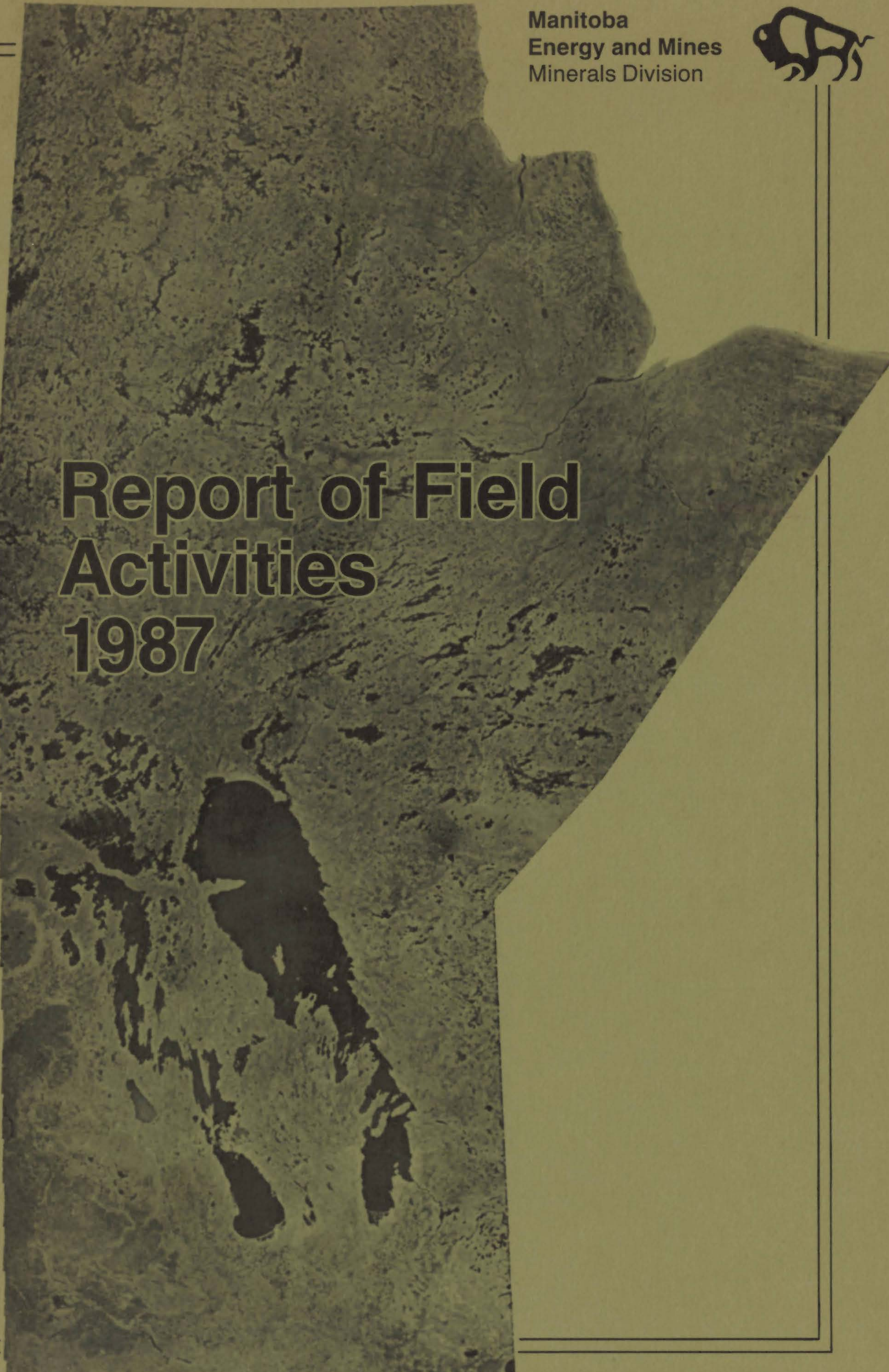
Manitoba
Energy and Mines
Minerals Division

Report of Field Activities 1987



Manitoba
Energy and Mines

MINERALS DIVISION

REPORT OF FIELD ACTIVITIES 1987

ERRATA:

p.119: Table GS-24-1 - Age for sample M716 should read 2729, not 2739

p. 129: Figure GS-25-7 - The station number 85-87-21, at UTM 5557770N and 316000E, should read 85-87-26.

1987

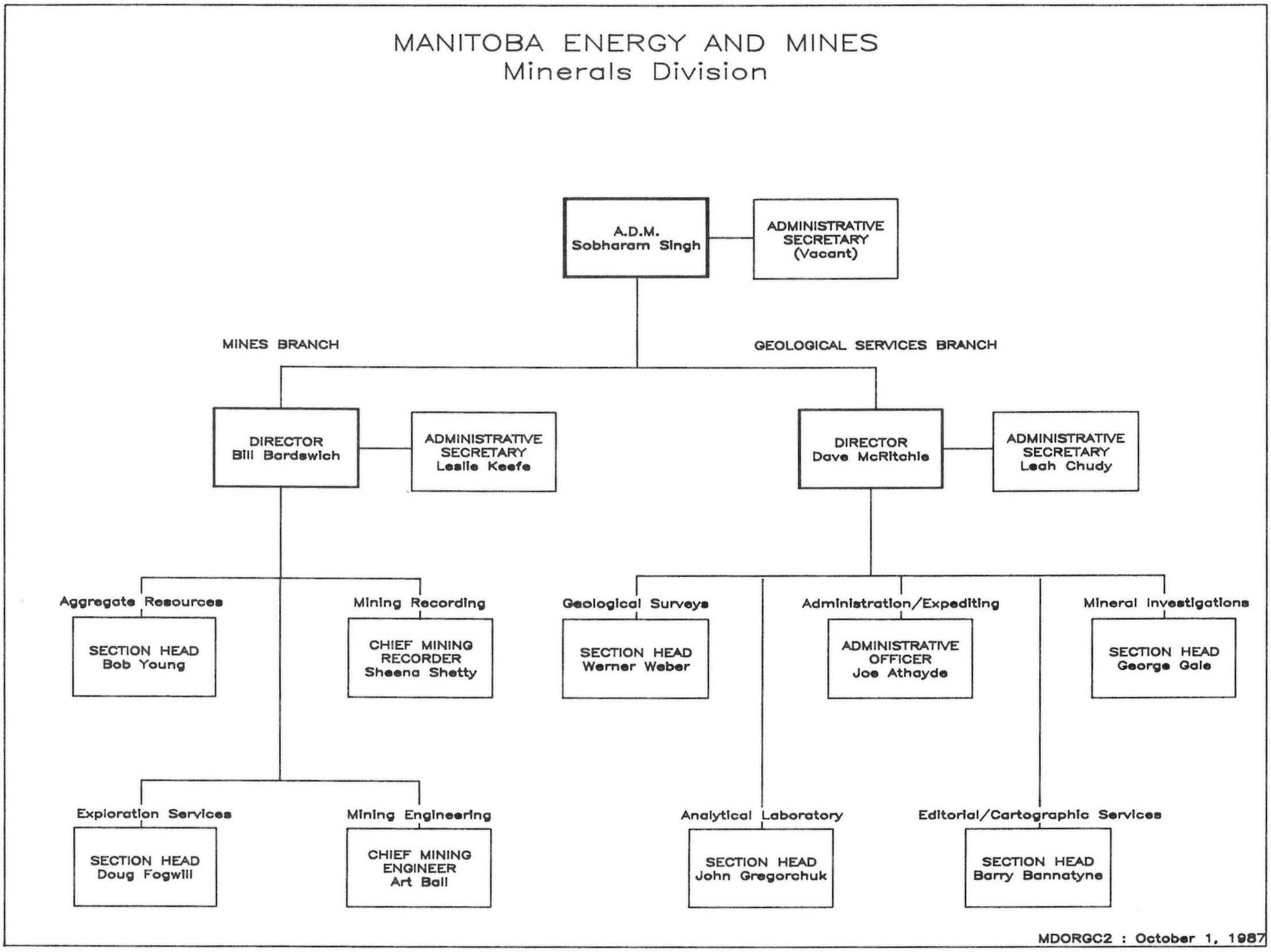

MANITOBA ENERGY AND MINES
Minerals Division
A.D.M.
Sobharam Singh
ADMINISTRATIVE SECRETARY (Vacant)
MINES BRANCH
GEOLOGICAL SERVICES BRANCH
DIRECTOR
Bill Bardswich
ADMINISTRATIVE SECRETARY
Leslie Keefe
DIRECTOR
Dave McRitchie
ADMINISTRATIVE SECRETARY
Leah Chudy
Aggregate Resources
SECTION HEAD
Bob Young
Mining Recording
CHIEF MINING RECORDER
Sheena Shetty
Geological Surveys
SECTION HEAD
Werner Weber
Administration/Expediting
ADMINISTRATIVE OFFICER
Joe Athayde
Mineral Investigations
SECTION HEAD
George Gale
Exploration Services
SECTION HEAD
Doug Fogwill
Mining Engineering
CHIEF MINING ENGINEER
Art Ball
Analytical Laboratory
SECTION HEAD
John Gregorchuk
Editorial/Cartographic Services
SECTION HEAD
Barry Bannatyne
MDORGC2 : October 1, 1987

TABLE OF CONTENTS

GEOLOGICAL SERVICES Page

Page

SOUTHEAST MANITOBA

Page

Page

MINES BRANCH

GEOLOGICAL SERVICES

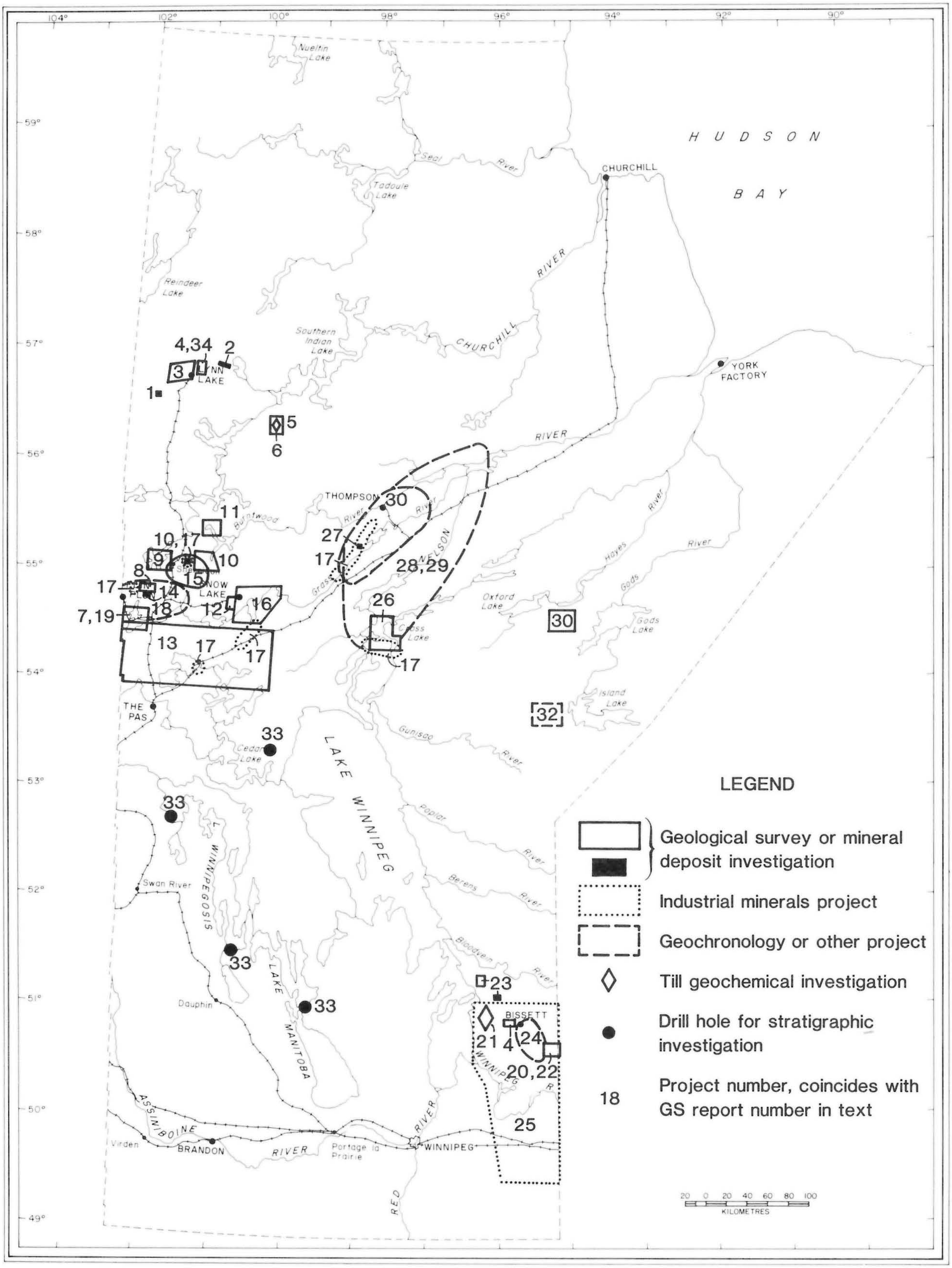


Figure GS-1: *Location of field projects, 1987. (Numbers refer to 'GS' reports in this publication.)*

INTRODUCTORY REVIEW
by W.D. McRitchie

During 1987 an accelerated level of geological surveys and investigations was undertaken in Manitoba by the Provincial and Federal Geological Surveys in this the fourth year of the (1984-89) Canada-Manitoba Mineral Development Agreement (MDA). This year's program reflected a slight shift in emphasis from field investigations to office compilation, data analysis, and report production.

The joint workplan for Sector "A" Geoscientific Activities was approved in March by the MDA Management Committee and copies distributed to members (6) of the newly expanded Mineral Exploration Liaison Committee (MELC).

A total of 46 Provincial and 22 Federal projects were mounted with operational budgets of $791 K and $1521 K, respectively. The combined expenditures were 23% Lynn Lake directed, and 37% went toward the Flin Flon-Snow Lake region. The remaining 40% of programming is evenly divided between Southeast Manitoba, the Churchill-Superior Boundary Zone, the Gods and Island Lakes regions, and Winnipeg-based compilations.

Ten Applied Geoscience Research Agreements were sponsored under the MDA with the Department of Geological Sciences, University of Manitoba (5 through the GSC and 5 through Manitoba Energy and Mines).

In 1987, although most projects represent a continuation of work initiated in earlier years, several new projects were introduced as outgrowths of recommendations from industry. Where possible, other projects were modified to respond to specific requests from exploration personnel.

An outline of the intended programming was presented in each of the mining districts prior to the field season, and at the April meeting of the Winnipeg CIM. Pamphlets listing MDA projects scheduled for 1987 were distributed throughout the Province in late May.

A Sector "A" Progress Report for 1986/87 was tabled in manuscript form at the April CIM meeting and final printed copies distributed June 29.

Survey personnel gave field tours and demonstrations for industry, university and government geologists working in the Kisseynew region, at Herb Lake, in the Churchill-Superior Boundary Zone, for building stone interests in Southeast Manitoba, and in support of ongoing research by NASA[1] personnel into the anorthosites and granitic plutons of the Bissett-Bird River region.

In the Phanerozoic sector of the Province, field tours provided detailed examination of the Paleozoic sequence, as one of Manitoba's contributions to the 5th International Williston Basin Symposium, and the CSPG[2]-hosted 2nd International Symposium on the Devonian System.

As part of the Canadian-hosted XIIth International INQUA[3] congress, Branch personnel (in concert with the GSC and Saskatchewan) led a 13-day field demonstration of Quaternary deposits stretching from Churchill, Manitoba to Waterton Park, Alberta.

Advice and guidance in the field were also provided in support of a feasibility study investigating the probable impact of iceberg scouring on seafloor pipelines.

Eight papers were given by Branch geologists at the Geological Association of Canada-sponsored Symposia on "Gold in Central Canada" and the "Trans-Hudson Orogen" convened in May at Saskatoon. Other information releases, open files, etc. continued throughout the summer.

This year's offering of preliminary Precambrian maps (15) includes a 1:1 000 000 compilation of sub-Phanerozoic basement geology in Hudson Bay Lowland.

In addition to their mandated activities Branch personnel provided advisory and editorial services to other Sectors of the Agreement including production of a Geological Highway Map of Manitoba, a Schools' Movie series, various educational pamphlets, presentations and tours for foreign investment interests, and the production of a brochure on Manitoba's Industrial Minerals.

An Interim Evaluation of the MDA by Price Waterhouse was completed in July 1987. Comments from industry provided valuable insight into the usefulness of MDA activities, as well as suggestions for new initiatives and improved services/liaison. The evaluation concluded that "during the first three years of its implementation (the Canada/Manitoba MDA) is generally well founded, efficiently managed and producing tangible results".

In a broader context, at the Mines Ministers' Conference in St. Johns (Newfoundland), the MDA mechanism for delivering government sponsored-industry supportive minerals programming received favourable comment from industry (PDA and MAC)[4] the geological community (CGC and CPG)[4], and senior officials from both levels of government.

Accordingly, Manitoba's MELC representatives were requested in late September 1987 to canvas exploration interests in their respective regions for project proposals that could be considered for implementation during a successor agreement (1989-94), as well as suggestions for changes to the focus, level and emphasis of Survey programming in the longer term.

This year's Report of Field Activities contains written contributions from the Geological Survey of Canada, in the form of abstracts describing the results of their current MDA work in Manitoba. These valuable contributions, together with a GSC-generated preliminary geological map and report of the Elbow Lake area, completes the roster of progress reports covering government geoscientific activities conducted during the summer of 1987 under Sector "A".

In keeping with the expanded format of this year's publication, an introductory review of GSC projects is presented by Alan Galley (Federal Cochairman for Sector "A") at the beginning of the section entitled "Federal MDA Geoscience Programs in Manitoba 1987-88".

PROVINCIAL PROJECTS

LYNN LAKE

Strong emphasis has been given toward supporting industry's gold oriented exploration programs in the Lynn Lake region. This year one of the Branch's activities focussed on the south flank of the Lynn Lake metavolcanic belt in the Gemmell Lake and Wasekwan Lake area. Deformed metavolcanics at Gemmell Lake containing quartz veins, sulphide mineralization and chloritic alteration veinlets are thought to represent a westward extension of the Johnson Shear Zone which elsewhere has demonstrated a consistent track record for hosting small but significant gold occurrences.

Re-inspection of the Sickle conglomerates and associated arenites suggests a possibility for placer gold deposition derived from gold-bearing quartz veins in granodiorite lying beneath the Sickle unconformity.

---
[1] National Aeronautics and Space Administration

[2] Canadian Society Petroleum Geologists

[3] International Union for Quaternary Research

[4] PDA — Prospectors & Developers Association; MAC — Mining Association of Canada; CGC — Canadian Geoscience Council; CPG — Committee of Provincial Geologists.

Continued exploration interest along the length of the Agassiz Metallotect inspired the successful search in 1986 for western extensions of the metalliferous zone in the Sheila Lake and Margaret Lake area west of the town of Lynn Lake. In 1987 a detailed examination of the 700 m thick stratigraphic section west of Burge Lake demonstrated significant differences to the Agassiz Metallotect including a lack of high-magnesium basalts, and the absence of abundant sulphide mineralization, carbonatization and silicification. In a similar context, searches at Frances Lake and Suttie Lake failed to encounter sections analogous to those of the metallotect.

A study of the MacLellan Mine revealed the presence of an early shear zone and associated zoned alteration pattern, paralleling the iron formations and high-magnesium basalt that are the most obvious features of the Agassiz Metallotect. The identification of this "paleo-shear zone" and its spawn the "North Shear" echoes a recurring theme in which silicified shear zones and their associated splays appear to be spatially coincident with (and possible conduits for) gold mineralization in the Churchill Province, e.g. McLeod Road thrust (Nor-Acme), Johnson Shear Zone, Rusty Lake fault (Vol), Tartan Lake and numerous others reported in the Athapapuskow and Flin Flon regions (see Report GS-7).

The recent discovery of gold at Farley Lake in sulphidized magnetite-rich banded iron formation has elevated interest in the metallogenic significance of the associated Agassiz Metallotect. Geological mapping at 1:5000 and geochemical sampling initiated in the Eagle Lake-Farley Lake area (in direct response to requests from exploration companies active in the area) demonstrated a good correlation between specific rock units and airborne INPUT anomalies as well as a consistent stratigraphy over much of the area (see Report GS-2).

Near Ruttan, drill core from the Darrol Lake deposit was sampled to determine the level of gold and associated pathfinder elements. Outcrops in the vicinity of the Vol gold deposit were mapped and sampled, and it was noted that the associated sulphide zones may represent splays from the major east-trending fault that transects the Rusty Lake metavolcanic belt.

Till examinations in the region of the Vol fault were extended east, as well as to the south in the Darrol Lake area.

Vegetation geochemical surveys continued in the Lynn Lake area and in Southeast Manitoba.

Scheelite identified at Nickel Lake within the Agassiz Metallotect may have applications as a pathfinder mineral for gold exploration.

Several MDA-sponsored M.Sc. theses and a Ph.D. thesis were completed on studies initiated in earlier years on the LAR deposit, the Fox Mine, Cartwright Lake, and the felsic volcanic rocks of the Ruttan area.

FLIN FLON-SNOW LAKE

Documentation of the structure and stratigraphy of the Amisk Group north of Flin Flon extended the block-bounding faults, mafic intrusions and volcanic sequences (demonstrated in the White Lake region) north and west towards Saskatchewan. Structural and compositional features were used to categorize the three mafic intrusive complexes in the region and to discriminate between complete and incomplete/tectonized stratigraphic sequences. Several new occurrences of mineralization were encountered, the most prominent lying within or close to the margins of the supracrustal enclaves within the Tartan Lake Gabbro Complex.

In the Athapapuskow region 1:20 000 mapping encountered superbly exposed 0.3-1.9 km thick sections of proximal Missi conglomerates and sandstones as well as basaltic sequences with trace element signatures more akin to volcanics from "spreading centres" rather than the "island arc" affinity typical of the Flin Flon metavolcanics to the north. Three new rhyolite flow complexes were identified and all block-bounding faults traced through from the Flin Flon-White Lake area.

Repeated attempts over the last few years to isolate dateable zircons from the Flin Flon volcanic belt were finally successful and firm ages were obtained for an Amisk rhyolitic crystal tuff from the Bear Lake Block (1886 Ma), as well as an unfoliated granodiorite from the Lynx Lake pluton (1847 Ma). The volcanic age is intermediate between that of the Wasekwan (1910 Ma) and the Ruttan volcanics (1878 Ma) but compares favourably with zircon ages of volcanic rocks in the La Ronge and Glennie domains, as well as the Hanson Lake Block.

Detailed mapping was extended north of the Baker Patton deposit to encompass the widespread fragmental rhyolitic, rhyodacitic, and associated dykes between Flintoba Lake and Leo Lake. A wide variety of primary textures and structures including lithophysae and possible accretionary lapilli and spherulites are invariably overprinted east of Flintoba Lake by a penetrative axial planar foliation. Sporadic chloritization was noted throughout the northern half of the area whereas pyritization tended to be centrally localized.

Detailed 1:15 840 mapping continued in the Chisel Lake area with the prime objectives being to provide an improved understanding of the complex stratigraphic and structural relationships in this economically significant portion of the Flin Flon metavolcanic belt. This year's work succeeded in establishing the stratigraphic setting of the Chisel, Lost and Ghost Lake mineralized zones, confirmed the restriction of hydrothermally altered rocks to the stratigraphic footwall, identified a key marker unit that can be used to guide future base metal exploration, and illustrated the fundamental role that interference fold structures can have in localizing the distribution of base metal mineralization.

Mineral occurrence documentation in the Snow Lake area continued together with 1:2500 and 1:5000 mapping around selected mineral occurrences. The mapping represents an outgrowth of site-specific work conducted since 1984. Detailed petrographic studies, geochemical sampling and mapping were initiated in the Squall Lake area on a variably textured biotite diorite, and on the Cook Lake alteration zone in conjunction with work being undertaken by the GSC. Much of the work requires extensive outcrop stripping in order to make definitive observations on the rock types and associated mineralization.

Examination of lithological sequences around the Pulver and Herblet gneiss domes revealed several possible similarities, with the attendant inference that Cu-Zn deposits (Wim deposit) and disseminated sulphide/gold mineralization (such as the Bee zone) may be subject to stratigraphic control and have analogues elsewhere in the region.

Further work on the south side of the Kisseynew gneiss domain attempted to pin down the key factors controlling the localization of base and precious metal mineralization in the paragneisses and associated migmatites.

The complex relationships of the Burntwood and 'Sherridon' gneisses on Kississing Lake were partially resolved into four fundamental 'type' lithological sequences with structural overprinting ranging from early recumbent folding, through synkinematic intrusion of major plutons and shear zone formation, to late stage conjugate faulting with varying degrees of associated retrograde metamorphism.

Gradiometer and total field surveys conducted in 1986 by the GSC were used extensively and with varying success to aid 1:20 000 and 1:50 000 geological mapping of the Kisseynew metamorphic complex in the Batty Lake, Limestone Point Lake and Star Lake area. Large areas previously designated as Sherridon and Nokomis paragneiss were reinterpreted as orthogneiss derived by dynamothermal metamorphism of intrusive rocks. Distinctive porphyroblastic gneisses at the margins of the orthogneiss are thought to represent tectonized alteration zones comprising locally mineralized schuppen complexes of supracrustal rocks.

On Limestone Point Lake an outlier of locally fossiliferous isoclinally folded Paleozoic dolomite, with a pronounced fracture cleavage testifies to a Phanerozoic deformational event for which there is little evidence elsewhere in the Province. Projections of the Paleozoic/Precambrian surface from south of Reed Lake suggest the outlier is depressed 120 m below its original position; however, the nature and orientation of the bounding structures remain unknown.

Mineral occurrence documentation was continued on the southern flank of the Kisseynew gneiss belt at Batty Lake and Martell ('Wood') Lake, and surface mapping continued at the Puffy Lake Gold Mine.

At the west end of Burntwood Lake one of the few known aegirine-augite syenites in the southeastern Churchill Province was mapped and sampled in detail to obtain further information of this body's geochemistry and potential to contain rare elements. Although highly folded and deformed the intrusion exhibits unique igneous layering and cumulus textures confirming a well fractionated and differentiated magmatic history.

Gradiometer releases scheduled for October 1987 will provide 1:20 000 contoured total field and vertical gradient maps for the Namew Lake region in Saskatchewan and Manitoba as well as Hargrave Lake and northern Moose Lake areas. GSC Open Files released in May 1987 provided similar coverage for the Nokomis-Sherridon area north of the Flin Flon greenstone belt. The Province completed eight scout drill holes to test magnetic signatures in the south part of the Project Cormorant area, complementing eight holes drilled in the spring by the GSC in areas of remote access. In cooperation with the Federal Survey 55 representative company drill holes were relogged as part of the ongoing compilation of subsurface data for the area, which also includes a three-dimensional analysis of the geophysical data by the GSC.

Examination of the Cliff Lake tonalite as a source for building stone resulted in a negative evaluation; however, work is continuing on reddish to purple dolomite from the Wekusko Lake area as well as buff to tan dolomite near the village of Cormorant. Sampling of the Naosap Lake quartz porphyry indicated that a distinctively coloured, good ornamental stone could be quarried but closely spaced fracturing would limit the size of extractable blocks. Work at Star Lake continued and was extended to the possibly equivalent garnet-anthophyllite occurrence northeast of Molly Lake.

SOUTHEAST MANITOBA

A complex association of silicified pillow basalts, felsic pyroclastics, volcanic conglomerates, sandstones and argillites were encountered during detailed mapping of well burnt-over exposures in the Lily Lake area. Considerable lateral facies changes were documented from coarse proximal felsic pyroclastics to more distal sandstones. Gold-bearing veins appear to predate the development of major shear zones and their associated barren white quartz veins.

Detailed deposit examination and channel sampling continued also at Lily Lake, where previous work had identified visible gold in an array of quartz veins hosted in meta-arkose and sandstone. The systematic documentation of mineral occurrences in southeastern Rice Lake region is now complete.

In the Bissett district vegetation geochemical surveys indicate that dwarf birch twigs are a more effective concentrator for a wider range of elements than alder twigs and, consequently, dwarf birch is a preferred medium for biogeochemical surveys.

At English Lake, gabbros, gabbroic breccias and megabreccias were found to display some similarities to the Roby Zone in the Lac des Isles PGE occurrence; however, gabbros at Shallow Lake are small in size and PGE potential is deemed to be minimal.

Placer gold occurrences in littoral Quaternary sand and gravel deposits in the Manigotagan region were investigated further. At this time the origin of the placer gold grains remains uncertain.

In its final year the evaluation of dimension stone potential in southeast Manitoba concluded that the highest potential for building stone production lies within the Betula Lake Pluton. Possible conflicts with Parks' interests are currently the subject of debate between the respective Departments. Sources of "Black Granite" might be obtained from the McMunn diorite and gabbro, and the diorite of the Falcon Lake Igneous Complex; however, drilling and test quarrying would be required to confirm this potential.

U-Pb zircon ages from the Bissett region, generated as part of a co-operative program with the universities of Windsor and Kansas, confirmed the presence of older (2880 Ma) granitoid phases in the Wanipigow complex north of the Rice Lake greenstone belt, a 2730 Ma age for the main felsic volcanism and contemporaneous intrusive rocks, and a younger (2663 Ma) age thought to represent the main anatexis and Kenoran metamorphism in the English River gneissic belt. Synoptic geological compilations at 1:250 000 for NTS areas 52E and 52L are being prepared for release in preliminary form at the annual Meeting with Industry in November 1987.

THOMPSON

In the Thompson region detailed mapping of Pipe Pit lithologies, using low altitude high-resolution aerial photographs, confirmed a Molson affinity for the diabase dykes and identified an early Hudsonian metamorphic and deformational event in the metasedimentary host rocks that predates dyke intrusion at 1884 Ma.

Mapping at 1:20 000 was completed in the central portion of Cross Lake, and the Pipestone Lake intrusive complex was extended to the west. Anorthosites near Jenpeg were also mapped and sampled. Northwest of the town of Cross Lake a single sample, from alteration haloes around quartz pods, assayed close to 6 gm/tonne Au.

Monazite, sphene and zircons were sampled to provide additional geochronological data for the Thompson region. Preliminary results range from around 3000 Ma for zircons in gneisses from Manasan and Sasagiu Rapids, to the youngest Hudsonian event variously dated around 1770 Ma by monazite, sphene, and by zircons in late pegmatite.

The industrial minerals program returned a favourable first appraisal of the Ospwagan granite as having building stone potential. Thick overburden at Pipe Pit appears to constrain the potential of marble in this region. Migmatites at Sasagiu Rapids do not polish well, and the Moak Lake serpentinite does not appear to be a viable source for carving quality serpentine.

Near Jenpeg a Molson dyke shows good potential as a source for "Black Granite"; however, no readily accessible outcrops of good quality anorthosite appear available at this time.

GODS-ISLAND LAKES

Only two Provincial field projects continued in this region during 1987, although a 1:250 000 synoptic compilation for NTS 53L is nearing completion, and compilation and report production for adjacent sheets continues in Winnipeg.

Uranium-lead zircon ages from the greenstones at Bigstone and Knight Lakes are comparable to those at Island Lake indicating a minimum age of 2890 Ma for the mafic volcanics in these regions.

Samples were collected from the Magill Lake granite and associated pegmatites at Magill and Knee Lakes, and near Hawkins and McLaughlin Lakes. With the exception of a single columbite-tantalite-bearing dyke crosscutting the Oxford Lake Group, rare-element minerals are typically absent within the pegmatite pods and dykes on Magill Lake. Spodumene was confirmed at McLaughlin Lake.

A MDA-sponsored thesis on the rare-element-enriched pegmatites from Red Sucker Lake was completed during the summer.

SOUTHERN MANITOBA

A broad range of stratigraphic studies was conducted in Paleozoic rocks throughout the south part of the Province. Outputs include a comprehensive guidebook of the Devonian outcrop belt, five drill holes in Winnipegosis reef settings, a preliminary study of caves in the Interlake area along with Parks personnel, and logging of the Paleozoic sections of core obtained from the Project Cormorant area.

This year's drilling (including holes drilled for industrial minerals purposes), encompassed 15 holes for a total of 1316 m. Cumulative drilling since the inception of the stratigraphic drilling project in 1969 now amounts to over 13 000 m. Computerization of this data base has been initiated.

APPLIED GEOSCIENCE RESEARCH

Applied Geoscience Research agreements with the Department of Geological Sciences, University of Manitoba once again provided the means for focussing the unique expertise of university staff into projects complementing the work of the Provincial and Federal Geological Surveys.

Geochemical characterization of the felsic plutons in the Flin Flon region and the mafic/ultramafic sequences in the Thompson region expanded the sample collection program and provided new insights into the genesis of these formations. The initial results from the Thompson region are especially revealing in that volcanics from Ospwagan Lake appear to have an "ocean floor" chemistry not unlike that emerging from metavolcanic rocks of the Athapapuskow region.

In the Superior Province the final phase of field investigations focussed on the rare-element-bearing intrusives in the Magill Lake area.

Ongoing rubidium/strontium studies, this year will analyze three samples from Cross Lake and four from the Thompson-Split Lake region.

EXPLORATION SERVICES (MINES BRANCH)

The Exploration Services Section continues to support Sector "A" MDA initiatives in the areas of drill core retrieval, liaison with industry, and by generating compilations of various types. The Department's publications distribution function has been transferred to the Information Office, Room 555 on the fifth floor of Eaton Place.

The principal objective set for the core retrieval program during 1987 was to establish a computer-based master inventory of the northern Manitoba drill library holdings. By September approximately 70% of the inventories from The Pas, Thompson and Lynn Lake had been entered onto computer files.

Other projects conducted during the year included updating of inventories, field collection, reboxing and culling of core, and improvements to building site drainage.

One of the major new thrusts of the Section was the re-establishment in September of the Regional Geologist in The Pas, a position that fell dormant in 1977. David Prouse is welcomed to the position which will provide an elevated level of liaison and services to the mineral industry in northern Manitoba.

Exploration Services also continued to monitor and report on company activities in the Province as well as distributing large numbers of brochures and publications. Significant additions were made to the content and retrievability of the Bibliography of Manitoba Geology, as well as completing the updating of the mineral inventory for gold deposits/occurrences.

An Economic Geology report "Gold Deposits in Manitoba" (produced jointly with the Geological Services Branch) is to be released in November 1987.

Assessment files were completely re-organized and new index maps completed for airborne geophysical surveys. Displays and brochures were prepared for several major public events, including the annual Prospectors & Developers Convention, the Careers Symposium, and articles for various journals.

September 28, 1987

GS-1 GOLD MINERALIZATION ASSOCIATED WITH THE JOHNSON SHEAR ZONE
by D.A. Baldwin

INTRODUCTION

Geological investigations of gold mineralizaton on the south flank of the Lynn Lake metavolcanic belt (Johnson Shear Zone) have been ongoing since 1984 (Peck, 1984, 1986; Ferreira, 1986). These investigations continued during the 1987 field season with examination of outcrops in the Gemmell Lake area and examination of drill core from the Wasekwan Lake area (Fig. GS-1-1). The data from the Wasekwan Lake area have not yet been synthesized and, thus, this report will deal only with the geology of the mineralization in the Gemmell Lake area.

GEMMELL LAKE AREA

The area examined near Gemmell Lake is underlain by Wasekwan Group mafic and felsic metavolcanic rocks, Wasekwan and Sickle Group metasedimentary rocks and pre-Sickle Group granitic plutonic rocks (Fig. GS-1-2). All rock types have a superimposed foliation defined by the alignment of mafic minerals, the flattening of fragments, pebbles and cobbles, and the transposition of layering that resulted from regional deformation and metamorphism. Locally, this foliation was deformed by faulting and folding.

The pre-Sickle Group plutonic rocks (Fig. GS-1-2) are equigranular medium grained granodiorite in which the mafic minerals are aligned. In these rocks there are three sets of quartz veins (Fig. GS-1-3); one set is parallel to the foliation. In a 0.3-0.5 m wide zone on either side of this vein set the grain size of the granodiorite decreases gradually and the intensity of the mafic mineral alignment increases toward the vein boundaries. Within these veins are xenoliths of the more intensely deformed granodiorite as well as xenoliths of black, aphanitic material that contains a small number of 0.5-1 mm rounded quartz grains. The xenoliths are probably mylonitized granodiorite. The two vein sets that crosscut the foliation do not contain this material nor is the granodiorite more intensely deformed at the margins of these vein sets. Quartz veins in the granodiorite are neither folded nor boudinaged.

The porphyritic rhyolite is generally massive and locally exhibits an alignment of micaceous minerals. The upper 60 m of porphyritic rhyolite and the aphyric rhyolite are characterized by folding and rotation of an earlier fabric that is either a fracture cleavage or flow layering (Fig. GS-1-4). The deformation of this earlier fabric appears to have resulted from strain slip on closely spaced microfaults (Fig. GS-1-4). Quartz veins, quartz veinlets and chloritic alteration veinlets are folded and boudinaged. In addi-

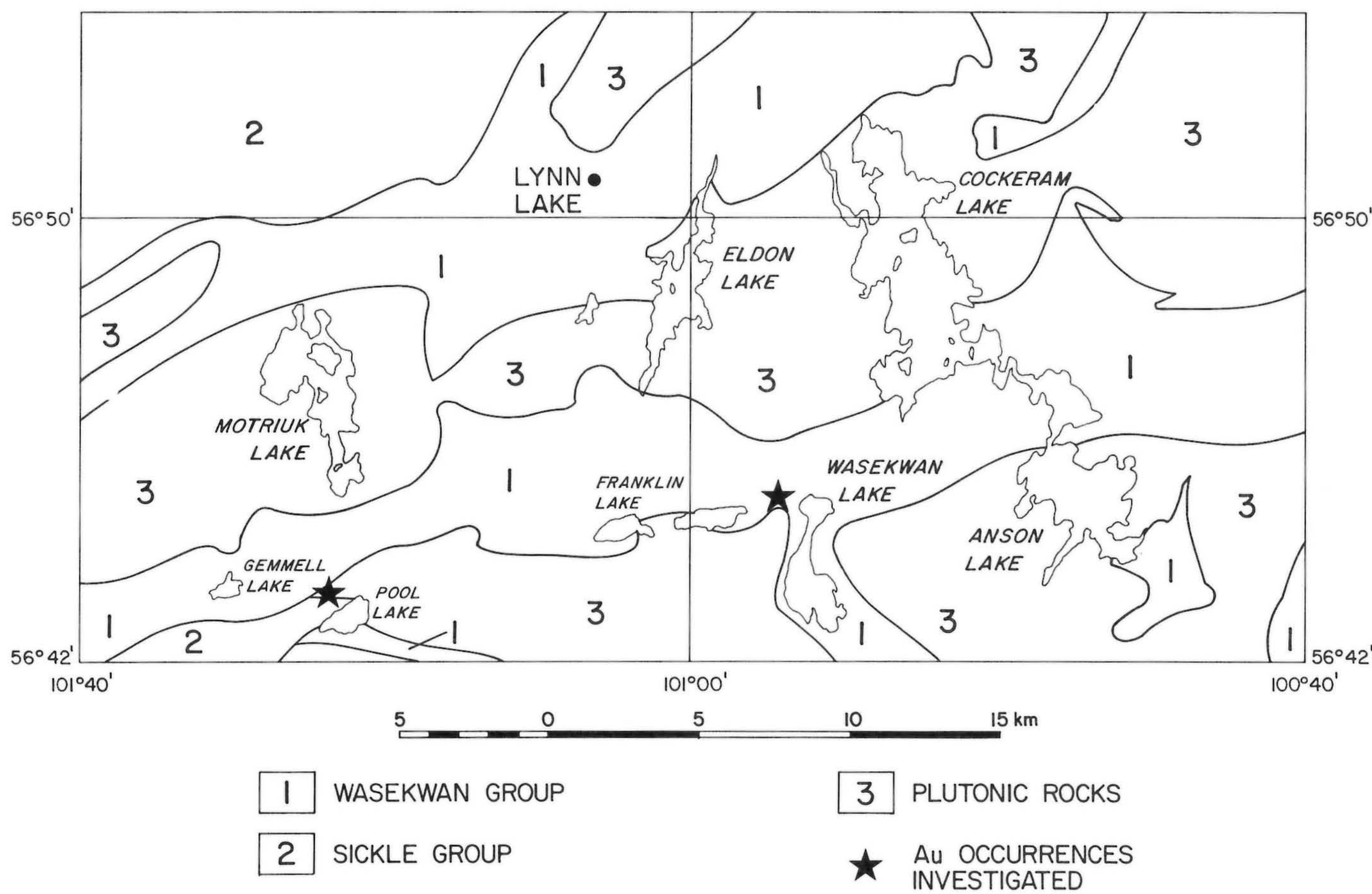


Figure GS-1-1: Location of areas of investigation on the Johnson Shear Zone (*) and general geology of the Lynn Lake area.

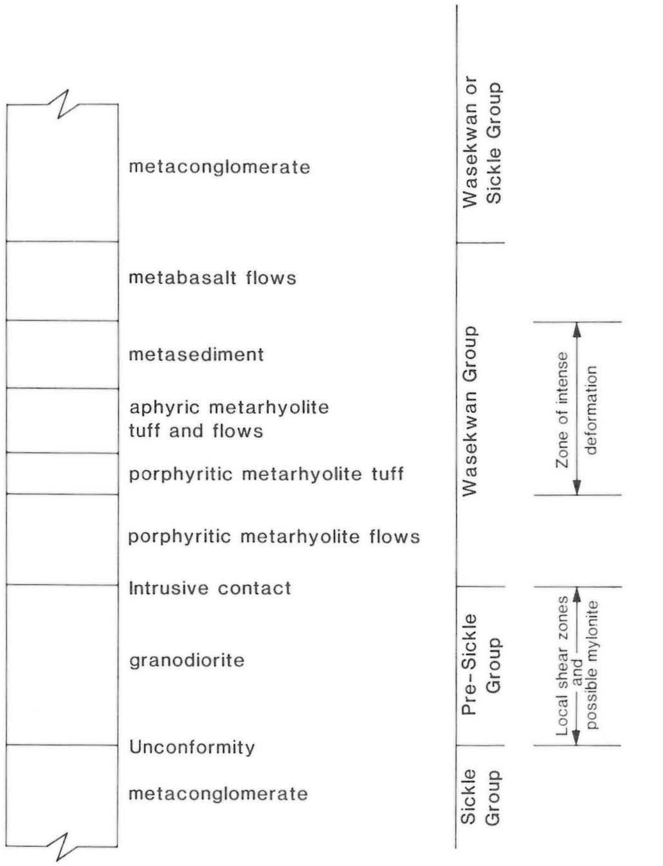


Figure GS-1-2: *Columnar section of the geology in the vicinity of the Johnson Shear Zone in the Gemmell Lake area.*

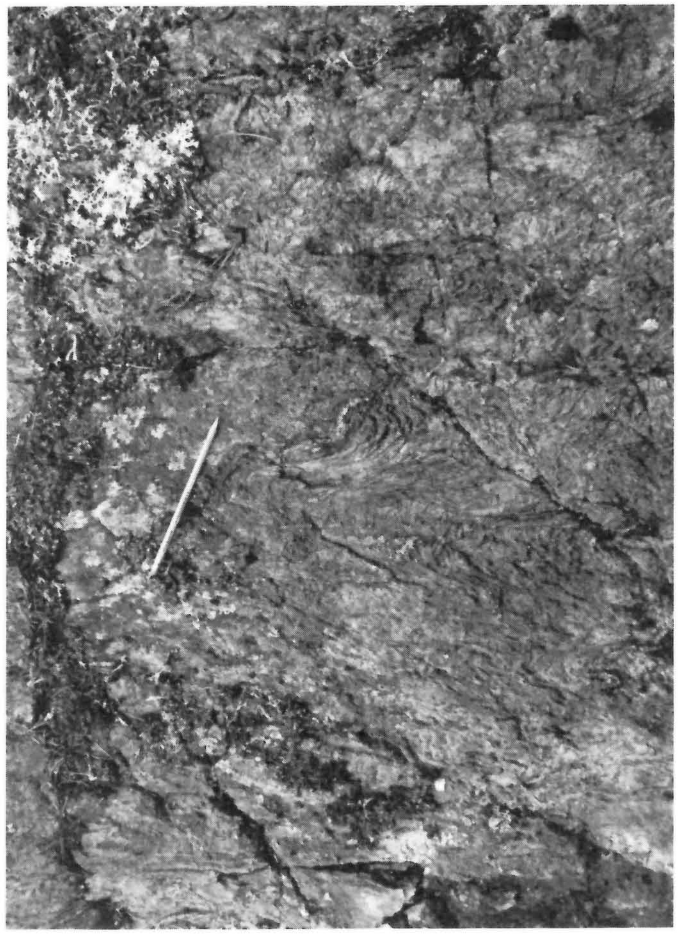


Figure GS-1-4: *Deformation of early fabric by strain slip on microfaults in metarhyolite.*

Figure GS-1-3: *Outcrop map of sulphide and gold occurrence in quartz vein in pre-Sickle Group granodiorite in the Gemmell Lake area.*

tion, two zones of rhyolite breccia, 1 and 1.4 m thick respectively, occur within this part of the rhyolite sequence. The breccia is characterized by angular to subrounded fragments of fracture cleaved or flow layered rhyolite in a fine grained schistose rhyolitic matrix (Fig. GS-1-5); the orientation of cleavage or flow layering in the breccia fragments is random. It is suggested that these are fault breccias.

Wasekwan Group metasedimentary rocks are more intensely deformed than other lithologies in the succession. This metasedimentary unit consists of folded and faulted metagreywacke, meta-iron formation, meta-argillite and quartzite. Many lithologic boundaries within the metasedimentary unit are faults (Fig. GS-1-6 and 7) that parallel the unit boundaries. Most depositional boundaries within the resultant fault blocks are parallel to sub-parallel with the faults; however, some are folded within and/or at the margins of the fault blocks (Fig. GS-1-8). Locally, blocks of rock that are transected by the faults have been rotated adjacent to these faults (Fig. GS-1-7 and 9). Quartz veins and veinlets in the metasedimentary unit are folded and boudinaged (Fig. GS-1-10).

The mafic volcanic unit is poorly exposed and flattening of fragments in breccia layers and alignments of mafic minerals are the only deformational indicators observed. Flattened pebbles and cobbles, and alignment of micaceous minerals in matrix, characterize the metaconglomerate units. The faulting, folding, brecciation and boudinage observed in the upper part of the metarhyolitic unit and in the adjacent metasedimentary unit are apparently absent in the mafic metavolcanic and metaconglomerate units.

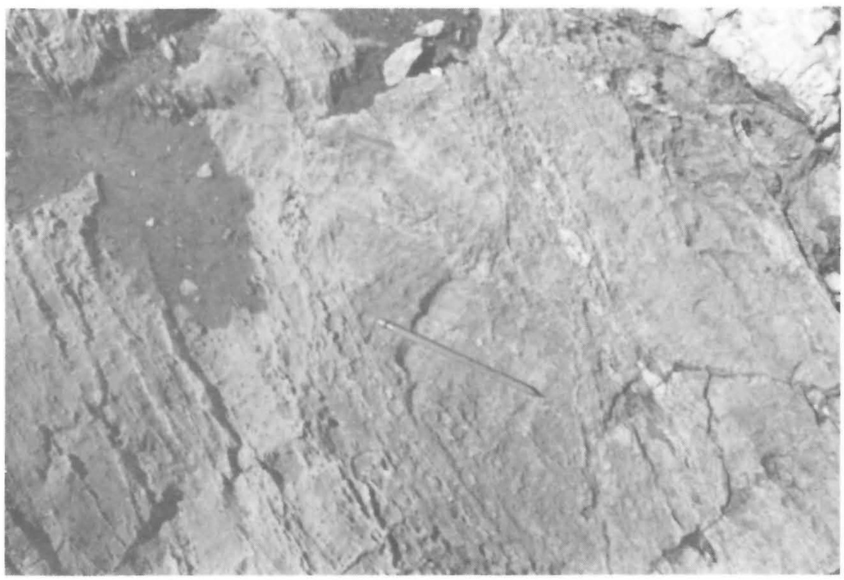
Figure GS-1-5: *Fault breccia in metarhyolite sequence.*

Figure GS-1-6: *Faulted lithologic boundary in the metasedimentary unit.*

Figure GS-1-7: *Faulted lithologic boundary in the metasedimentary unit. A block of the rock on the left side of the fault has been rotated adjacent to the fault.*

Figure GS-1-8: *Folded foliation and lithologic boundary adjacent to a fault in the metasedimentary unit.*

Figure GS-1-9: *Rotated block adjacent to a faulted lithologic boundary in the metasedimentary unit.*



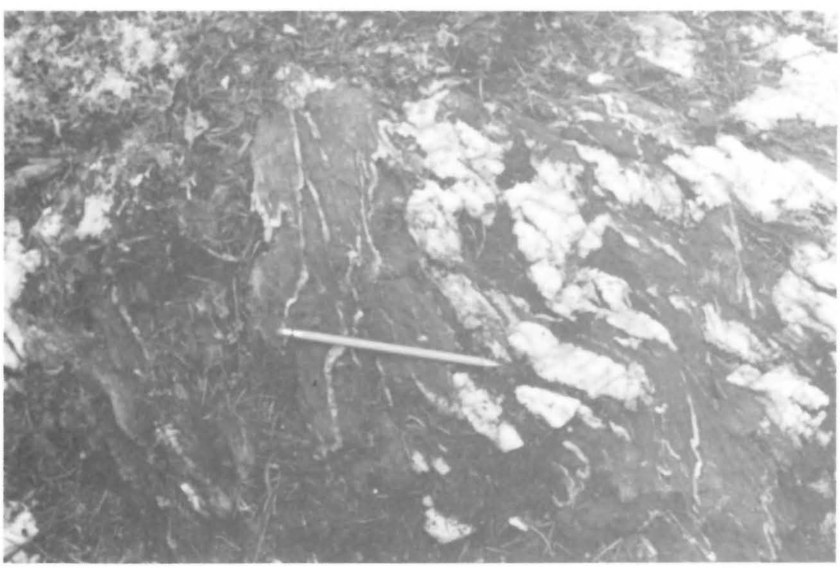


Figure GS-1-10: *Folded and boudinaged quartz veins in the metasedimentary unit.*

Sickle Group metaconglomerate rests unconformably upon the granodiorite. It contains pebbles and cobbles of the granodiorite and quartz vein material. Quartz veins in the granodiorite are truncated at the unconformity.

The disrupted and intensely deformed upper part of the metarhyolite succession and the adjacent metasedimentary unit suggest a zone of high strain where the strain was taken up predominantly by faulting and to a lesser degree by folding.

MINERALIZATION

In the granodiorite disseminated pyrite, chalcopyrite, sphalerite, galena and free gold occur in the quartz veins that parallel the foliation. Disseminated pyrite occurs in the more intensely foliated zone adjacent to this vein set and also in the vein set that is oblique to the foliation; however, it has not been observed in the quartz veins that are perpendicular to the foliation (Fig. GS-1-3).

Quartz veins in Wasekwan Group metavolcanic and metasedimentary rocks appear to be barren of mineralization. However, minor disseminated pyrite and arsenopyrite occur in the metasedimentary rocks in association with the deformed quartz veins.

Samples for lithogeochemical studies of the granodiorite, metavolcanic and metasedimentary rocks are being processed.

SUMMARY AND PRELIMINARY CONCLUSIONS

The upper part of the metarhyolite succession and the adjacent metasedimentary rocks form an intensely deformed zone. This zone, which is spatially close to the southern boundary of the Lynn Lake metavolcanic belt, contains quartz veins, sulphide mineralization and chloritic alteration veins and veinlets. These features are consistent with some of the characteristics of the Johnson Shear Zone at other locations in the Lynn Lake metavolcanic belt (Gilbert et al., 1980; Peck, 1984, 1986; Ferreira, 1986). Thus, it is suggested that the intensely deformed zone in the Gemmell Lake area is part of the Johnson Shear Zone and that the lateral extent of the Johnson Shear Zone can be extended 9 km westward from its previously indicated termination at Franklin Lake.

Gold mineralizaton in the granodiorite is associated with quartz veins that may occupy shear zones. The Sickle Group metaconglomerate rests unconformably on the granodiorite, and quartz veins in the granodiorite are truncated at the unconformity. Pebbles and cobbles of the granodiorite and quartz vein material are present in the conglomerate. Sickle Group metaconglomerate has the potential to contain paleoplacer gold mineralization.

REFERENCES

Gilbert, H.P., Syme, E.C., and Zwanzig, H.V.

1980: Geology of the metavolcanic and volcaniclastic metasedimentary rocks in the Lynn Lake area; Manitoba Mineral Resources Division, Geological Paper GP80-1, 118 p.

Ferreira, K.

1986: Geological investigations in the Foster Lake-Wasekwan Lake area; **in** Manitoba Mineral Resources Division, Report of Field Activities, 1986, p. 13-17.

Peck, D.C.

1984: An investigation of gold mineralization at Cartwright Lake, Manitoba; **in** Manitoba Mineral Resources Division, Report of Field Activities, 1984, p. 25-27.

1986: The geology and geochemistry of the Cartwright Lake area: Lynn Lake greenstone belt, Northwestern Manitoba; Unpublished M. Sc. thesis, University of Windsor, Windsor, Ontario, 270 p.

GS-2 INVESTIGATION OF AGASSIZ METALLOTECT STRATIGRAPHY

by D. Parbery and M.A.F. Fedikow

INTRODUCTION

Mineral deposit studies have been ongoing in the Lynn Lake area since 1982 with considerable attention focussed on the Agassiz Metallotect stratigraphy — a series of high-Mg volcanic rocks with associated clastic sedimentary rocks, iron formation, and base and precious metal mineralization (Fedikow, 1986). The MacLellan Au-Ag mine is hosted within this stratigraphy as is the Dot Lake Au deposit to the west of the MacLellan mine. The recently discovered Farley Lake Au deposit, located 30 km east of Lynn Lake along the Agassiz Metallotect, was formed by sulphidization of a magnetite-rich, banded iron formation and reinforces the significance that this metallotect holds for the northern belt of the Lynn Lake greenstone belt.

In response to requests from exploration companies operating in the Lynn Lake area, detailed 1:5000 geological mapping and geochemical sampling were initiated along the Agassiz Metallotect, in the Eagle Lake and Farley Lake areas, to:

1) investigate the stratigraphy of iron formations; and,
2) establish the relationship between mineralization and airborne INPUT anomalies obtained by a Questor survey in 1976.

The results of an investigation of a tungsten occurrence in the Nickel Lake portion of the Agassiz Metallotect are also discussed.

GENERAL STRATIGRAPHY AND STRUCTURE

Figure GS-2-1 is a sketch of idealized stratigraphic sections from the Eagle Lake and Farley Lake areas. Rock units strike approximately ESE and dip steeply to the north and south. Changes in dip direction are due to folding of the rock units. The iron formation and its associated rock units are described below.

I: IRON FORMATION

Outcrops of both banded magnetite and hematite iron formation occur east and southeast of Key Lake and southwest of Gordon Lake. Only magnetite iron formation was found between Gordon and Farley Lakes and to the southwest of Eagle Lake (Fig. GS-2-2). Small folds are common throughout the hematite iron formaton. The magnetite and hematite iron formations have an exposed thickness of 500 m in the Key Lake — Gordon Lake area.

The magnetite iron formation is banded with alternating very fine grained 1-20 mm thick, magnetite, siliceous and cherty layers. Magnetite layers average 2-3 mm in thickness and contain more than 80% magnetite. Siliceous layers contain quartz, chlorite ± feldspar and 1-20% magnetite. Cherty layers contain no visible chlorite and very little magne-

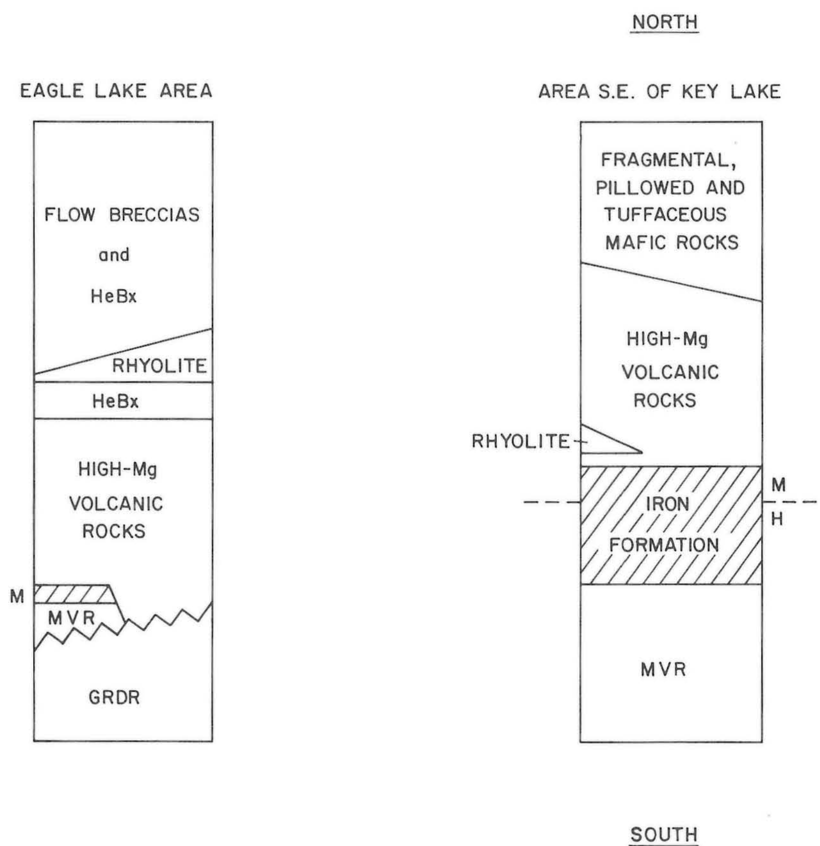


Figure GS-2-1: Diagrammatic stratigraphic sections of the Eagle Lake area, southeast Key Lake, and Farley Lake areas. HeBx: heterolithologic breccias; GRDR: granodioritic intrusive rocks; MVR: mafic volcanic rocks; M: magnetite iron formation; H: quartz-hematite iron formation.

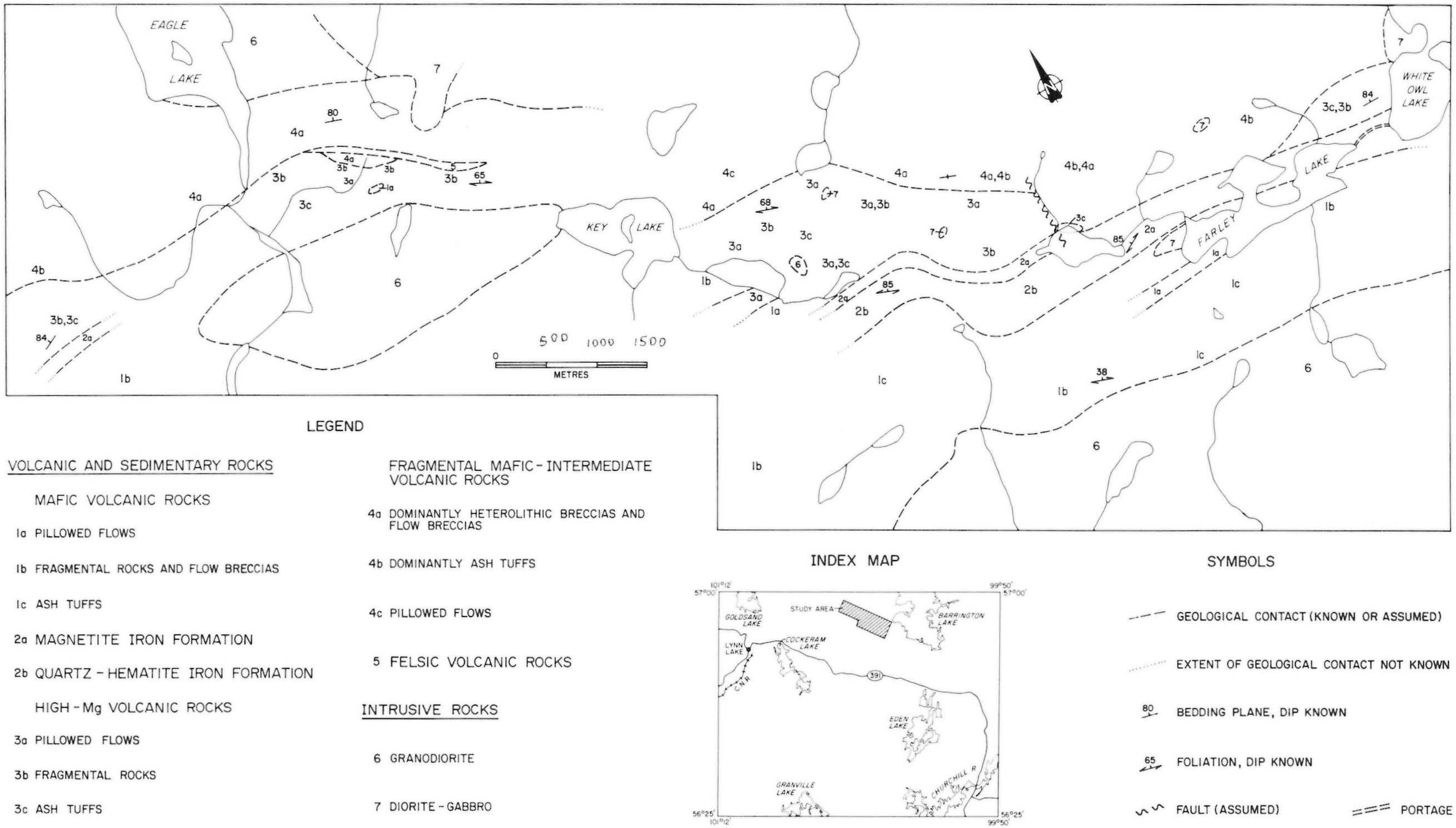


Figure GS-2-2: Geological map of the Eagle Lake-Farley Lake area.

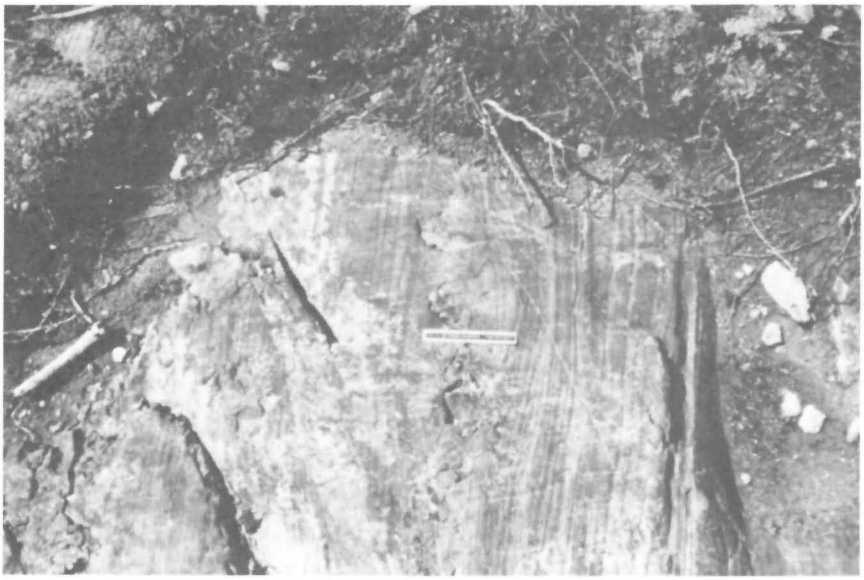


Figure GS-2-3: Magnetite iron formation at Farley Lake.

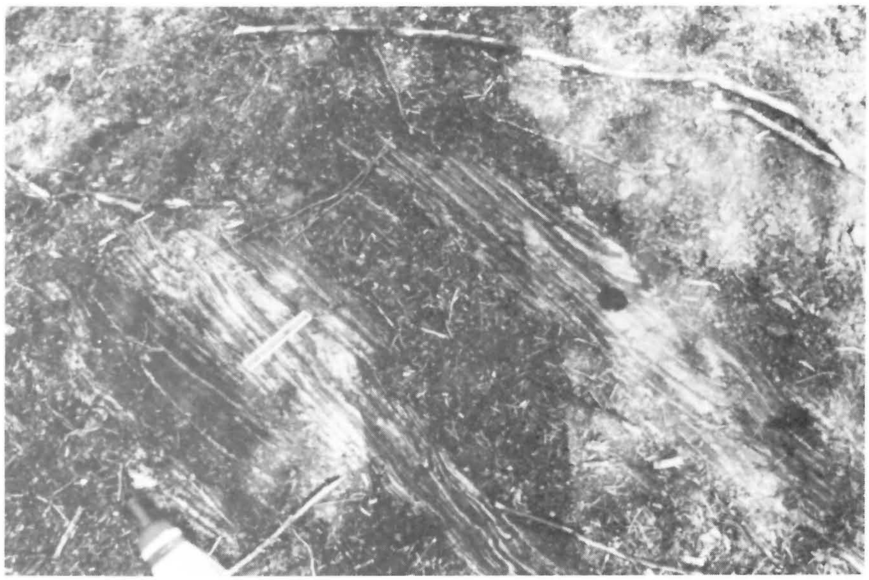


Figure GS-2-4: Quartz-hematite iron formation; southeast of Key Lake. Laminae are folded.

Figure GS-2-5: Fragmental high-Mg volcanic rock; Eagle Lake area.

tite. At Farley Lake the iron formation consists of 50% magnetite layers and 50% saccharoidal siliceous and cherty layers (Fig. GS-2-3). Southeast of Key Lake the iron formation consist of 20% cherty layers, 50% saccharoidal siliceous layers and 30% magnetite layers.

The hematite iron formation consists of alternating 3 mm-20 cm red-brown hematitic layers and 1 mm-1.5 cm siliceous to cherty layers. The siliceous layers comprise 20-50% of the rock (Fig. GS-2-4).

The magnetite and hematite iron formations contain up to 2%, 1 mm, disseminated pyrite grains.

II: HIGH-Mg VOLCANIC ROCKS

Dark green to blue-green weathering mafic volcanic rocks occur throughout the map area, and stratigraphically overlie the iron formation. In the Eagle Lake area they are fragmental and tuffaceous rocks. The tuffs are very fine grained ash tuffs and occur in 3-20 cm thick layers. Fragmental volcanic rocks have a very fine grained amphibolitic/chloritic groundmass with 10% anhedral, 1-4 mm long amphibole crystals (after pyroxene). Fragments are subangular to subrounded and comprise 20-50% of the rock. The fragments are aphanitic and of intermediate composition, average 5 x 2 cm in size, and contain 10%, 1 mm feldspar amygdales and up to 5%, 1-5 mm anhedral mafic phenocrysts (Fig. GS-2-5).

Southeast of Key Lake and in the Farley Lake area, high-Mg volcanic rocks are pillowed, tuffaceous and fragmental in nature. Pillows are 0.1-0.3 x 0.2-0.5 m in size and contain small plagioclase amygdales at the pillow rims. Ash tuffs are massive (except at the northeast end of Farley Lake where they contain conjugate shear sets). Fragmental volcanic rocks have a dark green mafic groundmass and contain up to 30% fragments. The fragments have a wide compositional range and the rocks have been mapped as heterolithic breccias.

III: FRAGMENTAL MAFIC-INTERMEDIATE VOLCANIC ROCKS

Fragmental mafic intermediate volcanic rocks overlie the high-Mg volcanic rocks in the Eagle Lake and Farley Lake areas. In the Eagle Lake area they consist of grey weathering heterolithic breccias and flow breccias with minor ash and crystal ash tuffs. These rocks are analogous to the high-Al basalts of Gilbert (1980). In the Farley Lake area these rocks consist of green weathering crystal ash tuffs, and ash tuffs with minor flow breccias, heterolithic breccias and pillowed flows.

IV: FELSIC VOLCANIC ROCKS

Felsic volcanic rocks are found only in the Eagle Lake area. The rocks are aphanitic containing 1%, 1-3 mm anhedral garnets and 1%, 0.5-3.0 mm anhedral to subhedral quartz crystals. Small patches (up to 15 x 6 cm) contain up to 10% quartz crystals. These areas represent either clasts or stretched and boudinaged layers. Many of the felsic volcanic rocks contain conjugate shears and most outcrops are cut by 10-20 cm mafic amphibolitic, green dykes. The felsic rocks are contained within Unit III.

V: GRANODIORITE

A medium grained, pink-orange weathered plagioclase-phyric intermediate intrusive rock is present in the southern part of the map area.

VI: MISCELLANEOUS VOLCANIC ROCKS

Mafic to intermediate ash tuffs and pillowed flows occur south of Gordon Lake and Farley Lake, between the iron formation and the granodioritic intrusion. Massive mafic volcanic rock and flow top breccias occur north of Low Lake (Fig. GS-2-2).

VII: MISCELLANEOUS INTRUSIVE ROCKS

Small outcrops of diorite and gabbro are found throughout the north part of the map area within the fragmental mafic-intermediate volcanic rocks (IV). A small gabbro body outcrops 200 m west of Farley Lake and another outcrop occurs approximately 500 m west of Farley Lake.

Very fine grained felsic dykes intrude the mafic volcanic rocks that lie south and southwest of Farley Lake and have silicified the host rocks.

GEOLOGY, MINERALIZATION, AND INPUT SURVEY

The Eagle Lake-Farley Lake area is characterized by strong geophysical responses, detected during airborne INPUT surveys (Questor, 1976). This distinctive geophysical signature extends southeast of a point south of Eagle Lake, north and southeast of Key Lake and through the Gordon Lake-Farley Lake area. Many of the strongest responses are located in swamps or areas of little or no outcrop; however, responses that do occur in areas of outcrop were found to parallel the strike of local rock units. This is best demonstrated southeast of Eagle Lake where the INPUT anomaly coincides with a felsic volcanic unit that locally contains up to 5% pyrrhotite and pyrite (Fig. GS-2-2). Other correlations between INPUT anomalies and specific rock units are located: 1) north of Low Lake, where the anomaly is explained by the presence of 2-4% disseminated pyrite and chalcopyrite in a mafic flow breccia (site #159, in Milligan, 1960); 2) north of Gordon Lake, where the geophysical anomaly parallels a silicified basaltic rock unit containing approximately 2% sulphides; 3) southwest of Gordon Lake and south of a small lake southeast of Key Lake, where weak INPUT responses correspond to outcrops of hematite and magnetite banded iron formation with up to 2% sulphides; 4) east of Key Lake, where a moderate geophysical response is explained by the presence of a rusty weathered mafic pillowed unit and mafic fragmental rocks; 5) southest of Key Lake, where an INPUT anomaly coincides with an outcrop of fragmental felsic volcanic rock with 10% disseminated pyrite, chalcopyrite ± pyrrhotite.

It is probable that, in some instances, the recorded INPUT anomalies are due to larger concentrations of sulphides at depth instead of the weakly mineralized, rusty weathered rocks exposed.

The major rock units (high-Mg volcanic rocks, banded iron formation, felsic volcanic rocks and mafic-intermediate fragmental rocks) are also present in other parts of the Agassiz Metallotect, for example, iron formation has been reported from the MacLellan Mine area and at Arbour Lake (Fedkiow, 1986b; Gilbert, 1980), and quartz-phyric felsic volcanic rocks occur at Nickel Lake and Spider Lake at the eastern end of the metallotect (Fedikow, 1985, 1986a).

The strong geophysical responses seen in the Eagle Lake-Farley Lake area are typical of the remainder of the Agassiz Metallotect (Fedikow, 1984).

NICKEL LAKE TUNGSTEN OCCURRENCE (M.A.F.F)

In the course of field work during 1985 in the Nickel Lake portion of the Agassiz Metallotect (Fedikow and Eccles, 1985), a mineral occurrence (NL-62) on the south shore of Nickel Lake was mapped and sampled for geochemical analysis (cf. Fig. GS-6-2, Fedikow and Eccles, 1985). An unusually high tungsten analysis was obtained for a sample collected from a silicified, sheared quartz and feldspar-phyric rhyolite. The outcrop contained finely disseminated pyrite and chalcopyrite and a geochemical analysis indicated anomalously high Cu, Ag, and Au in addition to W (Table GS-2-1). A hand sample of the outcrop was slabbed and irradiated with an ultraviolet lamp revealing flecks, pods, laminae and veinlets of a blue fluorescent mineral identified by X-ray diffraction as scheelite. This occurrence of scheelite appears to be the first documentation of tungsten within the Agassiz Metallotect, and its association with anomalous Au and Ag in the general area of the occurrence deserves closer examination. Six hand samples of mineralization collected from the Main Zone orebody of the MacLellan Au-Ag deposit contained negligible tungsten (Table GS-2-1).

TABLE GS-2-1

GEOCHEMICAL ANALYSIS OF ROCK SAMPLES FROM MINERAL OCCURRENCE NL-62, NICKEL LAKE AREA, AGASSIZ METALLOTECT AND SIX SAMPLES FROM THE MACLELLAN MAIN ZONE OREBODY

All concentrations in ppm unless otherwise noted. Tungsten analyses are based on INAA. Analyses of sample 00593, including the tungsten value in brackets, are based on partial digestion ICP.

Sample No.	W	Mo	Cu	Pb	Zn	Ag	Au
00593	320(387)	5	1388	21	21	3.3	2280
MacLellan Mine Zone							
1000	13						
2000	<3						
3000	10						
4000	9						
5000	<9						
6000	<8						

REFERENCES

Fedikow, M.A.F.
1984: Preliminary results of biogeochemical studies in the Lynn Lake area; Manitoba Mineral Resources Division, Open File Report OF84-1; 104 p.

1986a: The Agassiz Metallotect — Spider Lake area; **in** Manitoba Mineral Resources Division, Report of Field Activities, 1986, p. 23-25.

1986b: The geology of the Agassiz stratabound Au-Ag deposit, Lynn Lake, Manitoba; Manitoba Energy and Mines, Geological Services, Open File Report OF85-5, 80 p.

Fedikow, M.A.F. and Eccles, D.R.
1985: Geology and mineral occurrences in the Nickel Lake area, Agassiz Metallotect; **in** Manitoba Mineral Resources Division, Report of Field Activities 1985, p. 29-31.

Gilbert, H.P., Syme, E.C., and Zwanzig, H.V.
1980: Geology of the metavolcaniclastic-metasedimentary rocks in the Lynn Lake area; Manitoba Mineral Resources Division, Geological Paper GP80-1, 118 p.

Milligan, G.C.
1960: Geology of the Lynn Lake district; Manitoba Mines Branch, Publication 57-1, 317 p.

Questor
1976: Airborne Input survey, Lynn Lake area (Phase I and II); Manitoba Mineral Resources Division, Miscellaneous Publication.

GS-3 GEOLOGICAL INVESTIGATIONS AT BURGE LAKE, LYNN LAKE GREENSTONE BELT

by K. Ferreira

INTRODUCTION

A 700 m thick stratigraphic succession of rocks on the western shore of Burge Lake (Fig. GS-3-1, 2) was examined. Oxide-facies iron formation rocks interlayered with gritty sandstone are underlain by intermediate to mafic volcanic fragmental rocks and overlain by immature greywacke; thin lenses of amphibolite occur throughout the succession. The rocks strike approximately 045° and dip vertically. Numerous top determinations, including graded and scoured beds and rip-up structures, indicate that the sequence youngs to the northwest.

VOLCANIC FRAGMENTAL ROCKS

Intermediate to mafic volcanic fragmental rocks with a minimum aggregate thickness of 350 m are bounded to the southeast by quartz diorite. The fragmental rocks are texturally and compositionally inhomogeneous. Tuff-breccia-sized clasts are common; tuff beds and possible mafic volcanic flows are present. Clasts are heterolithic, mafic to intermediate, aphanitic to fine grained, and occasionally bear small plagioclase phenocrysts (maximum 0.5 cm) and more rarely, plagioclase amygdules. Small amounts of epidosite are present locally. Minor quartz blebs and discontinuous quartz veinlets are common.

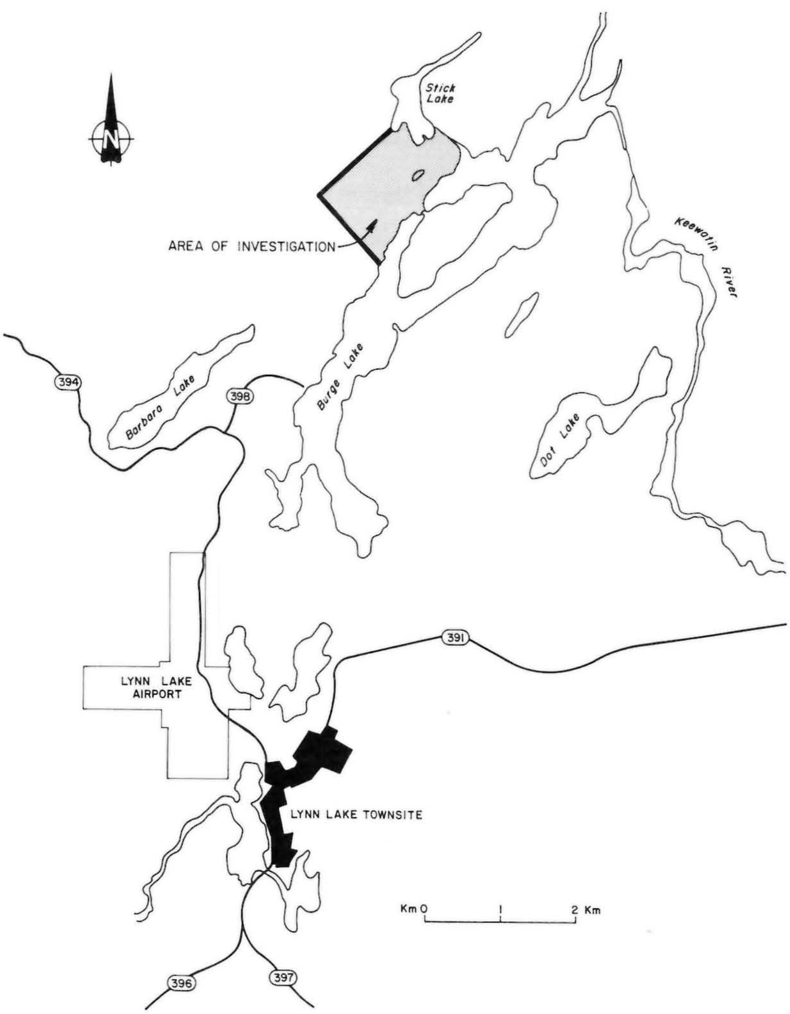


Figure GS-3-1: Location map.

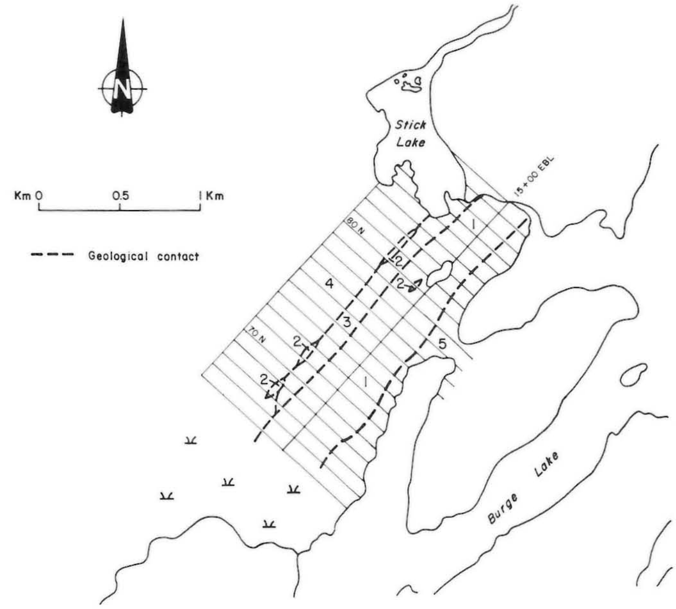


Figure GS-3-2: General geology: 1. Volcanic fragmental rock; 2. Amphibolite; 3. Iron formation, gritty sandstone; 4. Greywacke; 5. Quartz diorite.

IRON FORMATION ROCKS

Numerous layers of oxide facies iron formation are interbedded with gritty felsic sandstone in a succession that is up to 115 m thick. Very fine grained iron formation layers range from 5 cm to 5 m thick, but are generally about 1 m or less in thickness. The beds display thin bedded to laminated internal stratification characterized by variable proportions of magnetite and quartz.

Coarse silt-sized to fine sand-sized gritty felsic sandstone consists of beige weathering, angular, felsic grains and lacks magnetite. Sandstone layers range from 5 cm to 5 m in thickness, averaging 10-20 cm thick; internal layering is rare and most units are massive. The sandstone commonly has scoured underlying iron formations, indicating high energy grain flow interspersed throughout the period(s) of activity (exhalative?) that produced the iron formation units.

The character of the sedimentary rocks interlayered with the iron formation changes to a micaceous garnetiferous siltstone at the top of the iron formation sequence in the southern part of the study area (Fig. GS-3-3). Subhedral red garnets (average 5 mm) are irregularly distributed, but may be concentrated along layering over 1-2 cm widths and constitute up to 10% of the rock.

A staurolite-bearing micaceous siltstone overlies the garnetiferous section. The silty matrix is similar to that of the garnetiferous siltstone, but iron formation rocks are not interlayered with this siltstone. Euhedral staurolite crystals constituting 15-25% of the rock are up to 2.5 cm long, commonly twinned, unoriented, and vary in abundance in different layers.

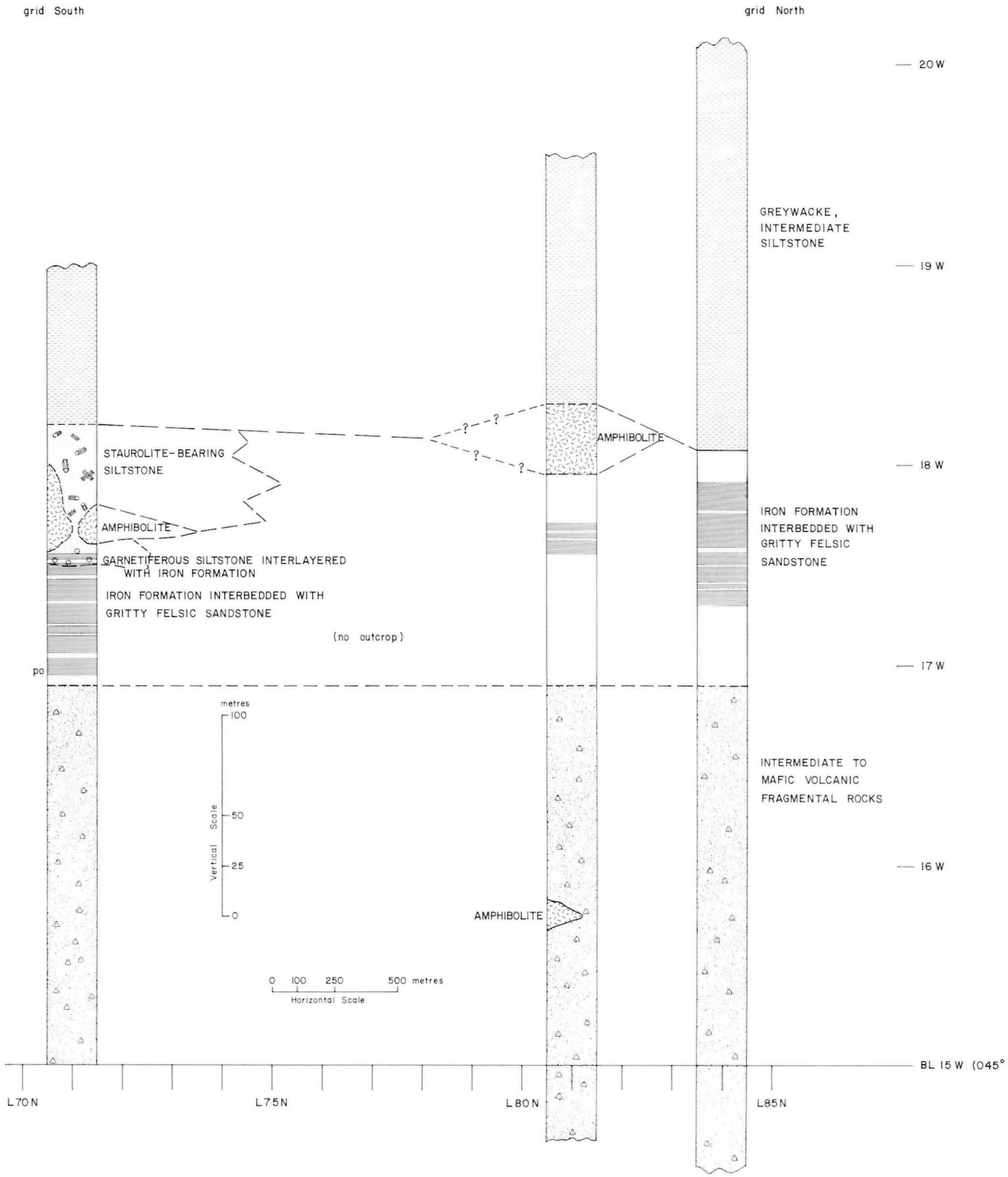


Figure GS-3-3: Composite stratigraphic sections, west side, Burge Lake.

Quartz blebs and discontinuous veinlets are rare, generally less than 10 cm in the longest dimension. They are restricted to the iron formation layers or their contacts with the sandstone, and are generally conformable with the strike of the layers.

Sulphide minerals were observed only in one outcrop, in the western part of the study area. There, fine grained pyrrhotite (2%) is disseminated throughout a thick gritty sandstone at the base of the interlayered iron formation and sandstone sequence.

GREYWACKE

An immature intermediate greywacke at least 200 m thick overlies the iron formation sequence. Silt-sized to elongate, probably stretched clasts range from 5 to 10 cm long and are less than 1 cm wide. The composition of these clasts ranges from felsic to mafic, and includes rare clasts of the iron formation and rare dropstones of intrusive rocks. Micaceous minerals are abundant, amphibole minerals are common, and feldspar constitutes about 20% of the rock. The compositional heterogeneity and the angular nature of visible grains indicate the immaturity of this sedimentary rock.

AMPHIBOLITE

Numerous lenses of amphibolite occur throughout the succession, but are most common within the volcanic fragmental rocks and near or at the base of the immature greywacke sequence. As these occurrences are up to 45 m thick and cannot be traced along strike for more than 300 m, it is assumed that they are present as lenses.

The amphibolite is dark green (C.I. = 70) with actinolite porphyroblasts up to 1 cm across in an intergrown matrix of medium grained amphibole, carbonate and plagioclase. Amphiboles in the matrix have a poor to moderately developed foliation that is parallel to layering in the sedimentary rocks.

Rare, late, feldspar porphyry dykes up to 1 m wide are in sharp contact with amphibolite.

COMPARISON WITH AGASSIZ METALLOTECT

One of the objectives of this examination was to compare the stratigraphy at Burge Lake with the stratigraphy of the Agassiz Metallotect as described by Fedikow (1986) and Ferreira (1986). Several major differences were noted:

1. The intermediate volcanic rocks at Burge Lake have different clast compositions and shapes, and lack the glomerophyric plagioclase that is present in the matrix and some clasts at Ralph Lake and Motriuk Lake farther to the west.
2. High Mg-Ni-Cr basalts, an essential element of the Agassiz Metallotect stratigraphy, were not identified at Burge Lake.
3. The highly aluminous character of siltstone at Burge Lake, as indicated by abundant garnet and staurolite, is not characteristic of the Agassiz Metallotect.
4. Abundant sulphide mineralization, carbonatization, silicification, and abundant crosscutting quartz veinlets are not present at Burge Lake.

It is concluded that this sequence of rocks along the northwestern shore of Burge Lake is not similar to the stratigraphy of the Agassiz Metallotect.

OTHER INVESTIGATIONS IN THE LYNN LAKE GREENSTONE BELT

Studies were conducted elsewhere in the Lynn Lake greenstone belt to investigate the possible westward continuation of the Agassiz Metallotect (Fig. GS-3-4). Ferreira (1986) described a stratigraphic equivalent to the Agassiz Metallotect in the Sheila Lake-Margaret Lake area west of the town of Lynn Lake that included a sedimentary sequence of greywacke conglomerate, siltstone and fine grained sandstone with minor amphibolite and mafic volcanic rocks. High Mg-Ni-Cr basalt, iron formation, and pyritic siltstone are essential elements of this sedimentary sequence. Distinctive heterolithic volcanic breccia underlies and felsic tuff overlies the sedimentary rocks. Reconnaissance work conducted in 1987 attempted to locate further extensions of these rocks.

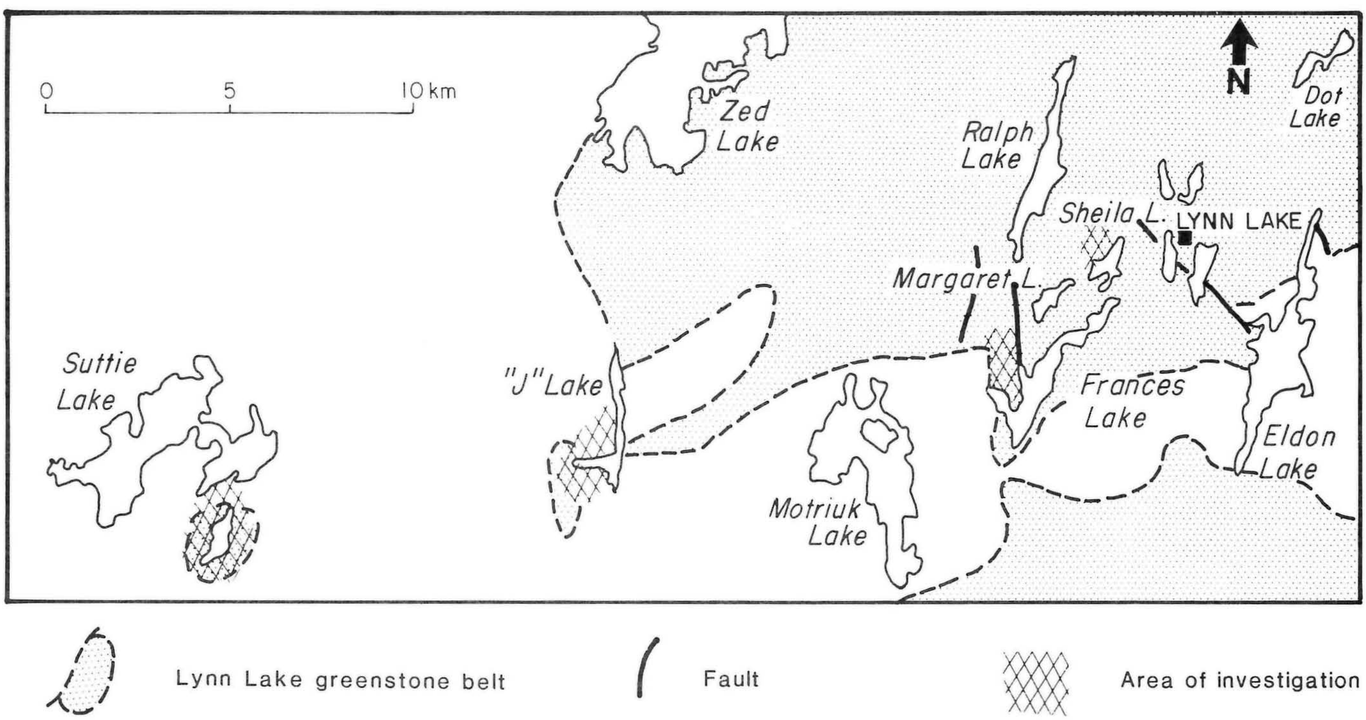


Figure GS-3-4: Areas of other investigations.

1) *Sheila Lake.* An area between Sheila Lake and Ralph Lake (Fig. GS-3-4) was re-examined to locate additional outcrops to infill a gap in the composite stratigraphy between the the volcanic breccia and the sedimentary rocks. Volcanic breccias similar to those stratigraphically downsection were found within 120 m of the north shore of Sheila Lake. This limits the total thickness of the sedimentary sequence to 735 m and increases the total thickness of the breccia pile by approximately 755 m.

2) *Frances Lake.* West of Margaret Lake (Fig. GS-3-4) a northtrending fault disrupts the stratigraphy. Distinctive heterolithic volcanic breccias occur west of this fault, and north of them are fine grained pyritic felsic sandstones. It is assumed that these rocks are lateral facies equivalents to the rocks at Margaret Lake; however, because of the notable absence of other elements of the stratigraphy, these rocks are not considered an equivalent of the Agassiz Metallotect rocks.

3) *Suttie Lake, "J" Lake.* Areas near an unnamed lake south of Suttie Lake and a lake here referred to as "J" Lake (Fig. GS-3-4) are shown on Bedrock Geology Compilation Map Granville Lake NTS 64C as unsubdivided Wasekwan Group metavolcanic rocks of the Lynn Lake greenstone belt. However, examination of these areas revealed only medium grained granodiorite.

REFERENCES

Fedikow, M.A.F.

1986: Geology of the Agassiz stratabound Au-Ag deposit, Lynn Lake, Manitoba; Manitoba Energy and Mines, Open File Report OFR85-5.

Ferreira, K.

1986: Geological investigations in the Sheila Lake-Margaret Lake area; **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 8-12.

Manitoba Energy and Mines

1986: Bedrock Geology Compilation Map Series, Granville Lake NTS 64C, 1:250 000.

GS-4 VEGETATION GEOCHEMICAL SURVEYS, LYNN LAKE AND BISSETT AREAS

by M.A.F. Fedikow

INTRODUCTION

Vegetation geochemical surveys were continued in the Lynn Lake area (Dot Lake, MacLellan Au-Ag deposit) and southeast Manitoba (Bissett). The Dot Lake survey represents a major program involving 2600 samples of black spruce (*Picea mariana*) needles and twigs collected over a gold-bearing stratigraphy west of the MacLellan mine. The black spruce needles have been analyzed for Cu, Zn, Ni, Cr, Fe and Mn by AAS in ashed samples. Data processing of these results is underway. The twig portion of this sample set is currently undergoing preparation in the geological services laboratory and a tentative date for analysis utilizing both AAS and INAA in ashed sample for Ni, Cr, Mn, Au and As is February, 1988.

The Bissett area vegetation geochemical surveys represent a cooperative study undertaken with Mr. Steve Lesavage. The studies are divided into a grid-controlled survey utilizing dwarf birch (*Betula glandulosa*) twigs (n = 169) and a multi-element geochemical comparison between dwarf birch twigs and alder (*Alnus rugosa*) twigs (n = 26) from the same grid. The larger dwarf birch twig survey is currently in the analysis stage and no results are available at time of writing. Results from the dwarf birch and alder twig geochemical comparison are described below.

Alder and dwarf birch twigs were collected during a one day period in January, 1987 from a frozen bog. Each twig sample represents 2-3 branches, 25 cm long, from 1 to 5 healthy and vigorous bushes for each of the two species of interest. The samples were collected approximately 130 m west of the Johnston gold occurrence, a quartz vein deposit containing disseminated pyrite, pyrrhotite and occasional grains of visible gold. No assays are available from this occurrence at the time of writing. Drainage is west from the Johnston occurrence towards the survey area. The soil profile over the entire study area is undisturbed, with glaciolacustrine deposits (proglacial lake sediments) of clay, silt, sand and minor gravel ranging from 1-30 m in thickness.

Prior to this vegetation geochemical survey a rock geochemical survey was undertaken in the area by Theyer (1984). Unpublished data indicate the presence of anomalous populations for Au, As and Sb in the rocks from the general vicinity of the Johnston occurrence. The anomalies are low contrast with threshold values of 5 ppb for Au, 8 ppm for As and 1.1 ppm for Sb. The range of concentrations and the number of anomalous samples above the threshold are: Au 6-18 ppb (n = 15); As 8-100 ppm (n = 30) and Sb 1.1 (n = 37). Clearly, multi-element rock geochemical anomalies are present in the area and when complete the geochemical analysis of the alder twig survey (n = 169) should indicate whether similar anomalies can be detected in vegetation from the same area.

RESULTS

The 26 samples of alder and dwarf birch twigs were analyzed for 16 elements in ashed sample utilizing instrumental neutron activation. Analyses were conducted by Nuclear Activation Services Ltd. in Hamilton, Ontario. Analytical specifications for the analyses are given in Table GS-4-1 and geochemical results are provided in Table GS-4-2. A statistical comparison of geochemical data from both species of twigs is given in Table GS-4-3.

Examination of data from Table GS-4-2 indicates the dwarf birch twigs (DBT) overwhelmingly concentrate As, Au, Ba, Br, Co, Cr, Fe, Sb, Se, Th, Ta and Zn, whereas alder twigs (AT) contain more Mo and possibly U and W. Only one sample of DBT contained measurable Ag (1.0 ppm) and Ag was not detected in ash of the AT. Alder twigs consistently produced more ash. The AT display a wider range in concentration for some elements and tend to contain a single highly anomalous analysis (Fe — 2.07%; As — 4.80 ppm). Accordingly the arithmetic means displayed in Table GS-4-3 indicate that As is equivalent for both DBT and AT and that Fe has accumulated in the AT rather than the DBT. The individual analyses, however, show that 12 of 13 DBT samples contain more Fe than the AT and 8 of 13 samples of DBT contain higher amounts of As than do the AT samples. It is not known whether the highly variable As, Fe and Mo in AT (see standard deviations — Table GS-4-3) and the Au and Ba in DBT (see standard deviations — Table GS-4-3) are indicative of mineralization since neither diamond drilling nor trenching has been undertaken in the area. The single sample anomaly of 83 ppb Au in a DBT sample from grid coordinate 5W/1 + 65N certainly warrants a close examination of the sample area.

TABLE GS-4-1

ANALYTICAL SPECIFICATIONS FOR ASHED SAMPLES OF DWARF BIRCH (*BETULA GLANDULOSA*) AND ALDER (*ALNUS RUGOSA*) TWIGS, BISSETT AREA

Element	Lower Limit of Detection	Unit	Method
Ag	0.30	ppm	INAA *
As	0.01	ppm	INAA
Au	0.10	ppb	INAA
Ba	20.00	ppm	INAA
Br	0.01	ppm	INAA
Co	0.30	ppm	INAA
Cr	0.30	ppm	INAA
Fe	0.005	%	INAA
Mo	0.05	ppm	INAA
Sb	0.01	ppm	INAA
Se	0.50	ppm	INAA
Ta	0.20	ppm	INAA
Th	0.10	ppm	INAA
U	0.02	ppm	INAA
W	0.05	ppm	INAA
Zr	2.00	ppm	INAA
Ash	0.10	%	DRY *

INAA — Instrumental Neutron Activation Analysis
DRY - Dry ashing at 450° C.

STEPWISE DISCRIMINANT FUNCTION ANALYSIS

This statistical analysis was undertaken to determine the most efficient geochemical discriminators between alder and dwarf birch twigs based on the analytical results for 17 elements and compounds as reported in Table GS-4-2. The analysis was undertaken on log-transformed data.

RESULTS

Figure GS-4-1 illustrates the separation between the alder twigs (Group 1) and the dwarf birch twigs (Group 2) utilizing the discriminant function derived from the geochemical data. The function designates Ba-Mo-Se-Zn as the most efficient discriminating elements and results in 100% correct classification between the two groups of data. Although this group of elements probably would have been included as effective "discriminators" between the two data populations upon visual examination, the discriminant analysis provides the four most effective elements for group separation.

TABLE GS-4-2

GEOCHEMICAL DATA FOR ASHED SAMPLES OF DWARF BIRCH (*BETULA GLANDULOSA*) AND ALDER (*ALNUS RUGOSA*) TWIGS, BISSETT AREA

Elements & Units

Sample	Grid Coord	Ag ppm	As ppm	Au ppb	Ba ppm	Br ppm	Co ppm	Cr ppm	Fe %	Mo ppm	Sb ppm	Se ppm	Ta ppm	Th ppm	U ppm	W ppm	Zn ppm	Ash %
AT-1	4W/0+20N	<0.3	0.61	16.0	500	38	2.7	4.7	0.200	59.0	0.25	4.8	<0.7	<0.1	<0.30	<0.50	2600	3.0
AT-2	4W/0+80N	<0.3	0.65	9.7	560	25	2.8	7.4	0.193	36.0	0.08	5.4	1.1	<0.1	<0.30	<0.40	1600	3.1
AT-3	5W/2+45N	<0.3	1.60	6.3	520	28	3.6	7.7	0.191	6.3	<0.08	3.8	<0.5	1.0	<0.30	<0.50	2300	2.7
AT-4	5W/1+65N	<0.3	0.95	9.2	600	33	4.4	6.1	0.230	54.0	0.14	6.6	<0.5	<0.1	<0.30	<0.50	2400	2.9
AT-5	5W/0+65N	<2.0	4.80	7.6	460	23	3.8	7.0	2.070	58.0	0.31	6.2	<0.4	0.5	<0.30	<0.50	2400	3.2
AT-6	6W/0+53N	<0.3	0.95	11.0	360	18	4.5	10.0	0.182	9.6	0.13	4.0	<0.5	<0.1	<0.30	<0.50	2300	3.6
AT-7	6W/1+20N	<0.3	1.4	18.0	490	28	4.6	10.0	0.164	56.0	0.42	4.2	<0.6	1.1	0.36	<0.60	2900	3.1
AT-8	6W/1+70N	<0.3	1.3	8.1	540	25	5.9	12.0	0.240	65.0	0.38	4.7	<0.6	1.1	0.40	1.6	3000	2.8
AT-9	5+80W/2+35N	<0.3	1.5	7.9	620	24	3.8	11.0	0.210	56.0	0.15	4.0	<0.6	1.1	<0.30	<0.50	2600	3.0
AT-10	5W/0+65S	<0.3	0.91	5.4	310	18	2.1	10.0	0.180	7.2	0.11	5.6	<0.6	<0.3	<0.30	<0.50	1800	2.9
AT-11	6W/4S	<0.3	0.90	10.0	480	20	2.7	5.0	0.175	18.0	<0.06	<2.5	<0.6	0.9	<0.30	<0.50	1500	3.5
AT-12	7W/4+25S	<0.3	1.3	7.7	550	21	2.7	4.6	0.132	24.0	0.24	3.6	<0.5	0.7	<0.30	<0.50	2200	3.9
AT-13	8W/4+50S	<0.3	2.4	10.0	690	22	2.9	5.4	0.130	22.0	0.12	6.1	<0.4	<0.1	<0.30	<0.40	1400	3.5
DBT-1	4W/0+20N	<0.3	1.5	14.0	2000	32	8.2	11.0	0.300	3.9	0.33	11.0	<0.5	1.3	<0.30	<0.60	9900	1.6
DBT-2	4W/0+80N	1.0	1.0	9.4	3300	22	12.0	8.9	0.250	2.6	0.59	5.3	<0.6	1.3	<0.40	<0.60	9300	1.9
DBT-3	5W/2+45N	<0.3	1.5	12.0	3800	29	11.0	16.0	0.320	3.3	0.30	8.6	<0.6	<0.1	0.67	<0.70	11000	1.6
DBT-4	5W/1+65N	<0.3	1.1	83.0	3100	23	16.0	15.0	0.240	5.6	0.23	6.1	<0.6	0.7	<0.36	<0.70	10000	1.7
DBT-5	5W/0+65N	<0.3	2.0	15.0	2600	33	7.4	13.0	0.276	<1.7	0.22	4.6	0.7	0.8	<0.34	<0.60	8700	2.0
DBT-6	6W/0+53N	<0.3	0.74	16.0	2600	29	9.1	22.0	0.220	<2.0	0.16	5.9	2.9	<0.1	<0.40	<0.70	9100	1.5
DBT-7	6W/1+20N	<0.3	1.3	18.0	2900	29	14.0	16.0	0.323	5.3	0.12	9.8	<0.5	1.1	<0.30	<0.60	9800	1.7
DBT-8	6W/1+70N	<0.3	1.7	15.0	1300	33	13.0	24.0	0.310	4.2	0.27	5.8	0.9	0.9	<0.40	<0.70	9900	1.5
DBT-9	5+80W/2+35N	<0.3	1.6	17.0	2900	33	10.0	17.0	0.260	<2.0	0.19	8.1	<0.6	1.5	<0.50	<0.70	7300	1.7
DBT-10	5W/0+65S	<0.3	1.5	16.0	2200	45	9.5	17.0	0.300	<1.8	0.21	11.0	<0.6	1.2	<0.40	<0.70	7900	1.6
DBT-11	6W/4S	<0.3	1.3	8.1	2600	34	11.0	14.0	0.234	<1.7	0.18	8.5	0.7	0.9	<0.40	<0.60	6000	2.3
DBT-12	7W/4+25S	<0.3	1.9	17.0	2900	37	13.0	16.0	0.207	<1.7	0.25	8.7	1.1	0.9	<0.30	<0.60	9200	1.8
DBT-13	8W/4+50S	<2.0	2.2	11.0	3100	37	7.5	9.0	0.220	2.4	0.12	13.0	<0.6	0.8	<0.30	<0.60	6100	2.0

TABLE GS-4-3

DESCRIPTIVE STATISTICAL COMPARISON BETWEEN DWARF BIRCH (N = 13) AND ALDER TWIGS (N = 13).
All analyses in ppm unless otherwise indicated. Bracketed figures for arithmetic means indicate number of analyses averaged for that particular mean.

Element	Range		Arithmetic Mean		Standard Deviation	
	DBT	AT	DBT	AT	DBT	AT
Ag			(1)			
As	0.74-2.20	0.61-4.80	1.5	1.5	0.4	1.1
Au (ppb)	8.10-83.0	6.30-18.00	19	10	19	4
Ba	1300-3800	310-690	2715	514	628	102
Br	22-45	18-38	32	25	6	6
Co	7.4-16.0	2.1-5.9	10.9	3.6	2.6	1.1
Cr	8.9-24.0	4.6-12.0	15.3	7.8	4.4	2.6
Fe (%)	0.207-0.323	0.130-2.070	0.27	0.32	0.04	0.52
Mo	2.4-5.6	6.3-65.0	2.7 (7)	36	1.4	22
Sb	0.12-0.59	0.08-0.42	0.24	0.21 (11)	0.12	0.12
Se	4.6-13.0	3.6-6.6	8.2	3.8 (12)	2.6	1.1
Ta	0.7-2.9		1.3 (5)	(1)		
Th	0.7-1.5	0.5-1.1	1.0 (11)	0.9 (7)	0.4	0.4
U		0.36-0.40	(1)	0.38 (2)		0.03
W				(1)		
Zn	6000-11000	1400-3000	8785	2230	1538	515
Ash (%)	1.5-2.3	2.7-3.9	1.8	3.2	0.2	0.4

CONCLUSIONS

Although this comparative survey was based on only 13 twig samples from the dwarf birch and alder it appears that the DBT are more significant concentrators of a wider range of trace elements than the AT. Some of these elements such as As, Ba, Sb, Se and Au represent effective pathfinders for precious metal mineralization while others, such as Zn, Fe and Cr, are useful for base metal exploration and in lithologic/geochemical mapping programs where little or no outcrop is available. It is hoped that the larger grid-controlled vegetation geochemical survey (n = 169) currently underway in the Bissett area will draw valid conclusions between any superior trace element uptake characteristics in dwarf birch and alder twigs in specific substrate conditions and whether or not the vegetation geochemical survey can reproduce the rock geochemical anomalies from the same area.

The elements Ba-Se-Zn are known to be associated with base and/or precious metal alteration zones that represent a broader exploration target than the deposit. Dwarf birch twigs represent a vegetation type capable of concentrating these elements and, accordingly, should be considered in any integrated exploration effort directed towards base and/or precious metal mineralization. Mo is concentrated by the alder twigs and thereby finds application in the search for some types of precious metal mineralization.

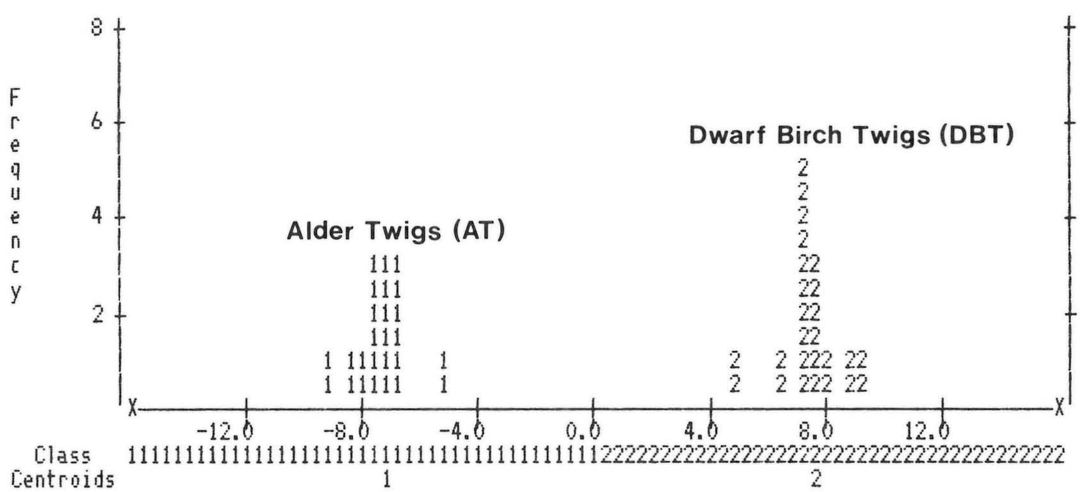


Figure GS-4-1: *Stepwise discriminant function analysis histogram illustrating group separation between alder and dwarf birch twigs on the basis of a Ba, Mo, Se and Zn function.*

The above results represent a vegetation survey undertaken during winter months when trace element fluctuations in vegetation are minimal or absent. The twig samples will record trace element patterns, acquired before freeze-up, from the substrate in which the species were growing. The wet bog that represents the sampling site for this survey will reflect variable trace element mobility as compared to a well-drained substrate. This requires that if sampling is undertaken during the winter months the substrate will, nevertheless, need to be standardized to avoid the possibility of false, drainage-induced geochemical anomalies.

ACKNOWLEDGEMENTS

Glen Conley is thanked for computing assistance.

REFERENCE

Theyer, P.
1984: Mineral deposit investigations in the Rice Lake greenstone belt; **in** Manitoba Mineral Resources, Report of Field Activities 1984, p. 87-91.

GS-5 MINERAL DEPOSIT INVESTIGATIONS IN THE RUTTAN LAKE AREA

by D.A. Baldwin

INTRODUCTION

Diamond drill core from an iron formation located approximately 1 km east of Darrol Lake (Fig. GS-5-1) was examined and sampled. The samples will be analyzed for Au and gold pathfinder elements.

Outcrops in the vicinity of the Vol deposit, (Fig. GS-5-1) located about 3.5 km northeast of the Ruttan Mine were examined to determine the geological setting of known Au mineralization in this area.

DARROL LAKE IRON FORMATION

The iron formation most commonly consists of interlayered solid magnetite, tremolite schist and tremolite-garnet schist. Less commonly, it consists of interlayered solid pyrite, solid magnetite and tremolite schist. Locally, quartzite (possibly recrystallized chert) is interlayered with the other components of the iron formation. The iron formation is bounded by, and has sharp contacts with, variably altered metasedimentary rocks

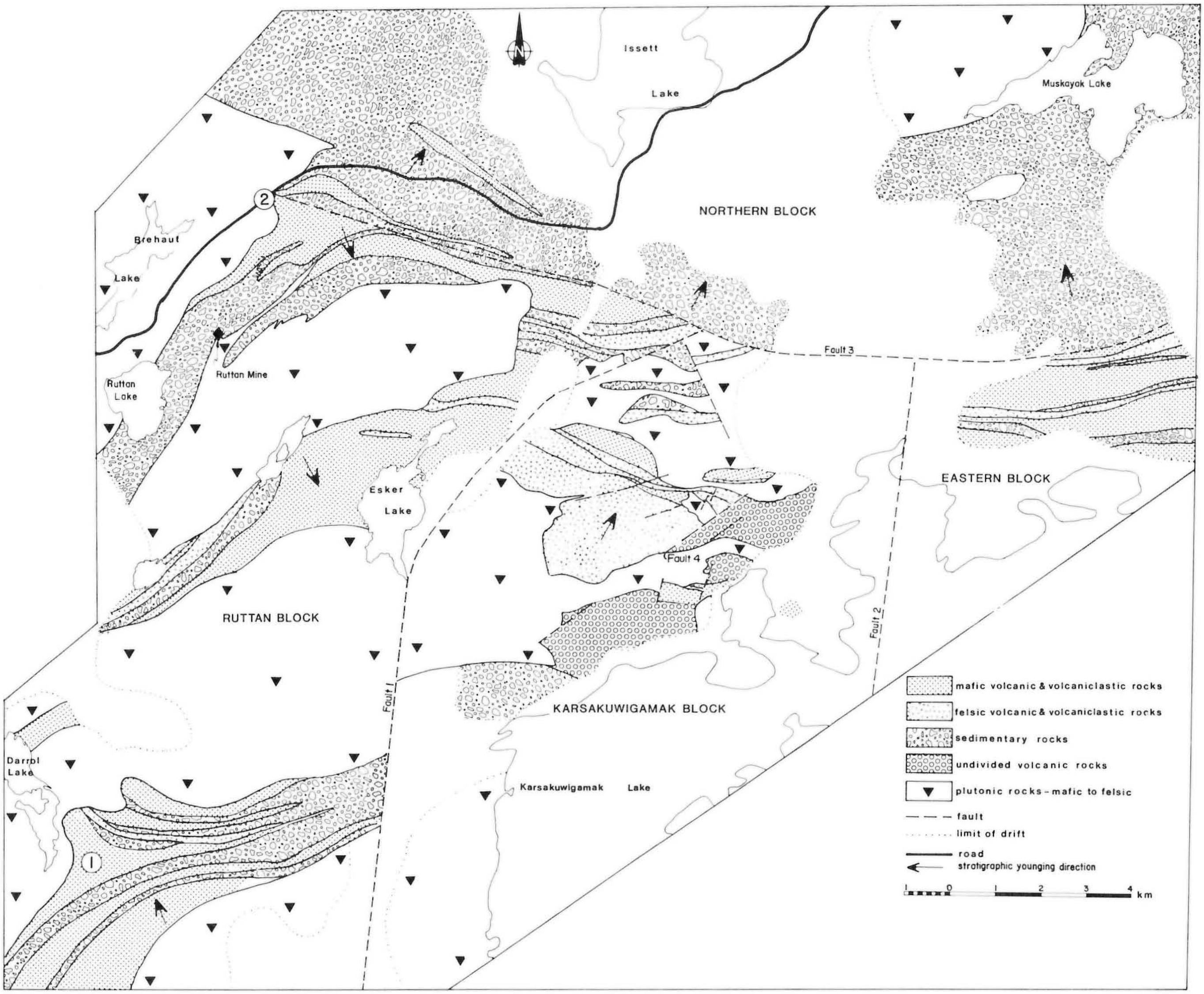


Figure GS-5-1: Geology of the southern part of the Rusty Lake metavolcanic belt and the location of the Darrol Lake iron formation (1) and the Vol deposit (2).

(Baldwin, 1982). Magnetite and pyrite layers range in thickness from 0.1 to 1.5 cm and layers of tremolite schist, tremolite-garnet schist and quartzite are 0.1-20 cm thick. The thickness of the iron formation ranges from 3 to 16 km.

In some drill intersections of the iron formation the mineralized layers consist of solid magnetite. In others the mineralized layers are solid pyrite and solid magnetite. Where solid pyrite and solid magnetite layers are present in the iron formation, the pyrite layers occur in a zone about I m thick; magnetite layers occur throughout the remainder of the iron formation. The change from pyrite to magnetite is gradational and generally pyrite veinlets occur in the tremolite schist adjacent to the massive sulphide layers.

In addition to the iron formation there are meta-argillite units that most commonly contain 2-3% finely disseminated magnetite. Locally in these meta-argillite units finely disseminated sulphide zones 1-2 m thick alternate with the magnetite bearing meta-argillite.

Geochemical and petrographic data from these diamond drill cores are not yet available; however, it is suggested that the habit and spatial relationships of oxide and sulphide in the iron formation and meta-argillite are due to sulphidization of oxide. Therefore, the sulphide facies in both the iron formation and meta-argillite are potential sites for gold exploration.

VOL DEPOSIT

The Vol deposit consists of three en echelon disseminated sulphide zones in an intrusion breccia that consists of angular to subangular blocks of mafic to felsic, phyric and aphyric volcanic rocks, metasedimentary rocks and mafic plutonic rocks in a granodiorite matrix. The sulphide zones are 1-2 m thick and are exposed for 10-20 m along strike. They consist of sulphide in quartz-sericite schist, silicified fault gouge and boudinaged quartz veins. The sulphide minerals are pyrite, pyrrhotite, sphalerite, galena and chalcopyrite. Geochemical analyses of drill cores indicate that gold values are generally less than 100 ppb. However, values of 500 to 9000 ppb over sample intervals of 0.3 to 0.75 m have been reported.

The sulphide zones are spatially associated with, and occur a few tens of metres south of, a major east-trending fault that transects the Rusty Lake metavolcanic belt. The absence of outcrop in critical areas precludes the establishment of the relationships between the sulphide zones and the major fault. However, it is possible that the sulphide zones are in fault splays associated with the major east-trending fault.

REFERENCE

Baldwin, D.A.
1982: Mineral deposits in the Ruttan Lake, Karsakuwigamak Lake, Muskayk Lake areas, Manitoba; **in** Manitoba Energy and Mines, Mineral Resources Division, Open File Report OF81-4, 59 p.

GS-6 TILL GEOCHEMISTRY IN SELECTED AREAS OF NORTHERN MANITOBA

by E. Nielsen

Till geochemical mapping along the Vol fault, northeast of Ruttan Mine, conducted in 1985 and 1986 (Nielsen, 1985, 1986) was extended to the east. In addition a new till sampling program was initiated in the Darrol Lake area. The programs were conducted to (1) demonstrate further the viability of using shallow overburden sampling as a mineral exploration tool in northwestern Manitoba and (2) delineate till geochemical anomalies.

VOL FAULT

An additional 42 till samples were collected along a 2 km strike length of the Vol fault to the east of the area sampled previously (Fig. GS-6-1). The additional sampling was undertaken to determine the extent of gold and arsenic anomalies mapped earlier (Nielsen, 1986).

The hills in the area are generally less than 20 m and more commonly less than 10 m high. They are either bedrock or bedrock overlain by glaciolacustrine clay. The low areas are primarily muskeg overlying glaciolacustrine clay and till. Till is scarce and difficult to find in shallow hand-dug holes.

Poorly preserved striations trending 235° were recorded at one site.

DARROL LAKE

Overburden sampling was undertaken approximately 11 km south of Ruttan Mine to determine the potential for gold mineralization in the area and to map till geochemical anomalies (Fig. GS-6-2).

The Darrol Lake area has relatively high relief with hills rising almost 50 m on the east shore of Darrol Lake. Bedrock, swamp and glaciolacustrine clay are widespread and till is generally difficult to find in shallow hand-dug holes.

Glacial striae (Fig. GS-6-3) and roches moutonnées (Fig. GS-6-4) indicate the ice flow was toward the southwest between 210° and 230°.

The bedrock comprises mafic to felsic metavolcanic and metasedimentary rocks as well as a variety of altered rocks. Banded iron formation consisting of magnetite interlayered with quartzite and tremolite schist is associated with the altered rock (Sherritt Gordon Mines unpublished map; Baldwin, 1982).

A total of 23 (4 littoral sand and 19 till) samples were collected from hand-dug holes (Fig. GS-6-2) located around and down-ice from the iron formation and associated altered rocks.

SAMPLE ANALYSIS

Samples from the area along the Vol fault and Darrol Lake have been submitted for heavy mineral analyses and gold grain counts. The less than 2 micron fraction has been submitted for trace element geochemistry.

REFERENCES

Baldwin, D.A.

1982: Mineral deposits in the Ruttan Lake, Karsakuwigamak Lake, Muskayk Lake areas, Manitoba; Manitoba Mineral Resources Division, Open File OF81-4, 59 p.

Nielsen, E.

1985: Till geochemical investigations in northern Manitoba; **in** Manitoba Energy and Mines Report of Field Activities 1985, p. 14-19.

1986: Till geochemistry east of the Ruttan Mine; **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 26-31.

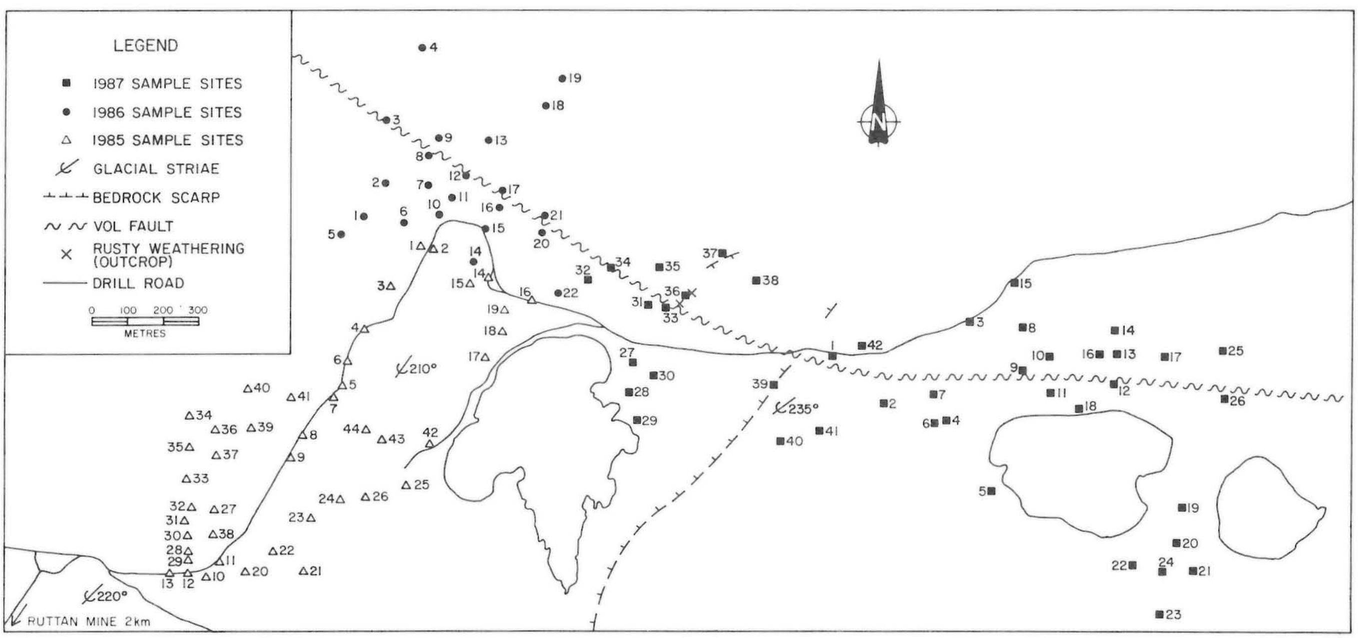


Figure GS-6-1: Till sampling sites along the Vol fault.

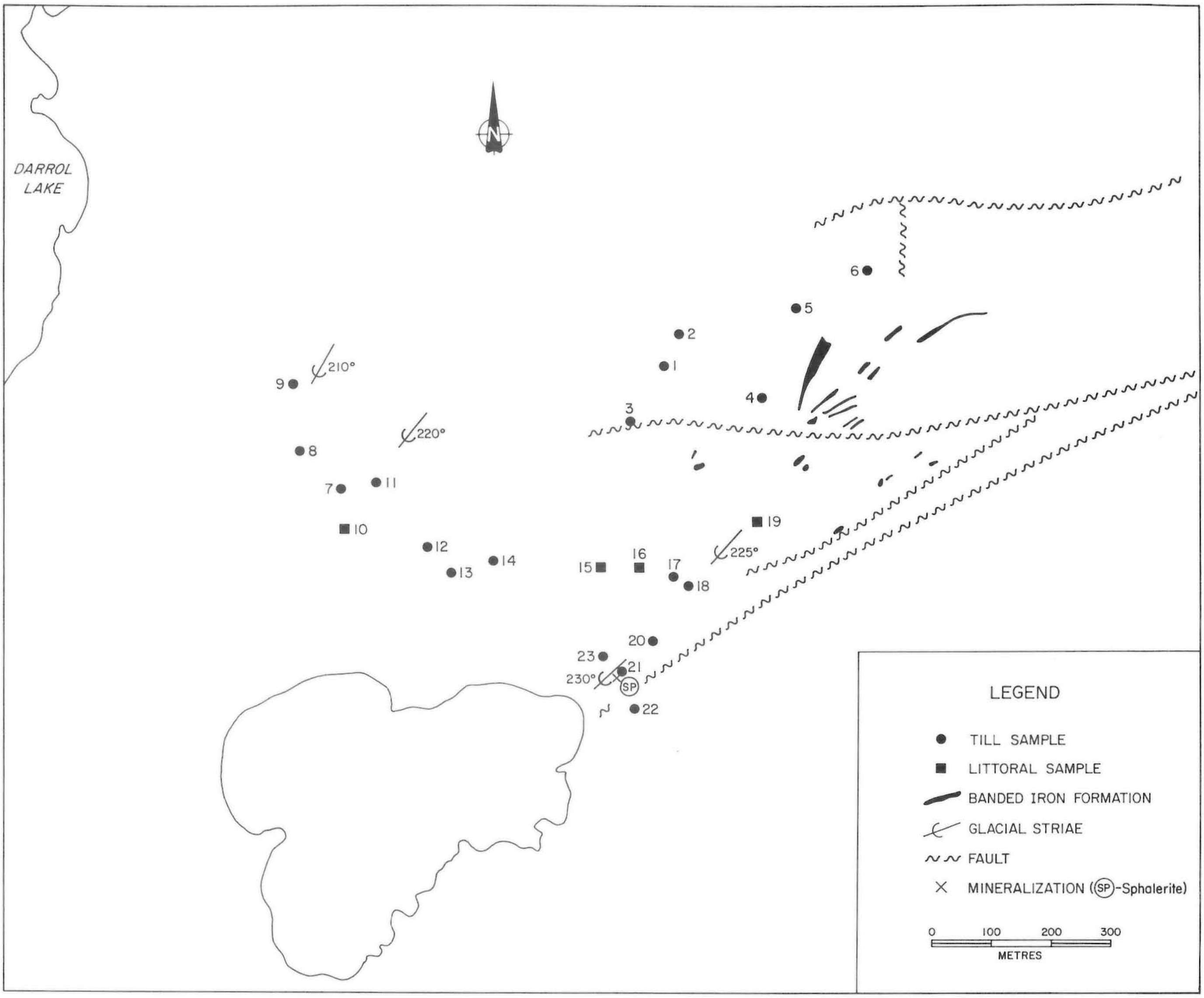


Figure GS-6-2: *Location of overburden samples collected in the Darrol Lake area.*

Figure GS-6-3: *Striated outcrop near sampling site DL-87-21 indicating ice flow towards 230°. Note sphalerite mineralization indicated by an arrow.*

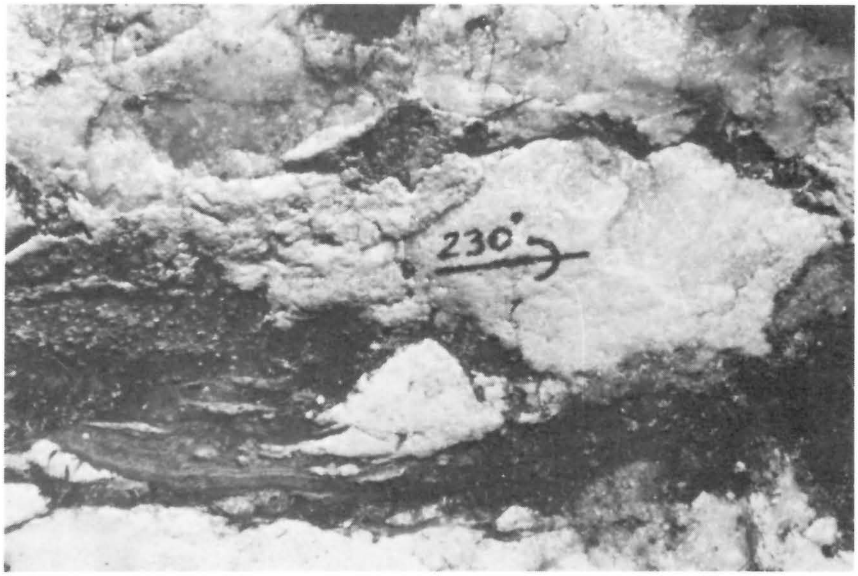


Figure GS-6-4: *Roche moutonnée formed on banded iron formation near sampling site DL-87-18 indicating ice flow towards 210°.*

GS-7 ATHAPAPUSKOW LAKE PROJECT

by E.C. Syme

INTRODUCTION

The Athapapuskow Lake project entails detailed, 1:20 000 mapping of Early Proterozoic metavolcanic, metasedimentary and intrusive rocks in the southwestern portion of the Flin Flon metavolcanic belt. The project area (Fig. GS-7-1) lies to the south of the recently mapped Flin Flon-White Lake area (Bailes and Syme, 1987). This continuation of detailed mapping will ultimately provide an improved understanding of the complex stratigraphic and structural relationships in the Flin Flon belt.

Field work during this second year of a three-year project was concentrated on Athapapuskow Lake (Fig. GS-7-1, and Syme (1987a, b) Preliminary Maps 1987 F-1 and 1987 F-2). The results of the first year of mapping are described by Syme, (1986).

OBJECTIVES AND RESULTS

Specific objectives of this project are listed below, with summaries of results to date. More detailed discussion of the geology follows in subsequent sections.

(1) *Recognition and analysis of major (block-bounding) faults.* These structures dominate the western Flin Flon belt and have important implications in exploration for both Cu-Zn sulphide and Au deposits. Their relative and absolute ages, sense of movement and amount of displacement provide constraints for the tectonic evolution of the belt. All of the block-bounding faults in the Flin Flon-White Lake area (Bailes and Syme, 1987) have now been identified and extended into the Schist Lake-Athapapuskow Lake area (Fig. GS-7-1) and some of the relative age relationships have been determined (Syme, 1986). Several additional faults have also been identified (Fig. GS-7-1), some of which bound structural blocks. Faults in the Schist Lake-Athapapuskow Lake area postdate folds in both Amisk and Missi Groups. Payuk Lake and Millwater faults cut the 1847 Ma Lynx Lake pluton (Syme et al., GS-19, this volume), and several faults cut the Missi Group, dated at 1832 Ma at Wekusko Lake (Gordon et al., 1987). Faults also postdate the metamorphism that affected both Amisk and Missi Groups, as they juxtapose domains or blocks with different metamorphic grade (Syme, 1985, 1986). As a group the faults constitute the youngest structural elements in the belt.

(2) *Detailed subdivision of Amisk Group metavolcanic rocks,* to form a framework in which future exploration for volcanogenic Cu-Zn sulphide deposits can be conducted. Massive sulphide deposits have historically been the mainstay of mining activity in the Flin Flon belt. Stratigraphic analysis of Amisk Group rocks may identify areas where exploration can be concentrated. For example, mapping this year has identified three major rhyolite flow complexes; in the Flin Flon-White Lake area four of the five rhyolite complexes present are stratigraphically associated with known Cu-Zn sulphide deposits (Bailes and Syme, 1987).

(3) *Mapping and geochemical characterization of intrusive rocks.* Mafic and felsic plutons are important because they are potential hosts for certain types of mineral deposits and because their trace element compositions reflect the tectonic environment in which they were emplaced (Pearce et al., 1984; Halden et al., 1987). There are five felsic plutons in the map area, and each can now be defined with respect to composition, zoning, texture, contact metamorphic effects and relationship to shear zones. Of the two large mafic intrusives identified to date, one is a rather homogeneous gabbro plug whereas the other is a tectonically disrupted, layered mafic complex of gabbro, leucogabbro, gabbroic anorthosite and pyroxenite; the latter body may have potential for Pt-group mineralization.

(4) *Geochemical characterization of Amisk Group basalts.* The purpose of this aspect of the project is to develop an understanding of the tectonic environment in which the Amisk Group was deposited. In the Flin Flon-White Lake area, Amisk basalts have trace element compositions consistent with an island-arc type of environment (Syme, 1987c). Preliminary work on a lithologically distinct group of basalts on Athapapuskow Lake indicates that these flows may have been emplaced in a different environment, perhaps a back-arc basin. If the Amisk Group is composed of juxtaposed domains that represent different environments, one domain may be better suited for a particular mineral deposit type than another.

STRUCTURAL SETTING

Structure in the Schist Lake-Athapapuskow Lake area is dominated by a system of NNW to NNE and NE faults which separate distinct domains. Each domain or fault-bounded block has a characteristic stratigraphic sequence, style of internal deformation, metamorphic grade, and suite of contained intrusions. Juxtaposition of such disparate supracrustal assemblages implies that displacement on the bounding faults must be in the order of kilometres.

Blocks in the Schist Lake area have been previously described (Syme, 1986). In the Athapapuskow Lake area there are at least six blocks, (Fig. GS-7-1) some of which are only tentatively defined because mapping is incomplete. The blocks include:

(1) the southward continuation of the Whitefish-Mikanagan Lakes block (Bailes and Syme, 1987), bounded by Centennial and Scheiders Bay faults and in this area composed of more than 2 km of Missi Group coarse clastic sediments.

(2) the southward continuation of the Sourdough Bay block, bounded by Scheiders Bay and North Arm faults and composed of a sequence of fine grained Amisk Group sedimentary rocks intruded by a diverse suite of diorite-quartz diorite sills; subgreenschist metamorphic grade.

(3) Bakers Narrows block, bounded by North Arm and Mistik Creek faults and composed of a more strongly deformed Amisk Group sequence of proximal and vent facies mafic flows, breccias, and rhyolite flows, intruded by Neso Lake pluton.

(4) Little Athapapuskow block (or sub-block), bounded by the Mistik Creek fault system and composed of Missi Group sediments that subcrop almost entirely beneath Athapapuskow Lake.

(5) Mink Narrows block, bounded by Mistik Creek and Payuk Lake faults and comprising Mink Narrows Granodiorite pluton, a layered mafic intrusion, and isoclinally folded Amisk Group basalts.

(6) Millwater block, bounded on the north by Payuk Lake fault and composed of three Amisk Group basalt units and one mafic epiclastic formation, intruded by the Lynx Lake pluton.

AMISK GROUP

BAKERS NARROWS BLOCK

Amisk Group rocks in the Bakers Narrows block comprise a thick bimodal sequence of mafic and felsic volcanic rocks broadly folded about the Neso Lake pluton. Internal faults within the block preclude the establishment of a definitive stratigraphic sequence; from the block-bounding North Arm fault to the core of the major syncline more than 3.5 km of east-facing section is exposed.

Mafic volcanic rocks include plagioclase-phyric and aphyric breccias and subordinate pillowed and massive flows. There is an extraordinary abundance of amoeboid pillow breccia, a rock type that in the Flin Flon-White Lake area demonstrably forms the tops of flows (Bailes and Syme, 1987). In the Bakers Narrows block, however, flows are much less abundant than breccia; locally several hundred metres of amoeboid pillow breccia occur, without intercalated flows. The breccias are composed of highly irregular to oval bodies of amygdaloidal basalt with chilled sel-

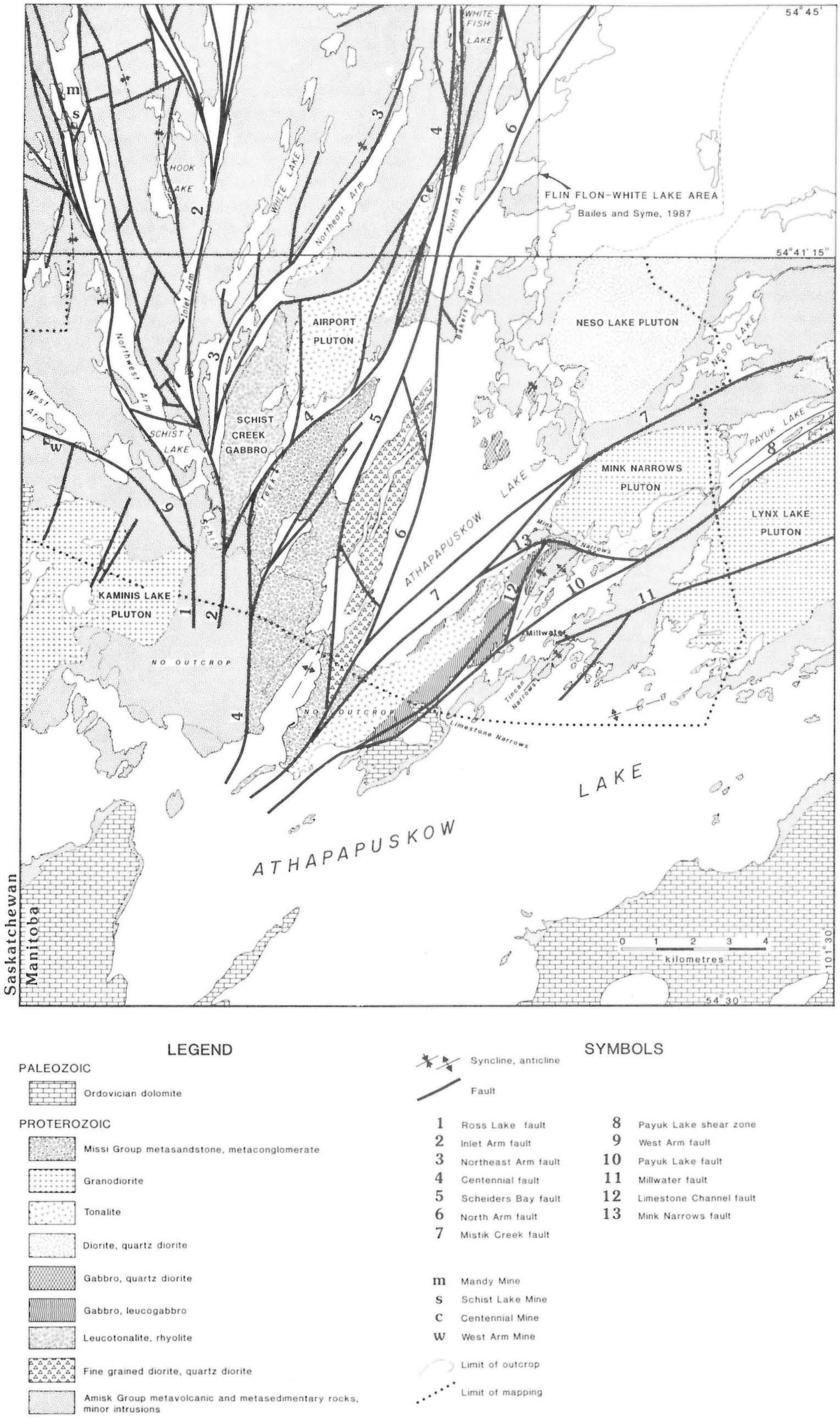


Figure GS-7-1: *Athapapuskow Lake project area (south of 54° 41'15") with simplified geology. Area mapped during the 1986 and 1987 field seasons is outlined with dots.*

vages ("amoeboid pillows" — Fig. GS-7-2) set in a fine grained recrystallized matrix of what was presumably hyaloclastite. Similar rocks have been interpreted by Dimroth et al. (1971) and Staudigel and Schmincke (1984) as in part the products of subaqueous lava fountaining. The breccias have not been redeposited (delicate amoeboid shapes are preserved) and thus the section probably represents a proximal or vent facies. Some of the associated flows are highly amygdaloidal, representing volatile-rich, non-degassed lavas, consistent with a proximal volcanic environment.

Three thick rhyolite flow complexes occur in the Bakers Narrows block: one in the southern part of Bakers Narrows campground (more than 460 m thick), one in the islands southeast of Bakers Narrows (about 210 m thick), and one west of Paradise Lodge (about 900 m thick) (Preliminary Map 1987 F-2). In addition, locally abundant rhyolite dykes/sills are emplaced in the mafic rocks in the section.

The Campground rhyolite is aphyric and comprises a core of massive rhyolite with basal and upper zones of massive rhyolite lobes in rhyolite microbreccia matrix (Fig. GS-7-3). The lobes are centimetres to metres thick, elongate, irregular, with flow banded margins and, locally, rinds that have partially to completely spalled into the microbreccia matrix. Similar structures have been observed in subglacial rhyolite flows in Iceland (Furnes et al., 1980) and subaqueous flows in the Archean of Quebec (de Rosen-Spence et al., 1980).

A massive aphyric rhyolite flow in the islands southeast of Bakers Narrows is approximately 210 m thick and is exposed for a strike length of 3.3 km. This flow is perhaps unique in the Flin Flon area in that the present erosional surface has intersected the fissures through which the rhyolitic magma was extruded — in effect, the vent area of the flow. These feeding fissures are now represented by massive rhyolite dykes up to 30 m thick that form a stockwork (originally in a predominantly subvertical orientation) in the stratigraphic footwall, continuous with the massive part of the flow. The basal part of the flow is spherulitic and contains polygonal cooling joints. The upper third of the flow consists of massive rhyolite, flow-folded flow-banded rhyolite, and rhyolite breccia containing large tabular slabs of flow-banded material. These structures are virtually identical to those in the rhyolite flow that hosts the Flin Flon Cu-Zn orebody (Bailes and Syme, 1987). The rhyolite rests upon mafic amoeboid pillow breccia and is overlain by a very distinctive package of mafic rocks comprising amoeboid pillow breccia with sporadic rhyolite fragments, and massive, strongly amygdaloidal basalt flows.

The third major rhyolite body occurs in the islands west of Paradise Lodge (Preliminary Map 1987 F-2). Sparse structural data (flow banding, layering) suggest that the body strikes approximately east-west, and the complex is at least 900 m thick. Like the Campground rhyolite, this complex is composed predominantly of massive rhyolite lobes and rhyolite microbreccia; some of the clastic material in the microbreccia is pumiceous.

MILLWATER BLOCK

Amisk Group rocks in the Millwater block include three separate units of basalt and a unit of mafic volaniclastic rocks. These, and similar basalts in the adjacent Mink Narrows block, occur in isoclinal, upright, northeast-trending folds which are truncated by northeast-trending Payuk Lake and Millwater faults (Fig. GS-7-1). The Millwater fault produces 360 m of dextral offset on the contact of the Lynx Lake pluton; this fault must also have considerable displacement in a vertical sense because there are significant offsets in Amisk Group volcanic and intrusive units across the fault.

Basaltic units in the Millwater block include buff-brown weathering pillowed flows, buff weathering pillowed flows, and dark green massive to pillowed flows. The buff-brown and buff basalts are probably compositionally similar (representative analyses are pending) and differ mainly in weathering and fresh colour, selvage thickness, pillow size and form, occurrence of spherulites, and mineralogy of inter-pillow void filling.

An extensive unit of mafic volcaniclastic rocks is associated, and locally intercalated on an outcrop scale, with the buff weathering pillowed basalt. Maximum thickness of this unit is about 400 m; it is truncated to the north by the Payuk Lake fault. The unit comprises a spectrum of layered clastic rocks ranging from fine grained breccias to greywacke-siltstone-mudstone. The "breccias" are commonly thickly bedded, framework supported and composed of fragments 2 mm — 10 cm but generally less than 2 cm in diameter. Fragments are usually rounded but locally are angular to subangular. In detail the breccias are heterolithologic, comprising light buff, light grey, rusty brown, cream and light grey-green types which vary from non-vesicular to scoriaceous; all are aphyric and broadly mafic in composition. Finer grained members of the unit are thinly bedded (5 mm — 5 cm) and composed of mafic arenites interbedded with siltstone-mudstone; sedimentary structures include normal grading, turbidite bed zonation (AB), scours and rip-ups. The unit represents redeposited mafic detritus derived from hyaloclastite and mafic tuff.

The final major volcanic unit in the Millwater block is a group of medium to dark green weathering basalts (Athapapuskow basalts) exposed in the islands south of Lynx Lake pluton. These rocks correspond to the northern edge of a very large area of high magnetic response (Geological Survey of Canada, 1983: total field and vertical gradient surveys). In the area southeast of Millwater, the mapped contact between buff pillowed basalts and green Athapapuskow basalts corresponds exactly to the abrupt change in magnetic response shown on the aeromagnetic maps. This lithologic/magnetic contact is significant because Athapapuskow basalts represent a very different geochemical type than the basalts in the low magnetic response area to the north, and may in fact have erupted in a somewhat different tectonic environment (discussed below).

Athapapuskow basalts are dark green on weathered and fresh surfaces and contain a ubiquitous epidote alteration assemblage, in contrast to the non-epidotized nature of the buff Millwater basalts. Massive sheet flows are the dominant flow morphology, although subordinate pillowed flows also occur. The sheet flows are commonly 1.5-5 m thick and have a chilled base, sporadic vesicles in the basal zone, and a coarse (1 mm) equigranular non-vesicular central zone; the top third to half of the flow has abundant large (to 2 cm) vesicles (Fig. GS-7-4). The vesicular tops of some of the thicker sheet flows are pillowed. This flow type is strikingly different from mafic flow types elsewhere in the Schist Lake-Athapapuskow Lake area.

The trace element characteristics of Amisk Group mafic rocks in the Flin Flon-White Lake area are very similar to those of Cenozoic intra-oceanic island arc basalts, distinguished by relative enrichment in LIL elements (Rb, Sr, Ba, Th) and depletion in HFS elements (Ti, P, Zr, Hf) (Syme, 1987). Analyses of a reconnaisance collection of Athapapuskow basalts show that they have a different trace element pattern, with little enrichment of LIL elements and without depletion of HFS elements. This flat pattern resembles those characterizing basalts erupted at spreading centres, perhaps in a back-arc basin. More extensive sampling was conducted during the 1987 field season to more completely define the geochemical affinities of this potentially important group of basalts.

The magnetically sharp contact between Athapapuskow basalts and Millwater basalts is in part faulted (Preliminary Map 1987 F-2), and the two sequences are structurally discordant. Within about 120 m of the fault contact the normally buff Millwater basalts locally assume a green colour and an epidote-rich alteration assemblage, and thus superficially resemble Athapapuskow basalts. These altered Millwater basalts, however, maintain their characteristic pillowed form with few vesicles, narrow selvages and common marginal pipe amygdales.

SOURDOUGH BAY BLOCK

Amisk Group rocks in the Sourdough Bay block are exposed as narrow (30-100 m) septa caught between a suite of high level mafic sills (described below). A total of 320 m of section is exposed but, because the Amisk rocks are recessive lithologies, much of the lake-covered portion of this narrow block is probably also underlain by Amisk rocks.

The Amisk section represented in the block is highly anomalous in that it is almost entirely sedimentary. The predominant rock type is relatively thick bedded greywacke (beds commonly 20 cm-2 m) composed of detrital plagioclase, quartz and volcanic rock fragments, with grain size

Figure GS-7-2: *Amoeboid pillow breccia, Bakers Narrows block. Highly irregular amoeboid pillows (light grey) are supported by a matrix of recrystallized hyaloclastite (dark).*

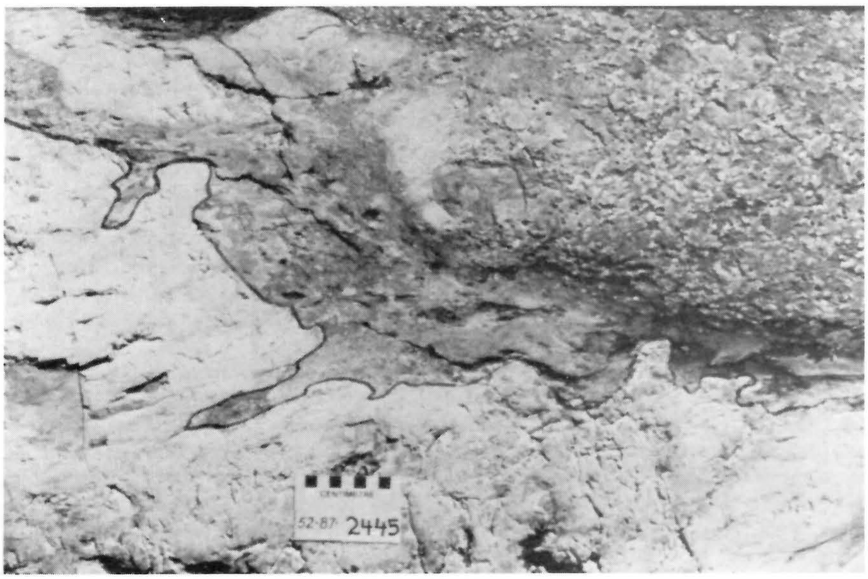
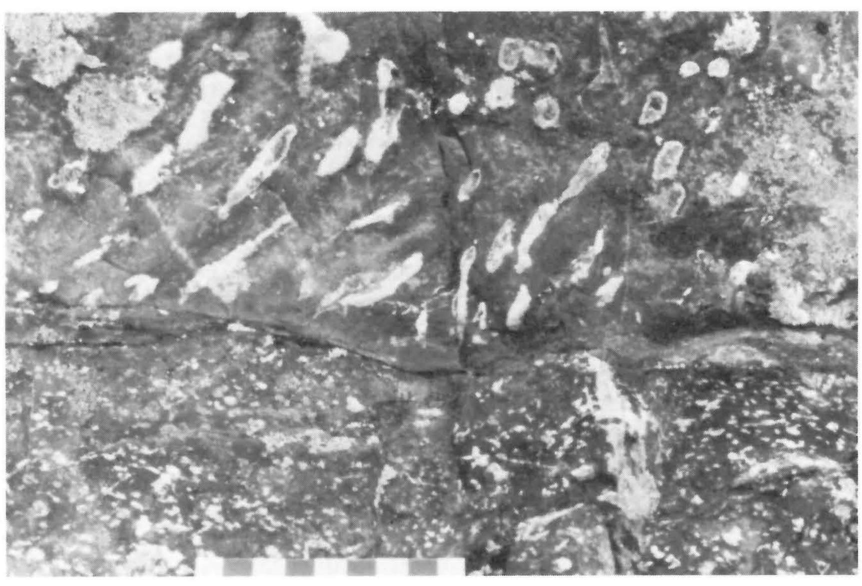


Figure GS-7-3: *Contact between massive rhyolite lobe (light) and rhyolite microbreccia (dark), Bakers Narrows Campground flow. The contact has been highlighted with marker pen (black). Spherulites up to 1 cm in diameter occur in the microbreccia.*

Figure GS-7-4: *Contact between flows, Athapapuskow basalt. The top of the lower flow is strongly amygdaloidal, and the base of the overlying flow contains large pipe amygdales.*



up to 1 mm. The greywackes are interlayered with siltstone, mudstone, pyritic mudstone and siliceous argillite. A significant portion of the sedimentary section on the northern part of the peninsula is composed of siliceous argillite and chert.

MISSI GROUP

Missi Group rocks occur in two fault bounded blocks: the southern continuation of the Whitefish-Mikanagan Lakes block and the Little Athapapuskow block. The latter is a lens-shaped, fault-bounded, lake-covered sliver a maximum of 800 m thick; only one outcrop exists and the distribution of Missi is known from drilling.

Missi Group rocks in the former block, bounded by the Centennial and Scheiders Bay faults (Fig. GS-7-1), are cut by two internal faults. These internal faults divide the Missi into three stratigraphic packages 1.9 km, 1.6 km and 320 m thick. The thickest section, bordered on the west by Centennial fault, is lithologically the most diverse and is locally superbly exposed. The distribution of units and facing directions define an upright syncline trending and plunging north-northeast. The east limb of the syncline represents a longitudinal section through the Missi Group, approximately parallel to the primary depositional axis: crossbeds in the lower two-thirds of the section display a consistent sense of transport to the northeast. Lateral facies changes in the coarse clastic sediments are consistent with an interpretation placing the more proximal area to the southwest and more distal area to the northeast.

The Missi section is comparable in thickness to the Missi Group at Flin Flon, but represents a significantly different stratigraphic sequence, dominated by coarse clastics with abundant detritus derived from hematiferous, weathered Amisk rocks (regolith). The entire section constitutes a more proximal assemblage than the sequence at Flin Flon.

The lowermost unit in the Missi section on Athapapuskow Lake consists of 460 m of buff weathering, polymictic, pebble-cobble conglomerate; the base of this unit is truncated by a fault. The conglomerate is massive, clast-supported, and contains well rounded clasts of Amisk mafic and felsic volcanics, quartz, jasper, chert, epidosite, fine grained sandstone (intraformational), diorite, gabbro, tonalite, and granodiorite. The abundance (2-15%) of granitoid clasts distinguishes this conglomerate from all other Missi conglomeratic units in the Flin Flon area.

The conglomerate is overlain by at least 760 m of purple-weathering interlayered pebble conglomerate and crossbedded coarse pebbly sandstone, which were deposited in a fluvial environment. The more proximal portion of this unit is relatively thin bedded (10 cm-1.5 m) and characterized by the abundance of pebble conglomerate dominated by hematiferous regolith clasts (Fig. GS-7-5). Beds are superficially continuous but in detail most are lenticular (Fig. GS-7-6). The proximal portion also contains a wedge-shaped unit of purple pebble-cobble conglomerate (up to 300 m thick) that abruptly pinches out to the northeast. The more distal part of the unit consists of rocks deposited as crossbedded sands, pebbly sands and pebbly gravels; crossbeds include troughs and tabular sets up to 30 cm thick in sands and 70 cm in gravels (Fig. GS-7-7). These purple-weathering, regolith-rich arenites are sharply interbedded with cleaner, more quartz-rich, buff crossbedded sands in the most distal portion of the unit. These very distinct facies changes occur within only 2-3 km of strike length preserved in the fault block.

The purple weathering coarse clastic unit is overlain by a unit of thinly interbedded buff to mauve fine sandstone, mauve siltstone and purple mudstone. Flaser bedding (possibly ripples), and low angle crossbeds with opposing transport directions, suggest this package may represent a tidal environment.

The succeeding unit comprises 460 m of grey-buff to pinkish buff weathering medium-coarse sandstone (0.5-1 mm). The sandstone is massive, fairly well sorted and contains rare isolated rounded pebbles to 2 cm.

The topmost major unit in the Missi consists of at least 300 m of buff weathering polymictic pebble-cobble conglomerate; the top of the unit is truncated by Centennial fault. This conglomerate is clast-supported, massive, with intercalated massive to crossbedded sandstone lenses 10-100 cm thick. The lower part of the unit includes tabular crossbedded coarse pebbly sandstone and pebble conglomerate. In the topmost part of the unit, along the shore of Schist Bay, there are thin mappable units of purple-weathering pebble conglomerate and grey pebbly sandstone-pebble conglomerate. Clasts in the pebble-cobble conglomerate are rounded to well rounded and are predominantly derived from the Amisk Group. Red, purple, grey and black chert clasts (including jasper, iron formation; Fig. GS-7-8) form a significant proportion of the rock (Table GS-7-1).

TABLE GS-7-1
FRAMEWORK CLAST PERCENTAGES IN MISSI CONGLOMERATE (SCHIST BAY)

	(1)	(2)	(3)
Mafic Volcanic	35.6	20.7	27.0
Felsic Volcanic	9.2	9.0	11.8
Diorite	6.1	3.2	2.9
Quartz Diorite	3.0	-	1.2
Chert, I. F.	6.1	11.5	11.0
Quartz	0.2	1.1	0.5
Epidosite	3.4	3.9	3.8
Sandstone } Siltstone	4.3	0.7	2.9
		-	1.4
Matrix	32.0	49.8	37.5
Counts	441	434	442

INTRUSIVE ROCKS

Intrusive rocks form at least 60% of the exposed portion of the map area (Fig. GS-7-1), and range from a layered gabbroic complex through gabbro, quartz diorite, tonalite and granodiorite stocks. The Kaminis Lake pluton, Schist Creek gabbro and Airport tonalite pluton (Fig. GS-7-1) have been described previously (Syme, 1986).

The **Airport tonalite** pluton (incompletely mapped in 1986) is particularly interesting in that it has been extensively dissected by faults. The pluton is concentrically zoned, with an equigranular margin and quartz megacrystic core. The zonation, and contacts of the pluton, are offset by two north-trending sinistral faults, an east-trending dextral fault, and a major east- to northeast-trending fault that truncates the entire northern half of the pluton. This latter fault (not recognized in the Flin Flon-White Lake area) is part of a larger structure exposed on the northeast arm of Schist Lake, where mylonitized tonalitic rocks occur on the eastern shore (Preliminary Map 1987 F-1). The fault effectively separates the Scotty Lake block into a supracrustal domain (to the north) and a plutonic domain (to the south).

Diorite sills emplaced in west-facing Amisk Group sedimentary rocks in the Whitefish-Mikanagan Lakes block are zoned, polyphase bodies, some of which are extremely high level. The sills, and host Amisk sediments, are offset along two northwest-trending sinistral faults that are probably conjugate to the north-northeast-trending Scheiders Bay-North Arm fault system. The easternmost sill is about 460 m thick and is composed of basal and upper zones (30-150 m thick) of fine grained, rusty buff weathering feldspathic diorite and a central zone (100-150 m thick) of fine grained ferrodiorite containing 7-10% 1 mm magnetite crystals. A concordant body of quartz diorite 120-330 m thick intrudes the contact between ferrodiorite and the upper zone, and locally forms the greater portion of the sill. The quartz diorite is characterized by tabular plagioclase crystals (2-3 mm), prismatic to blade-like amphibole after pyroxene (to 6 mm) and 5-10% quartz. A similarly zoned and intruded sill 300 m thick forms the central part of the peninsula.

The western sill complex, adjoining Scheiders Bay, is approximately 460 m thick and is a sequence of (unzoned) fine grained diorite-quartz diorite sills, again intruded by concordant bodies of coarse quartz diorite. These sills differ from those to the east in that their western (top)

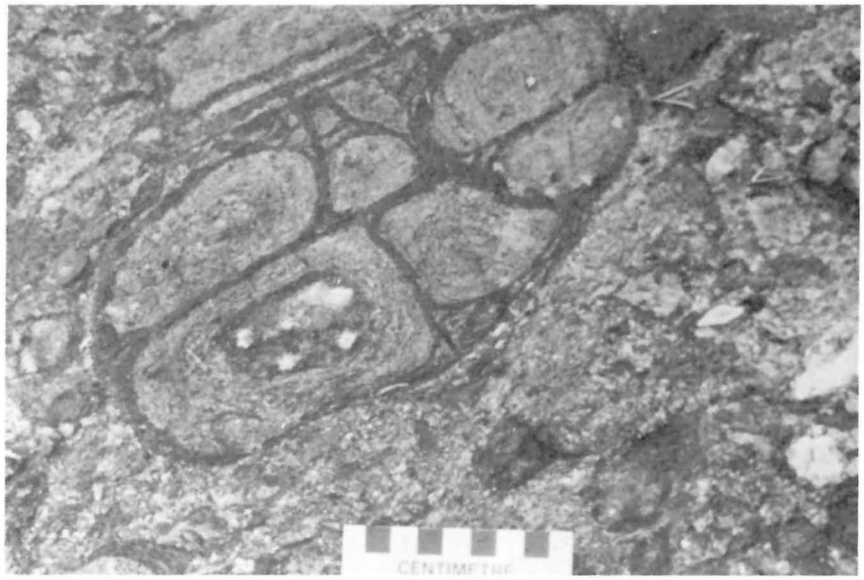


Figure GS-7-5: *Regolith clast with spheroidal weathering in hematiferous joint-bounded domains, Missi Group conglomerate, Athapapuskow Lake.*

Figure GS-7-6: *Lenticular sandstone bed in sequence of purple weathering pebble conglomerate and pebbly sandstone; Missi Group, Athapapuskow Lake. Top is to the left; hammer (33 cm) for scale.*

Figure GS-7-7: *Tabular crossbed sets in purple weathering pebbly sandstone; Missi Group, Athapapuskow Lake.*

Figure GS-7-8: *Chert-jasper-hematite iron formation clast; Missi Group, Athapapuskow Lake. The iron formation was deformed (boudinaged, faulted) prior to its incorporation into the conglomerate.*

portions grade to highly vesicular 'basaltic' material, locally containing large inclusions of Amisk sediments. At the time of their intrusion the sills were probably overlain by only a few metres of sediment; some 'sills' may in fact be flows. The age of these bodies is therefore considered syn-Amisk.

A lenticular **leucotonalite-rhyolite** body in the Bakers Narrows block is post-Amisk in age; it is intruded along the axis of a broad syncline yet has regional axial planar foliation and is thus syn-tectonic. The larger part of the body weathers grey-white, has a 0.5-1 mm equigranular texture and is composed of 30% quartz, a few mafics, and feldspar. The core of the body contains slabby mafic inclusions; the margins and northern, smaller part of the body are white-weathering fine grained rhyolite.

A layered **gabbro-leucogabbro-gabbroic anorthosite-pyroxenite complex** southwest of Mink Narrows differs from other mafic intrusions in Athapapuskow-Schist Lakes and Flin Flon-White Lake areas in that well defined modal layering occurs throughout much of the body. The portion of the intrusion mapped to date is about 1.5 km thick, although a significant proportion of that thickness comprises younger unrelated tonalite and quartz diorite intrusion breccia.

The intrusion is bounded and dissected by faults, and contains within it a great many shears, fractures and veins that are related to the major structures (Fig. GS-7-9). Most of these minor structures, and measured foliations, have the same orientation as the bounding faults to the northwest (Mistik Creek fault system, 045°) and to the southeast (Limestone Channel fault: 020°, 040°). Minor structures in the Mistik Creek and Payuk Lake fault directions are dominantly dextral whereas those parallel to the Limestone Channel faults are sinistral. Shears in the 100°-120° direction appear to be younger, sinistral features, probably related to the Mink Narrows fault. Sinistral shears in the 160°-170° direction (Fig. GS-7-9) are not associated with any known major structure.

The layered intrusion is composed of subequal proportions of gabbro and leucogabbro. Modal layers are defined by abrupt variation in the plagioclase:mafic ratio, and range from 5 cm to more than 2 m thick (Fig. GS-7-10). Some layers, with as little as 5% mafics, are anorthositic. Exposed ultramafic parts of the body include thin pyroxenite sills and a 100 m thick pyroxenite layer. Olivine-bearing cumulates were not observed within the body, but an outcrop of poikilitic peridotite occurs on a nearby island, east of the Limestone Channel fault. The layered complex is cut by plagioclase-amphibole pegmatite dykes 3 cm — 3 m wide (Fig. GS-7-11).

The **Mink Narrows pluton** is a small oval stock (2.5 x 6 km) of homogeneous biotite-hornblende granodiorite that intrudes mafic flows in the Mink Narrows block (Fig. GS-7-1). It is characterized by 2-7 mm subhedral oscillatory zoned plagioclase, 2-10 mm equant polycrystalline quartz, euhedral hornblende to 5 mm and euhedral biotite to 4 mm, with interstitial finer grained quartz, microcline perthite and plagioclase; some of the perthite is poikilitic. Mafics comprise 10% of the rock. The granodiorite is generally unfoliated, except along its northern margin where it contains a shear foliation related to the Mistik Creek fault system. Later dykes are virtually absent, except for rare porphyritic granodiorite dykes.

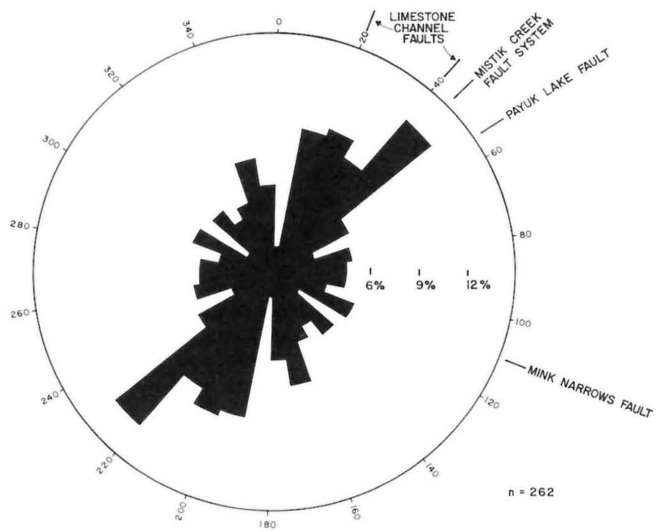


Figure GS-7-9: *Rose diagram showing orientations of shear zones, fractures and veins in the area bounded by Mistik Creek fault, Limestone Channel fault, and Mink Narrows fault.*

Figure GS-7-10: Modal layering in gabbro-leucogabbro-anorthosite intrusion, Athapapuskow Lake.

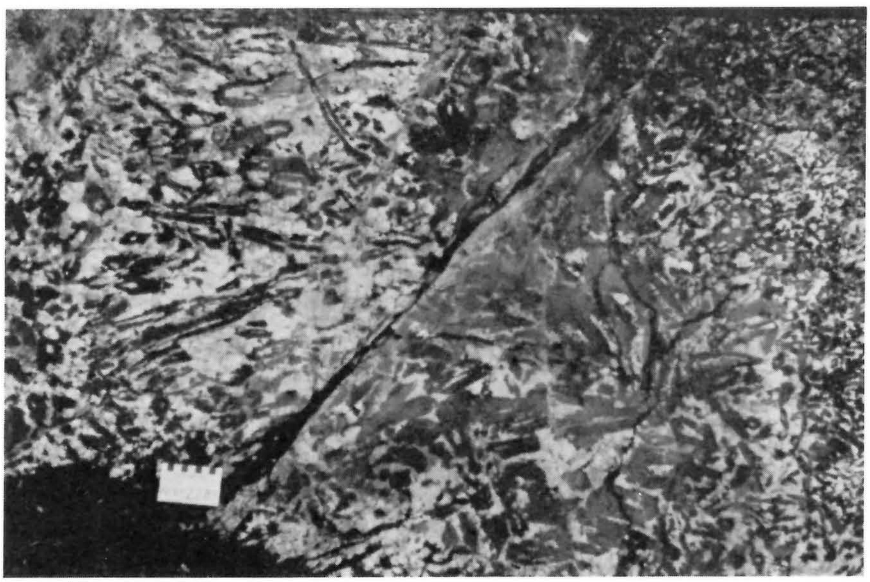


Figure GS-7-11: Part of a 3 m wide, zoned, plagioclase-amphibole pegmatite dyke which cuts the layered gabbro complex southwest of Mink Narrows.

The **Lynx Lake pluton** is an oval stock (3.8 x 8.6 km) similar to the Mink Narrows pluton. It is concentrically zoned: the margin is biotite-hornblende granodiorite composed of 2-5 mm subhedral oscillatory zoned plagioclase, 2-7 mm subhedral green hornblende and 1-2 mm euhedral biotite enclosed by poikilitic perthite (to 1 cm) and polygranular quartz. The core of the pluton is muscovite-biotite granodiorite, somewhat finer grained than the margin, with about 3% muscovite, less than 5% biotite and interstitial microcline rather than poikilitic perthite. The marginal granodiorite is metaluminous whereas the core is slightly peraluminous, containing higher SiO_2, K_2O, Ba and Rb, and less CaO, MgO, total iron as FeO and Sr than the margin. Rare earth element distribution patterns for the Mink Narrows, Lynx Lake (margin) and Lynx Lake (core) granodiorites are virtually identical, with pronounced LREE enrichment and no europium anomaly.

The Lynx Lake pluton is cut by Payuk Lake and Millwater faults. The pluton has been dated at 1847 Ma (Syme et al., GS-19, this volume), placing the age of faults as post-1847 Ma.

The Mink Narrows and Lynx Lake plutons have produced wide aureoles of thermal metamorphism in the older basalts. The thermal aureole associated with the Lynx Lake pluton is 1 km wide (Preliminary Map 1987 F-2). Within it basalts that normally weather buff to medium green have been converted to a black, unfoliated rock with conchoidal fracture; flattening is rare and primary structures are well preserved. These zones of hornfels are truncated and displaced by faults.

The **Neso Lake pluton** is a slightly irregular oval body 3.8 x 6.3 km, emplaced into dominantly basaltic rocks of the Bakers Narrows block (Fig. GS-7-1). This pluton differs from other felsic plutons in the area in that it contains a wide variety of intrusive rock types, is dominated by more mafic (diorite-quartz diorite) lithologies, and compositional zonation is highly irregular. In general the sequence of intrusion is from more mafic (oldest) to more felsic (youngest), although exceptions to this general relationship imply near contemporaneity of the different phases. In order of decreasing mafic content the major mappable units include:

(1) Gabbro, melagabbro, pyroxenite — these mafic rocks form a continuous unit 1.3 km long near the centre of the pluton, and represent what is essentially a very large inclusion. They occur as xenoliths in virtually every other phase of the pluton.

(2) Diorite/gabbro — these strongly magnetic rocks form a plug-like body on the west side of the pluton. This unit is characterized by 40-50% 1-5 mm black amphibole (in part after pyroxene), 50-60% 0.5-3 mm tabular plagioclase, 0-3% fine grained quartz. Diorite locally contains inclusions of pyroxenite, melagabbro, and gabbroic anorthosite.

(3) Diorite intrusion breccia — a mixed unit of diorite, gabbro and later quartz diorite, commonly forming inclusion-rich phases.

(4) Biotite-hornblende quartz diorite — these rocks form extensive bodies that are marginal to the diorite plug. The rock has a variable but generally coarse grain size, with 5-15% quartz, 60% 1-3 mm tabular plagioclase, 15-25% 1-8 mm prismatic hornblende (some with cores of pyroxene), and 5-20% 1-8 mm euhedral biotite. It contains a few inclusions of pyroxenite and diorite but is overall more homogeneous than the diorite unit.

(5) Intrusion breccia with biotite-hornblende quartz diorite-tonalite matrix — this inclusion-rich unit partly surrounds a plug of homogeneous tonalite (8, below). The matrix varies in mafic and quartz content depending on the degree of assimilation of the many diorite, gabbro, melagabbro-pyroxenite and basalt xenoliths. Xenoliths range in size from a few centimetres to several metres.

(6) Fine grained biotite-hornblende quartz diorite-tonalite — this unit occurs on the southeast margin of the pluton. It contains 15-25%, 1 mm quartz, 55-60% blocky plagioclase to 2 mm, and 20% combined biotite (flakes) and hornblende (slender prisms).

(7) Biotite-hornblende quartz diorite-tonalite, similar to above (6) but significantly coarser grained.

(8) Tonalite — forms a plug-like body in the east-central portion of the pluton, almost entirely surrounded by intrusion breccias. This unit is probably the youngest phase, and is characterized by 25-30% 1-3 mm quartz, 50-60% 1-3 mm blocky plagioclase and 10-20% combined biotite (to 2 mm) and hornblende (to 5 mm).

MINERAL POTENTIAL

BASE METALS

The base metal potential of the Schist Lake-Athapapuskow Lake area has been evaluated and tested by drilling over the past decades by mining companies active in the Flin Flon belt. The fact that economically viable massive sulphide deposits have been found as recently as the mid- to late- 1970s suggests that the potential for discovery of additional small orebodies is not yet exhausted. Most near-surface conductors have probably been drilled, and exploration targets in the future will increasingly be identified by geology.

In the Flin Flon-White Lake area (Bailes and Syme, 1987) most of the rhyolite flow complexes present are stratigraphically associated with massive sulphide deposits. This association can be either direct (as in Flin Flon and Centennial Mines) or indirect (as in Cuprus and White Lake Mines which, although hosted by sediments and volcaniclastic rocks, are stratigraphically equivalent to a large rhyolite complex). In the Athapapuskow Lake area three rhyolite flow complexes of significant size to date have no known directly associated sulphide deposits. There is no geological reason why these rhyolites should be barren, and they constitute packages of Amisk stratigraphy that could be closely evaluated.

The Athapapuskow basalt suite, characterized by oceanic, rift-type geochemistry, may be equivalent to a group of basalts in the East Amisk area (Saskatchewan) with similar geochemical characteristics (Parslow and Gaskarth, 1984). In Saskatchewan, this suite of basalts hosts the Coronation, Birch Lake and Flexar massive sulphide deposits (Parslow, 1984). If the Athapapuskow and East Amisk rocks are indeed related, the possibility exists for similar mineralization in Manitoba. Note that this type of deposit need not be stratigraphically associated with rhyolite, as in the arc-type sequences.

GOLD

Gold exploration in the Flin Flon area also has had a long history, but the controls on mineralization are only recently beginning to be understood. In the Phantom Lake-Douglas Lake area of Saskatchewan, which borders the Athapapuskow project area, gold mineralization occurs in quartz-sulphide veins that predate and postdate the Phantom Lake pluton (1.82 Ma, R. MacQuarrie, unpublished data; Pearson, 1987). Galley and Franklin (1986) consider that the relationship between faults and mineralized zones within the Phantom Lake and Boot Lake intrusions and surrounding volcanic rocks suggests a close temporal relationship between gold mineralization and the latest tectonic event, involving plutonism and faulting.

In the Schist Lake-Athapapuskow Lake area, as in the Flin Flon-White Lake area to the north (Bailes and Syme, 1987), most faults are considered to have been initiated during the final (P5) phase of deformation, postdating the Missi Group, four previous folding events, and metamorphism. At Tartan Lake, gold mineralization occurs in a shear zone adjacent to a mafic intrusive body (Peloquin et al., 1986); the shear zone is very likely related to the faults mapped in the Flin Flon-White Lake area. A number of gold showings in the Athapapuskow Lake area are either directly associated with major faults (e.g. south side of Neso Lake) or associated with secondary faults or splays from the larger structures (e.g., Billy Boy showing, west of Paradise Lodge; Preliminary Map 1987 F-2).

Shears zones within or at the contacts of competent intrusive bodies appear to be promising exploration targets, e.g. Phantom and Boot Lake plutons; Tartan Lake deposit; Star Lake pluton, Saskatchewan (Poulsen et al., 1986). Plutons in the Schist Lake-Athapapuskow Lake area that contain mapped shear zones include the Airport tonalite and Lynx Lake granodiorite; Schist Creek gabbro is in part bordered by major faults. The area with perhaps most promise is southwest of Mink Narrows, within an intrusive complex of mafic and tonalitic rocks. This area, bounded by the Mistik Creek fault system, Limestone Channel and Mink Narrows faults, contains a great many associated shears (Fig. GS-7-9). Some of these shears were observed to contain Cu mineralization (malachite).

PLATINUM GROUP ELEMENTS

Magmatic sulphide/oxide deposits containing platinum group elements are hosted by: (1) large ultramafic-mafic layered intrusions, where they typically occur in plagioclase-rich rocks stratigraphically above the ultramafic members, and (2) tholeiitic and komatiitic intrusions, where PGE are associated with Ni and Cu (Hulbert, 1987). In the area mapped to date, only one mafic intrusion would be of possible interest: the layered gabbro-leucogabbro-gabbroic anorthosite intrusion southwest of Mink Narrows. Ultramafic members within the intrusion are restricted to pyroxenite sills and a larger (100 m thick) pyroxenite layer. Neither the base nor the top of the intrusion is exposed, so it is unknown whether a significant ultramafic component ever existed. Disseminated sulphides were observed in one gabbro layer; chromite layers were not observed.

REFERENCES

Bailes, A.H. and Syme, E.C.
1987: Geology of the Flin Flon-White Lake area; Manitoba Energy and Mines, Map GR87-1-1.

Dimroth, E., Cousineau, P., Leduc, M. and Saschagrin, Y.
1971: Structure and organization of Archean subaqueous basalt flows, Rouyn-Noranda area, Quebec, Canada; Canadian Journal of Earth Sciences, v. 15, p. 902-918.

Furnes, H., Fridleifsson, I.B. and Atkins, F.B.
1980: Subglacial volcanics — on the formation of acid hyaloclastites; Journal of Volcanology and Geothermal Research, v. 8, p. 95-110.

Galley, A.G. and Franklin, J.M.
1986: Gold-tungsten-copper-molybdenum mineralization in the Phantom Lake area: progress report; Saskatchewan Energy and Mines, Summary of Investigations 1986, Miscellaneous Report 86-4, p. 141-142.

Geological Survey of Canada
1983: High resolution aeromagnetic total field and vertical gradient surveys; Geological Survey of Canada Open File 937.

Gordon, T.M., Hunt, P.A., Loveridge, W.D., Bailes, A.H. and Syme, E.C.
1987 U-Pb zircon ages from the Flin Flon and Kisseynew belts, Manitoba: Chronology of Early Proterozoic crust formation; Geological Association of Canada — Mineralogical Association of Canada, Joint Annual Meeting, Saskatoon, 1987; Program with Abstracts, v. 12, p. 48.

Halden, N.M., Clark, G.S., Lenton, P.G., Corkery, M.T. and Schledewitz, D.C.P.
1987: Geochemical and isotopic constraints on the tectonic significance of the Chipewyan batholith, and Proterozoic magma genesis; Geological Association of Canada — Mineralogical Association of Canada, Joint Annual Meeting, Saskatoon, 1987; Program with Abstracts, v. 12, p. 51.

Hulbert, L.
1987: Geological environments for platiunum group element mineralization — a brief overview; **in** Economic Minerals of Saskatchewan, Saskatchewan Geological Society Special Publication No. 8, p. 33-36.

Parslow, G.R.
1984: Lithogeochemistry, Flin Flon and Hanson Lake Areas; Saskatchewan Energy and Mines, Summary of Investigations 1984, p. 92.

Parslow, G.R., and Gaskarth, J.W.
1984: Geochemistry of the East Amisk area; Saskatchewan Energy and Mines, Open File Report OF84-23, 79 p.

Pearce, J.A., Harris, N.B. and Tindle, A.G.
1984: Trace element discrimination diagrams for the tectonic interpretation of granitic rocks; Journal of Petrology, v. 25, p. 956-983.

Pearson, J.G.
1987: Gold mineralization in the Flin Flon-Amisk Lake area, Saskatchewan; **in** Economic Minerals of Saskatchewan, Saskatchewan Geological Society Special Publication No. 8, p. 37-43.

Peloquin, S., Tannahill, B. and Gale, G.H.
1986: Geology of the Tartan Lake gold deposits; **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 56-64.

Poulsen, K.H., Ames, D.E., and Galley, A.G.
1986: Controls on gold mineralization in the Star Lake pluton, La Ronge Domain; Saskatchewan Energy and Mines, Summary of Investigations 1986, Miscellaneous Report 86-4, p. 139-140.

de Rosen-Spence, A.F., Provost, G., Dimroth, E., Gochnauer, K. and Owen, V.
1980: Archean subaqueous felsic flows, Rouyn-Noranda, Quebec, Canada, and their Quaternary equivalents; Precambrian Research, v. 12, p. 43-77.

Staudigel, H. and Schmincke, H.V.
1984: The Pliocene seamount series of La Palma/Canary Islands; Journal of Geophysical Research, v. 89, p. 11195-11215.

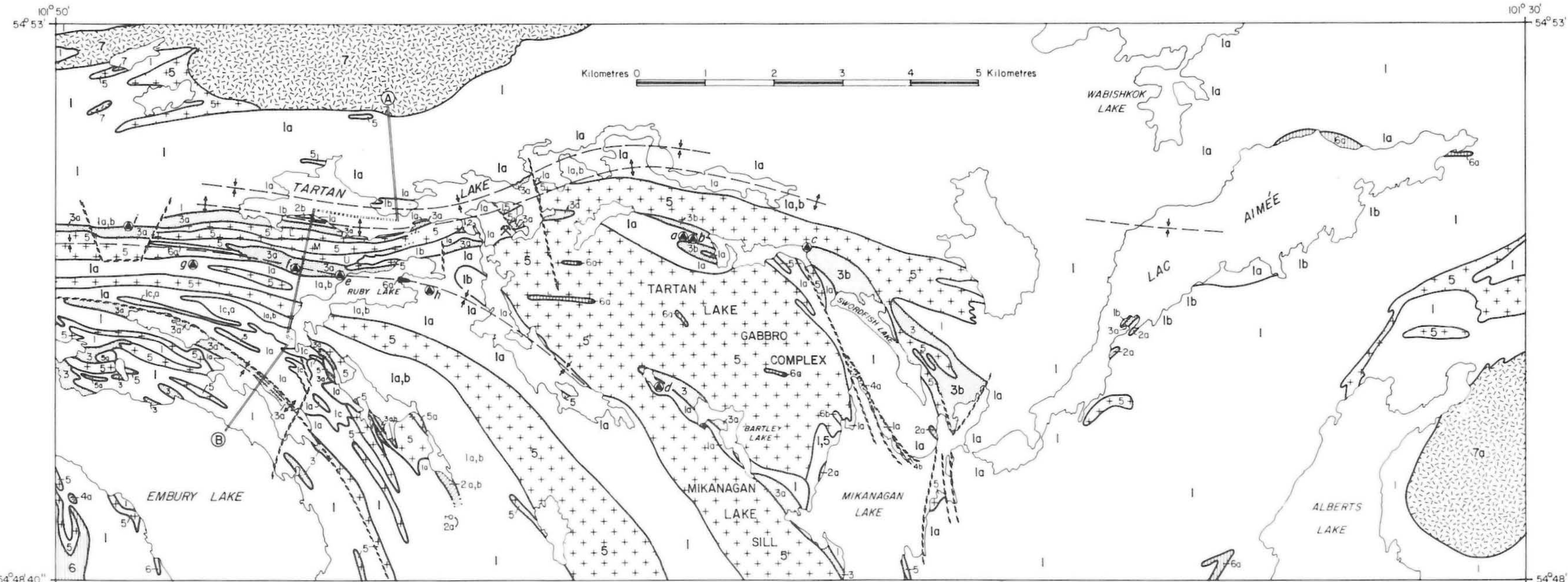
Syme, E.C.
1985: Athapapuskow Lake Project; **in** Manitoba Energy and Mines, Report of Field Activities 1985, p. 44-47.

1986: Schist Lake area (Athapapuskow Project); **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 36-42.

1987a: Schist Lake, Manitoba Energy and Mines, Preliminary Map 1987F-1.

1987b: Athapapuskow Lake, Manitoba Energy and Mines, Preliminary Map 1987F-2.

1987c: Stratigraphy and geochemistry of two Proterozoic arcs: Lynn Lake and Flin Flon metavolcanic belts, Manitoba; Geological Association of Canada — Mineralogical Association of Canada, Joint Annual Meeting, Saskatoon 1987; Program with Abstracts, v. 12, p. 94.



LEGEND

INTRUSIVE ROCKS	7	Porphyritic granite to granodiorite
	7a	Granodiorite gneiss
	6	Minor felsic intrusive rocks
	6a	Quartz-feldspar porphyry, felsite; 6b leucotonalite
	5	Gabbro, diorite, minor leucogabbro and hornblendite
	5a	Peridotite, pyroxenite, serpentinite
MISSI GROUP	4	Sedimentary rocks
	4a	Polymictic conglomerate; 4b arkosic wacke
AMISK GROUP	3	Sedimentary rocks
	3a	Greywacke, siltstone; 3b siltstone, mudstone
	2	Felsic porphyritic rocks
	2a	Flows and/or sills; 2b volcanic fragmental rocks
	1	Mafic and intermediate volcanic rocks, derived schist and gneiss
	1a	Mainly flows; 1b mainly fragmental rocks; 1c synvolcanic gabbro

SYMBOLS

	Geological contact
	Axial trace of anticline, syncline
	Inferred fault
	Tartan Lake Mine
a to i	Mineralized locality
	Diamond drill hole
U	Upper } zones of Tartan Lake gabbro sill
M	Middle
L	Lower
A—B	Section line of Figures GS-8-2 and GS-8-3

Figure GS-8-1: Geology of the Tartan Lake-Lac Aimée area, utilizing data from Tanton (1941) and Bateman and Harrison (1945) showing structure and selected mineralized localities.

GS-8 GEOLOGICAL INVESTIGATIONS IN THE TARTAN LAKE — LAC AIMÉE AREA

by H.P. Gilbert

INTRODUCTION

Geological mapping (5 weeks) extended the areas investigated last season (Gilbert, 1986); coverage at 1:15 840 was completed in the vicinity of Tartan Lake and further mapping was undertaken in the area between Tartan Lake and Embury Lake. The aim of this project is to investigate the structure and stratigraphy of the Amisk Group, the nature of mafic intrusions, the setting of various types of mineralization and the economic potential of the area. A geochemical study of the volcanic rocks is in progress. Further mapping will be conducted next season to complete the coverage west to the Saskatchewan-Manitoba boundary.

STRUCTURE

Two major fold axes correspond, in part, to the margins of a fine grained sedimentary unit (3a) extending west from the area between Ruby Lake and Tartan Lake (Fig. GS-8-1). The stratigraphic discontinuities across the hinge lines of these folds have been interpreted as major axial-planar faults (Fig. GS-8-2). A third, synclinal fold has been mapped through the northwest arm of Tartan Lake, extending farther east along the north side of the lake. South-facing pillows along the north side of Tartan Lake, and north-facing flows in the thick, monoclinal mafic volcanic section (1a, b, c) south of Ruby Lake indicate a synclinorial structure for this part of the greenstone belt. The fine grained sedimentary unit (3a) between Ruby Lake and Embury Lake contains an anticline/syncline pair, and structurally underlies the mafic volcanic section to the north; a fault is inferred at the contact between these two units. This fault may be continuous southward with the Inlet Arm Fault, which is a major block-bounding feature between the Bear Lake and Manistikwan Lake blocks (Bailes and Syme, 1980); alternatively the inferred fault may be a less significant structure within the Bear Lake block.

A minor fault block west of Tartan Lake is indicated by a conjugate fault set, with up to 170 m left lateral displacement on the north-northeast-trending fault (Fig. GS-8-1). Different amounts of displacement along these faults are attributed to variable dip of the units, localized flexure within the block, and possible rotational movement. Major northwest- and northeast-trending faults have been defined or inferred elsewhere (e.g. at the peninsula north of Tartan Lake Mine, and in the north part of Mikanagan Lake.

STRATIGRAPHY

Pillowed mafic volcanic flows and related breccia (1a, b), which occur in a 2.9 km thick monoclinal sequence extending through Ruby Lake and the area to the south, constitute the oldest part of the section (Fig. GS-8-1 and GS-8-3). The base of the section is interpreted as fault-bounded and thus the original extent of the mafic volcanic sequence is unknown. These rocks are laterally equivalent to basaltic andesite (up to 3.3 km thick) comprising the lower part of the Bear Lake block immediately south of the map area (Bailes and Syme, 1980). This unit, which is described by Bailes and Syme (1979 and in prep.), consists of pillowed and subordinate massive flows that are laterally and vertically gradational with autoclastic breccias (Fig. GS-8-4 and GS-8-5). There is complete gradation between pillowed flows, pillow-fragment breccia and flow-breccia with densely to sparsely packed angular fragments of basalt and dark, tabular chips derived from selvages. The flows are largely amygdaloidal and aphyric, but plagioclase phenocrysts (1-3 mm) occur in some units and plagioclase-megaphyric basalt occurs in the lower part of the section. Breccia fragments are commonly densely amygdaloidal. Variolitic structure, locally with clinopyroxene quench-texture (Fig. GS-8-6) occurs in several flows. Concentric cooling fractures are locally common within pillows (Fig. GS-8-7) and several lava tubes up to 2 m across with concentric zoning were observed in the lower part of the section (Fig. GS-8-8). The thickness of both pillowed flows and breccia units is typically 2-10 m (up to 25 m). Fine grained mafic feeder dykes up to 9 m thick locally display concordant diffuse layering similar to the zoning observed in lava tubes (Fig. GS-8-9).

A lensoid zone of plagioclase-megaphyric basalt and related gabbro (1c) up to 600 m thick occurs in the mafic volcanic section south of Ruby Lake. Plagioclase phenocrysts up to 6 cm across occur in both extrusive and intrusive units. Megaphyric flows containing 1-15% plagioclase phenocrysts are intercalated with aphyric units and variously porphyritic to aphyric gabbros. An irregular, interdigitating subzone of megaphyric gabbro to anorthositic gabbro (20-30 m wide) contains 30-50% plagioclase (Fig. GS-8-10); another unit over 6 m thick contains 80-90% plagioclase megacrysts (Fig. GS-8-11). Contacts between basalt and gabbro are very irregular, suggesting the gabbro permeated the volcanic flows in an irregular, laccolith-type structure (Fig. GS-8-2). The thickest part of the megaphyric zone coincides with an inferred fault south of Ruby Lake, possibly related to an early synvolcanic fault providing access for magma movement.

A discontinuous body (up to 200 m wide) of intermediate siltstone, greywacke and subordinate slaty, graphitic argillite (3a, b) outcrops over a strike length of 1.8 km immediately southeast of the south end of Ruby Lake. This unit occurs approximately 650 m above the base of the monoclinal mafic volcanic section south of Ruby Lake, and is on-strike with the upper part of the plagioclase-megaphyric basalt and gabbro zone. Localized plagioclase porphyroblasts are attributed to contact metamorphism by the mafic/ultramafic sill which pervades and partly overlies the sedimentary rocks.

Felsic volcanic rocks (2a, b) approximately 90 m thick occur within the mafic volcanic section at a small lake midway between Embury Lake and the south part of Tartan Lake, just above the stratigraphic level of the fine grained sedimentary rocks southeast of Ruby Lake. Quartz-plagioclase-phyric rhyolite and interlayered, highly attenuated breccia are apparently truncated by a mafic/ultramafic intrusion to the northwest; the southeast extension of the felsic unit is unknown. Dacite to rhyolite, related schists and massive mineralized zones up to 4 m wide (with pyrite, pyrrhotite and minor chalcopyrite) were intersected by a diamond drill hole 0.5 km south of the rhyolite and breccia unit (cancelled assessment data); the mineralized felsic volcanic unit, which is at least 85 m thick, is on-strike with mafic volcanic rocks to the northwest, indicating a stratigraphic or structural discontinuity. The two felsic units (which may be continuous at depth) are the only felsic volcanic flows encountered this season. Previous mapping indicated three minor occurrences of felsic rocks interpreted as volcanic flows, at northwest and northeast Mikanagan Lake, and at the east shore of Lac Aimée; a 65 m thick unit of felsic fragmental rocks (2b) was mapped within the mafic volcanic section at west Tartan Lake.

A unit of fine grained sedimentary rocks (3a), up to 330 m thick, extends from the south shore of west Tartan Lake to the north shore of Ruby Lake; the Tartan Lake gabbro sill (5) has been emplaced through the central part of this unit. The sedimentary rocks, previously described as the basal part of the stratigraphic section (Gilbert, 1986) have been reinterpreted as a south-facing fault slice overlying the north-facing monoclinal succession of older mafic volcanic rocks between Ruby Lake and Embury Lake. The sedimentary rocks consist of intermediate, fine grained siltstone and feldspathic greywacke, with minor siliceous siltstone, felsic wacke and pebble-bearing units, and rare argillaceous siltstone and mafic, chloritic greywacke. Layering occurs at all scales from fine laminae (2-10 mm) to homogeneous units over 7 m thick (Fig. GS-8-12); graded bedding and rare scouring occur at several localities. Poorly preserved shapes of felsic grains and prominent layering indicate a significant degree of reworking of the intermediate to felsic tuffs from which these rocks are

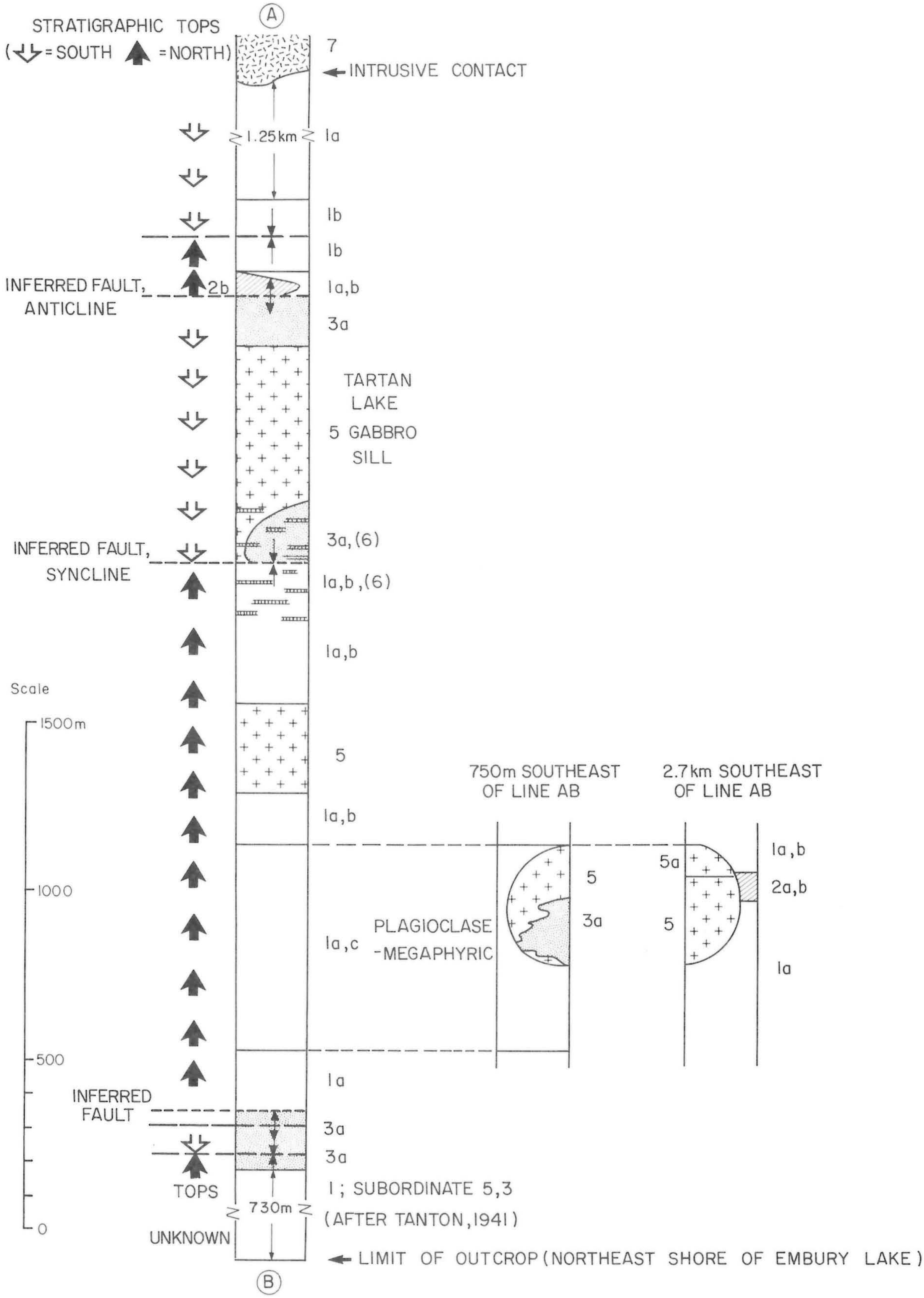


Figure GS-8-2: *Transverse section from Tartan Lake to Embury Lake; section line AB and legend are shown in Figure GS-8-1.*

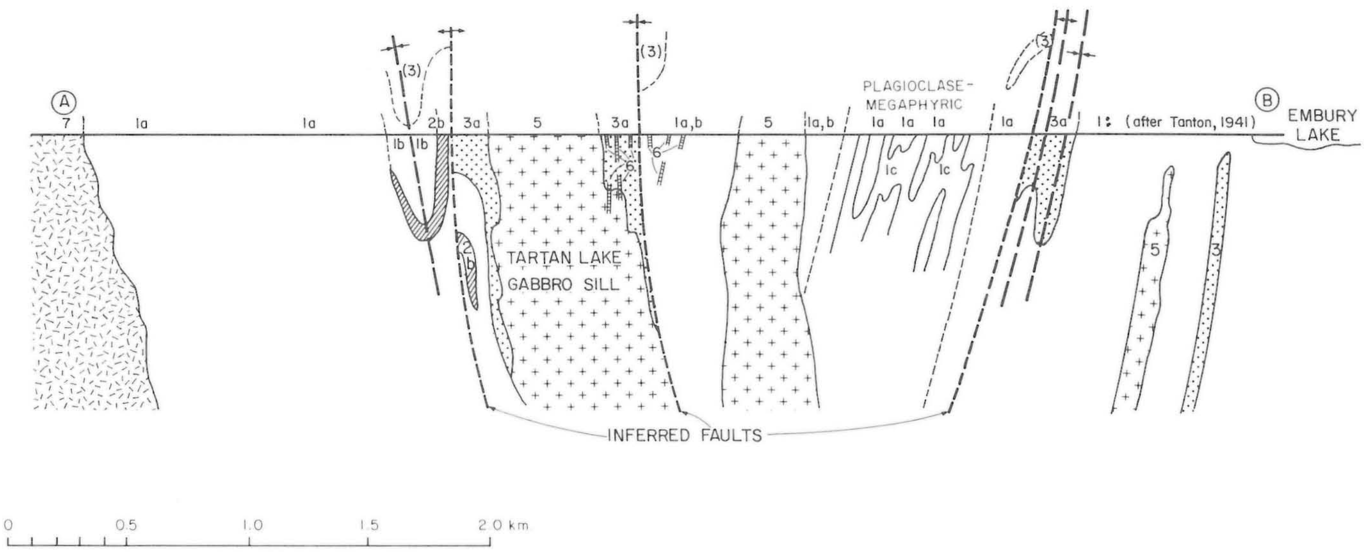


Figure GS-8-3: *Stratigraphic section from Tartan Lake to Embury Lake; section line AB and legend are shown in Figure GS-8-1.*

derived; however, subordinate units of intercalated water-lain tuff were interpreted at several localities within the sedimentary section. This section occupies a similar stratigraphic position to that of subaqueous intermediate pyroclastic flows in the Bear Lake area to the south (unit 7, Bailes and Syme, 1979). If these units are stratigraphically equivalent, a lateral transition toward a more distal environment is indicated from the Bear Lake area north to the Tartan Lake area, resulting in a decreased thickness (825 m to 330 m), a greater degree of reworking, general absence of scouring and pumice fragments, and possibly a higher proportion of siltstone (relative to greywacke).

Sedimentary rocks (3a) have been recognized at one locality in the core of the syncline at north Tartan Lake, but otherwise these rocks are absent in the syncline, possibly due to the inferred fault parallel to the axial plane of the anticline to the south (Fig. GS-8-2). The isolated sedimentary unit (up to 50 m thick) occurs 600 m north of Tartan Lake Mine and consists of strongly deformed siltstone, greywacke, and associated oligomictic volcanic breccia with subangular dacitic fragments. The sedimentary enclave is on-strike with mafic volcanic fragmental rocks (1b) in the synclinal core 1.5 km farther west. A pyroclastic origin is considered likely for these rocks, in contrast to the autoclastic derivation clearly indicated for the mafic volcanic breccias in the monoclinal section extending through Ruby Lake and the area to the south.

The fine grained sedimentary unit (3a) between Ruby Lake and Embury Lake (Fig. GS-8-1) is up to 160 m wide, and extends laterally for approximately 4.5 km. This unit is lithologically similar to the sedimentary rocks between Tartan Lake and Ruby Lake, but is distinguished by a greater lithologic diversity and development of primary structures, which locally indicate deposition by turbidity currents. Cyclic units conforming to Bouma AE divisions are developed in the northwest part of the section, and graded bedding, locally with rip-ups and scouring, is relatively com-

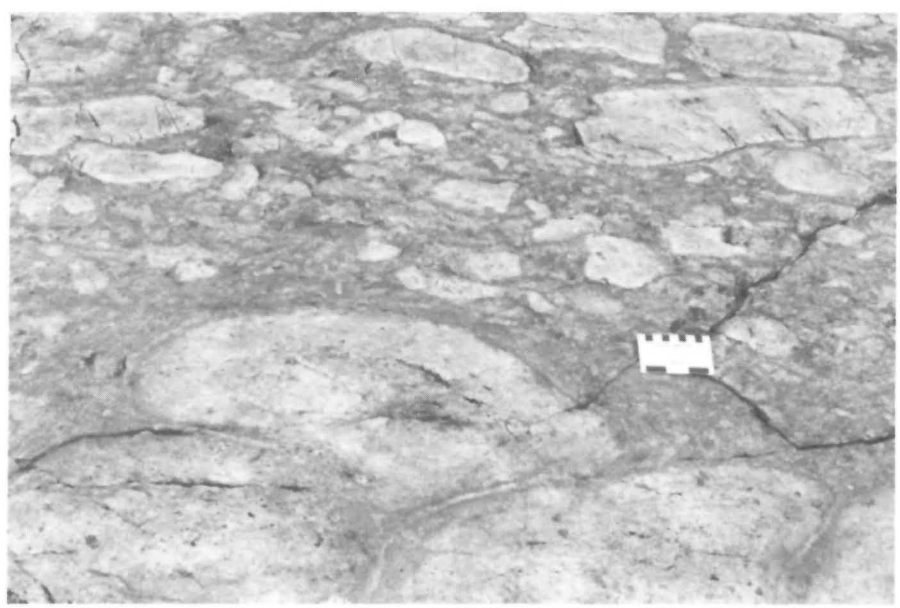


Figure GS-8-4: *Contact between aphyric pillowed basalt and overlying autoclastic breccia.*

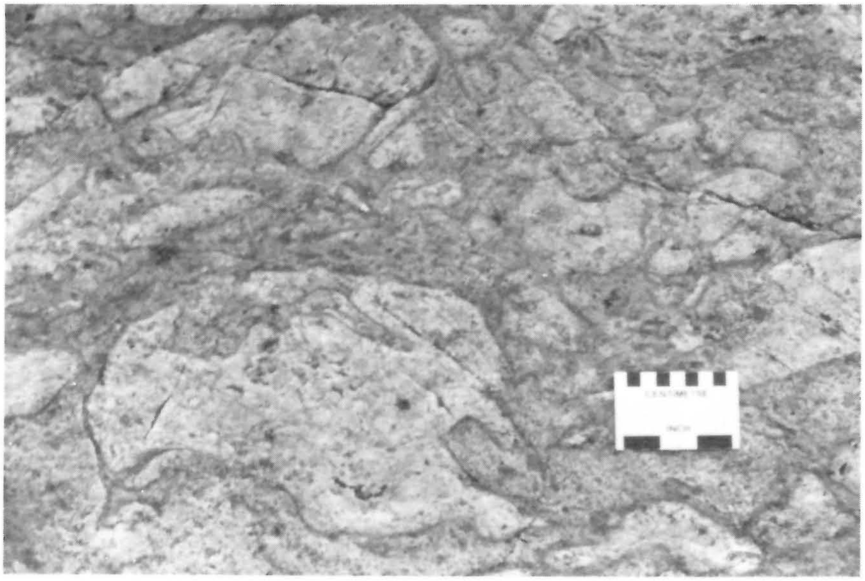
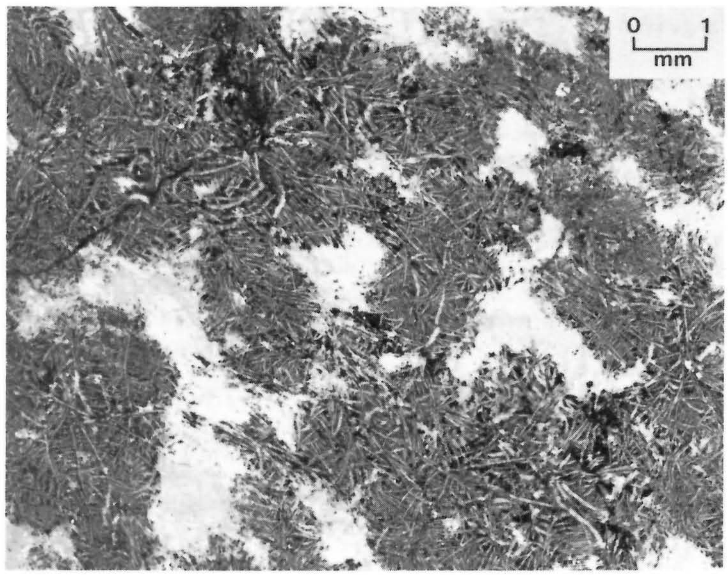


Figure GS-8-5: *Autoclastic breccia with aphyric, amygdaloidal basalt clasts derived from pillowed flows.*

Figure GS-8-6: *Clinopyroxene quench-texture in aphyric, variolitic basalt 800 m west of the north end of Swordfish Lake. Green hornblende = white and pale grey, irregular masses and very fine skeletal pseudomorphs after clinopyroxene; quartz + plagioclase = dark grey to black mesostasis; epidote = very dark grey microfracture filling.*



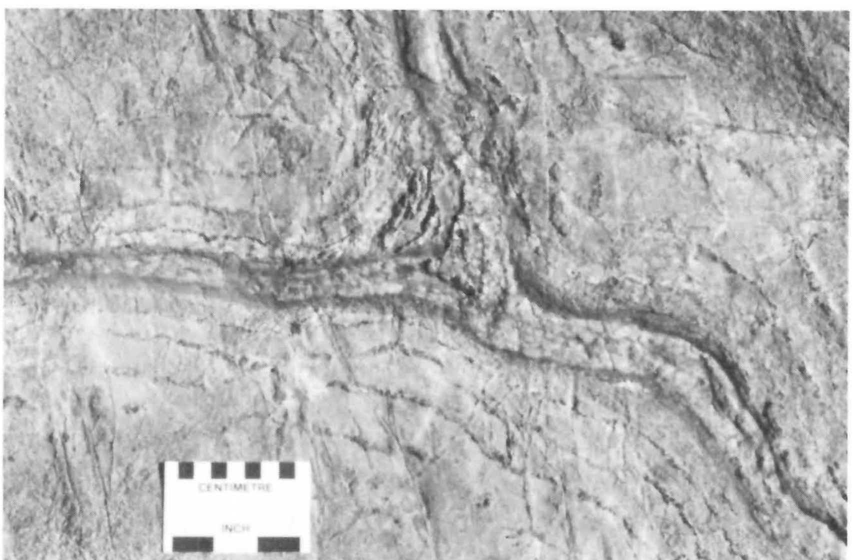


Figure GS-8-7: *Concentric cooling fractures with chloritic filling in marginal parts of pillows.*

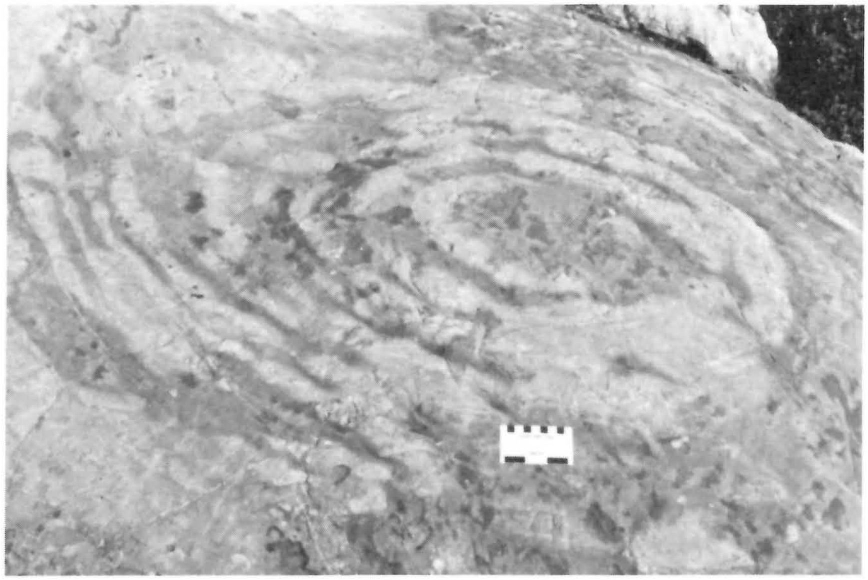


Figure GS-8-8: *Lava tube with concentric zoning.*

Figure GS-8-9: *Mafic volcanic feeder dyke with diffuse, concordant zoning.*

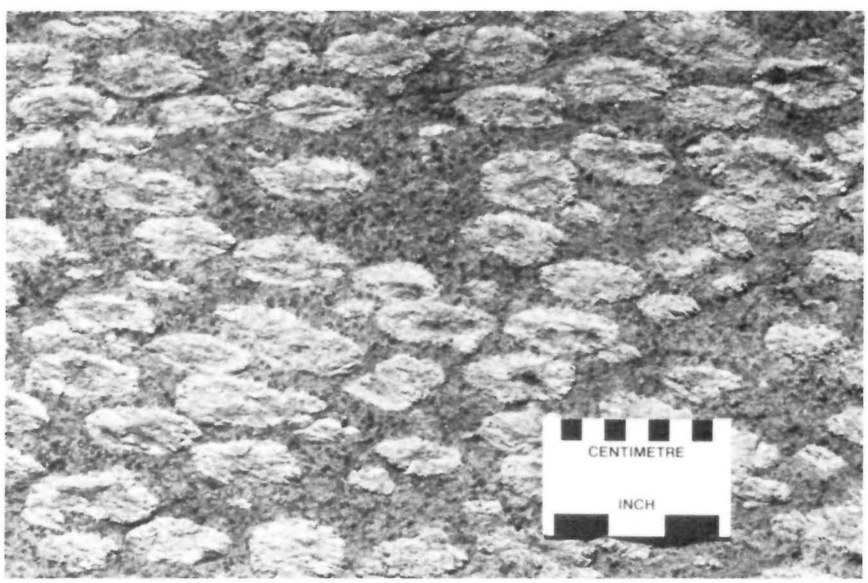


Figure GS-8-10: *Anorthositic gabbro with plagioclase megacrysts.*

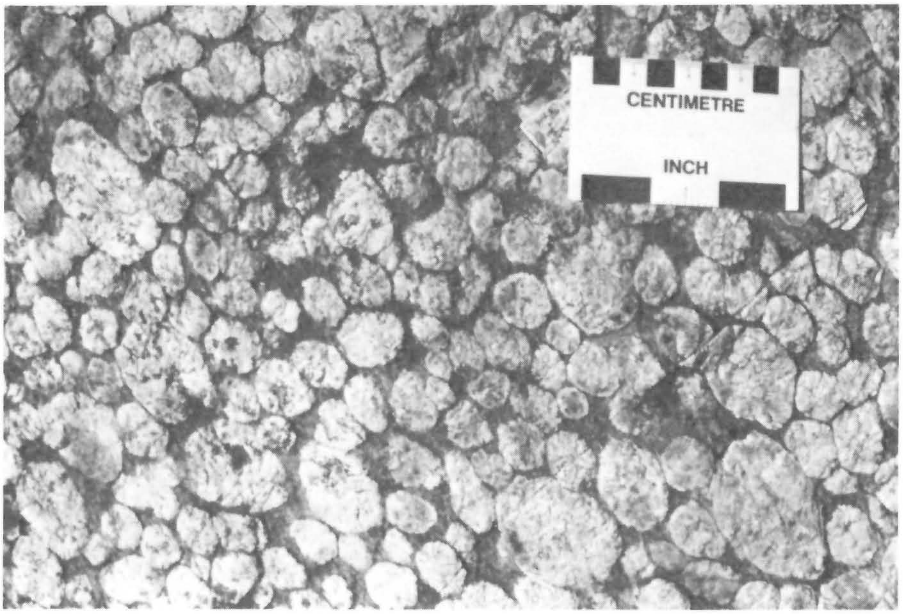


Figure GS-8-11: *Anorthositic gabbro to anorthosite with plagioclase megacrysts.*

mon (Fig. GS-8-13); several occurrences of flame structure, and rare ball structure were also observed. The composition of the sedimentary rocks is mainly intermediate, with subordinate argillaceous siltstone and cherty siltstone. The sedimentary section between Tartan Lake and Ruby Lake is compositionally and lithologically similar to much of the unit between Ruby Lake and Embury Lake, although argillitic and cherty siltstone are relatively less common, and turbidite-type features have not been recognized in the former section. The stratigraphic position of the sedimentary unit between Ruby Lake and Embury Lake is uncertain since it is interpreted to be in fault contact with the mafic volcanic section to the north. It is also uncertain whether the sedimentary unit is part of the Bear Lake block or adjacent Manistikwan Lake block to the west (Bailes and Syme, 1980); Syme (1986) observed that similar-appearing lithologic units occur in different fault blocks in the Flin Flon-White Lake area and are not equivalent.

INTRUSIVE ROCKS

Gabbroic rocks (5) underlie a large part of the Tartan Lake — Lac Aimée area, and are the subject of several investigations (Peloquin et al., 1986; Peloquin and Gale, 1985; J. Young, M.Sc. thesis in prep., University of Manitoba). The present mapping included a part of the Tartan Lake gabbro sill (which extends west from the area between Tartan Lake and Ruby Lake), a major gabbro sill extending through the south part of Ruby Lake, and a mafic to ultramafic intrusion immediately southeast of the south end of Ruby Lake.

The south-facing Tartan Lake sill (up to 520 m thick) is divided into three main compositional zones; a minor transition zone occurs between the lower and middle zones (Table GS-8-1). The lower zone consists mainly of homogeneous, massive mesocratic gabbro. Igneous layering is best developed in the middle and upper zones and consists of rhythmic variations in hornblende/plagioclase ratio at a scale of 2-30 cm; thinner (0.5-1 cm) laminae (Fig. GS-8-14) and thicker (1-20 m) units are also locally developed (Fig. GS-8-15). Graded layers (2-15 cm) occur sporadically in the middle and upper zones, and one occurrence of scour and probable ripups was observed in the middle zone. The gabbro is generally medium grained; very coarse grained to pegmatitic gabbro occurs in a minor (1-3 m) sill within the transition zone, and in sporadic minor layers and irregular patches in the middle and upper zones. Minor, concordant to discordant diabase intrusions occur sporadically in the sill. The gabbro is generally massive, but igneous lamination (defined by subparallel hornblende) is not uncommon in melagabbro; cataclastic foliation and minor shearing occur locally, especially toward the contacts between layers, and locally within the transition zone. Minor cross faults (with displacements of 10 cm — 1 m) are probably contemporaneous with the block faulting at the west end of the part of the sill that has been mapped. The age of the sill is uncertain relative to the volcanism; differentiation indicated by systematic change from lower to upper zones in the sill shows the intrusion was emplaced horizontally, prior to major folding; the igneous layering is also more likely to have developed during horizontal emplacement. The Tartan Lake sill is similar to the zoned White Lake gabbro, interpreted as synvolcanic, which occupies a similar stratigraphic position in the Bear Lake block farther south, and extends north to within 10 km of the south end of Tartan Lake (Bailes and Syme, 1987).

Reconnaissance of the north part of the Tartan Lake gabbro complex (5) northwest of Swordfish Lake indicated an upper zone (up to 200 m thick) of quartz gabbro (locally granophyric), quartz diorite and minor gabbro and leucogabbro, overlying approximately 400 m of mesocratic gabbro and subordinate melagabbro. Lithologic similarities and the distribution of quartz-bearing, granophyric phases indicate the gabbro extending along the north flank of the Tartan Lake gabbro complex may be laterally equivalent to the Tartan Lake sill farther west.

The mafic sill (5) trending east-southeast through the south part of Ruby Lake is the central part of an elongate sill extending west into Saskatchewan and south almost to Bear Lake, for a total strike length of approximately 25 km (Tanton, 1941; Bateman and Harrison, 1945). Within the map area, the sill ranges from 150 to 1250 m thick and consists of relatively homogeneous, massive gabbro and melagabbro, with minor related hornblendite and pyroxenite. Localized wispy feldspathic stringers, generally roughly parallel to the trend of the sill, may represent incipient primary layering. Pegmatitic gabbro veins (up to 40 cm thick) occur sporadically, generally toward the margins of the sill; green hornblende prisms up to 22 cm long contain relicts of clinopyroxene in one vein.

Gabbro, melagabbro and minor pyroxenite and pyroxene-phyric peridotite (5) occur in a sill up to 500 m thick, extending laterally for approximately 2.5 km southeast of the south end of Ruby Lake. The ultramafic phases and absence of plagioclase megacrysts distinguish this intrusion from the synvolcanic, plagioclase-megaphyric gabbro on-strike to the northwest. Dark brown weathering, quartz-plagioclase-stilpnomelane gneiss with minor ilmenite, which occurs in the northwest part of the intrusion, is interpreted as a reaction phase between gabbro and fine grained sedimentary rocks that occur in an enclave (up to 200 m thick) just below the gneiss. Pyroxenite and peridotite with phenocrysts of clinopyroxene

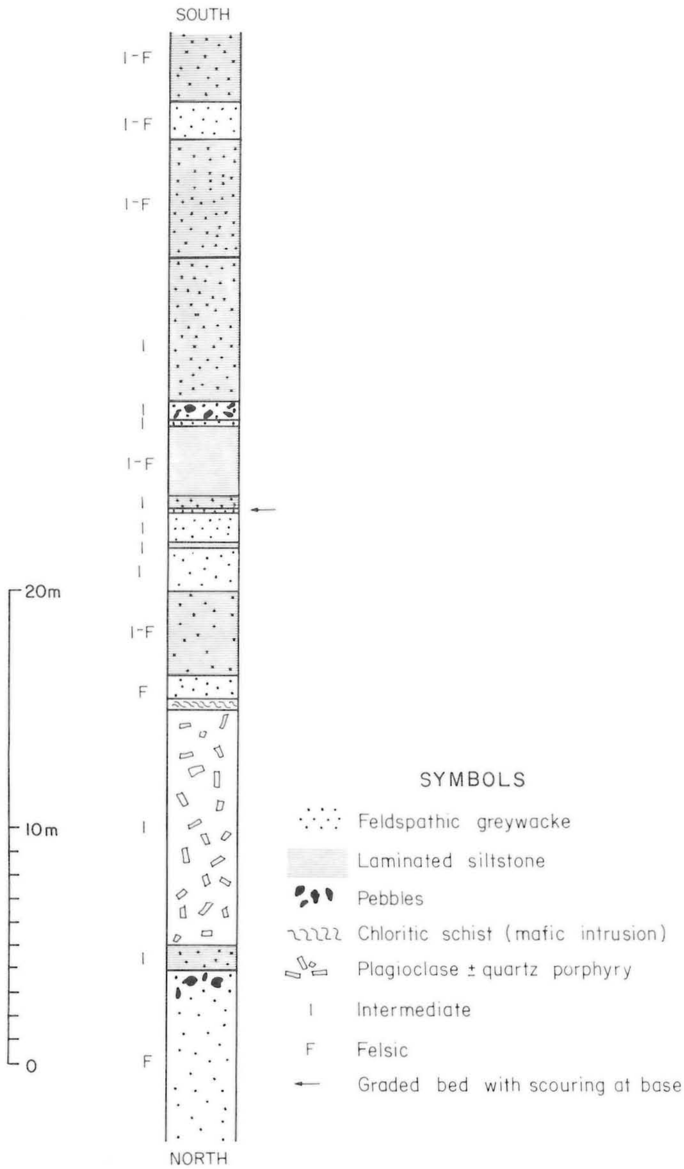


Figure GS-8-12: Stratigraphic section through fine grained sedimentary rocks 400 m north of the west end of Ruby Lake.

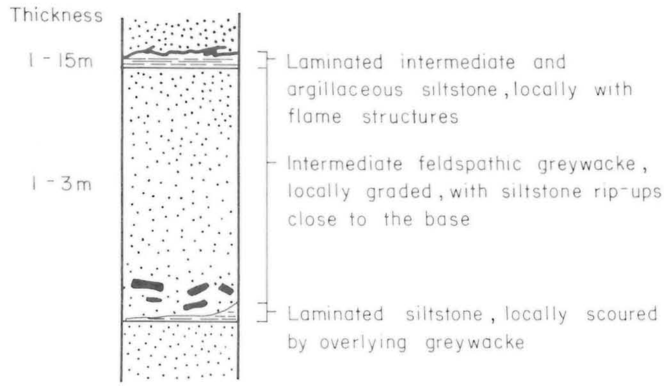


Figure GS-8-13: Rhythmic layering conforming to Bouma AE divisions in fine grained sedimentary rocks between Ruby Lake and Embury Lake.

and minor hypersthene occur in a small body (at least 350 x 100 m) extending along the north margin of the east end of the sill. The largely altered ultramafic rocks are assumed to be related to the gabbro sill, but their contact relationships are unknown.

Plagioclase ± quartz porphyries and related felsitic sills (6a) occur in a 300 m wide section in the axial zone of the syncline trending east-southeast through the north part of Ruby Lake. The felsic sills postdate the Tartan Lake sill and are typically 1-10 m (locally up to 50 m) thick; they locally contain diffuse, intermediate zones resulting from contamination by their host rocks, which occur as sporadic sheet-like enclaves within some intrusions. Two populations of plagioclase phenocrysts occur: 1-4 mm and 4-10 mm; subordinate quartz is up to 4 mm; pyrite is a common accessory. Similar porphyries occur adjacent to gold-bearing quartz veins at Tartan Lake Mine.

ECONOMIC GEOLOGY

The most prominent mineralization encountered this season occurs within or close to the margins of supracrustal enclaves within the Tartan Lake gabbro complex. Massive sulphide mineralization (Cu, Zn) and traces of gold occur in a 5 m wide zone in aphyric basalt 2.5 km east of Tartan Lake Mine (*a;* Table GS-8-2 and Fig. GS-8-1). This zone is exposed 150 m farther east, where a 30 m wide iron-stained section contains massive sulphides in silicified basalt and sericite schist with quartz veining (*b*). Sulphides and traces of gold also occur in the same supracrustal enclave 750 m northwest of the north end of Swordfish Lake, at the contact between basalt and argillaceous siltstone (*c*); the sulphides occur in a thin chert bed, intruded by quartz-plagioclase porphyry.

Numerous electromagnetic conductors along the south side of Bartley Lake and the area to the northwest are associated with massive sulphide and graphitic zones in mafic to felsic volcanic rocks and related sedimentary rocks and schists, comprising a supracrustal enclave between the Mikanagan Lake sill to the southwest and Tartan Lake gabbro complex to the northeast (Bartley claims, cancelled assessment data). Blasting 0.5 km northwest of Bartley Lake has exposed mineralization in a section containing three massive sulphide zones, each approximately 1 m wide (*d*); the section occurs at or close to the contact between basalt and overlying felsic to intermediate volcanic and sedimentary rocks.

Gold, silver and sulphide mineralization (Cu, Zn) occur in a quartz vein (over 0.5 m thick) in the contact zone between basalt and overlying intermediate greywacke and siltstone on the hinge line of the syncline close to the northwest shore of Ruby Lake (*e;* Fig. GS-8-1). This horizon, which contains a minor gabbro intrusion and related chloritic schist, is approximately on-strike with Tartan Lake Mine. The sedimentary section immediately overlying locality (*e*) is characterized by interlayered mafic and intermediate feldspathic greywacke with up to 50% felsic porphyries (0.5-5 m thick) and related intermediate porphyries contaminated by the host rocks; the porphyries contain 30-40% plagioclase (1-4 mm) but little or no quartz phenocrysts. Quartz-tourmaline veining is locally extensive in this section. Mineralization occurs on the same horizon 650 m farther west where a 0.5-1 m thick quartz vein contains abundant tourmaline and minor sulphides, but no gold (*f;* Table GS-8-3).

Sulphide mineralization and traces of gold and silver occur in a quartz vein 120 m below the top of the monoclinal mafic volcanic section between Ruby Lake and Embury Lake (*g*). The 0.5-1 m wide vein occurs between a felsitic unit and overlying micaceous schist derived from argillaceous siltstone to the north; mafic volcanic flows and breccia underlying the mineralized zone are strongly silicified. Above this zone, basaltic flows (locally pillowed) and mafic tuffs are commonly highly attenuated and altered to gneiss and schist. Approximately 3.5 km east-southeast

TABLE GS-8-1

MAJOR ZONES OF THE TARTAN LAKE GABBRO SILL

Thickness (m) of Section West	East	Zone	Lithologies	Notes
265	115	Upper	Quartz leucogabbro, mesocratic quartz gabbro and quartz diorite, commonly granophyric; gabbro and melagabbro	Igneous layering, sporadic grading; localized pegmatitic zones. Quartz-bearing, granophyric phases diminish westwards, where zone consists of gabbro, melagabbro and related hornblendite pervasively intruded by felsic porphyries
135	190	Middle	Gabbro, melagabbro, hornblendite; minor pegmatitic gabbro. Zone consists largely of leucogabbro at east end of sill	Rhythmic igneous layering and sporadic grading (compositional); rare scour and rip-ups
15-20	-	Transition	Melanocratic to leucocratic gabbros, medium grained to very coarse grained	Locally strongly sheared and gneissic. Only recognized in west part of mapped area of sill
105	140	Lower	Mesocratic gabbro, minor leucogabbro	Homogeneous, massive; igneous layering relatively uncommon

of (*g*) and roughly on-strike, a 2 m wide dacitic unit containing minor sulphides occurs at the contact between mafic volcanic breccia and overlying massive aphyric basalt (*h*). The dacitic unit is gradational upwards with silicified basalt, and may represent a zone of intense silicification of mafic volcanic rocks.

A mineralized quartz vein with arsenopyrite and traces of gold and base metals occurs at the contact between mafic volcanic flows and fragmental rocks and overlying greywacke, siltstone, and minor argillaceous siltstone 1.6 km west of Tartan Lake (*i*). This locality is 100 m east of the Glendale (gold) property, first staked in 1931. The occurrence of a magnetic anomaly on the volcanic/sedimentary contact 800 m west of the arsenopyrite showing and recent drilling in the vicinity are favourable indicators for mineralization. The intersection of this contact with the north-northeast-trending fault just east of locality (*i*) warrants investigation.

TABLE GS-8-2

GEOCHEMICAL ASSAYS OF ROCKS FROM SELECTED MINERALIZED ZONES

Sample	Au (oz/ton)	Ag (oz/ton)	Cu (ppm)	Ni (ppm)	Zn (ppm)	Pb (ppm)	Mo (ppm)
a	trace	0	187	91	884		
b	trace	0	223	22	48	12	29
c	trace	0	642	16	61		21
d	trace	0	342	204	80		15
e	0.23	0.15	817	12	37		
f	0	0	55	11	12		
g	trace	trace	804	22	94	32	
h	0	0	80	16	84		
i	trace	0	37	14	13		

Figure GS-8-14: Igneous layering in the Tartan Lake gabbro sill.

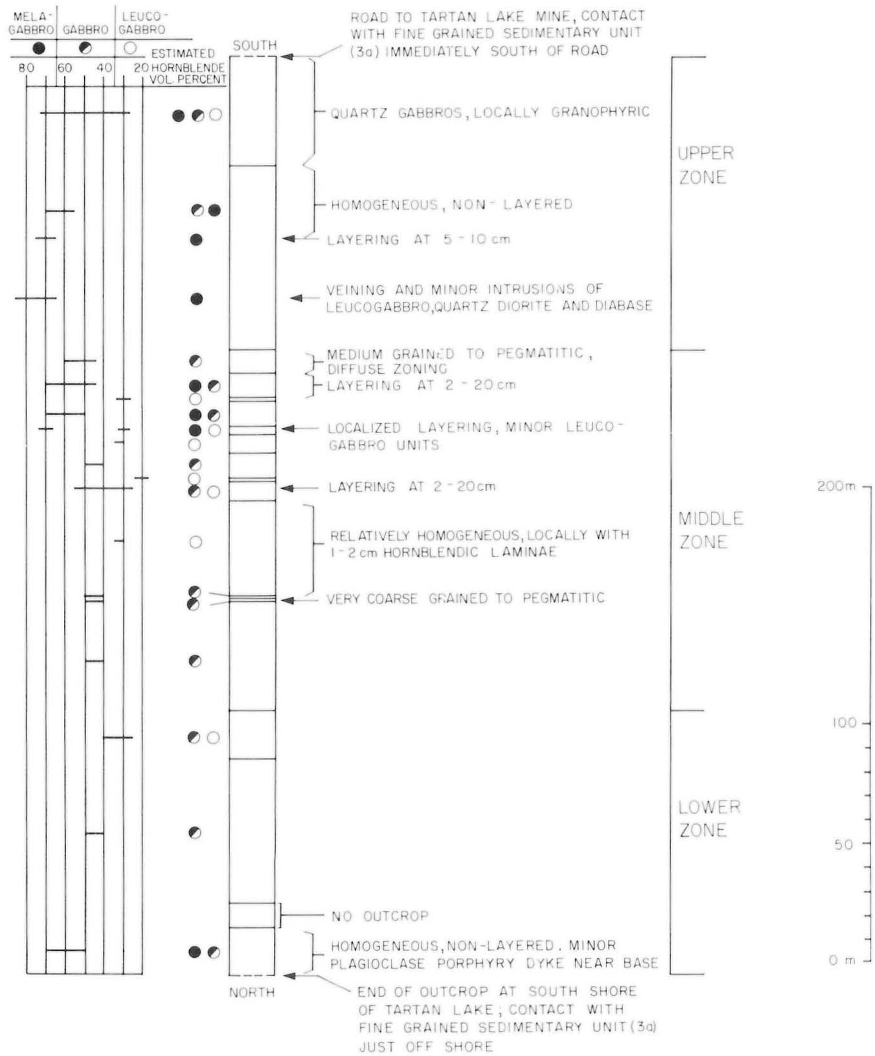


Figure GS-8-15: Stratigraphic section through the Tartan Lake gabbro sill 0.5 km east of the west end of Tartan Lake, showing compositional layering and variation of hornblende content (visual estimates at outcrops).

REFERENCES

Bailes, A.H. and Syme, E.C.
in prep: Geology of the Flin Flon-White Lake area; Manitoba Energy and Mines, Geological Report GR87-1

1987: Geology of the Flin Flon-White Lake area; Manitoba Energy and Mines, Map GR87-1-1

1980: White Lake-Mikanagan Lake Project; **in** Manitoba Mineral Resources, Report of Field Activities 1980, p. 43-50

1979: White Lake-Mikanagan Lake Project; **in** Manitoba Mineral Resources, Report of Field Activities 1979, p. 46-54

Bateman, J.D. and Harrison, J.M.
1945: Mikanagan Lake, Manitoba; Geological Survey of Canada, Map 832A

Gilbert, H.P.
1986: Geological investigations in the Tartan Lake-Lac Aimée area; **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 43-48

Peloquin, S. and Gale, G.H.
1985: Geology of the Tartan Lake area; **in** Manitoba Energy and Mines, Report of Field Activities 1985, p. 71-73.

Peloquin, S., Tannahill, B. and Gale, G.H.
1986: Geology of the Tartan Lake gold deposit; **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 56-64

Syme, E.C.
1986: Schist Lake area (Athapapuskow Project); **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 36-42.

Tanton, T.L.
1941: Flin Flon, Saskatchewan and Manitoba; Geological Survey of Canada, Map 632A

TABLE GS-8-3

STRATIGRAPHIC SECTION THROUGH THE MINERALIZED ZONE (*f*) ON THE SYNCLINAL HINGE LINE WEST OF RUBY LAKE

Thickness (m)	Lithologies
>2	Intermediate greywacke and felsic porphyry intrusions
14	Plagioclase porphyry (phenocrysts 1-10 mm, 30-40%) with concordant tourmaline veins (up to 4 cm)
5	Melagabbro and related chloritic schist with black tourmaline veins (up to 1 cm)
0.5 — 1	Quartz vein with abundant tourmaline and minor sulphides within intermedate greywacke, siltstone, and plagioclase porphyry
5	Plagioclase porphyry (equivalent to thicker porphyry above)
>5	Intermediate greywacke, siltstone, and minor cherty siltstone layer (15 cm) with subordinate plagioclase porphyries
>30 <50	Inferred fine grained sedimentary rocks and felsic porphyries
	Amygdaloidal basalt and pillowed basalt, with felsic porphyries (at north margin of thick monoclinal mafic volcanic section)

GS-9 KISSEYNEW PROJECT: KISSISSING LAKE

by D.C.P. Schledewitz

INTRODUCTION

In 1987 the Kississing Lake portion of the Kisseynew project concentrated on the southeast corner of Kississing Lake. Mapping along the eastern edge of Kississing Lake was extended to join with the western limit of mapping by Froese and Goetz (1981). The lithologies (Table GS-9-1) have been described previously (Schledewitz 1985, 1986). A departure, in this report, from these earlier preliminary reports is to adopt the use of the term Burntwood gneisses (Burntwood River metamorphic suite) for the garnet-biotite-feldspar-quartz paragneiss to metatexite, derived from greywacke. These rocks were previously termed Nokomis gneisses. The quartzofeldspathic gneisses previously tentatively equated with the Sherridon Group are now termed Missi gneisses, (Missi Metamorphic Suite). Present mapping suggests the Sherridon Group should be restricted to the area where that group was recently mapped by Froese and Goetz (1981).

Mapping at a scale of 1:20 000 was continued to:

1. outline the variations in the Burntwood gneisses and the Missi gneisses;
2. delineate structures, their geometry and relationships;
3. delineate mineralogical trends which may be associated with specific rock types and/or geological structures.

GENERAL GEOLOGY

Contacts between the Burntwood gneisses and the Missi gneisses can be grouped into the following categories:

Type 1. In this type garnetiferous amphibolite and/or calc-silicate lies between the Burntwood and Missi gneisses. Where well exposed the garnetiferous amphibolite grades into the calc-silicate rock which is in contact with the quartzofeldspathic rocks of the Missi gneisses.

Type 2. A second variation is characterized by quartz enrichment and a decrease in the biotite content in the Burntwood gneisses. This rock type may be in contact with a varied suite of quartzofeldspathic (Missi) gneisses with variable hornblende and quartz content. This type of contact is best developed in Collins Point and Home Bay. At this locality the more siliceous variety of Burntwood gneiss is structurally underlain by a variably hornblende-bearing garnet-biotite-feldspar-quartz gneiss. Sulphide mineralization is very prevalent in this area.

Type 3. Low angle faults form very narrow to sharp contact zones between the Burntwood and Missi gneisses. These zones can be highly injected with granitic *lits* and variably silicified. An

TABLE GS-9-1

TABLE OF FORMATIONS

INTRUSIVE ROCKS	15	Pink granite pegmatite
	14	Pink and white granite + biotite + muscovite
	13	Medium grained to pegmatitic white granite
	12	Medium- to coarse-grained grey biotite granite
	11	Magnetiferous hornblende-biotite granodiorite
	10	Hornblende-biotite granodiorite
	9	Magnetite-biotite monzogranite
	8	Metadiorite ± garnet
	8a	Massive coarse grained amphibolite ± garnet
UNCERTAIN AFFINITY	7	Mesocratic ± magnetite-hornblende-biotite gneiss
POSSIBLE MISSI METAMORPHIC SUITE	6	Magnetite-biotite-hornblende-feldspar-quartz gneiss
	5	Magnetite-biotite(20%)-feldspar-quartz gneiss
	4	Siliceous leucocratic ± magnetite ± hornblende-biotite(8%)- feldspar-quartz gneiss with epidote-rich lenses
	3	Siliceous leucocratic biotite(8%) ± hornblende-feldspar quartz gneiss
	2	Amphibolite massive, medium grained with white granitic *lits*
	2a	Garnetiferous amphibolite and interlayered garnet-hornblende-biotite-plagioclase-quartz gneiss
	2b	Coarse grained amphibolite
	2c	Calc-silicate and interlayered carbonate ± garnet
BURNTWOOD METAMORHPIC SUITE	1	± garnet-graphite-biotite paragneiss
	1a	± garnet-graphite-biotite metatexite
	1b	± garnet-biotite metatexite and diatexite with plagioclase megacrysts

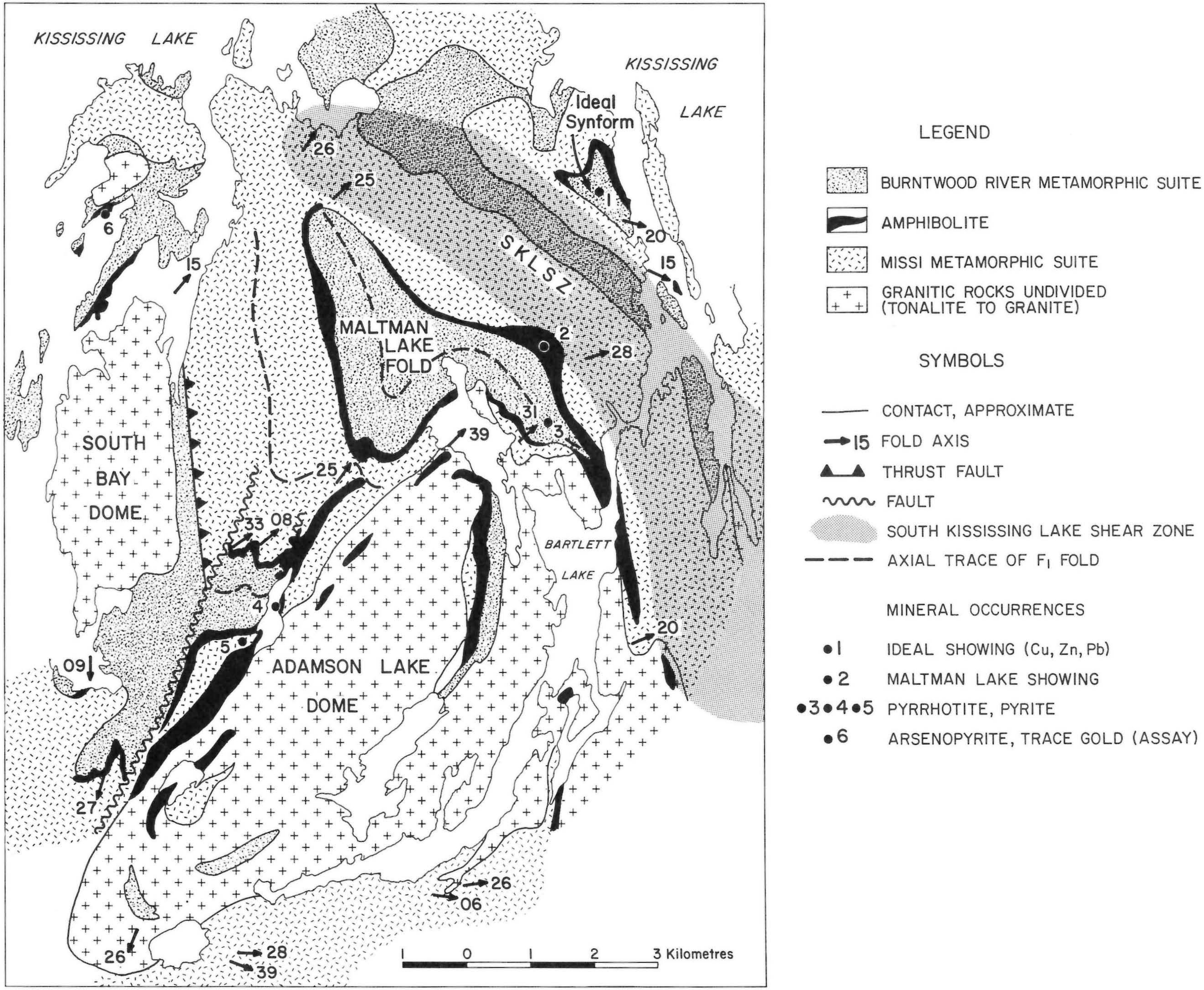
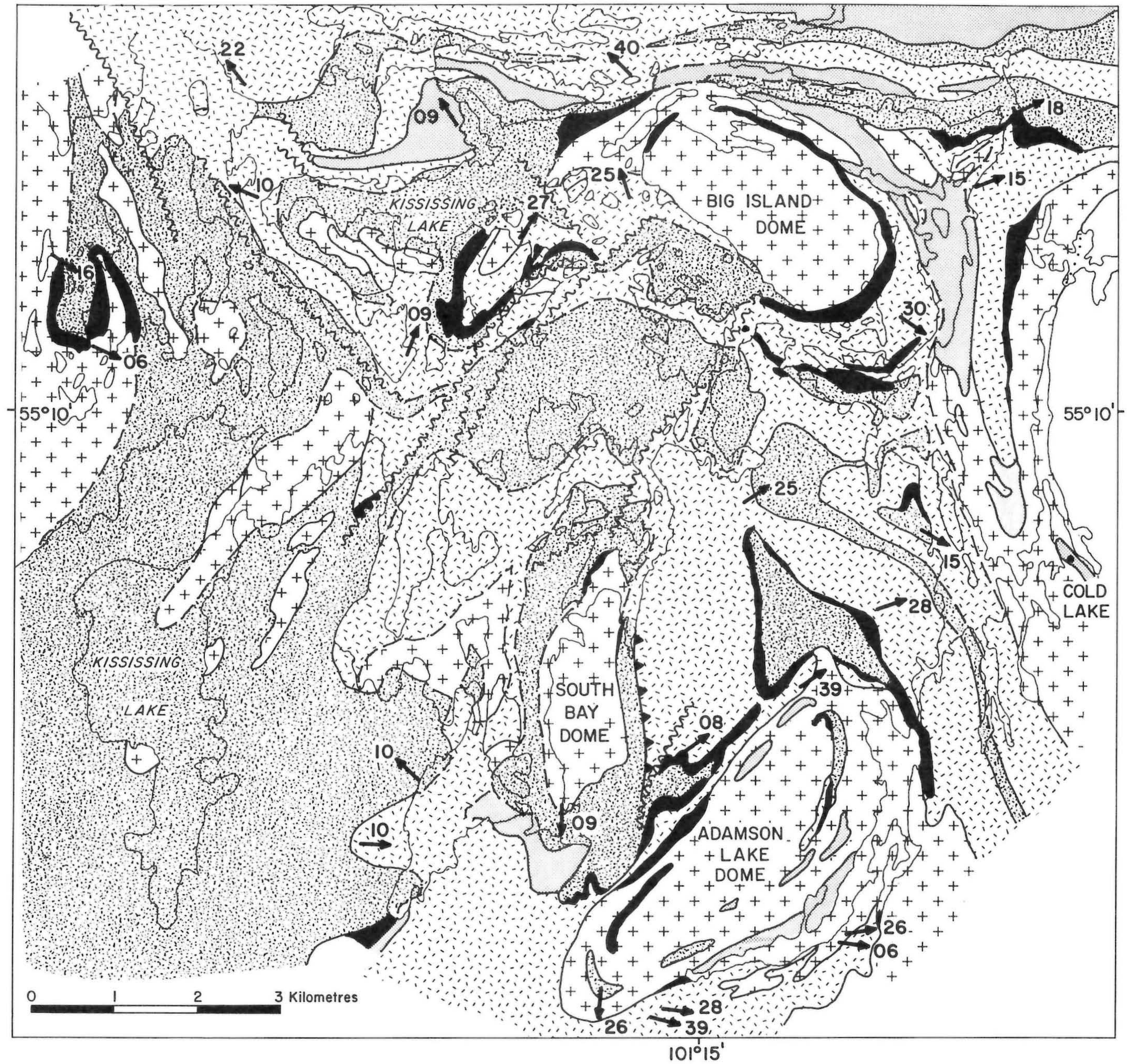


Figure GS-9-1: Simplified geology of the southeast portion of the Kississing Lake map area.



LEGEND

- BURNTWOOD RIVER METAMORPHIC SUITE
- AMPHIBOLITE
- MISSI METAMORPHIC SUITE UNDIVIDED
- MESOCRATIC GNEISSES (POSSIBLE METADIORITES TO QUARTZ DIORITES)
- GRANITIC ROCKS UNDIVIDED (TONALITE TO GRANITE)

SYMBOLS

- 16 FOLD AXIS
- FAULTS, ASSUMED, UNDERWATER
- THRUST FAULT
- CONTACTS, APPROXIMATE, UNDERWATER

Figure GS-9-2: Simplified geology of the Kississing Lake map area.

example of this type of contact occurs along the east flank of the South Bay dome with a northerly trend and a strike length of several kilometres (Fig. GS-9-1).

Type 4. A granitized contact zone due to extension or shearing. An example of this type occurs on the southwest flank of the Maltman Lake fold (Fig. GS-9-1). During the refolding of the already highly flattened structure the amphibolite was attenuated. Abundant garnet-magnetite leucocratic granodiorite occurs along with fine- to coarse-grained leucocratic granite in this zone of extension.

STRUCTURAL GEOLOGY

The following sequence of events is postulated based on the combined results of mapping from 1985 to 1987.

D_1 — an early period of recumbent folding (F_1).

D_2 — intrusion of gabbro, metadiorite, tonalite and granodiorite accompanied by synkinematic folding and development of major shear zones.

M_1 — upper amphibolite grade of metamorphism

D_3 — intrusion of leucocratic granites, development of conjugate fault zones and related folding accompanied by varying degrees of retrograde metamorphism.

DEFORMATION D_1

Recumbent folding is proposed on the basis of repetition and inversion of the shallow dipping Burntwood and Missi gneisses. Remnants of refolded early fold hinges (F_1) are preserved along the west to northeast flank of the Adamson Lake dome, the southeast end of the Big Island dome and at the south end of the South Bay dome (Fig. GS-9-1). The array of orientations for the azimuths of minor and small-scale folds (Fig. GS-9-2) also indicates post-recumbent fold deformation on a regional scale.

DEFORMATION D_2

This period of deformation and folding either postdated or was synkinematic with the formation of the Adamson Lake, South Bay and Big Island domes. The F_2 structures on the west to northeast side of the Adamson Lake dome have a shallow plunge to the northeast and are folded about shallow dipping northerly striking axial surfaces. The folds are predominantly overturned to the northwest. The Maltman Lake fold (F_1) (Fig. GS-9-1) on the northeast side of the Adamson Lake dome is an overturned sheath-like fold with axes that have a shallow plunge to the northeast. This F_1 structure has also been refolded about shallow dipping northerly trending axial planes.

The Ideal synform lies immediately northeast of the Adamson Lake dome (Fig. GS-9-1). This overturned synform plunges to the south of east 112°/14° and southeast and has also been refolded about northerly trending shallow dipping axial surfaces.

These two zones of folding with widely divergent plunges but similarly trending axial planes lie on the opposite side of a broad zone of shearing (south Kississing Lake Shear Zone) that dips with shallow to intermediate values to the northeast and has a dextral sense of movement. The divergent fold attitudes on opposite sides of the shear may be a result of rotation of an earlier fold axis (F_1) or the formation of a drag fold on the hanging wall of the northeast-dipping shear.

DEFORMATION D_3

The presence of retrograde metamorphism is the main criteria for the identification of D_3 structures. The D_3 structures are generally coplanar to D_2 shear zones and fold belts. However, the D_3 shears and faults and axial planes may also have steep dips. Fine grained to pegmatitic siliceous granites accompany this phase of deformation. This system of D_3 structures may relate to a conjugate set of shear zones, one at 330°-340° at intermediate to steep dips exhibiting an apparent dextral movement and the second at 045°-055° at intermediate to steep dips exhibiting an apparent left lateral sense of movement.

ECONOMIC GEOLOGY

Sulphide occurrences in the southeast quarter of the Kississing Lake area at the Ideal showing and the Maltman Lake showing (Fig. GS-9-1) have been examined in detail by Gale (1980).

At the Ideal showing, Gale postulates that the zone of sulphide mineralization (Sp-Ga-Cp-Py-Po) is "underlain by an anthophyllite-rich rock (alteration zone)". Examination of the structural geology at the Ideal showing and the surrounding area indicates the showing lies in the core of a tightly folded and overturned synform with a shallow southeast plunge (112°/14°). The potential for down-plunge mobilization of sulphides is possible in a structure of this type. Smaller occurrences of chalcopyrite and pyrite occur within a garnet-hornblende-biotite-feldspar-quartz gneiss that structurally underlies a pyrrhotite-bearing amphibolite and overlies garnet-biotite-feldspar-quartz gneiss. This occurrence lies on a small island in Kississing Lake 1.3 km southeast of the Ideal showing.

The Maltman Lake sulphide occurrence lies on the east limb of the Maltman Lake fold within the garnetiferous amphibolite. The Maltman Lake fold is cored by garnet-biotite-feldspar-quartz (Burntwood) gneiss. The amphibolite lies between the Burntwood gneiss and quartzofeldspathic (Missi) gneisses all around the structure with the exception of a segment along the southwest flank of the structure. The amphibolite has been attenuated in this area. The sulphide minerals in the amphibolite at the Maltman showing are "disseminated and near solid sulphide (Po ± Py)" (Gale, 1980). Similar types of mineral occurrences lie within the amphibolite all around the structure but the best occurrence is at Maltman Lake.

A system of trenches lies 1 km to the south of the Maltman Lake occurrence (Fig. GS-9-1). The host rock in this instance is the Burntwood gneiss. The sulphide mineralization (Py — Po) is in a plagioclase-quartz layer? or sill? underlying a rusty coarse grained hornblende gneiss to amphibolite.

Sulphide mineralization also occurs in a zone of amphibolites and granitoid rocks on the northwest flank of the Adamson Lake dome. An F_1 fold with a stratigraphy similar to that of the Maltman Lake fold has been refolded about northerly striking shallow dipping axial surfaces with shallow plunges to the northeast. The complex character of the refolded F_1 folds and the resultant infolding of granitic rocks greatly increase the possibility of having remobilized sulphides along the plunge orientations of the F_2 fold axis trend.

REFERENCES

Froese, E. and Goetz, P.A.
1981: Geology of the Sherridon Group in the vicinity of Sherridon, Manitoba; Geological Survey of Canada, Paper 80-21.

Gale, G.H.
1980: Mineral deposit studies — Flin Flon/Kisseynew; **in** Manitoba Mineral Resources Division, Report of Field Activities 1980, p. 51-64.

Schledewitz, D.C.P.
1985: Kisseynew Project: Kississing Lake, Big Island-Yakushavich Island region; **in** Manitoba Energy and Mines, Report of Field Activities 1985, p. 54-56.

1986: Kisseynew Project: Kississing Lake; **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 92-95.

GS-10 KISSEYNEW PROJECT: LIMESTONE POINT LAKE-STAR LAKE AREAS

by H.V. Zwanzig and P.G. Lenton

INTRODUCTION

A 625 km^2 area around Limestone Point Lake, between Batty Lake and File River, was mapped on a 1:15 840 scale and reduced to 1:50 000 scale for publication (Preliminary Map 1987K-3, Zwanzig et al., 1987). About 45 km^2 mapped at Star Lake was reduced to 1:20 000 scale (Preliminary Map 1987K-4, Zwanzig and Miller, 1987). Work was restricted to accessible areas and contacts were extrapolated using gradiometer and total field magnetic maps (Geological Survey of Canada, 1987). Shallow-dipping units and hematized zones near faults reduced the usefulness of the gradiometer maps. Exposure is good on the shores of the largest lakes, in the vicinity of Moody Lake and east of Limestone Point Lake. Extensive areas of overburden occur along Limestone Creek.

The aims of the mapping were to identify the types of high-grade gneisses in this part of the Kisseynew metamorphic domain, where possible to assign them to existing stratigraphic divisions, and to interpret their origin in order to provide data for mineral exploration.

SUMMARY

Large areas in the vicinity of Batty Lake, Limestone Point Lake and Star Lake (Fig. GS-10-1) were identified as orthogneiss and interpreted to be derived by dynamothermal metamorphism of intrusive rocks. Much of these areas had been mapped previously (Robertson, 1953; Kornik, 1968; Froese and Goetz, 1981) as paragneiss of the Sherridon Group and Nokomis Group. The newly designated orthogneiss comprises uniform, zoned and composite bodies ranging in composition from ultramafic to granitic. Various subunits of orthogneiss are interpreted as different intrusive phases. Banding in these rocks consists of secondary gneissosity, transposed inclusion-layering and granitoid veining produced during metamorphism and mobilization. Garnet is a common secondary constituent. Veins and dykes of younger pegmatitic granite and pegmatite occur in migmatitic orthogneiss.

Supracrustal rocks are commonly finer grained than the orthogneiss. They include: (1) amphibolite (volcanic and metasedimentary rocks), (2) biotite-garnet gneiss with accessory graphite (metagreywacke-mudstone), (3) layered amphibolite (largely metasedimentary), (4) biotite gneiss ± amphibole with accessory magnetite (metasandstone and conglomerate-gneiss) and felsic (volcanic) gneiss. The supracrustal rocks are locally interlayered with orthogneiss and cannot be easily distinguished from finer grained, highly foliated and protomylonitic orthogneiss.

Distinctive porphyroblastic zones containing garnet, cordierite, ortho- and clino-amphibole and locally sillimanite occur within and at the margins of the orthogneiss complexes. The porphyroblastic rocks are interpreted as recrystallized, altered rocks and are associated with fault zones and tectonic slivers of supracrustal rocks. Some of these zones are mineralized.

An outlier of folded dolomite on Limestone Point Lake is interpreted as Ordovician.

STRATIGRAPHIC NOMENCLATURE

In this report the stratigraphic names used for the three main supracrustal components of the gneisses on the southern margin of the Kisseynew domain are: (1) "Amisk Group" for the metavolcanic succession that extends south into the Flin Flon belt; (2) "Burntwood River Metamorphic Suite" (Gilbert et al. 1980; Lenton, 1981) for the greywacke-derived gneiss and migmatite that extend north across the entire Kisseynew domain; and (3) "Missi Metamorphic Suite" for the gneisses that are apparently equivalent to the lower-grade Missi Group (Bailes, 1980). The units are considered to be metamorphic suites rather than groups because a stratigraphic top and bottom generally cannot be recognized (North American Commission on Stratigraphic Nomenclature, 1983).

The term "Amisk Group" has been retained only for fine grained amphibolite interpretated to be derived from massive and pillowed basalt and for closely associated layered gneiss. The Burntwood River Suite is a quartz-feldspar-biotite gneiss or migmatite, generally with garnet and graphite. Similar rocks and low grade metagreywacke-mudstone have been mapped as part of the Amisk Group (Bailes, 1980; Ashton and Wheatley, 1986) but this correlation is not adopted here because the stratigraphic relationship between the sedimentary and volcanic rocks is not well understood. The Missi Suite comprises magnetite-bearing quartz-feldspar-biotite gneiss ± hornblende (derived from sandstone), and amphibolite and pink felsic gneiss apparently derived from sedimentary and volcanic rocks. Similar rocks and slightly lower grade metamorphic equivalents have been included in the Missi Group elsewhere (Bailes, 1980; Ashton and Wheatley, 1986; Gordon, 1987) The term "Sherridon" is retained for paragneiss or orthogneiss in the type area (Sherridon-Star Lake area).

GENERAL GEOLOGY

A transition from a belt of predominantly greenstones (amphibolite interpreted as metabasalt) intruded by foliated plutons to a belt of predominantly orthogneiss (highly metamorphosed intrusive rocks) and belts of metasedimentary rocks takes place across Moody Lake (Fig. GS-10-1). The paragneiss in the main part of the Kisseynew domain (northeast of Limestone Point Lake) becomes progressively more migmatitic towards the northeast and is intruded by granitic rocks younger than the orthogneiss. No major mylonitic zones separate the different belts but numerous faults are inferred to occur throughout the structural section. Semi-continuous layers of porphyroblastic schist are closely associated with the fault zones. The belts probably represent large recumbent folds and thrust slices that were transported south onto the margin of the greenstone-granite domain and refolded into a dome-and-basin or sheath-fold pattern. The Moody Lake area is dominated by a domal structure that is overturned towards the southwest. Its core contains strongly foliated gneiss and amphibolite (Amisk Group?), and strongly foliated intrusive rocks ranging in composition from ultramafic to granitic (orthogneiss). Along the southwest flank of the dome the core gneisses are in apparent fault contact with a unit of conglomerate and associated banded gneiss that forms the base of the Missi Suite. The conglomerate-gneiss was traced for 3 km along the south shore of Moody Lake. It lies north of Amisk Group amphibolite. The contact is not exposed but probably represents an unconformity: the conglomerate contains abundant amphibolite clasts.

The Amisk Group amphibolite forms a mantle around the dome and is overlain by Missi Suite gneisses comprising metasandstones and amphibolite (basalt or andesite?). At Dow Lake uniform grey biotite gneiss with accessory magnetite and garnet lies at the same structural level as the amphibolite and may be part of the Amisk Group or an unusual composition in the Missi Suite. North of Evans Lake the same structural level is occupied by Burntwood River and Missi gneisses. These rocks are separated from the Moody Lake dome by a late, northerly trending fault.

The structures at Evans, Moody and Dow Lakes are overlain to the north by a belt of Burntwood River greywacke-derived gneiss which is generally less than 100 m in true thickness but can be traced for 50 km from Dow Lake to Star Lake in a large S-shaped fold pair. The belt of metagreywacke is overlain by layered amphibolite, locally with calcite and other accessory calc-silicate minerals ± pyrite. The amphibolite contains units of felsic gneiss, biotite-garnet gneiss and discontinuous garnet-anthophyllite schist. West of Moody Lake the thin, continuous belt of Burntwood River metagreywacke is overlain by Missi metasedimentary and metavolcanic (?) rocks.

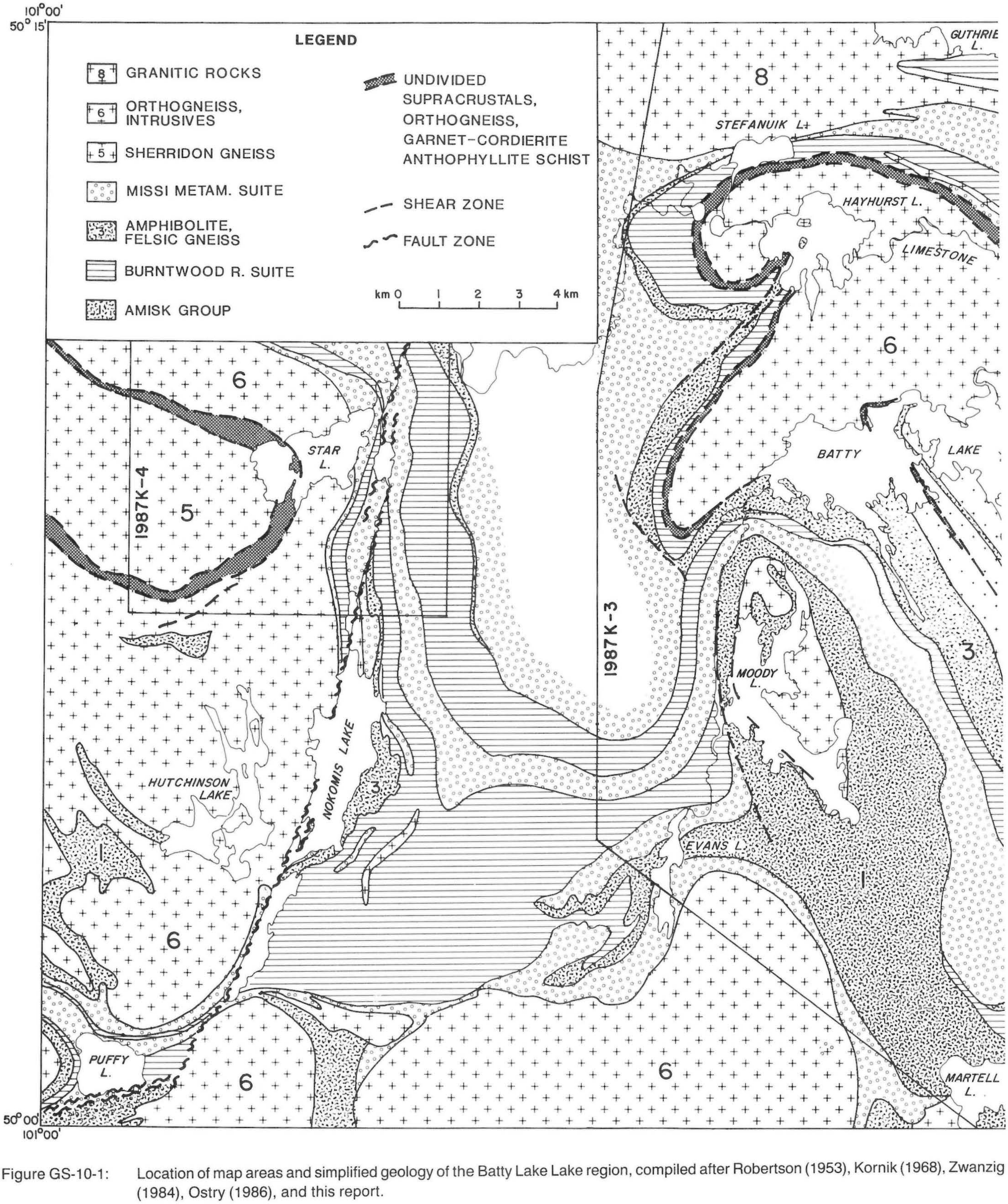
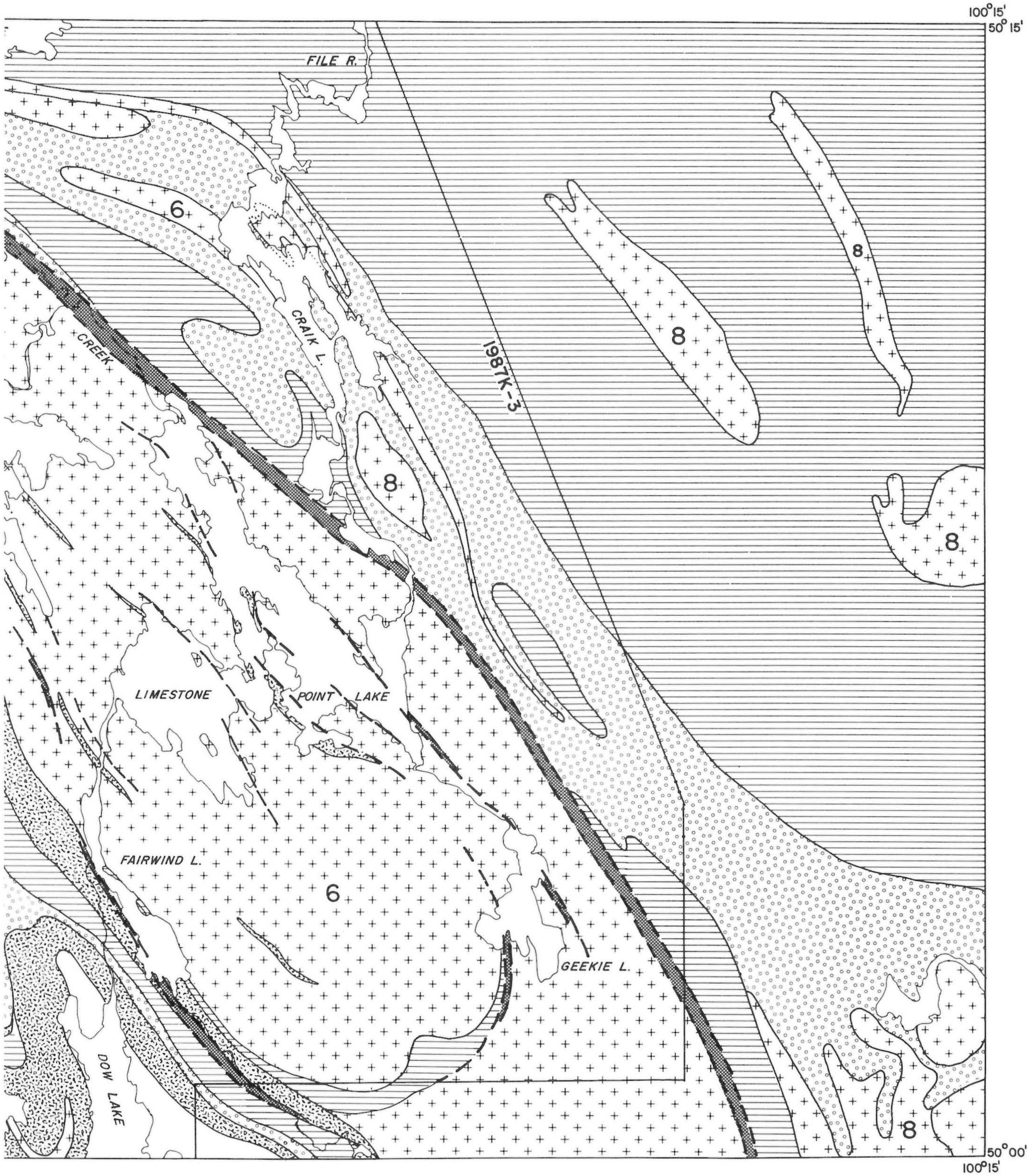


Figure GS-10-1: Location of map areas and simplified geology of the Batty Lake Lake region, compiled after Robertson (1953), Kornik (1968), Zwanzig (1984), Ostry (1986), and this report.



100°15'
50°15'
FILE R.
6
CRAIK L.
CREEK
1987K-3
8
8
8
8
LIMESTONE
POINT LAKE
FAIRWIND L.
6
GEEKIE L.
DOW LAKE
8
50°00'
100°15'

Overlying these supracrustal belts on the northeast side is the largest mass of orthogneiss in the region (Batty Lake complex). It has a maximum width of 9 km (4.5 km true thickness) on the south shore of Limestone Point Lake. The complex extends northwest to Batty Lake where it is tightly folded. It comprises tonalitic gneiss with local granodioritic margins and encloses a large (25 km^2) elongate body of quartz-rich tonalite-granodiorite gneiss; granite gneiss forms a smaller but distinctive body within the complex.

The gneissic complexes at Star Lake structurally underlie the supracrustal belts. Gneissic tonalite and granodiorite form a 1.6 km wide (0.7 km true thickness) northern extension of the Hutchinson Lake dome that crosses Star lake. Very quartz-rich tonalitic gneiss occurs in the core complex of the "Sherridon" structure west of Star Lake. Both complexes grade outward into finer grained garnetiferous gneiss of unknown origin. Their contact zone contains a distinctive layer of garnet-cordierite-anthophyllite rock (Robertson, 1953; Froese and Goetz, 1981; and Gunter and Yamada, 1986) and discontinuous slivers of carbonate amphibolite, magnetiferous biotite ± amphibole gneiss (Missi Suite) and metagreywacke (Burntwood River Suite). The lack of stratigraphic continuity within this layer suggests that it represents a fault zone and that the porphyroblastic schist is recrystallized altered rock.

The area east of Star Lake contains alternating belts of Burntwood River Suite and Missi Suite rocks. A narrow belt of amphibolite between these units extends north of Nokomis Lake and contains a stratigraphic sequence that includes the unit that is gold-bearing at Nokomis Lake. Minor gossan staining occurs in the single outcrop area examined southeast of Star Lake. The repetition in the section east of Star Lake results from folding and faulting. Late faults predominate in a wide zone of retrogression where the rocks are chlorite-epidote-hematite-bearing and silicified. The fault zone is the northern extension of the fault that lies along the west shore of Nokomis Lake (Zwanzig, 1984).

The area east of Limestone Point Lake and north of Hayhurst Lake is underlain by discontinuous belts of alternating metagreywacke-gneiss (Burntwood River Suite) and relatively biotite-rich ± hornblende gneiss (Missi Suite). Narrow zones of orthogneiss and supracrustal belts truncated along schistose zones (that are locally anthophyllite-garnet-cordierite bearing) occur between the Batty Lake orthogneiss and the paragneisses to the northeast. Granitic rocks which are younger and less deformed than the orthogneiss make up a major part of the section north of Stefanuik Lake. Farther northeast is a large area of Burntwood River migmatite. The volume of *lits* rapidly increases at the margin of this area.

STRATIGRAPHY

Amisk Group (1)

AMPHIBOLITE

Uniform fine grained amphibolite interpreted as metabasalt weathers dark green and has weak (secondary) layering or thin plagioclase-rich veining. Minor units with plagioclase grains up to 2 mm long or hornblende crystals up to 3 mm long may represent porphyritic flows. Local, black, garnetiferous selvages, 1 cm thick and several centimetres apart, constitute up to 30% of the rock. They appear to be relicts of pillow rinds (Fig. GS-10-2). Elsewhere, grey-green bands, 0.3-1 cm thick and about 4 cm apart, or larger (50 cm x 5 cm) calc-silicate lenses may have been derived from epidosite alteration-domains in basalt. Layers (20 cm thick) of medium grained amphibolite may have formed from diabase sills. Locally the fine grained amphibolite is cut by gabbro (coarse grained amphibolite), metadiorite or tonalite sills.

LAYERED INTERMEDIATE GNEISS

The core of the dome at Moody Lake contains interlayered felsic to intermediate gneiss, calc-silicate rock and amphibolite. Felsic layers contain biotite ± garnet ± clino- and ortho-amphibole and magnetite, and have been assigned to the Amisk Group because of their association with amphibolite.

Burntwood River (Nokomis) Metagreywacke-migmatite (2)

The Burntwood River Metamorphic Suite ranges from fine grained biotite-garnet ± graphite gneiss at Moody Lake to highly mobilized migmatite east of Craik Lake. It contains layering defined by biotite content and garnet size and content. Layers are 1-30 cm thick and were apparently derived from bedding in greywacke-mudstone protolith. The fine grained (0.1 mm) gneiss is dark grey on the fresh surface and weathers medium grey to brown or reddish. It generally cleaves into small slabs coated with brown biotite. In thin section biotite looks red-brown; it constitutes 15-40% of the rock. Garnet forms small (1.5 mm) subhedral grains and is absent only in light grey quartzofeldspathic gneiss near the contacts of the metagreywacke unit. Graphitic schist ± sulphides occurs elsewhere near the contact. Other local features are calc-silicate lenses, grey-green amphibole-bearing layers, quartz-plagioclase veins and 5 mm long faserkiesel (fibrolitic sillimanite-quartz knots).

Figure GS-10-2: Fine grained amphibolite (Amisk Group basalt) with black selvages derived from pillow rinds, south of Moody Lake.

Along File River northeast of Craik Lake the Burntwood River metagreywacke contains *lits* of pegmatitic granitoid mobilizate. At the margin of the migmatite belt, veins constitute 10-15% of the rock; 3 km to the northeast a diatexitic structure with 75% mobilizate and lenses of restite is common. The best preserved rocks contain graded bedding defined by reverse metamorphic grading of garnet. The most mobilized rocks form schlieren complexes containing porphyroblasts of cordierite, sillimanite and garnet.

Rocks of Uncertain Age (3)

A structurally complex belt of amphibolite, felsic gneiss and biotite-garnet gneiss that extends from Batty Lake southeast to Dow Lake does not have a clear stratigraphic relationship to other supracrustal rocks in the area. The belt lies in the footwall below the Batty Lake orthogneiss complex; the units within it are laterally discontinuous and suggest extensive structural disruption.

LAYERED AMPHIBOLITE

A unit of predominantly layered amphibolite and calc-silicate gneiss extends from Batty Lake 10 km southeast to Fairwind Lake and the (upper) File River. The unit is interlayered with massive amphibolite, felsic gneiss and biotite-garnet ± hornblende gneiss. Much of the succession appears to be metasedimentary rock and is locally interlayered with metagreywacke gneiss. It structurally overlies and locally underlies a sliver of Burntwood River metagreywacke; if the layered amphibolite forms a syncline it represents the top of the Burntwood River Suite and may correlate with the gold-bearing succession at Nokomis Lake (Zwanzig, 1984). At Star Lake layered amphibolite is interpreted to be a large structural slice in a fault zone. A thin unit of layered amphibolite locally overlies the Batty Lake orthogneiss north of Batty Lake and on Craik Lake.

Amphibolite layers are 2-3 cm thick and weather pale grey-green to black on a ribbed surface. They consist of alternating plagioclase-diopside-rich layers and hornblende-rich layers. The rock is locally streaked with ochre carbonate segregations. Pink and green weathering calc-silicate rocks contain abundant epidote. Locally abundant scapolite, sphene and magnetite or clino- and ortho-amphibole are visible in thin section. The unit may contain pyrrhotite, pyrite and rare chalcopyrite.

MASSIVE AMPHIBOLITE

Layered amphibolite grades into medium grained massive amphibolite and rocks that are spotted grey-green and black with diopside- and hornblende-rich domains. The coarser varieties may represent metagabbro. Fine grained hornblende-rich amphibolite may represent metavolcanic rocks.

GARNETIFEROUS AMPHIBOLITE

Garnet-bearing amphibolite occurs only locally. A thin unit of black and rusty weathering garnet-magnetite amphibolite (iron formation) near Star Lake separates the Burntwood River metagreywacke from a calcareous plagioclase-rich gneiss resembling the gold-bearing unit at Nokomis Lake.

PLAGIOCLASE GNEISSES

The main unit of layered amphibolite on Batty Lake and to the southeast grades also into grey to cream weathering plagioclase-rich rocks containing biotite-hornblende ± garnet or minor diopside-amphibole-calcite. Similar rocks occur on the margin of the orthogneiss complexes north of Batty Lake and on Star Lake. They generally form units within the belt of layered amphibolite or at its margins.

FELSIC GNEISS

Centrally within the belt of layered amphibolite are one or several units of light grey weathering gneiss of quartz-rich or of plagioclase- and quartz-rich composition. White mica is commonly present and garnet occurs locally. The rocks are fine to very fine grained and contain layers with a significant biotite content. They appear to represent metasedimentary rocks. Part of the gneiss at Fairwind Lake contains lenticular quartz-rich mineral aggregates up to 6 mm long and feldspar aggregates up to 10 mm long and large porphyroblasts of garnet. This may be a layer of altered orthogneiss within the amphibolite belt.

BIOTITE GNEISS

Uniform, medium grey felsic biotite gneiss occurs on Dow Lake. The rock contains magnetite and scattered small (0.3 mm) grains of garnet throughout. It has local layering defined by biotite concentrations and is interpreted as paragneiss but does not resemble any other supracrustal rock unit in the region and cannot be assigned to a stratigraphic division.

Missi (Sherridon) Metamorphic Suite (4)

CONGLOMERATE-GNEISS

A unit of metaconglomerate and banded gneiss derived from conglomerate occurs on the south shore of Moody Lake where it is interpreted as the base of the Missi Suite. Clasts are highly elongate parallel to a shallow-plunging (ca. 15°) stretching direction. Dimension ratios on horizontal exposures average 20:1. Recognizable clasts are in decreasing abundance: (1) light grey fine grained metasedimenatry rocks, (2) fine grained buff and pink volcanics, (3) granitoids (up to 3 mm grain size), (4) epidosite, (5) pink (hematitic) quartzite and (6) quartz. The matrix and most interbeds are fine grained, greenish to pinkish grey, metasedimentary rocks with approximately 40% plagioclase, 30% quartz and hornblende (up to 30%), epidote, biotite and magnetite. Coarse sand- to pebble-sized (2-10 mm) rocks form rare interbeds 20-40 cm thick. At the top of the unit (north) are 50 cm thick beds of uniform grey metasandstone.

The conglomerate-gneiss is increasingly mafic towards the base of the unit. It overlies fine grained Amisk Group (?) amphibolite at a probable unconformity: locally there are abundant fine grained amphibolite clasts near the inferred base of the unit (Fig. GS-10-3). The basal conglomerate has also more calc-silicate pebbles but lacks granitoid clasts. The matrix is darker than in the upper part of the unit and contains beds rich in epidote.

Similar conglomerate-gneiss occurs on Martell (Wood) Lake (Peloquin et al., 1985), Nokomis Lake and Puffy Lake where the unit forms the base of the Missi Suite (Sherridon Group in Zwanzig, 1984). Its occurrence on the (volcanic) amphibolite at Moody Lake and on layered (sedimentary) amphibolite and granite elsewhere is consistant with the interpretation that it marks an unconformity.

The conglomerate-gneiss is overlain by muscovite-sillimanite ± garnet-bearing felsic gneiss of probable intrusive origin. Strongly foliated biotite schist suggests that the upper (northern) contact is a fault, possibly an early thrust.

HORNBLENDE-BEARING METASANDSTONE

A single outcrop at the top of the conglomerate-gneiss consists of interlayered pinkish grey, green (epidote-rich) and greenish grey (hornblendic) metasandstones. The rocks are thin-layered or laminated. More extensive belts of Missi Suite hornblende-bearing metasandstone occur northeast and northwest of Moody Lake, and in the Star Lake area. Missi Suite metasedimentary rocks north of Moody Lake and on Craik Lake are locally very rich in hornblende. They may have been derived from mudstone. The hornblendic metasandstone also contains pink, grey and greenish weathering layers, some of which are internally laminated. More uniform grey beds (1-3 cm thick) are defined by variations in hornblende content or by its absence. Elsewhere, the unit is dark grey and massive with up to 30% hornblende. All of these varieties contain quartz, plagioclase, potassium-feldspar, biotite and variable amounts of magnetite ± sphene. The average grain size is commonly 0.2 mm, slightly coarser than Burntwood River metagreywacke. The biotite is less abundant (15%) and has pale brown and dark brown to green pleochroism compared to red-brown to neutral for the metagreywacke.

MICACEOUS METASANDSTONE

Medium grey, uniform metasedimentary rocks occur as interbeds and separate units within hornblende-bearing metasandstone. Layers are

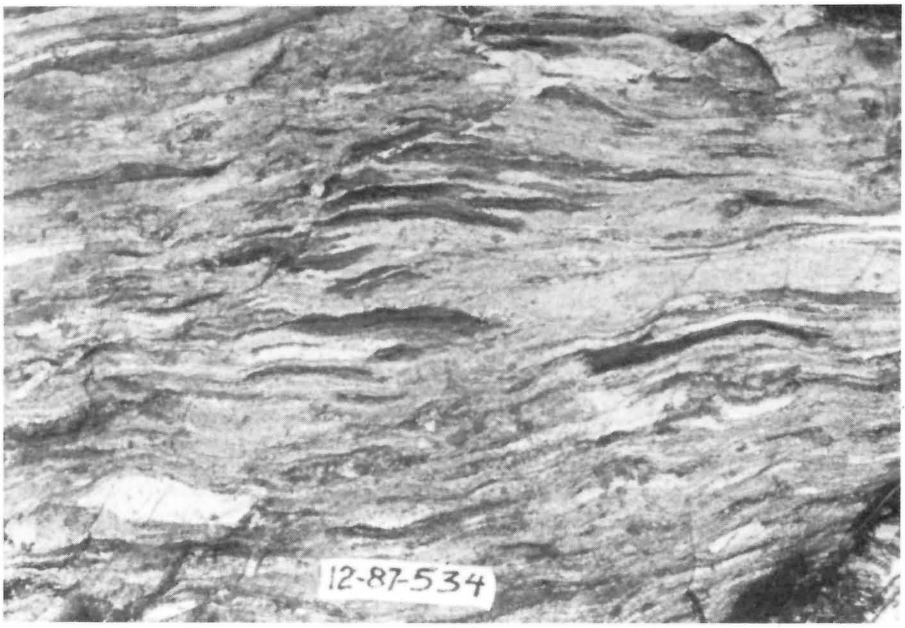


Figure GS-10-3: Conglomerate-gneiss (Missi Suite) with a variety of flattened clasts including fine grained amphibolite (black), south shore of Moody Lake. (Tape is 10 cm long.)

1-3 cm thick and have biotite-rich partings. The most felsic beds occur west of Moody Lake. They are pinkish grey or tan and contain muscovite. Pink or cream granitoid veins are locally present in the Moody Lake area. East of Star Lake the rock is commonly retrogressed to pink hematite-chlorite-epidote-bearing assemblages.

East of Limestone Point Lake and Geekie Lake medium grained, dark grey metasedimentary rocks make up much of the Missi Suite. They generally contain 25% biotite and a small amount of magnetite. Some layers are biotite and magnetite-rich. More felsic beds weather medium grey with a pink cast. The rocks are weakly banded or laminated. They are slightly mobilized in the south with up to 10% pinkish grey granitic *lits*. In the north they are locally highly migmatitic and contain sills of pink weathering pegmatite. These rocks occupy the most northerly belt of the Missi Suite and may have been derived from a distal, fine grained argillaceous sandstone facies.

AMPHIBOLITE

Fine grained hornblende- and biotite-rich rocks are interlayered with the Missi metasandstones in the Moody Lake and Star Lake areas. They are correlated with intermediate mudstone and basalt found farther west in the Missi Suite (Sherridon Group in Zwanzig, 1984).

FELSIC GNEISS

Very fine grained pink weathering gneiss occurs northwest of Moody Lake and north of Martell Lake. The rock is weakly layered and possibly fragmental in one locality. It has some 1.5 mm quartz eyes or quartz-rich lenses 1 mm thick and up to 4 cm long. This unit is interpreted as felsic tuff.

Pinkish grey to white weathering fine grained felsic rock underlies the pink gneiss west of Moody Lake. This unit contains abundant 1.5 mm quartz-eyes in a muscovite-bearing matrix. The unit is weakly layered and appears to be a metasedimentary rock associated with the felsic (volcanic) gneiss.

Sherridon Orthogneiss or Paragneiss (5)

The eastern part of the "Sherridon structure" at Star Lake had been mapped as Sherridon Group paragneiss (Robertson, 1953; Froese and Goetz, 1981) but has been interpreted by one of us (H.V. Zwanzig) to consist largely or partly of recrystallized granitoid rocks. West of Star Lake the core of the structure contains coarse grained grey tonalitic to quartz-rich gneiss. In this rock type plagioclase and quartz form separate, often irregular-shaped aggregates up to 10 mm long. The composite grains can also be elongate or lensoid and appear to define a partly annealed protomylonitic igneous texture. Locally quartz has been mobilized into discontinuous ribs with plagioclase-rich margins to form a coarse gneissosity. Biotite aggregates are generally elongate and wispy; magnetite is accessory. Some coarse patches have a massive interlocking texture and were partly remobilized during metamorphism.

The gneiss resembles and is tentatively correlated with the granitoid orthogneiss (6) of the Batty Lake Complex but it has a higher quartz content. Alternatively, the gneiss at Star Lake may have been derived from metasandstone but it does not resemble the fine grained Missi gneisses found elsewhere in the region.

The core gneiss is surrounded by a weakly layered shell of medium grained garnetiferous quartz-plagioclase-biotite ± magnetite gneiss. Scattered, oval quartz aggregates in this rock type can be interpreted as remnants of a primary coarser grained texture. Garnet is generally fine grained and not abundant but in the outer part of the shell it can be up to 12 mm in diameter. The large porphyroblasts contain quartz-filled extension gashes. The rocks are annealed protomylonitic orthogneiss and/or paragneiss.

A second shell contains slivers of clearly recognizable supracrustal rocks and spectacular porphyroblastic rocks (7). The shell appears to be enclosed in a curved shear zone and overlain by a third shell of quartz-plagioclase-biotite ± garnet, K-feldspar, ± magnetite gneiss. This shell forms the western margin of the Hutchinson Lake dome (Zwanzig, 1984). It contains recrystallized, sheared orthogneiss and/or paragneiss. The rocks are medium- to fine-grained and have a lower quartz content than the rocks to the west. The typical gneiss from this shell has an average grain size of 0.4 mm with a maximum length of 2 mm of quartz. The quartz grains are polygonized and have strain lamellae. Protomylonitic textures become prominent near the shell of supracrustal rocks suggesting a fault.

Orthogneiss (6)

Major belts of predominantly granitoid orthogneiss include (1) the Batty Lake complex extending from Batty Lake southeast to Geekie Lake, (2) the Hutchinson Lake dome (Zwanzig, 1984) which extends from Puffy Lake north to Star Lake, (3) part of the Sherridon gneiss which lies west of Star Lake and (4) part of the Moody Lake dome. Each belt contains supracrustal rocks and amphibolite of unknown origin in addition to granitoid gneiss.

Orthogneiss generally ranges in composition from tonalite to granite but is predominantly tonalitic (Fig. GS-10-4). The rocks are metamorphosed, highly foliated and locally mobilized. Garnet occurs in varying amounts in most of the orthogneiss units and much of the rock is quartz-rich.

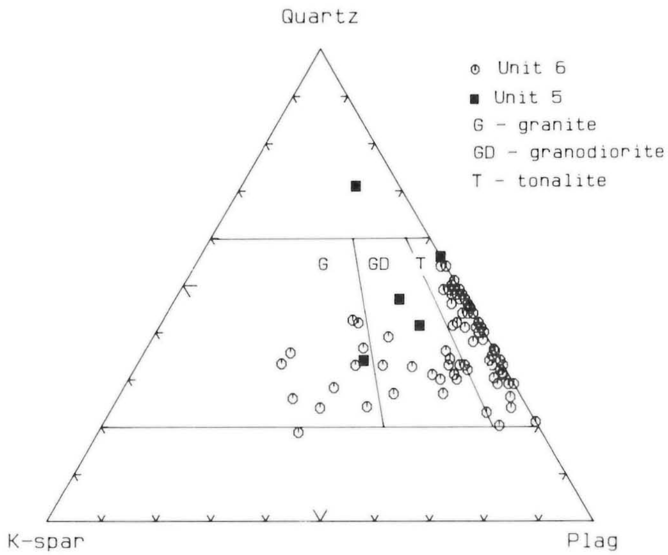


Figure GS-10-4: Ternary plot showing modal composition (quartz: K-feldspar: plagioclase) of granitoid orthogneiss (unit 6) and Sherridon orthogneiss and/or paragneiss (unit 5); (500 points counted per sample).

Three major divisions constitute the Batty Lake complex. From central Batty Lake to Limestone Point Lake the dominant phase is a light grey, coarse grained, quartz-rich tonalite. Garnet is ubiquitous, ranging in size from 0.5 to 10 mm (average 1 mm). Biotite is the predominant mafic mineral with minor hornblende developed in and along the margins of mobilizate *lits*. Magnetite is a common accessory phase. Quartz typically forms thin lenticular aggregates (up to 2 cm long) in the foliation plane. Biotite ± hornblende forms mafic aggregates (Fig. GS-10-5).

Grey, beige or pink weathering, medium grained biotite tonalite gneiss lies north and east of the quartz-rich orthogneiss. This unit is also highly foliated and weakly mobilized. Garnet and magnetite are common accessory phases but not always present. Small elongate inclusions and large screens of supracrustal rocks are common in parts of the unit. Throughout the Limestone Point Lake area the rock is strongly sheared and zones of augen gneiss are common features.

In central Limestone Point Lake a smaller belt of grey, medium grained biotite-hornblende tonalite is homogeneous, equigranular and contains white granodiorite mobilizate *lits* with subhedral magnetite crystals up to 2 cm long. Garnet is rare, generally restricted to margins of mobilizate *lits*. Amphibolite inclusions are a common feature throughout this unit.

Orthogneiss from the Hutchinson Lake dome (Zwanzig, 1984) extends north in a belt that curves northwest across Star Lake. The belt contains several varieties of gneissic tonalite in the core. The main phase is characterized by lensoid quartz and plagioclase aggregates up to 5 mm long and wispy biotite aggregates up to 10 mm long. This fabric is interpreted as a remnant of originally coarse- to medium-grained granitic texture.

The margins of the belt consist of finer grained granodioritic to tonalitic gneiss and biotite ± garnet gneiss. Highly elongate amphibolite inclusions and biotite schlieren occur on the northwest margin of the orthogneiss.

The Moody Lake dome has a core that contains orthogneiss in the north, supracrustal rocks (Amisk Group?) in the centre and an outer shell of highly foliated, commonly garnetiferous and muscovite-sillimanite-bearing orthogneiss (?) in the south. The northern body contains leucocratic gneissic tonalite and granodiorite. Potassium-feldspar locally defines a weak gneissic layering apparently due to partial remobilization of the rock. Quartz and plagioclase form irregular to lensoid grains up to 7 mm long.

The outer shell contains pale grey uniform strongly foliated granodioritic gneiss and pink augen granite that locally intrudes the Amisk Group (?) core. Igneous texture is best preserved on its western margin. The remaining unit is sheared; it contains small flattened and round garnets, and thin partings coated with muscovite ± sillimanite. The rock is locally cut by pink granite veins. The sheared rock is interpreted as orthogneiss but a supracrustal origin cannot be ruled out.

COARSE GRAINED AMPHIBOLITE, METAGABBRO

Coarse grained amphibolite forms a thin, nearly continuous layer around the shell of granitoid orthogneiss at Moody Lake. The rock ranges from weakly foliated amphibolite with approximately 60% green hornblende up to 5 mm long to patchy amphibolite with clots up to 1.5 x 3 cm of pure coarse grained black hornblende. The rock is interpreted as a partly remobilized gabbro that has locally retained its igneous texture but elsewhere is segregated into plagioclase-rich mobilizate ± quartz ± biotite and pure amphibole restite.

ULTRAMAFIC ROCKS

The core of the Moody Lake dome contains a 1 km long body of very coarse grained patchy hornblendite with a vein network of diopside-calcite-bearing rock. A small island in Dow Lake is underlain by ultramafic rocks containing olivine, pyroxene and amphibole.

GRANITIC GNEISS

Pink granitic gneiss occurs as thick sill-like bodies intruded along stratigraphic contacts: on Craik Lake along the amphibolite horizon, and east of Limestone Point Lake along the contacts between Missi and Burntwood River gneisses.

The gneiss is a pink and grey mottled migmatite comprising 15-20% grey granitic *lits* in a pink weathering fine grained to aplitic granite gneiss. The rock is well foliated with the veins commonly tightly folded and boudinaged. The gneissic component is a homogeneous equigranular rock with 1-3% biotite, 25-30% quartz and traces of muscovite and magnetite.

Garnet-anthophyllite ± cordierite gneiss and sillimanite gneiss (7)

Porphyroblastic rocks with uncommon mineralogy occur at or near the contact between the orthogneiss and the Burntwood River greywacke-derived gneiss, and locally within the orthogneiss complexes. These zones contain a variety of rock types as discontinuous slices, including orthogneiss, amphibolite and Burntwood River and possibly Missi gneisses. The rocks in these zones are generally strongly foliated. Associated shear zones contain augen gneiss, sulphide-bearing gossan and protomylonite. Massive white quartz veins and quartz-rich pegmatite are common in the zones of heaviest shearing. Supracrustal units are locally truncated against or occur as tectonic slivers parallel to the porphyroblastic zones. These features suggest that the porphyroblastic rocks are alteration products of a variety of rock types and that they may be associated with major faults. Some of the porphyroblastic rocks, in particular on Star Lake, are massive and indicate genesis before metamorphism but there was much post-metamorphic shearing (Fig. GS-10-6 and 7).

The mineralogy of the porphyroblastic rocks is variable, reflecting the composition of the host and probably the type of alteration. Most commonly the rocks are rich in quartz and garnet (and apparently depleted in alkalies). They may contain fibrous anthophyllite, magnetite, cordierite or sillimanite and rare remnants of staurolite. The iron- and magnesium-rich rocks are the coarsest grained and most spectacular.

Where the host is orthogneiss the unit is commonly a pink, quartz-rich granitoid gneiss with a fine- to coarse-grained matrix and centimetre-size red garnets, locally with sprays of brown anthophyllite in the foliation plane. Where amphibolite is the host the rock consists of interlayered hornblende-plagioclase gneiss, biotite-garnet-cordierite quartz-rich gneiss and mafic garnet-biotite-anthophyllite schist. Carbonate layers may also be altered amphibolite. Burntwood River gneiss grades into highly garnetiferous siliceous biotite-cordierite-sillimanite-graphite gneiss with rare anthophyllite. All varieties contain little or no potassium feldspar but peraluminous minerals are common.

Foliated Tonalite to Granite (8)

The northern part of the large intrusion southeast of Evans Lake is zoned. The northern margin consists of pink foliated granite cut by pegmatite. The granite contains irregular grains of quartz and feldspar with elongate lenses of biotite and minor retrograde muscovite. The inner margin consists of pink granodiorite and farther south the rock comprises uniform, buff weathering tonalite, locally cut by the granodiorite phase of the margin. The tonalite is leucocratic with 5-10% biotite in flat lenses and abundant irregular grains of plagioclase (60-65%) up to 5 mm long. The tonalite has an interlocking texture with a weak fabric. The tonalite is very similar to (though less foliated than) the orthogneiss body on the north shore of Moody Lake. Rocks like those in the large zoned pluton are considered to be a protolith of the orthogneiss.

Figure GS-10-5: *Uniform, granitoid orthogneiss showing coarse grain size of flattened quartz, feldspar and mafic aggregates on the south shore of Batty Lake. (Tape is 10 cm long.)*

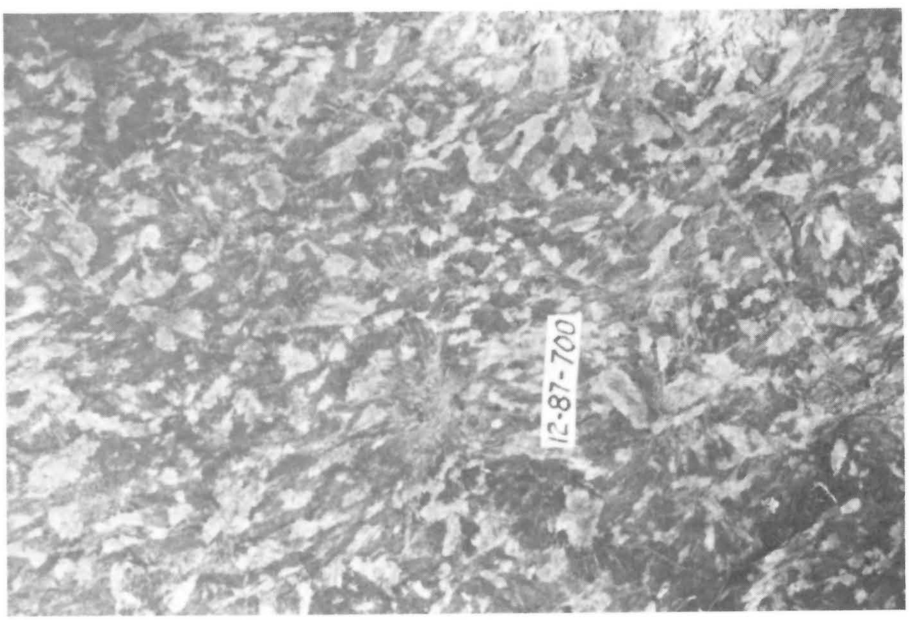


Figure GS-10-6: *Massive porphyroblastic cordierite-anthophyllite rock, south of Star Lake. (Cordierite is the lighter mineral; the tape is 10 cm long.)*

Tonalite to granodiorite (9)

The area between Stefanuik Lake and Guthrie Lake is predominantly beige to grey weathering biotite tonalite to granodiorite. It is a very homogeneous medium grained rock with 25% quartz, 7-10% biotite and traces of hornblende and magnetite. Inclusions of supracrustal rocks are common near the south margin of the body but absent in the core of the body. It is well foliated, locally sheared, especially on the south margin but shows no sign of mobilization and was apparently intruded late in the metamorphic history of the Kisseynew domain.

PALEOZOIC ROCKS

Mottled dolomite is exposed over a 1.5 x 2.0 km area in central Limestone Point Lake. The beds comprise buff dolomite and reddish argillaceous dolomite. Beds are generally massive with well developed bedding plane partings. Thin breccia and conglomerate beds with green argillite clasts were observed in two locations. The contact with Precambrian rocks is not exposed. The southwest limit of Paleozoic exposure lies within 3 m of a Precambrian fault.

Bedding attitudes in the carbonates range from subhorizontal to near vertical. Isoclinal folds of 2-3 m amplitude plunge at shallow angle (20°) to the west. Strong fracture cleavages in two directions combined with bedding plane partings result in a rubbly appearance to most exposures (Fig. GS-10-8).

Samples collected were examined by H.R. McCabe who concluded that the dolomites have a definite Ordovician aspect (see also GS-33, this volume). McCabe suggests that, although extrapolation of regional structural trends to the Limestone Point Lake area is approximate at best, the Paleozoic outlier may be 120 m (maximum) structurally low.

Folding of Paleozoic rocks is not observed elsewhere in Manitoba: it may be related to the fault origin and structural dropping of the outlier.

We thank David Gray, Yonnus Idris and Mark Prystupa for their enthusiastic help in the field, and Bart Miller for his excellent mapping.

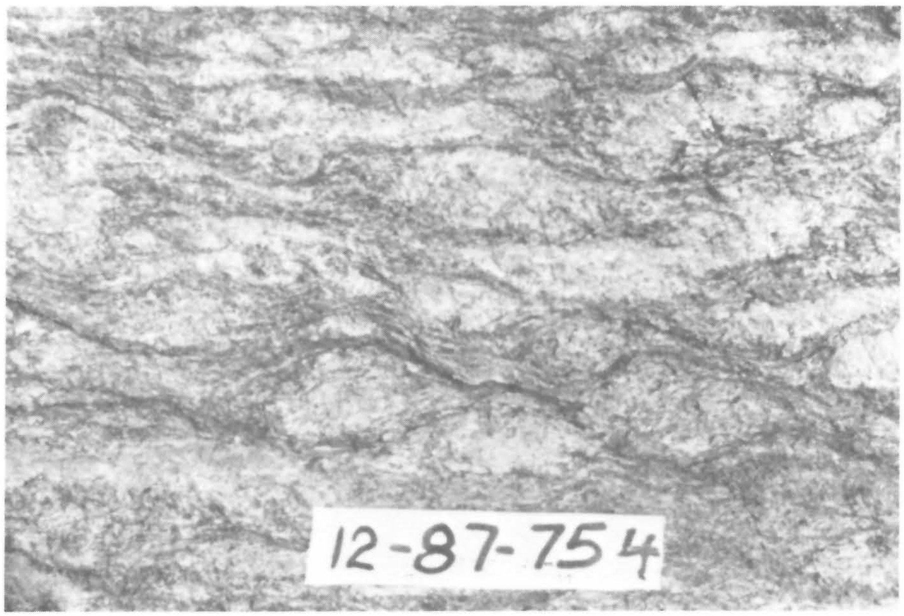


Figure GS-10-7: *Garnet-cordierite-anthophyllite rock with S-surfaces parallel to tape (10 cm long) and weak C-surfaces extending diagonally down from left to right, indicating dextral shear, south shore of Star Lake.*

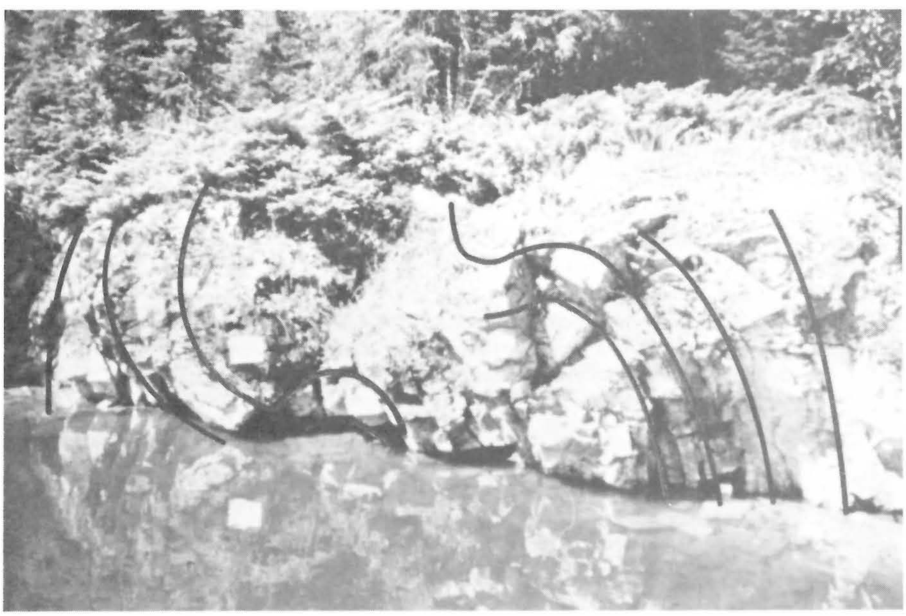


Figure GS-10-8: *Steeply dipping, tightly folded bedding with parting surfaces in Ordovician dolomite on Limestone Point Lake.*

REFERENCES

Ashton, K.E. and Wheatley K.J.
1986: Preliminary report on the Kisseynew gneisses in the Kisseynew-Wildnest Lakes area, Saskatchewan; **in** Current Research, Part B, Geological Survey of Canada, Paper 86-113.

Bailes, A.H.
1980: Geology of the File Lake area; Manitoba Mineral Resources Division, Geological Report 78-1.

Froese, E. and Goetz, P.A.
1981: Geology of the Sherridon Group in the vicinity of Sherridon, Manitoba; Geological Survey of Canada, Paper 80-21.

Geological Survey of Canada
1987: Aeromagnetic Maps; Open File 1478.

Gilbert, H.P., Syme, E.C. and Zwanzig, H.V.
1980: Geology of the metavolcanic and volcaniclastic metasedimentary rocks in the Lynn Lake area; Manitoba Mineral Resources Division, Geological Paper GP 80-1.

Gordon, T.M. and Lemkow, D.R.
1987: Geochemistry of Missi Group volcanic rocks, Wekusko Lake, Manitoba; Geological Survey of Canada, Open File 1442.

Gunter, W.R. and Yamada, P.H.
1986: Evaluation of industrial mineral occurrences in the Flin Flon-Snow Lake areas; **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 86-91.

Kornik, L.J.
1968: Geology of the Guay Lake area (west half); Manitoba Mines Branch, Publication 64-6.

Lenton, P.G.
19781 Geology of the McKnight-McCallam Lakes area; Manitoba Mineral Resources Division, Geological Report GR 79-1.

North American Commission on Stratigraphic Nomenclature
1983: North American Stratigraphic Code; American Association of Petroleum Geologists Bulletin, v. 67, p. 841-875.

Peloquin, S., Ostry, G. and Gale, G.H.
1985: Investigation of mineral occurrences in the Kisseynew sedimentary terrain; **in** Manitoba Energy and Mines, Report of Field Activities l985, p. 64-70.

Ostry, G.
1986: Mineral investigations in the Kisseynew gneiss terrain; *in* Manitoba Energy and Mines, Report of Field Activities, 1986, p. 100-106.

Robertson, D.S.
1953: Batty Lake map-area, Manitoba; Geological Survey of Canada, Memoir 271.

Zwanzig, H.V.
1983: Kisseynew Project: Lobstick Narrows; *in* Manitoba Mineral Resources Division, Report of Field Activities 1983, p. 15-22.

1984: Kisseynew Project: Lobstick Narrows-Cleunion Lake, Puffy Lake and Nokomis Lake areas; **in** Manitoba Mineral Resources Division, Report of Field Activities 1984, p.38-45.

Zwanzig, H.V., Lenton, P.G. and Miller, B.S.
1987: Limestone Point Lake; Manitoba Energy and Mines, Preliminary Map 1987K-3.

Zwanzig, H.V. and Miller, B.S.
1987: Star Lake; Manitoba Energy and Mines, Preliminary Map 1987K-4.

GS-11 BURNTWOOD LAKE SYENITE

by W.D. McRitchie

BACKGROUND

In 1972 two samples of aegirine-augite-bearing syenite were collected near the western end of Burntwood Lake (Fig. GS-11-1), during routine 1:50 000 scale mapping of the Kisseynew gneissic terrain (Burntwood Project — Baldwin et al. 1979; McRitchie et al., 1979). Alkaline intrusions are otherwise rare in the region between Flin Flon-Lynn Lake and Thompson (Fig. GS-11-1).

Numerous new applications have recently been discovered foı a variety of rare elements, including zirconium, and major new exploration programs have been initiated in Canada, the United States and Greenland.

Accordingly, the current project was undertaken to determine whether any of the alkaline complexes in the Churchill Province of Manitoba are potential sources of zirconium minerals in economic concentrations.

The Burntwood Lake locality was revisited in 1987 and detailed mapping conducted to obtain additional samples for geochemical characterization of the intrusion, as well as further information on field relationships.

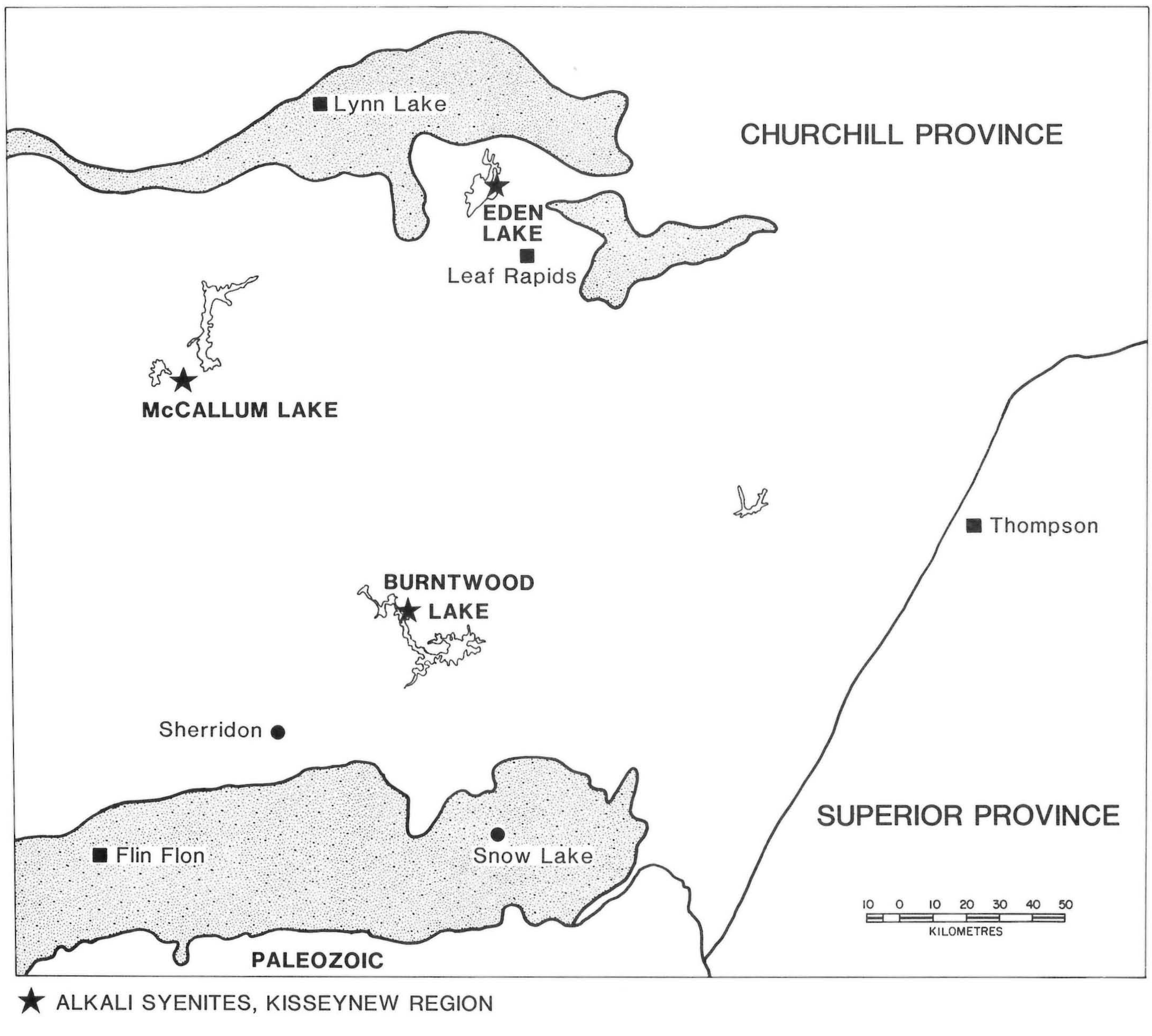


Figure GS-11-1: Alkali syenites in the Lynn Lake-Kisseynew region, southern Churchill Province.

CURRENT WORK

A five-day mapping program confirmed the existence of a moderately sized (1.4 x 2.4 km) phacolithic syenite intrusion lying within regionally dominant turbidite-derived migmatites and associated S-type peraluminous granites.

GENERAL SETTING

The syenite occurs on high-relief outcrops and its original form has been substantially modified by post-intrusion deformation. The body exhibits a dentate shape with several south-southeast-trending "roots" (fold keels) the easterly two of which wrap partially around the main north-plunging shallow (25°) synformal fold hinge (Fig. GS-11-2).

A steep northeast- and east-dipping penetrative axial planar gneissic foliation is variably developed, but more pronounced near the east and west flanks, and within the hinge zone of the intrusion.

Contacts with migmatitic country rocks are generally sharp, but at three locations (Stations 6, 12, and 17) large (5-10 m) blocks of the adjacent biotite gneiss have been extensively recrystallized and metasomatized, and included within an hybridized and bleached contact zone of the syenite. Elsewhere an almost ubiquitous 3-5 m wide oxidized zone within the syenite is a persistent feature adjacent to the outer contact.

Pink granitic dykes between 50 cm and 2 m thick are common in the outer contact and hinge zones of the syenite. However, the central more massive phases of the intrusion are rarely cut by younger phases with the exception of sporadic 5-20 cm thick, parallel sided, dykes of white, leucoquartz monzonite (Unit 18 — Burntwood Project Maps 7, 10, and 11).

The thickest and best preserved development of the syenite occurs in the northern sector of the synform; however, the northern contact was not observed during the current mapping program.

The syenite is in contact, on all sides, with Burntwood River Metamorphic Suite diatexitic migmatites derived from greywacke-mudstone precursors. The migmatites comprise well layered, coarse grained, blastic and foliated garnet, biotite, cordierite and sillimanite-bearing gneisses, commonly with predominant white seriate pegmatite/granite leucosomes.

The 315-355° trending foliation is generally parallel to the axial planes of early tight isoclinal folds. Local reactivation of the S-fabrics along hairline foliae has resulted in retrogression of garnet to biotite, straining and granulation of quartzofeldspathic phases and widespread regeneration of biotite. In the southwest corner of the area the diatexitic gneisses are cut by a 40 cm thick D_3 cataclastic zone striking 315°/80° which displays typical augen and microgranulation textures.

Although its differentiation layering is repeatedly folded and many of the marginal phases display a pronounced penetrative gneissosity, the syenite still exhibits numerous primary features from which it is inferred that the intrusion had a relatively late stage emplacement (post-M_2, pre-D_3; Bailes and McRitchie, 1978) compared to other granitoids in the Kisseynew gneissic belt.

AEGIRINE-AUGITE SYENITE

In its least altered form the syenite is salmon-red, phaneritic, medium-coarse grained, heterogeneous, and weakly to moderately foliated. It universally exhibits textural and compositional layering in units from 2-40 cm thick. The layering is typically undulating and may be substantially segmented and displaced in almost isoclinally folded hinge zones with an axial planar gneissosity.

The composition on any one outcrop may range from almost monomineralic microcline syenite, to syenodiorite with up to 70% concentrations of densely packed equant, equigranular aegirine-augite in 3-20 cm thick mafic layers.

Grain size is highly variable but consistent within individual layers and may range from 1 mm to 3 cm, the coarser phases typically being microcline syenite. Local pegmatite layers up to 20 cm thick contain an equigranular matrix of 3-4 cm microcline crystals.

Crescumulate (comb) layering was noted at four widely spaced localities. Layers range from 3-20 cm thick and contain tabular (2 cm long) aegirine-augite arranged perpendicular to the lower boundary, with an inferred upper zone containing only microcline. In the extreme northeast corner of the map area, a comb-layered phase exhibits white acicular apatite crystals (0.5 x 10 mm) intergrown with slightly longer pyroxene blades. Adjacent cumulate concentrations (30%) of subround aegirine-augite (0.5-1 cm) in a microcline matrix form a 15 cm thick layer flanked on both sides by more feldspathic layers. At Station 41 an 8 cm thick comb-textured layer exhibits tabular pyroxenes growing in opposing directions into an aplitic microcline-dominant central zone.

With increasing degrees of deformation the grain size becomes progressively finer and the colour changes from red through honey-brown to buff, cream and white. Pyroxenes are retrograded to hornblende and biotite, and the microcline microperthite is unmixed to plagioclase, quartz and microcline.

The southern lobes of the complex are predominantly finer grained and buff.

PETROGRAPHY

In thin section the syenite displays a relatively simple mineralogy comprising various amounts of aegirine-augite or augite, microcline, microcline microperthite and mesoperthite, apatite and sphene, with trace opaques and zircon, and secondary hornblende, carbonate, scapolite and pale green biotite. Quartz and plagioclase (An_{8-14}) are generally absent in fresh syenite but constitute a minor component of the more altered and finer grained gneissic buff syenite. Rare zoned tourmaline is pleochroic from dark to light brown.

Aegirine-augite (X-C = 60°-70°; 2V: 74°-82°) is pleochroic from deep green to olive-green and straw yellow and occurs in 0.3-15 mm crystals that are generally consistently sized within individual layers. Rare layers are characterized by pyroxene clots up to 3 x 7 cm in a syenite matrix. Most aegirine-augite crystals are cumulitic, and either equant or subhedral tabular; however, oikocrysts were identified in some mafic layers and blades up to 3 cm in length occur within some comb-layered phases. Cross-cutting mafic stringers locally define a pre-foliation vein network.

Pale green augite is more common within the southern buff coloured gneissic syenite.

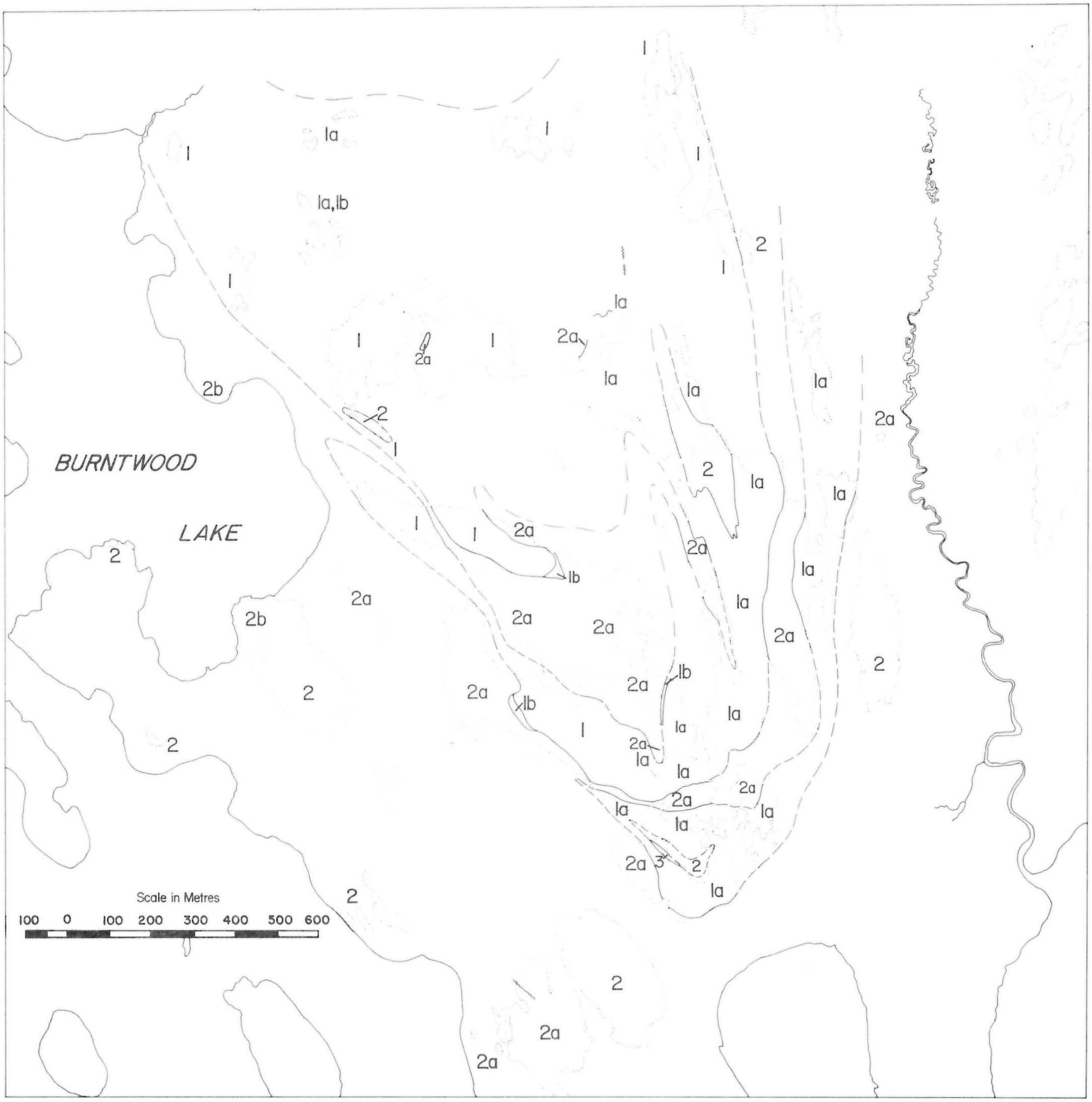
Turbid microcline (up to 3 cm) exhibits a wide range of perthitic intergrowths and intergrowth textures from mesoperthite to microperthite. Grain boundaries are either sutured or recrystallized-granular with preferential exsolution of plagioclase at the grain contacts. A pronounced mortar texture is evident adjacent to the outer contacts of the intrusion, whereas in the less altered red phases microcline perthite occurs as clouded crystals forming a polygonal mosaic with limited grain boundary granulation. Such undeformed contacts locally exhibit delicate suturing or myrmekite development. Most coarse grained crystals are poikilitic with numerous small inclusions of pyroxene and accessory phases.

Apatite and local euhedral sphene are ubiquitous and fairly abundant accessory phases. Apatite contents up to 30% are not uncommon in more mafic layers, approximately 10 cm thick, in which the yellow to reddish-brown apatite prisms may reach 3 cm in length. Some contain numerous fine needle-like inclusions oriented parallel to the c-axis.

Zircon is restricted to selected phases but where present occurs in well zoned crystals up to 0.6 mm.

Magnetite is present in some layers, and in the most northeasterly ridges was recorded in 20 cm clots and segregations parallel to the igneous layering.

Green or variably blue-green amphibole patchily replaces pyroxene in some contact zones; associated carbonate occurs as skeletal aggregates or lattice-works either disseminated throughout the matrix or filling cracks in feldspar. Carbonate and scapolite-bearing bleached phases were recorded in plagioclase-rich zones near the northern contact of the syenite.



BURNTWOOD LAKE SYENITE

1 Pink aegirine-augite syenite

1a Buff gneissic augite syenite

1b Hybridized contact zone

2 Migmatite-greywacke-derived diatexite

2a White pegmatite/granite mobilizate dominant

2b Paragneiss dominant (garnet, biotite, cordierite & sillimanite-bearing)

3 Amphibolite

Figure GS-11-2: *Burntwood Lake aegirine-augite syenite.*

TABLE GS-11-1
BURNTWOOD LAKE SYENITE: CHEMICAL ANALYSES

SAMPLE NO.	04-87-1A-1	04-87-1B	04-87-1-D	04-87-03(B)	04-87-5(1)A	04-87-5(1)B	04-87-12(1)	04-87-16(2)	04-87-16(3)	04-87-20(3)-2	04-87-21	04-87-21(C)
SiO2	62.0	61.6	59.8	63.7	62.4	62.7	62.7	68.3	59.0	64.4	60.7	60.2
Al2O3	15.1	14.0	15.7	14.6	14.9	15.1	14.7	14.8	11.5	16.2	14.3	12.8
FeO	1.96	2.70	3.41	1.23	2.69	2.47	2.59	0.71	3.47	0.92	2.82	3.90
Fe2O3	0.88	0.86	1.01	1.41	0.49	0.78	0.60	0.48	0.67	0.63	0.99	1.31
CaO	4.50	5.76	4.89	3.56	4.62	4.43	4.30	1.44	7.97	2.43	5.29	5.87
MgO	1.33	1.59	1.96	1.29	1.70	1.67	1.44	0.39	2.87	0.75	1.35	1.58
Na2O	4.50	4.35	5.44	4.87	4.03	4.09	3.92	3.89	2.96	5.17	3.58	3.80
K2O	6.61	5.89	4.50	7.14	7.02	7.08	6.88	8.09	6.89	7.09	7.41	6.54
TiO2	0.78	1.04	1.21	0.47	0.11	0.04	0.63	0.10	0.16	0.36	0.53	0.47
P2O5	0.49	0.61	0.88	0.55	0.70	0.74	0.59	0.96	1.63	0.38	0.95	0.77
MnO	0.07	0.09	0.07	0.06	0.11	0.10	0.07	0.01	0.10	0.05	0.07	0.11
H2O	0.47	0.58	0.47	0.34	0.50	0.50	0.55	0.34	0.45	0.42	0.46	0.63
S	0.01	0.01	0.03	0.03	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.01
CO2	0.25	0.11	0.07	0.25	0.32	0.26	0.41	0.17	0.23	0.23	0.21	0.21
F	0.10	0.12	0.38	0.09	0.07	0.08	0.09	0.15	0.15	0.06	0.12	0.10
Other	0.59	0.57	0.52	0.39	0.45	0.45	0.47	0.11	0.55	0.40	0.92	0.67
Total	99.60	99.83	100.17	99.93	100.09	100.46	99.91	99.88	98.55	99.47	99.66	98.93
FeO(T)	2.75	3.47	4.32	2.50	3.13	3.17	3.13	1.14	4.07	1.49	3.71	5.08
O=S	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O=F	-0.04	-0.05	-0.16	-0.04	-0.03	-0.03	-0.04	-0.06	-0.06	-0.02	-0.05	-0.04
* Y	28	40	34	16	18	17	23	43	23	14	26	29
* Zr	180	217	557	167	256	242	186	27	195	117	391	659
* Nb	25	41	29	18	0	6	23	0	8	11	27	33
* Rb	126	115	77	192	161	159	175	220	218	146	200	199
* Sr	1909	1929	1889	933	1412	1397	1567	256	1391	1545	2386	1567
Ba	2820	2590	1830	2030	2022	2060	2140	380	2930	1660	4980	3280

SAMPLE NO.	04-87-22(B)	04-87-22(C)	04-87-24(1)	04-87-25(1)	04-87-28(B)	04-87-32(A)	04-87-40-1	04-87-40-2	04-87-43	04-87-75(1)	04-87-76(B)
SiO2	69.5	63.3	49.5	61.4	64.7	65.6	63.9	62.4	61.8	57.7	58.7
Al2O3	15.4	15.1	3.2	14.2	16.8	16.7	17.1	15.8	15.0	12.5	11.1
FeO	0.43	1.37	9.31	3.00	1.00	0.69	0.57	1.29	2.16	3.84	2.35
Fe2O3	0.50	0.52	1.67	0.51	0.57	0.52	0.58	0.97	0.67	0.71	1.47
CaO	0.72	3.43	20.8	5.15	2.06	1.49	1.74	3.48	4.69	9.06	8.86
MgO	0.42	1.10	6.80	1.89	0.69	0.60	0.65	1.38	1.25	2.62	3.70
Na2O	4.35	5.05	0.93	3.56	5.27	5.14	3.99	3.86	4.51	2.06	2.26
K2O	7.47	6.50	1.53	7.03	7.37	8.03	9.55	8.46	6.45	7.71	7.85
TiO2	0.06	0.71	0.24	0.36	0.01	0.13	0.02	0.04	0.75	0.14	0.17
P2O5	0.20	0.42	3.74	0.73	0.22	0.20	0.35	0.59	0.53	1.36	1.46
MnO	0.01	0.06	0.23	0.09	0.04	0.03	0.02	0.05	0.07	0.09	0.08
H2O	0.41	0.42	0.78	0.52	0.39	0.41	0.38	0.50	0.46	0.36	0.28
S	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.02	0.01	0.00	0.01
CO2	0.10	0.35	0.35	0.28	0.28	0.19	0.30	0.30	0.38	0.77	0.15
F	0.05	0.07	0.29	0.07	0.03	0.02	0.03	0.05	0.10	0.12	0.11
Other	0.12	0.42	0.08	0.45	0.28	0.44	0.45	0.46	0.52	1.00	0.69
Total	99.72	98.53	99.33	98.96	99.69	100.19	99.63	99.62	99.31	99.99	99.19
FeO(T)	0.88	1.84	10.81	3.46	1.51	1.16	1.09	2.16	2.76	4.48	3.67
O=S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00
O=F	-0.02	-0.29	-0.12	-0.29	-0.01	-0.01	-0.01	-0.02	-0.04	-0.05	-0.05
* Y	0	22	na	22	7	9	8	12	27	30	24
* Zr	17	124	na	195	81	235	102	91	216	359	221
* Nb	0	25	na	18	0	10	0	0	29	0	0
* Rb	121	151	na	121	123	198	202	187	167	148	181
* Sr	408	1511	na	1580	1196	1418	1434	1199	2014	2574	1518
Ba	510	1850	720	1950	980	1980	2170	2500	2000	5600	4100

* Elements analyzed by Dept. of Geological Sciences,U.of M. Values have been rounded.

CHEMISTRY

Twenty-two samples were submitted for major and trace element analyses (Table GS-11-1) including yttrium, niobium and zirconium. Initial results indicate elevated levels of strontium in some zones (2600 ppm) near the northern end of the complex. The unique composition, and highly heterogeneous and well fractionated nature of the intrusion, may indicate a good potential for the development of near-monomineralic phases during the magmatic or late magmatic evolution of the syenite.

Significant concentrations of zirconium were not encountered during initial geochemical screening. However, elevated levels of zircon minerals were detected in some layers, and further indications may become apparent once the results of the chemical analyses are received.

REFERENCES

Bailes, A.H. and McRitchie, W.D.
1978: The transition from low to high grade metamorphism in the Kisseynew Gneiss Sedimentary Belt, Manitoba; **in** Metamorphism in the Canadian Shield, Geological Survey of Canada, Paper 78-10.

Baldwin, D.A., Frohlinger, T.G, Kendrick, G., McRitchie, W.D. and Zwanzig, H.V.
1979: Geology of the Nelson House-Pukatawagan region (Burntwood Project); Manitoba Mineral Resources Division, Geological Maps 78-3-7, 10 and 11, 1979.

Cameron, H.D.M.
in prep.: Geology of the Eden Lake area; Manitoba Energy and Mines, Geological Report GR84-2.

Lenton, P.G.
1981: Geology of the McKnight-McCallum Lake area; Manitoba Mineral Resources Division, Geological Report GR79-1.

McRitchie, W.D., Peters, J. and Frohlinger, T.G.
1979: History of exploration and geological work in the Nelson House- Pukatawagan region; Manitoba Mineral Resources Division, Geological Report 78-3 (Part II).

GS-12 CHISEL-MORGAN LAKES PROJECT

by Alan H. Bailes

INTRODUCTION

The Chisel-Morgan Lake project entails 1:15 840 mapping of Early Proterozoic metavolcanic, metasedimentary and intrusive rocks in the eastern portion of the Flin Flon metavolcanic belt. The project area (Fig. GS-12-1), which lies 5 km southwest of the town of Snow Lake, contains six significant volcanogenic base metal sulphide deposits, including the Chisel Lake and Ghost Lake Mines. Detailed mapping is being undertaken with the objective of providing an improved understanding of complex stratigraphic and structural relationships.

Field work was begun in 1986 in the southwest part of the project area (Bailes, 1986). In 1987 effort was concentrated on completing mapping in eastern and northern portions of the area. Some of the progress made in 1987 includes:

1) mapping of the upper part of the relatively untectonized supracrustal sequence east of the Varnson Lake fault, which has established the stratigraphic setting of the Chisel-Lost-Ghost base metal mineralized zone (Fig. GS-12-1, Table GS-12-1).

2) identification of a distinctive 100-250 m thick unit of massive dacite tuff and lapilli tuff in the immediate stratigraphic footwall to the Chisel-Lost-Ghost zone. Skirrow (1987) has shown that related synvolcanic dacite dykes at Edwards Lake are clearly synchronous with hydrothermal activity and locally are associated with extensive zones of silicification. The implication is that this dacite tuff and related intrusions may be important indicators of proximity to Zn-Cu mineralization elsewhere in the Snow Lake area.

3) delineation of the distribution of hydrothermally altered rocks in the Chisel Lake area, which indicates that: a) alteration, as expected, is confined to the stratigraphic footwall of the Chisel-Lost- Ghost Zn-Cu zones; and b) rocks north of Chisel Lake are strongly altered and as such belong to the footwall sequence. A corollary of the latter is that a major F_1 syncline must be present north-northwest of Ghost Lake, approximately coincident with the structure proposed by Froese and Moore (1980).

4) identification of two fold events, F_1 and F_2 (see also Froese and Moore, 1980), which intersect at high angles in the immediate vicinity of Chisel Lake. Interference structures produced by these folds have obvious economic significance as they affect the spatial distribution of base metal mineralization, a fact already established for the Chisel Lake orebody (Martin, 1966).

SUPRACRUSTAL ROCKS

Most of the Chisel-Morgan Lakes area is structurally too complex for supracrustal rocks to be kept in stratigraphic order. An exception is an approximately 5.5 km intact sequence of Amisk Group metavolcanic rocks east of the north-trending Varnson Lake fault and south of Chisel Lake (Table GS-12-1; Preliminary Map 1987S-1, Bailes, 1987). Facies equivalents and more complexly folded and structurally dismembered portions of this same sequence occur between the Varnson and Kobar Lake faults and north of Chisel Lake. Metavolcanic rocks west of the Kobar Lake fault are dissected by numerous faults which inhibit documentation of stratigraphy and correlation of strata with those to the east.

Regional metamorphic grade increases from middle greenschist facies at the south boundary of the map area to middle and upper almandine-amphibolite facies at the north. Most primary textures and structures have been destroyed in recrystallized rocks in the northern third of the map area and this, combined with poorer outcrop exposures and generally higher level deformation, has resulted in less control on stratigraphy and structure.

SOUTH OF CHISEL LAKE

The section south of Chisel Lake tops and dips steeply to moderately to the north, except south of the Sneath Lake pluton and north of Lost Lake. South of the Sneath Lake pluton they top and dip steeply to the west and are crosscut at a high angle by the pluton. North of Lost Lake strata are deformed by west to northwest-trending F_1 folds and by north-northeast-trending F_2 folds which interfere to produce shallow dips and structural repetition of the section.

The 3300 m of sparsely pyroxene-phyric and aphyric mafic flows, exposed at the base of the mapped section, are typically more massive lower in the section and pillowed with locally abundant amoeboid pillow breccia towards the top. Sparsely pyroxene-phyric flows (1-3% pyroxene, 0.5-2 mm), which occur sporadically throughout the section, are most abundant around Welch and Stroud Lakes. Strongly porphyritic flows are abundant near the top of the section east of Stroud Lake.

Up to 750 m of quartz-phyric, quartz-plagioclase-phyric and aphyric felsic flows are exposed between the sparsely porphyritic mafic flows (previously described) and an overlying unit of aphyric pillowed mafic flows (Table GS-12-1). The largest accumulation of these flows occurs south and southwest of Daly Lake. The flows are composed of white lobate bodies of massive rhyolite, monolithologic rhyolite breccia and light grey recrystallized microbreccia (Fig. GS-12-2). The flows, which may contain up to 10% quartz (0.5-3 mm) and 5% plagioclase phenocrysts (0.5-1 mm), are interpreted to be part of a subaqueous rhyolite extrusive complex by analogy to descriptions of such deposits given by de Rosen-Spence et al. (1980) and Furnes et al. (1980).

Overlying the rhyolite flows are 300-1000 m of aphyric pillowed flows which are characterized by local prominent silicification (Fig. GS-12-3). The silicification has not affected overlying units.

North of Stroud Lake up to 300 m of intermediate to mafic greywacke, siltstone and mudstone overlies the aphyric mafic flows. They are characterized by disseminated pyrite and pyrrhotite, and a single 3 m wide zone of massive pyrrhotite with trace zinc, copper and lead (D. Ziehlke, pers. comm. 1986). The sediments are fine grained and well bedded, with bed forms and primary structures typical of turbidity current deposits. Although the sediments pinch out to the east, the associated barren sulphide zone can be traced over 9 km in diamond drill holes and geophysical expression to correlate with barren sulphides 10 m stratigraphically above the Anderson Cu-Zn sulphide deposit (D. Ziehlke, pers. comm., 1986).

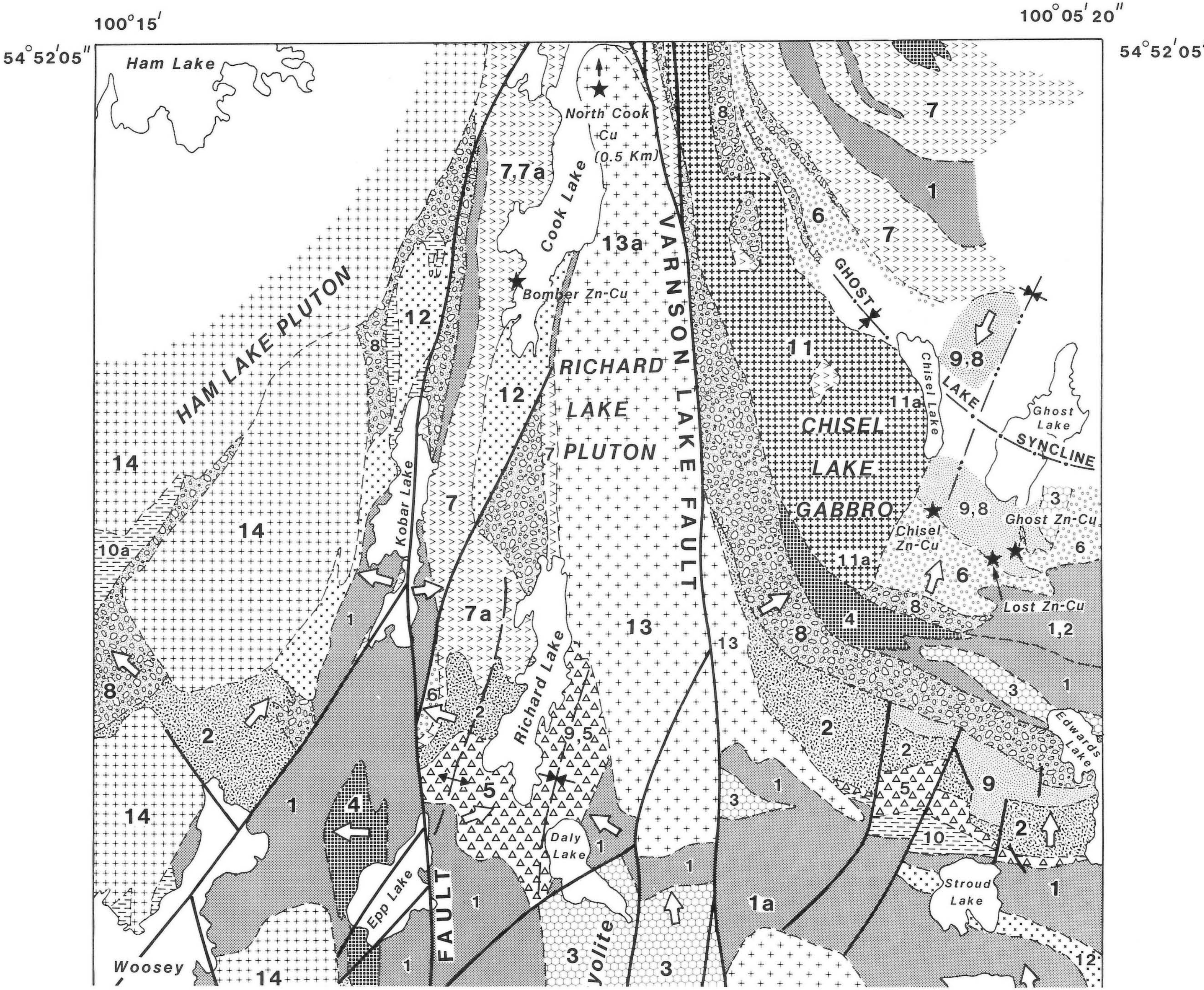
Stratified heterolithologic and monolithologic felsic breccia and wacke are locally intercalated with sulphide-bearing intermediate to mafic volcanic wacke, siltstone and mudstone and form a 100-300 m thick unit north of Stroud Lake. Felsic breccia beds in this unit range in thickness from less than 1 m to more than 20 m. Their bed organization is consistent with deposition from subaqueous debris flows (Bailes, 1986; Skirrow, 1987). Similar to the underlying volcanic wacke unit, this unit decreases in thickness to the east.

A distinctive 200-500 m thick unit of plagioclase and plagioclase-pyroxene-phyric and glomerophyric mafic flows overlies the felsic breccias. Flows are commonly thick (up to 100 m), massive and/or pillowed, with few vesicles. Massive portions of thick flows are gabbroic textured.

TABLE GS-12-1
STRATIGRAPHY OF THE SOUTH CHISEL LAKE SECTION

Thickness (metres)	Unit No. (Preliminary Map 1987S-1)	Lithology
Ghost Lake syncline		
200	10	**Mafic wacke, tuff breccia and lapilli tuff,** minor pillowed porphyritic mafic flows; well stratified with turbidite bedforms and local accretionary lapilli
0 — 30		**Massive Zn-Cu sulphides** (Chisel-Lost-Ghost zone)
0 — 100	7	**Aphyric, plagioclase-phyric and quartz-phyric subaqueous rhyolite flow(s)**
100 — 250	13	**Plagioclase-phyric dacite tuff and lapilli tuff,** minor stratified heterolithic breccia; forms footwall to Chisel-Lost-Ghost Zn-Cu zone
100 — 150	1, 3, 15	**Mixed unit of mafic flows and coarse volcaniclastics;** aphyric and plagioclase-phyric pillowed flows with intercalated monolithologic and heterolithologic breccia
0 — 200	8	**Quartz-phyric to aphyric felsic flow,** characterized by chlorite-amphibole-filled vesicles
250	1, 1b	**Aphyric pillowed mafic flows and amoeboid pillow breccia;** characterized by high vesicularity and radial pipe vesicles.
250	16a	**Heterolithologic volcanic breccia,** minor intercalated mafic wacke; stratified with 1 to more than 35 m thick beds; includes both mafic and felsic debris with mafic detritus more prominent
0 — 400	12a	**Mafic volcanic wacke** and minor breccia
200 — 500	3, 4	**Plagioclase and plagioclase-pyroxene-phyric massive and pillowed mafic flows;** flows are up to 100 m thick
100 — 300	14	**Stratified heterolithologic and monolithologic felsic breccia and wacke;** beds up to 20 m thick, minor mafic wacke
0 — 300	17	**Intermediate to mafic greywacke, siltstone and mudstone turbiditite** locally iron sulphidic, barren sulphide zone
300 — 1000*	1	**Aphyric pillowed mafic flows;** locally strongly silicified
0 — 750*	7	**Quartz, quartz-plagioclase and aphyric subaqueous rhyolite flows,** minor breccia
3300	2	**Sparsely pyroxene-phyric and aphyric massive and pillowed mafic flows,** minor strongly porphyritic flows
Limit of mapping		

* Includes portions of these units exposed south and southwest of Daly Lake.



100°15′
100°05′20″
54°52′05″
54°52′05″
Ham Lake
HAM LAKE PLUTON
North Cook Cu (0.5 Km)
Cook Lake
7,7a
Bomber Zn-Cu
RICHARD LAKE PLUTON
VARNSON LAKE FAULT
13a
13
12
8
7
7a
14
10a
Kobar Lake
Richard Lake
9,5
5
6
2
1
4
Daly Lake
Epp Lake
FAULT
Woosey
3
yolite
1a
11
11a
CHISEL LAKE GABBRO
Chisel Lake
GHOST LAKE SYNCLINE
Ghost Lake
9,8
Chisel Zn-Cu
Ghost Zn-Cu
Lost Zn-Cu
1,2
Edwards Lake
9
10
Stroud Lake

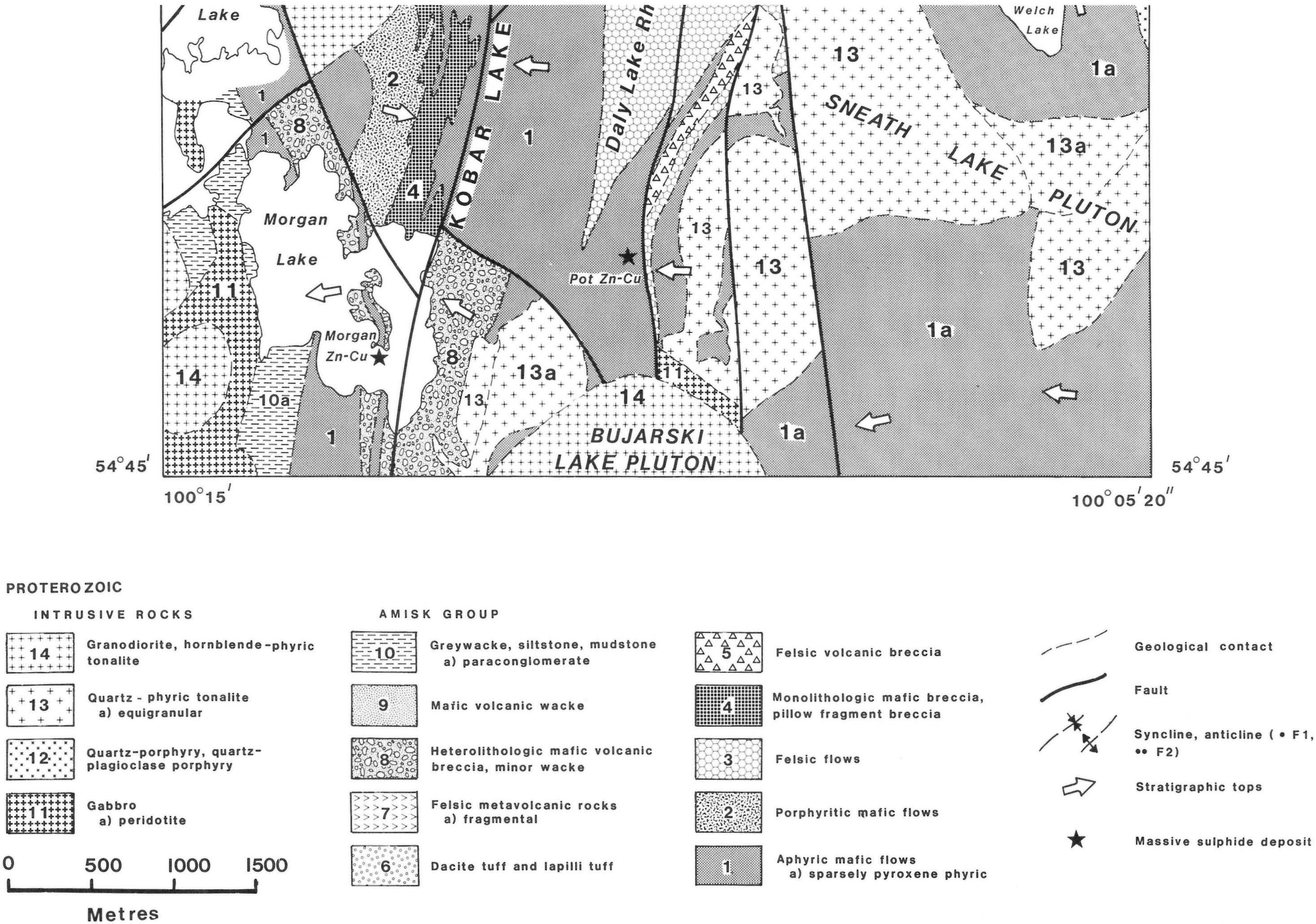


Figure GS-12-1: Simplified geology of the Chisel-Morgan Lakes area.

Figure GS-12-2: *Lobate massive rhyolite bodies (with dark margins) hosted by rhyolite breccia and microbreccia, 350 m south of Daly Lake.*

Figure GS-12-3: *Pillows with silicified margins, aphyric mafic flows 400 m north-northeast of Daly Lake.*

Up to 400 m of fine grained mafic volcanicastic sediments overlie the porphyritic mafic flows north of Stroud Lake. Abrupt lateral changes in thickness and distribution of this unit, which are not reflected in the overlying heterolithic mafic breccia (Fig. GS-12-1), indicate deposition of this unit may have been controlled by topographic basins formed by synvolcanic faults. Skirrow (1987) notes an upward change in these mafic volcaniclastics from pyroxene phenoclast-bearing massive wacke and breccia, to massive bedded siltstone and wacke, to plagioclase phenoclast-bearing massive wacke and breccia.

Heterolithologic volcanic breccia overlies the mafic volcanic wacke north of Stroud Lake but to the west is deposited directly upon porphyritic mafic flows. The boundary with the underlying mafic volcanic wacke is marked by an increase in heterogeneity of the clast population in the breccias (particularly an increase in felsic volcanic clasts), an abrupt increase in maximum clast size, and a change in weathering colour from dark green and green-black to light brown-green (Skirrow, 1987). Breccia beds are composed mainly of plagioclase-phyric mafic lava, with lesser amounts of plagioclase-pyroxene-phyric and fine grained mafic and felsic volcanic clasts. Most beds are 1-20 m thick; Skirrow (1987) reports one 60 m bed. Organization of breccia beds is consistent with deposition by subaqueous debris flows (Bailes, 1986; Skirrow, 1987).

Aphyric subaqueous mafic flows and related breccia form a 150 m thick unit overlying the heterolithologic volcanic breccias. Substantial portions of this unit are amoeboid pillow breccia. Pillowed portions are characterized by abundant vesicles, including many 2-3 cm long radial pipe vesicles. Many vesicles are filled by chlorite and amphibole, in contrast to quartz-filled vesicles in underlying formations. A change from mainly flows to pillow fragment breccia and monolithologic mafic breccia occurs west of the railway track (Preliminary Map 1987S-1). East of the railway track, up to 200 m of quartz-phyric to aphyric felsic rocks, containing 5-10% 2-7 mm chlorite-amphibole filled vesicles, occur within the aphyric flow unit. Because of the high content of large vesicles this felsic rock formation is interpreted to be an extrusive flow.

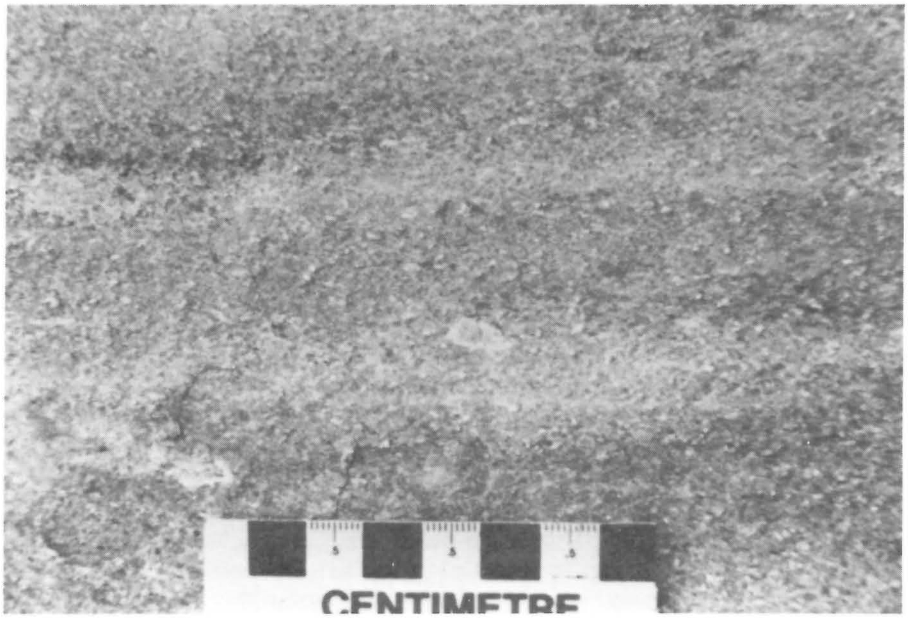


Figure GS-12-4: Dacite tuff containing angular, white weathering, felsic fragments, 650 m southwest of Chisel Lake Mine.

Overlying the aphyric mafic flows is a 100-150 m thick mixed mafic volcanic unit composed of intercalated coarse heterolithologic mafic volcanic breccia, monolithologic aphyric and porphyritic mafic volcanic breccia, and aphyric and porphyritic mafic pillowed flows and related amoeboid pillow breccia. Flows decrease in abundance to the west, and west of the railway track the unit consists mainly of breccia. Northwest of Edwards Lake, this unit is characterized by 30-40% 1-3 mm dark green amphibole porphyroblasts, interpreted to be caused by synvolcanic hydrothermal alteration and subsequent recrystallization during regional metamorphism.

A 100-250 m thick unit of plagioclase-phyric and rare plagioclase-quartz-phyric dacite tuff and lapilli tuff forms the stratigraphic footwall to the Chisel Lake, Lost Lake and Ghost Lake Zn-Cu massive sulphide deposits. Heterolithic debris flow breccia beds, composed of mixed felsic and mafic detritus, are locally intercalated with the dacite tuff. The dacite tuff is typically a massive, pale buff to buff pink weathering unbedded rock with 5-15% 0.5-2 mm tablet-shaped plagioclase phenocrysts. It locally contains angular white weathering plagioclase-phyric lithic felsic fragments (Fig. GS-12-4) and is occasionally well bedded. The dacite tuff is identical in chemical composition to a high-TiO_2 dacite dyke complex located west of Edwards Lake (Skirrow, 1987). Skirrow interprets the dacite tuff to be the extrusive equivalent of the high TiO_2 felsic intrusions because of their unusual, similar compositions. This interpretation is supported by the fact that dacite dykes are present in all formations underlying the dacite tuff but do not occur in stratgraphically overlying formations.

North of the Ghost Lake Zn-Cu orebody, the dacite tuff is overlain by up to 100 m of rhyolite. The rhyolite is typically massive, strongly recrystallized and varies from aphyric to quartz and plagioclase-phyric. In one locality it consists of massive, white lobate bodies of rhyolite in monolithic felsic breccia and microbreccia. The rhyolite resembles subaqueous flows described by de Rosen-Spence et al. (1980) and Furnes et al. (1980).

Massive Zn-Cu sulphides, belonging to the Chisel, Lost and Ghost deposits, occur only south of the aforementioned rhyolite flow(s) where they directly overlie dacite tuff. The Ghost, Lost and more easterly ore lenses of the Chisel deposit are overlain by a 0.5-10 m thick unit of coarse felsic breccia (Bailes et al., 1987) composed of angular to highly irregular quartz feldspar-phyric fragments. These fragments could possibly have been derived from the rhyolite flows north of the Ghost deposit. The massive sulphides themselves are up to 30 m thick in the Chisel Lake deposit and display an upward increase in Zn/Cu ratio. Western ore lenses in the Chisel Lake deposit have footwall alteration zones whereas those to the east, including the Lost and Ghost deposits, have no associated footwall alteration (N. Provins, pers. comm., 1987).

Over 200 m of well stratified mafic volcanic wacke, breccia, tuff and lapilli tuff, and minor porphyritic pillowed mafic flows, overlie the Chisel-Lost-Ghost mineralized zone. The mafic volcaniclastic rocks are characterized by excellent graded bedding, sccur channels, crossbedding and load structures, and were likely deposited from turbulent density currents (Fig. GS-12-5). The monolithologic character of many beds and the local presence of accretionary lapilli (Fig. GS-12-6) suggest that at least some of these volcaniclastic rocks are pyroclastic in origin and were erupted subaerially. Both the volcaniclastic rocks and associated mafic flows are pyroxene-plagioclase-phyric. They are all characterized by absence of the hydrothermal alteration that affects so many of the rocks in the footwall to the Chisel-Lost-Ghost zone.

Indication of transport direction, for example, budding direction of pillows, crossbedding and lateral thinning or pinching out of units, suggest that from the base of the section to the heterolithologic volcanic breccia west of Edwards Lake the paleoslope is predominantly easterly dipping. Paleoslope indications from this point to the Chisel-Lost-Ghost mineralized zone are rare but those observed indicate a westerly component of transport. The mafic volcaniclastics at the top of the section show many indications of a westerly source with transport directions consistently toward the east.

NORTH OF CHISEL LAKE

The section north of Chisel Lake is quite different from the section to the south. It is composed primarily of nondescript aphyric and quartz-phyric massive felsic metavolcanic rocks and local units of strongly deformed, flattened felsic breccia. Other rocks include recrystallized aphyric mafic flows and breccia, scattered small units of mafic porphyritic breccia and a narrow unit of dacite tuff.

Determination of the stratigraphic position of these rocks relative to the well documented section south of Chisel Lake is hampered by an absence of facing directions in these poorly exposed, tectonized and recrystallized rocks, and by a lack of correlatable units. Nevertheless, two lines of evidence suggest that the north Chisel section is part of the foot-

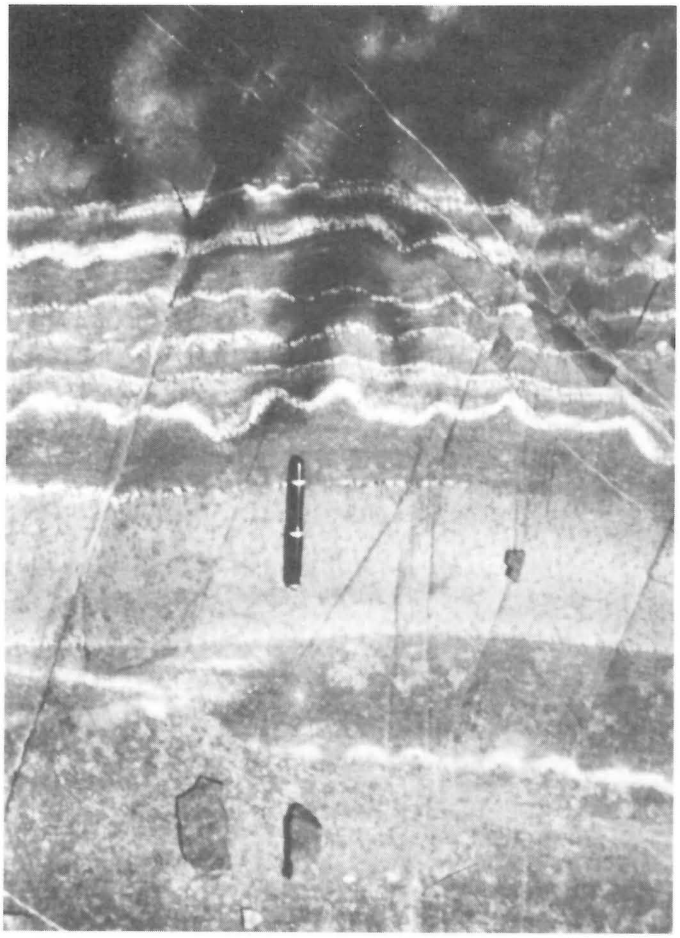


Figure GS-12-5: *Bedded mafic volcaniclastic rocks displaying graded bedding and a scour channel, 1.2 km east of Chisel Lake Mine.*

wall to the Chisel-Lost-Ghost zone and as such is probably a lateral facies equivalent of the south Chisel section:

1) south and south-southwest-facing beds in well preserved mafic volcaniclastics northeast of Chisel Lake indicate the presence of a major northwest-trending F_1 syncline (Ghost Lake syncline) through Chisel and Ghost Lakes. This structure should repeat footwall strata on its northeast limb.

2) many rocks north of Chisel Lake are hydrothermally altered (Preliminary Map 1987S-1) and as such should belong to the footwall of the Chisel-Lost-Ghost zone (alteration is restricted to footwall rocks in the section south of Chisel Lake).

It is not known whether the north Chisel section is monoclinal southwest-facing or whether it is structurally repeated by other F_1 folds north of the Ghost Lake syncline. However, a facies change in the north Chisel section to a volcanic regime with more abundant felsic volcanism is probable.

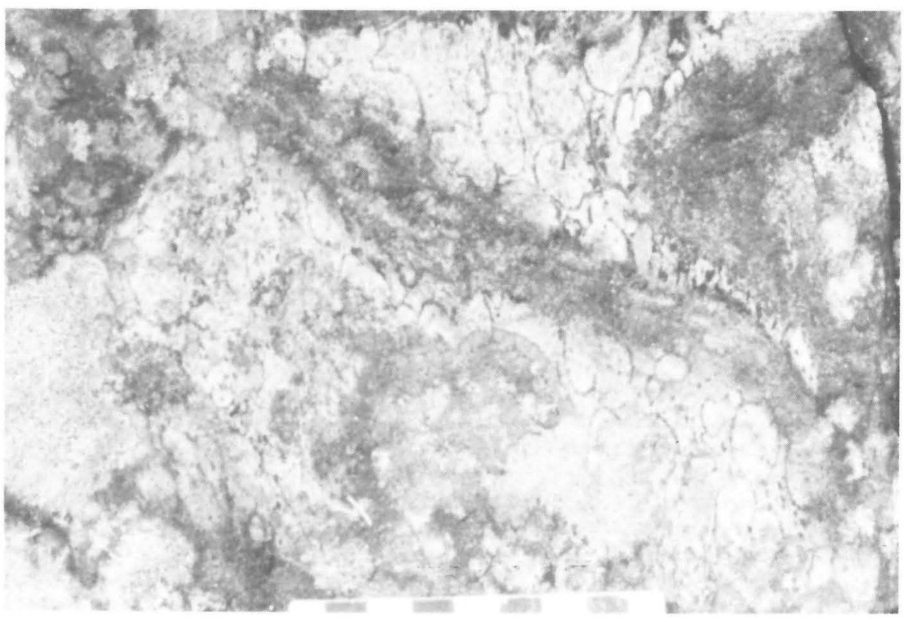
RICHARD AND COOK LAKES

The Richard-Cook Lakes area is separated from the Chisel Lake area by the Richard Lake pluton and the younger north-trending Varnson Lake fault. Offset on the fault is left lateral with approximately 1.5 km of apparent horizontal movement and an unknown component of vertical offset involving relative east side down movement. Rock formations exposed on Richard Lake correlate with the Stroud-Edwards Lake portion of the south Chisel section, whereas those on Cook Lake are similar to the north Chisel section. The Bomber Zn-Cu and North Cook Cu-Zn massive sulphide deposits occur in the Cook Lake section.

On Richard Lake a north-younging section is tightly folded about north-northeast-trending and moderate to steeply north-plunging folds. Dacite tuff, 600 m west of Richards Lake, may be equivalent to the dacite tuff in the footwall to the Chisel-Lost-Ghost Zn-Cu zone. If so the tuff indicates that most of the strata overlying the porphyritic mafic flows, between Edwards and Chisel Lakes, is missing in the section at Richard Lake.

At Cook Lake quartz-phyric, quartz-plagioclase-phyric and aphyric felsic metavolcanics and tectonically flattened felsic breccia form over 75% of exposed rocks. Primary orientation and facing direction of these

Figure GS-12-6: *Accretionary lapilli in mafic tuff, 1.8 km north of Chisel Lake Mine.*



rocks is largely unknown. The only indicators of primary trend of rock formations are north-northeast-trending units of heterolitholgic mafic breccia and massive mafic flows west of Cook Lake. On the north shore of Cook Lake, 650 m north of the map boundary and at a locality west of the North Cook Cu-Zn sulphide deposits, two west-topping north-trending debris flow beds were observed.

The relationship between the felsic breccias and massive felsic metavolcanic rocks on Cook Lake and the quite different north younging volcanic section on Richard Lake is unclear due to poor exposures and numerous intrusions between the two areas. Abrupt truncation of units and fold structures suggest the two sections are probably separated by a fault.

FELSIC PLUTONS

Felsic plutonic rocks include early tectonic, possibly synvolcanic, bodies as well as late to post-tectonic intrusions. The late tectonic intrusions do not contain the distinctive hydrothermal alteration characteristic of the early tectonic intrusion (Bailes, 1986), are generally much less foliated and deformed, and are lithologically much more diverse.

One of the early tectonic intrusions, the Sneath Lake pluton (Fig. GS-12-1), is generally considered to be synvolcanic and to be the "heat engine" that drove the hydrothermal system responsible for base metal volcanogenic sulphide deposits and associated alteration in the Snow Lake area (Walford and Franklin, 1982; Bailes, 1986; Bailes et al. 1987). Mapping in 1987 has more clearly defined the internal character of this and similar plutons, more precisely documented their relationship to host volcanic strata, and raised some reservations about their synvolcanic age.

The Sneath Lake pluton has an unusual shape with a width averaging 1.5 km and a strike length of more than 14 km. It is generally considered to be a single, more or less conformable sill (Harrison, 1949; Bailes, 1986). However, mapping in 1987 indicates that this body is more likely a string of individual but genetically related intrusions, some of them truncating host volcanic stratigraphy at a high angle. All of the phases display Fe and Mg alteration along and adjacent to fractures and anastomosing vein systems. The timing of this alteration is early as it is common for younger unaltered phases to contain xenoliths of older altered tonalite. The quartz-phyric tonalite body south-southeast of Welch Lake truncates volcanic formations at a high angle; it is unclear whether the volcanic rocks were folded prior to or during emplacement of the intrusion.

The Richard Lake pluton texturally resembles the Sneath Lake tonalite and is also a multicomponent intrusion containing older altered tonalite xenoliths in younger phases. However, unlike the Sneath Lake pluton, it has no discrete, texturally distinct, mappable subdivisions. It also has a number of relationships with host strata that are difficult to reconcile with the synvolcanic age touted for the Sneath Lake pluton; for example:

1) it appears to postdate the Chisel-Lost-Ghost mineralizing event as it cuts the footwall alteration zone, and
2) it appears to truncate folded supracrustals at Daly Lake.

HYDROTHERMALLY ALTERED ROCKS

Both supracrustal rocks and early tectonic (synvolcanic?) tonalite plutons are altered in the Chisel-Morgan Lakes area. Between 10 and 20% by volume of both the supracrustal and tonalite plutons are altered. The alteration includes Fe-Mg metasomatism, silicification, and minor epidotization and pyritization. Metamorphically recrystallized Fe-Mg metasomatized rocks are characterized by abundant chlorite, garnet, staurolite, anthophyllite and actinolite.

A footwall Fe-Mg enriched alteration zone has been traced in drilling for approximately 1000 m stratigraphically below the Chisel Lake Zn-Cu deposit (G. Kitzler, pers. comm. 1986) and appears to connect at depth with a more regionally disposed semi-conformable zone of alteration (Skirrow, 1987; Bailes et al. 1987; Preliminary Map 1987S-1). This alteration zone is not observed in rocks that stratigraphically overlie the deposit, an observation consistent with the widely accepted view that such alteration is a product of synvolcanic hydrothermal solutions that passed through footwall rocks to deposit massive sulphides at the seafloor/seawater interface. The implication is that synvolcanic hydrothermal activity has affected large portions of both the supracrustal rocks and early tectonic tonalite plutons in the project area.

Four major zones of Fe-Mg metasomatism are recognized: Chisel Lake, Cook Lake, Parisian Creek and Hirst Lake. The Chisel, Cook and Hirst zones all are known to have associated base metal sulphide deposits. The Parisian Creek zone has no documented occurrences of sulphide mineralization, possibly because the upper part of this stratigraphic section has been invaded by the Ham Lake pluton.

In the relatively well studied lower conformable alteration zone below the Chisel deposit, it can be demonstrated that the alteration zone crosscuts stratigraphy at a shallow angle such that its upper surface is between 0.6 and 0.7 km directly below the Chisel deposit but to the southeast, at Edwards Lake, is over 1.5 km below the deposit (Skirrow, 1987; Bailes et al., 1987). Of interest is the lateral variation of the alteration zone from Fe-Mg metasomatized rocks at Chisel Lake to mainly silicified rocks to the southeast at Edwards Lake. Geochemical study of the silicification by Skirrow (1987) indicates that Fe, Mg, Zn and other elements were leached from these rocks. Skirrow hypothesizes that these elements may have moved up through the semiconformable alteration zone to be deposited in the stratigraphically higher zone of Fe-Mg metasomatism and the sulphide deposit itself. Thus silicification, as well as Fe-Mg metasomatism, is an important part of the hydrothermal/mineralization process responsible for base metal massive sulphide deposition.

STRUCTURAL GEOLOGY

FOLDING

Two phases of folding are recognized in the project area, belonging to the F_1 and F_2 events of Froese and Moore (1980). Of interest is the fact that the west and northwest-trending F_1 Ghost Lake syncline interferes with north-northeast-trending F_2 structures, in the Ghost and Chisel Lakes area, forming flat lying bedding surfaces in a structural basin northwest of Chisel Lake and in a col structure southeast of Ghost Lake. In the col structure, F_1 minor folds have a steeply north-dipping axial planar S_1 foliation and shallow-plunging, west-trending fold axes. The implication is that:

1. F_1 fold structures are south vergent; and
2. F_1 fold structures probably had near-horizontal and westerly trending fold axes prior to F_2 folding.

Although F_1 fold structures have not been mapped elsewhere in the project area, S_1 foliations are prominent, particularly in rocks in the northern one-third of the map area (see also Froese and Moore, 1980). On Cook Lake, just north of the map sheet, S_1 foliations dip 15° to 20° to the north and are folded about a north-trending F_2 antiformal structure with a steeply dipping, north-striking, axial planar foliation. In both the Cook and Chisel Lakes area, the presence of early F_1 folds is economically significant since both areas contain massive base metal sulphide deposits.

Froese and Moore (1980) note that the younger F_2 folds open and die out to the south in the Snow Lake area. This also appears to occur south of Ghost Lake where there is no expression of F_2 folds except for a penetrative, steeply dipping, axial planar schistosity trending at 015° to 025°.

The timing of regional metamorphism relative to folding has generally been considered to be syn- to post-F_2 (Bailes, 1980; Froese and Moore, 1980). However, fabrics in the Chisel Lake area indicate that metamorphism may predate F_2 (Fig. GS-12-7).

FAULTING

Several major faults, some juxtaposing strata with opposing facing directions, occur in the Chisel-Morgan Lakes area. The faults post-

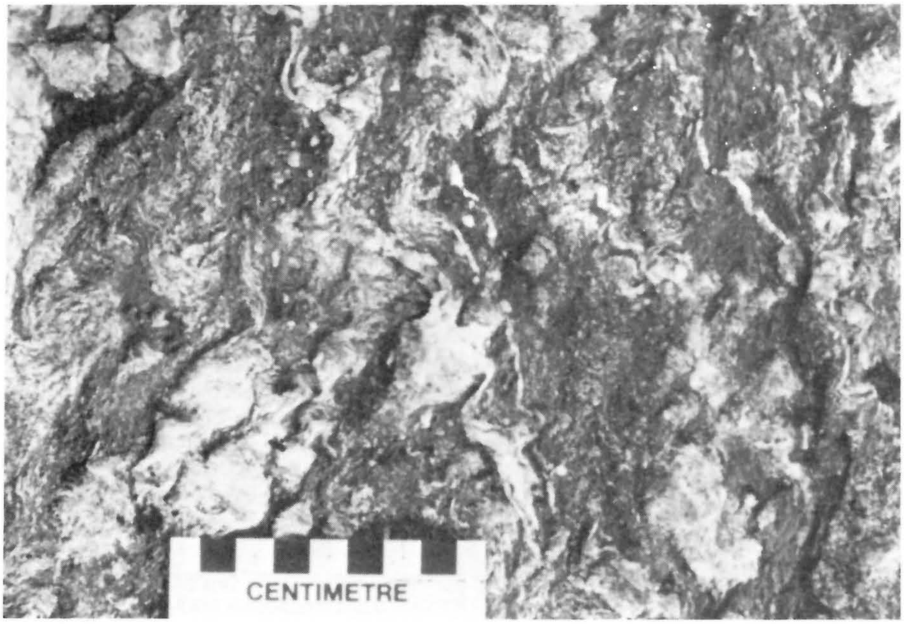


Figure GS-12-7: *F_2 crenulated quartz veinlets cutting across large anhedral regional metamorphic garnet porphyroblasts.*

date F_1 and F_2 folds, offset regional metamorphic isograds, and postdate most late tectonic felsic plutons (with the possible exception of the one at Bujarski Lake). Lack of associated shear foliation suggests that rocks behaved in a brittle manner during faulting (i.e. were at a high crustal level).

Faults are identified by stratigraphic discontinuities, and in some instances, by associated topographic linears. Where rock formations trend at a high angle to faults, the faults are easily delineated (e.g. Varnson Lake fault). Where formations parallel the faults, they are difficult to identify (e.g. north half of Kobar Lake fault).

Galley et al. (1986) have shown that gold mineralization postdates regional metamorphism and is fault-controlled in the Snow Lake area. However, it is not clear at this time whether the late tectonic fault structures in the Chisel-Morgan Lakes area are also possible hosts for gold. The absence of gold showings in proximity to these faults suggests it is unlikely that they are mineralized.

ECONOMIC GEOLOGY

An important purpose of this mapping program is to establish the stratigraphy of Amisk Group metavolcanic rocks and to place volcanogenic base metal mineralization in this stratigraphic framework. In this context, the possible stratigraphic equivalence of the barren sulphide zone between Stroud Lake and Edwards Lake with another barren sulphide zone in the stratigraphic hanging wall of the Anderson Lake base metal deposit (Ziehlke, pers. comm. 1986) is important. It would imply that:

1) the Anderson "zone" occurs in one of the lowest three formations listed in Table GS-12-1;
2) the Chisel, Lost and Ghost Zn-Cu massive sulphide deposits occur higher in the section (Table GS-12-1) than the Anderson, Stall, Ram, Rod and Linda Cu-Zn massive sulphide deposits; and
3) a much thicker section of volcanic rocks was deposited in the Chisel Lake than in the Anderson Lake area.

It is interesting to speculate on the possible position of the Anderson "zone" in the Chisel-Morgan Lakes area, as this could have important economic ramifications. One possible position for the Anderson "zone" is atop the lowermost unit of sparsely pyroxene-phyric mafic flows (Table GS-12-1), at the same stratigraphic position as the rhyolite flows located south of Daly Lake. Local, prominent zones of Fe-Mg alteration associated with the rhyolite flows south of Daly Lake (Preliminary Map 1987S-1) should therefore bear consideration when targeting exploration activity in the Chisel-Morgan Lakes area.

REFERENCES

Bailes, A.H.

1980: Geology of the File Lake area; Manitoba Mineral Resources Division Geological Report 78-1, 134 p.

1986: Chisel-Morgan Lakes project; Manitoba Energy and Mines, Report of Field Activities 1986, p. 70-76.

1987: Chisel-Morgan Lakes area; Manitoba Energy and Mines, Preliminary Map 1987S-1.

Bailes, A.H., Syme, E.C., Galley, A.G. and Skirrow, R.G.

1987: Early Proterozoic volcanism, hydrothermal activity and associated ore deposits at Flin Flon and Snow Lake, Manitoba; Field Trip Guidebook 1, Geological Association of Canada, Annual Meeting, Saskatoon, Saskatchewan, 95 p.

Froese, E. and Moore, J.M.

1980: Metamorphism in the Snow Lake area, Manitoba; Geological Survey of Canada, Paper 78-27, 16 p.

Furnes, H., Fridleifsson, I.B. and Atkins, F.B.

1980: Subglacial volcanics — on the formation of acid hyaloclastics; Journal of Volcanology and Geothermal Research, v. 8, p. 95-110.

Galley, A.G., Ziehlke, D.V., Ames, D.E. and Gordon, T.M.
1986: Gold mineralization in the Snow Lake-Wekusko Lake region, Manitoba; **in** Gold in the Western Shield (L.A. Clark, ed.), The Canadian Institute of Mining and Metallurgy, Special Volume 38, p. 379-398.

Harrison, J.M.
1949: Geology and mineral deposits of the File-Tramping Lakes area, Manitoba; Geological Survey of Canada, Memoir 150, 92 p.

Martin, P.L.
1966: Structural analysis of the Chisel Lake orebody; Transactions of the Canadian Institute of Mining and Metallurgy, v. 69, p. 208-214.

de Rosen-Spence, A.F., Provost, G., Dimroth, E., Gochnauer, K. and Owen, V.
1980: Archean subaqueous felsic flows, Rouyn-Noranda, Quebec, Canada, and their Quaternary equivalents; Precambrian Research, v. 12, p. 43-77.

Skirrow, R.G.
1987: Silicification in a semiconformable alteration zone below the Chisel massive sulphide deposit, Manitoba; Unpublished M.Sc. thesis, Carleton University, Ottawa, 171 p.

Walford, P.C. and Franklin, J.M.
1982: The Anderson Lake Mine, Snow Lake, Manitoba, **in** Precambrian sulphide deposits, R.W. Hutchinson, C.D. Spence and J.M. Franklin (eds.); Geological Association of Canada, Special Paper 15, p. 481-523.

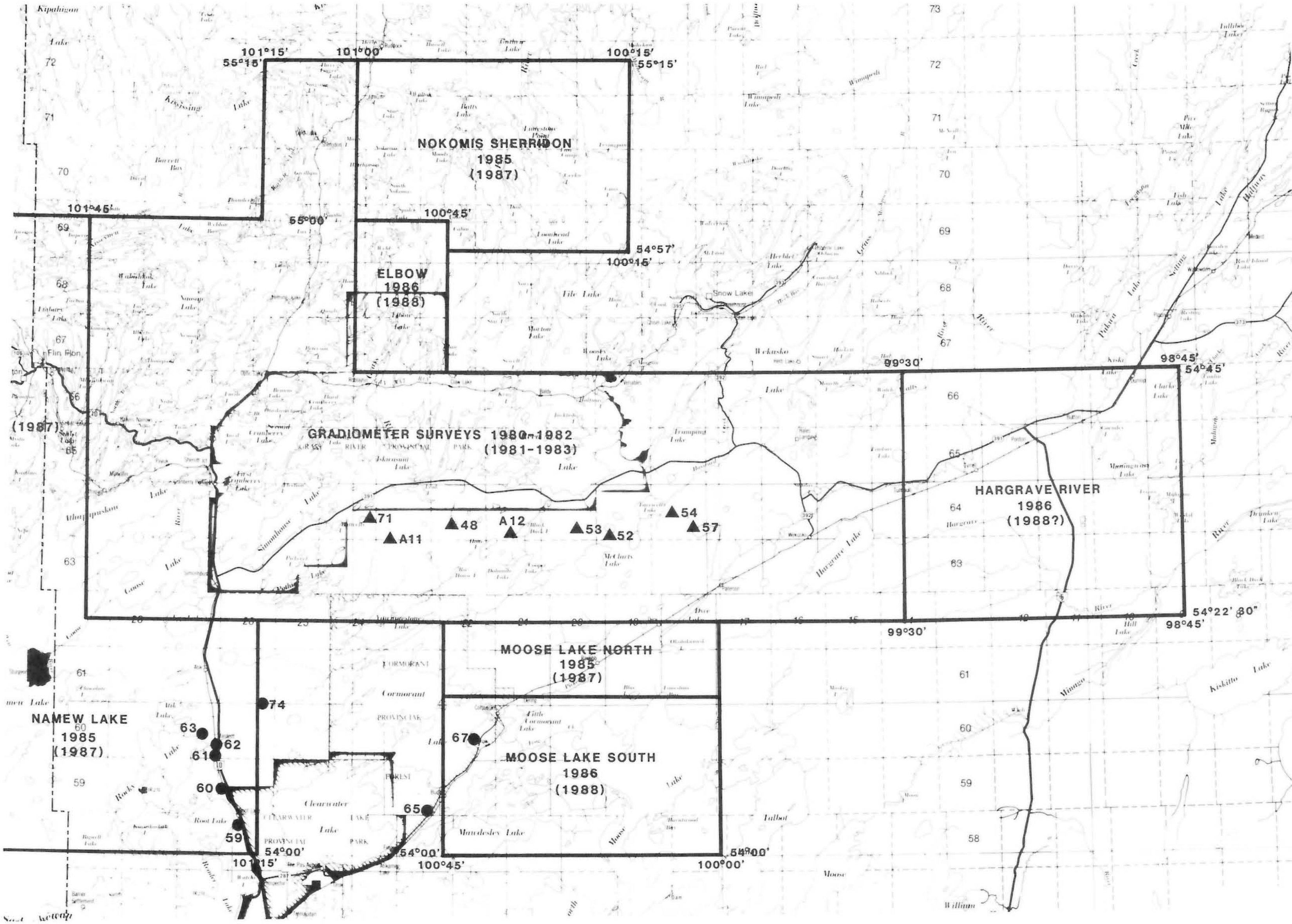


Figure GS-13-1: *Project Cormorant with coverage of GSC airborne gradiometer surveys showing the year flown, and, in brackets, year published. Holes drilled in 1987 by Manitoba Geological Services (circles) and Geological Survey of Canada (triangles).*

GS-13 PROJECT CORMORANT: SUB-PALEOZOIC INVESTIGATIONS SOUTH OF FLIN FLON AND SNOW LAKE

by W. Weber and I.T. Hosain

The Cormorant Project area is now almost completely covered by airborne gradiometer surveys. Black and white 1:20 000 contour maps for the Namew Lake and Moose Lake north areas and the narrow north-south corridor along the Saskatchewan border are being released this fall (Fig. GS-13-1); 1:50 000 Applicon plots for those areas and the remainder of the project, flown in 1986 (Elbow Lake, Moose Lake south and Hargrave River) are in the final compilation stages and should be available in 1988.

Investigations into the sub-Paleozoic Precambrian basement south of Flin Flon-Snow Lake continued and consisted of ground truthing of selected magnetic signatures.

Eight "scout" drill holes were completed by the Province in the southern sector of 63K, between Rocky Lake and Cormorant Lake (Fig. GS-13-1). Most holes were targeted to test adjacent magnetically low and high signatures which were interpreted as felsic gneiss or granite and mafic gneiss, respectively, by Taiga Consultants (1986). A total of over 800 m were drilled yielding approximately 170 m of Precambrian core (Table GS-13-1). An attempt was also made to ground truth an extensive east-west fault zone through Cormorant Lake postulated by Taiga Consultants (1986). However, since ground magnetometer surveys in the Wanless area did not indicate a magnetic target over the postulated shear zone, plans to drill for this target were cancelled.

The thickness of Paleozoic cover is 60-91 m in this area (see Table GS-33-1 for description of Paleozoic core). Kaolinitic zones were intersected in holes 59, 61, 62 and 65, and could be more widespread, since the interval between the base of the Paleozoic and unweathered Precambrian yielded only partial core.

The results of the scout drilling indicate that the majority of the area is underlain by mafic meta-igneous rocks which were apparently "granitized" by younger tonalitic to granitic intrusions. The difference in magnetic signature does not appear to be related mainly to differences in composition, i.e. mafic-felsic as apparently assumed by Taiga (1986) in their compilation. This is not surprising since the cored granitic rocks commonly contain significant amounts of magnetite.

In holes 59, 60, 62 and 65 the mafic rocks are in places hydrothermally altered and contain possibly related sulphide mineralization. Assay data do not indicate that the intersected sulphides are of economic interest.

The Geological Survey of Canada initiated a winter drilling program in early 1987 to ground truth gradiometer signatures in the eastern and central part of 63K (Fig. GS-32-1), in areas which are not accessible for the Provincial trailer-mounted drill. Results of this program are described elsewhere in this volume.

Both Provincial and Federal drilling will continue for at least another year.

During the summer, 55 representative company drill holes were relogged in detail to clarify Taiga's compilation and to obtain material for possible further work, such as metamorphic, geochemical, isotopic and petrological studies.

In addition detailed evaluation of all airborne magnetic data (vertical gradient and total field) has been initiated by the GSC to determine the most likely three-dimensional unit distributions (see report GSC-5, this volume). Provincial and Federal representatives reported on the main aspects of Project Cormorant during the GAC-MAC Annual meeting in Saskatoon (Blair et al. 1987; Weber and Gordon, 1987).

REFERENCES

Blair, B.B., Kornik, L.J. and Gordon, T.M.
1987: Sub-Paleozoic geology of the Cormorant Lake map area: Interpretation based on airborne gradiometer surveys and drill core data; **in** GAC-MAC Joint Annual Meeting, Program with Abstracts, v. 12, p. 25

Taiga Consultants Ltd.
1986: Sub-Paleozoic geology of the Cormorant Lake map area (63K), Manitoba; report and map (1:250 000); Geological Survey of Canada, Open File 1381.

Weber, W. and Gordon, T.M.
1987: Project Cormorant: An attempt to delineate Precambrian basement geology beneath Paleozoic carbonates south of Flin Flon-Snow Lake; **in** GAC-MAC Joint Annual Meeting, Program with Abstracts, v. 12, p. 100.

TABLE GS-13-1
CORMORANT CORE DESCRIPTIONS: PRECAMBRIAN 1987 DRILL PROGRAM

Intervals in Metres	Lithologies, Remarks
	#59 (M-7-87)
106.60 - 107.40	Kaolinitic zone, grading into
107.40 - 108.30	Green weathered biotite gneiss
108.30 - 110.60	Fine grained massive "psammitic", intermediate biotite gneiss with occasional pink pegmatoid "layers"
110.60 - 113.65	Hybrid granodiorite. Paleosome is psammitic biotite gneiss and minor biotite hornblende gneiss amphibolite to metagabbro
113.65 - 117.70	"Psammitic" biotite ± hornblende gneiss with several hybrid granodiorite and pegmatoid layers
117.70 - 140.00	Amphibolite to metagabbro variably granitized to biotite ± hornblende gneiss and injected by granodiorite
117.70 - 119.6 125.70 - 126.40 128.50 - 130.50 131.50 - 133.80 139.0 - 140.0	Mainly metagabbro
118.15 - 118.35	Coarse grained, metagabbro with 1-10% sulphides
121.6 - 121.7	Actinolite and zoisite-rich
125.1 - 125.2 125.6 - 125.8 129.1 - 130.5 132.0 - 132.25 132.3 - 133.9 135.55 - 136.9	Hydrothermally altered: green biotite, saussuritized pink plagioclase, some kaolinitic seams
	#60 (M-6-87)
84.53 - 91.90	Weathered zone of coarse garnet pyroxenite intruded by granitoid mobilizate, locally forming intrusive breccia
91.90 - 103.05	Similar to above but not weathered
93.2 - 93.8 94.45 - 94.75 99.0 - 101.0	Hydrothermally altered, locally carbonatized
99.4 - 100.4	Sulphide-bearing (pyrite + pyrrhotite), generally less than 10%
99.9 - 100.2	10-30% sulphide in mobilizate
103.05 - 105.75	Fine- to medium-grained biotite ± hornblende gneiss (granitized amphibolite) with diffusely bounded granitoid mobilizate
105.75 - 109.70	Garnet-bearing biotite amphibolite to metapyroxenite with granitoid mobilizate
109.70 - 112.30	Similar to 103.05 - 105.75
112.30 - 115.0	Similar to 105.75 - 109.70
	#61 (M-10-87)
ca. 73.00 - 75.35	Kaolinitic shale
75.35 - 77.50	Strongly weathered mafic rock
77.50 - 77.70	Weakly weathered mafic gneiss
77.70 - 98.11	Medium - coarse metagabbroic (hornblende-biotite-plagioclase) gneiss with coarse granitoid ± pegmatite intrusions
79.30 - 80.70	Granodiorite, pegmatite
82.10 - 82.25	Pink pegmatite
83.90 - 84.80	Ultramafic, hornblende-rich
84.80 - 87.30	Mafic to ultramafic, variable composition
94.65 - 98.11	Fine-medium grained, in part finely layered, gneissic

Intervals in Metres	Lithologies, Remarks
	#62 (M-9-87)
63.30 - 66.30	White, coarse kaolinitic zones (This zone may be thinner, since only 1 m of core was retrieved between 63.25 and 66.30; Paleozoic may go deeper than 63.30.)
66.30 - 67.20	Weathered mafic - intermediate, medium grained gneiss
67.20 - 72.80	Intermediate biotite ± hornblende gneiss
71.50 - 72.10	Weakly weathered zone
72.80 - 75.10	Hydrothermally altered coarse granitoid
75.10 - 78.88	Fine grained amphibolite with a few granitoid injections.
	#63 (M-8-87)
62.70 - 63.15	Brownish, highly weathered material
63.15 - 63.30	Weathered mafic rock
63.30 - 77.75	Weakly foliated, medium-coarse grained biotite granodiorite with diffusely defined small pegmatitic phases (layers)
69.40 - 70.60	Pink pegmatite
71.00 - 71.60	Pink pegmatite
	#65 (M-12-87)
ca. 91.00 - 94.00	Coarse whitish kalolinitic zone with sulphide-cemented sandstone concretions (only 5 cm core recovered between 90.55 and 93.60) grading into
94.00 - 94.70	Greenish weathered material
94.70 - 95.15	Medium grained, hydrothermally altered intermediate material
95.15 - 97.00	Feldspar porphyroblastic biotite ± hornblende gneiss

Intervals in Metres	Lilthologies, Remarks
97.00 - 97.00	Amphibolite, granitized?, sphene-rich, locally with garnet?
97.00 - 98.60	Hydrothermally altered, in part "weathered granitized" amphibolite
98.60 - 122.15	Variable granitized amphibolite to feldspar porphyroblastic biotite ± hornblende gneiss with less than 20 cm wide, pink pegmatitic leucogranite, feldspar porphyroblasts up to 10 cm long
102.10 - 103.00 109.90 - 110.20 111.70 - 112.10	Pink foliated granite
	#67 (M-11-87)
72.35 - 73.20	Highly weathered pink granitoid
73.20 - 74.10	Highly weathered white granitoid
74.10 - 81.30	Pink magnetite-bearing leucocratic pegmatitic granite
	#74 (M-13-87)
ca. 75.50 - 77.80	Highly weathered, dark green clay-rich mafic material, grading into
77.80 - 78.80	Slightly weathered amphibolite
78.80 - 82.60	Medium grained amphibolite locally with 1-5% sulphides
82.60 - 83.30	Quartzite, coarse grained sulphides (10% over 5 cm) at contact with
83.30 - 88.30	Pink biotite-magnetite granite
88.30 - 88.90	Amphibolite
88.90 - 90.80	Pink leucogranite
90.80 - 92.82	Light grey biotite granodiorite

GS-14 GEOLOGY OF THE LEO LAKE AREA

by K. Ferreira

A geological mapping program at a scale of 1:2400 was conducted in the area between Flintoba Lake and Leo (a.k.a. Mud) Lake (Fig. GS-14-1). This study is part of a larger project to investigate mineralization associated with one of the largest felsic volcanic sequences in the Flin Flon area that includes the Baker Patton deposit (Hayden-Luck and Gale, 1985; Tannahill and Gale, 1986). Grid lines (baseline at 040°), spaced at 200 feet (61 m) with 100 foot (30.5 m) stations, were used to provide location control during mapping; the grid had been cut by Granges Exploration Ltd. for exploration work.

LITHOLOGY

Felsic volcanic rocks of rhyolitic to rhyodacitic composition are dominantly fragmental with fragment sizes ranging from tuff to tuff-breccia (see Preliminary Map 1987-MI-1; Ferreira, 1987). The abundance, size, and distribution of quartz crystals were instrumental in distinguishing lithological types. Minor quartz-feldspar porphyry intrusive rocks and rhyolite flows are also present. The felsic rocks are bounded by gabbro to the north and west.

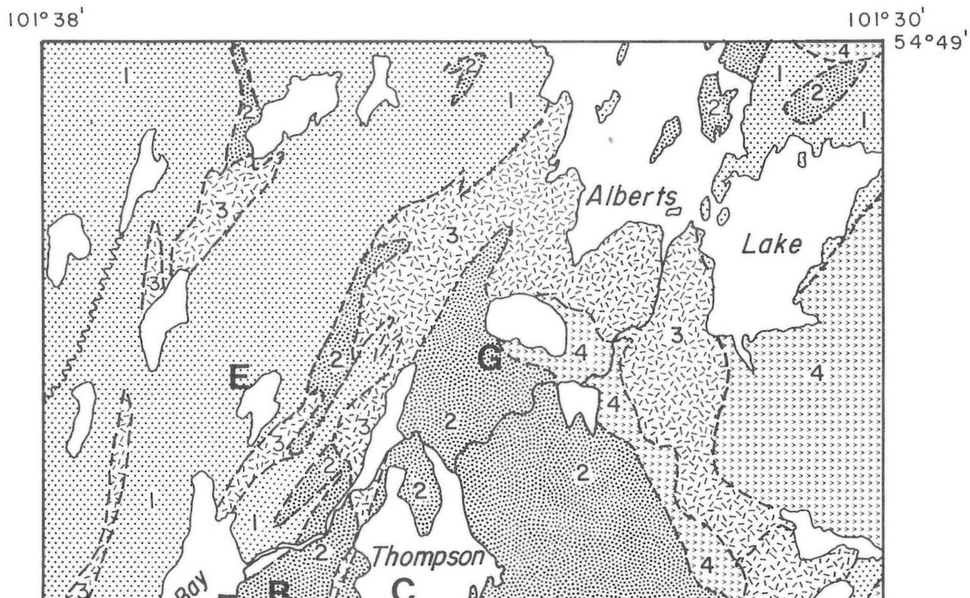


Figure GS-14-1: *Location and regional geology of the Leo Lake map area (after Bateman, 1945). 1. Mafic volcanic rocks; 2. Rhyolite; 3. Gabbro; 4. Porphyritic granodiorite gneiss; 5. Granite 'quartz-eye' porphyry. A. Pine Bay deposit; B. Baker Patton deposit; C. North Star mine; D. Don Jon mine; E. Amulet Lake deposit; F. Cabin Zone deposit; G. Mud Lake occurrence.*

QUARTZ-FELDSPAR PORPHYRY (1)

'Two-quartz' porphyry (1a) weathers creamy white, is aphanitic, and bears 20-25% subhedral quartz crystals in two distinct size ranges: 1-3 mm and 5-12 mm with smaller crystals outnumbering the larger crystals by approximately 2:1. Euhedral prismatic feldspar crystals (10-15%) are up to 1 cm, but average 4 mm. Although the rock appears massive, the quartz crystals are not equidistributed; this may be due to a fragmental texture in which fragment outlines are obscure. The bimodal size distribution of quartz in this unit is similar to a 'two-quartz' rhyolite, an extensive reworked pyroclastic and flow rock in the Baker Patton area (Tannahill and Gale, 1986). The relatively large volume of quartz and the lack of observable flow textures in Unit 1a probably negate a similar mode of emplacement; however, the rocks probably share a common magma source on the basis of the distinctive large size and bimodal size distribution of quartz crystals in both the Baker Patton and Leo Lake areas.

Quartz porphyry (1b) is creamy beige to very light green weathering, aphanitic to fine grained. Uniformly distributed, euhedral to rounded or oval quartz crystals (10%) range in size from 1 to 15 mm with an average size of 5 mm. Microfractures with minute offsets crosscut some crystals. No fragment outlines were observed in this rock.

A third quartz-feldspar porphyry (1c) is exposed at the north edge of the map in contact with gabbro. It contains 10% euhedral and subhedral quartz and 15-20% subhedral to euhedral plagioclase crystals that range in size up to 5 mm (average 1-2 mm) in an aphanitic to fine grained massive matrix. Minor grain size variations are present. Aplite dykes are not common. The contact with gabbro is sharp; the gabbro is chilled over approximately 20 cm and is roughly foliated parallel to the contact.

RHYOLITIC VOLCANIC ROCKS, WITH LESS THAN 2% VISIBLE QUARTZ CRYSTALS (2)

The majority of rocks in the project area are creamy beige weathering fragmental rocks with a very low to absent quartz-crystal population and a large range in fragment size. In addition, many outcrops appear to consist of similar rocks, but lichen cover, rusty weathering surfaces, and deformation mask the textures.

Fragments are predominantly tuff to lapilli-tuff; tuff and tuff-breccia are also present. All fragments are derived from felsic volcanic rocks; accidental clasts of different compositions are absent. Larger breccia-sized fragments may consist of felsic fine grained fragments and are up to 10 cm long. Most large fragments are elliptical and elongated in the direction of the axial cleavage.

Quartz crystals are usually absent; where present, they constitute less than 2% of the rock. Most commonly they are enclosed within lapilli- or breccia-sized fragments and yield an inhomogeneous distribution of quartz crystals on the outcrop. In most places, the matrix is indistinguishable from fragments on outcrop. Where discernible, it weathers light brown or reddish-brown and is very fine grained.

Ovoid structures with uniform composition, possibly accretionary lapilli (average 2.5 mm) are present in a 60 cm thick bed within an area of tuff to fine lapilli-tuff of similar felsic composition west of the north end of Flintoba Lake. Grading was not observed in that bed.

Lithophysae are present in an outcrop at about 20N/156E (Fig. GS-14-2). They are brownish, negative weathering, rounded to irregularly shaped areas 0.3-2.5 cm across that are surrounded by a bleached rim 2-4 mm in width. They are clustered in large areas on outcrop and in places constitute up to 5% of the rock. Suspected spherulites are also present in clusters on this outcrop. These structures are round to slightly ovoid quartz bodies 5-10 mm in diameter. Not all of the quartz present in this outcrop is spherulitic; less than 5 mm, euhedral and subhedral clear quartz is concentrated in local areas that possibly represent fragments. In addition, there are brownish, thin, fine grained tuff lenses up to 20 cm long. If this rock is indeed fragmental, the presence of lithophysae would indicate that it was a welded tuff.

Whole rock silicate analyses indicate that these rocks are rhyolitic (Table GS-14-1).

RHYOLITIC-RHYODACITIC VOLCANIC ROCKS, WITH GREATER THAN 2% VISIBLE QUARTZ CRYSTALS (3)

Volcanic rocks with greater than 2% quartz crystals weather creamy white to very light beige. They are fragmental, with a range of fragment sizes from tuff to tuff-breccia, most commonly tuff to fine lapilli-tuff, and lesser massive rocks, probably flows. Fragments, where discernible, are similar in shape and size to those in the less quartzose rhyolite (2). Matrix is rarely distinguishable from fragments; where it is observed, it is a reddish brown, very fine grained tuff.

Quartz is present as free crystals, particularly in crystal tuff beds where quartz crystals constitute up to 20% of the rock volume. Quartz is also enclosed within clasts of felsic material; these clasts have both massive and fragmental internal textures. The distinctive bimodal quartz population observed in Unit 1a is also present in quartz crystal tuffs and breccias containing 'two-quartz' fragments (3a). These latter breccias also contain aphyric fragments and/or quartz-phyric fragments whose quartz population is not bimodal.

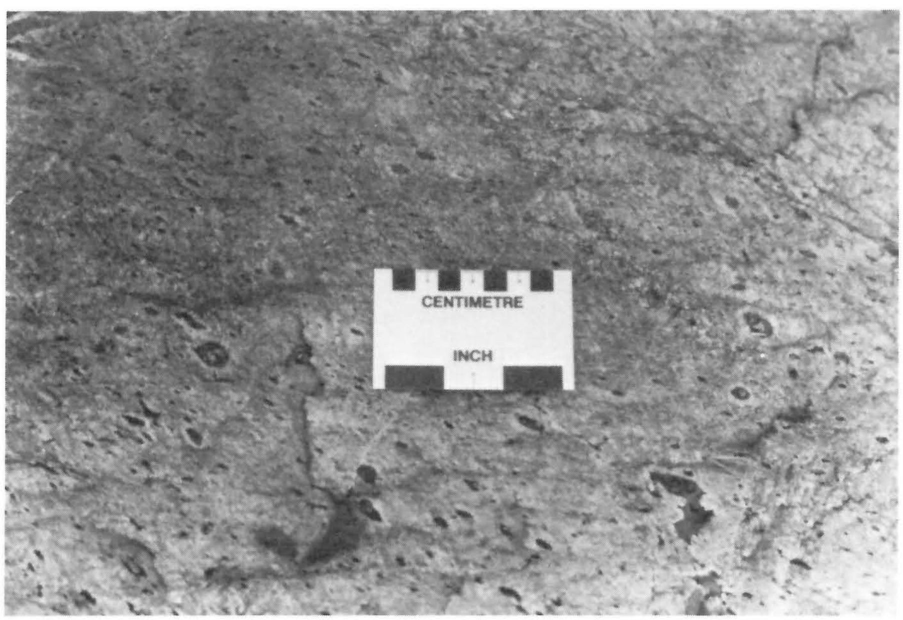


Figure GS-14-2: Lithophysae, 20N/156E.

Reddish brown discontinuous layers or lenses of tuff, usually less than 10 to 20 cm thick, occur throughout Unit 3. They commonly contain less than 1 mm quartz crystals, and mark contacts between layers of pyroclastic and/or flow material.

Whole rock silicate analyses of these rocks show that they have rhyolitic to rhyodacitic compositions (Table GS-14-1).

TABLE GS-14-1

SELECTED WHOLE ROCK SILICATE ANALYSES

Sample No.	M-8	M-22	M-15	M-52
SiO_2	71.0	72.3	73.8	71.6
Al_2O_3	10.9	11.0	10.6	13.5
FeO(T)	4.71	5.54	5.51	3.05
CaO	1.18	0.07	0.46	0.24
MgO	2.79	3.47	1.71	1.78
Na_2O	3.40	2.03	3.27	3.94
K_2O	0.92	0.98	1.04	2.07
TiO_2	0.3	0.3	0.3	0.3
P_2O_5	0.07	0.09	0.06	0.06
MnO	0 11	0.06	0.07	0.04
LOI	3.8	3.0	2.7	2.0
Total	99.18	98.84	99.52	98.58

M-8: Felsic volcanic rock, less than 2% quartz (2)
M-22: Felsic volcanic rock, less than 2% quartz (2)
M-15: Quartz-bearing felsic volcanic rock (3a)
M-52: Quartz-bearing felsic volcanic rock (3a)

STRUCTURE

Bedding attitudes are inconsistent within the map area, are oriented roughly at shallow angles to grid lines and are folded. West of the fault north of Flintoba Lake bedding planes are approximately perpendicular to grid lines and are not folded.

An early foliation (S1) apparently parallels bedding, particularly in the very fine grained brownish tuffaceous material. A near vertical north-northeast-trending axial planar cleavage (S2) is pervasive in rocks east of Flintoba Lake. Rocks in the eastern half of the map area are marked by a chloritic fracture cleavage with regular spacings of 2-10 cm. The cleavage appears as light green, soft, chloritic, subparallel bands about 5 mm or less in width. They may be straight, curved or folded. Evidence of movement along these cleavage surfaces was not observed.

Minor shearing occurs in zones (usually 10-20 cm in width) that are subparallel to cleavage (S2). Massive, white veins and irregularly shaped pods of quartz are discontinuous along strike, pinch and swell to widths from less than 1 mm to 30 cm, and have irregular orientations. The formation of these veins/pods may not have required a major introduction of siliceous fluids, but could simply have been concentrations of silica mobilized from the rhyolitic rocks.

ALTERATION

Rocks that have been chloritized occur throughout the northern half of the map area. Progressive chloritization ranges from the development of small amounts of chlorite imparting a light greenish hue to virtually complete replacement of the original mineralogy and textures. More commonly, irregularly shaped areas a few metres across have a greenish hue and the rock is slightly softer than its unaltered counterpart.

Fine grained mafic dykes, usually chloritic, are present locally. Some of these are irrefutably dykes, but more commonly they are difficult to distinguish from non-quartzose tuff layers or chloritized areas, especially the former since the latter generally have more diffuse margins.

Widespread pyritization is evidenced by rusty weathering surfaces. Whole outcrops may be completely obscured by rust, but varying degrees of rust colouring are more common. Old trenches (ca. 1940s) contain crumbly yellow and white sericitized rock bearing up to 10% pyrite. Although the rusty weathering obscures original textures, it can be generalized that: 1) the rhyolitic rock with less than 2% quartz crystals is more commonly pyritized and 2) the pyritized areas occupy central parts of the map area with the southern, eastern, and far northern areas of the map lacking appreciable pyrite.

REFERENCES

Bateman, J.D. and Harrison, J.M.
1945: Mikanagan Lake; Geological Survey of Canada, Map 832-A.

Ferreira, K.
1987: Geology of the Leo (Mud) Lake area; Manitoba Energy and Mines, Preliminary Map 1987-MI-1; 1:2400.

Hayden-Luck, D. and Gale, G.H.
1985: Geological investigations in the Baker Patton-Centennial Mine area; **in** Manitoba Energy and Mines, Report of Field Activities 1985, p. 74-76.

Tannahill, B. and Gale, G.H.
1986: Geology of the Baker Patton area; **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 65-67.

GS-15 MINERAL INVESTIGATIONS IN THE KISSEYNEW GNEISS TERRAIN

by G. Ostry

INTRODUCTION

Mineral occurrence documentation on the southern flank of the Kisseynew gneiss belt in Manitoba continued during the 1987 field season in the Batty Lake and Martell (formerly Wood) Lake areas. Surface geological mapping at 1:5000 continued at the Puffy Lake Gold Mine near Sherridon, Manitoba (Fig. GS-15-1).

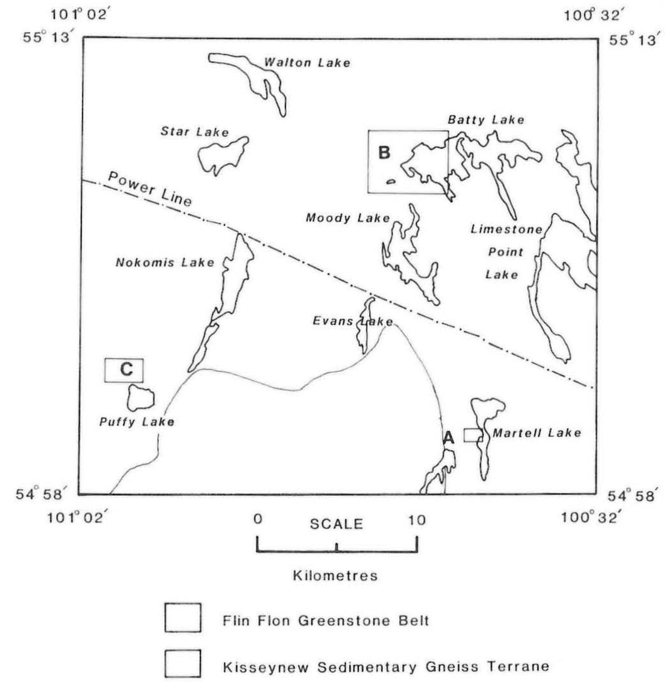


Figure GS-15-1: *Project area location map, Batty Lake area, Manitoba (part of 63K/15 and 63N/2): A) Martell Lake; B) Batty Lake; and C) Puffy Lake.*

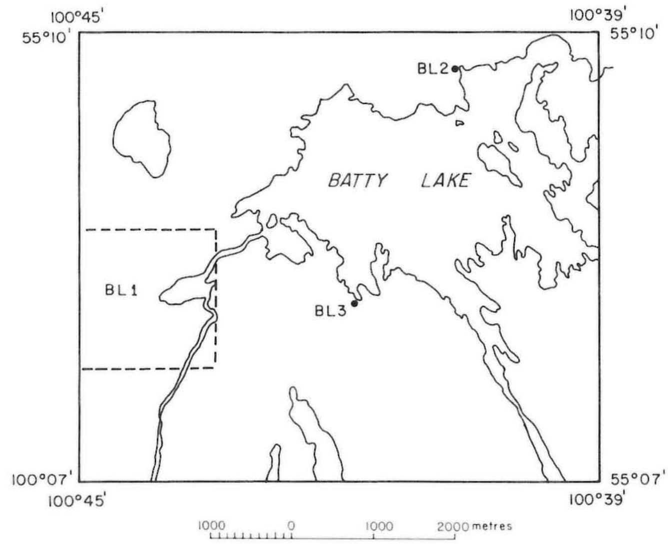


Figure GS-15-2: *Mineral occurrence locations, Batty Lake project area.*

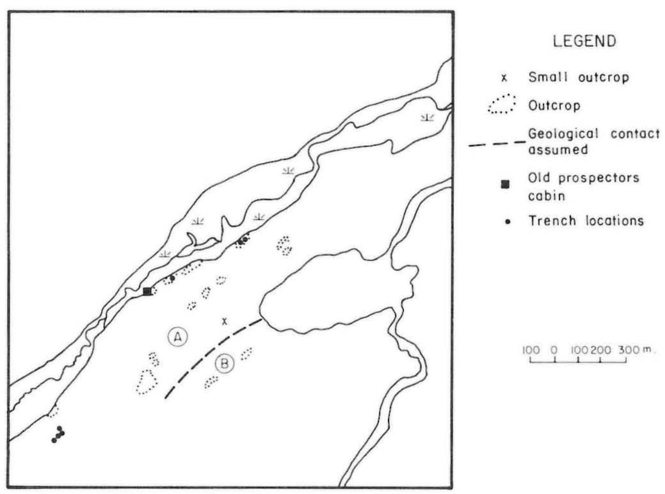


Figure GS-15-3: *Geology and trench locations at mineral occurrence BL-1, Batty Lake project area. Legend: A) amphibolite and calcareous amphibolite; and B) quartz-rich quartzofeldspathic gneiss.*

BATTY LAKE

Three mineral occurrences were investigated in the Batty Lake area (Fig. GS-15-2). Two of these, Locations BL-1 and BL-2, were noted by Robertson (1953).

At locality BL-1 a series of seven trenches intersect a rusty weathered pyrite ± pyrrhotite bearing zone(s) up to several metres thick that is hosted by a northeast-trending, north dipping sequence of amphibolite and calcareous amphibolite (Fig GS-15-3). The amphibolite sequence is bounded to the north by a linear swamp and is structurally underlain by layered, quartz-rich quartzofeldspathic gneiss similar to the quartz-rich gneisses of the Sherridon structure mapped as Unit 7 by Robertson (1953) and those observed at Walton and Elken Lakes (Ostry, 1986). Most trenches have been recently cleaned out however all surviving exposure has been effaced by oxidation confining investigation to fresh rock surfaces from the remaining exposure and adjacent rubble. The pyrite occurs as small pockets of solid sulphide and disseminations within erratically distributed coarse- to very coarse-grained hornblende-quartz ± feldspar ± garnet mobilizate. The zone commonly contains a very fine grained biotite- and garnet-bearing (up to 2%) siliceous (silicified ?) rock that contains up to 5% fine grained disseminated pyrrhotite. Thin shear zones up to 20 cm wide occur locally and appear parallel or sub-parallel to the trend of the gneissosity within the host amphibolite sequence.

Locality BL-2 occurs in an poorly exposed, apparently layered, anthophyllite-bearing rock sequence up to 30 m thick (possibly structurally thickened) on the north shore of Batty Lake (Fig. GS-15-2). The anthophyllite sequence comprises a coarse grained anthophyllite-rich rock

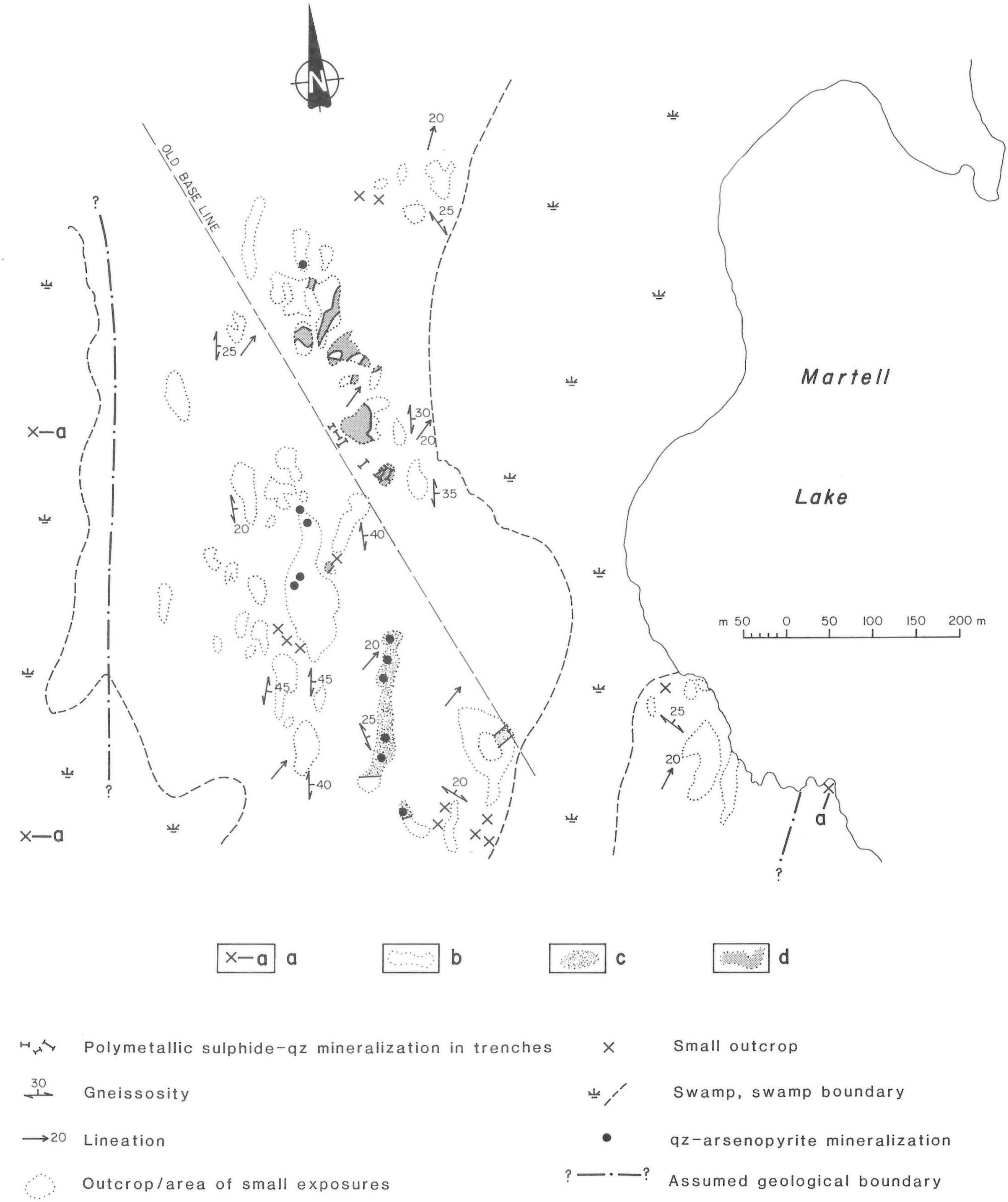


Figure GS-15-4: *Geology, mineral occurrence and trench locations, Martell Lake project area. Legend: a) massive to layered amphibolite; b) 'augen' gneiss; c) sericitic quartz-feldspar-biotite ± garnet gneiss; and d) sericitic quartz-feldspar ± garnet gneiss that commonly contains 1-2% disseminated arsenopyrite.*

(up to 90% anthophyllite), medium grained quartz-feldspar-garnet-sillimanite gneiss and medium grained quartz-feldspar-garnet-biotite gneiss that contains fist-sized or smaller, erratically distributed pods of coarse grained anthophyllite. All rock types contain up to 5% very fine grained disseminated pyrite and/or pyrrhotite and occasionally fine grained chalcopyrite. A pit approximately 10 m in diameter and 5 m deep was dug at this location and exposed heavily oxidized sand-sized and smaller material, but not any bedrock. Layered quartz-rich quartzofeldspathic gneiss ± magnetite ± garnet, similar to that observed underlying the amphibolite at BL-1, outcrops on both sides of the anthophyllite unit.

On the south shore of Batty Lake a 10 m wide rusty weathered zone was investigated at locality BL-3 (Fig. GS-15-2). This zone occurs in a graphitic quartz-feldspar-biotite-garnet gneiss mapped as greywacke gneiss by Robertson (1953). Sulphides were not observed at BL-3; however, the zone exhibits slight enrichment in graphite (up to 5%) and evidence of shearing.

MARTELL LAKE (formerly Wood Lake)

Arsenopyrite-galena-sphalerite-pyrite-pyrrhotite-chalcopyrite mineralization associated with quartz veins is exposed in seven trenches west of Martell Lake (Fig. GS-15-4). Smaller isolated quartz veins with local development of massive arsenopyrite mineralization at vein margins occur adjacent to the trenches (Fig. GS-15-4). The trenched area is believed to be the elusive Wood Lake gold occurrence (cf. Gale and Ostry, 1984) reported by Robertson (1953).

Lithologies in the map area (Fig. GS-15-4) include:

a) fine grained massive to layered amphibolite;
b) a composite unit of 'augen' gneiss that comprises fine- to medium-grained felsic quartz-feldspar-biotite-muscovite gneiss, locally containing up to 40% coarse grained, tectonized white and/or pink feldspar blasts;
c) fine- to medium-grained felsic sericitic quartz-feldspar-biotite ± garnet gneiss that is pink weathering; and
d) altered fine- to medium-grained felsic sericitic quartz-feldspar ± garnet gneiss that is pink to white weathering and commonly contains 1-2% disseminated arsenopyrite.

The dominant rock type within the map area is the composite augen gneiss unit (b) flanked to the east and west by amphibolite (unit a). The amphibolite is poorly exposed and occurs as small isolated outcrops or subcrops. The pink gneiss (units c and d) appears to be contained within and crosscutting the augen gneiss, although, relationships between the pink gneiss and augen gneiss are unclear. Contacts between these units, where observed, appear to be sharp; however, pink gneiss is locally developed adjacent to the isolated mineralized veins (away from the trenches) hosted by augen gneiss. Obtaining reliable foliation/gneissosity/layering data in both the augen gneiss and pink gneiss is complicated by local coarse recrystallization, lack of mineral segregation, well developed lineated fabrics, shallow dips of structures, and a possible overprinting by a fracture cleavage and alteration (most obvious in unit d) within some or all of these units.

Mineralization at the outlying occurrences is restricted to irregular and regular shaped quartz-filled tension gashes or joints that seldom exceed 10 m in length and 0.5 m in width and crosscut the gneissosity/lineation within the augen gneiss and pink gneiss (unit c). Arsenopyrite was the only sulphide observed and occurs locally as solid sulphide pockets, less than 2-3 cm thick, at vein margins and more rarely as disseminations throughout the quartz and immediate wall rock. At one occurrence a fine grained arsenopyrite vein, 2-3 cm thick, occupies a tension joint in pink gneiss (unit d) with minor associated quartz. Visible alteration associated with the mineralization consists of local development of a pink sericitic gneiss within 10 cm of the vein margins.

At the main occurrence mineralized quartz veins are exposed in trenches over a distance of 125 m and appear to form an irregular anastomosing network of individual and composite veins (individually less than 1 m in width) that crosscut the perceived gneissosity. The composite veins contain abundant wall rock. Arsenopyrite is the predominant sulphide and occurs as: 1) very fine- to coarse-grained crystal aggregates accompanied by a fine grained light green mineral (possibly epidote or sericite) at vein margins; 2) individual fine- to medium-grained euhedral crystals, aggregations of crystals and more rarely in rosette forms throughout the quartz; 3) mobilizate in late fractures in the quartz; and, 4) small crystals and blebs within the fracture cleavage developed in the host pink gneiss (the only sulphide mineral observed outside of the quartz veins). Galena occurs as fine- to coarse-grained individual crystals or as aggregations of crystals. Sphalerite occurs as small individual crystals and grains and locally exhibits a fine grained intimate intergrowth with a dark green mineral, possibly the zinc spinel gahnite. Pyrite and pyrrhotite are less common and occur as individual grains; the former was also observed as a vug filling. Chalcopyrite is rare and when observed occurs as small specks associated with pyrrhotite. Late coarse grained pink pegmatite dykes (on the order of cm to tens of cm thick) crosscut the quartz veins and pink gneiss. A green feldspar (amazonite) is locally an important constituent of the pegmatite dykes.

The trenched quartz veins occupy relatively late structural sites within the pink gneiss (unit d) that postdates development of the regional gneissosity/lineation. All quartz veins occupy extension fractures in the pink gneiss (and augen gneiss at the outlying occurrences) and have been deformed by a post-mineralization deformation event (Fig. GS-15-5). Thin (less than 1 m) very fine- to fine-grained sericite-quartz-feldspar schist zones occur in the pink gneiss and are coincident or nearly coincident with the gneissosity/fracture cleavage (?) direction. Their development has created what appears to be an anastomosing network of quartz veins by stretching, attenuation and dismembering of original mineralized veins. Mobilization of sulphide minerals into fractures within the larger more resistant quartz veins is further evidence for a post mineralization structural event.

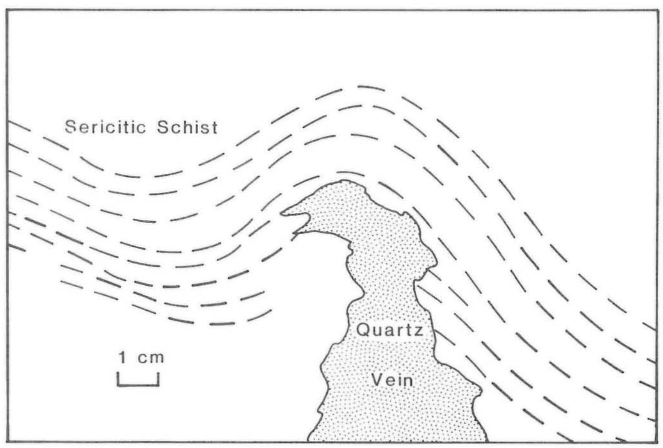


Figure GS-15-5: Sectional view of a deformed mineralized quartz vein within sericitic quartz-feldspar schist in trench at Martell Lake. Figure drawn from photogragh.

Grab samples of quartz-arsenopyrite mineralization from four of the trenches yielded 1.14 to 32.3 grams/tonne (0.04-1.04 oz./ton) Au. Grab samples of quartz-arsenopyrite mineralization from the outlying occurrences yielded nil to 3.53 grams/tonne (0-0.11 oz./ton) Au.

PUFFY LAKE

Surface geologic mapping at 1:5000 and geochemical investigations in the Puffy Lake Gold Mine area were continued adjacent to the areas mapped previously (Ostry, 1986). The lithologic and stratigraphic relationships established by Zwanzig (1984) and Ostry (1986) remain essentially unchanged. Further 1:5000 mapping and geochemical studies will be continued in this area.

ACKNOWLEDGEMENTS

Lawrence Norquay is thanked for his able assistance during the course of the field season. Pioneer Metals Corporation is thanked for their hospitality at the Puffy Lake Mine site during the mapping project.

REFERENCES

Gale, G.H. and Ostry, G.
1984: Stratabound gold mineralization in the Kisseynew gneiss terrain; **in** Manitoba Energy and Mines, Mineral Resources, Report of Field Activities 1984, p. 73-80.

Ostry, G.
1986: Mineral investigations in the Kisseynew gneiss terrain; **in** Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, p. 100-106.

Robertson, D.S.
1953: Batty Lake Map-Area, Manitoba; Geological Survey of Canada, Memoir 271, 55 p.

Zwanzig, H.V.
1984: Kisseynew Project: Lobstick Narrows-Cleunion Lake, Puffy Lake and Nokomis Lake areas; **in** Manitoba Mineral Resources Division, Report of Field Activities 1984, Report GS-12, p. 38-45.

GS-16 MINERAL OCCURRENCE DOCUMENTATION AND GEOCHEMICAL SURVEYS IN THE SNOW LAKE AREA

by M.A.F. Fedikow and C. Malis[1]

INTRODUCTION

Mineral occurrence documentation in the Snow Lake area, initiated in 1984, was continued in 1987. In addition, programs of 1:2500 and 1:5000 scale mapping around selected mineral occurrences were undertaken. The mapping projects represent outgrowths of site-specific trench mapping and sampling investigations from previous years. The mapping projects were selected from areas that represent favourable metallogenetic environments. Detailed mapping was commenced at Puella Bay (mineral occurrence NTS 63J13-75) and at the Wim deposit (mineral occurrence NTS 63O4-129). These maps will be released as part of the Mineral Deposit Map Series and will be accompanied by open file reports detailing results of geochemical surveys conducted in the map area.

Detailed petrographic, geochemical and mapping studies were commenced in the Squall Lake area. Initially, these studies are concerned with a variably textured mafic complex, mapped as biotite diorite by Harrison (1946; Map 929A), associated with garnet-staurolite pelite, siliceous and arkosic gneisses and gold mineralization. This survey represents a first step towards detailed (1:5000) geological mapping and metallogenetic studies of the Kisseynew gneiss in the Snow Lake area.

Petrographic and geochemical studies of the Cook Lake alteration zone were continued this summer in conjunction with E. Froese of the Geological Survey of Canada. Drill core logging and sampling from two diamond drill holes were completed and microprobe studies of alteration mineral assemblages are scheduled for late 1987; results of the study will be released as an open file report upon completion of the program.

WEKUSKO LAKE

(i) SPARKY OCCURRENCE (NTS 63J13-128)

The Sparky occurrence is located on a peninsula in Wekusko Lake (Fig. GS-16-1) approximately 500 m west of the shoreline and south of a power-line. This occurrence is a fracture-controlled system of arsenopyrite-pyrite-bearing quartz veins hosted within diorite and megacrystic gabbro. Quartz veins, generally less than 0.5 m thick are developed along two intersecting fractures bearing 25° and 65°, respectively. The veins have been traced by test pits that reveal disseminated grains, wisps, pods and lenses of near- solid arsenopyrite with minor pyrite. At the strongly foliated vein/wall rock contact intense silicification of the wall rocks extends for approximately 3 cm. Stubby, euhedral and subhedral 1-3 mm arsenopyrite crystals occur in this zone of silicification, in contrast to the generally fine grained arsenopyrite that occurs in near-solid to solid lenses up to 3 cm thick. Garnetiferous patches in rusty weathered wall rock occur adjacent to some of the quartz veins. This system was mapped over an approximate strike length of 300 m. Samples have been collected for geochemical analysis. Results of the analysis will be released as part of a mineral deposits open file report for the Snow Lake area.

(ii) GRASS RIVER (NTS 63J13-51)

A brief investigation of this occurrence was undertaken in 1985 and the geology and mineralization were described (Eccles and Fedikow, 1985). The area was re-examined this year to expand outcrop coverage and to sample the mineralization. As a result of outcrop washing, stripping and clearing of deadfall, a significant amount of new outcrop has been exposed and, consequently, the nature of the occurrence and its host rocks are now redefined. Originally, the host rocks were described as rusty weathered and bleached sedimentary rocks within bleached, rusty and siliceous massive and pillowed basalts. The mineralization, which consists of disseminated pyrite and pyrrhotite, occurs within intensely silicified and deformed pillow basalts and not within altered sedimentary rocks as previously reported. The silicification can be traced from deformed pillow basalt into a very fine grained, aphanitic zone with disseminated iron sulphides. Within this silicified and rusty weathered zone pillow forms are clearly visible as well as pillow fragments. The nature of this occurrence is therefore considered to represent alteration and replacement of mafic pillow lavas by iron sulphide-bearing fluids. The extent of alteration and mineralization is unknown due to overburden cover.

(iii) PUELLA BAY (NTS 63J12-75)

Mineral occurrence WL-75 was described in 1986 (Fedikow et al., 1986) in the Report of Field Activities. An area measuring approximately 2.8 x 0.8 km centred on the polymetallic sulphide-bearing quartz veins was selected for detailed mapping in order to:

(i) determine the extent and the nature of mineralization and related alteration;
(ii) delineate the stratigraphy over the map area; and
(iii) complete sampling of trenches discovered in the map area.

Due to significant outcrop stripping and cleaning in the area 1:2500 scale mapping was not completed this year. The following description of the area represents geological details to date.

Outcrop stripping at the northern tip and south of the peninsula at Puella Bay revealed a multi-directional set of up to 2 m wide quartz-carbonate veins crosscutting and replacing subaerially deposited immature arkose containing abundant lithic clasts, sandstone and sedimentary breccias. The stratigraphic sequence is determined to have an east-facing younging direction on the basis of flame structures. The quartz-carbonate veins transect the rocks on the peninsula from east to west. On the west side of the peninsula the veins are developed within a feldspar porphyry intrusion that is altered to a chloritic schist adjacent to the veins. Approximately 700 m south of the northern tip of the peninsula a trench exposes similar alteration with the first observation of sulphide mineralization. A maximum of 2% disseminated euhedral to subhedral pyrite occurs in silicified and carbonate-altered sedimentary rocks. In general, the quartz-carbonate veins and surrounding wall rocks are low in sulphide content.

Farther south, disseminated pyrite is observed in a variety of lithologies including a carbonate-veined ultramafic dyke, gabbroic intrusions, quartz porphyry with distinctive blue quartz "eyes" and in an enigmatic rock unit described as biotite dacite by Frarey (1949; Map 987A). A trench in the biotite dacite exposes polymetallic sulphide mineralization consisting of sphalerite, chalcopyrite, arsenopyrite, pyrite and galena as described by Fedikow et al. (1986). Some representative analyses of this mineralization are listed in Table GS-16-1. It is noteworthy that sulphide mineralization throughout the study area consists only of disseminated iron sulphides with very rare arsenopyrite whereas the occurrence in the biotite dacite is polymetallic. A layered gabbroic intrusion north of this trench contains occasional disseminated pyrite. The intrusion displays cyclical compositional layering with a 0.5-1.0 cm amphibole-rich base and a finer grained feldspar-rich top. The cyclicity suggests an eastwards younging direction. All rock units in the study area have been affected by the development of a north-south planar fabric or foliation.

A total of 27 trenches have been located in the Puella Bay WL-75 study area. To date, 14 of these trenches have been channel-sampled with rock chips collected over 1 or 2 m intervals. Some analyses are currently

[1]University of Winnipeg, Winnipeg, Manitoba

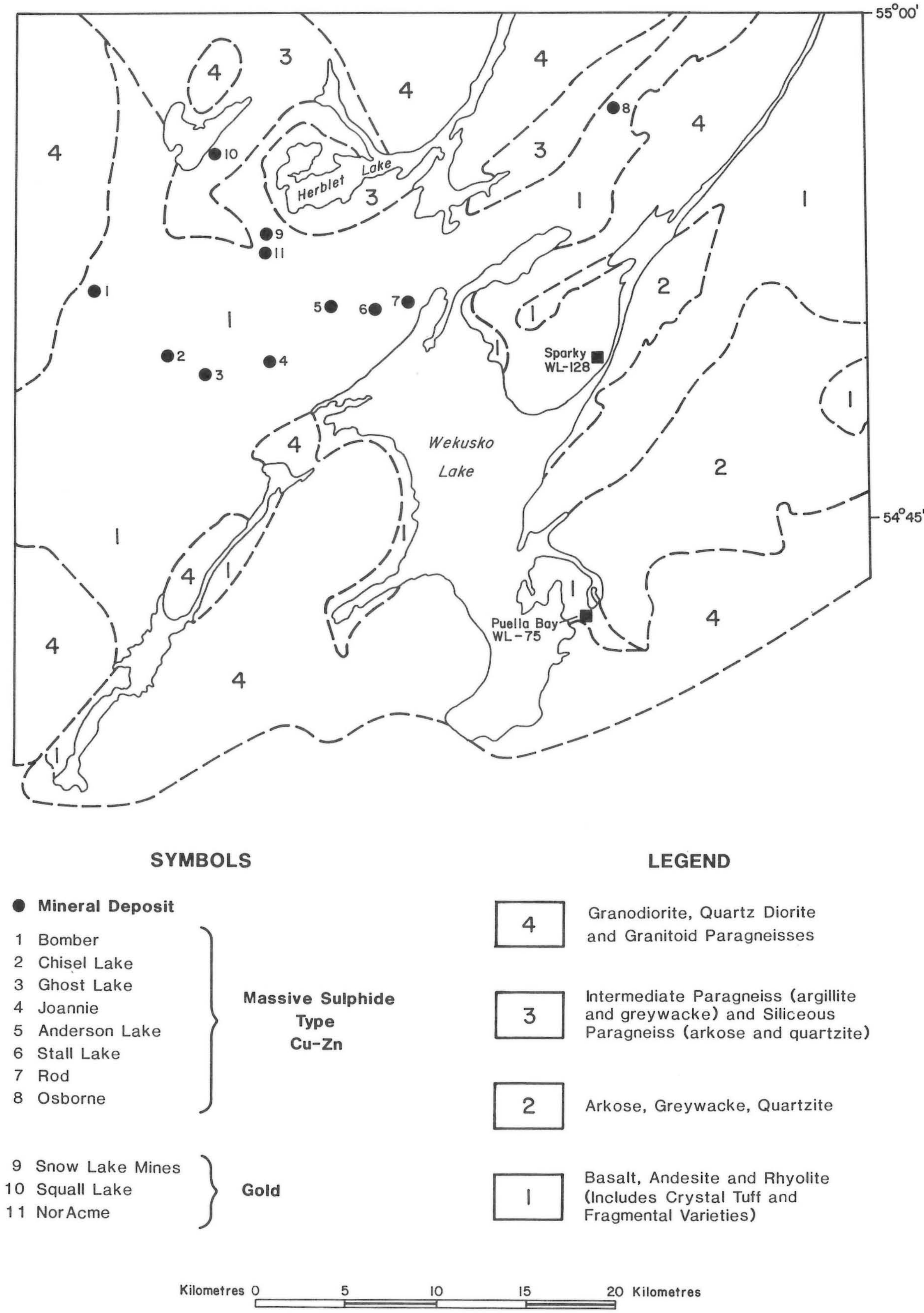


Figure GS-16-1: Generalized geology and mineral deposits of the Snow Lake area including the Sparky occurrence (WL-128) and Puella Bay (WL-75). Modified after Bailes (1975).

TABLE GS-16-1.
ANALYSIS OF ROCK CHIP SAMPLES FROM MINERAL OCCURRENCE WL-75,PUELLA BAY, WEKUSKO LAKE BY INDUCTIVELY COUPLED ARGON PLASMA.
All values in ppm unless otherwise indicated.

Sample No.	Mo	Cu	Pb	Zn	Ag	As	Cd	W	Au (ppb)
01149	20	1132	14	26125	2.1	18	90	204	98
01150	14	1457	172	17372	3.6	36	59	331	94
01151	21	1198	12	29041	1.7	29	106	242	53

available. Further detailed mapping and trench sampling will be conducted.

Part of the Puella Bay area represents a quartz-carbonate sulphide-poor vein system hosted within subaerially deposited conglomerate and lithic arkose. The occurrence of polymetallic sulphide mineralization in the biotite dacite is unique to the study area and its origins are uncertain. A geochemical/petrochemical investigation of the biotite dacite has been initiated to ascertain the genesis of the biotite dacite and its metallogenetic significance. Disseminated and veinlet sulphide mineralization, which is predominantly pyrite, was observed over the entire 2.8 x 0.8 km area.

(iv) WIM DEPOSIT (NTS 63O4 — 129)

The Wim Cu-Zn deposit and its associated host rocks were examined at the deposit site, in diamond drill core and in outcrop exposures at Chartier Lake. The outcrop in the area of the deposit is characterized by rusty weathered, quartz-phyric felsic volcanic rocks with the local development of a garnet-anthophyllite-sillimanite-biotite-magnetite alteration assemblage. Alteration, presumably related to the Wim mineralization, was observed over 5 km adjacent to the three linear lakes that occur along the deposit stratigraphy. In drill core the alteration mineral assemblage also includes cordierite and the mineralization comprises disseminated and near-solid to solid pyrite, pyrrhotite, chalcopyrite and gahnite.

The host felsic volcanic rocks, in association with a hornblende-plagioclase gneiss, have been mapped by Bailes (1975) as a continuous thin unit that persists along the western and northern edges of the Herblet gneiss dome. A one day reconnaissance was undertaken at Chartier Lake for comparison with the Unit 1 exposures of Bailes (1975) at the Wim deposit. The Chartier Lake Unit 1 felsic volcanic rocks are intensely recrystallized and may be described as grey granitoid gneisses containing abundant pegmatite and marked by diffuse zones of rusty weathering rock. This description is similar to the rock unit mapped by Froese and Moore (1980) on the west side of the Pulver gneiss dome. Their Unit 1a, described as a white to grey oligocalse-quartz gneiss, correlates with Bailes (1975) Unit C1 which contains the Bee Zone Cu-Zn deposit. Bailes (1975) also maps Unit C1 in the cores of both the Herblet and Pulver gneiss domes. If, in fact, Bailes' (1975) Unit 1a and Unit C1 are genetically similar to Froese and Moore's (1980) Unit 1a then the potential for the discovery of repetitions of massive sulphide-type mineralization, such as the Wim Cu-Zn deposit, and of disseminated sulphide/gold mineralization, such as the Bee Zone, becomes obvious. Establishing the origins and correlatability of these three rock units is critical to mineral deposit exploration in the Snow Lake area.

ACKNOWLEDGEMENTS

J. Kitzler of Hudson Bay Exploration and Development, Snow Lake and D. Ziehlke, formerly Hudson Bay Exploration and Development, currently Snow Lake Mines Ltd., are thanked for their assistance and discussions regarding the Puella Bay area. J. Kitzler is also acknowledged for his help in acquiring diamond drill cores from the Wim deposit area. Jim Franklin and Al Galley of the Geological Survey of Canada are thanked for their comments during a visit to the Puella Bay area.

REFERENCES

Bailes, A.H.
1975: Geology of the Guay-Wimapedi Lake area; Manitoba Mineral Resources Division, Geological Services Branch, Publication 75-2, 103 p.

Eccles, D.R. and Fedikow, M.A.F.
1985: Mineral occurrence documentation and alteration zone mapping, Snow Lake area; **in** Manitoba Mineral Resources Division, Report of Field Activities 1985, p. 82-99.

Fedikow, M.A.F., Roney, C.T., Schmidt, G.J. and Robbie, T.J.
1986: Mineral deposit studies in the Snow Lake area; **in** Manitoba Mineral Resources Division, Report of Field Activites 1986; p. 77-85.

Frarey, M.J.
1949: Crowduck Bay; Geological Survey of Canada, Map 987A.

Froese, E. and Moore, J.M.
1980: Metamorphism in the Snow Lake area, Manitoba; Geological Survey of Canada, Paper 78-27.

GS-17 INDUSTRIAL MINERAL OCCURRENCES IN THE FLIN FLON, SNOW LAKE AND THOMPSON AREAS

by W.R. Gunter and P.H. Yamada

INTRODUCTION

The industrial mineral program, in the Flin Flon-Snow Lake area focussed mainly on an evaluation of occurrences of dimension stone in the northwest part of the province. These included: dolomite at Wekusko and Cormorant, granite at Cliff Lake and porphyry at Naosap Lake. A preliminary investigation was undertaken of the garnet-anthophyllite unit at Molly Lake. The localities investigated are shown in Figure GS-17-1.

In the Thompson area the industrial minerals program focussed on marble at the Pipe Lake Mine and the Manasan Quarry, granite at Ospwagan Lake and migmatites at Sasagiu Rapids as potential sources of dimension stone. A serpentinite occurrence at Moak Lake was investigated as a source of carving stone. A Molson dyke (black granite) near Jenpeg and anorthosites south of Cross Lake were evaluated as sources of dimension stone. The localities investigated are shown in Fig. GS-17-2.

CLIFF LAKE TONALITE

A large intrusion of "quartz-phyric tonalite with abundant, small, highly digested xenoliths" occurs 1.5 km northeast of Flin Flon (Bailes and Syme, 1987). The excellent exposure and good access prompted an investigation of the tonalite to determine if portions of it were sufficiently fracture-free to be a potential dimension stone.

Three steeply dipping sets of fractures in the rock trend at 004°, 056° and 118°, and occur at 0.8-1 m spacings throughout the area investigated. The blocks that form at the intersection of these fracture sets are

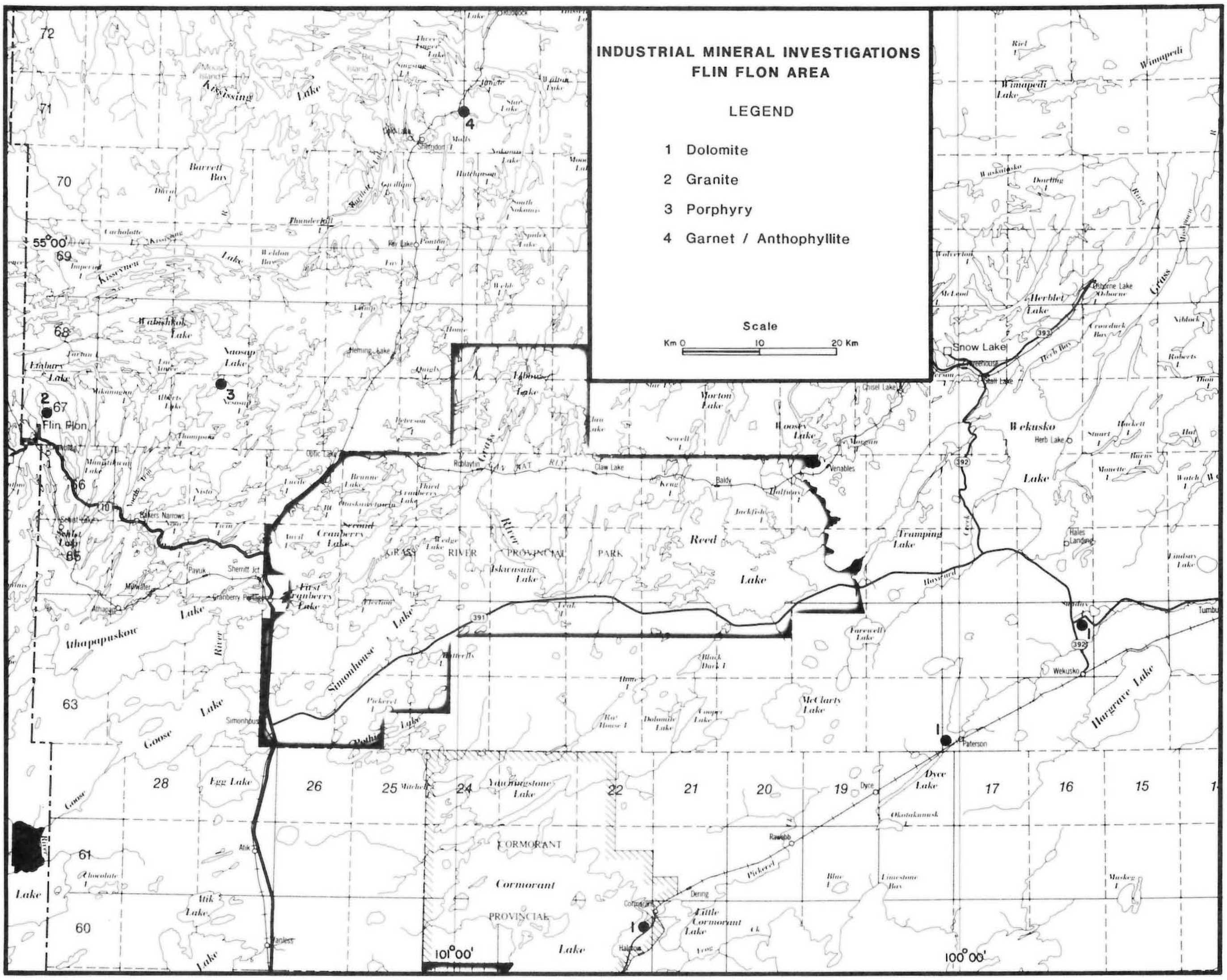


Figure GS-17-1: Location map, Flin Flon-Snow Lake area.

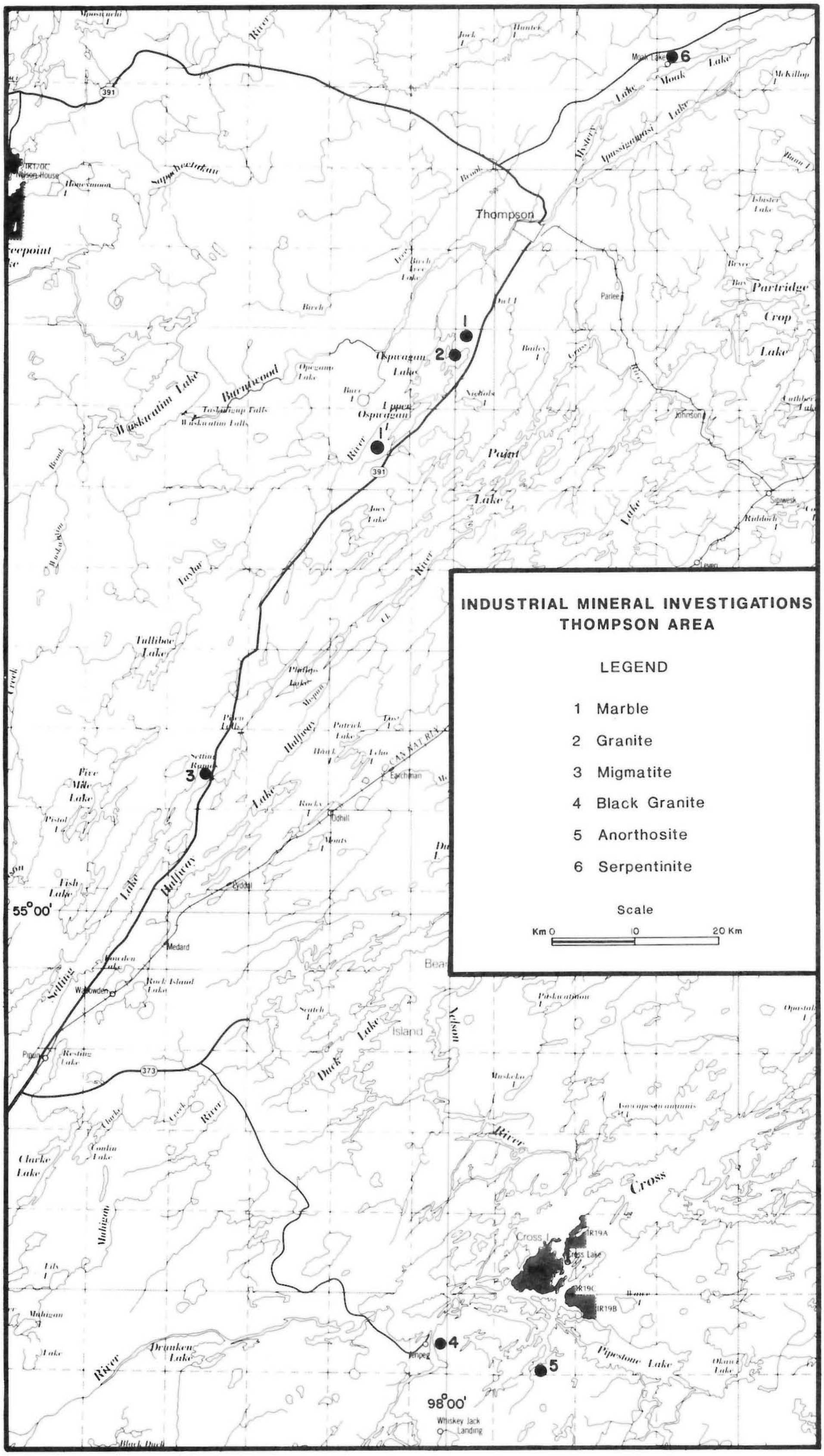


Figure GS-17-2: Location map, Thompson area.

generally less than 1 m, and triangular in outline. Only one block, which had a roughly square outline, was found to be greater than 1 m on a side.

The close spacing of the fractures precludes the quarrying of this rock for a large-scale dimension stone operation.

NAOSAP LAKE QUARTZ PORPHYRY

A fine grained, grey to brown, porphyry dyke, with 1-2 cm blue quartz phenocrysts, occurs within "fine grained granodiorite" (Kalliokoski, 1952) on the west shore of Naosap Lake, adjacent to the Sherridon road. A similar rock occurs at several localities in the Flin Flon area.

Trenches and roadcuts in the immediate area provide fresh exposures of the unit. The fracture pattern within these exposures is irregular; the fractures are closely spaced and their boundaries exhibit very little alteration. The blocks commonly have splintery, fragile edges that indicate slices made from this rock would probably be brittle. Blocks from both blasted areas and outcrops are roughly 30-50 cm on an edge.

An ornamental stone could be quarried from this location since the colour is distinctive and tests have shown that the porphyry polishes well. Larger blocks for use in dimension stone would not be obtainable due to the closely spaced fracturing at this locality.

THE GARNET-ANTHOPHYLLITE LOCALITY AT MOLLY LAKE

Approximately 1.5 km northeast of Molly Lake (Fig. GS-17-1), an occurrence of garnet-anthophyllite was indicated by Froese and Goetz (1980). The locality was investigated in an attempt to extend the stratigraphy of the Star Lake garnet-anthophyllite unit within the Sherridon structure (Gunter and Yamada, 1986).

The stratigraphy recorded at Star Lake is present at Molly Lake. Tectonic complications plus a paucity of large outcrops provide only a fragmentary exposure for the complete unit. A possible thrust fault, identified by the absence of portions of the type lithologic sequence, is oriented approximately 060° and overlies the exposures of the garnet-anthophyllite. For example, near the northeast shore of Molly Lake (Fig. GS-17-3) unit 1 is exposed directly beneath the Sherridon gneiss. At the easternmost exposure mapped (location 84-87-ML-2-4), a section containing units 1 and 2 and possibly unit 3 is overlain by unit 1; the absence of exposures does not permit the determination of the rocks that overlie the uppermost unit 1 rocks. Although dips in the area generally range from 35° to 45° north, the beds underlying the possible thrust fault have dips that are vertical to overturned. However, dips on the contact are 60° to 80° north, and flatten rapidly to 40° to 45° north. All strikes are nearly parallel.

Samples were taken from the different garnet-anthophyllite units at this locality for detailed comparisons with the Star Lake material.

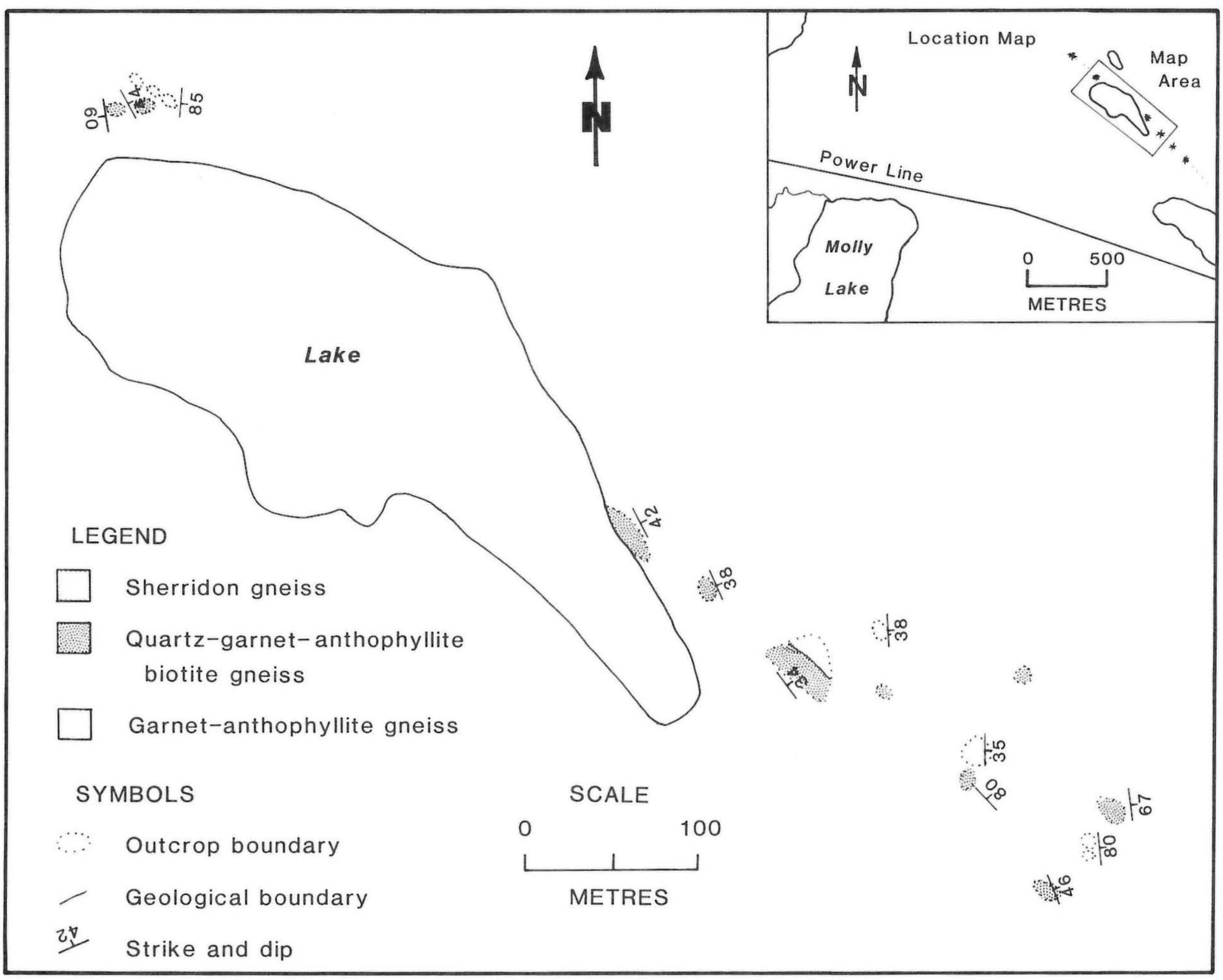


Figure GS-17-3: Geological map, Molly Lake garnet-anthophyllite.

ORDOVICIAN DOLOMITE AT CORMORANT

An area underlain by dolomite, with little or no overburden, occurs from 1 to 4 km south of the village of Cormorant (Fig. GS-17-1). This area of dolomite is surrounded on three sides by a pronounced escarpment that ranges in height from 5 to 10 m. Excavations along the escarpment have been made by several groups over a number of years. The railroad and the highways department have opened up gravel quarries and roadcuts along the north face of the escarpment. The gravel quarries exposed unweathered ledges of dolomite, following the removal of the overlying aggregate. The roadcuts occur west of the gravel quarries and expose beds of buff to tan coloured dolomite that contains small amounts of reddish coloration toward the base of the 3 m high section. A building stone quarry was developed, in equivalent beds, at Mile 39 of Hudson Bay Railway during the period 1929 to 1936.

A sample was taken from a ledge in the large abandoned gravel quarry using a Cobra drill, and feather and wedges. A cut slab from this sample is a slightly vuggy, mottled light and darker brown dolomite which takes an acceptable polish.

ORDOVICIAN DOLOMITE AT WEKUSKO

Reddish to purple coloured dolomite, of the Ordovician lower Stony Mountain Formation, outcrops sporadically in an area southeast of Wekusko Lake, and as far south as Dyce Lake on the Hudson Bay Railway (Fig. GS-17-1). The dolomite has been exploited for building stone during the 1930s at the "Manitoba Marble" quarry, 1.5 km south of Paterson. More recently it has been quarried by the Department of Highways, for crushed stone aggregate, at Sunday Lake, north of Wekusko and on the south shore of Wekusko Lake. All of the quarries exploit isolated bedrock ridges within a generally muskeg covered terrain. These quarries have been located and described during previous investigations (Gunter and Yamada, 1985, 1986).

Suitable sites for the production of building stone were sought within known areas of purple dolomite. The present investigations were conducted in areas away from the roadstone quarries, where the fabric of the dolomite may have been disturbed by blasting. An oval area of dolomite, which has been cleared of overburden and trees, occurs adjacent to the south side of Highway 39 (Fig. GS-17-4) approximately 270 m northeast of the Wekusko road- stone quarry. Detailed mapping (Fig. GS-17-4) revealed large blocks of 5 x 5 m or greater, separated by 1-2 cm orthogonal fractures. A cross-section on the edge of an escarpment (Fig. GS-17-5) shows horizontal joint spacing of 0.5-1.2 m. Two vertical drill holes in the area encountered separations of only 5-20 cm on horizontal fractures. Summary logs of the drill holes are presented in Table GS-17-1. Polishing tests will be conducted to determine the suitability of this stone as interior decorative material.

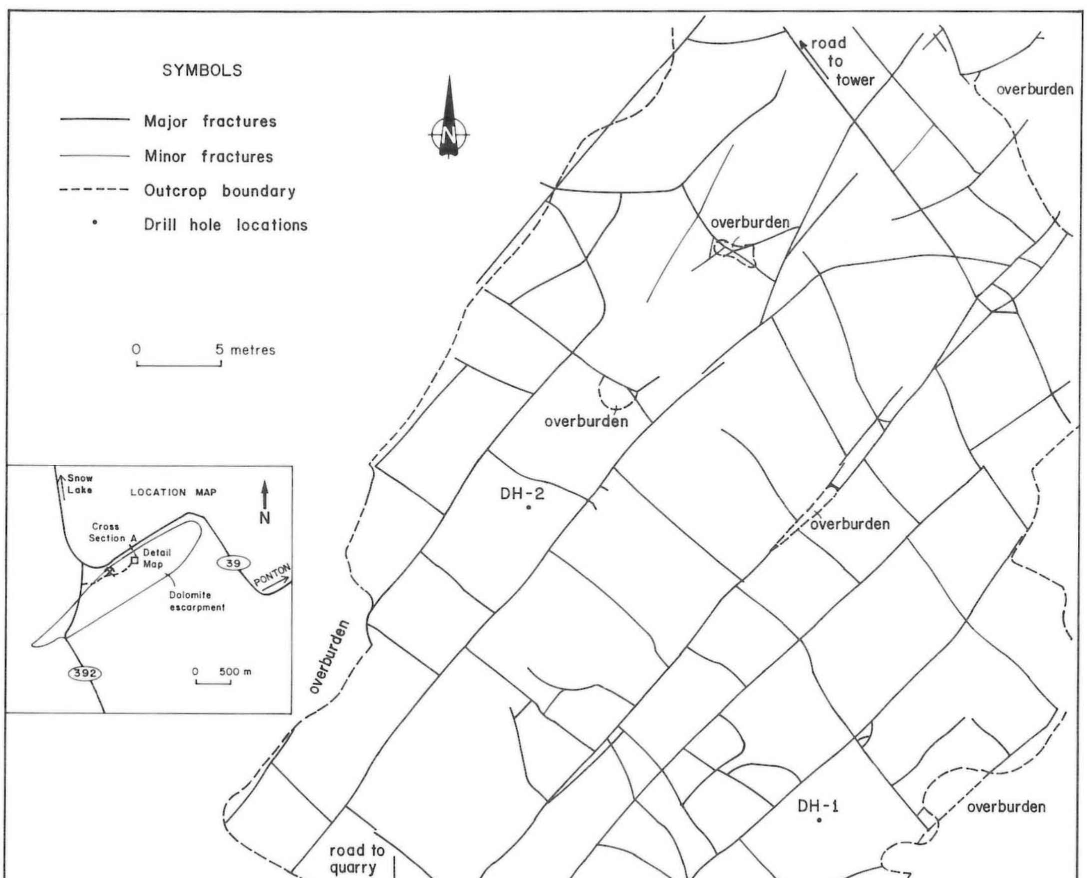


Figure GS-17-4: Wekusko dolomite: joint map.

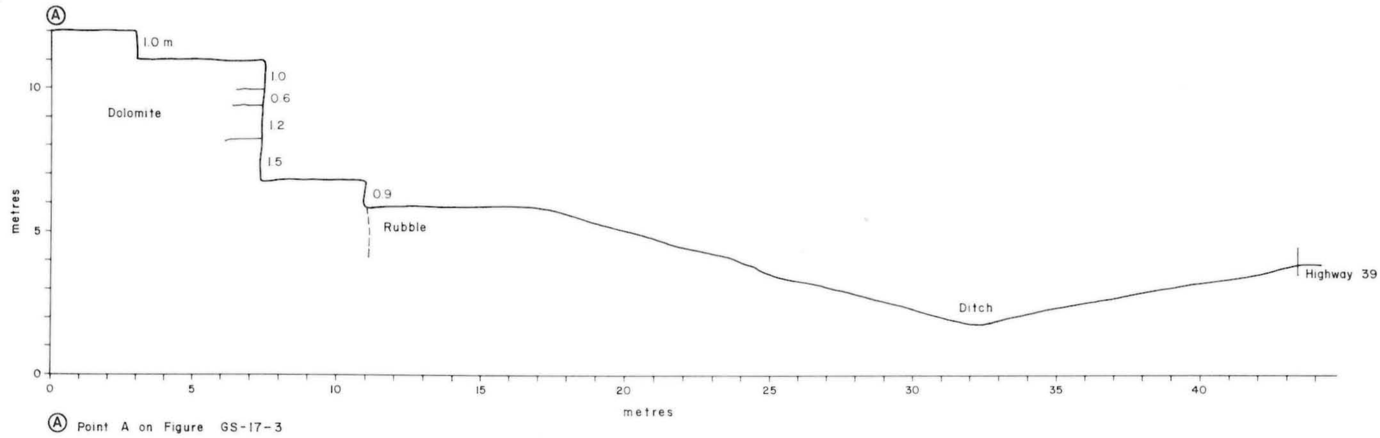


Figure GS-17-5: Wekusko dolomite: escarpment cross-section.

TABLE GS-17-1
WEKUSKO DOLOMITE: LITHOLOGICAL SUMMARY LOGS

Drill Hole WD #1

Depth (m)	Lithology	Comments
0.0 — 3.72	Dolomite: nodular bedded, reddish shaly partings between 1-3 cm red-buff irregular nodules; lower contact is gradational with a gradual decrease in the percentage of nodules.	Average length of core sections between fractures is 6-10 cm.
3.72 — 15.07	Dolomite: wispy bedded, very fine grained shaly partings and mud seams at 7.89 m, 10.15 m and 12.15 m. The Stony Mountain — Fort Garry contact is at 9.44 m.	Average length of core sections between fractures is 15-20 cm; one section is 56 cm long (12.15-12.71 m).
15.07 — 17.00	Dolomite: very fine grained, grey, argillaceous, red lamellae and dendritic aggregates are common. One vug is lined with pyrite.	Average length of core sections between fractures is 15-20 cm.
17.00	E.O.H.	

Drill Hole WD #2

Depth (m)	Lithology	Comments
0.0 — 6.16	Dolomite: nodular bedded, reddish shaly partings between 1-3 cm red-buff irregular nodules; lower contact is gradational with a gradual decrease in the percentage of nodules.	Average length of core sections between fractures is 5-10 cm.
6.16 — 15.02	Dolomite: wispy bedded, fine grained with thin red-purple lamellae; clay-rich seams at 8.99 m and 10.00 m. The Stony Mountain-Fort Garry contact is at 8.05 m.	Average length of core sections between fractures is 15-20 cm; one section is 40 cm in length.
15.02 — 16.85	Dolomite: very fine grained, grey, argillaceous.	Average length of core sections between fractures is 10-15 cm.
16.85	E.O.H.	

THOMPSON MARBLE

Drill programs at the Manasan Quarry and at the Pipe Lake Mine were initiated to supplement geological mapping undertaken in 1986 (Gunter and Yamada, 1986). At the Manasan Quarry two AQ size holes were drilled through the hinge and south limb of the major fold. The summary drill logs (Table GS-17-2) illustrate the lithologic variability within the marble layer at this location.

The core for hole MQ-1, near the fold hinge, consists of an amphibole-rich calc-silicate with little lithologic change; however, rapid changes in the core/bedding angles indicate the presence of considerable minor folding. This suggests that the carbonate-rich sections of this unit probably occur to the south of the drill site. The core for hole MQ-2, on the limb of the fold, contains a considerably thinner amphibole-rich unit with fewer minor structures and a carbonate-rich marble; this unit occurs south of the amphibole-rich calc-silicate unit, which does not outcrop in this area. Overburden depths are not known.

The drill program at the Pipe Lake Mine consisted of nine completed holes laid out along three lines at 50 m intervals, to the east of the marble exposures. The drilling indicated overburden depths of more than 14 m. Thus the outcrop of marble on the northeast corner of the Pipe Lake Mine is a small bedrock rise which decreases in elevation sharply to the east.

TABLE GS-17-2
MANASAN QUARRY: LITHOLOGICAL SUMMARY LOG

Drill Hole MQ-1

Depth (m)	Lithology	Comments
0.0 - 1.77	Overburden	
1.77 — 2.90	Pegmatite: coarse grained, pink-orange, contact with calc-silicate is gradational, veinlets of pegmatite near the contact are parallel to bedding.	
2.90 — 22.9	Amphibole-rich calc-silicate: medium grained green-black, minor pegmatite stringers and quartz veins.	Highly contorted
22.9	E.O.H.	

Drill Hole MQ-2

Depth (m)	Lithology	Comments
0.0 — 3.50	Overburden	
3.50 — 9.13	Amphibole-rich calc-silicate: medium- to fine-grained, green-black, with minor serpentine-rich bands to 5 cm.	Core angles to layers are high; some folded layers.
9.13 — 16.22	Serpentine-carbonate marble: with 2-5 cm thick bands of amphibole-rich calc-silicate.	This unit is highly contorted.
16.22 — 18.72	Amphibole-rich calc-silicate: no serpentine-rich bands.	Layer angles average 38°.
18.72 — 23.83	Carbonate-rich marble, buff to yellow, medium grained; with minor serpentine and phlogopite.	This unit is highly contorted.
23.83 — 25.55	Serpentine-carbonate marble interbands of amphibole-rich calc-silicate.	Highly contorted
25.55 — 27.43	Carbonate-rich marble with major amounts of phlogopite; phlogopite occurs as 1-2 cm thick contorted bands.	Highly contorted
27.43 — 29.00	Serpentine-rich marble: with minor, 1-2 cm amphibole-rich calc-silicate bands.	Highly contorted
29.00	E.O.H.	

OSPWAGAN GRANITE

A pinkish white, coarse grained, granitoid (Macek and Russell, 1978) occurs approximately 250 m south of the Manasan Quarry at the north end of Ospwagan Lake, (Fig. GS-17-6). On one of the numerous granitoid outcrops along the eastern edge of the peninsula, 4-5 m spaced joints resulted in the development of 1-2 m high ledges. Detailed maps of the joints and lithologies were produced for this outcrop (Fig. GS-17-7).

The three lithologic units are pegmatite, granite and gneissic granite. These units are mineralogically similar but differ in their physical characteristics; however, there are no significant differences in colour. The pegmatite is a heterogeneous mixture of coarse grained, 4-5 cm, graphic feldspars, biotite and minor garnet. Quartz veins, parallel to the fabric, are locally abundant. Little megascopic evidence of retrograde metamorphism is identifiable within this unit.

The granite is a coarse grained, 2-3 cm, equigranular largely homogeneous rock. It consists of feldspar, muscovite and garnet with minor biotite. A relatively common phase within the granite is a plumositic, silver-grey muscovite, which occurs as 2-3 cm radiating sheaves. The contacts between the granite and the pegmatite are sharp; the contacts with the gneissic granite are gradational and often result in a lacework pattern of gniessic granite. Late fractures within the granite are lined with aggregates of fine grained, greenish mucovite. These fractures are planes of weakness and are noted on the structural map.

The gneissic granite is composed of medium- to coarse-grained aggregates of augen-like feldspars in a finer grained matrix of muscovite and quartz. A well developed nearly vertical, northeast-trending fabric, parallel to the regional fabric, is developed in this rock. Feldspar augen within the gneissic granite often contain graphic quartz.

Large test blocks, obtained by the use of a Cobra drill and feather and wedges, were tested to determine if the rocks could be polished suitably for a commercial product. Preliminary indications are favourable for all three rock types.

MIGMATITES AT SASAGIU RAPIDS

Migmatites and associated granitoid rocks occur in a roadcut, and as flat outcrops on low ridges, on either side of the Highway 39 bridge over the Grass River, at Sasagiu Rapids (Fig. GS-17-2). A brief reconnaissance survey was conducted to determine if the rocks were sufficiently fracture-free, and if selected samples would retain a polish well enough to be considered as potential building stone.

The rocks exposed along the edge of the Grass River, adjacent to the bridge, are highly contorted, inhomogeneous, and contain pods and thin layers of mafic minerals. The fractures, generally spaced at 0.5 m or less, have little correlation with either the rock type or the complex structure. The surface of the sample did not polish because the mafic minerals plucked. The dimension stone potential at this locality is low as it would be difficult to avoid the mafic layers during quarrying.

SERPENTINITE FROM MOAK LAKE

Serpentinite is associated with the nickel-copper sulphide deposit at Moak Lake (Patterson, 1963). The mine dump was examined to determine if the serpentine would be a suitable material for soapstone carving.

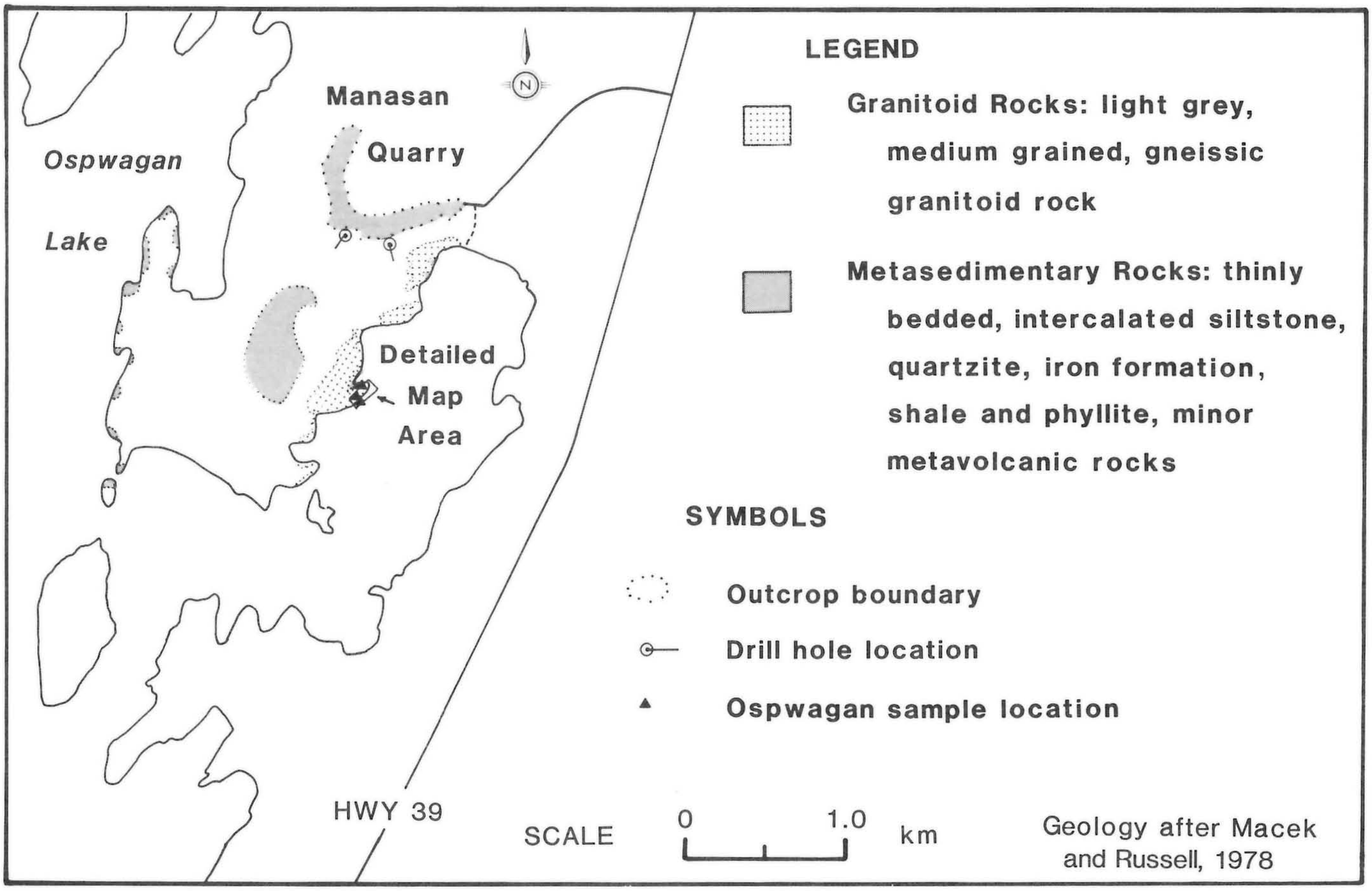


Figure GS-17-6: Location map, Manasan Quarry and Ospwagan granite.

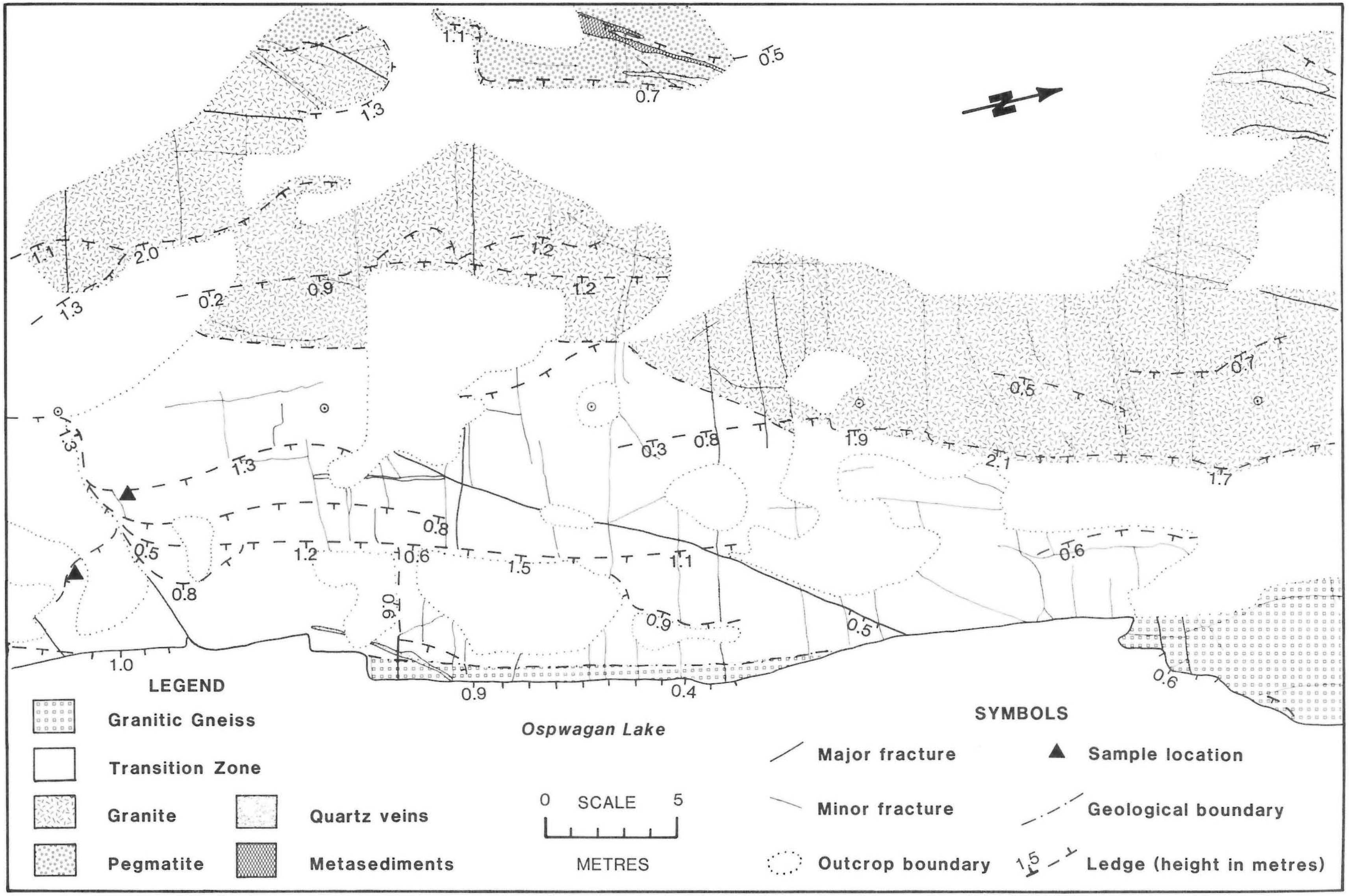


Figure GS-17-7: *Detailed structural and lithological map of Ospwagan granite.*

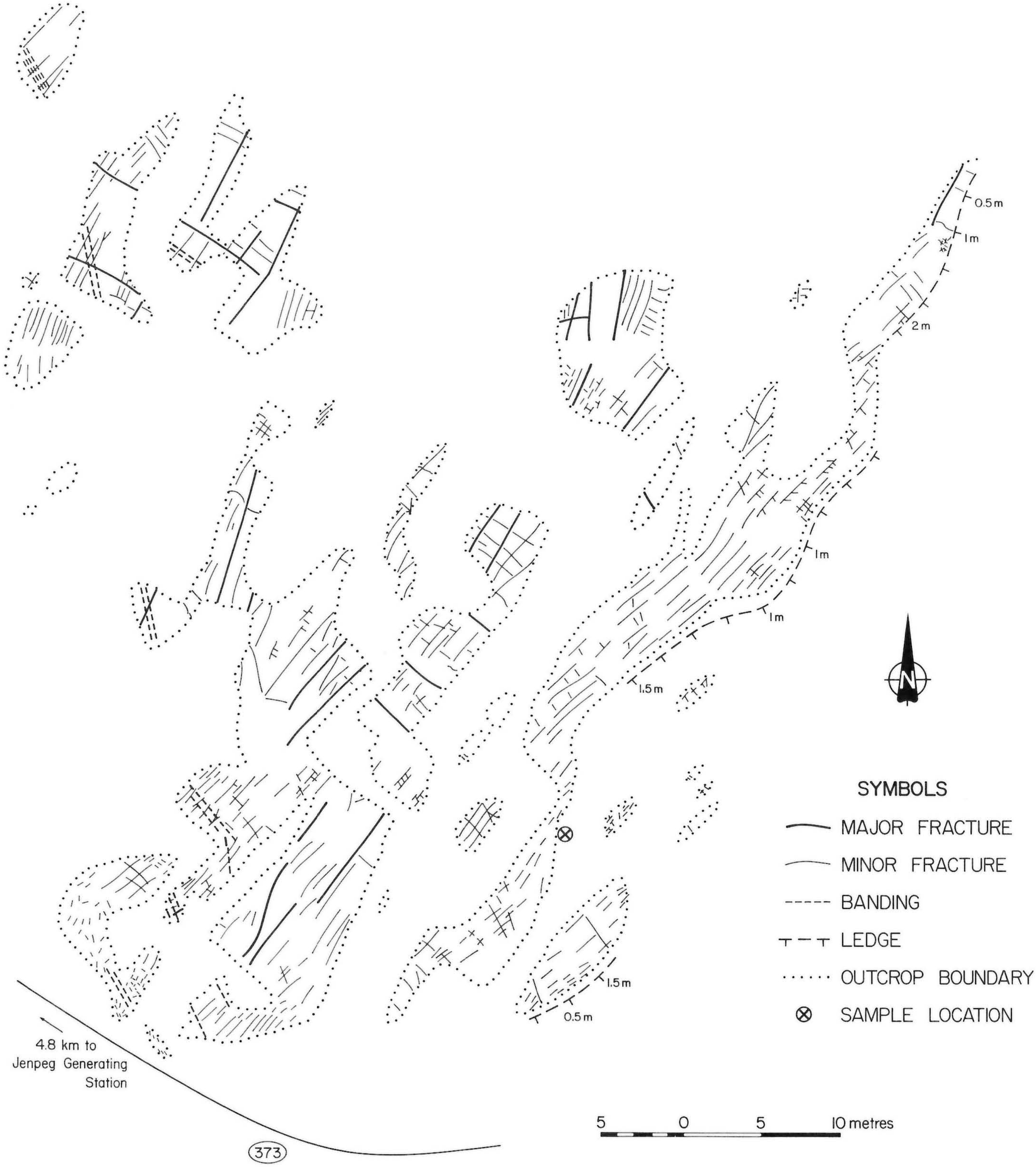


Figure GS-17-8: Detailed structural map of the Cross Lake diabase.

The mine dump contains significant amounts of a coarse granular, medium to light green serpentinite in blocks of 0.5 m or less in size. The megascopic appearance of the blocks is similar to that of the Pipe Lake Mine serpentinite. In view of the small size of the blocks and the large reserves of similar material at the Pipe Lake Mine, the Moak Lake Mine does not appear to be a viable source for carving-quality serpentinite.

MOLSON DYKE, EAST OF JENPEG

A fine grained, medium grey, predominantly homogeneous diabase dyke, of the Molson Dyke swarm, (Scoates and Macek, 1978) outcrops on the north side of the Cross Lake-Norway House road (P.R. 373) 4.8 km east of the dam at the Jenpeg Generating Station (Fig. GS-17-2). Figure GS-17-8 shows the fracture pattern and banding within the dyke. The rocks enclosing the dyke are augen gneiss (Lenton et al., 1986) that are structurally unrelated to the north- trending dyke system.

Although 80-90 per cent of the rock is massive, the westernmost portion (Fig. GS-17-8) is a banded diabase. It is characterized by repetitions of 1-2 mm concentrations of plagioclase and mafic minerals. The banding does not appear to affect the physical properties of the diabase as fractures within the dyke pass through the banded portion without deflection.

Many of the microfractures that are visible at the surface do not extend for more than 1 m even though they often occur in en echelon groups. It is not known whether these fractures have any depth continuity since they differ in appearance from the longer, prominent joints and they are not visible on polished surfaces.

Minor pegmatites occur as randomly distributed 4-5 cm pods. These pods contain 1-1.5 cm grains of plagioclase, amphibole and magnetite. They are rare and unpredictable in occurrence and thus would be unavoidable during quarrying.

Faces produced within the quarried blocks, during the feather and wedge sampling procedure, were straight over a distance of 0.8-1.2 m along the line of Cobra drill holes; thus quarrying within the dyke should not encounter strong anisotropy.

CROSS LAKE ANORTHOSITE

In the Cross Lake area (Fig. GS-17-2), anorthosite is known to occur in the West Channel and at Pipestone Lake. These units have not been correlated with any certainty. Those outcrops of the West Channel anorthosite that have been investigated have revealed an unmetamorphosed, friable aggregate of 0.5-1.0 cm crystals of plagioclase, amphibole and biotite. This friability makes it unsuitable as a building stone. The Pipestone Lake anorthosite is largely metamorphosed to amphibolite grade. The metamorphism has converted the orthopyroxene into an unoriented aggregate of amphibole and locally has resulted in the recrystallization of the plagioclase from 10 cm megacrysts into a felted aggregate of 0.5 cm crystals. This anorthosite is compact with no conspicuous planes of weakness.

Two locations along the Cross Lake road were found to be sufficiently homogeneous and fracture-free to map on a 1:200 scale. Test polishing of 15-20 kg samples from each of the mapped localities showed that the mafic minerals pluck from the polished surface. Thus the anorthosite does not appear to be a potential source of dimension stone.

REFERENCES

Bailes, A.H. and Syme, E.C.
1987: Geology of the Flin Flon-White Lake area, Manitoba Energy and Mines, Map GR87-1-1.

Froese, E. and Goetz, P.A.
1980: Geology of the Sherridon group in the vicinity of Sherridon, Manitoba; Geological Survey of Canada, Paper 80-21.

Gunter, W.R. and Yamada, P.H.
1985: Evaluation of industrial mineral occurrences in the Snow Lake area; Manitoba Energy and Mines, Report of Field Activities 1985, p. 82-100.

1986: Evaluation of industrial mineral occurrences in the Flin Flon-Snow Lake area; Manitoba Energy and Mines, Report of Field Activities 1986, p. 86-72.

1986: Evaluation of industrial mineral occurrences in the Thompson area; Manitoba Energy and Mines, Report of Field Activities 1986, p. 172-178.

Kalliokoski, J.
1952: Weldon Bay Map 1020A; Geological Survey of Canada, Ottawa, Geological Map 1 inch to 1 mile.

Lenton, P.G., McRitchie, W.D., Corkery, M.T. and Cameron, H.D.M.
1986: Kiskitto, Kiskittogisu, Playgreen Lakes; Manitoba Energy and Mines, Preliminary Map 1986N-2, 1:50 000.

Macek, J.J. and Russell, J.K.
1978: Thompson Nickel Belt Project; Manitoba Mineral Resources Division, Geological Services Branch, Report of Field Activities 1978, p. 43-46; also: Preliminary Map 1978T-1.

Patterson, J.M.
1963: Geology of the Thompson-Moak Lake area; Manitoba Mines Branch, Publication 60-4.

Scoates, R.F.J. and Macek, J.J.
1978: Molson Dyke Swarm; Manitoba Mineral Resources Division, Geological Survey, Geological Paper 78-1.

GS-18 GEOCHEMISTRY OF GRANITES IN THE SNOW LAKE-FLIN FLON AREA

by N.M. Halden[1]

Sampling of granitoid rocks in the Snow Lake-Flin Flon area has formed a component of numerous geological studies conducted by Manitoba Energy and Mines, Geological Services. There are two primary objectives of this study: firstly, to determine whether or not there is a relationship between the geochemistry of the granites and economic mineralization; secondly, to establish the tectonic provenance of the Snow Lake-Flin Flon terrane. A by-product of these studies will be a potentially more rigorous breakdown of the physical and geochemical features of various intrusive events. The sampling program until 1987 was concentrated within post-Missi intrusive units to the west of Elbow Lake.

Field work in the 1987 season has been aimed at expanding this sample set with suites of rocks obtained from previously unsampled units. In addition field observations have been made with respect to determining the relative ages of some of the units being discussed. The additional samples have been obtained from units outcropping on Highway 10 between Flin Flon and Cranberry Portage in the vicinity of Otter Lake and Mistik Creek, from Naosap Lake, from the northern end of Simonhouse Lake, and from a distinctly zoned pluton that outcrops dominantly to the east of Jenny Lake. In order to provide some form of internal comparison of the granitic magmatism in the Snow Lake-Flin Flon district a number of samples have also been obtained from plutons to the east of Elbow Lake. The units sampled include granites and migmatite neosome from the northern end of Reed Lake and from the Tramping Lake pluton southwest of Wekusko Lake.

Field observations made at a number of sites would tend to confirm previous opinions that the post-Missi intrusive group can be subdivided into two groups, essentially equigranular igneous intrusions and gneissic granitoid bodies. The relationships, however, between these two groups tend to present problems of interpretation, and potential for future mapping.

The zoned batholith to the east of Jenny Lake is, around its margin, zoned and layered rather than gneissic. Disaggregated inclusions with a relatively more mafic composition than their dioritic host were observed within discrete north-trending layers to the north of Jenny Lake. The problem of identifying the relationship between gneissic and migmatitic bodies is also highlighted by those units observed and sampled at Simonhouse Lake and Reed Lake. At the northeast end of Reed Lake the granitoid rocks are reportedly gneissic; the dominant lithology, however, is a schollen migmatite with the paleosome consisting of biotite and amphibole schists. Obviously, neosome emplacement postdates a fabric-forming deformational event; in addition, the neosome is unfoliated. Sizeable accumulations of granitic neosome occur and these would represent relatively homogeneous granitic intrusions. All the granite in this case is post-tectonic despite the fact that some of the neosome is involved in the creation of a migmatite. Close observation of the neosome component reveals a number of subtly different granitic neosomes at this locality, thus adding to the complexities of the igneous history. The relationships between gneissic and granitic bodies at Simonhouse Lake is superficially the same in that a homogeneous granitic body is fringed by a *lit-par-lit* migmatite and gneissic envelope. In that occurrence, however, some of the neosome and a considerable proportion of the granitic body are foliated, which might suggest that the onset of emplacement predated deformation.

Questions related to solving these problems are of critical importance when considering the possible results of this goechemical study. Although it might be suspected that broad geochemical similarities will exist given that most of the rocks are granitic, critical differences in geochemistry and the internal nature of the plutons will have to be matched to the field observations. This will require that consistent field observations are made with respect to relative times of emplacement. Additional questions that will have to be addressed will include those related to granite provenance and to the level of the various intrusions that are exposed.

Preliminary observation of a number of the granites reveals a potential alternative subdivision of the granites exclusive of tectonic relationships. Broadly, they may also be divided into a compositionally and mineralogically restricted group, dominantly at the felsic end of the compositional spectrum, and a second group that ranges in compostion between diorite and granodiorite. This could lead to an "I" or "S" type subdivision but this would have to be confirmed by comprehensive goechemical analyses.

The differences discussed earlier with respect to the relationship between various bodies to their migmatitic or gneissic envelopes may require investigation from the point of view of emplacement mechanism, i.e. are some bodies emplaced as diapirs, gneissic envelopes essentially representing the synchronous deformation of the granite's outer margins, or are some bodies emplaced passively into dilatant areas where a homogeneous granite is surrounded by a migmatitic envelope. Considerations such as these will require an extensive mapping effort.

Analytical work in progress at the moment has resulted in a number of partial analyses being created for the original set of 400 specimens. Trace element analyses are about 25% complete and major element analyses about 10% complete. Samples collected during the 1987 field season (80 specimens) are being crushed and prepared for bead and pellet manufacture.

[1] Department of Geological Sciences, University of Manitoba

GS-19 U-Pb ZIRCON GEOCHRONOLOGY IN THE FLIN FLON BELT: AGE OF AMISK VOLCANISM

by E.C. Syme, A.H. Bailes, T.M. Gordon[1] and P.A. Hunt[1]

Manitoba Energy and Mines and Geological Survey of Canada have over the past several years conducted a joint program of U-Pb zircon geochronology in the Lynn Lake and Flin Flon areas. Investigations in the Flin Flon area have until recently been hampered by the virtual absence of zircon in Amisk Group rhyolite flows. This preliminary report includes the first successful direct age determination of Amisk Group rocks, and a determination from a granodiorite pluton which intrudes the Amisk Group.

GEOLOGICAL SETTING

Early Proterozoic supracrustal rocks in the Flin Flon-Snow Lake belt are subdivided into Amisk Group metavolcanic and minor sedimentary rocks, and unconformably overlying Missi Group metaconglomerate and metasandstone (Bailes and Syme, 1987). A wide variety of intrusive rocks are emplaced in the Amisk Group but because few are in contact with the Missi Group the relative age of most plutons is unknown.

Amisk Group is dominated by subaqueous basalt and basaltic andesite flows and related breccias; rhyolite flows occur as sporadic bodies that form less than 10% of the section at Flin Flon. Faults, initiated during the last of five phases of deformation to affect the area, divide the Amisk Group into a number of fault-bounded blocks, each with a definable stratigraphic sequence (Bailes and Syme, 1987). Correlation of units or stratigraphy across block-bounding faults cannot be done. The geochronological priorities in the Flin Flon area have been, first, to obtain an age determination from the Amisk Group and, second, to refine the mapped, uncorrelated stratigraphic blocks by obtaining age determinations from as many blocks as possible.

AMISK GROUP

The sample for which an age determination has been made is from the Bear Lake block (Bailes and Syme, 1987). It was collected from a 1.5 m thick, normally graded rhyolite crystal tuff bed, one of a series of beds that occur between mafic lava flows in a chemically distinctive unit of ferrobasalt (Bailes and Syme, 1987; Fig. GS-19-1, 2). Zircon crystals separated from the tuff yield a U-Pb age of 1886 ± 1.3 Ma (Fig. GS-19-3).

These rhyolite crystal tuff beds, 30 cm — 8.5 m thick, are found only within and at the top of the ferrobasalt unit; together the flows and tuff form an excellent time-stratigraphic marker in the Bear Lake block. The tuffs are composed of varying amounts of quartz and plagioclase crystals and crystal fragments and, in some, a heterolithologic suite of small rock fragments including ferrobasalt, plagioclasite, tonalite, and porphyritic rhyolite. The sample contains 20% quartz crystals (to 4.5 mm), 10% plagioclase crystals (to 2 mm) in a very fine grained, foliated matrix of quartz, feldspar, chlorite, epidote, sphene and carbonate.

LYNX LAKE PLUTON

The Lynx Lake pluton (Fig. GS-19-1) is a concentrically zoned unfoliated granodiorite stock 3.8 x 8.6 km, emplaced in folded Amisk Group rocks in the Millwater block (Syme, GS-7, this volume). Within 1 km of the pluton contact, Amisk Group volcanic and intrusive rocks have been hornfelsed. Faults, which postdate folds in the area, displace the contacts of the pluton and truncate the thermal aureole (Preliminary Map 1987F-2, Syme, 1987).

The stock is composed of a marginal zone of metaluminous biotite-hornblende granodiorite and a core of slightly peraluminous muscovite-biotite granodiorite (descriptions in Syme, GS-7, this volume). The sample was collected from the marginal zone, and yields a U-Pb age of 1847 ± 4 Ma (Fig. GS-19-4).

DISCUSSION

A considerable number of U-Pb age determinations have now been conducted in the Trans-Hudson Orogen of Manitoba and Saskatchewan, and a full discussion of the Flin Flon data will be presented in a subsequent publication.

The 1886 age of Amisk Group volcanism is similar to zircon ages of volcanic rocks in the La Ronge Domain, Glennie Domain and Hanson Lake Block (1888-1876 Ma; Van Schmus et al., submitted). The Amisk Group at Flin Flon is intermediate in age between the Wasekwan Group at Lynn Lake (1910 +15/-10 Ma) and volcanic rocks in the Rusty Lake belt (1878 ± 3 Ma, Baldwin et al., 1987). Precise age dating techniques now permit temporal definition (and possible subdivision) of these belts, which are all broadly comparable in age and petrochemical characteristics. In the Flin Flon area, dates from other blocks may ultimately allow stratigraphic sequencing between blocks, which is not possible on purely lithologic criteria.

The 1847 Ma Lynx Lake pluton is, on the basis of its lack of foliation and absence of crosscutting dykes, considered one of the youngest plutons in the Flin Flon-Athapapuskow area. The age of the pluton places constraints on some of the structures in Millwater block: folds must be pre-1847 and faults post-1847 Ma. The fact that Lynx Lake pluton predates the Missi Group (1832 ± 2 Ma; Gordon et al., 1987) suggests that most plutons in the Flin Flon area are pre-Missi in age. Younger plutons (1830-1836 Ma) occur in the Snow Lake area (Gordon et al., 1987) and at Phantom Lake in Saskatchewan (1.82 Ga; R. MacQuarrie, unpublished data). The Cliff Lake pluton northeast of Flin Flon may represent one of the older plutons to cut the Amisk Group, but the age determination has a considerable uncertainty (1871 +34/-24 Ma). The Lynx Lake pluton is comparable in age to plutons in the La Ronge domain (1848 — 1866 Ma, Van Schmus et al., submitted) but is significantly younger than the 1876 Ma plutons in the Lynn lake belt (Baldwin et al., 1987).

1987 SAMPLING

During the 1987 field season five additional samples were obtained from Amisk Group rocks:

1. Quartz-phyric phase of a rhyolite dome in the stratigraphic footwall of Flin Flon Mine.
2. Quartz-plagioclase-phyric massive rhyolite flow which hosts the Flin Flon massive sulphide orebody.
3. Sparsely quartz-phyric rhyolite, Bakers Narrows block.
4. Quartz-phyric rhyolite flow, Daly Lake, 10 km southwest of Snow Lake.
5. Quartz-phyric rhyolite flow in stratigraphic footwall of Ghost Lake Mine.

REFERENCES

Bailes, A.H. and Syme, E.C.
1987: Geology of the Flin Flon-White Lake area; Manitoba Energy and Mines, Map GR87-1-1.

[1] Geological Survey of Canada, 601 Booth Street, Ottawa, K1A 0E8

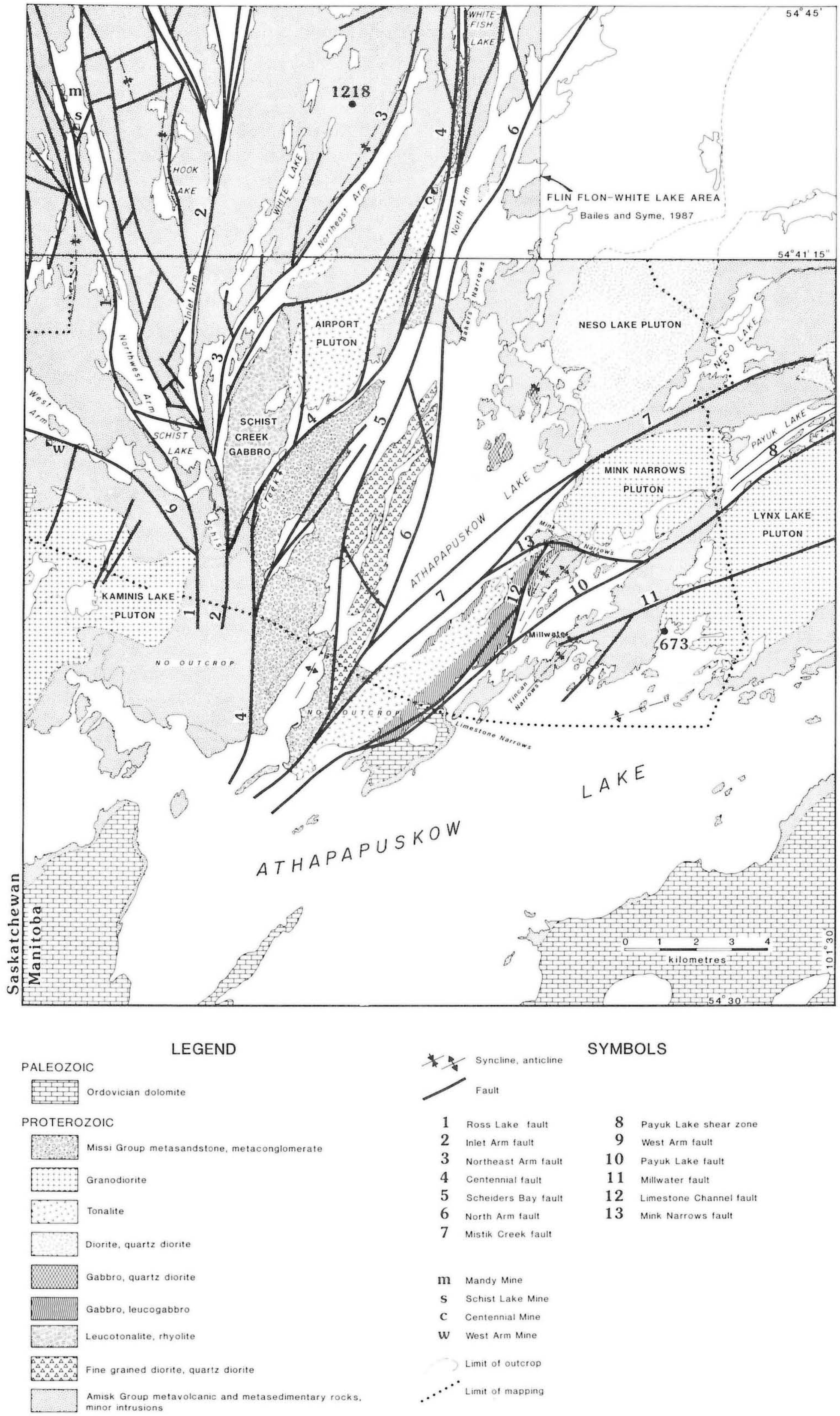


Figure GS-19-1: Simplified geological map of Schist Lake-Athapapuskow Lake area, with locations of the analyzed samples: 1218 — Amisk Group rhyolite crystal tuff; 673 — Lynn Lake granodiorite pluton.

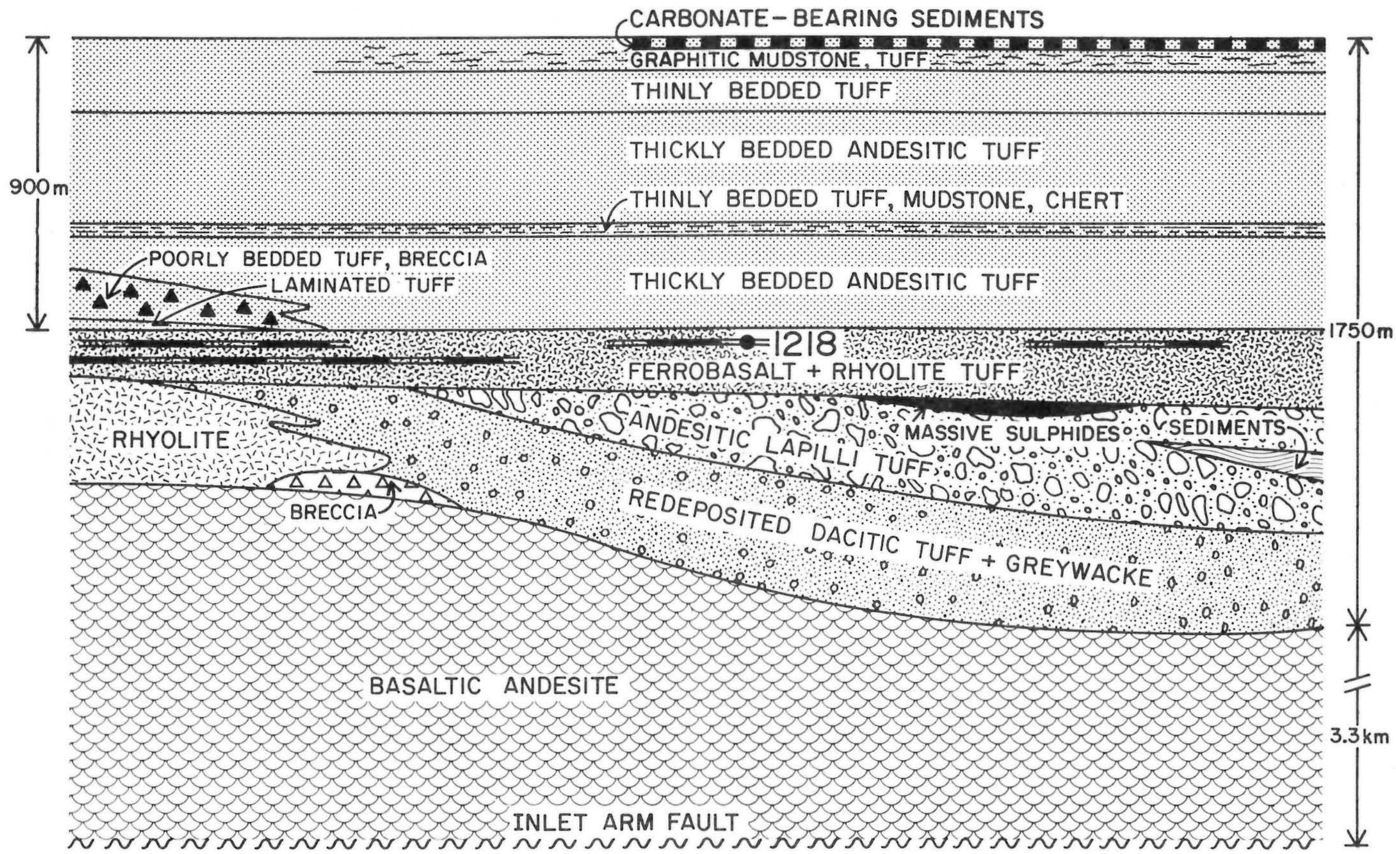


Figure GS-19-2: *Reconstruction of stratigraphic relationships in the Bear Lake block, showing location of analyzed rhyolite crystal tuff, sample 1218.*

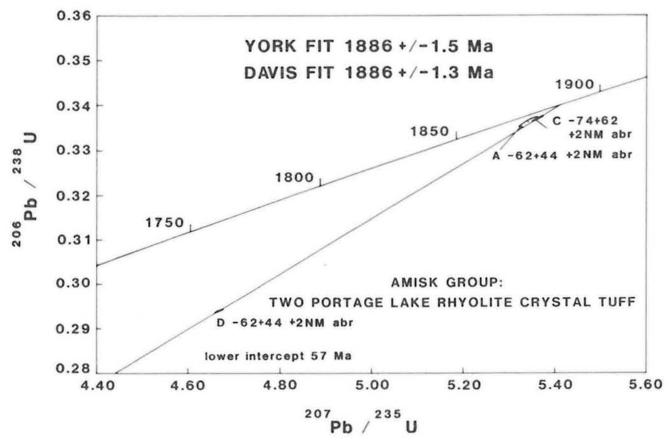


Figure GS-19-3: *Concordia diagram showing data from Amisk Group rhyolite crystal tuff, (sample 1218).*

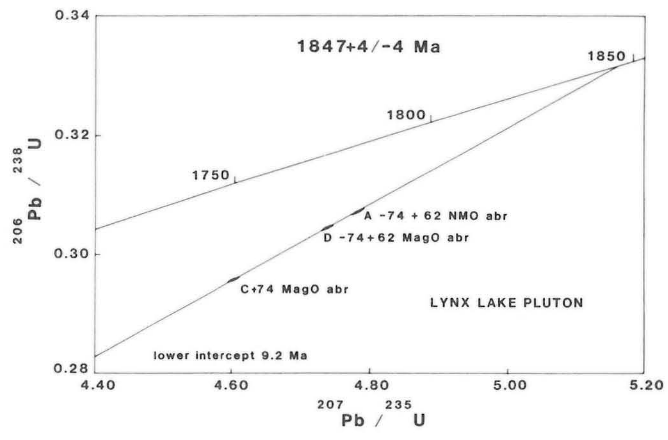


Figure GS-19-4: *Concordia diagram showing data from Lynx Lake pluton (sample 673).*

Baldwin, D.A., Syme, E.C., Zwanzig, H.V., Gordon, T.M., Hunt, P.A. and Stevens, R.D.
1987: U-Pb zircon ages from the Lynn Lake and Rusty Lake metavolcanic belts, Manitoba: two ages of Proterozoic magmatism; Canadian Journal of Earth Sciences, v. 24, p. 1053-1063.

Gordon, T.M., Hunt, P.A., Loveridge, W.D., Bailes, A.H. and Syme, E.C.
1987: U-Pb zircon ages from the Flin Flon and Kisseynew belts, Manitoba: chronology of Early Proterozoic crust formation; Geological Association of Canada-Mineralogical Association of Canada, Joint Annual Meeting, Program with Abstracts, v. 12, p. 48.

Syme, E.C.
1987: Athapapuskow Lake; Manitoba Energy and Mines, Preliminary Map 1987F-2.

Van Schmus, W.R., Bickford, M.E., Lewry, J.F. and Macdonald, R.
________: U-Pb geochronology in the Trans-Hudson Orogen, Northern Saskatchewan, Canada; Canadian Journal of Earth Sciences, submitted.

GS-20 GEOLOGICAL INVESTIGATIONS IN THE LILY LAKE AREA

by W. Weber

INTRODUCTION

A 10-day remapping of the Lily Lake area, west of Gem Lake, was undertaken to investigate the geological setting of gold occurrences reported by Theyer and Gaba (1986). Quality and extent of bedrock exposure was enhanced substantially by forest fires in 1983.

LITHOLOGY

Lithologically the area is considerably more complex than previously indicated (Weber, 1971). Areas mapped as metasediments between Slate Lake and Lily Lake are a sequence of highly sheared and in part silicified pillow basalts, interlayered with minor felsic tuff (Unit 1, Fig. GS-20-1).

These predominantly mafic rocks are overlain and interlayered with Unit 2 felsic pyroclastic rocks units, Unit 3 feldspathic wacke with argillite — locally with thin magnetite-bearing beds — and conglomerate, and Unit 4 rhythmically layered argillite, in part magnetiferous, felsic tuff and intraformational (?) conglomerate (Fig. GS-20-1).

Supracrustal rocks locally show considerable lateral facies changes, e.g. between Slate Lake and Lily Lake, coarse proximal felsic pyroclastics (2b) grade laterally northwestward into volcanic conglomerates (2c) and finally into more distal sandstones (3a), rhythmically layered, in part magnetiferous argillite (3b) and debris flow (?) polymictic conglomerate (3c). These sandstones contain the gold-bearing quartz veins south of Lily Lake. This sandstone unit becomes considerably thicker and more homogeneous between Lily Lake and Banksian lake.

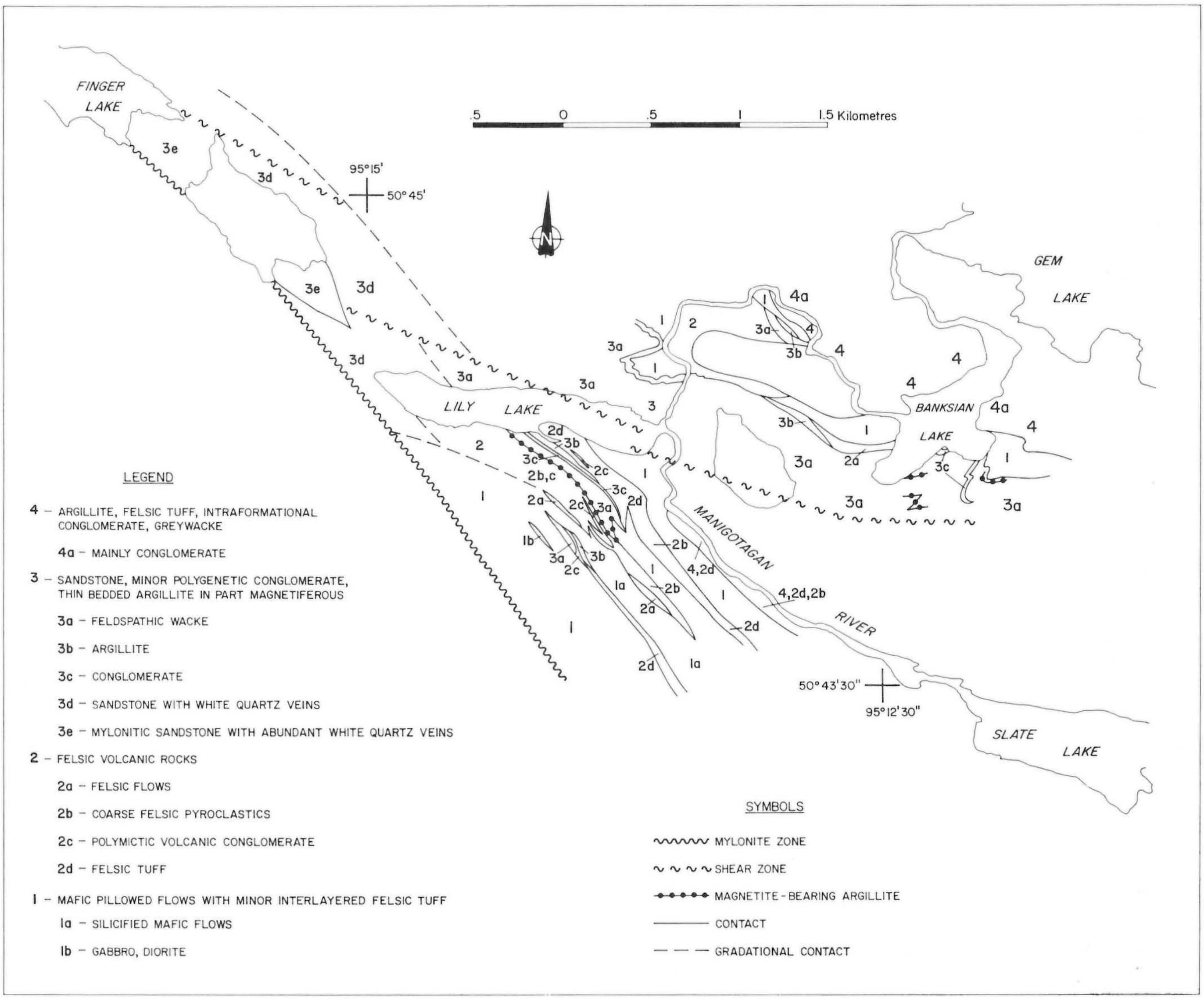


Figure GS-20-1: Geology of the Lily Lake area.

STRUCTURE

The area is structurally very complex as already indicated by previous mapping (Weber, 1971). Relatively late, dextral movement produced widespread Z folding on a centimetre to several tens of metres scale of previously sheared and highly flattened supracrustal sequences. This makes the tracing of individual units very difficult, in view of the highly diverse lithologies and lateral facies changes. Axial traces trend approximately 60° and are slightly rotated clockwise near the major mylonite zone through Finger Lake.

GOLD MINERALIZATION

Controls on the gold mineralization in quartz veins south of Lily Lake are not obvious. Gold mineralization appears to be restricted to relatively small, dark grey, deformed (generally folded) fine quartz vein networks or deformed small quartz veins in dark grey-green medium- to coarse-grained feldspathic wacke. The quartz veins are generally surrounded by lighter coloured (1-3 cm) altered wacke containing arsenopyrite.

Similar quartz veins occur throughout the supracrustal sequence elsewhere but arsenopyrite and gold mineralization was observed only at the presently known occurrences.

All these quartz veins appear to have developed locally, and are not part of a more extensive quartz veining, such as that associated with major shear or regional alteration zones.

A different type of quartz veining is associated with the mylonite zone trending through Finger Lake and individual quartz veins extend close to Lily Lake. But this type of quartz veining is white, and is less deformed than the dark grey quartz veins, and thus appears to be younger. The white quartz appears to be barren.

The gold-bearing quartz possibly formed initially in small tensional fracture systems in relatively competent rocks (sandstone) in response to dextral movement taking place in less competent lithologies (argillite). Examples of such quartz veining were observed in several places (Fig. GS-20-2) where lack of subsequent deformation reveals original structural relationships. If, because of their greater relative competency sandstones represent the best host for tensional fractures, and thus a structural control for gold mineralization, it is still not known why apparently only certain portions of the sandstones carry gold-bearing quartz veins. Since the sandstones in the Lily Lake area are closely associated with felsic volcanic debris, it is possible that erosion products of volcanogenic epithermal gold mineralization were deposited in certain strata and that some of the control is stratabound.

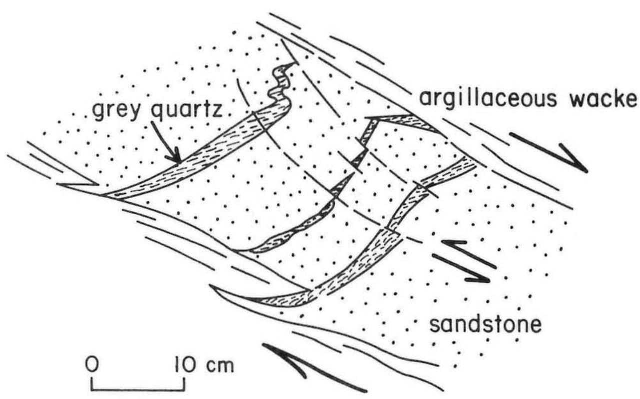


Figure GS-20-2: *Tension fractures filled with dark grey quartz in massive sandstone bed of unit 3a caused by dextral movement in surrounding argillaceous wackes. Fractures indicate compensating sinistral movement inside sandstone bed.*

REFERENCES

Theyer, P., and Gaba, R.G.
1986: Mineral occurrences investigations in the Rice Lake greenstone belt; **in** Manitoba Energy and Mines, Report of Filed Activities, p. 120-124.

Weber, W.
1971: Geology of the Long Lake — Gem Lake area; **in** Geology and geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie and W. Weber, eds.; Manitoba Mines Branch, Publication 71-1, p. 63-106, and Map 71-1/5.

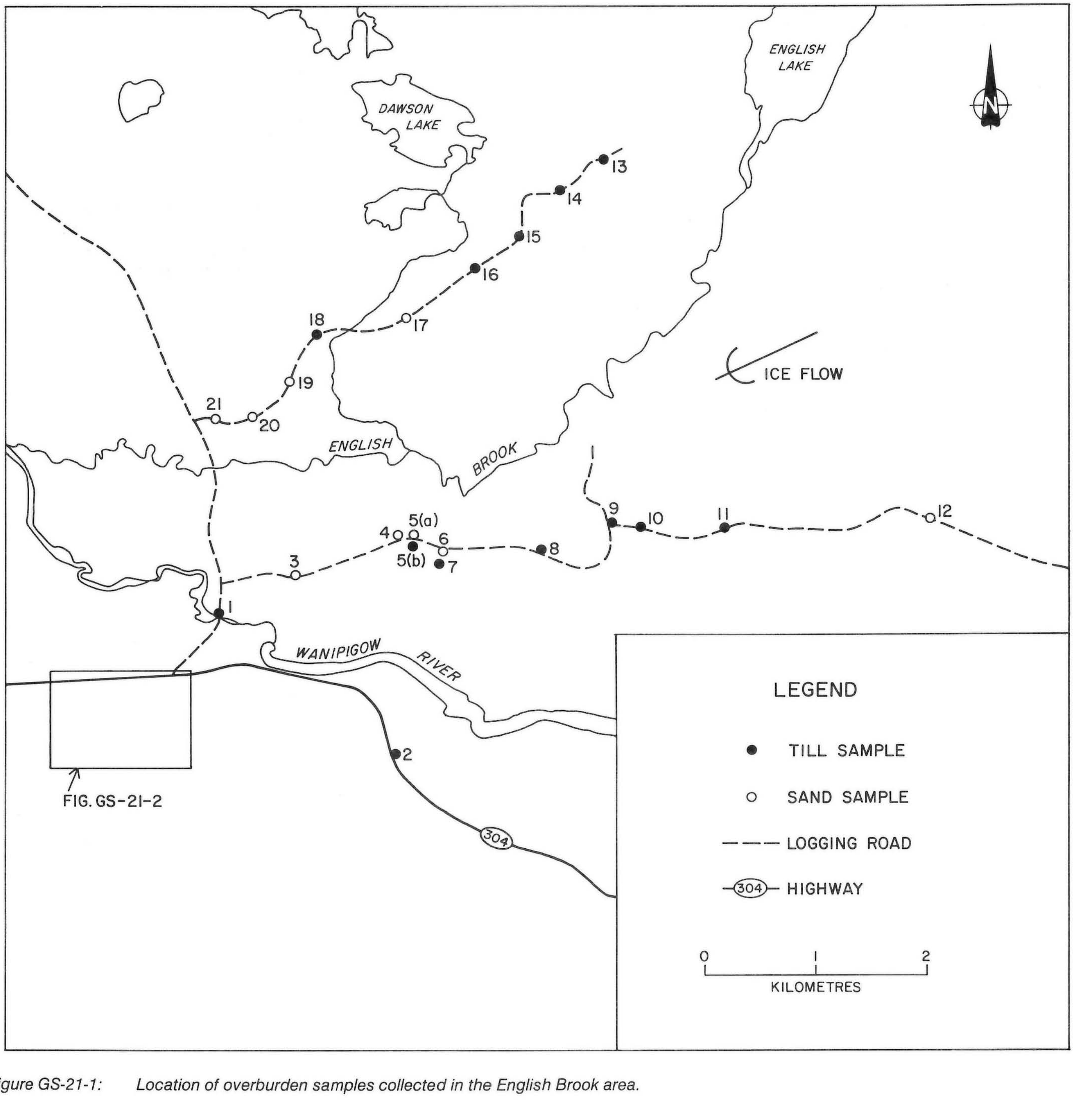


Figure GS-21-1: Location of overburden samples collected in the English Brook area.

GS-21 INVESTIGATIONS OF QUATERNARY PLACER GOLD OCCURRENCES IN THE MANIGOTAGAN AREA

by E. Nielsen and R.N.W. DiLabio[1]

Placer gold occurrences in Quaternary sand and gravel deposits in the Manigotagan area, reported previously by Nielsen (1986), were investigated further during the 1987 field season. Both regional and detailed sampling were undertaken to determine (1) if the placer gold in the Lake Agassiz beach sediments was derived from till transported into the area from the English Lake region and (2) if the placer gold was concentrated in a particular beach facies.

REGIONAL STUDY

A total of 22 samples, 9 littoral sand and 13 till samples, were collected from 21 sites in the English Brook area, located up-ice from the area investigated in 1986 (Fig. GS-21-1).

[1] Geological Survey of Canada, 601 Booth Street, Ottawa. K1A OE8

The maximum relief in the area is about 20 m. The hills are mainly bedrock, with only minor Quaternary deposits which are generally restricted to the low-lying areas. The Quaternary sediments consist mainly of Lake Agassiz deep-water clay and littoral sand and gravel deposits, with minor till deposits.

Glacier flow was almost uniformly toward 245° as indicated by abundant striated outcrops.

DETAILED STUDY

Detailed sampling at the placer gold occurrence investigated in 1986 resulted in an additional 62 sand samples collected from 21 backhoe pits (Fig. GS-21-2). The pits were dug along the berm of the beach and across the profile of the beach. Paleocurrent directions in the sand as well as the geomorphology of the deposit suggest the sand was trans-

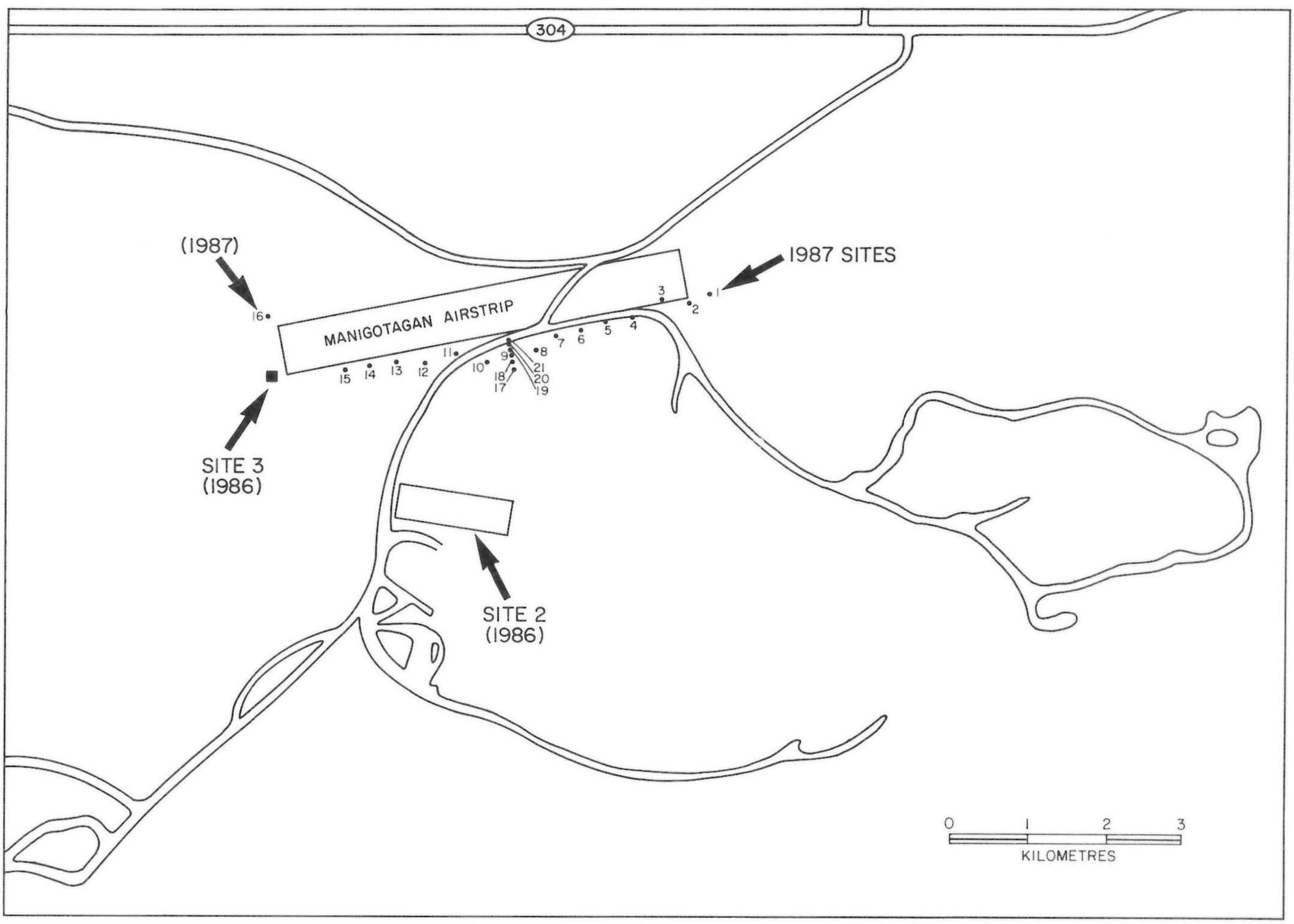


Figure GS-21-2: Location of backhoe pits along the Manigotagan airstrip.

ported toward the west by longshore drift. The present-day airstrip is situated on the upper foreshore facies of the beach.

SAMPLE ANALYSIS

A total of 84 samples each weighing approximately 8 kg were collected and have been submitted for heavy mineral separation and gold grain counts. Detailed microprobe and scanning electron microscope (SEM) studies will be undertaken to determine the source of gold grains. The heavy fraction of selected till samples will be analyzed for gold and platinum.

The less than 2 micron fraction of the till samples will be analyzed for copper, lead, zinc, nickel, cobalt, chromium, iron, manganese and arsenic.

COMMENTS

The origin of the placer gold grains discovered previously in the Manigotagan area (Nielsen, 1986) is still uncertain. It is hoped that the limited regional sampling undertaken this year will determine the most probable source of the gold, i.e. whether it was derived from till transported into the area from an unknown source in the English Lake region or from a more local occurrence in the Wanipigow River area.

REFERENCE

Nielsen, E.
1986: A preliminary investigation of Quaternary placer gold in the Manigotagan area; **in** Manitoba Mineral Resources Division, Report of Field Activities 1986, p. 131-133.

GS-22 MINERAL DEPOSIT INVESTIGATIONS IN THE RICE LAKE GREENSTONE BELT

by P. Theyer

The Lily Lake mineral occurrence (Fig. GS-22-1; Russell, 1949) consists of gold-bearing quartz veins in arkose and wacke over a distance of approximately 600 m (Theyer and Gaba, 1986). These quartz veins and other quartz veins in the vicinity of Banksian Lake (approximately 1.5 km east of Lily Lake) contain minor but anomalous quantities of gold and define a large area with the potential to host other, as yet unrecognized gold-bearing quartz veins. The mineral deposit investigations were complemented by a regional geological mapping program (Weber, GS-20, this volume).

The geological investigations and the documentation of several mineral occurrences in southeastern Rice Lake greenstone belt completes the mineral occurrences documentation program of this greenstone belt. Information on the documentation of the mineral deposits including maps and assay results are available from the author prior to publication, which is currently scheduled for 1988.

QUARTZ VEINS

Two types of quartz veins were distinguished in the Lily Lake and Banksian Lake areas: a) white, sugary textured, generally thick (0.2-2 m) and at least several metres long, undeformed quartz veins of late to post-deformation emplacement; and b) light to dark grey quartz veins characterized by randomly distributed white (1-2 cm) areas and a very fine grained to aphanitic "flinty" texture. The latter veins are generally disrupted and deformed, and with highly irregular lengths and thicknesses; they commonly contain arsenopyrite, pyrrhotite, pyrite and anomalous gold concentrations, even visible gold. Although the grey quartz veins occur in rocks of volcanic and sedimentary origin, they appear to be preferentially located in wackes and related sedimentary rocks. On the other hand the white quartz veins are generally barren of sulphide.

DISTRIBUTION OF QUARTZ VEINS

Although the grey quartz veins occur as far north as the northern shore of Gem Lake, arsenopyrite and to a minor degree pyrite are concentrated in the area defined by southwest Banksian Lake, Nora Lake and southeast to northwest Lily Lake. The grey mineralized quartz veins in the area between Banksian Lake and Nora Lake are hosted by sedimentary rocks ranging from pebble conglomerate to gritty arkose and fine grained wacke, i.e. sedimentary rocks such as those hosting the visible gold-bearing quartz veins south of Lily Lake (Russell, 1952; Theyer and Gaba, 1986).

The rocks north of Lily Lake, however, are characterized by gritty, highly siliceous, rocks of tuffaceous appearance containing minor pyrite and randomly distributed grey quartz veins ubiquitously mineralized with minor amounts of arsenopyrite. A large exposure near northwestern Lily Lake (Fig. GS-22-1) is characterized by westerly striking grey quartz veins, ranging from 1 cm to 1 m thick, that are mineralized with abundant up to 5% arsenopyrite in intensely shear folded and altered arkose. Alteration zones straddling the quartz veins are characterized by several metres thick

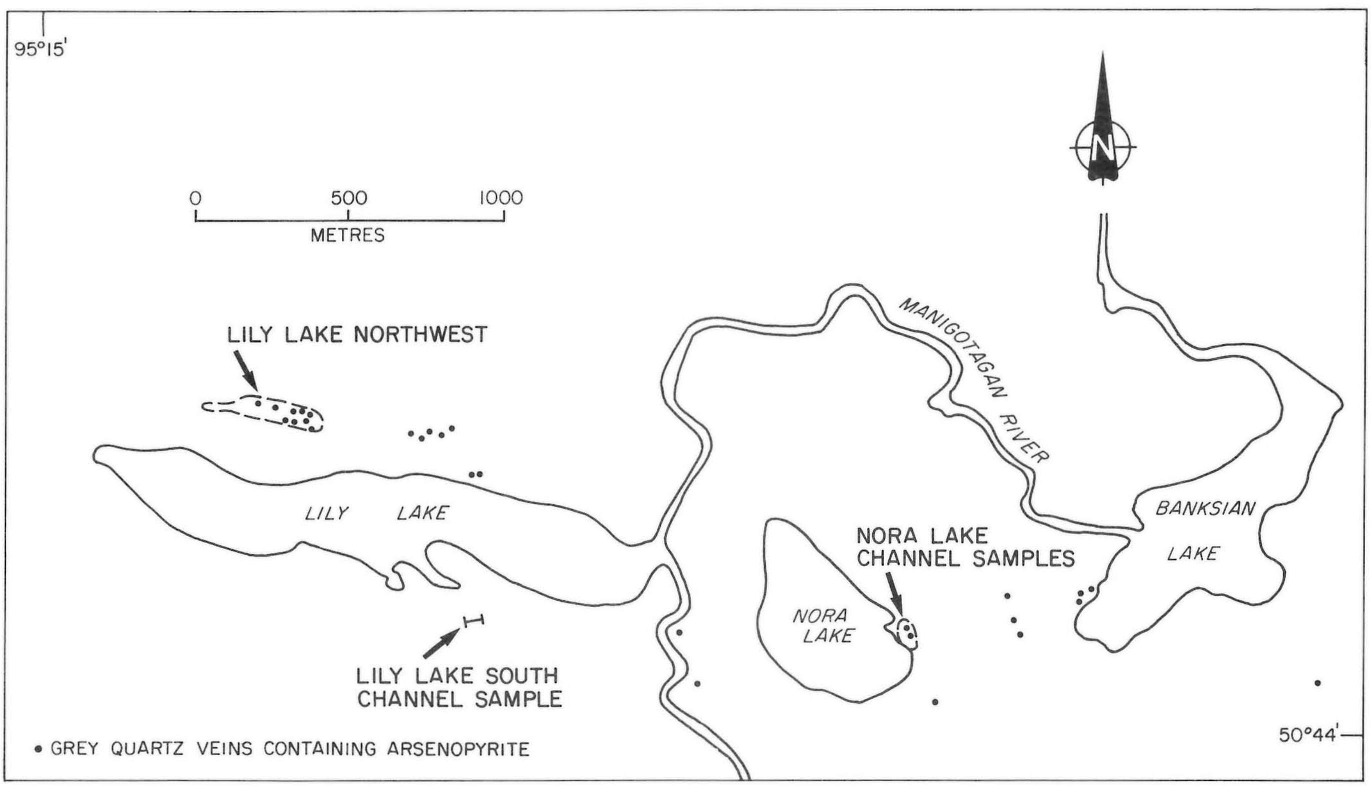


Figure GS-22-1: Distribution of sampled grey quartz veins and location of channel samples in the Lily Lake-Banksian Lake area.

rock layers that show bleaching, silicification and tourmalinization. Arsenopyrite appears to be concentrated near the eastern edge of this outcrop area and declines to nominal concentrations within a distance of approximately 300 m in a westerly direction.

SAMPLING

LILY LAKE SOUTH

A channel sample (Fig. GS-22-1) approximately 22 m long was cut across arkose and wacke containing grey quartz veins southeast of Lily Lake to determine:

1. whether gold occurs exclusively within the quartz veins or is also hosted by the surrounding sedimentary rocks;
2. the gold tenor of the quartz veins and the sedimentary rocks; and
3. whether arsenopyrite in quartz veins and host rock is indicative of the occurrence of gold.

NORA LAKE

Two channel samples were cut near the eastern shore of Nora Lake across an approximately 2 m thick intensely sheared arkose hosting grey quartz veins mineralized with arsenopyrite and minor amounts of pyrite. The location of these and additional samples of grey quartz veins taken in this region are shown in Figure GS-22-1.

GEOCHEMISTRY

Analyses for gold returned mostly background concentrations for the cut samples from the Nora Lake and south of Lily Lake areas. The samples from the outcrop northwest of Lily Lake (Fig. GS-22-1) contained anomalous gold concentrations (Table GS-22-1).

These results suggest:

(a) that gold is concentrated within grey quartz veins in the area southeast and northwest of Lily Lake,
(b) there is no evidence of significant gold concentrations in the sedimentary rocks surrounding the quartz veins; and,
(c) the occurrence of arsenopyrite in grey quartz veins does not necessarily indicate the presence of gold.

TABLE GS-22-1
LITHOGEOCHEMICAL SAMPLING RESULTS

Sample Number	As (ppm)	Au (ppb)
18	1400	84
19	1304	380
20	7936	1050
21	4995	122
22	65	6
23	1179	21
24	I333	7
25	2635	45

CONCLUSION

Grey quartz veins characterized by similarities in the mode of occurrence, deformation and mineralization occur in an area circumscribed by Gem, Banksian, and Lily Lakes. Arsenopyrite mineralization, although virtually ubiquitous in very minor amounts, appears to be concentrated in an outcrop north of Lily Lake. Visible gold occurs in quartz veins of this type south of Lily Lake.

REFERENCES

Russell, G.A.
1949: Geology of the Lily Lake-Kickley Lake area, Manitoba; Manitoba Mines Branch, Publication 50-3.

Theyer, P. and Gaba, R.
1986: Mineral deposit investigations in the Rice Lake greenstone belt; **in:** Manitoba Energy and Mines, Report of Field Activities 1986, p. 120-124.

GS-23 PLATINUM GROUP ELEMENTS IN SOUTHEASTERN MANITOBA

by P. Theyer

'DONNER OPTION' AREA (Part of NTS 62P/1)

INTRODUCTION

The 'Donner option' group of claims are located east of English Lake and north of the western Rice Lake greenstone belt (Fig. GS-23-1). This area is underlain by felsic, intermediate, mafic and ultramafic rocks that contain sporadic occurrences of disseminated Fe, Ni and Cu sulphides. Karup-Møller (1969) described the sulphide mineralogy in drill core from a Falconbridge Ltd. exploration project.

This study was initiated on the basis of the occurrence of sulphides in mafic and ultramafic rocks showing evidence of igneous brecciation and the development of pyroxene-plagioclase pegmatites, features that

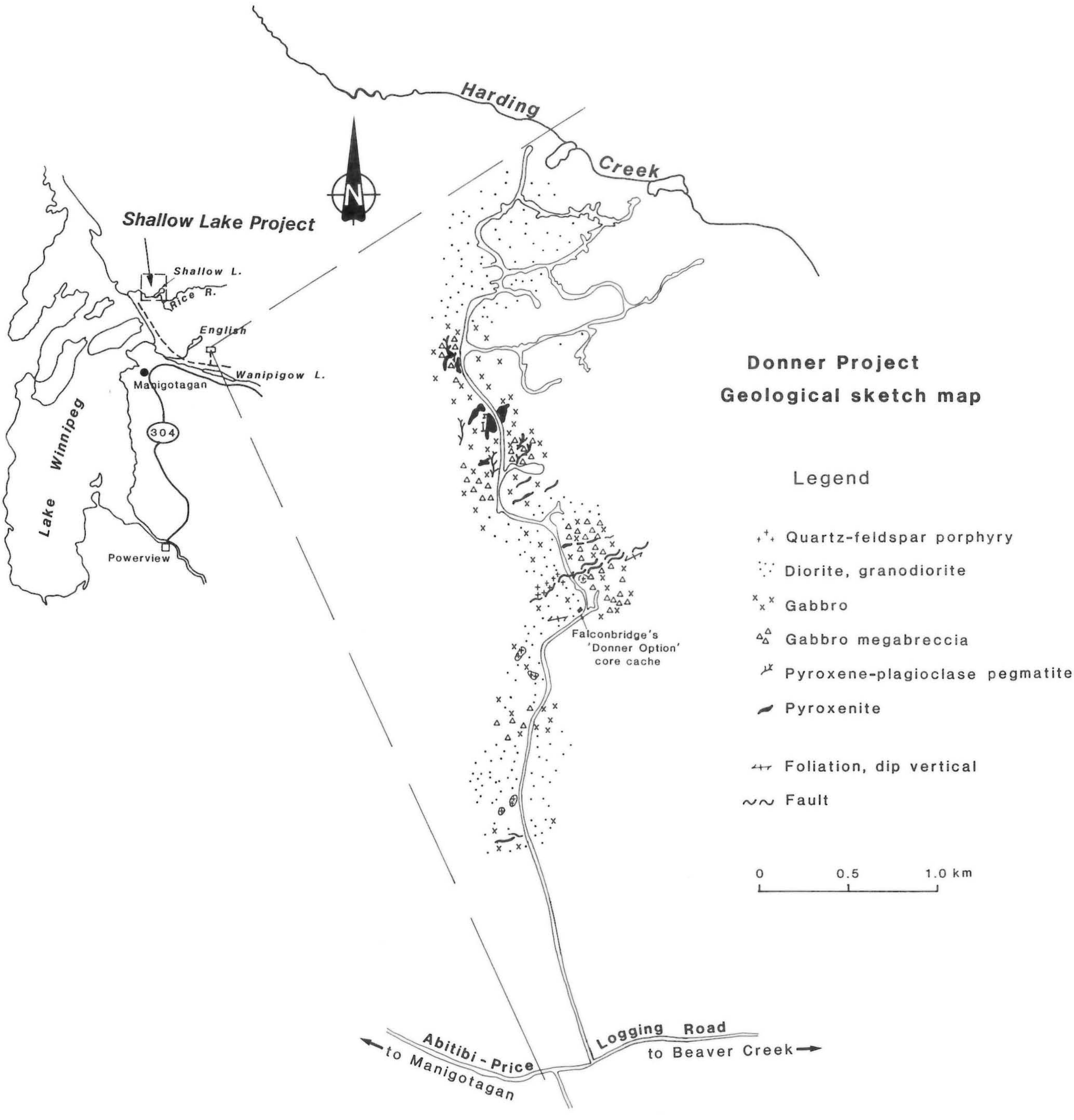


Figure GS-23-1: Geological sketch map of the Donner Option and location map of the Shallow Lake project.

appear to typify a class of platinum group element (PGE) occurrences, for example, the Lac des Isles PGE deposit.

A network of logging roads and extensive clear-cuts from recent logging operations have provided good access and abundant new exposures in the area.

GEOLOGY

Russell (1949) mapped this area as underlain by a rock unit that included felsic, intermediate and mafic volcanic rocks with an intercalated wedge of quartz-hornblende gneiss and hornblende-plagioclase gneiss. Reconnaissance mapping in the vicinity of a logging road that crosses the area adjacent to the "Donner option" (Fig. GS-23-1) showed that the underlying rocks can be subdivided into a northern and southern granodioritic to dioritic domain flanking a central domain of mafic and ultramafic rocks that are intruded by small felsic and mafic dykes and stocks.

Gabbro, classified preliminarily into three major types, is the most common rock in the central domain. The three rock types, which show a wide variety of gradational changes into each other, are:

a) massive gabbro — fine- to medium-grained homogeneous and generally massive pyroxene-plagioclase ± magnetite gabbro;

b) layered gabbro — fine- to medium-grained layered pyroxene-plagioclase-magnetite gabbro. Layering, normally in the centimetres to tens of centimetres thickness range, is due to variations in the plagioclase to pyroxene ratio; and,

c) gabbro megabreccia — the massive and/or the layered gabbro are in places intruded and disrupted by an ultramafic (pyroxenitic?) magma. Outcrops underlain by this rock are characterized locally by chaotic gabbro fragments (centimetre to several metres across) in a generally homogeneous pyroxenitic matrix.

Figure GS-23-2: Metasomatized GMB; note the partially assimilated gabbroic breccia component.

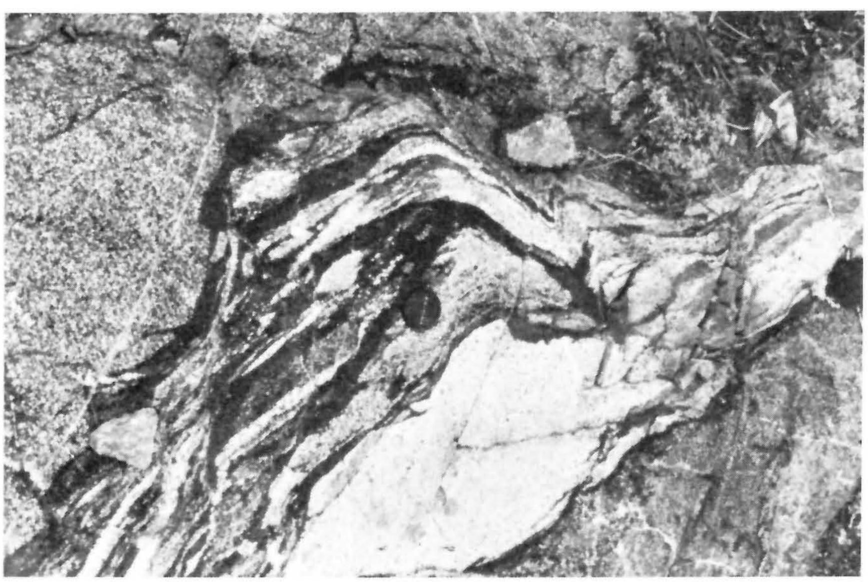


Figure GS-23-3: Plastic GMB; gabbro sinuously interdigitated with pyroxenite.

The gabbro megabreccia (GMB) can be classified into three varieties that are, in order of decreasing abundance:

1) metasomatized GMB (Fig. GS-23-2); the components of this breccia are highly altered and in places almost totally assimilated by the ultramafic matrix. Outcrops showing this advanced degree of metasomatism are characterized by barely discernible gabbroic ghosts of gabbro breccia in an ultramafic matrix;
2) plastic GMB (Fig. GS-23-3); outcrops underlain by plastic GMB are characterized by components that are partially deformed into centimetre to tens of centimetres thick gabbro layers that are sinuously interdigitated with the pyroxenite. This is interpreted to indicate that the gabbro was in a plastic stage at the time of, or shortly after, the ultramafic intrusions; and,
3) unaltered GMB (Fig. GS-23-4); components of this breccia appear to have undergone only mechanical interaction with the matrix, i.e. separation and in place rotation, but not metasomatic or thermal alteration.

The pyroxenite matrix of the GMB occurs in centimetre to metre thick veins, stocks and lenses. Some of the thinner, distal pyroxenite veins exhibit peculiar pegmatitic plagioclase-pyroxene intergrowths. Pyroxene megacrysts (up to 8 cm long) show skeletal crystal shapes (Fig. GS-23-5) suggesting rapid crystallization from a supersaturated magma.

Massive, homogenous pyroxenite occurs in stocks several tens of metres across, lenses and dyke-shaped bodies. It is coeval and consanguineous with the pyroxenite veins that form the matrix of the GMB.

The time of emplacement of the pyroxenite is uncertain. Brecciation and stoping of the gabbro by the pyroxenite suggests intrusion of the proxenite into a rigid gabbro; however, the plastic deformation of some of the GMB may indicate a remelting or that some of the gabbro was still in a plastic state. Quartz-feldspar porphyry and feldspar porphyry stocks and lenses, ranging from tens to hundreds of metres in diameter, clearly postdate the pyroxenite intrusions. The youngest and areally most insignificant rocks are thin, fine grained mafic dykes ranging from centimetres to tens of centimetres in thickness that crosscut all other rock types.

Figure GS-23-4: *Unaltered GMB; gabbroic components are separated and rotated but show no evidence of metasomatism.*

Figure GS-23-5: *Skeletal pyroxene megacrysts*

ECONOMIC GEOLOGY

Pyrrhotite, pyrite and rare chalcopyrite occur as disseminations in layers and concentrated in pockets in most of the mafic and ultramafic rocks underlying this area. The complexity of the sulphide-bearing rocks in the central domain (that are surrounded by the sulphide-poor lithologically monotonous granodiorite and diorite of the southern and northern domain) as well as the correlation between the concentrations (2-3%) of sulphides, GMB and plagioclase-pyroxene pegmatite should be of particular interest to explorationists. These features are also characteristic of the Roby Zone in the Lac des Isles (Ontario) PGM occurrence (Macdonald, 1985; Sutcliffe and Sweeney, 1985).

Results of a lithogeochemical sampling program of this area should be available shortly.

SHALLOW LAKE (Parts of NTS 62P/8)

Rocks in the vicinity of Shallow Lake and part of Rice River, mapped as a granodioritic to gabbroic complex by Ermanovics (1970), were investigated to determine their potential to contain platinum group elements. Reconnaissance traverses indicated that the rocks consist predominantly of diorite and granodiorite, and that the gabbro is restricted to a small enclave (less than several hundred metres) near Shallow Lake and north of Rice Lake. This gabbroic lens is massive, homogeneous and appears to be devoid of sulphides and chromite. The potential of this area to contain substantial concentrations of platinum group elements is thus considered to be low.

REFERENCES

Ermanovics, I.F.
1970: Precambrian Geology of Hecla-Carroll Lake map area, Manitoba Ontario; Geological Survey of Canada paper 69-42.

Karop-Møller, S.
1969: Secondary violarite and bravoite, English Lake, Manitoba; Canadian Mineralogist, Part 5, p. 629-643.

Macdonald, A.J.
1985: The Lac des Iles platinum group metals deposit, Thunder Bay district, Ontario; **in** Report of Field Activities, regional and resident geologists, C.R. Kustra, ed.; Ontario Ministry of Natural Resources, p. 235-241.

Russell, G.A.
1949: Geology of the English Brook area; Manitoba Mines Branch, Publication 48-3.

Sutcliffe, R.H. and Sweeney, J.M.
1985: Geology of the Lac des Isles complex, district of Thunder Bay; **in** Report of Activities, regional and resident geologists, C.R. Kustra, ed.; Ontario Ministry of Natural Resources, p. 47-53.

GS-24 U-Pb ZIRCON GEOCHRONOLOGY OF THE RICE LAKE GREENSTONE BELT

by A. Turek[1], R. Keller[1], W. Weber and W.R. Van Schmus[2]

The purpose of this U-Pb zircon geochronology project is to establish a time frame for volcanism, plutonism and tectonic events in the Rice Lake region in support of a better understanding of the gold mineralization in the Rice Lake greenstone belt.

Gold was discovered in the Rice Lake area in 1911 and was continuously mined from 1932 to 1968; since then gold has been mined discontinuously at the San Antonio Mine and at the former Packsack Mine.

The most recent regional mapping and related investigations, published by McRitchie and Weber (1971), form the basis of the geological framework.

Previous isotopic age determinations include K-Ar mineral and Rb-Sr whole rock and mineral ages discussed by Turek (1971). Preliminary results of the present study were reported by Turek et al. (1985). Results of the present study were released at the GAC-MAC meeting in Saskatoon (Turek et al., 1987) and will be published in detail soon.

SUMMARY

Sixteen 50 kg rock samples were evaluated for U-Pb zircon geochronology. Seven of these have yielded results (Table GS-24-1, Fig. GS-24-1).

TABLE GS-24-1
U-Pb ZIRCON AGES FROM THE RICE LAKE REGION

	Sample*	Age (Ma) = 2 sigma	
M702	Ross River quartz diorite Unit 22d	2727.6 ± 8.4	Concordia
M703	The Narrows Formation dacite Unit 7a	2731.0 ± 1.5	Concordia
M705	Granite of Wanipigow River complex Unit 32a	2730.7 ± 9.8	Concordia
M708	Sheared porphyritic granodiorite Unit 32e	2880.2 ± 9.0	Concordia
M710	Black Lake granite Unit 27	2663 ± 7.3	Concordia
M711	Gunnar porphyry Unit 22g	2730.7 ± 12.6	Concordia
M716	Hare's Island felsic tuff Unit 7c	2739 2732	$^{207}Pb/^{206}Pb$ age Estimated Concordia age

* Rock units refer to Map 71-1/4 (Weber 1971a).

The age data indicate three separate felsic magmatic events:

- one at ca. 2880 ± 10 Ma in the Wanipigow River complex north of the Rice Lake belt (Berens River domain)
- one at ca. 2730 ± 10 Ma apparently representing the main felsic volcanism in the greenstone belt. All felsic volcanic and related intrusive rocks yielded this age
- one age at 2663 ± 7 Ma for an anatectic(?) granite in the Manigotagan gneiss belt south of the Rice Lake greenstone belt. This magmatism is probably related to the main regional Kenoran metamorphism in the region.

DISCUSSION

At the former Gunnar Mine the Gunnar porphyry (M 711) yielded an age of 2730.7 ± 12.6 Ma. This porphyry intrudes basalts of the Gunnar Formation which is part of the stratigraphically lower part of the Rice Lake Group (see Campbell, 1971). Thus, 2730.7 Ma is a minimum age for this lower part. Unfortunately, the rocks in this lower part of the Rice Lake Group are unsuitable for U-Pb zircon geochronology.

The Narrows Formation dacite (M 703) which lies concordantly above the Gunnar Formation was dated at 2731.0 ± 1.5 Ma. At Bissett a felsic tuff from Hare's Island which was considered time equivalent to the Narrows Formation by Weber (1971a) yielded a concordia intercept age of approximately 2732 Ma. The Ross River quartz diorite interpreted as comagmatic with The Narrows Formation (Weber, 1971b) dacite yielded an age of 2727.6 ± 8.4 Ma (M 702).

Ages from units of the Wanipigow River complex confirmed previous data (Ermanovics and Wanless, 1983) that the southern margin of the Berens River domain consists of 2730 Ma granitoids intruded into older approximately 3 Ga sialic crust. A granite from the Wallace Lake area (M 705) yielded an age of 2730.7 ± 9.8 Ma and a strongly foliated porphyritic granodiorite (M 708) from near the former Jeep Mine yielded an age of 2880.2 ± 9 Ma. The isotopic data indicate an even older component of ca. 2919 Ma.

A granite from Black Lake (M 710), a post-M_1 intrusion from the Black Lake granitic suite yielded an age of 2663 ± 7.3 Ma. The same unit yielded a Rb-Sr whole rock isochron age of 2677 ± 35 Ma[3] (Turek, 1971). This age is significantly younger than the dated greenstone belt magmatism and the data support previous interpretations that this granite crystallized from (anatectic?) magma intruded during the main high grade Kenoran metamorphism. This interpretation is consistent with U-Pb data from northwestern Ontario. The youngest greenstone belt plutonism was dated at 2705-2700 Ma (Corfu and Andrews, 1987) and the high grade metamorphism in the English River domain yielded U-Pb zircon ages of a 2680 Ma (Corfu, in prep.). Rb-Sr data on biotite from paragneiss and muscovite of pegmatite yielded a minimum age for this metamorphism of ca. 2575 Ma in the Rice Lake region (Turek, 1971).

IMPLICATIONS (by W. Weber)

Felsic volcanism in the Rice Lake area is time equivalent to the calc-alkaline final pulse of volcanism in the Red Lake area (Corfu and Andrews, 1987). In the Red Lake area major plutonism postdates the felsic volcanism, and gold mineralization is dated at 2720-2700 Ma which is the time of youngest greenstone belt plutonism, associated metamorphism and metasomatism. In the Rice Lake area a corresponding plutonism has not been recognized (yet?). The dated plutonism is coeval to the felsic volcanism. The existence of a post-volcanic heat generating source may be critical for gold mineralization and further geochronology work is required.

The 2880 Ma granodiorite and related ca. 3 Ga old rocks along the southern margin of the Berens River domain (see Ermanovics and Wanless, 1983) may be related to an older volcanic cycle in the Red Lake area,

[1]Department of Geology, University of Windsor, Windsor, Ontario N9B 3P4
[2]Department of Geology, University of Kansas, Lawrence, Kansas 66045
[3]$Rb^{87} = 1.42 \times 10^{-11}\ yr^{-1}$

dated at 3000-2890 Ma (Corfu and Andrews, 1987) It is possible that the Conley Formation in the Wallace Lake area (McRitchie, 1971), marginal to the 2.9 Ga old granitic rocks, is part of this older supracrustal cycle.

The Conley Formation is lithologically similar to the lower volcanic cycle at Red Lake; it contains abundant quartz-rich arenites, granitoid boulder conglomerate, iron formation and some limestone. Also, ultramafic rocks might be part of the cycle. They are widespread along the southern margin of the Wanipigow River Complex and together with iron formation occur along the southern margin of the Berens River domain farther west.

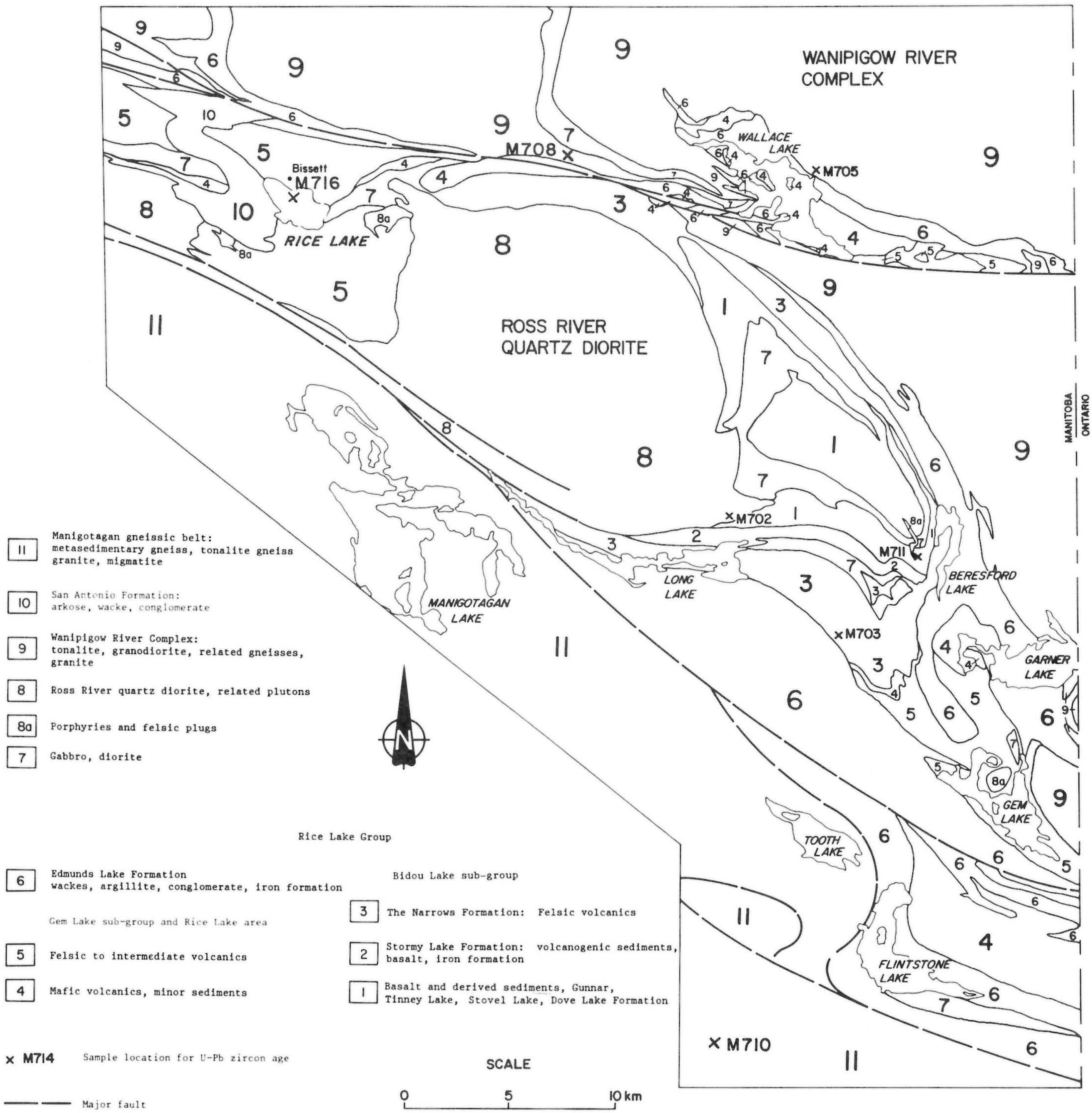


Figure GS-24-1: Generalized geology of the Rice Lake greenstone belt and sample locations for the U-Pb zircon geochronology.

REFERENCES

Campbell, F.H.A.

1971: Stratigraphy and sedimentation of part of the Rice Lake Group, Manitoba; **in** Geology and Geophysics of the Rice Lake region, southern Manitoba (Project Pioneer); W.D. McRitchie and W. Weber, eds., Manitoba Mines Branch, Publication 71-1, p. 135-188.

Corfu, F.

in prep.: Differential response of U-Pb systems in coexisting accessory minerals, Winnipeg River Subprovince, Canadian Shield: implications for Archean crustal growth and stabilization.

Corfu, F. and Andrews, A.J.

1987: Geochronological constraints on the timing of magmatism, deformation and gold mineralization in the Red Lake greenstone belt, northwestern Ontario; Canadian Journal of Earth Sciences, v. 24, p. 1302-1320.

Ermanovics, E.F. and Wanless, R.K.

1983: Isotopic age studies and tectonic interpretations of Superior Province in Manitoba; Geological Survey of Canada, Paper 82-12, 22 p.

McRitchie, W.D.

1971: Geology of the Wallace Lake-Siderock Lake area: a reappraisal; in Geology and geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie and W. Weber, eds., Manitoba Mines Branch, Publication 71-1, p. 107-126 and Map 71-1/6.

McRitchie, W.D. and Weber, W. (eds.)

1971: Geology and geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer); Manitoba Mines Branch, Publication 71-1, 430 p., 15 maps.

Turek, A.

1971: Geochronology of the Rice Lake-Beresford Lake area; **in** Geology and geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer); W.D. McRitchie and W. Weber, eds.; Manitoba Mines Branch Publication 71-1, p. 313-324.

Turek, A., Keller, Weber, W. and Van Schmus, W.R.

1987: New U-Pb zircon ages for the Rice Lake greenstone belt, southeastern Manitoba; **in** GAC-MAC Joint Annual Meeting, Program with Abstracts, v. 12, p. 97.

Turek, A., Weber, W. and Van Schmus, W.R.

1985: U-Pb zircon geochronology of the Rice Lake area; **in** Manitoba Energy and Mines, Report of Field Activities 1985, p. 120-121.

Weber, W.

1971a: Geology of the Wanipigow River-Manigotagan River region; **in** Geology and geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie and W. Weber, eds.; Manitoba Mines Branch, Publication 71-1, Map 71-1/4.

1971b: The evolution of the Rice Lake-Gem Lake greenstone belt; **in** Geoscience Studies in Manitoba, A.C. Turnock, ed.; Geological Association of Canada, Special Paper 9, p. 97-104.

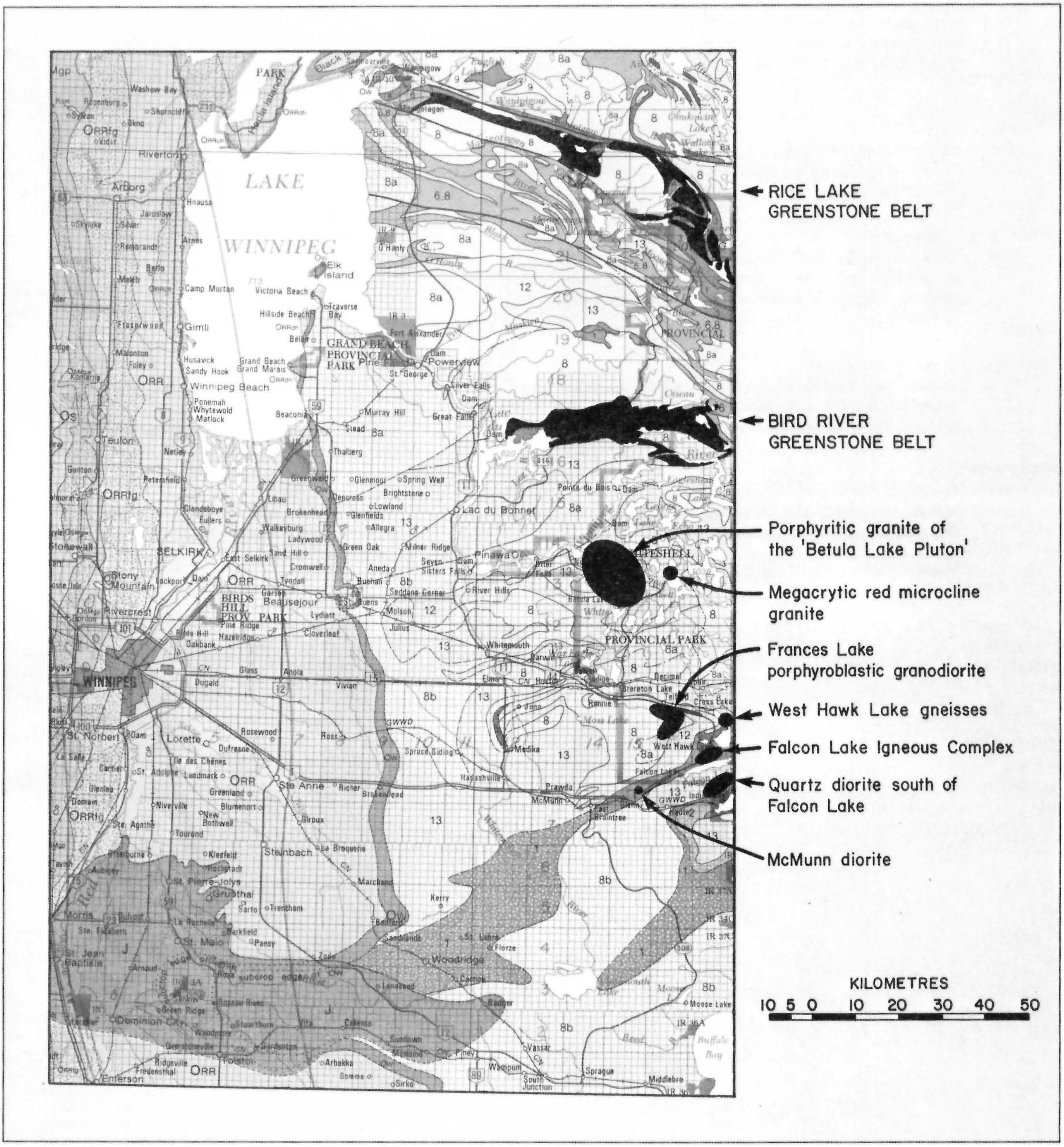


Figure GS-25-1: Location of granitic intrusions and supracrustal belts studied for dimension stone potential in southeast Manitoba.

GS-25 DIMENSION STONE POTENTIAL OF SOUTHEAST MANITOBA

by B.E. Schmidtke and D.I.D. Gaye[1]

INTRODUCTION

Investigations of granitic intrusions in southeast Manitoba to determine potential for building stone production concentrated on those intrusions identified in the 1985 field season (Leathers, 1985). As expected, the youngest intrusions have the highest potential because they are not extensively fractured, metamorphosed or deformed by subsequent intrusion of younger plutons. The youngest intrusions of batholithic proportions in the Precambrian Shield south of the Bird Lake greenstone belt are the Lac du Bonnet Batholith (Schmidtke, 1986), and the "Betula Lake pluton" (McRitchie, 1971) in the Winnipeg River area (Fig. GS-25-1). The Falcon Lake Igneous Complex, located between Falcon Lake and West Hawk Lake, (Fig. GS-25-1) is also relatively younger than the surrounding rocks. The McMunn diorite, located north of the Trans-Canada Highway between McMunn and East Braintree, was also studied as a potential source of building stone.

Several older intrusions investigated were: 1) the Frances Lake porphyroblastic granodiorite; 2) the gneisses north of West Hawk Lake and, 3) a quartz diorite south of Falcon Lake (Fig. GS-25-1). None of these intrusions are sufficiently massive and homogeneous to warrant consideration as potential building stone sources. Data from all documented sites are presented in Table GS-25-1.

A reconnaissance project was undertaken to identify potential flagrock deposits in the Bird River and Rice Lake greenstone belts. Roadside outcrops of cleavable metamorphosed volcanic and sedimentary rocks were sampled and described. Several sites are considered to be potential sources of flagrock.

METHODS

All outcrops located within a kilometre of a road or trail in the high-potential intrusions were sampled and documented. The outcrops with the optimum joint spacings, textures, and colours were mapped at a scale of 1:200. Samples were taken with a Cobra drill and feather and wedge sets for preparation of large polished slabs (Fig. GS-25-2). Two sites were drilled to a depth of 4.5 m and large diameter core was taken from the Falcon Lake Igneous Complex diorite for compressive strength and Brazilian tests.

FALCON LAKE IGNEOUS COMPLEX

The Falcon Lake Igneous Complex is a concentrically zoned, layered intrusion consisting of four gabbros, a diorite and a granodiorite surrounding a quartz monzonite core (Mandziuk et al., 1986). Gabbros three and four (Fig. GS-25-3) have been quarried previously; gabbro three contained an unacceptably high percentage of sulphides and was abandoned in favour of the quarry in gabbro four, which has not been worked since the 1960s.

The joint spacing of the complex tends to be less than one metre, and the joint orientations vary from outcrop to outcrop (Fig. GS-25-4). Most of the rock contains sulphides, particularly in the vicinities of the igneous contacts, the contact with the surrounding volcanic rocks of the Falcon Lake greenstone belt and the breccia pipes in the quartz monzonite core. Each rock type hosts dykes and veins of subsequent phases and xenoliths of previous ones.

Road-accessible massive outcrops are located in the diorite phase of the diorite-granodiorite zone, adjacent to the Trans-Canada Highway (Fig. GS-25-3). It is coarse grained and when polished the translucent qualities of the plagioclase enable the black biotite and hornblende to show through, imparting an almost black colour to the rock.

The outcrops chosen for mapping appeared to have joint spacings in excess of two metres; however, once the outcrop was stripped and cleaned with javex, many small infilled fractures and quartz veins became apparent. East of the javexed area large blocks of diorite have exfoliated from a 5 m high cliff. Many of these blocks are 2 x 2 x 1.5 m, whereas others are small and oddly shaped; this indicates both horizontally and vertically inconsistent joint spacings. The roadcut on the Trans-Canada Highway has exposed shears and offset veins of quartz monzonite and quartz. Drill results indicate that the close horizontal spacings occur within 8 m of the surface, below which 1.5 m sections of core were intersected (Fig. GS-25-5).

The diorite has pleasing and fashionable colour and texture. The problems encountered in quarrying a rock with an erratic joint spacing, veins and shears would have to be weighed against the market value of such a rock since the the average block size would be small in the upper 8 m and the waste factor would be high.

Figure GS-25-2: Porphyritic granite sampled with a Cobra drill and feather and wedge set.

---

[1]University of Manitoba, Winnipeg

TABLE GS-25-1

GRANITIC ROCKS OF SOUTHEASTERN MANITOBA: BUILDING STONE POTENTIAL

Sample	Access	Rock Type	Colour/ Texture	Average vert. joint spacing*	Comments	Reference
85-87-1	Hwy 44	porphyroblastic granodiorite	pink/ porphyroblastic	close	-intruded by pegmatite dykes and f.g. pink granite; shallow dipping joints, biotite schlieren, heterogenous texture	Janes 1976 Springer 1950
85-87-4,5	Hwy 44	porphyroblastic granodiorite	pink/ gneissic porphyroblastic	close	-strong gneissosity, pegmatite dykes and f.g. pink granite intrusions	Janes 1976 Springer 1950
85-87-6,7,8	PR 312	gneissic granodiorite	grey, pink/ gneissic	close	-abundant pink pegmatites crosscutting foliation, rock type and colour variations	Springer 1950
85-87-9	cart track south of Falcon L.	quartz diorite	black/grey gabbroic to gneissic	close	-intruded by pink granitic veins from younger granite, these veins decrease toward centre of pluton, non orthogonal jointing	Springer 1950
85-87-11	PR 309	quartz monzonite	red/ porphyritic	medium	-tabular twinned red microcline phenocrysts, some metamict sphene	Janes 1976
85-817-12	Hwy 44	granodiorite	red lineated	close	-three well developed vertical joint sets, large (1.5 m wide) pegmatite dykes	Springer 1950
85-87-13	PR 301	granodiorite	gneissic	medium	-heterogenous colour and texture	Springer 1950
85-87-14	Hwy 44	granodiorite	pink/ granitic	close	-intruded by > 1 m wide pegmatites, generally homogeneous in colour and texture	Springer 1950
85-87-15	Hwy 1	diorite	grey to black/ coarse grained gabbroic	close to medium	-note shears, infilled fractures, quartz veins	Mandziuk et al. 1986
85-87-16	PR 309	granite	pink/ porphyritic	medium to wide	-small localized fractures infilled with epidote -blue quartz -good access by old wood-cutting road	Janes 1976
85-87-17	PR 309	granite	brown/sparsely porphyritic	wide	- < 10% microcline phenocrysts	Janes 1976
85-87-18	PR 309	granite	red/ megacrystic	wide	-rock altered and crumbling at surface	Janes 1976
85-87-19	PR 309	granite	red/ medium grained	wide	-abundant felsite dykes -heterogenous grain size and texture to megacrystic	Janes 1976
85-87-20, 21	PR 307	granite	pink/ porphyritic	close to medium	-same rock as 85-87-16, but joint spacing is closer	Janes 1976
85-87-22	PR 307	granite	red/ f.g. to m.g.	medium to wide	-heterogenous grain size and texture	Janes 1976
85-87-23, 24	PR 307	granite	red/ porphyritic	wide	-microfracturing through feldspars and quartz -blue quartz -up to 5% metamict sphene -xenolithic	Janes 1976

TABLE GS-25-1 (Cont'd.)

GRANITIC ROCKS OF SOUTHEASTERN MANITOBA: BUILDING STONE POTENTIAL

Sample	Access	Rock Type	Colour/ Texture	Average vert. joint spacing*	Comments	Reference
85-87-25	PR307	granite	red/ porphyritic	close to wide	-variation in grain size -xenolithic -felsite dykes -contains metamict sphene	Janes 1976
85-87-26	George Lake Road	granite	amber/ porphyritic	no vertical joints	-xenolithic -most massive outcrop found in Manitoba	Janes 1976
85-87-27, 28	PR 307	granite	red/ m.g. to porphyritic	close	-variation in grain size and rock type	Janes 1976
85-87-29	George Lake Road	granite	red/ porphyritic	medium to wide	-xenolithic	Janes 1976
85-87-30	Trans-Canada	diorite	green and black/gabbroic	close to medium	-small dyke difficult access through swamp over Trans-Canada pipeline.	Janes 1976
85-87-31	Hwy 11	quartz diorite	grey	medium	-intruded by Lac du Bonnet batholith	McRitchie 1969

Note: * vertical joint spacing: < 1 m is close, 1-2 m is medium, > 2 m is wide.

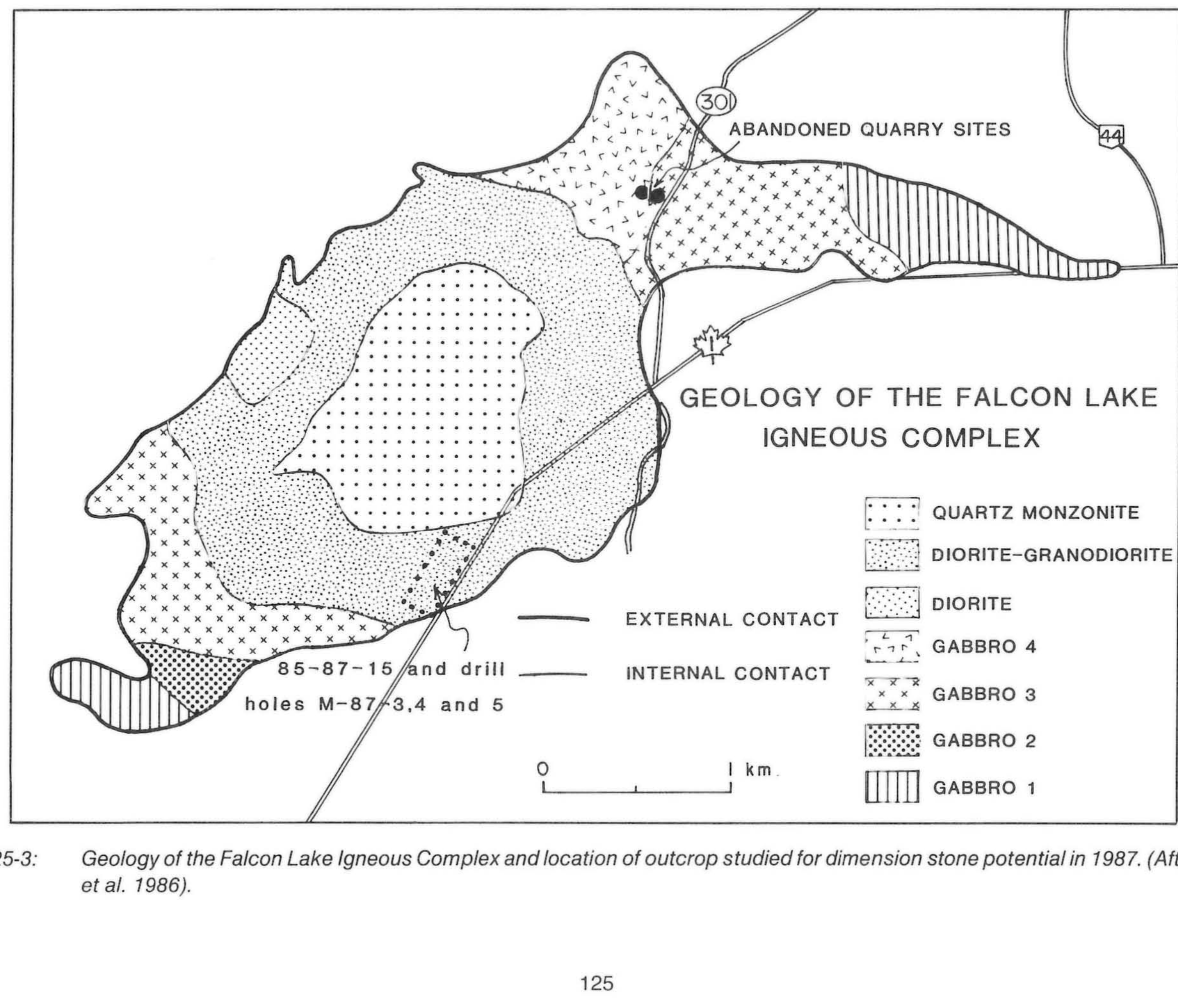


Figure GS-25-3: Geology of the Falcon Lake Igneous Complex and location of outcrop studied for dimension stone potential in 1987. (After Mandziuk et al. 1986).

McMUNN DIORITE

The McMunn diorite is a very small dyke located north of the Trans-Canada Highway near McMunn (Fig. GS-25-1). The rock has a fine- to medium-grained ophitic texture. The pale green plagioclase laths are intermixed with black biotite and hornblende and impart an unusual, very attractive colour to the polished rock. The outcrop is accessed from the highway via a swampy trail over the Trans-Canada pipeline. This site has been quarried previously but was abandoned, apparently because of oxidation of sulphides in the rock (Manitoba Mineral Inventory). Rusty spots were noted on the surfaces of the blocks remaining in the quarry; however, they constitute less than one per cent of the rock. The joint spacing at the surface is usually less than one metre, whereas on the floor of the quarry the joint spacings are two metres; this indicates that the vertical joint spacings probably increase with depth.

WEST HAWK GNEISSES

The rock north of West Hawk Lake is a grey gneissic granodiorite. Roadside outcrops have close horizontal joints and range in colour and texture from a fine grained pink granitic rock to a fine grained grey gneiss over a distance of 10 m. A more extensive examination of the unit revealed that narrow, 2-4 cm, pink pegmatites crosscutting the foliation are ubiquitous. Microcline appears locally as porphyroblasts. The several large ridges studied all show nonorthogonal close vertical joint spacings. Joint sets are well developed on individual outcrops but joint orientations vary from outcrop to outcrop. Although the rock does not appear to be a suitable building stone, the strong fissility along the gneissosity may render it suitable for other applications such as curbing and paving stone.

FRANCES LAKE PORPHYROBLASTIC GRANODIORITE

This unit was described by Springer (1952) as a porphyritic granodiorite. The major portion of this unit occurs south of Highway 44 between Caddy Lake and Rennie (see Fig. GS-25-1). Polished samples are very attractive, featuring large twinned pink microcline crystals set in a gneissic groundmass of plagioclase, quartz, biotite and hornblende. The joint pattern is close and pegmatite dykes and intrusions of fine grained pink granite are common.

QUARTZ DIORITE SOUTH OF FALCON LAKE

This is a black and grey quartz diorite that is accessed by a 7 km cart track through muskeg. Outcrops are generally poorly exposed, and close jointed. Veins of a later pink granite are common. Non-orthogonal vertical joints up to 2 m in spacing were observed; however, the average spacing is less than 1 m.

RED MICROCLINE GRANITE

This is the youngest intrusion in the study area (Janes, 1980). Massive outcrops occur at Jessica, White and Big Whiteshell Lakes, but they are all adjacent to or within cottage subdivisions. Outcrops north of Big Whiteshell Lake are massive and megacrystic with few joints (Fig. GS-25-6) and rare felsite dykes. The rock has a deep red colour with red twinned microcline crystals, smoky quartz, anhedral whitish plagioclase and sparse black aggregates of biotite, accessory sphene and magnetite. This rock is heavily microfractured and drill cores indicate that the rock crumbles readily until a depth of approximately 8 m is reached. Below 8 m, 2.5 m sections of core were recovered that appear to be competent,

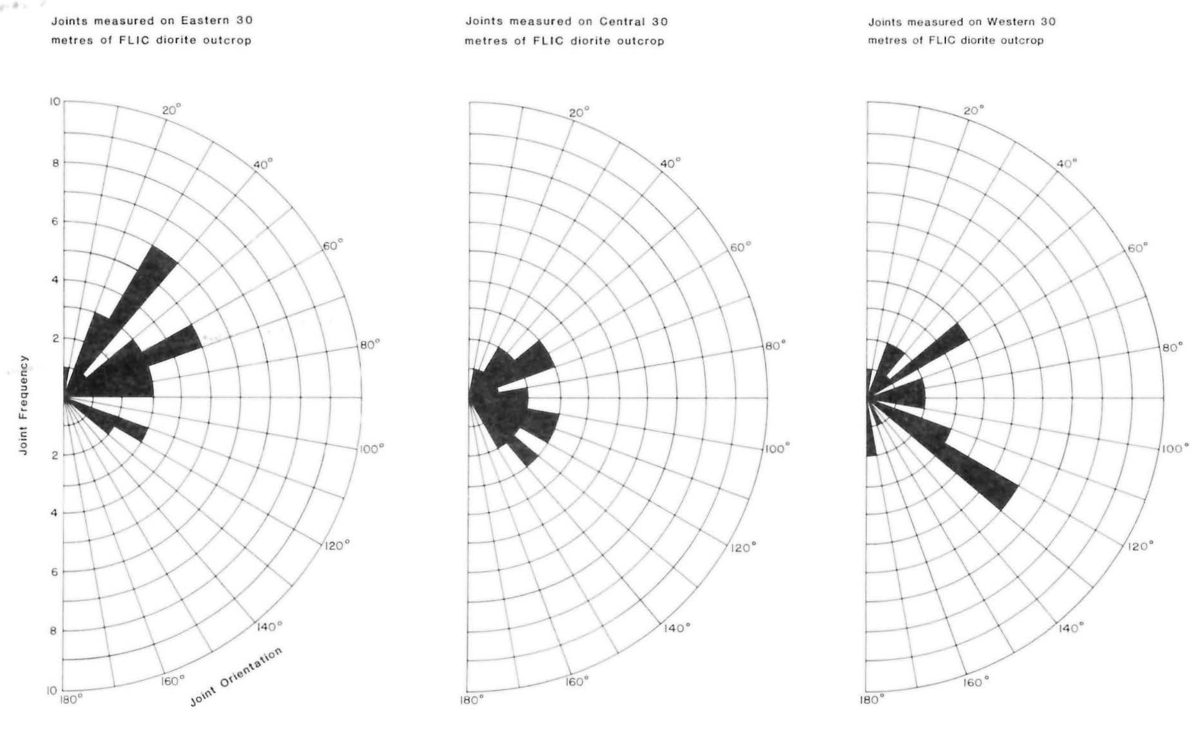


Figure GS-25-4: Rose diagrams of subvertical fracture frequency over 30 m intervals of an outcrop area of the Falcon Lake Igneous Complex (FLIC). Note the variation and scatter of fracture orientations across the area.

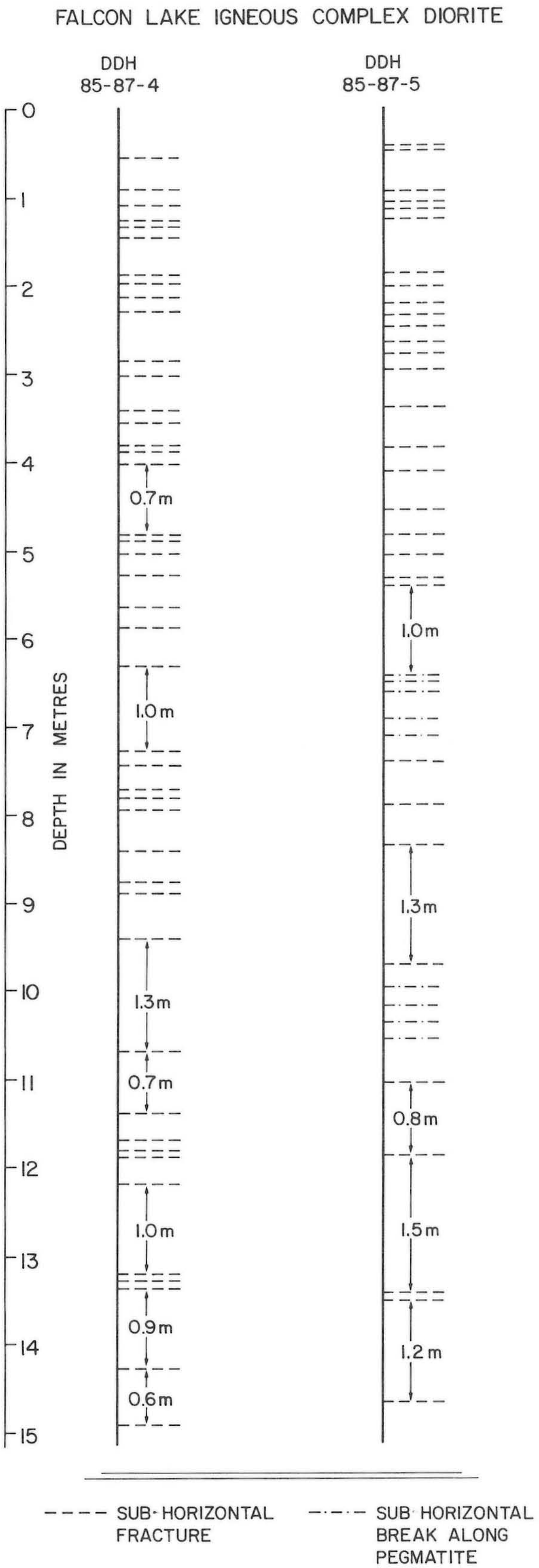


Figure GS-25-5: Horizontal fracturing exposed in drill core of the Falcon Lake Igneous Complex diorite.

although they contain microfractures. This rock has the deepest red colour found to date in southeast Manitoba.

A traverse along the west shore of Green Lake revealed rock that was heterogenous in colour, texture and rock type. Therefore, the most massive part of this intrusion occurs north of Big Whiteshell Lake.

BETULA LAKE PLUTON

This unit is a porphyritic granite that extends from the fireguard road eastwards past Meditation Lake. Several outcrops examined revealed a potential for four different colours: amber, red, pink and brown (Fig. GS-25-7).

A triangular outcrop approximately 3 km^2 in area, which is located west of Bryan Lake (Fig. GS-25-7), is unique in Manitoba. Outcrop areas of 200 x 200 m do not exhibit a single vertical fracture. In traverses across the entire outcrop only one vertical fracture was found.

The rock is a porphyritic granite containing large (2-3 cm) phenocrysts of tabular amber microcline. Carlsbad twinning of these feldspars produces an attractive schiller on polished surfaces. The groundmass consists of medium grained anhedral white plagioclase and milky quartz with black biotite, and accessory magnetite and sphene. The rock polishes extremely well. The outcrop is flat and massive and is virtually impossible to sample with a sledge hammer or Cobra drill. Mafic schlieren and xenoliths elongated in the direction of foliation (240°) are scattered evenly throughout large areas of the outcrop. The absence of joints and the unusual colour and attractive texture result in this outcrop area having the highest potential for building stone in the province.

Several outcrops of red granite of the same rock type surround the massive amber type. Most outcrops have close joint spacings and wide felsite dykes. The rock at site 27 ranges from porphyritic to medium grained equigranular. All sites contain a high percentage of metamict sphene. The most massive homogeneous outcrops of this colour occur within the Tie Creek Basin, adjacent to the amber outcrops. The central western area of site 24 shows 5-10 m vertical joint spacing and 1.5-2 m ledges indicating that large blocks may be obtained from this area. A sample was taken with a Cobra drill from this location. Professionally polished slabs have a beautiful red colour and porphyritic texture. Again, twinning of the microcline phenocrysts imparts a schiller to the polished surface. Quartz is anhedral, medium- to coarse-grained and blue. Partially assimilated mafic xenoliths containing up to 30 per cent magnetite were revealed on polished slabs; these do not detract from the appearance of the rock since the magnetite will tend to dull rather than rust. Metamict sphene in the sample did not pluck when polished. The sample is microfractured, but slabs 2 cm thick are competent and thus microfracturing may not prove to be detrimental.

Further test quarrying and strength testing are required to determine if these microfractures reduce the strength and coherence of the rock to an unacceptable level. Small xenoliths and schlieren are ubiquitous throughout the outcrops of red granite. Some pegmatite dykes are present, but are sporadic and widely spaced.

Outcrops of pink porphyritic granite were sampled and mapped at the junction of PR307 and PR309. The microcline phenocrysts are deeper pink and sparser here than in the outcrops of red porphyritic granite. The groundmass contains anhedral medium- to coarse-grained milky grey quartz, white to green anhedral plagioclase, black biotite, hornblende, magnetite, anhedral red garnet, minor pyrite and metamict sphene. The outcrop covers an area of approximately 4 km^2. The area that was mapped in detail is located on the eastern margin and is accessed by an old woodcutting road from PR309.

Although there are some closely spaced joints, large areas are relatively joint free (Fig. GS-25-8). Concentrations of closely spaced epidote-filled fractures occur locally. Horizontal joints of 2 m were noted at a cliff face alongside the access road. Large blocks with dimensions of 3 x 1.5 x 1.5 m have exfoliated from the side of the outcrop.

Outcrops of brown rock located 7 km east of the junction are accessed by an old logging road to Meditation Lake (Fig. GS-25-7). One massive outcrop forms part of the road. The outcrop surface and the polished slabs cut from samples taken using a Cobra drill are brown in

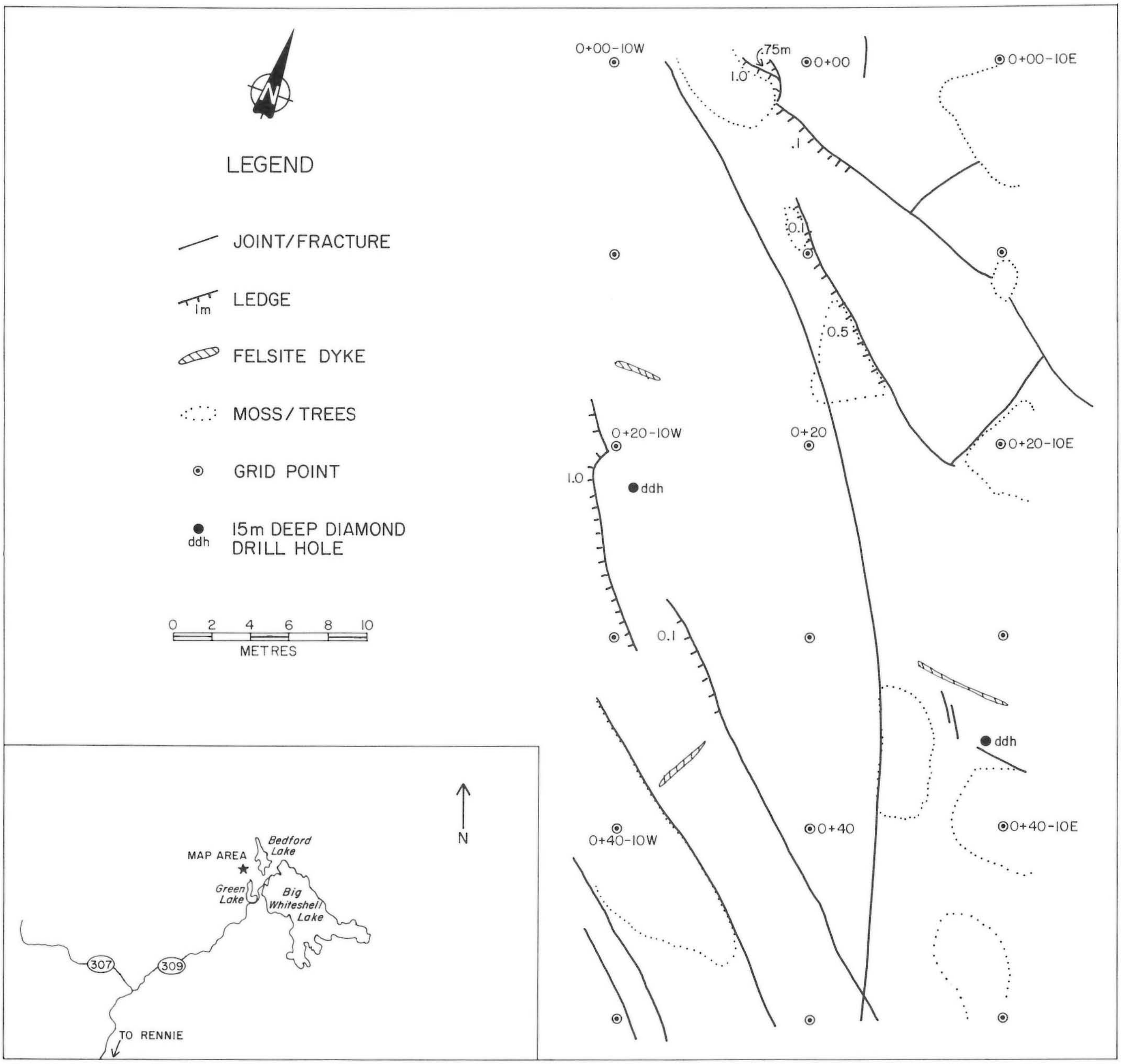


Figure GS-25-6: Joint diagram of megacrystic red microcline granite near Big Whiteshell Lake.

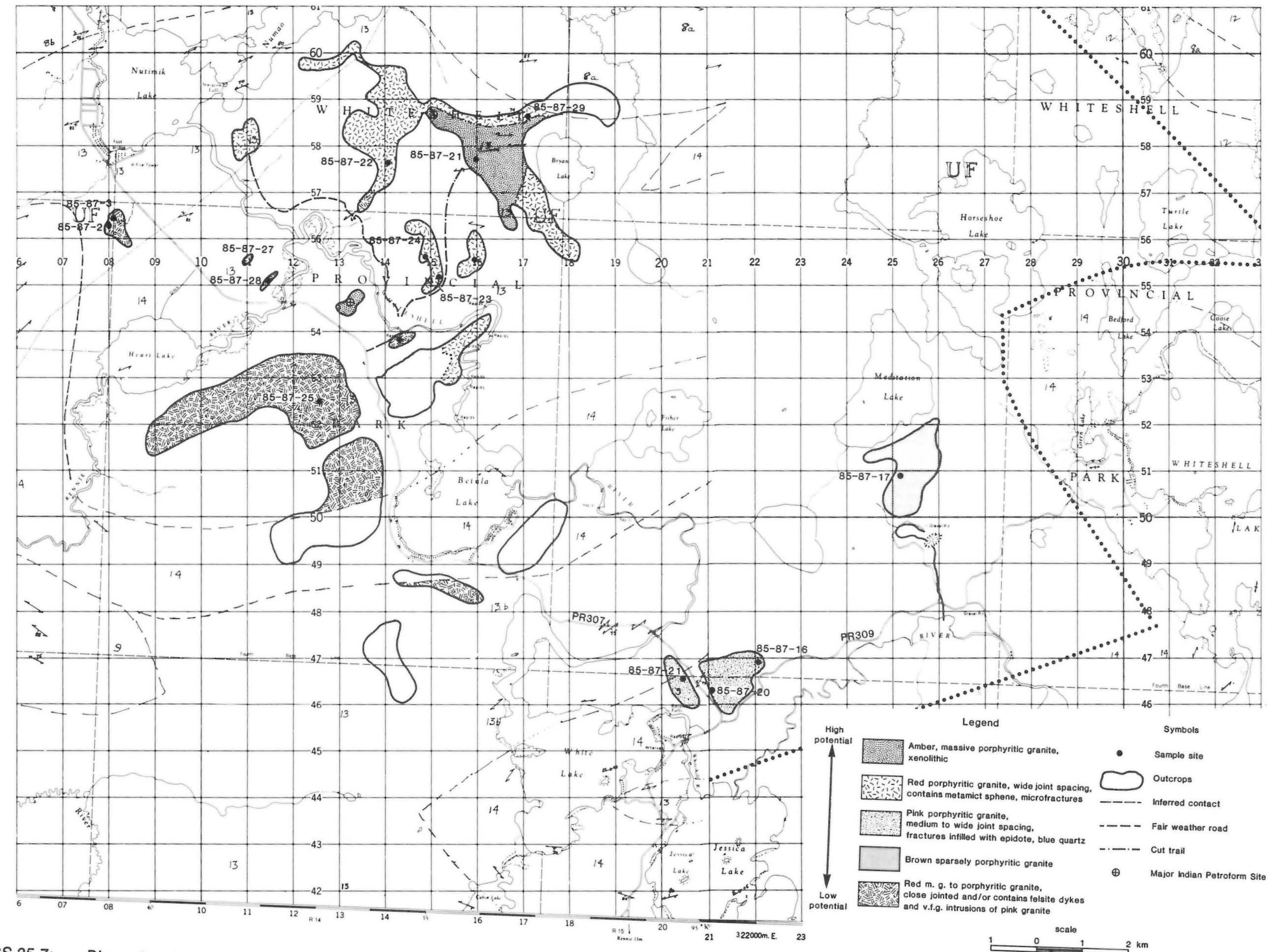


Figure GS-25-7: Dimension stone potential map of the Betula Lake porphyritic granite. (After Janes, 1976).

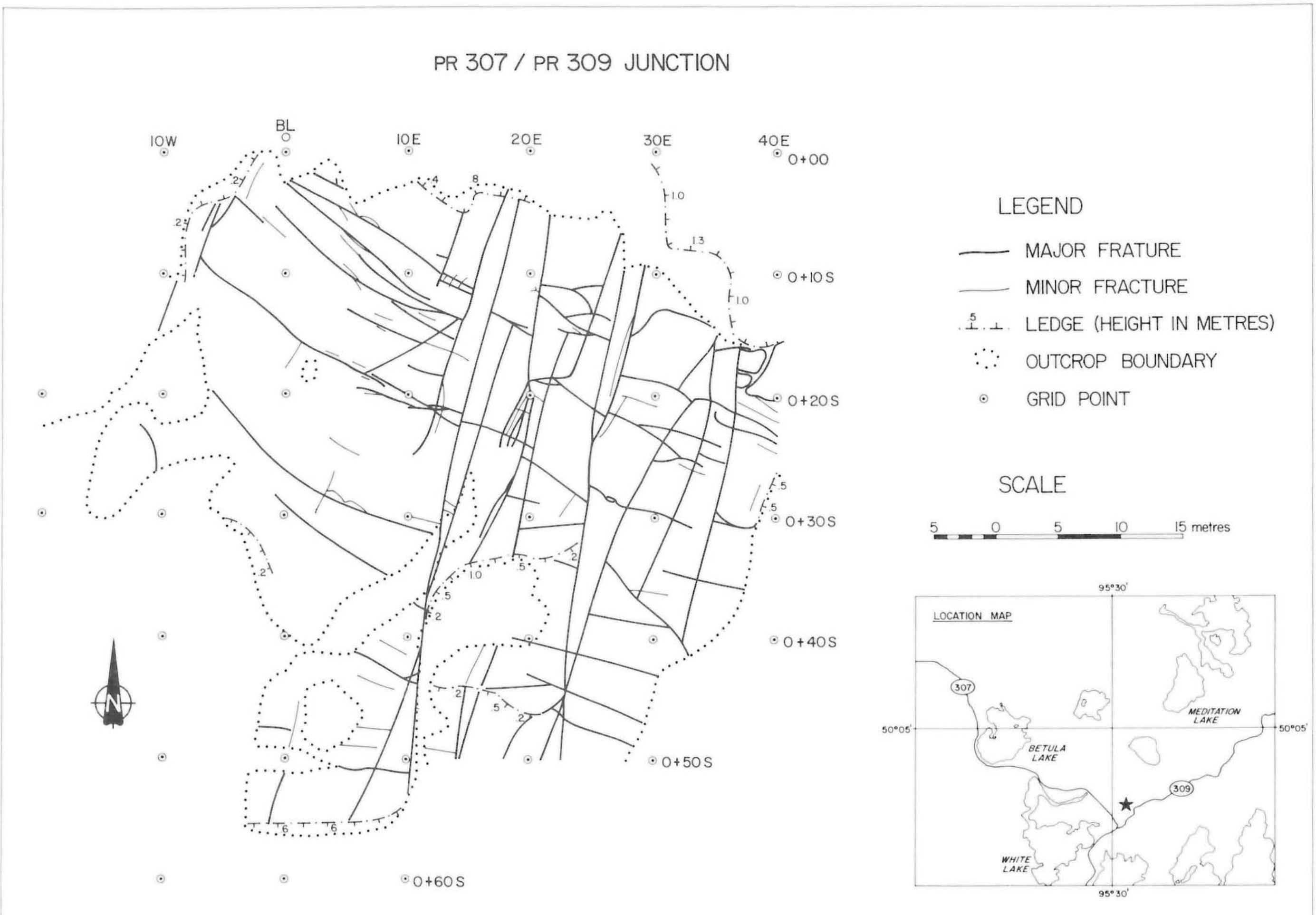


Figure GS-25-8: Joint diagram of pink porphyritic granite of the Betula Lake Pluton.

colour. Feldspar phenocrysts constitute less than 10 per cent of the rock and the groundmass is fine- to medium-grained. Joint spacings of up to 10 m are common. Irregular intrusions of a pegmatitic red granite are ubiquitous; however, they are widely spaced.

FLAGROCK

Flagrock is a cleavable metamorphosed volcanic or sedimentary rock that can be split into thin slabs for use as building facings, fireplace rocks and flagstones in walkways and patios. Micaceous schists are preferred because they sparkle in the sunlight. White, green, silver and other pale colours are the most valuable.

BIRD RIVER GREENSTONE BELT

The geology and locations examined are illustrated in Figure GS-25-9. The most promising sites are described below.

Site 85-87-42 is a blasted road cut in a basalt. Pieces of flyrock, 2-4 cm thick, surround the outcrop. A 40 cm diameter, 4 cm thick slab was split from the outcrop. It is dull black and would make an excellent flagstone for patios and walkways.

Site 85-87-88 is a garnet-biotite schist of the Bernic Lake Formation located on the south shore of Bird Lake. It is composed of fractured red garnet, biotite and quartz with small amounts of limonite and magnetite (Černý et al., 1981).

Site 85-87-87 is a pale buff metamorphosed volcanic sedimentary rock of the Peterson Creek Formation (Černý et al., 1981). It has a good cleavage and large thin sheets can be split from the outcrop.

Site 85-87-86 is a pale silver green micaceous schist presently quarried by Whiteshell Quarries of Winnipeg. Pieces 6 cm thick are blasted from the outcrop.

RICE LAKE GREENSTONE BELT

Site 85-87-98 is a fissile pale pink and green felsic rock occurring on the Hole River Indian Reserve (Fig. GS-25-10). A mica, possibly sericite, gives a sheen to the split surface of the sample. Green and red schistose metavolcanic rocks were sampled from road blasts on PR304 approximately 20 km west of Bissett. Large thin slabs were produced by blasting.

The reconnaissance survey indicated that many outcrops throughout the greenstone belts have flagrock potential. The degree of fissility of the outcrops sampled appears to vary and thus produces only small pockets of rock suitable for quarrying. Further sampling along roads and hunting trails and mapping of specific outcrops are required to determine the extent of quarriable rock. Samples taken during the summer are available for viewing at the Energy and Mines offices in Winnipeg.

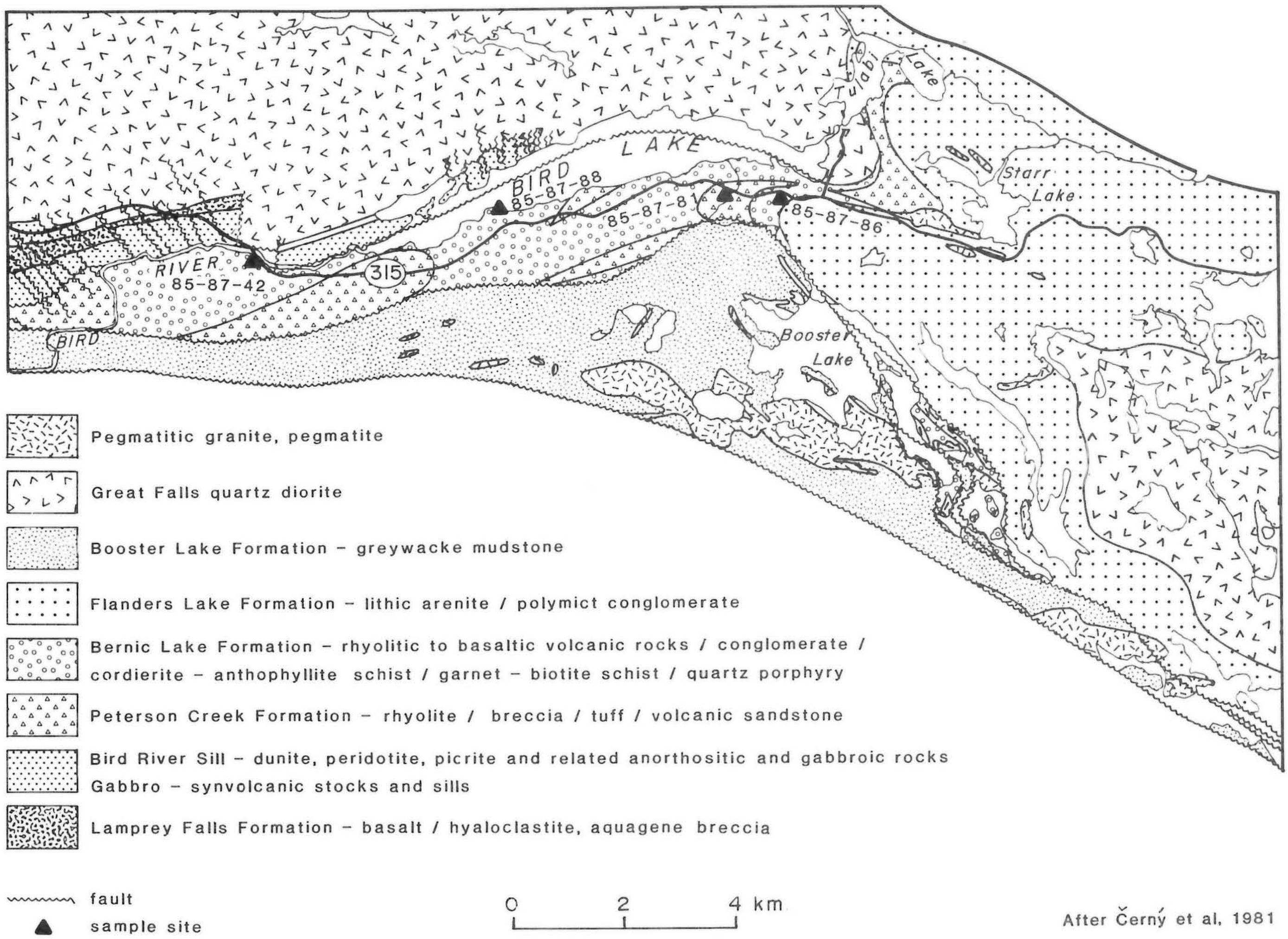


Figure GS-25-9: Location of sites studied for flagrock potential in the Bird River greenstone belt.

CONCLUSIONS

The Betula Lake pluton has the highest potential for building stone production because of its accessibility, massive structure, and attractive colours and porphyritic textures. The McMunn diorite and gabbro and diorite of the Falcon Lake Igneous Complex are possible sources of black granite. Drilling and test quarrying are required to confirm that these intrusions are quarriable.

Joint maps and polished samples are available for viewing on request by any parties interested in these properties.

REFERENCES

Cěrný, P., Trueman, D.L., Ziehlke, D.V. Goad, B.E. and Paul, B.J.
1981: The Cat Lake-Winnipeg River and the Wekusko Lake pegmatite fields, Manitoba; Manitoba Mineral Resources Division, Economic Geology Report ER80-1.

Currier, L.W.
1960: Geological appraisal of dimension stone deposits; United States Geology Survey, Bulletin 1109.

Davies, J.F.
1952: Geology of the Oiseau (Bird River) area; Manitoba Mines Branch, Publication 51-3.

1954: Geology of the West Hawk Lake, Falcon Lake area; Manitoba Mines Branch, Publication 53-4.

Janes, D.A.
1976: Preliminary Maps 1976F1 — F8, Manitoba Mineral Resources Division.

Leathers, B.E.
1985: Evaluation of dimension stone potential of granite rocks in southeastern Manitoba; in Manitoba Energy and Mines, Report of Field Activities 1985, p. 153-164.

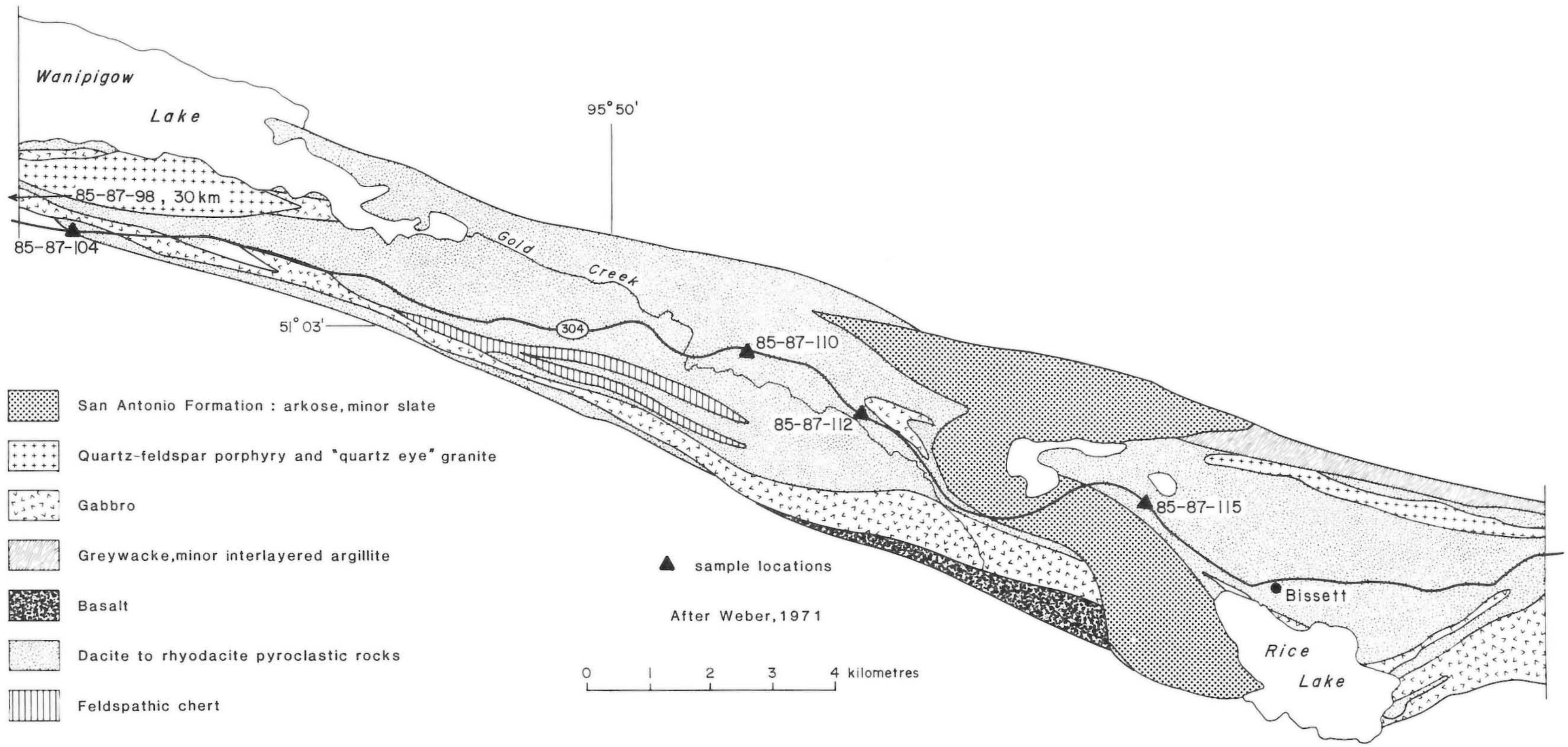


Figure GS-25-10: Location of sites studied for flagrock potential in the Rice Lake greenstone belt.

Mandziuk, W., Brisbin, W.C. and Scoates, R.F.J.
1986: The Falcon Lake Igneous Complex, Southeastern Manitoba, **in** Layered Intrusions of Southeastern Manitoba and Northwestern Ontario, Field Trip No. 13 Guidebook; GAC-MAC Joint Annual Meeting, Ottawa, Ontario 1986, p. 21-36.

McRitchie, W.D.
1969: Project Pioneer Extension; Manitoba Mines Branch, Preliminary Maps 1969F1 — F7.

1971: The petrology and environment of the acidic plutonic rocks of the Wanipigow-Winnipeg River area; **in** Geology and Geophysics of the Rice Lake Region, Southeastern Manitoba (Project Pioneer); W.D. McRitchie and W. Weber, ed.; Manitoba Mines Branch, Publication 71-1, Report 2, p.7-61.

Schmidtke, B.E.
1986: Industrial Minerals of Southeastern Manitoba, **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 134 - 138.

Springer, G.D.
1950: Geology of the Rennie-West Hawk Lake area; Manitoba Mines Branch, Publication 50-6.

Storey, C.C.
1986: Building and ornamental stone inventory in the Districts of Kenora and Rainy River; Ontario Geological Survey, Mineral Deposits Circular 27.

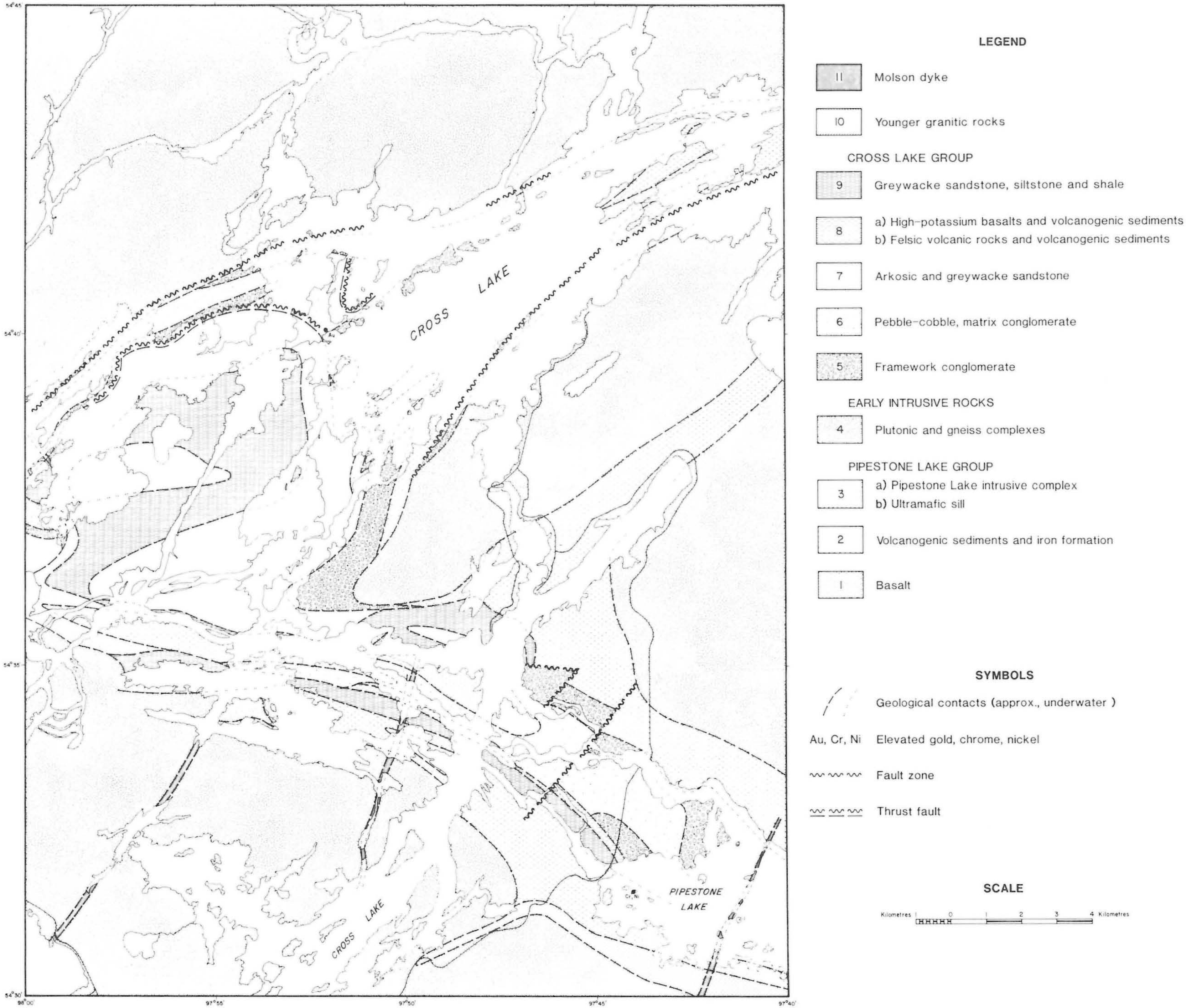


Figure GS-26-1: Simplified geological map of the central Cross Lake area.

GS-26 CROSS LAKE SUPRACRUSTAL INVESTIGATIONS (NTS area 63-I/12)

by M.T. Corkery and H.D.M. Cameron

Geological mapping at a scale of 1:20 000 completed the central area of Cross Lake, covering NTS areas 63-I/12 NE, SE, SW, and NW. Mapping in 1987 concentrated on completing coverage of 63-I/12 NW and SW (Preliminary Maps 1987N-1 and 1987N-2, Corkery, 1987). Further sampling was carried out for U-Pb zircon age determination at the Royal Ontario Museum funded by the GSC under the Mineral Development Agreement. Mapping of the Pipestone Lake intrusive complex was extended to the southwest, and the northeast portion of the Nelson River anorthosite near Jenpeg was mapped and sampled.

Mapping in the northwest segment of the area extended previously defined units (Corkery, 1983, 1985; Corkery and Lenton, 1984). The distribution of major lithologies is shown in Figure GS-26-1. A preliminary summary of geological events in the central Cross Lake area is as follows (from youngest to oldest):

1) Development of Pipestone Lake group basalts with subordinate sedimentary and felsic volcanic rocks.
2) Intrusion of anorthosite and anorthositic gabbro bodies.
3) Intrusion of batholiths (5, 6, 7, and 8 — Preliminary Maps 1987N-1,2) probably concomitant with the development of early folding and extensive compressive zones.
4) Uplift and erosion of the Pipestone Lake group and batholithic terrain.
5) Deposition of Cross Lake Group alluvial and fluvial conglomerate and sandstone.
6) Initiation of volcanism — high-potassium basalt (12) and rhyodacite (13) — with continued sedimentation of greywacke sandstone and siltstone.
7) Intrusion of small gabbro-diorite dykes and plugs.
8) Period of regional metamorphism, granite plutonism and folding concomitant with activation of major linear shear zones.
9) Intrusion of late granitic plugs and pegmatites largely controlled by the major shear zones.
10) Periodic reactivation of shear zones and minor folding.
11) Intrusion of the Molson dyke swarm; most abundant in the major NE shear zone.
12) Late brittle deformation manifested by fault breccia, pseudotachylite and erratic foliation developed in some Molson dykes.

Specimens representing four rock types were submitted to the Royal Ontario Museum for age determination in 1986. Of these, two did not contain dateable zircon and in another zircons were altered and unsuitable for dating. The fourth unit, "town" tonalite (8), contained abundant zircon and three fractions from each of two samples were analyzed isotopically.

The results of analyses of zircons from the tonalite give a magmatic age of 2719.1 ± 1.2 Ma; a second population of inherited zircons give an age of 2747 Ma (D. Davis, written communication). The tonalite has intruded the Pipestone Lake group basalts (1) and is unconformably overlain by the Cross Lake group which contains rhyodacitic pyroclastic rocks for which preliminary U-Pb ages of 2707 and 2709 Ma have been determined (D. Davis, personal communication). A third age determined from a titanite fraction from the tonalite gives a much younger age — 2570 Ma — "which probably records titanite growth during a later metamorphism" (D. Davis, written communication). This is interpreted to represent the major period of regional metamorphism and tectonism which postdates the deposition of the Cross Lake group.

Sampling carried out during the 1987 field season may provide ages for: the Pipestone Lake group (1), Pipestone Lake anorthosite-anorthositic gabbro (4), rare-element-enriched pegmatites (19d), tonalite gneiss (6b), and quartz-feldspar porphyry of the Cross Lake group (13a).

ECONOMIC CONSIDERATIONS

Small quartz veins and pods with black alteration haloes rich in tourmaline occur within polymictic conglomerate (9) and conglomeratic sandstone (10) north and northwest of the community of Cross Lake. At one location northwest of the town of Cross Lake (see Preliminary Map 1987N-1) quartz pods 60-100 cm long with 3-50 cm tourmaline-rich (up to 80%) alteration haloes, contain abundant arsenopyrite and minor pyrite. Assay values for one specimen indicate: Au = 0.02 oz./ton, and traces (less than 0.01%) of Cu, Ni, Zn and Pb.

Disseminated chromite occurs within metadunite in a layered ultramafic on Pipestone Lake (Fig. GS-26-1). Analysis of one sample yielded 0.7% Cr and 0.25% Ni. About 15 m of metadunite is exposed on the south shore of the island, in contact to the north with altered peridotite and pyroxenite. Fine grained chromite (0.2-0.8 mm) is disseminated throughout the dunite and minor concentrations of chromite and magnetite occur along joint surfaces on 5-25 cm spacing.

REFERENCES

Corkery, M.T.

1983: Cross Lake supracrustal investigation; **in** Manitoba Mineral Resources Division, Report of Field Activities, 1983, p. 32-45.

1985: Cross Lake supracrustal investigations in the eastern Pipestone Lake area; **in** Manitoba Mineral Resources Division, Report of Field Activities, 1985, p. 165-172.

1987: North Central Cross Lake, 63-I/12 NW; Manitoba Energy and Mines, Preliminary Map Series 1987N-1.

1987: South Central Cross Lake, 63-I/12 SW; Manitoba Energy and Mines, Preliminary Map Series 1987N-2.

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

1984: Cross Lake supracrustal investigation; **in** Manitoba Mineral Resources Division, Report of Field Activities, 1984, p. 107-109.

Figure GS-27-1: *Aerial photograph (1:90) of an outcrop of migmatitic gneiss.*

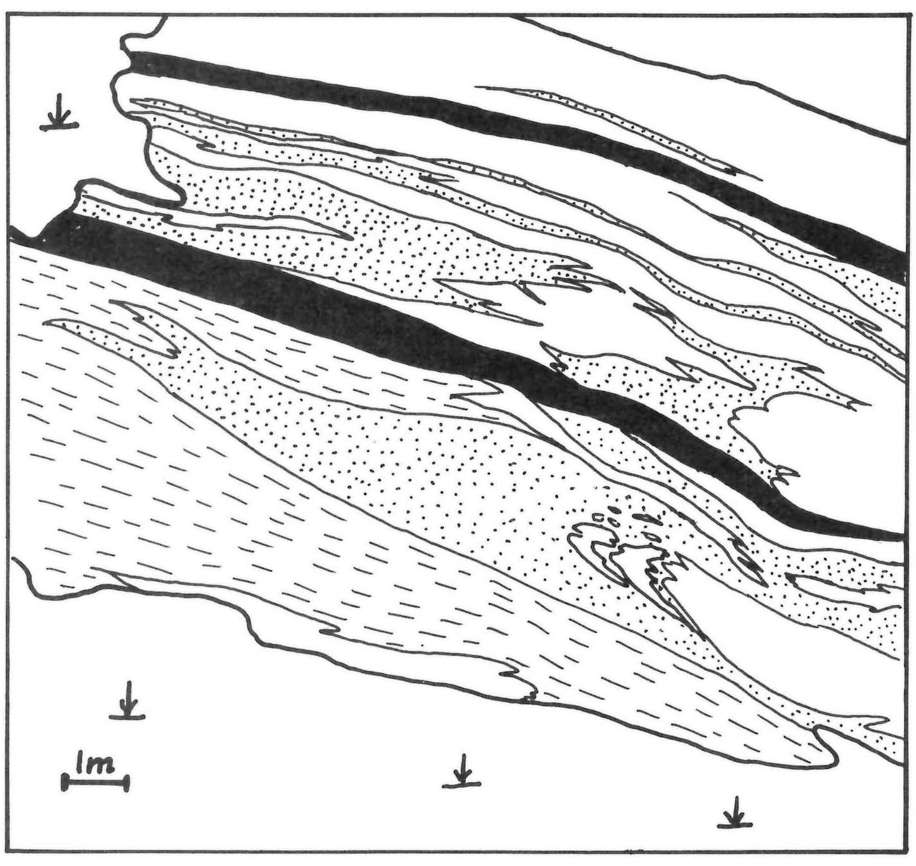


Figure GS-27-2: *Geological map of the area shown in Figure GS-27-1. See text for explanation.*

GS-27 GEOLOGICAL MAPPING AT PIPE MINE (part of 63-O/8NE)

by J.J. Macek

INTRODUCTION

Geological investigation of Thompson belt lithologies continued and focussed on exposures at Inco's Pipe Mine open pit. Migmatitic gneiss was the main subject of this summer's mapping.

Instead of traditional time-consuming grid mapping, low altitude airphotos (scale 1:90; Fig. GS-27-1) were used to produce an accurate and detailed map (Fig. GS-27-2) of the topographically and geologically complex Pipe pit.

The author wishes to acknowledge the permission to work on the mine site which was kindly granted by Inco Ltd. and LTEA. Expert advice and equipment for low altitude aerial photography was provided by Manitoba Surveys and Mapping Branch. Ron Pryhitko (Department of Geological Sciences, University of Manitoba) kindly helped with final processing of the photographs.

GEOLOGICAL OBSERVATIONS

Migmatitic gneiss forms the Archean basement of the early Proterozoic(?) Pipe Mine supracrustal rocks. It comprises five lithological units (Fig. GS-27-2):

1. Light grey quartzofeldspathic gneiss (no pattern).
2. Dark grey (biotite) quartzofeldspathic gneiss (dashed pattern).
3. Dark green, inhomogeneous amphibolites (dotted pattern).
4. Grass-green lenses of chloritized amphibolites (not shown).
5. Very dark grey, fine grained metadiabase dykes (black pattern).

Metadiabase dykes (Unit 5) are subvertically lineated amphibolites that crosscut every other lithological unit listed above. Their width ranges from several centimetres to several metres with the majority 10-100 cm wide. Most are homogeneous in composition; however, well preserved igneous layering typical for Molson dykes was observed in one 8-10 m wide dyke. These metadiabase dykes are deformed to various degrees. Dykes in migmatitic gneiss are thinned or locally boudinaged, and are rarely dismembered into trails of boudins and/or folded. In contrast, metadiabase dykes located in Pipe Mine metasediments are commonly intensely folded, boudinaged and faulted. At one location a metadiabase dyke cuts folded metasediments. A reaction rim consisting of up to 2 cm of tremolite needles occurs sporadically between the metadiabase dyke and marble layers.

In contrast to the relatively homogeneous and simply deformed metadiabase amphibolite dykes, the dark green amphibolites (Unit 3) are compositionally inhomogeneous and form complexly deformed layers and lenses (Fig. GS-27-2). The compositional inhomogeneity is typical for the intensely deformed metavolcanic rocks in the Pikwitonei domain and Thompson belt. Remnants of enclosed M_2-mobilizate fingerprint these amphibolites as Archean metavolcanics (Hubretgse, 1980). The complex and intricate shapes of these units are a result of polyphase deformation.

A medium grained, highly cataclastic and in places mylonitic light grey, schlieric quartzofeldspathic gneiss (Unit 1) hosts other rock units.

Dark grey, medium- to fine-grained, biotite quartzofeldspathic gneiss (Unit 2) is also strongly cataclastic. Despite the strong cataclasis and retrogression both gneiss units are recognized as part of the multicomponent migmatite unit described by Macek and Russell (1978).

Isolated inclusions and boudins of grass-green chloritized amphibolites (Unit 4) are inferred to be dismantled ultramafic protoliths (metapyroxenites, Mg-rich metavolcanics 2) of unknown age.

The following preliminary interpretations can be derived from this summer's field work:

a) Metadiabase dykes (Unit 5) of the Pipe Mine belong to the Molson dyke swarm.
b) Since metadiabase dykes intrude folded metasediments and since they do not produce consistent and extensive contact metamorphic reaction zones in carbonates, the metadiabase dykes must have intruded previously folded and metamorphosed sediments.

Should the metadiabase dykes indeed belong to the Molson swarm, and since no other early Proterozoic diabase dyke swarm has been documented, the folding and metamorphism of the supracrustals prior to the Molson dyke intrusion represents an early, previously undocumented, event of the Hudsonian orogeny in the Thompson belt.

REFERENCES

Macek, J.J. and Russell

1978: Thompson Nickel Belt Project; **in:** Manitoba Mineral Resources Division, Report of Field Activities 1978.

Hubretgse, J.J.M.W.

1980: The Archean Pikwitonei granulite domain and its position at the margin of the northwestern Superior Province, central Manitoba; Manitoba Mineral Resources Division, Geological Paper GP80-3, 16 p.

GS-28 GEOCHEMISTRY OF MAFIC VOLCANISM AT THE CHURCHILL-SUPERIOR BOUNDARY ZONE

by N.M. Halden[1]

Mafic volcanic rocks, comprising both pillowed and massive flows, outcrop at a number of localities along the Churchill-Superior boundary zone, e.g. at Ospwagan Lake, Mystery Lake, Assean Lake and Fox River. The complexity of the deformational history of the boundary zone precludes any straightforward determination of the likely mode of origin of these rocks. One of the objectives of this project is to compare and contrast the geochemical characteristics of the rocks from these areas to determine if similarities exist; in addition, a tentative tectonic setting for the rocks might be proposed. Constraining the latter consideration is that discriminant diagrams tend to reveal more about processes (partial melting and differentiation) and source regions than about specific tectonic regimes.

Samples have been collected from Assean Lake, Ospwagan Lake, Mystery Lake and Liz Lake, and were augmented by a number of samples from the Fox River belt (specifically for trace element analysis), which formed part of a study by R.F.J. Scoates (1981). Analytical work in progress has resulted in 40 major and trace element analyses of material from Ospwagan Lake; 80 trace element analyses from Assean Lake (complementary major element analyses will be completed shortly); and 5 major and trace element analyses from Mystery Lake. Material from Fox River and from Liz Lake will be completed early in 1988.

Table GS-28-1 shows some major and trace element data from a selected suite of samples from Ospwagan Lake. The data are incomplete

[1]Department of Geological Sciences, University of Manitoba

TABLE GS-28-1
SUMMARY OF GEOCHEMICAL DATA FROM A SELECTED SUITE OF VOLCANIC ROCKS FROM OSPWAGAN LAKE

	01	02	03	04	05	06	07	08	09	010A	010B	011	012	013	014	015	016
SiO2	51.86	48.38	47.77	49.46	49.35	48.46	49.82	50.60	49.15	45.03	44.76	47.65	47.35	51.13	52.65	52.49	51.52
TiO2	0.79	0.74	0.66	0.63	0.60	0.66	0.40	0.57	0.62	0.41	0.56	0.61	0.56	0.90	0.85	0.86	0.85
Al203	13.50	11.24	10.67	10.87	12.01	11.00	7.01	8.53	9.82	6.85	7.70	9.05	8.69	13.13	14.10	13.51	12.93
Fe203	11.41	11.68	10.86	11.21	10.35	11.71	9.45	9.32	12.27	11.53	12.02	11.36	12.03	11.02	11.03	9.15	10.40
FeO	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MnO	0.18	0.17	0.17	0.16	0.15	0.17	0.15	0.21	0.22	0.12	0.15	0.16	0.15	0.18	0.20	0.17	0.15
MgO	8.50	12.84	12.71	14.12	11.19	13.16	21.83	14.92	13.58	25.23	24.72	18.29	19.88	9.09	7.82	9.75	8.22
CaO	11.31	12.69	14.94	11.11	13.24	12.33	9.37	14.53	12.74	7.55	6.99	10.69	9.78	13.11	10.25	12.25	15.20
Na20	2.61	1.49	1.25	1.27	0.83	1.59	0.72	0.95	1.03	0.38	0.37	0.83	0.88	1.75	2.99	1.63	1.43
K20	0.27	0.40	0.43	1.21	1.26	0.55	0.09	0.55	0.61	0.09	0.09	0.21	0.24	0.41	0.47	0.16	0.14
H20+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
H20-	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
P205	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.03
Total	100.44	99.64	99.47	100.05	98.99	99.64	98.85	100.19	100.05	97.20	97.37	98.86	99.57	100.73	100.38	100.01	100.87
Rb	5	7	19	92	160	13	nd	63	41	nd	nd	2	5	12	5	2	nd
Sr	179	136	124	78	106	94	28	90	46	33	34	61	63	73	101	118	153
Y	22	16	17	14	8	19	8	13	17	10	2	16	12	19	26	22	23
Nb	nd	2	7	4	7	4	nd	nd	14	3	12	4	6	5	6	3	7
Zr	45	39	35	39	38	41	21	26	38	21	22	29	28	45	59	49	49

	017	018	019	020	021	022	023	024	025	026	027	028	029	030	031	032	033
SiO2	50.82	49.38	48.96	51.58	48.72	48.13	50.84	47.75	48.90	58.48	55.03	47.27	57.47	53.48	50.07	64.00	49.34
TiO2	0.83	0.73	0.76	0.85	0.80	0.43	0.79	0.62	1.12	0.74	0.85	0.52	0.80	1.06	0.93	0.82	1.34
Al203	13.47	15.96	15.61	13.35	16.30	7.59	12.29	9.54	14.03	14.60	16.57	9.06	14.54	13.84	15.08	13.55	14.37
Fe203	9.62	10.60	11.08	10.74	10.14	10.09	12.93	11.64	12.73	7.56	10.59	12.20	8.90	12.20	12.72	6.03	15.52
FeO	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MnO	0.17	0.18	0.17	0.18	0.16	0.15	0.19	0.17	0.18	0.14	0.12	0.19	0.14	0.17	0.21	0.07	0.22
MgO	6.32	8.86	8.81	8.01	9.02	22.34	11.98	18.10	9.21	4.42	6.68	20.53	5.16	8.11	7.17	4.79	6.57
CaO	16.76	13.32	13.19	14.21	12.87	8.88	10.47	10.53	5.77	10.09	3.71	8.57	7.99	7.24	11.46	4.12	10.31
Na20	1.95	1.70	1.56	2.36	1.84	0.57	1.36	1.24	4.49	2.85	2.69	0.36	3.58	4.88	2.94	3.14	1.55
K20	0.28	0.28	0.31	0.34	0.25	0.09	0.15	0.10	0.57	0.25	0.56	0.09	0.50	0.13	0.16	1.23	1.16
H20+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
H20-	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
P205	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.02	0.01	0.03	0.03	0.01	0.05	0.05
Total	100.24	101.02	100.46	101.63	100.11	98.28	101.01	99.70	97.03	99.15	96.82	98.80	99.11	101.14	100.75	97.80	100.43
Rb	nd	5	4	2	5	nd	7	nd	3	3	3	nd	10	nd	nd	20	35
Sr	230	127	126	238	142	23	162	48	95	57	231	10	48	233	309	159	103
Y	21	19	19	24	21	15	20	16	21	22	20	15	20	21	23	25	34
Nb	8	2	3	7	3	nd	nd	3	7	nd	nd	nd	nd	nd	nd	nd	3
Zr	45	37	38	48	41	21	42	29	55	94	53	103	98	58	56	125	70

Where "nd" is recorded for a trace element analysis, the analysis was below detection limits; for Rb and Nb this is 2 ppm.

in that FeO and H_2O remain to be determined. Most samples were collected from an isthmus of land separating Lower and Upper Ospwagan Lakes. A map referring to the specific locations and lithologies will form part of a later publication when data collection has been completed. Obviously the petrogenetic significance of the geochemistry must be constrained by the geological relationship between the various units at this locality. A more detailed comparison between the rocks from the Fox River belt and those at Ospwagan Lake may be possible as the lithological subdivision between massive and pillowed volcanic flows is explored. An additional constraint upon any internal relationships within the Ospwagan Group volcanic rocks is the existence of low angle décollement surfaces between major lithological units. These surfaces predate the upright NE-SW faults and the steeply plunging folds (with NE-SW axial traces) at Ospwagan Lake. If these surfaces represent thrusts then any original stratigraphic association between volcanic units within the Ospwagan Group may well be obscured.

Figure GS-28-1 represents a preliminary synthesis of the available data. Figures GS-28-1a and 1b are an AFM diagram and Jensen cation

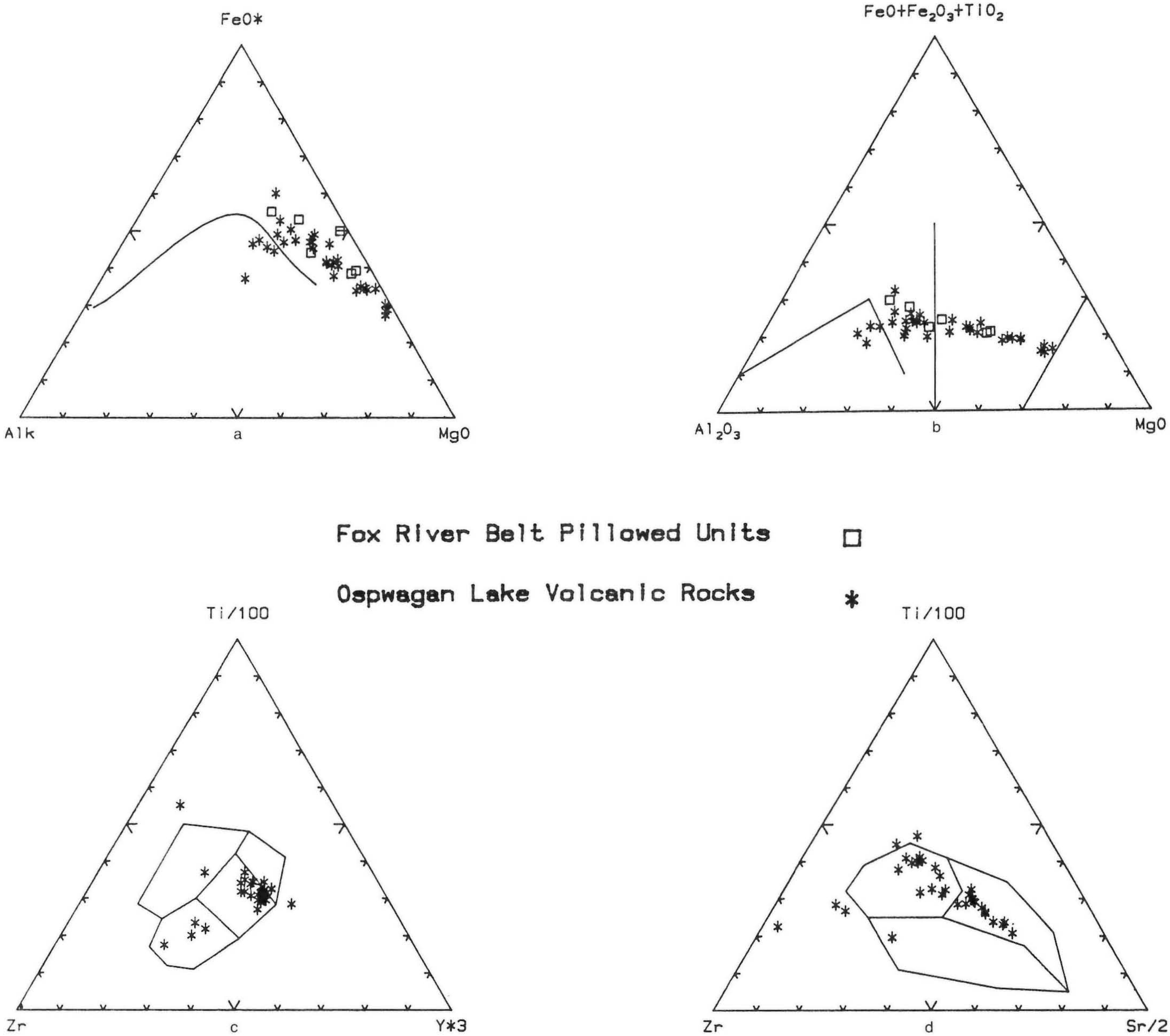


Figure GS-28-1: Geochemical plots of the data from Table GS-28-1. Figures GS-28-1a and 1b include selected analyses of pillowed units from the Fox River belt after Scoates (1981). Figure GS-28-1a is an AFM diagram and Figure GS-28-1b is a Jensen cation plot; the field boundaries are from Jensen (1976). FeO values were calculated independently based upon the method described by Irvine and Baragar (1971) for use on the Jensen cation plot until gravimetric determinations of FeO are available. Figures GS-28-1c and 1d are trace element ternary diagrams; the field boundaries are those of Pearce and Cann (1973). The trace element data plotted are those from Table GS-28-1.

plot respectively. The diagrams include the data from Table GS-28-1 and some data from the pillowed flows from the lower, middle and upper zones of the Fox River belt (Scoates, 1981). On Figure GS-28-1a the analyses plot dominantly within the tholeiitic field and seem to indicate a slight Fe enrichment trend; the analyses from the Fox River belt overlap with those of the Ospwagan volcanic rocks. Figure GS-28-1b shows the same compositional overlap of the two suites; however, the rocks lie dominantly within the Mg tholeiitic fields and basaltic komatiite fields. Figures GS-28-1c and 1d show the data from the Ospwagan Lake volcanic rocks on discriminant diagrams from Pearce and Cann (1973). In Figure GS-28-1c the majority of the rocks lie within the fields of ocean floor basalts and low-K tholeiites, and Figure GS-28-1d illustrates that they lie at the boundary between ocean floor basalts and low-K tholeiites; there is some spread of the data into the field of calc-alkali basalts. This latter observation could be consistent with the fact that some of the data plots within the calc-alkali fields on Figures GS-28-1a and 1b. At this stage, however, a closer examination of the samples, and the geochemical data, may be required to determine the possible effects of alteration, which could also have the effect of spreading the data points. The possible significance of these diagrams, as to what they might reveal about the tectonic setting of the Ospwagan volcanic rocks, remains to be tested. It might be argued that the Ospwagan Group volcanics have an "oceanic affinity"; the details, however, of the processes, for example derivation from a depleted mantle source by partial melting, subsequently modified by differentiation processes, remain to be worked out. In addition, any reference to the fact that the rocks might represent ocean floor would have to be confirmed with respect to their geological association with other rocks; the question would also have to be addressed concerning their mode of emplacement and subsequent incorporation in the Superior Province continental margin.

REFERENCES

Irvine, T.N. and Baragar, W.R.A.

1971: A guide to the chemical classification of the common volcanic rocks; Canadian Journal of Earth Sciences, v. 8, p. 523-549.

Jensen, L.S.

1976: A new cation plot for classifying subalkalic volcanic rocks; Ontario Division of Mines, Miscellaneous Paper 66.

Pearce, J.A. and Cann, J.R.

1973: Tectonic setting of basic volcanic rocks determined using trace element analyses; Earth and Planetary Science Letters, v. 19, p. 290-300.

Scoates, R.F.J.

1981: Volcanic rocks of the Fox River Belt, northeastern Manitoba; Manitoba Mineral Resources Division, Geological Report GR81-1.

GS-29 Rb-Sr GEOCHRONOLOGY OF THE CHURCHILL-SUPERIOR BOUNDARY ZONE AND CROSS LAKE AREA

by G.S. Clark[1]

INTRODUCTION

Rubidium-strontium whole-rock and mineral ages are being obtained for selected rock units in the Cross Lake area, northern Superior Province and from the Thompson open pit and Split Lake block of the Churchill-Superior boundary zone.

THOMPSON OPEN PIT

Samples of muscovite and biotite were separated from pegmatite collected in the open pit. The intrusion of the pegmatite was controlled by late shearing, so this is an attempt to obtain a minimum age for this event.

Two biotite samples give identical ages of 1460 $\pm$ 20 Ma. The much less radiogenic muscovite yields an age of 1620 $\pm$ 23 Ma. The muscovite age is considered to be the best estimate of the minimum age of late shearing, whereas the lower biotite age is a reflection of the lower retentivity of that mineral.

CROSS LAKE AREA

Hornfels and pseudotachylite samples were collected from the contact zone of a large Molson dyke on Pipestone Lake (Corkery, 1985a) in an attempt to date intrusion and cataclasis of the Molson dyke. The samples include spotted and massive hornfels, and pseudotachylite derived from metasandstones and metasiltstones. The pseudotachylite parallels bedding, and in some cases occurs in faults.

Three analyzed samples of pseudotachylite are colinear and give an apparent age of about 2100 Ma. However, the initial $^{87}Sr/^{86}Sr$ ratio is unrealistically low. This could be partly caused by contamination of the pseudotachylite by the host rock. Our result is higher than the 1884 $\pm$ 2 Ma U-Pb zircon age reported by Machado et al. (1986) for the main Molson dyke at Cross Lake. Additional analyses for the pseudotachylite and hornfels are in progress.

SPLIT LAKE BLOCK

Two rock units are being investigated from this part of the Churchill-Superior boundary zone. The Fox Lake granite is a medium grained, pink and grey granite composed of K-feldspar, plagioclase (oligoclase) and quartz, with subordinate hornblende, biotite and muscovite. Accessory minerals are chiefly sphene and zircon. Texturally, the granite is equigranular and xenomorphic, with no evidence of recrystallization or tectonism. Because of field relationships and the massive nature of the granite, it is considered to be Early Proterozoic in age (Corkery, 1985b; Halden, pers. comm.). Eleven samples of the granite were analyzed isotopically.

The Rb-Sr isotopic data show extreme scatter and it is unlikely, even with additional work, a Rb-Sr age can be obtained. The analytical results clearly show that the granite is depleted in alkali elements (detailed geochemical study is in progress by N.M. Halden), with Rb concentrations ranging from about 2.5 to 60 ppm. Strontium concentrations are high (675-1800 ppm). The isotopic results are interpreted as being strongly affected by contamination of the magma during ascent through older crustal rocks.

A layered hornblende gneiss unit is considered to be one of the oldest units in the Split Lake block (Corkery, 1985b). It hosts all later intrusive rocks, including Molson dykes and Fox Lake granite. The gneiss has a relict granulite texture and may be equivalent to granulites from the Pikwitonei domain.

Twenty slabbed samples were obtained from 10-30 kg samples. Six isotopically analyzed samples have a range in Rb concentrations from about 1.5 to 30 ppm, while Sr concentrations range between 440-1100 ppm. As in the case of the Fox Lake granite, the data points show extreme scatter, indicating severe disturbance of the Rb-Sr isotopic system. An age for the gneiss cannot be resolved at this time.

REFERENCES

Corkery, M.T.

1985a: Cross Lake supracrustal investigations in the eastern Pipestone Lake area; **in** Manitoba Mineral Resources Division, Report of Field Activities 1985, p. 165-172.

1985b: Geology of the Lower Nelson River Project area; Manitoba Energy and Mines, Geological Services, Geological Report GR82-1.

Machado, N., Heaman, L., Krogh, T.E. and Weber, W.

1986: U-Pb zircon ages of the Molson Dyke swarm and the Rox River sill, NE Manitoba; **in** Geological Association of Canada-Mineralogical Association of Canada Joint Annual meeting 1986, Ottawa, Ontario, Program and Abstracts, v. 11, p. 97.

[1] Department of Geological Sciences, University of Manitoba

GS-30 GRANITE AND PEGMATITES AT MAGILL LAKE, MANITOBA

by R.E. Meintzer[1], P. Černý[1], and P. Penner[1]

INTRODUCTION

The pluton of Magill granite (Fig. GS-30-1) and associated pegmatites at Magill Lake were sampled in detail for geochemical, mineralogical, and petrological studies. In addition, reconnaissance sampling of the small pluton of Magill granite at Knee Lake and pegmatites near Hawkins Lake and McLaughlin Lake was also conducted. Other plutonic rocks sampled for reference included members of the Bayly Lake Complex, the Semple River granodiorite near Oxford Lake, and undifferentiated, but apparently older, granite within the Magill Lake pluton. The Magill granite, associated pegmatites, and the Semple River pluton have intruded metavolcanic and metasedimentary rocks within a greenstone belt located

[1]Department of Geological Sciences, University of Manitoba

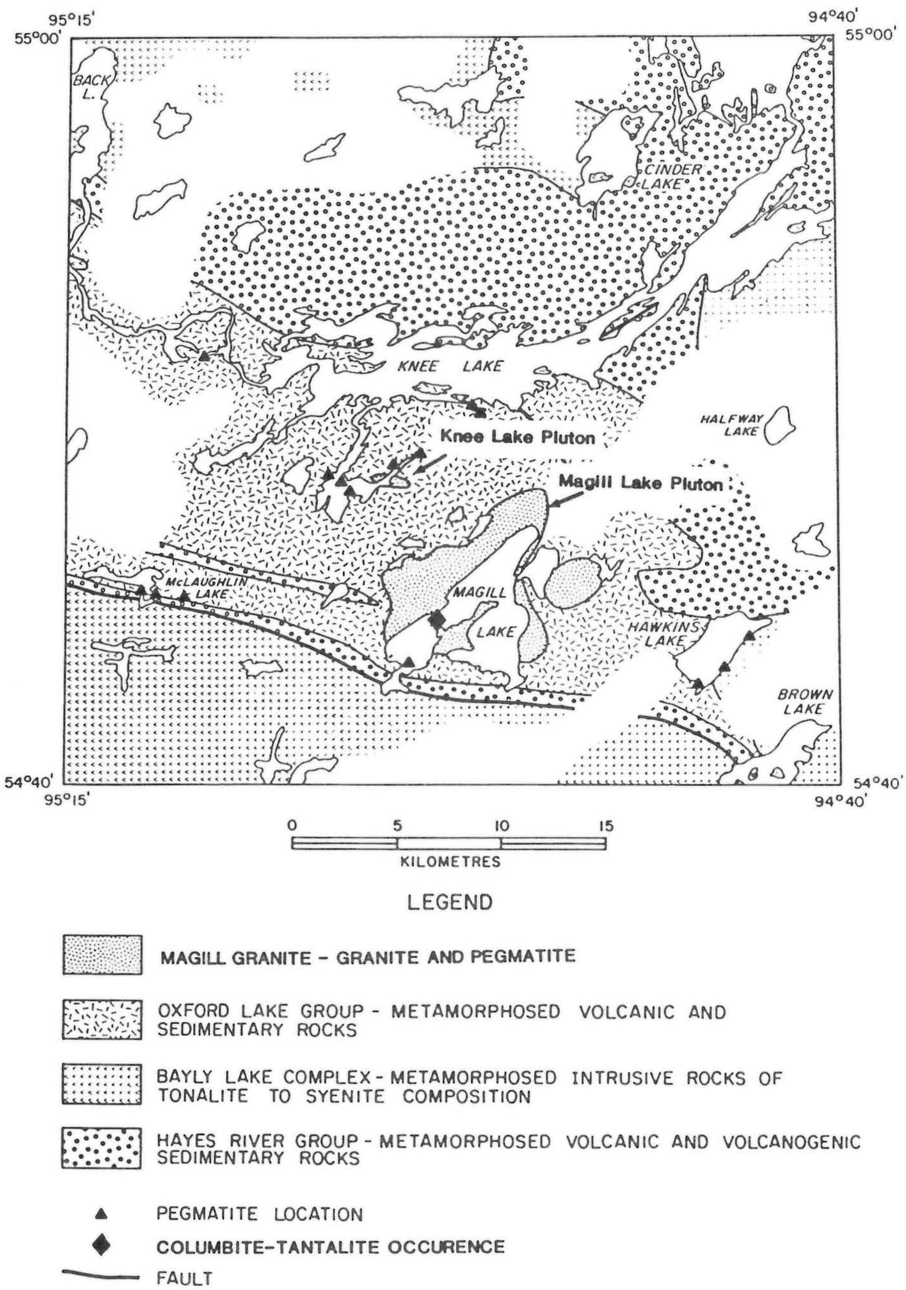


Figure GS-30-1: General geology of the Magill Lake area (after Lenton, 1985).

in the Cross Lake subprovince of the Archean Superior Province of the Canadian Shield. Results of recent mapping are reported by Gilbert (1985), Hubregtse (1985), and Lenton (1985).

MAGILL GRANITE

Magill Lake Pluton

The largest body of the Magill granite outcrops as a triangular-shaped intrusion centred on Magill Lake. Barry (1959) and Gilbert (1985) mapped the pluton in relationship to other rock units and Lenton (1985, Fig. GS-40-2) subdivided the pluton into six textural units: a) biotite granite, b) leucocratic granite, c) coarse leucogranite, d) pegmatitic leucocratic granite, e) garnetiferous sodic aplite, and f) pegmatite. These units correspond to five facies of fertile granite as defined by Černý and Meintzer (in press): biotite granite (a), 'fine grained' leucogranite (b,c), pegmatitic leucogranite (d), sodic aplite (e), and potassic pegmatite (f).

Although Lenton (1985) mapped a zone of biotite granite along the northwestern shore of Magill Lake and considered it part of the Magill Lake pluton, further examination suggests that the biotite granite may be older than the Magill granite and possibly part of the Bayly Lake Complex. An additional outcrop of this primitive phase was located farther to the northeast along the northwestern shore. A separate outcrop on an island in the central part of the pluton is considered to be a biotite granite facies of the Magill granite, but petrochemical data are required to solve this question.

The granite has a distinctly peraluminous mineralogy as noted by Lenton (1985) with ubiquitous garnet (locally up to 5 cm across; Fig. GS-30-2) and variable contents of biotite, schorl, and rare muscovite. Although pegmatitic granite and graphic granite are widely distributed, the evolution into distinct pods or veins is poorly developed. In a singular occurrence, a well zoned 2 x 3 m pod displayed a fine- to medium-grained wall zone of Qtz + Kfs + Pl + Bt + -Gt, a medium- to coarse-grained Qtz + Kfs + Gt intermediate zone, and a coarse grained quartz core. Plagioclase is present as blocky crystals of very pale orange peristerite, biotite is partially altered and has a greenish cast, and garnet is common as well developed dark reddish brown to very dusky red crystals with the tetragonal trisoctahedral habit (Fig. GS-30-3).

Rare-element minerals are typically absent within the pegmatite pods and dykes within the pluton, and within the dykes observed along the southern shores of Magill Lake. Columbite-tantalite has been observed in only one dyke crosscutting an inlier of the Oxford Lake Group.

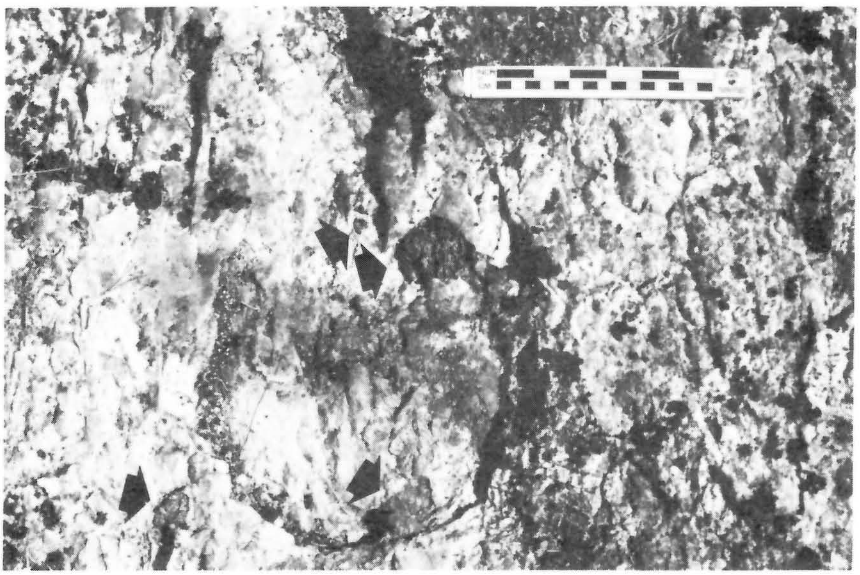


Figure GS-30-2: Garnet crystals in pegmatitic leucogranite facies of the Magill Lake pluton of Magill granite.

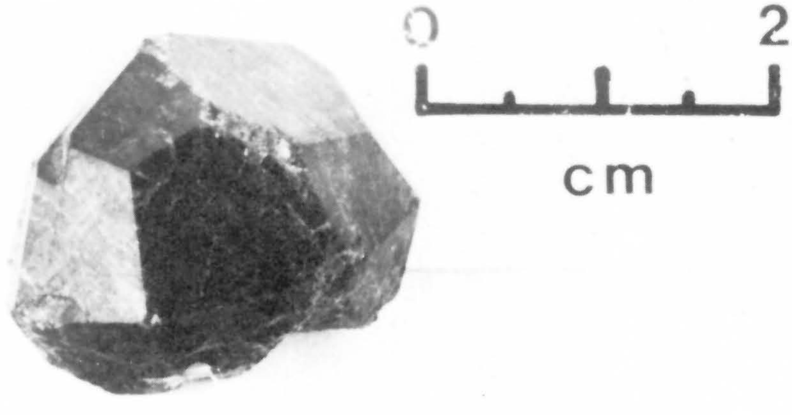


Figure GS-30-3: Garnet crystal displaying tetragonal trisoctahedral habit from the intermediate zone of pegmatite pod in the Magill Lake pluton.

Knee Lake Pluton

Reconnaissance sampling of the Knee Lake pluton revealed similar textural facies to those in the Magill Lake pluton as described by Lenton (1985).

PEGMATITES

Hawkins Lake

Preliminary sampling of the pegmatite dykes at Hawkins Lake confirmed Lenton's (1985) description of the dykes as being simple, unzoned pegmatites without rare-element mineralogy. Nonetheless, garnet, biotite, and K-feldspar were sampled to establish petrochemical relationships.

McLaughlin Lake

The spodumene-bearing pegmatite at McLaughlin Lake, previously described by Barry (1959), Bannatyne (1985), and Lenton (1985), was sampled for spodumene, muscovite, garnet, schorl, and K-feldspar. No other pegmatite dykes in the area were observed or sampled.

REFERENCES

Bannatyne, B.B.
1985: Industrial minerals in rare-element pegmatites of Manitoba; Manitoba Energy and Mines, Economic Geology Report ER84-1.

Barry, G.S.
1959: Geology of the Oxford House-Knee Lake area; Manitoba Mines Branch, Publication 58-3.

Černý, P., and Meintzer, R.E.
in press: Fertile granites in the Archean and Proterozoic fields of rare-element pegmatites: crustal environment, geochemistry, and petrogenetic relationships; **in** Taylor, R.P., and Strong, D.F., eds., Recent Advances in the Geology of Granite-related Mineral Deposits; Canadian Institute of Mining and Metallurgy, Special Volume 39.

Gilbert, H.P.
1985: Geology of the Knee Lake-Gods Lake area; Manitoba Energy and Mines, Geological Report GR83-1B.

Hubregtse, J.J.M.W.
1985: Geology of the Oxford Lake-Carrot River area; Manitoba Energy and Mines, Geological Report GR83-1A.

Lenton, P.G.
1985: Granite-pegmatite investigations: Knee Lake-Magill Lake area; **in** Manitoba Energy and Mines, Report of Field Activities 1985, p. 203-208.

GS-31 U-Pb GEOCHRONOLOGY PROGRAM: THOMPSON BELT — NORTHERN SUPERIOR PROVINCE

by N. Machado[1], L. Heaman[1], T.E. Krogh[1] and W. Weber

During the winter of 1986/87, 17 zircon fractions, three monazite fractions and four titanite (sphene) fractions were analyzed at the Royal Ontario Museum's Jack Satterly Geochronology Laboratory as part of a largely Federally funded contribution to the Canada-Manitoba Mineral Development Agreement.

Nine units from the Thompson belt and two units from the Pikwitonei domain were investigated (Table GS-31-1 and Fig. GS-31-1). During the summer more material was sampled, mainly from the Thompson belt. At the GAC-MAC annual meeting in Saskatoon U-Pb data from the Thompson belt were presented (Machado et al., 1987).

SUMMARY DISCUSSION (BY W.W.)

As shown in Table GS-31-1 the youngest (Hudsonian) orgenic event has been dated by sphene U-Pb ages at approximately 1720-1776 Ma, by monazite at 1770-1786 Ma and by zircon in pegmatites at 1768-1774 Ma. These ages are in agreement with a U-Pb zircon-monazite age of 1786 $\pm$ 3 Ma for a pegmatite from the Paint Lake area (Krogh et al., 1985). Measurements of common Pb in feldspars should narrow the spread and improve the reliability of the sphene ages.

All units contain zircons which reflect their Archean origin, with two exceptions: 1) the obviously young pegmatites at Pipe Pit and Thompson Pit and 2) the Pipe Pit amphibolite which is a metamorphic dyke intruded into marble of the Pipe Pit supracrustal suite and probably represents a Molson dyke (see also Macek, GS-27, this volume). Wintering Lake granite (10), Mystery Lake granodiorite (11), Thompson Pit amphibolite (5) and Thompson Pit gneiss (6) yield zircon ages (in part minimum ages) which are similar to zircon ages for Pikwitonei granulite metamorphism (Krogh et al., 1986) suggesting that the protolith of these rocks are probably Pikwitonei-type granulites.

In contrast, zircon of Manasan gneiss (4) and Sasagiu Rapids gneiss (3) yield older ages of around 3 Ga suggesting that these rocks have a different history. Rocks of this age and appearance occur, e.g., at the southern edge of the Berens River domain and the English River domain.

A monazite age of 1821 Ma, and the upper intercept age of 1822 $\pm$ 3 Ma based on this monazite and two zircon fractions, for the Wintering Lake granite is interpreted as dating the time of crystallization of this pluton. Two other zircon populations yielding an upper intercept age of 2590 $\pm$ 14 Ma are interpreted as relict population of the protolith. This age of 1822 Ma is considerably older than the late(?) Hudsonian event discussed earlier and indicates a major metamorphic-magmatic event prior to intrusion of Molson dykes at this edge of the Archean craton. It might be related to the early Hudsonian event recognized in the Pipe Pit (Macek, GS-27, this volume). Plutonic rocks of similar age were recently reported by Gordon et al. (1987) from the Kisseynew sedimentary gneiss belt.

REFERENCES

Gordon, T.M., Hunt, P.A., Loveridge, W.D., Bailes, A.H. and Syme, E.C.
1987: U-Pb zircon ages for the Flin Flon and Kisseynew belts, Manitoba: Chronology of early Proterozoic crust formation; GAC-MAC joint annual meeting, Program with Abstracts, v. 12, p. 48.

Krogh, T.E., Heaman, L., Machado Fernandez, N. and Weber, W.
1985: U-Pb geochronology program; Thompson belt and Pikwitonei domain; **in** Manitoba Energy and Mines Report of Field Activities 1985, p. 183-184.

Krogh, T.E., Heaman, L., Machado, N., Davis, D. and Weber, W.
1986: U-Pb geochronology program: Northern Superior Province; **in** Manitoba Energy and Mines Report of Field Activities 1986, p. 178-180.

Machado, N., Heaman, L., Krogh, T.E. and Weber, W.
1987: U-Pb geochronology of the Thompson mobile belt; GAC-MAC joint annual meeting, Program with Abstracts, v. 12, p. 69.

[1] Department of Geology and Mineralogy, Royal Ontario Museum, Toronto, Ontario

TABLE GS-31-1

U-Pb ZIRCON RESULTS FOR THE 1986/87 MANITOBA CONTRACT

Unit Location	Description: Sample Number	Fraction*	Concentration: U (ppm)	Concentration: Pb (ppm)	Apparent Age (Ma): $^{206}Pb/^{238}U$	Apparent Age (Ma): $^{207}Pb/^{235}U$		Apparent Age (Ma): $^{207}Pb/^{206}Pb$	Age (Ma)
11	MYSTERY LAKE GRANODIORITE (MAN85-16)								
	1	Z,b,1M,y,A	93	64	2570	2614		2648	
	2	Z,b,1M,cl,A	124	52	2061	2183		2300	
10	WINTERING LAKE GRANITE (MAN85-10)								
	1A	M,c,IF,y	514	4726	1817	1819		1821C*	ui 1822 ± 3
							(1)	1779	
							(1)	1784	
							(1)	2371	
							(1)	2234	ui 2590 ± 14
9	PIPE PIT PEGMATITE (MAN85-1)								
	1	Z,a,0M,cl,A	5957	1694	1648	1682		1724	ui 1768
	2	Z,a,0M,cl,A	4803	1412	1728	1740		1754	
8	PIPE PIT AMPHIBOLITE (MOLSON DYKE?) (MAN85-3)								
	1	S,b,IF,cl,A	4	3	1608	1683		1776	
7	THOMPSON PIT PEGMATITE (02-86-24)								
	1	Z,b,0NM,br,A	1125	341	1761	1765		1770	
	2	Z,b,0M,br,A	1209	362	1744	1754		1766	ui 1771 ± 2
	3	Z,b,0M,br	1314	377	1680	1714		1757	
6	THOMPSON PIT GRANITIC BASEMENT GNEISS (MOAK LAKE GNEISS) (02-6-162)								
	1	Z,b.0M,cl,A	331	181	2572	2627		2669	i 2770
	2	M,b,IF,y,A	1701	5906	1770	1770		1770C	
	3	S,b,IF,br,A	30	13	1724	1722		1720	
5	THOMPSON PIT AMPHIBOLITE INCLUSION IN MOAK LAKE GNEISS (02-6-163)								
	1	Z,b,0NM,cl,A	519	277	2622	2645		2663	
	2	Z,b,0M,br,A	892	450	2513	2570		2615	
	3	S,b,IF,br,A	155	52	1693	1715		1743	
4	MANASAN GRANITOID BASEMENT GNEISS (TK84-12)								
	1	Z,b.0M,cl,A	144	94	2943	2994		3029	i 3086
	2	M,b,IF,y,A	824	3565	1782	1784		1786C	
3	SASAGIU RAPIDS TONALITIC GNEISS (MAN85-4)								
	1	Z,c,0NM,cl,A	135	79	2658	2738		2798	
	2	S,b,7M,br,A	99	35	1756	1761		1768	ui 2926
	3	S,b,7M,br,A	77	26	1732	1735		1737	li 1774
	4	Z,c,0NM,cl,A	145	53	2004	2110		2215	
2	NATAWAHUNAN LAKE PEGMATITE (MAN85-14)								
	1	Z,a,0NM,cl,A	79	53	2676	2679		2682 C	
	2	Z,c,0NM,cl,A	84	55	2686	2688		2690 C	
1	NATAWAHUNAN LAKE MAFIC GRANULITE (MAN85-15)								
	1	Z,b,0NM,cl,A	211	128	2652	2664		2673 C	
	2	Z,b,0NM,pk,A	132	83	2664	2667		2669 C	

*NOTES FOR MINERAL FRACTION DESCRIPTION

Format (mineral, grain size, magnetic susceptibility, colour, abrasion)
Mineral: Z=zircon, M-Monazite, S=sphene (titanite)

Grain Size (mesh): a) +100 b) -100+200 c) -200+325 d) -325
Magnetic Susceptiblity: NM, M=non-magnetic and magnetic, IF=initial frantz
Colour: cl=colourless, br=brown, y=yellow, pk=pink

*C: data plots on concordia
i, ui, li: intercept, upper intercept, lower intercept with the concordia
(1) data reported in 1986

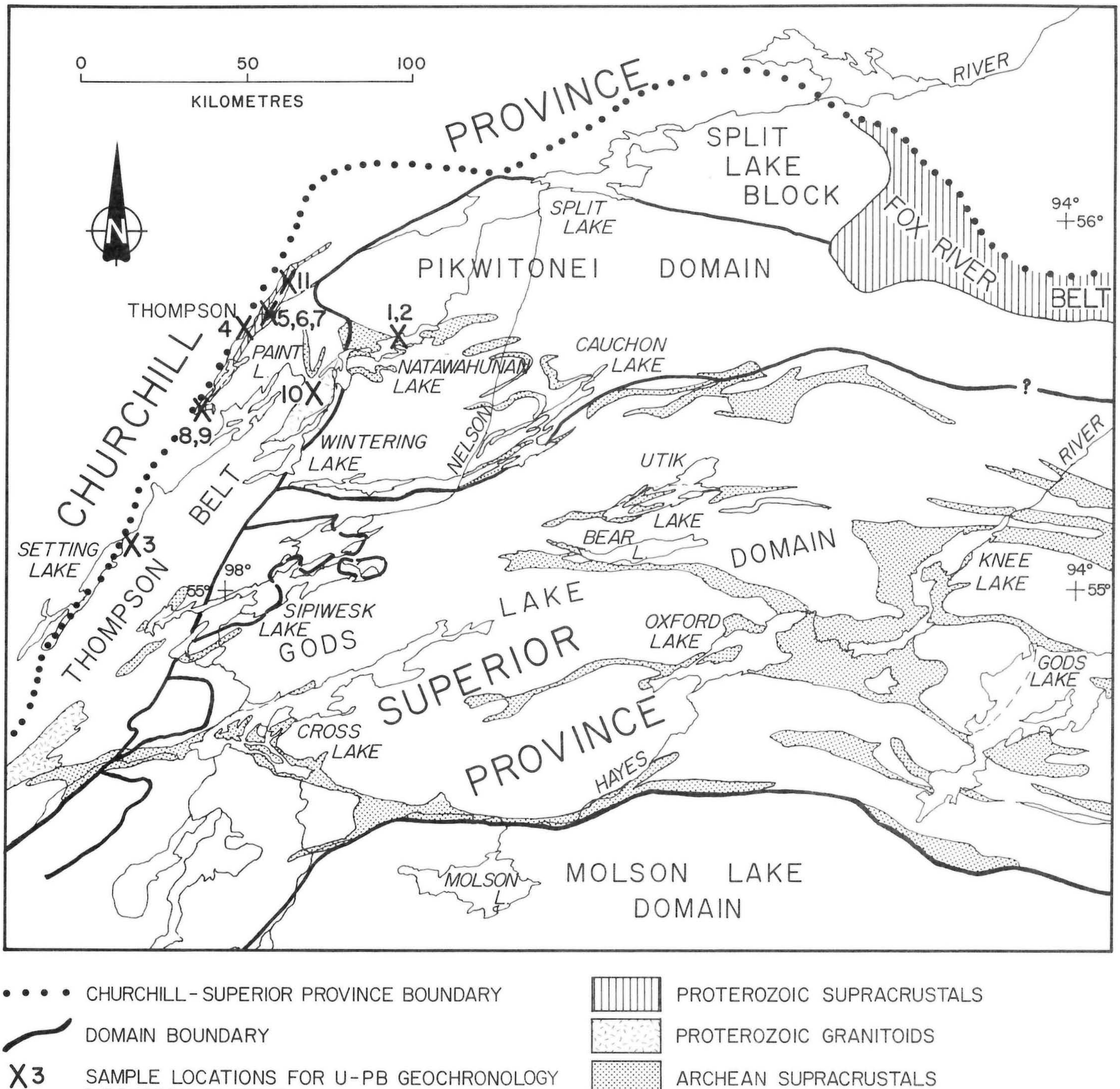


Figure GS-31-1: *Locations of rock units investigated by U-Pb geochronology.*

GS-32 U-Pb ZIRCON GEOCHRONOLOGY OF THE BIGSTONE LAKE-KNIGHT LAKE AREA

by A. Turek[1] and W. Weber

U-Pb zircon geochronology ages were determined for two of four rock units sampled during mapping of the Bigstone-Knight Lakes area (Neale, 1984, 1985a).

A U-Pb zircon age of 2893.6 ± 9 Ma was obtained for gabbro-quartz diorite (unit 2, Fig. GS-32-1) which is intruded by tonalite of unit 11. This age is a minimum age for mafic volcanics of unit 1, since unit 2 contains inclusions of unit 1. The age is derived from the concordia intercept of 3 discordant zircon fractions (Fig. GS-32-2, Table GS-32-1).

An intermediate feldspar-phyric tuff (unit 3, Fig. GS-32-1) gave a U-Pb zircon age of 2888.2 ± 8 Ma. The age is derived from 3 zircon fractions of which one plots on the concordia (Fig. GS-32-3).

[1]Department of Geology, University of Windsor, Windsor, Ontario

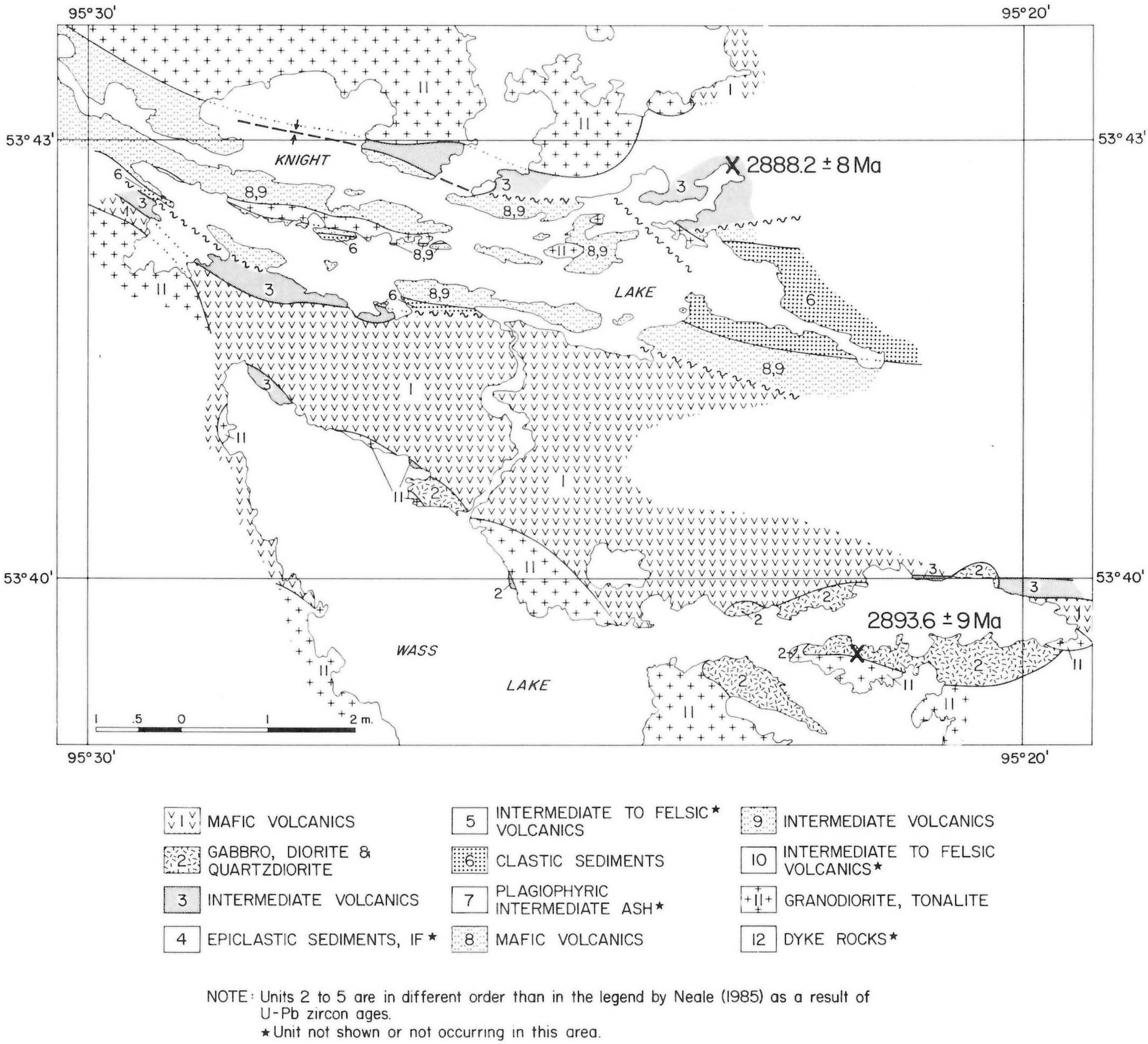


Figure GS-32-1. Geology of the Knight Lake-Wass Lake area (after Neale, 1985b) with locations of U-Pb zircon ages.

TABLE GS-32-1

ANALYTICAL RESULTS AND CALCULATED AGES

Sample Detail				Concentration (ppm)		Atomic Ratios					Model Ages			Concordia Ages
Sample Number	Magnetism Type	Tyler Mesh Grain Size	Wt. (mg)	U	Pb	(1) $^{204}Pb/^{206}Pb$	(2) $^{208}Pb/^{206}Pb$	(2) $^{207}Pb/^{206}Pb$	(3) $^{207}Pb/^{235}U$	(3) $^{206}Pb/^{238}U$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	Upper Intercept
WASS LAKE GABBRO (102-85-860)														
WL(B)	NM0° Hp.Ab	-100+200	4.3	233	134	0.000107	0.06280	0.208463	15.0343	0.5254	2722.1	2817.4	2886.3	
WL(C)	NM1° Hp.Ab	-100+200	2.1	305	177	0.000277	0.07050	0.210742	15.0738	0.5256	2723.0	2819.9	2889.8	2893.6 ± 9
WL(D)	NM0° Ab	-200+325	2.6	279	150	0.000199	0.06316	0.208874	13.9208	0.4877	2560.7	2744.3	2882.4	Ludwig (1982) Model 2 P = 13%
KNIGHT LAKE TUFF (102-85-110)														
102(A)	M0° Hp	-100+200	2.7	208	135	0.000190	0.15591	0.209181	15.8272	0.5532	2838.3	2886.3	2886.3	
102(B)	NM0° Hp	-200+325	0.4	169	114	0.000888	0.17008	0.213361	16.16509	0.5648	2886.3	2886.6	2886.7	2888.2 ± 8.2
102(C)	M0°-NM3° Hp	-200+325	1.4	202	132	0.000470	0.17594	0.211028	15.4221	0.5412	2788.6	2841.7	2879.5	Ludwig (1982) Model 1 P = 53%

Note: NM refers to magnetic susceptibility as measured by the inclination of the Frantz isodymanic separator. Hp is hand picked. Ab is abraded.

Decay constants used are $\lambda^{238}U = 1.55125x10^{-10}$ year^{-1} and $\lambda^{235}U = 9.8485x1^{0-10}$ year^{-1} (Steiger and Jager, 1977)

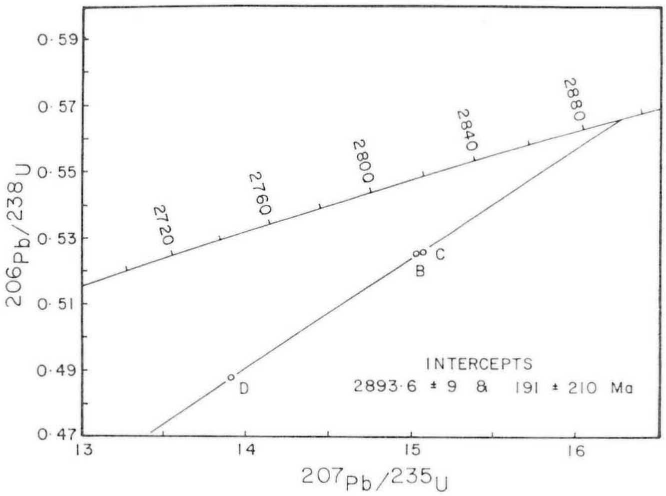


Figure GS-32-2: Concordia plot of Wass Lake gabbro.

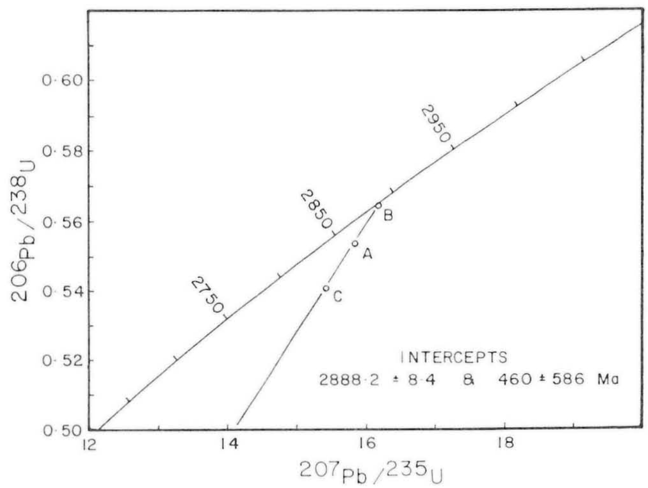


Figure GS-32-3: U-Pb zircon concordia plot of Knight Lake tuff.

These ages confirm earlier assumptions (Neale, 1984, 1985a) that the greenstones at Bigstone and Knight Lakes are comparable to those at Island Lake.

At Island Lake the U-Pb zircon of 2888 $\pm$ 15 Ma for the Bella Lake tonalite is a minimum age for mafic volcanics intruded by the tonalite (Turek et al., 1986), and quartz-feldspar porphyritic dacite yielded a U-Pb zircon age of 2861 $\pm$ 26 Ma (Turek et al., 1985, and in prep.). In the Gods Lake-Oxford Lake area, available U-Pb zircon ages are similar (D. Davis, written comm., Manitoba Energy and Mines, in press).

Further age data are required to determine whether unit 6 (Fig. GS-32-1) is correlative with the Island Lake Group at Island Lake, and whether the volcanics of units 7 to 10 are part of this younger cycle — or if the entire succession is part of the Hayes River Group.

REFERENCES

Neale, K.L.

1984: Bigstone Lake project; **in** Manitoba Energy and Mines Report of Field Activities 1984, p. 126-128.

1985a: Geological Investigations in the Knight Lake-Bigstone Lake area; **in** Manitoba Energy and Mines Report of Field Activities 1985, p. 200-202.

1985b: Knight Lake-Wass Lake, Preliminary map 1985B-1, scale 1:20 000.

Manitoba Energy and Mines

In press: NTS 53L-Gods Lake; Geological Compilation Map Series.

Turek, A., Carson, T.M., Smith, P. E., Van Schmus, W.R. and Weber, W.

1986: U-Pb zircon ages for rocks from the Island Lake greenstone belt; Canadian Journal of Earth Sciences, v. 23, p. 92-101.

Turek A., Smith, P., E., Van Schmus, W.R. and Weber, W.

1985: Advances in the geochronology of the Island Lake greenstone belt, Manitoba GAC-MAC Joint Annual Meeting, Program and Abstracts, v. 10, p. 64.

GS-33 STRATIGRAPHIC MAPPING AND STRATIGRAPHIC AND INDUSTRIAL MINERALS CORE HOLE PROGRAM

by H.R. McCabe

INTRODUCTION

Stratigraphic studies for 1987 involved a number of projects. A comprehensive guidebook for the Devonian outcrop belt of Manitoba was prepared for, and issued by, the Canadian Society of Petroleum Geologists, Calgary, in conjunction with a field trip for the Second International Symposium on the Devonian System, August 22-25. The guidebook includes a comprehensive review of Devonian stratigraphy and a proposed model for Winnipegosis reef development.

Work continued on a regional Winnipegosis reef study of the outcrop belt with five core holes drilled in three separate areas. A brief reconnaissance survey north of Grand Rapids outlined the location of a number of caves in Silurian strata, and three short core holes were drilled at one of the cave sites. Drilling continued in the Project Cormorant area north of The Pas, with eight more holes.

Table GS-33-1 presents all stratigraphic core hole data, including data for several holes drilled for an industrial minerals project. Fifteen holes were drilled for a total depth of 1316 m. Cumulative drilling since inception of the project in 1969 now amounts to more than 13 000 m.

GRAND RAPIDS CAVE PROJECT

Previous reconnaissance studies in the area north of Grand Rapids (Willard Anderson, Parks Branch, pers. comm.) had determined the presence of a number of caves. In order to check the extent, and stratigraphic and structural control of cave development, a brief reconnaissance was undertaken, and three shallow core holes were drilled in the vicinity of the largest cave, referred to locally as "Cook's Cave" (Fig. GS-33-1). Air photographs of the Cook's Cave area show a well developed fracture set trending at 105° in a broad area of thin overburden and scattered outcrop. Bedrock consists of interbedded microcrystalline, fossil-fragmental and stromatolitic dolomites which are tentatively correlated with the lower Cedar Lake and/or the upper East Arm Formation. Sandy dolomites definitely attributable to the East Arm were intersected at a depth of 21.2 m in hole M-16-87.

Cook's Cave extends for a strike length of approximately 29 m, and attains a maximum width of 4 m at a depth of 11.5 m. Maximum cave height is 5.5 m. Cave development, at least in the vicinity of Cook's Cave, is localized approximately along the 105° fracture set, and a number of small sinks and caves were found on strike with the Cook's Cave fracture.

Three inclined (70°) core holes were drilled along the trend of the Cook's Cave fracture. The deepest hole, M-16-87, was sited so as to intersect the fracture plane at a point below the cave floor, to ascertain if additional cave development occurs at depth. The hole bottomed at a vertical depth of 23.4 m, approximately on the fracture line, with no evidence of any appreciable solution opening. Holes M-17-87 and M-18-87, located approximately 50 m and 25 m to the southeast along the fracture line, also failed to detect any appreciable solution openings.

Cook's Cave was discovered by chance, close to a bush trail cut for access to a mineral exploration core hole site. Several additional small caves have subsequently been found in the little explored area south of Little Limestone Lake, and other caves are probably present. The time of cave development cannot be determined from presently available data, but possibly could range from late Paleozoic to pre-Pleistocene or even Recent.

DEVONIAN — WINNIPEGOSIS REEF STUDY

The five core holes for this project were located on what are believed to be larger Winnipegosis reef complexes, representing three different basin facies. The objective was to obtain further information as to size, shape, configuration and lithofacies. These data are particularly relevant in view of the current major oil discoveries in Winnipegosis reefs of southern Saskatchewan (Martindale and Orr, 1987).

A) NARROWS AREA

Two holes were located in the vicinity of Lake Manitoba Narrows (Fig. GS-1), which area is believed to represent a basin-edge facies of the Winnipegosis. Figure GS-33-2 shows a diagrammatic representation of the change in facies of the Winnipegosis along the outcrop belt. Most reefs in The Narrows area have a distinctly dome-like configuration, except for two occurrences, one at Gunnlaugson Farm and the other at the Dog Lake Quarry (McCabe, 1987). Two drill holes, M-1-87 and M-2-87, tested these occurrences.

The Gunnlaugson Farm occurrence comprises a flat, low-lying, roughly circular peninsula about 1.6 km in diameter. The peninsula is characterized by about 20 small bedrock mounds, up to 10 m long and 1 m high, trending roughly at 25° and consisting of algal dolomite. This configuration contrasts markedly with the nearby Rosehill Reef, located only 1.6 km to the southeast and on regional strike. Both the Rosehill and Gunnlaugson reefs should thus have been eroded to approximately the same stratigraphic level. The Rosehill reef, however, has a distinctly domal configuration with a massive central core surrounded by relatively steeply dipping (20°) flank beds. The writer believes that the Gunnlaugson reef represents a much larger, flat-topped, platform-type reef, distinctly different from the pinnacle-type reefs such as Rosehill.

Core hole M-2-87 was located beside one of the small algal mounds near the western edge of the peninsula, and yielded some unexpected results. Most of the Upper Winnipegosis dolomite (19 m) consists of fragmental to micritic dolomites. Several zones of relict limestone in the lower part of the sequence show a well preserved texture of fossiliferous wackestone with sparse to abundant fossil debris (brachiopod, crinoid, gastropod). This lithology is almost identical to the underlying platform beds (Elm Point Formation). Preservation of such relict limestone in the dolomites of an Upper Winnipegosis reef complex is uncommon in the Manitoba outcrop belt.

The most unexpected feature is the occurrence at the base of the Upper Winnipegosis of a 2 m section containing well developed, black, laminated bituminous mudstone intervals interbedded with fossil fragmental limestones and dolomite; bedding is subhorizontal. Lithologically these bituminous beds appear identical to the bituminous interreef facies developed in the deeper portions of the basin, in the Winnipegosis and Dawson Bay areas. This lithology had not previously been known to occur in this area, and the writer had assumed that shallower water conditions towards the edge of the basin would have raised the depositional interface above the anoxic level and precluded preservation of the bituminous material. Apparently the anoxic level within the Elk Point Basin must have been rather high (i.e. surface oxygenated zone relatively shallow). Total thickness of Upper Winnipegosis reef buildups in this area is no more than about 35 m (a minimum water depth) so depth of the anoxic zone must have been less than this, possibly only 20-25 m.

The Dog Lake Quarry reef (hole M-1-87), like the Gunnlaugson reef, differs from the predominantly dome-like reefs in the area, exposing flat-lying to irregularly undulating beds with no obvious reef buildups. Initially the writer believed that this outcrop represented the more deeply eroded portion of a larger platform-type reef such as Gunnlaugson. Core from this site yielded inconclusive results, showing only largely textureless, apparently flat-bedded dolomites with no obvious break between platform and reef. The total Winnipegosis section, however, is 27.0 m thick, which is thicker than the Lower Winnipegosis platform beds at Rosehill reef (20.0 m) and Gunnlaugson reef (23.2 m), indicating that the upper few metres of the Dog Lake sequence probably are Upper Winnipegosis.

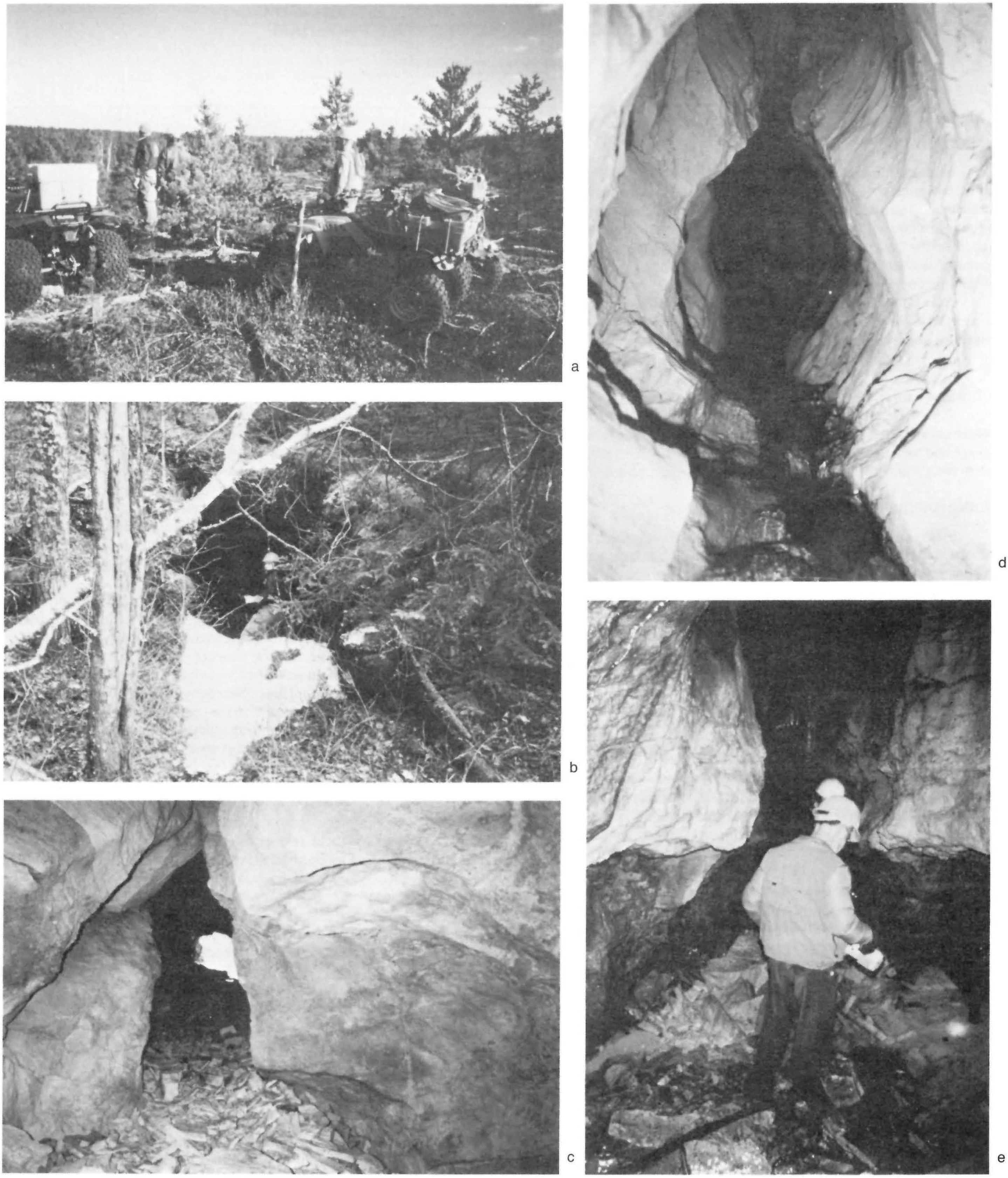


Figure GS-33-1: *"Cook's Cave", Grand Rapids area. (a) View of typical high, well drained, bedrock-paved upland on which caves are located. (b) Entrance to cave. (c) View back towards cave opening from floor; slope 28°, distance 25 m, vertical depth 11.5 m. (d) View upward (almost vertical) showing solution scallops developed along the fracture that has localized cave development. (e) In main cavern, looking along narrow cave continuation along fracture line. (Photographs by W.D. McRitchie.)*

TABLE GS-33-1

SUMMARY OF CORE HOLE DATA

Hole No.	Location and Elevation	SYSTEM/Formation/(Member)	Interval	Summary Lithology
M-1-87 (Dog Lake Quarry)	16-30-22-8W +249.9 m	DEVONIAN - Upper Winnipegosis	0.0-6.6	Dolomite buff, microcrystalline, vuggy, faint calcarenite texture. Grades to:
		Lower Winnipegosis	6.6-27.0	Dolomitic limestone, mottled, biomicrite, few dark partings, fine basal breccia
		Ashern	27.0-28.6	Argillaceous dolomite, light grey to buff, several fine breccia bands near top
			28.6-40.4	Shale, dolomitic, brownish red with grey reduction patches, becoming lighter orange-grey at base
		SILURIAN-Interlake	40.4-52.8	Dolomite, buff, variable, dense to fossil fragmental
M-2-87 (Gunnlaugson Farm Quarry)	5-35-24-10W +249.3	DEVONIAN-Upper Winnipegosis	0.0-11.0	Dolomite, buff, porous, finely crystalline, fine fragmental
			11.0-17.1	Interbedded limestone and dolomite, biomicrite
			17.1-19.1	Black laminated bituminous mudstone with interbedded fossilferous limestone and dolomite
		Lower Winnipegosis	19.1-42.4	Calcareous dolomite and mottled dolomitic limestone with some irregular dark partings, biomicrite
		Ashern	42.4-54	Argillaceous dolomite to dolomitic shale, some breccia, red to buff
		SILURIAN-Interlake	54-57.1	Dolomite, buff to yellowish grey, dense, partly vuggy
M-3-87 Paradise Beach	15-20-30-17W +266	DEVONIAN - Dawson Bay (upper)	0.0-4.0	Limestone, light-grey, dense, fossilferous
			4.0-9.4	Dolomite, brown, finely crystalline, granular to saccharoidal
		(middle)	9.4-21.7	Calcareous shale, mottled greyish red, fossilferous
		(lower)	21.7-35.8	Fossilferous limestone grading down to sparsely fossilferous argillaceous micritic limestone and dolomite
		(Second Red)	35.8-46.2	Shale, dolomitic, medium brownish red to greenish grey, mottled, brecciated toward base
		Upper Winnipegosis	46.2-57.2	Dolomite, subhorizontal bedding, mostly porous, fossilferous pelletal intraclastic calcarenite
			57.2-87.8	Dolomite, finely crystalline, granular to saccharoidal
			87.8-95.8	Dolomite, some dark partings, abundant fossil fragments, large crinoids common towards base. Grades to:
		Lower Winnipegosis	95.8-120.4	Dolomite, buff, vuggy porosity, finely crystalline granular, thin breccia at base
		Ashern	120.4-129.9	Shale, dolomitic, medium grey to dark brownish red, some brecciated
		SILURIAN - Interlake	129.9-136.5	Dolomite, buff, variable
M-4-87 Salt Point E.	6-21-44-24W +266.7	DEVONIAN - Dawson Bay (lower)	0.0-4.0	Overburden
		(Second Red Beds)	4.0-14.2	Shale, dolomitic, grey to dark brownish red, brecciated towards base
		Upper Winnipegosis	14.2-15.3	Limestone, microcrystalline, dense, partly brecciated; some coarsely recrystallized algal calcarenite?
			15.3-18.3	Dolomite, good pinpoint to fenestral porosity, micritic to coarse algal/ pelletal calcarenite, subhorizontal bedding
			18.3-79.3	Dolomite, pale yellowish brown, massive, very finely crystalline, slightly to moderately granular, faint calcarenite, large crinoids towards base
		Lower Winnipegosis	79.3-95.8	Mottled dolomite, yellowish brown, massive, vuggy porosity, sparsely fossilferous
		Ashern	95.8-105.0	Shale, dolomitic, medium grey to dark brownish red, fine breccia at top, and dolomite breccia fragments at base
		SILURIAN - Interlake	105.0-112.0	Dolomite, variable

TABLE GS-33-1 (Cont'd.)

SUMMARY OF CORE HOLE DATA

Hole No.	Location and Elevation	SYSTEM/Formation/(Member)	Interval	Summary Lithology
M-5-87 Salt Point W	6-17-44-24W +274 m	DEVONIAN - Dawson Bay (lower)	0.0-4.1	Limestone, buff, dense, fossiliferous micrite, fossil content decreases downward
			4.1-7.45	Dolomite, argillaceous to bituminous, buff to dark brownish black, burrow-mottled to finely laminated
		(Second Red)	7.45-17.6	Shale, dolomitic, medium grey to orange-brown, breccia at top and bottom
		Upper Winnipegosis	17.6-18.2	Limestone, very finely crystalline, dense, partly brecciated, sulphide at top
			18.2-18.9	Dolomite, minor limestone, laminated algal calcarenite with good fenestral porsity
			18.9-93.8	Dolomite, variable, fine to coarse pelletal/intraclastic algal? calcarenite with much calcite spar infill, fossiliferous with corals towards top and crinoids common towards base
		Lower Winnipegosis	93.8-109.7	Dolomite, mottled, yellowish brown, massive, vuggy porosity, crinoidal at top
		Ashern	109.7-117.8	Shale, dolomitic, medium grey to dark brownish red, breccia towards bottom
M-6-87 Site #60	8-19-59-26W +265		0.0-4.4	Overburden
		ORDOVICIAN - Stony Mountain (upper)	4.4-5.0	Dolomite, buff to pinkish to greyish red, argillaceous
			5.0-22.5	Dolomite, light grey buff, very finely crystalline, dense, hard, faintly mottled, faint nodular bedding
		(lower)	22.5-32.4	Dolomite, buff to reddish mottled and burrow-mottled, scattered crinoid fragments
		Upper Red River - (Fort Garry)	32.4-32.7	Dolomite, brownish buff, cherty
			32.7-36.2	Dolomite, argillaceous, pinkish to reddish grey
			36.2-38.9	Dolomite, buff, mottled, cherty
			38.9-44.3	Dolomite, argillaceous, buff to reddish grey, burrow-mottled
			44.3-46.5	Dolomite, medium grey, argillaceous, burrow-mottled
		Lower Red River	46.5-79.0	Dolomite, massive, faintly mottled and burrow-mottled, finely to very finely crystalline, dense, pinpoint porosity towards base
			79.0-80.0	Dolomite, sandy, to dolomitic sandstone, in part pinkish mottled
		Winnipeg	80.0-84.6(?)	Fine silty sandstone, light grey shale interbeds, medium grained clean sand at base (lost core 4.1 m)
		PRECAMBRIAN	(?)84.6-85.4	(lost core 0.8 m, Precambrian?)
			85.4-92.6	Highly weathered, grading to:
			92.6-115.0	Fresh hornblende gneiss, pyroxenite and granite
M-7-87 (Root Lake) (Site #59)	16-5-59-26W +290		0.0-32.8	Overburden
		ORDOVICIAN - StonyMountain (lower)	32.8-56.2	Dolomite, light buff, faintly mottled becoming slightly reddish to orange toward base, finely crystalline dense with scattered crinoid fragments, massive to partly thin nodular bedded near top
		Upper Red River - (Fort Garry)	56.2-57.0	Dolomite, brownish buff, massive, medium crystalline, dense, fair fine poristy, some chert
			57.0-57.6	Dolomitic shale, grey to reddish grey
			57.6-58.0	Dolomite, buff to pinkish, medium calcarenite
			58.0-59.6	Argillaceous dolomite, medium greyish red
			59.6-62.8	Dolomite, medium brownish buff, abundant soft chert, massive, very finely crystalline, fair porosity
			62.8-70.4	Dolomite, slightly to moderately argillaceous, mottled and burrow-mottled, buff to greyish red
		Lower Red River	70.4-102.3	Dolomite, light brownish buff, faintly mottled, massive, very finely crystalline, slightly granular, some burrow-mottling

TABLE GS-33-1 (Cont'd.)

SUMMARY OF CORE HOLE DATA

Hole No.	Location and Elevation	SYSTEM/Formation/(Member)	Interval	Summary Lithology
			102.3-102.7	Dolomite, as above, few floating sand grains
			102.7-103.7	Sandy dolomite to dolomitic sandstone, purplish mottled
		Winnipeg	103.7-106.6(?)	Sandstone and sandy shale, thin, basal quartz conglomerate (lost core 2.6 m)
		PRECAMBRIAN	(?)106.6-107.1	(lost core, 0.5 m, Precambrian?)
			107.1-108.3	Highly weathered, kaolin and quartz, grading to:
			108.3-140.0	Fresh biotite gneiss and metagabbro
M-8-87	4-22-60-27W	ORDOVICIAN - Stony Mountain (Lower)	0.0-12.6	Dolomite, light buff to pinkish, grading to medium
Rocky Lake N. (Site #63)	+275 m			greyish red, burrow-mottled, thin nodular bedded at top, grading to massive, very finely crystalline
		Upper Red River - (Fort Garry)	12.6-28.0	Dolomite, variable, argillaceous, mottled and burrow-mottled, buff to medium reddish grey
		Lower Red River	28.0-59.8	Dolomite, light grey buff, faintly mottled and burrow mottled, massive, finely crystalline, slightly granular. Chert nodules in upper 1 m and floating sand grains bottom 0.7 m
			59.8-60.6	Sandy dolomite to dolomitic sandstone, purplish mottled, Receptaculites
		Winnipeg	60.6-61.0(?)	Sandy shale and argillaceous sandstone, medium brownish grey, pyritic
		PRECAMBRIAN	(?)61.0-64.7	(3.7 m lost core-Precambrian?)
			64.7-65.0	Highly weathered quartz-kaolin, grading to:
			65.0-77.8	Fresh gneissic granodiorite and pegmatite
M-9-87	16-12-60-27W		0.0-6.0	Overburden
Rocky Lake N.E. (Site #62)	+270	ORDOVICIAN - Stony Mountain	6.0-20.8	Dolomite, buff to pinkish, faintly mottled, very finely crystalline, nodular
		Upper Red River - (Fort Garry)	20.8-33.4	Argillaceous dolomite and dolomite, buff to greyish red, some chert
		Lower Red River	33.4-61.2	Dolomite, massive, buff, faintly mottled
			61.2-63.2	Sandy dolomite to dolomitic sandstone, reddish mottled
		Winnipeg	63.2-63.3(?)	Sandstone, medium grained (lost core 0.9 m)
		PRECAMBRIAN	(?)63.3-65.7	(lost core 2.3 m, Precambrian?)
			65.7-67.2	Highly weathered quartz-kaolin grading to:
			67.2-78.8	Fresh mafic gneiss with granitoid injections, some weathered intervals
M-10-87	4-6-60-26W		0.0-2.5	Overburden
Rocky Lake E. (Site #61)	+276	ORDOVICIAN - Stony Mountain	2.5-14.5	Dolomite, buff, nodular bedded
			14.5-24.3	Dolomite, buff to reddish, massive, crinoidal
		Upper Red River - (Fort Garry)	24.3-38.2	Argillaceous dolomite and dolomite, medium greyish red to buff, partly burrow-mottled
		Lower Red River	38.2-70.8	Dolomite, buff, partly mottled, massive
			70.8-72.3	Sandy dolomite to dolomitic sandstone, dense, mottled
		Winnipeg(?)	72.3-72.4(?)	Sandstone, medium to coarse grained, pyritic
		PRECAMBRIAN	(?)72.4-75.2	(lost core 2.8 m. Precambrian?)
			75.2-77.7	Highly weathered quartz-kaolin grading to:
			77.7-98.1	Fresh, mixed granite, pegmatite and mafic gneiss
M-11-87	2-2-58-23W		0.0-0.5	Overburden
Cormorant S.W. (Site #67)	+268	ORDOVICIAN - Stony Mountain	0.5-17.5	Dolomite, buff. thin bedded, nodular to platy
			17.5-25.2	Dolomite, buff, massive, faintly mottled, crinoid fragments
		Upper Red River - (Fort Garry)	25.2-36.2	Argillaceous dolomite and cherty dolomite, buff to greyish red, burrow-mottled
		Lower Red River	36.2-67.5	Dolomite, massive, buff, faintly mottled
			67.5-68.6	Sandy dolomite to dolomitic sandstone, faintly mottled

TABLE GS-33-1 (Cont'd.)

SUMMARY OF CORE HOLE DATA

Hole No.	Location and Elevation	SYSTEM/Formation/(Member)	Interval	Summary Lithology
		Winnipeg	68.6-69.4(?)	Sandstone, white, friable, medium grained, well rounded
		PRECAMBRIAN	(?)69.4-73.1	(lost core 3.7 m, Precambrian?)
			73.1-74.8	Highly weathered quartz-kaolin, partly porous mesh of quartz and biotite, grading to:
			74.8-81.3	Fresh granite
M-12-87 Cormorant S. (Site#65)	2-2-59-23W +268 m	ORDOVICIAN - Stonewall	0.0-9.0	Dolomite, buff, very fine grained, dense, thin bedded, some conglomerate/breccia
		Stony Mountain	9.0-26.9	Shale marker at top, grey to orange-red. Dolomite, buff, faintly mottled, very fine grained.
			26.9-43.4	Dolomite, massive to slightly nodular, crinoid fragments
		Upper Red River - (Fort Garry)	43.4-56.2	Argillaceous dolomite, grey to greyish red, variably weathered, and buff cherty dolomite
		Lower Red River	56.2-89.4	Dolomite, cherty at top, mostly buff, faintly mottled, massive, scattered crinoid fragments
			89.4-90.6	Sandy dolomite to dolomitic sandstone, prominent purplish mottling, fine- to medium-grained (lost core, 0.15 m)
		Winnipeg	90.5-90.6(?)	Sandstone, medium grained, friable
		PRECAMBRIAN	(?)90.6-93.6	(lost core, Precambrian?)
			93.6-95.7	Highly weathered kaolin-quartz grading to:
			95.7-122.1	Fresh, variably granitized mafic gneiss
M-13-87 Mitchell Lake Road (Site#74)	1-34-60-26W +292		0.0-18.0	Overburden
		ORDOVICIAN - Stony Mountain	18.0-26.6	Dolomite, buff to faintly reddish mottled and streaked, nodular to massive
		Upper Red River - (Fort Garry)	26.6-45.0	Argillaceous dolomite, buff to greyish red, mottled, and dolomite, buff, mottled, cherty
		Lower Red River	45.0-72.2	Dolomite, buff, faintly mottled, massive, scattered crinoid fragments
			72.2-75.3	Sandy dolomite to dolomitic sandstone, purplish mottled, fine- to medium-grained
		Winnipeg	75.3-75.4(?)	Sandstone, medium- to coarse-grained, friable, pyritic
		PRECAMBRIAN	(?)75.4-77.0	(lost core 1.6 m, Precambrian?)
			77.0-78.8	Highly weathered dark grey claystone with mica, grading to:
			78.8-92.8	Fresh amphibolite and granite
M-14-87 Wekusko (WDH#1)	8-26-64-16W +289	ORDOVICIAN - Stony Mountain	0.0-9.4	Dolomite, variably mottled buff to medium dark reddish gray, yellowish etc., nodular at top, grading to massive
		Upper Red River - (Fort Garry)	9.4-16.2	Dolomite, very fine grained, variably argillaceous, colour-mottled as above to grey at base
M-15-87 Wekusko (WDH#2)	8-26-64-16W +289	ORDOVICIAN - Stony Mountain	0.0-8.0	Dolomite, buff to reddish mottled, nodular to massive
		Upper Red River - (Fort Garry)	8.0-16.9	Dolomite, variably argillaceous, very fine grained, mottled as above to grey at base

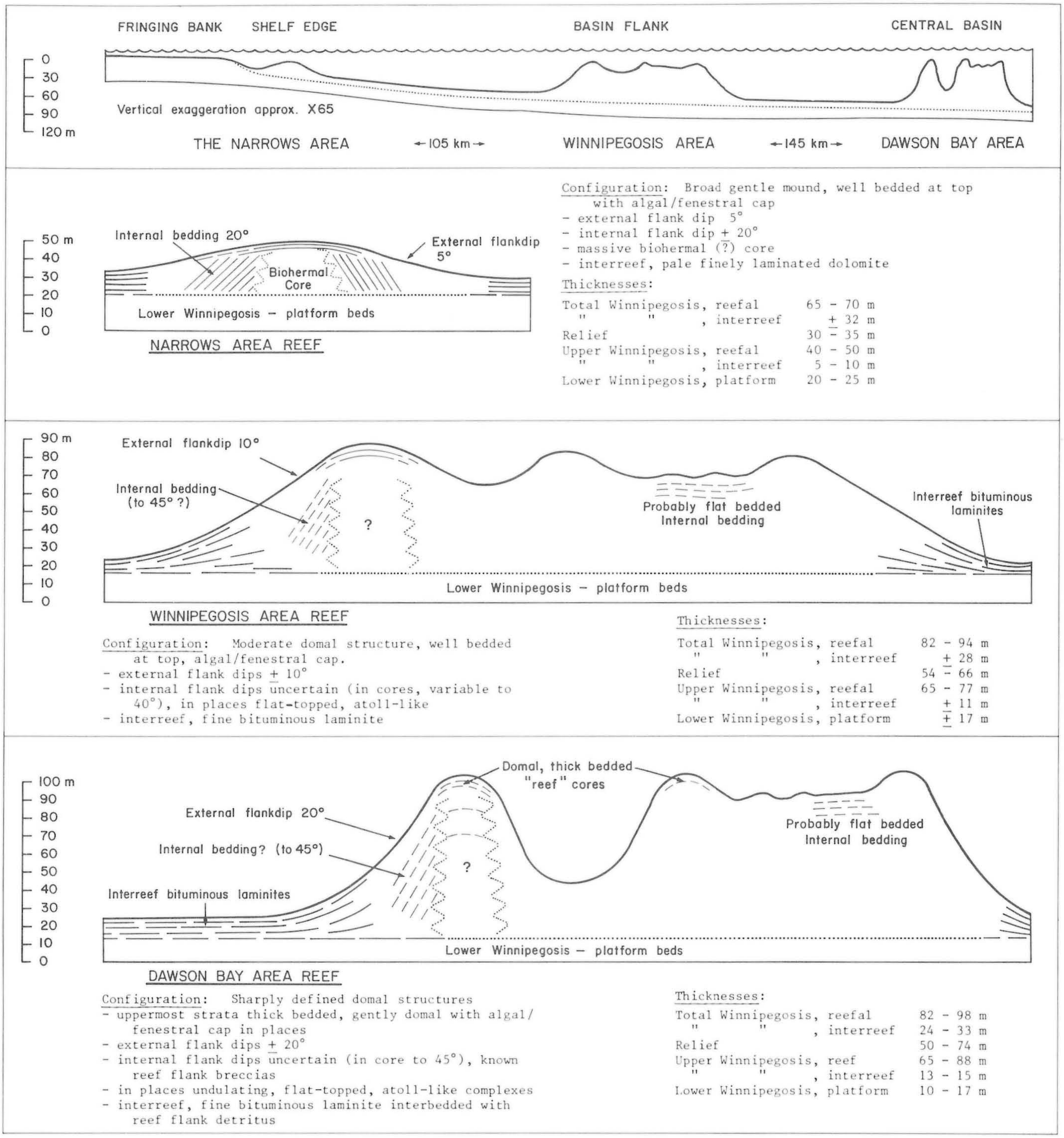


Figure GS-33-2: Winnipegosis reef configuration (inferred) and known reef parameters.

Lower water level in the quarry in late summer exposed a considerable irregularity in structure, with what appears to be a minor angular unconformity in one place. This unusual internal structure suggests that the Upper Winnipegosis strata at Dog Lake may not represent reefal strata, but rather may represent Upper Winnipegosis of the shelf facies, where distinct reef-interreef differentiation has not occurred (i.e. beyond the limit of anoxic basin conditions). More detailed examination of the quarry and surrounding area is required to clarify the exact stratigraphic relationship. Figure GS-33-3 shows a generalized cross-section from the Gunnlaugson reef to Rosehill to Dog Lake.

B) WINNIPEGOSIS AREA — PARADISE BEACH REEF COMPLEX

Winnipegosis strata in the vicinity of the south end of Lake Winnipegosis, including the Paradise Beach area (hole M-3-87), are believed to comprise a basin-flank facies, midway between the shelf-edge facies of The Narrows area, and the deeper, central-basin portion of the outcrop belt in the Dawson Bay area (Fig. GS-33-2). The Paradise Beach core hole (M-3-87) was located within what appears to be a large, flat-topped Winnipegosis reef complex (Norris et al., 1982; Fig. 22). The edge of this complex is marked by a relatively sharply defined series of elongate domal occurrences of Lower Dawson Bay strata draped over underlying Winnipegosis reefs that are up to 91.5 m thick. In contrast, the Winnipegosis in hole M-3-87 (reef interior lagoon?) is only 74.2 m thick.

The central area of the Paradise Beach reef complex is evidenced, in outcrop, by the uniform widespread occurrence of flat-lying Upper Dawson Bay strata. Ground checking northwest of the drill site showed continuous and perfectly flat, uniform outcrop over an area at least 0.5 km^2. Regional mapping (Norris et al., op. cit.) suggests that the reef complex (as expressed by the Upper Dawson Bay outcrop distribution) possibly extends over an area about 12 km by 5 km, although outcrop control is insufficient to prove that this is one single continuous reef complex. Hole M-3-87 is located close to the reef rimming the eastern edge of the complex, and appears to be situated on a gentle domal structure slightly higher topographically than the central, flat area described above. The strata in hole M-3-87 thus may represent a "proximal lagoon facies" immediately within the fringing reef rim, containing a higher than average content of rim-derived detrital material.

Core for hole M-3-87 is generally massive, with traces of faint horizontal bedding, and consists largely of fossiliferous and fragmental material, totally dolomitized and with poorly preserved primary textures. The black bituminous mudstones characteristic of the interreef facies were not seen. This suggests that the entire area of the reef complex existed as a reef complex from inception, rather than forming as a result of merging of a series of smaller pinnacle-type reefs. Most reef-associated outcrops in the Winnipegosis area, however, appear to be discrete domal occurrences. Because of insufficient data, it is still uncertain if these are discrete (pinnacle-type) reefs or merely small mounds sitting on top of larger platform-type reefs. To date, limited evidence suggests that these broad flat-topped platform reefs may be rimmed, at least on their northeastern (windward ?) flanks, by fringing reefs, with a uniform flat-topped interior lagoon — essentially an atoll-type configuration.

C) SALT POINT REEF COMPLEX — DAWSON BAY AREA

Two core holes (M-4-87 and M-5-87) were located within what is now believed to be a large flat-topped reef complex or platform reef which seems to underlie all of Salt Point (Fig. GS-1). Initially, the occurrence of two small outcrops of flat-lying Lower Dawson Bay strata on Salt Point was the only indication of the presence of an underlying flat-topped Winnipegosis reef. Recently, however, ground access along forestry trails has permitted more detailed mapping as well as core hole drilling.

Preliminary mapping in 1987 showed that the Lower Dawson Bay caprock is relatively widespread in the Salt Point area, suggesting that all of Salt Point probably is underlain by a large reef complex. In addition, it was possible to trace outcrops at one of the massive reefal knobs on the north shore of Salt Point (Fig. GS-33-4) and show that the reefal knob passes laterally to flat-lying bedded dolomites.

In 1985, Inco had drilled three shallow core holes on Salt Point as part of a mineral exploration program. Unfortunately these holes did not penetrate the complete reefal sequence. As a follow up to the Inco drilling, two deeper stratigraphic test holes were drilled in 1987 by the Branch to determine true structure, reefal thickness, and the nature of the lower part of the reef and the platform beds. These holes also provide an accurate frame of reference for the Inco holes. Results show uniform regional structure, total Winnipegosis thickness of 82-93 m, and Upper Winnipegosis reefal buildup of 65-75 m on a relatively uniform Lower Winnipegosis platform sequence approximately 17 m thick.

Lithology of the entire Upper Winnpegosis sequence in holes M-4-87 and M-5-87 consists of fragmental beds (algal, pelletal, oolitic, fossiliferous), apparently flat lying, and passing almost imperceptibly into the underlying platform beds. Corals and large crinoids (in part intact stems to several centimetres in length) become common towards the base of the reefal sequence, suggesting a vertical zonation within the reef, possibly a shoaling-upward, catch-up type of reef development. As in the case of the Paradise Beach reef complex, evidence is lacking for any black bituminous mudstones characteristic of the interreef facies, as described for the reef-flank profile drilled in 1986 (McCabe, 1986). Thus the large platform-type reefs of the Dawson Bay area also appear to have developed from inception of reef growth and are not the result of merging of smaller, closely spaced pinnacles.

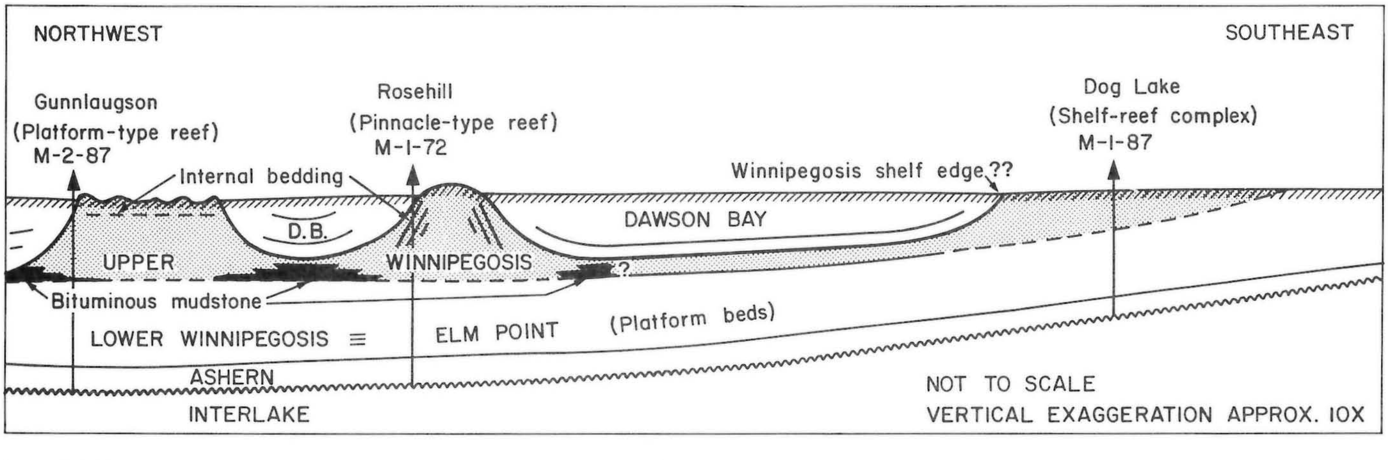
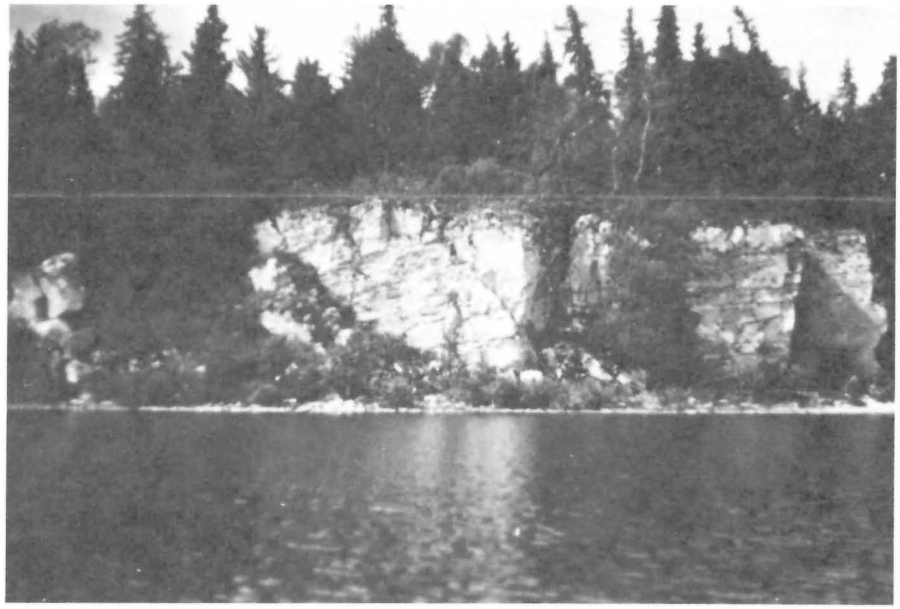


Figure GS-33-3: Diagrammatic cross-section, Winnipegosis reefs, The Narrows area.

Figure GS-33-4: Winnipegosis reef, shore cliff, Salt Point (platform rim).



Unlike the Paradise Beach area, there is no evidence in the Salt Point area of **extensive** flat-topped reefs; only a few small outcrops of flat-lying Lower Dawson Bay strata occur, indicative of underlying locally flat-topped reefs. The abundance of small, closely spaced Lower Dawson Bay domes, in areas such as the Pelican Rapids road between Steeprock and Bell Rivers, and to a lesser extent Salt Point itself, suggests that these domes represent small mounds on top of (or along the rim of) a more extensive platform-type reef. Despite this, many of the more isolated domes in the Dawson Bay area probably represent isolated pinnacle-type reefs rising sharply from the platform, and surrounded by black bituminous laminites of the inter reef facies.

The Salt Point reef complex may possibly shed some light on distribution of the thicker reefal mounds that appear to fringe the larger reef complexes. At Salt Point, these thicker mounds (shore cliffs, Fig. GS-33-4) occur only along the northern shore of the point, where they rise at least 15-20 m above the main reef platform (interior lagoon?). This distribution possibly reflects preferential fringing reef development on the northern (windward ?) flank of the complex.

The paleo-wind direction, and possible resultant asymmetry of reefs such as the Salt Point complex, may have relevance for the reef-flank profile of the Steeprock Bridge reef (McCabe, 1986). This profile is for the western flank of the reef, and the reef itself, which appears to be an isolated pinnacle, is situated within a broader complex of reefs; other reefs occur within 1 km to the east and northwest. The reef-flank profile noted above for the Steeprock Bridge reef thus may represent a leeward-flank profile. Outcrop data are not presently available for windward-flank deposits, and the present geographic distribution of reefs indicates that such data are not likely to be obtainable in the Dawson Bay area. Indirect evidence possibly can be seen in the thick reef-flank breccia sequence found in the Gulf Minitonas 13-10-36-26 core hole.

In summary, the core hole and outcrop data acquired in 1987 provide considerable additional information concerning Winnipegosis reef distribution and configuration, but the reefs are so complex that only the broad generalities can be outlined at the present time.

PROJECT CORMORANT

Drilling to determine Precambrian basement geology beneath thin Phanerozoic cover continued in the Cormorant map sheet (63K; Weber, GS-13, this volume). A total of eight holes were completed for 806 m, including 163 m of Precambrian core, and 577 m of Paleozoic core. Paleozoic strata range from 58 m to 91 m in thickness; overburden thicknesses range from zero to a maximum of 33 m in hole M-7-87, located on the edge of The Pas Moraine.

As indicated in reports of previous drilling (Reports of Field Activities 1982-1986), the Precambrian erosion surface is extremely flat and uniform. Estimates were made for expected depth to Precambrian for all 1987 core holes; the maximum error in estimation was 7 m and the average error only 3 m, well within the limits of error in estimating from both topographic and structural contours.

Lithology of Paleozoic strata was normal, with little variation other than a gradual southward thickening.

WEKUSKO DRILLING

Two shallow core holes, M-15-87 and M-16-87, were drilled south of Wekusko Lake to evaluate quality of the reddish mottled dolomite in that area as a potential decorative stone (R. Gunter, GS-17 this volume, Fig. GS-17-4). Outcropping strata consist of a thin sequence (8-10 m) of dolomite of the Lower Stony Mountain Formation, overlying reddish mottled dolomite of the Upper Red River Fort Garry Member (Table GS-33-1). Regional structural and topographic data indicate that this occurrence is a mesa-like outlier, separated from the main belt of Stony Mountain strata outcropping to the south and west.

The bright reddish coloration of both the Stony Mountain and Fort Garry beds is anomalous, and is indicative of a high but variable degree of oxidation. A similar situation occurs at the town of Stony Mountain, north of Winnipeg, where the City of Winnipeg quarry is located on an outlier of Stony Mountain strata completely separated from the main outcrop belt. At Stony Mountain a portion of the Lower Stony Mountain beds (i.e. Penitentiary Member) also is atypical, showing bright yellowish coloration and extensive fossil solution in comparison to the normal reddish grey to buff coloration characteristic of the main outcrop belt.

In all probability both Stony Mountain and Wekusko existed as erosional outliers prior to Pleistocene glaciation, and during this time were subjected to circulation of oxidizing meteoric waters, and vadose diagenesis. It seems unlikely that such extensive alteration could have taken place in Recent time.

Stony Mountain strata are highly resistant and form a prominent bedrock escarpment along much of the outcrop belt. Other occurrences of colourful oxidized carbonate rocks may occur along the Stony Mountain/Fort Garry outcrop belt, either as outliers or possibly as well drained promontories along the escarpment. Such coloration, however, can be expected only in the above units, which appear to be the only major units with a sufficiently high Fe content to produce such pigmentation.

LIMESTONE POINT LAKE "OUTLIER"

One other small but unusual and possibly highly significant Paleozoic occurrence was mapped in 1987. Zwanzig and Lenton (GS-10, this volume) in mapping the Limestone Point Lake area (63N/2), describe a Paleozoic outlier, approximately 1.6 km in diameter, on that lake. This outlier had been reported previously (Robertson, 1953) as Silurian, with a brief note that the strata were disturbed. The "Silurian" strata were shown as being in fault contact with Precambrian. No subsequent studies have been made to determine the relation of this outlier to the main Paleozoic outcrop belt. The writer had previously "dismissed" the occurrence as probably a normal erosional remnant disturbed by glacial ice movement, but on the basis of the following data, such is not the case.

From descriptive notes by Lenton, and a representative suite of samples from the outcrop, the carbonate rocks present in the outlier are all dolomites and argillaceous dolomites with a definitely Ordovician (rather than Silurian) appearance, although no fossil age determinations are yet available. Deformation of these dolomites is extreme, with development of isoclinal-type folding and possibly shear cleavage (Lenton, op. cit.). The lithologies are, in part, normal for basal Paleozoic strata, but admixed with the normal carbonates are highly fragmental carbonates ranging from breccias to conglomerates. In part these may be tectonic breccias, but some appear to be primary bedded sedimentary conglomerates. Such conglomerates are not known in the Paleozoic outcrop belt to the south. Furthermore, although much of the rock is a buff, faintly mottled very finely crystalline dolomite typical of basal Paleozoic, Lower Red River strata, reddish argillaceous dense dolomites also are present as beds and breccia fragments. These argillaceous dolomites do not occur in Lower Red River strata to the south, but are present in the Upper Red River Fort Garry Member, which occurs approximately 30 m above the base of the Paleozoic sequence.

Although Robertson (op. cit.) reported the Limestone Point Lake carbonates to be in fault contact with Precambrian rocks, the contact is not exposed, and the precise relationship between the carbonate rocks and the Precambrian is not known. A fault has been mapped in the Precambrian, close to the contact, but Lenton indicates that this fault is Precambrian in age with no obvious features suggestive of later, Paleozoic, displacement.

Extrapolation of a regional dip of 2.2 m/km for the main Paleozoic outcrop belt 55 km to the south of Limestone Point Lake suggests that the Paleozoic/Precambrian contact at Limestone Point Lake should be approximately 120 m higher than at the regional Paleozoic edge. In fact, lake elevation on Reed Lake, at the edge of the Paleozoics, is + 279 m, exactly the same as lake level at Limestone Point Lake, indicating that the Limestone Point Lake occurrence is approximately 120 m below its expected regional elevation, and hence cannot represent a "normal" erosional outlier. Either the Paleozoic carbonates at Limestone Point Lake have been tectonically dropped by about 120 m to their present elevation in a graben-like structure, or the entire occurrence is exotic, moved to its present site by glacial ice transport.

The above extrapolation of structural data for a distance of 55 km is obviously subject to considerable uncertainty. Dip must eventually flatten out at some point, so the indicated structural relief of 120 m should be considered a maximum value. Nevertheless, the regional rate of change of dip over the adjacent 50 km portion of the Paleozoic outcrop belt is slight, so the writer believes that the 120 m estimate is reasonably close. Furthermore, if some of the outcropping dolomites are about 30 m above the base of the Paleozoic, as suggested, the above estimate would have to be increased by 30 m to about 150 m.

The most puzzling aspect of the outlier, and the most important as to paleogeologic implications, is the complexity of the structural deformation — essentially a predominantly plastic type of deformation suggestive of relatively high confining pressure. It seems unlikely that such deformation could be the result of glacial ice movement, and the lack of any comparable features in the glaciated Paleozoic terrane to the south seems to support this contention. This would seem to leave some type of tectonic deformation as the only (?) remaining explanation, but much the same argument can be used against a tectonic origin. Although paleogeological reconstructions for the area are tentative, it seems unlikely that any great thickness of Phanerozoic sedimentary strata existed in the Limestone Point Lake area. Any deformation would have been relatively near-surface, and would be expected to give rise to brecciation or brittle deformation rather than folding. However, if the carbonate strata were not completely lithified at the time of deformation (i.e. early Paleozoic?), a more plastic type of deformation would be expected.

The anomalous occurrence of conglomeratic sediments indicates local deformation at the time of sediment deposition.

If the occurrence of the Limestone Point Lake outlier and its complex internal structure are the result of tectonic activity, such activity could range in age from Ordovician to Recent. The implication would be that some (major?) post-Precambrian tectonic event had occurred, and evidence of such an event should be seen in Precambrian rocks and also possibly in the regional Paleozoic outcrop belt to the south. To date, evidence of fault displacement of Paleozoics in northern Manitoba has not been reported, although mapping has been on a reconnaissance level, and such structures could have been overlooked. It is worth noting that faulting of Paleozoic strata is shown on Saskatchewan maps approximately 170 km west of the Limestone Point Lake area.

In summary, the origin of the structurally complex outlier of Paleozoic strata in the Limestone Point Lake area is not known, but it most probably involves a previously unreported post-Precambrian (Phanerozoic) tectonic event. Further studies will be necessary to explain this highly anomalous feature, including core hole drilling to determine the nature of the contacts with Precambrian basement.

REFERENCES

Martindale, W. and Orr, N.E.

1987: Middle Devonian Winnipegosis reefs of the Tableland area, S.E. Saskatchewan; Abstract, Second International Symposium on the Devonian System, Canadian Society of Petroleum Geologists, Calgary.

McCabe, H.R.

1986: Stratigraphic mapping and stratigraphic and industrial minerals core hole program; **in** Manitoba Energy and Mines, Report of Field Activities 1986, p. 191-198.

1987: Devonian stratigraphy of the southwestern Manitoba outcrop belt; Field Guidebook, Second International Symposium on the Devonian System, Canadian Society of Petroleum Geologists, Calgary.

Norris, A.W., Uyeno, T.T. and McCabe, H.R.

1982: Devonian rocks of the Lake Winnipegosis — Lake Manitoba outcrop belt, Manitoba; Geological Survey of Canada Memoir 392, and Manitoba Mineral Resources Division, Publication 77-1.

Robertson, D.S.

1953: Batty Lake area, Manitoba; Geological Survey of Canada, Memoir 271.

GS-34 PRELIMINARY OBSERVATIONS FROM A DETAILED GEOLOGICAL INVESTIGATION OF THE MacLELLAN Au-Ag DEPOSIT, LYNN LAKE

by Joel Gagnon[1]

INTRODUCTION

A detailed geologic study of the MacLellan Au-Ag deposit at Lynn Lake was initiated during the 1987 field season. The purpose of the study is to (1) identify and describe the mineralogic alteration patterns about the Main Zone orebody, (2) interpret the timing and relationship beween the gold and sulphide mineralization, (3) interpret any structural modifications superimposed on initial mineral concentrations, i.e. was the protore to the deposit syngenetic, epigenetic or a structurally modified version or combination of these two styles of mineralization; and (4) establish a firm date for sulphide mineralization utilizing sulphur isotope methods.

The petrographical, geochemical and sulphur isotope data, alteration descriptions and all related maps, figures and sections will be contained in a M.Sc. thesis currently being researched in the Department of Geology, University of Windsor.

REGIONAL GEOLOGY

The following is a summary of the regional geology of the Lynn Lake area. The information is derived from Gilbert et al. (1980).

The MacLellan Au-Ag deposit occurs within the 130 x 60 km Lynn Lake greenstone belt. The belt consists of metamorphosed volcanic, sedimentary and plutonic rocks of the Wasekwan Group with an Aphebian age of deposition, intrusion and metamorphism. These rocks, in turn, were intruded by small, subvolcanic plutons; the Wasekwan Group was then folded, faulted and intruded by large mafic and felsic plutons. The Sickle Group sandstone and conglomerate unconformably overlie the Wasekwan Group rocks.

The Wasekwan Group rocks in the Lynn Lake greenstone belt are divided into the northern and southern belts by large granitic intrusions. The northern belt consists of tholeiitic basalt and andesite interlayered with aluminous basalt and andesite (Al_2O_3 greater than 18%). These rocks have been divided into six units which from top to bottom are: (1) a 2400 m thick lens of rhyolitic and mafic volcanic rocks and conglomerate; (2) mafic to felsic volcanic flows and fragmental rocks; (3) fine- to coarse-grained sedimentary rocks; (4) basaltic flows and flow breccia, mafic tuff, felsic fragmental rocks and iron formations, and the MacLellan deposit; (5) mafic tuff, flows and breccia, and greywacke; (6) rhyolite flows and breccias and volcaniclastic rocks. The southern belt consists of tholeiitic, aphyric and porphyritic basalts that are overlain by turbidite units in the west and felsic to mafic volcanic rocks in the east.

The Wasekwan Group rocks of the Lynn Lake greenstone belt have been isoclinally folded on steeply dipping, east-northeast-trending axial surfaces. The metamorphic grade varies within the greenstone belt. The northern belt rocks have attained lower to middle amphibolite metamorphic conditions and the southern belt rocks are characterized by greenschist facies metamorphism.

LOCAL GEOLOGY

The following description of the local geology of the MacLellan deposit is summarized from Fedikow (1986).

The host rocks to the MacLellan mineralization are structurally and stratigraphically overlain and underlain by amygdaloidal, porphyritic, aphyric, massive and fragmental, mafic volcanic rocks. The mafic fragmental rocks (autoclastic breccia and agglomeratic tholeiitic basalt) attain thicknesses of 5-7 m and commonly contain up to four different, angular to rounded, matrix supported fragment types. These fragments include (1) quartz-phyric rhyolite, (2) dark green amygdaloidal and porphyritic basalt, (3) lighter green aphyric basalt, and (4) dark green amygdaloidal basalt. The matrix contains a low concentration of amygdales and/or feldspar phenocrysts and the breccia fragments may be partially to totally epidotized. These breccia units conformably overlie the interlayered clastic and chemical sedimentary rocks, and high Mg-Ni-Cr mafic volcanic flows and tuffs that host the MacLellan mineralization.

The footwall and hanging wall rocks to the MacLellan deposit consist of 3-8 m thick, high Mg-Ni-Cr basaltic flows and tuffs that are composed predominantly of amphibole (hornblende-ferroactinolite-actinolite) crystals in a chloritic groundmass. The alignment of the amphiboles defines the foliation present in the wall rocks. Other rock-forming minerals include garnet, quartz, minor plagioclase, and opaques.

The mineralized zone, which attains a thickness of 10-20 m and has a strike length of 1500 m, consists of thinly laminated, interlayered biotite-rich and siliceous siltstones, oxide, silicate and sulphide facies iron formations and high Mg-Ni-Cr basaltic flows and tuffs. The rock-forming minerals of the siliceous and biotitic siltstones are quartz, biotite, very minor plagioclase, minor subhedral to euhedral staurolite porphyroblasts and opaque minerals.

The iron formations are characterized by laterally discontinuous, tightly folded, 1-10 cm bands of oxide facies (1-3 cm bands of chert and finely laminated magnetite), silicate facies (chlorite-garnet-actinolite rock with iron and base metal sulphides), and sulphide facies (1 mm to 5 cm bands of solid iron sulphide and biotite-rich laminae).

The high Mg-Ni-Cr rocks of the mineralized zone consist of 1-3 m thick basaltic flows and tuffs that are mineralogically and chemically similar to the footwall and hanging wall mafic rocks. These rocks may contain disseminated, blocky and acicular arsenopyrite, galena, iron sulphide and sphalerite layers.

DATA ACQUISITION

Detailed underground mapping on the 370 m level of the mine was undertaken utilizing a conveyor drift. This drift provides a section through the MacLellan Main zone mineralization as well as the structural and stratigraphic hanging wall and footwall rocks. A wide variety of sample types were collected for the various phases of this study. A total of 250 rock samples were collected at approximately 1 m intervals along the conveyor drift for petrographic and major and trace element analysis. An additional 450 samples were collected from diamond drill core. The analysis of these samples will complement four detailed structural-lithologic cross-sections through the Main zone mineralization constructed on the basis of detailed core logging. A suite of sulphide-bearing rock samples representing the various styles of mineralization were collected for sulphur isotope studies.

ALTERATION PATTERNS

Previous investigation of the MacLellan mineralization (Fedikow, 1986) has led to the interpretation of the deposit host rocks as interlaminated biotitic and siliceous siltstones, iron formation and high Mg-Ni-Cr basaltic flows and tuffs. Although sedimentary rocks may be present within the mineralized zone, the detailed mapping of a cross-section of the Main zone mineralization (370 m conveyor drift) gives evidence for the progressive alteration of the high Mg-Ni-Cr, amphibolitic-chloritic basalt to a laminated, siliceous, biotitic-sulphidic rock. This occurs as a result of deformation and progressive silicification of the basalt about a centrally located structural entity.

This alteration pattern occurs symmetrically about, and is partially contained by, an intensely fractured zone which appears to represent a

[1]Department of Geology, University of Windsor, Windsor, Ontario

precursor of the North Shear, a 1.5-2.0 m, east-trending fracture zone that marks the upper structural/stratigraphic boundary of the MacLellan mineralizaton. The relationship of the Main Zone mineralization, which abuts and is regionally parallel but locally sub-parallel to the North Shear, suggests multiple fracturing episodes with the earlier shearing event providing a conduit along which mineralizing fluids could have migrated.

The following four alteration assemblages were identified both in core and in the conveyor drift and represent a generalized section through the Main zone. The alteration assemblages were observed on both sides of the Main zone mineralization and define an alteration halo about this centrally located structure.

ALTERATION ASSEMBLAGES

ASSEMBLAGE 1: HIGH MG-NI-CR BASALT ("PICRITE")

This unit is a fine grained, foliated basalt containing carbonate and quartz stringers. The unit is predominantly chloritic when carbonate stringers and pods are present and amphibolitic when associated with quartz stringers. The basalt is locally recrystallized to a massive medium grained (0.1-0.5 cm) amphibolite.

ASSEMBLAGE 2: MODERATELY SILICIFIED HIGH MG-NI-CR BASALT

Silicification of the basalt resulted in a rock containing quartz/biotite patches and trace disseminated iron sulphides. In core this alteration appears to be an interlamination of basalt and clastic sedimentary rock but in underground exposure these alteration "pods" are laterally discontinuous and are contained within the chloritic-amphibolitic basalt. This alteration was also noted along minor fractures; locally the silicification of the basalt has resulted in a rock composed of quartz and biotite with minor disseminated iron sulphides (similar to Unit 3). This rock is locally recrystallized into a medium grained amphibolite that may contain disseminated iron sulphides interstitial to silicate minerals.

ASSEMBLAGE 3: FINE GRAINED, SACCHAROIDAL QUARTZ-BIOTITE ROCK

This unit is characterized by ragged chlorite-amphibole patches within a quartz-biotite matrix. The number and size of these patches are proportional to proximity to the Main zone mineralization. Close to the Main zone there are only a few 0.5-1.0 cm chlorite-amphibole patches whereas away from the Main zone these patches are numerous and attain dimensions of 5-15 cm. This unit also contains massive, fine grained and recrystallized amphibole patches resembling those in Assemblage 1. The sulphide content of this assemblage is proportional to the degree of silicification, with high sulphide content being associated with intense silicification.

ASSEMBLAGE 4: LAMINATED QUARTZ-BIOTITE ROCK WITH ABUNDANT IRON SULPHIDE STRINGERS AND BANDS (0.1-1.0 cm) — MAIN ZONE MINERALIZATION

This laminated assemblage appears to be the result of biotitization, silicification, albitization and sulphide enrichment of the host rock along a set of closely spaced, 2-4 cm, fractures. Towards the outer edges of the Main Zone the fractures are parallel to sub-parallel. In the middle of this unit the rock is crosscut by numerous anastomosing fractures along which intense biotitization and garnet development (1 cm almandine) have occurred. This band of pervasively fractured and altered rock reflects a concentrated deformational event (shearing). This assemblage also contains quartz-arsenopyrite layers that parallel and locally crosscut the lamination. Adjacent to these veins the host rock is silicified. It is unclear whether this style of mineralization represents a mobilization of previously deposited sulphide or a separate, unique mineralization and silicification event.

In many places this altered unit abuts the North Shear and this laminated rock is characterized by late, crosscutting (approximately 40°-60° to the North Shear) mineralized "gash" quartz-sulphide veins up to 30 cm thick. These late veins appear to be quartz infillings in parasitic dilatant fractures developed contemporaneously with the North Shear. The fractures effectively act as concentrating mechanisms for sulphide and gold mineralization by "damming" late fluid movement through the rocks. This produces quartz veins with outer sulphidic rinds of pyrrhotite, pyrite, sphalerite, galena and gold. The veins also contain this sulphide and native metal assemblage as infillings of later dilatant transverse fractures resulting from extension and boudinage of the quartz vein.

A final "common" alteration assemblage was recognized in each of assemblages 1, 2 and 3. Where these units or assemblages are crosscut by boudinaged quartz veins, up to 25 cm thick, the adjacent host rock is biotitized or chloritized resulting in a "sheath" extending for approximately 5 cm around the vein. Coarse grained (1-1.5 cm) euhedral, dark green amphibole crystal growth occurs within the boundary of the vein, i.e. towards the vein core. These particular quartz veins are barren of sulphide mineralization and sub-parallel to parallel to the foliation.

CONCLUSIONS

The identification of this alteration pattern and style and the presence of the "paleo-shear" within the MacLellan stratigraphy presents new difficulties in this deposit's interpretation. Due to intense structural modifications and possible overlapping of metamorphic sedimentary and volcanic alteration assemblages it was impossible to clearly define any particular sedimentary "marker" unit. The stratigraphy was mapped largely on the appearance (or disappearance) of specific minerals (i.e. quartz, biotite, garnet and sulphides). A study utilizing microscopy will be undertaken to clearly define mineralogical assemblages and thereby develop mapping criteria for this deposit.

The identification of this mineralogical pattern of alteration, however, appears to clarify some of the problems involved in interpreting the podiform stratigraphy characteristic of the host rocks to the MacLellan mineralization.

ACKNOWLEDGEMENTS

I would like to acknowledge the generous support and assistance of Sherritt Gordon Mines Ltd. and Manitoba Energy and Mines for their initiation and ongoing support of this geological study. In particular, I acknowledge the logistical support received from, and discussions regarding the MacLellan deposit with, Jim Chornoby, Phil Wright and Dave Tenney, exploration manager, chief geologist (exploration) and chief geologist (mining), respectively, with Sherritt Gordon. Dave Baldwin and Mark Fedikow of Manitoba Geological Services are thanked for comments and discussions regarding the deposit. Jim Franklin and Al Galley of the Geological Survey of Canada are acknowledged for their comments regarding ore genesis and geochemistry during an underground tour of the study area.

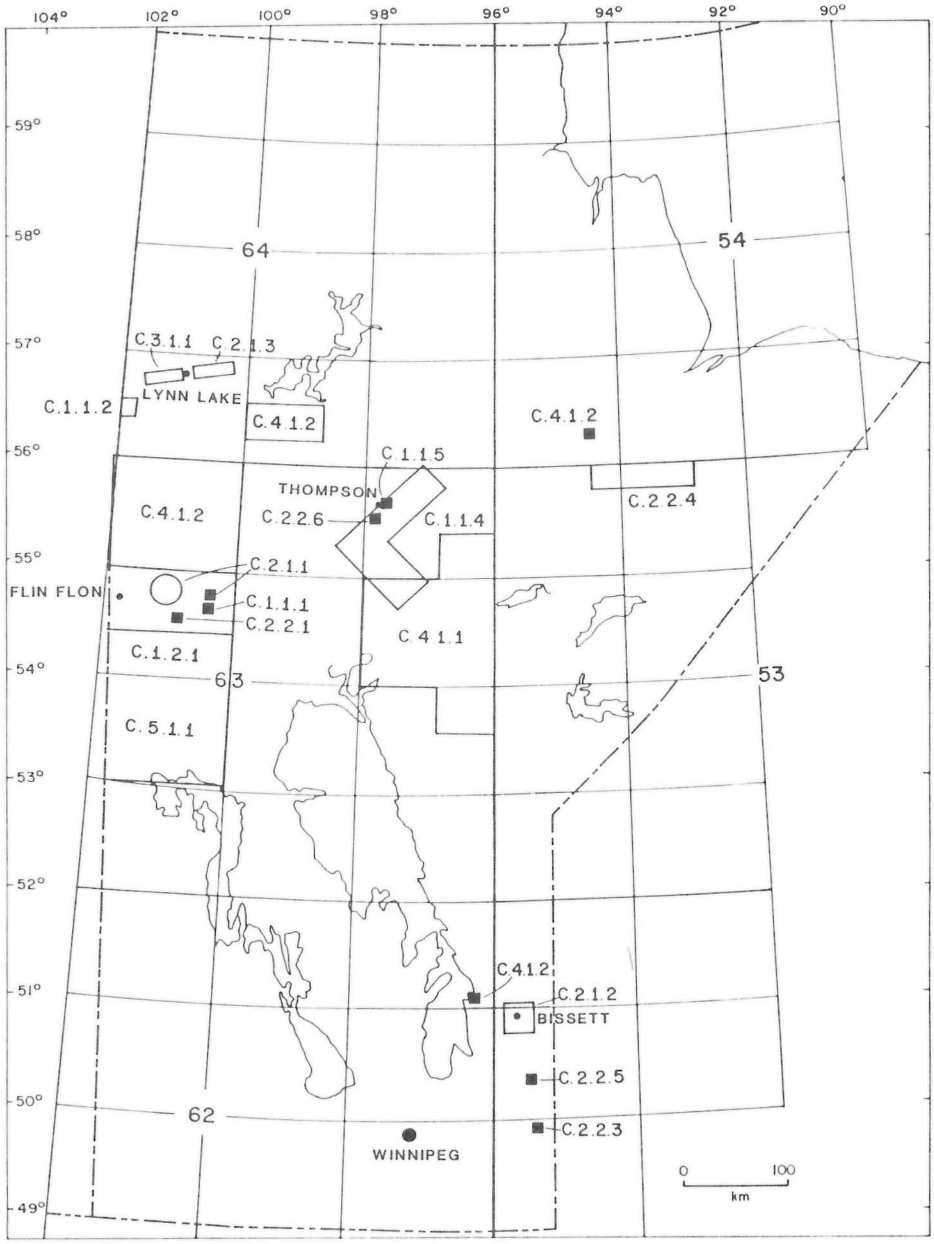
REFERENCES

Fedikow, M.A.F.
1986: Geology of the Agassiz (MacLellan Stratabound Au-Ag Deposit, Lynn Lake, Manitoba; Manitoba Energy and Mines, Geological Services, Open File Report OF85-5, 80 p.

Gilbert, H.P., Syme, E.C., and Zwanzig, H.V.
1980: Geology of the metavolcanic and volcaniclastic metasedimentary rocks in the Lynn Lake area; Manitoba Mineral Resources Division, Geological Paper GP80-1.

FEDERAL MDA GEOSCIENCE PROGRAMS IN MANITOBA 1987-88

FEDERAL SECTOR A PROJECTS: 1987/88



Lithosphere & Precambrian Studies
C1.1.1 Mineralized Alteration Zones
C1.1.2 Metamorphism in the Lynn Lake-Laurie Lake Area
C1.1.3 U/Pb Geochronology, Churchill Province
C1.1.4 U/Pb Geochronology, N.W. Superior Province
C1.1.5 Structural Studies, Thompson Belt
C1.2.1 Subpaleozoic Compilation/Core Drilling

Mineral Resources Division - Mineral Deposits
C2.1.1 Flin Flon-Snow Lake Metallogeny
C2.1.2 Bissett Structural Studies
C2.1.3 Agassiz Remote Sensing Research
C2.2.1 Flin Flon-Snow Lake
C2.2.2 Northern Churchill
C2.2.3 Falcon Lake Stock

Mineral Resources Division - Mineral Deposits (cont'd)
C2.2.4 Fox River Sill
C2.2.5 Bird River Sill
C2.2.6 Thompson Nickel Belt

Earth Physics Branch
C3.1.1 Aeromagnetic Gradiometer INPUT Surveys

Mineral Resource Division - Exploration Geochemistry
C4.1.1 Geochemical Surveys

Terrain Sciences
C4.1.2 Glacial Prospecting
C4.1.4 Quaternary Geochemistry
C5.1.1 Quaternary Compilation

Figure GSC-1: Location of Geological Survey of Canada field projects, 1987.

INTRODUCTORY REVIEW

by A.G. Galley

LYNN LAKE-RUTTAN DISTRICT

The Geological Survey of Canada has contracted out a $205K electromagnetic INPUT survey of the MacMillan Lake area (west of Lynn Lake) to commence in the late fall of 1987. Survey results should allow enhancement of the geological data base east of Lynn Lake along the strike extension of the belt containing the MacLellan Mine and the Farley deposit.

A basal till sampling program was carried out north and south of the Ruttan Mine area covering areas of potential sulphide mineralization at a sample density of one per square kilometre. A wider sample spacing was used in the Leaf Rapids-Ruttan-South Bay region in an attempt to map drift-covered sections of the greenstone belt using till lithology.

The study of metamorphosed alteration zones in the Laurie Lake region is continuing, with the purpose of determining the history of crustal evolution in the region with implications as to the timing and evolution of regional metallogenic provinces.

Detailed in-fill lake sediment surveys were carried out in the McVeigh-Sickle Lake and Hughes-Rusty Lake regions in order to improve knowledge of factors influencing the mobility and accumulation of trace elements, in particular gold, in lake sediments. The refining of the regional lake sediment data will assist exploration companies in identifying prospective areas for exploration.

The Agassiz remote sensing project is continuing with remote sensing data being compiled with available geochemical, geophysical and geological data bases. This multi-level approach will permit further definition of mineral potential in areas of thick and extensive overburden.

FLIN FLON-SNOW LAKE DISTRICT

Geochronological sampling continued in the belt in order to pinpoint ages within the Amisk Group volcanics and the syntectonic intrusions.

Field work was completed on alteration studies in the Sherridon, Snow Lake and Wolverton Lake areas. These studies are concentrating on alteration zones commonly associated with massive sulphide deposits in the region. A clearer definition of the mineral assemblages within these zones will allow exploration companies to further understand the different types of alteration and their spatial relationships to orebodies.

The sub-Phanerozoic geological compilation program continued, with relogging of available drill core. Closely tying known formations to geophysical signatures will allow for the compilation of more detailed and accurate maps of the Precambrian rocks below the Phanerozoic.

The field component of gold studies in the belt was completed. Maps of the geological setting of gold in the Snow Lake and Elbow Lake regions are being completed, as well as a report on the geochemistry and structure of the gold deposits on the east shore of Wekusko Lake.

Samples selected from mafic-ultramafic intrusions in the belt are being analyzed for PGE concentrations. This is in conjunction with a study being completed on the chemistry and internal stratigraphy of these intrusions.

Aeromagnetic vertical gradient and total field survey maps for the Flin Flon and Root Lake (Namew) areas, will be released as 1:20 000 scale open file maps by the late autumn. Final edition 1:50 000 scale colour maps for the Moose Lake (South) and Hargrave River regions will be released before the new year.

Field checking airphoto interpretation of surficial geology was completed in the The Pas area for NTS areas 63C, F and K.

SOUTHEAST MANITOBA DISTRICT

The study of the gold metallogeny of the Rice Lake region (Bissett) continued with the completion of a 1:10 000 scale map of the area. Detailed studies of the alteration associated with gold deposits (San Antonio Mine and San Norm) are continuing along with detailed structural studies in this area and in the Long Lake-Beresford Lake region.

Studies of the metallogeny of mafic-ultramafic intrusions continued on the Falcon Lake Stock and Bird River Sill, concentrating on the internal stratigraphy and gold mineralization in the former and on the stratigraphy and chromite-PGE potential of the latter.

Aeromagnetic vertical gradient and total field surveys of the Rice Lake region will be released at 1:50 000 scale by the end of 1987.

Backhoe sampling of gold-bearing Lake Agassiz beach sands and underlying till at Manigotagan was completed in an effort to identify sedimentological controls on these placers.

THOMPSON DISTRICT

In the Thompson region two structural studies continued, one concentrating on the deformational history of the nickel orebodies and the other examining a transect across the Pikwitonei terrane to the Churchill-Superior boundary.

Geochronological studies continued with sampling in the Cross Lake region.

Regional water and lake sediment sampling survey was completed in 63H(NE), 63-I, and 63P(SE).

NORTHERN SUPERIOR DISTRICT

Studies were continued on the Fox River mafic-ultamafic sill with further definition of the internal stratigraphy and its relationship to PGE concentrations.

PROGRAM 1: PRECAMBRIAN INVESTIGATIONS

GSC-1 METAMORPHOSED ALTERATION ZONES (PROJECT C.1.1.1) by E. Froese

Edgar Froese (GSC) completed field investigations of altered rocks in the Wolverton Lake area. The dominant type of alteration is represented by the assemblage garnet-cordierite-anthophyllite. Aluminous rocks, marked by the presence of cordierite-sillimanite and biotite-rich rocks are less common. Petrographic studies of surface samples and drill core, made available by Hudson Bay Exploration and Development Company, are in progress. As part of a cooperative project with Mark Fedikow of the Manitoba Geological Services Branch, Edgar Froese examined thin sections of drill core from the Cook Lake alteration zone, made available by Falconbridge Ltd.

Eva Zaleski completed detailed mapping in the vicinity of the Linda deposit and logging drill core, made available by Minnova Inc. A doctoral thesis on the geochemistry and mineralogy of the Linda deposit is in progress at the University of Manitoba.

Mark Leroux collected samples from the Star Lake garnet-cordierite-anthophyllite occurrence and is preparing an M.Sc. thesis on the mineralogy of these rocks at the University of Manitoba.

GSC-2 ALTERATION STUDIES: KISSEYNEW GNEISS BELT (PROJECT C.1.1.2) by T.M. Gordon

Steve Jackson carried out petrographic studies and microprobe analysis of metamorphism in the Laurie Lake area as part of his doctoral study at Queen's University. Mineral assemblages in metamorphosed alteration zones were used to define the metamorphic zonation, previously established on the basis of reactions in more potassic rocks. Also, a structural model of fabric elements has been nearly completed.

Terry Gordon (GSC) presented a paper at an international symposium in Dublin, Ireland, on the thermal evolution of the Kisseynew sedimentary gneiss belt.

GSC-3 GEOCHRONOLOGY OF THE CHURCHILL PROVINCE (PROJECT C.1.1.3) by T.M. Gordon

Two new U/Pb zircon ages have been determined; a rhyolite crystal tuff from the Amisk Group in the Flin Flon area yielded an age of 1886 $\pm$ 1.3 Ma, and the Lynx Lake Pluton in the Leaf Rapids area was dated at 1847 $\pm$ 4 Ma. More samples were collected this year from the Flin Flon and Snow Lake areas in order to further define the age of the Amisk Group in the Flin Flon-Snow Lake Belt. Details of this program are discussed by Syme et al. (1987) in this volume (GS-19).

GSC-4 STRUCTURAL STUDIES IN THE THOMPSON BELT (PROJECT C.1.1.5) by E. Froese

Frank Feuten completed field work in the Paint Lake-Wintering Lake area. A doctoral thesis dealing with the deformation in the granitoid gneisses is in progress at the University of Toronto.

GSC-5 PROJECT CORMORANT; INTERPRETATION OF SUB-PHANEROZOIC GEOLOGY (PROJECT C.1.2.1) by B.B. Blair

The Geological Survey of Canada carried out a diamond drill program during the winter of 1987 to aid in compiling a 1:250 000 scale map of the sub-Phanerozoic geology of the Cormorant map sheet (NTS 63K). The results were made public at an oral presentation to the GAC/MAC Annual Meeting in Saskatoon (May, 1987) by Bruce Blair (GSC), on the work carried out by Blair, Les Kornik (GSC) and Terry Gordon (GSC). The summer field season was spent relogging core drilled by exploration companies in the map area. A follow-up drill program will be carried out in the winter of 1987-88.

Generalized sub-Phanerozoic geology for the map area features a large central granitoid complex flanked by NE-SW trending metavolcanic and metasedimentary rocks. These rocks become more gneissic to the south. The central granitic domain consists of multiple felsic to intermediate phases and injections, as reflected by the aeromagnetic gradiometer surveys flown in the region by the GSC.

The 1987 drill program consisted of ten holes with a total of 610 m of core recovered. The drill sites were spotted on different magnetic domains as interpreted from the aeromagnetic vertical gradient and total field surveys. The drilling of magnetic highs revealed mafic and magnetite-bearing intermediate intrusive rocks. A distinct layering or zonation is observed in these bodies from their geophysical signatures. A series of biotite-hornblende-epidote gneisses was discovered within a strongly linear domain of low magnetism on the northern flank of the large central granitoid domain.

The drill core relogging program was carried out during July, with a total of fifty-one holes examined in order to standardize rock nomenclature across the region. Systematic magnetic susceptibility measurements were recorded during relogging of the core.

A contract is now in place for a second phase of drilling to complete ten drill holes across the magnetic domains to the south of the large, central granitoid complex. It is hoped that this project will enable the GSC and Manitoba Geological Services Branch to design a comprehensive, multi-disciplinary approach to the study of sub-Phanerozoic geology, resulting in improved accuracy of geological maps and improved efficiency in the exploration of a region that has enormous mineral potential.

GSC-6 FLIN FLON-SNOW LAKE METALLOGENY (PROJECT C.2.1.1) by A.G. Galley

During the 1987 field season, eight weeks were spent in the Snow Lake-Wekusko Lake and Elbow Lake regions. In the Snow Lake area, Alan Galley (GSC) spent two weeks finishing a 1:5000 scale study of the area around the town of Snow Lake. This area contains the Nor-Acme Mine (now being dewatered), and Snow Lake Mines Ltd. Main Zone (now exposed by a large pit). Galley also took part in the GAC/MAC field tour of the area by guiding participants for a half day around the various gold occurrences.

The purpose of the study is to determine the timing and controls on gold mineralization in the area. To date, gold mineralization in the study area is restricted to a wedge of Amisk Group volcanics bordered by the McLeod Road Fault to the west and south, and by the Birch Lake Fault to the east and northeast. The tectonic history of the area is dominated by compressive deformation. The first folding event isoclinally folded and attenuated the felsic and mafic volcanic sequences with axial planes striking NNW and dipping ENE. Continued deformation caused the fold planes to become shallow-dipping, with the formation of thrust faults parallel to the axial planes. This first folding event was accompanied by low to middle grade regional metamorphism. During a second compressive phase, the thrust faults were folded and reactivated. It was during this post-peak metamorphic phase that gold-bearing fluids circulated through faults in the hanging wall of the reactivated McLeod Road Fault. Auriferous zones and accompanying alteration formed elongate bodies parallel to the tectonic transport direction along the faults, again reflecting a dominantly compressive tectonic regime. Mineralogical studies on the alteration associated with the Snow Lake deposit were completed by Angela Gulley for a B.Sc. thesis at Queen's University. Studies of the gold-related alteration will continue in the hope of defining characteristics that will be useful in further exploration. A 1:5000 scale map of the study area will be open filed by the GSC by December, 1987.

James Franklin (GSC) and Alan Galley, assisted by Elizabeth Koopman, spent two weeks along the east shore of Wekusko Lake completing 1:2000 scale mapping of the Rex-Laguna property and the area around Herbtown in order to further define controls on gold mineralization in the area. Shoreline traverses were also completed from Crowduck Bay south to the mouth of Puella Bay in order to further define the character of the Crowduck Bay Fault. It was determined that the Crowduck Bay Fault displays evidence of sub-horizontal sinistral movement, while the faults controlling gold mineralization are earlier, parallel to the Herb Lake Syncline, and display sub-vertical dextral movement. Interestingly, the timing of the Crowduck Bay Fault appears coeval with reactivation of the McLeod Road Thrust.

In the Elbow Lake region, a 1:20 000 scale analysis of the geological setting of gold in the area was completed by Alan Galley and Doreen Ames (GSC), assisted by Kathyrn Baker and Elizabeth Koopman. The 1:20 000 scale map and a description of the work are to be found in this volume (GSC-2).

GSC-7 STRUCTURAL AND ALTERATION STUDIES, BISSETT AREA (PROJECT C.2.2.1) by K.H. Poulsen

During the 1987 field season a 1:10 000 scale map of a 96 km^2 area centred on Rice Lake was completed. This area can be divided geologically into northern, central and southern parts.

The northern part consists of a 1 kilometre wide zone of supracrustal rocks bounded to the south by the Wanipigow Fault and to the north by granitoid rocks of the Wanipigow River Plutonic Complex. The supracrustal rocks are portrayed on existing geological maps as "greywacke, quartzite, arkose and argillite". One of the principal characteristics of these highly deformed rocks is a compositional banding at scales ranging from centimetres to tens of metres. Individual bands are of compositions ranging from ultramafic through mafic and intermediate, to felsic without a systematic pattern of alternation. Intense complex folding and boudinage of the bands suggest a high strain and it seems likely that these supracrustal rocks represent a sequence of strongly transposed volcanic rocks and their plutonic equivalents. Thus, the "quartzites" represent metamorphosed rhyolites, the "greywackes" intermediate to mafic volcanic or dyke rocks and the "arkoses" deformed quartz-feldspar porphyritic intrusions. Garnetiferous rocks may represent argillaceous sedimentary rocks or a product of pre-metamorphic hydrothermal alteration. The primary textures and structures in these supracrustal rocks are masked by their strong planar metamorphic fabric which probably formed during amphibolite grade metamorphism. Sulphide mineralization consists of primary pyrite within and adjacent to strongly deformed auriferous quartz veins, and as pyritic sericite schists. Numerous pits and shafts have been developed in gold-bearing quartz veins, whereas the gold content of the pyritic schists is presently unknown.

The central part of the area is bounded by the Wanipigow River on the north and by the south shore of Rice Lake on the south, and contains a sequence of metamorphosed felsic to intermediate volcaniclastic rocks with subordinate basalt flows and metagabbro dykes and sills. In contrast to the narrow transposed units north of the Wanipigow fault, individual map units attaining thicknesses of up to one kilometre have been mapped along strike lengths as great as 12 km in the central area. Detailed mapping of the sequence hosting the San Antonio and San Norm deposits was completed this season; all of the elements of the San Antonio Mine stratigraphic sequence including the footwall epiclastic rocks and sericite schist, the layered gabbroic rocks of the San Antonio Mine Unit and hanging wall rocks composed of andesite, basalt and porphyritic dacite have been definitively traced north of Normandy Creek into the area of the San Norm deposit. Carbonate alteration of the footwall epiclastic rocks (i.e.: sericite schist) and of the gabbroic rocks, although localized in and adjacent to specific shear zones, is far more abundant near the deposits than in the area between them.

A structural analysis of the vein system at the San Antonio Mine is near completion. Numerous structural intersections of planes (i.e.: shear zones and host units, extensional veins and shear zones, NW-dipping and SE-dipping shears) coincide with the direction of elongation in regionally foliated rocks nearby and with the mean plunge of the deposit as a whole. Lineations and data obtained from an analysis of observed offsets suggest that the ore-bearing shears are high angle reverse faults. Mineable concentrations of gold appear to be localized by the coincidence of three factors: the structures, intense carbonatization and the leucogabbroic portion of the layered intrusion.

The southern part of the area, south of Rice Lake, is underlain primarily by intermediate metavolcanic rocks which, although steeply dipping, are not penetratively deformed. Strong deformation in these rocks is confined to north to northwesterly striking shear zones, typically 10 m wide, which contain 2-3 m wide lenticular quartz veins. Levels of carbonatization are generally low adjacent to these veins and they do not appear to be inherently auriferous except where they are crosscut and redeformed by transverse shear zones which tend to strike E-W.

In addition to the mapping at Rice Lake, structural aspects of shear zones were examined in the Long Lake-Beresford Lake area where the gold-bearing structures are also westerly to northwesterly striking. Two distinctly different slip directions were noted in this set of structures: one plunging moderately to the southeast (Hope Shear, Central Manitoba Mine) and the other plunging moderately to the northwest (Gunnar #1 Shear, Ogama Shear, North Carbonate Shear). The curvature of individual shear zones in both strike and dip, the variable attitudes of strata cut by the shears and the observed variability of slip directions results in complex geometric relationships in map view. The empirically determined easterly to southeasterly plunge of ore shoots may be a consequence of a combination of these factors and should be considered in the design of future exploration programs in this area.

Under the supervision of Howard Poulsen (GSC), mapping was completed in the central part of the Rice Lake area by Doreen Ames (GSC), assisted by Kathryn Baker, and south of Rice Lake by Alan Galley (GSC), assisted by Elizabeth Koopman. Isabelle Derome and Rex Brommecker carried out mapping north of the Wanipigow Fault and in the Long Lake-Beresford Lake area. Sebastian Lau supervised by Bill Brisbin (MDA contract, University of Manitoba) conducted the vein study at the San Antonio Mine and Larryn Diamond (MDA contract, Carleton University) examined aspects of carbonate alteration.

Inco Ltd. and D. Busch, consulting geologist, are thanked for their assistance in providing access to mining properties and private company information.

GSC-8 AGASSIZ REMOTE SENSING (PROJECT C.2.1.3) by A. Rencz

Work is now underway on the second year of a contract with Dr. Moon of the University of Manitoba, under the supervision of Andy Rencz (GSC), to study the Agassiz metallotect using multi-variate data sets including remotely sensed and geochemical data. The first year of the study experienced certain difficulties, particularly with respect to computer breakdowns. However, the principal investigator (D. Kettler) a graduate student with the Department of Geological Sciences, was able to acquire airborne remotely sensed and geochemical data. The objective of the study will be to analyze the remotely sensed data and correlate the results with geophysical and geochemical data in order to further define the geologic setting in the region. The refinement of this type of study is important in allowing explorationists to utilize an alternative multi-level approach to exploring in regions of heavy overburden and scarce outcrop.

GSC-9 METALLOGENY OF MAFIC-ULTAMAFIC ROCKS: FLIN FLON-SNOW LAKE BELT (PROJECT C.2.2.1) by R.F.J. Scoates

Field work on this project was completed under contract to Lorne Ayres of the University of Manitoba, under the supervision of Jon Scoates (GSC), with data collected on the chemistry and internal stratigraphy of several important mafic-ultramafic intrusions. Jeff Young, a graduate student with the Department of Geological Sciences, is now in the process of completing a comprehensive report on the results of the study. Samples collected during the study are being selectively analyzed for platinum group element concentrations. The definition of the internal stratigraphy of these intrusions will permit exploration companies to be more selective in their approach when investigating these bodies for related mineralization.

GSC-10 METALLOGENY OF MAFIC-ULTRAMAFIC ROCKS: NORTHERN CHURCHILL (PROJECT C.2.2.2) by L. Hulbert

Larry Hulbert (GSC) completed field studies last season in which selected intrusions were examined within the Lynn Lake-Rusty Lake Belts and in the Kisseynew Gneiss Belt for their platinum group element, nickel-copper and titanium potential. Nd/Sm and Rb/Sr have been obtained from the intrusions; comparison of the two different types of age determination indicates that the Nd/Sm method is by far the most accurate in relation to primary ages. Nd/Sm ratios also corroborate S/Se ratios with respect to indicating the presence of crustal contamination within certain mafic-ultramafic intrusions. These contaminated intrusions appear to contain low concentrations of platinum group elements. Laboratory work is continuing in order to further define chemical signatures that would allow mafic-ultramafic intrusions to be screened for mineral potential.

GSC-11 FALCON LAKE IGNEOUS COMPLEX (PROJECT C.2.2.3) by R.F.J. Scoates

The Falcon Lake Intrusive Complex (FLIC), located near the Manitoba-Ontario border in southeastern Manitoba, is a small composite body, approximately 5 km long and 2 km wide, which intruded Archean metavolcanic and metasedimentary rocks. It has a concentric elliptical core with tapered dyke-like apophyses to the northeast and southwest. The body consists of a series of intrusions ranging from gabbroic rocks (oldest) in the dyke-like apophyses, through diorite to granodiorite in the central part of the complex, to quartz monzonite (youngest) in the central core. Most rocks are characterized by cumulate textures and primary igneous structures that include aligned minerals, steeply dipping concentric layering, scour structures, trough bands, angular and buttress unconformities, clots and mineral segregations, and numerous inclusions and xenoliths.

The distribution and relative age of the intrusions suggest that the body was tabular in its early stages, subsequently evolved into a larger, more cylindrical form, and in the waning stages, igneous activity became progressively constricted towards the core of the complex.

All of the intrusions appear to have been intruded as crystal-liquid mixtures, and the emplacement processes led to widespread mineral alignments and layering. The primary igneous structures, especially the unconformities, scours and troughs, point to periods of erosion and construction. The origin of magma flow, whether a consequence of intrusion and intrusive surges, convection, sidewall slump or density currents, or some combination of these processes, is not clear at this time.

Whole rock chemical analyses have been completed on 46 of the 166 samples collected for petrochemical study. On the basis of the available geochemistry, the rocks of the complex form a differentiated series of related rocks. In addition there is a clear absence of silica gaps between major units of the complex. These observations support a hypothesis of a single liquid line of descent. This contrasts with the presence of sharp discontinuities between some to the major intrusive phases of the complex. Intrusion of successively more silicic magmas or magma mixing might explain this apparent dichotomy of field and geochemical evidence.

Four periods of gold mineralization within and in close proximity to FLIC, are tentatively proposed on the basis of associated structural elements, composition of associated alteration, and the character of the mineralization.

1) pre-FLIC mineralization (hosted by iron formation immediately north of the north contact of the complex).
2) mineralization associated with intrusion of FLIC diorite to granodiorite (hosted by iron formation, quartz veins in mafic volcanic and metasedimentary rocks, immediately north of the north contact of the complex).
3) mineralization associated with late stage consolidation of the complex (breccia pipe and shear zone hosted mineralization within the complex).
4) post-consolidation mineralization (shear zone and fault hosted mineralization within the complex).

On the basis of 51 assays for Pt, Pd and Au, Pt is <15 ppb, Pd is <10 ppb and Au ranges up to 7000 ppb. These samples represent mineralized occurrences within and external to the contacts of the complex. It is clear that early reports of the presence of PGE with Au in some mineralized occurrences cannot be substantiated by these assays.

GSC-12 FOX RIVER SILL (PROJECT C.2.2.4) by R.F.J. Scoates

Correlation of exploration drill hole data in the western part of the Fox River Sill indicates that the lower 600 m of Upper Central Layered Zone (UCLZ) stratigraphy (approximately the lower half of UCLZ) consists of a minimum of 24 cyclic units. Cyclic units are composed of the following cumulate layers (listed from base to top):

olivine + clinopyroxene + plagioclase,
olivine + clinopyroxene,
olivine + plagioclase,
clinopyroxene + plagioclase.

Layer thicknesses are highly variable.

In addition, the lowermost 80 m of UCLZ consists of a number of small-scale cyclic units, each of which consists of a lower olivine + chromite ± clinopyroxene cumulate layer overlain by a clinopyroxene ± olivine cumulate layer.

Anomalous platinum-group element (PGE) concentrations (> 100 ppb combined Pt + Pd + Au) occur sporadically throughout the stratigraphic succession. These anomalous concentrations are hosted by sulphide-bearing olivine clinopyroxenites (clinopyroxene ± olivine cumulates).

S/Se x 106 ratios for mineralized rocks straddle the range of mantle values and a number are anomalously high. The most anomalous Se/S ratios represent mineralized intervals from the middle part of the UCLZ, characterized by abundant plagioclase cumulates although the mineralized intervals are consistantly clinopyroxene ± olivine cumulates.

GSC-13 BIRD RIVER SILL (PROGRAM C.2.2.5) by B.L. Williamson

Field and laboratory work continued on the Bird River Sill, concentrating on the Chrome Property where the most complete section of the sill is exposed. Field work this summer involved a total of 11 person months with up to 8 GSC personel and summer students, and completes the most important field component of the current MDA project.

Mapping of the sill at 1:1000 scale was essentially completed, covering the full width of the sill and adjacent country rocks for 1 km of strike length (approximately 80 ha). This mapping has successfully defined units within the Mafic Series (not previously investigated by this project) and documents the effects of cross faulting on stratigraphy.

Mapping of the Chromitiferous Zone at 1:100 scale has been extended to complete coverage of 600 m of strike length. Mapping of the lower part of the Ultramafic Series at 1:200 scale has been completed in the west end of the property for 200 m of strike length. Together the mapping of these detailed areas has led to a refinement of the Ultramafic Series stratigraphy, including recognition of new zones of chromitite layers, gabbro and plagioclase-bearing ultramafic rocks, which have implications for the crystallization history of the sill; have shown the general continuity and validity of the stratigraphy previously proposed by Scoates, and the effects of cross faulting (which will be important in any future exploitation of potential stratabound chromite or PGE deposits); and have uncovered numerous examples of outcrop-scale synmagmatic disruptive features that may control concentration of PGE mineralization.

Channel sampling of the Ultramafic Series using diamond saws was completed, concentrating on stratigraphic intervals of known and potential PGE mineralization. About 30 five gallon rock pails of samples were collected for petrographic, whole rock and PGE analyses. Additionally, GSC personel supervised channel sampling by Manitoba Geological Services Branch personnel to check grades obtained by CANMET in previous bulk sampling of a potentially mineable chromite zone.

Numerous whole rock and precious metal analyses were completed on previously collected samples, and these data will be amalgamated with results from this year's more extensive sampling. Statistical analysis of the chemical data in hand (by Eckstrand and Scoates) has uncovered a correlation between PGE and Cr (surprisingly not between PGE and sulphide, as observed at outcrop scale). The results of this investigation were presented at the Geoplatinum 87 conference in Milton Keynes, UK (April 1987), and are in press in the forthcoming symposium volume.

GSC-14 THOMPSON NICKEL BELT (PROJECT C.2.2.6) by W. Bleeker

Wouter Bleeker continued his doctoral study at the University of New Brunswick of the deformational history of the Thompson nickel orebodies. Petrological studies, microprobe analyses and pressure-temperature-water fugacity calculations were carried out during April and May. Preliminary findings were presented at the GAC/MAC Annual Meeting, 1987, and included the following:

- The metamorphic evolution of the metasediments appears to be a relatively simple loop in P-T space.
- Although commonly showing a strong textural zonation, garnets in metapelites from the Thompson and Pipe Mines are compositionally homogeneous, apart from very thin rims with retrograde zonation.
- Peak metamorphic temperatures based on garnet-biotite pairs are 700-750°C for Thompson and 600-650°C for the Pipe No. 2 Mine.
- Geobarometry indicates a considerable pressure difference between the two localities, with peak metamorphic pressures at Thompson at least 1 kbar higher than at the Pipe. Large pressure differences are in agreement with the dominantly dip-slip movement in the late-metamorphic mylonite zones, such as the Burntwood River lineament. The pressure gradient agrees with kinematic indicators in these zones.
- Garnet-biotite temperatures are between 500 and 600°C representing diffusive closure. Grossular contents in the garnets decrease in the retrograde rims, suggesting decompression during cooling, although the picture is being complicated by weak irregular zoning in coexisting plagioclases.
- Garnet-biotite pairs from garnet-biotite gneisses along the east shore of Paint Lake give temperatures similar to Thompson.
- Metapelite inclusions in the massive sulphide ore of Thompson commonly contain reaction rims of biotite with or without garnet. Garnet-biotite pairs in reaction zones of structurally early inclusions give peak metamorphic temperatures, whereas poorly developed reaction rims around structurally late inclusions in typical breccia ore indicate low temperature, retrograde conditions, i.e. 475°C. This temperature difference is in agreement with structural and textural observations on the different ore types, which indicate that the incorporation of abundant wall rock inclusions in typical breccia ore was a very late event.
- Water fugacity calculations indicate water pressures much lower than P-load for both Thompson and Pipe metapelites. This is in accordance with the observation of CO_2-rich fluid inclusions in various thin sections. Systematic work on fluid inclusions will be started this fall.

The field season was spent completing the work in the Thompson Pit. Several pegmatites and sphene-bearing boudin-neck infillings, all of which date or bracket the various structural events, were sampled for geochronology. Further structural work provided direct evidence for the relationship between F3 and F4 folds. These fold groups are part of the same event and represent the opposite hinges of doubly plunging folds related to the main antiform at T1.

The remainder of the summer was spent on Sipiwesk Lake, Ospwagan and Mystery Lakes. At all localities there is strong evidence for dip-slip transport in high strain zones. However, evidence is slowly emerging that dominant dip-slip transport was overprinted by transcurrent movements in the brittle stage.

GSC-15 GRADIOMETER SURVEYS (PROJECT C.3.1.1)
by E.E. Ready

Airborne gradiometer surveys were not flown this year. An INPUT survey is scheduled to be completed in the Lynn Lake region by the late fall.

Results of the gradiometer survey flown over the Sherridon-Nokomis region were released in May 1987 (GSC OF 1478) as open file 1:20 000 vertical gradient and total field sets. Survey results from the Root Lake (63K/3 cdef, 63K/4, 63K/5 abcdef, 63K/6 cd) and Flin Flon (63K/12 cdef, 63K/13 cdef) will be open filed by the GSC by November 1987. Moose Lake (South) (63K/1, 63K/2 abgh), Hargrave River (63J/6 efgh, 63J/7 ef, 63J/10 cdef, 63K/11) and Rice Lake (52M/4, 52L/13 gh) regions should be released as 1:50 000 scale final maps by January 1988.

GSC-16 GEOCHEMICAL SURVEYS (PROGRAM C.4.1.1) by P.W.B. Friske and R. Schmitt

During the past field season a regional lake sediment and water survey was carried out by the Geological Survey of Canada covering approximately 21 600 km^2 of central Manitoba (63H NE, 63-I, 63P SE). Samples were collected from a total of 1699 sites, for an average density of one sample per 12.7 km^2.

Lake sediments will be analyzed for Zn, Cu, Pb, Ni, Co, Ag, Mn, Cd, Fe, Mo, V, As, Hg, U, LOI, Sb, and Au. Lake waters will be analyzed for U, F, Ca, Mg, alkalinity and pH. Survey results will be released as GSC Open File 1641 in the summer of 1988, consisting of sample location and element value maps at 1:250 000 scale, and a text containing field, analytical and statistical data.

Results of the 1986 lake sediment and water survey, covering 39 000 km^2 at an average density of one sample per 11.4 km^2, were released on July 7, 1987 as GSC Open File 1359, consisting of 21 maps and 129 pages of text. Data are available for the same suite of elements as this year's survey. Approximately 3332 hectares were staked following the release (up to early September) mainly in areas of anomalous responses in gold and/or associated pathfinder elements.

In addition to the regional lake sediment survey being carried out in 1987, detailed in-fill sampling and interpretation of previously released geochemical data are being undertaken. The objectives of this work are: 1) to improve knowledge of factors influencing the mobility and accumulation of trace elements, in particular gold in lake sediments, and 2) to identify prospective areas for mineral exploration.

The helicopter-supported in-fill lake sediment and water sampling was carried out over the following two areas:

1) South of the Johnson 'Shear Zone' from McVeigh Lake east to Sickle Lake (500 km^2), eighty sites were sampled to further define the broad Au in lake sediment anomalies identified by the earlier regional surveys (GSC Open Files 999 and 1288) and test the Au potential of the Black Trout Lake gabbro.
2) From Hughes to Rusty Lake (1500 km^2), over 260 sites were sampled. The area covers the easternmost part of the Lynn Lake greenstone belt and westernmost Rusty Lake greenstone belt, as well as a pronounced coincident regional U and F anomaly in lake sediment, and an airborne radiometric anomaly east of Eden Lake.

The interpretation of previously released lake sediment and water data will focus on map sheets 64B and 64C and will involve the integration and evaluation of geochemical, geological, and geophysical data. Much of the data analysis will be carried out using the GSC-developed IDEAS statistical/graphics software package and the recently acquired Spatial Analysis System (SPANS).

These programs are being carried out under the supervision of Peter Friske (GSC) and Rolf Schmitt (GSC).

GSC-17 DRIFT PROSPECTING PROGRAM (PROJECT C.4.1.2) by R.N.W DiLabio and C.A. Kaszycki

During June and July 1987, detailed sampling was carried out in the Rusty Lake — Opachuanau Lake area north of the Ruttan Mine, and in the Darrol Lake — Karsakuwigamak Lake area south of Ruttan. The primary objective was to cover areas of potential sulphide mineralization at a sampling density of 1 per km^2, in an effort to provide reconnaissance level till geochemical data on a local scale suitable for prospecting purposes. Logistical problems related to extensive clay cover, and the inherent inefficiency of sampling at a 1 km grid spacing by ground traverse, restricted sampling density to 52 samples in the Rusty Lake area, and 60 samples in the Karsakuwigamak Lake area. The heavy mineral fraction of these samples is being analyzed for Au and As, and the trace element geochemistry of the –2 micron till fraction will also be determined. Results should be available by November 1 1987, and will be presented at the Meeting with Industry in November. On a regional level, approximately 100 samples were collected over the greenstone belt in the Leaf Rapids — Ruttan — South Bay area in an effort to map drift-covered extensions of the belt using till lithology.

Spot sampling of till east of Baldock Lake was carried out to check aeromagnetic anomalies suspected to be ultramafic intrusives similar to those found in 1986 at Osik Lake and Baldock Lake through boulder tracing and till sampling. Follow-up work in the Osik Lake region was undertaken to determine the source of high Au concentration in the heavy mineral fraction of several samples in the uppermost part of a till section within the ultramafic dispersal train. Samples of possible gold-bearing erratics and bedrock of similar lithology were collected and will be analyzed for Au. Further sampling was also carried out in the Wheatcroft Lake study area. Detailed sampling in 1986 revealed a linear zone of elevated Au and As concentration in the <63 micron and <2 micron fractions of till. This summer approximately 15 more samples were collected within this zone, and the heavy mineral fraction of these plus the 1986 samples will be analyzed for Au and As. Results should be available by November 1, and a preliminary report will be presented at the Meeting with Industry in November.

Backhoe sampling of gold-bearing Lake Agassiz beach sands and underlying till at Manigotagan was completed in an effort to identify sedimentologic controls on these placers. Several large exposures between Lynn Lake and Leaf Rapids were also excavated by backhoe and studies were carried out to provide detailed stratigraphic, sedimentologic and compositional information concerning till provenance and dispersal directions. This will provide valuable information for companies conducting drift prospecting studies along the Lynn Lake greenstone belt in this area. Preliminary study of till composition and genesis of lithologically banded till near Gillam was also completed, in an attempt to identify the glaciologic controls on compositional variability in exotic tills.

Surficial geology maps for NTS 64F, G and B have been completed and are scheduled for open file release this fall. A contract for airphoto interpretation and compilation of surficial geology maps for NTS 63N and O will begin on October 15. Till geochemical data for NTS 64G and B, and 63N is also scheduled for open file release this fall. Reports on the Osik Lake dispersal train and the Wheatcroft Lake study will be published this winter in Current Research, GSC Paper 88-1, and a paper entitled 'Carbonate dispersal and till geochemistry in northwestern Manitoba' will be submitted for publication as part of a GSC symposia volume on drift prospecting (a simplified version of this paper will also be submitted to GEOS). All subprojects were under the supervision of C.A. Kaszycki (GSC) and R.N.W. DiLabio (GSC).

GSC-18 SURFICIAL GEOLOGY ATLAS COMPILATION, MANITOBA — NORTH OF 52° (PROJECT C.5.1.1)

by M. Clarke

Under the supervision of Martin Clarke (GSC), regional mapping of surficial geology continues in areas of Manitoba previously unmapped at scales of 1:250 000 or larger. Until this year the project has concentrated on the eastern side of the province but 1987 field investigations were conducted in western Manitoba in the areas between Flin Flon and Swan River. In an effort to field check surficial geology units interpreted from aerial photographs, over 150 sites were visited in NTS 63C, F and K. Field sites were examined with a bias towards understanding the regional relationships of geologic units. Particular attention has been paid to surface distribution of till and glaciolacustrine sediments in the region. An attempt to identify ice contact sediments linking the Reed Lake Moraine with the Pas Moraine received a considerable amount of fieldwork but no evidence of these deposits was found.

Investigations into the usefulness of satellite imagery for mapping surficial geology in the boreal forest of Manitoba have assisted in the interpretation of airphotos and have also provided an alternative method of regional mapping. Although there are a few problems with detailed mapping of some glaciogenic deposits by interpretation of this remotely sensed imagery, the production of detailed and accurate regional maps has been shown to be possible.

GSC-19 GEOLOGICAL SETTING OF GOLD MINERALIZATION IN THE ELBOW LAKE REGION, MANITOBA

by A.G. Galley[1], D.E. Ames[1] and J.M. Franklin[1]

INTRODUCTION

The geological setting of gold occurrences in the Elbow Lake region was studied by the Geological Survey of Canada during the 1984, 1986 and 1987 field seasons. More than two dozen gold occurrences are hosted by a multi-deformed supracrustal sequence bounded by large plutons and batholiths (Fig. GSC-19-1). The most significant of these is the Century Mine, which has estimated reserves of 300 000 tons grading 0.35 oz./ton Au (Canmindex Files).

The geology of the region around Elbow Lake was first examined by Bruce (1918). Gold properties in the area were described by Armstrong (1922), Wright (1931) and Stockwell (1935). McGlynn (1959), following on a preliminary map by Robertson (1950), completed 1:50 000 scale mapping in the Elbow-Hemming Lakes area. In 1978 E.C. Syme of the Manitoba Geological Services Branch evaluated the area for a future 1:20 000 mapping project (Syme, 1978). As part of our investigation of the controls on gold mineralization in the area, the preliminary 1:20 000 scale geologic map which is being released with the present volume was prepared (Preliminary Map 1987GSC, Galley et al., 1978).

[1]Mineral Resources Division, Geological Survey of Canada

GEOLOGICAL SETTING

The supracrustal rocks in the Elbow Lake region consist of metavolcanic and subordinate metasedimentary rocks of the Aphebian Amisk Group, intruded by felsic to mafic, synvolcanic to syntectonic, dykes, sills and plutons. Metamorphic grade ranges from greenschist over most of the area to amphibolite grade within contact aureoles surrounding several of the plutons. Although age relationships of the volcanic rocks relative to one another are still not fully understood due to the multi-deformational nature of the terrane, rock types have been defined and traced through parts of the area.

The most abundant volcanic rock-type in the area is basalt, which can be divided into two major types. The first is aphyric, massive to pillowed and amygdaloidal basalt with associated thick sequences of graded monolithic tuff to tuff breccia. The pillowed units vary from flows with thin rimmed pillows to sequences in which pillows have 5-10 cm wide cherty rims. In places the interpillow sediment is jasper-magnetite-chert. Horizons

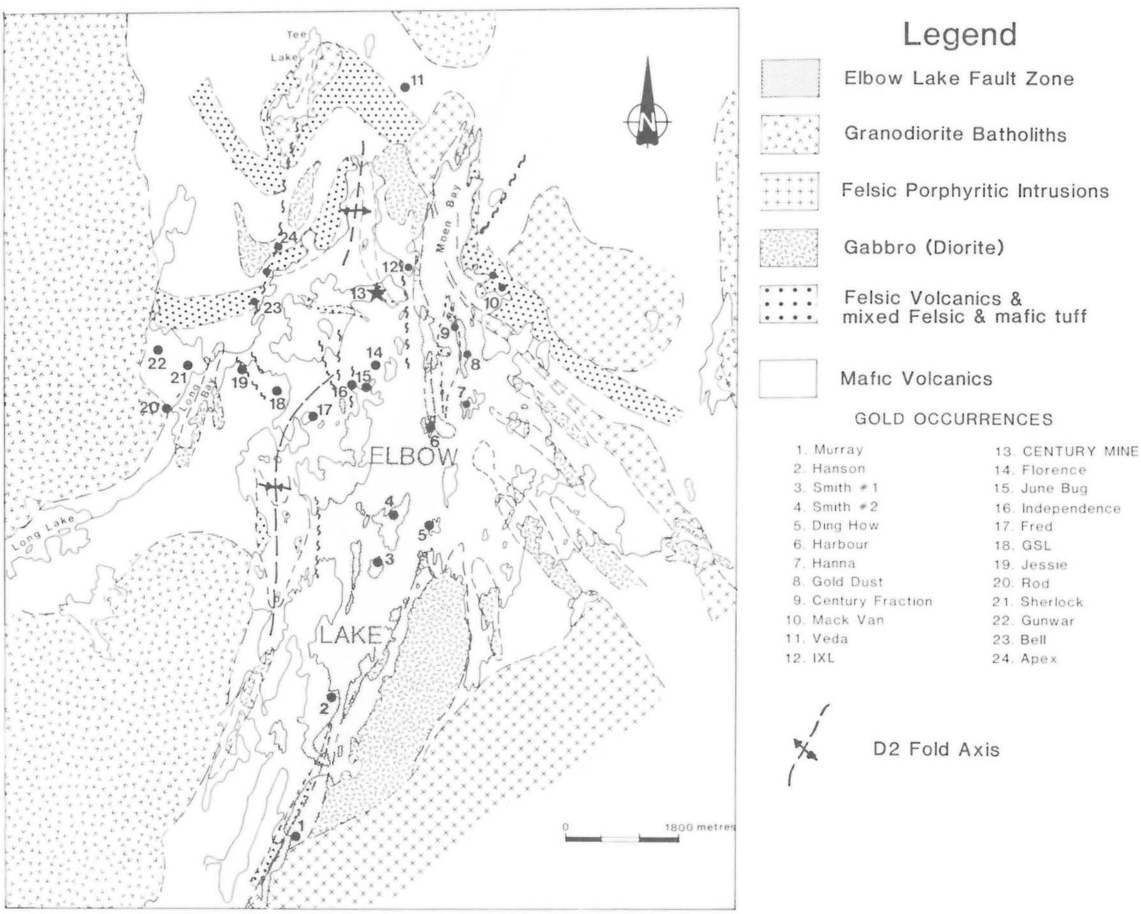


Figure GSC-19-1: Sketch map of the geological setting of gold mineralization in the Elbow Lake area.

of iron formation up to several metres thick at the contact between pillowed basalt and overlying coarse mafic breccia also occur. The volcaniclastic sequences include proximal vent breccias, graded aquagene units rich in scoria, and coarse heterolithic debris flows.

The second type of mafic volcanic consists of plagioclase-phyric massive to pillowed flows, monolithic tuff breccias and subsidiary fine grained volcaniclastic rocks. The aphyric basalts dominate, whereas the feldspar-phryic flows are most abundant along the shore of Long Lake up to Long Bay, and southwest of Centre Lake on the east side of Elbow Lake (Fig. GSC-19-1).

Interlayered felsic and mafic tuff with subordinate chemical sedimentary rocks form a sequence up to 1000 m thick in the eastern portion of the study area, thinning as it crosses Moen Bay to the west side of the lake (Fig. GSC-19-1). Interlayered units consist of finely bedded tuff to lapilli tuff centimetres to metres thick. In places, these finely interbedded rocks resemble ribbon cherts characteristic of deep water sedimentation. Within this sequence, along the east shore of Moen Bay, a 10 m thick sequence of chert contains semi-massive and massive lenses of pyrite-pyrrhotite.

Felsic volcanic rocks occur in isolated rhyolite domes characterized by internal flow banding and proximal breccia aprons, and more extensive sequences of quartz-phyric tuff to monolithic tuff breccia. Mixed debris flows composed of large angular blocks of rhyolite in a mafic matrix form distal facies along strike from the rhyolite dome complexes.

Mapping is complicated by the presence of massive intermediate volcanic rocks, some of which may be dacite, but also include mafic rocks which have been extensively carbonatized and silicified. This alteration may be synvolcanic, as there is no apparent relationship between the alteration and strongly deformed rocks or gold mineralization in the area.

The volcanic sequence has been intruded by a large number of gabbro to diorite sills which display a variety of magnetic signatures. On the southern shore of the lake is a large composite mafic intrusion in which the main gabbro body is intruded by a leucogabbroic core. Some of the smaller mafic plugs intruding the stratigraphy are quartz-magnetite-bearing. Felsic intrusions include the large quartz-feldspar porphyritic Elbow Lake porphyry (Baldwin, 1980), and a large sill-like body of quartz porphyritic granite in the eastern half of the map area. These bodies may be synvolcanic. A swarm of rhyolite, quartz porphyry and feldspar porphyry dykes can be traced up the centre of the lake. These dykes are restricted to a wide zone of deformation and may be related to a late syntectonic igneous event. Felsic to intermediate dyke swarms are also associated with the margins of a large composite batholith that intrudes the supracrustal rocks around the west margin of the map area.

A NNE-striking zone of strongly deformed rocks underlies the long axis of Elbow Lake. These rocks have been mapped as tectonites, and consist of sericite-carbonate-chlorite-quartz and chlorite-carbonate-quartz schists with local concentrations of green mica. Within this zone of strongly deformed rocks are areas of less deformed pillowed flows, iron formation, chert breccia and mafic and felsic dykes. The dykes are usually massive, with strongly foliated margins.

STRUCTURE

The Elbow Lake region has undergone multi-phase deformation making lithostratigraphic correlation and age relationships difficult to interpret. In order to further understand the structure, geological observations are currently being coupled with 1:20 000 scale aeromagnetic vertical gradient and total field maps. Data are also being analyzed by developing structural trend maps.

Preliminary results indicate that the deformational history of the region can be divided into two parts, the first involving a complex history of folding and faulting, and the second the creation of a major ductile fault system. The folding event involved the formation of isoclinal E-W-trending folds with the foliation (S_1) generally parallel to bedding (S_0). A second phase of folding deformed the D1 structures into northerly trending tight folds. D2 deformation appears to have been accompanied by the intrusion of large batholiths. The volcanic rocks wrap around the ends of these batholiths and are characterized by converging fold axes forming complex fold structures. It is the interference patterns set up by the interrelationship of these batholiths and folding that makes the structural pattern difficult to unravel.

The second deformational event involved the formation of an extensive fault system up to 2000 m wide that underlies the long axis of the lake (Fig. GSC-19-1). Two other distinct fault zones of similar age are recognized; one zone strikes northwest from Claw Lake, which is 3 km southeast of the area, to join the Elbow Lake zone, whereas the other has been traced from Tee Lake to Long Bay, with a possible extension down through Long Lake (Fig. GSC-19-1). The penetrative foliation that developed during the formation of the fault systems overprints all other structures in the study area. The Elbow Lake fault system is composed of a series of parallel to anastomosing ductile shear zones which are characterized by the transposition of stratigraphy parallel to the strike of the shears, the development of mylonite and conjugate shear bands. Several large-scale zones within the fault system have been affected by potassic-carbonate alteration characterized by retrograde mineral assemblages that overprint the regional metamorphic assemblages.

Slickenslides and stretch lineations within the shear zones indicate subvertical movement with a dextral component. This dextral component is also apparent from the large-scale warping of units from the east half of the study area into the Elbow Lake Fault Zone (Fig. GS-19-1). Transposition of gabbro and quartz porphyritic intrusions across the fault system indicate apparent horizontal dextral displacement of greater than 2000 m.

MINERALIZATION

The gold occurrences are associated with zones of intense deformation that are either within the Elbow Lake Fault Zone (Fig. GSC-19-1), or in discrete fault zones of similar age to the larger system. Within the faults, the gold mineralization is associated with two principal lithologic types: felsic dykes and jasper-magnetite iron formation. The feslic dyke association is predominant, with pyrite or arsenopyrite concentrated in quartz-carbonate veins and breccia zones within deformed dykes, or disseminated within zones of intense carbonate alteration surrounding the vein systems. The mineralized dykes are part of a swarm, the majority of which are concentrated within the Elbow Lake Fault Zone. Pyrite is the dominant sulphide mineral in most occurrences. In the case of the Murray occurrence (#1, Fig. GSC-19-1), a quartz porphyry dyke up to 20 m wide is brecciated and mineralized for over 50 m of strike length, with visible gold common in the main trenched zone. At the Century Mine (#13, Fig. GSC-19-1), a brecciated, altered and mineralized quartz porphyry dyke up to 3 m wide is exposed intermittently for 140 m. Examination of dump material and 1:1000 scale mapping revealed that a mafic dyke striking parallel to and in contact with the porphyry is also extensively quartz veined and mineralized, with some impressive examples of visible gold. Other occurrences within felsic dykes have been affected by extensive carbonate alteration with disseminated sulphide mineralization, but contain low gold values. As in many other gold districts, it is the occurrences with both alteration and quartz-carbonate veining that have the greatest potential.

Occurrences associated with jasper-magnetite iron formation tend to be much smaller than those associated with dykes and contain lower concentrations of gold. This may be due to the fact that the iron formation is present as small boudins with high aspect ratios. These rod-like structures are usually less than 10 m long in plan view, with a long axis parallel to the downdip lineation. The iron formation is strongly brecciated, with fractures annealed with white quartz and small veinlets of pyrite. Replacement of magnetite bands by sulphidization is not observed. These small magnetite-rich segments may form efficient chemical traps for gold precipitation, but their size limits their effectiveness as structural traps. This type of occurrence includes the IXL (#12, Fig. GSC-19-1), June Bug and Independence (#15-16, Fig. GSC-19-1).

SUMMARY

One of the more interesting results of this study is the definition of a large-scale structure, formed late in the tectonic history of the belt, which appears to have control over gold mineralization in the region. This relationship between late faulting and precious metal mineralization has also been recognized in the Snow Lake region (Galley, Introductory Review, this section), and in the Phantom Lake area of Saskatchewan (Galley and Franklin, in press). On a broader regional scale, the Elbow Lake Fault system has many of the same characteristics of those described for Neso-Payuk Lake-Twin Lake region (Parbery, 1986; Syme, 1985). Aeromagnetic vertical gradient maps of this region show a possible connection between what may be the two ends of a very large lineament extending from Lake Athapapuskow in the south to north of Elbow Lake. The presence of a lineament of this size, with alteration and associated gold mineralization recognized along broad sections, has implications to gold exploration when compared to such structures as the Cadillac-Bouzan Break in the Abitibi Belt and the Porcupine-Destor Fault in the Timmins area.

ACKNOWLEDGEMENTS

Reliable and efficient assistance was provided by James Scoates and Teresa Middleton (1984), Angela Gulley, Timothy Heena and Elizabeth Koopman (1986) and Kathryn Baker and E. Koopman (1987). We thank E.C. Syme for the use of his field map of the area, and for his stimulating ideas of the region. We would also like to thank M. Duke for his suggestions and criticisms on the manuscript.

REFERENCES

Armstrong, P.
1922: Geology and ore deposits of the Elbow Lake area, northern Manitoba; Geological Survey of Canada, Summary Report, 1922, Part C; p. 37-44.

Baldwin, D.A.
1980: Porphyritic intrusions and related mineralization in the Flin Flon volcanic belt; Manitoba Mineral Resources Division, Economic Geology Report ER79-4.

Bruce, E.L.
1918: Amisk-Athapapuskow Lake District; Geological Survey of Canada, Memoir 105.

Galley, A.G., Ames, D.E. and Franklin, J.M.
1987: Geological setting of gold occurrences, Elbow Lake, Manitoba; Manitoba Energy and Mines, Preliminary Map 1987GSC.

Galley, A.G. and Franklin, J.M.
1987: The geological setting of gold, copper, tungsten and molybdenum mineralization in the Phantom Lake region, Saskatchewan; Summary of Investigations 1987; Saskatchewan Energy and Mines, Miscellaneous Report (in press).

McGlynn, J.C.
1959: Elbow-Heming Lakes area, Manitoba; Geological Survey of Canada, Memoir 305.

Parbery, D.
1986: Mineral occurrence studies — Flin Flon area; Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, p. 49-55.

Robertson, D.S.
1950: Preliminary map, Elbow Lake, Manitoba; Geological Survey of Canada, Paper 50-1, with descriptive notes.

Stockwell, C.H.
1935: Gold deposits of the Elbow-Morton area, northern Manitoba; Geological Survey of Canada, Memoir 186.

Syme, E.C.
1978: Elbow Lake reconnaissance; Manitoba Mineral Resources Division, Report of Field Activities 1978, p. 20-23.

1985: Athapapuskow Project; Manitoba Mineral Resources Division, Report of Field Activities 1985, p. 44-47.

Wright, J.F.
1931: Geology and mineral deposits of a part of northwest Manitoba; Geological Survey of Canada, Summary Report, Part C, p. 43c-48c.

MINES BRANCH

EXPLORATION SERVICES AND AGGREGATE RESOURCES

ES-1 MANITOBA'S PRECAMBRIAN DRILL CORE COLLECTION PROGRAM

by D.E. Prouse

INTRODUCTION AND HISTORY

Prior to 1970, drill core was collected by the Mines Branch largely as an aid to specific research projects. This core was stored at the University of Manitoba.

A small-scale core collection program was started in the early 1970s to assist exploration companies and prospectors across the province. This small scale program has evolved into the present day Precambrian Core Library System.

In the early 1970s, the construction of core sheds in The Pas (1972), Thompson (1973) and Lynn Lake (1974) allowed for a more concerted effort towards core collection. In 1980, part of the Geological Services Branch rock laboratory was allocated for core storage in Winnipeg.

Between 1971 and 1977, the Resident Geologist in The Pas was responsible for the core collection program. By 1977, when this position was discontinued, 72 600 metres of core had been collected. From 1978 to 1982, 16 067 metres of core was periodically collected by various members of the Department (Mining Recorder, Claims Inspector, Geologists, etc.) or delivered by various exploration companies. Due to a limited staff in the 1970s, a comprehensive cataloguing of core collections was not possible. The total amount of core collected to the end of 1982 was 88 667 metres.

In January 1983, the province's core program was reactivated. The 1983 program involved three components: accomplishments achieved by the Thompson Job Creation Program, work completed by departmental staff during summer field season and selected core retrievals completed throughout the year. Most efforts were directed towards the Lynn Lake and The Pas libraries. These facilities underwent major reorganizations as a result of core racking and inventory procedure standardization throughout the system. Work in 1983 resulted in the addition of 24 329 metres of core to the provincial core library system.

In April, 1984, the Government of Canada and the Manitoba Government finalized the Mineral Development Agreement. A portion of the funds available under the five-year term of the Agreement has been allocated to the provincial core libraries program.

The 1984 program was highlighted by the construction of a new wing on the core library in The Pas. This addition expanded the capacity of the library by 300% or 109 049 metres. In 1984, twenty core collections resulted in the addition of 26 169 metres of core.

The 1985 program had two specific objectives. The first, was the reorganization and selective reduction of specific holdings. The second objective was to compile a master file system for all holdings within the libraries. Drill logs, collar locations and other pertinent data were gathered as a prelude to computerization.

The 1986 program consisted of expanding storage capacity in Thompson and Lynn Lake, inventory reorganization, and continued work on the master file system. In Thompson, new inside and outside rack construction increased storage capacity by 30 413 metres. At Lynn Lake, the construction of two outside racks increased library capacity by 31% or 18 507 metres (Fig. ES-1-1). Inventory organizational efforts consisted of selective core reduction, updating library inventory records and core box relabelling using new computer generated tags.

Since 1984, significant increases in requests for service and, especially, library utilization have been recorded (Fig. ES-1-2). During the 86-87 fiscal year, a 58% increase in usage from the previous year was recorded for the provincial core libraries.

Since 1983, a noteworthy spinoff of the Provincial Core Libraries Program has been the participation of community oriented job training programs in library building improvement and expansion projects. For example, The Pas Human Resources Opportunity Centre has been involved in the construction and assembly of modular core racking. In 1984, these activities resulted in the creation of 665 person-days of work and an additional 100 person-days in 1985. Presently they are manufacturing core boxes for use by the provincial drill core collection program.

1987 Program

This year's and next year's programs, the last 2 years of the Mineral Agreement, are scaled down to nearly maintenance levels because the

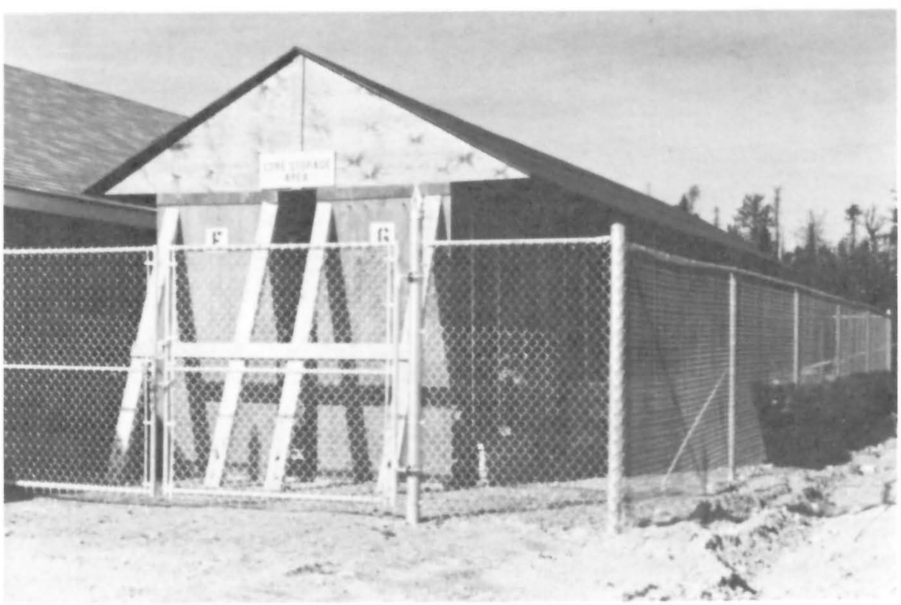


Figure ES-1-1: *Lynn Lake outside core racks, constructed 1986 — September 1987.*

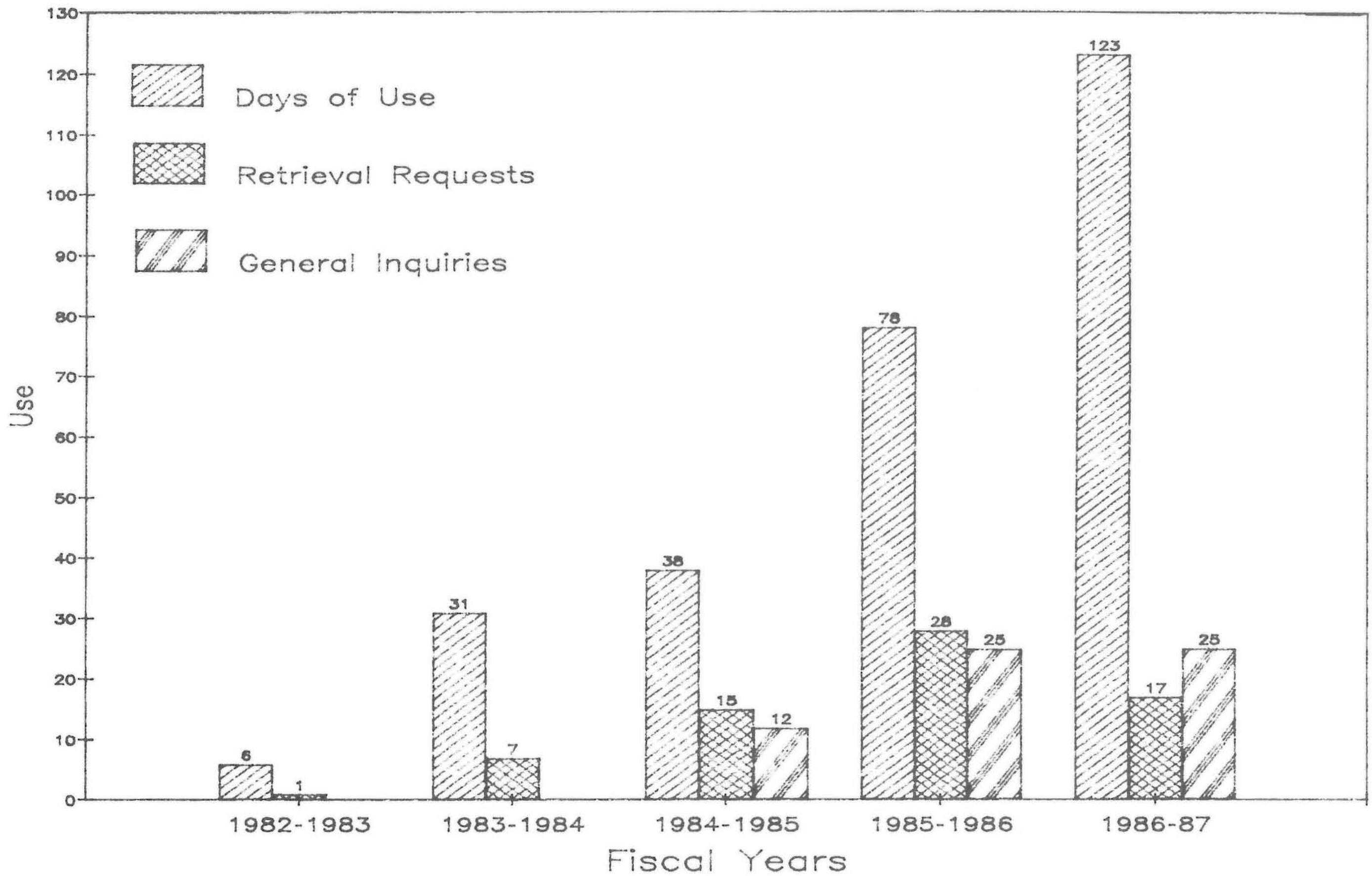


Figure ES-1-2: Use of Core Libraries System.

bulk of the expansion work was completed in the first 3 years of the Agreement.

A primary objective this year has been to develop a computer based master inventory of the northern Manitoba drill core library holdings. As of September 1, 1987, approximately 70% of the inventories from The Pas, Thompson and Lynn Lake have been entered into computer files. When this has been completed, inventory management and industry requests will be handled more efficiently. At present, library holdings in Winnipeg do not easily lend themselves to computer application.

In The Pas library, 265 boxes or 1615 metres of core were selectively discarded from the inventory. Computer generated labels were applied to 3541 boxes of core. Nineteen previously unlogged drill holes were logged to complete inventory files.

In Lynn Lake, 642 boxes of core were reboxed to increase future storage capacity. Other duties consisted of inventory reorganization and the application of 4452 computer core box labels. With the aid of local contractors efforts to improve building site drainage were undertaken. A concrete diversion wall was constructed, eavestroughing was applied to the core shed and extra fill was placed around the outside racking area.

In Thomspon, inventory checking was completed and 890 metres of core was transferred from Winnipeg and added to the inventory (Fig. ES-1-3).

This fiscal year, drill core staff have thus far compiled 145 days of field work. As of September 1, 1987, four industry requests for collections have been completed resulting in the addition of 3627 metres of core to the provincial core storage system. Library use for the current fiscal year (to date) has been 89 days during 14 visits (Fig. ES-1-4).

Present Holdings in Core Libraries (Fig. ES-1-5)

The four libraries currently hold 172 284 metres of core.

(A) The Pas Library (Fig. ES-1-6)

Located in the Natural Resources Compound at Grace Lake, this library contains 69 153 metres of core collected from the Flin Flon — Snow Lake district. With an estimated capacity of 164 153 metres this facility is presently 42% full.

Current holdings include:

Dome Exploration: 1 project, 25 holes, 3 024 m.
Espina Copper: 2 projects, 33 holes, 1 487 m.
Granges Exploration: 31 projects, 303 holes, 17 782 m.
Hudson Bay Exploration: 42 projects, 229 holes, 21 214 m.
Manitoba Mineral Resources: 12 projects, 82 holes, 7 114 m.
Maverick Mountain Resources: 1 project, 110 holes, 10 284 m.
Alpha Mines, BP-Selco, L. Bunn, Camflo Mines, Cominco, W.B. Dunlop, Imperial Oil, Inco, W.B. Kobar, Newmont Mining, Nor-Acme Gold Mines, Pronto Exploration, Red Earth Energy, Shell Canada Resources, and Thompson Brothers.

(B) Thompson Library

This library facility is located at the Burntwood River floatplane

Figure ES-1-3: *Thompson core library — September 1987.*

Figure ES-1-4: *Geological Survey of Canada core inspection at The Pas, July 1987.*

base. It has a capacity of 59 204 metres. With a current inventory of 28 974 metres this library is 49% full.

Current holdings include:

BP-Selco: 1 project, 7 holes, 1 728 m.
Canamax Resources: 27 projects, 202 holes, 11 869 m.
Cominco: 3 projects, 23 holes, 3 328 m.
Falconbridge Exploration: 3 projects, 14 holes, 2 573 m.
Granges Exploration: 3 projects, 8 holes, 3 085 m.
Hudson Bay Exploration: 2 projects, 6 holes, 2 067 m.
Nor-Acme Gold Mines: 1 project, 13 holes, 1 024 m.
Rio Algom Exploration: 1 project, 5 holes, 732 m.
Tantalum Mining Corporation: 2 projects, 12 holes, 987 m.
Inco, Manitoba Hydro, and Nufort Resources.

(C) Lynn Lake Library

This building, located near Parsons Airways floatplane base at Eldon Lake, contains 45 598 metres of drill core from the Lynn Lake greenstone belt, northern part of the Kisseynew Basin and northern Manitoba in general. The current capacity of this facility is 77 468 m. and at present it is 59% full.

Current holdings include:

BP-Selco: 1 project, 17 holes, 1 426 m.
Falconbridge Exploration: 2 projects, 8 holes, 841 m.
Granges Exploration: 9 projects, 140 holes, 11 241 m.
Hudson Bay Exploration: 7 projects, 59 holes, 4 578 m.
Manitoba Mineral Resources: 17 projects, 202 holes, 15 636 m.
S.M.D.C.: 12 projects, 42 holes, 4 133 m.

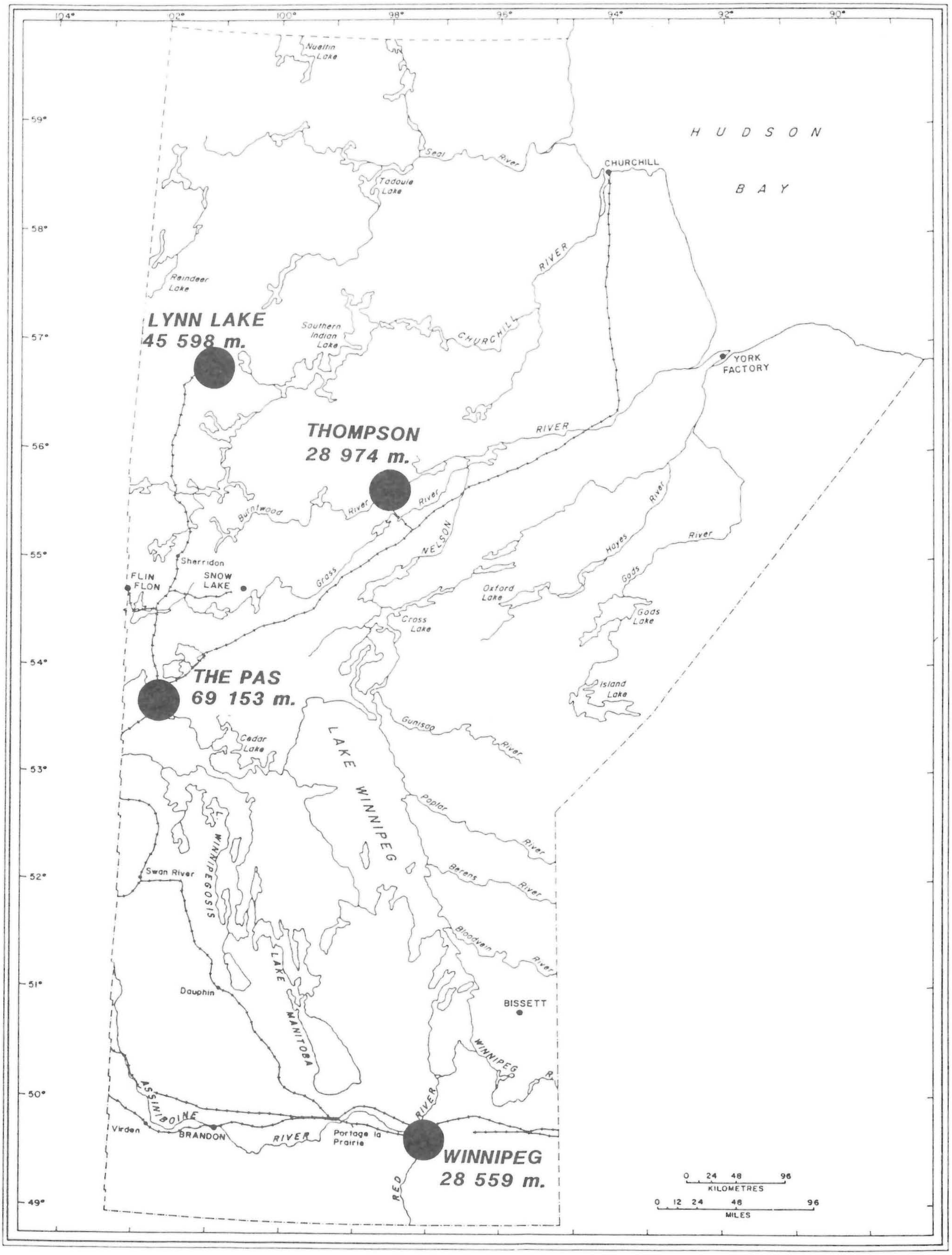


Figure ES-1-5: *Manitoba Core Library locations and present core holdings.*

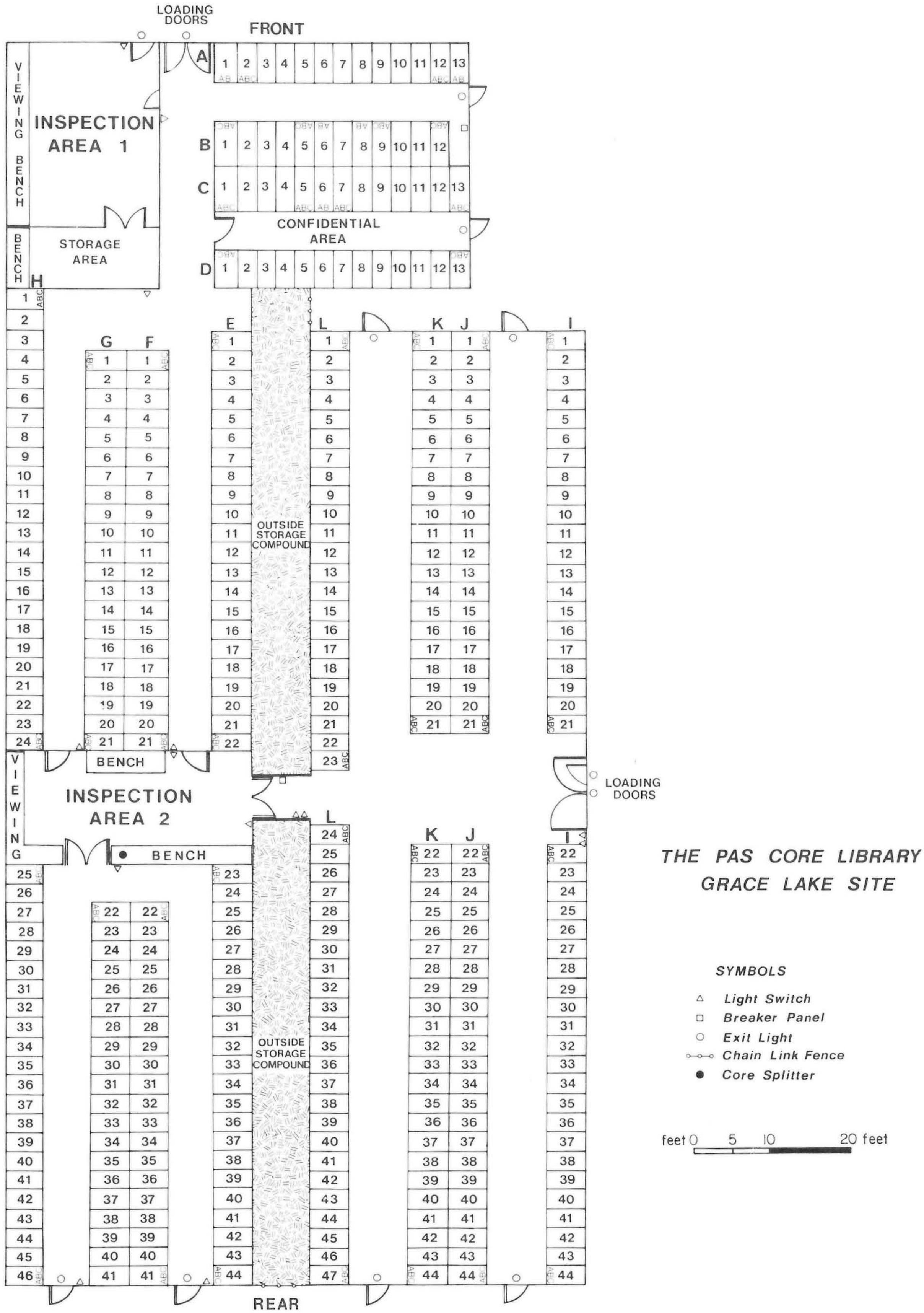


Figure ES-1-6: *The Pas Library floor plan.*

Sherritt Gordon Mines: 3 projects, 15 holes, 2 012 m.
Cyprus Exploration, Denison Mines, Gigantes Exploration, Gods Lake Gold Mines, Homestake Mineral Development Company, Keevil Mining Group, McIntyre Mines, Rock Ore Exploration, Shell Canada Resources, and Yukon Antimony.

(D) Winnipeg

This library located at Brady Road holds 28 559 metres of drill core from south-eastern Manitoba. This facility has no racked storage at the present time. The inventory is organized neatly on pallets in an outside storage compound.

Current holdings include:

BP-Selco: 2 projects, 15 holes, 1 811 m.
Brinco: 1 project, 16 holes, 829 m.
Dumbarton Mines: 4 projects, 59 holes, 5 401 m.
Esso Minerals: 6 projects, 47 holes, 2 548 m.
Falconbridge Exploration: 5 projects, 52 holes, 7 860 m.
Manitoba Mineral Resources: 6 projects, 57 holes, 2 798 m.
Maskwa Nickel Chrome Mines: 2 projects, 11 holes, 695 m.
J. Donner, Exploration Operations Branch, Footloose Resources, S. Lesavage, Neepawa Iron Mines, Schmirf Exploration, Tantalum Mining Corporation and University of Manitoba.

How to Use the Core Libraries

The core libraries at The Pas, Lynn Lake and Thompson are now well organized for use by industry and the public. Well lighted, heated inspection rooms with core splitters are provided.

None of the Department's core libraries are permanently manned, therefore all enquiries and permission for access must be made to:

D. Prouse, Resident Geologist
Exploration Services Section
Manitoba Energy and Mines
Provincial Building, 3rd and Ross Avenue
The Pas, Manitoba R9A 1M4
Phone: (204) 623-6411
OR
B. Esposito, Assessment Geologist
Exploration Services Section
Manitoba Energy and Mines
555 — 330 Graham Avenue
Winnipeg, Manitoba R3C 4E3
Phone: (204) 945-6535

If necessary, arrangements will be made with appropriate local Government representatives who have keys to the core libraries. These are:

The Pas: F.H. Heidman, Mining Recorder
Provincial Building, 3rd and Ross Avenue
The Pas, Manitoba R9A 1M4
Phone: (204) 623-6411

Lynn Lake: Conservation Officer
Manitoba Natural Resources
675 Halstead Avenue
Lynn Lake, Manitoba R0B 0W0
Phone: (204) 356-2413

Thompson: W. Schumacker or W. Comaskey
Manitoba Environment and Workplace Safety and Health
Mines Inspection Branch
Provincial Building, 59 Elizabeth Drive
Thompson, Manitoba R8N 1X4
Phone: (204) 778-4411

NOTE: Do not contact these people directly; phone The Pas or the Winnipeg office first.

Access to confidential core is only through written permission from the company which holds the ground. This written permission must be presented to the Resident Geologist or Assessment Geologist.

Core boxes placed in the library will be managed by drill core personnel. If sampling of core is desired, prior consideration and permission are required from the Resident Geologist in The Pas. When sampling is carried out the assay results and pulps, if requested, must be forwarded to the Resident Geologist or Assessment Geologist. Quartering of previously sampled core will not be permitted in order to preserve the stratigraphy.

Library users must be prepared to physically handle the core boxes and return them to the racks.

Local representatives will not give out door keys to users of core libraries. In special cases involving major inspections, the Resident Geologist in The Pas will travel to assist the user.

The master file of drill logs and plans, as well as other open file assessment data, is available for inspection in The Pas.

For a more comprehensive outline of Manitoba's Precambrian Drill Core Libraries program, please refer to the bilingual brochure of the same title produced under the Mineral Development Agreement. This is available free of charge from the Winnipeg or The Pas office.

Acknowledgements

The author wishes to extend thanks to G. Harris and J. Root whose hard work made the 1987 field season a success. The previous incumbent, Peter Doyle, is acknowledged for his diligent efforts and guidance to the core program and author respectively. The Winnipeg office staff are also acknowledged for their backup assistance.

ES-2 COMPILATION, PROMOTION AND EXPLORATION SERVICES (MDA PROJECT 5.9)

by J.D. Bamburak, D.J. Richardson and L.E. Chackowsky

INTRODUCTION

The Exploration Services Section of the Mines Branch has been involved in compilation, promotion and exploration services since 1979. The Mineral Development Agreement (MDA), signed in April 1984 by the Government of Canada and the Manitoba Government, increased staffing and funding and has allowed expansion of these services. This has resulted in: the Bibliography of Manitoba Geology project; the Manitoba Mineral Inventory project; and quality displays, reports and brochures.

COMPILATION

1. BIBLIOGRAPHY OF MANITOBA GEOLOGY

The bibliographic compilation project began in April 1985, with the objectives of compiling an alphabetical listing and archival library of all geologic literature pertaining to the landmass of Manitoba, and to provide an on-line computerized storage and retrieval system (STAIRS) to allow bibliographic retrievals by author, year, title information, NTS and selected subject keywords.

By October 1986, 3600 citations of provincial and federal publications had been entered into the data base, and 100 copies of Open File Report OF86-1 "Bibliography of Manitoba Geology 1" (BMG-1) were printed and released in November. Reprinting of 50 copies was done in May after the initial run sold-out. Copies of most of these publications, entered into the data base, were acquired and stored in the archival library. The continually updated STAIRS system was developed to search the bibliography by author, year or title information.

By September 1987, 1600 more citations, mostly of journals, periodicals and theses, were added to the data base. Approximately 1500 more will be added by the end of 1987, and BMG-2 will be published early in 1988 as a supplement to BMG-1.

The STAIRS system will be modified in 1988 to enable bibliographic searching by NTS area (eg. 64C; 53K/15), and by subject keywords that may not occur in the title of a citation. This system will also be used to generate NTS and subject indexes for subsequent publications of the bibliography.

Figure ES-2-1: Jim Campbell checking the Mineral Inventory file for deposit information.

2. MANITOBA MINERAL INVENTORY

The mineral inventory update of Manitoba gold deposits/occurrences was completed in November 1987 and is available as: 1) a complete set, 2) a set that covers a specific geological subdivision i.e. gold deposits/occurrences of the Flin Flon-Snow Lake greenstone belt; or 3) single mineral inventory cards for a specific deposit or occurrence. Mineral inventory cards describing base metal deposits/occurrences will be updated in 1988.

Economic Geology Report ER86-1 "Gold Deposits of Manitoba", a project carried out jointly by Exploration Services and Geological Services, was published in late 1987. It is hoped that the report will assist prospectors and mining companies in exploring Manitoba and provide a source of information for use in promoting the province's gold potential.

3. ASSESSMENT FILE REORGANIZATION

From October 1986 until March 1987, over 3600 whiteprints, mylars, autopositives, linens and negatives contained in 421 assessment reports were inventoried, labelled and stored in Stacors and vertical hanging cabinets. Overtime, amounting to over 500 hours, was utilized by staff due to a shortage of regular time and to reduce interruption to normal Assessment services provided to customers.

During the summer, a student updated to the end of July all map mylars in the assessment report index map series. These maps, at a scale of 1:31 680, show former mineral disposition outlines with five-digit accession numbers. The mylars are used for reproduction or for overlaying on Mining Recording's claim maps.

Supplements to the "Index to Non-confidential Assessment Reports" (OF86-5) were produced in May and November.

4. INDEX MAP SERIES

The Section reproduces index data plotted on 1:1 000 000 scale mylars. Eleven mylars show outlines of permits, exploration reservations and airborne geophysical surveys. Six mylars outline map areas of geoscientific publications. Three new index maps were compiled and two mylars drafted during the year showing airborne geophysical surveys. Aggregate Resources generated an updated version of their map showing aggregate and surficial map areas as two complimentary mylars.

PROMOTION

1. MONITORING EXPLORATION

During 1986-87, Exploration Services staff undertook 12 field trips; 44.5 person-days (excluding the drill core program) were spent in the field and many contacts were made with exploration personnel in on-going liaison and monitoring of exploration activity. From April to August 1987, an additional 8 field trips involving 42 person-days were made.

2. DISPLAYS

During the past year, the Section has produced displays depicting exploration activity and mining in the Province and services provided by the Department. Two major events were: the Annual Meeting with Industry in Winnipeg last November, and the Prospectors and Developers Convention in Toronto in March. Other events were the Manitoba School Career Symposia in Winnipeg (a joint display with The Mining Association of Manitoba), Brandon, Flin Flon and Norway House. During the year, several talks on geology and mines were given by Section staff to classes ranging from elementary to university level students.

3. ARTICLES

Staff wrote several articles describing the activities of exploration companies in the Province, including: "Mineral Exploration in Manitoba 1986" and "Manitoba Exploration Highlights March 1986 — February 1987".

"Junior Mining Company Activity in Manitoba 1986-87" was published in The Northern Miner supplement on Junior Companies June 15, 1987.

4. COMMITTEES

Two Section staff have served on the CIM Winnipeg Branch Executive and also on the Mineral Exploration Liaison Committee (MELC) during the year. The Head of the Section served as Manitoba's Co-Secretary to the Mineral Development Agreement Management Committee.

EXPLORATION SERVICES

1. PUBLICATION DISTRIBUTION

As of June 30, 1987, the function of over-the-counter and mail cash/pre-paid minerals publication sales and complimentary and free requests was transferred to Energy and Mines Information Centre. Most of the publications contained in the Minerals Division Price List and those of Geological Survey of Canada are now distributed by the Info Centre. Exploration Services Section, however, is still responsible for release notices of new publications; the mailing list of over 600 customers; gift and exchange agreements; preliminary and index maps; Geological Survey of Canada open file reports; various published geophysical maps (aeromagnetic, gradiometer, total field, input, etc.); and for providing consultative services to the Info Centre.

Publication distribution continues from The Pas Mining Recording Office, with new releases for Minerals Division publications and Geological Survey of Canada open files available at the same time as in Winnipeg. Coordination is provided by Exploration Services Section.

Open File Reports (OF85-7, 86-1, 86-3, 86-6 and 87-1) and the second Bedrock Geology Compilation Map (64C), produced under the Canada-Manitoba interim and current Mineral Development Agreements, were distributed following a notification process.

The "Canada-Manitoba Mineral Development Agreement 1984-89, Sector 'A' Geoscientific Activities, Progress Report 1986-87" (Open File Report OF87-3) was released in June 1987. This report reviews activities conducted in Manitoba by Manitoba Geological Services Branch, Exploration Services Section of the Mines Branch, and the Geological Survey of Canada during the 12-month period ending March 31, 1987, and outlines projects scheduled for implementation during 1987-88.

In May, the first edition of "The MDA News" was mailed to over 600 addresses on the publications mailing list. During July, a volunteer supplied under the "Manitoba Youth Volunteers in Government" program, assisted in the mail-out distribution of 512 copies of "Industrial Minerals of Manitoba" (OF85-7) which was produced under the Canada-Manitoba Mineral Development Agreement, as well as other secretarial duties for the Section.

2. BROCHURES

The following brochures were revised in November 1986 and March 1987:

a. "Staff and Functions of the Geological Services Branch";
b. "Staff and Duties of the Exploration Services Section";
c. "Mining and Exploration Companies in Manitoba"; and
d. "Selected Contractors and Consultants Serving the Exploration Industry in Manitoba."

In March 1987 a revised "Mineral and Exploration Services in Manitoba" brochure was released at the Prospectors and Developers Convention in Toronto.

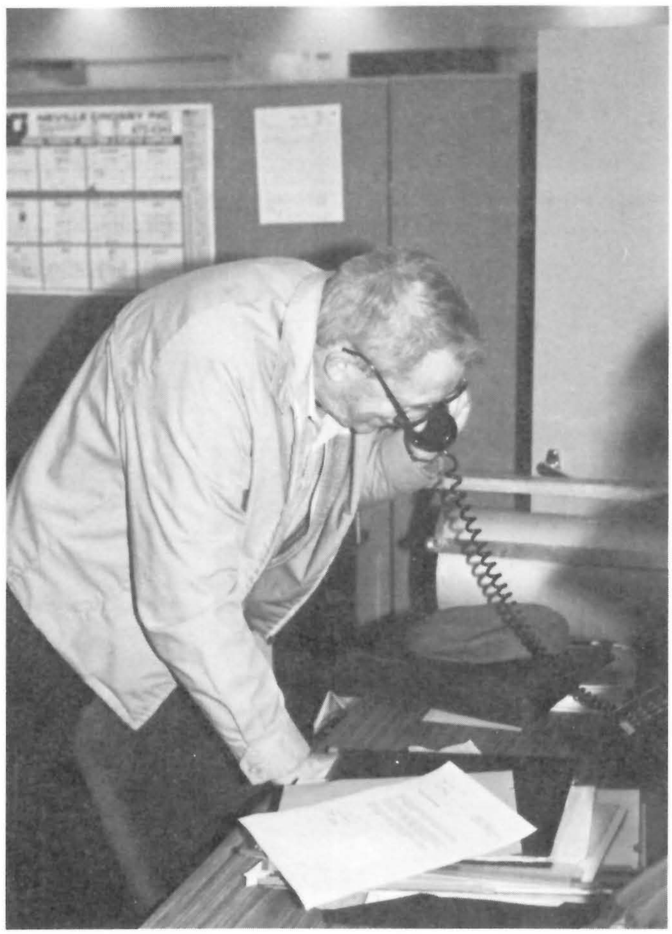


Figure ES-2-2: Cliff Gibson making a phone call after examining the Assessment file.

REFERENCES

Bamburak, J.D., Richardson, D.J., and Leskiw, P.D.
1986: Compilation, Promotion and Exploration Services (MDA Project 5.9); **in** Manitoba Minerals Division, Report of Field Activities 1985, p.217-219

Fogwill, W.D.
1987: Junior Mining Company activity in Manitoba 1986-87; **in** The Northern Miner, Supplement on Junior Companies, June 15, 1987, p. B13, B15.

IBM
1984: Storage and Information Retrieval System (STAIRS) — Terminal User's Guide, 4th Ed.; Publication S320-5785-3, International Business Machines Corporation.

Leskiw, P.D.
1986: Bibliography of Manitoba Geology 1; Manitoba Energy and Mines, Mines Branch, Open File OF86-1, 198 p.

Richardson, D.J. and Ostry, G.
1987: Gold deposits of Manitoba; Manitoba Energy and Mines, Economic Geology Report ER86-1.

AR-1 AGGREGATE RESOURCE INVENTORY OF THE RURAL MUNICIPALITY OF LOUISE

by R.V. Young

INTRODUCTION

An aggregate resource inventory was carried out in the R.M. of Louise with the objective of determining location, quality and reserves of aggregate resources. Aggregate deposits are shown at a scale of 1:50 000 on Preliminary Map 1987-LOU released with this report (Young, 1987).

The municipality is located 125 km southwest of Winnipeg and includes Townships 1-4 and Ranges 10-12 West.

METHODOLOGY

Airphotos at scales of 1:50 000 and 1:15 840 were used to identify potential aggregate deposits. All potential deposits were visited and existing gravel pits sampled. An EM31 resistivity meter was used to help define deposit boundaries. Samples were seived to determine grain size and pebble lithologies were determined for the 9.5-38.1 mm size fraction.

Figure AR-1-1: *Kame deposit at site RY 318 consisting of interbedded sand and gravel with 100% shale. Shovel for scale.*

BEDROCK GEOLOGY

The municipality is underlain by Cretaceous shale of the Odanah Member of the Riding Mountain Formation. This shale is a light, hard siliceous shale (Bannatyne, 1970). Outcrops are found in several roadcuts and along the Pembina River Spillway which appears to have been cut into bedrock to a depth of 75 m. Several small outcrops are located in the Balfours and Barbours Lakes area along a ridge complex which may be ice-pushed bedrock.

Several small bedrock quarries are used for road maintenance. The locations of the quarries are shown on Preliminary Map 1987-LOU. The quarries are located along creeks and meltwater channels that have cut into bedrock.

SAND AND GRAVEL RESOURCES

Sand and gravel deposits consist of glaciofluvial and outwash deposits. The glaciofluvial deposits include eskers and kames located primarily in the southwest portion of the municipality. The outwash deposits are located along the Pembina Spillway and along secondary meltwater channels.

The eskers, trending southeast, are sinuous ridges up to 6 m high and consist primarily of fine sand. The kames are found as isolated hummocks consisting of interbedded sand and gravel (Fig. AR-1-1). The lithology of these glaciofluvial deposits consists of 90-100 per cent shale.

The largest outwash deposit is located 6 km northwest of Crystal City. The deposit is a flat outwash plain with 3 m of horizontally bedded sand overlying 3 m of interbedded sand and gravel. At site RY325 the deposit consists of 51 per cent shale, while at site RY328 the deposit lithology is 92 per cent shale. Minor outwash along small secondary meltwater channels consisted of 100 per cent shale sand.

CONCLUSION

High quality sand and gravel deposits were not observed within the study area. The high shale content limits potential end uses for the aggregate except for surfacing gravel on municipal roads. The outwash deposit northwest of Crystal City has the lowest shale content of all the deposits evaluated.

REFERENCES

Bannatyne, B.B.
1970: The clays and shales of Manitoba, Manitoba Mines Branch, Publication 67-1.

Young, R.V.
1987 Aggregate resources of the Rural Municipality of Louise; Manitoba Energy and Mines, Preliminary Map 1987-LOU

AR-2 AGGREGATE RESOURCES IN THE RURAL MUNICIPALITIES OF WINCHESTER AND MORTON

by H.D. Groom

INTRODUCTION

A sand and gravel inventory of the Winchester and Morton area was carried out in order to provide detailed aggregate information for resource management and land-use planning. The program involved sampling all existing pits and backhoe testing all deposits judged to be economically significant and unopened deposits with aggregate potential.

The aggregate deposits are delineated on two 1:50 000 scale Preliminary Maps 1987-WIN and 1987-MOR (Groom, 1987).

LOCATION AND PHYSIOGRAPHY

The Winchester-Morton area covers 1865 km^2 between Townships 1-4 and Ranges 19-23W in southwestern Manitoba. The location and surficial geology are shown in Figure AR-2-1. It is primarily a farming district and the towns of Deloraine and Boissevain are the major service centres.

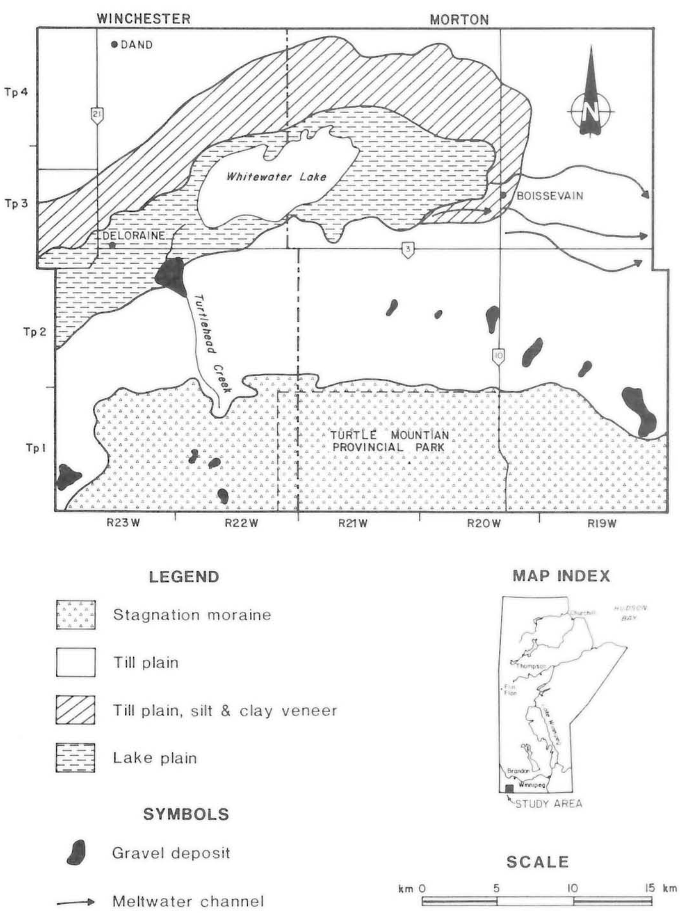


Figure AR-2-1: Surficial geology of the R.M.'s of Winchester and Morton; modified from Elson (1961).

Turtle Mountain, rising to elevations of 710 m above sea level, forms the height of land in the southern part of the area. The mountain plateau lies, in general, 190 m above the surrounding prairie level. The plateau is formed of bedrock overlain by hummocky stagnation moraine resulting in a surface topography of knolls separated by sloughs and lakes. The mountain is steep sided, particularly along the western edge where it rises over 100 m in less than 2 km. The mountain edge is cut by numerous streams; Turtlehead Creek is the largest of these.

Elevations in the remainder of the area fall gently from 568 m a.s.l. at the base of Turtle Mountain to 492 m a.s.l. at the northern edge of the municipalities. Whitewater Lake, in the centre of the study area, is surrounded by a narrow zone of flat lake sediments. The northern part of the municipalities is underlain by a rolling till plain. The ridges in this area are usually 2-3 m high.

BEDROCK GEOLOGY

The northern half of the area is underlain by upper Cretaceous marine shale of the Riding Mountain Formation. The Odanah member is a hard grey siliceous shale outcropping and exposed in roadcuts in the northwestern corner of the R.M. of Winchester. The overlying Coulter member, a silty shale, was not seen in outcrop.

The southern part is underlain by sediments of the Boissevain and Turtle Mountain Formations (Bamburak, 1978). The upper Creteaceous Boissevain Formation is primarily fine grained sandstone. The crossbedded facies of this formation is well exposed in ravine cuts along Highway 3 southeast of Boissevain. The overlying Tertiary Turtle Mountain Formation is generally unconsolidated interbeds of sand, silt and clay. The Goodlands and overlying Peace Garden members of this formation outcrop along the west side of Turtle Mountain.

LATE GLACIAL HISTORY

The surface till in the area was deposited by southeastward-flowing ice during the Late Wisconsinan. During deglaciation, the ice overlying Turtle Mountain stagnated resulting in the present day knob and kettle topography. As the active ice on the surrounding plain retreated to the northwest, meltwater, ponded between the ice front and Turtle Mountain, formed a small glacial lake in the Whitewater Lake basin. This lake first drained eastward through channels south of Boissevain. Ice retreat opened lower outlets west of the study area and the lake then drained westward into Glacial Lake Souris (Elson, 1956, 1961).

The major gravel deposits in the Winchester-Morton area were formed by streams flowing off Turtle Mountain carrying meltwater from the stagnating ice sheet. Most streams deposited alluvial fans at the base of the mountain. However, Turtlehead Creek flowed into Lake Whitewater and formed a small delta at its mouth.

AGGREGATE DEPOSITS

Aggregate reserves in the R.M.s of Winchester, and Morton occur in ice-contact, alluvial fan and deltaic deposits. The deposits are widely scattered and most are located in the southern part of the municipalities.

ICE-CONTACT DEPOSITS

Ice-contact deposits occur as isolated hummocks or ridges within the stagnation moraine on Turtle Mountain. Turtle Mountain Provincial Park occupies most of this area. However, several small pits have been opened west and north of the Park.

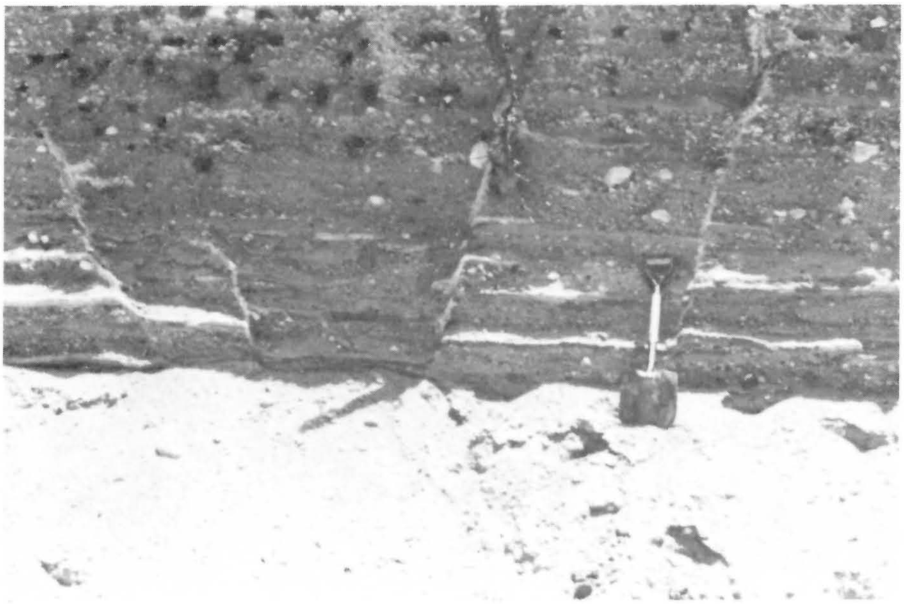


Figure AR-2-2: Faulting in outwash sediments, SW4-1-22W; shovel is 1 m.

The deposits are quite variable in extent, depth and quality of gravel they contain. The pit in SE 17-1-22W is extensive but shallow. The north end of the pit is still active and shows 3 m of poorly sorted pebble gravel and sand over till. The unopened deposit in NW 17-1-22 is a ridge rimming a kettle lake. The deposit contains 3-4 m of poorly sorted cobble gravel which thins rapidly eastward to less than a metre of gravel over till. The pit in SW 9-1-19W is excavated into the side of a hummock containing greater than 8 m of well sorted, sandy pebble gravel. By contrast, the material in the pit in the adjacent quarter-section (NW 4-1-19W) is extremely variable: to the north, 5 m of poorly sorted, shale-rich pebble gravel; to the east, 0.6 m of silt and clay rhythmites overlie well sorted beds of sand and granules; to the south, highly deformed beds of gravel, sand and silt overlie poorly sorted pebble gravel; and shallow gravel overlies till along the western part of the pit. At the base of this deposit, a small outwash plain extends eastward to the edge of a kettle lake. The deposit consists of 2-3 m of well sorted, crossbedded coarse sand, granules and fine pebble gravel overlying fine sand. Extensive faulting indicates the sediment was deposited over blocks of ice. The deposit in SW 10-2-20W contains 4 m of poorly sorted material overlain by 2 m of till. The pit is presently active but excavation is limited by the water table.

These deposits are primarily used to meet local needs. The high shale content and limited volume of gravel as well as the discontinuity of the gravel beds make them uneconomic except as secondary aggregate sources.

ALLUVIAL FAN DEPOSITS

Alluvial fan deposits are the most important source of aggregate in the area. Several have already been mined to depletion; three are currently active.

The largest of these runs along Stark Creek in sections 23, 26 and 35 in township 1-19W. This deposit is quite coarse at its apex but the material fines rapidly both laterally and downstream. The large pits at the apex are near depletion. However, there are stockpiles of cobbles and crushed and screened material on site. Downstream, the material is sandy pebble gravel, and sand at the northern end of the deposit. This deposit is significant both because the shale content is low enough for the material to be used in concrete production and because the crushed coarse material is being sold to gravel operators as far away as Deloraine to be mixed with finer aggregate available in other deposits.

The second active deposit is in the east half of section 22-2-20W. The pits in the southeast quarter are nearing depletion but the gravel continues northward. Test pits in the northeast quarter show a minimum of 2 m of interbedded pebble gravel and sand occasionally overlying or capped by silts and clays. However, in most test holes the water table was at 2.5 m and the gravel continued below the water line. Gravel from this deposit is sold to operators in Boissevain.

The fan deposit in section 7-1-23W contains the coarsest material found in the study area. There is more than 3 m of cobble gravel at the fan apex. The coarse gravel trends westward along the southern edge of the deposit, becoming coarse pebble gravel with cobbles. The gravel fines to the north and west. The active pit in the northwest quarter of the section shows 4.5 m of sandy fine pebble gravel over 3 m of coarse sand which fines down to silty sand at the base where the water table was encountered. The shale content of this deposit may limit some end uses. However, the large volume of material available for crushing makes it one of the most valuable deposits in the area.

DELTAIC DEPOSITS

The deltaic deposit lying 3 km southeast of Deloraine is the major producer of aggregate for the area. The deposit is coarsest in the southeast where 2-4 m of coarse pebble gravel with cobbles overlies bedrock. The gravel trends northwest into section 36-2-22W. The active pit in the northeast quarter shows 4 m of predominantly sandy fine pebble gravel overlain by less than a metre of sand. The gravel is poorly sorted with occasional small cobbles. This gravel seam continues into the northwest quarter of the section but the material rapidly changes to fine sand and silt.

CONCLUSIONS

Although gravel reserves are adequate to meet the current needs of the area, aggregate deposits are scarce in the R.M.s of Winchester and Morton. The deposits that do exist are widely scattered and concentrated in the southern half of the area. They tend to be of limited extent, with shallow and fine grained gravel. Therefore, the large, coarse grained alluvial fan deposits in 1-19W and 1-23W are much more important to the local gravel industry than the quality of the aggregate and their isolated locations would indicate.

REFERENCES

Bamburak, J.D.
1978: Stratigraphy of the Riding Mountain, Boissevain and Turtle Mountain Formations in the Turtle Mountain area, Manitoba; Manitoba Mines Branch, Publication 78-2.

Elson, J.A.
1956: Surficial geology of the Tiger Hills region, Manitoba, Canada; Ph.D. Dissert., Yale University.

1961: Surficial geology, Virden, Manitoba and Saskatchewan; Geological Survey of Canada, Map 39-1961.

Groom, H.D.
1987: Aggregate resources in the Rural Municipality of Morton; Manitoba Energy and Mines, Preliminary Map 1987-MOR.

1987: Aggregate resources in the Rural Municipality of Winchester; Manitoba Energy and Mines, Preliminary Map 1987-WIN.

AR-3 SURFICIAL GEOLOGY AND AGGREGATE INVENTORY OF THE CROSS LAKE AREA

by M.A. Mihychuk

INTRODUCTION

A surficial geology and aggregate inventory program was conducted in the Cross Lake area, NTS sheet 63-I/12 and range 4W on 63J/9 (Fig. AR-3-1). Regional surficial mapping was initially conducted to identify geologically favourable environments for aggregate deposits. Detailed testing was then concentrated in favourable areas with good access to demand areas, primarily the community of Cross Lake. The objectives of the field work were to:

(1) identify all aggregate deposits,
(2) locate sources of concrete sand,
(3) identify potential quarry sites,
(4) assess aggregate resources for future land-use management, and
(5) test suitability of Lake Agassiz clays for brick manufacturing.

The surficial geology, aggregate deposits, site and sample locations are shown on Preliminary Map 1987-CL (Mihychuk, 1987). A total of 84 samples were collected in the Cross Lake area. Of these, 68 were sand or sand and gravel, 6 were bedrock and 3 were clay samples; the remainder were till.

SURFICIAL GEOLOGY

Geomorphologically, the Cross Lake area is flat to gently rolling plains with low relief and numerous swamps and wetlands. Highest elevations occur north of Pipestone Lake on a moraine complex system 30 m higher than the surrounding area. The study area is drained by Nelson River, and major drainage patterns are structurally controlled. A generalized stratigraphic column is shown in Figure AR-3-2.

Bedrock comprises approximately 10 per cent of the surficial units in the area. Outcrops predominate along shorelines and in numerous roadcuts where bedrock is exposed. Generally bedrock (Fig. AR-3-3) consists of Precambrian granodiorite gneiss overlain by volcanic and sedimentary rocks of the Pipestone Lake and Cross Lake groups (Corkery and Lenton, 1984). Several bedrock quarries in the area, most near Jenpeg, were used during construction of the generating station and dam. Presently only one quarry is active in the study area; it is located 2 km northeast of the community of Cross Lake. The basalt being quarried is preferred over other rock types because of relative ease of blasting and crushing. Potential bedrock quarry sites are shown in Figure AR-3-3.

Striated bedrock surfaces were observed along shorelines and road outcrops. Based on 19 sites, only one ice flow direction was observed, ranging from 221° to 242°, with a mean of 235°. Striae recorded on Rousell's (1965) geological map of the area are included on the preliminary map.

Till exposures were limited to roadcuts, in the lee of bedrock knobs. Generally this lee-side till is stony with a sandy sometimes silty matrix. Clasts are subangular to subrounded, often with striated surfaces. Lenses of sand, and boulder lags or concentrations, were observed in association with the till.

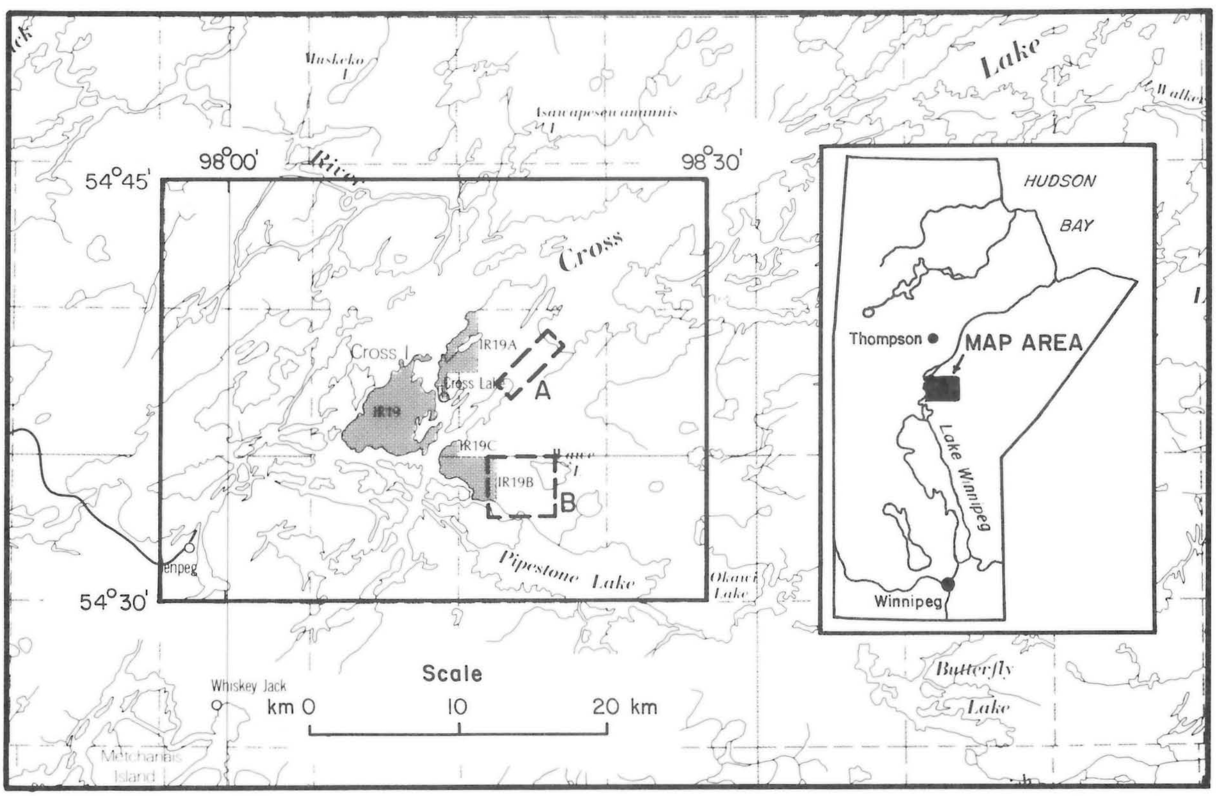


Figure AR-3-1: Location map of the Cross Lake area showing detailed map areas. A. Cross Lake deposit. B. Wawe Lake deposit.

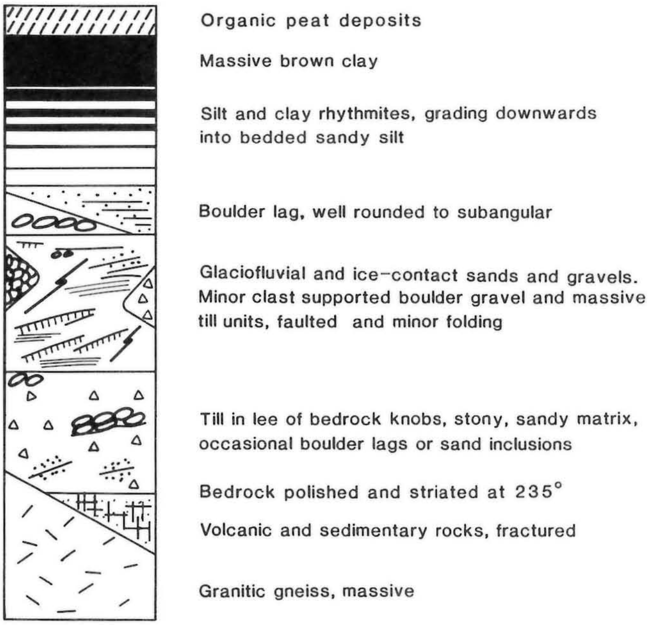


Figure AR-3-2: Generalized surficial stratigraphic column for the Cross Lake area.

A major ice-contact deposit is located north of Pipestone Lake and west of Wawe Lake. It appears to form part of a discontinuous morainic system over 50 km long (Klassen and Netterville, 1980). It trends northeast to southeast in a broad arcuate pattern perpendicular to ice flow. This appears to mark an ice frontal position during retreat in the late Wisconsinan. The Wawe Lake aggregate deposit (Fig. AR-3-3) is the northern portion of the moraine. Other deposits have been identified in the moraine along the Oxford House winter road, north and east of Pipestone Lake. Only one esker was identified in the study area, and it is located 4 km northeast of the Cross Lake community (Fig. AR-3-3). The esker is approximately 3 km in length, trends southwest, and reaches a maximum height of 14 m. Morphologically it consists of two pronounced esker beads that are separated by a sand plain.

Glaciolacustrine sediments deposited in Lake Agassiz form 50 per cent of the surficial sediments. The sediments are fine grained, consisting of silts and clays. The sediments range from a few centimetres to more than 3 m in thickness. A massive brown clay unit, generally 30-50 cm thick grades down into silt rhythmites.

Organic deposits and wetlands constitute approximately 30 per cent of the surficial landscape. Peat deposits are shallow, generally less than 30 cm thick.

AGGREGATE DEPOSITS

CROSS LAKE DEPOSIT

The Cross Lake deposit is a glaciofluvial esker deposit, 4 km north of the community of Cross Lake. It is orientated west-southwest and ends at Sand Bay. The deposit has two producing sites, the Cross Lake pit in the north and the Sand Bay pit in the southern part.

The Cross Lake pit actually consists of two smaller pits, separated by approximately 100 m of unmined deposit. The eastern pit is smaller and coarser than the other pit. Sediments in the eastern pit are cobbly to bouldery pebble gravel, up to 5 m in thickness above the water table. The flanks of the deposit are composed of till, silty rhythmites and laminated sands. Mining is progressing westwards. The western pit (Fig. AR-3-5) consists of 9 m of well sorted sandy pebble gravel (Table AR-3-1). Generally the gravel in the Cross Lake pits is high quality and can be used for most end uses.

The Sand Bay pit (Fig. AR-3-6) is located west of the Cross Lake highway, on the southeast shore of Sand Bay (Nakow Bay). Very sandy pebble gravel (Table AR-3-1) is presently extracted from the pit. Material from the Sand Bay pit is used for concrete sand. The deposit can be traced northeastward for approximately 600 m but it becomes discontinuous and is composed of finer material.

WAWE LAKE DEPOSIT

The Wawe Lake deposit (Fig. AR-3-7) is located 10 km south of the community of Cross Lake, north of Nelson River and east of the highway. Access to the north and central portions is by a good quality forestry road. Fine- to medium-grained sand with occasional fine pebble sand beds dominate the northern part of the deposit. Sandy pebble gravel overlies finely laminated, well sorted sand at site CL111 in the central portion of the deposits and the gravel unit increases in thickness to 3 m at site CL112 (Table AR-3-1) at the south end. Greater than 1.5 m of good quality pebble gravel was identified approximately 700 m southeast of site CL115; however, there is no road access to this part of the deposit. Total thickness of the gravel could not be determined because of lack of access.

CONCLUSIONS

The following conclusions have been reached after preliminary assessment of the aggregate potential of the Cross Lake area.

(1) There are two major accessible sand and gravel deposits in the study area: the Cross Lake esker deposit and the Wawe Lake moraine deposit.

(2) Potential quarry sites in the vicinity of the community of Cross Lake are limited, especially in the preferred basalt rock type. Expansion of the existing basalt quarry, 2 km north of town, is possible southwards; however, most available rock reserves have been quarried. A potential new quarry in basalt could be developed 1 km north of Nelson River. Thirdly, a potential granitic quarry site was identified northeast of the community, along the route of the proposed road extension.

(3) Two alternate sites for concrete sand from the Sand Bay pit were identified: relocation of the Sand Bay pit east of the highway or development of the Wawe Lake deposit. Development of the Wawe Lake deposit is preferred because of the large reserves available without conflicting land uses.

(4) With management of the high quality aggregate reserves of the Cross Lake deposit and development of the Wawe Lake deposit there should be sufficient aggregate for the near future given present rates of consumption.

(5) Clay suitability tests for brick manufacturing will be conducted with Industrial Minerals Section, Geological Sciences Branch.

REFERENCES

Corkery, M.T.
1985: Cross Lake supracrustal investigations in the eastern Pipestone Lake area; **in** Manitoba Energy and Mines, Report of Field Activities 1985, p. 165-172.

Corkery, M.T. and Lenton, P.G.
1984: Cross Lake supracrustal investigation; **in** Manitoba Energy and Mines, Report of Field Activities 1984, p. 107-109.

Klassen, R.W. and Netterville, J.A.
1980: Surficial geology of Cross Lake; Geological Survey of Canada, Open File Report 631.

Mihychuk, M.A.
1987: Aggregate inventory of Cross Lake area; Manitoba Energy and Mines, Preliminary Map 1987-CL.

Rousell, D.H.
1965: Geology of the Cross Lake area; Manitoba Mines Branch, Publication 62-4.

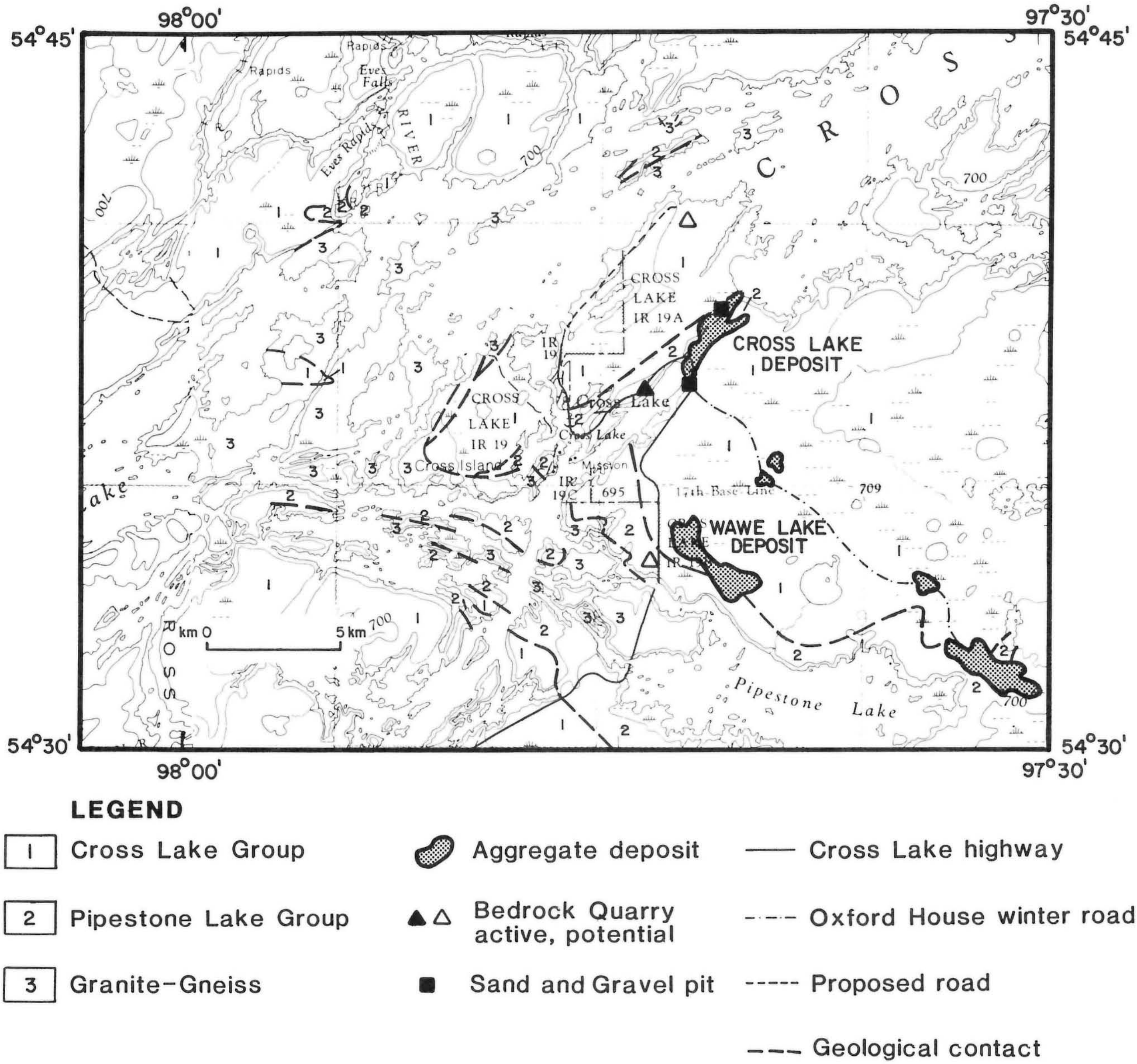
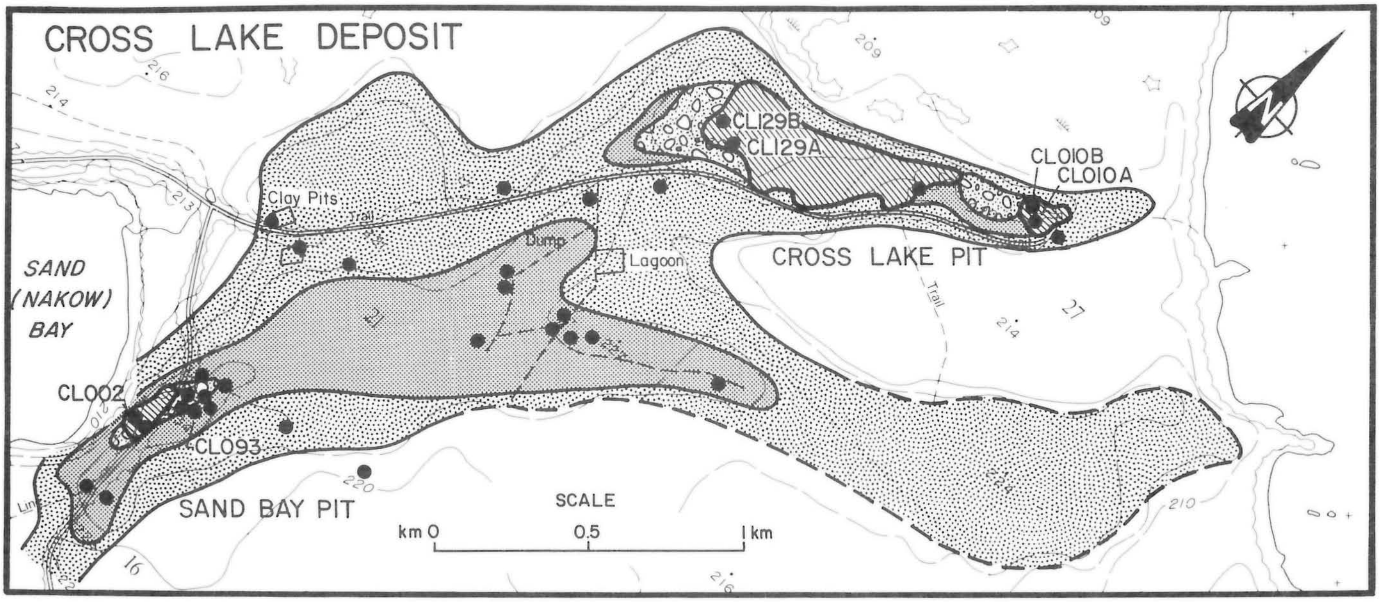


Figure AR-3-3: Generalized aggregate deposits and bedrock geology map (bedrock generalized from Corkery and Lenton, 1984 and Corkery, 1985).



LEGEND

- Gravel or gravelly sand
- Sand, minor gravel
- Clay (<1m) over sand

SYMBOLS

- Gravel or sand pit
- Road
- Trail
- Geological contact known
- Geological contact assumed
- Site location
- CL093 Data in Table 1

Figure AR-3-4: *Detailed map of the Cross Lake deposit with sample locations. See Figure AR-3-1 for location map.*

Figure AR-3-5: *View of the west pit of the Cross Lake pit.*

TABLE AR-3-1
GRAIN SIZE RESULTS FOR SELECTED SAMPLES IN THE CROSS LAKE AREA, IN PER CENT PASSING

Mm	75.0	37.5	18.8	9.4	4.8	2.4	1.2	0.6	0.3	0.2	0.1
Sieve size	3	1.5	0.75	0.375	4	8	16	30	50	100	200
SANDBAY PIT											
CL002A	100.0	100.0	100.0	100.0	100.0	100.0	99.9	99.9	99.1	70.8	24.3
CL002B	100.0	97.8	79.3	60.8	45.3	29.3	14.6	6.1	2.6	1.0	0.5
CL002C	100.0	100.0	100.0	100.0	99.2	96.3	91.1	83.8	13.2	2.1	0.3
CL093	100.0	100.0	100.0	100.0	100.0	100.0	99.9	99.7	92.8	25.8	6.4
CROSS LAKE PIT											
CL010A	99.0	93.5	89.9	80.4	68.4	53.0	38.1	26.9	17.6	10.2	5.7
CL010B	95.6	86.1	73.8	65.4	55.3	39.2	21.3	11.6	6.6	4.5	3.6
CL129A	95.4	90.2	76.3	67.4	55.7	40.0	21.4	9.1	4.0	2.5	2.0
CL129B	100.0	99.0	94.9	85.4	60.3	45.9	35.1	29.3	17.2	8.0	3.6
WAWE LAKE DEPOSIT											
CL055A	98.9	88.9	78.2	69.1	55.1	41.7	30.1	20.6	9.8	4.7	3.0
CL055B	98.8	98.2	96.1	94.4	88.9	81.3	74.0	66.0	40.5	16.5	7.8
CL055D	100.0	100.0	100.0	96.3	91.2	82.5	73.5	59.5	20.6	4.6	2.2
CL107	100.0	100.0	100.0	100.0	100.0	100.0	99.9	97.9	71.1	22.6	8.2
CL109	100.0	99.6	98.0	88.2	75.2	62.3	48.3	32.1	17.4	9.7	4.6
CL110	100.0	100.0	100.0	100.0	99.9	99.9	99.8	99.5	87.3	22.7	6.1

Figure AR-3-6: *Sand Bay pit, west of the Cross Lake highway. View westwards into Sand (Nakow) Bay.*

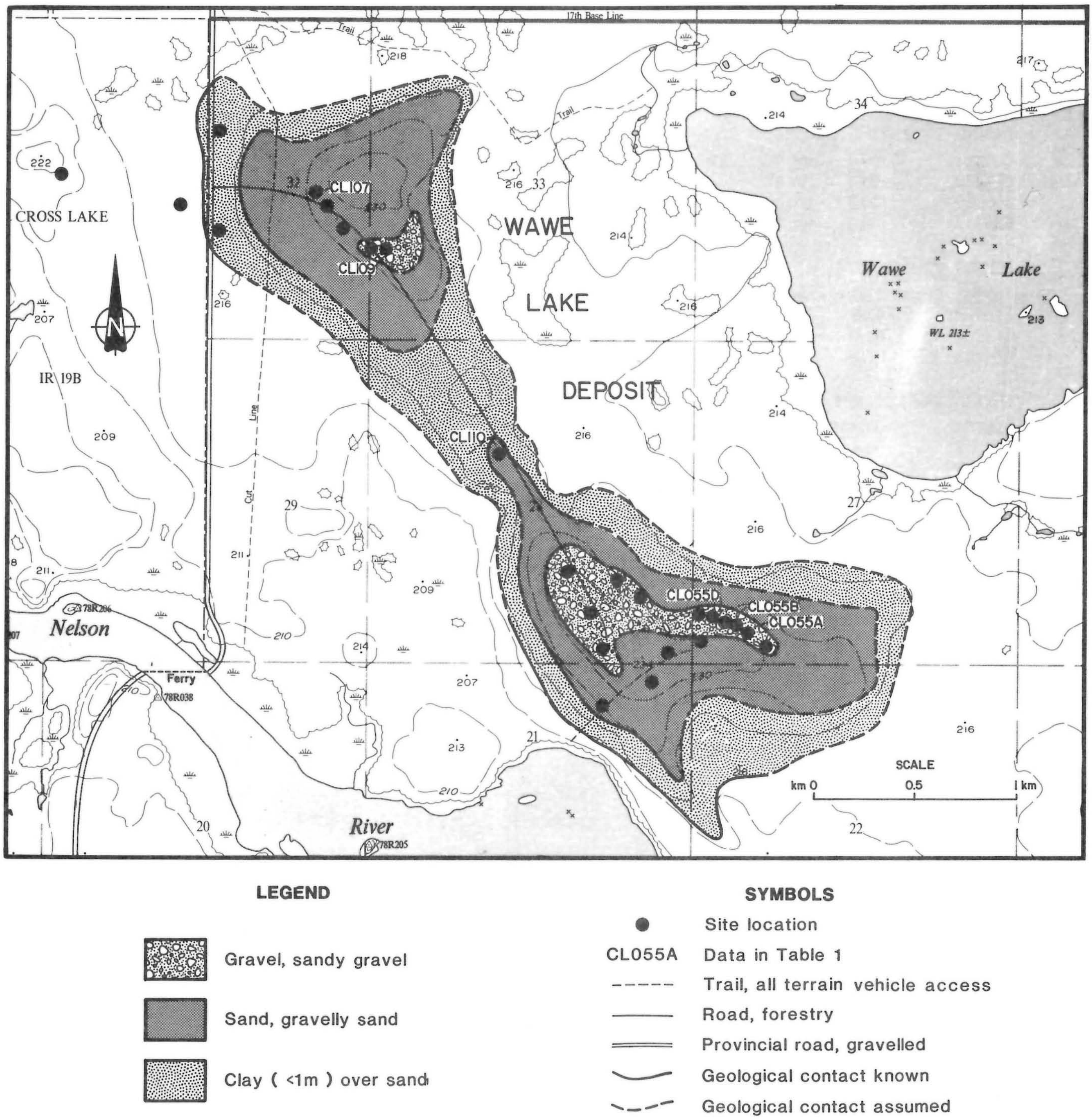


Figure AR-3-7: *Detailed map of the Wawe Lake deposit with sample locations. See Figure AR-3-1 for location map.*

PUBLICATIONS AND GEOLOGICAL STAFF

PUBLICATIONS RELEASED
(November 21, 1986 - November 24, 1987)

MANITOBA ENERGY AND MINES

Price

GEOLOGICAL SERVICES REPORTS

Manitoba Energy and Mines (1986):
Granville Lake — NTS 64C, 1:250 000, with marginal notes;
Bedrock Geology Compilation Map 64C — $5.00

A.H. Bailes and E.C. Syme (1987)
Geology of the Flin Flon-White Lake area;
Geological Map GR86-1-1 — 5.00

M.T. Corkery (Map Committee Chairman) (1987):
Geological Highway Map of Manitoba;
MDA Special Publication No. 1; scale 1:1 000 000 — No Charge

Canada-Manitoba Mineral Development Agreement 1984-89 (ERDA) (1987):
Sector A Geoscientific Activities, Progress Report 1986-87;
Open File Report OF87-3 — 5.00

Simpson, F., McCabe, H.R. and Barchyn, D. (1987):
Subsurface disposal of wastes in Manitoba; Part 1: Current status and potential of subsurface disposal of fluid industrial wastes in Manitoba;
Geological Paper GP83-1 — 10.00

Fedikow, M.A.F. (1987):
Detection of gold mineralization and lithologic mapping within the Agassiz Metallotect (Lynn Lake area) utilizing black spruce *(Picea mariana)* bark;
Open File Report OF86-6 — 5.00

Fedikow, M.A.F. (1987):
Results of a vegetation geochemical survey near Bissett, southeastern Manitoba;
Open File Report OF86-3 — 5.00

Gunter, R.W. and Segard, S. (1987):
Industrial Minerals of Manitoba;
Open File Report OF85-7 — No Charge

Leskiw, P.D. (1986):
Bibliography of Manitoba Geology 1;
Open File Report OF86-1 — 5.00

Nielsen, E. (1987):
Till geochemistry of the Seal River area, east of Great Island, Manitoba;
Open File Report OF87-1 — 5.00

Agricola Mineralia (1987):
Manitoba Stone; MDA (ERDA) contract, distributed by
Manitoba Energy and Mines — No Charge

Manitoba Energy and Mines:
Earth Science Film Program for Manitoba schools; MDA project — No Charge

AGGREGATE RESOURCES REPORTS

Jones, C.W. (1987):
The aggregate potential of selected Paleozoic and Precambrian rocks in Manitoba;
Aggregate Report AR86-1 — 6.00

MINES BRANCH REPORTS

Esposito, B. (1987):
(Supersedes ES 80-2) Copper and zinc in Manitoba;
Mineral Education Series — No Charge

Gunter, W.R. (1987):
(Supersedes ES77-1) Gypsum in Manitoba;
Mineral Education Series — No Charge

EXTERNAL PUBLICATIONS

Bailes, A.H.

1987: Silification, Fe-Mg metasomatism and synvolcanic plutonism, Snow Lake, Manitoba; **in** Geological Association of Canada-Mineralogical Association of Canada, Program with Abstracts, v. 12.

Baldwin, D.A., Syme, E.C., Zwanzig, H.V., Gordon, T.M., Hunt, P.A. and Stevens, R.P.

1987: U-Pb zircon ages from the Lynn Lake and Rusty Lake metavolcanic belts, Manitoba: Two ages of Proterozoic magmatism; Canadian Journal of Earth Sciences, v. 24, p. 1053-1063.

Clark, G.S. and Schledewitz, D.C.P.

In press: Rubidium-strontium age and origin of uraniferous granite, Molson Lake-Red Sucker Lake area, northwestern Superior Province, Manitoba; Canadian Journal of Earth Sciences.

Clark, G.S. and Weber, W.

In press: Rubidium-strontium ages of Archean and Proterozoic rocks in the Nejanilini and Great Island domains, Churchill Province, northern Manitoba, Canada; Canadian Journal of Earth Sciences.

Fedikow, M.A.F.

1986: Gold mineralization association with the Agassiz Metallotect and the Johnson Shear Zone, Lynn Lake greenstone belt, Manitoba; **in** Gold in the western Shield; Canadian Institute of Mining and Metallurgy, Special Volume 38, p. 361-378.

Gordon, T.M., Hunt, P.A., Loveridge, W.D., Bailes, A.H. and Syme, E.C.

1987: U-Pb zircon ages from the Flin Flon and Kisseynew belts, Manitoba: Chronology of early Proterozoic crust formation; **in** Geological Association of Canada-Mineralogical Association of Canada, Program with Abstracts, v. 12.

Halden, N., Clark, G.S., Lenton, P.G., Corkery, M.T. and Schledewitz, D.C.P.

1986: Geochemical and isotope constraints on the tectonic significance of the Chipewyan batholith, and Proterozoic magma genesis; **in** Geological Association of Canada-Mineralogical Association of Canada, Program with Abstracts, v. 12.

Heaman, L.M., Machado, N., Krogh, T.E. and Weber, W.

1986: Precise U-Pb zircon ages for the Molson dyke swarm and the Fox River sill: Constraints for Early Proterozoic crustal evolution in northeastern Manitoba, Canada; Contributions Mineralogy and Petrology, v. 94, p. 82-89.

Machado, N., Heaman, L., Krogh, T.E. and Weber, W.

1987: U-Pb geochronology of the Thompson mobile belt, Manitoba:
Preliminary results, **in** Geological Association of Canada-Mineralogical Association of Canada, Program with Abstracts, v. 12.

McCabe, H.R.

1987 Devonian stratigraphy of the southwestern Manitoba outcrop belt; Field Guidebook, Second International Symposium on the Devonian System, Canadian Society of Petroleum Geologists, Calgary.

McRitchie, W.D.

1987: Geological program highlights 1986-87, Geological Services Branch, Manitoba Energy and Mines; Provincial Geologists Journal 1986, v. 4, p. 42-50.

Stewart, J., Gilbertson, D. and Dixon, R.

1986: Peatland Inventory of Manitoba: II - S.E. Manitoba using Landsat; Manitoba Natural Resources, Surveys and Mapping, Manitoba Remote Sensing Centre.

Syme, E.C.

1987: Stratigraphy and geochemistry of two Proterozoic arcs: Lynn Lake and Flin Flon metavolcanic belts, Manitoba; **in** Geological Association of Canada-Mineralogical Association of Canada, Program with Abstracts, v. 12.

Turek, A., Keller, R., Weber, W. and Van Schmus, W.R.

1987: New U-Pb zircon ages for the Rice Lake greenstone belt, southeastern Manitoba; **in** Geological Association of Canada-Mineralogical Association of Canada, Program with Abstracts, v. 12.

Weber, W.

1987: The Churchill-Superior boundary zone: Constraints for the tectonic evolution of the southeastern margin of the Trans-Hudson orogen; **in** Geological Association of Canada-Mineralogical Association of Canada, Program with Abstracts, v. 12.

Weber, W. and Gordon, T.M.

1987: Project Cormorant: An attempt to delineate Precambrian basement geology beneath Paleozoic carbonates south of Flin Flon-Snow Lake; **in** Geological Association of Canada-Mineralogical Association of Canada, Program with Abstracts, v. 12.

Zwanzig, H.V.

1987: Stratigraphy and tectonics of the Kisseynew complex, Manitoba; **in** Geological Association of Canada-Mineralogical Association of Canada, Program with Abstracts, v. 12.

PRELIMINARY MAPS — 1987

GEOLOGICAL SERVICES BRANCH

Geological Survey

		Scale
1987C-1	Subsurface Precambrian of Hudson Bay Lowland by C.R. McGregor	1:1 000 000
1987F-1	Schist Lake (Parts of 63K/12W and 12E) by E.C. Syme (Supersedes 1986F-1)	1:15 840
1987F-2	Athapapuskow Lake (Part of 63K/12E) by E.C. Syme	1:15 840
1987F-3	Tartan Lake-Lac Aimée (Part of 63K/13) by H.P. Gilbert (Supersedes 1986F-2)	1:15 840
1987K-1	Kississing Lake West (63N/3) by D.C.P. Schledewitz (Supersedes 1986K-1)	1:20 000
1987K-2	Kississing Lake East (63N/3) by D.C.P. Schledewitz (Supersedes 1986K-2)	1:20 000
1987K-3	Limestone Point Lake (Parts of 63N/1,2) by H.V. Zwanzig, P.G. Lenton and B.S. Miller	1:50 000
1987K-4	Star Lake (Part of 63N/2) by H.V. Zwanzig and B.S. Miller	1:20 000
1987K-5	Burntwood Lake Syenite (63N/8, 9, 10) by W.D. McRitchie	1:4 200
1987N-1	Cross Lake Northwest (63-I/12 NW) by M.T. Corkery and H.D.M. Cameron	1:20 000
1987N-2	Cross Lake Southwest (63-I/12 SW) by M.T. Corkery and H.D.M. Cameron (Supersedes 1984N-2)	1:20 000
1987S-1	Chisel-Morgan Lakes (Part of 63K/16) by A.H. Bailes (Supersedes 1986S-1)	1:15 840
1987T-1	Thompson Open Pit Mine — 1C Pit Cross-section (Part of 63P/12W) by J.J. Macek	1:500

Bedrock Geology Compilation Map Series, Preliminary Edition

________	Kenora, NTS 52E by C.R. McGregor, D. Kowerchuk and W. Weber	1:250 000
________	Pointe du Bois, NTS 52L by D. Kowerchuk and W. Weber	1:250 000

Mineral Investigations

1987MI-1	Leo Lake (Part of 63K/13) by K. Ferreira	1:5 000

Mineral Deposit Map Series, Preliminary Edition

________	Mineral Deposits and Occurrences in the Mikanagan Lake Area (63K/13SE) by D.R. Eccles	1:20 000

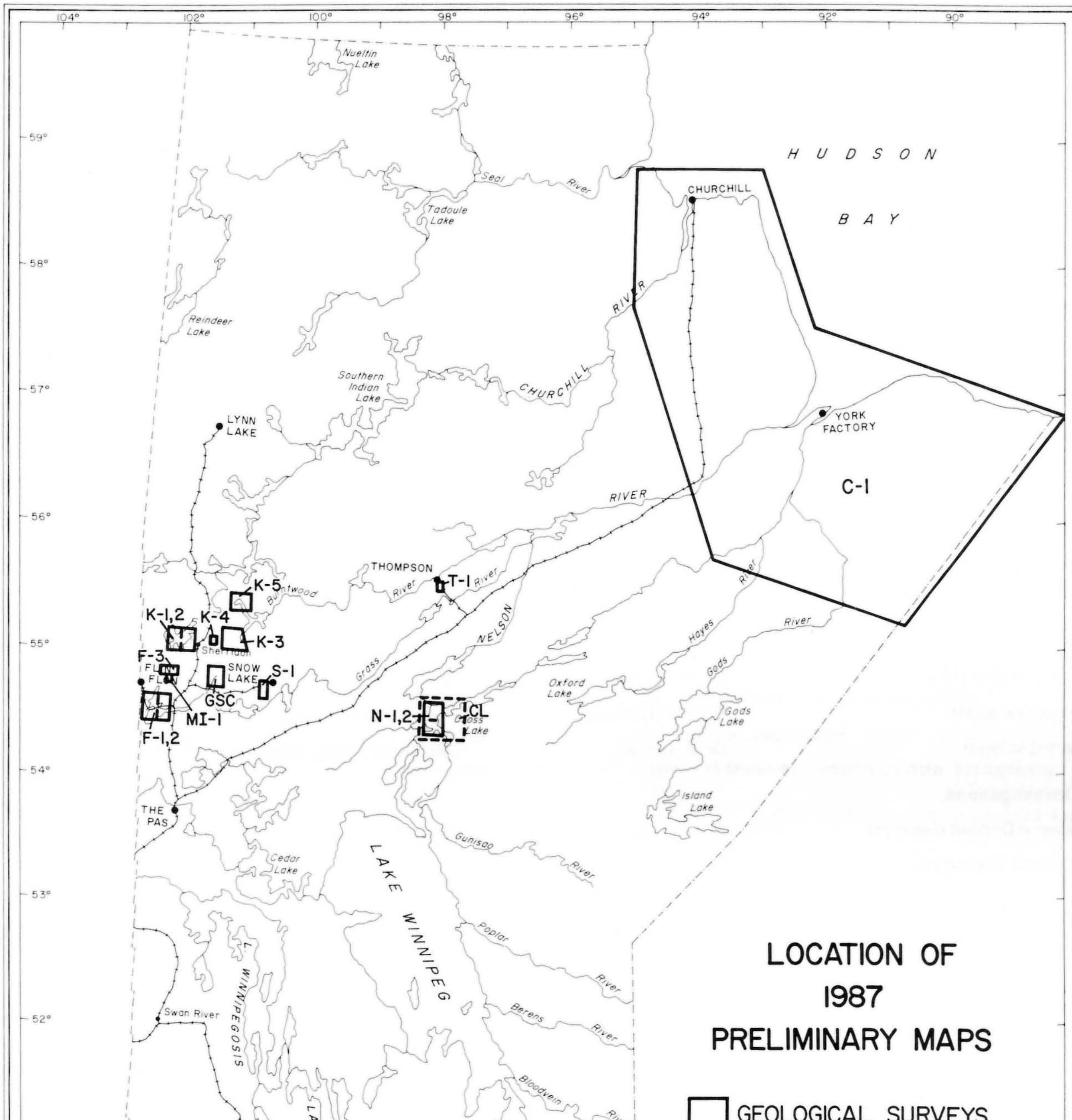
MINES BRANCH

Aggregate Resources

1987-CL	Aggregate Inventory of Cross Lake area (Parts of 63-I/12 and 63J/9) by M.A. Mihychuk	1:50 000
1987-DS	Aggregate Resources in R.M. of De Salaberry (Parts of 62H/6,7,10,11) by G.L.D. Matile	1:50 000
1987-LOU	Aggregate Resources in R.M. of Louise (Parts of 62G/2,3,6,7) by R.V. Young	1:50 000
1987-MOR	Aggregate Deposits in R.M. of Morton (Parts of 62G/4,5 and 62F/7,8) by H.D. Groom	1:50 000
1987-WIN	Aggregate Deposits in R.M. of Winchester (Parts of 62F/1,2,7,8) by H.D. Groom	1:50 000

GEOLOGICAL SURVEY OF CANADA

1987GSC	Geological Setting of Gold Mineralization in the Elbow Lake Region, Manitoba (Part of 63K/15) by A.G. Galley and D.E. Ames	1:20 000


LOCATION OF
1987
PRELIMINARY MAPS
GEOLOGICAL SURVEYS
AGGREGATE RESOURCES
(ALL MAPS ARE PREFIXED '1987')
HUDSON
BAY
CHURCHILL
YORK FACTORY
C-I
LYNN LAKE
THOMPSON
T-I
K-5
K-I,2
K-4
K-3
F-3
FLIN FLON
SNOW LAKE
S-I
GSC
MI-I
F-I,2
N-I,2
CL
THE PAS
LAKE WINNIPEG
L. WINNIPEGOSIS
LAKE MANITOBA
Swan River
Dauphin
BISSETT
52L
52E
Virden
BRANDON
Portage la Prairie
WINNIPEG
WIN
MOR
LOU
DS
KILOMETRES

LIST OF GEOLOGICAL STAFF AND AREAS OF CURRENT INVOLVEMENT

GEOLOGICAL SERVICES

POSITION	PERSONNEL	AREA OF CURRENT INVOLVEMENT
Director	Dr. W.D. McRitchie	Manitoba
Geological Survey:		
Senior Precambrian Geologist	Dr. W. Weber	Manitoba
Precambrian Geologists	Dr. A.H. Bailes	Snow Lake
	H.D.M. Cameron	Cross Lake area
	M.T. Corkery	Cross Lake-Northern Superior Province, Nelson and Churchill River
	H.P. Gilbert	Tartan Lake, Island Lake, Barrington Lake
	P.G. Lenton	Cross Lake-Kisseynew gneissic belt — granite and pegmatite
	Dr. J.J. Macek	Thompson, Bird River
	D.C.P. Schledewitz	North of 58°; Kississing Lake
	E.C. Syme	Flin Flon, Athapapuskow Lake
	Dr. H.V. Zwanzig	Churchill Province/Kisseynew, Lynn Lake
Mineralogist	C.R. McGregor	Sub-Phanerozoic Precambrian
Geological Compiler (Atlas)	D. Kowerchuk	Map compilations
Phanerozoic Geologist	Dr. H.R. McCabe	Southwest Manitoba and Interlake
Quaternary Geologist	Dr. E. Nielsen	Manitoba-Stratigraphy, basal till geochemistry
Mineral Investigations:		
Senior Mineral Deposit Geologist	Dr. G.H. Gale	Manitoba, specifically Flin Flon and Snow Lake
Mineral Deposit Geologists	Dr. D.A. Baldwin	Lynn Lake-Ruttan area
	Dr. P. Theyer	Southeast Manitoba
	Dr. M.A.F. Fedikow	Snow Lake area and geochemistry
	G. Ostry	File Lake-Sherridon area
	D. Parbery	Mineral Deposit Geological Assistant
	K. Ferreira	Mineral Deposit Geological Assistant
Industrial Minerals Geologists	W.R. Gunter	Northern Manitoba
	B.E. Schmidtke	Southern Manitoba
	P.H. Yamada	Industrial Minerals Geological Assistant
Computerization	G.G. Conley	Stratigraphic data files
	D.R. Eccles	Mineral Deposit files
Editorial & Cartographic Services:		
Geological Editor	B.B. Bannatyne	

MINES BRANCH

POSITION	PERSONNEL	AREA OF CURRENT INVOLVEMENT
Director of Mines	W.A. Bardswich	Manitoba
Aggregate Resources:		
Section Head	R.V. Young	Aggregate inventory R.M. of Louise; Manitoba
Geologist	G.L.D. Matile	Aggregate inventory R.M. of De Salaberry
	H.D. Groom	Aggregate inventory R.M. of Morton and Winchester
	M.A. Mihychuk	Aggregate inventory Cross Lake Area
Mining Engineering:		
Resource Management Geologist	C.W. Jones	Aggregate resources management
Exploration Services:		
Section Head	W.D. Fogwill	Exploration activity in Manitoba
Assessment Geologist	B. Esposito	Assessment files
Special Projects Geologist	D.E. Prouse	Exploration activity, drill core program
Staff Geophysicist	I.T. Hosain	Regional compilation of assessment data
Mineral Information Geologist	J.D. Bamburak	Publications, information
Compilation Geologist	L. Chackowsky	Indices to Manitoba geoscience data; bibliography
Mineral Inventory Geologist	D.J. Richardson	Mineral deposit data