Souris River-First Red Beds	0 - 10.95	Interbedded limestone dolomite and shale, grey to reddish.
		Dawson Bay	10.95 - 11.45	Limestone, light grey, coarsely crystalline.
M-16-81	NW15-9-31-18W (+ 257.6 m est.)	Devonian-Souris River- Sagamace	0 - 13.6	Limestone, some dolomite, brecciated towards base.
		Point Wilkins	13.6 - 25.2	Shale and dolomitic shale, brecciated.
		(First Red Beds)	25.2 - 42.1	Limestone and dolomite.
		Dawson Bay	42.1 - 54.15	Shale, grey to red, highly brecciated.
			54.15 - 64.8	Limestone and dolomite.
			64.8 - 76.5	Grey calcareous shale, fossiliferous.
			76.5 - 92.85	Limestone, fossiliferous; dolomite.
		(Second Red Beds)	92.85 - 102.15	Dolomitic shale, brecciated.
		Winnipegosis(Upper)	102.15 - 116.1	Dolomite and limestone, brecciated, shaly laminated at base (inter-reef facies).
			116.1 - 121.3	Dolomite, bituminous laminate.
		(Lower)	121.3 - 137.95	Dolomite, massive, vuggy (platform).
		Ashern	137.95 - 139.55	Dolomitic shale.
M-17-81	SE8-14-44-25W (+ 254.5 m est.)	Devonian-Souris River Dawson Bay	1.6 - 7.5	Red dolomitic shale (First Red Beds).
			7.5 - 15.0	Limestone and dolomite.
			15.0 - 33.5	Grey calcareous shale, fossiliferous.
			33.5 - 40.2	Limestone, brachiopod biomicrite, grading to argillaceous dolomite.
		(Second Red Beds)	40.2 - 53.4	Red to grey shale, brecciated.
		Winnipegosis(Upper)	53.4 - 57.85	Limestone, in part breccia.
			57.85 - 79.3	Dolomite, bituminous laminate with fragmental interbeds (proximal, inter-reef).
		(Lower)	79.3 - 85.75	Dolomite, vuggy (platform).
M-18-81	NE7-5-45-25W (+ 274.3 m est.)	Devonian-Souris River Dawson Bay	0 - 5.5	Dolomite and shale (First Red Beds).
			5.5 - 13.6	Limestone and dolomite.
			13.6 - 20.6	Calcareous shale, fossiliferous.

M-19-81	2-6-26-9-E (+ 232 m est.)	Ordovician-Winnipeg Precambrian	0 - 10.2	Sandstone, quartzose, poorly consolidated.
			10.2 - 12.0	Highly weathered basement, clay.
M-20-81	16-25-25-8E (+ 247 m est.)	Ordovician-Winnipeg Precambrian	0 - 25.4	Sandstone, quartzose, unconsolidated.
			25.4 - 27.0	Highly weathered, basement, chloritic, gneissic?

*Holes inclined 45° towards granite. Depths corrected to vertical.

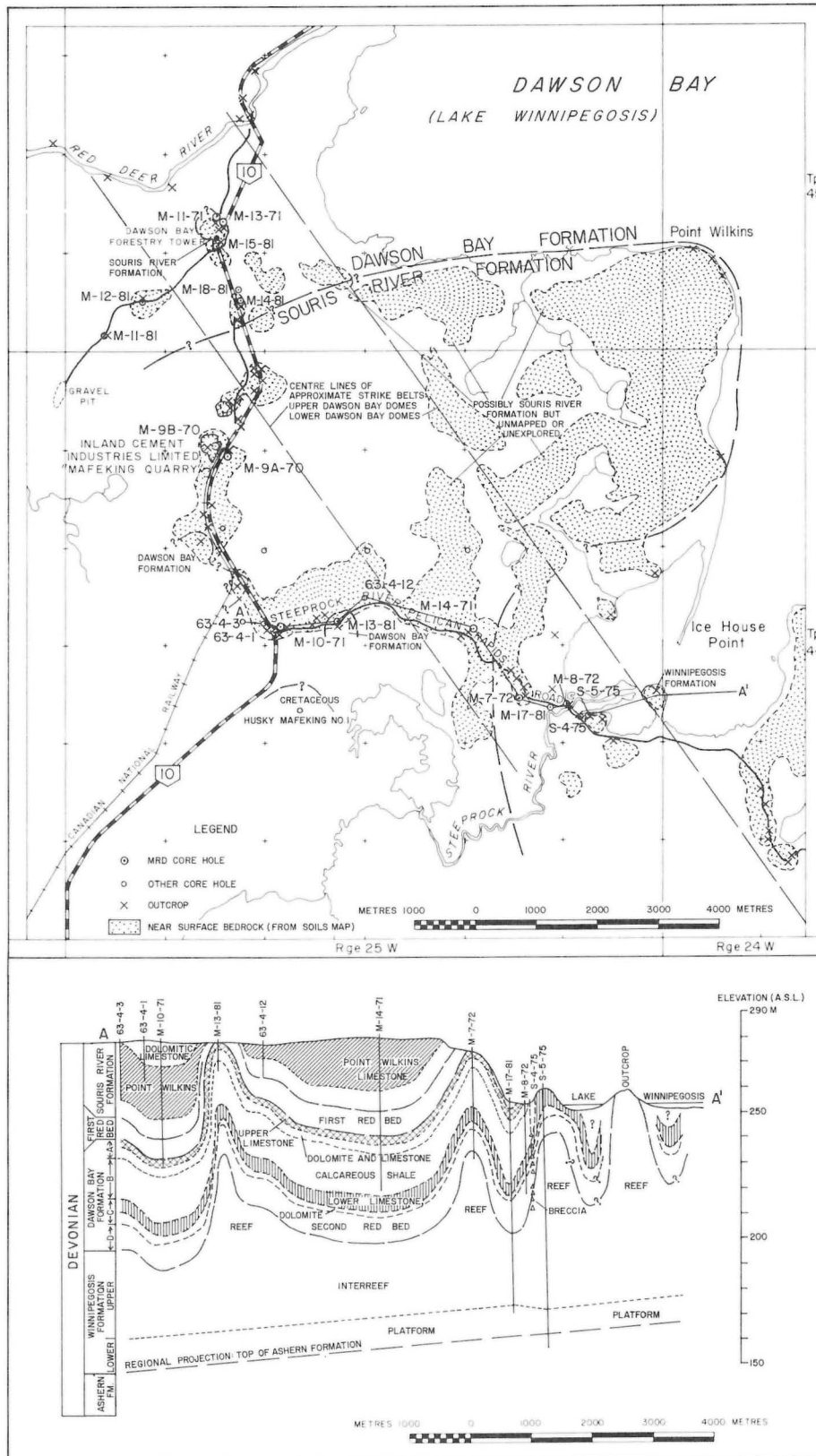


Figure GS-19-1: Geology of the Dawson Bay area (a revision of Fig. 10A, Bannatyne, 1975).

GS-19 LIMESTONE RESOURCES OF THE DAWSON BAY AREA

by B.B. Bannatyne

INTRODUCTION

The Dawson Bay area, as shown in Figure GS-19-1, is underlain by the Middle Devonian Winnipegosis, Dawson Bay and Souris River Formations. Lithologies present include limestone, dolomite and shale. A description of the limestone resources of that area was included in Bannatyne (1975). High-calcium limestone occurs at the top of the Winnipegosis Formation, in both the lower and upper parts of the Dawson Bay Formation, and in the Point Wilkins Member of the Souris River Formation. In that report it was stated or implied that three outcrops were of strata above the Point Wilkins Member and that another limestone unit (part of the Sagemace Member) occurred 9 m above the Point Wilkins Member, analogous to the Winnipegosis area where such a sequence has been proven by drilling. (See McCabe, GS-18, this report). However, it was recognized that the stratigraphic position of some other outcrops was uncertain.

In 1981, seven outcrops in the Dawson Bay area were drilled, and results showed that the bedrock surface was formed of either the upper Dawson Bay limestone, or the immediately overlying First Red Bed; no occurrence of the Sagemace Member has been found to date. These new drill results require a re-evaluation of the high-calcium limestone resources of the Dawson Bay area.

DEVONIAN REEFS AND SALT SOLUTION

The distribution of the various limestone beds is dependent primarily on the presence or absence of Winnipegosis reefs, as well as on such factors as topography and thickness of overburden. In Devonian time, inter-reef areas were filled with halite of the Prairie Evaporite, and the Dawson Bay and Souris River Formations were subsequently deposited. Solution of the halite in post-Souris River time resulted in the draping of beds over the reefs and their subsidence into the inter-reef basins. Erosion to the present day surface has resulted in the distribution shown on the map and in cross-section A-A' in Figure GS-19-1.

HIGH-CALCIUM LIMESTONE RESOURCES

The limestone of the Point Wilkins Member is 20 m thick and

averages 96.45% CaCO_3 , 1.36% MgCO_3 and 1.59% SiO_2 . Under ideal conditions, such as at drill site M-14-71, the full thickness is preserved with no overburden. In other places, e.g. M-10-71, as much as 9 m of dolomitic limestone overlies the Point Wilkins Member. The limestone has been quarried by Inland Cement Industries Limited since 1963, and other companies hold permits or leases in the area. It had been assumed that the member underlain most of the area between the Mafeking quarry and Point Wilkins, but the results of this year's drilling indicate that, because of the possible presence of reefs, detailed mapping and drilling will be required to determine reserves in the region marked "unmapped and unexplored."

The numerous occurrences of the upper limestone of the Dawson Bay Formation may be of economic importance. The area around the 1981 drill sites, the extensive outcrop area east and southeast of M-14-71, and other locations are worthy of exploration. The unit has a maximum known thickness of 4.8 m with an estimated average thickness of 3 m, and is a very clean limestone. Available analyses indicate:

M-8-72:	4 m of core	98.36% CaCO_3	0.94% MgCO_3
M-13-81:	outcrop sample	99.09% CaCO_3	0.73% MgCO_3
M-14-81:	1.1 m in outcrop	98.22% CaCO_3	0.94% MgCO_3

Silica content, where determined, was 0.30% SiO_2 .

Occurrences of the lower Dawson Bay limestone and the limestone at the top of the Winnipegosis Formation are described in the 1975 report.

The assistance of H.R. McCabe in unravelling the stratigraphy of this area is greatly appreciated, and the complexities revealed by the drilling vindicate the modest cost of this program. Once again, the resourcefulness of our drilling crews must be acknowledged.

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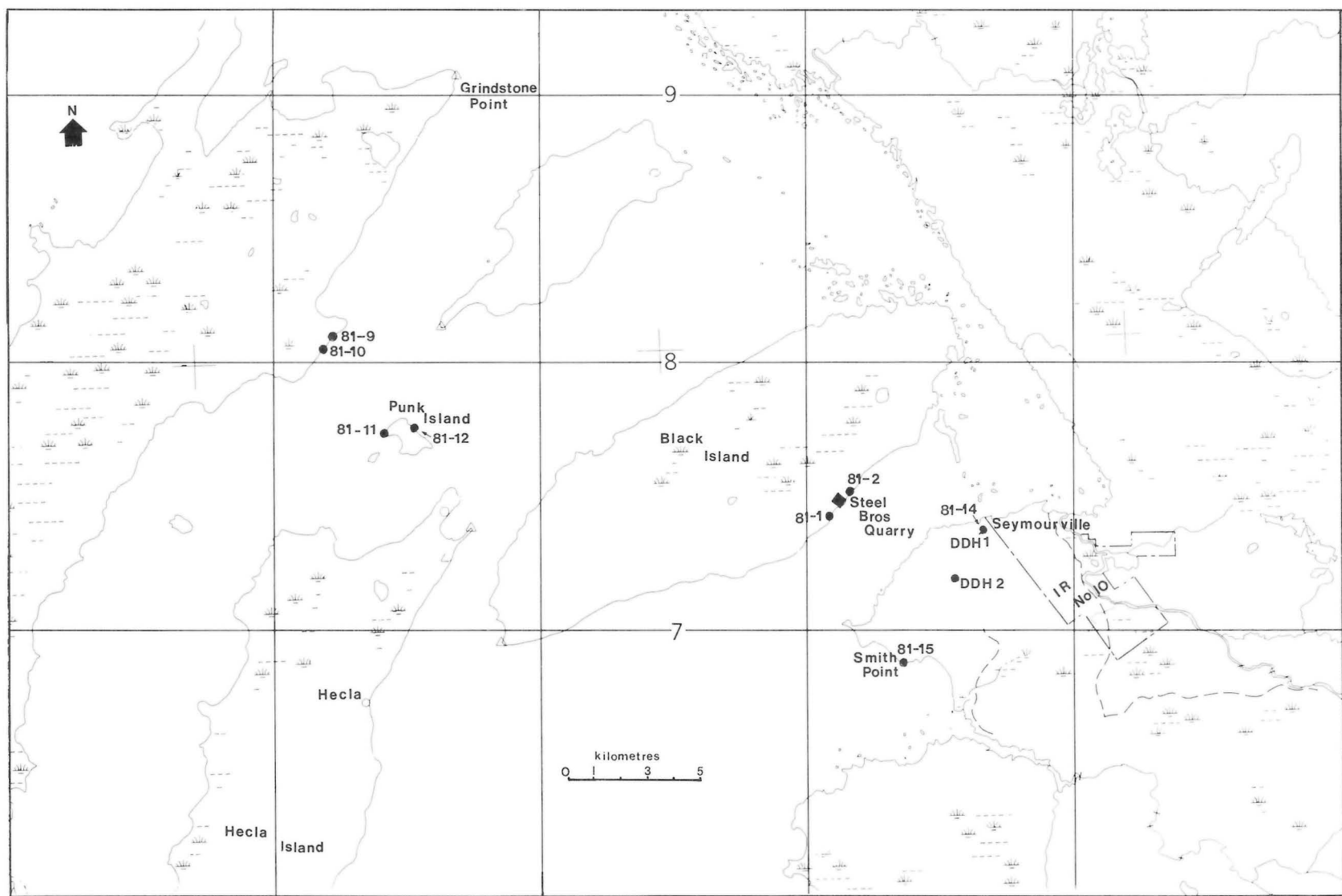


Figure GS-20-1: Sample locations, Winnipeg Sandstone in the Grindstone-Hecla-Black Island area.

GS-20 SILICA RESOURCES OF SOUTHERN MANITOBA

by David M. Watson

INTRODUCTION

Silica, silicon dioxide or quartz is an important industrial raw material. The presence of significant amounts of silica in Manitoba has been known (or suspected) since Tyrrell and Dowling's (1900) study of the Ordovician strata in the Lake Winnipeg area. A paper on silica sand in Manitoba was published recently (Spiece, 1980).

During this first year of a two year study of the silica deposits of Manitoba, the Ordovician Winnipeg Sandstone was examined in the Hecla-Black Island-Manigotagan area. This area includes Manitoba's only current silica producer, the Black Island operation of Steel Brothers Canada Limited. Several samples from other areas were also obtained and examined.

FIELD WORK

Known exposures of Winnipeg Sandstone in the Grindstone Point, Hecla, Black Island and Manigotagan areas were examined. At each location, sections were measured and samples were collected to represent

- 1) the entire section and
- 2) specific beds that appeared significantly different from the whole, i.e. coarser or more highly coated with iron oxide or kaolin.

In addition, two holes were drilled in the Seymourville area (Fig. GS-20-1). These were designed to penetrate the entire Winnipeg Sandstone and to give some idea as to its thickness in an area of little outcrop. These holes penetrated 10.2 and 26.8 m of sand before bottoming in the underlying Precambrian rocks.

Sieve and chemical analyses of samples from these holes are presented in Figure GS-20-2 and Table GS-20-1, along with those of the other samples collected during the summer.

LABORATORY WORK

All of the sandstone samples were dried at 110°C, and then crushed by hand rolling until they were completely disaggregated. Portions of each sample were examined optically to determine whether or not the coarse grains were individual grains or cemented aggregates of smaller particles. The samples were then split and passed through a nest of sieves on a Ro-Top machine. Sieving time was 20 minutes.

After sieving the fractions were weighed, then stored in bags for chemical analysis or further examination. Results of sieve analyses are given in Figure GS-20-2.

Chemical analyses of some samples are given in Table GS-20-1. The sands that were analysed were split from the unwashed, unscreened samples. Some impurities could be removed by washing or selective sieving, and the silica content upgraded. Analyses of washed samples are planned.

In addition to analyses of samples collected in the field this summer, chemical analyses are given in Table GS-20-1 for some "silica-rich" sands collected by G. Conley (Aggregate Resources Section) as part of a study of aggregate resources and land use in the Brokenhead area (Conley, 1980). Location of these samples are given in Figure GS-20-3. These Pleistocene sands are currently quarried at Beausejour and east of Libau for use as traction sand, in brick, and in portland cement.

TABLE GS-20-1

Sample No.	Location	wt.% SiO ₂	Sample	Location	wt.% SiO ₂
Drill hole 2	Seymourville			Beausejour-Brokenhead area (see Figure GS-20-2 for locations)	
0 - .9m		96.95	1	Sample from Backhoe Pits	87.10
1.8 - 3		96.70	2	Sample from Backhoe Pits	90.25
6.0 - 6.1		96.85	3	Sample from Backhoe Pits	87.45
7.2 - 7.9		95.35	4	Sample from Backhoe Pits	82.75
7.9 - 9.1		93.15	5	Sample from Backhoe Pits	90.60
9.1 - 10.1		85.55	6	Sample from Backhoe Pits	90.25
16.2 - 17.1		98.85	7	Sample from Backhoe Pits	86.70
17.1 - 18.2		96.85	8	Sample from Backhoe Pits	88.20
18.2 - 19.3		98.35	9	Sample from Backhoe Pits	91.45
22.3 - 22.9		96.45			
			81 - 15	Smith Point	96.50
			81 - 14	Seymourville	97.75

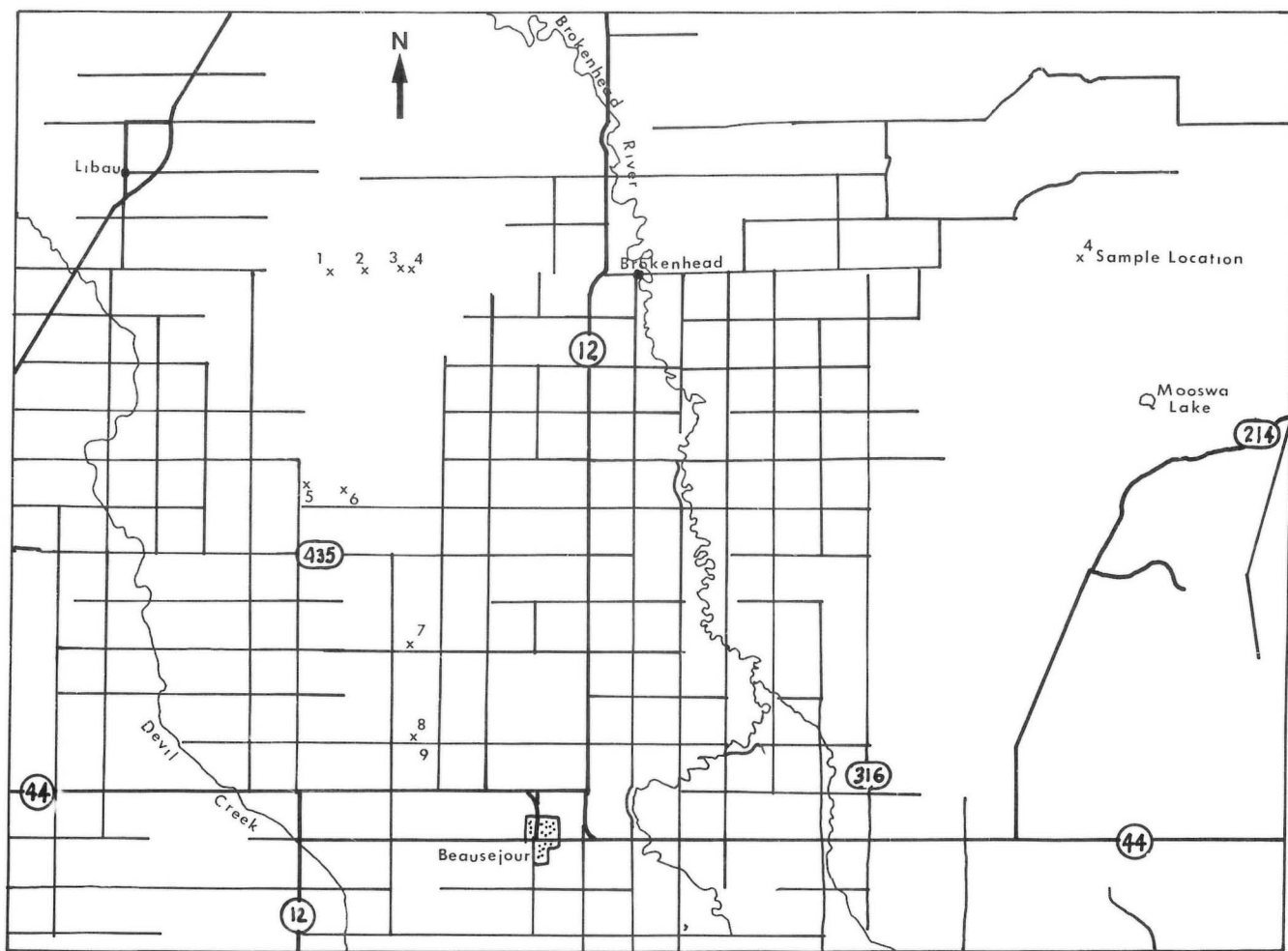


Figure GS-20-2: Sample locations from silica-rich sands in the R.M. of Brokenhead (Conley, 1980).

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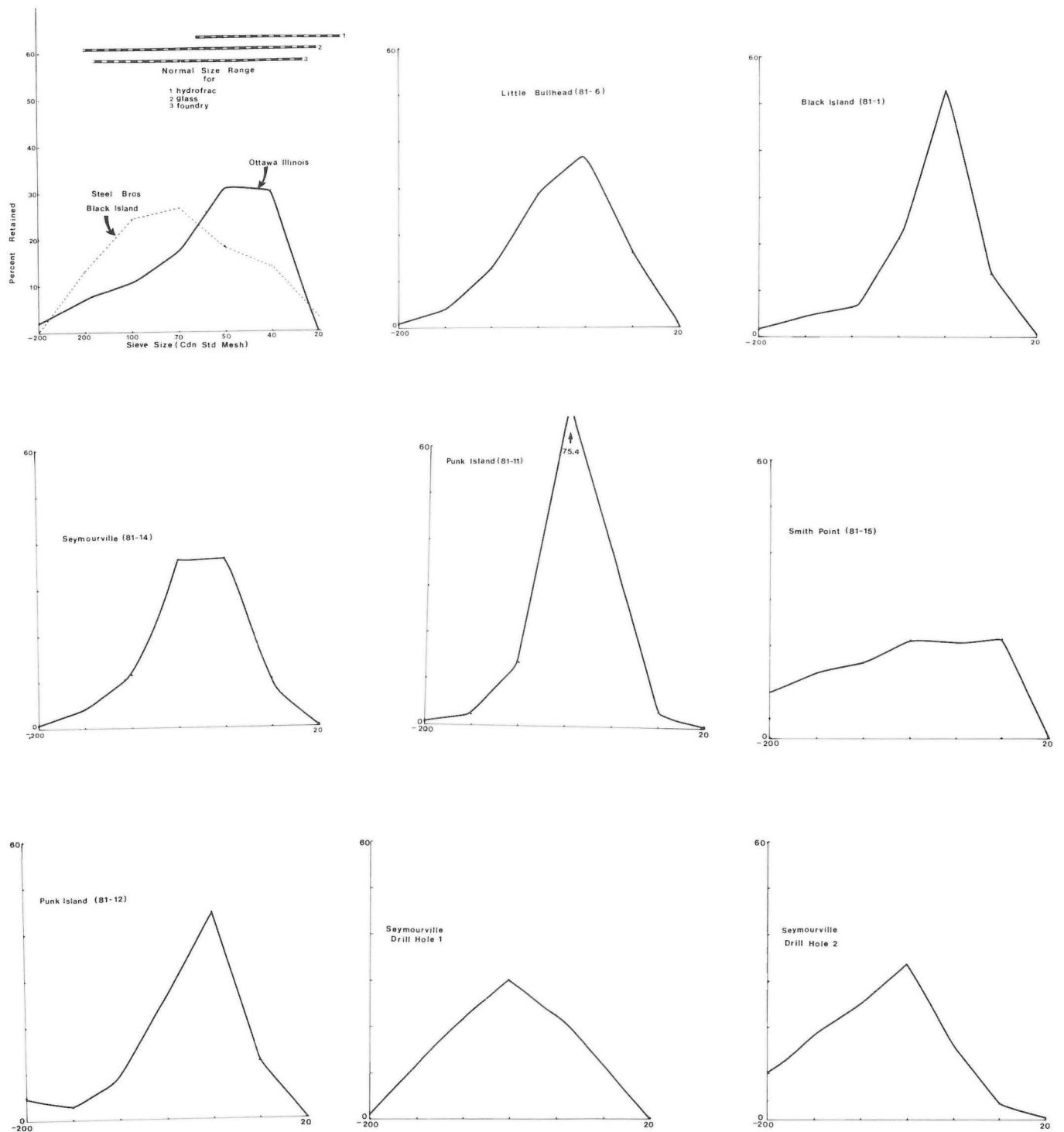


Figure GS-20-3: Size distribution of sand grains in the Winnipeg Sandstone.

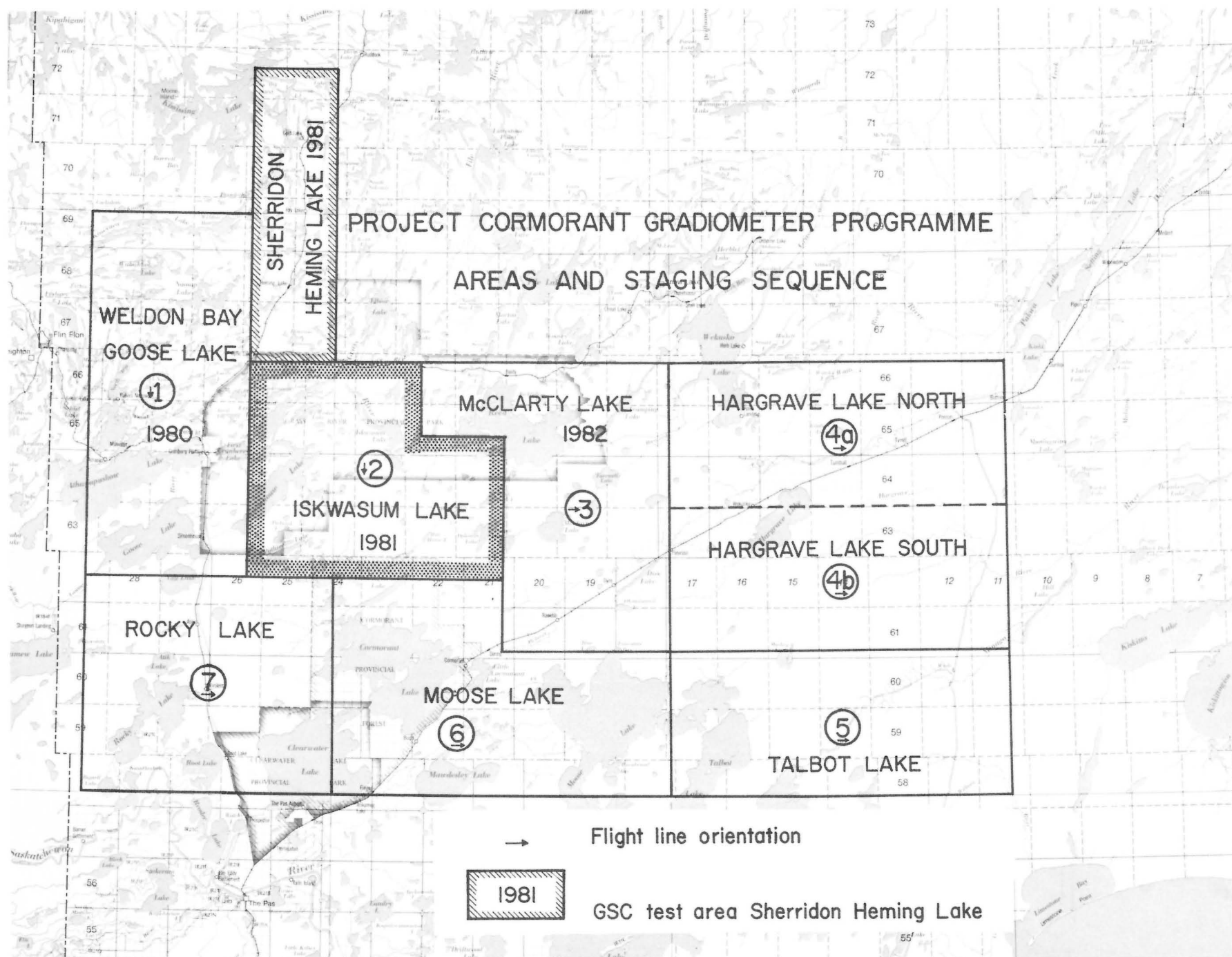


Figure GS-21-1: Project Cormorant Gradiometer program. Areas and staging sequence.

GS-21 GRADIOMETER SURVEYS

by W.D. McRitchie and I. Hosain

The region to the south of the Flin Flon-Snow Lake greenstone belt has long been considered an area with promising potential for economically viable base metal mineralization.

Although exploration has continued for several decades in this area much of the work has been hindered by the lack of a suitable geological data base, a continuous and southward thickening veneer of Paleozoic carbonate rocks, and from less than perfect ground control.

Drill hole data is spotty and clustered reflecting the drive to test anomalies detected primarily from airborne geophysical surveys. This scattered sampling of the basement in conjunction with the ½ mile Federal/Provincial aeromagnetic surveys was neither representative nor discriminating enough to derive a geological compilation for the area.

With the advent of vertical gradient aeromagnetic surveys and their demonstrated capability as a mapping tool (Hood *et al.*, 1979), the decision was made to acquire gradiometer and total field coverage for part of the area covered by Paleozoic rocks. The need to establish a base from which to extrapolate the correlation between observed geology and magnetic response was recognized and, accordingly, a test area was selected in 1980/81 (Weldon Bay-Goose Lake) that provided representative geology containing elements of both gneissic and greenstone terrane and an overlap into the region covered by the Paleozoic veneer (Fig. GS-21-1).

The survey was flown on north-south flight lines by the GSC Queenair aircraft at a mean altitude of 150 m with a line spacing of 305 m. The data was obtained using an on board gradiometer system consisting of two optical absorption magnetometers vertically separated by approximately 2 metres. The advantages of the magnetic gradiometer over the total field magnetometer are as follows:

- 1) superior resolution (0.0005 gammas) of anomalies produced by closely-spaced geological formations;
- 2) anomalies produced by near-surface features are emphasized with respect to those caused by deeply-buried lithologic units;
- 3) direct delineation of vertical contacts of the different rock types by the zero gradient contour;
- 4) regional gradient of the earth's magnetic field and diurnal variation are automatically removed.

Funding was provided under the Northlands Agreement and was shared between Canada Department of Regional Economic Expansion (60%) and the Manitoba Department of Energy and Mines (40%).

The results of the 1980/81 survey of the Weldon Bay-Goose Lake test area were released as GSC Open File 756 on June 30, 1981 and comprised 10 vertical gradient maps and 10 total field aeromagnetic maps at a scale of 1:20 000 covering N.T.S. areas 63K/5NE; 63K/6NW; 63K/11(W½); 63K/12(E½); 63K/13(E½) and 63K/14(W½). Copies of the file can be obtained at the user's expense from Campbell reproductions, 880 Wellington Street, Ottawa, Ontario, K1R 6K7. Digital magnetic tapes containing the edited recorded data and gridded aeromagnetic data are available from the Geological Survey of Canada, Room 567, 601 Booth Street, Ottawa, Ontario, K1A 0E8, at the user's expense on a cost recovery basis. On the day of the release 1:50 000 scale multi-

coloured Applicon Jet plots were also made available for inspection, together with Topographic overlays. Overlays of the airborne and ground electromagnetic surveys from the non-confidential assessment files for part of the area were also made available for inspection.

A team of Provincial geologists is currently engaged in analyzing the new data and in making comparisons and correlations with previously acquired geological, airborne and ground magnetic and electromagnetic data. The improved resolution of anomalies and greater detail and sensitivity provided by the gradiometer has resulted in the delineation of hitherto unidentified anomalies of both intermediate and high intensity as well as clearly demarkating totally unsuspected fault zones and major lithostructural domains with a diagnostic magnetic character. In addition there is a striking coincidence of gradiometer and electromagnetic anomalies. This is not so with the total field results. As the gradiometer is extremely sensitive it may be recording the minute magnetic signatures produced by the sulphide intersections causing the electromagnetic conductors. VLFEM data were also recorded on an experimental basis during the surveys using a Herz Totem 1A VLFEM receiver. Should this configuration prove operationally viable this additional capability could be added to future surveys thereby reducing the unit cost of data collection.

Although the evaluation of the results from the test area was still in a preliminary stage the initial findings were sufficiently encouraging to embark upon a longer term plan (Project Cormorant) that could eventually see the application of the new technology to the much larger area covered by Paleozoic rocks south to latitude 54° (Fig. GS-21-1). In 1981/82 the Iskwasum Lake area, to the east of the Weldon Bay-Goose Lake test area, was flown by the GSC at the request of the Province and is to be funded jointly under an agreement between the Canada Department of Energy and Mines and Resources and the Manitoba Department of Energy and Mines. Subsequent coverage (subject to the availability of appropriate funding), east to the Churchill-Superior boundary zone in the vicinity of Ponton, will complete a northern corridor with continuous overlap across the Precambrian/Paleozoic contact (Fig. GS-21-1). Should the correlation between vertical gradient response and geology prove sufficiently reliable a second generation of surveys will be attempted in the corridor to the south to complete coverage to latitude 54°, thereby providing the means to generate a geological compilation for the entire area.

In 1981 an additional area extending to the north of Iskwasum Lake, covering the area between Heming Lake and Sherridon, was flown at the request of GSC personnel working in that area. Information from this and the Iskwasum area should be made available in late Spring 1982 using a similar format to that adopted for the Weldon Bay-Goose Lake program.

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TABLE GS-21-2 GRADIOMETER SURVEYS IN MANITOBA 1980 - 1982

Project Designation	Total Area km²	Total Line km	Year Flown	Release Date
Weldon Bay/Goose Lake	2300	10 000	1980	June 30, 1981
Iskwasum Lake	1900	7900	1981	Spring '82
Sherridon/Hemming Lake	950	3700	1981	?
McClarty Lake	2000	9000	(1982)	?

GS-22 RUBIDIUM-STRONTIUM GEOCHRONOLOGY IN THE CHURCHILL STRUCTURAL PROVINCE, NORTHERN MANITOBA

by G.S. Clark

Department of Earth Sciences
University of Manitoba

INTRODUCTION

A Rb-Sr isotopic age investigation of selected lithological units in the Churchill province of Manitoba was initiated in 1979. The purpose of the study is to establish the temporal relationships of plutonism and metamorphism within and between the major tectonic domains of the Churchill province. Ages were obtained (or attempted) for ten rock units representing six tectonic domains as well as the Churchill-Superior Boundary area. Three metasedimentary rock units were included in the study. The Rb-Sr systematics of paragneisses are often useful to determine the time of metamorphism, and hence correlate this with periods of major plutonism, to place limits on the age of sedimentation and to use initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios to speculate on sediment provenience.

Thus study is part of an ongoing program to establish a geochronological framework for the Churchill province of Manitoba as detailed mapping progresses and the required geological control becomes available.

SUMMARY OF ISOTOPIC AGES

The following table summarizes the Rb-Sr ages for the rock units investigated. The ages were calculated using the ^{87}Rb decay constant of $1.42 \times 10^{-11} \text{ yr}^{-1}$ and the data were regressed using the York I treatment (Brooks et al., 1972). Blanket errors (1 sigma) of 1.5% for $^{87}\text{Rb}/^{86}\text{Sr}$ and 0.006% for $^{87}\text{Sr}/^{86}\text{Sr}$ were used in calculating the ages. Over the course of this work, the E and A Sr CO_3 standard gave an average value of 0.7083 ± 0.0003 (1 sigma).

TABLE GS-22-1 SUMMARY OF Rb-Sr AGES^{1,2}

UNIT	AGE (Ma)	($^{87}\text{Sr}/^{86}\text{Sr}$) Initial
(1) Nejanilini Granulite Massif	2575 $\pm$ 85	0.7057 $\pm$ 0.0011
(2) Caribou Lake Porphyritic Quartz Monzonite	1795 $\pm$ 60	0.7084 $\pm$ 0.0038
(3) Great Island Metasedimentary Rocks	1885 $\pm$ 170	0.7093 $\pm$ 0.0063
(4) Chipewyan Batholith	1800 $\pm$ 50	0.7028 $\pm$ 0.0010
(5) Katimiwi Monzocharnockite	1815 $\pm$ 55	0.7034 $\pm$ 0.0007
(6) Wasekwan Paragneiss	1975 $\pm$ 180	0.7050 $\pm$ 0.0028
(7) Thorsteinson Granite	1710 $\pm$ 20	0.7046 $\pm$ 0.0012
(8) Baldock Batholith	1930 $\pm$ 50	0.7014 $\pm$ 0.0013
(9) Kisseynew Paragneiss (Stephens Lake)	1700 $\pm$ 95	0.7041 $\pm$ 0.0013
(10) Mystery Lake Granodiorite	Scatter of data points precludes age estimation.	

¹All isochron error parameters are quoted at 2 sigmas.

² $^{87}\text{Sr}/^{86}\text{Sr}$ ratios normalized to a value of 0.1194.

BRIEF DISCUSSION OF RESULTS

Units 1 - 3 of Table GS-22-1 are from the Nejanilini and Wollaston-Seal River domains. The Nejanilini granulite has been established as being Archean in age and the results reported here are considered to be a minimum (metamorphic) age. The high $^{87}\text{Sr}/^{86}\text{Sr}$ initial ratio supports this conclusion. The Caribou Lake porphyritic quartz monzonite is intrusive into the Nejanilini massif and field evidence suggests that it intruded the Great Island Group of metasedimentary rocks as well, although direct field evidence is lacking. The high initial ratio of 0.7084 could be due to the assimilation of the older basement rocks or the rock could be a mobilizate.

The Great Island metasedimentary rocks are predominantly schists of lower amphibolite grade, and quartzite. The age is interpreted as a metamorphic age and the high initial ratio is consistent with the results for other metasedimentary rocks from the Wollaston-Seal River domain in Saskatchewan and northern Manitoba, reflecting a provenance, at least in part, from the Archean.

Units 4 and 5 (Table GS-22-1) are from the Wathaman (Chipe-
wyan) batholith which is primarily granite to tonalite in composition and occupies an extensive region between the Seal River and Southern Indian domains in Manitoba. It is the largest batholithic complex in the Rottenstone tectonic domain of Saskatchewan. The Katimiwi monzocharnockite is a large body of ortho- and clinopyroxene-bearing monzonite with the main body of the Chipe-
wyan. Its close lithological similarity to Archean rocks of the Wollaston and Nejanilini regions suggested it may also be Archean basement. The results reported here indicate strongly that it is a more mafic phase of the Chipe-
wyan batholith. This is consistent with detailed field observations.

Unit 6 (Table GS-22-1) consists of psammitic to pelitic gneiss of sillimanite grade, interlayered with metavolcanic rocks. The samples were collected just east of Southern Indian Lake and lie

within the Southern Indian tectonic domain. The unit is believed to be correlative with the Wasekwan group. This is the first Rb-Sr age reported for Wasekwan group rocks, and although the eight points regressed show considerable scatter, the apparent age is significantly older than Rb-Sr ages reported from this laboratory for Kiseynew metasedimentary rocks to the south and Sickle Group metasedimentary rocks from the Lynn Lake belt. The high age of 1975 Ma suggests a provenance from older Wasekwan volcanic rocks. Uranium-lead zircon ages from Wasekwan volcanics could help resolve this question.

The Thorsteinson granite is a large pluton located between the Chipe-
wyan and Baldock batholiths. It is intrusive into the supracrustal rocks at the eastern limit of the Southern Indian domain. The age of 1710 Ma indicates the pluton is significantly younger than the main body of the Chipe-
wyan batholith. Field evidence indicates a younger age from the standpoint of deformation. It also has associated pegmatitic phases.

The Baldock batholith occurs within the Lynn Lake domain and is centered around Baldock Lake. It is similar in lithology to the Chipe-
wyan batholith and has been considered to be genetically related. Although the age of 1930 Ma is considerably higher than that for the Chipe-
wyan batholith, the larger error of 150 Ma does not allow a distinction in the age to be made at this time. The large error is due to a low range in the Rb-Sr ratios and a large extrapolation to the $^{87}\text{Sr}/^{86}\text{Sr}$ axis.

The 1700 Ma age for the Kiseynew paragneiss from Stephens Lake is consistent with two other ages obtained (in this lab) for paragneiss from the Kiseynew metasedimentary gneiss belt. Although the age is considered to register the time of metamorphism in this area, the relatively low initial ratio suggests the provenance for the sediment to be late Aphebian rocks.

Ten samples of the Mystery Lake granodiorite from the vicinity of Thompson (within the Churchill-Superior Boundary) showed an extremely low range in Rb/Sr ratios and extreme scatter. The results clearly show the affect of ubiquitous cataclasis caused by later or post-Aphebian faulting in the area.

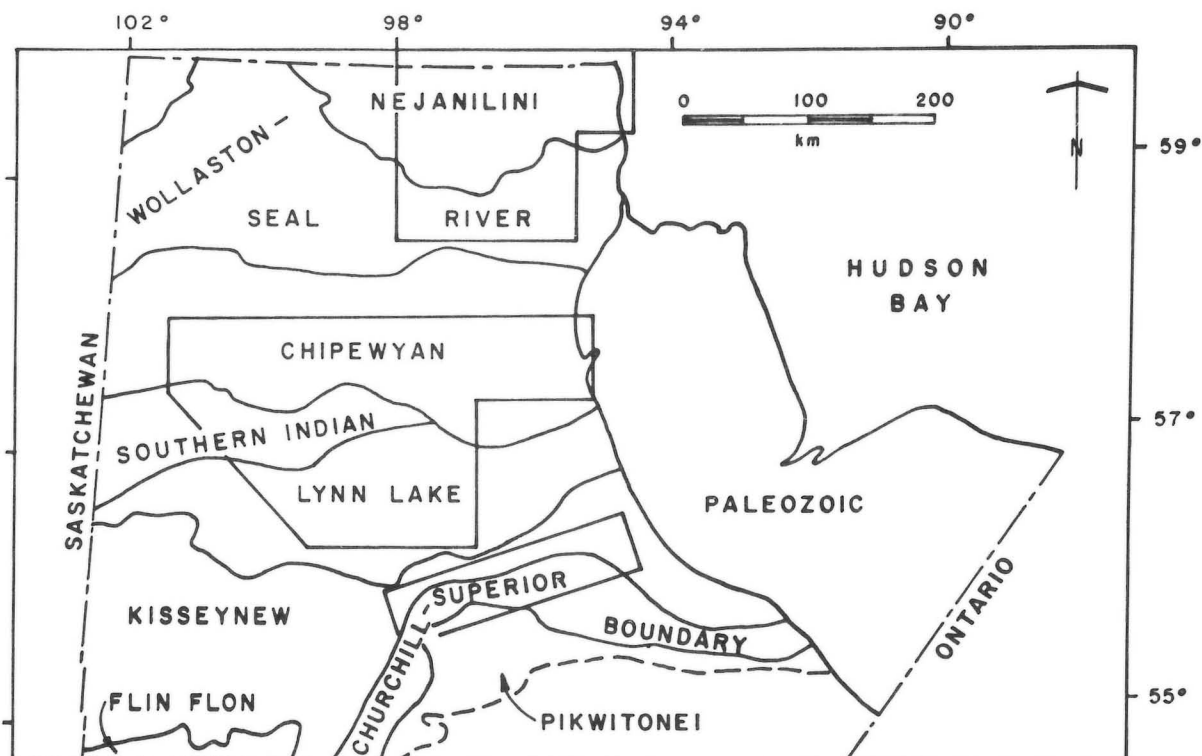


Figure GS-22-1: Index map showing main domains sampled in developing the Rubidium/Strontium geochronological framework for the Churchill Structural Province.

LIST OF PRELIMINARY GEOLOGICAL MAPS — 1981

1981B-1	McNeill Lake (630/3) by P.G. Lenton	1:20 000
1981B-2	Pistol Lake (West-half) (630/2W) by P.G. Lenton	1:20 000
1981I-1	Island Lake - Cochrane Bay by K.L. Neale and W. Weber	1:20 000
1981I-2	Island Lake - Sinclair-Savage Islands by K.L. Neale	1:20 000
1981L-1	Watt Lake Northeast (64C/7) by H.V. Zwanzig	1:20 000
1981L-2	Trophy Lake Northeast (64C/2) by H.V. Zwanzig	1:20 000
1981L-3	Suwannee Lake Northwest (64C/1) by H.V. Zwanzig	1:20 000
1981T-1	Setting Lake, Northeast (630/1, 2) by K.C. Albino and J.J. Macek with R.B. Kujanpaa, F.G. Zimmer, B.D. Deverill and D.D. McNeill	1:25 000
1981T-2	Setting Lake, Southwest (63J/15) by K.C. Albino and J.J. Macek with R.B. Kujanpaa, F.G. Zimmer, B.D. Deverill and D.D. McNeill	1:25 000

MANITOBA GEOLOGICAL SURVEY

993 Century Street, Winnipeg, Man. R3H 0W4

Position	Staff	Area of current involvement
Director:	Dr. W.D. McRitchie	
Senior Precambrian Geologist:	Dr. W. Weber	Superior Structural Province (north to south)
Precambrian Geologists:	D.C.P. Schledewitz	North of 57° and Molson- Kalliecahoolie belt
	M.T. Corkery	Lower Churchill River and Stull Kistigan Lakes
	P.G. Lenton	Lower Churchill River and Kisseynew region
	Dr. H.V. Zwanzig	Churchill Structural Province and Lynn Lake region
	H.P. Gilbert	Island Lake and Lynn Lake
	Dr. R.F.J. Scoates	Thompson belt and Fox River region
	E.C. Syme	Flin Flon belt and Lynn Lake
	Dr. J.J. Macek	Thompson belt, Setting Lake
Mineral Deposit Geologists:	Dr. A.H. Bailes	Flin Flon and Snow Lake
	H.D.M. Cameron	McMillan and Granville Lakes
	Dr. G.H. Gale	Manitoba and Flin Flon, Snow Lake
	D.A. Baldwin	Ruttan and Churchill Province
	Dr. P. Theyer	Island and Bigstone Lakes, Superior Province
	M.A.F. Fedikow	Southeast Manitoba
Phanerozoic Geologist:	Dr. H.R. McCabe	
Industrial Minerals Geologists:	B.B. Bannatyne	
	D. Watson	
Secretarial:	B. Thakrar	
	L. Chudy	
	D.S. Navitka	
Administrative Officer:	J.P. Athayde	

MINES BRANCH

Aggregate Resources Section

AR-1 QUATERNARY GEOLOGY AND AGGREGATE RESOURCE INVENTORY OF THE THOMPSON AND CHURCHILL AREAS

By E. Nielsen and R.V. Young

Surficial geology mapping and aggregate resource inventories were carried out in both the Thompson and Churchill areas (Fig. AR-1-1). The objectives of the study were:

1. To acquire and evaluate additional ice flow directional indicators for extended areas of north-central Manitoba as background for the 1:1 000 000 scale Surficial Geological Map of Manitoba;
2. Map the surficial geology at a scale of 1:50 000 for a 24 km radius of both the townsites of Churchill and Thompson;
3. To inventory and evaluate economically viable sand and gravel deposits within the study areas;
4. Assess Proterozoic erratics from the Circum Ungava and Keewatin areas as "indicators" of glacier provenance;
5. Assess the Churchill River area for proposed extensive stratigraphic studies for future field seasons.

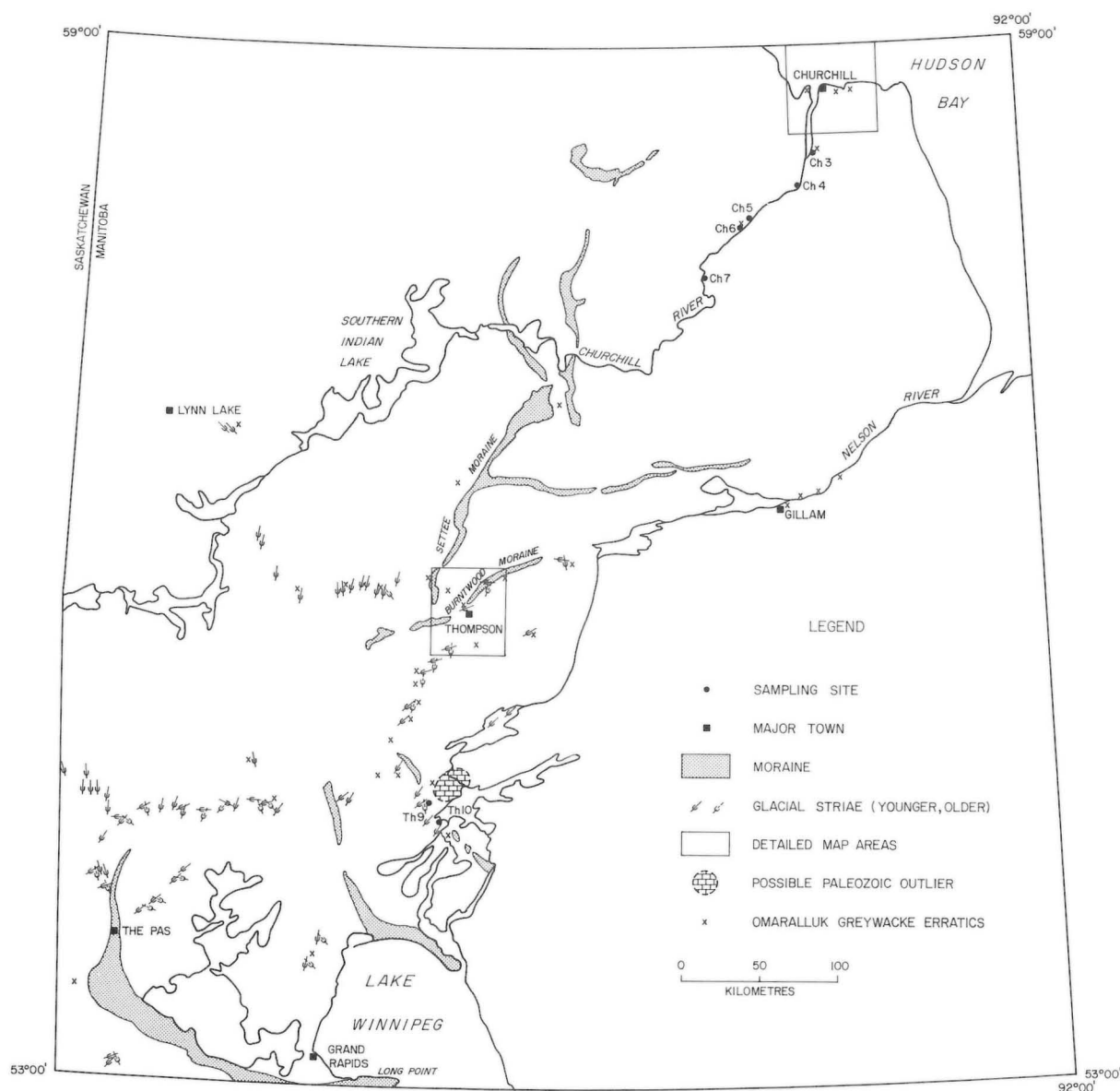


Figure AR-1-1: Location map and ice flow features of north-central Manitoba.

2.1 QUATERNARY GEOLOGY OF THE THOMPSON AREA

Intersecting glacial striae and glacially faceted outcrops record ice advances from two directions in north-central Manitoba. Striae indicate that the earliest ice flow in the Thompson area was towards the southwest followed by a more westerly ice flow. West of Thompson, the older striae infer a southerly and southeasterly ice flow direction, whereas the younger striae infer westerly ice movement. This suggests that the older striae record the presence of two ice masses converging possibly along a line close to the present Settee Moraine and extending south through the Ponton area.

Overlying the bedrock, but poorly exposed, is a sandy till often showing lee-side facies which is attributed to the youngest ice advance. This till, except for a number of anomalous outcrops, is typically sandy and composed almost exclusively of Precambrian crystalline material. The carbonate content of this sandy till overlying Precambrian bedrock in the Thompson area is generally less than 3 per cent. The 4 mm - 16 mm size fraction of two till samples from west of Jenpeg contain 49 to 12 percent dolomite

clasts, suggesting there may be a Paleozoic bedrock outlier directly up ice (approximately 30°) from the samples sites (Fig. AR-1-1).

A notable feature of the landscape is an extensive interlobate moraine system (Klassen, 1980). These moraines, which rise to over 100 m above the surrounding landscape can be traced for hundreds of kilometres and are believed to mark the late glacial suture between three major ice lobes (Fig. AR-1-2). The two lobes north and south of the Burntwood Moraine and east of the Settee Moraine are of eastern provenance, whereas the lobe to the west of the Settee Moraine is of Keewatin origin.

Reddish brown varved clay, deposited in the Grass River Basin of Lake Agassiz mantles the bedrock and till throughout the area. The thickness of the clay is highly variable, ranging from non-existent over morainic ridges and bedrock outcrops to as much as 48 m (Inco Geologist pers. comm.) in low lying depressions.

Lake Agassiz strandlines are extensively developed on the flanks of the moraines. The elevation of numerous strand levels was measured between 252 and 348 m a.s.l., however, a correlation of these water planes has not been possible.



Figure AR-1-2:

Interlobate moraine system north of Thompson. The prominent ridges are ice-contact sand and gravel Kame deposits.



Figure AR-1-3:

Sand and gravel pit on the Burntwood Moraine west of Thompson.

1.2 SAND AND GRAVEL RESOURCES OF THE THOMPSON AREA

Extensive reserves of sand and gravel are located in the Burntwood and Settee Interlobate Moraines west of Thompson. These moraines are generally 2 to 3 km wide and in the Thompson area the moraines rise as high as 50 m above the surrounding countryside. The moraines are several hundred kilometres long with only minor discontinuities. The composition of the moraines ranges from coarse gravel in the large gravel pit located in the Burntwood Moraine west of Thompson (Fig. AR-1-3), to fine well-sorted sand on the Settee Moraine at Baldock Lake. Within the Thompson study area gravel constitutes a substantial portion of the moraines.

2.1 QUATERNARY GEOLOGY OF THE CHURCHILL AREA

Glacial striae are poorly preserved on the bedrock in the Churchill area. Several glacial grooves were observed along the shoreline of Hudson Bay and record ice flow towards 160°.

The surficial deposits in the Churchill area are predominantly wave washed beach gravels and offshore sand. Along the present coastline of Hudson Bay the Tyrrell Sea beaches are well preserved, (Fig. AR-1-4), but further inland, thick swamp deposits mantle the marine deposits.

On Churchill River, upstream from the confluence with the Deer River, the usually low swampy river banks rise to form cliffs as high as 30 m. A long and complex Quaternary stratigraphy, consisting of Illinoian till, Sangamonian gravels, sand and clay deposits with organic remains and two Wisconsinian tills is exposed along the river. The details of the stratigraphy and tentative correlations are shown in Figure AR-1-5.

Oolitic jasper from Proterozoic outcrops in the Sutton Hills in Ontario, is common on Nelson River but not present on Churchill River, indicating the northern limit of these erratics lies between these two rivers. Three distinctive volcanic erratics of unknown provenance and red arkose from the Baker Lake area increase in frequency towards the north. The northern limit of greywacke er-

atics from the Omaralluk Formation outcropping in eastern Hudson Bay (Nielsen, 1980) is located near the townsite of Churchill.

Omaralluk greywacke, assorted volcanic and red arkose erratics are present in the Illinoian till and somewhat more abundant in the Sangamon gravels along the Churchill River. They are also present in the Wisconsinian tills and beach gravels of the Tyrrell Sea.

2.2 SAND AND GRAVEL RESOURCES

Abandoned beaches constitute the only source of sand and gravel in the Churchill area. The average height of the beach ridges is 2 to 3 m with the water table in close proximity of the surface. The beaches are composed of wave washed gravel and pebbly sand. The composition of the gravel is approximately 80 percent dolomite and 20 percent Precambrian clasts. The percentage of dolomite clasts increases eastward from the Churchill townsite. An example of an abandoned beach ridge is presented as Figure AR-1-6.

Extraction of the beach ridges is limited by the close proximity of the water table to the surface, the presence of large boulders within the deposits, and limited road access. Furthermore, some of the potentially high quality deposits are not mined as they are located on Federal Administered Lands.

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Figure AR-1-4:

Tyrrell Sea beaches along the coast of Hudson Bay.

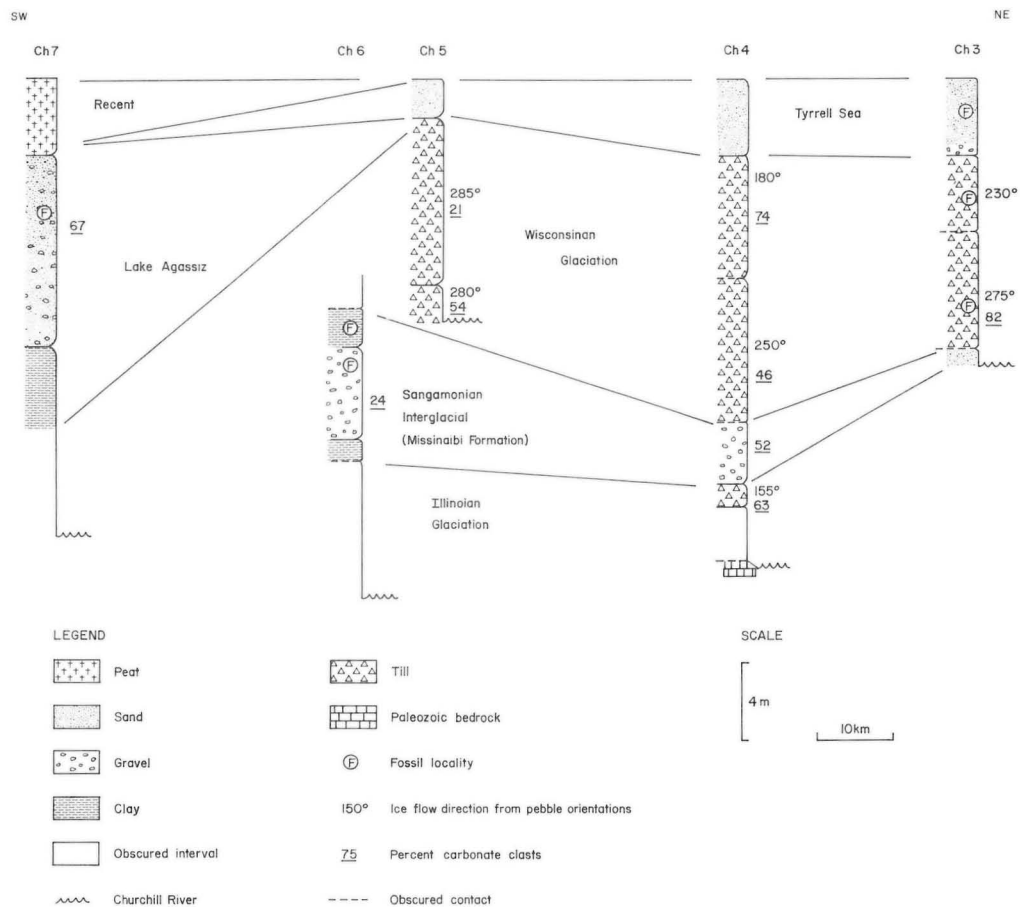


Figure AR-1-5: Stratigraphy and correlation of Quaternary deposits along Churchill River. The location of the sections is shown on Figure AR-1-1.



Figure AR-1-6:

Abandoned Tyrrell Sea beaches inland from Hudson Bay. Note successive strandlines in background and wave-washed boulders in foreground.

AR-2 STRATIGRAPHIC INVESTIGATIONS IN THE BIRDS HILL AREA

by Gaywood Matile

INTRODUCTION

Surficial mapping of the Birds Hill esker complex was carried out in the summer of 1980. The primary objective of the mapping project was to delineate surficial deposits of concern for aggregate resource management. This summer, mapping was again carried out in the area, with the main emphasis on stratigraphy.

The general stratigraphy of the Birds Hill esker is outlined in Figure AR-2-1. The units are: Basal Till, Glaciofluvial Sand and Gravel, Upper Till, Water-lain Till, Lacustrine Silt and Clay and Littoral Sand and Gravel. All of the units overlying the glaciofluvial sediments are discontinuous.

BASAL TILL

The oldest Quaternary deposit in the Birds Hill area is a till unit which underlies the glaciofluvial sediments. From drillhole information, the till appears to be silt-rich and very hard and due to its stratigraphic position probably correlates with the Roseau Formation (Fenton and Teller, 1980).

GLACIOFLUVIAL SAND AND GRAVEL

Well over half of the glaciofluvial sediment in the Birds Hill area is sand. The sediments are severely faulted due to subsequent melting of the glacial ice. Kettle holes are present; they are infilled with poorly stratified silt and clay, which was probably deposited prior to the close of glaciofluvial deposition, and glaciolacustrine sediments.

Although the glaciofluvial sediments are highly contorted, there is no evidence of glacial overriding. Till wedges, which are generally indicators of the ice flow direction, are found at the upper contact of the glaciofluvial sediments, but have a highly variable orientation, consequently their origin is questionable.

UPPER TILL

This unit forms a discontinuous cover overlying the glaciofluvial sediments. The Upper Till is compact and fissile with an average composition of 40 percent sand, 42 percent silt and 18 percent clay. The texture is highly variable.

The lower portion of this unit commonly contains rounded sand and gravel clasts which have been incorporated into the till from the underlying glaciofluvial unit. If this incorporation was a result of active ice overriding the esker, the sand content should, in the vicinity of the sand and gravel, increase down ice. Figure AR-2-2 shows the percent sand at the till sampling sites. The expected trend is absent, making the origin of this till unit question-

able. The unit may represent an initial phase of deglaciation following the conclusion of fluvial deposition.

WATER-LAIN TILL

This unit can be broken down into two sub-units. The first is more variable. The Water-lain Till is generally varved with well developed graded beds up to 1 m thick. The thicker graded beds are composed of boulders grading up into sandy silt. The thinner beds (several millimetres thick) are composed of silty clay. When graded beds are not well developed, the sub-unit can very closely resemble the silt till in the area.

The second sub-unit is poorly stratified and highly contorted stony lake clay. This sub-unit is less common than the varved sediments and generally overlies them.

The water-lain till is faulted in some locations, which indicates that it represents the final stage of deglaciation in the area. It is a result of subaqueous deposition in a deep phase of Lake Agassiz. Deposition was initiated by rapid debris flow within the ice walled channels towards the close of fluvial sedimentation and continued by the melting of icebergs in Lake Agassiz as the ice front retreated to the north.

Within the varved sediments, there is commonly a sand layer which is up to 0.8 m thick. The sand layer is crudely varved and poorly sorted, and can contain till clasts. The sand layer may represent a shallow water phase of Lake Agassiz.

LACUSTRINE SILT AND CLAY

This unit is made up of thinly varved silt and clay and massive silty clay. Towards the flank of the esker complex, sand laminae are common within the generally clay-rich sediments. This unit is generally stone free.

LITTORAL SAND AND GRAVEL

Five strandlines of Lake Agassiz have been recognized in the Birds Hill area. They have been delineated in Figure AR-2-3. Sediments resulting from this final regression of Lake Agassiz are:

- 1) a blanket of fine sand generally found between the 240 and 253 m contours
- 2) ridges of well sorted horizontally bedded sand and gravel (see Fig. AR-2-4), and
- 3) thick accumulations, up to 20 m thick, of cross-bedded sandy fine pebble gravel (see Fig. AR-2-5).

The cross-bedded sand and gravel forms sharp scarps as a result of spit development along the eastern flanks of the esker complex.

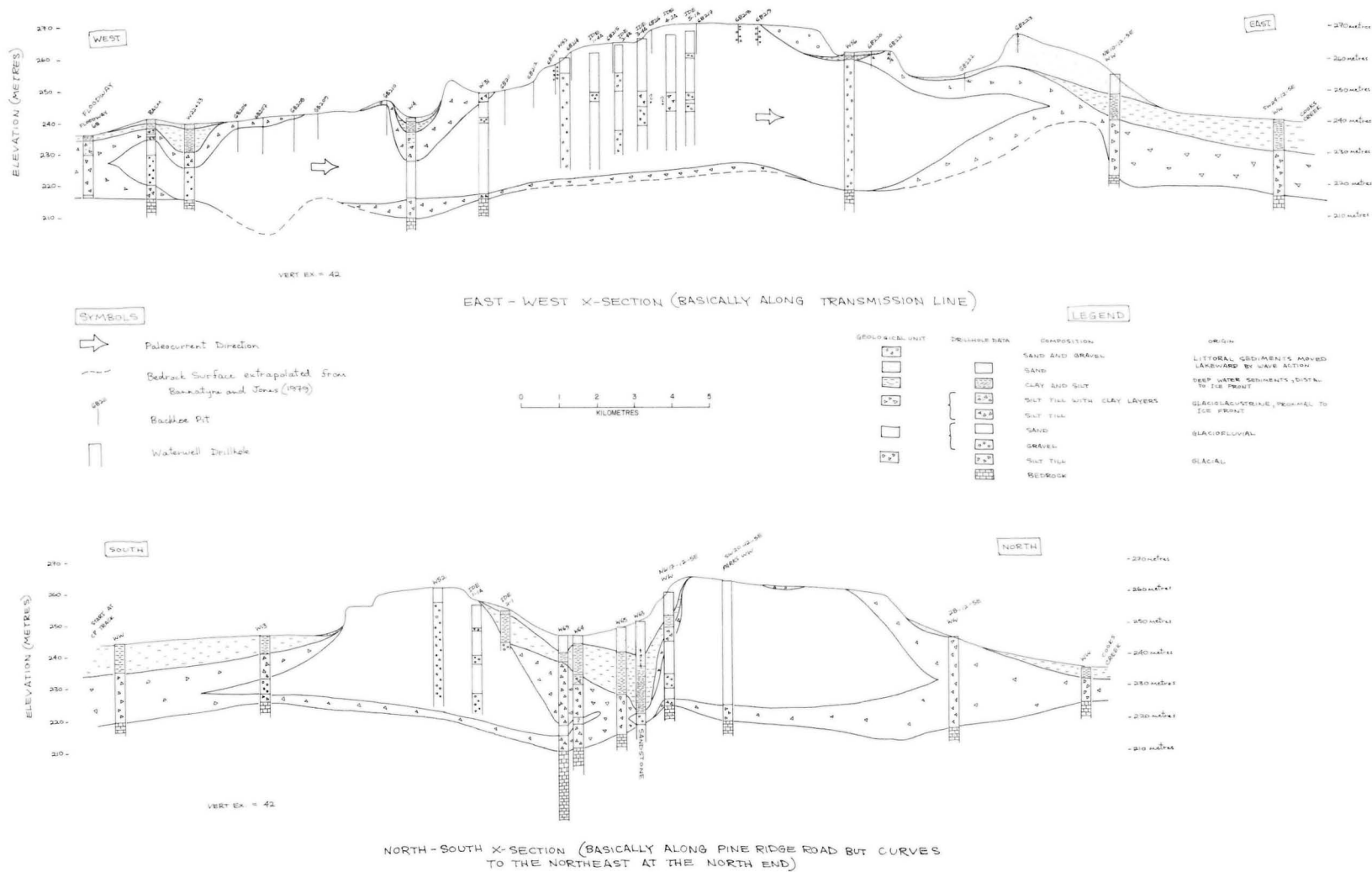


Figure AR-2-1: Cross-sections through Birds Hill with generalized stratigraphy.

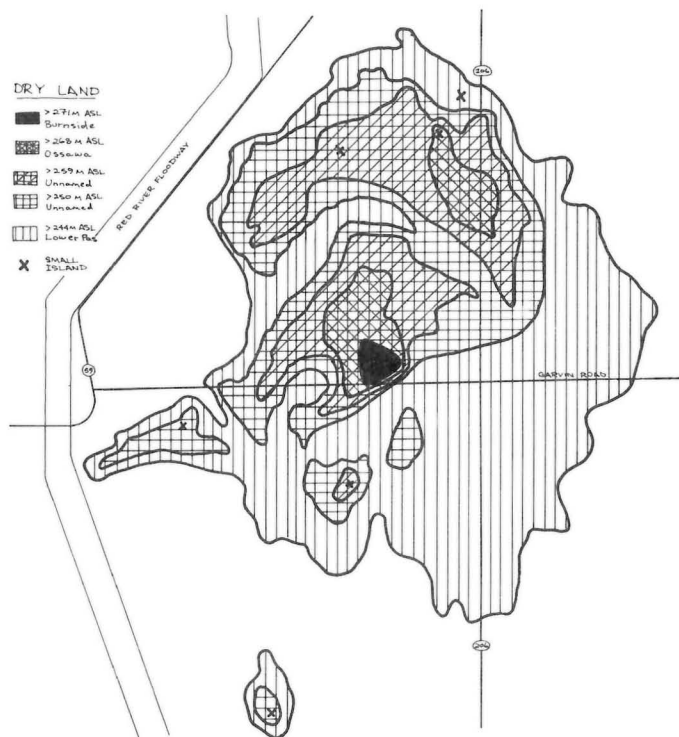


Figure AR-2-2: Schematic of major glaciofluvial deposits.

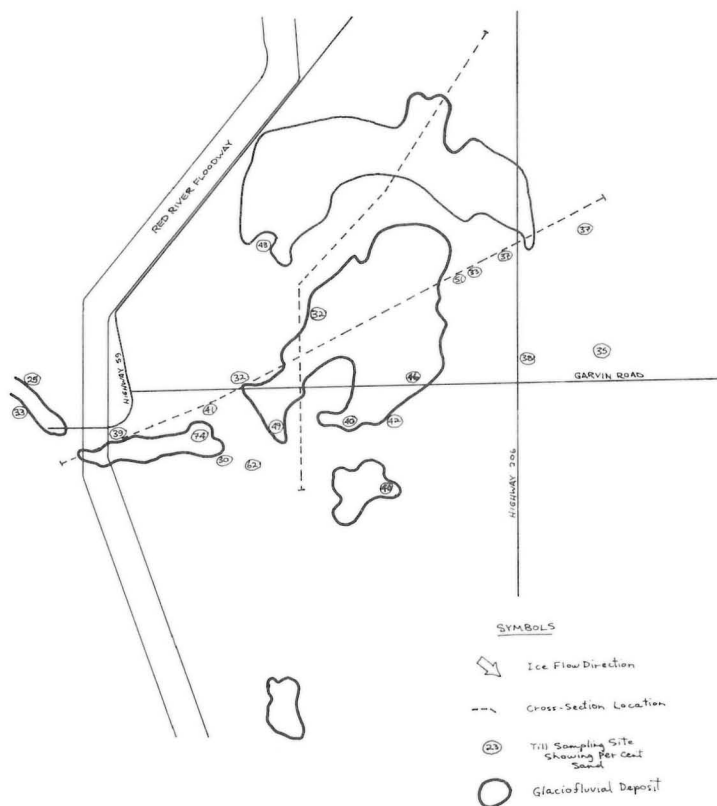
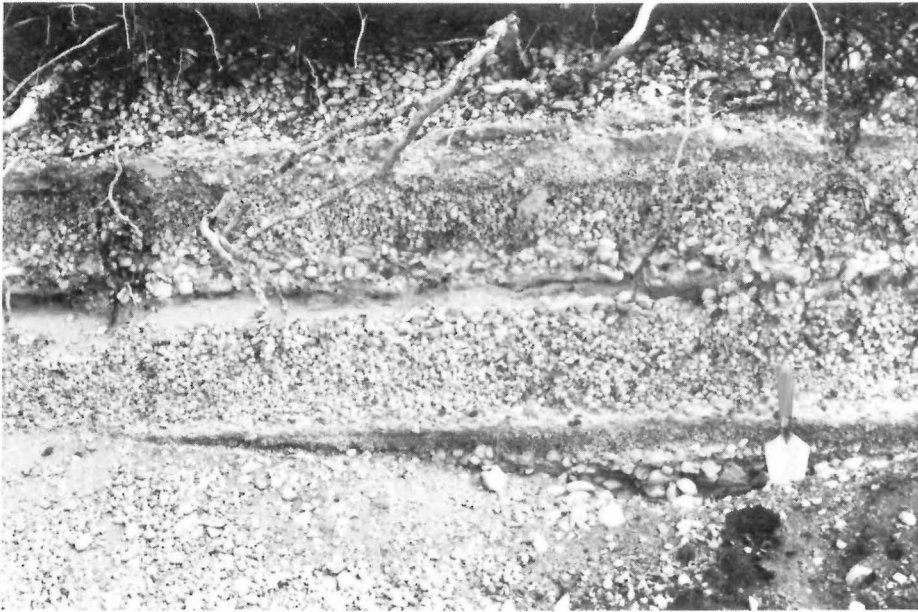


Figure AR-2-3: Lake Agassiz strandlines in the Birds Hill area.



*Figure AR-2-4:
Well-sorted horizontally bedded shoreline sediments.*



*Figure AR-2-5:
Cross-bedded littoral sand and gravel. Paleocurrent direction varies between 110°E and 150°SE.*

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AR-3 QUATERNARY GEOLOGY OF THE R.M. OF MINTO

by H.D. Groom

Quaternary mapping was carried out in the R.M. of Minto to complete the west half of the Clanwilliam map sheet (62J/5) begun in 1980 as part of the South Riding Mountain project (Groom, 1980). The east half of the map sheet was mapped in 1979 as part of the Neepawa study area (Mihychuck, 1979). Preliminary Map 1981 SRM-3, at a scale of 1:50 000, supercedes Map 1980 SRM-3.

The R.M. of Minto lies west of the Manitoba escarpment at the Second Prairie Level between latitudes 50° 15'N and 50° 25'N and longitudes 99° 41'W and 99° 57'W (Fig. AR-3-1). The topography is generally that of hummocky stagnation moraine. In the extreme north and south of the map area, relief exceeds 10 m and kettle lakes are numerous. In the central portion, the relief is more subdued, and lakes are less common.

The major rivers are the Little Saskatchewan River in the west and Neepawa Creek in the east. Neepawa Creek runs through the McFadden Valley Spillway for most of its course east of the map area.

The bedrock consists of shales of the Upper Cretaceous Riding Mountain Formation, predominantly the hard, siliceous Odanah member (Bannatyne, 1970). Large ironstone concretions are present in the beds exposed in the walls of the Minnedosa Spillway east of Minnedosa.

SURFICIAL GEOLOGY

The earliest Quaternary deposit occurs in a pit, 3 km east of Bethany, which contains unusually high percentages of quartzite and chert. Lithologically, it is similar in composition to the Souris sand and gravel and may be of early Pleistocene age.

There are four tills exposed in the area: the Largs, Min-

nedosa, Lennard and Zelena, all named and described by R.W. Klassen (1979).

The oldest is the Largs till seen in outcrop at its type section near Largs, Manitoba (SW¼, Sec. 9, Twp. 15, Rge. 18W). It is dark grey, (5Y 4/1) compact and characterized by an extremely high percentage of shale clasts in the coarse fraction. In the type section, it underlies the Minnedosa and Lennard tills.

The Minnedosa type section (NW¼, Sec. 20, Twp. 16, Rge. 18W) is also within the R.M. of Minto. This till is yellow brown (10YR 5/6) to grey brown, (10YR 4/2) compact, jointed and manganese stained along the joints. It is commonly seen in outcrop, in road cuts and valley walls where it underlies either the Zelena or Lennard tills.

There are two surface tills in the municipality: the Lennard, west of the Little Saskatchewan River, and the Zelena to the east. Lithologically and physically they are very similar. They are loose, structureless, slightly clayey and yellow brown (10YR 5/4) to grey brown (2.5Y 4/2) in colour. Klassen (1979) differentiates them on the basis of the carbonate content of the matrix; the Lennard contains 14 to 19 percent carbonate, whereas the Zelena contains between 26 to 36 percent.

Sand and gravel is found as terrace deposits along the Minnedosa Spillway and minor meltwater channels and as outwash east of Bethany.

The material in the terraces varies considerably from coarse pebble gravel (10-20 percent of sample > 16 mm) to pebbly sand and fine sand. Pit depths range from 1 to 8 m and are usually sand and gravel floored. They are the major source of aggregate for the municipality.

The Bethany outwash plain covers about 15 km² in the east central portion of the map area. Its surface is gently irregular and

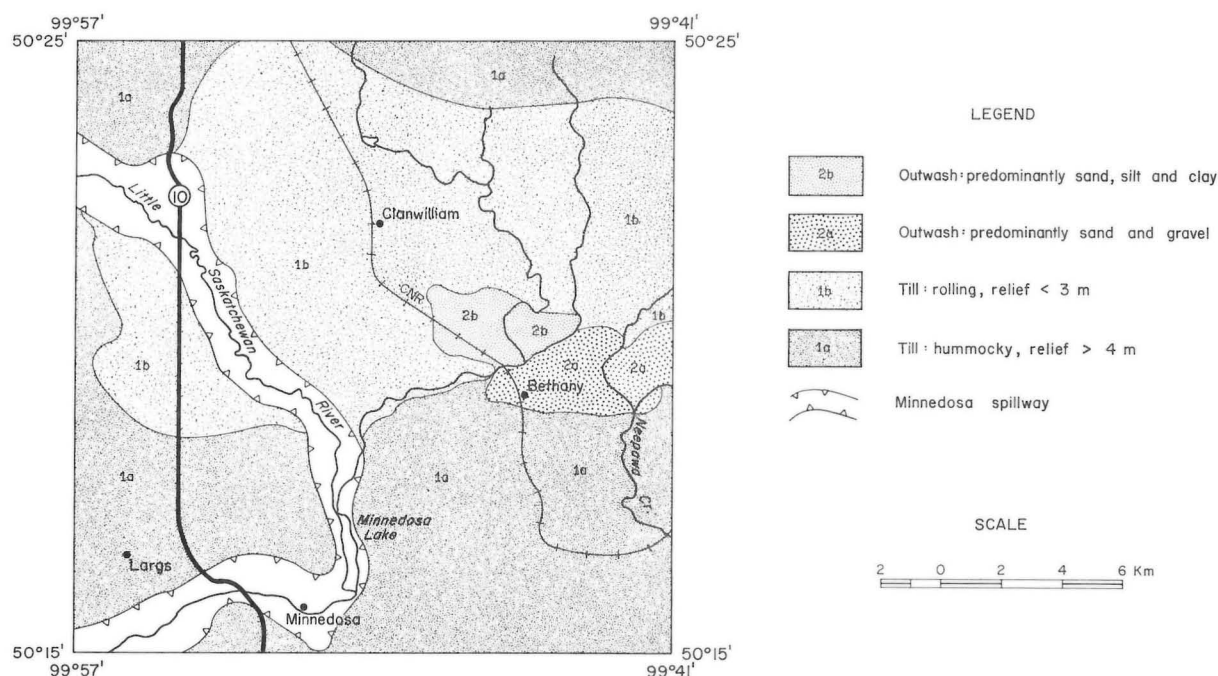


Figure AR-3-1: Quaternary Geology of the R.M. of Minto.

it is cut by several wide meltwater channels. The outwash was probably deposited by meltwater from the McFadden Valley Spillway, located immediately east of the municipal boundary. The materials show a general proximal-distal relationship with cobbles and coarse gravel (40 percent of sample $\gt 16$ mm) in the east, increasing amounts of fine gravel and sand in the central portion and shallow deposits of sand, silt and clay at the extreme western edge of the outwash plain. The outwash gravels have a high shale content but there are a few large active pits with up to 8 m of granular material.

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AR-4 PRELIMINARY SURVEY OF THE FISHER BRANCH AREA

by H.D. Groom and C.W. Jones

The Fisher Branch area comprises the L.G.D. of Fisher and the R.M. of Bifrost. The study area covers 3 000 km² between Twps. 22 to 26 and Rges. 4E to 3W. A survey of the surficial materials was begun this summer and is expected to be completed next year. A preliminary map at a scale of 1:100 000 will be available in 1982.

The study area lies west of Lake Winnipeg in the Interlake Plain. The land has a gentle northeast slope, falling from 285 m a.s.l. in the west to 218 m a.s.l. at the shore of Lake Winnipeg. Major drainage channels are the Icelandic and Fisher Rivers. The swell and swale topography is due to fluted ground moraine. The ridges are oriented southeast (135°) across the drainage slope, and swamp fills the intervening troughs. Bedrock highs are common, particularly in the west and northwest. In the east, the terrain becomes more level as the till plain is mantled by deposits of Lake Agassiz silt and clay.

REGIONAL BEDROCK GEOLOGY

A succession of Paleozoic carbonate formations, specifically of Ordovician and Silurian age, overlie the basement Precambrian granites of Archean age. These sedimentary formations generally strike in a north-south direction, and dip gently to the west. The Ordovician outcrop belt, with an average width of approximately 60 km, is bounded by Lake Winnipeg on the east and by the Silurian strata on the west (Baillie, 1951). Furthermore, the Silurian outcrop belt comprises an area approximately 20 km wide within the western portion of the study area. The carbonate bedrock generally is composed of dolomite to dolomitic limestone that contains minor quantities of argillaceous and arenaceous material.

QUATERNARY GEOLOGY

One till unit was recognized in the area. It is a compact, basal till, light yellow in colour and extremely stony. The composition of the till strongly reflects the regional bedrock. The matrix is silty and calcareous; the coarse fraction is predominantly angular carbonate clasts with sub-angular Precambrian clasts forming the remaining part of the lithology. Till thickness varies considerably. It ranges from less than a metre on the bedrock highs to over 20 m, as shown in water well records.

Glacial striae record an ice advance to the southeast (130°) which corresponds to the orientation of the flutes (135°). A secondary set of striae record ice movement in a more east-west direction. These are presumed to be older but since all striae measurements were on flat bedrock surfaces, relative ages are not certain.

Several beach ridges mark successive levels of glacial Lake Agassiz as it receded from the area. The beach ridges are tentatively correlated with the lake levels described and named by Johnson (1946). The highest level is the Stonewall beach (283 m a.s.l.), 3 km west of Broad Valley. The most pronounced level is The Pas beach (260 m a.s.l.) which can be traced for 26 km in a

northwest line from Fisher Branch to north of Fisherton. The Lower Pas (256 m a.s.l.) and the Gimli beaches (247 m a.s.l.) lie in the east central portion of the map area. The Gimli Lake level is defined both by accretional beach ridges and a wave cut scarp.

Lake Agassiz silts and clays are the major surficial materials in the eastern portion of the map area. The silt is yellow, blocky and highly calcareous. The clays are either yellow or grey, blocky or massive and locally dropstones are present. These lake sediments reach their greatest areal extent near Arborg where 3 to 15 m overlie till. East towards Hnausa, till is frequently the surface material although intervening silt and clay deposits still reach up to 10 m depths.

North of the lake plain, deep accumulations of peat and other organics overlie till and lake deposits.

ECONOMIC GEOLOGY

The beach ridges are the only sources of sand and gravel in the study area, with the exception of an esker 3 km east of Hodgson. Beach ridges flanking bedrock highs are generally shallow and the material poorly sorted. The larger ridges are better sorted, show horizontal bedding or large foreset structures and contain up to 4 m of granular material. Field counts indicate the lithology is fairly consistent (80 percent carbonate, 20 percent Precambrian) for all of them. Nearly all the ridges have been mined to some degree and the major beach ridges have been mined extensively. Substantial amounts of aggregate are present in the pits west of Broad Valley and near Fisher Branch. The pits north of Rosenberg are nearing depletion, but extraction from new areas north and south along the ridge is possible. The esker comprises 4 m of highly variable material; locally it contains high quality aggregate but beds of silt and flow till limit its potential as an aggregate resource.

The near surface bedrock within the study area could be utilized as a source of quality aggregate when the present sand and gravel resources become depleted. Crushed stone and gravel can be used interchangeably when their respective prices are competitive, and when there is complete substitute ability. Presently, the only active quarry operations producing crushed stone in the study area are located approximately 9.6 km northwest, and 17.7 km northeast of Riverton.

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AR-5 SURFICIAL GEOLOGY OF THE RURAL MUNICIPALITY OF TURTLE MOUNTAIN

by Glen Conley

Surficial geological mapping was undertaken in the Rural Municipality of Turtle Mountain. The purpose of this study was to delineate and catalogue the aggregate deposits to serve as a base for land use planning and municipal development. In addition, the study was extended into the municipalities to the east and north to obtain additional information to aid in the stratigraphic interpretation of the Quaternary geology of Southwestern Manitoba.

BEDROCK GEOLOGY

The study area is underlain by Cretaceous Boissevain and Riding Mountain Formations. Turtle Mountain, in the southwest, is underlain by the Paleocene Turtle Mountain Formation. The bedrock geology of this area has been described, in detail, by Bamburak (1978).

QUATERNARY GEOLOGY

The oldest Quaternary unit recognized in the study area is a very compact till, typically black or dark grey in colour, and strongly oxidized along joint planes. The matrix is clayey with very little sand. Although, the clast content is predominantly shale, carbonates make up more than 80 percent of the non-shale component. The till overlies bedrock and is less than 2.0 m thick. This till is tentatively correlated with the Largs Formation, as described by Klassen (1979), in the Riding and Duck Mountains.

In the Long River section, 8 km north of Cartwright, this till is overlain by a well developed cobble lag, consisting primarily of Precambrian lithologies. Two km east of Dunrea, on Highway 23, the black till is in sharp contact with an overlying, heavily oxidized brown till. This same till sequence was observed in a ditch exposure approximately 3 km west of Killarney on Highway 3.

The heavily oxidized brown till is the lowermost of three brown tills which can be separated as distinct units on the basis of texture and clast content. It is clayey, compact, highly jointed and darker in colour than the other brown tills. Also, the pebble fraction, has noticeably more coarse carbonate clasts than either of the overlying units. This till is separated from the middle brown till by a 10 cm thick lens of yellow oxidized sand. The contact between the till and the sand is sharp.

The middle brown till is also compact, clayey and highly jointed. Although similar to the underlying brown till, it is more silty, not as strongly oxidized, and the carbonate clasts are considerably smaller. This till is overlain by a boulder pavement which is found extensively throughout the area.

The uppermost brown till has a silty texture and shows little or no oxidation. Although shale clasts are present, carbonate and Precambrian clasts predominate. This till frequently contains small stringers of greyish silt or silty-sand. Well developed striations on the boulder pavement at the base indicate deposition by a southeasterly flowing glacier. This till is found extensively through the study area, however, it is only south of the Pembina Trench that it forms the uppermost till unit. Both the upper and middle brown tills have been observed at the bottom of the Pembina Trench where they are overlain by fluvial sediments, indicating the spillway had been in existence prior to their deposi-

tion. The upper brown till is correlated with the till of the Lennard Formation and the middle brown till with the till of the Minnedosa Formation as described by Klassen (1979). The lowest brown till is tentatively correlated with the till of the Shell Formation on the basis of stratigraphic position.

North of the Pembina Trench, the Lennard Formation is overlain by a calcareous, beige, silty till. The pattern of flutes in this area indicate that the southwardly flowing glacier which deposited this till spread out in an arcuate lobe and terminated just north of the Pembina Trench, where it deposited the Darlingford Moraine. This till is the youngest in the area and is correlated with the till deposited by the Red River Lobe.

Numerous ice thrust features are present in the Tiger Hills north of the Pembina Trench. The orientation of the thrust blocks indicates an ice advance to the southeast, and are therefore correlated with the ice advance which deposited the Lennard till. Subsequently, these blocks were overridden and streamlined by the Red River Lobe.

ECONOMIC RESOURCES

The major source of aggregate in the Rural Municipality of Turtle Mountain is a large outwash deposit which extends eastward from Killarney, for 16 km. This is a complete deposit, consisting of approximately 1 m of well sorted fluvial gravel overlying several metres of poorly sorted glaciofluvial sand and gravel. The two deposits are superimposed from east of Killarney to 5 km west of Homefield, where the fluvial deposit trends southeast, away from the eastward trending glaciofluvial deposit. At this point, the glaciofluvial deposit is overlain by 1 to 3 m of till. Although abundant quantities of good gravel are present, there is a tendency toward variability with respect to quality and quantity. Numerous small eskers were observed throughout the municipality, but only a few contain economic gravel exposed near surface.

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LIST OF PRELIMINARY MAPS — 1981

(Surficial Geology)

PRELIMINARY MAPS, SURFICIAL GEOLOGY OF THE SOUTH RIDING MOUNTAIN AREA

1981-SRM-3	Clanwilliam (62J/5)	1:50 000
	by H. Groom	

SURFICIAL GEOLOGY OF THE THOMPSON AREA

1981-TH-1	Noble Lake (E½ 63 0/16)	1:50 000
	by E. Nielsen and R. Young	
1981-TH-2	Mystery Lake (63P/13)	1:50 000
	by E. Nielsen and R. Young	
1981-TH-3	Ospwagan Lake (E½ 63 0/9)	1:50 000
	by E. Nielsen and R. Young	
1981-TH-4	Thompson (63P/12)	1:50 000
	by E. Nielsen and R. Young	

