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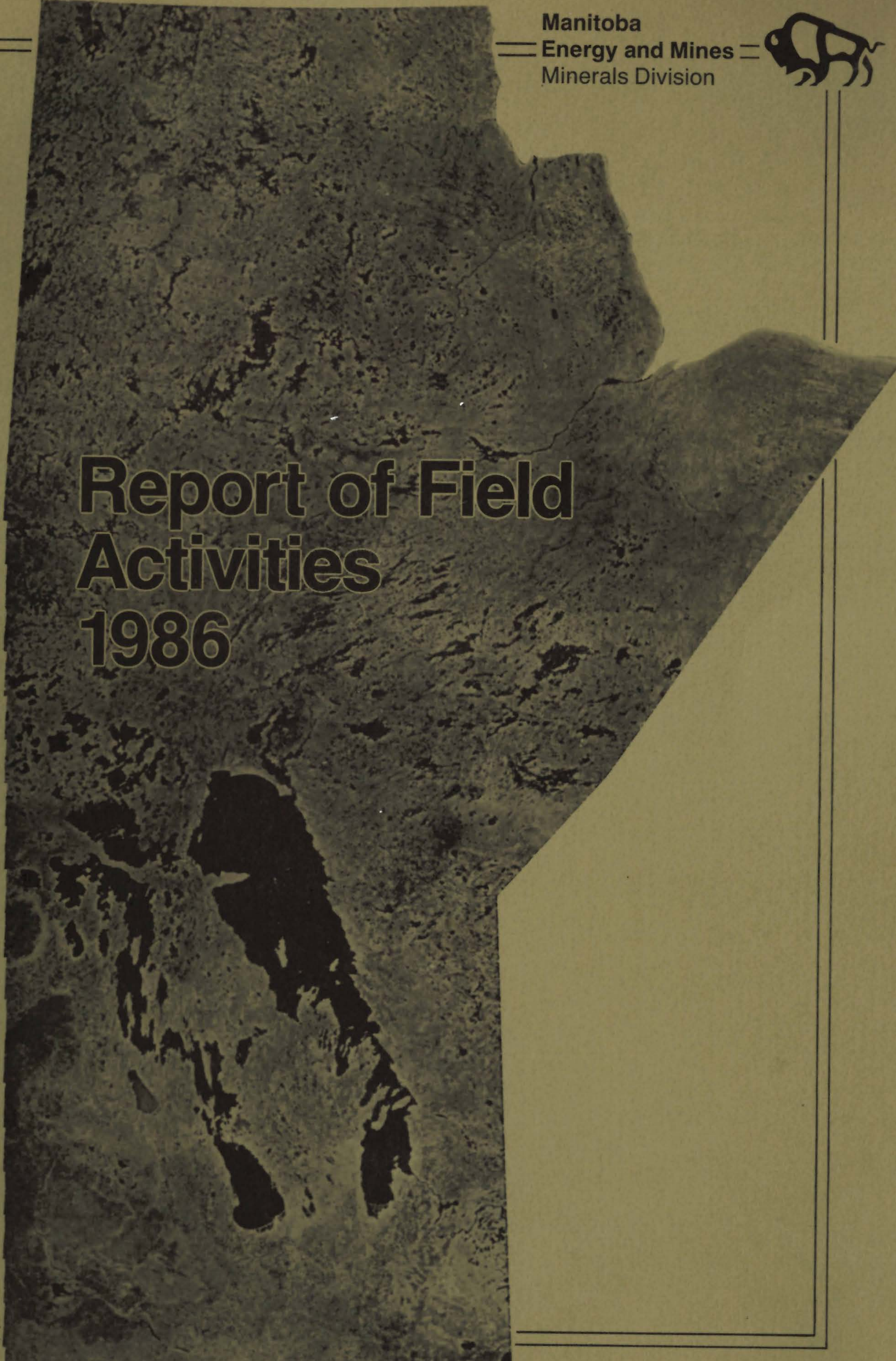


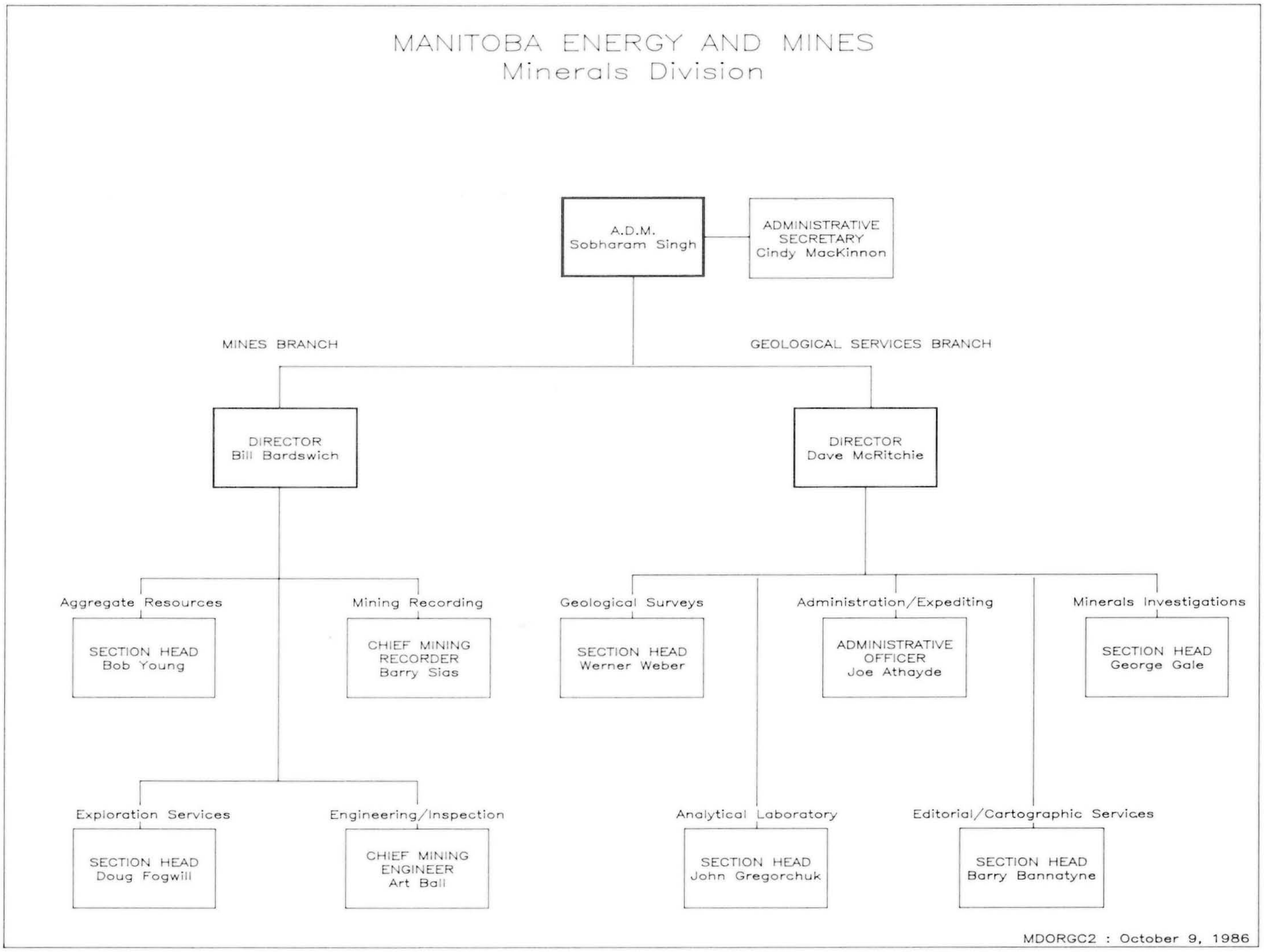
Report of Field Activities 1986

Manitoba
Energy and Mines

MINERALS DIVISION

REPORT OF FIELD ACTIVITIES 1986

1986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MDORGC2 : October 9, 1986

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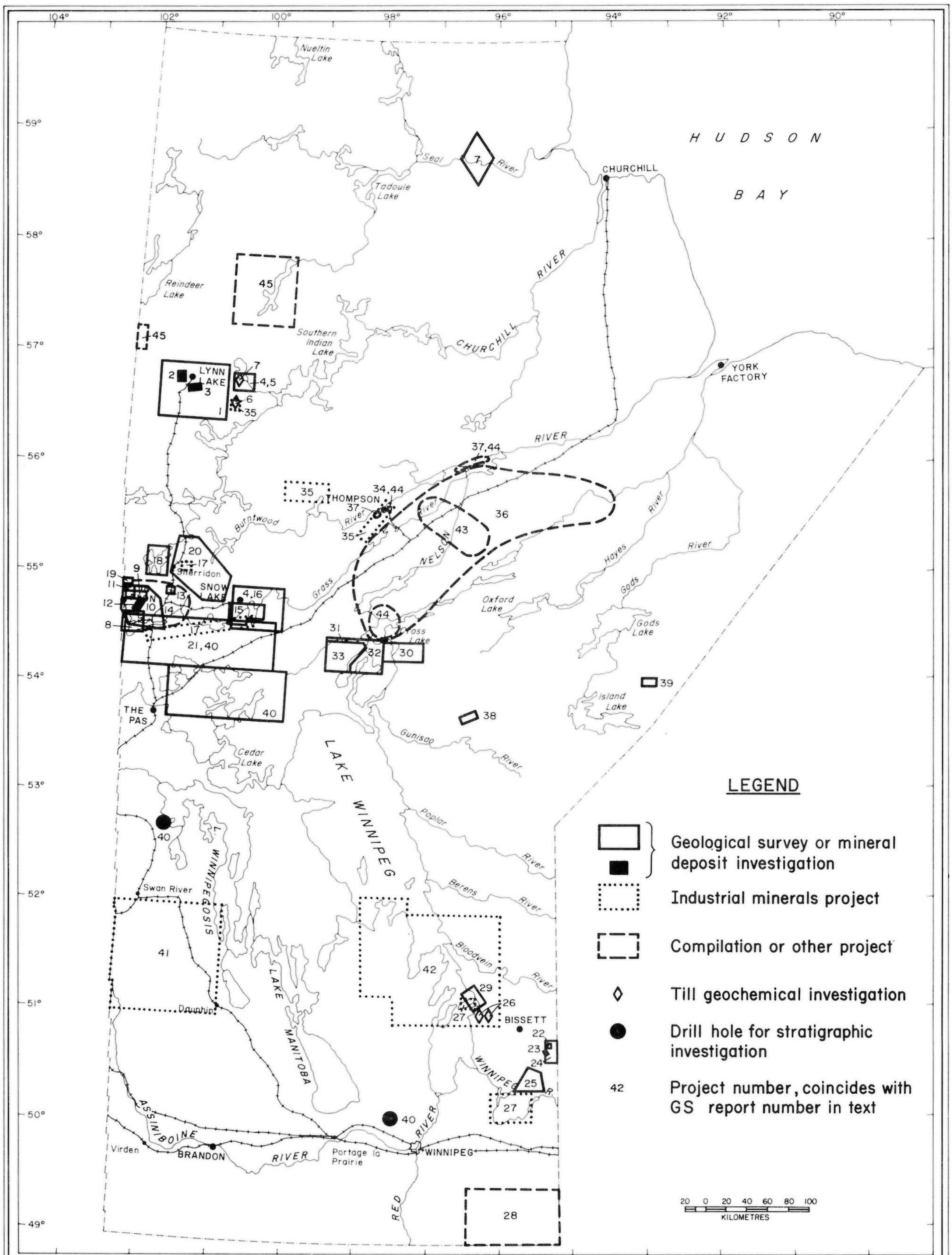

Figure GS-1: *Location of Field Projects, 1986. (Numbers refer to reports in this publication.)*

INTRODUCTORY REVIEW
by W.D. McRitchie

In this the third year of the Canada-Manitoba Mineral Development Agreement (1984-89)[1] an accelerated level of industry-supportive, minerals-oriented programming was again mounted by the Provincial Department of Energy and Mines in concert with parallel program delivery by EMR Canada.

The joint Federal/Provincial Workplan for 1986-87 was approved by the Management Committee to the Agreement in February, 1986, and copies distributed in March to members of the newly constituted Mining and Mineral Exploration Liaison Committees.

The Sector A Geoscientific program encompassed 55 Provincial and 22 Federal projects with operational budgets of one million and two million dollars, respectively. In large part the projects were conducted by staff of the Manitoba Geological Services Branch (MGSB) and the Geological Survey of Canada (GSC).

Although Provincial Sector A budgets were reduced to 66% of those available in 1985, efforts were still maintained in all districts of concern with a special focus on the Lynn Lake-Ruttan and Flin Flon-Snow Lake mineral belts. For several projects, the initial field objectives set under the MDA were attained, and the stage set for data compilation analysis and final report production during the concluding years of the Agreement.

Briefing sessions were given in each of the northern mining districts and a complete review of all MDA activities was presented to the Winnipeg section of the CIM in April prior to the field season. Government-industry field tours and demonstrations were held in the Thompson and Flin Flon-Snow Lake areas. However, an extensive demonstration planned for the Cross Lake region had to be postponed in the face of extraordinarily high water levels on the Nelson River, a factor which also necessitated radical rescheduling of mapping programs planned for the Jenpeg region.

A progress report covering all aspects of Sector A programming during fiscal year 1985-86 was released in August, 1986. Other Open File reports were released throughout the year together with numerous brochures on various aspects of Agreement programming.

The reduced funding levels impacted adversely on the Province's ability to sponsor support studies and, accordingly, applied geoscience research (AGR) efforts were constrained to 6 projects, 5 being with the University of Manitoba. The Geological Survey of Canada sponsored 12 AGR projects, 6 through the University of Manitoba and 6 to universities and agencies in other provinces.

MGSB staff also provided input to other MDA Sectoral activities including drilling of tailings at Sherridon and Flin Flon, dimension stone site-selection in southeast Manitoba, acquisition of kaolin samples from Black Island for beneficiation studies by CANMET, and editorial and technical input to brochures on industrial minerals, gold, basal till studies, educational programs, and a contracted evaluation of feldspar from Bernic Lake.

Enquiries from the private sector focussed principally on gold and platinum, with an equivalent level of demand for information on industrial minerals including high-calcium limestone, silica, gypsum, kaolin, building stone, peat and crushed stone (dolomite).

Although the MDA mechanism continues to facilitate the generation of useful, timely and pragmatic geoscientific information, as a backdrop and underpinning to exploration initiatives in the Province, efforts are still being made to encourage and maintain a high level of dialogue between all interested parties.

The principal successful elements of the MDA approach appear to be:

(a) the emphasis given to task-oriented and co-operative (parallel and integrated) program delivery by the Federal and Provincial Surveys (with full support from other agencies, universities, etc.).
(b) an increased level and commitment to liaison and collaboration with industry geologists in all stages of programming from planning to implementation;
(c) a concerted effort to increase everybody's awareness of the programming through widespread circulation of interim and progress reports, briefs, etc.;
(d) an elevated sense of urgency fostered by immediate association with communities overshadowed by possible mine closure, as well as the awareness that these difficulties are part of a much larger crisis requiring readjustments on a national as well as international scale;
(e) provision of the Governmental staffing and budgetary resources necessary to plan, mount, audit, restructure, and conclude a coherent and unbroken five-year Survey program; and, most importantly,
(f) a coincident upsurge and expansion of the Private Sector's ability to mount aggressive exploration programs funded in large part with capital stemming from flow-through shares.

In addition to its MDA commitments the Provincial Geological Services Branch also contributed to a Workshop convened in April, 1986, at the University of Manitoba. Discussions led to the formation of a steering committee and the formulation of a proposal for a Lithoprobe geophysical and geological transect of the Trans-Hudson Orogen, with coordinated participation by universities in Manitoba and Saskatchewan. If accepted the proposal could lead to the generation of unique data on megascopic crustal features associated with the Churchill-Superior Province boundary, as well as additional near-surface data of use to the mining sector.

Studies of Quaternary deposits led to joint MGSB/GSC involvement in the regional documentation of the Gillam area, as well as Provincial participation in the EMR-sponsored reconnaissance of sea-floor sediments and submarine resources in Hudson Bay.

A Devonian outcrop belt tour provided to Home Oil was reportedly helpful in interpreting reef structures in Saskatchewan and in the subsequent discovery of a producing well in that province.

MGSB staff also collaborated in other research projects involving U-Pb geochronology (University of Kansas); fluid inclusion studies, geothermobarometry of the Pikwitonei region; petrographic investigation of the Namew Lake deposit (University of Regina); and ongoing cooperative studies with geologists from NASA on anorthosites from the Pikwitonei region and elsewhere in the Province.

LYNN LAKE-RUTTAN DISTRICT (including northern Churchill Province)

Documentation of mineral deposits in the Lynn Lake area was completed as a first step to creating a mineral deposit inventory for the district. The results will be compiled into 1:50 000 synoptic maps identifying, on a geological base, the deposit type, host rock to mineralization, ore type by weight and volume, and other relevant parameters of the deposits.

Detailed mapping and geochemical sampling at Sheila, Ralph, Spider, Farley and Motriuk Lakes compared these sections with those of the MacLellan gold mine, and extended the Agassiz Metallotect at least

[1]A subsidiary Agreement to the Economic and Regional Development Agreement (ERDA).

5 km southwest of Lynn Lake to Margaret Lake. Other settings of gold mineralization between Franklin and Wasekwan Lakes were also investigated, as was the relationship between stratigraphy and base metal mineralization in the Lynn Lake Rhyolite complex, and the West Anomaly near Ruttan.

Vegetation studies at the MacLellan Mine, Spider, Farley and Dot Lakes (as well as the Ferguson Mine near Herblet Lake) encountered much lower levels of trace gold in alder twigs than has been recorded from control studies in Saskatchewan. It was concluded that the gold contents of ash from alder twigs may be substantially affected by the drainage pattern of the sampling area.

Multi-spectral remote sensing data have now been acquired for the Lynn Lake region, and will be used to search for metal-induced stress in vegetation associated with blind mineralization along the entire length of the Agassiz Metallotect.

Basal till studies initiated in 1985, and subsequently adopted by exploration companies active in northern Manitoba, encountered anomalous arsenic and gold values in the Ruttan region in till deposited on the lee side of large outcrops. Several factors indicate a principal source associated with the Vol fault.

Till sampling east of Great Island, Seal River, confirmed earlier reported high arsenic values, some of which were significantly well above regional background values. These results, together with previously identified lake sediment geochemical anomalies and recent accounts of extensive arsenopyrite traced to bedrock northwest of Great Island, collectively indicate a hitherto unrecognized metallogenic signature and high gold potential for the greenstones of this region.

U-Pb zircon ages from porphyritic granite and monzocharnockite in the Chipewyan Batholith are coeval, agree with those from the Saskatchewan extensions of the pluton, and appear to indicate emplacement of magma at 1855 Ma into slightly older (1875-1880 Ma) crustal rocks. Although intense deformation appears to have waned by 1832 Ma, the largely post-tectonic dyke on Reindeer Lake giving this age shows evidence of subsequent deformation and recrystallization.

FLIN FLON-SNOW LAKE DISTRICT

Detailed mapping, sampling and mineral deposit investigations focussed on the Vamp, Tartan Lake, Baker Patton, Neso Lake, Twin Lakes and Fay Lake deposits. At Tartan Lake the recognition of a distinctive zonation in the shear zones, and pattern of alteration, will assist the search for extensions to the shear zones containing the main mineralization. Preliminary geological maps of volcanogenic sulphide mineralization were prepared for the Baker Patton and Fay Lake occurrences.

In the Snow Lake region the bulk of data acquisition for preparation of 1:50 000 and 1:20 000 scale metallogenic maps has been completed. Further evidence was obtained supporting the concept that polymetallic quartz veins, within or close to mafic volcanic rocks containing Cu-Zn massive sulphide deposits, represent a genetically associated 'leakage' or 'sweat-out' alteration phenomenon.

Industrial minerals investigations focussed on garnet and sillimanite deposits at Star Lake, talc at Iskwasum Lake, dolomite south of the exposed Flin Flon and Snow Lake greenstone district, and kaolin associated with the Paleozoic unconformity.

Mineral deposit studies in the Kisseynew terrain entailed detailed mapping of selected mineral occurrences at Puffy, Walton and Evans Lakes as well as a reconnaissance north of Nokomis Lake and south of Walton Lake. It is now apparent that quartzofeldspathic gneisses may locally occur within the so-called Nokomis greywacke sequence; however, the structural as opposed to stratigraphic controls on this more complex configuration have yet to be resolved.

Mapping at a scale of 1:20 000 in the Flin Flon region extended coverage into the Athapapuskow Lake area and confirmed the principal structural control by major block-bounding faults of several different ages, as well as the difficulty of correlating stratigraphy and mineralized zones between fault blocks.

Reconnaissance mapping of the Tartan Lake and Lac Aimée area established the late emplacement age of the gabbro complex which hosts the sulphide and gold mineralization.

Continuing work in the Kisseynew Lake area provided further confirmation that a single mineralized metallotect is an oversimplified concept since the paragneissic sequences contain numerous amphibolite layers at different levels within the intensely deformed migmatitic complex. A unit of metamorphosed feldspar-phyric basalt on Weasel Bay, and a metamorphically armoured norite intrusion south of Imperial Lake, may represent northern extensions of the Amisk Group and Boundary Intrusions, respectively.

On Kississing Lake intensive documentation of shoreline exposures seems to confirm the existence, at a regional scale, of the three principal lithologic associations defined by earlier workers (garnet-biotite-graphite gneiss, amphibolites, and quartzofeldspathic gneiss). However, in detail this simplistic grouping appears invalid and numerous instances occur where units appear out of sequence and with little along-strike continuity. Preliminary interpretations of structural history indicates at least three folding events (recumbent, isoclinal, cross-folding), the latter with associated brittle deformation. Mineral occurrences/conductors appear associated with the amphibolite sequence, especially in areas of considerable deformation.

Geological mapping at a scale of 1:15 840 in the Chisel-Morgan Lakes area, delineated several major fault structures and identified more than one age of synvolcanic quartz-phyric tonalite displaying Fe-Mg alteration networks. A direct though tentative corollary to this is the inference that associated hydrothermal activity (and hence mineralizing events), may have spanned a considerable time interval during the evolution of the Flin Flon-Snow Lake greenstone belt and consequently mineral deposits may occur at several rather than a single stratigraphic level in the volcanic sequence.

Close to 400 samples collected from granitic intrusives in the Flin Flon belt are being analyzed at the University of Manitoba as the initial step of a longer term program to geochemically categorize the felsic intrusions of this region and evaluate their metallogenic potential.

Ten additional holes were drilled south of Athapapuskow Lake as a continuation of the sub-Paleozoic compilation in the Project Cormorant area.

SOUTHEAST MANITOBA DISTRICT

An additional 30 mineral occurrences were examined in the Rice Lake region bringing documentation in this region near to completion. Particular attention was given to gold associated with epigenetic sulphide mineralization at the 'Tut' occurrence, gold-bearing quartz veins in a 2 km long stratigraphic unit at Lily Lake, and gold within arkosic rocks of the Edmunds Lake Formation.

Samples from the Dumbarton Mine/Maskwa West pit, the Wards occurrence, New Manitoba Mine, Hititrite and Mayville occurrences, English Lake and the Bird River Complex, returned only sub-economic and/or marginally detectable Pt and Pd values, as did 50 samples from the Neepawa mafic-ultramafic complex.

Industrial minerals activities continued evaluation of potential sites for dimension stone in southeast Manitoba as well as collection of additional samples of kaolin on Black Island using a solid stem auger. Ground truthing of peat bogs near Grindstone Point was conducted in cooperation with the Manitoba Centre for Remote Sensing and the University of Manitoba Department of Botany, as part of an ongoing program to evaluate the use of remote sensing as a means to conducting a rapid and economic regional inventory of sphagnum peat bogs.

Detailed mapping near Stormy Lake and the Manigotagan River refined the structure and stratigraphy of the Wadhope-Gunnar anticlinorium as well as the transition from volcanism to sedimentation in the Rice Lake Group. Several new factors of economic significance were unveiled including definition of subaerial volcanics, location of volcanic vents and a structural control of mineralization in gabbroic rocks.

Backhoe sampling in the Manigotagan area confirmed the presence of trace gold in reworked littoral glacial sands, and a potential for placer deposits.

An evaluation of geophysical and subsurface drill hole information has led to an enhanced interpretation of the Precambrian geology beneath Phanerozoic cover rocks in the Whitemouth and Black Island areas.

THOMPSON DISTRICT

In north-central Manitoba the industrial minerals evaluation focussed on marble in the Thompson and Pipe open pits, cordierite in the Nelson House region and alteration minerals at the Ruttan Mine. Samples were also collected from the Manasan quarry which may have a potential as a source for lump silica.

Mapping at a scale of 1:20 000 at Cross Lake extended eastwards to encompass supracrustal sequences at Butterfly Lake as well as all lithologies in the Jenpeg forebay, on Playgreen and Kiskittogisu Lakes. Geologically the latter area is similar to the Molson Lake batholithic domain comprising an older suite of large batholith complexes with an extended tectonic history. The batholiths predate the Cross Lake supracrustal sequence. Detailed sampling of anorthosites and the associated magnetite/ilmenite deposit on Pipestone Lake was extended westwards to include the "West Channel" anorthosite between the Minago River and Kiskitto Lake. Although no chromitite seams were discovered in this anorthosite, numerous samples were collected for analysis and the initial appraisal suggests mineralogical and textural similarities with the Fiskenaesset complex in Greenland, a generally high anorthite content, as well as some potential for building stone.

In Thompson the recent development of INCO's new open pit mine facilitated detailed documentation of a complete reference section of metasedimentary and mafic-ultramafic rocks, associated with the ore zone, which are only sporadically and incompletely exposed elsewhere. Several factors appear to support an originally Archean age for ultramafics exposed in the Pit.

Geochemical, rare earth and trace element analyses are being undertaken, with cooperation from the University of Manitoba, on mafic and ultramafic rocks along the Thompson belt, and rubidium-strontium determinations were also initiated on felsic intrusions and late deformation zones (pseudotachylite). Together with detailed and regional structural studies funded by the GSC, and the U-Pb geohronology program, these projects represent a concerted attempt to come to grips with the geology of the Churchill-Superior boundary zone, to understand the paragenesis of the nickel deposits, and to evaluate the potential for other types of mineralization.

U-Pb geochronology in the Pikwitonei-Cross Lake region consistently revealed the presence of two distinct events at a number of localities throughout the Pikwitonei subprovince, although minor differences in these ages were also evident. The older ages all fall within a limited range, i.e. 2719 (Sipiwesk), 2690 (Natawahunan) and 2695 Ma (Cauchon); however, the younger set encompasses a time span of 44 Ma with the youngest age occurring at Cauchon Lake where post-granulite pegmatite has been dated at 2629 Ma.

Ages on a Cross Lake-Molson Lake dyke (1884 Ma), a Cuthbert Lake ultramafic dyke (1883 Ma) and the Fox River Sill itself (1884 Ma) suggest that these intrusions are coeval and possibly comagmatic, recording an intrusive event that took place after extrusion of the Lynn Lake arc volcanics (1910 Ma) and slightly prior to intrusions along the Churchill River magmatic zone, and the contemporaneous Ruttan volcanics (1878 Ma).

NORTHWEST SUPERIOR PROVINCE — GODS-ISLAND LAKE REGION

A reconnaissance of the Ponask Lake region encountered widespread mylonites, amphibolites and quartz diorite, but, with the exception of some small mafic intrusions, no economically significant mafic or ultramafic complexes were encountered. Consequently, there appears to be little potential for economic Ti, V, Cr or Pt mineralization in the area.

The continuing evaluation of rare-element pegmatites in the Province, by the University of Manitoba, has brought to light extensive and possibly economically significant occurrences of petalite in pegmatitic leucogranite at Red Sucker Lake. The associated highly fractionated geochemical anomaly is not only large but compares favourably with that developed over the Bernic Lake pegmatite in southeast Manitoba.

SOUTHERN MANITOBA

Documentation of industrial minerals in the Duck Mountain area was undertaken to provide background data for an industrial minerals potential map, the first of several intended for southern Manitoba.

Four projects were conducted as part of the stratigraphic mapping, and stratigraphic and industrial minerals drilling program. Sampling and core drilling of the Stonewall Formation were undertaken to provide accurate stratigraphic control on the location of the Silurian/Ordovician boundary in Manitoba. Additional drilling was undertaken to obtain a detailed profile of a Winnipegosis reef and to establish a model for reef development.

Outcrop mapping was completed in the Clearwater-Cormorant-Moose Lake area as part of an extensive program, also involving 'scout' drilling, designed to provide information on the lower Paleozoic sequences, as well as additional control on the distribution of units in the Precambrian basement inferred from gradiometer surveys conducted by the GSC.

Eight Precambrian sites in southeastern Manitoba were cored as part of a project to evaluate the quality of selected granitic rocks as ornamental/dimension stone.

EXPLORATION SERVICES

The Exploration Services Section of the Mines Branch continued core collection and cataloguing of existing holdings at its four facilities — Lynn Lake, Thompson, The Pas and Winnipeg. A considerable effort was expended to condense holdings at Lynn Lake and Thompson and in the construction of additional racking at the Thompson River Base. Consolidation of core in Winnipeg has been suspended and awaits the availability of new quarters at Midland Street currently occupied by the Department of Highways.

Compilation work resulted in the issuance of several new brochures and publications, including a Bibliography of Manitoba Geology, updates to the Manitoba Mineral Inventory, and the new Index to Non-confidential Assessment Reports.

GEOLOGICAL SURVEY OF CANADA

A comprehensive array of programs were also delivered by the Geological Survey of Canada as the Federal contribution to the MDA. These included several new aeromagnetic gradiometer surveys of the Elbow Lake, Hargrave River, and Moose Lake regions near Flin Flon, and Rice Lake (NTS 52M/4 and 52L/13NE) and Whitemouth (52E/6, 11) areas in southeast Manitoba.

Total field and vertical gradient maps at a scale of 1:50 000 were released for the Laurie Lake-Lynn Lake and Issett Lake-Pemichigamau Lake areas on April 29, 1986.

Regional lake sediment geochemical surveys were extended to the Red Sucker Lake and Island Lake region (NTS areas 53K, 53L, 53M (S 1/2) and 53E (N 1/2)), and regional till sampling and surficial mapping to NTS areas 63N, 63-O (W 1/2), 64B (S 1/2) and the north half of 63K near Flin Flon. The Terrain Sciences Division is also continuing research into the influence of glacial Lake Agassiz clays on the geochemistry of recent lake sediments, including deep coring of several lakes to assess vertical geochemical variations and possible vertical pathways for metal migration.

Detailed geological mapping is continuing near Laurie Lake and the Fox Mine, as well as investigations concentrated on examining alteration zones associated with volcanogenic massive sulphide deposits in the Lynn Lake, Flin Flon and Snow Lake areas.

U-Pb ages have been determined for several of the key units in the southern Churchill Province and others are near to completion.

Mineral investigations in the Flin Flon area involve the study of gold metallogeny, the metallogeny of mafic and ultramafic rocks and the study of deep footwall alteration zones below massive sulphide deposits.

A Master's degree will be completed at Carleton University on the pervasive silicification of rocks deep in the footwall to the Chisel Mine. Gold studies involved mapping of areas containing gold deposits in the Elbow Lake and Snow Lake regions, as well as around Phantom Lake, in Saskatchewan.

A University of Manitoba study, characterizing the mafic and ultramafic intrusions in the Flin Flon-Snow Lake belt, concentrated this year on the Reed Lake Pluton.

An initial compilation of all available sub-Paleozoic geological and geophysical data for NTS 63K is being undertaken by Taiga Consultants Ltd.

The Namew Lake PGE-nickel deposit was also investigated.

In the Bissett area, the GSC continued regional structural studies in the area centred on the San Antonio Gold Mine. The University of Manitoba continued its work on the mine-scale structures controlling the gold mineralization.

On the Chrome Property, in the Bird River layered intrusion, mapping of the chromite layers continued at a 1:100 scale.

Farther south, several students from the University of Manitoba engaged in studies on the Falcon Lake Stock including a thesis on the internal structure of the plug as well as studies of the petrography and gold mineralization, the latter centred on the Sunbeam-Kirkland Mine.

In the Thompson region the U-Pb geochronology program under contract to the Royal Ontario Museum continued, with the area of interest extended to Cross Lake, where mapping by provincial geologists has revealed well exposed rock types amenable to age dating.

A University of Toronto doctoral study investigated the structural setting of the Thompson Belt based on a detailed transect from the Pikwitonei granulite terrain to the Churchill-Superior boundary.

Under the Mineral Investigations sub-program the structure and related geology of the nickel deposits at the Thompson Mine constitutes a Ph.D. study at the University of New Brunswick.

The Terrain Sciences Division supervised a shallow seismic survey in the Thompson area along a line towards Gillam, the objective being to define thick deposits of glacial material that can be drilled during the 1987/88 season in the hope of characterizing the glaciation that has affected much of Northern Manitoba.

Several 1:250 000 scale Quaternary maps covering a large portion of the Superior Province in Manitoba are also being compiled from airphoto interpretations, together with selected ground truthing.

W.D. McRitchie
September 27, 1986.

GS-1 MINERAL DEPOSIT STUDIES IN THE LYNN LAKE AREA

by D.A. Baldwin

Field work related to the documentation of the geology of exposed mineral deposits in the Lynn Lake area is completed (Ferreira and Baldwin, 1984; Stewart and Brewer, 1984; Baldwin et al., 1985). These data as well as data collected for those deposits that can be investigated only from diamond drill core have been compiled to form a mineral deposit inventory for the Lynn Lake area. A preliminary classification of each deposit has been completed and the data portrayed on 1:50 000 topographic maps. These maps and the data file for each deposit are available for viewing upon request at the offices of the Manitoba Geological Services Branch, Winnipeg. Preparation of the final draft of the Lynn Lake area mineral deposit maps will commence during the winter of 1986-87. As well as location, symbology will identify deposit type, immediate host rock to mineralization, ore type by weight and/or volume and chemical class of each deposit. Mineral deposit symbols will be presented on a geological base that will also include the position and form of geophysical responders.

Detailed studies related to gold mineralization associated with the Agassiz Metallotect (Fedikow, 1983; Fedikow et al., 1984) are continuing (Fedikow, 1986). This past summer the stratigraphic successions containing disseminated sulphide in siliceous volcaniclastic metasedimentary rocks at Sheila Lake, Margaret Lake, Ralph Lake and Motriuk Lake (Baldwin, 1983; Ferreira and Baldwin, 1984) were re-examined and compared to the stratigraphic succession at the MacLellan Mine, formerly the Agassiz gold deposit (Ferreira, 1986a). The stratigraphy and gold mineralization in the area from Franklin Lake east to Wasekwan Lake (Baldwin et al., 1985) was investigated with a view to determining the nature of the gold mineralization in relationship to stratigraphy and geological structures (Ferreira, 1986b). Stratigraphic studies of the Lynn Lake Rhyolite Complex (Baldwin, 1983) and the relationship between volcanic stratigraphy and massive sulphide deposition in this complex are continuing.

A detailed study of the geology, geochemistry and gold mineralization at Cartwright Lake has been completed and reported in an M.Sc. thesis (Peck, 1986). The study of the Lar deposit alteration zone (Elliott, 1984; Elliott and Appleyard, 1985) is in the final stages of completion. A study of stratigraphy, structure and geochemistry of the rocks in the Fox Mine area (Olson, 1984) is nearing completion.

In addition to mineral deposit studies in the Lynn Lake area, a detailed analysis was made of mineralized intersections in diamond drill cores from the West Anomaly at the Ruttan Mine. The objective of this investigation was to establish a genetic model for this mineralization. The sulphide mineralization is transected by numerous granitic dykes and much of the sulphide has been mobilized. Nevertheless, several solid sulphide layers or lenses have sulphide textures and associated alteration mineral assemblages similar to those reported for the main Ruttan deposit by Speakman et al. (1982). The sulphide in the West Anomaly may represent a satellite deposit to the main sulphide lenses at the Ruttan Mine. Details of this investigation will not be presented here. In conjunction with the study of the West Anomaly, an evaluation of the residual exploration potential in the Rusty Lake greenstone belt was initiated utilizing information supplied by exploration companies who are or have been active in the area since the early 1960s.

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GS-2 GEOLOGICAL INVESTIGATIONS IN THE SHEILA LAKE-MARGARET LAKE AREA

by K. Ferreira

INTRODUCTION

Stratigraphic studies were undertaken in the Sheila Lake-Margaret Lake area in order to extend the stratigraphic data base and to compare the stratigraphy at Sheila and Margaret Lakes with the stratigraphy of the Agassiz Metallotect. The area of investigation extended north to Ralph Lake, south to Frances Lake, east to the Lynn River, and west of Margaret Lake (Fig. GS-2-1, -2). The stratigraphy at Sheila Lake was described by Baldwin (1983), based on outcrop examinations on a peninsula along the southeast shoreline. Pyritic siliceous metasedimentary rocks have been identified as a continuous unit traceable by airborne EM.

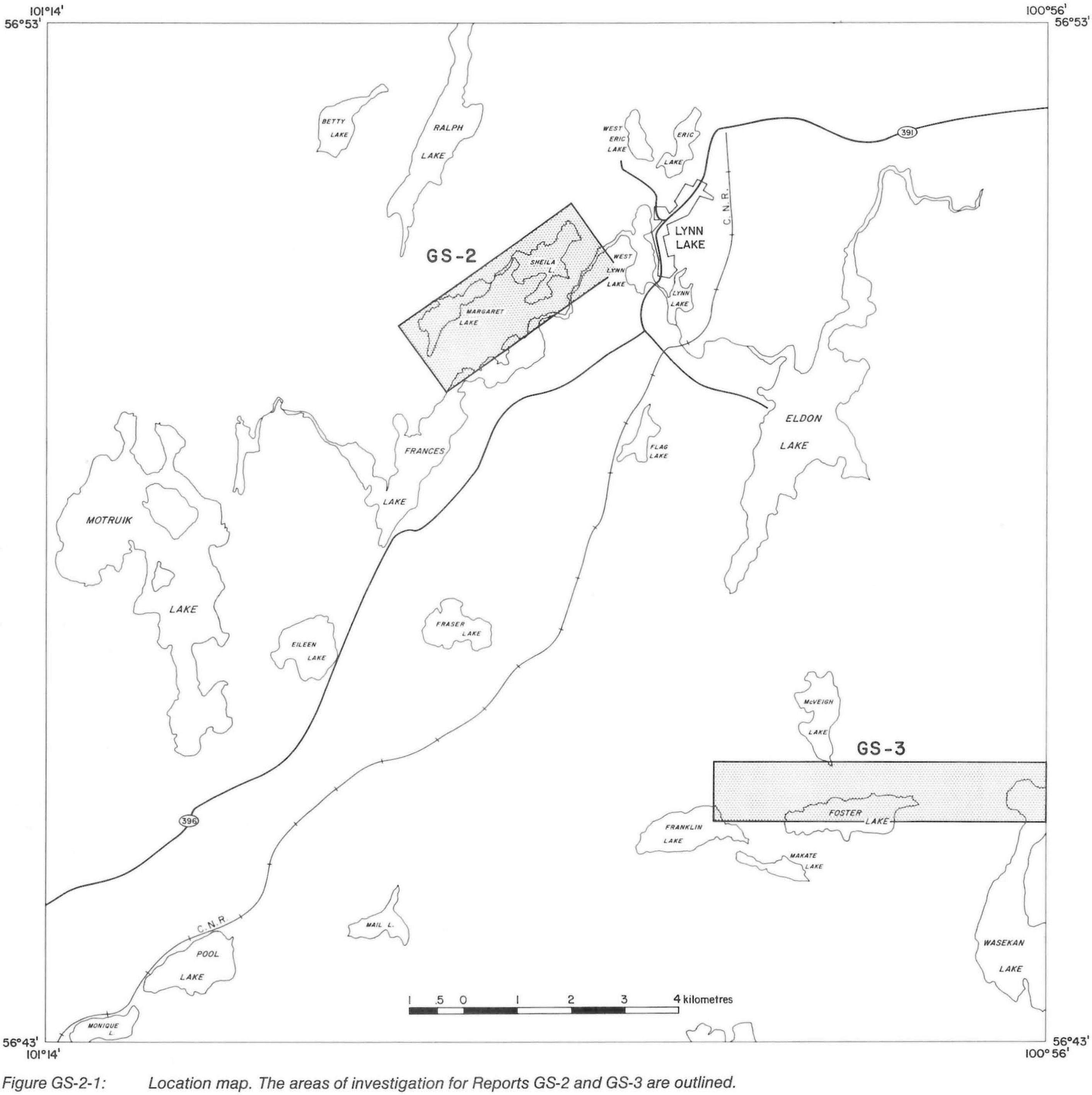

Figure GS-2-1: Location map. The areas of investigation for Reports GS-2 and GS-3 are outlined.

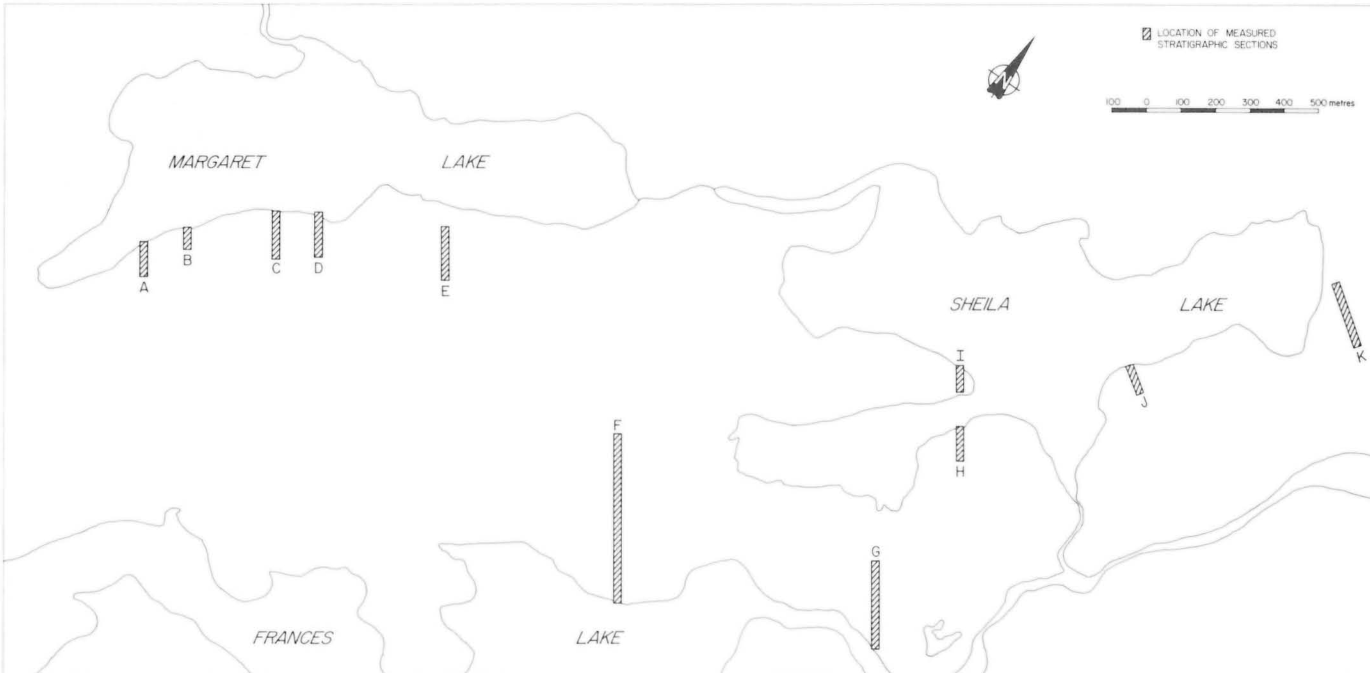

Figure GS-2-2: Location of measured stratigraphic sections in the Sheila Lake-Margaret Lake area. See Figure GS-2-1 for the location of the area of investigation.

STRATIGRAPHY

The stratigraphy at Sheila and Margaret Lakes is summarized in Figure GS-2-3. A sequence of heterolithic volcanic breccias, at least 1065 m thick, occurs at the base of the sequence at Ralph Lake. It is overlain by a sedimentary sequence of greywacke conglomerate, siltstone and fine grained sandstone at least 530 m thick that is commonly amphibolitized and includes minor garnetiferous amphibolite and mafic metavolcanic rocks. Overlying these rocks is a sequence at least 410 m thick of felsic tuffs with associated breccias, mafic volcanic rocks, and amphibolite that extends to Frances Lake. Although exposure is reasonable within 150 m of the lake shores, outcrop is otherwise scarce.

The heterolithic volcanic breccias contain 10-70% (average 40-60%) mafic to intermediate volcanic fragments that range in size from less than 1 cm to a maximum of 9 x 35 cm (average 3 x 10 cm). Approximately 60% of the clasts are light grey, amygdaloidal, aphyric and plagioclase-phyric, and are usually lensoid but also can be irregularly shaped, angular and blocky. Plagioclase amygdules (0-15%) are up to 7 mm in diameter (average 4 mm), and quartz amygdules (0-40%) are up to 6 mm in diameter (average 2 mm) and occur either together or separately. Amygdules occur in both aphyric and plagioclase-phyric varieties of these light grey fragments. Pink carbonate (-plagioclase-quartz?) amygdules are rare and are 3-5 mm in diameter. In addition, some of the fragments contain 10-15% plagioclase phenocrysts that are euhedral, equant to tabular and have a maximum dimension of 5 mm (average 3 mm). Aphanitic medium to dark grey fragments (some with vesicular rims) constitute an additional 25% of the overall fragment types, and the remaining 15% consist of dark green aphanitic fragments with epidosite cores, other incidental fragments and felsic fragments (observed along the northeastern shores of Ralph Lake). The breccia matrix is very fine grained, dark green-grey, and locally contains up to 10% plagioclase phenocrysts and amygdules similar in size to those in the fragments.

Bedding planes in heterolithic breccia are rarely observed, but thick bedding is inferred from a repetitive change from larger to smaller fragments over a stratigraphic distance of a few metres. In addition, thin mafic tuff layers, decimetres thick, locally separate heterolithic breccias. This thick succession of heterolithic volcanic breccias is interpreted to be the depositional product of debris flows.

Stratigraphically above the volcanic breccias there is a 530 m thick sequence of interbedded greywacke conglomerate, siltstone and lesser sandstone with lesser amphibolite, minor mafic metavolcanic rocks, and rare high Mg-Ni-Cr basalt similar to the high Mg-Ni-Cr basalt described by Fedikow (1986). The greywacke conglomerate consists of aphanitic felsic fragments and minor intermediate and sedimentary fragments in a silt- to sand-sized matrix. Matrix composition is dominantly mafic but on the peninsula at Sheila Lake it is felsic. Fragment size ranges from pebble to boulder with a maximum of 2.5 x 26 cm. Siltstone and fine grained sandstones are thin to thick bedded; their mineralogy is difficult to discern in hand specimen because of the fine grain size and the destruction of primary features by silicification, but includes plagioclase, biotite and/or hornblende, and quartz. In the siltstone and sandstone, hornblende crystals, less than 1 to 5 mm across are randomly oriented, homogeneously distributed throughout the rock and overprint bedding. Locally these crystals are concentrated in layers within the beds.

Amphibolite occurs as dark green and white, medium- to coarse-grained layers and commonly has a streaky mottled appearance and an inhomogeneous distribution of hornblende. Carbonate content ranges from minor veinlets to major grains and veins in amphibolite. Minor mafic volcanic rocks include mafic tuff, pillowed and massive flows, and autoclastic breccia. These rocks usually occur as lenses up to 18 m thick that can be traced along strike for approximately 60 m. Epidote and epidote-quartz-carbonate in fractures are common in the volcanic rocks.

High Mg-Ni-Cr basalt was identified at two locations at Sheila Lake by chemical analyses (Table GS-2-1). Compositions of these high Mg-Ni-Cr basalts at Sheila Lake exhibit the following characteristics compared to the compositions of the high Mg-Ni-Cr basalt flows from the Agassiz deposit: (1) slightly higher SiO_2 and Na_2O; (2) slightly lower $Fe_2O_3(T)$, TiO_2 and (3) slightly lower, but still high Ni; other elemental analyses are similar (Fedikow, 1986). The high Mg-Ni-Cr basalt is olive-green, fine grained, and chloritic with 10%, 1-2 mm equidistributed darker green-black amphibole crystals. These rocks have a pronounced foliation due to the alignment of chlorite, with local crenulations in foliation. Where high Mg-Ni-Cr

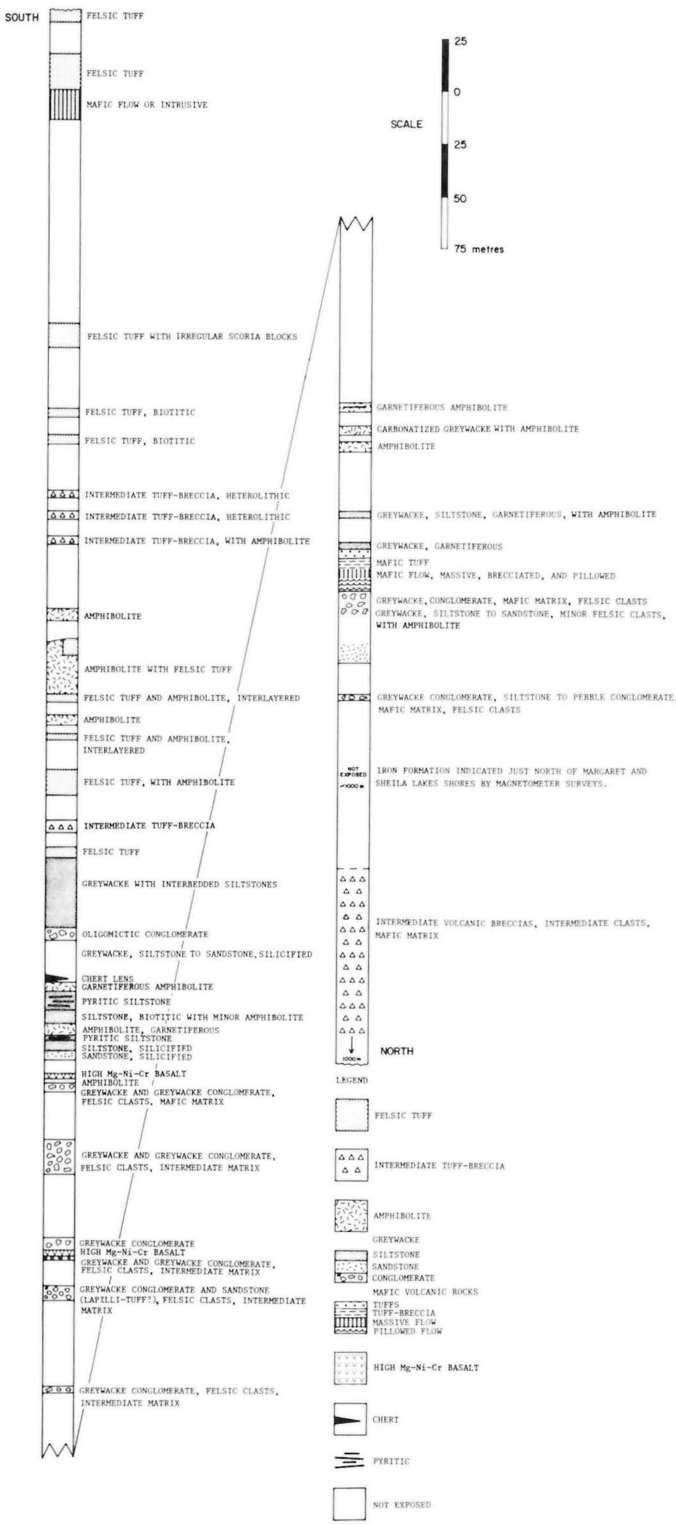

Figure GS-2-3: *Composite stratigraphic section compiled from measured stratigraphic sections from Frances Lake to Ralph Lake.*

TABLE GS-2-1
CHEMICAL ANALYSES OF PICRITES FROM SHEILA LAKE COMPARED WITH ANALYSES OF PICRITES FROM THE AGASSIZ DEPOSIT

Sample Number	30-86-1002-3 Sheila Lake	30-86-1019-4 Sheila Lake	AGC 557 MacLellan Deposit[1]	AGC 1 MacLellan Deposit[2]
SiO_2, wt%	45.6	46.9	44.8	49.5
Al_2O_3	8.6	8.3	8.2	20.8
Fe_2O_3(T)	10.2	10.2	13.5	10.3
CaO	9.4	9.9	9.8	9.2
MgO	18.7	17.9	17.8	3.3
Na_2O	0.4	0.5	0.2	4.1
K_2O	0.1	0.1	0.1	0.5
TiO_2	0.7	0.5	1.6	1.0
P_2O_5	0.11	0.08	0.10	0.04
MnO	0.19	0.21	0.24	0.13
LOI	4.1	3.4	3.9	0.8
TOTAL	98.1	98.0	100.2	99.7
Cr, ppm	1900	1900	1551	25
Ni, ppm	470	530	897	24

[1]from Fedikow, 1986; high-Mg basaltic rocks (picrite)
[2]from Fedikow, 1986; amygdaloidal basalt, aluminous

basalt is in contact with sedimentary rocks contacts are not sharp and are represented by a zone of mixing.

Rocks with similar mineralogical composition and texture occur on the peninsula at Sheila Lake, where high Mg-Ni-Cr basalt occurs as layers up to 3 m thick within a succession of greywacke conglomerate and finer grained sedimentary rocks. These layers cannot be followed for more than 15 m before disappearing under overburden. Contacts with surrounding units are characterized by a zone of mixing.

A 410 m thick sequence of felsic tuffs with amphibolite, minor tuff-breccia and mafic metavolcanic rocks occurs above the sedimentary succession. The felsic tuff is white, fine grained and moderately foliated with euhedral and broken 0.5-3 mm plagioclase crystals. Included in the felsic tuff are minor lapilli-tuff beds that contain felsic aphyric fragments up to 1 x 2.5 cm. Mafic mineral content is usually less than 5% except for one distinctive rhyolite lapilli-tuff with 10% biotite in foliated wisps less than 1 mm wide and up to 2.5 cm long. Rare scoria blocks with a maximum diameter of 1 m occur in a tuff bed at Frances Lake.

A medium grey, heterolithic tuff breccia, 24 m thick, occurs within the felsic fragmental succession. It contains 50% intermediate to felsic, plagioclase-phyric and plagioclase-amygdaloidal fragments up to 11 x 52 cm in a fine grained intermediate to mafic matrix.

Mafic flows or intrusive rocks and minor tuff with an aggregate thickness of 14 m occur within the felsic fragmental sequence. These rocks are dark green, very fine grained, and composed of plagioclase and partially chloritized hornblende. The rocks in the basal 160 m of this felsic fragmental succession contain lenses of amphibolite up to 40 m thick and exhibit amphibole growth in veins, irregularly shaped areas and lenses throughout the felsic rocks.

Similar rocks occur north of Motriuk Lake, approximately 5 km west of Margaret Lake (Ferreira and Baldwin, 1984). There, north-facing heterolithic volcanic breccias similar to those at Ralph Lake are overlain by mafic and felsic volcanic rocks and mafic intrusive rocks. Some of the mafic volcanic rocks are chlorite-actinolite-magnetite schists that appear similar to the high Mg-Ni-Cr basalt. In addition, pyritic fine grained felsic sedimentary rocks occur near the top of the stratigraphic sequence. They are overlain to the north by amphibolite and mafic intrusive rocks.

Figure GS-2-4: Fractures offsetting breccia fragments in intermediate tuff-breccia unit.

STRUCTURE

A moderately well developed foliation, apparently parallel to bedding is oriented approximately 245°/86°N. Dips range from 75° to 90° to the north. Rare sedimentary structures, i.e. graded bedding and mixing, indicate that the stratigraphic sequence at Sheila and Ralph Lakes has tops to the south and is thus overturned to the north.

Secondary deformation has imposed small crenulations at approximately 90° to foliation in the high Mg-Ni-Cr basalt. This deformation is not seen in the surrounding sedimentary layers and thus is probably a reflection of the lower competency of the chloritic rocks.

Fractures at 127°/45°S are well developed in the intermediate tuff-breccia in the felsic fragmental sequence. Centimetre-scale right lateral and left lateral offset of breccia fragments occurs along the fractures (Fig. GS-2-4).

Jointing is common throughout the sedimentary sequence and the lower part of the felsic sequence. The joints preferentially strike 225°-255° with a near vertical northerly dip but also occur at a variety of other orientations. Joint spacing is usually on a decimetre scale. These fractures are frequently marked by millimetre-wide discontinuous quartz-carbonate ± chlorite veinlets.

ALTERATION

In addition to layers of amphibolite, sedimentary rocks and felsic fragmental rocks in the lower part of the stratigraphic succession exhibit growth of amphibole along bedding planes and joints. The amphibolite consists of up to 70% medium grained hornblende and chloritized hornblende, in some areas accompanied by carbonate and plagioclase. Alteration spreads away from the planes of structural weakness in varying intensity from minor amphibole overprinting to total destruction of primary texture and mineralogy.

Silicification is common particularly near areas where pyrite and/or pyrrhotite occur. Silicification partially obscures original textures and mineralogy in these areas.

Garnet occurs as euhedral red crystals from 1 to 3 mm, average 2 mm, in sedimentary rocks especially in those that have porphyroblastic amphibole. Up to 10% garnets, average 1-3%, occur both equidistributed and irregularly sprinkled throughout the rock layers. Garnets also occur as larger, 3-5 mm, pink-red, spongy to euhedral crystals in a 24 m thick amphibolite layer near the centre of the sedimentary succession at Margaret Lake. However, the garnet development does not appear to be controlled by stratigraphy, although a rough correlation exists between the presence of garnets and the presence of the pyritic siliceous siltstones.

MINERALIZATION

A pyritic siltstone can be traced from Sheila Lake to the west end of Margaret Lake in outcrop and by an airborne EM conductor. It is 20-40 m thick and thickens eastward. The rock is a massive, bluish-light grey, rusty siliceous siltstone. Up to 5% pyrrhotite occurs as fine grained aggregates and disseminations. Minor pyrite accompanies the pyrrhotite. At Margaret Lake up to 20% hornblende and less than 1% actinolite sheaves overprint the siltstone. Less than 1% very fine grained disseminated pyrrhotite occurs in the garnetiferous amphibolite at Margaret Lake.

COMPARISON WITH STRATIGRAPHY OF THE AGASSIZ METALLOTECT

The Agassiz Metallotect is a 65 km metallogenetic feature including the stratabound MacLellan (formerly the Agassiz) Au-Ag deposit and the Farley Lake gold deposit. The stratigraphy of the metallotect consists of interlayered high Mg-Ni-Cr basalts, biotitic and siliceous sulphidic siltstones, and silicate- sulphide- and oxide-facies iron formations (Fedikow, 1986). Au-Ag mineralization is hosted by the high Mg-Ni-Cr basalts and siltstones and is associated with post-depositional carbonate-quartz-sulphide veins. Mafic volcanic flows and fragmental rocks overlie and underlie the Agassiz Metallotect (Fedikow, 1986; Fedikow et al., 1986).

The stratigraphic sequence at Sheila and Margaret Lakes is in some respects similar to that of the Agassiz Metallotect. The sedimentary succession of greywacke conglomerate, siltstone and fine grained sandstone with interlayered high Mg-Ni-Cr basalt is present in both localities. Iron formation, although not observed in the field, is interpreted to occur directly north of Margaret and Sheila Lakes on the basis of magnetometer surveys. Distinctive heterolithic volcanic breccias are present at both localities.

Rocks that overlie the sedimentary and iron formation sequence at Sheila and Margaret Lakes differ from those that overlie the Agassiz Metallotect at the MacLellan mine. The Metallotect is overlain by a mafic volcanic flow sequence whereas the Sheila-Margaret Lakes succession is topped by a thick sequence of felsic volcanic fragmental rocks. In addition, there are other differences: (1) the high Mg-Ni-Cr basalts are apparently not as abundant at Sheila and Margaret Lakes in comparison with the area of the MacLellan Mine; however, the rocks underlying Sheila and

Margaret Lakes are unknown; (2) high Mg-Ni-Cr basalts near the MacLellan Mine are identified as flows (Fox and Johnson, 1981; Fedikow, 1986); however, at Sheila Lake it appears that they have undergone at least partial reworking since there is mixing at some contacts with the sediments; and (3) whereas quartz-carbonate veinlets are present in the sedimentary rocks at Sheila Lake, similar rocks at the MacLellan mine site exhibit a greater degree of silicification and a greater abundance of quartz-carbonate-sulphide veins.

SUMMARY

The similarities in stratigraphy outweigh the local differences and, therefore, the Agassiz Metallotect can be extended west of the MacLellan mine site to Margaret Lake and possibly as far west as Motriuk Lake.

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GS-3 GEOLOGICAL INVESTIGATIONS IN THE FOSTER LAKE-WASEKWAN LAKE AREA

by K. Ferreira

INTRODUCTION

Stratigraphic investigations in the vicinity of the Johnson Shear Zone were undertaken in the area of Foster, Wasekwan and Franklin Lakes. The objectives of the current study were to determine the stratigraphy across the gold-bearing section and to investigate the nature of the shear zone and associated gold mineralization. Stratigraphic sections were derived from detailed outcrop and diamond drill core examinations (Fig. GS-3-1).

The Johnson Shear Zone has been the subject of sporadic geological investigations and exploration efforts since gold mineralization was first found within the zone in 1938 (Bateman, 1945; Milligan, 1960; Gale, 1983; Peck, 1985; Fedikow et al., in press). Recent exploration activity by SherrGold Inc. identified anomalous gold values over at least 2500 m of strike length on the basis of 25 shallow diamond drill holes (The Northern Miner, 28-04-1986).

STRATIGRAPHY

Within the area of investigation a foliated alkali granite sill is flanked to the north by intercalated mafic to felsic fine grained metasedimentary rocks, mafic metavolcanic rocks, and minor quartz-feldspar porphyry (Table GS-3-1, Fig. GS-3-2). The sequence is oriented approximately 270°/60°N and faces north.

The alkali granite is characterized by a well defined alignment of quartz blebs that is parallel to the regional foliation. Quartz blebs (1 x 7 mm) constitute 20-30% of the granite. Locally the granite has a weak foliation and minor grain size variations. Dykes of this alkali granite (from 2.5 to 10 cm in width) occur in the adjacent mafic metasedimentary rocks. These dykes can be traced for up to 3 m along strike before disappearing under the overburden.

A 155-275 m thick succession of mafic, intermediate and felsic metasedimentary rocks of probable volcanic derivation occurs north of the granite sill. Greywacke and/or mafic sedimentary rocks ranging in thickness from 6 to 73 m occur adjacent to the granitic sill. The greywacke is characterized by the presence of felsic and mafic clasts less than 2 cm long in a fine grained intermediate to mafic matrix. The mafic sedimentary rock is a dark green chloritic siltstone. Xenoliths of these rocks were observed at different localities within the granite.

North of the greywacke there are 150-275 m of intercalated fine grained mafic, intermediate and felsic sedimentary rocks. These rocks probably include a minor tuffaceous component. Minor mafic metavolcanic lenses occur in this sequence, for example near Franklin Lake and in drill core from northwest of Wasekwan Lake. These sedimentary rocks occur as lenses (e.g. the magnetite-bearing felsic sedimentary unit in Fig. GS-3-2). Contacts between lithologic units are rarely observed in the field; however, in drill core, contacts between the mafic/intermediate units, and the intermediate/felsic units are gradational whereas mafic/felsic contacts are distinct. Units range from 9 to 195 m in thickness with an average thickness of 50-60 m. Felsic units are the least common portion of the stratigraphy and range from 0 to 32 m thick with an average thickness of 15 m. Intermediate sedimentary rocks are most common, have an average thickness of 45 m and a maximum thickness of 150 m. Mafic sedimentary rocks attain thicknesses of up to 280 m but are highly variable in thickness.

The fine grain size necessitated the determination of chemical composition mainly by colour in the field. The sedimentary rocks may be classified as siltstone with local bed-to-bed variations from mudstone to fine grained sandstone. Hornblende, where present, may be slightly coarser grained than other minerals, and is commonly wholly to partially chloritized. The sedimentary units are laminated with local variation in laminae composition. Less commonly bed thickness is 3 m or more. The sedimentary sequence is similar to that of Division "D" in the Wasekwan series described by Bateman (1945).

Mafic metavolcanic rocks, including some gabbro, occur above the sedimentary succession. Massive, plagioclase-phyric, and plagioclase-amygdaloidal flows, tuffs, as well as gabbro were identified. These rocks are similar to Division "E" of the Wasekwan series as described by Bateman (1945).

A small body of quartz-feldspar porphyry with a known strike length of 200 m and up to 23 m thick, with associated small dykes that intrude the sedimentary sequence, were intersected in drill holes near Wasek-

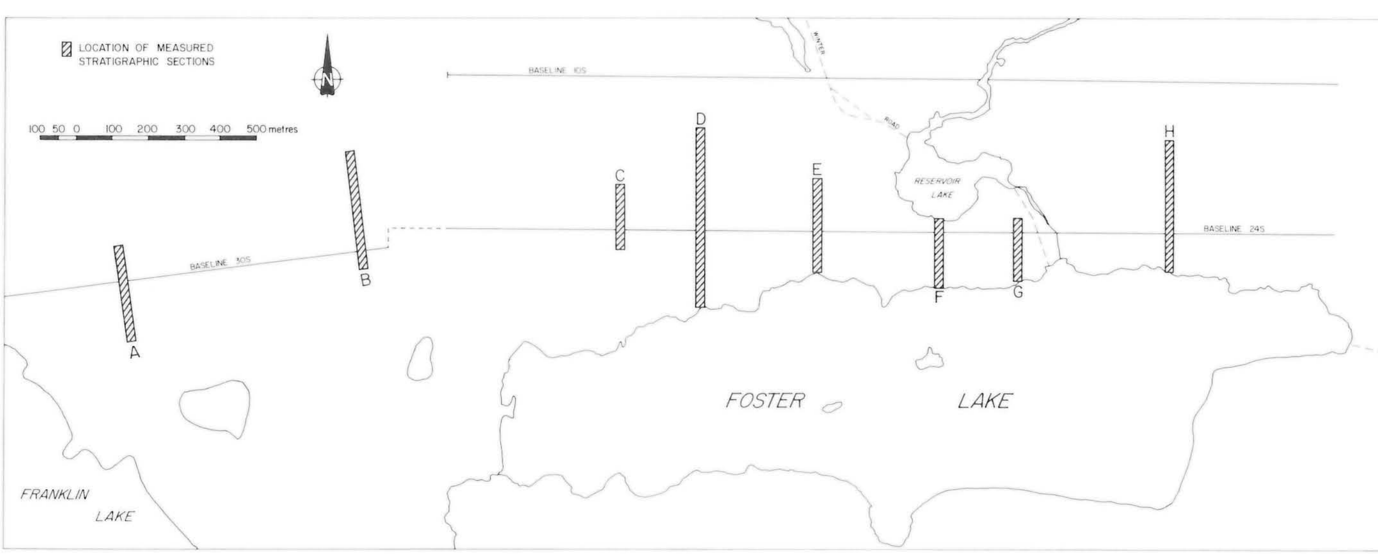

Figure GS-3-1· Location of measured stratigraphic sections at Foster Lake. See Figure GS-2-1 for the location of the area of investigation.

TABLE GS-3-1
TABLE OF FORMATIONS

Unit	Lithology
MAFIC VOLCANIC ROCKS	Tuffs and flows, dark green, very fine grained; tuffs are moderately- well foliated, flows are massive to poorly foliated and chloritic; flows may contain 1-2 mm plagioclase amygdules and/or phenocrysts. Thickness: 213-366 m
GABBRO	Coarse grained, dark green. Thickness: 30 m
TALC-CARBONATE-CLAY SCHIST	Pale green-cream, very fine-to medium-grained; schistose with small-scale irregularities in schistosity; white talc (sericite?), carbonate and clay minerals in feathery sheaves and as fine-grained replacements of plagiocase and felsic lithic fragments; 15% pale-medium green streaks in mm-widths and irregular lengths; <1% quartz in thin drawn-out veinlets; no sulphide minerals observed. Thickness: min. 6 m
FELSIC SEDIMENTARY ROCKS, rusty, deformed	Light grey to dark green, very fine grained; very well foliated, laminated to thin bedded; tough, siliceous, plagioclase-rich, 5-10% very fine grained biotite, 5-10% very fine grained hornblende usually concentrated in layers; magnetic, up to 20%, average 5-10% pyrrhotite, trace pyrite, (chalcopyrite?), rare arsenopyrite in fine grained aggregates forming streaks along foliation planes; rare quartz veinlets <5 cm wide, discontinuous, associated with irregular chlorite blebs; small-scale recumbent folding, fold axes 225°/45° N, limbs 005°/55°-75° S and 230°-255°/55°-75° N, hairline fractures along fold axes which may be marked by mm-wide quartz veinlets, drag folds. Thickness: 0-30 m
FELSIC SEDIMENTARY ROCKS, magnetic	Light grey, creamy to pinkish, very fine grained; poor to moderate foliation; very tough, siliceous; magnetic due to very fine grained disseminated magnetite; rare vugs bear 2 mm dark blue-grey magnetite octahedra, quartz crystals, and fine grained chlorite. Thickness: 8 m
Unit	Lithology
INTERMEDIATE (TO MAFIC) SEDIMENTARY ROCKS	Light to medium grey, very fine grained; well bedded and foliated; siliceous, biotitic, plagioclase-bearing; more mafic beds may bear hornblende or chloritized hornblende imparting mottled greenish coloration; minor quartz veinlets common subparallel to bedding with chlorite envelopes or included patches. Thickness: 0-91 m
MAFIC SEDIMENTARY ROCKS	Dark green, very fine grained; moderately foliated, biotitic, hornblendic (may be partially to wholly altered to chlorite), may be tough, silicified. Thickness: 20-282 m
GREYWACKE	Dark greyish-green, very fine- to fine-grained; moderate foliation; 25% felsic clasts, average 1 x 5 mm; 35% mafic clasts in streaks, average 1-2 cm long; 5-10%, <1 mm plagioclase; 40% dark greenish-brown, very fine grained matrix. Thickness: 76 m
GRANITE foliated	Salmon pink, fine- to medium-grained; well defined quartz foliation (265°/60° N); 20-25% quartz in clear foliated blebs, up to 1 x 10 mm, average 7 mm long; 70% subhedral feldspars, average 1 mm, K-feldspar > plagioclase. Thickness: 30-215 m on north shore of lakes.

wan Lake. The porphyry contains 5-30% white feldspar crystals up to 8 mm in size in a grey siliceous matrix. Small quartz veinlets up to 3 cm are common.

STRUCTURE

A well developed foliation oriented at 270°/60°N apparently parallels layering throughout the sedimentary succession. The foliation is an alignment of biotite, chlorite, some hornblende and rare muscovite. A linear topographic feature with an east-west strike, corresponding to the foliation in rocks of the sedimentary succession, is pronounced on airphotos of the area.

A fracture cleavage has been superimposed on intermediate and felsic metasedimentary rocks north of Foster Lake (Fig. GS-3-2, Sections C, E, F, G, H; Fig. GS-3-3, 4). This resulted in small-scale recumbent folds with slip cleavage along fold axes (225°/45°NW) and shear cleavage marked by drag folds, millimetre-thick discontinuous quartz veinlets and

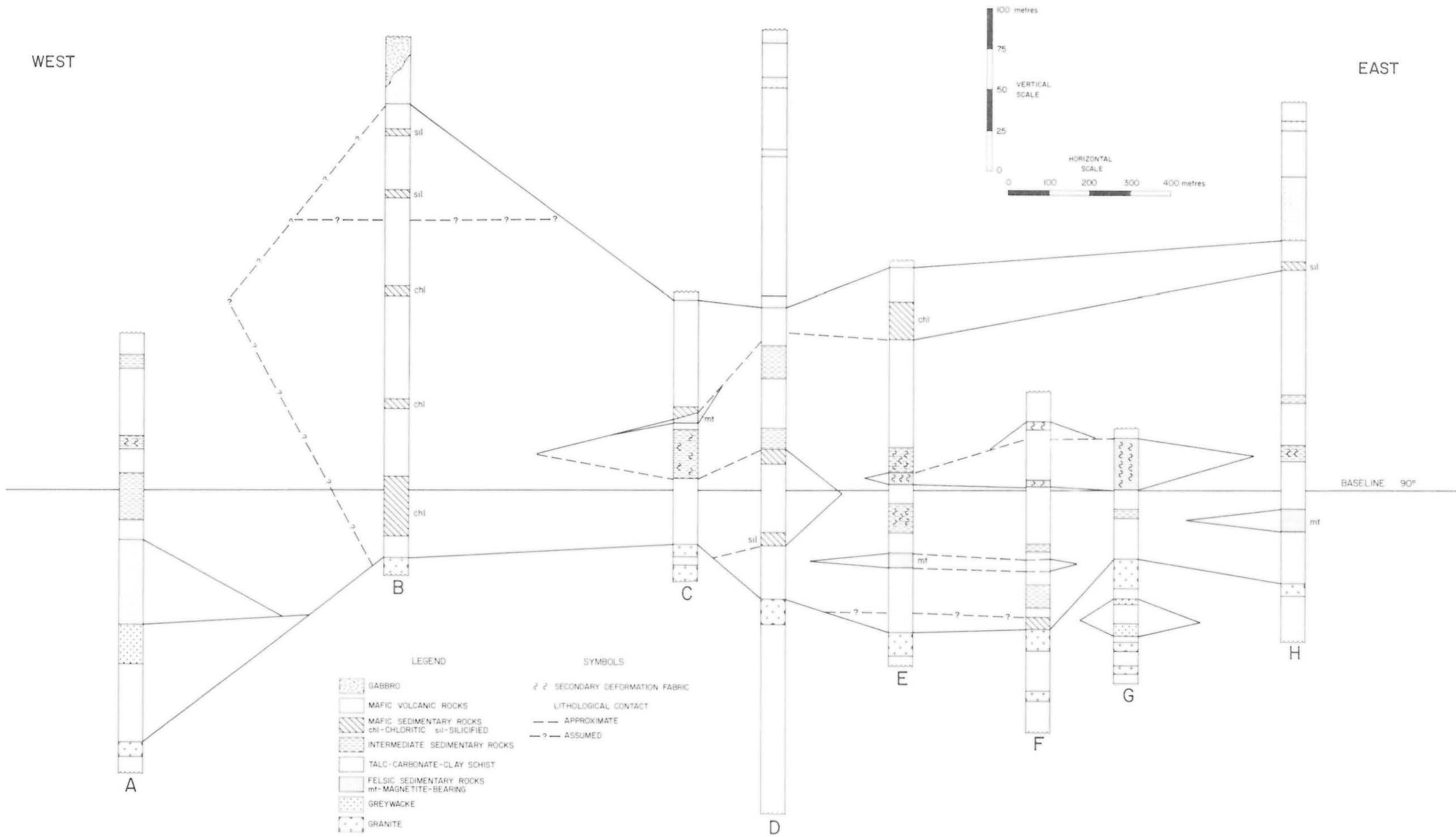

Figure GS-3-2: *Generalized stratigraphy of the Foster Lake area. See Figure GS-3-1 for the location of the area of investigation.*

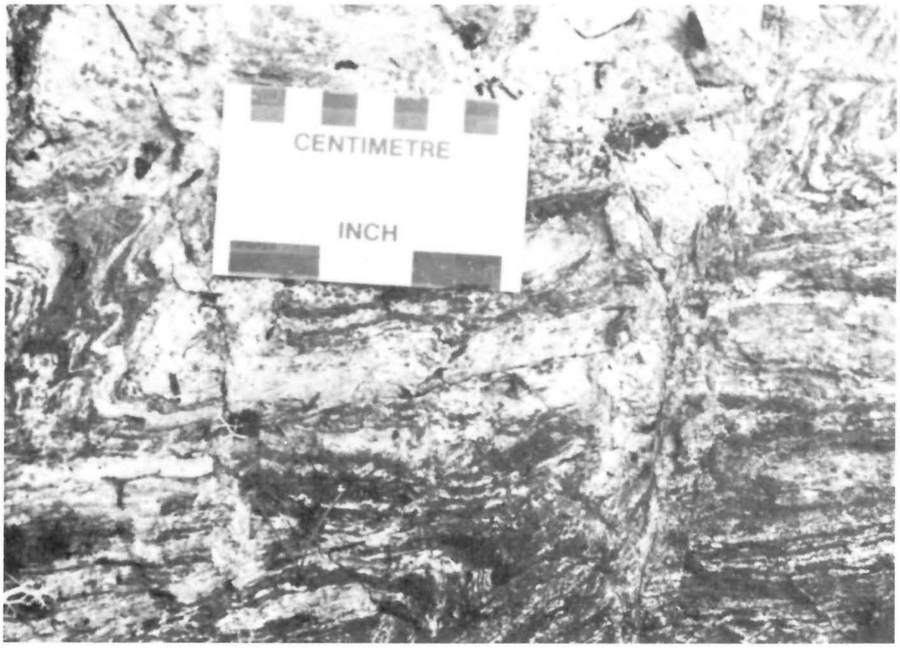

Figure GS-3-3: *Small-scale folding and offset beds.*

Figure GS-3-4: *Drag folds along fractures.*

centimetre-scale bed offsets. In the absence of quartz veinlets shear cleavage is identifiable by hairline fractures. Limbs on the recumbent folds are preferentially oriented 005°/55-75°S and 230°-255°/55°-75°N. Rare, discontinuous quartz veinlets less than 5 cm wide with associated chlorite blebs also occur parallel to foliation. Sulphide mineralization preferentially occurs parallel to foliation where the fracture cleavage is present (see "Mineralization").

Structures related to the "Johnson Shear Zone" such as shearing or brecciation were not observed on outcrop. In some drill core sections, however, local zones up to 44 m (average 9 m) exhibit angular, brecciated lithic fragments in a siliceous matrix. Rarely, sections of light green clay-rich fault gouge occur in some of the intensely brecciated segments. When projected to plan view these structures rarely continue from one drill core to another.

ALTERATION

Alteration of the sedimentary sequence is most intense south of Reservoir Lake (Fig. GS-3-2, Section F) where the original mineralogy has been wholly replaced by a talc-carbonate-clay-(sericite?) schist (Table GS-3-1). Silicification is common and ubiquitous in the intermediate and felsic sedimentary rocks. Rocks of intermediate composition may be in part altered derivatives of mafic sedimentary rocks. This is supported by the gradational nature of the contacts and similarities in textures and mafic mineral content of the mafic and intermediate rocks. Chloritization is common in the mafic sedimentary rocks. Alteration is most intense where fracture cleavage is well developed. Alteration of mafic metavolcanic rocks, gabbro and alkali granite was not observed.

MINERALIZATION

Sulphide mineralization occurs preferentially in felsic sedimentary rocks, and to a lesser degree in intermediate sedimentary rocks, where the fracture cleavage is well developed. Pyrrhotite, generally present in amounts of 1-5%, is locally present in concentrations of up to 20% and is accompanied by trace amounts of pyrite, rare arsenopyrite, and trace chalcopyrite. The sulphide minerals occur as fine grained aggregates forming streaks along foliation planes. Deformed sulphide-bearing felsic rocks occur as siliceous lenses enveloped in intermediate rocks. These are overlain and locally underlain by less siliceous, mafic sedimentary rocks. Sulphide mineralization is most abundant at Foster Lake and can be traced eastward to Wasekwan Lake. The amount of sulphide mineralization decreases westward from Foster Lake to Franklin Lake (Fig. GS-3-2, between Sections B and C).

In a description of gold mineralization along the Johnson Shear Zone Bateman (1945) reports "some short narrow shoots approaching ore grade" from surface sampling and shallow diamond drilling in an area north of Foster Lake. Gold mineralization also occurs associated with sulphide minerals at Foster and Wasekwan Lakes. Visible gold is present in some narrow (approximately 10 cm) quartz veins in drill cores from northwest of Wasekwan Lake.

An average of less than 1 to 2% fine grained, interstitial, disseminated pyrite and lesser pyrrhotite occurs throughout the quartz- feldspar porphyry. Anomalous gold values may be found within this rock type; however, the presence of gold is not restricted to, nor is it evenly distributed within, the quartz porphyry.

Sulphide mineralization and associated gold mineralization appear to be related to a later tectonic event that superimposed a later tectonic fabric on existing foliation and was followed by silicification of the adjacent rock.

SUMMARY

Although shear textures to support the designation "Johnson Shear Zone" were not observed in outcrop, deformational fabrics and the introduction of sulphide mineralization and accompanying alteration occurring along a regional linear trend attest to the influence of regional structural features (faults?) in localizing the mineralization in this area.

ACKNOWLEDGMENTS

The assistance of SherrGold Inc. and Sherritt Gordon Mines Ltd. in providing access to diamond drill core and drill logs from the Wasekwan Lake area is gratefully acknowledged.

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GS-4 VEGETATION GEOCHEMICAL STUDIES, LYNN LAKE AND SNOW LAKE AREAS

by M.A.F. Fedikow

Recent literature (Dunn, 1983, 1986) indicates that alder twigs *(Alnus crispa, Alnus rugosa)* appear to be effective concentrators of gold. In several case history studies bedrock containing gold mineralization is effectively outlined by the neutron activation analysis of gold in samples of ashed alder twigs. Since alders are not cyanogenic the danger of losing gold as gold cyanide by volatilization during sample preparation is minimized and the gold in the twigs may be effectively pre-concentrated in ash before analysis. Ashing of the sample allows a more representative analysis since a greater weight of sample is collected initially, i.e., 50 g for ashing and neutron activation analysis versus 8-10 g of dry sample for macerating, briquetting and neutron analysis.

Sampling of alder twigs was undertaken at the MacLellan Au-Ag deposit where 10 samples of alder twigs *(Alnus crispa, Alnus rugosa)* were collected from bushes 1-2 m in height growing immediately adjacent to the MacLellan Main Zone (Fig. GS-4-1). Each alder sample represents the outermost 25-35 cm of twig collected from each branch on a single bush. Two samples (00931, 00932) were collected from the same bush to serve as a check on sampling error. Leaves were stripped from the twigs and discarded although useful results have been reported from alder leaf gold analyses (Cohen et al., 1986). Samples were analyzed for gold using instrumental neutron activation by Becquerel Laboratories (Mississauga) after ashing of the alder twigs in a muffle furnace at 450°C. The results of the analyses are presented in Table GS-4-1. In addition, Table GS-4-1 contains gold analyses from alder twigs collected from other mineral properties examined during the 1986 field season. This includes 7 alder twig samples collected from the Spider Lake area along the Agassiz Metallotect. These samples were intended to serve as "background" geochemical samples since they do not occur near any known base or precious metal mineralization. The alder twigs collected at the MacLellan deposit and those collected at Spider Lake were sampled within two days of one another during the first week of June. All other samples were collected during the second and third weeks of June.

RESULTS

LYNN LAKE AREA

The alder twig samples collected from the immediate vicinity of the MacLellan Au-Ag deposit contain a surprisingly narrow range of gold concentrations. The gold contents range from 6 to 18 ppb and from 1.82 to 2.70% ash. Samples 00931 and 00932, collected from the same alder bush have comparable gold and ash contents of 12 and 18 ppb and 1.82 and 2.10%, respectively. These results may be contrasted with the analytical results obtained from 6 background alder twig samples collected at Spider Lake. The background samples are characterized by a lower range of ash contents (1.18 — 2.42%) and lower gold contents than the MacLellan samples. Four of six background samples are below the limits of detection and in each of the two remaining background samples a value of 7 ppb Au was obtained. The higher ash contents in the MacLellan alder twigs may be related to particulate dust contamination due to production development at the MacLellan property. The higher gold contents of the MacLellan samples reflect the presence of gold mineralization although there is some overlap in the range of gold concentrations between the anomaly and background sample populations that are marked by a relatively small maximum contrast (18 to 7 ppm, respectively). Alder twig samples collected from the vicinity of mineral occurrence SL-80 have gold contents below the limits of gold detection. Sample 01000, collected from a wet swamp directly over the geophysical (EM) expression of the Agassiz Metallotect in the Spider Lake area contains 35 ppb gold and represents the highest content of gold determined in any sample during this survey. A single sample of alder twig collected from the vicinity of a massive pyrrhotite occurrence near the Rat River contained 10 ppb Au.

SNOW LAKE AREA

Five alder samples were collected from trenches at the Ferguson Mine located along the northeast arm of Herblet Lake. The geology of this occurrence and sample locations are presented in Figure GS-4-2. The deposit is hosted by quartz veins within sheared and recrystallized mafic volcanic rocks and minor greywacke that are bounded on the north by granitic gneiss. The mineralized quartz veins contain visible gold, sphalerite, chalcopyrite, arsenopyrite and pyrite. The vein/wallrock contact is characteristically rusty weathered. Seven rock samples collected from the trenches contained between 0.09 and 2.32 ppm Au. The results of the alder twig analyses indicate a narrow range of 8-14 ppb Au and an equally narrow range of 1.00-1.58% ash. Two "background" samples (01544, 01545), collected for comparison with the Ferguson Mine samples, contained 13 and 19 ppb Au, respectively. These samples were collected from an area of shallow overburden characterized by glaciolacustrine clay and humus, with abundant outcrops of massive and crossbedded arkose nearby. As a result of the higher than expected Au contents in the "background" twig samples, rock samples from the vicinity of the alder sample locations have been collected for gold geochemical analyses. Results are not available at the time of writing. Alder twigs (01139, 01171) collected from two mineral occurrences located on the southeast shore of Wekusko Lake returned analyses of 13 ppb Au in each case. Both occurrences are characterized by quartz veins reportedly containing visible gold. Assay samples have been collected from both of these occurrences but results are not yet available.

SUMMARY

The results of this small alder twig geochemical survey are somewhat surprising with respect to the low gold concentrations in the ash of alder twigs collected in the immediate vicinity of proven gold mineralization. Previously undertaken studies (Dunn, 1986) of gold in ash of alder twigs in the northern forests of Saskatchewan indicate a background concentration of 10 ppb Au with samples from mineralized zones commonly containing 50 ppb Au. Clearly, the results from the Snow Lake and Lynn Lake surveys are lower than these reported results, probably indicating a regional difference in background Au contents (and also background:anomaly contrasts) in the alder samples between discrete lithotectonic domains. Nevertheless, in the case of the MacLellan samples the presence of gold in the substrate appears to be reflected in ash of the alder twigs, albeit with low background:anomaly contrast and some overlap with "background" samples.

The maximum gold content determined in the Lynn Lake and Snow Lake surveys is 35 ppb from an alder growing in wet swamp at Spider Lake. All other samples were collected from well drained substrate dominated by till, glaciolacustrine clay and bedrock. This suggests that the gold contents in ash of alder twigs may be substantially affected by the drainage characteristics of the sampling area. This possibility is significant in light of the importance given to the alder as an effective gold concentrator and the generation of false geochemical anomalies during routine geochemical surveys.

Further studies to elucidate the role of the alder in vegetation geochemical exploration, particularly to determine whether the geochemical response variation for gold in alders is due to changing substrate characteristics, are required.

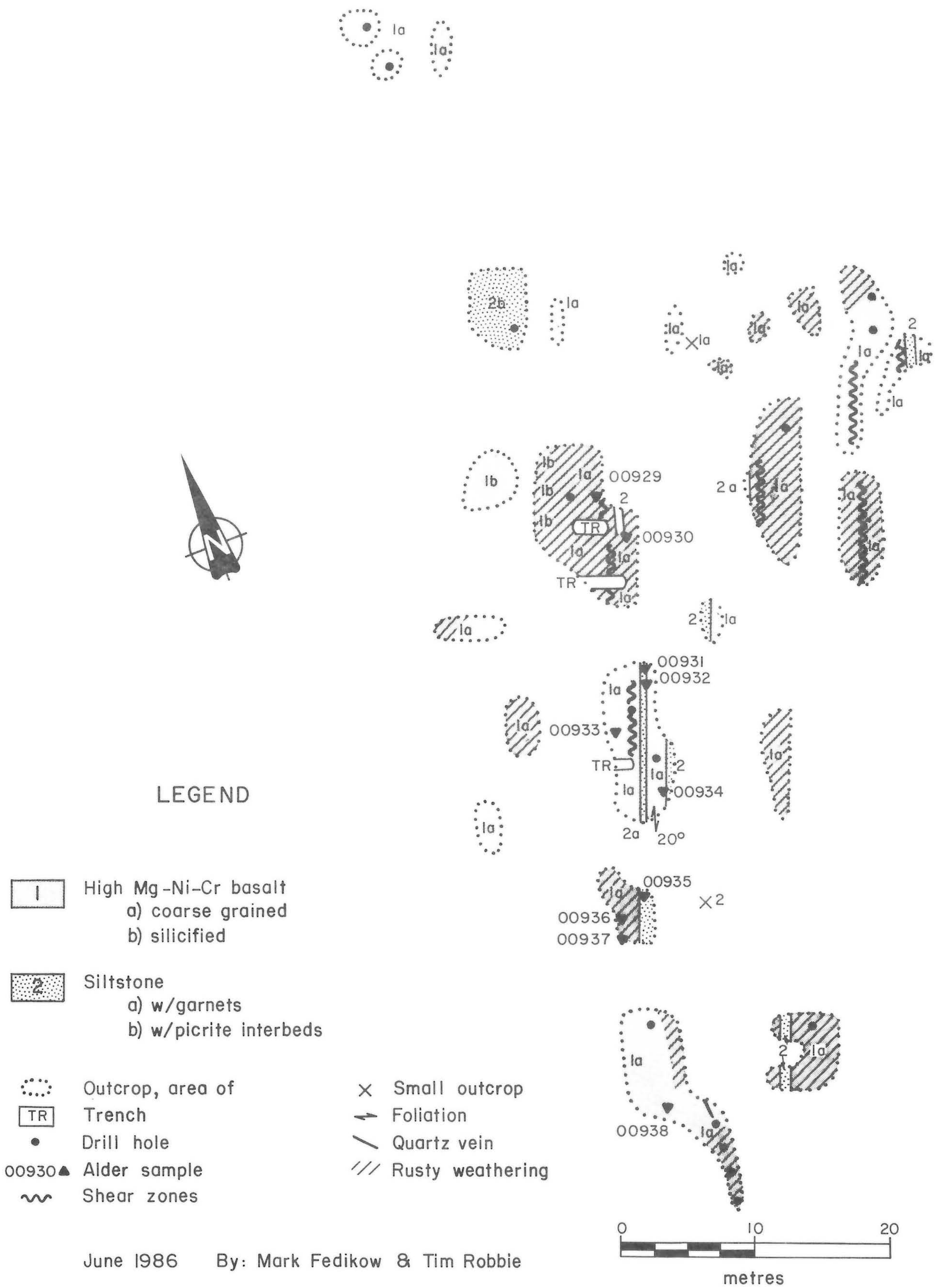

Figure GS-4-1: *Outcrop, geology and alder (**Alnus crispa**) twig sample location map, MacLellan Main Zone, Lynn Lake.*

TABLE GS-4-1
ANALYTICAL RESULTS FOR ALDER (*ALNUS CRISPA*) TWIG SAMPLES COLLECTED IN THE LYNN LAKE AND SNOW LAKE AREAS, 1986.
GOLD DETERMINED IN ASH OF ALDER TWIGS BY INAA.

SAMPLE LOCATION	SUBSTRATE DESCRIPTION	Sample Number	Au(ppb)	Ash(%)
MacLellan Au-Ag Deposit; samples collected immediately adjacent to surface exposure of Main Zone mineralization	much less than 1 m of sandy till with outcrop of high Mg-Ni-Cr basalt and sulphidic, biotite-rich clastic sedimentary rocks, visible arsenopyrite and pyrite	00929	17	2.14
		00930	12	2.38
		00931	12	1.82
		00932	18	2.10
		00933	12	2.12
		00934	8	2.70
		00935	6	2.56
		00936	16	2.42
		00937	8	2.60
		00938	10	2.30
Spider Lake, east end Agassiz Metallotect ("Background samples")	no outcrop; 1 m thick sphagnum overlying boulder alluvium along hillside sloping towards lake-shore	00946	<2	2.02
		00947	<2	2.42
		00948	<2	2.02
		00949	7	1.18
		00950	<2	1.28
		00951	7	1.32
Spider Lake; outside Agassiz Metallotect	sandy boulder alluvium; no outcrop	00939	<2	1.32
Spider Lake; outside Agassiz Metallotect	sandy boulder alluvium with felsic, pyritic pyroclastic rocks and intermediate clastic sedimentary rocks in outcrop	00940	<2	1.26
		00941	<2	1.40
		00942	<2	1.90
		00943	<2	1.56
Spider Lake; location corresponds to EM anomaly related to MacLellan-type stratigraphy	wet swamp with sphagnum and sparse black spruce	01000	35	1.14
Quarry, vicinity of Rat River	intermediate, garnetiferous volcanic rock cut by pegmatitic veinlets; solid sulphide pyrrhotite in quarry floor	01128	10	1.40

TABLE GS-4-1 (Cont'd)

SAMPLE LOCATION	SUBSTRATE DESCRIPTION	Sample Number	Au(ppb)	Ash(%)
SNOW LAKE AREA				
Ferguson Mine, Northeast Arm of Herblet Lake	mafic volcanic rocks, granite, quartz veins with visible gold, sphalerite, chalcopyrite, arseno-pyrite, pyrite	01539	13	1.32
		01540	14	1.00
		01541	8	1.58
		01542	13	1.10
		01543	11	1.04
Mineral Occurrence WL-75, Puella Bay-Wekusko Lake	sheared and silicified greywacke, quartz vein with sphalerite, galena, chalcopyrite, pyrite, humus	01171	13	1.22
Mineral Occurrence WL-79, southeast shore Wekusko Lake	rusty weathered quartz vein with pyrite in granite, humus	01139	13	1.28
Stan's Island, Herblet Lake ("Background")	arkose, humus, glaciolacustrine clays	01544	13	1.02
		01545	9	1.28

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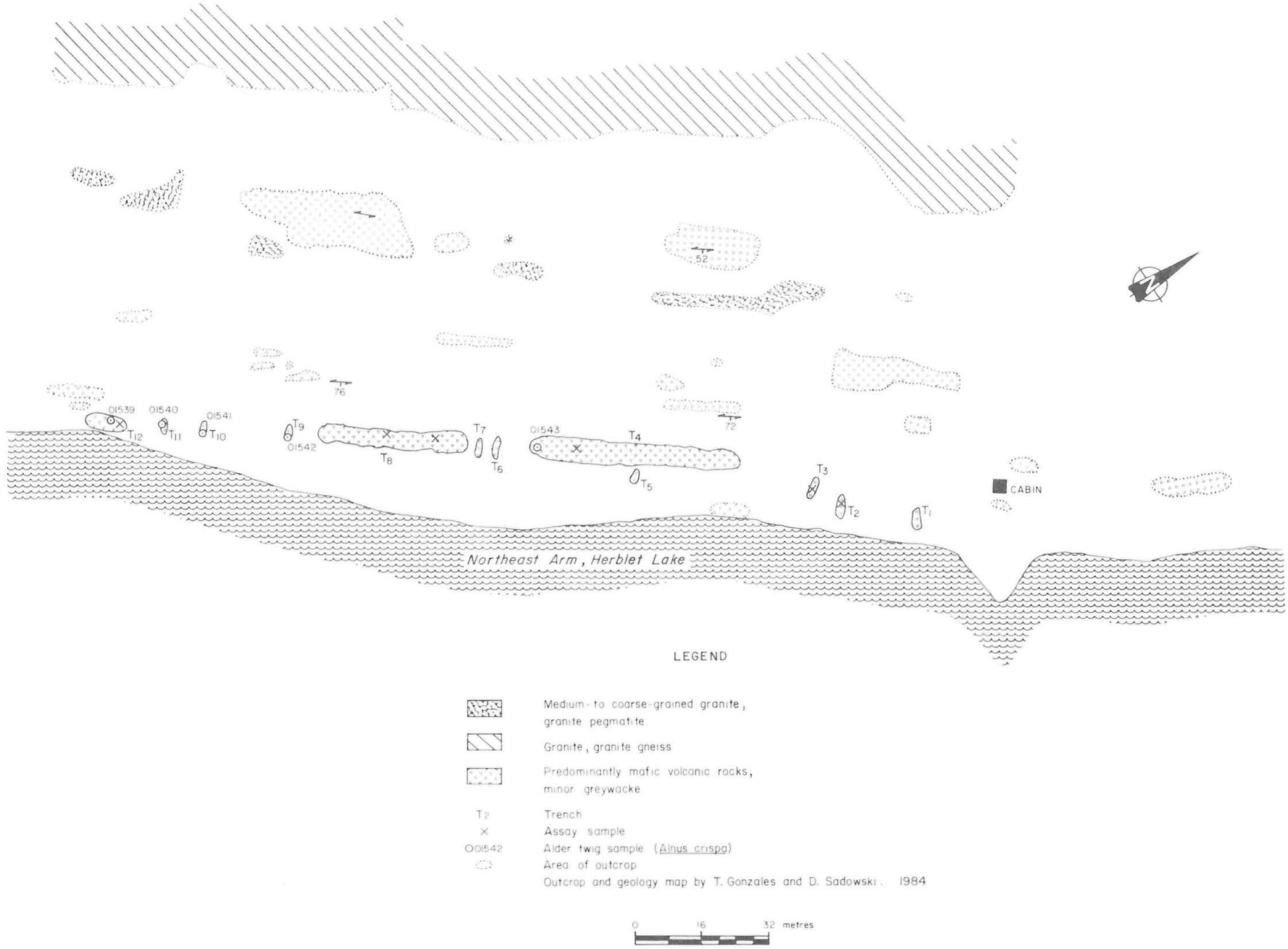

*Figure GS-4-2: Outcrop, geology and alder (**Alnus crispa**) twig sample location map, Ferguson Mine, Northeast Arm, Herblet Lake, Snow Lake.*

GS-5 THE AGASSIZ METALLOTECT — SPIDER LAKE AREA

by M.A.F. Fedikow

Mineral deposit studies were conducted in the Spider Lake area (Fig. GS-5-1) to determine whether the interlayered high Mg-Ni-Cr basalts and sulphidic clastic sedimentary rocks that characterize the MacLellan Au-Ag deposit (= Agassiz Au-Ag deposit) are present at Spider Lake, and whether the Spider Lake area represents the easternmost extension of the Agassiz Metallotect. The area south of Spider Lake (Fig. GS-5-2) is characterized by abundant multi-channel geophysical responses recorded by airborne INPUT surveys (Questor, 1976). These geophysical anomalies (the Agassiz Metallotect), as well as the flight lines for the Questor (1976) survey, terminate east of Spider Lake. Previous exploration in the area has been conducted by Sherritt Gordon Mines Ltd. and Mattagami Lake Mines Ltd.

SPIDER LAKE

Outcrop in the Spider Lake area is sparse due to an extensive cover of sphagnum-black spruce bog and Lake Agassiz glaciolacustrine clays. Outcrop in proximity to electromagnetic anomalies (Fig. GS-5-2) was examined to determine the stratigraphic relationships in this area and for similarities to MacLellan-type stratigraphy, i.e. interlayered high Mg-Ni-Cr basalt and clastic sedimentary rocks. Southwest of Spider Lake outcrops of strongly foliated, soft, recessive weathering mafic volcanic rock, in part amphibole- and feldspar-phyric, interlayered with rusty-weathering felsic sedimentary rocks and coarse grained pyroxene(?) crystal tuff were observed just a few metres south of a persistent multi-channel electromagnetic anomaly. Without geochemical analyses it is uncertain whether or not the weakly porphyritic mafic volcanic rock is, in fact, the MacLellan high Mg-Ni-Cr basalt and accordingly, several rock samples were collected from the outcrops for Mg, Ni and Cr analyses, elements that effectively fingerprint this rock unit. Analyses will be reported at a later date.

The electromagnetic anomalies trend associated with the suspected high Mg-Ni-Cr basalt southwest of Spider Lake has been tested by widely spaced diamond drilling (DDH SPY61-5, 61-6, 61-7, 61-8) along its trend (Fig. GS-5-2). The anomaly lies beneath swamp thereby restricting geological observation of the anomaly-related rocks to diamond drill core. Drill core from the SPY drill holes at Spider Lake was examined in the Sherritt Gordon core racks in Lynn Lake. Interlayered siliceous and biotite-rich siltstone and amphibolitic greywacke with 5% disseminated pyrrhotite characterize the stratigraphy associated with the geophysical anomaly.

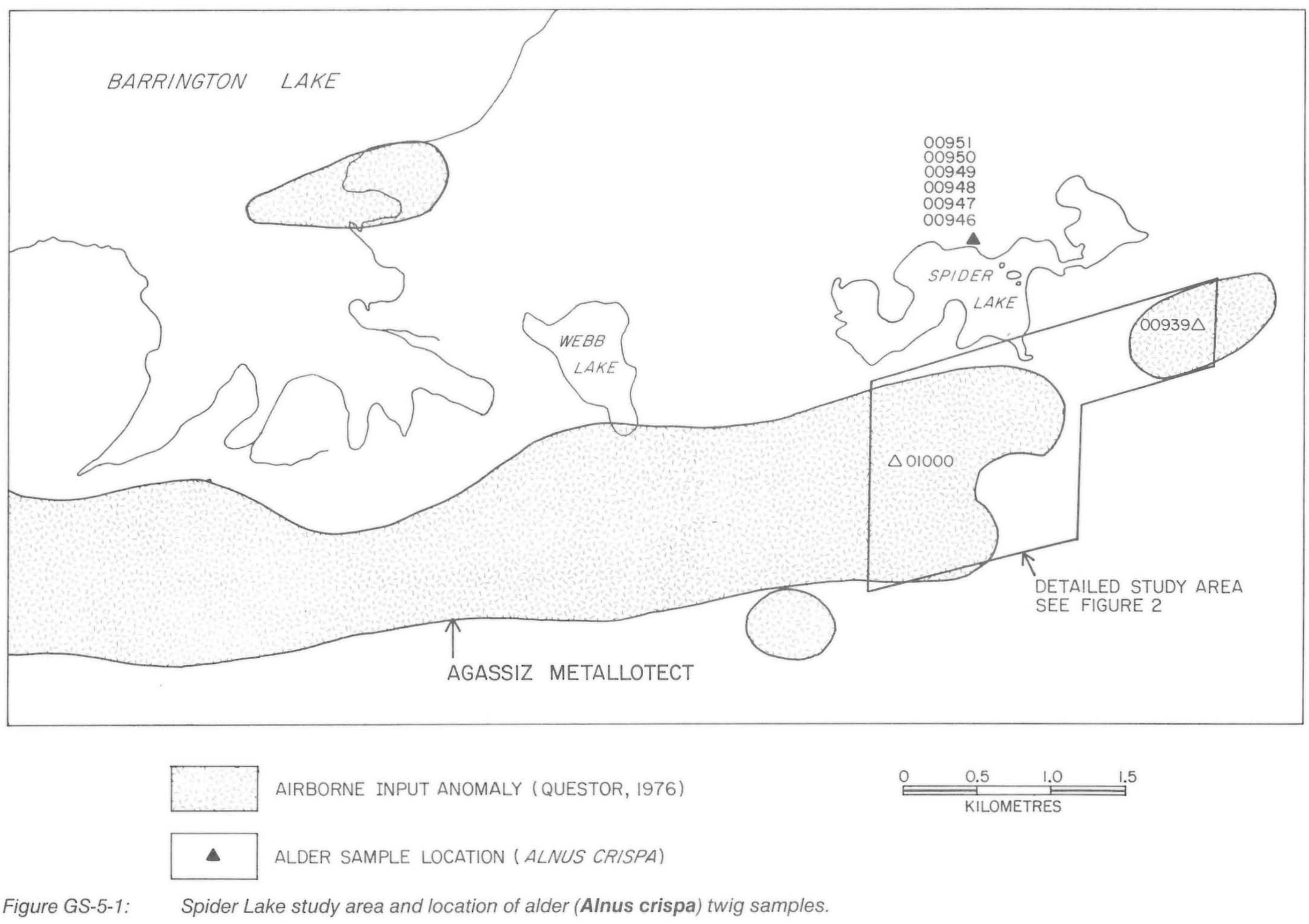

*Figure GS-5-1: Spider Lake study area and location of alder (**Alnus crispa**) twig samples.*

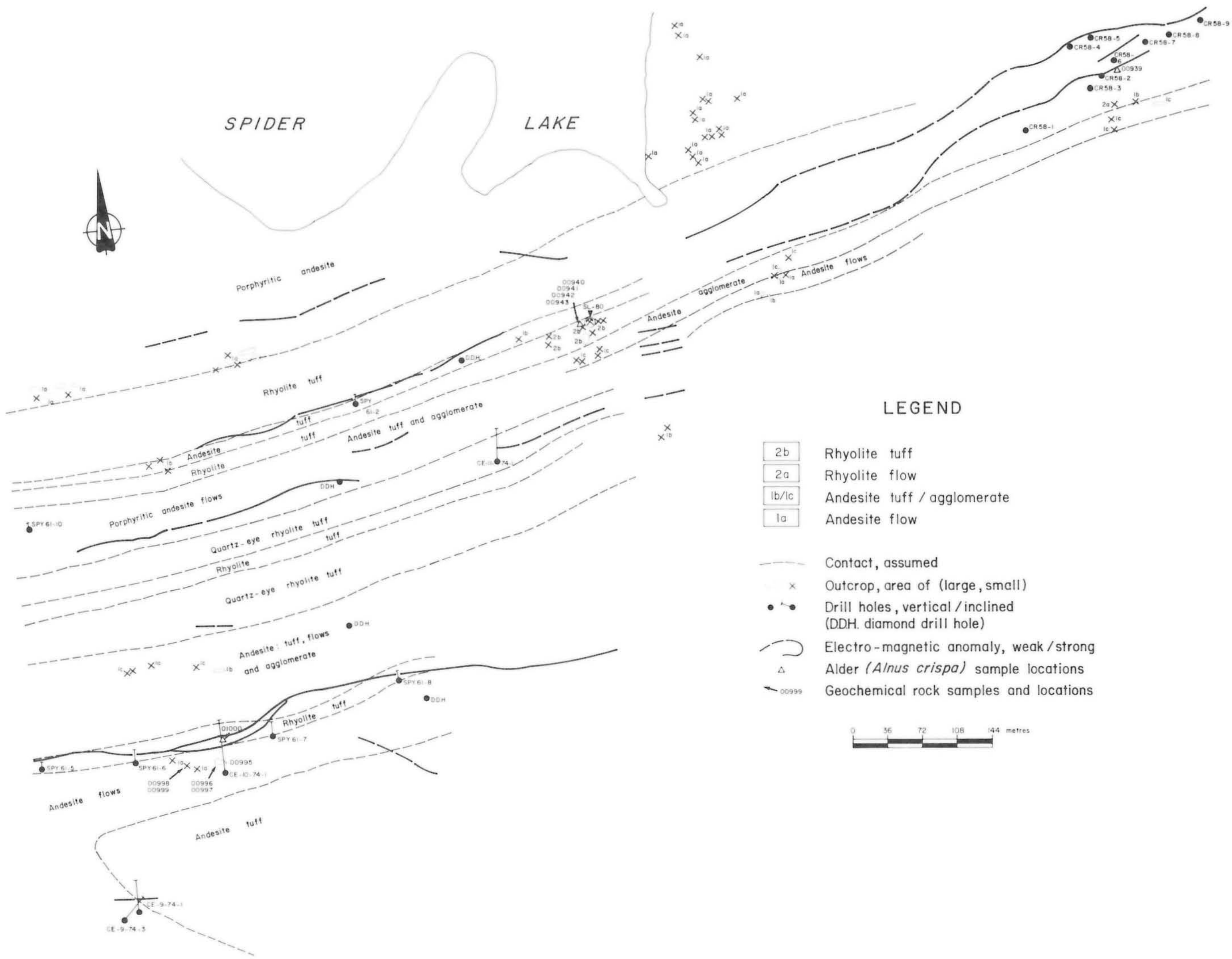

Figure GS-5-2: Compilation geology, geophysics and sampling map of the south shore of Spider Lake, Agassiz Metallotect. Geological and geophysical data from cancelled assessment files 91841 and 91858.

The most direct evidence for MacLellan-type stratigraphy at Spider Lake is observed in DDH SPY-61-7A. This diamond drill hole exposes a sequence of interlayered siliceous, biotite-rich siltstone and greywacke containing 1-10 cm thick solid sulphide (pyrrhotite) exhalite layers and a carbonate-rich fine- to coarse-grained chlorite-amphibole rock texturally and mineralogically equivalent to the MacLellan high Mg-Ni-Cr basalt. A comparison between the stratigraphy at Spider Lake and that at the MacLellan Au-Ag deposit indicates the relative absence of the high Mg-Ni-Cr basalt at Spider Lake. Greywacke-type sedimentary rocks (or altered felsic, tuffaceous volcanic rocks) hosting near-solid to solid pyrrhotite layers of variable thickness predominate over 1-5 cm thick chlorite-amphibole-rich units. The pyrrhotite layers effectively explain the persistent geophysical anomaly southwest of Spider Lake.

The likelihood of repetitions of MacLellan-type Au-Ag mineralization occurring in the Spider Lake area are diminished since the occurrence of MacLellan high Mg-Ni-Cr basalt as a signifiant portion of the stratigraphy is considered to be a prerequisite for anomalous concentrations of gold mineralization (Fedikow, 1986). A preliminary geological scenario would indicate that the Spider Lake area represents the distal portion of a depositional environment characterized by interlayered sulphidic siltstone, high Mg-Ni-Cr basalt and gold mineralization. A proximal equivalent would be the MacLellan deposit area characterized by abundant high Mg-Ni-Cr basalt.

OTHER MINERAL OCCURRENCES AT SPIDER LAKE

An occurrence of 10-15% fine grained pyrite hosted by a siliceous, cherty sedimentary rock was observed between cutlines 237E and 234E on the south shore of Spider Lake (Fig. GS-5-3). The cherty layer occurs between quartz- and feldspar-phyric felsic volcanic rocks containing silicified pumice and a sequence of thinly layered tuffaceous sedimentary rocks. The occurrence (SL-80) has been sampled and the geochemical results will be included in a mineral deposit open file available for inspection upon request.

OTHER PROGRAMS

Detailed geological and geochemical studies have been initiated at the Wendy gold zone at Farley Lake. This program has been undertaken

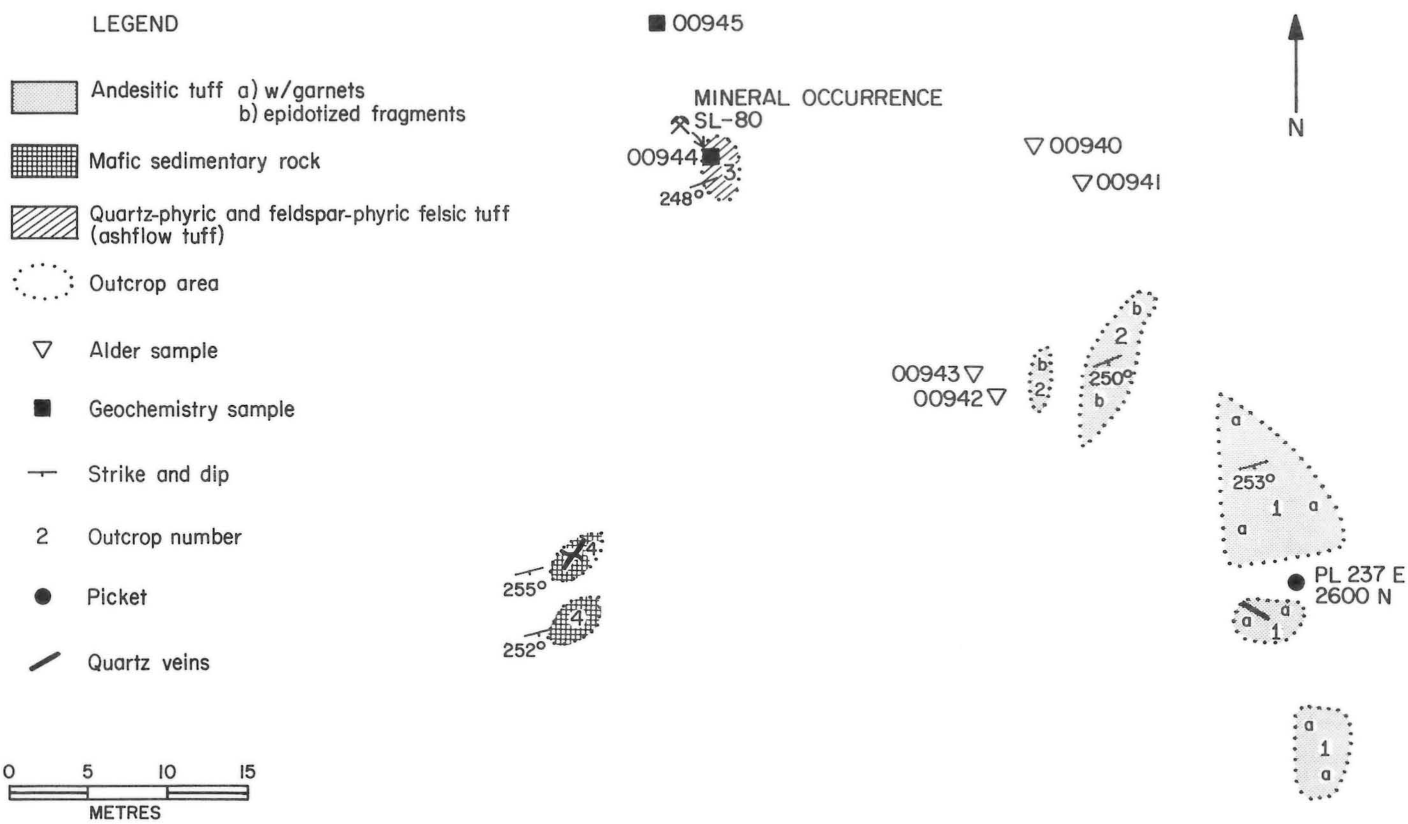

*Figure GS-5-3: Outcrop, geology and alder (**Alnus crispa**) twig sample location map in the vicinity of mineral occurrence SL-80, south shore, Spider Lake.*

in order to develop a better understanding of the nature of this mineralized zone that represents an apparently new style of mineralization within the Agassiz Metallotect.

At Farley Lake magnetite in silicified chlorite-amphibole mafic layers has been replaced by pyrrhotite with gold subsequently precipitated in the interstices of the associated silicate gangue minerals. Minor amounts of gold are observed mantling pyrrhotite grains. The source of the gold is unknown.

Multi-spectral remote sensing data have been acquired over the known length of the Agassiz Metallotect. The Farley Lake area was flown on a detailed grid and together with the other airborne data from the Agassiz Metallotect will be integrated with available geological, geophysical and geochemical data. This information will be utilized for an examination of metal-induced stress in vegetation associated with "hidden" or "blind" mineralization.

ACKNOWLEDGEMENTS

Doug MacMillan of Sherritt Gordon Mines Ltd. (Lynn Lake) is thanked for discussions and information on the Spider Lake area. Tim Robbie is acknowledged for his field assistance at Spider Lake.

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GS-6 TILL GEOCHEMISTRY EAST OF THE RUTTAN MINE

by Erik Nielsen

ARSENIC CONCENTRATION

During the summer of 1985 near-surface till sampling was undertaken to map variations in the till geochemistry east of the Ruttan Mine at Leaf Rapids (Fig. GS-6-1; Nielsen, 1985). Although the initial purpose was to map the distribution of copper and zinc in the less than 2 micron fraction of the till matrix, arsenic values were found to be almost an order of magnitude (mean 53.4 ppm, range 4-338 ppm) above the regional background of 10 ppm (C. Kaszycki, pers. comm., 1986).

As the source of the arsenic has not been identified, it was postulated that it was derived from the erosion of known gold occurrences and associated sulphides along the Vol fault, located north of the sampled area (J. Chornoby, Sherritt-Gordon Mines Ltd., pers. comm., 1985). In addi-

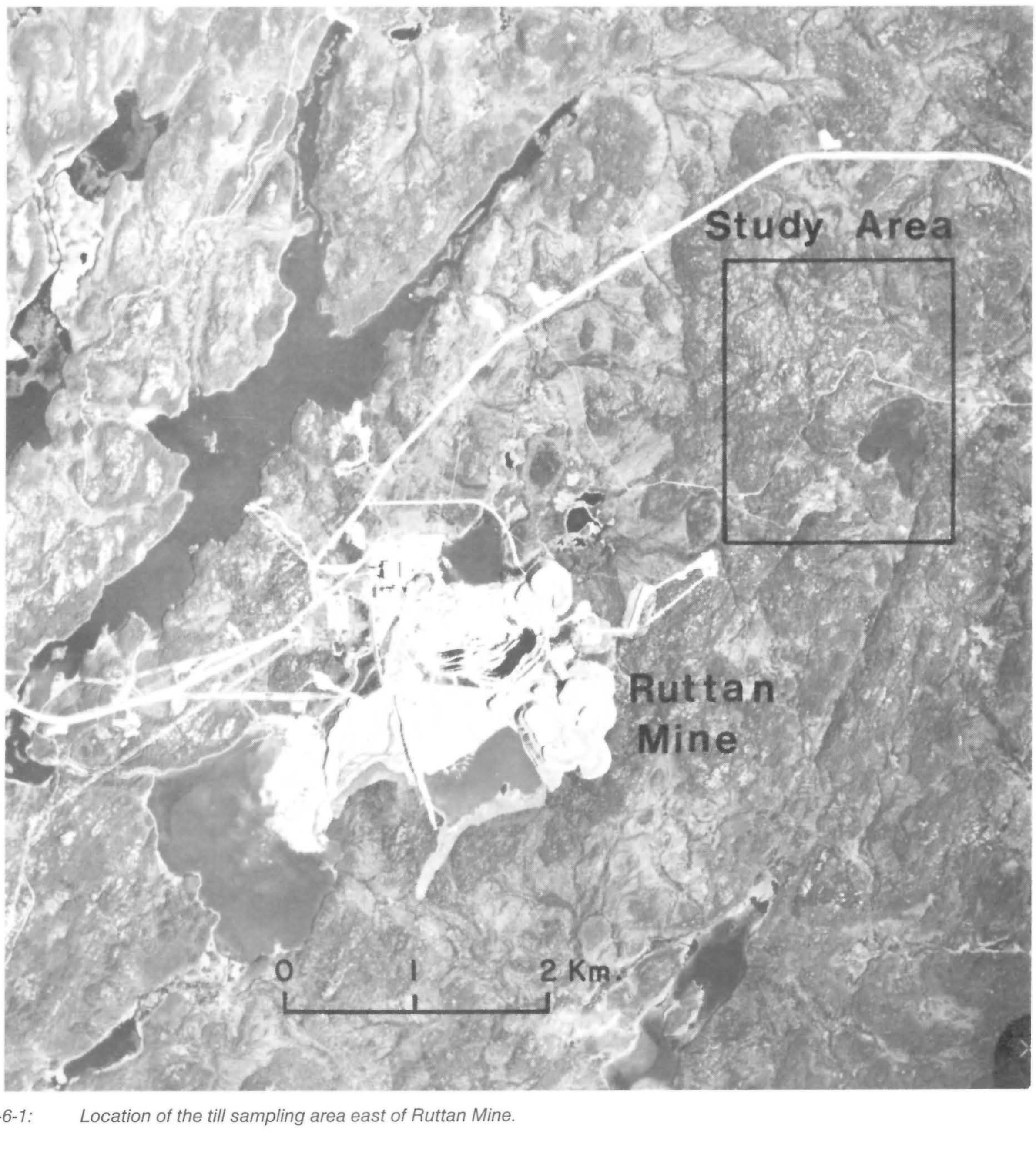

Figure GS-6-1: Location of the till sampling area east of Ruttan Mine.

tion to the 44 till samples collected in 1985, 22 samples were collected in 1986, north of the 1985 sampled area (Fig. GS-6-2).

The less than 2 micron fraction of the till matrix of the 66 samples has, to date, been analyzed for arsenic only. Heavy mineral concentrates (S.G. greater than 2.96) and gold grain counts have been completed on all 66 samples by Overburden Drilling Management Ltd. of Ottawa. Arsenic and gold analysis on the heavy mineral fraction and arsenic analysis on the clay-sized fraction were done by Bondar-Clegg and Co. Ltd. of Ottawa.

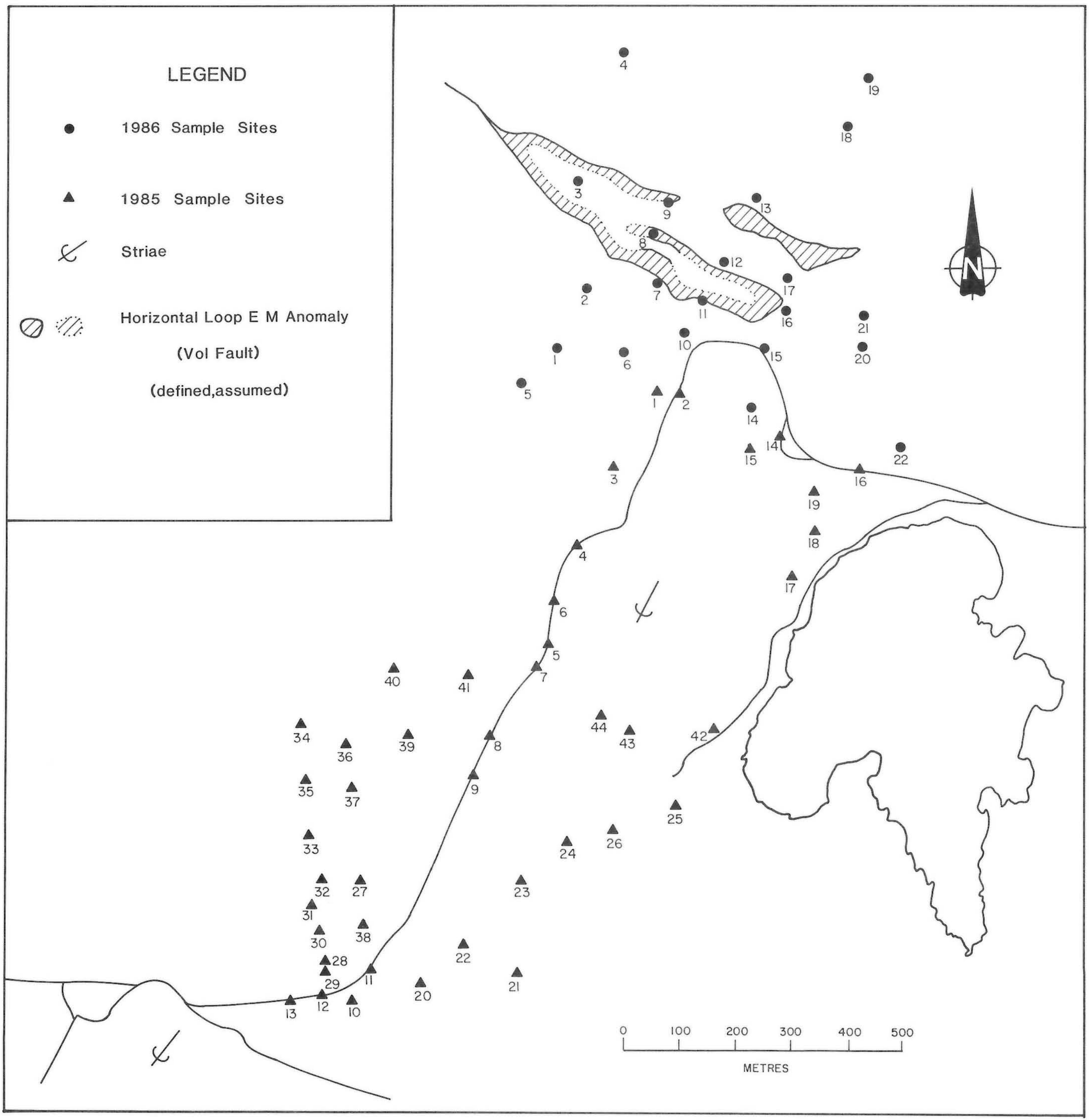

Figure GS-6-2: Location of till samples in the Ruttan area.

BEDROCK GEOLOGY

The bedrock geology of the area (Fig. GS-6-3) has been compiled from Baldwin (1982) and from unpublished maps by Sherritt-Gordon Mines Ltd. The area comprises parts of the Northern Fault Block and the Ruttan Block (Baldwin, 1982). These two major blocks are separated by the Vol fault, that can be traced for more than 20 km to the east.

The rocks of the Northern Fault Block include conglomerates, sandstones and siltstones of volcanic origin, conglomerates and greywackes of volcanic and plutonic origin, and minor mafic volcanic flows.

The Ruttan Block in this area comprises greywacke, siltstone, conglomerate and mafic volcanic flows. Minor dioritic intrusions are found in the volcanic flow rocks that occur stratigraphically below the Ruttan Mine.

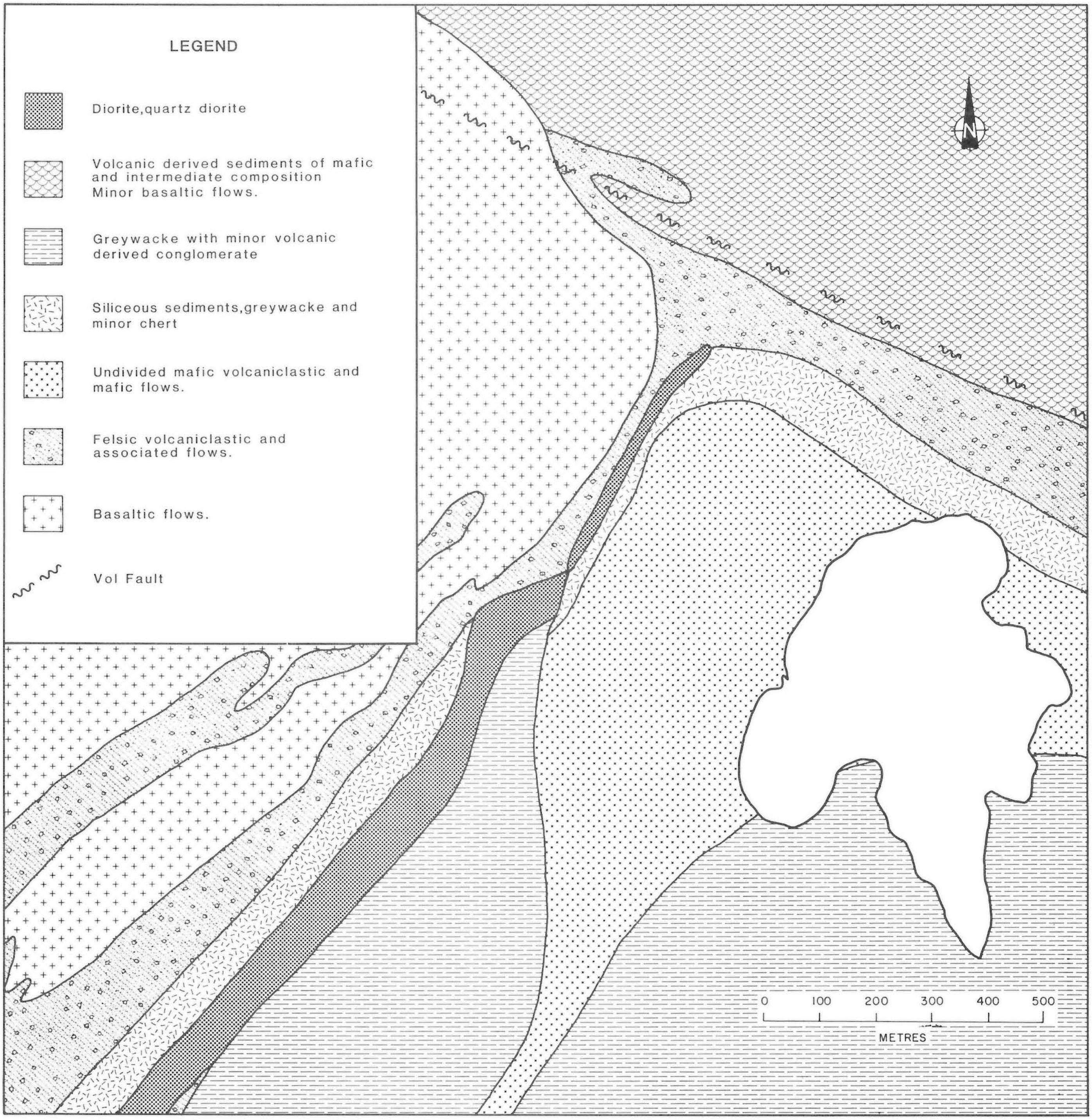

Figure GS-6-3: *Bedrock geology compiled from unpublished maps by Sherritt Gordon Mines Ltd. and from Baldwin (1982).*

Chemical sediments, chert and iron-rich siliceous beds are up to 100 m thick at the Ruttan Mine but thin to the east of the mine (Baldwin, 1982).

Gold mineralization is known to be associated with the Vol fault defined by a horizontal loop EM anomaly to the north and east of the Ruttan Mine (J. Chornoby, pers. comm., 1985).

SURFICIAL GEOLOGY AND ICE FLOW

Bedrock outcrops are abundant east of Ruttan Mine (Fig. GS-6-1). The principal surficial sediments are muskeg and glaciolacustrine clay but there is a general scarcity of till in the area.

Striations are poorly preserved and were recorded at only two sites. These striae, trending 210° and 220°, are consistent with regional trends, between 200° and 230°, in the Ruttan-Leaf Rapids area.

PRELIMINARY RESULTS

The distribution of arsenic in the less than 2 micron fraction of the till matrix and gold in the heavy mineral fraction are shown in Figures GS-6-4 and GS-6-5, respectively.

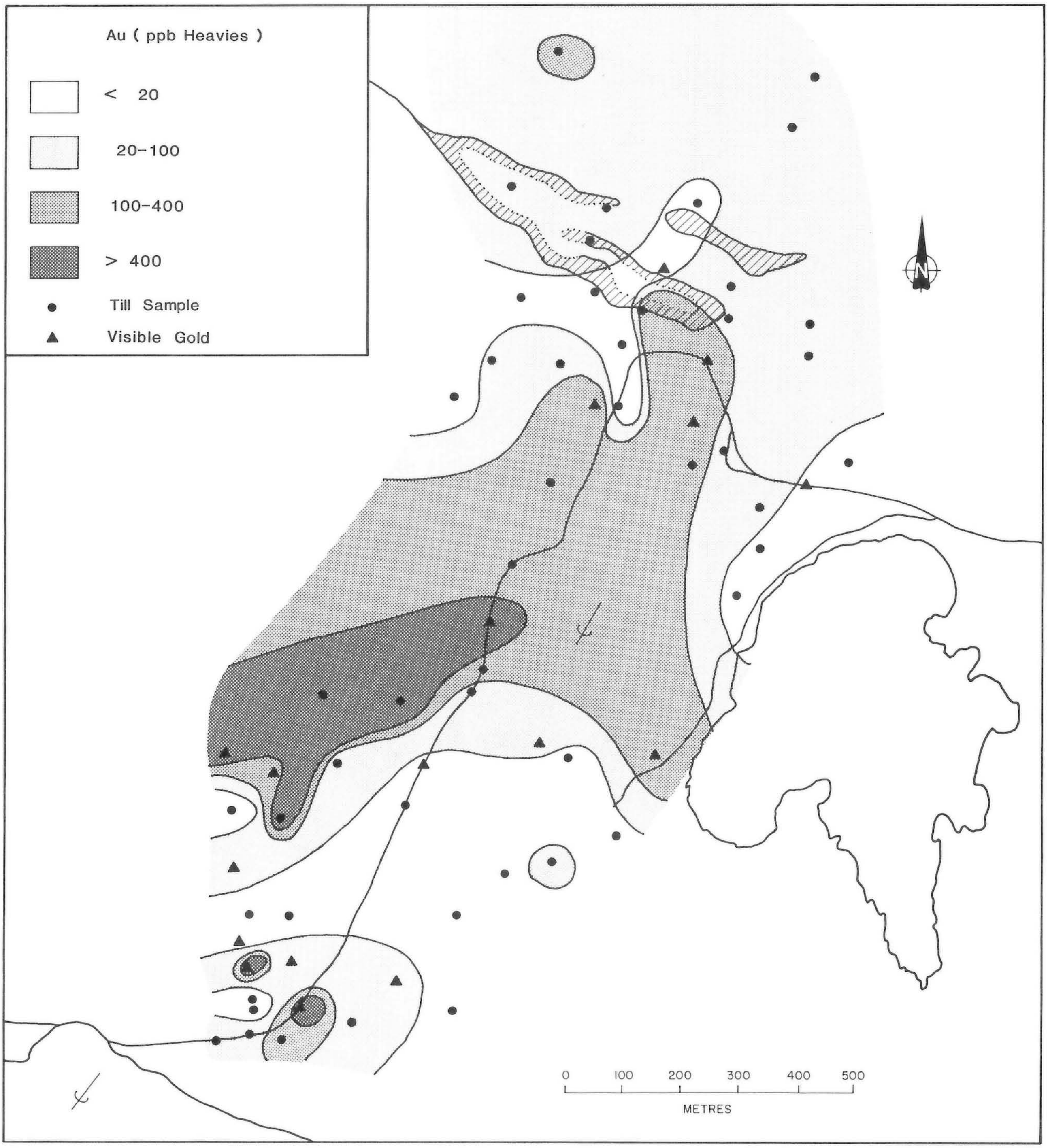

Figure GS-6-4: Gold concentrations (ppb) and visible gold grains in the heavy mineral fraction of till samples from the Ruttan area.

Anomalous values of arsenic are found in three bands trending perpendicular to the ice flow direction. Part of this pattern is also reflected by anomalous gold values above 400 ppb. The northern arsenic anomaly is approximately coincident with the Vol fault but the other anomalies are not associated with any known mineralization. The distribution of anomalous arsenic and gold is believed to reflect the deposition of till on the lee side of large bedrock outcroppings. Although multiple sources for the anomalies are possible, the distribution of gold (Fig. GS-6-5), the occurrence of delicate gold grains in the till adjacent to the fault, and irregular and abraded grains down ice from the fault indicate the fault is the principal source of the gold and associated anomalies. More widespread till sampling is required to substantiate these conclusions.

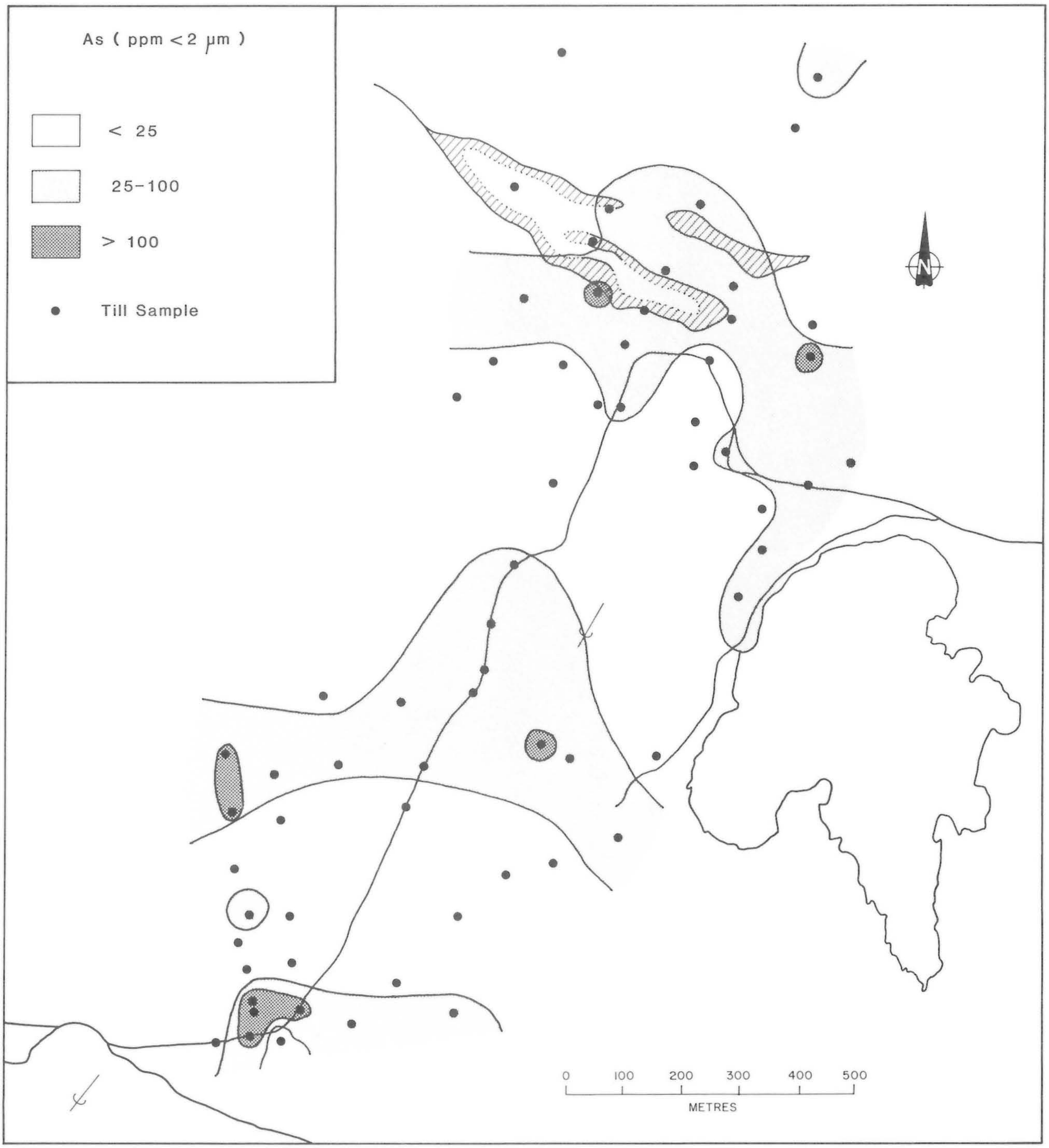

Figure GS-6-5: Arsenic concentrations in the clay-sized fraction of tills from the Ruttan area.

ACKNOWLEDGEMENTS

I wish to thank Jim Chornoby of Sherritt-Gordon Mines for supplying the geology and grid line maps of the area, for his helpful discussion and for his interest in the project.

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TABLE GS-6-1
CHARACTERISTICS OF VISIBLE GOLD GRAINS FROM TILL SAMPLES

Sample No.	No. of gold grains	Gold grain characteristics	ppb gold
86-12	4	1 irregular 3 delicate	10
86-14	6	2 abraded 4 delicate	390
86-15	1	1 abraded	160
85-1	2	2 delicate	340
85-6	5	2 abraded 1 irregular 2 delicate	495
85-8	5	5 delicate	10
85-11	1	1 abraded	480
85-16	1	1 abraded	10
85-22	1	1 abraded	80
85-30	1	1 irregular	540
85-31	1	1 abraded	10
85-33	1	1 abraded	30
85-34	1	1 irregular	485
85-36	1	1 irregular	75
85-38	1	1 abraded	380
85-42	1	1 abraded	355
85-44	1	1 irregular	80

GS-7 TILL GEOCHEMISTRY IN SELECTED AREAS OF NORTHERN MANITOBA

by Erik Nielsen

Till geochemical mapping along the Agassiz Metallotect, initiated in 1985 (Nielsen and Fedikow, 1986), was continued in the Nickel Lake area. In addition, a new till sampling program was started east of Great Island on Seal River in northern Manitoba.

NICKEL LAKE

An additional 22 till samples were collected this season on the north side of Nickel Lake and in an area on the south side of the lake, down ice from the region sampled in 1985. The additional sampling was undertaken because 30 of the 50 samples collected in 1985 had arsenic concentrations, in the clay-size fraction, above the regional background level of 10 ppm. Arsenic analyses from the 72 samples collected in the last two years are shown in Figure GS-7-1. Anomalous concentrations of arsenic are found over a distance of approximately 2.5 km along the south shore of Nickel Lake and form four distinct glacial dispersion trains. The orientation of the anomalies is related to the glacial flow that was initially southerly but later shifted to the southeast towards the end of glaciation. The location of the four anomalies is related to the regional northwesterly strike of the bedrock (Gilbert and Syme, 1980). The source of the arsenic is believed to be sulphide occurrences subcropping under Nickel Lake. Arsenic mineralization may be associated with gabbro underlying the anomalies.

SEAL RIVER

Previous work by Dredge (1983a, 1983b) and Dredge and Nielsen (1986), based on widely spaced till samples in the Great Island area, revealed anomalous arsenic in the less than 2 micron fraction and gold in the less than 63 micron fraction. The highest gold and arsenic values were from a sample collected 5 km east of Great Island on the north side of Seal

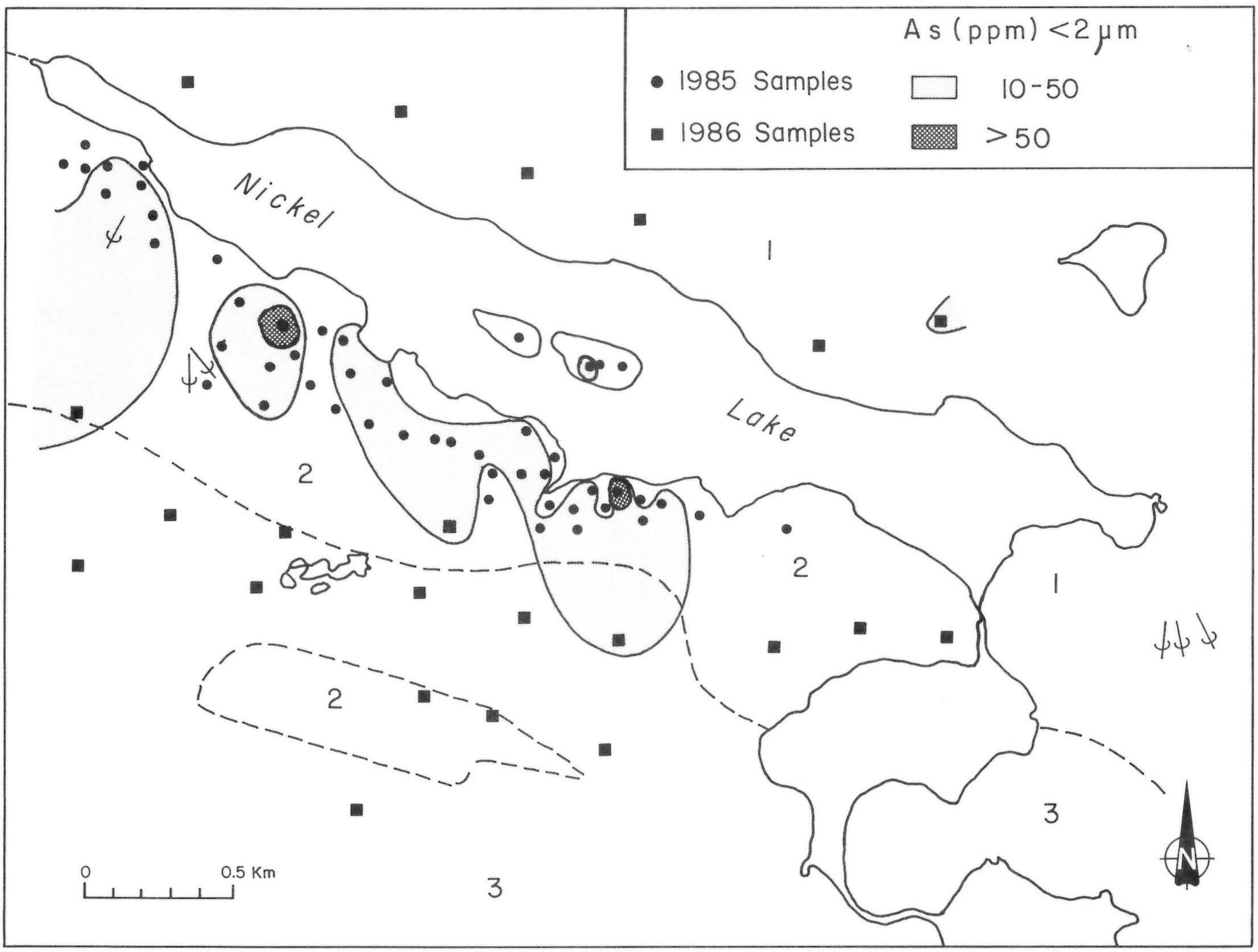

Figure GS-7-1: *Regional variation in the arsenic content in the less than 2 micron fraction around Nickel Lake. Bedrock geology, from Gilbert and Syme (1980):* **1)** *Mafic volcanic rocks;* **2)** *gabbroic intrusive rocks; and* **3)** *granitic and related intrusives.*

River. This area was revisited in 1986 and an additional 34 samples (27 till and 7 marine sand) were collected (Fig. GS-7-2).

The bedrock in the Seal River area is mantled by extensive overburden deposits. Muskeg, tundra peat, and postglacial marine sand and gravel cover much of the area. Till is relatively scarce and is generally found in higher areas associated with bedrock outcrops and felsenmeer. Striae measurements indicate ice flow was first toward 175°, followed by a shift toward 210° (Fig. GS-7-3). These measurements are consistent with the southerly ice flow reported by Dredge and Nielsen (1986).

BEDROCK GEOLOGY

The bedrock comprises quartzite and phyllite of the Seal River Group (Schledewitz, 1986). Quartz veins are common and sulphides were noted at one location (Fig. GS-7-2). Similar occurrences reported on the southwest corner of Great Island are associated with gold, as well as copper, nickel and zinc (Davies et al., 1962).

GOLD AND ARSENIC ANALYSIS

The results of arsenic analysis on the clay-sized fraction are shown in Figure GS-7-4. Three till samples in the proximity of the mineralized outcrop have arsenic concentrations above 2000 ppm and another 3 samples down ice from this area have arsenic values between 1000 and 2000 ppm. All samples, including the seven marine sand samples, have arsenic concentrations well above the regional background of 6 ppm. The samples are all highly anomalous in arsenic and are believed to be centered on or near the apex of what is probably a long glacial dispersion train extending to the south.

The less than 2 micron fraction of the till matrix will also be analyzed for Cu, Pb, Zn, Ni, Co, Cr, Fe and Mn. In addition to these elements the heavy mineral fraction (S.G. greater than 2.96) will be analyzed for Au and Ag. The less than 63 micron fraction of the till matrix will also be analyzed for gold and arsenic by neutron activation to make the results comparable with the previously published results of Dredge and Nielsen (1986).

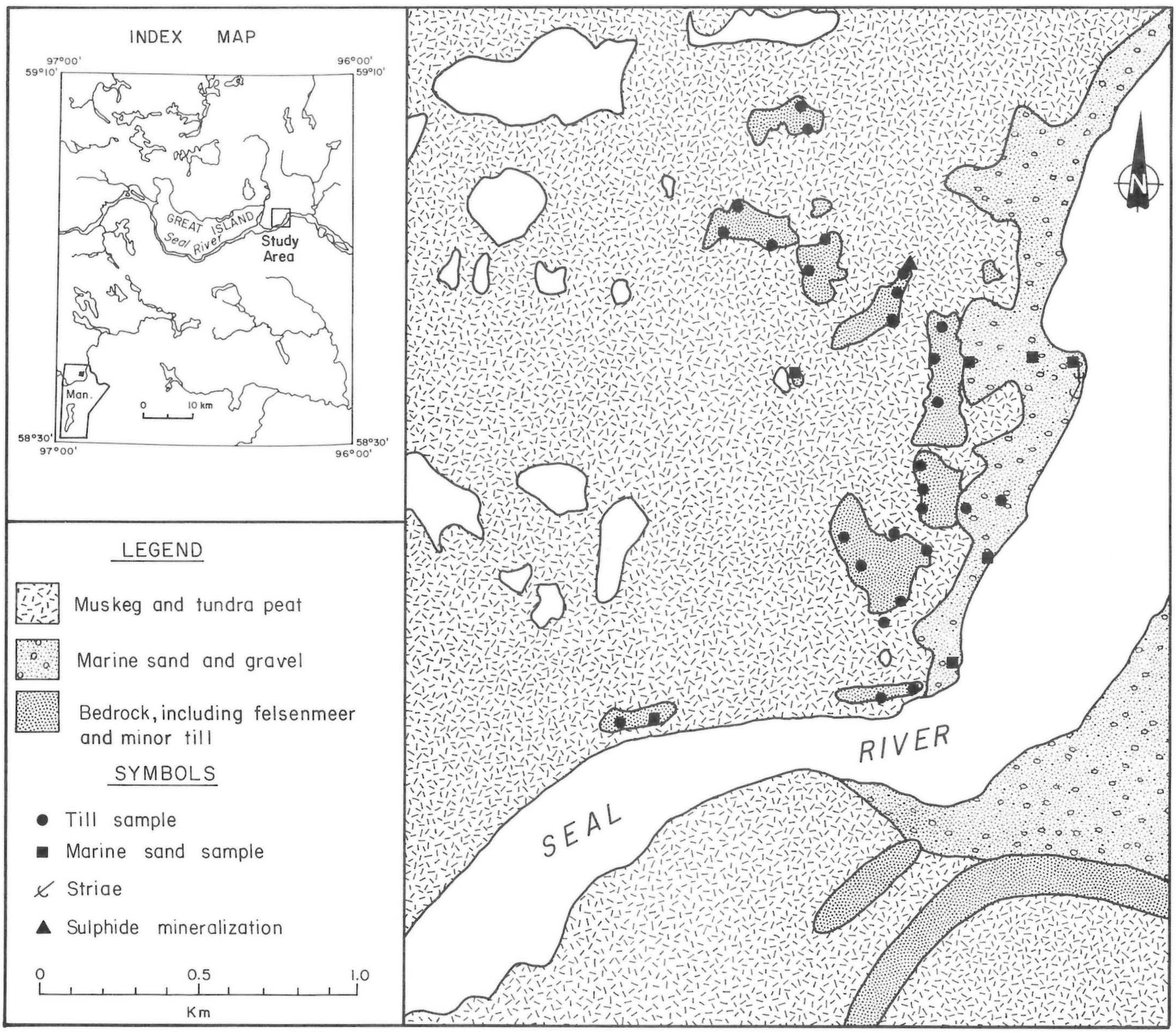

Figure GS-7-2: Location of samples from the Seal River area.

Figure GS-7-3: *Striated outcrop on the Seal River showing the southwesterly shift in the ice flow direction.*

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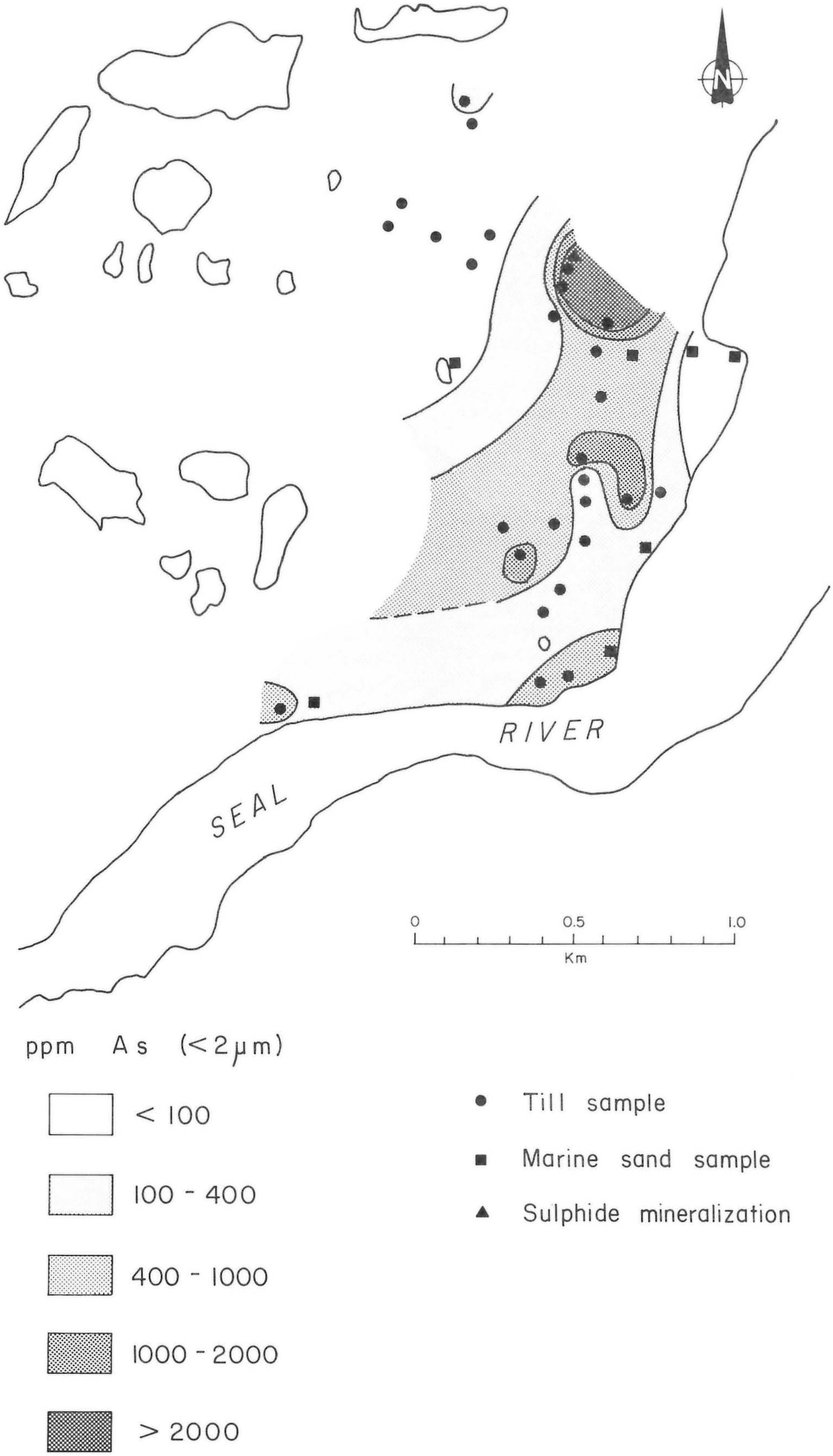

Figure GS-7-4: Variation in arsenic content in the less than 2 micron fraction along part of the Seal River.

GS-8 SCHIST LAKE AREA (ATHAPAPUSKOW 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-8-1) lies to the south of the recently mapped Flin Flon-White Lake area (Bailes and Syme, in prep. and Preliminary reports 1979, 1980, 1982, 1983). This continuation of detailed mapping will ultimately provide an improved understanding of the complex stratigraphic and structural relationships found in the Flin Flon belt.

Fieldwork during the 1986 season was concentrated on Schist Lake (Fig. GS-8-1, Preliminary Map 1986F-1), which provides access to the largest area of Amisk Group metavolcanic rocks in the project area.

STRUCTURAL SETTING

The Schist Lake area is divided into five major fault-bounded blocks (Fig. GS-8-2), four of which are a southern continuation of blocks mapped in the Flin Flon-White Lake area to the north (Bailes and Syme, 1983). Each block has a unique stratigraphic sequence, degree of internal deformation and intrusive suite. The faults which bound the blocks have considerable displacement because stratigraphic correlation cannot be made across them. Subordinate faults within the major blocks offset, repeat or cut out stratigraphy, but correlation of stratigraphy and structure is generally possible.

Deformation associated with the block-bounding faults varies considerably (Syme, 1985). The Centennial, Northeast Arm and Ross Lake faults (Fig. GS-8-2) are abrupt breaks with virtually no attendant shear foliation or brecciation observed in outcrops adjacent to the faults. West Arm fault is characterized by a zone of intense shear foliation several metres wide, locally superimposed on an earlier, brittle deformation. Inlet Arm fault juxtaposes greenschist grade rocks of the Bear Lake block against subgreenschist grade rocks of the Hook Lake block (Fig. GS-8-1). A wide zone of moderate to strong ductile deformation and southerly-plunging folds occur on the greenschist grade side of the fault whereas on the subgreenschist side deformation is restricted to minor subsidiary parallel breaks.

Zones of shear foliation, cataclasis, mylonitization and late intrusion occur on the islands and peninsulas of Northwest Arm and Northeast Arm, suggesting that these areas are underlain by several closely spaced faults in addition to the mapped block-bounding faults. One of these, the Northeast Arm zone, is described in a subsequent section.

FLIN FLON BLOCK

The Flin Flon structural block is bounded on the south by West Arm fault and on the east by Ross Lake fault (Fig. GS-8-2). The volcanic sequence is dominated by pillowed mafic flows, subdivided according to phenocryst population. The flows are extensively intruded by a wide variety of diorite, quartz diorite and tonalite bodies. Metamorphic grade in the Schist Lake portion of the block is largely subgreenschist, with many of the rocks containing prehnite, pumpellyite and primary clinopyroxene.

Best preservation of primary structures and textures is in the northern part of the block, between Ledge and Schist Lakes (Fig. GS-8-3). There the flows weather light buff to rusty buff and contain 10-20% 1-2 mm plagioclase phenocrysts and glomerocrysts. Some of the flows also contain up to 5% 1-2 mm pyroxene phenocrysts. In a 500 m wide zone adjacent to a plagioclase-phyric tonalite intrusion these flows weather dark grey and are altered, epidotized, and cut by porphyritic granodiorite dykes.

The central and southern part of the Flin Flon block is composed of intercalated aphyric and plagioclase-phyric flows, subordinate related breccias and tuff. The volcanic sequence is disrupted by sheets and irregular bodies of diorite and quartz diorite; many of the larger bodies are composite intrusions composed of a wide variety of fine grained, medium grained and porphyritic types.

The West Arm Cu-Zn massive sulphide deposit occurs within the Flin Flon block, adjacent to the block-bounding West Arm fault (Fig. GS-8-2). The massive sulphide orebody is stratiform and contained within a fine grained sedimentary sequence comprising black graphitic argillite, pyritic siltstone and banded chert-hematite iron formation. These rocks are not exposed on surface but may be stratigraphically equivalent to greywacke, siltstone and mudstone sporadically exposed in the eastern part of West Arm. The stratigraphic footwall of the West Arm deposit consists of altered, bleached, locally carbonatized and silicified plagioclase-phyric pillowed flows and related pillow fragment breccias. Despite white to light buff weathering of the rocks, they were probably basaltic andesite in composition and owe their unusually light colour to hydrothermal alteration. The flows and breccias are intruded by pale green fine grained diorite identical to a diorite type common in the mine. In contrast, diorites south of the West Arm fault, in the Kaminis Lake Block (Fig. GS-8-2) are typically dark green to dark grey.

HOOK LAKE BLOCK

The Hook Lake structural block is bounded on the east by Inlet Arm fault and on the west by Ross Lake fault (Fig. GS-8-2). In the Flin Flon-White Lake area the western bounding fault was defined as the Cliff Lake fault (Bailes and Syme, 1983); in the Schist Lake area the Cliff Lake fault appears to be a subordinate structure whereas the Ross Lake fault clearly separates completely different stratigraphic units.

The internal structural pattern of the Hook Lake block is dominated by a northerly trending anticline dissected by faults; the western limb of the fold has been removed by the Cliff Lake fault. Northeast- and northwest-trending faults in the Hook Lake block truncate and, in at least one instance, repeat volcanic stratigraphy.

The Hook Lake block is composed of distinct units of plagioclase-phyric pillowed basaltic andesite, four types of mafic volcaniclastics, rhyolite and minor conglomerate. In contrast to the Flin Flon and Kaminis Lake blocks, dioritic intrusions are virtually absent. The rocks are within the prehnite-pumpellyite zone of regional metamorphism and primary structures and textures are well preserved.

The key to stratigraphic subdivision of the Hook Lake block volcanic sequence is the differentiation between four general types of mafic fragmental rocks:

(1) Monolithologic pillow fragment breccia
(2) Heterolithologic breccia
(3) Scoria-rich lapilli tuff and interbedded breccia
(4) Tuff, lapilli tuff and tuff breccia.

Monolithologic pillow fragment breccias are poorly sorted, matrix-supported, and poorly stratified. Fragments are angular to subrounded, plagioclase-phyric, and up to about 30 cm across. They vary considerably in amygdale content and size, reflecting similar variations in associated pillowed flows and within individual pillows. Some fragments have bands of amygdales truncated at fragment margins; these were derived from pillows with concentric bands of vesicles. Pillow fragment breccia beds are massive in the lower part and are normally graded only in the upper portion, where fragment size and abundance decrease rapidly to the top of the bed.

Heterolithologic breccias contain three to four fragment types

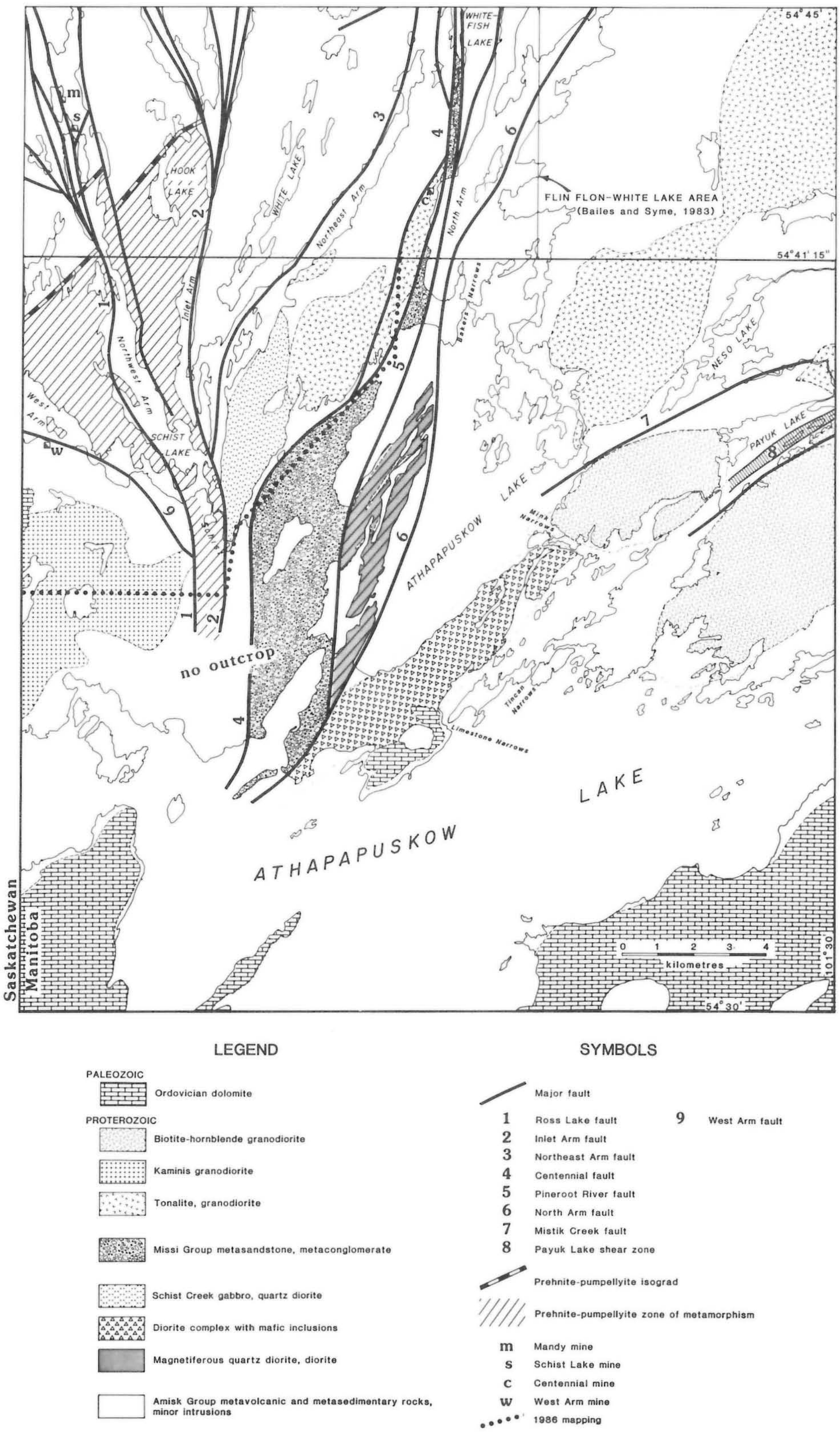

Figure GS-8-1: Athapapuskow Lake project area (south of 54°41'15") with geology modified from Tanton (1941) and Buckham (1944). Area mapped during the 1986 field season is outlined with dots.

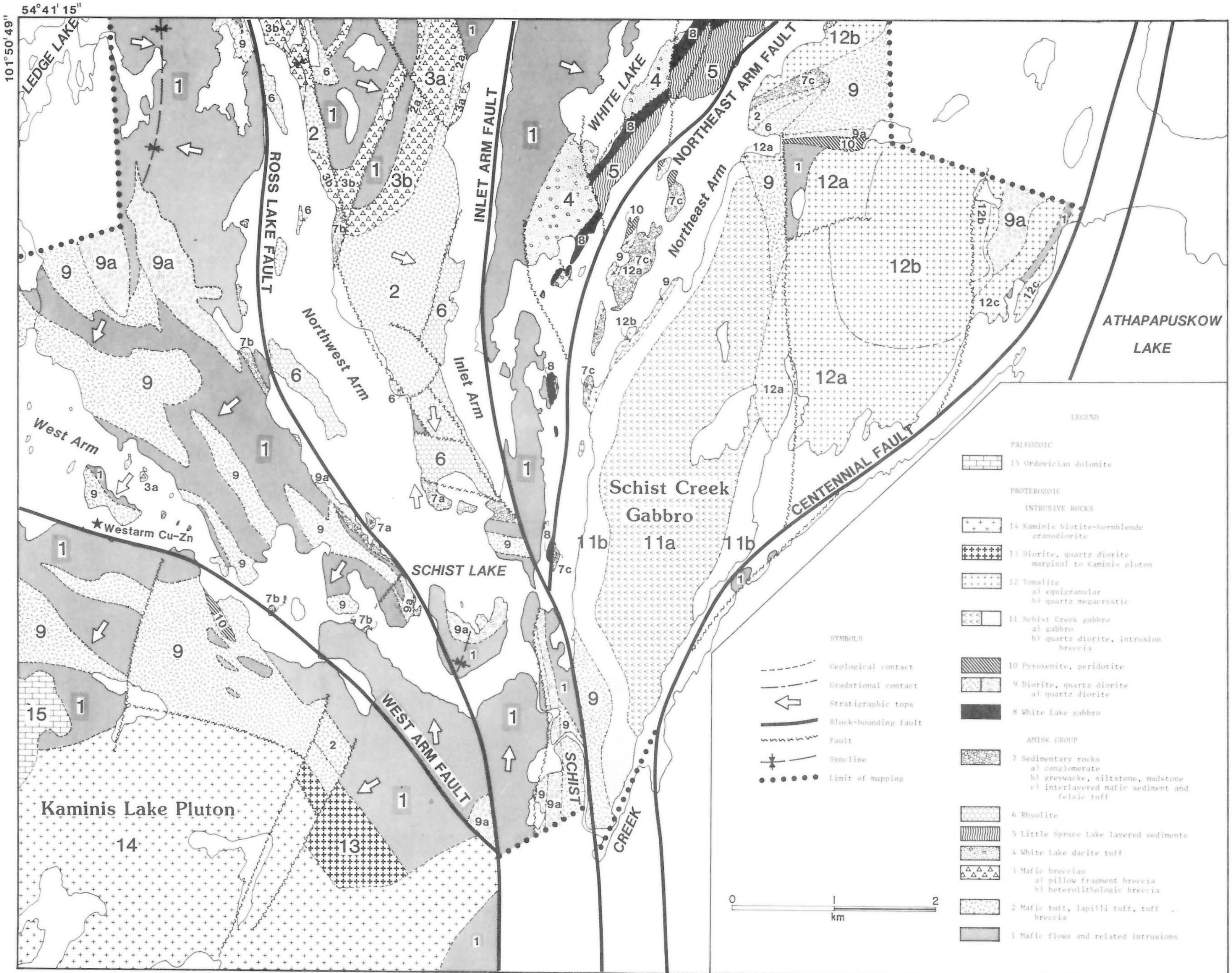

Figure GS-8-2: Simplified geology in the Schist Lake area.

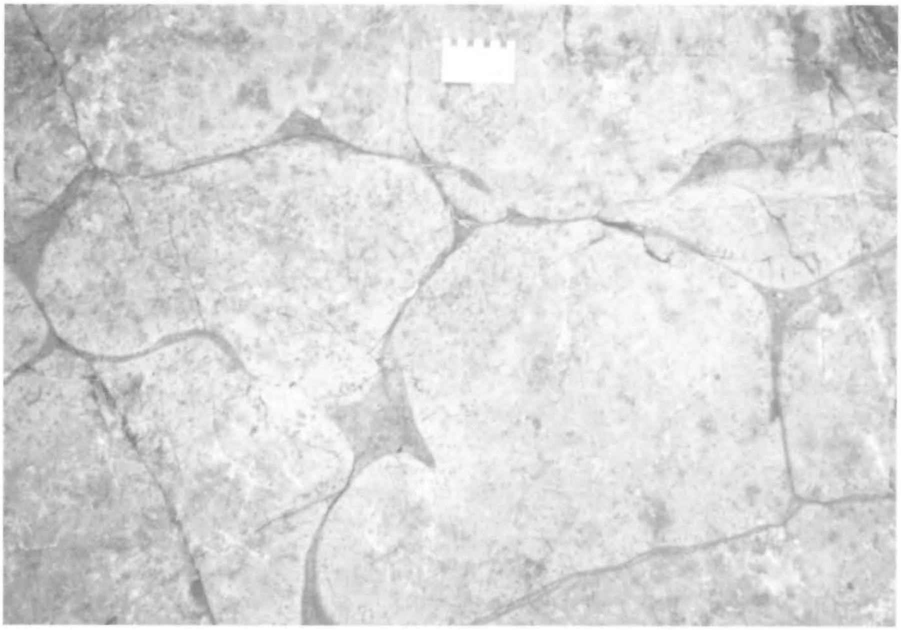

Figure GS-8-3: Undeformed, pillowed, plagioclase-phyric mafic flow east of Ledge Lake, Flin Flon block. The pillows have chlorite pipe amygdales (to 2 cm long) in their outer margins. Interpillow voids have been filled with brown weathering hyaloclastite.

(aphyric, sparsely porphyritic, plagioclase-phyric, felsic) in the size range 2 mm to 80 cm. Fragments tend to be angular and the deposits poorly sorted and in some instances framework supported. Bed contacts are defined by abrupt changes in clast size. Although some granules and fragments are scoriaceous, most fragments are amygdaloidal but not scoriaceous. The mode of origin of these breccias may be indicated in one particularly good exposure where an unfaulted, synvolcanic paleoscarp separates pillowed flows from heterolithologic (talus?) breccia. These breccias were clearly produced from pillow basalt debris derived from the walls of the scarp.

Scoria-rich lapilli tuff and interbedded breccia are dominated by much finer grained material than pillow fragment or heterolithologic breccias. The granules and lapilli are densely vesicular (scoriaceous) indicating they originated in magmatic or phreatomagmatic eruptions. Thin pillowed flows are intercalated with the scoriaceous tuff, indicating that the pyroclastic material was deposited in a subaqueous environment. Scoria lapilli are plagioclase-phyric, subrounded to rounded, and are in a matrix of plagioclase crystals and small scoria particles. Larger clasts (2-20 cm) are subrounded and tend to occur as isolated fragments in lapilli tuff; some distinctive oval clasts have cores of green (chlorite + pumpellyite) alteration (Fig. GS-8-4). Breccia beds contain angular to rounded amygdaloidal clasts (to 20 cm) that may represent concentrations of lithic clasts (pillow fragments). Bedding is better defined than in pillow fragment breccia.

Tuff, lapilli tuff and tuff breccia are, like the scoria tuff, well stratified subaqueous deposits. However, most fragments and granules, although amygdaloidal, are not scoriaceous. Tuff is composed of particles less than 5 mm across, comprising plagioclase crystals, lithic granules and subordinate scoria. Larger fragments (to 60 cm) are plagioclase-phyric, subrounded to subangular, variably amygdaloidal and occur: (1) in trains or strata within beds, (2) at the tops of beds, or (3) scattered throughout beds. Bedding is commonly well defined and relatively

Figure GS-8-4: Bedding in breccias composed of scoriaceous fragments, Hook Lake block. A sedimentary dyke of fine grained material extends about 30 cm into underlying breccia bed. Scoria fragments commonly have a core of green, chlorite-pumpellyite alteration.

thick (10 cm — 2 m), and beds commonly have non-graded lower parts and graded upper parts.

Rhyolite occurs in fault-bounded segments of the Hook Lake block and on two large peninsulas on Northeast Arm. The rhyolite consists of aphyric and quartz-phyric varieties. Primary structures (rare) include flow banding, anastomosing crackle (cooling) breccia, polygonal cooling joints, amygdales and stratified breccia. The types of primary structures are consistent with an interpretation of the rhyolite as a flow complex. The rhyolites are commonly tectonically brecciated and cut by anastomosing and planar veins of Fe-carbonate and later quartz; shoreline exposures on Inlet Arm are commonly strongly foliated. The southern, large peninsula on Northwest Arm (Fig. GS-8-2) is strongly deformed rhyolite containing 5-15% quartz phenocrysts to 2 mm; it therefore cannot be directly correlated with the sparsely porphyritic rhyolite segments exposed across the Arm to the east. Much of the body is composed of quartz-sericite schist, with augen of less deformed rhyolite.

A unit of conglomerate, pebbly greywacke and greywacke occurs near the southern end of Northwest Arm. The sedimentary unit is 180 m thick and apparently tops a thick (at least 3.5 km), north-facing succession of mafic flows that are exposed as far south as Schist Creek (Fig. GS-8-2). The conglomerate is in probable fault contact with rhyolite to the north. Rounded pebbles and cobbles in the conglomerate include plagioclase-phyric, aphyric, non-vesicular and vesicular mafic flow rocks, sporadic white flow banded rhyolite, laminated siltstone-mudstone, and fine grained diorite.

In the southern part of the Hook Lake block, west of Schist Creek, aphyric and sparsely plagioclase-phyric pillowed flows are characterized by a distinctive buff weathering colour and pale grey fresh colour. West of the Ross Lake fault, in the Flin Flon block, the basalt flows are medium to dark green. This juxtaposition of two completely different basalt types closely constrains the position of the Ross Lake fault and indicates that at this location the fault must have produced considerable displacement.

BEAR LAKE BLOCK

The Bear Lake block is bounded on the west by Inlet Arm fault and on the east by Northeast Arm fault (Fig. GS-8-2). The block terminates where the two faults intersect, north of Schist Creek. In marked contrast to the subgreenschist grade rocks in the adjacent Hook Lake block, the rocks in the Bear Lake block have lower greenschist mineral assemblages and are strongly deformed.

The stratigraphic sequence in the Bear Lake block has been defined in the Flin Flon-White Lake area, where the rocks are best preserved (Bailes and Syme, 1979). A portion of that sequence, with some variations, occurs in the Schist Lake area. From oldest to youngest the mapped formations include: Bear Lake basaltic andesite, White Lake dacite tuff, and Little Spruce Lake andesitic lapilli tuff and associated fine grained sediments. The White Lake gabbro, a strongly differentiated tholeiitic sill, intrudes the upper part of the succession.

Bear Lake basaltic andesite comprises pillowed and subordinate massive flows, intruded by sheets of fine grained equigranular diorite. In the Schist Lake area, primary pillow structure is obliterated through the combined effects of epidote alteration and subsequent ductile deformation. Epidosite domains, which formed in the cores of pillows, are now drawn out into lenticular or laminar forms, separated by recessive schistose zones that represent original pillow margins and selvages. Quartz amygdales occur in some epidosite domains and are commonly the only recognizable primary structure. Within about 200 m of the Inlet Arm fault, deformation is extreme, producing banded epidosites with a strongly cleaved, fissile, or schistose texture. These rocks locally contain boudinaged pegmatite veins. Within about 600 m of the fault the deformed epidosite domains and associated diorite sills locally define folds with north-northwest-trending axial planes and moderate to steep southerly plunges.

White Lake dacitic tuff overlies the epidotized basaltic andesite. The "tuff" comprises at least four different facies representing variable reworking of a relatively felsic tuff and incorporation of some detrital, intermediate to mafic components, resulting in an overall dacitic composition (Bailes and Syme, in prep.). In the Schist Lake area, the dacite tuff is commonly thinly layered to laminated, with beds defined principally by colour (buff, brown, orange, green) reflecting variable chlorite content. The tuff is characterized by the presence of small (0.2-0.5 mm) quartz crystals, which vary in abundance between beds. Locally, layering is poorly defined by colour and the tuff superficially appears homogeneous; however, variation in quartz abundance defines bedding. Some layers contain up to 10% 1-20 cm oval pumice lumps, demonstrating that the reworked tuff has a considerable pyroclastic component.

Little Spruce Lake andesitic lapilli tuff and associated fine grained sediments compose the uppermost formation in the Schist Lake portion of the Bear Lake block. The lapilli tuff occurs at the base of the unit; it is volumetrically insignificant and strongly flattened. Most of the unit comprises thinly layered to laminated greywacke and siltstone. Beds are defined by colour (buff, greenish buff, rusty brown, green) and are distinguished from similarly layered White Lake dacitic tuff by the absence of 0.5 mm quartz. The rocks contain three sets of minor folds: oldest folds are isoclinal, shallow southwest-plunging chevron types trending 050°-060°. These folds are overprinted by z-asymmetrical chevron folds trending 020°-040°. Both generations of folds have an associated axial planar schistosity. The youngest structures are a locally strongly developed set of z-asymmetrical chevron kink bands trending 360°.

The abundance of fine grained sediment in the Little Spruce Lake formation is consistent with the paleogeographic model for the Bear Lake stratigraphic succession proposed by Syme et al. (1982). The White Lake dacitic tuff and Little Spruce Lake formation are thought to have filled a southward-deepening basin, possibly a large caldera in the underlying Bear Lake basaltic andesite subaqueous shield volcano. In the Flin Flon-White Lake area to the north, the Little Spruce Lake formation is dominated by a more proximal assemblage of thick bedded andesitic tuffs and breccias. The thinly layered sediments that compose this formation in the Schist Lake area probably represent deposition in a deeper, more distal portion of the basin.

The final major component of the Bear Lake block is the White Lake differentiated gabbro sill. The sill is up to 150 m thick and comprises three members: a grey-buff gabbro base, dark green ferrogabbro, and greenish quartz ferrodiorite top. The sill is strongly foliated and appears to be isoclinally folded with the enclosing White Lake and Little Spruce Lake formations. Details of the sill have been described previously (Bailes and Syme, 1979, 1980). In the Schist Lake area the sill is cut by a series of splays from the Northeast Arm fault (Fig. GS-8-2), each with about 700 m of left lateral displacement.

NORTHEAST ARM ZONE

The Northeast Arm zone is the western portion of the Scotty Lake block (Fig. GS-8-2) and comprises strongly deformed sediments and intrusive rocks lying between the east shore of Northeast Arm and the Northeast Arm fault.

The oldest rocks in the zone are a sequence of thin bedded grey-green greywacke, mafic mudstone and light buff felsic tuff; these are locally recrystallized to chloritic schist. The sediments are intruded by irregular sheet-like veins (1-50 cm wide) of fine grained (0.5 mm) leucocratic tonalite. Both the sediments and tonalite are locally flattened and mylonitized, with tight disharmonic intrafolial folds. A more regular set of folds have steeply dipping northeast-trending axial planes and variable, moderate plunges to 035°-050°. The tonalite also intrudes an older diorite, and together these are folded. Two large, coarse grained pyroxenite dykes cut the earlier sediments, tonalite and diorite. The pyroxenite contains discrete zones of intense ductile shear, some of which contain large augen of less deformed pyroxenite. Aplite and two phases of diorite form dykes which are younger than this shearing.

The eastern margin of the Northeast Arm zone is marked by a 30 m wide tonalite dyke which is continuous with a larger body of quartz-megacrystic tonalite at the northern boundary of the map area. The tonalite dyke is strongly deformed: 5 mm-20 cm wide strips of foliated tonalite are separated by schistose, very fine grained mylonitic zones.

The Northeast Arm zone represents a high-strain boundary between two disparate blocks, and records a history of multiple intrusion, folding and repeated shearing. North of Schist Creek the zone and its bounding faults are terminated against the Inlet Arm fault. This is important because it demonstrates that the Inlet Arm fault postdates at least some of the reassembly of the belt into fault-bounded blocks.

SCOTTY LAKE BLOCK

In the Flin Flon-White Lake area the Scotty Lake structural block comprises a well defined sequence of iron-rich basalts and overlying mafic volcaniclastics (Bailes and Syme, 1979). In the Schist Lake area this block, bounded by the Northeast Arm and Centennial faults (Fig. GS-8-2), consists 90% of plutonic rocks.

Schist Creek gabbro forms a lens-shaped pluton 6.3 x 1.8 km. The pluton is concentrically zoned, with about 300 m of quartz diorite and quartz diorite intrusion breccia at the margins, and a core of gabbro. Dykes and small plugs of quartz-megacrystic tonalite cut the quartz diorite and gabbro. The pluton was emplaced into fine grained diorites containing abundant quartz diorite and tonalite dykes which are satellitic to the pluton.

Gabbro is coarse grained, weathers green, brown and white, and contains 0-3% fine grained interstitial quartz. Plagioclase (40-50%) occurs as stubby tabular to blocky euhedral crystals with a seriate size distribution from 1-10 mm. Mafic minerals (50-60%) include honey-brown subhedral clinopyroxene crystals 1-10 mm long, and dark green amphibole which occurs both as a partial replacement of clinopyroxene and as an interstitial phase. Gabbro is poorly foliated and contains 0-2% small dioritic xenoliths. It is cut by quartz-megacrystic tonalite veins, many of which have a core of bull quartz.

On the eastern side of the pluton gabbro grades to quartz diorite through increasing quartz content and decreasing mafic content; the contact is arbitrarily drawn at 5% quartz content. These eastern quartz diorites contain 5-10% fine grained quartz, 40-50% stubby tabular to equant plagioclase (1-5 mm) and 40-50% subhedral prismatic amphibole after pyroxene (1-5 mm). Textures are very similar to the somewhat coarser grained gabbro. Quartz diorite contains a few small subrounded diorite xenoliths and is cut by dykes of quartz-megacrystic tonalite and aplite.

The western margin of the pluton is an intrusion breccia composed of fine grained diorite xenoliths in a coarse quartz diorite matrix. The quartz diorite contains 10-25% quartz (0.5-2 mm), 50-60% euhedral stubby tabular to equant plagioclase (1-5 mm) and 25-30% prismatic amphibole (1-4 mm); it is thus more leucocratic than the eastern quartz diorite. Xenoliths are angular to subrounded, equant to elongate, 1-30 cm (locally to several metres), and commonly crudely aligned. Xenolith types include 2-3 varieties of diorite similar to the diorites comprising the country rocks of the pluton, and minor rusty brown basalt. Many of the xenoliths show coarse (1-6 mm) amphibole blastesis concentrated at xenolith margins (Fig. GS-8-5). The intrusion breccia is cut by quartz-megacrystic tonalite and aplite dykes.

The **tonalite pluton** southwest of Flin Flon airport also is concentrically zoned: it has an equigranular margin and quartz-megacrystic/porphyritic core. The core phase is further subdivided into a zone with few (1-2%) xenoliths and a zone with abundant xenoliths.

Equigranular tonalite is finer grained (1-2 mm) at the outer margin of the pluton and somewhat coarser grained (2-4 mm) in the interior. Mafic minerals (25-30%) include prismatic amphibole and chloritized biotite. Quartz megacrystic tonalite is characterized by equant quartz aggregates and rare euhedral phenocrysts 2-10 mm across; these are commonly deformed into ovals with aspect ratios of up to 4:1. Dioritic and amphibolite inclusions in the tonalite are rounded to subangular, and are commonly elongated parallel to schistosity and the plane of flattening of quartz megacrysts.

KAMINIS LAKE BLOCK

The Kaminis Lake block is bordered on the north by West Arm fault and contains a large pretectonic to syntectonic biotite-hornblende granodiorite pluton (Kaminis granodiorite of Heywood, 1966). In contrast to the adjacent Flin Flon block, the grade of metamorphism in the Kaminis Lake block is greenschist to lower amphibolite; metamorphic grade increases toward the granodiorite pluton.

Internal faults subdivide the Kaminis Lake block into western, central and eastern segments. The faults trend north-northeast and produce 200-500 m offsets in the contact between the granodiorite pluton and supracrustal rocks. These faults must also have considerable vertical components of displacement because they juxtapose different supracrustal domains.

Supracrustal rocks include strongly quartz-amygdaloidal epidotized basalts, dark green non-amygdaloidal basalts, medium green strongly carbonate-amygdaloidal basalts, and thinly layered intermediate-mafic tuff or sediment. Stratigraphic facing in the block is uniformly southwest.

In the central and western segments of the block the volcanic rocks

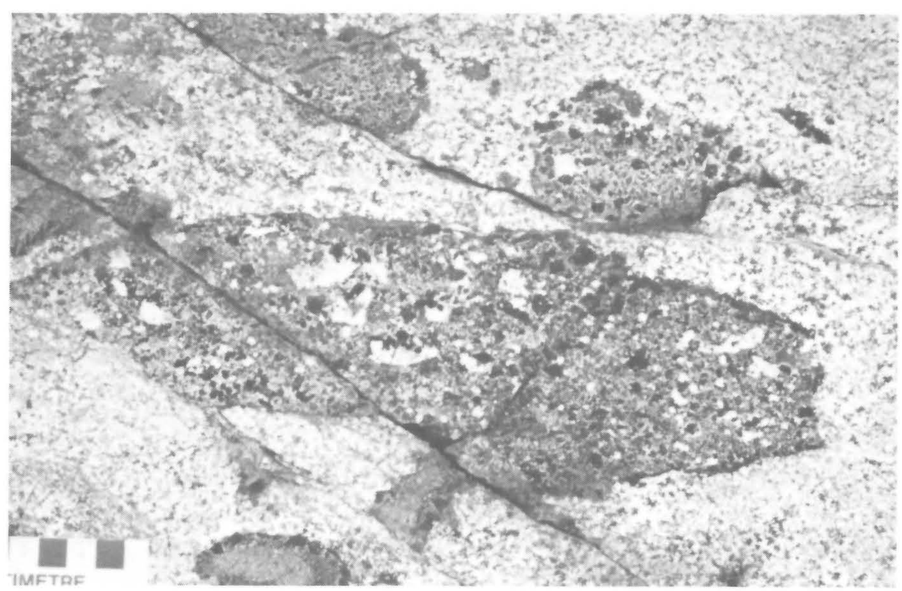

Figure GS-8-5: Coarse amphibole and plagioclase blastesis in fine grained diorite xenoliths; quartz diorite intrusion breccia, Schist Creek gabbro, Scotty Lake block. The blastesis occurs throughout some xenoliths and only at the margins of others.

are extensively intruded by composite dioritic intrusions, generally sill-like in form. Screens and rafts of the volcanics occur within the diorite complex; the rafts range in size from a few metres to mappable bodies 360 m long. The predominant diorite type in the complex weathers medium to dark green, is fine grained (up to 1 mm), and contains 50-60% amphibole and 40-50% recrystallized plagioclase. The diorites and the volcanic host rocks are commonly foliated and flattened.

The contact between the granodiorite pluton and Amisk Group diorite is exposed in two outcrops in the central segment of the block. Foliated diorite near the contact is cut by numerous anastomosing granitoid veinlets up to 4 cm wide, and contains narrow shear zones parallel to schistosity. A strip of strongly mylonitized granodiorite (20-150 cm wide) separates the recrystallized diorites from the marginal phase of the pluton. Within 10-15 m of the contact the granodiorite is fine grained (1-2 mm) and contains abundant angular to elongate mafic xenoliths.

A complex injection zone, 180-630 m wide, occurs in the eastern segment of the block, between the country rocks and the granodiorite pluton. The zone comprises sills, sheets and veins of medium grained (1-5 mm) diorite/quartz diorite intruded into amphibolite; the amphibolite occurs as large rafts and xenoliths.

The Kaminis granodiorite is a large pluton but only a small portion of the northern margin was mapped during this field season. The granodiorite is medium grained (1-2.5 mm), equigranular, with 20% quartz, 25-30% mafic minerals (prismatic hornblende and barrel-shaped euhedra of biotite) and subhedral buff and pink feldspars. It contains 1-2%, 1-10 cm mafic xenoliths flattened parallel to a moderate to strong penetrative fabric; this foliation is parallel to the regional foliation in supracrustal rocks and locally crosses the contact of the pluton at a high angle.

CONCLUSIONS

Mapping in the Schist Lake area has confirmed and extended southwards the fault block structural pattern observed in the Flin Flon-White Lake area (Bailes and Syme, 1983). Stratigraphic continuity cannot be shown between structural blocks; this fact has important consequences for mineral exploration because it means that virtually every mineral deposit is stratigraphically unique. The lateral continuity of mineralized units can be tested only within an individual block; similar-appearing lithologic units in different blocks occur within completely different stratigraphic settings and are not equivalent.

The highly variable nature of the block-bounding faults, together with evidence of different ages (e.g. Northeast Arm zone and the younger Inlet Arm fault), suggests that assembly of the fault blocks took place over an extended period of time, and was not the outcome of a single deformational event. Further mapping in the Athapapuskow project area will continue to define structural blocks to the south and east, and will attempt to resolve some of the timing problems.

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GS-9 GEOLOGICAL INVESTIGATIONS IN THE TARTAN LAKE-LAC AIMÉE AREA

by H.P. Gilbert

INTRODUCTION

Mapping was initiated at Tartan Lake, Lac Aimée and Mikanagan Lake to extend northwards (from Lat. 54°48'40") detailed mapping of the Flin Flon greenstone belt (see Bailes and Syme 1980; 1983; in prep.). The objectives of five weeks field work were:

1. identification of major geological structures;
2. investigation of the stratigraphy and comparison with that established in the area to the south;
3. initiation of geochemical investigations;
4. examination of the setting of mineralization.

Mapping will be conducted at a scale of 1:15 840 in 1987 in the area extending from Embury Lake to Lac Aimée. Investigation of the Amisk Group volcanic stratigraphy and structure will be the main focus, together with the setting of the major gabbroic intrusions, and their potential economic significance. Detailed mapping and investigation of mineralization in the Tartan Lake area are in progress (Peloquin and Gale, 1985; this report, GS-11). Economic geology data have been compiled by Gale (1981) and Parbery and Gale (1984).

STRUCTURE

The map area is situated in the north part of the Flin Flon greenstone belt where the major structural trend turns from north to west. Major structures are thus mainly northwest-trending at south Tartan Lake and Mikanagan Lake. A west-trending anticline occurs in the west arm of Tartan Lake (Fig. GS-9-1); extrapolation of this structure through the east arm is conjectural. This fold, and a northwest-trending syncline in the south part of Tartan Lake, are interpreted as major, early (F_1) folds which are probably tight to isoclinal and related to the regional foliation. The foliation is commonly deformed by minor F_2 similar folds with axial-planar foliation (Fig. GS-9-2), shallow- to steep-plunging axes and related linear structures. The F_2 structures strike west to northwest at Lac Aimée and mainly southeast at Tartan Lake. Strain-slip cleavage and chevron minor folds are attributed to a late stage of F_2.

Major north- to northwest-trending faults, inferred from stratigraphic discontinuities and/or airphoto lineaments, are locally indicated by strong shearing, alteration and carbonatization. Considerable displacement is locally inferred, e.g. in the fault-bounded body of Missi Group conglomerate at Mikanagan Lake. The abrupt termination of the mafic mudstone unit at northeast Mikanagan Lake is interpreted as a result of a major northeast-trending fault (Fig. GS-9-1). The age of the faulting is uncertain; some faults may affect the Tartan Lake gabbro complex, which postdates F_1. Major faults in the area south of Mikanagan Lake are probably early, with possible later reactivation (Bailes and Syme, 1980); these faults distinguish major fault blocks — the Bear Lake block to the west and the Whitefish Lake-Mikanagan Lake block to the east lie immediately south of the map area shown in Figure GS-9-1 (Bailes and Syme, op. cit.). Pervasive faulting at Mikanagan Lake is consistent with the style of deformation of the Whitefish Lake-Mikanagan Lake fault block farther south (Bailes and Syme, op. cit.).

STRATIGRAPHY

Intermediate tuffaceous greywacke and siltstone in the axial zone of the anticline at west Tartan Lake are apparently the oldest rocks in that area. They include pebbly and rare conglomeratic units and are probably derived from intermediate to felsic volcanic fragmental rocks.

Mafic to intermediate flows and breccia overlie the sedimentary rocks and are very well preserved in the south arm of Tartan Lake, where pillowed aphyric and minor porphyritic flows are intimately interlayered with hyaloclastic tuff and breccia on the south limb of the major syncline. Flows or tuffs are alternately the predominant facies type (Figs. GS-9-3 and GS-9-4). Pillows (0.5-2 m average; up to 5 x 1.3 m) commonly contain vesicles, quartz amygdales and quartz-filled gas cavities; concentric cooling fractures (Fig. GS-9-5) and alteration zones of epidosite occur sporadically. One distinctive flow displays thick (4 cm) selvages containing an inner zone of dark green hyalotuff (Fig. GS-9-6). Hyalotuff and tuff-breccia consist of angular fragments of pillows and platy selvage chips in a fine grained hyaloclastite matrix (Fig. GS-9-7); rare blocks of pillowed flow over 1 m long occur sporadically in the breccia. These unsorted to moderately sorted units (Fig. GS-9-8) are probably derived from subaqueous mass flows of largely consolidated pillowed units (Carlisle, 1963; Dimroth and Rocheleau, 1979). Minor diabase dykes, which are locally pervasive in the flows, are interpreted as feeders. Interflow gabbros are absent in the section at south Tartan Lake, consistent with a depositional environment in which extrusion and mass flow were unimpeded. Equivalent basaltic andesite flows have been described in the Bear Lake block to the south (Bailes and Syme, 1980; Syme et al., 1982).

The north limb of the syncline at south Tartan Lake contains a 350 m wide zone of unsorted, oligomictic mafic breccia containing quartz-amygdaloidal, angular fragments in a tuffaceous matrix. In contrast to the south limb, this section contains only minor massive flows and is characterized by plagioclase and altered pyroxene phenocrysts (now hornblende). North of this zone, porphyritic mafic flows (intruded by sporadic felsic porphyries) and related amphibolite and schist extend north to the vicinity of the Tartan Lake gold mine, where the section includes some aphyric mafic flows and several units of intermediate and felsic tuff and lapilli tuff. These rocks are very strongly attenuated in a 120 m wide zone just north of the mine (Fig. GS-9-9). Semipelitic schist containing altered porphyroblasts (now epidote) occurs to the east in a fine grained sedimentary enclave (up to 100 m thick) within gabbro, on strike with the attenuated zone. The age of these sedimentary rocks is uncertain since they are probably displaced by a major fault to the west (S. Peloquin, pers. comm.); they may be a part of the sedimentary section in the anticlinal core at west Tartan Lake. A 65 m thick unit of felsic crystal tuff and possible breccia occurs within the mafic volcanic section at west Tartan Lake.

A 12 m thick enclave of alternating graphitic and sericitic schists occurs close to the north margin of the Tartan Lake gabbro complex (*a* in Fig. GS-9-1). The schists have a "pseudoscoriaceous" texture, probably due to pervasive carbonatization and later leaching of carbonate. Chloritic slate and cherty laminae are locally preserved (Fig. GS-9-10); minor disseminated sulphides (largely altered) occur mainly in the sericitic units. A strong electromagnetic anomaly is associated with this enclave (cancelled assessment data, Hudson Bay Exploration and Development, 1962).

Mafic flows in the northeast arm of Tartan Lake are generally strongly attenuated (Fig. GS-9-11) but otherwise similar to flows at south Tartan Lake — i.e. they are mainly pillowed, aphyric and plagioclase-phyric, locally with quartz amygdales and sporadic epidosite alteration bodies. Related volcanic breccia is apparently minor but much of the section is too deformed for the recognition of primary structures. The available structural data indicate these flows may be equivalent to the section at south Tartan Lake.

Mafic to intermediate volcanic rocks at Lac Aimée are provisionally divided into a unit of volcanic fragmentals with minor flows to the southeast, and predominantly massive to pillowed flows to the northwest. Limited structural data suggest a major west-trending and west-plunging syncline through central Lac Aimée (Fig. GS-9-1). Basalt to andesite is mainly plagioclase- and altered pyroxene-phyric, and contains subordinate aphyric interlayers and minor intrusions. Quartz amygdales are common

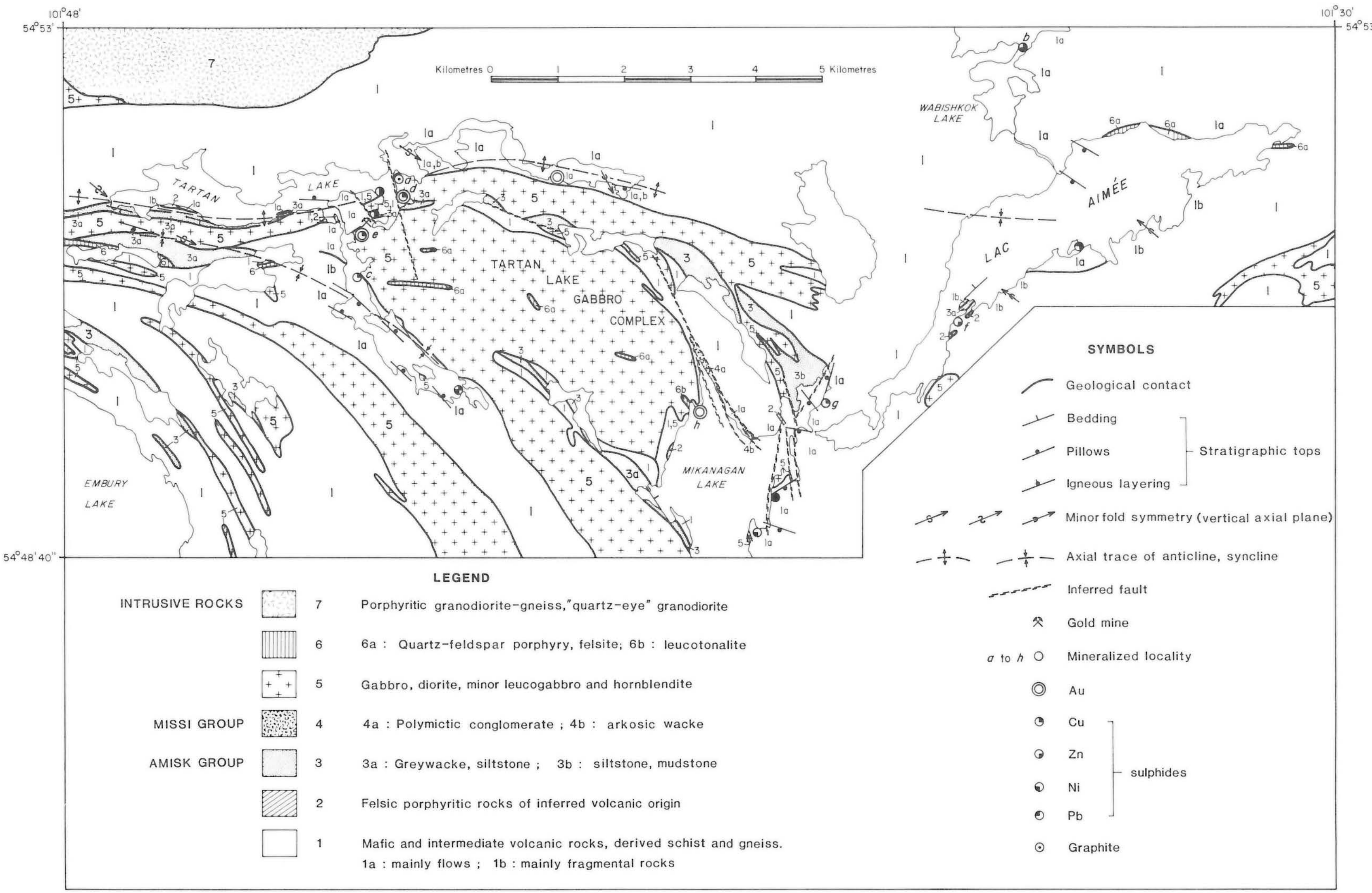

Figure GS-9-1: Geology of the Tartan Lake-Lac Aimée area modified from Tanton (1941) and Bateman and Harrison (1945) showing structure and selected mineralized localities.

Figure GS-9-2: *Minor M_2 fold with axial-planar foliation in intermediate to felsic greywacke — north Tartan Lake.*

and especially abundant in breccia fragments. The volcanic fragmentals are interpreted as autoclastic, but a subaqueous mass flow origin is also possible. Primary structures have commonly been obliterated along the southeast shore due to alteration of the volcanic rocks to schist and mafic gneiss.

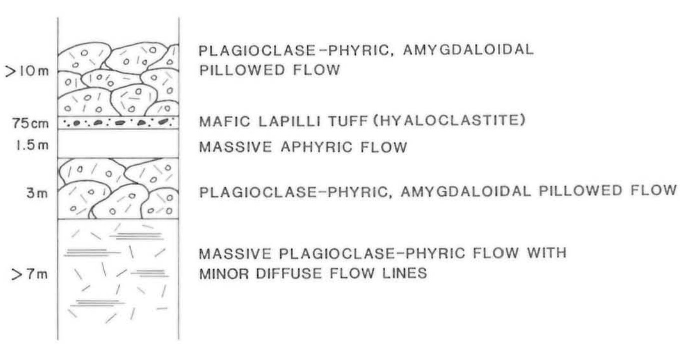

Figure GS-9-3: *Section of intercalated porphyritic and aphyric mafic flows with minor hyalotuff — south Tartan Lake.*

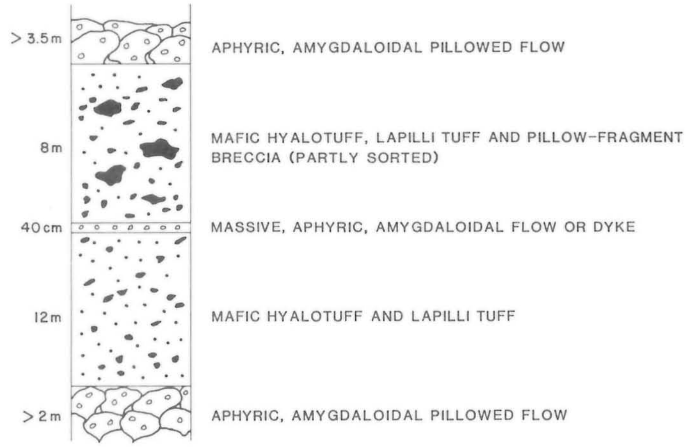

Figure GS-9-4: *Section of hyalotuff and pillow-fragment breccia with subordinate interlayers of aphyric, massive to pillowed, mafic flows — south Tartan Lake.*

A unit of intermediate greywacke, siltstone, and intermediate to mafic tuff (up to 100 m thick) apparently overlies the mafic flows and breccia at south Lac Aimée. Minor sulphide mineralization occurs at the base of this unit in greywacke containing chert interbeds; the underlying mafic volcanics (to the south) contain several plagioclase-phyric felsic units (up to 60 m thick) which include intrusive and possibly extrusive types. Minor interlayers of mafic mudstone and argillitic schist (1-3 m thick) occur within basalt at the creek between Wabishkok Lake and Lac Aimée.

Grey to black siltstone and mudstone and minor greywacke (600 m thick) at northeast Mikanagan Lake underlie part of the mafic volcanic section in that area. These relatively homogeneous sedimentary rocks apparently extend through the north margin of the Tartan Lake gabbro complex (Bateman and Harrison, 1945) and may be equivalent to the sedimentary enclave within the gabbro just east of the Tartan Lake gold mine.

Mafic flows at Mikanagan Lake are commonly pillowed, largely aphyric and devoid of associated breccia in contrast to the section at Lac Aimée. One 50 m thick plagioclase-phyric flow and a 35 m distinctive variolitic flow occur at the east shore. Minor intercalated gabbros are locally gradational with the extrusive rocks. Two units of quartz-plagioclase porphyry (each more than 20 m thick) at north Mikanagan Lake are provisionally interpreted as volcanic flows; one unit is partly brecciated, probably during extrusion. The northwest shore of Mikanagan Lake is a contact zone between aphyric basalt and intrusive rocks (gabbro to hornblendite) of the Tartan Lake gabbro complex. Minor intrusions of leucotonalite and quartz-feldspar porphyry occur in this zone and a small stock of leucocratic diorite to quartz diorite occurs at the east shore of Mikanagan Lake.

At north Mikanagan Lake, a fault slice of Missi Group conglomerate, with a minimal thickness of 40 m, contains a diverse assemblage of volcanic, sedimentary and granitoid clasts, consisting of unsorted, well rounded to strongly flattened pebbles to boulders, up to 80 x 40 cm. Hematite microveining is characteristic of some altered clasts, which locally display cellular structure typical of spheroidal weathering. Minor arkosic wacke southeast of the conglomerate is probably part of the same tectonic slice.

ECONOMIC GEOLOGY

Pyrite ± pyrrhotite mineralization occurs sporadically in 0.5-4 m wide zones within mafic volcanic sections or at contacts between mafic flows and gabbro sills. Massive sulphide with graphite, in zones up to 40 cm thick occurs in a 4 m wide zone within aphyric basalt adjacent to a melagabbro sill at south Wabishkok Lake (*b* in Fig. GS-9-1); this zone is located at the north margin of a moderate positive aeromagnetic anomaly

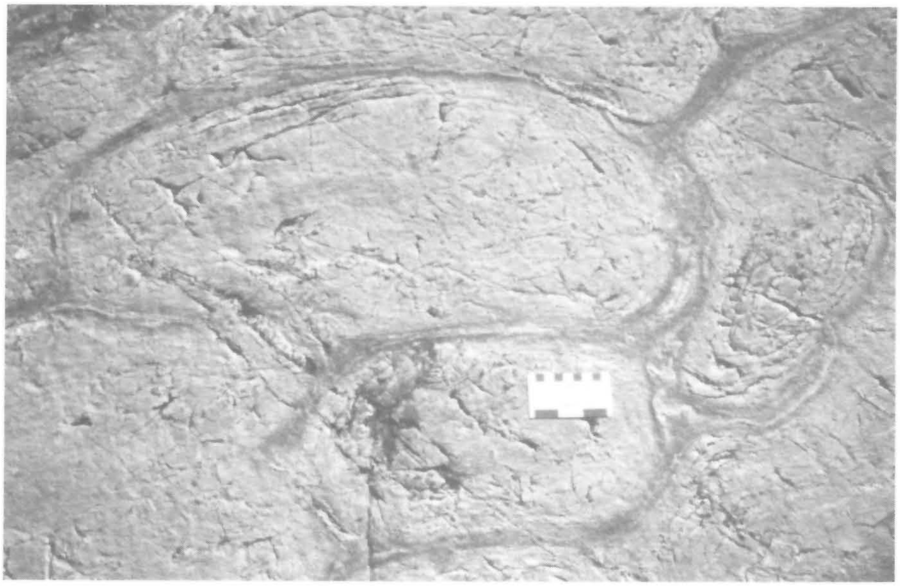

Figure GS-9-5: Aphyric pillowed mafic flow showing concentric cooling fractures — south Tartan Lake.

(Flin Flon, Map C20,348G, Federal-Provincial Aeromagnetic Series). Chalcopyrite occurs in a 3 m wide quartz intrusion at the contact between gabbro and carbonatized mafic schist 900 m south of Tartan Lake gold mine (*c*). Several zones with pyrite ± chalcopyrite occur in the gabbro complex 600 m east of the mine (*d*); gold, pyrite and chalcopyrite occur in 2-3 m wide quartz intrusions cutting a mafic schist enclave in gabbro 250 m south-southwest of the mine (*e*).

Minor sulphide mineralization occurs within fine grained sedimentary units at south Lac Aimée (*f*) and northeast Mikanagan Lake (*g*). Gold with arsenopyrite occurs in quartz intrusions in mafic schist close to the margin of the Tartan Lake gabbro complex at northwest Mikanagan Lake (*h*); partly silicified and carbonatized quartz diorite and felsitic intrusions occur in the mineralized zone. Strong shearing and carbonatization are characteristic of many mineralized zones in the map area; grey or black tourmaline is a common accessory in the quartz veins.

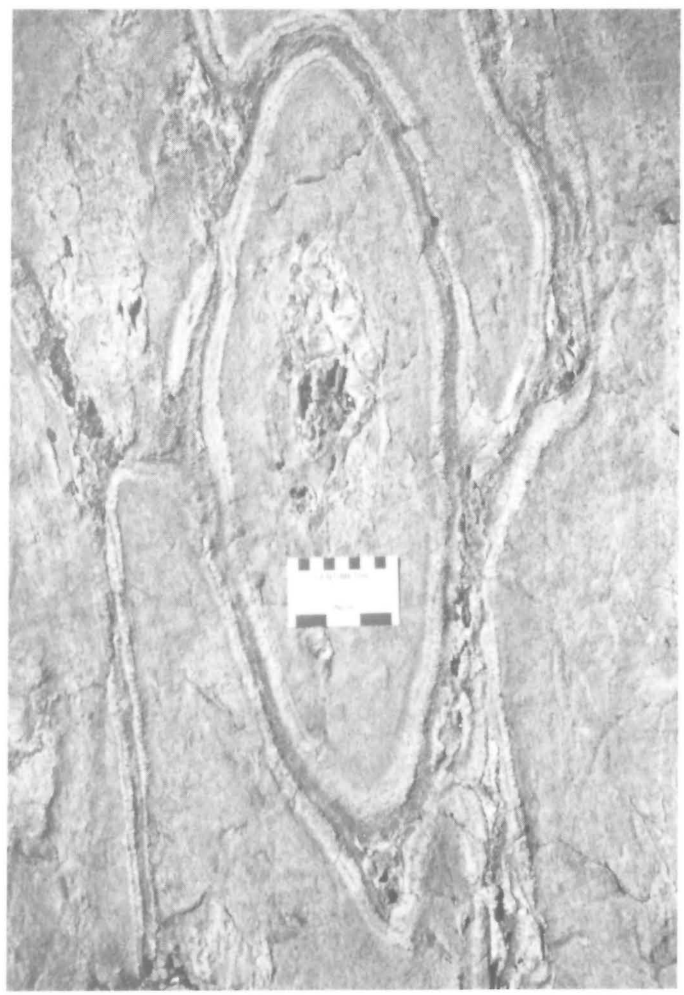

Figure GS-9-6: Pillows with thick selvages showing inner hyalotuff zone, minor interpillow chert and a quartz-filled gas cavity — south Tartan lake.

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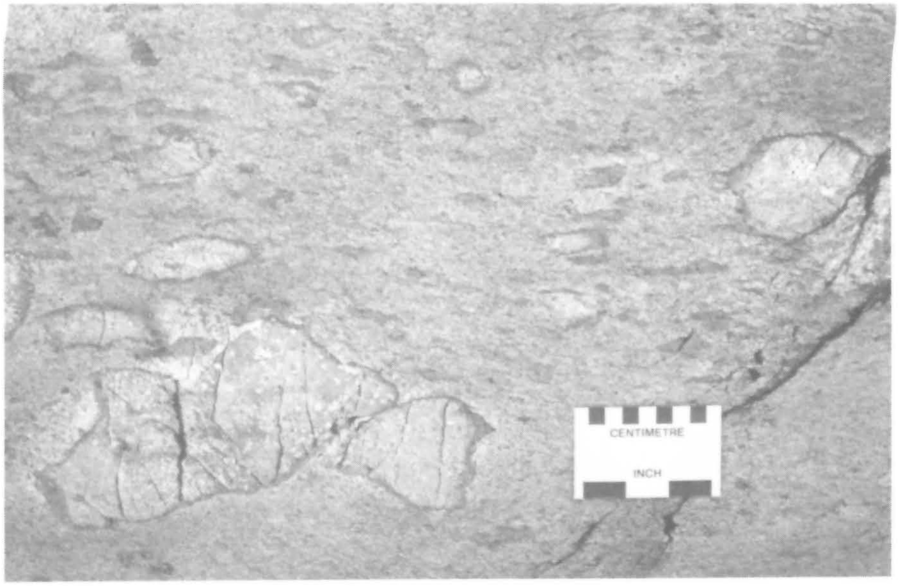

Figure GS-9-7: *Pillow fragment breccia — south Tartan Lake.*

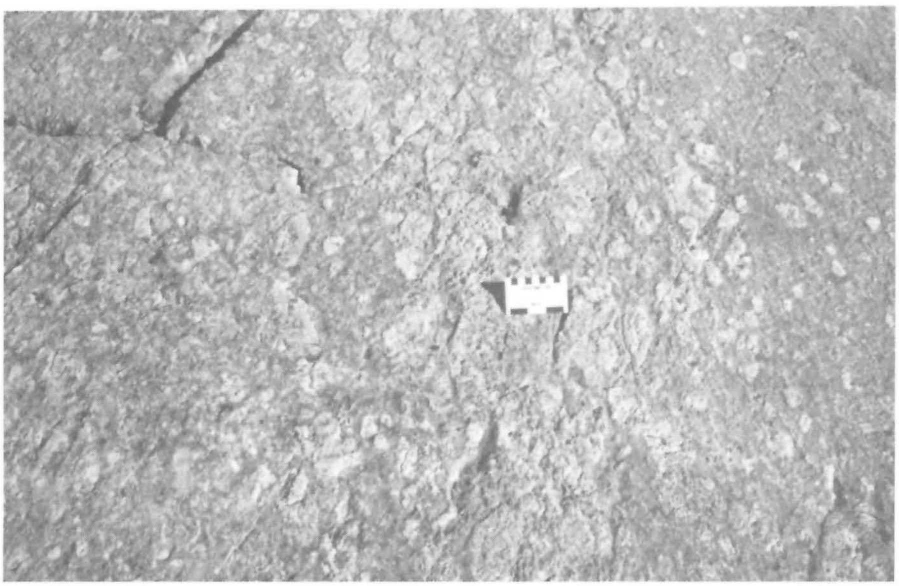

Figure GS-9-8: *Partly stratified hyaloclastic lapilli tuff and breccia — south Tartan Lake.*

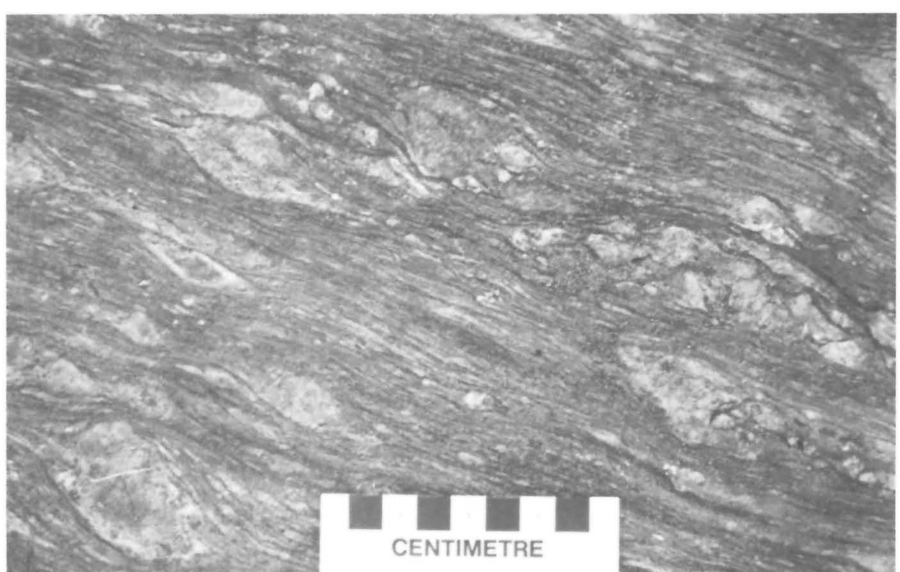

Figure GS-9-9: *Sheared and attenuated intermediate volcanic breccia in strongly deformed zone just north of Tartan Lake gold mine.*

Figure GS-9-10: Graphitic and sericitic schists with remnants of cherty laminae; "pseudoscoriaceous" texture occurs in the fold core — north Tartan Lake.

Figure GS-9-11: Highly attenuated aphyric pillowed basalt with ovoid epidosite alteration body — north Tartan Lake.

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GS-10 MINERAL OCCURRENCE STUDIES — FLIN FLON AREA

by D. Parbery

INTRODUCTION

A number of gold-bearing mineral occurrences in the Neso Lake area are associated with quartz and/or carbonate veins. In addition, gold mineralization is associated with quartz veins and a major zone of shearing and quartz-carbonate alteration at Twin Lake (Parbery and Gale, 1984). Geological maps (Fig. GS-10-1, -3) at a scale of 1:5000 were prepared for areas around the mineral occurrences to establish a geological data base for use in future geochemical studies and investigations of the structural controls to the mineralization.

At Fay Lake (Fig. GS-10-4) solid sulphide mineralization is associated with felsic and mafic volcanic rocks (Parbery and Gale, 1984). The occurrence was mapped at a scale of 1:10 000 to establish the lithologies present and the nature of the mineralization.

NESO LAKE AREA

NESO LAKE — NORTH OCCURRENCES

At the northeast end of Neso Lake (Fig. GS-10-1) minor intermediate volcanic rocks are intercalated with a thick sequence of massive rhyodacitic rocks. The rhyodacitic rocks consist of dacitic tuffs, vesicular quartz-plagioclase-phyric flows, massive flows and lithic tuffs. The volcanic rocks of intermediate composition consist dominantly of crystal tuffs(?) and minor fragmental and massive units.

On the east shore of Neso Lake, an orange-brown weathering, 0.3-0.5 m wide by 70 m long siliceous vein is hosted by an aphanitic to very fine grained grey-green weathered, massive, intermediate rock at 285°/70°N. Parts of the vein are very siliceous and contain 1-3 cm yellow-brown iron carbonate pods and veinlets that strike parallel to the major vein. Other sections of the vein consist of white quartz. The vein has a sharp contact with the host rock and probably formed by fracture fill. The host rock is also cut by several 2-3 mm thick quartz stringer veinlets and contains trace pyrite.

An outcrop of sheared and silicified rock is located on a small island 600 m west of the siliceous vein (Fig. GS-10-1). The rock resembles a breccia due to the intrusion of many crosscutting carbonate veins that are up to several centimetres thick. Fuchsite is present on some fracture surfaces. This 15 m wide sheared outcrop has a 2 m wide strongly silicified zone near its centre; however, the remainder of the rock is less silicified. The shear strikes 236° and has a very steep dip to the northeast.

A quartz-phyric rock containing 2% subhedral to anhedral quartz phenocrysts (up to 1 mm in diameter) in an extremely fine grained felsic to intermediate groundmass occurs several metres to the south of the sheared zone. The shear zone was probably developed in this type of rock.

On the south shore of a large island 400 m west of the shear zone (Fig. GS-10-1) a 0.3 m wide zone of intensely sheared rock cuts a light green, aphanitic rock that contains up to 5% plagioclase as 0.5 mm phenocrysts. The shear zone is oriented 281°/61°N. The adjacent rock is silicified and cut by iron carbonate veins.

The two sheared, silicified and carbonatized zones are probably related to the carbonate-silica vein located on the east shore of the lake; however, no carbonate-silica alteration was found on the west shore of the lake.

NESO LAKE — WEST OCCURRENCE

Rhyodacitic to dacitic volcanic rocks occur at the south-southwest end of Neso Lake and extend northeastward as far as the Kississing Lake road. Portions of these rocks exposed rock along Highway 10 are silicified and carbonatized (Fig. GS-10-1).

Rhyodacitic rocks weather buff-white, are aphanitic to very fine grained and contain quartz and plagioclase phenocrysts. Subhedral quartz phenocrysts average 1.5 mm in diameter and make up 1-10% of the rock. Anhedral plagioclase phenocrysts, 1-1.5 mm in diameter, make up 5% of the rock. Some outcrops have up to 5% small chlorite blebs that are probably remnants of mafic phenocrysts. Dacitic rocks are differentiated from the rhyodacitic rocks by their coarser grain size, a darker coloured weathered surface and only trace amounts of quartz phenocrysts. Most of the rocks termed "dacitic" are feldspar-phyric, with 1 mm anhedral white plagioclase phenocrysts comprising approximately 5% of the rock.

Vugs are commonly found in both rock types. They are small (on average, 1-2 mm long by 0.25-1 mm wide), have irregular outlines and constitute 10-15% of the rock on weathered surfaces; however, they are not visible on fresh surfaces. In some exposures the vugs are filled by a light grey-green mineral aggregate of medium hardness. The vugs probably represent a weathered mafic phenocryst such as biotite.

The felsic to intermediate rocks are vesicular, tuffaceous and contain mafic fragments. However, most of the outcrop in this area consists of white to light tan, weathered massive rhyodacitic to dacitic flows. These rocks are aphanitic to very fine grained and contain plagioclase and/or quartz phenocrysts. Changes in phenocryst content may occur over several metres but only a few contacts were observed between different units. These rocks strike between 222° and 253° and most dip steeply to the northwest.

Volcanic and volcaniclastic rocks of intermediate composition are intercalated with the felsic volcanic rocks. These rocks consist of plagioclase crystal tuffs, monolithic breccias and rare felsic fragmental rocks. Several intermediate plagioclase ± hornblende-phyric dykes intrude the rocks of this area.

Several outcrops of the rhyodacitic-dacitic volcanic rocks along Highway 10 are silicified and carbonatized. Areas up to 30 m wide are weakly altered and the rocks are red-brown due to the presence of Fe-carbonate. Weakly altered rocks are aphanitic, massive and have a waxy lustre on fresh surfaces. Quartz phenocrysts are visible in these rocks but are not seen in the strongly carbonatized rocks. Since quartz phenocrysts have an uneven distribution over several metres, it is not known if their absence in the strongly carbonatized rocks is due to the alteration process or is an original feature of the unaltered rock.

The alteration is most intense on the south side of Highway 10, 250 m west of the junction to Neso Lake. The rock at this site is moderately silicified and strongly carbonatized. It is aphanitic, red-brown on weathered surfaces and a waxy brown-green on fresh surfaces, and is cut by white quartz veins that are 2-20 cm thick. The strongly altered rock is exposed over a 10 m width and grades into unaltered rock over a further 10-20 m.

Late-stage 3-5 cm wide and 20 m long quartz-carbonate veins cut the altered rock (Fig. GS-10-2). The veins strike between 242° and 270° and dip 65-75° to the north. The rock is fractured and weakly sheared over 10 cm on both sides of the veins. Carbonate and silica alteration is very strong adjacent to the veins. The quartz and carbonate have been mobilized from the surrounding rock into fractures to form the veins. Some of the veins are offset by late faulting.

Red-brown 1-2 mm veinlets of Fe-carbonate crosscut the altered rock. Carbonatization of the rock has taken place along fractures that are filled by Fe-carbonate. Outcrops of altered rocks exposed along the highway are interspersed with outcrops of unaltered rhyodacitic to dacitic rocks. The uneven distribution of outcrops of carbonate/silica alteration may be the result of a faulted alteration zone. Several northwest-trending fractures (some with slickensides), weakly sheared zones, and a fault occur in the altered and unaltered rocks exposed along the highway.

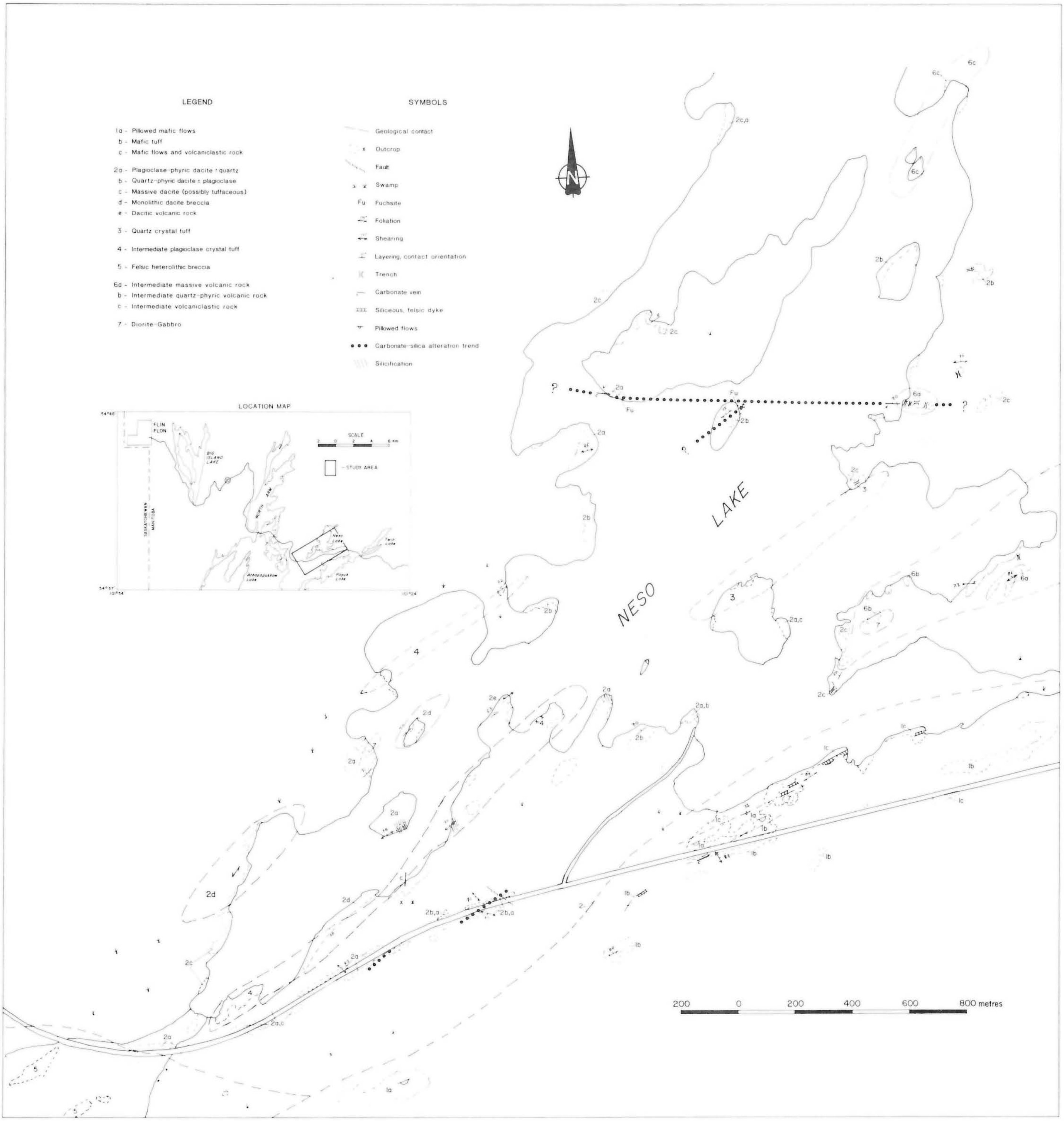

Figure GS-10-1: Geology of the Neso Lake area.

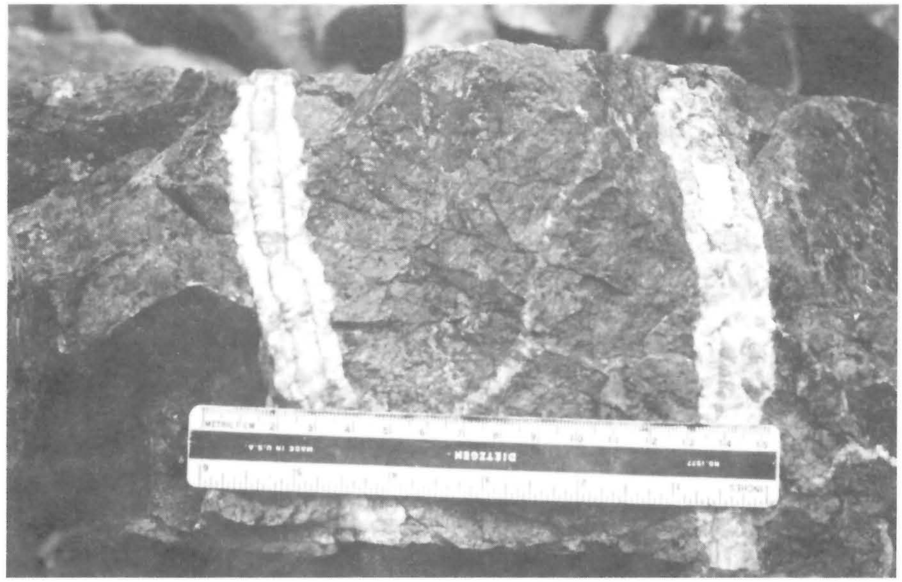

Figure GS-10-2: Quartz-carbonate veining at Neso west occurrence.

Only trace amounts of pyrite and chalcopyrite have been found in the altered and unaltered rocks in this area. Most of the sulphides seen occur on fracture surfaces or in rare 1-5 cm stringer veinlets that parallel the late-stage quartz-carbonate veins. Arsenopyrite occurs in a 15 cm thick quartz vein exposed in a road-cut through carbonatized rock near the southwest end of Neso Lake.

Small areas (maximum size 2 x 3 m) of rhyodacitic-dacitic breccia occur within 200 m of the altered rocks exposed along the highway. The fragments range in size from less than 1 to 20 cm in length, and are enclosed in a soft, weathered, brown, chloritic matrix. The fragments make up 70% of the breccia and are identical in composition and texture to the surrounding massive rhyodacitic-dacitic rock.

The breccia does not occur in discrete units or layers, but occurs randomly throughout the area. Breccia formation was a late-stage event and probably the result of fluid movement through the felsic volcanic rocks (D. Baldwin, pers. comm., 1986).

NESO LAKE — SOUTH OCCURRENCE

Rocks at the southeast end of Neso Lake consist of interlayered mafic tuffs, mafic pillowed flows, massive flows, flow breccia and intermediate breccias. Pillow tops are to the south. The units strike between 243° and 258° and dip steeply to the north and south (Fig. GS-10-1). The mafic volcanic rocks carry trace pyrite (locally up to 2%) as 1 mm and less, anhedral grains and as 2 mm cubes in quartz veinlets. Rocks to the east of the mafic volcanic rocks consist of a quartz monzonitic-granodioritic intrusion and a mafic intrusive breccia of gabbroic composition. The mafic intrusive rock contains a 0.6 x 0.4 m pod of approximately 30% pyrite.

A felsic dyke with a strike length of 800 m and a width of 25 m cuts the mafic volcanic rocks at the southeast end of Neso Lake (Fig. GS-10-1). Contacts with the surrounding mafic volcanic rocks are either obscured or are sheared and weathered and trend between 238° to 251°, subparallel to the local stratigraphy. The dyke is strongly silicified, mildly feldspathized and is cut by numerous quartz veins.

This altered dyke is aphanitic to fine grained, siliceous, and comprises roughly 60% quartz, 30% feldspar and less than 10% chlorite. The chlorite occurs along fractures and foliation planes. The strong foliation and fractures cutting the rock and quartz veinlets produce 1-2 mm fragments of quartz and groundmass material. The groundmass is felsic, aphanitic, pink cream to light brown-grey, and carries subhedral quartz grains that are 0.5 mm in diameter. Rare blue-grey quartz grains up to 4 mm in length were noted in one outcrop. In some areas quartz and plagioclase grains are up to 2 mm across; grain sizes change commonly over short distances.

The many crosscutting quartz veins and pods present in the silicified rock are 0.1-20 cm thick and 0.1-10 m in length. The quartz is normally white and becomes grey where the veins thin to only several millimetres in width. Although most veins trend east to northeast, several veins strike at right angles to the general trend and have a moderate to shallow dip. The north-south veins are offset a few millimetres along foliation planes that trend 242°/85°N. Locally quartz veins compose 20% of the rock. A salmon-pink to orange weathered feldspar is found within, and adjacent to, many of the quartz veins. Fine grained feldspar forms 5-10% of vein material. Quartz veins where present in the adjacent mafic volcanic rocks commonly carry pink-orange feldspars.

Some portions of the altered dyke are grey and siliceous whereas the more intensely altered rock is white due to the greater amount of quartz vein material present. Rusty weathered fractures in the altered rock are randomly oriented and stain approximately 5% of the outcrop surface in some areas.

TWIN LAKE AREA

The Twin Lake area consists of southward-topping pillowed basaltic flows (in the southwest part of the area) overlying massive mafic flows, mafic monolithic and heterolithic fragmental rocks, and mafic tuffs intercalated with minor argillite towards the north. A gold-bearing quartz, carbonate and fuchsite alteration zone cuts across this stratigraphy. Fine grained quartz-phyric felsic rocks, with minor felsic to intermediate tuffs and felsic fragmental rocks, occur in the northern part of the area.

The mafic volcanic rocks are cut by numerous quartz-feldspar porphyry and felsite dykes that strike between 173° and 257°, and by small fine- to medium-grained dioritic to gabbroic intrusive bodies. A felsic to intermediate intrusion, quartz monzonitic to granodioritic in composition, is exposed west of the study area. Trace pyrite and chalcopyrite (locally up to 2%) are found within the mafic volcanic rocks as disseminated grains and stringers several millimetres in length.

The strike of the volcanic rocks in the southwest area is between 230° and 260°, whereas the strike of the rocks in the north and northeast is between 215° and 240°.

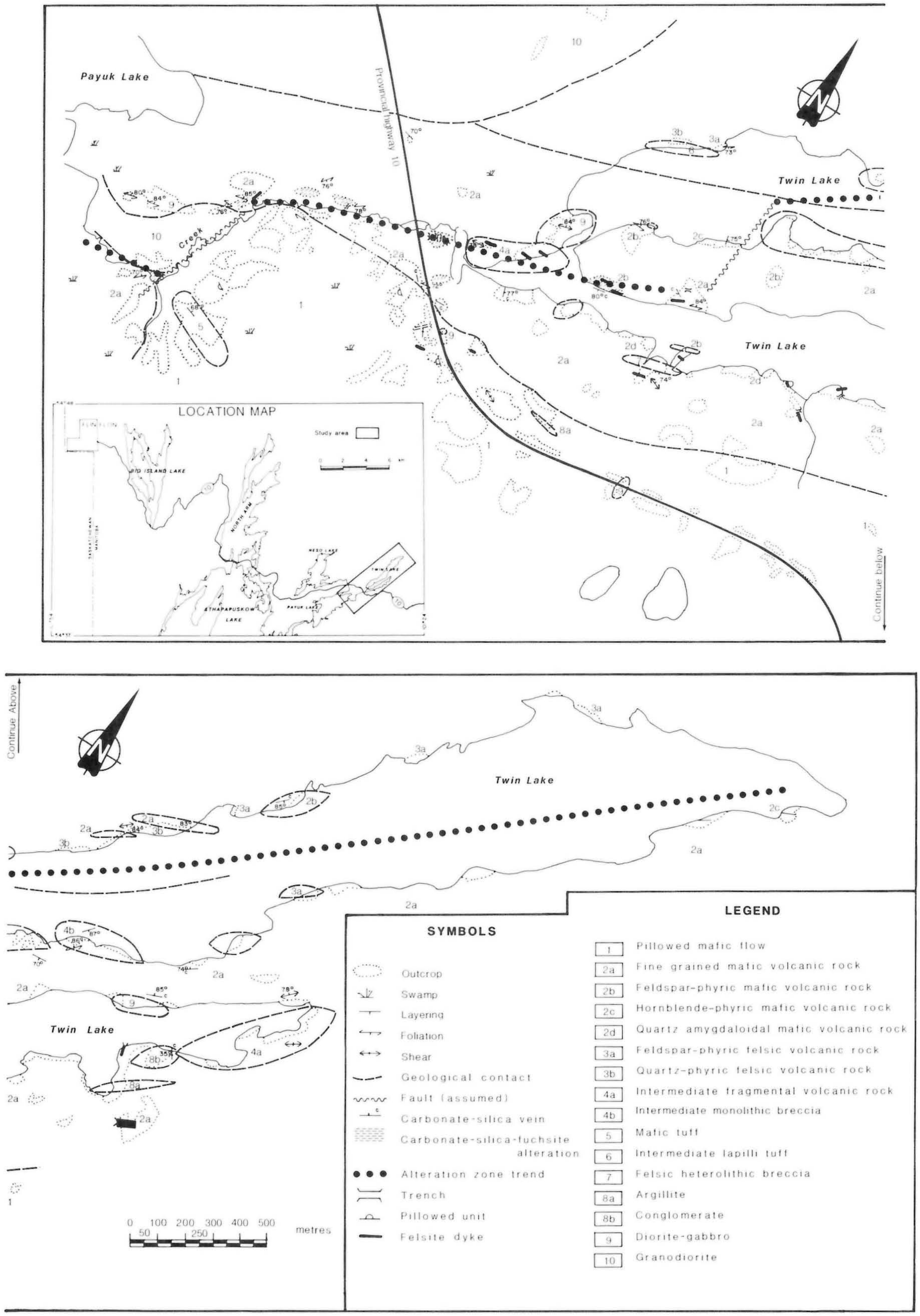

Figure GS-10-3: Geology of the Twin Lake area.

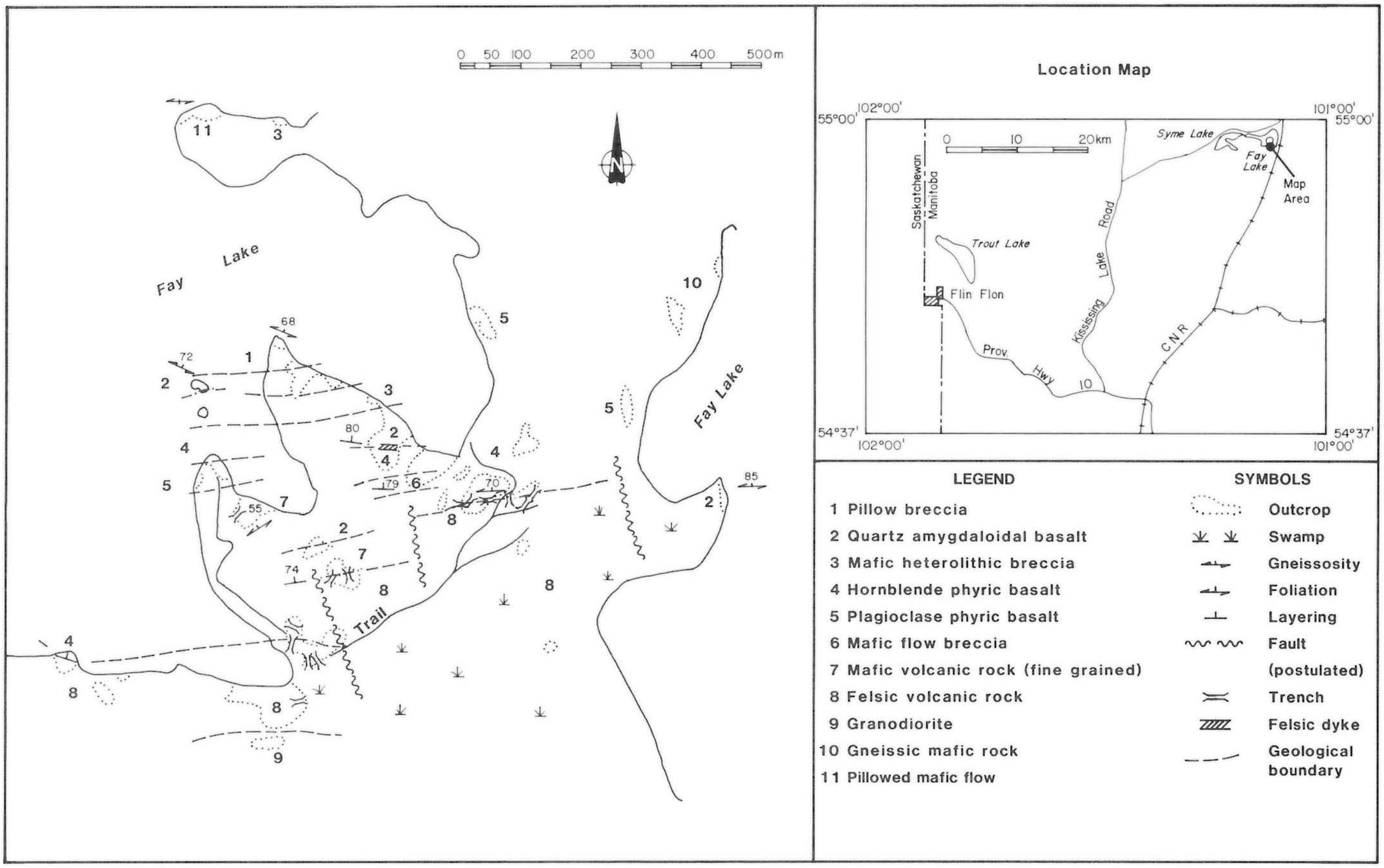

Figure GS-10-4: Geology of the Fay Lake area.

TWIN LAKE

An alteration zone extends from the northeast end of the larger of the Twin Lake, southward along Twin Creek to the south of Payuk Lake (Fig. GS-10-3). The zone has a length of 5000 m and a width of up to 30 m. This zone is defined by: (1) strongly sheared rock; (2) quartz veins and silicification of host rock; (3) carbonatization of host rock and siliceous veins as indicated by minor carbonate veining of the former and brown weathering of the latter; (4) presence of fuchsite along fractures in the silicified rock; and (5) recessive weathering.

The host rocks to the alteration are mafic metavolcanic rocks. Disseminated pyrite constitutes approximately 1% of the altered rock. Several outcrops of mafic rocks along Twin Creek are strongly silicified and carbonatized and contain fuchsite. The trend of the creek defines the trend of the alteration zone. One outcrop of altered rock located along the creek within the mafic volcanic rocks and south of the felsic intrusion is offset from the main trend of the alteration by a fault (Fig. GS-10-3).

An outcrop that exhibits the most alteration features and which is easily accessible occurs between the old and new Highway 10 near the junction of Twin Creek and the west-southwest end of Twin Lake. Here the alteration zone has a maximum width of 20 m.

A change in alteration style is evident in the northeastern part of the Twin Lake area. Rocks along the shores of the larger part of Twin Lake are cut by brown weathered, Fe-carbonate coated, siliceous veinlets. The veinlets are found in rocks on both the northwest and southeast shores of the lake, are 1-5 cm in width, up to 30 cm in length, and up to 1 m in depth. The veinlets are discontinuous and appear to have been stretched out in the planes of shearing. Shearing is not as intensely developed as in the Twin Creek area, but host rocks are commonly strongly foliated. The silica and carbonate veining has a maximum zone width of 10 m.

MINERALIZED FELSITE DYKES — TWIN LAKE AREA

Weakly mineralized felsite dykes, with 1-3% disseminated, anhedral pyrite and chalcopyrite (pyrite to chalcopyrite ratio of 10:1) intrude the mafic volcanic rocks south of Twin Lake (Fig. GS-10-3). The felsite dykes are pink-brown and aphanitic. Some of the dykes are quartz-phyric and contain up to 5% subhedral phenocrysts up to 1 mm in diameter. The dykes range in size from 1 to 6 m in width by 5 to 30 m in length and generally strike 90°.

Adits, cut into felsite dykes, were observed at two locations. One of the adits is located on the south shore at the east end of the smaller of the Twin Lake. It is 2 m wide, 6.2 m long, 2-2.5 m deep and is open to the lake. The felsite dyke has a northwest strike and cuts the mafic volcanic fragmental rocks.

The other adit is approximately 350 m southeast of the northernmost adit located between the lakeshore and the old Highway 10. It is cut into a 6 m wide dyke and is 1.8-2.3 m wide, 2 m deep and 15 m long. The dyke strikes northeast and intrudes fine grained to aphanitic, massive, mafic rock that contains disseminated, anhedral pyrite.

MINERALIZATION AND SHEARING

The northeast-trending shear zone and alteration zones in the two areas are subparallel to layering and foliations. Carbonatization and silicification are found along both shear zones and in (tensional) fractures at both Neso and Twin Lake.

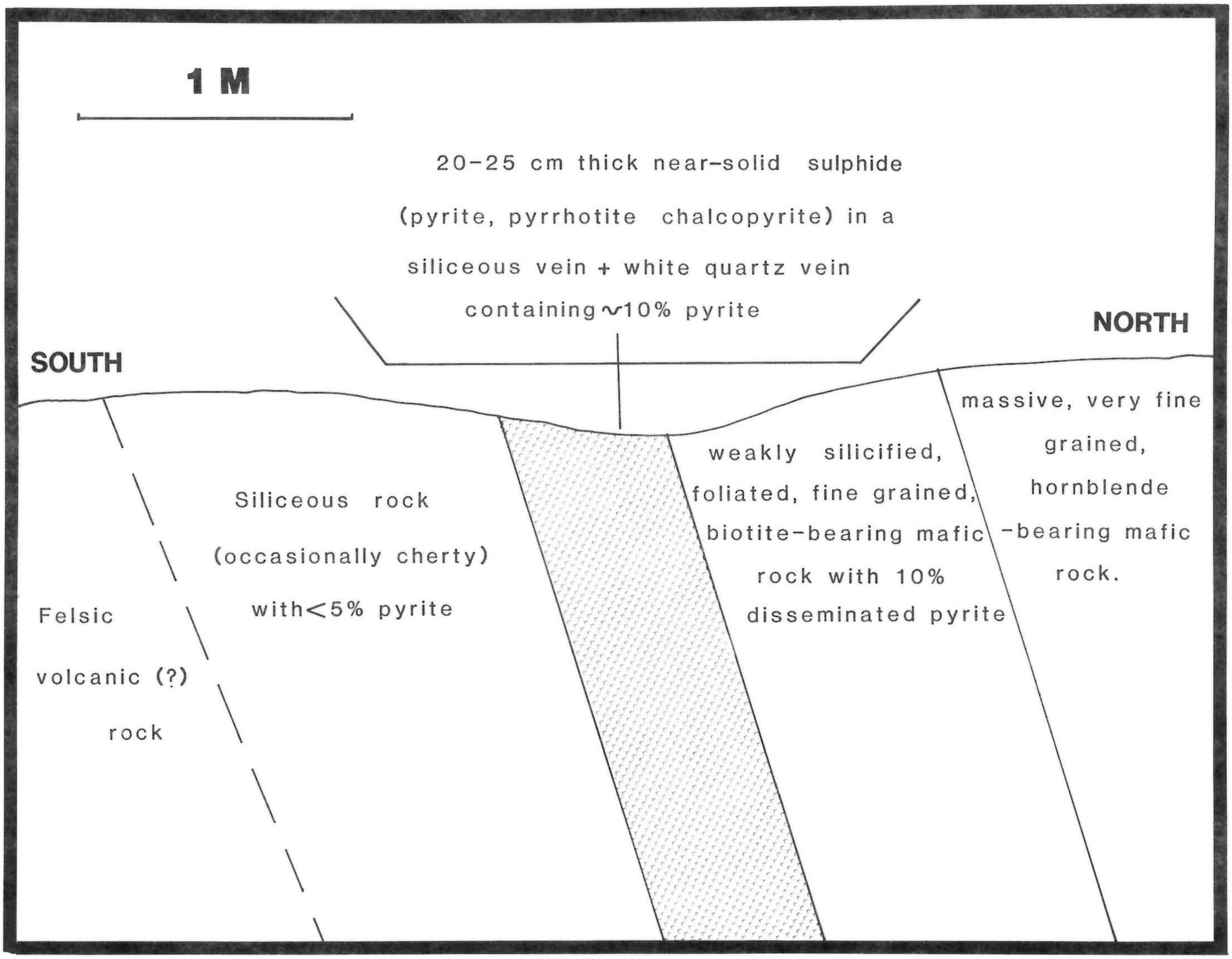

Figure GS-10-5: Schematic diagram of typical mineralized zone, at Fay Lake.

The two areas have been extensively prospected for gold in the past as indicated by many trenches and adits at Neso north occurrence and in the Twin Creek area. Grab samples of altered rocks from the Twin Lake area yielded values ranging from 50 to 164 ppb gold. However, sulphide mineralization (as a possible carrier of gold) is rare in both areas and only trace amounts of sulphides are present in the altered rocks. Sulphides typically occur as small, 1 mm diameter, anhedral grains of pyrite and chalcopyrite disseminated through the rock. Up to 2% sulphide occurs along some fracture planes, and infrequently as 1-5 cm thick stringers and veinlets parallel to the quartz-carbonate veins at the Neso west occurrence.

Shearing and associated carbonate/silica alteration can be followed along linear topographic depressions for a distance of several kilometres in both the Neso and Twin Lake area. Exploration for gold along these linear features to the northeast and southwest, where shearing and carbonate alteration are also present, may be warranted.

FAY LAKE SULPHIDE OCCURRENCES

The Fay Lake area contains a sequence of west-trending mafic metavolcanic rocks that are intercalated with minor felsic volcanic rocks. Outcrops of mafic heterolithic breccia, mafic flow breccia, mafic pillowed flows, amygdular flows and mafic tuffs occur on the large, mushroom-shaped peninsula at the east end of the lake. Hornblende-phyric and massive fine grained sections of mafic rock are believed to be of volcanic origin. Most of the above rock types have a fine grained to aphanitic groundmass and weather medium to dark green. Small diorite-gabbro bodies are found within the mafic volcanic rocks. Outcrops of pillowed, mafic flows are poorly exposed and the pillows have been stretched, making the determination of top directions difficult; tops may be towards the south.

Felsic rocks are aphanitic, weather pink-orange to buff-white and resemble very fine grained intrusions; however, a few outcrops of felsic rock are quartz-phyric and one outcrop contains possible quartz amygdales. Most of the felsic volcanic(?) rock is located in the southern part of the map area.

A sulphide-bearing siliceous vein occurring between mafic and felsic volcanic rocks is exposed in several trenches in the area (Fig. GS-10-4).

A typical lithologic sequence, from south to north, in association with the sulphides is:

- felsic volcanic rocks that become increasingly siliceous (occasionally cherty in appearance) toward the sulphide zone;
- a 20 cm thick near solid sulphide zone consisting of pyrrhotite with some pyrite and trace chalcopyrite $\pm$ covellite and siliceous rocks or quartz veins with coarse grained pyrite;
- a foliated fine grained mafic to intermediate rock containing biotite and up to 10% disseminated pyrite;
- a hornblende-bearing fine grained to very fine grained massive mafic rock.

The above sequence is exposed over 3-4 m in several trenches (Fig. GS-10-5). Several metres to the north the mafic rock present is either a hornblende-phyric basalt or a quartz amygdaloidal basalt. A trench in the southern part of the map area exposes 4-5 m of solid pyrrhotite and a felsic rock of volcanic(?) origin.

The solid sulphide zones appear to occur near the contact between mafic and felsic volcanic rocks. Locally, quartz and sulphide minerals have been mobilized to form veins subparallel to the contact. Geological mapping indicates that the sulphide zones strike east to northeast but cannot be aligned over their approximately 600 m strike length. This suggests that the sulphide zones are probably offset by north-trending faults (Fig. GS-10-4).

Visible gold was reported in two trenches by Wright (1930); however, none was located during this study.

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GS-11 GEOLOGY OF THE TARTAN LAKE GOLD DEPOSITS

by S. Peloquin[1], B. Tannahill[2] and G.H. Gale

A general geological setting of the Tartan Lake gold deposit was provided by Peloquin and Gale (1985). Since this project is designed to provide a geological synthesis of the area around the deposit and to investigate the source of gold mineralization, a six week study was initiated on rock units in the immediate vicinity of the main ore zones at Tartan Lake and the westward extension of the shear zone towards Ruby Lake. The general geology of the area is shown in Figure GS-11-1.

Three small areas were mapped in detail: (1) gabbroic rocks south of the Main Zone that host the South and Base Line Zones of mineralization; (2) volcanic and sedimentary rocks of the Mine Peninsula that occur north of the Main Zone, and (3) volcanic and sedimentary rocks of the Ruby Lake Grid area between Ruby and Tartan Lake that appear to contain the westward extension of a shear zone present at the Main Zone (Fig. GS-11-1). The regional geological setting of the Tartan Lake gold deposit is described by Gilbert (GS-9, this volume).

SOUTH ZONE

Gold mineralization occurs in association with gabbroic rocks in both the Main Zone and several zones of shearing south and east of the Main Zone. Accordingly, investigation of the gabbroic rocks was centred on the rocks around and southeast of the South Zone.

Gabbroic rocks in this area form the northwest corner of a multiple intrusion of gabbroic and dioritic rocks (Peloquin and Gale, 1985). A medium- to coarse-grained leucogabbro, that locally ranges to coarse grained melanocratic gabbro, contains small pods of pyroxenite and is cut by aphanitic intermediate, fine grained dioritic and feldspar porphyry felsic dykes. Since more than one rock type is commonly present in an exposure of the 'gabbroic complex' and the individual rock types could not be delineated at a scale of 1:5000 (Peloquin and Gale, 1985), the area was remapped at a scale of 1:1200 utilizing 100 foot (30 m) grid lines (Fig. GS-11-2).

The gabbroic complex consists predominantly of medium grained gabbro and a fine grained diorite or gabbro. The medium grained gabbro is generally a multiphase rock ranging in composition from pyroxenite to olivine gabbro to medium- and coarse-grained (2-3 mm) hornblende diorites. Although these rock types are considered to be genetically related to the same magmatic event, only the ultramafic phase appears to contain magnetite. In the area depicted in Figure GS-11-2 the medium grained, dark green gabbro contains 2 mm sized plagioclase and pyroxene crystals and exhibits only slight textural variations.

The fine grained diorite is the second most abundant rock type in this area. This rock type has an average grain size of less than 1 mm. It exhibits a diabasic texture and locally contains small (less than 1 mm) magnetite crystals. Biotite and chlorite (40%), epidote (25%), saussuritized feldspar (25%) and quartz (5%) are the main minerals present. Trace amounts of tourmaline were observed in thin section.

The fine grained diorite intrudes the medium grained gabbro and locally forms a distinctive igneous breccia (Fig. GS-11-3). In the area of Figure GS-11-2 this igneous breccia is a minor component of the 'gabbroic complex'; however, elsewhere in the Tartan Lake area the igneous breccia is a common phase (Fig. GS-11-1).

Other intrusive phases observed in this area are coarse grained (3-5 mm) felsic feldspar-quartz porphyries, aphanitic diorites and pink aplite dykes. The feldspar-quartz porphyries are present on the western and northern extremities of the peninsula. The western occurrences were not found to continue east of the Base Line Zone and appear to have been displaced by the shear zones.

An obvious, but as yet unexplained, feature of the 'gabbroic complex' is the homogeneous nature of the medium grained gabbro along its western and northern margins (Fig. GS-11-2). In addition some of the schistose and altered rocks locally have subhorizontal contacts with the intrusion, e.g. south of the base line between 800 and 1000 east. Although a subhorizontal attitude to the gabbroic mass is suspected, conclusive evidence could not be found to determine a compositional layering or structure for the gabbroic rocks. Contacts between the fine grained diorite and medium grained gabbro are sharp, highly irregular and vary from subvertical to subhorizontal.

Altered rocks have been separated into two units: (1) 'massive' to weakly schistose green weathering mafic rocks; and (2) chlorite-carbonate-quartz ($\pm$ fuchsite $\pm$ quartz veins $\pm$ tourmaline $\pm$ sericite) schists.

The 'massive' to weakly schistose rock includes a carbonatized (brown weathering) chloritic rock that appears to be a carbonatized equivalent of the massive fine grained diorite and is simply a less sheared rock than the chlorite-carbonate-quartz schists.

A weakly schistose altered rock (Fig. GS-11-2) is a pale green, partly chloritized rock of dioritic/gabbroic composition with pink feldspar lenses.

MINE PENINSULA

The area north of the main zone referenced here as the 'Mine Peninsula' (Fig. GS-11-4) is underlain mainly by volcanic flows and volcaniclastic sedimentary rocks. Intrusive rocks include felsic feldspar-quartz porphyry dykes, a 'knotted gabbro' with hornblende lenses, a fine grained gabbro and, in the extreme southeastern corner of the area, rocks of the 'gabbroic complex' that include: medium grained green gabbro, fine grained pale brown to green diorite and a fine grained brown (carbonatized) gabbro.

The mafic flow rocks consist of both aphyric and pyroxene-phyric pillowed flow units (Figure GS-11-4). Pyroxene phenocrysts and pseudomorphs of amphibole after pyroxene range from 5 to 15%. In general, pillow lavas south of the 14 + 25N base line are more intensely deformed and flattened within the plane of foliation than those north of the base line.

The sedimentary (volcaniclastic) rocks include siliceous quartz crystal tuffs, feldspar-quartz crystal tuffs, intermediate feldspar crystal and "lapilli" tuffs, and intermediate 'gritty' tuffs or sedimentary rocks. The siliceous tuffaceous rocks are white to white-grey weathering fine grained rocks with less than 10% quartz crystals. The feldspar-quartz crystal tuffs are white to pink weathering, and contain irregularly distributed 2 mm sized crystals of feldspar (20-25%) and quartz (10-15%). Boundaries with the surrounding intermediate tuffs are sharp.

Feldspar-bearing tuffaceous rocks include a moderately to well bedded felsic to intermediate, white weathering rock with 15-20% feldspar crystals (1-2 mm in size) and a reddish brown weathering rock with 10% feldspar (less than 1 mm in size). The former occurs interbedded with gritty tuffs in outcrops along the mine road whereas the latter is the more common rock unit and is commonly interbedded with siliceous quartz crystal tuff at and north of the 14 + 25N base line.

An intermediate "lapilli tuff" is present in areas where the feldspar crystal tuff is dominant; however, it has not been found in association with the siliceous tuff. This "lapilli tuff" has a reddish brown weathering matrix similar to the feldspar crystal tuff; however, it contains 1-2 cm epidosite pods but no feldspar crystals. The epidosite pods are not graded and do not appear to be related to mineralization.

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Figure GS-11-1: General geology of the Tartan Lake area (modified from Peloquin and Gale, 1985).

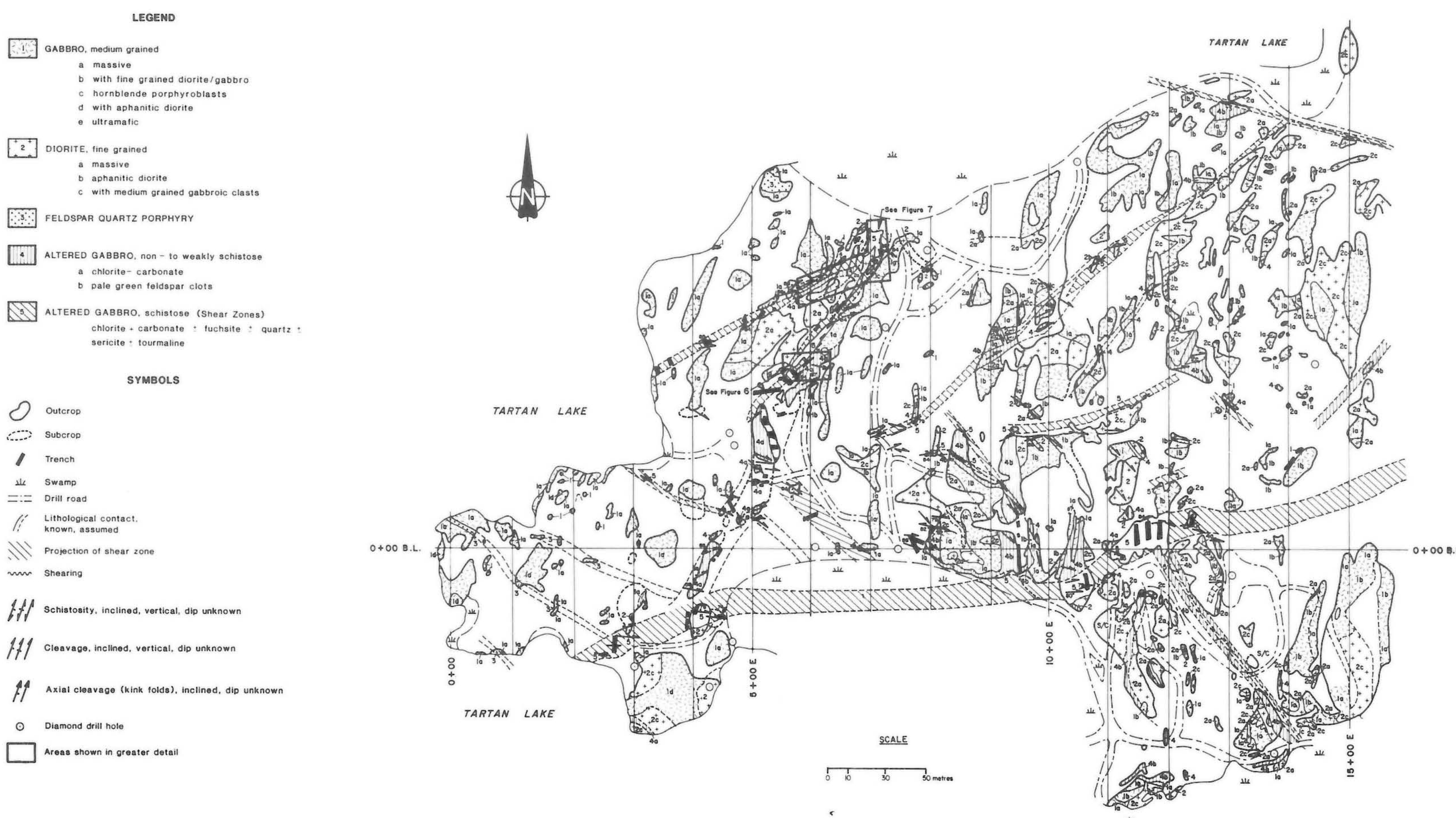
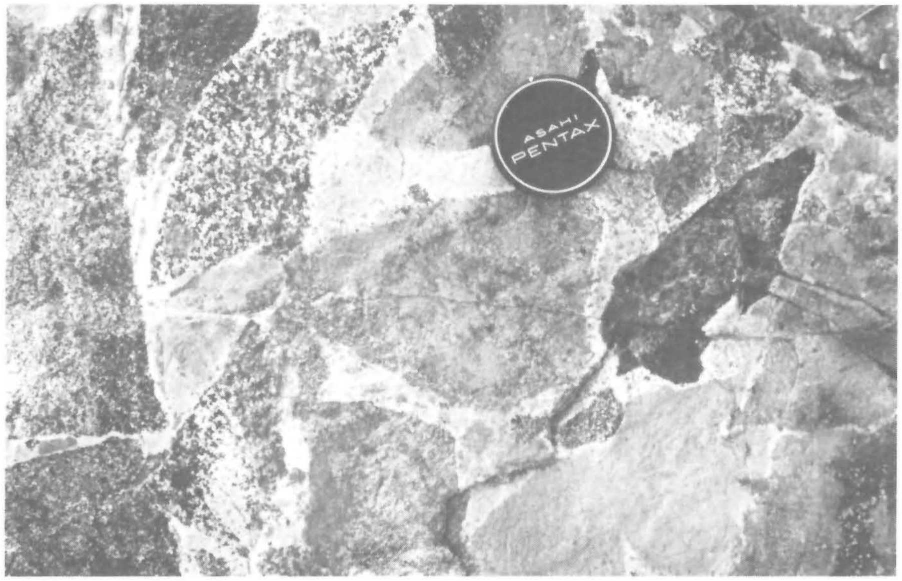


Figure GS-11-2: Geology of the South Zone area.

Figure GS-11-3: *'Igneous breccia', angular blocks of gabbro in a fine grained diorite matrix.*



Two types of 'gritty' intermediate tuff were observed on the Mine Peninsula. An outcrop south of the mine road has grey weathered surfaces, is fine grained and has indistinct to weakly defined beds. A buff brown weathering unit with moderately to well defined layering occurs between the southernmost pyroxene-phyric basalt and the aphyric basalt. In addition, a similar rock occurs interlayered with pillow lava in the aphyric flow unit. Arenaceous layers within interflow tuffs near the mine decline (Fig. GS-11-4) are probably graded beds.

The feldspar-quartz porphyry dykes resemble the feldspar-quartz tuffs; however, they are seen to cut across stratigraphy and intrude mafic intrusions. Locally, especially in the chloritic rocks along the southern margin of the peninsula, feldspar blastesis occurs in both the felsic intrusions and the chloritic schist. The felsic dyke intruding the 'gabbroic complex' shown in the southeastern corner of Figure GS-11-4 contains only 15% feldspar and 5% quartz instead of the 20-25% feldspar and 10% quartz commonly found in the felsic dykes of this area.

The medium grained green gabbro and fine grained brown to green diorite exposed in the extreme southeast corner of the Mine Peninsula (Fig. GS-11-4) are part of the 'gabbroic complex' that occurs south of the Main Zone (Fig. GS-11-2). Small mafic dykes are exposed at several places in the sedimentary and tuffaceous rocks. A fine grained pyroxene-feldspar-bearing microphyric gabbro immediately north of the decline is probably related to the 'knotted' gabbro. In thin section the 'knotted' gabbro consists of anhedral, 2-7 mm hornblende poikiloblasts (40-60%) with lath shaped 0.1-0.5 mm plagioclase laths. The groundmass consists of fine grained chlorite (16%) hornblende (6%), plagioclase (4%), carbonate (4%), epidote (6%), biotite (2%) and polygonal quartz (2%). The fine grained brown weathering gabbro exposed in the area 6E/18 + 25N contains rafts of flattened pyroxene-phyric pillow lava.

Chloritized mafic rocks, referred to as chloritic rocks (Fig. GS-11-4), are exposed south of the mine road. The northernmost unit is locally bedded, contains pyroxene crystals and was probably derived from mafic tuffs. The southern unit is more schistose and primary features are rare. Although most of the southern unit appears to have been derived from tuffaceous rocks some portions appear to be altered gabbro.

RUBY LAKE AREA

During the 1985 field season a number of shear zones were identified in the area between the Tartan Lake Main Zone and the gold occurrence at the east end of Ruby Lake (Peloquin and Gale, 1985). Since exposures in this area were small and moss covered and the shear zone associated with the Tartan Lake gold deposit was postulated to extend through this area, the area was remapped at 1:1200 along grid lines spaced 100 feet (30 m) apart.

Andesitic rocks in the southern part of the map area (Fig. GS-11-5) are dominantly pyroxene-phyric pillowed lava and resemble the lava occurring on the Mine Peninsula. The northernmost part of the map area consists mainly of mafic sedimentary rocks and felsic and mafic tuffaceous rocks that have been intruded by fine- to medium-grained gabbroic or dioritic dykes.

The mafic sedimentary rocks are generally layered and probably derived from an intermediate volcanic rock. The felsic tuffaceous rocks are layered, rarely contain quartz crystals and are commonly feldspar-bearing. The mafic sedimentary rocks and felsic tuffaceous rocks appear to be stratigraphic equivalents of rocks found in the hanging wall (north) of the Main Zone.

Medium grained gabbroic, fine grained dioritic and feldspar porphyritic intrusions occur as sills/dykes in the sedimentary and tuffaceous rocks.

STRUCTURAL GEOLOGY

The present map project areas were selected to provide a geological base for detailed structural studies; however, there was insufficient time to undertake more than preliminary studies this season. Furthermore the mineralized Main Zone was not accessible in mine workings.

The gabbroic complex south of the Main Zone contains a number of shear zones (Fig. GS-11-2). The most common directions of shearing are NE (50-70°) and SE (120-140°). Although the intersections of these two shear systems do not outcrop, it is possible to deduce from outcrop patterns at 500E/200N that the 130° shear zone is displaced along the NNE shear. In general, the shear zones have variable strikes and appear to be discontinuous.

The dominant shear zones are a) the sub-parallel South Zone and b) Base Line Zone (the latter cuts the base line at approximately 100E), and c) the 500E Zone (well exposed on line 500E) extending from the South Zone to the Base Line Zone is discordant to the other two major zones (see Fig. GS-11-2). These three major shear zones contain altered, sheared and schistose mafic rocks exhibiting different intensities of deformation.

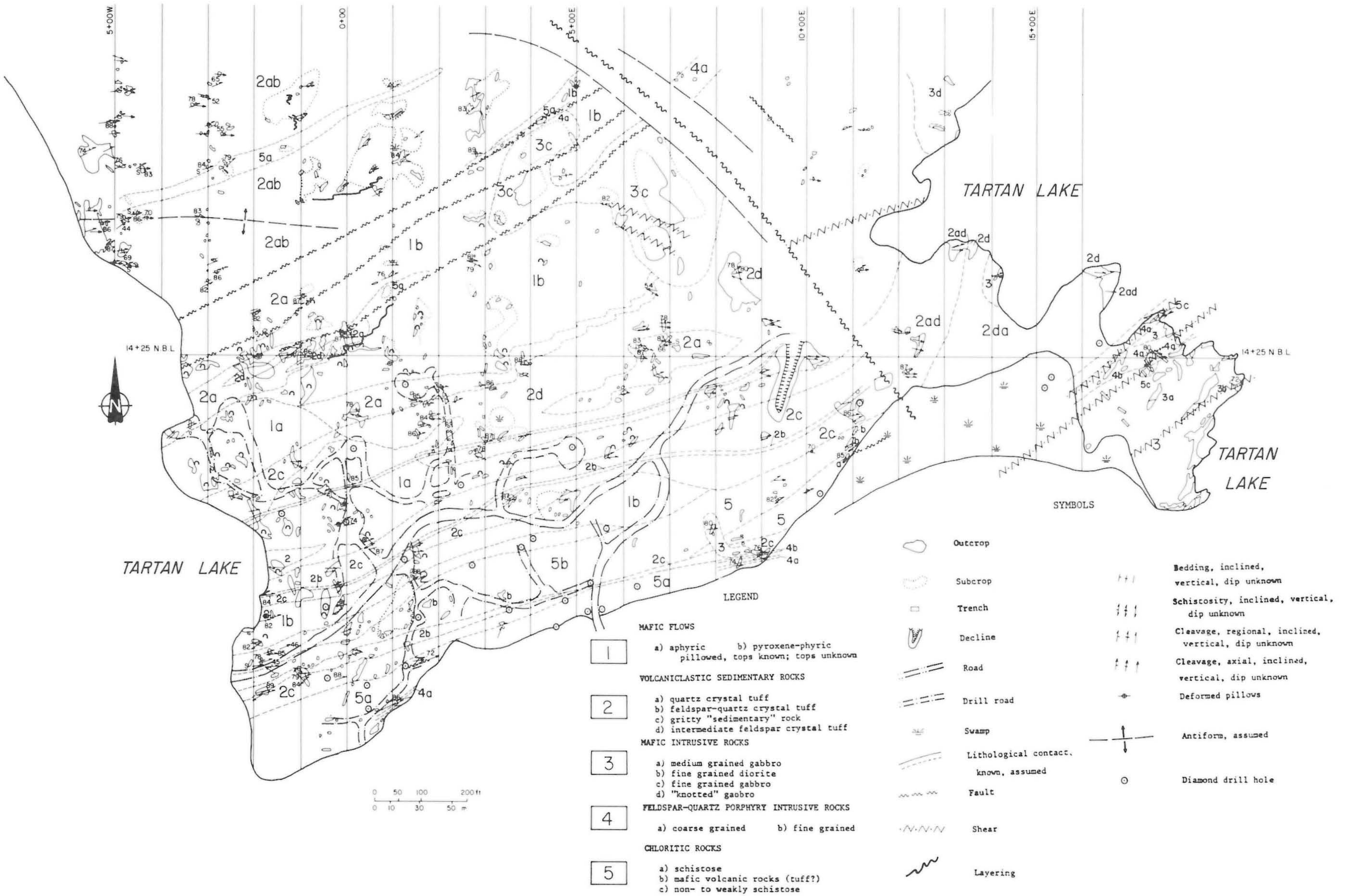


Figure GS-11-4: *Geology and structure of the Mine Peninsula area.*

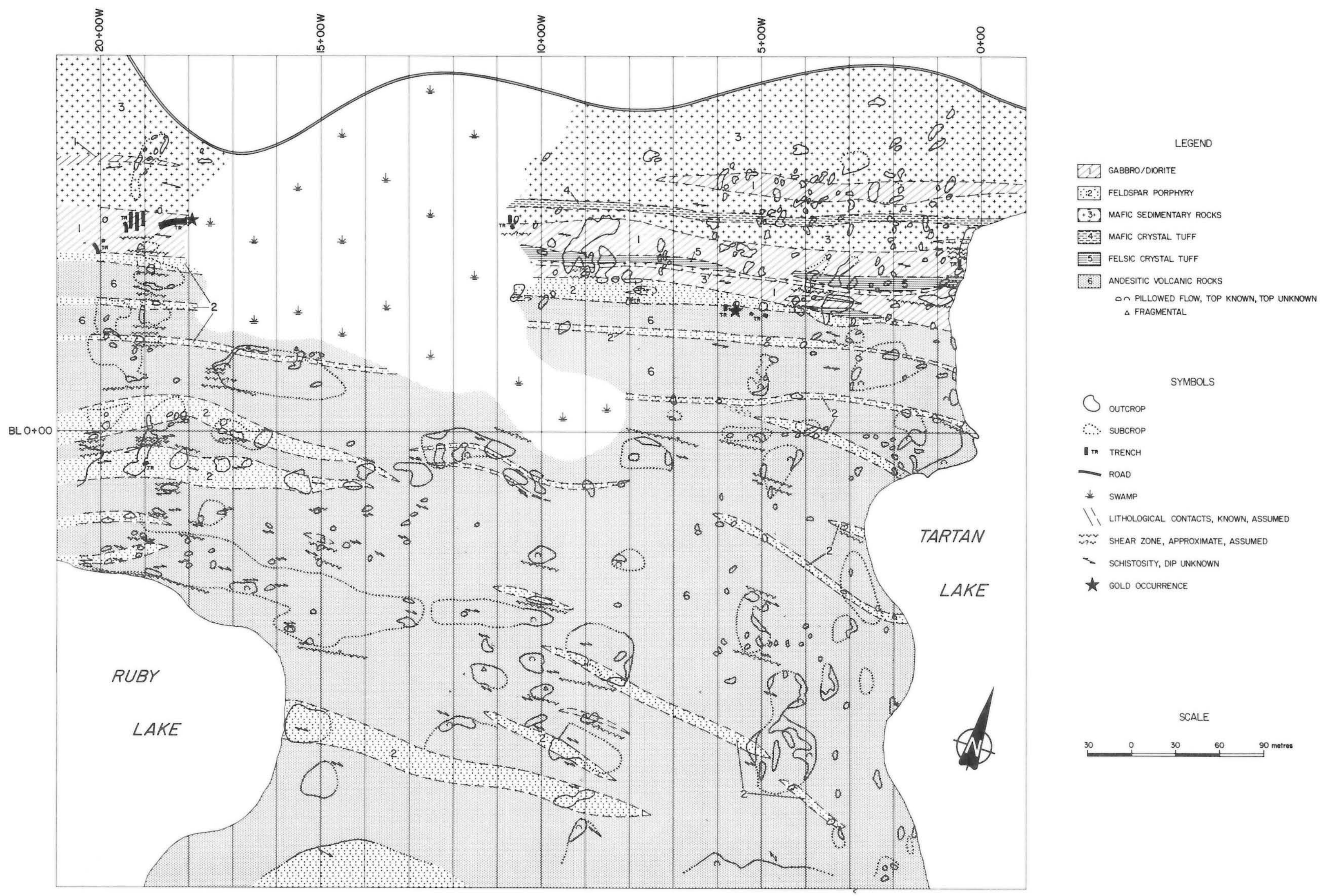
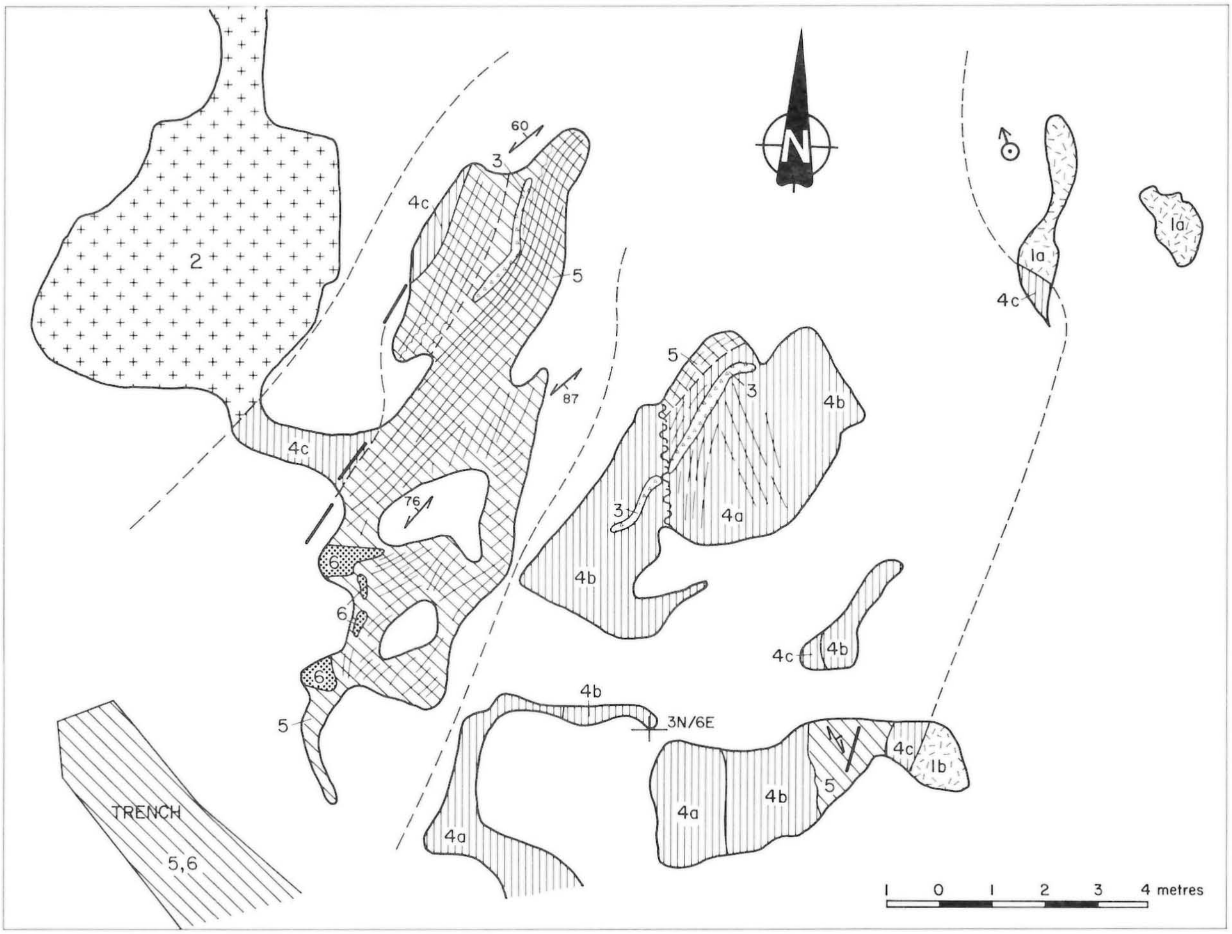


Figure GS-11-5: Geology of the Ruby Lake Grid area.



LEGEND

1 GABBRO, medium grained
- a massive
- b with fine grained diorite/gabbro
- c hornblende porphyroblasts
- d with aphanitic diorite
- e ultramafic

2 DIORITE, fine grained
- a massive
- b aphanitic diorite
- c with medium grained gabbroic clasts

3 FELDSPAR-QUARTZ PORPHYRY

4 ALTERED GABBRO, non – to weakly schistose
- a chlorite– carbonate
- b pale green feldspar clots

5 ALTERED GABBRO, schistose (Shear Zones)
chlorite + carbonate ± fuchsite ± quartz ± sericite ± tourmaline

6 QUARTZ ± CARBONATE ± TOURMALINE VEIN

SYMBOLS

- Outcrop
- Lithological Contact, Known, Assumed
- Foliation
- Cleavage
- 87 Schistosity, Inclined
- Diamond Drill Hole
- Shear Zone

Figure GS-11-6: Detailed geology of part of the South Zone.

Figure GS-11-7: Detailed geology of part of the 500 E Zone. See Figure GS-11-6 for legend.

Several deformational events are recorded by deformed schistosities, shearing, intersecting cleavages and folded quartz and/or tourmaline veins (see Fig. GS-11-6).

In general the well developed shear zones are characterized by a 'central' zone of chlorite-carbonate-quartz ± fuchsite ± tourmaline ± sericite schist, a marginal zone of weakly schistose chlorite-carbonate-quartz and an outermost zone of pale green non-schistose to weakly schistose chloritic rock with pink-feldspar blastesis and recognizable remnants of fine grained gabbroic rock. Fine grained massive gabbro, commonly with a zone of weak carbonate alteraton, is generally found at the margins of the shear zones (Fig. GS-11-7). The zonation in the shear zones and alteration of the host gabbro is so consistent that it has been possible to predict the presence of shear zones solely on the basis of small exposures of altered host rocks.

Although some quartz and tourmaline veins appear to have been folded within the schistosity, the majority of these veins, as well as some carbonate veins, formed later in zones of dilation. The veins were deformed by one of the latest regional deformational events — kink folds with near-vertical north-striking axial planes.

The Mine Peninsula and Ruby Lake Grid areas are structurally complex and further detailed structural analysis is warranted. Polyphase penetrative deformation of the area has taken place as evidenced by tight to isoclinal folds developed at the same time as an early schistosity (S_1), and the development of a regional cleavage (S_2) that is axial planar to S-folds at approximately 070°. In addition, a later cleavage (S_3) is axial planar to interference folds that locally produce a north-south enveloping surface in the northernmost part of the area depicted in Figure GS-11-4.

Structures associated with S_3 are best preserved in sedimentary rocks north of the 14 + 25N base line. Rocks south of the 14 + 25N base line appear to be dominated by the S_2 fabric, in that pillow lavas (Fig. GS-11-8) have been flattened and attenuated in the plane of S_2, and S_2 is found at a low angle (10-15°) to both S_1 and compositional layers. The S_1 fabric is rarely distinguishable in outcrop and has yet to be confirmed by thin section. Kink folds locally deform the regional schistosity (S_1 and/or S_2), e.g. near Ruby Lake, and produce a crenulation cleavage or lineation in schistose rocks throughout the area.

Shear zones predate the development of kink folds (e.g. Ruby Lake, South Zone). The shears occur as zones of intensely granulated rock from

Figure GS-11-8: Deformed pillow lava adjacent to shear zone, Mine Peninsula.

a few metres to several tens of metres in thickness. Locally within these zones the rocks have developed into schists.

A NNW-striking fault is postulated to occur on the east side of the mine adit, on the basis of different rock types on opposite sides of an overburden filled depression. This fault probably displaces the Main Zone shear northwards.

On the Mine Peninsula a major shear zone appears to be developed at the contact of the gabbroic complex and the volcano-sedimentary rocks. In the Ruby Lake Grid area a well developed shear zone occurs along the contact between the lavas to the south and the volcano-sedimentary rocks to the north; this shear system can be traced from the shore of Tartan Lake westwards to Ruby Lake and one shear passes through the area containing a large trench in mafic schists with gold-bearing quartz veins (Fig. GS-11-5).

Some felsic intrusions have sheared diffuse contacts and may be surrounded by a zone of post-shear feldspar blastesis (e.g. south of the base line near Ruby Lake).

CONCLUSION

Although several zones of shearing are present in the Ruby Lake Grid area, it is not yet certain which of these shear zones represents a continuation of the shear associated with the Main Zone. It may be postulated, however, that shear zones in the vicinity of the contact between the volcanic rocks and the volcano-sedimentary rocks in the Ruby Lake Grid area have the highest potential to contain gold mineralization.

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GS-12 GEOLOGY OF THE BAKER PATTON AREA

by B. Tannahill[1] and G.H. Gale

A four week program of geological mapping at 1:1000 scale was conducted in the general vicinity of the Baker Patton shaft to establish a geological base for further studies of the mineralizaton and alteration in the area. Mapping was facilitated by new grid lines established for exploration in the area; however, mapping proceeded slowly due to lichen covered exposures, rusty weathered exfoliation surfaces and similarity of lithologies. Considerable work was done in preparation of exposures for future studies.

LITHOLOGIES

The major rock units are shown on Figure GS-12-1. Copies of the 1:1000 scale map (Fig. GS-12-2) are available upon request.

The rhyodacitic breccia (unit 1) has subrounded to angular fragments of massive rhyodacitic rock in a reddish brown weathering fine grained matrix. Fragments range from 2-10 cm in longest dimension but are commonly 3-4 cm in length. Several of the larger blocks contain 1 cm rhyolitic fragments. The matrix commonly constitutes only 5% of the rock, although locally it accounts for more than 20% of the rock. Although unit 1 is surrounded by unit 2 their relationship is not certain.

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Dacitic flows (unit 2) include lobate bodies of dacite and related breccia and micro-breccia. The massive portions of the flows range from non-amygdaloidal to amygdaloidal; amygdules range from 1-20 mm in size. The breccias commonly contain amygdule-rich zones, and a large percentage of the fragments are commonly flow banded. Approximately 10% of the rock consists of a fine grained reddish brown weathering matrix with a 'gritty' texture.

Rhyodacitic fragmental rocks are exposed in several outcrops near Lake Athapapuskow. These rocks contain quartz-phyric and pumiceous fragments that appear to be reworked pyroclastic rocks. The source of the fragmental rocks is probably different from that of the rhyolitic fragmental rocks since megascopically they appear to be of slightly different composition.

Rhyodacitic fragmental rocks consist predominantly of 1-5 cm rock fragments in layers several to tens of metres thick with diffuse contacts. This unit also contains lapilli tuff, and ash layers. Locally parts of this unit may represent flow breccia; however, most fragmental rocks appear to be reworked pyroclastic material.

The 'two quartz rhyolite', the most extensive rock unit in the map area, is derived from quartz-phyric rhyolite flow rocks with approximately 5% quartz phenocrysts that are 0.5-1 mm and 3-5 mm in size. Locally,

Figure GS-12-1: *General geology of the Baker Patton area. Legend:* **1** *Rhyodacite breccia.* **2** *Dacitic flows;* **3** *Sedimentary rocks;* **4** *Rhyolitic breccia.* **5** *"Two quartz" rhyolite.* **6** *Diorite.*

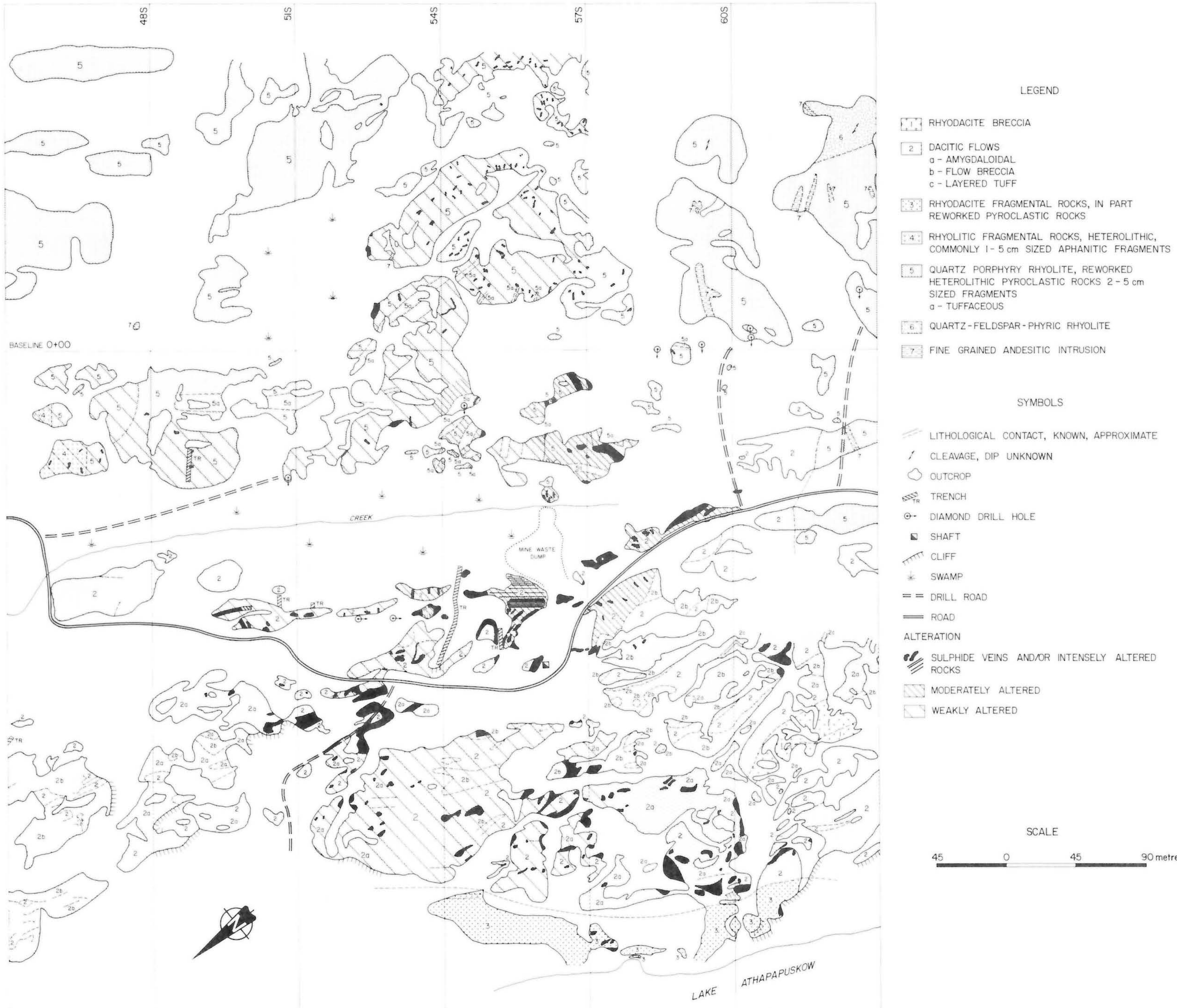

Figure GS-12-2: Geology of the mineralized zone at Baker Patton.

a feldspar and quartz-phyric rock is also present within this unit but has not been accurately delineated.

A 'two quartz rhyolite' flow rock is exposed at the eastern margin of the map area near Murray Lake. Elsewhere, this unit consists predominantly of reworked pyroclastic rocks with variable amounts of 2-5 cm 'two quartz rhyolite' rock fragments plus a quartz crystal and ash matrix that commonly contains 10-20% bimodally sized quartz crystals similar to those in the flow rocks.

Throughout the coarser fragmental rocks there are lenses and layers of 1-5 mm quartz-rich tuff and ash material. Commonly the two rock types are associated and the 15-30 cm thick ash layers occur at the boundaries of the 'gritty' rock types. Locally, it was not possible to determine if lichen covered fine grained rocks were thin ash layers or dykes. Only several small, several metre thick, andesitic dykes were positively identified in the map area. Thin section studies and further outcrop cleaning may reveal that some of the rocks mapped as ash layers are of intrusive origin.

MINERALIZATION

Abundant pyrite and minor chalcopyrite mineralization has been known in the Baker Patton area since the early 1920s. This widespread sulphide mineralization and rusty weathered exposures has prompted extensive exploration including trenching, diamond drilling and the sinking of a 150 m (500 foot) deep shaft. The presence of solid sulphide in drill intersections (30-50 cm) and large blocks in the waste pile had led to the assumption that this mineralization represented a small massive sulphide deposit and its associated alteration zone. Although it is still not definitely established that stratigraphic tops are towards the east, it appears from our preliminary studies that the mineralization exposed at the Baker Patton shaft area (Fig. GS-12-2) is part of a cross-cutting vein system. The 'dacitic' flow rocks are extensively altered and probably represent hydrothermal activity along a fracture system. The most intensely altered rocks occur close to or at the contact between the dacitic flows and the 'two quartz rhyolite' fragmental rocks. If a lens of solid sulphide exists it should occur in the area east of the shaft and probably below the area of swamp (assuming an eastward younging sequence).

Mineralization west and east of the Baker Patton shaft includes both vein type and disseminated pyrite mineralization. The mineralization exposed west of the shaft cuts across the massive dacitic lavas. Pyrite contents of the disseminated sulphide zones (altered areas) are generaly 2-3% whereas in the sulphide vein systems the pyrite contents are commonly 10-25% and rarely constitute more than 40% by volume of the mineralized rock.

Pyrite is common throughout a roughly east-trending zone in the 'two quartz rhyolite' extending from the Baker Patton shaft to Murray Lake. Pyritic veins in this rock are more common in the area adjacent to the shaft and the easternmost part of this unit near Murray Lake. Disseminated pyrite (1-2%) occurs throughout this east-trending zone and the distinctive rusty weathering surface to the rocks is produced by precipitation of iron oxide weathering products on exfoliation surfaces. Consequently, the mineralized fragmental rocks appear to be only weakly altered except locally in areas with vein-type mineralization.

A number of sulphide occurrences are exposed in trenches outside the main east-trending zone of mineralization centred on the Baker Patton shaft. These peripheral occurrences are commonly chalcopyrite-rich pyritic vein systems that are parallel to foliation or shears in the rocks, and probably represent leakage haloes formed by mobilization since they are not associated with extensive alteration.

GS-13 MINERALIZATION AND ALTERATION OF THE VAMP LAKE SULPHIDE DEPOSIT

by R.S. Wadien[1] and P. Laznicka[1]

INTRODUCTION

The gold-rich Vamp Lake Cu-Zn sulphide deposit and its geologic setting is the focus of a two-year study on the nature and genesis of the mineralization and associated wall rock alteration. Work on the project commenced in the summer of 1985 with three months of field work concentrated on geological mapping and sampling of the ore zones and host rocks. This field work was continued for three weeks during the 1986 field season. Subsurface data obtained in 1985 from selected drill holes were supplemented by the examination and sampling of additional drill holes; this permitted an improvement in correlation of stratigraphic units in areas without outcrop or marker beds. In addition, the surface geology of the area was re-examined in light of geochemical and petrographic data obtained subsequently to the preliminary mapping. Although there has been some refinement of the initial maps published in the Report of Field Activities, 1985 (Laznicka and Wadien, 1985), revised versions are not significantly different from the preliminary maps and are therefore not reproduced here. The focus of this report will be on the immediate wall rocks, their characteristics, mineralization and alteration. The general geological framework of Vamp Lake has already been discussed (Laznicka and Wadien, 1985).

WALL ROCKS

The wall rocks to the main ore zone crop out on the largest island on the lake. The wall rocks to the other major zone of mineralization are located beneath the lake (i.e. the lake zone), and can only be observed in drill core.

Outcrops of rocks stratigraphically underlying and forming the hanging wall to the main ore zone are dominated by various types of mafic metavolcanic rocks, with structures that include an assemblage of vesicular flows, pillows, mafic breccias, and massive flows. In addition, a mafic fragmental unit with a chloritized matrix underlies, and is in contact with, the main zone of mineralization.

Footwall units consist predominantly of intermediate to felsic pyroclastic and/or clastic rocks. Scattered mineralized fragments occur in some units and may imply redeposition of another sulphide body. Although the presence of well rounded rock fragments has been noted, field evidence for a sedimentary origin is inconclusive due to superimposed deformation and metamorphism.

ALTERATION

Close examination of the surface geology on the large island showed that alteration in the wall rocks to the main ore zone is evident only within the matrix of the fragmental units. An example of this is the chloritized matrix of the immediate hanging-wall breccias. In addition, some of the footwall fragmental rocks within approximately five metres of the ore zone have a higher proportion of garnets in the matrix. The proximity of this feature to the ore zone suggests that it is an alteration effect.

Hanging-wall alteration is readily visible in drill core because of the progressive development of a chlorite or chlorite-biotite assemblage in the intermediate to felsic section stratigraphically underlying the mafic metavolcanic rocks. A minor amount of quartz-sericite schist has also been noted in this area, although this particular assemblage is most pronounced in the hanging wall of the lake zone, westward along strike from the main zone of mineralization. The most extensive zone of alteration, characterized by a pervasive chloritization, was observed in drill core from the rocks stratigraphically underlying the main zone.

MINERALIZATION

The sulphide mineralization can be tentatively subdivided into two main morphological types commonly observed in massive sulphide deposits:

1. Near solid to solid sulphides, where sulphides form 50% or more of a particular section.
2. Disseminated to stringer sulphides.

Type 1 has been further subdivided texturally and mineralogically into:

A. Medium grained granular pyrite aggregates which generally contain only a minor amount of other sulphide minerals (i.e. chalcopyrite or sphalerite) and subordinate interstitial quartz gangue.

B. Pyrrhotite-rich breccia ore in which a predominantly fine grained pyrrhotite and a lesser amount of pyrite and/or chalcopyrite are interstitial to chloritized and/or silicic fragments.

Type 2 sulphide mineralization is common in rocks adjacent to sulphide bodies and within altered rocks stratigraphically underlying ore zones. Pyrite and chalcopyrite are the predominant sulphide minerals associated with this form of mineralization.

GEOCHEMISTRY

Whole rock and trace element analyses, in addition to assay data, have been obtained on 63 selected samples of wall rocks to the deposit and of the surrounding metavolcanic units. A comparison of analyses of samples that petrographically displayed progressive degrees of alteration indicates the existence of enrichment and depletion trends of specific major elements in the altered rocks. MgO enrichment is most pronounced in rocks displaying progressive chloritic alteration. Fe_2O_3 values also tend to increase in the altered samples. This enrichment trend is accompanied by a complementary, although less pronounced, depletion in SiO_2 and Na_2O values.

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GS-14 GEOCHEMICAL ANALYSIS OF GRANITIC ROCKS IN THE SNOW LAKE-FLIN FLON AREA

by N.M. Halden[1]

It was suggested by Bell (1975) that the Snow Lake-Flin Flon belt represented a Proterozoic greenstone belt association. More recent considerations have diverged from this initial interpretation to suggest that the terrane represents an ancient island arc which can be incorporated within a plate tectonic-type framework; this would include other volcanic terrane, and cordilleran-type magmatism (cf. Lewry et al., 1981; Green et al., 1984).

Approximately 400 samples of granitic and granodioritic rocks from the Snow Lake-Flin Flon area are being analyzed for major elements and selected trace elements (e.g. Rb, Sr, Cu, Ni, Zn, Y, Zr, Nb, U. Pb, Th) by X-ray fluorescence; analytical work is presently in progress. The samples are from granitic and granodioritic intrusions from the western portion of the greenstone belt, between Flin Flon and Elbow Lake (see Baldwin, 1980). Preliminary field observations indicate a clear distinction between homogeneous equigranular granites and granodiorites, and inclusion-rich intrusive phases. The primary objective of the project is to provide a geochemical data base whereby the characteristics of metallogenic associations related to granitic magmatism in the Snow Lake-Flin Flon area can be established (cf. Beckinsale, 1979). The data will also be used as the basis for the selection of specific intrusive bodies that would benefit from a more detailed sampling program, and more detailed field work.

A second, complementary, objective is also possible. Recent work by Pearce et al. (1984) has shown that it is possible to distinguish between the plate tectonic settings of various granitic intrusions on the basis of their trace element geochemistry. Lewry et al. (1981) considered the possibility that the Wathaman (Chipewyan) batholith (cf. McRitchie, 1977) presents a Proterozoic, cordilleran-type batholithic terrane that developed as a consequence of subduction; this would be consistent with a granite forming in a collision or convergent plate tectonic setting (cf. Pearce et al., 1984). Within a geochemically based discriminant framework it may be possible to establish the nature and affinity of granitic magmatism in the Snow Lake-Flin Flon terrane.

[1]Department of Geological Sciences, University of Manitoba, Winnipeg.

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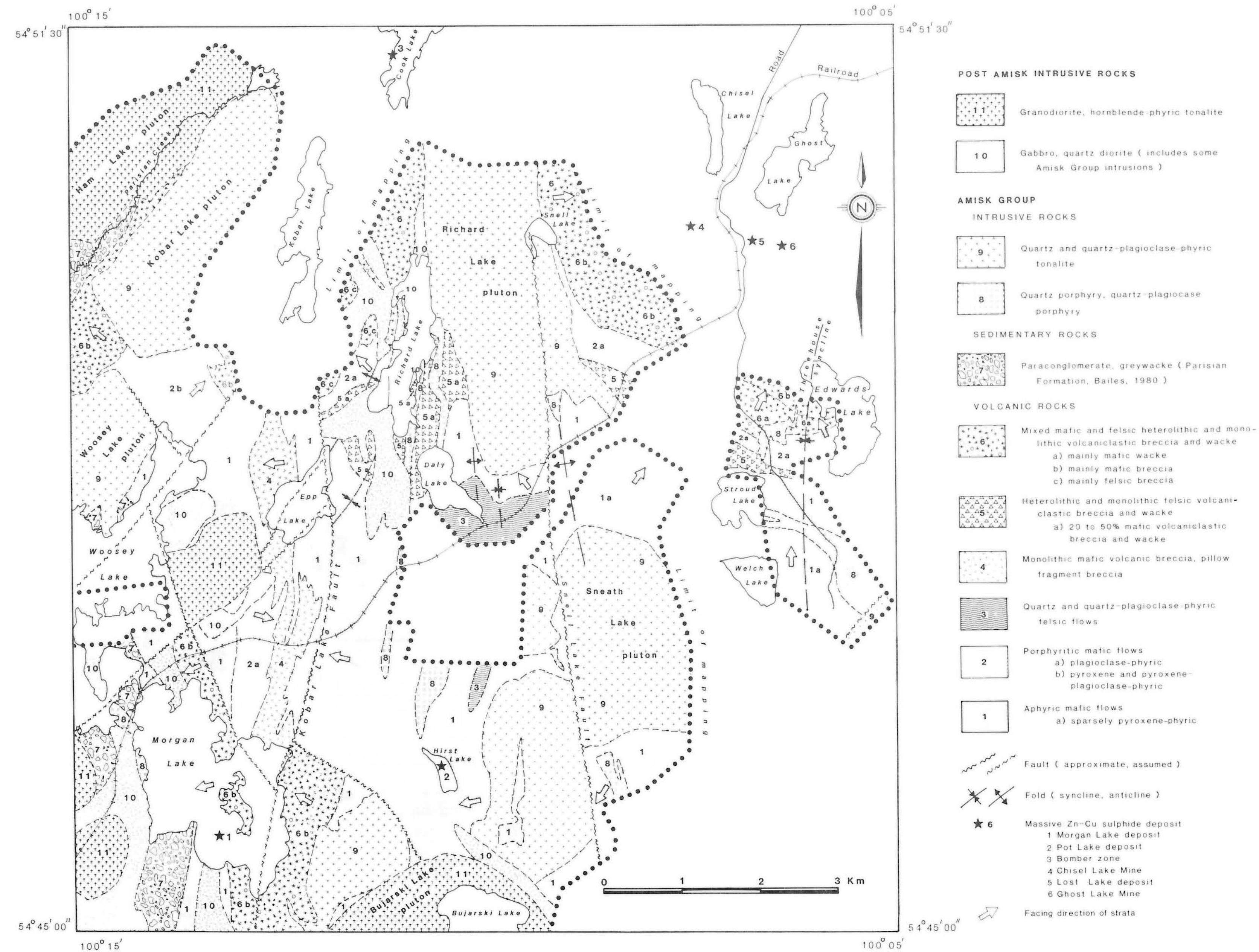


Figure GS-15-1: Simplified geology of the Chisel-Morgan Lakes area.

GS-15 CHISEL-MORGAN LAKES PROJECT

by A.H. Bailes

INTRODUCTION

Mapping at a scale of 1:15 840 has been conducted for approximately 75 km² of the Chisel-Morgan Lakes map area. The goal of the mapping program is to provide an improved, more detailed geological base for future mineral exploration in this base metal-rich mining district. Six significant volcanogenic sulphide deposits, including the Chisel Lake Mine, Ghost Lake Mine, and the recently discovered Morgan Lake Zn-Cu sulphide deposit, are located in the project area (Fig. GS-15-1).

Major findings during this year's work include:

1) delineation of several major fault structures, some of which have juxtaposed strata with opposing facing directions (e.g. Kobar Lake fault and the fault on the south shore of Epp Lake).
2) identification of a crude stratigraphy in rocks east of the Kobar Lake fault, and the consequent observation that the Pot Lake Zn-Cu massive sulphide deposit occurs approximately 4 km stratigraphically below units that host the Chisel Lake, Lost Lake and Ghost Lake Zn-Cu massive sulphide deposits.
3) placement of the recently discovered Morgan Lake Zn-Cu sulphide deposit near the top of the Amisk volcanic sequence.
4) recognition of more than one age of synvolcanic quartz-phyric tonalite ("Quartz-eye" granite of Harrison, 1949) and the delineation of extensive zones of Fe-Mg alteration in these intrusions.
5) identification of zones of hydrothermal alteration, including silicification, epidotization and Fe-Mg metasomatism, that have affected between 10 and 20% of exposed volcanic rocks.

GENERAL GEOLOGY

Although the Chisel-Morgan Lakes area is structurally complex, an approximately 4 km intact sequence of Amisk Group volcanic rocks was recognized in the area east of Kobar Lake fault (Fig. GS-15-1). West of this fault, volcanic units are dissected by numerous faults which make documentation of stratigraphy difficult.

AREA EAST OF THE KOBAR LAKE FAULT

The 4 km thick volcanic sequence east of the Kobar Lake fault faces north at Edwards Lake, is tightly folded about north-trending structures at Richard Lake, and tops west at Hirst Lake. It is broadly folded about the north-northeast-trending Threehouse syncline at Edwards Lake and a north-trending anticlinal structure coincident with the Richards Lake pluton. The synvolcanic Sneath Lake pluton forms the base of the mapped section.

Four major volcanic units comprise the section; from base to top these are:

1) more than 2500 m of aphyric to sparsely pyroxene-phyric pillowed mafic flows (including approximately 700 m of quartz and quartz-plagioclase-phyric felsic flows south of Daly Lake);
2) 100-350 m of heterolithic and monolithic felsic volcanic breccia and wacke, with minor mafic volcanic wacke and breccia;
3) 150-500 m of plagioclase-phyric mafic pillowed and massive flows;
4) 750 m of mixed mafic and felsic heterolithic and monolithic volcanic breccia and wacke.

The 2500 m of aphyric and sparsely pyroxene-phyric mafic flows, exposed at the base of the mapped section, between the synvolcanic Sneath Lake pluton and the overlying felsic volcanic breccia to the north, are typically pillowed and massive, with minor amoeboid pillow breccia. Sparsely pyroxene-phyric flows (1-3% pyroxene, 0.5-2 mm) are restricted to the area southeast and northwest of Welch Lake. Except at Stroud Lake, these rocks are deformed, recrystallized, and altered to such a high degree that individual flows cannot be identified. The upper 500 m of this unit is locally strongly silicified (Fig. GS-15-2). The silicification has not affected the overlying unit of felsic breccia and wacke.

South and east of Daly Lake the aphyric mafic flows include up to 700 m of quartz- and quartz-plagioclase-phyric felsic flows. The felsic flows are composed of white lobate bodies of massive rhyolite, monolithic rhyolite breccia and light grey recrystallized microbreccia. The massive rhyolite forms lobes, pods and narrow tongues enveloped by breccia and microbreccia. The massive bodies are typically a few metres to a few tens of metres in size and are elongate parallel to stratigraphy. The lobes, breccia and microbreccia contain 5-10% quartz (0.5-3 mm) and 0-5% plagioclase phenocrysts (0.5-1 mm). This sequence is 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).

Figure GS-15-2: Pillows with silicified margins, from an aphyric mafic flow 100 m northeast of Stroud Lake.

Stratified heterolithic and monolithic felsic volcanic breccia and wacke, and minor mafic volcanic breccia, mafic volcanic wacke and assorted sediments, abruptly overlie the mafic flows at Stroud and Daly Lakes (Fig. GS-15-3). Bedding in felsic breccia beds ranges in thickness from less than 1 m to more than 20 m. The lower three-quarters of most felsic breccia beds is clast-supported and either ungraded or reverse to normally size graded. The upper one-quarter of the beds is typically matrix-supported (with smaller fragments), displays grading in both fragment size and matrix grain size, and is commonly parallel laminated at the top. Fragments are subangular to subrounded and may be quartz-plagioclase-phyric, quartz-phyric or aphyric. Phenocrysts are typically less than 3 mm in size, but some beds contain coarsely porphyritic fragments with quartz phenocrysts up to 15 mm and plagioclase phenocrysts up to 4 mm. Felsic volcanic wacke beds are A and AB zoned, 10 cm to 2 m thick, and lithologically identical to the fine grained tops of felsic breccia beds. Mafic volcanic breccia, mafic volcanic wackes and sedimentary rocks display similar bedding characteristics as their more abundant felsic counterparts. The sediments, which include greywacke, siltstone and mudstone, include zones of intense rusty weathering. A preliminary interpretation of the unit is that the breccia beds were deposited by subaqueous debris flows derived from a predominantly felsic source, and the volcanic wacke beds and sedimentary rocks were deposited from turbulent subaqueous density currents.

A distinctive 150-500 m thick unit of plagioclase-phyric and glomerophyric (10-15%, 0.5-8 mm) mafic flows overlies the felsic breccias. This unit is present west of Edwards Lake, southeast of Snell Lake and west of Richard Lake, and provides a reliable stratigraphic marker that demonstrates the predominantly westerly (albeit folded) trend of stratigraphy. The flows are commonly thick (one flow is 100 m thick), massive and/or pillowed, with few vesicles. Massive portions of thick flows are gabbroic textured.

More than 750 m of mixed mafic and felsic volcanic breccia and wacke overlie the plagioclase-phyric mafic flows. This formation is exposed west of Edwards Lake, east and southeast of Snell Lake and west and northwest of Richard Lake; in each locality it differs slightly in lithology. West of Edwards Lake it comprises a basal 200-550 m thick unit of mafic, crystal-rich volcanic wacke overlain by greater than 200 m of heterolithic mafic and minor felsic volcaniclastic breccia. The mafic volcanic wacke locally displays well defined bedding (Fig. GS-15-4), but typically it is massive with poorly defined beds. The overlying breccia sequence contains well defined beds ranging from less than 1 m to more than 35 m thick. Most breccia beds display a mixture of both mafic and felsic volcanic clasts. East and southeast of Snell Lake this formation differs in that mafic volcanic wacke no longer forms a discrete mappable basal unit, mafic monolithic breccias are locally abundant, and the breccias are generally hydrothermally altered. The alteration is part of a semi-conformable zone of Fe-Mg metasomatism located approximately 0.5-0.75 km stratigraphically below the Chisel Lake and Ghost Lake massive Zn-Cu sulphide deposits. The primary lithologic make-up of most breccia beds in the Snell Lake area is obliterated by this alteration. This same unit, west of Richard Lake, is quite different in that it is unaltered, and heterolithic felsic breccia beds are common (forming more than half of the sequence). The remainder of the sequence at Richard Lake is composed of mafic heterolithic and monolithic volcanic breccia and wacke. A preliminary interpretation of this formation is that it was deposited by subaqueous debris flows and turbulent subaqueous density currents, with its heterolithic character and lateral variation reflecting derivation from a local, lithologically diverse source terrane.

The volcanic sequence east of the Kobar Lake fault is intruded by a wide variety of mafic and felsic stocks, plugs and plutons. Many of the intrusions are probably synvolcanic. Walford and Franklin (1982) have suggested that the Sneath Lake quartz-phyric tonalite is a possible subvolcanic heat source for the extensive hydrothermal system associated with volcanogenic massive sulphide deposits in both the Chisel Lake and Anderson Lake areas. This intrusion and the similar Richard Lake pluton have been affected by widespread Fe-Mg metasomatism of the same type as that associated with the volcanogenic massive sulphide deposits. This supports a synvolcanic age for these plutons. However, the Richard Lake pluton may be younger than both the Sneath Lake pluton and the genetically related(?) Chisel Lake and Ghost Lake Cu-Zn sulphide deposits as it crosscuts the semi-conformable Chisel-Ghost footwall Fe-Mg alteration zone north of Snell Lake. This implies that synvolcanic quartz-phyric tonalite plutonism and associated hydrothermal activity may have spanned a considerable time interval and, as such, volcanogenic massive sulphide deposits may also span a considerable stratigraphic interval. Other potential synvolcanic intrusions include quartz-plagioclase porphyritic dykes and stocks (such as the body north of Stroud Lake and those east of Richard Lake), plagioclase-phyric and aphyric dacite intrusions such as those intimately associated with the silicification in the area west of Edwards Lake (Roger Skirrow, pers. comm., 1986), and at least some of the gabbro intrusions on Richard Lake which appear to be truncated by the Richard Lake quartz-phyric tonalite.

AREA WEST OF THE KOBAR LAKE FAULT

The stratigraphic formations recognized east of the Kobar Lake Fault have not been identified west of this fault. This could mean that they are not present west of the fault, but it is more likely that numerous faults west of this structure simply do not permit large enough sections of volcanic rocks to be mapped in order to recognize similarities in stratigraphy. The faults are rarely observed and have been identified on the basis of abrupt truncation of stratigraphy (e.g. faults on south shore of Woosey Lake and one northwest of Morgan Lake), truncation of major intrusive bodies (e.g. faults on east shore of Woosey Lake and northwest of Woosey Lake), and on opposite facing of otherwise similar rock units (e.g. fault on south shore of Epp lake).

Rocks east of Woosey and Morgan Lakes mainly comprise pillowed to massive mafic aphyric to plagioclase-phyric flows and related pillow fragment breccias. Rocks on Morgan Lake, Woosey Lake and along Parisian Creek include a west-facing sequence of heterolithic mafic volcaniclastic breccia, mafic volcanic wacke, and minor associated mafic flows that are overlain by paraconglomerate and greywacke belonging to the Amiskage Parisian Formation (Bailes, 1980). The Morgan Lake massive Zn-Cu sulphide deposit, at the south end of Morgan Lake, occurs in the heterolithic mafic volcaniclastic sequence, 300 m stratigraphically below the Parisian Formation. Stratigraphically equivalent heterolithic mafic breccia to the north-northwest, on Morgan Lake, on Woosey Lake and along Parisian Creek, may also be potential hosts for massive sulphide base metal mineralization. Strong silicification and Fe-Mg metasomatism of heterolithic mafic breccias along Parisian Creek make this a particularly attractive area for exploration.

FELSIC PLUTONS

Felsic plutonic rocks of granodioritic to tonalitic composition are prominent in the Chisel-Morgan Lakes area (Fig. GS-15-1). Some are probably synvolcanic (Sneath Lake and Richard Lake plutons), some are of uncertain age (Kobar Lake and Woosey Lake plutons), and some are late tectonic (Ham Lake, Epp Lake, Morgan Lake and Bujarski Lake plutons).

SYNVOLCANIC PLUTONS AND PLUTONS OF UNCERTAIN AGE

The Sneath Lake quartz-phyric tonalite pluton is probably, but not definitely, synvolcanic, as suggested by:

1) its unusual semi-conformable sill-like shape, with a width averaging 1.5 km and a strike length of more than 14 km;
2) large parts of the pluton have been affected by intense Fe-Mg metasomatism (Fig. GS-15-5), of the same type as that associated with volcanogenic massive sulphide deposits.

Another, less convincing indication of its synvolcanic character is coarse quartz phenoclasts and coarsely quartz-plagioclase-phyric felsic fragments in overlying heterolithic volcaniclastic units; these could be derived from extrusive equivalents of the pluton.

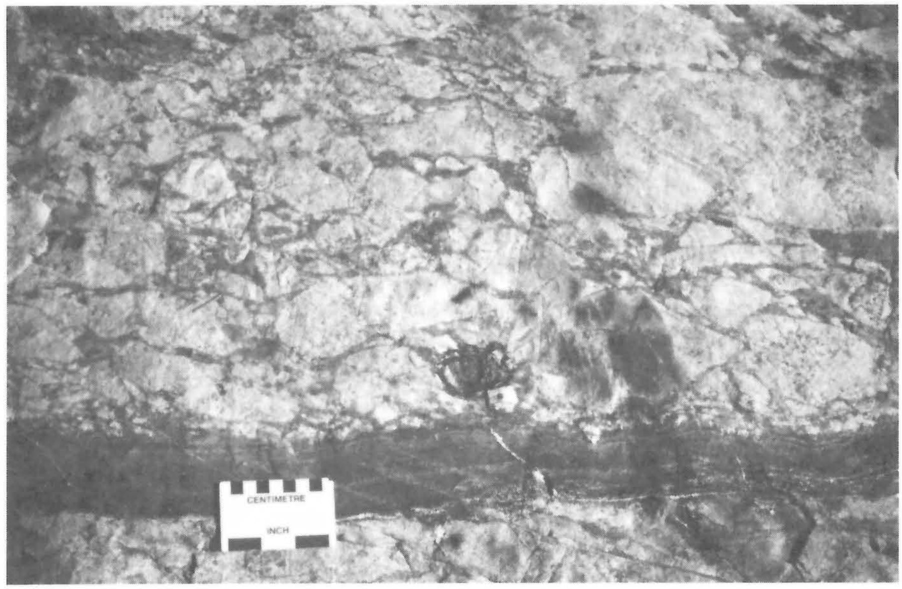


Figure GS-15-3: *Monolithic felsic breccia beds with a narrow interbed of mafic volcanic wacke, 250 m east of Stroud Lake.*

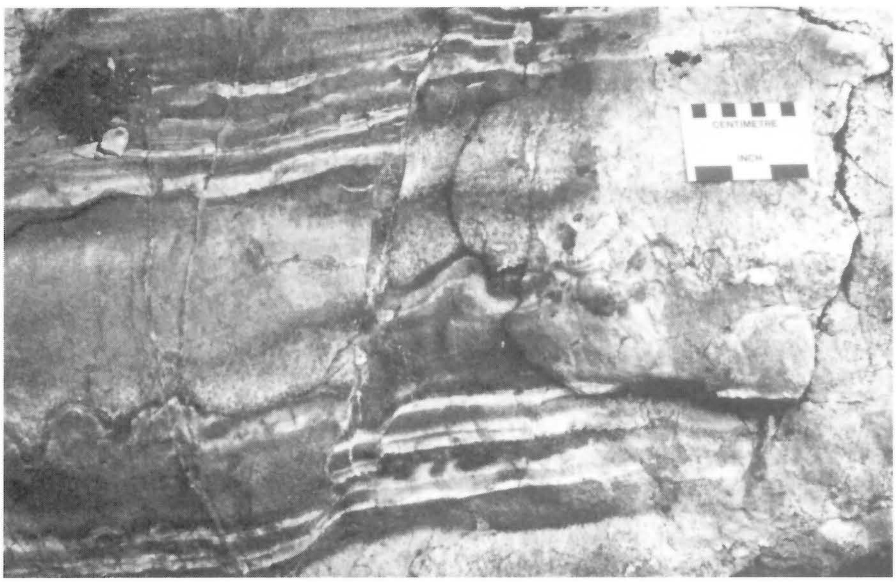


Figure GS-15-4: *Partly silicified mafic volcanic wacke cut by a zone of more completely silicified rocks, 100 m west of Edwards Lake.*

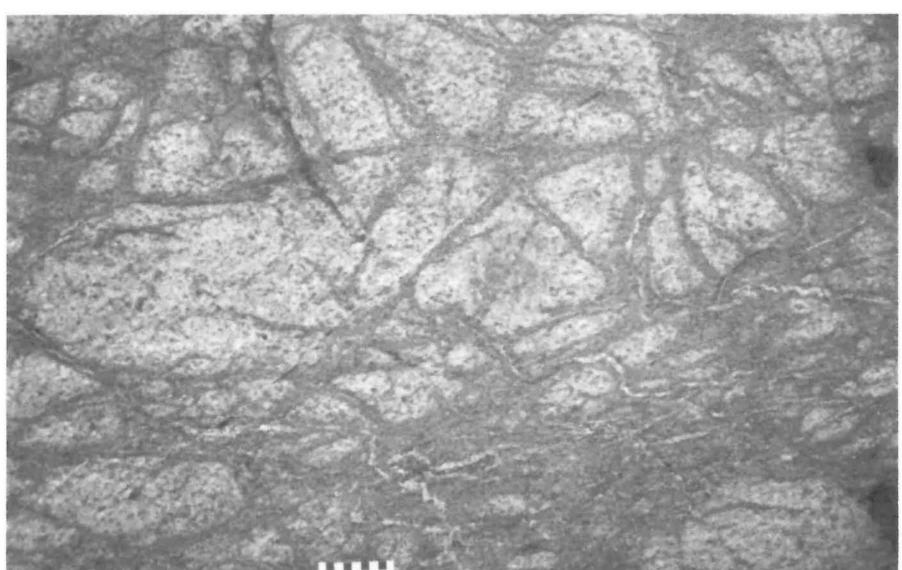


Figure GS-15-5: *Quartz-phyric tonalite, Sneath Lake pluton, cut by an irregular network of chlorite-staurolite-rich altered rocks.*

Harrison (1949) described the quartz-phyric Sneath Lake pluton as a "quartz-eye" granite, because it locally contains large oval quartz phenocrysts up to 2 cm in diameter. Coarsely quartz porphyritic varieties are, however, volumetrically minor; most tonalites contain 2-5 mm quartz phenocrysts in an only slightly finer grained 1-3 mm groundmass. The pluton is composed of numerous different phases of tonalite. This is most evident east of Morgan Lake where three mappable phases have been identified. The phases young to the east, with eastern phases containing xenoliths of those to the west. Tonalite xenoliths and intrusive contacts between different tonalite phases occur also in the main body of the pluton northeast of Bujarski Lake.

Large parts of the Sneath Lake pluton have been altered, largely through the addition of Fe and Mg. The alteration occurs along and adjacent to fractures in a rectilinear grid pattern, and along irregular anastomosing veinlets. Most of the pluton has been metamorphically recrystallized to lower to middle almandine amphibolite facies mineral assemblages, and Fe- and Mg-enriched altered rocks contain distinctive concentrations of chlorite, garnet, amphibole, biotite, and staurolite.

The Richard Lake pluton is texturally similar to the Sneath Lake pluton and, like it, contains Fe-Mg alteration defined by concentrations of chlorite, garnet, actinolite, biotite, and rare staurolite and anthophyllite. The pluton is strongly altered in outcrops near the east shore of Richard Lake, but elsewhere it is relatively unaltered. Towards the north the pluton becomes finer grained and more equigranular.

The Kobar Lake and Woosey Lake plutons are texturally similar to the Richard Lake pluton. They do not normally display the Fe-Mg alteration observed in the Richard or Sneath Lakes plutons, with the exception of a small area, on the extreme southwest corner of the Kobar Lake pluton, which contains an anastomosing network of alteration defined by concentrations of garnet and chlorite. These plutons are tentatively considered to be synvolcanic.

LATE TECTONIC PLUTONS

Late tectonic plutons include the Ham Lake pluton, Bujarski Lake pluton, and plutons west of Epp and Morgan Lakes (Fig. GS-15-1). The Ham Lake pluton is considered late tectonic as it contains xenoliths of folded and foliated Amisk Group rocks, the Bujarski Lake pluton postdates a fault that offsets the Sneath Lake pluton, the pluton between Epp and Woosey Lakes crosscuts a fault on the south shore of Epp Lake, and the plutons west of Morgan Lake are similar to the pluton west of Epp Lake.

The Ham Lake pluton is an equigranular, medium- to coarse-grained granodiorite, leucotonalite and tonalite. Along Parisian Creek the pluton has an irregular and xenolith-rich margin, with large angular inclusions of mafic volcanic and greywacke country rocks up to 300 x 200 m in size. Xenoliths of highly altered and/or rusty weathering volcanic rocks are common. The Ham Lake pluton is either unfoliated or only weakly foliated. On the small lake at the north end of Parisian Creek, the Ham Lake pluton contains strongly foliated xenoliths of the Kobar Lake quartz-phyric tonalite.

The plutons west of Epp and Morgan Lakes are zoned. The one west of Epp Lake has a core of equigranular granodiorite which is surrounded by hornblende-phyric tonalite gradational into an xenolith-rich marginal phase. This pluton has a prominent, well developed, 100 to 500 m wide aureole of contact metamorphism in which country rocks are recrystallized and criss-crossed by a fine-scale network of quartz-plagioclase veinlets. The plutons west of Morgan Lake are similar except that they are smaller and do not have a prominent xenolith-rich margin or metamorphic contact aureole. The Bujarski Lake pluton comprises hornblende-phyric tonalite similar to that in the pluton west of Epp Lake.

HYDROTHERMALLY ALTERED ROCKS

Between 10 and 20% of volcanic rocks in the Chisel-Morgan Lakes area are altered. The alteration includes intense Fe-Mg addition (Froese and Moore, 1978; Walford and Franklin, 1982) and Si-Ca addition (Harrison, 1949; Skirrow, 1985). In the metamorphically recrystallized rocks of the Chisel Lake area, zones of Fe-Mg addition are indicated by rocks with abundant garnet, chlorite, biotite, actinolite, staurolite and/or anthophyllite (Fig. GS-15-6). Zones of Si-Ca addition in mafic rocks comprise leucocratic zones that are characterized by unusually high contents of quartz and/or epidote (Fig. GS-15-4). Zones of Fe-Mg addition are commonly spatially associated with zones of Si-Ca addition, but also occur in areas without silification. Where both occur together, silicification typically predates the Fe-Mg metasomatism. R.G. Skirrow (pers. comm., 1986) has convincingly demonstrated the timing of these alteration events in the Edwards Lake area where he is conducting an M.Sc. thesis research project (Carleton University) on Si-Ca alteration under the supervision of J. Franklin (G.S.C.).

Silicification (Si-Ca addition) occurs widely in the Chisel-Morgan Lakes area. Some of the more prominent zones are:

1) an approximately 500 m wide interval between Stroud and Epp Lakes in aphyric mafic pillowed flows, below their contact with overlying felsic volcaniclastic breccia;
2) a large zone in heterolithic mafic and felsic volcanic breccias between Edwards and Snell Lake (areas of intense silicification are irregular in distribution and typically spatially associated with a small, felsic, quartz-plagioclase-phyric plug north of Stroud Lake and dyke complexes of plagioclase-phyric and aphyric dacite (R.G. Skirrow, pers. comm., 1986);
3) a zone of heterolithic mafic volcanic breccia east of Parisian Creek; and
4) smaller but still significant zones north-northwest of Epp Lake, west of Woosey Lake and on the northeast shore of Morgan Lake.

Silicification occurs in a number of different manners. It occurs adjacent to fractures (Fig. GS-15-7), at point sources (Fig. GS-15-8), as "fronts" that moved from porous interpillow areas into pillows (Fig. GS-15-2) or from porous detrital matrix material into large fragments (Fig. GS-15-9), or as areas marginal to some synvolcanic dykes.

The largest zones of Fe-Mg addition are spatially associated with the more regionally disposed zones of silicification at Snell Lake and along Parisian Creek. Smaller zones of Fe-Mg addition occur east and west of the Snell Lake fault (adjacent to and both north and south of the CNR railway), three-quarters of a kilometer north of Hirst Lake, and southeast of Morgan Lake. In addition, prominent zones of Fe-Mg metasomatism have affected parts of the Sneath Lake, Richard Lake and Kobar Lake(?) synvolcanic plutons.

Intense Fe-Mg alteration is present directly below the Chisel Lake massive Zn-Cu sulphide but not in stratigraphically overlying rocks (Syme et al., 1982). This observation is consistent with the widely accepted view that such alteration is a product of hydrothermal solutions that passed through footwall rocks to deposit massive sulphides at the seawater/sea floor interface. This implies that the more regionally disposed, earlier, and spatially associated zone of silicification between Edwards and Snell Lakes is also synvolcanic, and possibly related to an ore-forming hydrothermal event. Thus, in the Chisel-Morgan Lakes area, zones of silicification as well as zones of Fe-Mg metasomatism, are indicators of areas warranting consideration when targetting exploration programs.

SUMMARY

Field work in 1986 has established a crude stratigraphic framework for volcanic rocks east of the Kobar Lake fault. The mapping program has also demonstrated the probable synvolcanic character of a number of felsic plutons, most notably the Sneath Lake and Richard Lake plutons. In addition, it has documented the distribution and main characteristics of synvolcanic hydrothermal alteration zones. Perhaps the most important, albeit tentative, conclusion of this study is that there may be more than one age of synvolcanic quartz-phyric tonalite. As a corollary to this it must be assumed that associated hydrothermal activity may have spanned a considerable time interval and that volcanogenic massive sulphide deposits may have been deposited over a considerable stratigraphic interval. The presence of massive Zn-Cu sulphide deposits at the base (Pot Lake) and top (Chisel Lake, Lost Lake, Ghost Lake) of the section east of the Kobar Lake fault is consistent with this hypothesis.

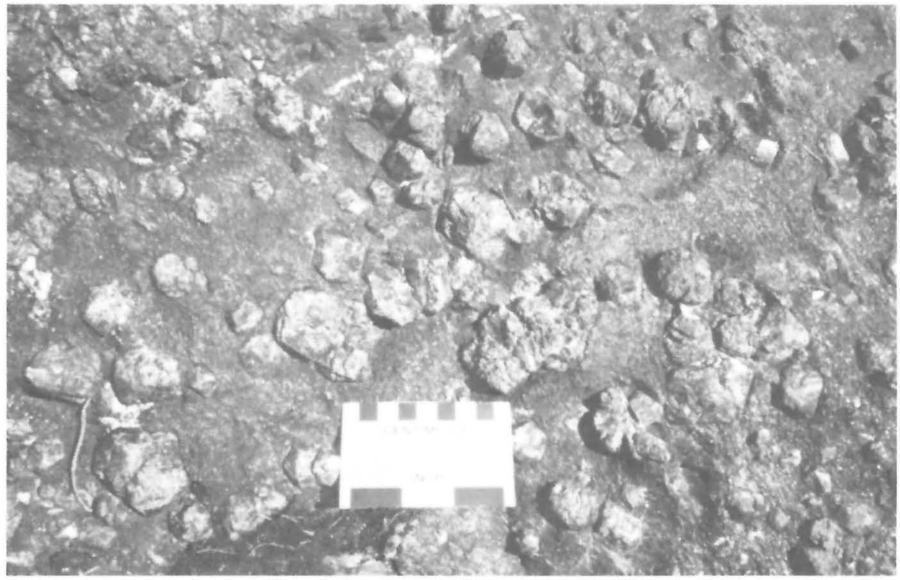


Figure GS-15-6: *Large garnet porphyroblasts in chlorite-biotite-rich altered rock from several metre wide zone cutting silicified volcanic breccias 60 m east of Snell Lake.*

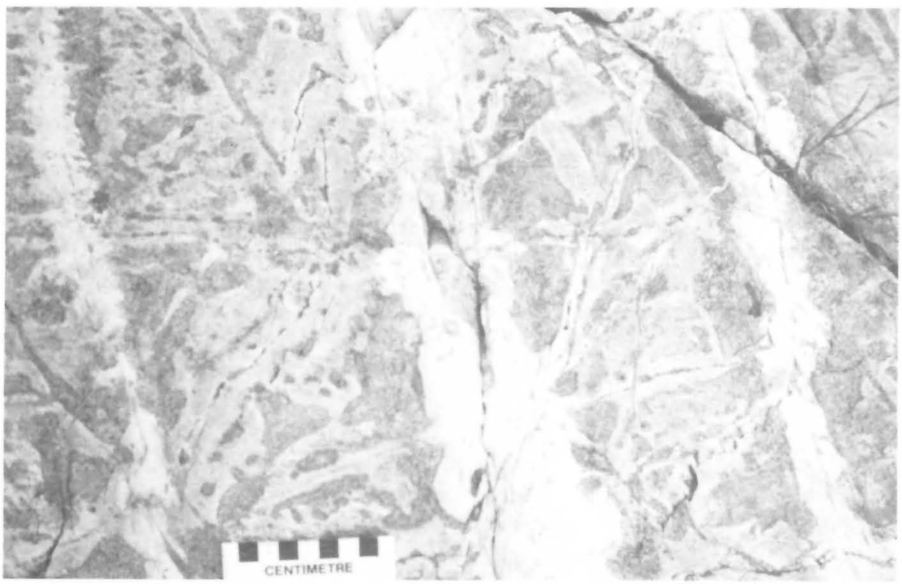


Figure GS-15-7: *Fracture-controlled silicification cutting mafic volcanic wacke 300 m west of Edwards Lake.*

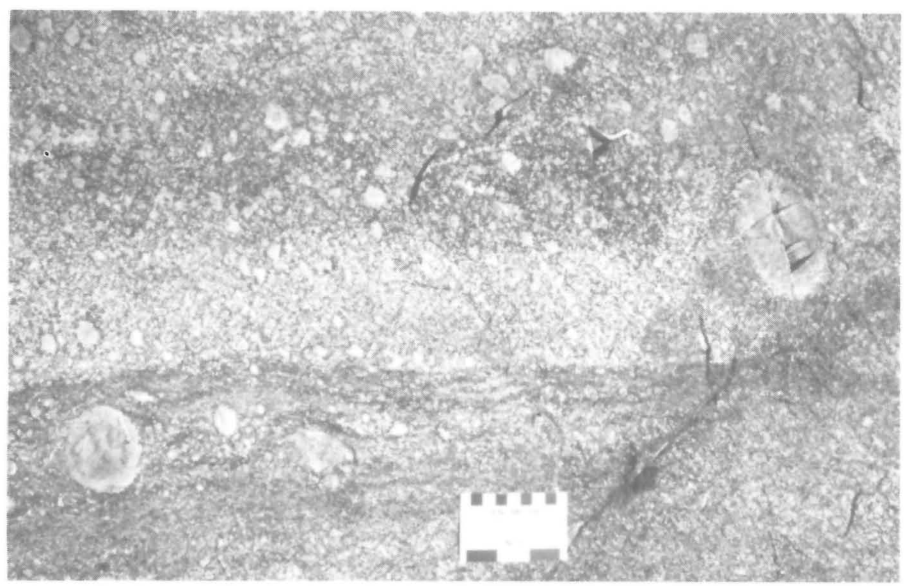
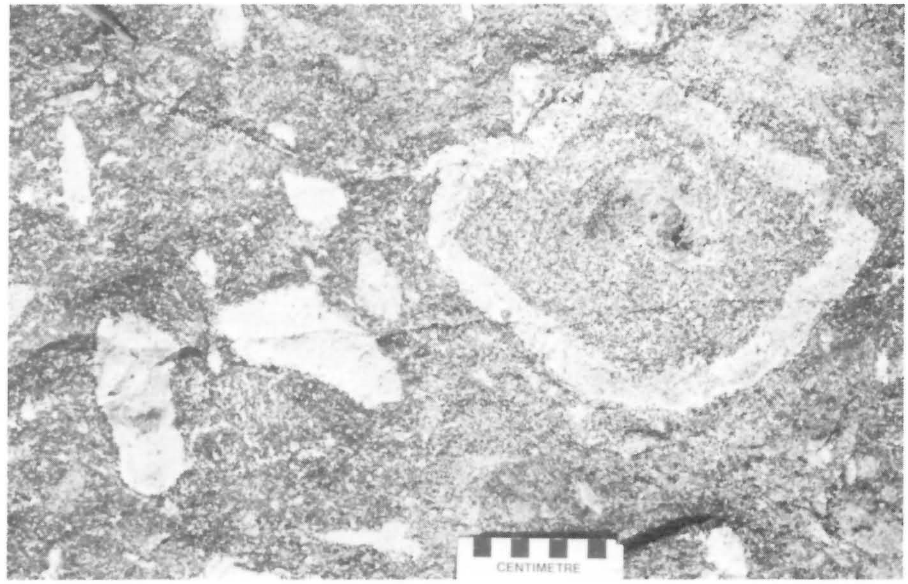


Figure GS-15-8: *Orbicular quartz-feldspar-rich alteration structures in mafic volcanic wacke, 400 m southeast of Snell Lake. Some orbicules contain an epidote-rich core.*

Figure GS-15-9: Altered mafic pillow fragment breccia 1.3 km southwest of the Chisel Lake mine. Fragments are silicified but the matrix is Fe-Mg metasomatized with abundant garnet and amphibole porphyroblasts.



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GS-16 MINERAL DEPOSIT STUDIES IN THE SNOW LAKE AREA

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INTRODUCTION

Mineral deposit studies, commenced in the Snow Lake area in 1984 and 1985, were continued in 1986. A total of 59 mineral occurrences were documented by a combination of detailed trench and outcrop maps and geochemical sampling. This completes the bulk of the data acquisition for preparation of 1:50 000 and local 1:20 000 metallogenetic maps of the Snow Lake area. Detailed (1:5000) mapping around selected mineral occurrences will commence in 1987.

The background geochemical outcrop sampling program was continued, albeit on a reduced scale from the previous field seasons. This program will be completed in 1987 and a mineral deposit open file report containing an approximation of background concentrations of a wide range of trace elements in the major lithologic units of the Snow Lake area will be released. An outcrop and geology map of the vicinity of the Rod Cu-Zn massive sulphide deposit was prepared and a suite of humus and rock samples were collected from the mapping grid. The geochemical samples were collected as close as possible to the sites of the Aurex Cup Hg-gas survey conducted last year (Fedikow, 1985). The rocks and the less than 2 micron size fraction of the humus samples will be submitted for multi-element geochemical analysis including Hg to determine if Hg haloes are present in these sampling media and also to determine whether or not any correlation exists between Hg results for humus, rock and Aurex Cups. The Aurex Cup Hg-gas survey failed to detect Hg-gas haloes associated with mineral deposits in the Snow Lake and Lynn Lake areas. Hg-gas measurements using the Aurex Cup method were found to be non-reproducible.

Mineral occurrences examined this year are plotted on Figures GS-16-1, GS-16-2 and GS-16-3. A summary of their geological characteristics is given in Table GS-16-1. Some interesting features of mineral occurrences examined during this past field season are discussed below.

DION LAKE

Ten days were spent examining mineral occurrences and selected rock units at Dion Lake. The geology of the area is described by Bailes (1985) and his report includes a summary of exploration work in the area as described in cancelled assessment files.

Figure GS-16-2 indicates the mineral occurrences examined and sampled for geochemical analysis in the Dion Lake area. The basic descriptions for these occurrences are summarized in Table GS-16-1. Results of geochemical analyses are available to the public for inspection upon request.

The mineral occurrences in association with siliceous and quartzofeldspathic gneisses (Unit 6) at Dion Lake are characterized by 1-2% disseminated pyrite and rare chalcopyrite and pyrrhotite. The exposures are often rusty weathered although sulphide mineralization may be present in the rock without visible alteration effects. Rusty weathering pods, laminae and layers of biotite-rich material may accompany the sulphides. Coarse grained granitic pegmatites, often rusty weathered, are spatially related to many of the mineral occurrences.

Of particular interest in the Dion Lake area is a unit of interlayered calc-silicate gneiss and amphibolite (Unit 7a) and a unit of coarsely garnetiferous amphibolite (Unit 7b). Both of these units were examined in outcrop over their mapped, areal extent and sulphide mineralization was observed at numerous localities. Units 7a and 7b are described by Bailes (1985); however, more geological details on the units were difficult to obtain because of a cover of black lichen on much of the outcrop. Examination of freshly broken surfaces revealed the presence of zones of silicification in both the calc-silicate and amphibolite with associated 3-5% pyrite ± chalcopyrite. Sulphide mineralization was not observed where these two units are fresh and unaltered. A suite of rock samples was collected for geochemical analysis. Unit 7b occurs in a north-trending series of outcrops approximately 1-1.5 km east of Dion Lake on the western shore of an unnamed lake (Fig. GS-16-2). This sequence comprises massive coarse grained, non-garnetiferous amphibolite interbedded with garnetiferous amphibolite and occasionally rusty weathered quartzofeldspathic layers. The observation by Bailes (1985) of minor (1-2%, locally 4%) but persistent disseminated sulphide mineralization including pyrite and chalcopyrite is corroborated. In addition to the sulphide mineralization, several discrete zones of intense silicification marked by the development of a coarse grained mineral assemblage of 2-3 cm red garnet, biotite, quartz, epidote and pyrite was observed in proximity to some mineral occurrences. Detailed mapping of these zones was hindered by lichen cover. A suite of rock samples was collected from this unit and results will be made available in an open file report.

WEKUSKO LAKE

At mineral occurrence WL-75 (Fig. GS-16-3) near Puella Bay, extensive zones of rusty weathered, pyritic, sheared and graphitic sedimentary rocks (at one locality interlayered with mafic volcanic rocks) were examined for a strike distance of 2000 m. Numerous trenches were mapped and sampled within this altered zone. The trenches expose sheared silicified and bleached greywacke commonly containing 5-7% disseminated pyrite. Rusty weathered, sugary textured quartz-carbonate veins were observed in outcrops of mafic volcanic rocks. A polymetallic quartz vein (sphalerite, galena, chalcopyrite, pyrite) occurs within one of the trenches in the area and represents the only known occurrence of base metal mineralization observed to date in this zone. Muck from around some of the trenches contains disseminated flakes of graphite and cobble-sized fragments of interlayered massive graphite and chert. In addition, a boulder of banded hematite was discovered in proximity to these workings although it is uncertain whether the boulder is an erratic or a representative portion of the stratigraphy. The combination of sheared, pyritic greywacke, polymetallic quartz veins and chemical sedimentary rocks interlayered with altered mafic volcanic rocks cut by rusty weathered quartz carbonate veins and gabbroic intrusions represents a unique metallogenetic environment. Detailed mapping will be commenced on this property in 1987.

NIBLOCK LAKE AREA

West of the south end of Niblock Lake three mineral occurrences originally recorded by Frarey (1950) were examined. The occurrences are within Unit 2, predominantly mafic volcanic rocks with minor intercalated sedimentary rocks, and have been interpreted as Amisk Group. The host rocks to these occurrences (MH-104, MH-105, BG-122 in Fig. GS-16-3) are characterized by fine- to medium-grained massive basalt. At the mineralized localities an approximate N20°E structure is represented by rusty quartz veins that contain disseminated to solid sulphide layers, up to 25 cm thick, of coarse grained (3-20 mm) arsenopyrite with very minor pyrite, chalcopyrite and pyrrhotite. At mineral occurrence MH-104 the N20°E quartz veins are barren and the arsenopyrite mineralization occurs in later quartz-carbonate veins(?). The relationship to the N20°E quartz veins is difficult to ascertain as the trenches are caved-in or flooded and this style of mineralization was observed only in the muck adjacent to the trenches. At occurrence BG-122 solid sulphide boulders of

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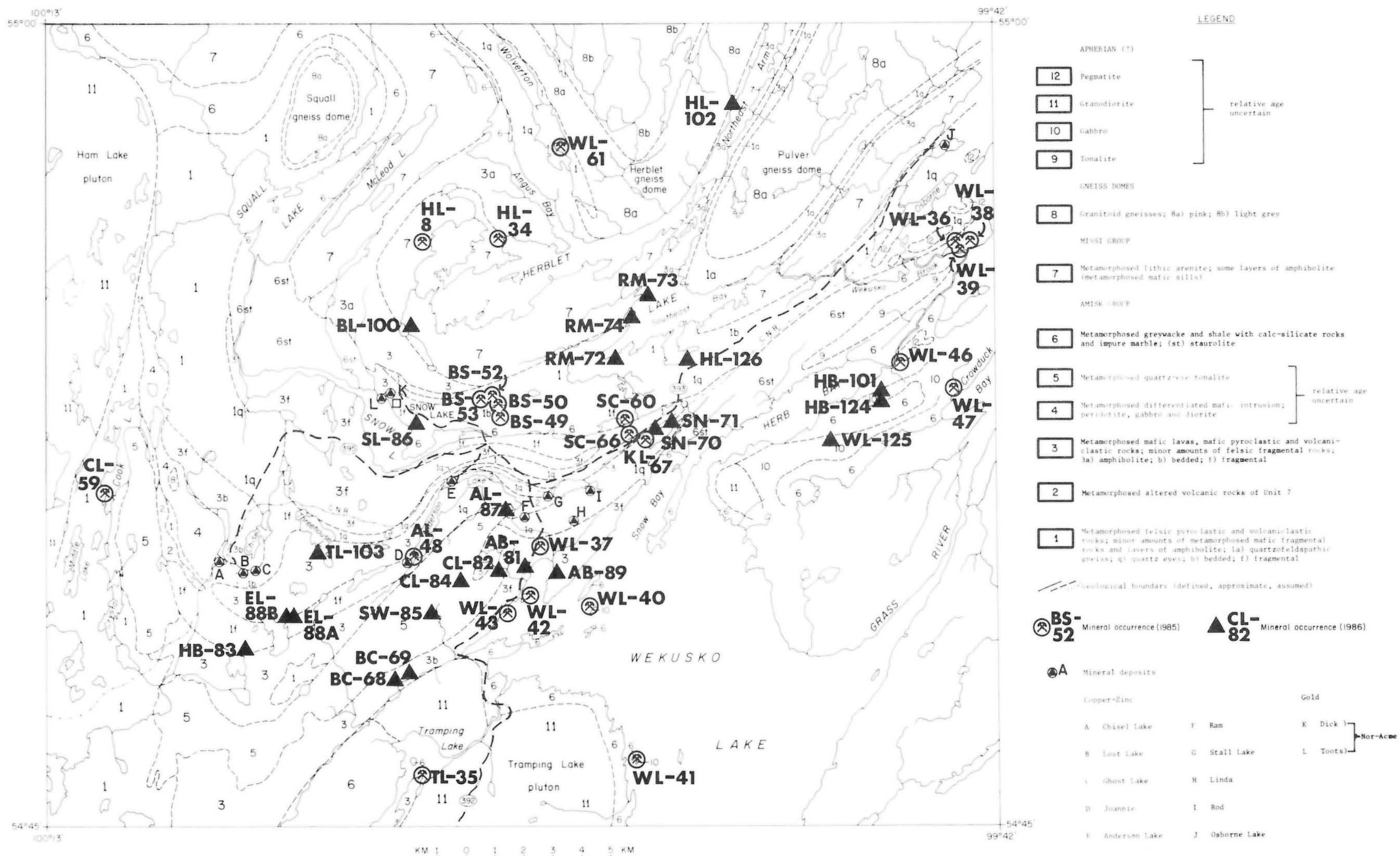

Figure GS-16-1: *Mineral occurrences examined in the Herblet Lake-Wekusko Lake-Cook Lake area, 1985 and 1986. Geology after Froese and Moore (1980).*

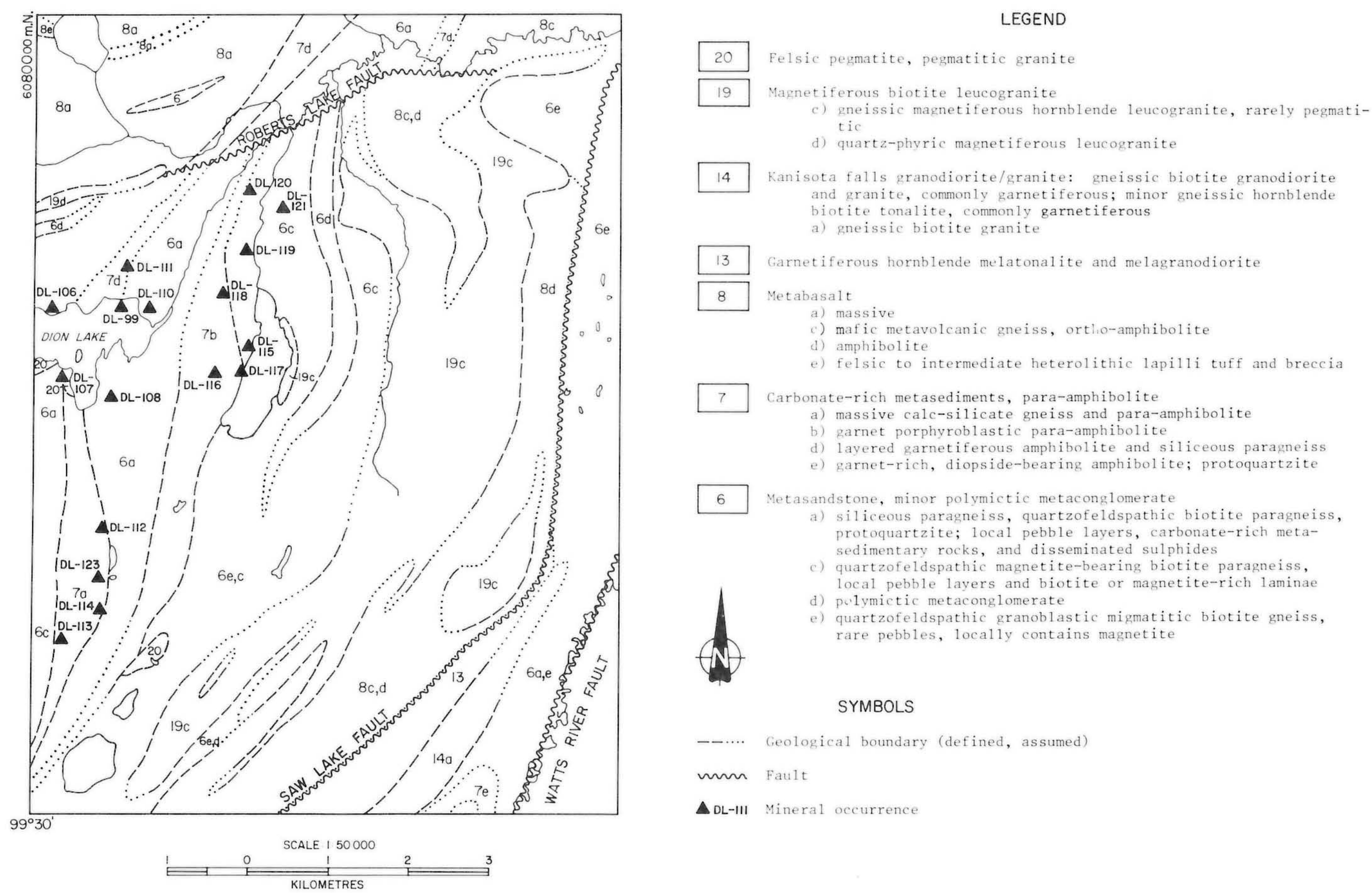

Figure GS-16-2: Mineral occurrences examined in the Dion Lake area, 1986. Geology after Bailes and Malyon, 1976 (Map GR83-1).

pyrrhotite-chalcopyrite, associated with arsenopyrite-pyrite bearing quartz veins, were observed in the muck along with blocks of altered basalt now comprised of garnet-chloritebiotite and garnet-anthophyllite(?) mineral assemblages. The host basalt is also silicified adjacent to the quartz veins and locally appears to overprint an earlier predominantly garnetiferous alteration.

The similarity between the occurrences in wallrock alteration, mineralization and north-trending structural character indicates that a metallogenetically significant structure is responsible for the development of these arsenic-rich mineral occurrences. Detailed geological mapping in the vicinity of the occurrences is difficult owing to dense, black lichen cover.

The interpretation of these basaltic rocks as Amisk Group, their subaqueous deposition (Frarey, 1950) and the recognition of one consistent style of mineralization indicates the potential for economically viable mineralization in these rocks.

BURNS LAKE

A polymetallic quartz vein exposed by multiple trenches (BL-96; Fig. GS-16-3) northwest of Burns Lake was examined. The vein is hosted by arkose that is rusty weathered in outcrop and silicified to a cherty rock adjacent to the vein. The vein contains disseminated grains, veinlets and blebs of galena, sphalerite, chalcopyrite, arsenopyrite and pyrite. Immediately south of this occurrence at the edge of a swamp a rusty weathered amphibolite (basalt?) was mapped. This unit contains pyrite, pyrrhotite $\pm$ chalcopyrite but due to overburden cover its relationship to the polymetallic quartz vein is unknown.

SUMMARY

The occurrence of polymetallic quartz veins within or in proximity to mafic volcanic rock sequences containing Cu-Zn massive sulphide deposits has been observed for some time in the Snow Lake camp (e.g., Pin Occurrence — KL-67, Rod Cu-Zn). This spatial relationship has suggested to some that the occurrence may represent a type of "leakage" or "sweat-out" alteration phenomena related to a nearby base metal massive sulphide deposit. Although this theory is tenuous and unproven it represents a prospecting tool for the area. In light of this observation the mineral occurrences at Wekusko Lake (WL-75) and Burns Lake (BL-96) will be examined more closely in 1987. Further, inasmuch as arsenic is an important mineralogical and chemical component of some Snow Lake massive sulphide deposits, the abundant arsenopyrite vein systems hosted by Amisk Group mafic volcanic rocks in the Niblock Lake area also deserve further attention.

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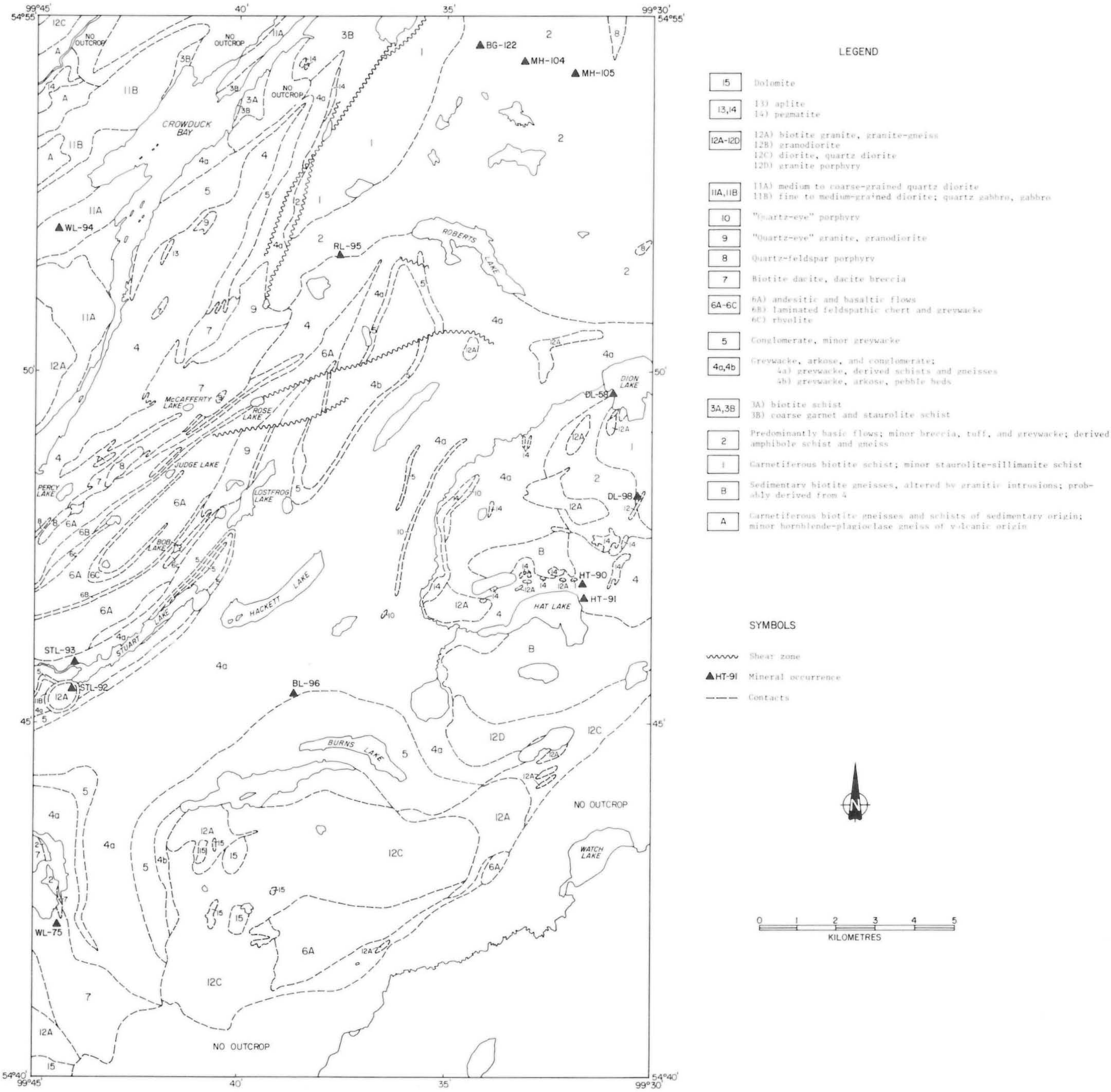

Figure GS-16-3: Mineral occurrences examined in the Crowduck Bay area, 1986. Geology after Frarey, 1950 (Map 987A).

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TABLE GS-16-1
SUMMARY OF THE GEOLOGICAL CHARACTERISTICS OF MINERAL OCCURRENCES EXAMINED IN THE SNOW LAKE AND LYNN LAKE AREAS, 1986

Locality Designation	Type of Occurrence	Nature of Mineralization	Host Rock Description	Comments/ Reference
WEKUSKO LAKE				
BC-68 (Berry Creek)	sulphide stratum; outcrop	disseminated pyrrhotite, pyrite and chalcopyrite	porphyritic and fine grained aphyric andesite	CAF #91514
BC-69 (Berry Creek)	sulphide stratum; outcrop	disseminated pyrite, chalcopyrite and pyrrhotite	porphyritic and fine grained aphyric andesite	CAF #91514
WL-75 (Vic. Puella Bay)	sulphide stratum, outcrop, quartz veins multiple trenches	disseminated sphalerite, pyrite and chalcopyrite in quartz veins, disseminated pyrite, sphalerite, galena, chalcopyrite in greywacke host rock	silicified, rusty weathered sheared and bleached greywacke	Mineral Inventory Card "PYR 1" interlayered graphite-chert and extensive alteration, limits of mineralization and alteration undefined
WL-76 (southeast shore)	quartz vein; outcrop	disseminated pyrite	rusty weathered quartz vein in granite	silicification at vein/granite contact (not plotted)
WL-77 (southeast shore)	quartz vein; outcrop	disseminated pyrite	rusty weathered quartz vein in granite	(not plotted)
WL-78 (southeast shore)	quartz vein; outcrop	disseminated pyrite, malachite stain	rusty weathered quartz vein in granite	Mineral Inventory "Au3" (not plotted)
WL-79 (southeast shore)	quartz vein; two trenches: 5 x 2 x 1 m 1 x 1 x 1 m	disseminated pyrite in quartz vein; blebs pyrite at vein granite contact	rusty weathered quartz veins in granite	Mineral Inventory "Au2" (not plotted)
AB-81 (northwest Anderson Bay)	sulphide stratum; quartz vein	disseminated chalcopyrite pyrrhotite and pyrite	silicified fragmental andesite	CAF #91514
SW-85 (northeast Berry Creek area)	intrusion-outcrop; quartz vein	disseminated chalcopyrite and pyrite in intrusion; disseminated magnetite in quartz vein	quartz-eye granite cut by intermediate and mafic dykes	CAF #91415 Berry Creek Fault
AB-89 (Anderson Bay)	outcrop	disseminated pyrrhotite, pyrite and chalcopyrite with malachite stain	in part silicified mafic volcaniclastic sedimentary rock	CAF #91415
WL-94 (Crowduck Bay)	outcrop, quartz veins	disseminated arsenopyrite, pyrite and chalcopyrite; 3-7 mm arsenopyrite crystals at vein/wallrock contact	rusty weathered and silicified quartz diorite	Frarey (1950) Map 987A
MBC-97 (Manitoba Basin Creek)	outcrop, quartz veins, multiple trenches	near solid to solid sphalerite, chalcopyrite, arsenopyrite, pyrite in muck	rusty weathered, sheared silicified and Mg-altered felsic volcanic rocks(?)	M. Evans (Not plotted)
HB-101	intrusion-outcrop	disseminated pyrrhotite, chalcopyrite and pyrite	rusty weathered quartz gabbro	CAF #92290
WL-124 (Herb Bay)	outcrop, multiple trenches	disseminated pyrrhotite, chalcopyrite, pyrite	rusty weathered quartz gabbro	

TABLE GS-16-1 (Cont'd)

Locality Designation	Type of Occurrence	Nature of Mineralization	Host Rock Description	Comments/ Reference
WL-125	outcrop	disseminated sulphide mineralization	quartz gabbro	not located
WL-127 (Herb Bay)	outcrop, trenches	disseminated pyrrhotite, chalcopyrite and pyrite	quartz gabbro	CAF #92290
DION LAKE				
DL-58	outcrop, trenches, drill core	yellow uranium oxide on outcrop and occasional grain pyrite; solid sulphide pyrrhotite in drill core	rusty weathered pegmatite, greywacke and mafic volcanic rocks	A.L. Parres (Flin Flon)
DL-98	outcrop, quartz vein, 1 trench: 1 x 1 x 1 m 1 shaft of undefined depth-flooded	disseminated pyrite and chalcopyrite as grains, blebs and fracture coatings	garnetiferous amphibolite altered to anthophyllite-quartz-garnet assemblage	Frarey (1950) Map 987A
DL-99	outcrop-sulphide stratum	disseminated pyrite and pyrrhotite	silicified, rusty weathered micaceous gneiss	Bailes (1985)
DL-106	outcrop-sulphide stratum	disseminated pyrite	rusty weathered micaceous gneiss intruded by pegmatite	Bailes (1985)
DL-107	outcrop-sulphide stratum	disseminated pyrite	rusty weathered siliceous garnetiferous gneiss intruded by pegmatite	Bailes (1985)
DL-108	outcrop-sulphide stratum	disseminated pyrite	rusty weathered "rotten" and siliceous gneiss	Bailes (1985)
DL-109	outcrop-sulphide stratum, 1 shallow and partially filled trench 1 x 1 x 1 m	disseminated pyrite	rusty weathered and and siliceous gneiss; locally abundant biotite	Bailes (1985)
DL-110	outcrop-sulphide stratum	disseminated pyrite	rusty weathered siliceous gneiss; locally abundant biotite	Bailes (1985)
DL-111	outcrop-sulphide stratum	disseminated pyrite adjacent to 5 mm wide translucent quartz veins	rusty weathering; brick-red siliceous gneiss intruded by pegmatite	Bailes (1985)
DL-112	outcrop-sulphide stratum	disseminated pyrite	rusty weathering and silicified amphibolite	Bailes (1985)
DL-113	outcrop-sulphide stratum	disseminated pyrite	silicified calc-silicate	Bailes (1985)
DL-114	outcrop-sulphide stratum	disseminated pyrite	silicified calc-silicate	Bailes (1985)
DL-115	outcrop-sulphide stratum	disseminated pyrrhotite and chalcopyrite	rusty weathered and silicified garnetiferous amphibolite	Bailes (1985)

TABLE GS-16-1 (Cont'd)

Locality Designation	Type of Occurrence	Nature of Mineralization	Host Rock Description	Comments/ Reference
DL-116	outcrop-sulphide stratum	disseminated pyrrhotite and chalcopyrite	rusty weathered and silicified garnetiferous amphibolite	Bailes (1985)
DL-117	outcrop-sulphide stratum	disseminated pyrrhotite	rusty weathered and silicified garnetiferous amphibolite	Bailes (1985)
DL-118	outcrop-sulphide stratum	disseminated chalcopyrite and pyrite	garnetiferous amphibolite cut by quartz and carbonate veins	Bailes (1985)
DL-119	outcrop-sulphide stratum	disseminated chalcopyrite and pyrite	silicified garnetiferous amphibolite, minor rusty weathered patches	Bailes (1985)
DL-120	outcrop-sulphide stratum	no visible sulphide	silicified quartzite with rust along fratures	Bailes (1985)
DL-121	outcrop-sulphide stratum	disseminated chalcopyrite and pyrite	silicified quartzite	Bailes (1985)
DL-123	angular float	disseminated pyrite	rusty weathered calc-silicate gneiss	Bailes (1985) Unit 7a
HERBLET LAKE				
RM-72 (Southeast Bay DDH-134)	drill core-sulphide stratum and quartz veins	disseminated pyrite in core	fine grained quartz-hornblende-biotite gneiss	CAF #90156
RM-73 (Southeast Bay DDH-242)	drill core-sulphide stratum and quartz veins	disseminated pyrrhotite, chalcopyrite and pyrite in core	quartz-hornblende-biotite gneiss	CAF #90156
RM-74 (Southeast Bay, DDH-227)	drill core, intrusion	disseminated pyrite and pyrrhotite	gabbro	CAF #90156
HL-102 (Northeast Arm)	quartz veins and sulphide stratum, 1 shaft and 19 trenches	disseminated pyrite, chalcopyrite and pyrrhotite in wallrock and quartz veins; near solid pyrite over 2-5 cm in veins	amphibolite, probably basalt	S. Rodziewicz (Snow Lake)
HL-126 (Whitefish Bay Landing)	outcrop-sulphide stratum	disseminated pyrite and pyrrhotite	silicified andesite/ basalt	Russell (1955) Map 55-3
SN-70 (DDH-206)	drill core-sulphide stratum and quartz	disseminated pyrite with graphite	fragmental and tuffaceous andesite	CAF #90122A
SN-71 (DDH-55)	drill core-sulphide stratum	disseminated pyrite	rusty weathered fragmental andesite	CAF #90122A
HAT LAKE				
HT-90	outcrop-sulphide stratum	disseminated pyrite and pyrrhotite	biotite greywacke	Frarey (1950) Map 987A
HT-91	outcrop-sulphide stratum	disseminated pyrite	rusty weathered and fractured greywacke with pegmatite dykes	

TABLE GS-16-1 (Cont'd)

Locality Designation	Type of Occurrence	Nature of Mineralization	Host Rock Description	Comments/ Reference
STUART LAKE				
STL-92	outcrop and quartz veins, 2 trenches: 2 x 1 x 1 m 12 x 1 x 1 m	disseminated, veinlet and bleb pyrite and arsenopyrite	silicified biotite granite	Frarey (1950) Map 987A; Mineral Inventory Card "Sn 1"
STL-93	outcrop	disseminated pyrite	rusty weathered, silicified, carbonate altered and fractured greywacke	
ROBERTS LAKE				
RL-95	outcrop and quartz veins	disseminated pyrite	rusty weathered, schistose basalt	Frarey (1950) Unit 2
UNNAMED LAKE				
CL-82	outcrop-sulphide stratum	disseminated chalcopyrite and pyrite	silicified garnet-chlorite schist with rusty patches	CAF #91514
CL-84	outcrop-sulphide stratum	disseminated chalcopyrite, pyrite and pyrrhotite	silicified, chloritic basalt	CAF #91514
HUB LAKE				
HB-83	outcrop-sulphide stratum and intrusion, 7 trenches	disseminated pyrite	quartz-eye granite cut cut by mafic dykes, fragmental volcanic rocks	Mineral Inventory Card "PYR 1"
UNNAMED LAKE				
MH-104	outcrop, quartz veins, multiple trenches	disseminated 3-10 mm arsenopyrite crystals in quartz-carbonate veins and in wallrock, minor disseminated pyrrhotite	fine to medium grained basalt altered to rusty weathered, silicified and garnetiferous basalt adjacent to veins	Frarey (1950) Map 987A
MH-105	outcrop, quartz veins, multiple trenches	disseminated 3-15 mm arsenopyrite crystals forming solid sulphide aggregates within quartz veins and at contact of quartz vein and wallrock	silicified, bleached and garnetiferous fine grained basalt	Frarey (1950) Map 987A
UNNAMED LAKE				
BG-122	outcrop, quartz veins, sulphide stratum, 3 trenches	near solid to solid pyrrhotite and chalcopyrite in wallrock; disseminated 3-10 mm arsenopyrite crystals in sugary textured quartz veins; disseminated and veinlet pyrite and arsenopyrite in grey, fine grained sheared quartz veins	fine grained basalt altered to garnet-biotite-chlorite and and garnet-anthophyllite assemblages	Frarey (1950) Map 987A
BURNS LAKE				
BL-96	outcrop, sulphide stratum, 4 trenches	disseminated, veinlet and bleb galena, sphalerite arsenopyrite, chalcopyrite and pyrite	rusty weathered and silicified greywacke with biotite clots	Frarey (1950) Map 987A

TABLE GS-16-1 (Cont'd)

Locality Designation	Type of Occurrence	Nature of Mineralization	Host Rock Description	Comments/ Reference
SNOW LAKE				
SL-86	outcrop, sulphide stratum, 2 caved and filled trenches	disseminated arsenopyrite and pyrite	siliceous, cherty sedimentary rocks	Mineral Inventory Card "Au 18"
ANDERSON LAKE				
AL-87	outcrop, sulphide stratum, quartz veins	disseminated pyrite, chalcopyrite and pyrrhotite	silicified mafic taffaceous volcanic rocks	CAF #91514
EDWARDS LAKE				
EL-88	outcrop, sulphide stratum	disseminated pyrite	silicified basalt and felsic volcanic rocks	Mineral Inventory Card "Au 5" not located
BIRCH LAKE				
BL-100	outcrop, sulphide stratum, quartz veins	disseminated chalcopyrite and pyrite	greywacke, ultramafic intrusion	Mineral Inventory Card "Au 13" not located
THREEHOUSE LAKE				
TL-103	outcrop, sulphide stratum, quartz veins, 3 trenches	disseminated pyrite, pyrrhotite and magnetite, visible gold	amygdaloidal and pillowed basalt	Mineral Inventory Card "Au 12"
SPIDER LAKE - LYNN LAKE AREA				
SL-80 (south shore)	outcrop, sulphide stratum	disseminated pyrite	siliceous to cherty sedimentary rock within felsic, pyroclastic volcanic rocks	

GS-17 EVALUATION OF INDUSTRIAL MINERAL OCCURRENCES IN THE FLIN FLON-SNOW LAKE AREA

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

INTRODUCTION

A detailed examination of the garnet-anthophyllite unit in the Star Lake area, east of Sherridon, was carried out to investigate the stratigraphy, structural relationships and chemistry of this rock unit. A rock saw was used to cut sections within the unit for analysis, and a detailed map was constructed for that portion of the garnet-anthophyllite unit directly south of Star Lake (Fig. GS-17-1).

Occurrences of talc within the Iskwasum Lake ultramafic complex were examined and samples of the talc-rich units were collected to determine the percentage of talc, carbonate, iron oxide and the grain size distribution of the talc particles (Fig. GS-17-1).

An investigation was initiated to determine the presence of kaolin in outcrops of paleoweathered basement adjacent to the Paleozoic carbonate rocks in the Snow Lake-Cranberry Portage area (Fig. GS-17-1). Dolomite quarries along Highway 10 and P.R. 391 in the Cranberry Portage-Snow Lake area were examined as potential sources for building stone (Fig. GS-17-1).

STAR LAKE GARNET-ANTHOPHYLLITE

Occurrences of abundant garnet and sillimanite in the "Cordierite-Anthophyllite" rock of Froese and Goetz (1981), were investigated briefly by Gunter and Yamada (1985). A detailed map was prepared of a section of this unit, approximately 500 m long, extending from the south shore of Star Lake towards Wapu Lake (Fig. GS-17-2). A rock saw was used to obtain cut sections at selected sites.

The sillimanite, originally found in only one location (Gunter and

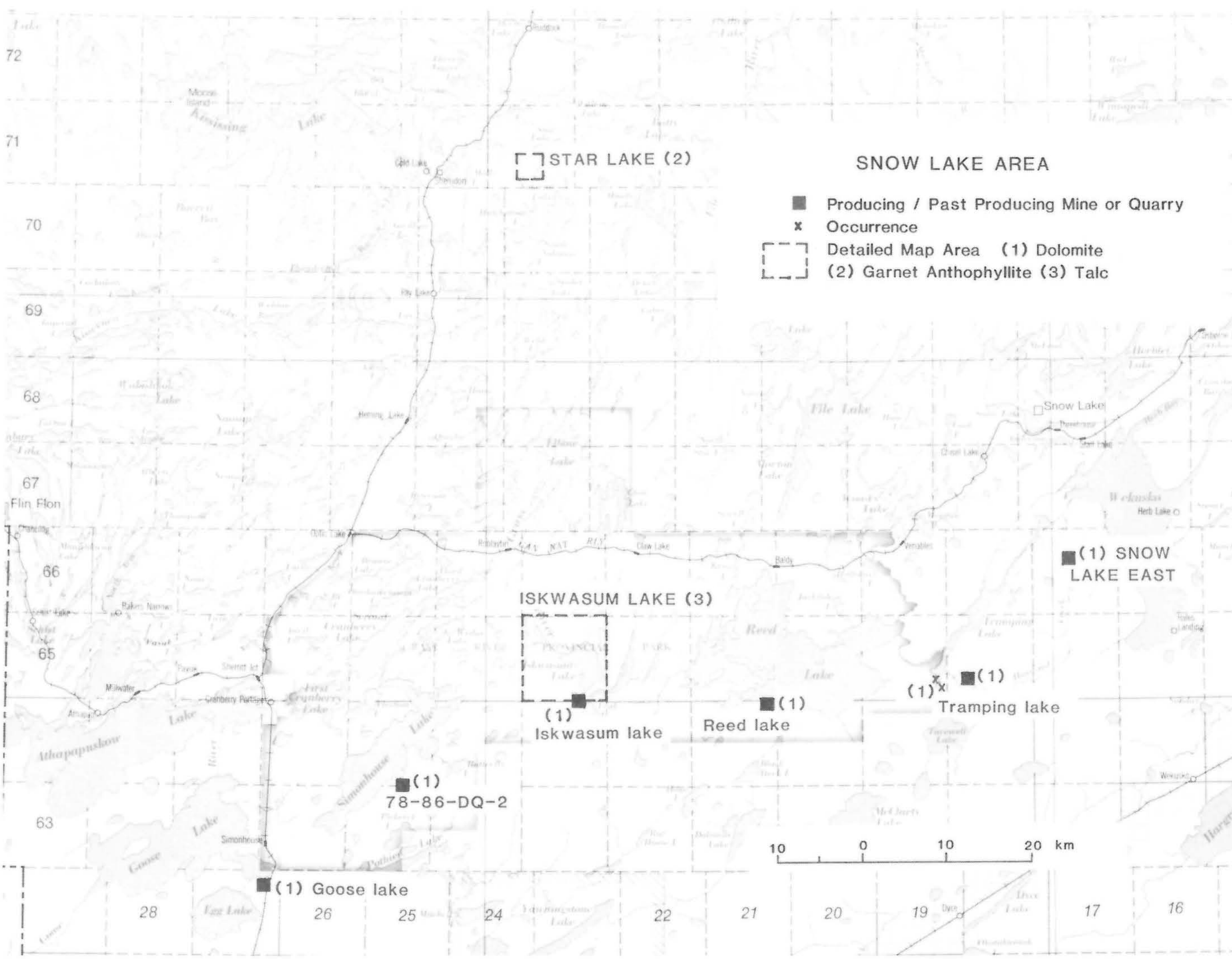

Figure GS-17-1: Industrial mineral occurrences in the Flin Flon-Snow Lake area. See Table GS-17-1.

Yamada, 1985), occurs at six and possibly seven locations within the area mapped. The concentration of sillimanite appears to be highest at the contact between the anthophyllite-bearing unit and a potassium feldspar-bearing unit.

Three mappable units have been recognized within the garnet-anthophyllite rock. These units are, from the structural base upwards: Unit 1 — quartz-garnet-anthophyllite-biotite; Unit 2 — garnet-anthophyllite ± cordierite; Unit 3 — anthophyllite-cordierite. The upper contact with a quartz-biotite gneiss is conformable and has been exposed at several localities. Elongation of the anthophyllite is parallel to the bedding-like concentrations of biotite within the gneiss. At one locality Units 1, 2 and 3 and the upper gneiss unit form a continuous exposure. At this locality the lineations of the quartz pods and garnets in Unit 1 and the garnets in Unit 2 are also parallel to the gneiss contact. These lineations can be used, therefore, as a layering surface in mapping the garnet-anthophyllite rock. Both the lower and upper contacts of units 2 and 3 are transitional over 1 to 3 m intervals and are also conformable with the garnet and anthophyllite lineations. The garnet-rich areas of Unit 2 (Fig. GS-17-3) and the Unit 1/Unit 2 sillimanite-rich contact (Fig. GS-17-4) appear to be stratiform; however, the intense structural complexity of the rocks in this area makes predictions of volume very difficult.

A possible metamorphic reaction for the production of the sillimanite layer is envisaged as the dealkalization of potassium feldspar, present in unit 1 during partial melting segregations by reactions with the anthophyllite-gedrite in unit 2. The idealized reaction is represented as:

$$\underset{\text{ferro-gedrite}}{4Fe_5Al_4Si_6O_{22}(OH)_2} + \underset{\text{potassium feldspar}}{4KAlSi_3O_8} \longrightarrow \underset{\text{biotite}}{4KFe_3AlSi_3O_{10}(OH)_2} +$$

$$\underset{\text{sillimanite}}{Al_2SiO_5} + \underset{\text{almandine}}{4Fe_3Al_2Si_3O_7} + \underset{\text{quartz}}{8SiO_2} + \underset{\text{hematite}}{2Fe_2O_3} + 5O_2$$

This reaction probably occurred late in the metamorphic history, after partial melting had started. This is an amphibole-consuming, garnet-generating reaction and would lead to the largest bodies of sillimanite occurring beneath the more amphibole-rich basal sections of unit 2.

Despite intense regional deformation the garnet-anthophyllite rock was recrystallized under static stress conditions as evidenced by the stellated aggregates of anthophyllite (Fig. GS-17-5). The absence of staurolite and biotite from Units 2 and 3 is probably a function of the original composition that resulted in a chlorite-garnet-cummingtonite assemblage

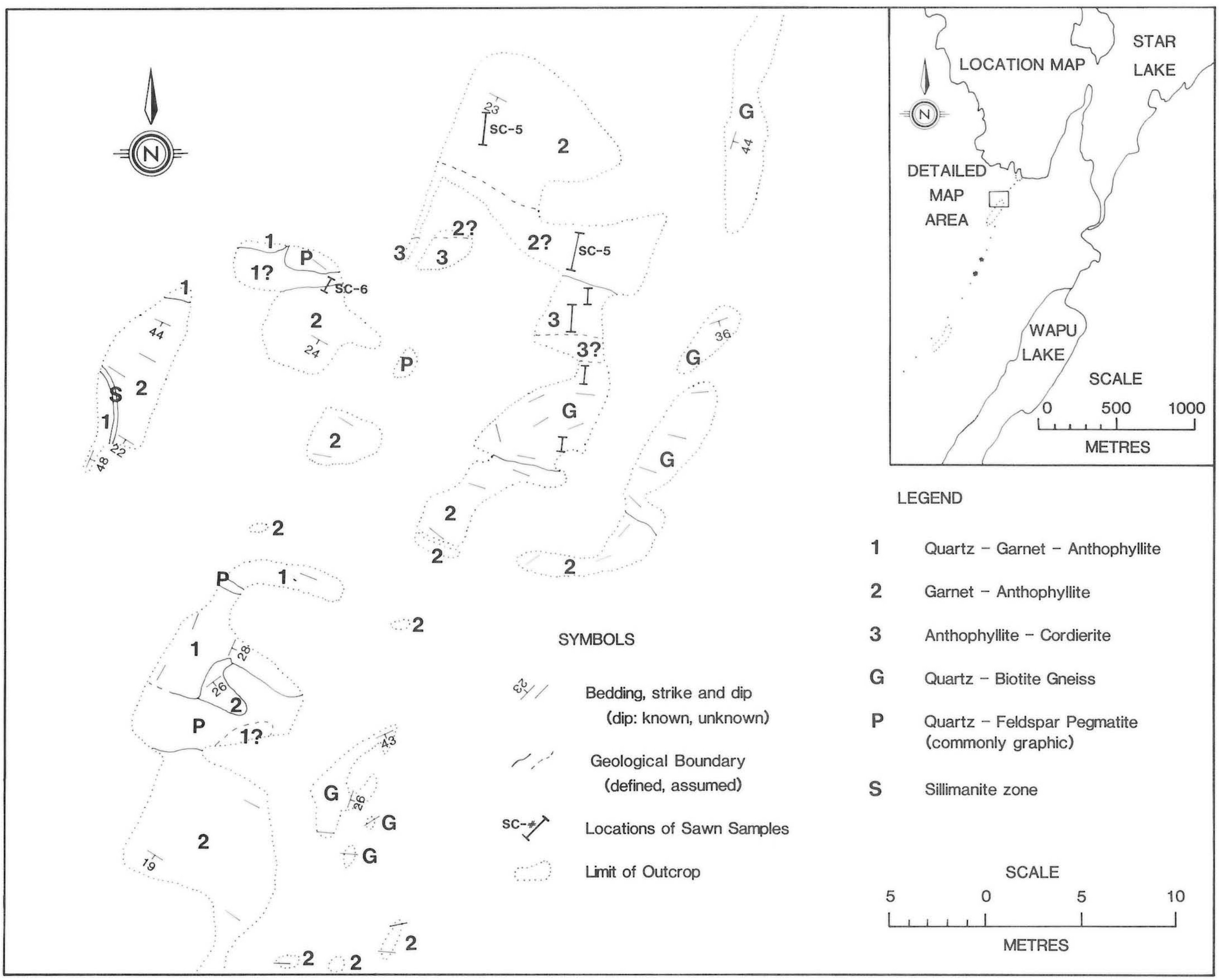

Figure GS-17-2: Portion of Star Lake garnet-anthophyllite.

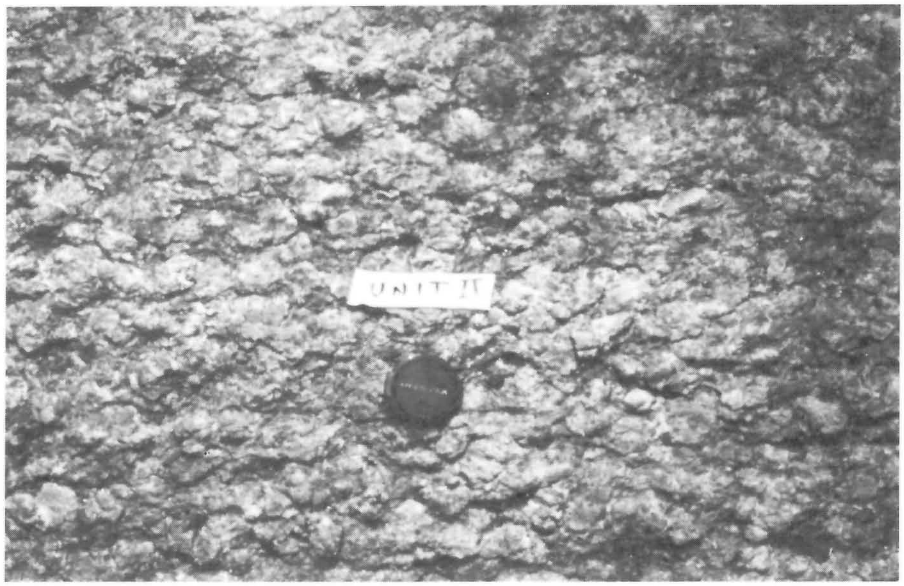

Figure GS-17-3: *Star Lake garnets, unit 2.*

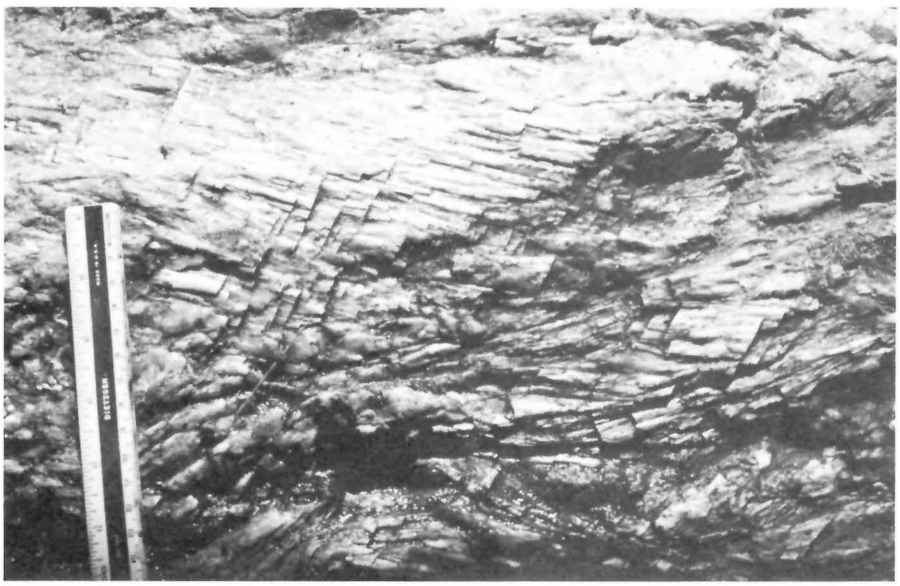

Figure GS-17-4: *Star Lake sillimanite.*

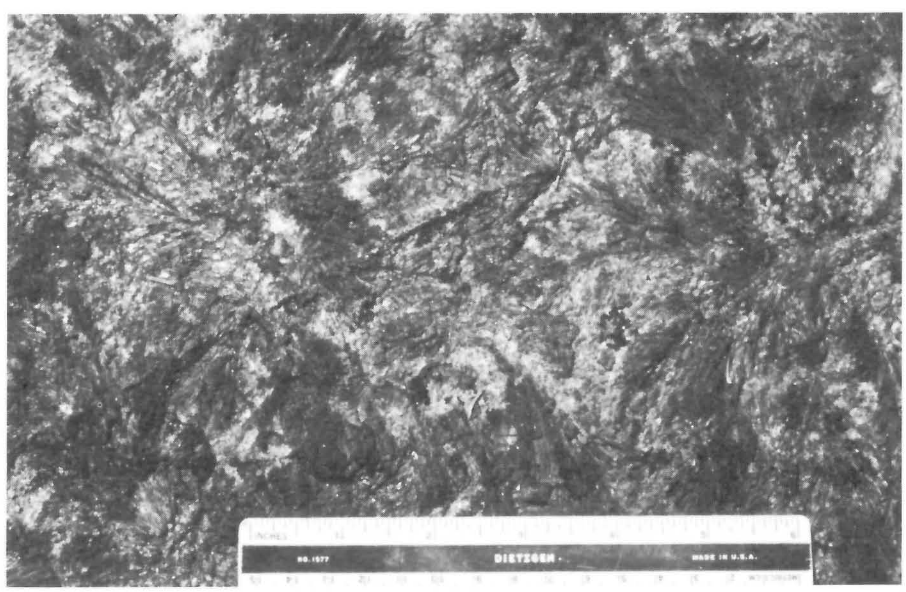

Figure GS-17-5: *Star Lake anthophyllite sprays, unit 3.*

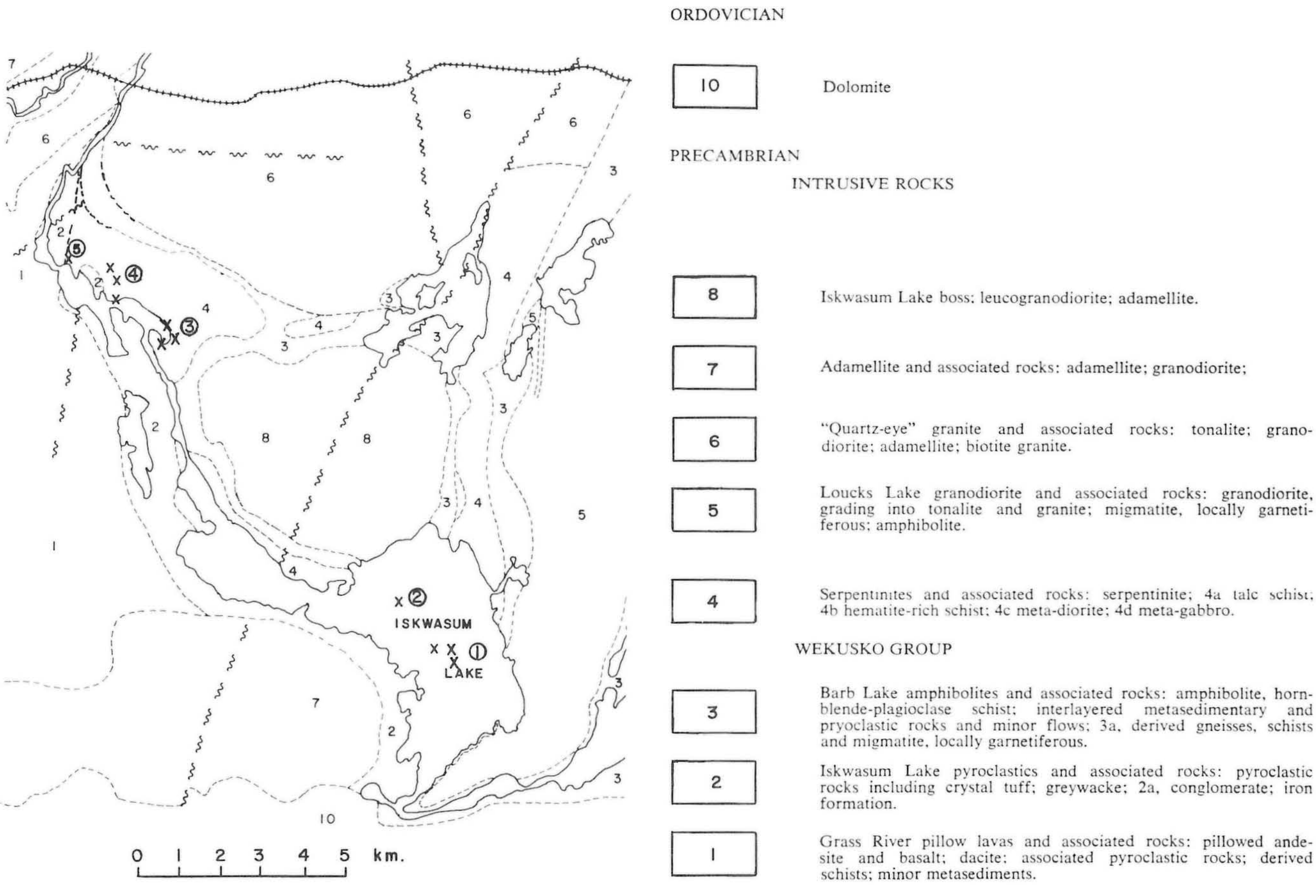

Figure GS-17-6: Talc occurrences on Iskwasum Lake (geology simplified after Hunt, 1970).

(E. Froese, in: Bailes and McRitchie, 1978). The garnet-anthophyllite assemblage could have been derived from the reaction:

chlorite + garnet + cummingtonite ⟶ anthophyllite + quartz + H_2O
(Bailes and McRitchie, 1978)

A zone of large euhedral crystals in the upper portion of Unit 1 is composed of diffusely bounded aggregates of potassium feldspar-quartz-biotite-cordierite-garnet-tourmaline. The recrystallized garnet and cordierite are euhedral and non-poikilitic in contrast to the quartz-garnet and quartz-cordierite aggregates which form the majority of the crystals in this assemblage. Sharply bounded quartz-feldspar pegmatites fill tension fractures.

A Master's thesis is being undertaken at the University of Manitoba to study the mineralogy of the garnet-anthophyllite rock in the Star Lake area. This study is intended to provide a basis for the prediction of further occurrences of garnet-rich Unit 2 and aluminum-rich sections of the sillimanite-bearing Unit 1/Unit 2 contact.

TALC AT ISKWASUM LAKE

Talc, a hydrous magnesium silicate, occurs with "quartz, dolomite and iron oxides" (Hunt, 1970), at Iskwasum Lake and along the Grass River. Selected occurrences were examined to determine the nature of the talc mineralization and the potential of the serpentinite as an ornamental stone (Fig. GS-17-6).

Two types of talc mineralization have been noted: (1) as a fine grained, platy talc with sand size, rhombic, carbonate grains in a massive to slightly foliated, buff weathering, talc-carbonate rock; and (2) as talc in veins up to 10 cm wide (Fig. GS-17-7). Large platy talc crystals, that are continuous across the width of the vein, occur at high angles to the vein walls. The only impurity in these veins are rare, 4-5 cm, carbonate crystals. The talc veins have sharp contacts and occur most commonly in both

TABLE GS-17-1
MINERAL OCCURRENCES AT ISKWASUM LAKE

Number Location	Deposit type	Comments
1	Serpentine	medium green, iron stained, fractured
2	Talc veins	abundant veins in serpentinite, translucent serpentinite occurs locally
3	Talc veins	large area of mixed talc-carbonate and serpentine with abundant talc veins
4	Talc/carbonate	talc-carbonate ridge with several areas of abundant talc
5	Talc/carbonate	talc-carbonate ridge with abundant carbonate and minor talc

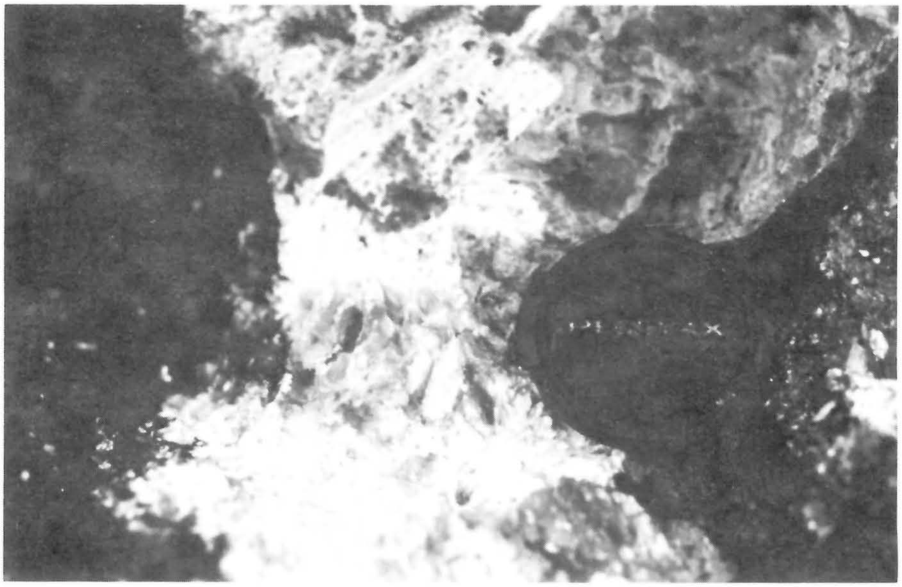

Figure GS-17-7: *Talc vein, Iskwasum Lake, location 3.*

the serpentinite and the talc-carbonate rock adjacent to the contact between these two rock types.

The weathering surfaces of the talc veins and the talc-carbonate rock have distinctive textures. The pure talc veins are light green on a fresh surface but weather to an opaque silver-white. The talc resembles muscovite superficially but is inelastic and greasy to the touch. The talc-carbonate rock weathers to a granular surface where the carbonate grains are dominant compared to the more recessive talc. A small population of carbonate grains in a soft, matte-finished matrix indicates that the rock contains a large proportion of talc.

The serpentinite within the Iskwasum Lake ultramafic complex ranges from a light green, granular, serpentinized gabbro to a medium dark green, relatively pure, serpentine rock. Adjacent to an area of serpentinite the serpentine is deformed into platy lenses 10-20 cm long by 2-5 cm wide. Locally this platy serpentine is a jade green colour and translucent, and may be useful as a jade-like ornamental stone; however, most of this serpentinite is brittle, iron stained and fractured in approximately 10-50 cm intervals and is not suitable as an ornamental stone.

At several locations within the serpentinite, small, white, very fine grained lenses occur, surrounded by highly sheared serpentine. One of the lenses, 2 x 5 m, has disseminated grains of an emerald green chrome or nickel mica. The contrast between green and white would make this a desirable ornamental stone if larger amounts could be found.

KAOLINITE

The Manitoba non-confidential assessment files contain numerous reports of "clay-rich sandstone", "highly weathered granite" and "clay" in diamond drill hole logs from holes drilled through the Paleozoic/Precambrian unconformity, in the Flin Flon-Snow Lake area. The purpose of the investigation was to determine if any kaolin-rich basement was exposed in outcrop.

Figure GS-17-8: *Brick-size pieces of mottled red-purple dolomite from the east Snow Lake quarry. Felt pen: 15 cm.*

In all locations where the area of the unconformity was investigated it was buried beneath glacial overburden or was covered by a series of slumped blocks derived from the Paleozoic escarpment in the immediate vicinity of the unconformity. Consequently a drill is required to locate the unconformity beneath the dolomite, or glacial overburden, in order to determine the presence of kaolinitic clays. Kaolinitic clays have been obtained in three drill cores at shallow depths in the course of reconnaissance drilling (McRitchie and Hosain, GS-21, this volume).

DOLOMITE

An examination was made of the mottled red-purple Ordovician dolomite that has been used in the past as an ornamental stone (Gunter and Yamada, 1985). Six quarries were examined containing Ordovician dolomites of the Red River Formation: one on the highway to Snow Lake; four along P.R. 391; and one on Highway 10, south of the junction with P.R. 391. Mottled red-purple dolomite was also observed in a road-cut on P.R. 391 at the east end of Grass River Provincial Park (Fig. GS-17-1).

The Snow Lake quarry contains a very fine grained crystalline mottled red-purple dolomite, that weathers buff. Buff dolomite also occurs locally. A combination of two steeply dipping joints and closely spaced bedding planes results in brick size pieces averaging 15 x 9 x 30 cm (Fig. GS-17-8).

The other five quarries contain buff to grey massive crystalline dolomite, that locally is characterized by mottled textures. The beds range in thickness from 2 to 20 cm in these quarries. Two of the quarries, Goose Lake and Reed Lake, are water filled, slightly overgrown and do not appear to have been active recently. In the new Reed Lake quarry lenses of blue-grey dolomite averaging 3 x 15 cm occur parallel to the bedding planes. In the Tramping Lake quarry cephalopods up to 15 cm in diameter and rare trilobites were observed.

Currently, five of the quarries are a source of crushed stone for highway construction. The quarries may have potential as a source of dolomite for magnesium metal production.

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GS-18 KISSEYNEW PROJECT: KISSISSING LAKE

by D.C.P. Schledewitz

INTRODUCTION

The Kississing Lake portion of the Kisseynew Project concentrated on the west half of Kississing Lake in 1986. Lithologies present (Table GS-18-1) are: variably garnetiferous medium grained graphite-biotite-feldspar-quartz paragneiss to metatexite (1); suites of amphibolites and hornblende gneisses (2); quartz-rich leucocratic gneisses (3 and 4); magnetiferous variably hornblende-bearing biotite-feldspar-quartz gneisses (5 and 6); and mesocratic, commonly magnetiferous gneiss (7) . These rocks have been variably intruded by granitic *lits* and have undergone polyphase deformation.

TABLE GS-18-1
TABLE OF FORMATIONS

Group		Lithology
	14	Pink granite pegmatite
	13	Pink and white granite + biotite + muscovite
	12	Medium grained to pegmatitic white granite
Intrusive Rocks	11	Medium to coarse grained grey biotite granite
	10	Magnetiferous hornblende-biotite granodiorite
	9	Yakushavich hornblende-biotite granodiorite
	8	Magnetite-biotite monzogranite
Uncertain affinity	7	Mesocratic ± magnetite-hornblende-biotite gneiss
	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
Possible Sherridon Group	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 ± grossular garnet
	1	± garnet-graphite-biotite paragneiss
Nokomis	1a	± garnet-graphite-biotite metatexite
	1b	± garnet-biotite metatexite with plagioclase megacrysts

GENERAL GEOLOGY

GRAPHITE ± GARNET-BIOTITE-FELDSPAR-QUARTZ PARAGNEISS (1) TO METATEXITE (1a)

The paragneiss (1) occurs only in the southwest corner of the map area at the south end of Barrett Bay (Fig. GS-18-1). It is well layered with light grey, medium grained leucocratic quartzofeldspathic layers interlayered with more dark grey biotite-rich interlayers and/or biotite laminae. Graded bedding is suggested at some localities. Graphite is common and garnet is a variable accessory. Muscovite is present and considered to be a retrograde mineral since it occurs oriented oblique to the layering and foliation. The paragneiss contains 10-20% biotite-leucotonalite *lits* and/or a younger coarse grained leucocratic, often muscovite-bearing siliceous white to pink granite as granitic *lits* and sills. The volume of both granitic rock types increases northward, the grain size of the biotite gneiss increases with the volume of granitic *lits*, and the layering becomes less distinct.

The paragneiss forms both large and small inclusion blocks in large sills of the intrusive rocks. Approximately at an east-trending line drawn through the midpoint of Barrett Bay the biotite-graphite gneiss contains 50 to 80% granitic *lits* and veins. The rock is characterized by an interlayering of medium- to coarse-grained biotite-graphite ± garnet granoblastic rock with *lits* of white leucocratic granite ± muscovite ± garnet commonly with biotite laminations. Dense fine- to medium-grained dark grey garnet-graphite-biotite feldspar-quartz restite sporadically occurs as discontinuous layers in the metatexite (1a). The metatexite is considered to be the derivative of the paragneiss (1). It is also apparent that the granitic rocks which had distinct intrusive contacts south and southwest of Barrett Bay are more intimately interlayered and folded along with the country rock. Graphitic garnetiferous metatexites occur throughout the remainder of the map area but nowhere else do they have the same areal extent, continuity and apparent uniform composition as in the southwest corner of the map area.

In the adjacent Duval Lake map area to the west Pollock (1954) equated a similar and contiguous suite of graphitic biotite paragneisses and metatexites with the Nokomis group (after Robertson, 1953). The whole-rock chemistry (Pollock, 1954) of these paragneisses is close to greywacke. However, the layering observed on outcrop suggests an interlayered psammite, semi-pelite and interlayered pelite. Immediately south of Barrett Bay, in the Lobstick Narrows area, Zwanzig (1984) also equates a similar graphite-garnet-biotite paragneiss with the Nokomis Group.

AMPHIBOLITE SUITE (2)

The amphibolite suite of rocks forms distinct thick mappable units on Moose Island, Big Island and northeast of Big Island. The amphibolite suite ranges from a massive, medium- to coarse-grained amphibolite with white granitic *lits* to a suite of thinly interlayered hornblende-biotite-feldspar ± quartz ± garnet, thin hornblendite ± garnet layers, hornblende-biotite-felds-par ± quartz with hornblende porphyroblasts. Both the garnet and hornblende porphyroblasts have coronas of white plagioclase and quartz. At Moose Island the layered amphibolite overlies graphite ± garnet-biotite metatexite (1a) in an overturned S-fold with shallow plunge to the southeast. The core of the synform is a variably deformed light grey medium grained leucotonalite to monzogranite ± garnet or magnetite. At Yakushavich Island and Big Island the amphibolite suite is folded in an overturned synform. It overlies and locally is interlayered, or tectonically interleaved, with a rusty graphitic-garnet-biotite metatexite. It is overlain by a suite of variably magnetiferous quartzofeldspathic gneisses (4, 5, 6). Also present at the upper contact but of local extent is a light grey garnet-magnetite quartzofeldspathic rock.

QUARTZ-RICH GNEISS SUITE (3 AND 4)

The quartz-rich rocks form two distinct types. One is a well laminated, light grey, fine- to medium-grained, siliceous rock (3). It contains sporadic red garnets, and hornblende as a variable accessory occurring

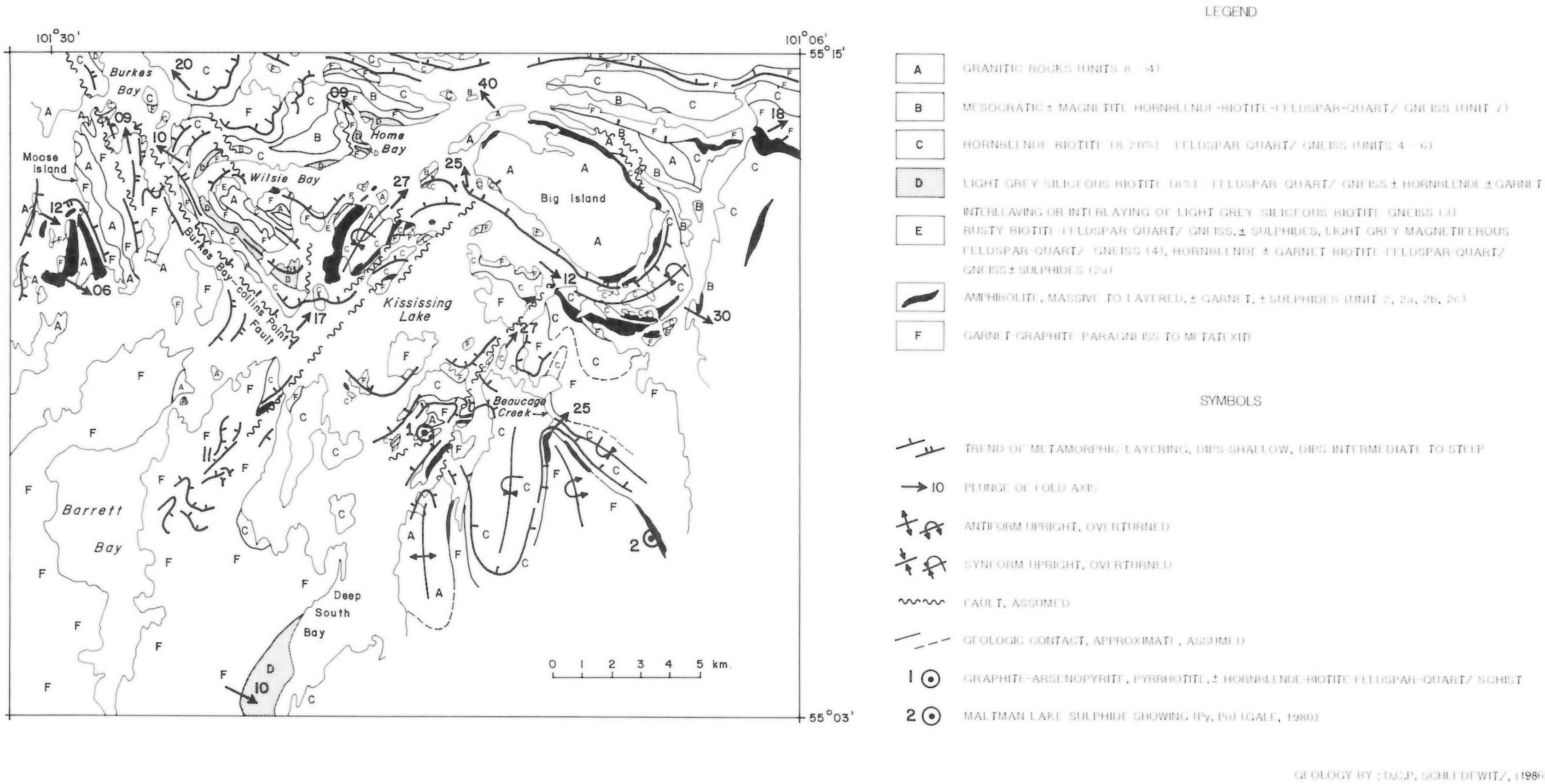

Figure GS-18-1: *Simplified geology of the Kississing Lake area.*

mainly in white feldspar-quartz granitic *lits*. This rock type occurs along Collins Point, Burkes Bay and around Home Bay. At Home Bay it is either interlayered with, or tectonically interleaved with, light grey graphite-garnet-biotite-feldspar-quartz metatexite.

The second siliceous type is a medium grained light grey magnetiferous feldspar-quartz gneiss (4). Hornblende occurs in white feldspar quartz granitic *lits*. Discontinuous epidote-quartz layers $\pm$ hornblende are sporadic. This rock type occurs extensively in the northern half of the area where it is interlayered with variably hornblende-bearing biotite-feldspar-quartz gneisses (5 and 6). The light grey siliceous magnetiferous gneiss also occurs along the west side of Deep South Bay (Fig. GS-18-1), where it overlies a light grey siliceous variably garnetiferous rock (3) interlayered with hornblende-biotite-feldspar-quartz gneiss and minor amphibolite. Immediately south of Deep South Bay, Zwanzig (1984) describes a layered sequence of quartz-rich metasandstones, hornblende-biotite-feldspar-quartz layers, and metaconglomerates, overlain(?) by a light grey magnetiferous quartzofeldspathic metasedimentary rock. Zwanzig has designated these as Sherridon Group rocks.

MAGNETITE-BIOTITE $\pm$ HORNBLENDE GNEISS SUITE (5 AND 6)

The variably hornblende-bearing suite of rocks is divisible into two types. One is a medium to dark grey magnetiferous-biotite-feldspar-quartz gneiss (5). Biotite ranges from 15 to 25% and the quartz content is low compared to the light grey siliceous magnetiferous gneiss (4). The hornblende occurs mainly in fine- to medium-grained granitic *lits* as lenticular porphyroblasts. This gives the rock a layered appearance. This rock type is commonly interlayered or associated with the light grey, magnetiferous, siliceous gneiss (4).

The second type is a dark grey, variably magnetiferous hornblende-biotite-feldspar-quartz granoblastic rock (6). The biotite and hornblende are evenly distributed giving the rock a uniform appearance with hornblende ranging from 10-15% and biotite from 10-15%. The rock contains medium- to coarse-grained granitic *lits* with coarse grained hornblende.

MESOCRATIC MAGNETITE GNEISS (7)

The mesocratic rocks are variably magnetiferous and contain 20-40% hornblende, 5-15% biotite and less than 20% quartz. Amphibolite layers are sporadic and granitic *lits* locally give the rock a layered appearance.

The mesocratic gneiss (7) occurs in the north half of the map area and it outcrops in an arcuate-shaped zone from Home Bay to southeast of Big Island. It was suggested (Schledewitz, 1985) that this rock type may represent a highly deformed intrusive rock.

STRUCTURE AND LITHOSTRATIGRAPHIC CONSIDERATIONS

The contact between the two major lithologic units, the Nokomis Group and the Sherridon Group, as described by Zwanzig (1984, after Robertson, 1951 and Pollock, 1964) appears to be folded about a south of east shallow-plunging fold axis (Fig. GS-18-1) at the south end of Deep South Bay. The overall metamorphic layering throughout the Kississing Lake area indicates a regional shallow dip to the northeast, with apparent repetition of a graphite-biotite metatexite (1a) and the variably magnetiferous hornblende-bearing quartzofeldspathic rocks (3 to 6). Assuming the subdivision into the two major lithologic groups — the older Nokomis Group (1a) and the younger Sherridon Group (3-6) — is applicable throughout the map area, then the apparent repetition can be explained by recumbent folding about shallow northerly dipping axial surfaces. The axis of these recumbent folds plunges to the south of east assuming the southeast-plunging folding of the Nokomis Group and Sherridon Group in the Deep South Bay area is regionally applicable. This assumption appears justified since a recumbent fold set with a shallow easterly plunge has been documented by Stockwell (1950) and Kalliokoski (1953).

The recumbent folds have been subsequently deformed about shallow northeast-plunging folds with shallow-dipping northwest axial surfaces. Froese (1981) has proposed a similar sequence of deformation in the area of Sherridon to the east of Kississing Lake. Syn-kinematic or subsequent faulting along northwest and northeast fault sets has resulted in the apparent rotation of earlier minor folds or the formation of a set of northwest-plunging drag folds in the hanging wall of the northeast-dipping Collins Point-Burkes Bay fault (Fig. GS-18-1).

ECONOMIC GEOLOGY

Sulphide occurrences in the Kississing Lake area at Yakushavich Island, Collins Point and Moose Island have been examined in more detail by Gale (1980, 1981). Gale classified the occurrences by their sulphide type and host rock association; in summary they are:

i) amphibolite + garnet with pyrrhotite and pyrite;
ii) rusty biotite-feldspar-quartz granoblastic rock with intermediate to high silica (35-50%) $\pm$ cordierite containing sphalerite, galena, pyrite, pyrrhotite.

It was found that the rusty biotite-feldspar-quartz granoblastic rock is interlayered with amphibolite or rusty graphite $\pm$ garnet-biotite-feldspar-quartz gneiss.

During the mapping in 1986 a similar occurrence of the rusty sulphide-bearing biotite-feldspar-quartz granoblastite was observed on Groves Island (Fig. GS-18-1). However, the main sulphide mineral of note at this occurrence was arsenopyrite. The outcrop is highly rusted and schistose with dense quartz-rich zones. Thick lenses of graphite occur along the planes of schistosity.

This mineral occurrence appears to lie along a fault zone within the graphite $\pm$ garnet-biotite-feldspar-quartz metatexite. The mineralized zone is overlain by a garnet-magnetite-biotite-feldspar-quartz gneiss. This garnet-magnetite-bearing rock also occurs eastwards along the strike extension of the mineralized zone. However, at this locality it appears to be part of a complex stratigraphy of interlayered garnet-hornblende-biotite-plagioclase-quartz gneiss (2a), leucocratic grey siliceous biotite-feldspar-quartz gneiss (3), leucocratic magnetiferous light grey siliceous biotite-feldspar-quartz gneiss, garnet amphibolite and garnet-graphite-biotite metatexite. These lithologic relationships are similar to the mineralized areas at the southeast end of Big Island or on parts of Yakushavich Island. Similar lithologies also occur along Wilsie Bay on the north side of Collins Point where numerous mineral occurrences lie along the north side of what is also a more varied stratigraphy involving alternations of garnet-hornblende-feldspar-quartz gneiss (2a), rusty biotite-feldspar-quartz gneiss, light grey leucocratic magnetiferous and non-magnetiferous quartz feldspar gneiss (3, 4) and garnet-graphite-biotite-feldspar-quartz gneiss. These rocks also appear to be intersected by a number of faults. Perhaps these areas of complex stratigraphy are related to conditions appropriate for primary mineralization. Subsequent intrusion and deformation may act to concentrate disseminated mineralization.

Mapping in 1986 in the Beaucage Creek area, just east of Groves Island, delineated an overturned antiform with a shallow northeast plunge. The structure is cored by $\pm$ garnet-graphite-biotite metatexite (1a), which is overlain by massive amphibolite (2) and hornblende $\pm$ garnet-plagioclase gneiss (2a). The amphibolite in turn is overlain by a suite of variably magnetiferous $\pm$ hornblende-bearing quartzofeldspathic gneiss. The amphibolite is variably mineralized and carbonate-bearing. This type of occurrence appears similar to the Maltman Lake occurrence (Gale, 1981) which lies to the southeast possibly on the limb of the same structure (Fig. GS-18-1).

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GS-19 KISSEYNEW PROJECT: GEOLOGICAL RECONNAISSANCE OF KISSEYNEW LAKE WEST (63K/13 NW)

by W. D. McRitchie

INTRODUCTION

Mapping programs on the south flank of the Kisseynew metasedimentary gneiss belt are designed to document the structure, stratigraphy and distribution of greywacke-derived and quartzofeldspathic gneisses, as well as associated amphibolite units that are thought to present a favourable target horizon for gold mineralization (Gale, 1984).

Systematic 1:20 000 and 1:50 000 mapping programs are being mounted by Schledewitz (1985, and GS-18, this volume) in the Kississing Lake area, and by Zwanzig (1984, 1985) in the Nokomis and Puffy Lakes area, and the eastern reaches of Kisseynew Lake.

This year, two weeks were committed to mapping a major ellipsoidal structure (the 'Spike' Lake "Dome") east of Florence Lake, as well as a noritic intrusion at Imperial Lake. Additional samples and stratigraphic information were gathered from hornblende and garnet-bearing granulites south of Weasel Bay as a continuation of earlier investigations (McRitchie, 1985).

SPIKE LAKE DOME

The Spike Lake "Dome" contains a variety of layered and more massive granitoid gneisses encircled by a major amphibolite unit up to 270 m thick (Fig. GS-19-1). The gneisses range from pink alaskite and monzogranite to grey granodiorite. A mildly radioactive zone (level 2) was detected at the southeast end of the structure during a combined aeromagnetic and scintillometer survey flown by the Manitoba Department of Mines and Natural Resources in June 1954. Inclusions are common throughout the structure and produce a magnetic striping as well as the linear array of ridges and gullies readily apparent on aerial photographs. Both east and west closures plunge at intermediate angles to the northeast, as do ubiquitous mineral lineations present throughout most of the structure (Fig. GS-19-2).

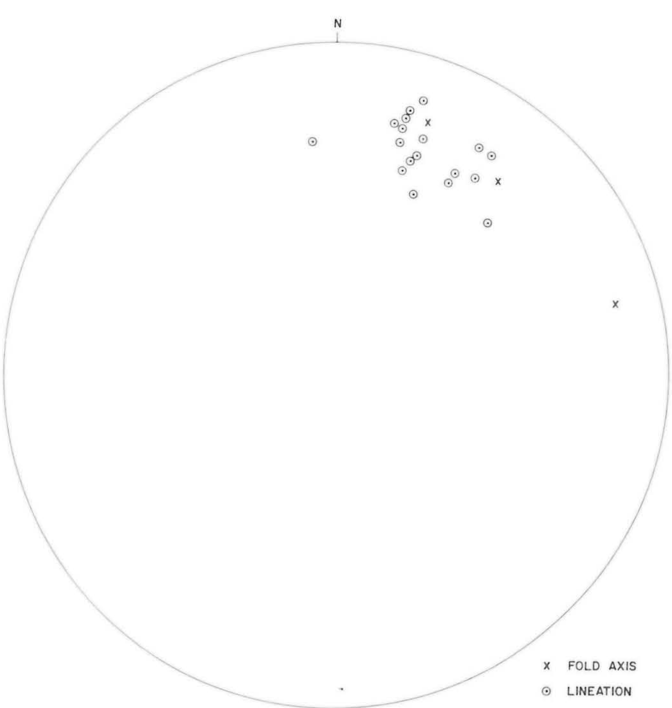

Figure GS-19-2: Fold axes and mineral lineations in the Spike and Hunt Lake regions.

Although superficially ellipsoidal in form, the "Dome" is thought to be a highly compressed Z-folded megaboudin lying en echelon and central to satellite pods of granitoid gneisses at Slug Lake and Weasel Bay, respectively, to the northeast and southwest (Fig. GS-19-1).

Flanking quartzofeldspathic gneisses resemble Sherridon Group gneisses mapped by Pollock (1964) in the Duval Lake area to the north.

On Hunt Lake, the quartzofeldspathic gneisses are relatively thin and give way rapidly to greywacke-derived garnet-biotite gneisses with common thin calc-silicate pods and lenses and sporadic highly graphitic and siliceous shear zones. These, in turn, are flanked to the north by a 600 m wide belt of magnetic garnet + biotite-bearing psammitic and semipelitic greywacke-derived gneisses that in many respects resemble non-magnetic Nokomis Group gneiss mapped on Forester Lake.

On the south side of the structure the east-trending ridge and gully-dominated terrain is underlain principally by highly quartzose and magnetic quartzofeldspathic gneisses that display good psammitic and semipelitic differentiation, coarse white mobilizate stringers and sporadic garnet and sillimanite. Non-magnetic garnet-biotite gneisses mapped at Florence Lake can be traced a limited distance to the east before being wedged out in a highly compressed and diatexitic zone, dominated by more siliceous and locally magnetic greywacke-derived gneisses.

A thin unit of garnet-biotite gneiss together with a structurally overlying amphibolite unit and arkosic gneisses can be traced for 2.5 km from Weasel Bay on Kisseynew Lake to the southwest corner of Imperial Lake. South of Imperial Lake, at the base of a high granite ridge (UTM E323750 N6093000), a second zone of garnet-biotite gneiss is locally coarsely blastic containing 1 x 2 x 5 cm porphyroblasts of cordierite and sillimanite in a coarse grained garnet and biotite-rich matrix with minor staurolite, and anthophyllite-bearing layers. A second occurrence of cordierite, garnet and sillimanite (in this case with abundant associated graphite and biotite), occurs as an inclusion zone near the southern contact of the norite body south of Imperial Lake.

IMPERIAL LAKE NORITIC INTRUSION

An intrusive complex ranging from leuconorite to orthopyroxenite forms a 1 x 2 km pod south of Imperial lake with east- and west-trending tails wedging out into the adjacent granitoid gneisses. The body possesses a discontinuous shell of recrystallized mesocratic, equigranular garnet and hornblende-bearing metagabbro up to 120 m wide, enclosing a core of fresh and unaltered, ophitic gabbro, norite and gabbronorite with local gabbro pegmatite and coarse grained layered pyroxenite and peridotite. Present coverage was not adequate to define internal layering relationships, nor to document consistent regional variations in composition. Good outcrops of layered orthopyroxenite (less than 5% interstitial plagioclase and scattered hornblende phenocrysts) ranging to serpentinite are well exposed in the east-trending tail on the powerline to Lobstick Narrows.

Nearby on the powerline, chilled contact phases of the norite display 2-3 mm feldspar microlites in a fine grained matrix traversed by late fractures with associated garnet blastesis.

A thin extension of the main body was traced 2 km to the east where a second pod of intrusive gabbro and ultramafics forms a prominent though highly weathered knoll on the north shore of Kisseynew Lake (see Tanton, 1938). Several exploration holes are known to have been drilled at this locality.

In thin section the norites display a variety of textures including cumulate, euhedral and tabular orthopyroxene, plagioclase as euhedral laths and poikilitic interstitial networks; more rare cumulate clinopyroxene and secondary amphibole occur as overgrowths on the original othopyroxene. The discontinuous nature of the metamorphic shell, local preservation of broad as well as sharp chilled contact zones and the abrupt truncation of internal layering near the outer contacts, are all taken to indicate that at least part of the contact zone is highly tectonized.

WEASEL BAY

South of Weasel Bay, additional samples were collected from leucocratic garnet, magnetite and hornblende-bearing granulite (McRitchie, 1985). The unit is well layered, and strongly lineated with hornblende foliae and laminae throughout. A wispy layering is defined by segregations of 3-4 mm garnet and/or quartz with sporadic well zoned yet discontinuous calc-silicate boudin trains. The unit grades upwards into coarsely blastic garnet amphibolite (at least 25 m thick) in which 1-2 cm garnet blasts commonly compose 25 per cent of the unit. This well bedded unit is overlain by a 30 m thick feldspar-phyric amphibolite (metabasalt) with numerous 0.5-1.5 cm subrounded feldspar megacrysts in a finer grained homogeneous, equigranular, unlayered yet foliated amphibolitic matrix. Although locally highly flattened, the overall homogeneity of the unit suggests it was once a flow emplaced in an otherwise tuffaceous sequence. The amphibolitic sequence is completed by a thinly layered, fine grained, locally garnetiferous amphibolite with thin siliceous layers, displaying a fine grained white saccharoidal weathering surface. The amphibolites are capped by layered granitoid gneisses which in turn give way to garnet + biotite-bearing greywacke-derived gneiss, the 'marker' amphibolite, and the main 'Sherridon' quartzofeldspathic sequence.

This extended sequence is significant in that it confirms the presence of several stratigraphically different amphibolites in the area, and more especially the existence of an amphibolitic suite beneath the greywacke gneisses and well below the inferred Kisseynew metallotect.

Although the region is known to be highly folded, with major strike-slip faults and possible thrusts, this extended quasi-stratigraphic lithologic sequence constitutes one of the means by which the numerous amphibolite formations present in the area can be discriminated.

TABLE GS-19-1
AMPHIBOLITES AND ASSOCIATED GNEISSES IN WEASEL BAY AREA, KISSEYNEW LAKE

	Quartz-rich magnetite, garnet and locally sillimanite-bearing pelitic quartzofeldspathic gneiss
Amphibolite (A_3)	Garnet-hornblende-feldspar amphibolite
	Sillimanite-bearing granofelsic arkosic gneiss Biotite-bearing arkosic gneiss (pink alaskite gneiss) Hornblende-bearing arkosic gniess
Amphibolite (A_2)	Calcareous diopside and hornblende-bearing amphibolite Garnet amphibolite
	Greywacke derived garnet-biotite gneiss Layered pink and grey granitoid gneisses
Amphibolite (A_1)	Fine grained interlayered amphibolite and siltstone Feldspar-phyric metabasalt Garnet amphibolite
	Garnet-hornblende-magnetite leucogranulite

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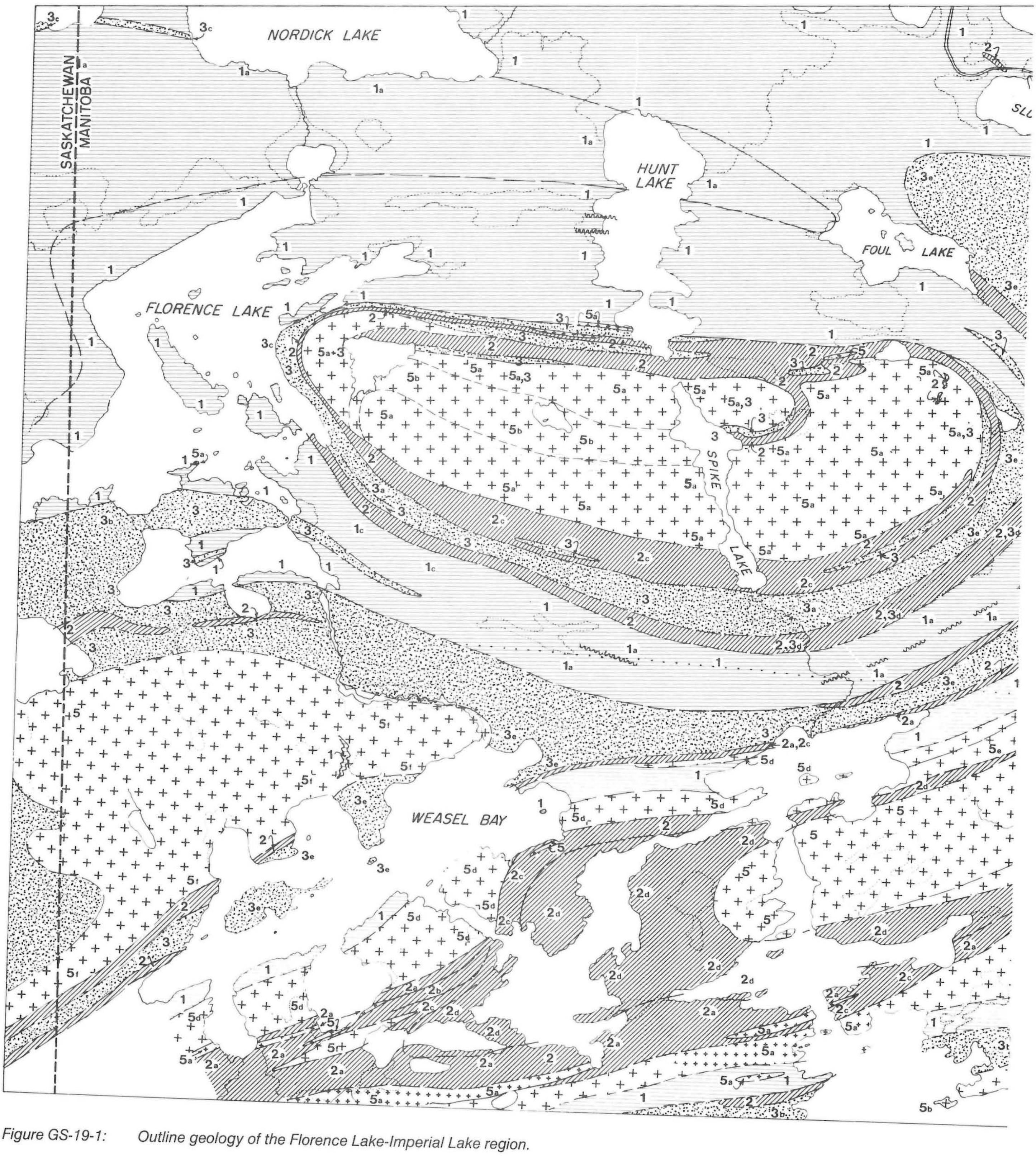
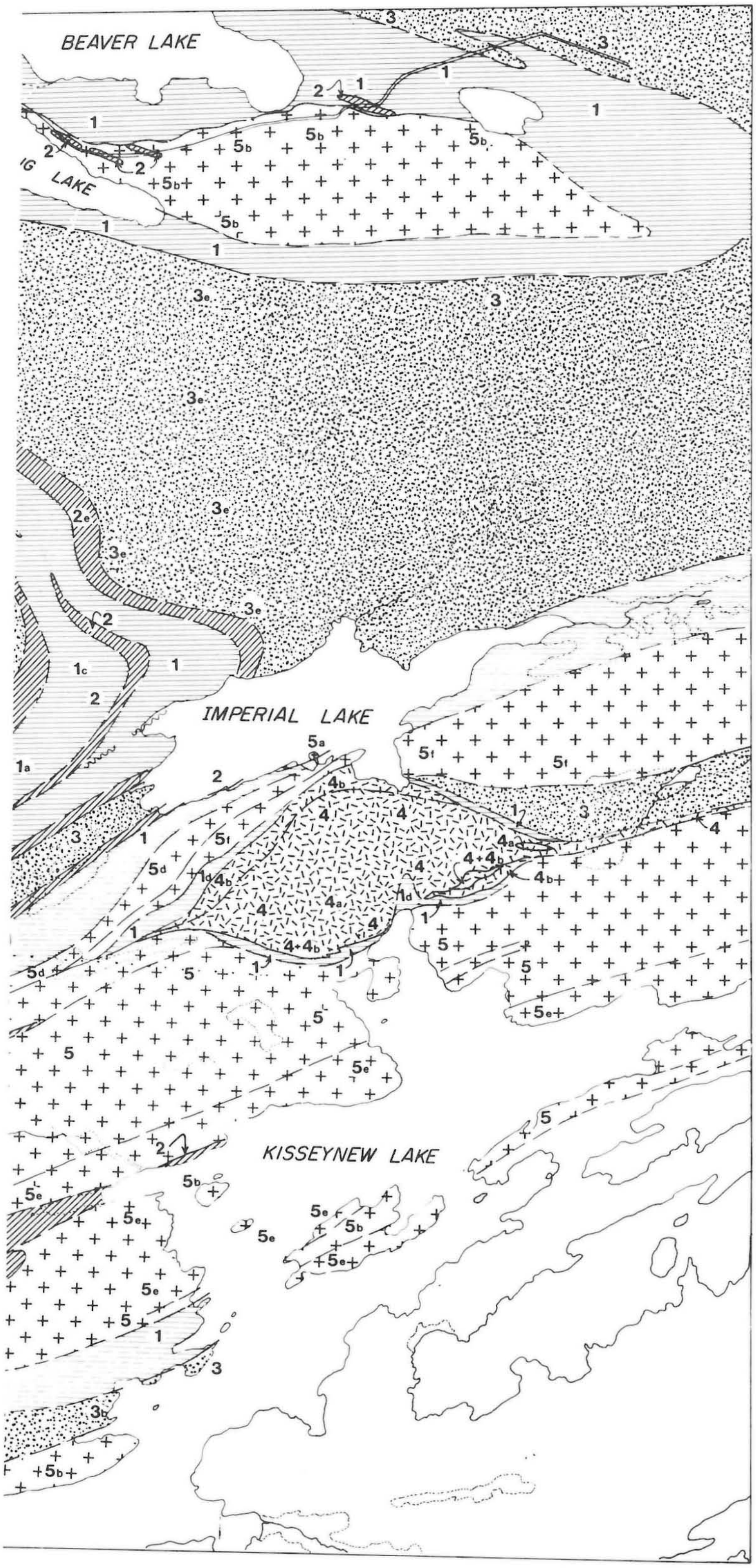


Figure GS-19-1: Outline geology of the Florence Lake-Imperial Lake region.



LEGEND

5 GRANITE AND GRANITOID GNEISS
- a) pink microcline granite/albite granite/pegmatite
- b) tonalitic-granodioritic hornblende-bearing orthogneiss
- c) aplitic and gneissic leucogranite
- d) foliated and layered granitoid gneiss
- e) garnet-bearing granitoid gneiss
- f) white gneissic granite-granodiorite

Peg

4 NORITE
- a) ultrabasic orthopyroxenite, hornblende melanorite
- b) garnet and hornblende-bearing metanorite-metagabbro

3 QUARTZOFELDSPATHIC GNEISS AND MIGMATITE (magnetic)
- a) non-magnetic biotite-bearing quartzofeldspathic paragneiss
- b) feldspathic quartzite-granulite
- c) gneissic conglomerate to metasandstone
- d) biotite-hornblende and locally garnet-bearing gneiss
- e) sillimanite (faserkiesel)-bearing quartzofeldspathic gneiss

2 AMPHIBOLITE AND HORNBLENDE-BIOTITE-QUARTZ-PLAGIOCLASE GNEISS
- a) hornblende ± diopside ± carbonate amphibolite
- b) feldspar-phyric metabasalt
- c) garnet amphibolite
- d) garnet-hornblende-quartz-bearing granulite
- e) garnet-hornblende-plagioclase gneiss

1 GNEISSIC METAGREYWACKE AND MIGMATITE (non-magnetic)
- a) magnetic garnet-biotite gneiss with minor amphibolite
- b) highly siliceous garnet-biotite granulite
- c) diatexitic, garnet-biotite gneiss
- d) cordierite, sillimanite, garnet, anthophyllite, staurolite gneiss

Geological Contacts: defined, approximate, inferred

Fault/mylonite zone

Km.0 0.5 1.0 1.5 2.0 2.5 Km

GS-20 MINERAL INVESTIGATIONS IN THE KISSEYNEW GNEISS TERRAIN

by G. Ostry

INTRODUCTION

Investigations during the 1986 field season (Fig. GS-20-1) were directed towards developing a better understanding of the stratigraphy on the southern flank of the Kisseynew sedimentary gneiss terrain within portions of NTS area 63N/2 (Batty Lake Sheet) and the position of mineralization within that stratigraphy. Mapping projects at 1:5000 were initiated at Puffy Lake and Walton Lake and continued at Evans Lake. A reconnaissance of geologic units was carried out northeast and northwest of Nokomis Lake and south of Walton Lake.

PUFFY LAKE

The 1:5000 mapping project initiated at Puffy Lake centred on an arsenopyrite occurrence west of Puffy Lake (Zwanzig, 1984) and the Puffy Lake gold deposit. The west area was mapped first in order to gain some insight into the stratigraphy of the area since there is a paucity of rock exposure in the immediate vicinity of the Puffy Lake gold deposit.

In the west area (Fig. GS-20-2) fourteen lithologic units were identified that form a southeasterly trending homoclinal sequence with dips of 30°-50° NE. Unit 1 is separated from the remainder of the sequence by 25-50 m of swamp and is composed of massive to banded variably garnetiferous fine grained mafic metavolcanic rock. With the exception of Unit 9 and possibly Unit 2 (intrusive?) all units are intermediate to felsic, fine- to medium-grained quartzofeldspathic or feldspathic hornblende- and/or biotite-bearing paragneisses with variable accessory magnetite, garnet and calc-silicate layers. Unit 9 is a fine grained grey weathering quartz-feldspar-biotite-garnet gneiss that is similar to the greywacke-derived gneisses observed northeast of Nokomis Lake. Unit 9 appears to be conformable within the quartzofeldspathic gneisses. Poorly exposed one metre thick sulphide mineralization (up to 15% sulphide) appears to be conformable and occurs near or at the structural top of Unit 9 (Fig. GS-20-2). The fine grained disseminated pyrrhotite, pyrite and arsenopyrite (both grains and needles) are associated with rusty weathering fine- to very fine-grained siliceous gneiss and/or coarse grained quartz mobilizate.

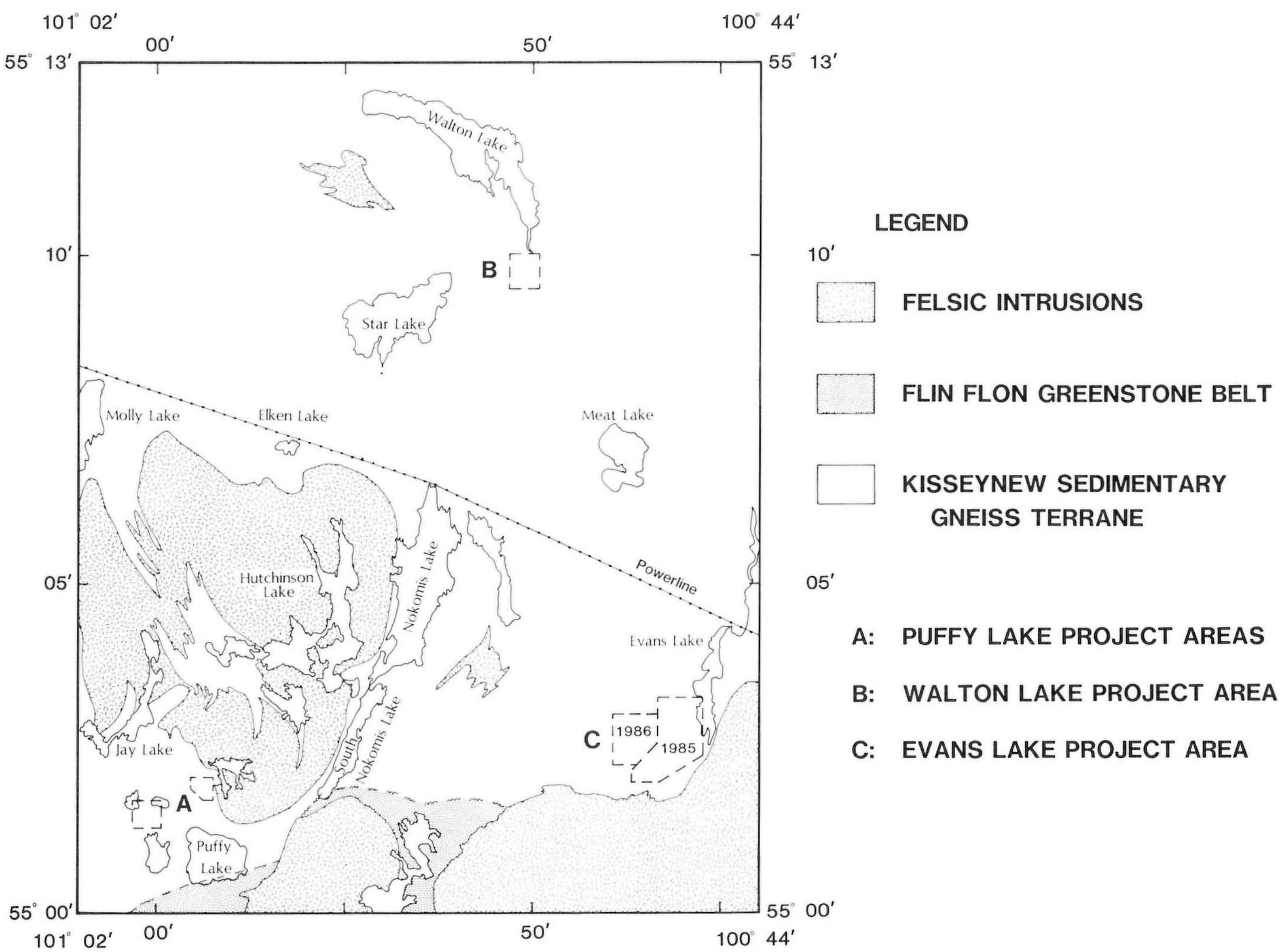


Figure GS-20-1: Location map (parts of 63N/2 and 63N/3).

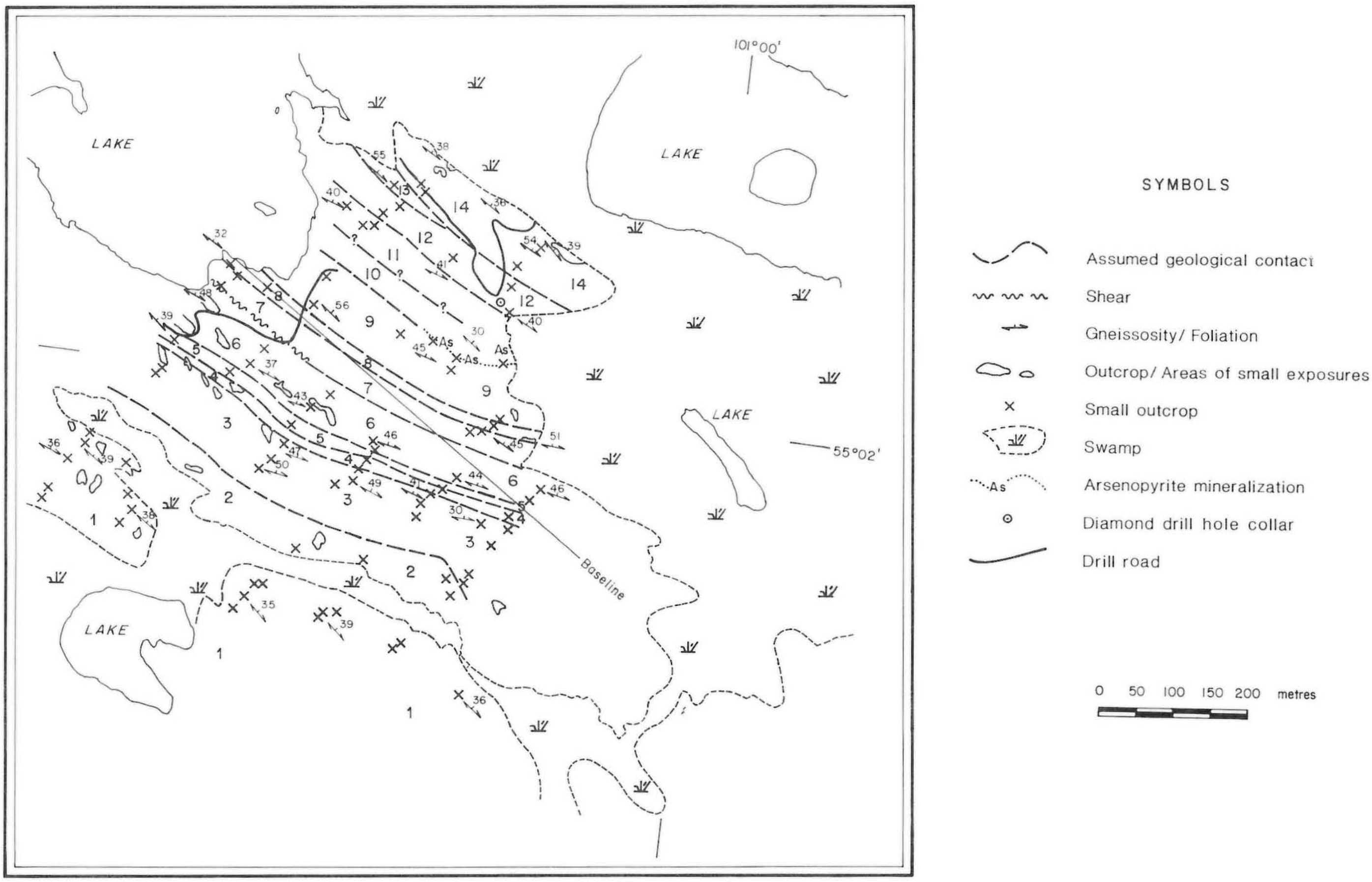


Figure GS-20-2: Geology west of Puffy Lake, Manitoba. Legend (all rocks are fine grained): **1)** *mafic metavolcanic rock;* **2)** *felsic qz-fd-muscovite rock (intrusive?);* **3)** *massive felsic qz-fd-bio-mgte gneiss with interlayers of intermediate fd-hb-qz-mgte gneiss;* **4)** *layered intermediate hb-fd-qz ± gt gneiss;* **5)** *banded felsic qz-fd-bio-mgte gneiss;* **6)** *intermediate hb-fd-qz-mgte gneiss;* **7)** *massive to banded felsic qz-fd-bio-mgte gneiss;* **8)** *intermediate banded fd-hb-qz gneiss with hb laminae;* **9)** *qz-fd-bio-gt gneiss;* **10)** *rusty weathered, felsic to intermediate, interlayered qz-fd-bio and qz-fd-hb gneiss;* **11)** *layered intermediate fd-hb ± qz ± gt gneiss;* **12)** *banded felsic qz-fd-hb gneiss (pink and green weathered);* **13)** *intermediate fd-hb-qz gneiss; and* **14)** *felsic massive to layered qz-fd-bio ± mgte gneiss (pink weathered). Abbreviations as follows: qz = quartz, fd = feldspar, hb = hornblende, bio = biotite, mgte = magnetite and gt = garnet.*

Although mapping in the area of the Puffy Lake gold deposit was hindered by the discontinuity of individual lithologic units and a paucity of rock exposure, seven main lithologic units were identified: 1) coarse grained hornblendite; 2) medium grained gneissic tonalite/granodiorite; 3) fine- to medium-grained intermediate biotite-rich gneiss ± garnet with hornblende-bearing layers; 4) fine- to medium-grained amphibolite/hornblende- feldspar gneiss; 5) fine- to medium-grained quartzofeldspathic paragneiss with fragmental (conglomeratic?) layers; 6) fine- to medium-grained intermediate to mafic metavolcanic rocks; and 7) fine- to medium-grained foliated granite (Fig GS-20-3). Numerous thin (2 m or less, up to 4 m) sill-like felsic intrusive rocks and pegmatites commonly intrude the paragneisses at lithologic contacts. In general, all units strike north-northwesterly and dip 25°-40° E.

The mineralized zone exposed in surface trenches (Fig GS-20-3) is apparently conformable with the regional structural trend and occupies a depositional site near the structural base of the biotite-rich Unit 3. Blebs, disseminations, vugs and veins of arsenopyrite, pyrrhotite and pyrite ± chalcopyrite, sphalerite and galena form up to 15% of undeformed white to smoky grey quartz vein(s) that are 0.2-1.0 m in thickness. The majority of sulphide grains within the quartz are subhedral to euhedral and are not deformed. A fine grained schistose biotite-rich (up to 50% biotite) quartzofeldspathic rock is the immediate host to the quartz vein(s). Adjacent to the quartz vein(s), and contained within the schistosity plane, the biotite-rich rock commonly has up to 20% arsenopyrite as thin wisps, laminae, and lenticular clots (less than 5 by 20 mm). Ubiquitous thin (1-2 cm) quartz veins parallel or subparallel to the main vein exhibit crystal growth perpendicular to the vein walls.

WALTON LAKE

A west to east section was examined in detail south of Walton Lake (Fig. GS-20-4) from a small lake south of the west end of Walton Lake to the #3 mineral occurrence noted by Robertson (1953). This section was studied to determine if the amphibolite sequence that hosts gold mineralization at Nokomis Lake (Gale and Ostry, 1984) extends into the Walton Lake area.

Five main lithologic units were identified; these strike north-northwest and dip moderately to the east. The lithologic units are, from structural base to top: 1) grey weathering arkosic gneiss in conformable contact with; 2) greywacke gneiss; 3) grey and pink weathering arkosic gneiss; 4) greywacke gneiss; and 5) quartz-rich quartz-feldspar-biotite-garnet gneiss that is probably gradational into 4. Interlayered amphibolite and hornblende-feldspar ± quartz gneiss occur in both arkosic gneiss sequences. Rocks similar to the amphibolite sequence that hosts the gold mineralization at Nokomis Lake were not identified in the Walton Lake area.

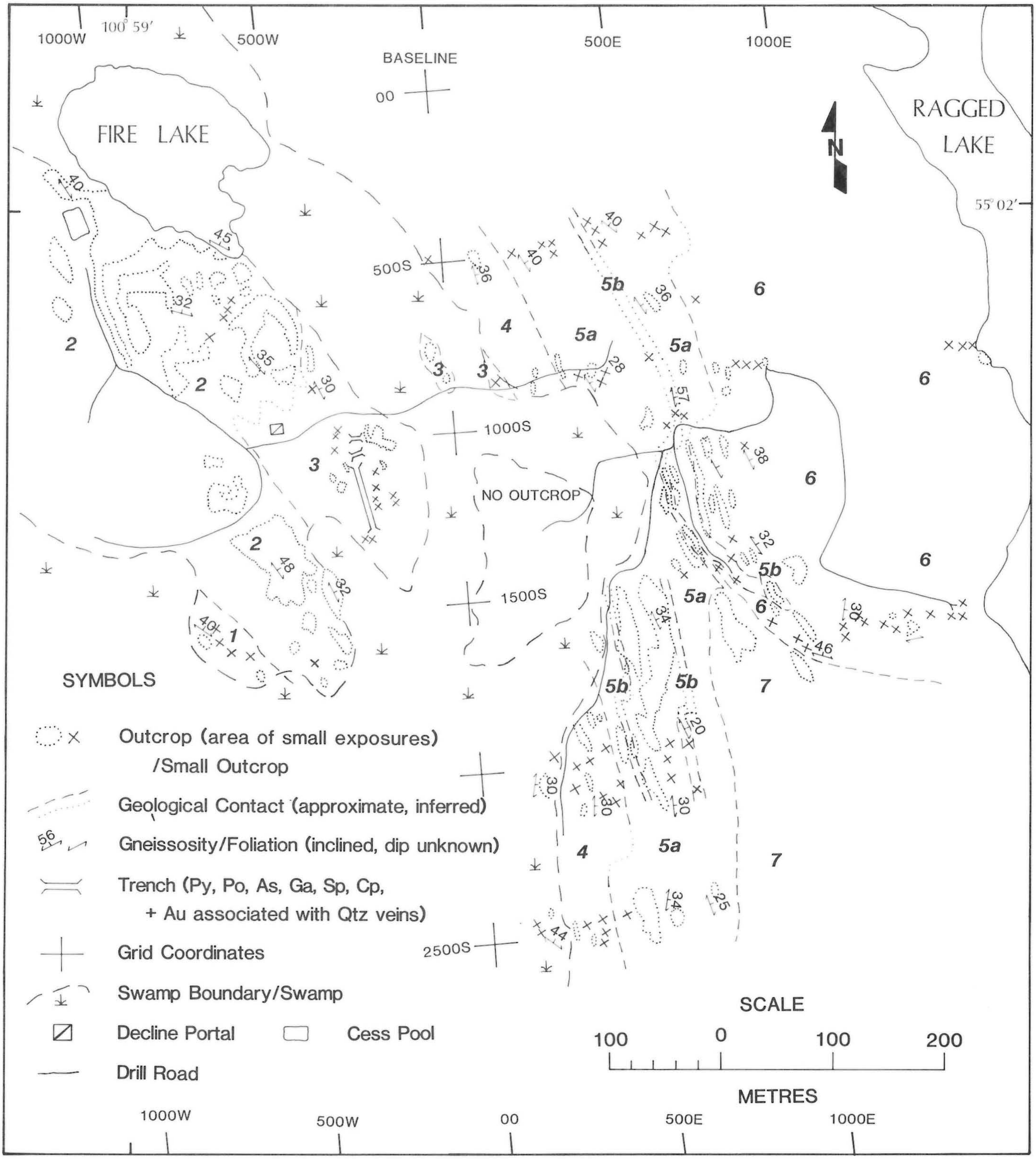


Figure GS-20-3: *Geology in the vicinity of the Puffy Lake gold deposit, Puffy Lake, Manitoba. Legend:* **1)** *coarse grained hornblendite;* **2)** *medium grained tonalite/granodiorite gneiss;* **3)** *fine grained biotite-rich gneiss ± garnet with hornblende bearing interlayers;* **4)** *fine- to medium-grained hornblende/feldspar/amphibolite gneiss;* **5)** *arkosic gneiss;* **5a)** *grey to white weathered fine- to medium-grained felsic gneiss with calc-silicate interlayers;* **5b)** *fragmental (conglomerate?) layers;* **6)** *fine to medium-grained intermediate to mafic metavolcanic rocks; and* **7)** *fine- to medium-grained foliated granite.*

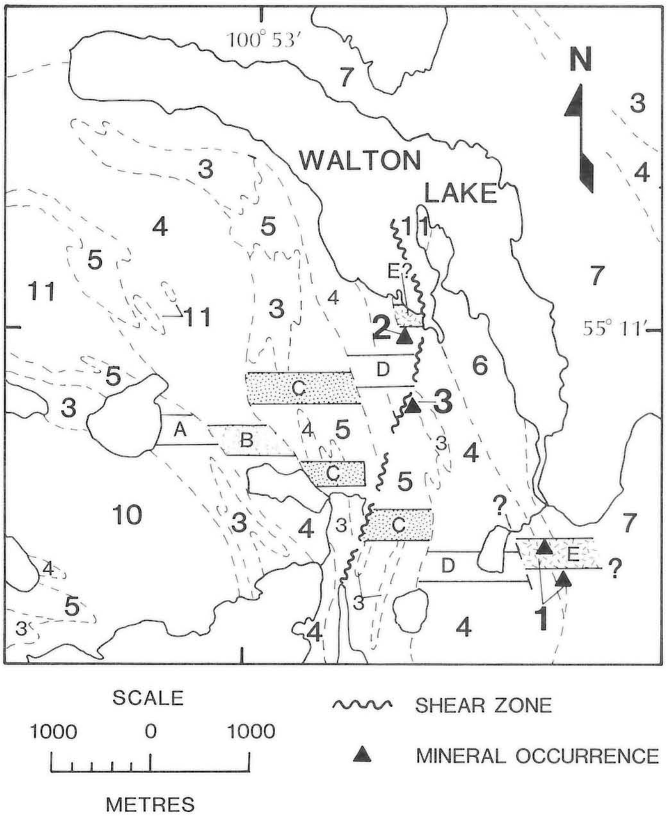


Figure GS-20-4: *Geology south of Walton Lake, Manitoba. Legend:* **A)** *grey weathered arkosic gneiss in conformable contact with;* **B(** *greywacke gneiss;* **C)** *grey and pink wethered arkosic gneiss with interlayered amphibolite;* **D)** *greywacke gneiss; and* **E)** *quartz-rich quartz-feldspar-biotite-garnet gneiss with interlayered amphibolite. Geology base after Robertson (1953).*

Three mineral occurrences were investigated in this area. Two of these, locations 1 (Occurrence # 3, Robertson, 1953) and 2, Figure GS-20-4, are associated with amphibolite within the quartz-rich gneiss adjacent to the contact with the underlying greywacke gneiss. At both locations up to 2 to 10 m of discontinuous disseminated to massive pyrrhotite mineralization was exposed in trenches. The establishment of the exact position of the the greywacke/quartz-rich gneiss contact was not possible due to the interlayering of the two rock types. In addition, there are discontinuous lateral and vertical transitions from the greywacke (biotite-rich) to the quartz-rich gneiss within the contact zone. Mineralization occurs over narrow widths (on the order of a few centimetres) at location 3 and consists of up to 10% fine grained disseminated pyrrhotite ± pyrite associated with graphite along a major north-south shear zone (Robertson, 1953). Exposed width of the shear zone at location 3 is approximately 4 m. All mineralization was sampled for geochemical analysis.

Two sets of trenches occur south of the east end of Walton Lake (Fig. GS-20-5) in the vicinity of the Douglas Group (#3) showing (Robertson, 1953). Disseminated to near-solid sulphide mineralization is associated with a coarse grained garnet-anthophyllite rock and garnetiferous quartz-rich paragneiss (herein termed the 'main' zone).

In the main zone, mineralization occurs sporadically over a thickness of approximately 5-10 m and consists of up to 20% disseminated fine grained pyrrhotite ± pyrite, near-solid pyrrhotite mobilizate, scattered lenses or thin (less than 2 mm) veins of pyrite, and layers (less than 3 cm) of pyrite. Host rocks include very fine- to fine-grained silicified and variably garnetiferous quartzofeldspathic paragneiss(es) and a structurally overlying coarse grained garnet-anthophyllite rock. The main zone is structurally underlain by 5-10 m of fine grained massive amphibolite and overlain by 15-20 m of fine- to medium-grained variably garnetiferous and epidote-rich amphibolite. At the south trenches a second zone of up to 10% disseminated fine grained pyrrhotite ± pyrite mineralization, approximately 5 m thick, occurs structurally above the garnetiferous amphibolite and within quartz-rich paragneiss. The main zone has a probable minimum strike length of approximately 200 m.

EVANS (KAY) LAKE

Due to the structural complexity identified by Robertson (1953) and Peloquin and Hayden-Luck (1985) in the vicinity of the gold mineralization at Evans Lake, a 1:5000 scale mapping program was undertaken west of the area mapped during the 1985 field season (Peloquin and Hayden-Luck, 1985). A map of the general geology that includes the 1985 results and this year's investigation is presented in Figure GS-20-6. The main objectives were to delineate any extension or repetition of the variably mineralized 'amphibolitic sequence' (Units 2-5 on Preliminary Map 1985-MI-2) and to compare and contrast the quartzofeldspathic 'Sherridon' type arkosic gneisses (Unit 6, op. cit.) structurally below, and above the amphibolitic sequence.

Two ages of folds were identified within the map area, i.e., early folds (F1) with east-west axial planes and later folds (F2) with north-south axial planes (Fig. GS-20-6). The early folding event is evidenced by: 1)east-trending minor folds that are locally preserved in the more competent felsic quartzofeldspathic gneisses; 2) amphibole lineations that are oblique to north-south lithologic contacts; 3) gneissic layering that is oblique to north-south lithologic contacts; and 4) the later north-trending minor folds and crenulations that plunge in opposite directions. Only several minor east-west folds were observed and their axes have shallow plunges to the west.

Major lithologic units identified in the west part of the map area consist of distinctive fine grained felsic massive to layered pink weathering arkosic gneiss, fine- to medium-grained massive and layered intermediate grey-green weathering limy quartz-feldspar-amphibole ± biotite-bearing gneiss and massive to layered quartz-feldspar-biotite ± garnet gneiss (Fig. GS-20-6). Hornblende-feldspar and amphibolite gneisses are restricted to the northern portion of the map area and were not observed to be intimately interlayered with the main quartzofeldspathic gneissic units.

Three sections were examined in detail through the Unit 6 arkosic rocks (Preliminary Map 1985-MI-2) that occur to the east of and structurally below the amphibolitic sequence. Lithologic units observed were dissimiliar to the arkosic rocks observed in the western part of the map area. The main lithologic units are a fine grained grey-white weathering quartzofeldspathic arkosic gneiss and interlayered hornblende-feldspar/amphibolite gneisses. In addition, biotite-rich gneisses observed in the western part of the map area (Unit 5, Fig. GS-20-6) can be distinguished from Unit 1 greywacke gneiss (Preliminary Map 1985-MI-2) by a paucity of garnet and distinctive layers. Consequently, in the Evans Lake area there are two different units of quartzofeldspathic arkosic paragneisses. In addition, the biotite-rich greywacke-derived rocks occur in at least two different stratigraphic positions.

Mineralization was not observed in the western part of the map area. It appears to be restricted to rocks of the amphibolitic sequence at the structural top of the lowermost arkosic gneisses.

NOKOMIS LAKE

A reconnaissance of lithologic units was conducted east and west of the north end of Nokomis Lake during attempts to locate mineral occurrences #4 and #10 indicated by Robertson (1953). Lithologic units observed from west to east along the powerline east of Nokomis Lake and in the general vicinity of the #4 showing were: 1) pink weathering quartzofeldspathic gneiss; 2) the amphibolitic sequence that along strike contains the Nokomis Lake gold occurrence; 3) greywacke gneiss with minor graphite in conformable contact with; 4) grey weathering arkosic gneiss

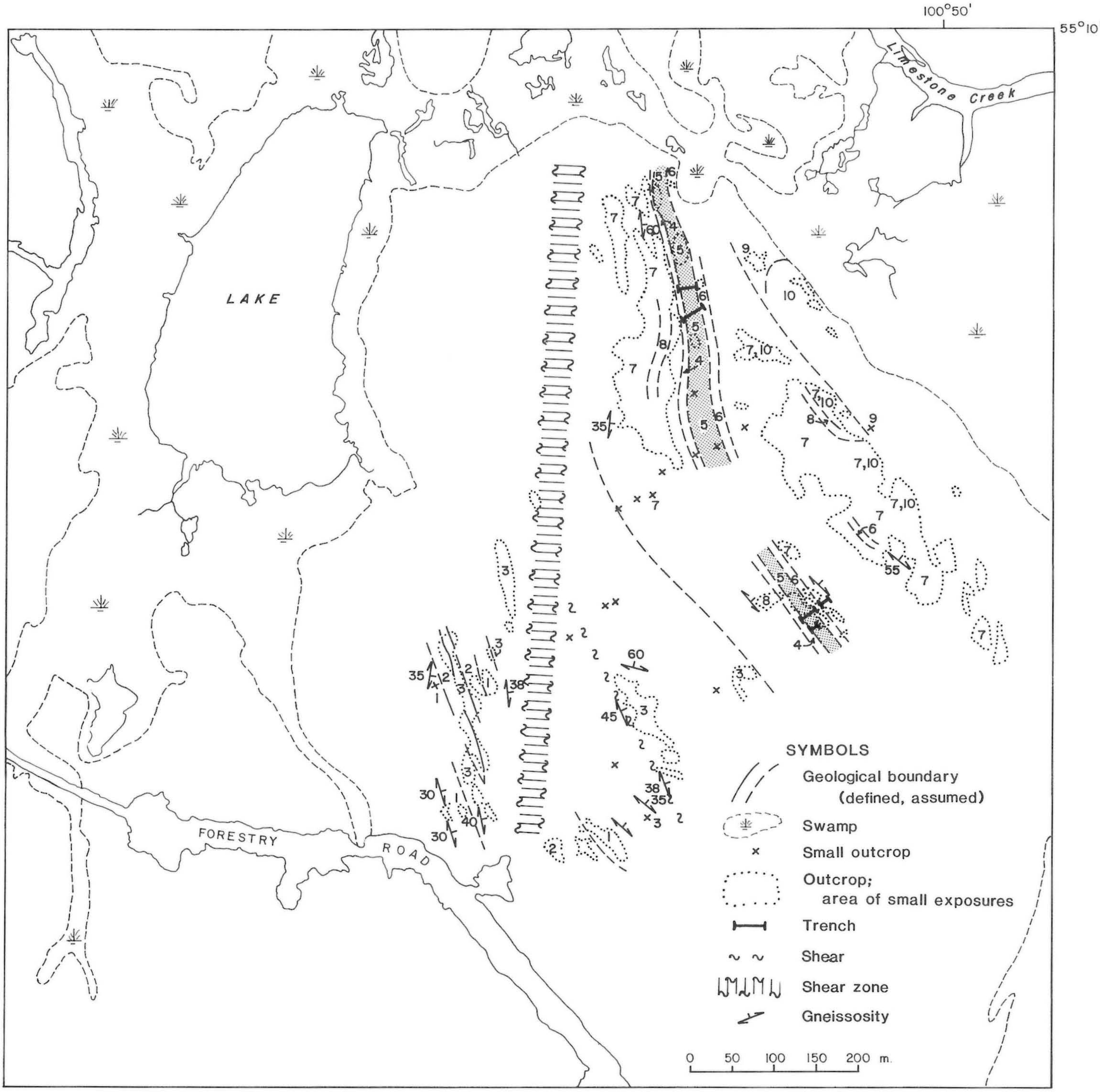


Figure GS-20-5: *Geology in the vicinity of the Douglas Group (#3) showing (Robertson, 1953). Legend (all units are fine- to medium- grained and intermediate to felsic in composition except where noted):* **1)** *biotite-rich qz-fd-gt gneiss with minor qz-rich qz-fd-bio-gt gneiss;* **2)** *qz-fd-hb-gt-mgte gneiss;* **3)** *epidote-rich amphibolite;* **4)** *amphibolite;* **5)** *rusty weathered coarse grained gt-anthophyllite rock and silicified paragneiss;* **6)** *amphibolite, variably garnetiferous and epidote-rich;* **7)** *qz-rich qz-fd-bio-gt gneiss;* **8)** *qz-fd-hb gneiss;* **9)** *interlayered amphibolite and unit 8; and* **10)** *coarse grained pink pegmatite. Abbreviations as follows: qz = quartz, fd = feldspar, hb = hornblende, bio = biotite, mgte = magnetite and gt = garnet.*

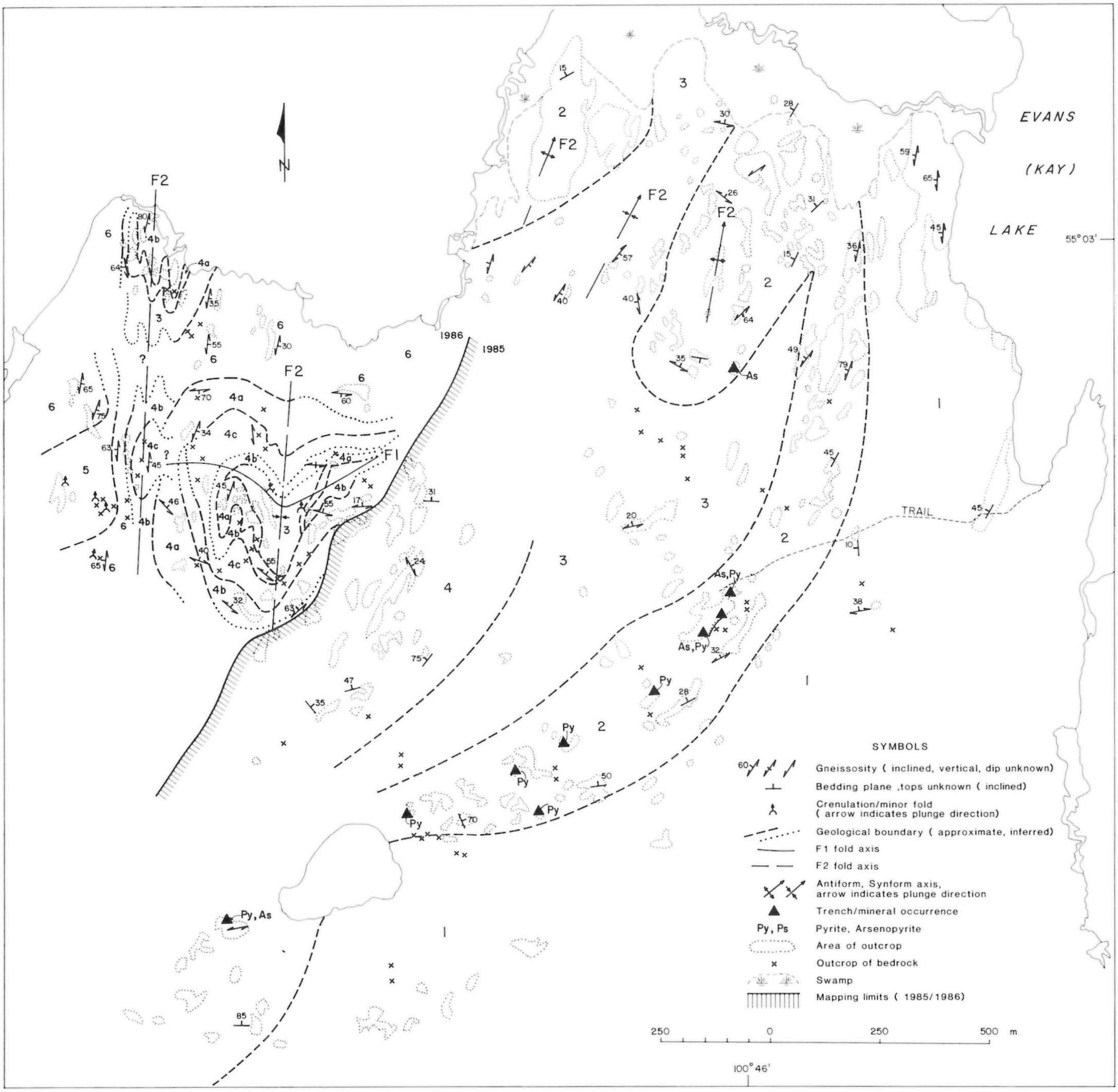


Figure GS-20-6: *General geology west of Evans Lake, Manitoba. Legend:* **1)** *felsic grey weathered arkosic gneiss with interlayered hornblende-feldspar/amphibolite gneiss;* **2)** *amphibolite sequence that contains arsenopyrite/gold mineralization;* **3)** *biotite-rich quartz-feldspar ± garnet gneiss;* **4)** *arkosic gneiss;* **4a)** *felsic pink weathered quartz-feldspar-biotite-magnetite gneiss;* **4b)** *banded pink weathered quartz-feldspar-biotite gneiss;* **4c)** *intermediate green weathered feldspar-amphibole-quartz ± calcite ± biotite gneiss;* **5)** *biotite-rich quartz-feldspar gneiss; and* **6)** *intermediate hornblende-feldspar gneiss with interlayered amphibolite. Geology of the east portion of map after Peloquin and Hayden-Luck (1985).*

with interlayered amphibolite; 5) greywacke gneiss; and 6) interlayered amphibolite and a lime-rich rock containing up to 50% calcite.

Along the powerline north of Nokomis Lake westward to Elken Lake the outcrops expose a felsic well foliated intrusion(?). A medium grained quartz-rich quartz-feldspar-biotite-garnet gneiss (the Sherridon gneiss of Robertson, 1953) and a medium grained garnet-anthophyllite unit form a series of ridges north of Elken Lake. This unit of quartz-rich gneiss is compositionally and texturally different from the arkosic gneisses observed both northeast of Nokomis Lake and at Evans Lake. Consequently Robertson's Unit 7 is considered to occupy a different stratigraphic position than the arkosic gneisses that occur immediately northeast of Nokomis Lake.

SUMMARY

Field examinations at Walton, Evans and Nokomis Lakes suggest that the Kisseynew gneisses in these areas comprise a quartz-rich quartzofeldspathic gneiss and repetitive sequences of greywacke and arkose derived gneisses that locally contain compositionally distinct amphibolitic units. In addition, the arkosic gneisses are lithologically dissimilar to the quartz-rich gneisses of the Sherridon structure mapped as Unit 7 by Robertson (1953).

At Puffy Lake stratigraphy within the two map areas is, in many respects, lithologically dissimilar. Direct stratigraphic correlation between the two areas is not suggested at this time.

Although observations at the Puffy Lake gold deposit indicate a different host lithology from that at the Nokomis and Evans Lake gold occurrences (cf. Gale and Ostry, 1984; Peloquin et al., 1985) all mineralization consists of visible gold and/or gold-bearing disseminated sulphide commonly associated with quartz veins and associated wall rocks. The quartz veins and sulphide mineralization are restricted to narrow stratigraphic intervals.

ACKNOWLEDGEMENTS

Cam Fehr is thanked for his able assistance during the course of the field season. Shirley Peloquin, Brian Tannahill and Dave Parbery are thanked for their assistance during portions of this summer's field work.

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GS-21 PROJECT CORMORANT — SUB-PALEOZOIC INVESTIGATIONS SOUTH OF FLIN FLON AND SNOW LAKE

by W.D. McRitchie and I.T. Hosain

Since 1980 the Provincial Geological Services Branch has collaborated with the Geological Survey of Canada in mounting combined airborne gradiometer, total field and VLF surveys in the Flin Flon-Snow Lake region with the intent of generating a geophysical data set that could be used to augment and facilitate a geological compilation of adjacent basement rocks concealed beneath Paleozoic carbonates (McRitchie and Hosain, 1985).

Surveys conducted in 1985 over the Namew Lake, Nokomis-Sherridon, and northern Moose Lake areas (Fig. GS-21-1) are now in an advanced stage of compilation with release as GSC open files scheduled for early 1987.

Coverage in 1986 focussed on the Elbow Lake, Hargrave River and southern Moose Lake areas (Fig. GS-21-1).

Ten "scout" drill holes were completed by the Province in the western sector of Paleozoic cover rocks south of Athapapuskow Lake and Cranberry Portage (Table GS-22-1). Ground magnetic surveys were again run prior to drilling to pinpoint the airborne responses. Complete drill logs, including the Paleozoic sections, are given by H.R. McCabe (GS-40, this volume).

Most holes were located over second-order priority magnetic highs and lows corresponding with amphibolite grade granitoid gneisses, hornblende diorite, and non-magnetic granite. Hole M-15-86, drilled to test an inferred fault zone, encountered retrograde, thoroughly pinked monzogranite with several discrete cataclastic zones and fractures lined with carbonate, chlorite and hematite. Many holes intersected shallow to near-horizontal layering which contrasts markedly with much steeper structures encountered in the greenstone terrain to the north. Gabbroic and ultramafic rocks were not encountered this year. White kaolinitic zones up to 2.5 m thick were penetrated in several holes (M-14, 16, 17, 20 and 21) immediately beneath the basal sandy Paleozoic carbonates. The kaolinite is pure with little associated silica. Underlying lithologies range widely from layered mesocratic gneisses to granite.

An initial compilation of all available geological and geophysical data is being undertaken by Taiga Consultants Ltd. for NTS area 63K, as an adjunct to the Federal and Provincial MDA investigations in the area. A report and map will be issued in due course as a GSC open file.

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McRitchie, W.D. and Hosain, I.T

1985: Project Cormorant — Sub-Paleozoic investigations south of Flin Flon and Snow Lake; in Manitoba Energy and Mines, Report of Field Activities 1985, p. 109-111.

TABLE GS-21-1
PROJECT CORMORANT DRILLING PROGRAM 1986. PRECAMBRIAN DRILL HOLE INTERSECTIONS — SUMMARY DESCRIPTIONS

M-13-86 #46[1] — Precambrian 20.7-44.6 m.(weathered to 21.4 m) non-magnetic
Grey foliated heterogeneous and migmatitic granitoid gneisses with narrow thin hornblende and biotite-rich foliae, blocks and schlieren throughout. Trace epidote and sporadic pyrite throughout. Pink-grey granite veins near base of hole. Local pinked and retrograde zones up to 20 cm thick.

M-14-86 #41 — Precambrian 22.8-30.19 m (weathered to 25.2 m) non-magnetic
Pink coarse grained equigranular homogeneous unfoliated granite with local feldspathic intervals; 20 cm kaolinized zone at top.

M-15-86 #47 — Precambrian 6.7-23.5 m
Medium grained homogeneous equigranular unfoliated pink and grey hornblende and biotite-bearing monzogranite with extensive pinking and retrogression throughout. Thin chlorite and carbonate-lined fractures and millimetre thick cataclastic zones.

M-16-86 #7 — Precambrian 38.5-47.85 m (weathered to 39.1 m) non-magnetic
Pink and locally grey, foliated medium grained equigranular granitoid gneisses with thin sporadic hornblende-rich mesocratic gneiss layers and quartz-feldspar veinlets. Foliation shallow to near horizontal. Uppermost 65 cm kaolinized.

M-17-86 #34 — Precambrian 64.8-81.5 m (weathered to 65.8 m) non-magnetic
Granitic gneiss with extensive sections of foliated mesocratic medium grained hornblende diorite. Coarse grained pegmatitic granite veins and *lits* throughout lower intervals. Kaolinite from 64.8-65.8 with 1.4 m missing core.

M-18-86 #38 — Precambrian 58.4-90.7 m (weathered to 59.8 m) moderately magnetic throughout
Medium-coarse grained weakly foliated generally homogeneous and equigranular and gneissic hornblende metadiorite with rare small mafic rafts and feldspathic veinlets.

M-19-96 #37 — Precambrian 62.7-78.17 m (weathered to 63.7 m) weakly magnetic throughout
Medium- to coarse-grained hornblende and biotite-bearing equigranular unfoliated grey diorite-granodiorite with rare pink pegmatite veins and metre thick retrograde zone with associated cataclasis.

M-20-86 #40 — Precambrian 32.3-75.4 m (weathered to 48.3 m) strong magnetic intervals.
Thinly layered and foliated hornblendic gneisses with 1-20 m white feldspathic layers and foliae throughout. Feldspathic grey gneisses from 47.5-53.25 m. Rare epidote-rich layers. Retrograde zone with abundant chlorite, biotite, and local breccia from 53.25-56.5 m. Pyrite-rich veinlets associated with late stage fractures. Foliation and layering shallow to subhorizontal; 2 m white kaolinite at top with some lost recovery.

M-21-86 #42 — Precambrian 37.7-42.0 m (weathered to 38.5 m) non-magnetic.
Fine- to medium-grained equigranular, weakly foliated, quartz-feldspar-biotite gneiss underlying foliated and layered pink and grey granitic gneisses. Steep discrete late fractures, carbonate and hematite-lined. Topmost 37 cm highly kaolinized; moderately kaolinized for a further 83 cm.

M-22-86 #49 — Precambrian 18.6-30.19 m (weathered to 18.8 m) non-magnetic
Coarse grained homogeneous, unfoliated, equigranular pink granite with local grey bleached zones from 19.03-20.45 and 21.67-21.89 m. Near-vertical late fractures, calcite, chlorite and hematite-lined.

[1] Location numbers refer to sequence used in program planning and are for internal reference only.

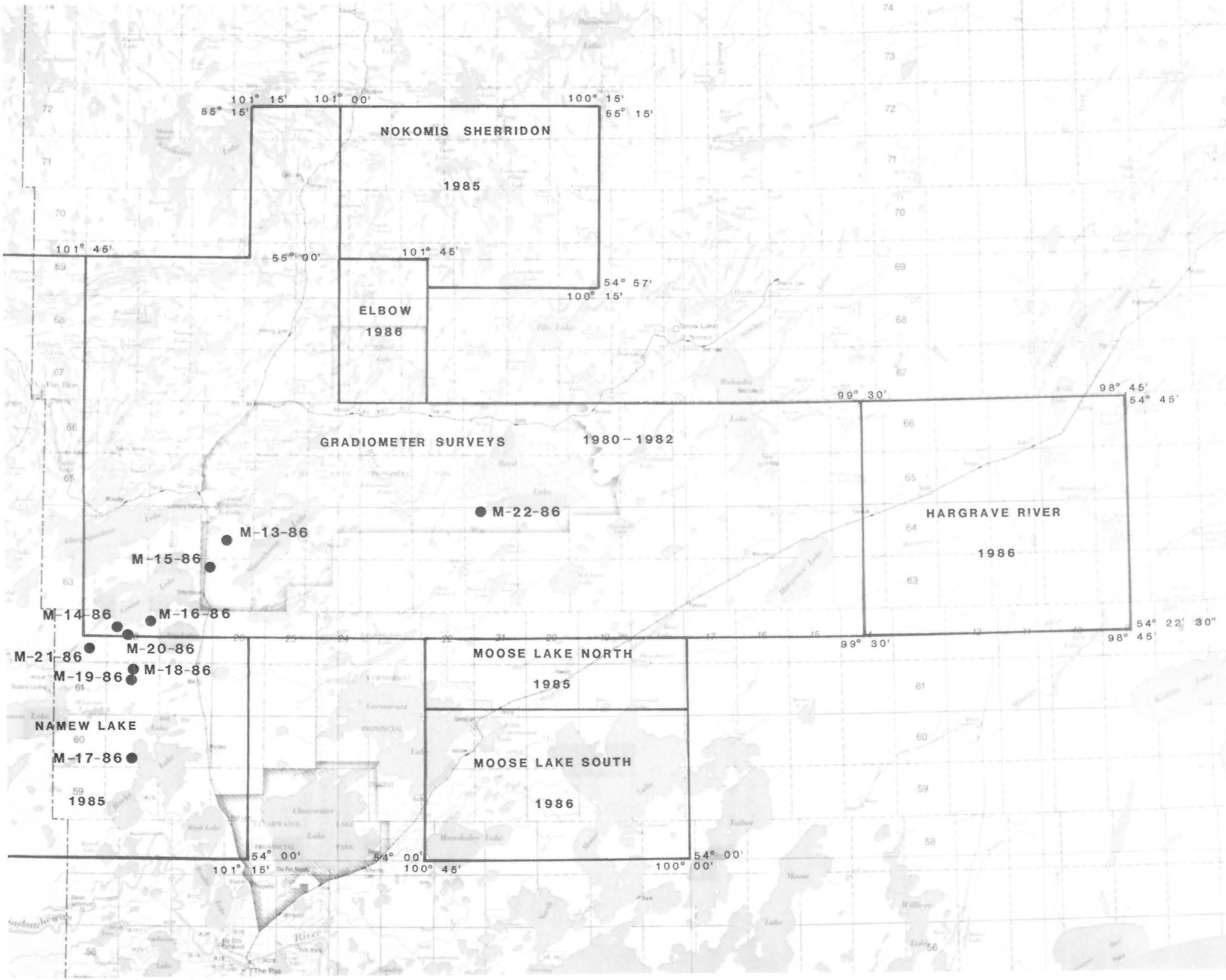

Figure GS-21-1: *GSC gradiometer surveys in the Project Cormorant area and location of 1986 "scout" drilling.*

GS-22 STRATIGRAPHY OF THE MANIGOTAGAN RIVER FORMATION; RICE LAKE GREENSTONE BELT

by D.M. Seneshen[1]

INTRODUCTION

Geological mapping of a part of the Manigotagan River Formation (MRF), recognized in 1985 (Seneshen and Owens, 1985), was conducted at a scale of 1:1000. The area mapped is indicated on Figure GS-22-1.

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The objectives of mapping the MRF in detail are two-fold:

(1) To achieve a better understanding of volcanic and sedimentary processes in the transition zone from volcanic to sedimentary environments in the Stormy Lake area.

(2) To determine the location of a vent complex based on stratigraphic relationships.

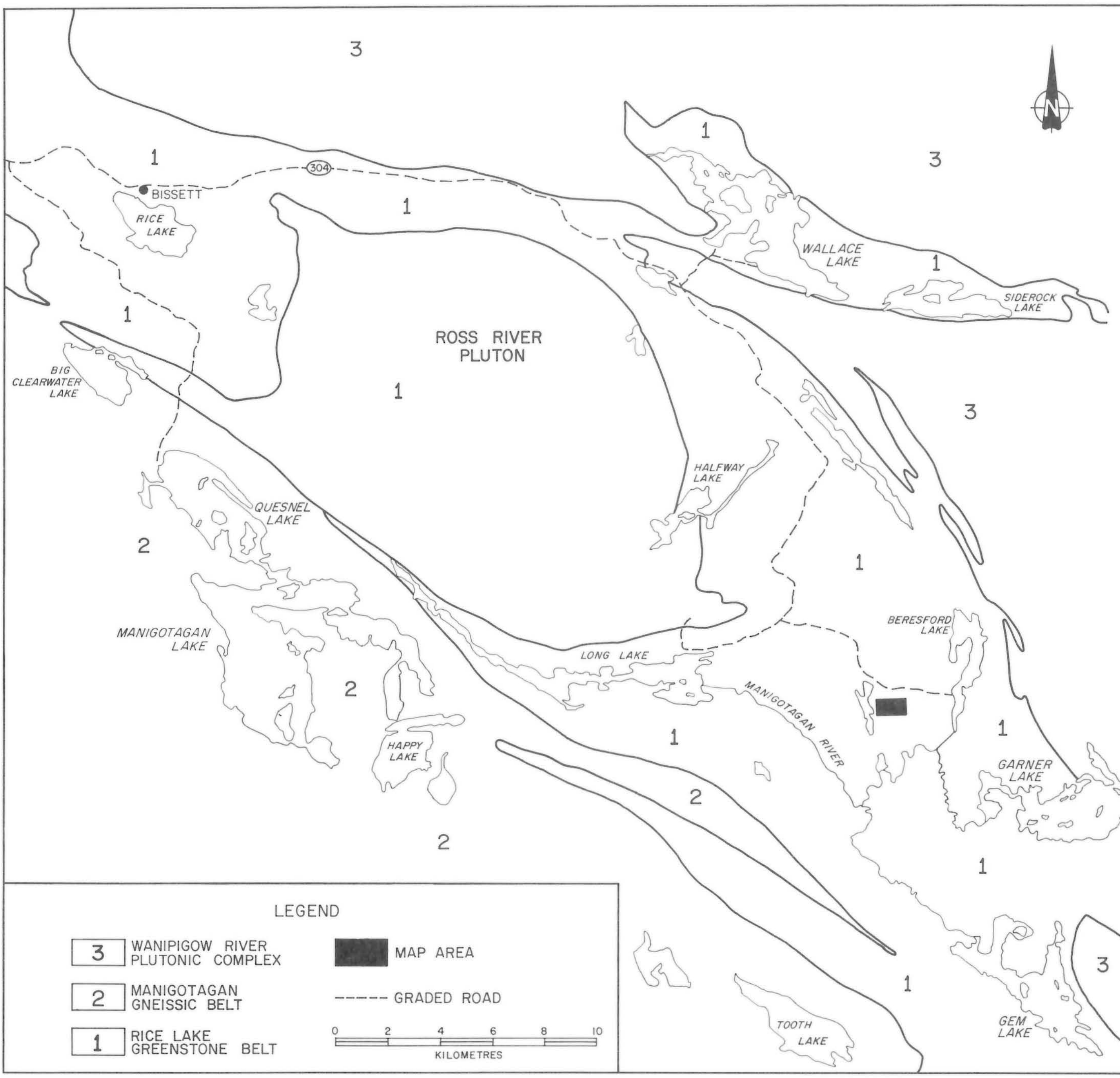

Figure GS-22-1: General geology of the Rice Lake belt with outline of map area.

SUMMARY OF RESULTS

The detailed mapping yielded the following results:

(1) The MRF records the waning stages of silicic and intermediate volcanism in the Stormy Lake area.
(2) Lateral and vertical facies variations within the MRF suggest the existence of a vent complex to the southeast.
(3) Deep erosional scour and fill structures at two separate stratigraphic levels in the formation indicate that the vent complex was probably subaerial.
(4) Shear zones at various stratigraphic levels within the formation are mineralized and represent exploration targets.

GENERAL GEOLOGY

The MRF is a 300 m thick southwest-facing homoclinal volcanic-sedimentary sequence which has been intruded by gabbros. The formation represents the transition zone between felsic pyroclastic rocks to the northeast (Narrows Formation) and turbiditic sediments to the southwest (Edmunds Lake Formation). The area mapped represents a portion of the west limb of a large-scale southward-plunging anticlinorium (see Weber, 1971).

UNIT DESCRIPTIONS

NARROWS FORMATION (1)

Within the map area the Narrows Formation is dominantly composed of well foliated dacitic lapilli tuff and tuff breccia. This formation has been described previously (Seneshen and Owens, 1985; Weber, 1971).

FELSIC PYROCLASTICS (2)

This unit is 10-35 m thick and was subdivided into: lapilli tuff (2a), tuff (2b), pumiceous tuff (2c). Where best exposed unit 2 shows at most two complete fining-upward cycles from lapilli tuff to massive tuff or pumiceous tuff. Numerous quartz veins typically occur in rocks of unit 2. The upper contact of unit (2) with unit (3) is extremely sheared and silicified.

INTERMEDIATE PYROCLASTICS (3)

This unit comprises brownish grey monolithic tuff breccia. It is 90 m thick in the southeast and 30 m in the northwest. The breccia contains 5-40% lensoid or irregular-shaped 1-50 cm intermediate volcanic fragments. The framents typically have hydrothermally altered rims (Fig. GS-22-2), cooling cracks and an abundance of vesicles which may be filled with quartz. Minor pyrite disseminations occur in the tuff breccia. The matrix of the breccia is a well foliated chlorite-biotite schist. The matrix is feldspar-phyric at the base of the unit (3). Both bedding and grading become more distinct upwards in the unit. Fragment vesicularity increases upwards. The top of the unit usually contains 10-20 cm rafts of pumice. The upper contact of unit (3) is irregular, possibly reflecting pre-existing topography.

PEPPERITE (4)

Unit (4) comprises intercalated mafic volcanics and feldspathic epiclastic sediments and has been subdivided into six subunits. Subunit 4a is an orange to reddish-brown planar bedded siliceous siltstone — fine grained sandstone succession. This subunit is thickest in the northwest part of the map area.

The mafic extrusive rocks (4b, 4c) are most prominent in the southeast part of the map area and taper out into discontinuous lenses in the northwest. The transition from pillowed to massive flows occurs rapidly along strike, possibly indicating an exposed vertical section of several flow lobes. Fine grained feldspathic sediments are commonly associated with the mafic extrusive rocks as interpillow cavity or crack fillings (Fig. GS-22-3). Pillows are essentially undeformed in the southeast whereas they are highly flattened in the northwest. In the southeast, scour and fill structures (4 m deep) as well as scoured pillows (Fig. GS-22-4) provide evidence for subaerial erosion.

Subunit 4d is a lens of mafic volcanic conglomerate in the southeast portion of unit 4. The conglomerate contains up to 10% subangular mafic vesicular clasts which have been eroded from underlying pillowed volcanics.

Subunit 4e is mainly pebbly arkose. Normal grading and scours in the arkose indicates tops consistently towards the southwest. In the northwest part of the map the pebbly arkose contains numerous siltstone intraclasts. Medium grained, pebbly arkose fines upwards into a planar bedded, fine grained feldspathic, quartz-poor sandstone (4f). The top 1 m of unit 4f is typically composed of well developed A-E turbidites.

VOLCANOGENIC EPICLASTIC SEDIMENTS (5)

Unit 5 has been subdivided into four separate subunits. Subunit 5a is a 10-30 m thick polymictic paraconglomerate which marks the base of unit 5. In the northwest part of the map a 20 m deep scour into turbidites of unit 4f is filled with polymictic conglomerate (Fig. GS-22-5). The conglomerate is composed of felsic and intermediate volcanic rounded boulders that float in a medium- to coarse-grained arkosic matrix.

The conglomerate grades upwards (SW) into pebbly arkose (5b). The arkose contains an abundance of 1-2 cm, felsic, plagioclase-quartz-phyric volcanic pebbles. The matrix comprises 70-80% well rounded plagioclase grains (1-2 mm) and 20-30%, 1-2 mm subangular quartz grains.

The pebbly arkose grades upwards into massive fine grained arkose (5c) that, in places, has a banded appearance due to variations in chlorite content.

Subunit 5d is a brownish green chloritic, planar bedded greywacke-grit succession and ranges in thickness from 20 m in the southeast to 10 m in the northwest. Grading in greywacke beds also indicates tops toward the southwest.

SHALLOW INTERMEDIATE INTRUSIVE ROCKS (6)

Unit 6 is 10-20 m thick, maintains a uniform texture along strike and has been subdivided into three subunits. Subunit 6a is a feldspar-phyric phase which is typically confined to the lowermost 2 m of the intrusion. The intrusion is greenish grey, fine grained and contains up to 10% subhedral 1-2 mm plagioclase laths.

Subunit 6b, representing the central portion of the intrusion, contains up to 5% fine grained disseminated magnetite and up to 7% disseminated pyrite clots and veinlets.

The upper part of the intrusion (6c) is non-magnetic, aphyric and is highly vesicular. In places, vesicles are filled with quartz-carbonate amygdules.

In outcrop, unit 6 has a well layered appearance with dark grey, more mafic layers alternating with medium grey layers. In the southeast part of the map area polygonal joints(?) occur in the intrusion near the contract with arkose (5c, Fig. GS-22-6).

Discordant offshoots from the intrusion occur in the overlying chloritic sediments of unit 5d. It is proposed that these offshoots may be feeder dykes for the intermediate extrusive rocks of unit 7.

INTERMEDIATE EXTRUSIVE ROCKS (7)

Unit 7 ranges in thickness from 5-30 m and thins significantly towards the northwest. It has been subdivided into three subunits. Subunit 7a is a massive, brownish grey, fine grained intermediate volcanic rock; it is usually confined to the base of unit 7. Subunit 7b is a pillow breccia which occurs as lens-like masses in the central portion of the flows. The pillow breccia contains up to 60% light grey, highly vesicular, amygdaloidal, irregular-shaped fragments set in a well foliated chloritic matrix. Subunit 7c is typically confined to the upper portions of flows. It is composed of well preserved light grey, carbonatized, extremely vesicular pillows. Interpillow cavities commonly contain pyritic chlorite-rich pods. Pillow shapes indicate tops towards the southwest.

Figure GS-22-2: *Hydrothermal reaction rim around andesitic fragments in tuff breccia.*

Figure GS-22-3: *Fractures in pillowed volcanics infiltrated with feldspathic sediments.*

Figure GS-22-4: *Scoured pillow volcanics near the top of unit 4.*

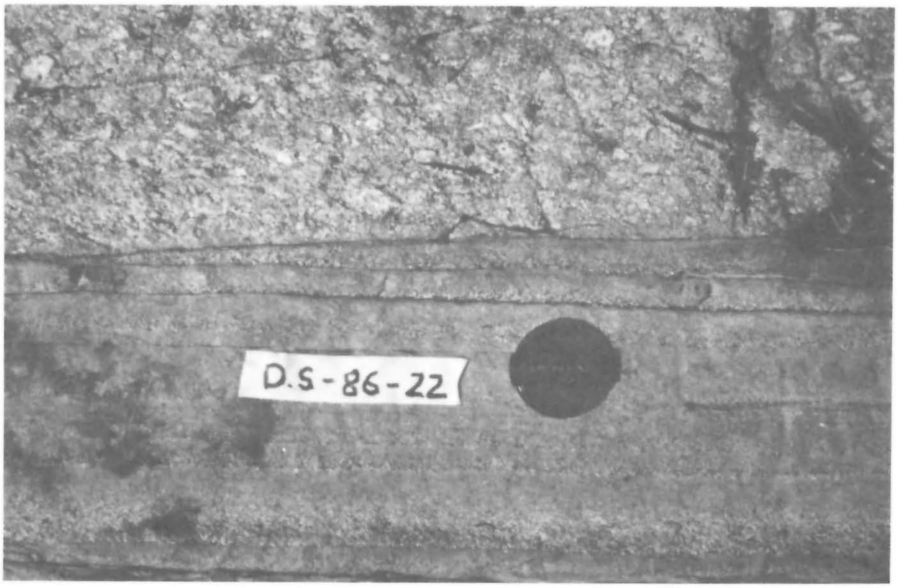

Figure GS-22-5: *Truncation of graded bedding by scour at the top of unit 4.*

Figure GS-22-6: *Polygonal jointing in shallow intermediate intrusion (6).*

FINE GRAINED CLASTICS (8)

Unit 8 is mainly composed of intercalated fine grained, reddish brown sandstones and siltstones. Normal grading and siltstone ripups in sandstone beds indicate tops to the southwest. Reddish brown, pyritic, plagioclase-phyric crystal tuff occurs in the basal part of unit 8. The crystal tuff is about 1 m thick and can be traced for 900 m along strike. A 1-2 m thick black argillite marks the top of unit 8.

FELSIC PYROCLASTICS (9)

Unit 9 consists of two subunits. Subunit 9a comprises orange coloured lapilli tuff. The lapilli tuff contains up to 10%, 1-5 cm, angular, dark grey, siliceous, feldspar-phyric fragments in a fine grained tuffaceous matrix. Subunit 9b comprises massive or bedded, maroon to orange coloured tuff. In the southeast part of the map area a number of normally graded and reverse graded beds outcrop. Lithic-rich lapilli tuff beds fine upwards while pumiceous beds coarsen upwards. Massive maroon tuff beds are commonly intercalated with graded lapilli tuff beds. The number of graded lapilli tuff beds decreases towards the northwest (Fig. GS-22-7), possibly indicating a transition from proximal to distal parts of a pyroclastic flow.

EDMUNDS LAKE FORMATION (10)

The boundary between the MRF and the Edmunds Lake Formation is gradational suggesting that no major unconformity exists. The Edmunds Lake Formation is represented by a succession of intercalated grit, fine grained greywacke, siltstone, mudstone and oxide facies iron formation. It has been defined and described by Campbell (1971).

MAFIC INTRUSIVE ROCKS (11)

The mafic intrusive rocks have been subdivided into magnetite-hornblende-phyric gabbro (11a) and hornblende-phyric gabbro. Magnetite-bearing gabbro usually occurs above the main phase hornblende-phyric gabbro. Magnetite occurs as discrete 2-5 mm clots and

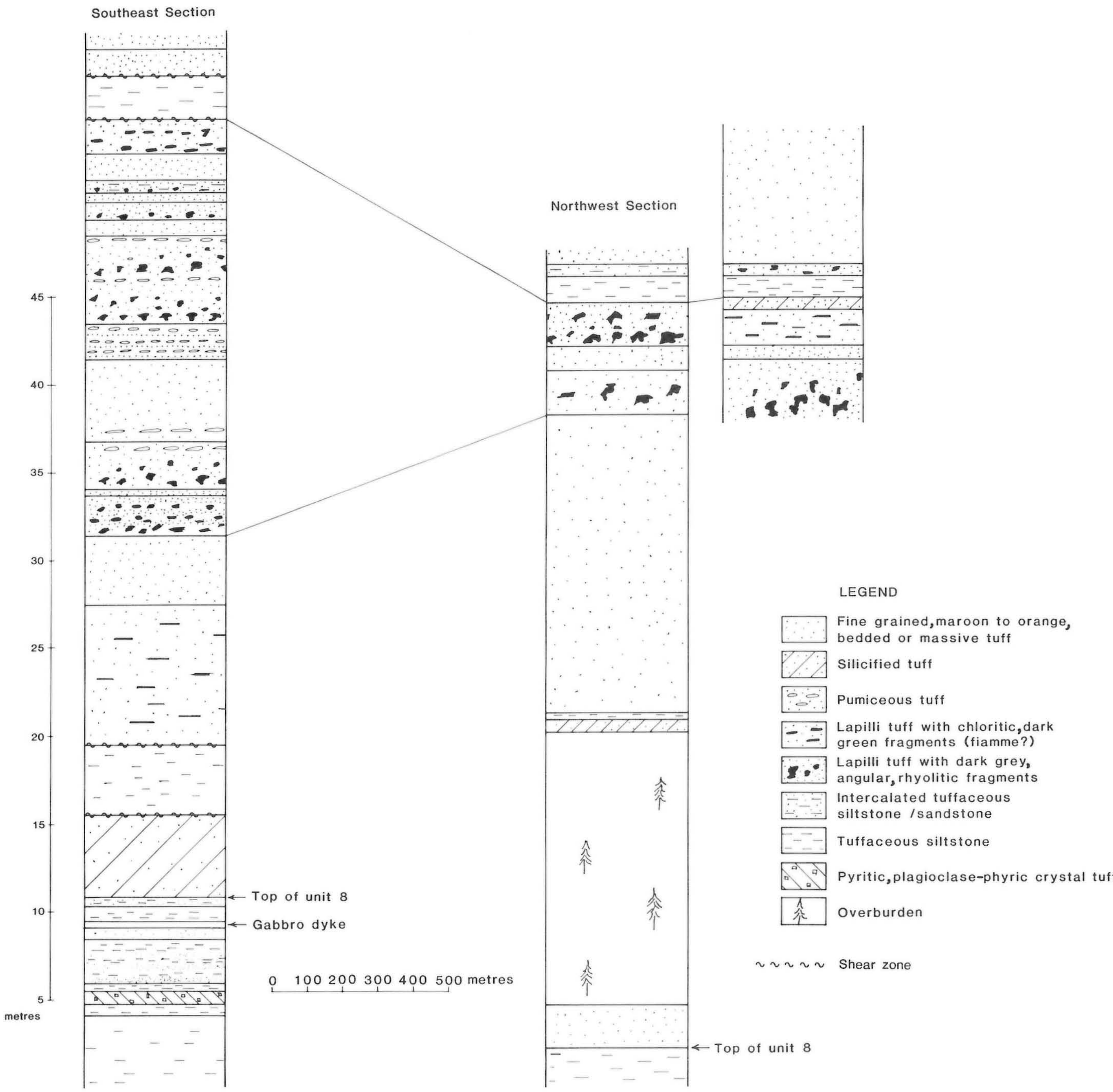

Figure GS-22-7: Stratigraphic sections through unit 9 showing a decrease in lapilli tuff bed thickness from the southeast to the northwest.

less commonly as irregular stringers. The main phase hornblende-phyric gabbro (11b) is greenish brown fine- to medium-grained and exhibits diabasic texture. Typically it contains 40-50% amphibole aggregate clots (derived from pyroxene?) which are enclosed in a greenish fine grained plagioclase groundmass. Minor pyrite disseminations also occur in the gabbro. Pegmatoidal gabbro is present in a few localities as a minor phase. For the most part the gabbro has been intruded along bedding planes; however, in the extreme southeast part of the map area an offshoot of the gabbro has intruded overlying sediments (Fig. GS-22-8). Country rock adjacent to the gabbro is typically well foliated and reddish brown.

DIABASE DYKES (12)

Diabase dykes are 1-2 m thick, brownish grey and fine grained, and have a distinct pitted appearance due to the presence of vesicles and the removal of pyrite cubes by weathering.

STRUCTURAL GEOLOGY

The main foliation in the map area ranges from 320° to 350°. Foliation becomes intense in proximity to mafic or intermediate intrusions. Broad warps in the bedding along strike may be the result of stoping

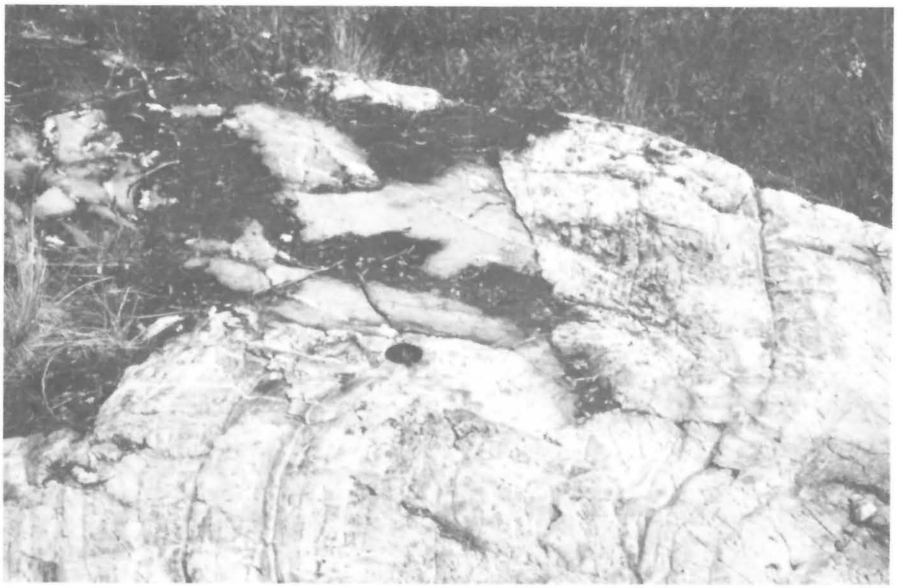

Figure GS-22-8: *Discordant relationship between gabbro (11) and feldspathic sediment (4).*

processes caused by mafic intrusions.

There may have been significant bedding plane slip within the MRF, e.g., in the central part of the map area an intermediate intrusion has apparently undergone right lateral offset. Further evidence in support of bedding plane movements includes: an abundance of drag folds observed along lithologic contacts, and shear zones at various stratigraphic levels that parallel the strike of bedding planes.

A few cross-cutting faults occur in the MRF; however, offset is minimal. For the most part, all of the stratigraphic units within the map area are correlatable.

ECONOMIC GEOLOGY

Three separate areas within the map area appear to be potential mineral exploration targets. A well foliated, pyritized zone occurs at and just above the upper contact of intermediate tuff breccia (3) with siliceous, pyritic reddish brown tuffaceous sandstones. The zone contains up to 10% pyrite in proximity to the mafic intrusion in the northwest part of the map.

Another potential exploration target is a 1.5 m reddish brown, pyritic crystal tuff which occurs at the base of unit 8 for about 900 m.

The thick, extensive hornblende-magnetite gabbro has potential for gold mineralization. In places it contains up to 15% quartz veins with minor pyrite disseminations. The contacts of the mafic intrusion are commonly well foliated and should also be investigated for gold mineralization.

Volcanic units within the MRF either thin dramatically or taper out completely towards the northwest. It is suggested that exploration should be concentrated towards the southeast part of the map area, as this would be more proximal to a vent complex. However, if the vent complex was subaerial and subsequently eroded, mineral exploration should be concentrated in a more distal facies (Lowe, 1982) such as the Edmunds Lake Formation.

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GS-23 STRATIGRAPHY AND STRUCTURE OF THE UPPER STORMY LAKE FORMATION, RICE LAKE GREENSTONE BELT

by D.J. Owens[1]

INTRODUCTION

Detailed geological mapping was conducted in the Stormy Lake area of the Rice Lake greenstone belt at a scale of 1:1000. The map area is outlined in Figure GS-23-1. Previous mapping in and around the map area was done by Stockwell (1945), by Weber (1971) and Zwanzig (1969, 1971) as part of Project Pioneer, and by Seneshen and Owens (1985).

In the summer of 1985, 1:10 000 mapping by Seneshen and Owens (1985) revealed important stratigraphic and structural problems in the area. More detailed mapping was undertaken to:

(1) further define the stratigraphy of the upper portion of the Stormy Lake Formation;
(2) provide a more detailed analysis of deformation within the Stormy Lake Formation;
(3) establish mineralization trends which may be associated with specific stratigraphic and structural features.

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SUMMARY OF RESULTS

(1) The Stormy Lake Formation contains a unique upper member with large-scale slump features.
(2) The rocks underwent at least three periods of deformation.
(3) Sulphide mineralization occurs along the axial trace of major folds within mafic rocks and iron formation.

GENERAL GEOLOGY

Volcanic and sedimentary rocks of the Stormy Lake Formation are part of the Bidou Lake Subgroup, the lowermost subgroup of the Rice Lake Group (Campbell, 1971). The stratigraphic sequence within the map area comprises the upper members of the Stormy Lake Formation. This formation was initially described by Zwanzig (1969) and further defined by Seneshen and Owens (1985). The map area itself is situated near the south-southeast-trending axial trace of a major fold in the Rice Lake greenstone belt.

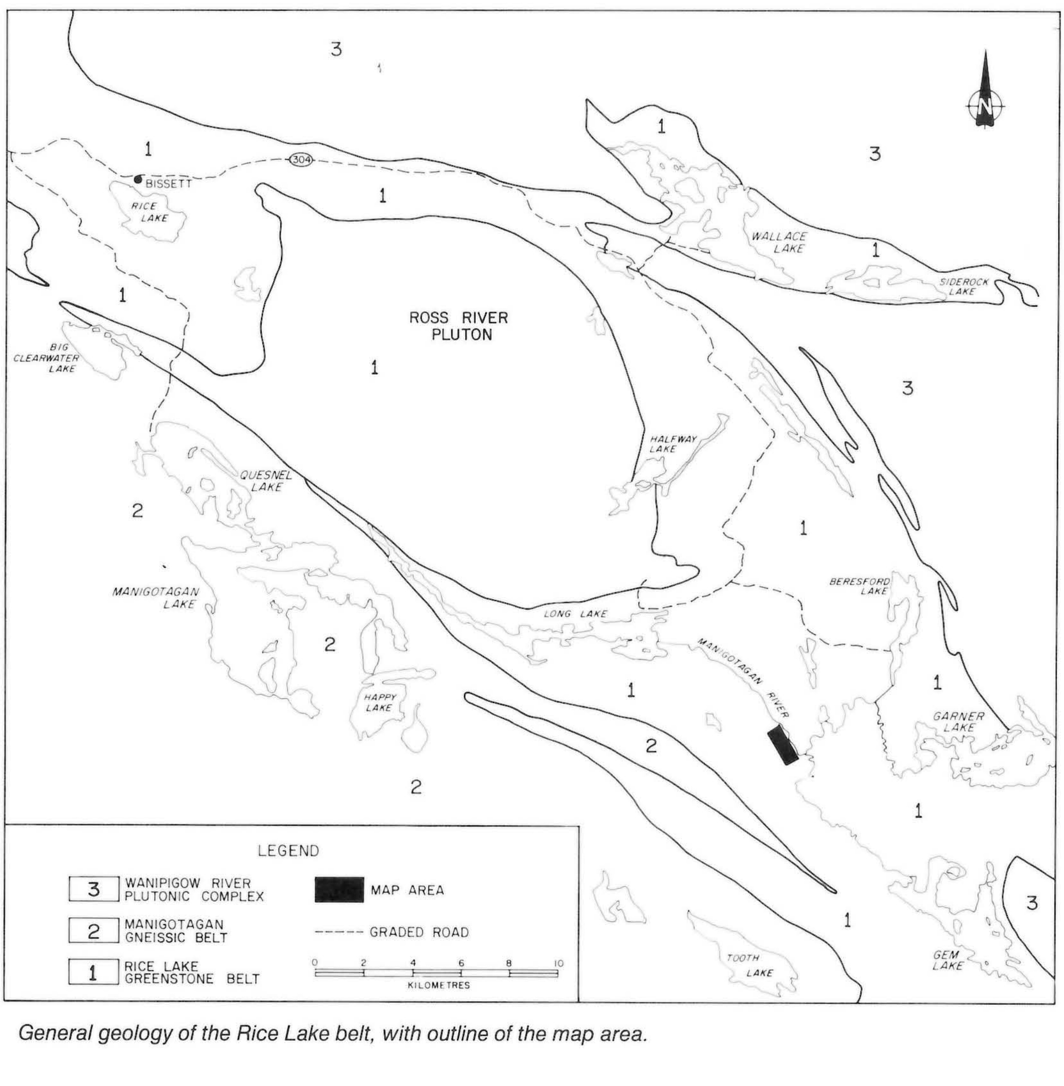

Figure GS-23-1: General geology of the Rice Lake belt, with outline of the map area.

The volcanic and sedimentary rocks within the map area can be subdivided into four successions, the lowermost of which has been largely intruded by gabbroic sills, and later felsic intrusions. The rocks subsequently underwent at least three periods of deformation (Fig. GS-23-2).

STRATIGRAPHY

FELSIC TUFF, TUFFACEOUS SANDSTONE, TUFFACEOUS SILTSTONE (1)

This unit comprises mainly felsic tuff, tuffaceous sandstone, and tuffaceous siltstone forming 1-60 cm thick massive and graded beds. Detrital quartz constitutes up to 20% of the reworked deposits.

Associated with unit 1 are 5-100 cm thick discontinuous horizons of intercalated finely laminated to finely bedded greywacke, chert, greenish chloritic argillite and whitish siliceous argillite. At least four of these horizons contain banded magnetite-rich iron formation. The iron formation is interlaminated with chert and occurs in 0.5-20 cm thick highly discontinuous beds. Associated argillaceous units are also magnetiferous. Minor 2-15 cm thick beds of pisolitic greywacke occur with the iron formation (Fig. GS-23-3).

VOLCANIC CONGLOMERATE, TUFF BRECCIA, TUFF (2)

This 2-20 m thick unit is an intercalation of coarse felsic volcanic conglomerate, heterolithic tuff breccia, lapilli tuff, and tuff with minor units of feldspathic greywacke, tuffaceous siltstone, and siliceous argillite. In places, the coarser units can be subdivided from the finer grained sediments. Tuffaceous units occur in 2-100 cm thick massive beds. The tuff breccia contains felsic and intermediate volcanic clasts, 2-60 cm across, in a tuffaceous sandstone matrix.

MASSIVE AND PILLOWED BASALT (3)

This 5-40 m thick discontinuous unit is composed mainly of massive and pillowed basalt with minor lenses of tuff breccia and tuff similar to that found in unit 2. The basalt is very fine- to medium-grained and shows graded igneous layering in places.

SLUMP BRECCIA (4)

This unit is a chaotic assemblage of blocks of all the lithologies defining units 2 and 3. Blocks of massive and pillowed basalt are as large as 30 m long; blocks of tuff breccia, well bedded siltstone, greywacke and

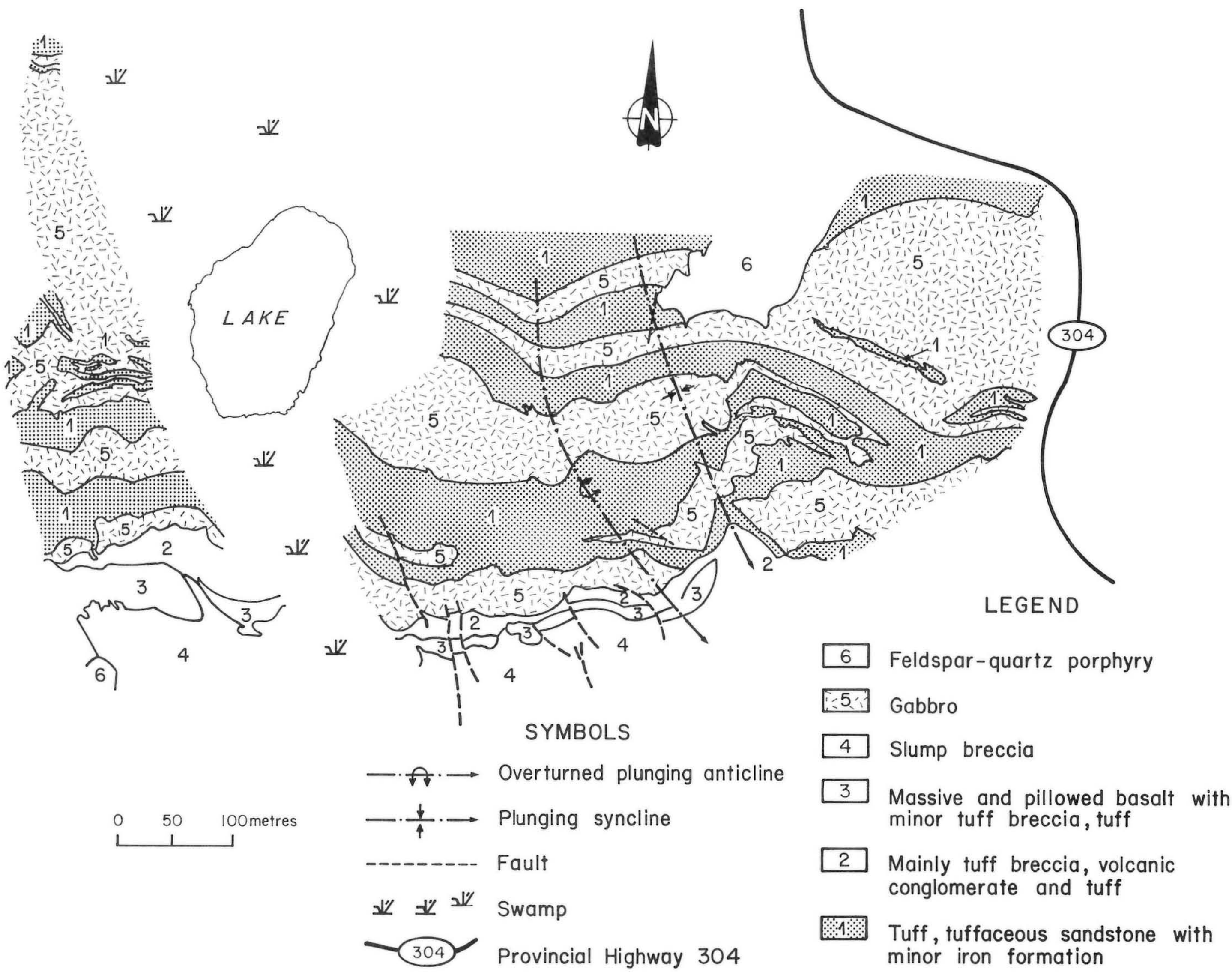

Figure GS-23-2: Lithology and structure of the map area.

Figure GS-23-3: *Banded magnetite-rich iron formation interbedded with dark green chloritic argillite.*

argillite are up to 20 m across. The matrix of the blocks is difficult to categorize and appears to comprise mainly a chaotic assemblage of felsic heterolithic tuff breccia and tuff.

Field relationships suggest that this unit is a large-scale slump feature, but its actual extent is unknown. It is presently assumed that this is the uppermost member of the Stormy Lake Formation, but its exact relationship with the overlying Narrows Formation (Seneshen and Owens, 1985) remains to be resolved.

MAFIC INTERMEDIATE INTRUSIONS (5)

Gabbroic sills form approximately 50% of the mapped stratigraphic succession. They are largely conformable with bedding in the sedimentary rocks, but many mappable crosscutting relationships are present.

The gabbro varies in composition and has been subdivided into two gabbroic phases: gabbro and leucogabbro (20-30% amphibole). The gabbro is very fine- to coarse-grained with subophitic textures predominating. The leucogabbro is coarse grained with oikocrystic and ophitic textures. Near the contact with country rocks gabbro is locally vesicular.

Andesitic dykes 20-50 cm wide crosscut gabbro and country rock contacts. They commonly contain medium grained plagioclase porphyritic cores with well developed chill margins.

FELSIC INTRUSIVE ROCKS (6)

One feldspar-quartz porphyry body forms an approximately 100 m thick, irregular-shaped intrusion at the northeastern edge of the area. A small ovoid-shaped body, about 20 m wide, occurs at the southwestern edge of the area.

STRUCTURAL GEOLOGY

Good top indicators such as scours, rip-ups, graded bedding, and crossbedding are common within sedimentary rocks of units 1, 2 and 3. They indicate that the strata have undergone an initial major open folding event (D_1) along at least two main northwest-trending axes. A main regional foliation that is well to poorly developed is axial planar to these major folds and the minor folds associated with them (Fig. GS-23-4). Associated minor folds plunge steeply, with an azimuth of 090 to 130°.

Figure GS-23-4: *Concentrically folded chert and argillite.*

A major overturned southeasterly plunging anticline transects the east-central part of the map area. A smaller syncline-anticline pair occurs on its upright eastern limb. A major southeasterly plunging syncline lies just east of the major anticline.

The curvilinear axial trace of the major folds and the extreme variation in the plunge of minor folds suggests a crossfolding event (D_2). The axis to this second folding event trends roughly east-west and may be equivalent to a second folding event described by Zwanzig (1969) at Long Lake, located about 5 km to the west.

The third deformational event (D_3) involves the development of late northwest- and north-trending faults and joints. Lateral displacements of up to 10 m were observed. Relative movements are dominantly sinistral, but textral displacements are also present (Fig. GS-23-5).

Late asymmetrical and conjugate kink folds appear to be associated with the late jointing and faulting (Fig. GS-23-6 and 7). The azimuth of these fold axes ranges from 020 to 060° and their plunge is moderate to steep. S-asymmetry kink folds have a dominant northeasterly plunge and z-asymmetry kink folds have a dominant easterly plunge.

MINERALIZATION

All lithologies contain minor pyrite. Gabbroic intrusions contain up to 5% pyrite and/or 15% magnetite concentrations in places. Argillaceous units associated with iron formation often contain up to 5% pyrite. Ductile zones associated with late faulting commonly contain pyrite.

Mafic rocks along the traces of the major anticline and syncline contain extensive quartz-ankerite veins. These areas contain numerous trenches which have been plotted in the preliminary map (Owens, 1986). Small, 0.5-3.0 cm thick lenses and blebs of massive pyrite are present within these areas and they appear favourable for gold mineralization. Significant pyrite mineralization is present within the axis of the major syncline at the intersection between banded iron formation and a felsic intrusive body.

Figure GS-23-5: *Dextral offset in interbedded tuffaceous sandstone and argillite.*

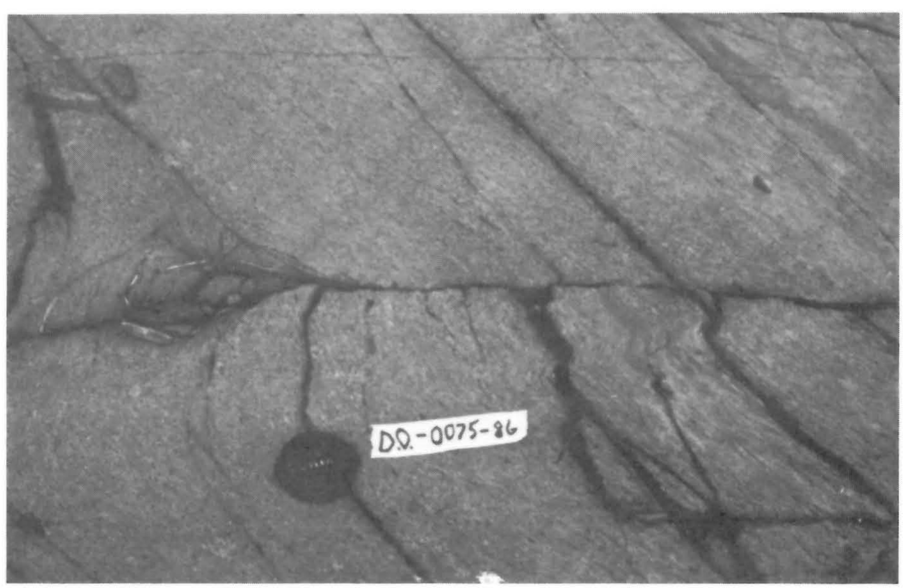

Figure GS-23-6: *Fault with associated kink folds.*

Figure GS-23-7: Conjugate kink folds in massive tuff.

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GS-24 MINERAL OCCURRENCE INVESTIGATIONS IN THE RICE LAKE GREENSTONE BELT

by P. Theyer and R.G. Gaba[1]

INTRODUCTION

Documentation of mineral occurrences in the Rice Lake greenstone belt is nearing completion. Mineral occurrences were examined, sampled and geologically mapped. The information collected in these investigations is available upon request and will be published in the form of a mineral deposit map upon completion of this program. Thirty mineral occurrences were documented in 1986. Two of these warranted detailed investigation and are described in this report. The first author focussed mainly on the western and central parts of the belt whereas the second author focussed mainly on the southeastern part. In addition, R.G. Gaba completed an investigation of gold in iron formations initiated in 1985 (Gaba, 1985).

THE "TUT" MINERAL OCCURRENCE

This occurrence (Fig. GS-24-1) consists of a complex system of mineralized quartz veins and pods hosted by a fractured and altered gabbroic sill (Fig. GS-24-2). Mineralization and intense alteration are exposed in an area measuring approximately 250 x 300 m; however, alteration and sulphide mineralization of a type considered to be similar to the Tut occurrence was observed for more than 2 km away from the occurrence. The mineralization consists of pyrite, arsenopyrite, pyrrhotite, chalcopyrite, magnetite, hematite and rare sphalerite and galena. Specks of visible gold were identified in two samples.

This mineral occurrence is named the "Tut" occurrence after George Buchanan, alias "King Tut", who held these claims under the name Tut in the 1930s. It is surprising how little has been recorded about this occurrence considering the fact that more than 142 trenches were dug in this area. Apparently the only written reference is a brief notation that a rock sample of "diorite" (gabbro) mineralized with arsenopyrite assayed approximately 0.5 oz/ton gold (J.H. Morgan, August 1940, Gunnar Mine File, Manitoba Energy and Mines, Mines Branch). This area has been mapped by Stockwell (1945), Weber (1971), and Seneshen and Owens (1985).

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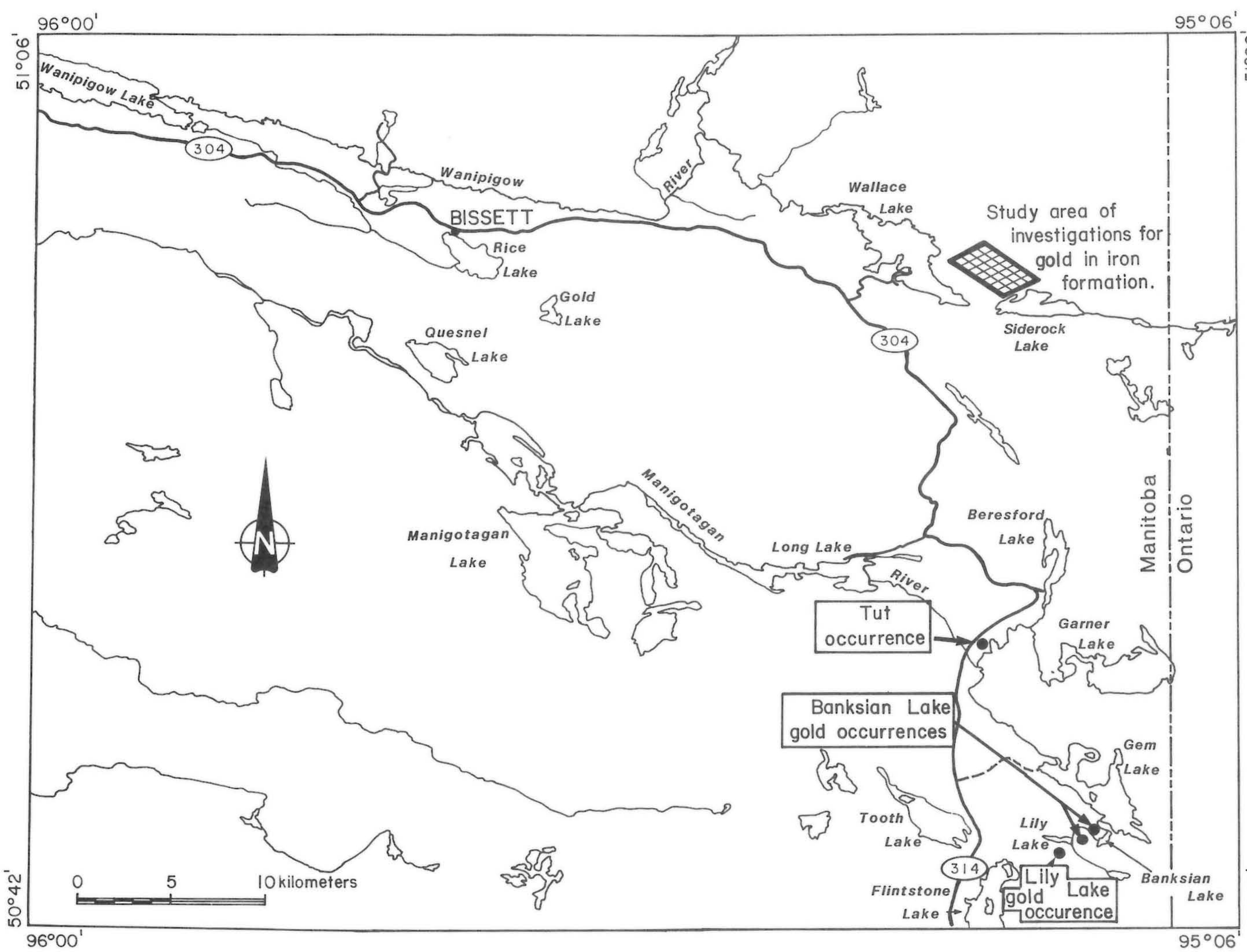

Figure GS-24-1: *Location map of investigated areas.*

HOST ROCK

The Tut mineralization is hosted by, but not exclusively restricted to, a gabbroic sill that is part of a regionally extensive sequence of mafic rocks that intruded the supracrustal rocks of the southeastern Rice Lake greenstone belt. Regional mapping indicates that these sills were emplaced prior to the deformation of the belt (Seneshen and Owens, 1985a).

The host rock to the mineralized zone is a heterogeneous assemblage of intrusive rocks ranging from melagabbro to gabbro, leucogabbro and anorthosite. The bulk of the rocks are coarse to fine grained, equigranular, dark grey to almost black. Gabbro with up to 3 cm equant plagioclase megacrysts, and orbicular gabbro with rounded feldspar crystal agglomerations up to 10 cm in diameter, appear to be concentrated predominantly along the edges of the sill. The edges of the intrusion are also characterized by ubiquitous chilled margins of fine grained to aphanitic gabbro and a rare hybrid "gabbro" layer, up to 10 m thick, containing abundant free quartz. Mineral graded layers are common in the central parts of the gabbroic sill. These graded layers are generally 10 to 20 cm thick but can range up to 1 m. Equigranular cumulate hornblende-rich rock with sharp basal contacts grades consistently southwards from melagabbro to leucogabbroic varieties. This indicates that stratigraphic tops of the sill are probably to the south.

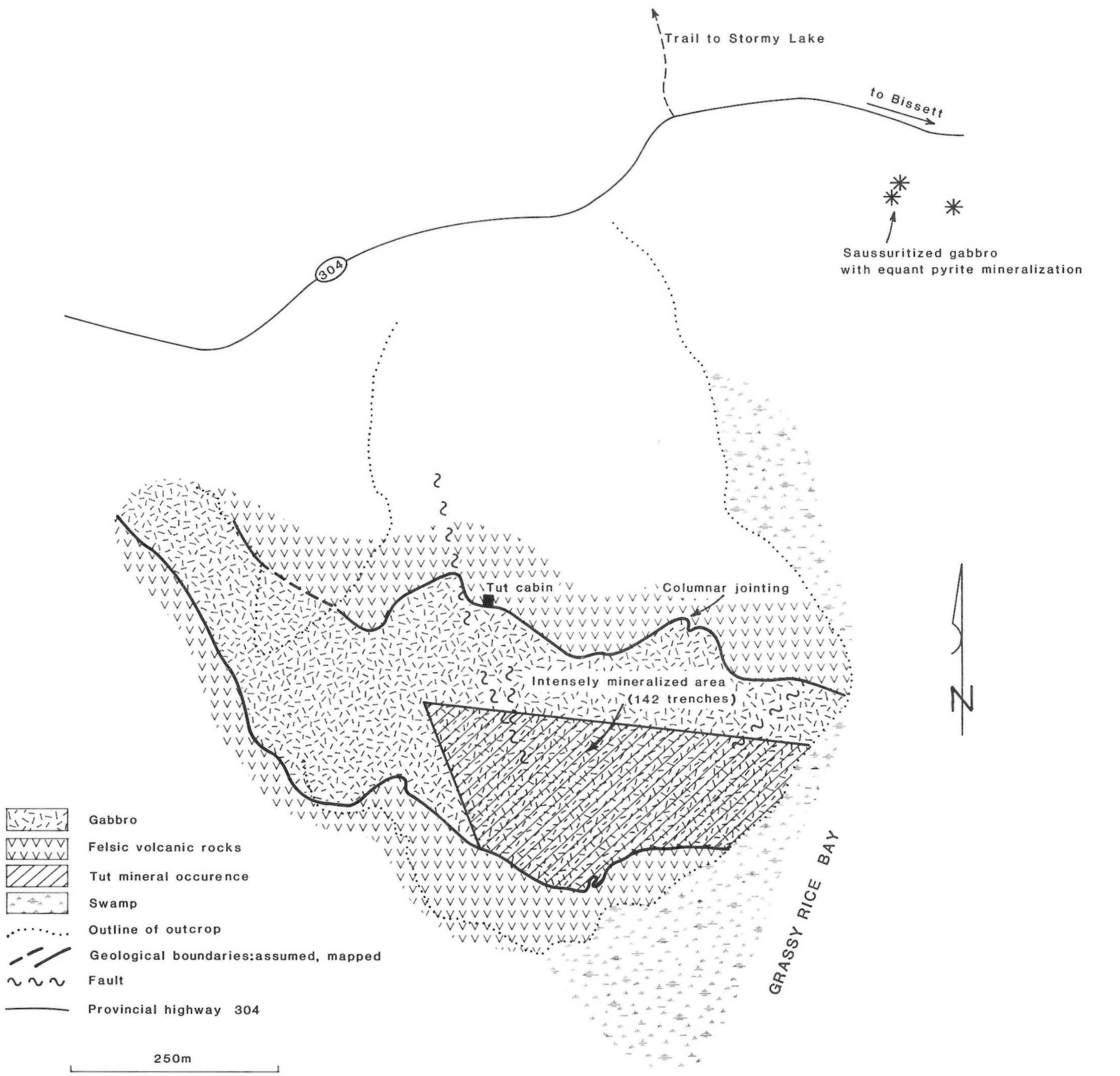

Figure GS-24-2: Geological sketch map of the 'Tut' mineral occurrence.

In the vicinity of the Tut claims, the sill intrudes a suite of felsic fragmental volcanic rocks, including lapilli tuff and heterolithic volcanic tuff breccia, that is part of the Narrows Formation (Seneshen and Owens, 1985). Columnar jointing is common in the massive phases of these rocks.

The gabbro containing the Tut occurrence is not strongly foliated but is intensely fractured. Northeast- and southeast-striking regional fracture systems appear to have been important mineralizing conduits. Large areas of the gabbro are also intensely jointed into irregular polygonal fragments.

Fracture interstices contain milky white quartz veins of irregular length and up to 2 m in thickness. Quartz also occurs as pods within the massive gabbro.

ALTERATION

The gabbro is intensely altered, especially in the vicinity of fractures and joints. Epidotization, chloritization and saussuritization are widespread and locally reduce the gabbro to a hard, dark green very fine grained mass of epidote, zoisite and chlorite. Alteration of feldspar, chloritization of hornblende and the process of sulphide mineralization have altered the gabbro to a whitish soft mass that weathers to an intensely red ochre soil.

MINERALIZATION

In the region of the Tut occurrence the gabbroic sill and the edges of the felsic volcanic rocks adjacent to the contact are altered to an assemblage of silicates, sulphides, oxides and carbonates.

Quartz and ankerite are the predominant minerals occurring in faults, joints, lenses and pods. Magnetite occurs in high concentrations as a primary mineral phase in parts of the gabbro. Magnetite was also observed to be a ubiquitous component of the alteration and coexists with sulphide, carbonate and silicate minerals. Magnetite occurs as 1) a thin coating on most fracture surfaces; 2) 8-10 cm pods; 3) veinlets; and 4) scattered crystals within quartz veins and the surrounding felsic volcanic rocks.

Tourmaline commonly occurs as thin coatings on fractures within the gabbro and also within the surrounding felsic volcanic rocks.

Sulphide mineralization occurs within quartz veins as well as the gabbro. Pyrite is the most common sulphide and occurs as fine grained disseminated crystals as well as euhedral crystals up to 1 cm. Disseminated pyrite occurs mainly within highly altered (saussuritized) portions of the gabbro. Wisps and laminae of pyrite also occur in unaltered gabbro; however, most of the pyrite is concentrated in and adjacent to quartz veins.

Arsenopyrite occurs most commonly in association with the mar-

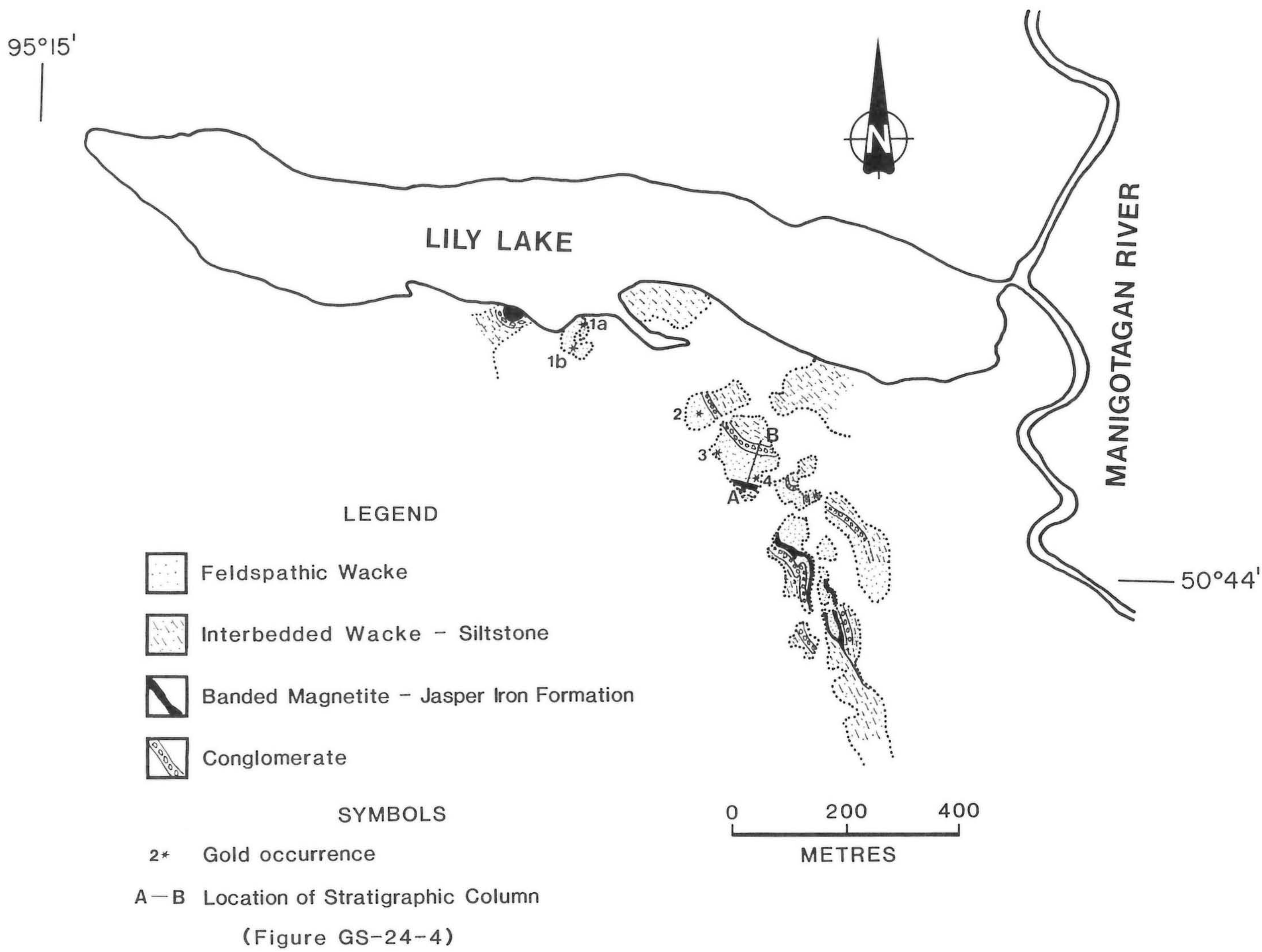

Figure GS-24-3: Geological sketch map of the Lily Lake gold occurrence.

gins of and adjacent to quartz veins. Minor arsenopyrite was also observed, however, in highly kaolinized portions of the gabbro, several metres distant from mineralized fractures.

Pyrrhotite is rare and appears to be restricted to a few trenches within the central portion of the gabbro. Chalcopyrite, sphalerite and galena are extremely rare. Visible gold was found in two samples of quartz that contained minor pyrite, arsenopyrite and magnetite.

DISCUSSION

Mineralization of the Tut occurrence appears to have been a complex multiphase process. Emplacement and cooling of the sill was followed by intense fracturing related to regional stresses. Some of the intense jointing developed in small areas of the sill is not as easily explained. The joints may have been induced either by cooling stresses or by highly pressurized liquids within the gabbroic body that shattered certain areas of the gabbro.

Virtually all fractures represent the site of an intense chemical exchange, manifested by pervasive epidotization, chloritization and saussuritization. Some fracture systems became conduits and repositories for silicate, carbonate, sulphide and oxide minerals. The mineralization is primarily restricted to one portion of the sill, although some mineralization was also observed in the adjoining felsic volcanic rocks. The reasons for the development of a restricted zone of intense alteration and mineralization in one area only are unknown since this area is neither intensely deformed nor geologically dissimilar to the other parts of the sill.

CONCLUSION

This occurrence represents an attractive exploration target for gold and platinum group mineralization.

THE LILY LAKE GOLD OCCURRENCE

The Lily Lake gold occurrence (Fig. GS-24-1) consists of visible gold-bearing quartz veins hosted by feldspathic wacke within a conformable sedimentary sequence. Russell (1952) mapped and briefly described this occurrence. Trenching and pitting were performed between 1948 and 1964 (Manitoba Energy and Mines, Cancelled Assessment File 91322).

HOSTROCK SEQUENCE

The gold-bearing quartz veins are hosted by an approximately 20 m thick, weakly layered feldspathic wacke that is part of a sequence of interlayered siltstone-argillite, banded magnetite-jasper iron formation and polymictic cobble conglomerate (Fig. GS-24-3). These rocks represent part of the Edmunds Lake Formation of the Rice Lake group of supracrustal rocks (Weber, 1971). Graded beds within the sequence of feldspathic wacke indicate stratigraphic tops to the southeast.

STRUCTURAL GEOLOGY

Rocks of the Edmunds Lake Formation in the area of the Lily Lake gold occurrence have been isoclinally shear folded (Fig. GS-24-4). This is most apparent near occurrences #1 (a) and #1 (b). The shear folding produced a marked thickening in the crest and trough areas of the folds. The feldspathic wacke southeast of occurrence #4 is adjacent to tightly folded banded magnetite-jasper iron formation.

All epiclastic rocks in the area have a well developed vertical or steeply northeast-dipping foliation that is generally parallel to compositional layers and beds. Secondary axial-plane foliation is well developed in the hinge zones of folds.

DISTRIBUTION AND NATURE OF QUARTZ VEINS

Quartz veins are concordant and discordant to layering and foliation of the host feldspathic wacke and tend to be erratically distributed and discontinuous. In isoclinally shear folded feldspathic wacke, stratiform quartz veins occupy concordant positions within fold crests, troughs and

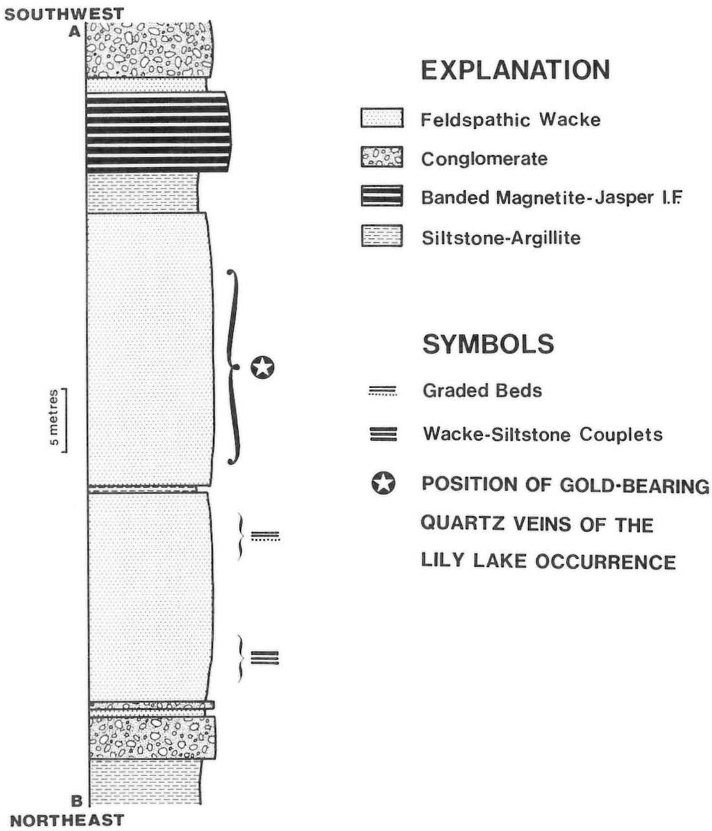

Figure GS-24-4: Stratigraphic section of the Edmunds Lake Formation in the area of the Lily Lake gold occurrence.

limbs (occurrence #1 (b)). Quartz veins that occupy discordant tension gashes or radial extension fractures are less common. Quartz veins at occurrence #3 tend to be slightly discordant, (10° to 20°) to the foliation of the feldspathic wacke.

The quartz veins are generally less than 5 cm thick. Stratiform veins tend to be consistent in thickness over a distance of less than 5 m, whereas discordant veins tend to be variable in thickness, sinuous and of irregular shape.

Vein quartz is dark grey to milky white, glassy to cherty and is locally brecciated with a white fine grained feldspathic groundmass. Feldspar, as single crystals up to 0.5 cm, and ankerite are common accessory minerals on fractures. Sericite occurs along fractures within quartz veins and at contacts with the wall rock.

METALLIC MINERALS

The abundance and distribution of visible metallic minerals within the quartz veins and adjacent wall rocks as well as within individual quartz veins is variable. Visible gold occurs exclusively in vein quartz and is commonly accompanied by arsenopyrite, pyrite, sphalerite and galena. Arsenopyrite and less pyrite form up to 40% of the adjacent feldspathic wacke. Visible gold-bearing quartz veins are not neccessarily associated with arsenopyrite-rich wall rock nor does the presence of arsenopyrite-rich wall rock indicate the presence of gold in the quartz veins. It is not known whether microscopic gold is present in the arsenopyrite-rich wall rocks.

Visible gold is present at all the Lily Lake occurrences as well as on surface between occurrences #3 and #4 (Fig. GS-24-3). At occurrences #1 (a) and #1 (b) gold occurs as blebs within glassy grey vein quartz and is accompanied by coarse prismatic arsenopyrite.

In the vicinity of occurence #3, native gold occurs as blebs, veinlets and spongy accumulations occupying fractures within cherty grey vein quartz. These fractures have an orientation similar to that of the foliation of the host feldspathic wacke. In the area between occurrences #3 and #4, native gold as fine grains occupies minute vuggy depressions in vein quartz on glaciated outcrop surfaces.

To the southeast of occurrence #4, quartz veins within feldspathic wacke contain coarse arsenopyrite and less pyrite. No visible gold was observed southeast of occurrence #4.

DISCUSSION

The occurrence of gold in the Rice Lake greenstone belt has generally been associated with mafic igneous host rocks and only in a minor way with sedimentary rocks (Stephenson, 1971). Sedimentary rocks of the Conley Formation that were correlated with the Edmunds Lake Formation (McRitchie, 1971) have recently been investigated for their gold content (Gaba and Theyer, 1984, and Gaba, 1985). The Gatlan gold occurrence, hosted by the Conley Formation, occurs within a sequence of sedimentary rocks comparable to that hosting the Lily Lake occurrence. Gold at the Gatlan occurrence does not occur in quartz veins but within chlorite- and sericite-rich argillaceous quartz wacke. Gold occurs as microscopic native metal spatially associated with arsenopyrite that is conformable with the layering and foliation (Gaba, 1985, and in prep.). By comparison, arsenopyrite-rich rocks adjacent to gold-bearing quartz veins at the Lily Lake occurrence may also contain gold.

The Edmunds Lake Formation to the west of Banksian Lake consists of sedimentary rocks similar to those in the area of the Lily Lake gold occurrences. These sedimentary rocks host stratiform quartz veins that are similar to those at Lily Lake and contain arsenopyrite and gold (Fig. GS-24-1; Russell, 1952). Stratigraphic continuity between the two areas is, however, uncertain.

WALLACE LAKE — SIDEROCK LAKE IRON FORMATION

Investigations for gold in iron formation in the Wallace-Siderock Lake area, initiated in 1985 (Gaba, 1985), were continued (Fig. GS-24-1). Abandoned diamond drill core of sulphide-bearing magnetite-chert iron formation collected in 1985 was analyzed. A polished section from DDH #7 at 68.1 m depth was observed to contain gold in silicate minerals. Assay results of this core, however, did not exceed 30 ppb Au. Follow-up investigations in the magnetite-chert iron formation exposed between Wallace Lake and Siderock Lake indicated the existence of only a few weakly mineralized sulphide-bearing zones. These zones were subsequently mapped and sampled for analysis.

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GS-25 PLATINUM GROUP ELEMENTS IN SOUTHEASTERN MANITOBA

by P. Theyer

INTRODUCTION

Studies of the platinum (Pt) and palladium (Pd) contents of mafic to ultramafic rocks in southern Manitoba were initiated in 1982 and continued over the ensuing years, (Theyer, 1982, 1983, 1984, 1985). In 1986 the investigations concentrated on outcrops on the north and south flanks of the Bird River Complex (BRC). In addition, geological investigations and sampling in search of Pt and Pd mineralization were carried out on mafic-ultramafic rocks in the English Lake area and on core from the Neepawa borehole.

DUMBARTON MINE AND MASKWA WEST PIT

These sulphide occurrences are located adjacent to and on the south flank of the mafic-ultramafic Bird River Sill (Fig. GS-25-1) and were mined for nickel and copper until their closure in 1976.

Data on the Pt and Pd contents of two sulphide concentrates from the Dumbarton Mine, published by Karup Moller and Brummer (1971), indicate concentrations of 1234 ppb and 1097 ppb Pt and concentrations of 3771 ppb and 4114 ppb Pd. These data indicate the presence of Pt and

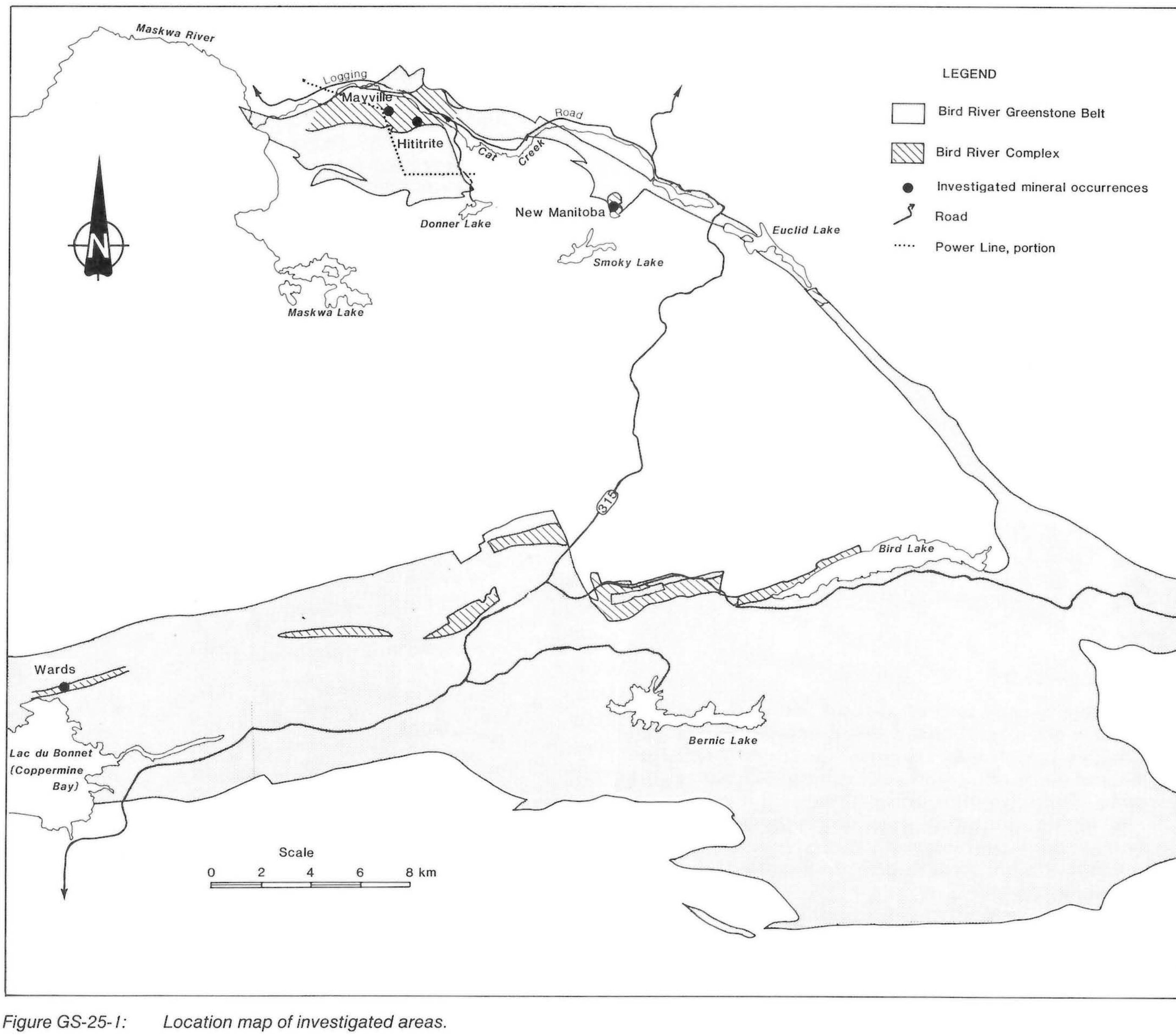

Figure GS-25-1: Location map of investigated areas.

Pd in the concentrate but do not permit any conclusions as to the concentration or distribution mode of Pt and Pd in the ore.

Mineralized core from selected diamond drill holes of the Maskwa West pit and the Dumbarton Mine were sampled and analyzed for Pt and Pd. Analytical results contained in Table GS-25-1 indicate the presence of up to 320 ppb Pd.

TABLE GS-25-1
PT AND PD IN ORE OF THE DUMBARTON MINE AND THE MASKWA WEST PIT

DDH #	Sample #	From - To	Pt	Pd	Mineralization
FB 74/42	DM-1	204'-205'	30	64	3-5% py, minor cpy
FB 74/42	DM-2	209'-210'	<20	63	2-3% py
FB 74/42	DM-3	225'-226'	<20	16	1% py and cpy
FB 74/42	DM-4	229'-230'	20	66	2-4% py and cpy
FB 74/42	DM-5	233'-234'	40	61	2-3% py and po intergrown
FB 74/42	DM-6	241'-242'	30	75	5% py in clusters
FB 74/42	DM-7	296'-297'	30	320	7-8% py, minor po and cpy
FB 74/43	DM-9	307'-308'	50	210	3-5% diss. py minor cpy
FB 74/43	DM-10	319'-320'	60	280	1-2% diss. py
FB 74/43	DM-11	359'-360'	50	200	1% diss. py
B45	DM-12	321'-322'	<20	7	1% diss. py
B45	DM-13	335'-336'	30	210	10-15% py and po
B45	DM-14	367'-368'	<20	43	20-25% py and po
B48	DM-15	318'-319'	<20	2	sporadic diss. py
B48	DM-16	322'-323'	<20	26	10% diss. py
B48	DM-17	352'-353' and 357'-358'	220	190	10% py in clusters and veins
B50	DM-18	394'-395'	30	32	approx. 80% po

NOTES (Apply to all tables in this report):

Analytical results expressed in ppb. Analyses performed by Neutron Activation Services Ltd., Hamilton, Ontario using lead fire assay concentration followed by DCP analysis.

Normal minimum detection limits: 10 ppb Pt and 2 ppb Pd; however, detection limits can be higher due to sample composition.

ABBREVIATIONS:

py	pyrite
cpy	chalcopyrite
po	pyrrhotite
diss.	disseminated

WARDS OCCURRENCE

The Wards group of claims, located at the southwestern end of the south flank of the BRC (Fig. GS-25-1), is partially underlain by gabbro that contains sulphides and chromite. The occurrence of chromite in this gabbro sets it apart from the other gabbroic rocks in the BRC since they are not known to contain chromite (Trueman, 1980).

The Wards group of claims was investigated by Canex Placer in 1973. Drill core intersections of gabbro containing pyrite and pyrrhotite assayed 1028 ppb Pt and 1200 ppb Pd. (Manitoba Energy and Mines, Cancelled Assessment File 91382).

Samples were taken from two pits located in the vicinity of Canex Placer's drilling. The rocks are foliated coarse grained hornblende-bearing gabbro containing minor amounts of disseminated pyrite. Both pits were sampled at 1 m intervals along their edges. Analytical results shown in Table GS-25-2 indicate a maximum of 540 ppb Pt and 780 ppb Pd from sulphide-rich samples.

TABLE GS-25-2
PT AND PD IN ROCK SAMPLES OF THE WARDS CLAIM GROUP OCCURRENCE

	Sample #	Pt	Pd
Pit #1	SF 2	230	300
	SF 3	540	780
	SF 4	170	350
	SF 5	370	680
	SF 6	210	470
	SF 7	340	690
Pit #2	SF 9	10	28
	SF 10	<10	82
	SF 11	160	360

NEW MANITOBA MINE

The New Manitoba mine situated west of Cat Lake (Fig. GS-25-1) was planned to exploit a small nickel-copper orebody in a gabbroic intrusion that may be related to the Bird River Complex. Development of this mine was suspended in 1957 due to a decrease in nickel prices.

Geological mapping indicates the gabbroic intrusion has a roughly circular configuration and is surrounded and intruded by granites (Fig. GS-25-2). The gabbro at the contact with the granite is frequently altered to a hybrid rock characterized by an abundance of mica on fractures and a pervasive recrystallization to either a very coarse grained "pegmatitic" texture or a very fine grained rock.

Samples were collected across the entire thickness of the mineralized zones using portable rock saws. Sample NF-A was cut over a length of 8.6 m on an outcrop located approximately 35 m east of the power house (Fig. GS-25-2). The rock is a coarse grained homogeneous gabbro containing approximately 1% disseminated pyrite and pyrrhotite. Sample NF-B was cut over a length of 17.8 m immediately north of the mill (Fig. GS-25-2). The fine- to coarse-grained gabbro contains sulphide concentrations ranging from 2% to 30%. Sample NF-C was cut over a length of approximately 12.4 m and is located a few metres north of the office buildings (Fig. GS-25-2). This rock contains approximately 2-3% finely disseminated pyrite and minor pyrrhotite.

TABLE GS-25-3
PT AND PD IN ROCK SAMPLES OF THE NEW MANITOBA MINE AREA

Channel Sample NF-A	Pt	Pd
0-2 m	10	4
2-4 m	10	<2
4-6 m	10	13
6-8.6 m	10	10
Channel Sample NF-B	**Pt**	**Pd**
0-2 m	<10	8
2-4 m	10	33
4-6 m	20	48
6-8 m	10	42
8-10 m	20	62
Channel Sample NF-C	**Pt**	**Pd**
0-2 m	40	68
2-4 m	20	47
4-6 m	20	38
6-8 m	30	12
8-10 m	10	26
10-12.4 m	30	59

In addition, samples NF1 to NF4 were collected from an ore dump. Representative samples were selected from all mineralization types. Table GS-25-3 includes the analytical data from these samples. They contain a maximum of only 40 ppb Pt and 68 ppb Pd.

HITITRITE OCCURRENCE

This sulphide occurrence, located on the north flank of the BRC (Fig. GS-25-1), is one of the few historically known mineral occurrences within the province that reportedly contained Pt (Wright, 1932). This is an iron-nickel-copper sulphide-rich zone in a medium- to fine-grained gabbro. The mineralized zone has approximate dimensions of 20 x 40 m and has previously been investigated with five shallow trenches and pits.

Mineralization is predominantly euhedral coarse grained (0.5 cm) pyrite in concentrations ranging from 1 to 15%. Samples were taken at 0.5 m intervals along the edges of the pits and trenches.

The results of this sampling series, listed in Table GS-25-4, show a maximum of 520 ppb Pt and 710 ppb Pd.

MAYVILLE OCCURRENCE

This sulphide occurrence is in gabbro on the north flank of the BRC (Fig. GS-25-1) in an area mapped by Macek (1984). The mineralized zone (approximately 35 x 60 m) is covered by a thick gossan and has been investigated by four north-trending and three west-trending old trenches. The host rock to the mineralization is an inhomogeneous gabbro characterized by abruptly varying grain sizes and compositions.

Grab samples of material from this mineral occurrence were taken from the walls or the bottom of the trenches at 1 m intervals. A schematic representation of the trenches and sampling pattern is shown in Figure GS-25-3. Analytical results of this investigation included in Table GS-25-5 show a maximum of 210 ppb Pt and 570 ppb Pd.

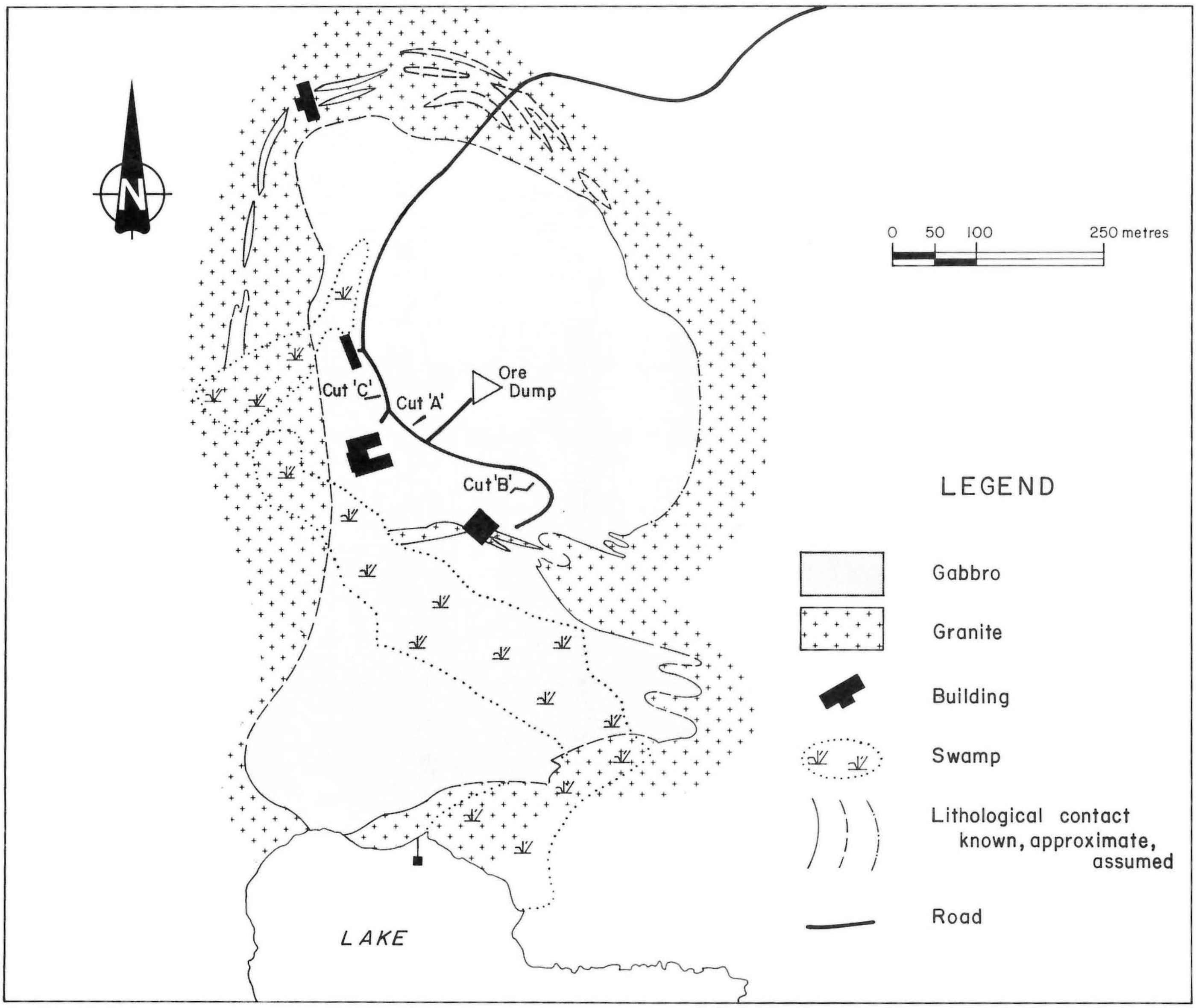

Figure GS-25-2: New Manitoba Mine; geological sketch map showing sampled areas.

TABLE GS-25-4
PT AND PD IN ROCK SAMPLES OF THE HITITRITE OCCURRENCE

	Sample #	Pt	Pd
Pit #1	NF 63	30	86
	NF 64	20	120
	NF 65	10	42
	NF 66	<10	23
	NF 67	<10	3
	NF 68	<10	56
Pit #2	NF 69	70	410
	NF 70	50	170
	NF 71	520	400
	NF 72	30	230
	NF 73	20	160
	NF 74	<10	2
Pit #3	NF 75	10	7
	NF 76	30	18
	NF 77	<10	9
	NF 78	20	22
	NF 79	10	180
	NF 80	50	170
	NF 81	90	210
	NF 82	10	44
	NF 83	50	340
	NF 84	90	230
	NF 85	40	64
	NF 86	30	120
	NF 87	50	80
Pit #4	NF 88	20	25
	NF 89	30	54
	NF 90	20	35
	NF 91	50	39
	NF 92	20	82
	NF 93	20	60
	NF 94	20	47
Pit #5	NF 95	10	3
	NF 96	50	140
	NF 97	50	110
	NF 98	20	72
	NF 99	40	230
	NF 100	90	250
	NF 101	<10	11
	NF 102	10	31
	NF 103	<10	10
	NF 104	<10	27
	NF 105	<10	12
	NF 106	40	130
	NF 107	<10	2
	[1]NF 108	130	710

[1] Sample NF 108 is a sample from pit #3 selected for its especially high sulphide concentration (approximately 20% py)

TABLE GS-25-5
PT AND PD IN ROCK SAMPLES OF THE MAYVILLE OCCURRENCE

	Sample #	Pt	Pd
Trench #1	NF 11	80	150
	NF 12	60	160
	NF 13	70	230
	NF 14	30	82
	NF 15	10	4
	NF 16	20	13
	NF 17	50	350
	NF 18	10	44
	NF 19	20	61
	NF 20	60	210
	NF 21	40	280
	NF 22	30	100
	NF 23	40	110
	NF 24	50	150
	NF 25	40	150
	NF 26	60	160
	NF 27	20	140
Trench #2	NF 28	70	170
	NF 29	50	290
	NF 30	40	320
	NF 31	20	80
	NF 32	130	92
	NF 33	10	6
	NF 34	40	89
	NF 35	10	15
	NF 36	10	34
	NF 37	10	4
	NF 38	60	110
	NF 39	30	35
	NF 40	10	30
	NF 41	60	190
	NF 42	10	9
Trench #3	NF 43	30	460
	NF 44	40	310
	NF 45	90	430
	NF 46	30	51
	NF 47	40	310
	NF 48	20	42
	NF 49	40	570
	NF 50	80	370
	NF 51	50	160
	NF 52	30	310
	NF 53	10	440
	NF 54	210	210
	NF 55	40	230
	NF 56	30	97
	NF 57	200	260
	NF 58	10	16
	NF 59	30	400
Trench #4	NF 60	10	33
	NF 61	40	210
	NF 62	20	100

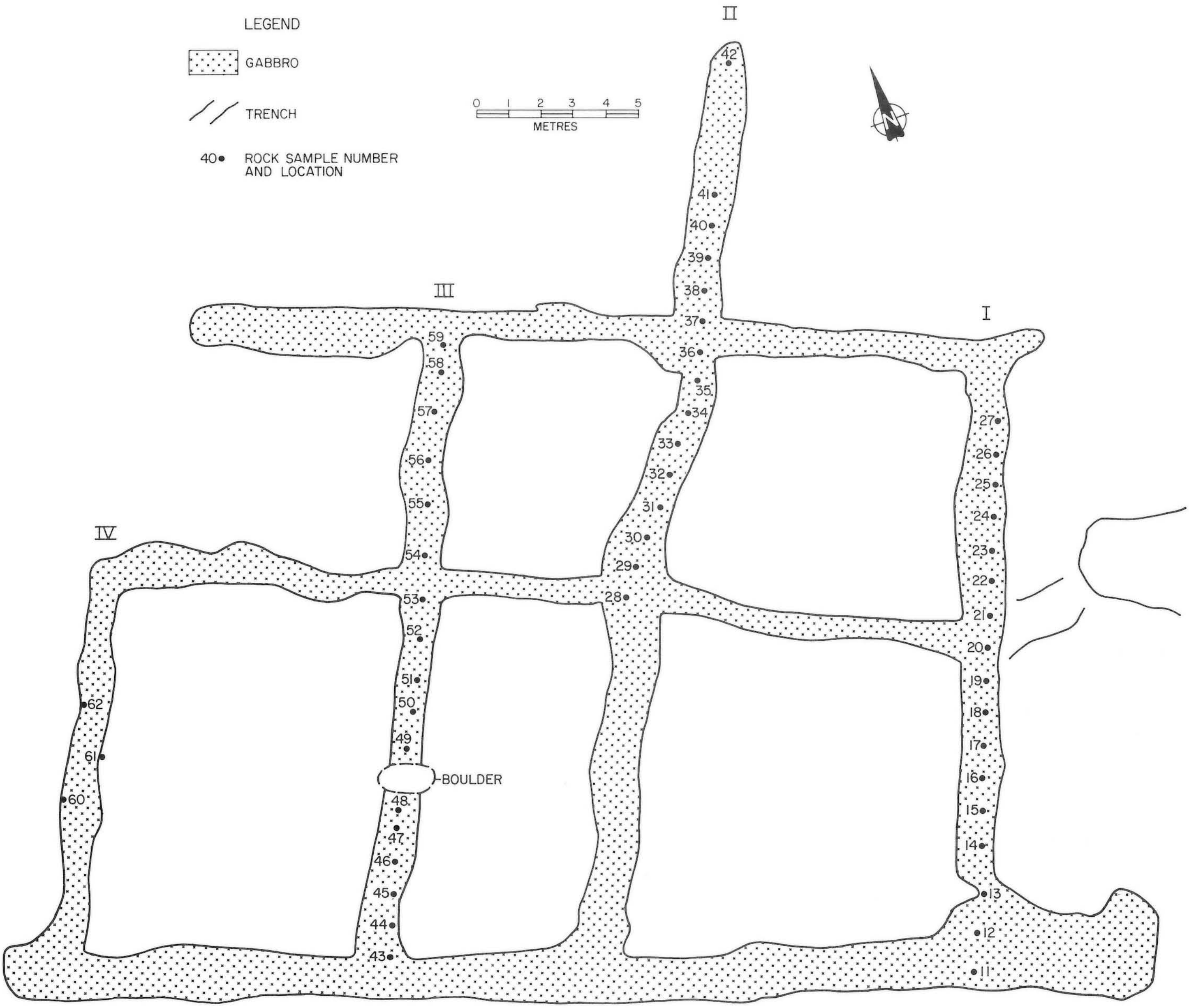

Figure GS-25-3: Mayville occurrence; sketch map showing sampling pattern.

NEEPAWA MAFIC-ULTRAMAFIC ROCK COMPLEX

A sequence of mafic to ultramafic rocks underlie iron formation near the town of Neepawa (southwest Manitoba). These rocks were drilled to test a magnetic anomaly and the core is stored in the Manitoba Energy and Mines core library. The entire suite of mafic and ultramafic rocks containing generally sparse and erratically distributed pyrite mineralization was sampled and analyzed for Pt and Pd. Publication of the 50 analytical results does not appear to be warranted since virtually all Pt and all Pd analyses are either below or close to the lower detection limit (i.e. 10 ppb Pt; 2 ppb Pd).

ENGLISH LAKE

An occurrence of ultramafic rocks on the southeastern shore of English Lake (western part of Rice Lake greenstone belt) was investigated for its potential to contain Pt and Pd. The virtual absence of sulphides and/or chromite in this body precludes further investigation.

BIRD RIVER COMPLEX

Figure GS-25-4 shows the Pt, Pd and Au concentrations across the thickness of the BRC ultramafic and gabbroic rocks sampled in 1982 and 1983 (Theyer, 1984, p. 130). This diagram includes additional data on the gabbroic rocks not previously published (Theyer, 1985). The analytical data are available on request.

DISCUSSION

Most of the occurrences sampled contain some Pt and Pd concentrations above 200 ppb; however, these concentrations may not necessarily be anomalous in view of the fact that they are from sulphide-bearing

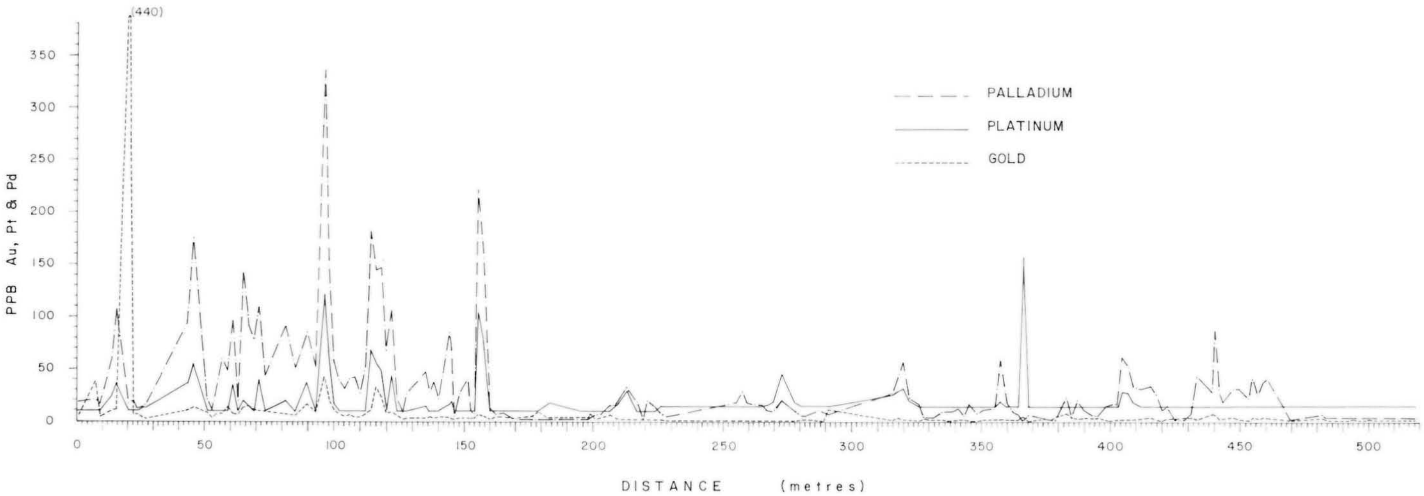

Figure GS-25-4: *Pt, Pd and Au concentrations across the thickness of the Bird River Complex in the vicinity of the Chrome property.*

rocks. Considering the large number of samples taken at each locality, the Pt and Pd concentrations obtained are probably representative of the rocks. None of these occurrences appear to contain economic concentrations of Pt and Pd.

At the Wards occurrence several features suggest the need for additional sampling and detailed investigation: a) the relatively high concentrations of Pt and Pd reported by Canex Placer (1028 ppb Pt, 1200 ppb Pd); b) the existence of chromite layers that have not been sampled; and c) the occurrence of some of the highest Pt and Pd concentrations obtained during this study (see Table GS-25-2).

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GS-26 A PRELIMINARY INVESTIGATION OF QUATERNARY PLACER GOLD IN THE MANIGOTAGAN AREA

by Erik Nielsen

Placer gold occurrences were reported recently from Quaternary sand and gravel deposits in the Manigotagan area. Detailed sampling and stratigraphic analysis were undertaken in this area to determine: (1) the origin of the Quaternary sediments; and (2) the amount of gold concentrations, if any, in the sediments.

STRATIGRAPHY

SITE 1

Three localities were investigated in the Manigotagan area (Fig. GS-26-1). The upper part of the overburden stratigraphy is well exposed in a 5.8 m high section in a gravel pit (site 1) approximately 3 km north of Manigotagan. The lower 1.8 m of the pit exposes interbedded silt and sand beds exhibiting graded bedding, horizontal laminations, crossbedding, oversteepened current ripples, flame structures and penecontemporaneous slump structures. These features indicate deposition by turbidity currents (Fig. GS-26-2) with paleocurrent directions ranging between 240° and 280°. The turbidite sediments were deposited in an ice-proximal environment in glacial Lake Agassiz.

The turbidites are overlain by 2.7 m of grey clayey silt with dropstones. The lower 2.1 m shows massive to poor bedding with minor sandy partings and soft sediment deformation including slumping and dewatering structures. The upper 60 cm consists of undeformed rhythmically bedded silt and clay couplets. The clay layers are of uniform thickness indicating the rhythmites are varves representing a distal deep water facies of Lake Agassiz.

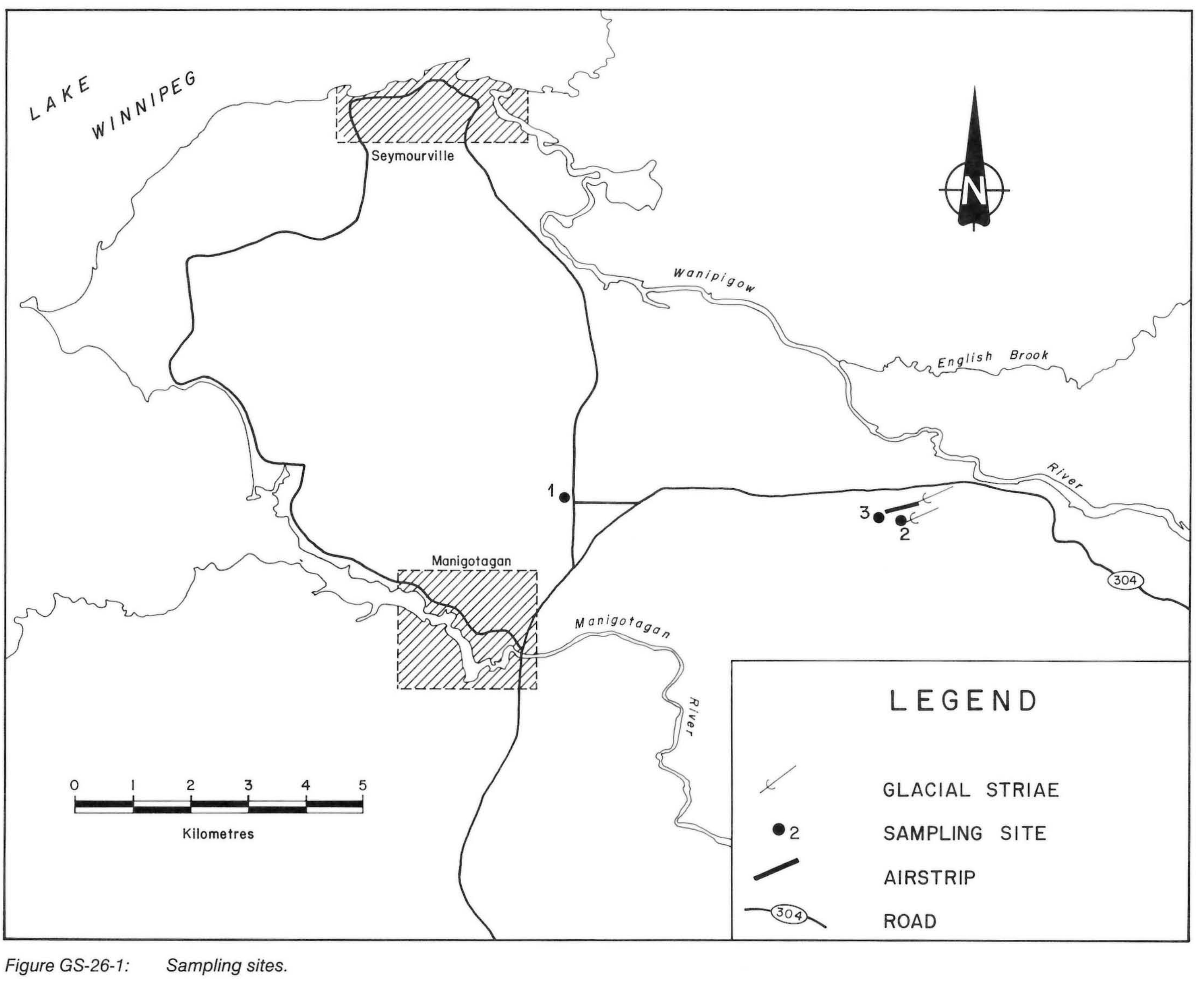

Figure GS-26-1: Sampling sites.

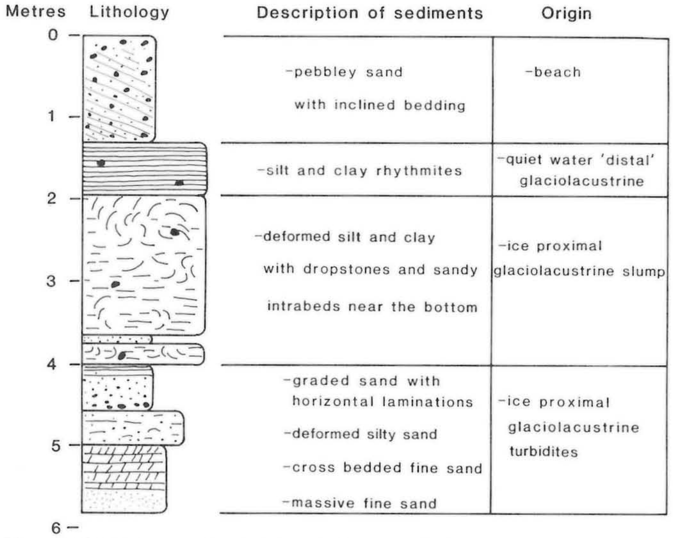

Figure GS-26-2: Stratigraphy in the gravel pit at site 1.

The varves are overlain by oxidized coarse sand and fine gravel forming a prominent beach ridge that can be traced for several hundred metres to the east. The beach shows poorly developed low angle beach bedding near the base but is massive near the top — the structures having been destroyed by pedogenic processes. The beach was deposited during the regressive phase of Lake Agassiz.

SITE 2

Detailed sampling was undertaken in an approximately 40 x 100 m area on a large 'sand plain' situated 7 km northeast of Manigotagan. This site, approximately 100 m south of the Manigotagan airstrip, is where placer gold has been reputed to occur. In 5 of 9 backhoe pits in this area, sand overlies deep water clay at depths between 3 and 4 m (Fig. GS-26-3) indicating the sand was deposited as littoral sediment during isostatic offlap of Lake Agassiz. The sand in places shows horizontal bedding and heavy mineral laminations but appears mostly massive. The sand is grey with zones of intense rusty oxidation. All pits showed soil development in the upper part of the profile. The 'sand plain', which is an estimated 0.25 km^2 in area, accumulated by the washing and sorting of previously deposited glacial sediments, mainly till, that blanketed the bedrock after deglaciation.

SITE 3

One backhoe pit was put down near the western end of the 'sand plain' at the end of the airstrip (Fig. GS-26-1). The clay pinches out and grey stratified sand with heavy mineral laminations and minor oxidation overlies grey oxidized sandy till at a depth of 3 m. The contact between sand and till is gradational with intercalated sand and till beds occurring between 2 and 3 m. The sand was deposited as a littoral blanket similar to the sand at site 2. The till was deposited by ice flowing toward 245° (Fig. GS-26-1).

GOLD CONCENTRATIONS

A total of 55 samples, each weighing approximately 8 kg, were collected from the 3 sites. Of these samples, 54 (excluding sample 42), were sent to Overburden Drilling Management Ltd. of Ottawa for heavy mineral separation and gold grain counts.

Samples 1-5, collected in the gravel pit at site 1, contained no visible gold grains. All the backhoe pits at sites 2 and 3, with the exception of pit number 1, had at least one sample with visible gold. The number of gold grains in each sample and their characteristics are listed in Table 1. The samples have not been assayed for gold.

COMMENTS

The origin of the gold grains is uncertain. The generally irregular to abraded nature of the gold grains suggests some transport by either the glacial flow or the subsequent reworking of the till by nearshore littoral processes. It is likely that the gold was reworked from the locally occurring till sheet. The gold is probably derived from a local gold occurrence in bedrock and was incorporated into the till by glacier erosion. To fully evaluate the gold potential of the littoral sand and determine its origin, detailed sampling of till and littoral sand, stratigraphic analysis and regional ice flow measurements should be undertaken in the area.

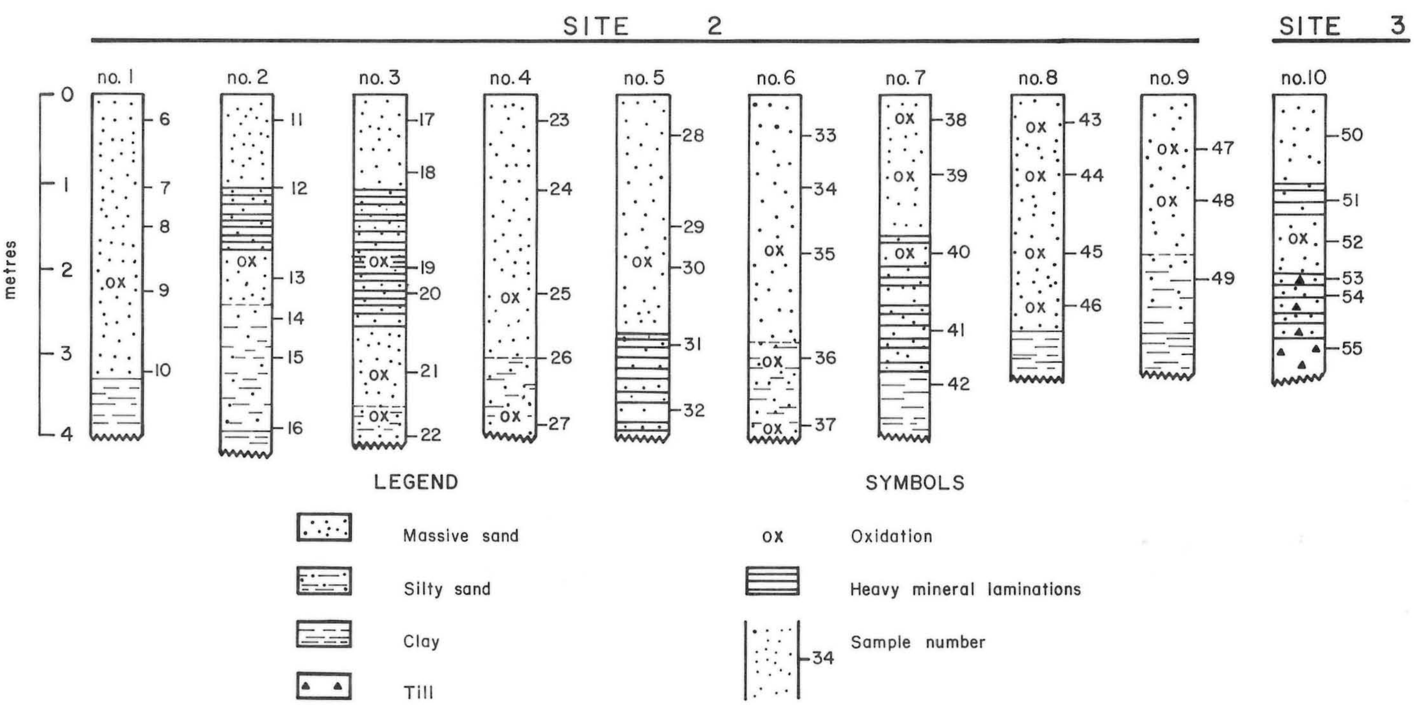

Figure GS-26-3: Stratigraphy in the backhoe pits at sites 2 and 3.

TABLE GS-26-1
CHARACTERISTICS OF VISIBLE GOLD GRAINS FROM SAND AND GRAVEL DEPOSITS NEAR MANIGOTAGAN

Sample Number	Dimensions of visible gold in microns[1]	Grain shape	Number of grains
69-86-MG	25 x 25 x 5	Abraded	1
12	25 x 50 x 8	''	1
	50 x 75 x 13	Irregular	1
13	25 x 50 x 8	Abraded	2
	50 x 50 x 10	Irregular	1
	50 x 200 x 25	''	1
17	50 x 125 x 18	''	1
20	100 x 100 x 20	Abraded	1
23	50 x 100 x 15	''	1
28	25 x 50 x 8	Delicate	1
	50 x 50 x 10	Abraded	1
	50 x 100 x 15	''	2
	50 x 100 x 15	Irregular	1
30	25 x 25 x 5	Abraded	1
	25 x 25 x 5	Delicate	1
	25 x 50 x 8	Abraded	3
	25 x 50 x 8	Delicate	3
	25 x 75 x 10	Abraded	1
	25 x 75 x 10	Delicate	1
	25 x 125 x 15	Irregular	1
	50 x 50 x 10	Abraded	2
	50 x 75 x 13	''	2
	50 x 75 x 13	Irregular	2
	100 x 125 x 22	Abraded	1
31	25 x 25 x 5	Abraded	1
	25 x 25 x 5	Delicate	1
	25 x 50 x 8	Abraded	4
	25 x 50 x 8	Irregular	2
	50 x 50 x 10	Abraded	1
	75 x 100 x 18	Irregular	1
32	25 x 25 x 5	Abraded	1
	25 x 50 x 8	Irregular	1
	50 x 50 x 10	''	1
	25 x 75 x 10	Delicate	1
34	25 x 25 x 5	Irregular	2
	25 x 50 x 8	Abraded	2
	50 x 75 x 13	''	1
	75 x 125 x 20	''	1

Sample Number	Dimensions of visible gold in microns	Grain shape	Number of grains
35	25 x 25 x 5	''	1
	25 x 25 x 5	Irregular	1
	25 x 100 x 13	Abraded	1
	50 x 50 x 10	''	1
	50 x 75 x 13	''	2
36	25 x 50 x 8	''	1
	25 x 50 x 8	Irregular	1
	50 x 75 x 13	Abraded	1
37	25 x 25 x 5	Irregular	1
	25 x 50 x 8	Abraded	1
	50 x 75 x 13	Irregular	1
38	25 x 25 x 5	''	2
	25 x 50 x 8	''	1
	25 x 75 x 10	''	1
	50 x 50 x 10	Abraded	3
	50 x 100 x 15	Irregular	1
	100 x 150 x 25	Delicate	1
39	25 x 50 x 8	Abraded	1
	25 x 100 x 13	''	1
	50 x 100 x 15	''	1
	50 x 125 x 18	''	1
	75 x 100 x 50	''	1
40	25 x 25 x 5	''	1
	25 x 25 x 5	Irregular	1
	50 x 50 x 10	''	1
	50 x 50 x 10	Abraded	3
	50 x 100 x 15	Irregular	1
	150 x 250 x 50	Abraded	1
41	25 x 25 x 5	Abraded	2
	25 x 25 x 5	Irregular	1
	25 x 100 x 13	''	1
	50 x 50 x 10	Delicate	2
	100 x 100 x 20	Abraded	1
43	25 x 50 x 8	Irregular	1
44	50 x 50 x 10	Abraded	1
45	25 x 25 x 5	Irregular	3
	25 x 50 x 8	''	3
	25 x 100 x 13	Delicate	1
	25 x 150 x 18	''	1

Sample Number	Dimensions of visible gold in microns	Grain shape	Number of grains
45 (cont'd)	25 x 150 x 18	Abraded	1
	50 x 50 x 10	''	1
	50 x 50 x 10	Irregular	1
	50 x 75 x 13	''	1
	75 x 100 x 18	Abraded	1
	75 x 125 x 20	Delicate	1
46	25 x 25 x 5	Abraded	1
	25 x 100 x 13	Delicate	1
	50 x 50 x 10	Abraded	1
	50 x 100 x 15	''	1
47	25 x 25 x 5	''	1
	25 x 25 x 5	Irregular	1
	25 x 75 x 10	''	1
	50 x 75 x 13	Abraded	1
	50 x 100 x 15	''	1
48	25 x 25 x 5	''	1
	25 x 50 x 8	Irregular	2
	25 x 75 x 10	Abraded	1
	25 x 100 x 13	''	1
	25 x 100 x 13	Irregular	1
	50 x 50 x 10	Abraded	1
	50 x 100 x 15	''	1
	25 x 50 x 8	Irregular	1
50	25 x 25 x 5	''	1
	25 x 50 x 8	''	2
	50 x 50 x 10	Abraded	1
	75 x 75 x 15	''	1
53	25 x 25 x 5	Abraded	1
	25 x 50 x 8	''	1
	50 x 50 x 10	''	1
	50 x 75 x 13	''	2
	50 x 100 x 15	''	1
	50 x 250 x 29	''	1
	75 x 100 x 18	''	1
55	25 x 50 x 8	''	1
	TOTAL:	Abraded	80
		Irregular	47
		Delicate	15

[1]measurements are approximate.

GS-27 INDUSTRIAL MINERALS OF SOUTHEAST MANITOBA

by B.E. Schmidtke

DIMENSION STONE

During the 1986 field season, a detailed study of fractures, pegmatites and other features in several outcrops of the Lac du Bonnet batholith was undertaken to determine its potential as a source of dimension stone. This area was selected for further study because most dimension stone quarries are generally located in the youngest intrusions in an area and the Lac du Bonnet quartz monzonite is the youngest pluton in the Winnipeg-Wanipigow Rivers region (McRitchie, 1971). Portions of the intrusion are massive, homogeneous in both texture and colour, and relatively free of imperfections such as schlieren, xenoliths, quartz pods and veins. In addition, many large areas of outcrop are accessible by a network of roads and railways that traverse the Lac du Bonnet batholith.

The Cold Spring Granite quarry is located approximately 10 km southwest of Lac du Bonnet and has been the site of dimension stone quarrying periodically since 1932. In 1985 polished slabs were made from a number of hand samples of the Lac du Bonnet quartz monzonite. The majority of these slabs are attractive and uniform in colour and texture. In addition, the instantaneous compressive strength of rock from the Cold Spring quarry has been measured at 226 MPa or 33,000 psi (Schmidtke and Lajtai, 1986), i.e. well above the minimum ASTM standard of 19,000 psi.

GENERAL GEOLOGY

The Lac du Bonnet batholith is located in the English River subprovince and consists mainly of a pink porphyritic quartz monzonite (McRitchie, 1971). Most of the outcrop is located between Lac du Bonnet and Lamprey Falls on the Winnipeg River system. Several isolated outcrops of Lac du Bonnet quartz monzonite are located as far west of Lac

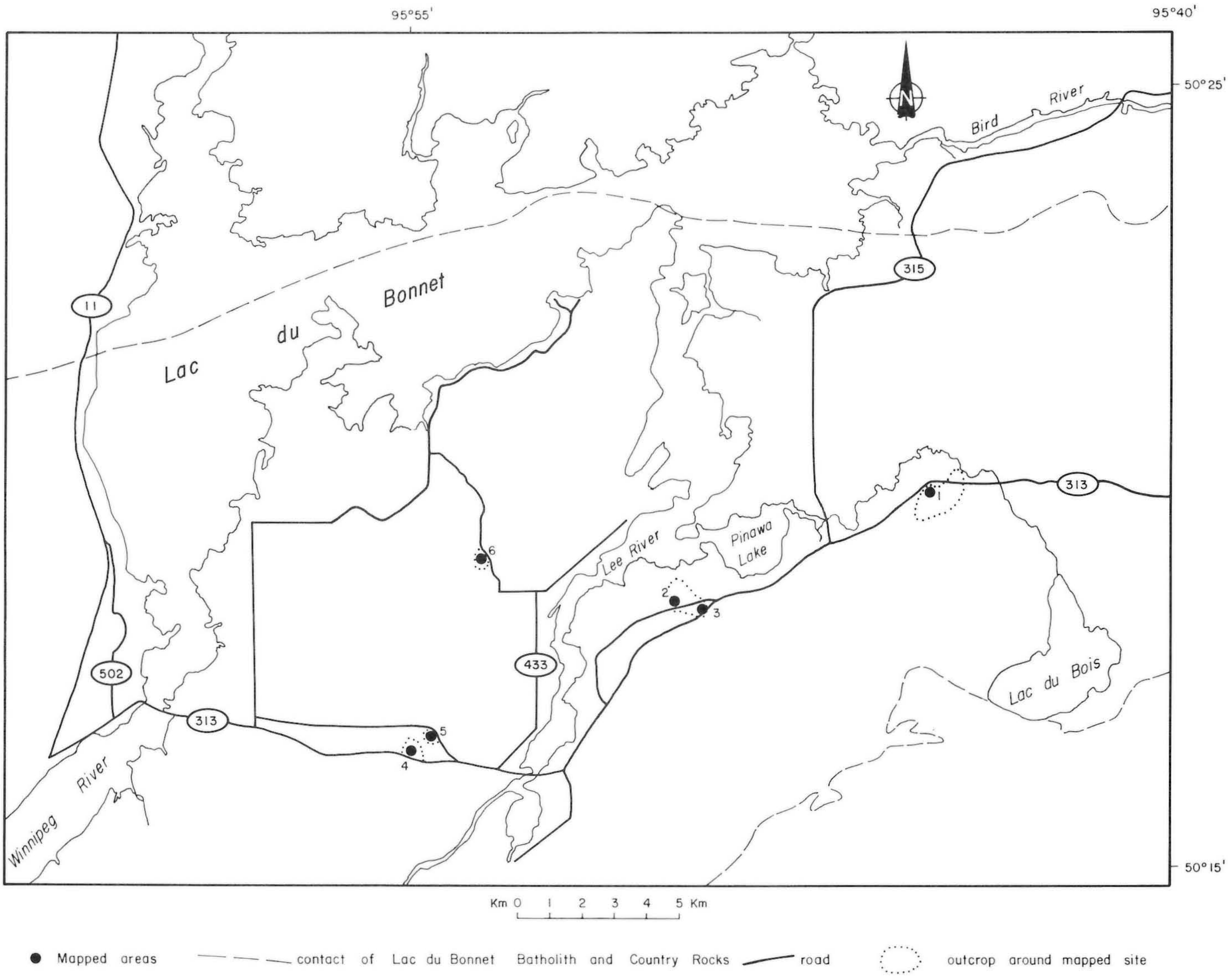

Figure GS-27-1: Location of sites mapped for building stone potential in the Lac du Bonnet batholith (contact after McCrank, 1985).

Figure GS-27-2: *Block taken from test pit at site 2, Pinawa Bay.*

du Bonnet as the Beausejour area. The batholith is bounded to the south by a grey, foliated tonalite (Cerny et al., 1981) of the Winnipeg River batholith belt, to the north by the Manigotagan-Ear Falls gneiss, and is in fault contact with the Bird River greenstone belt to the northeast. The geology is described in detail by McRitchie (1971), Tammemagi, (1980), Cerny et al. (1981) and McCrank (1985).

Several sites were chosen for detailed mapping on the basis of their massive and uniform appearance and ease of access (Fig. GS-27-1).

SITE 1: POINTE DU BOIS ROAD

A large outcrop is located adjacent to Provincial Road 313 approximately 3 km east of the junction of Provincial Roads 313 and 315; 5000 m^2 of outcrop were mapped. The entire area delineated in Figure GS-27-1 is characterized by flat and massive outcrop; the site chosen for detailed mapping is considered representative.

Subvertical joints strike east-west; however, the pegmatites strike approximately north-northeast. The vertical joint spacing is usually greater than 10 m. The pegmatites are 4-10 cm in width and are closer spaced than the subvertical joints. The horizontal joint pattern can only be determined by drilling.

Biotite schlieren and reddish streaks of iron oxide are visible in a nearby roadcut. A small granitic xenolith, 15 cm in diameter, was mapped in an area cleaned of lichen with Javex; as lichen covers more than 90 per cent of this outcrop, more xenoliths may be present.

SITES 2 AND 3: PINAWA BAY AREA

Sites 2 and 3 are located in an outcrop area approximately 1 km from the Pinawa Bay cottages (Fig. GS-27-1). The outcrop delineated has several flat to gently rounded areas.

SITE 2:

Several small blocks and one large block were removed from two old test pits. The large block (1 x 1 x 1.5 m) contains two subhorizontal pegmatites within the space of one metre (Fig. GS-27-2). Dykes and pods 15-20cm wide occur in the northern 20 m of the map area (Fig. GS-27-3). Only one widely spaced major subvertical joint set was noted.

SITE 3:

Joints in the southern 60 m of site 3 are spaced approximately 6 m apart. The spacing in the north 40 m of the map area decreases to 1-2 m but many of these joints appear to be exfoliation features and do not appear to extend more than 30 cm into the rock. Most of the outcrop is covered with exfoliated rubble.

Only two pegmatite dykes were noted; however, several biotite schlieren striking at 340° were observed. Schlieren were noted in a roadcut on the south side of Provincial Road 313, 100 m south of the map area. The horizontal joint pattern is not known.

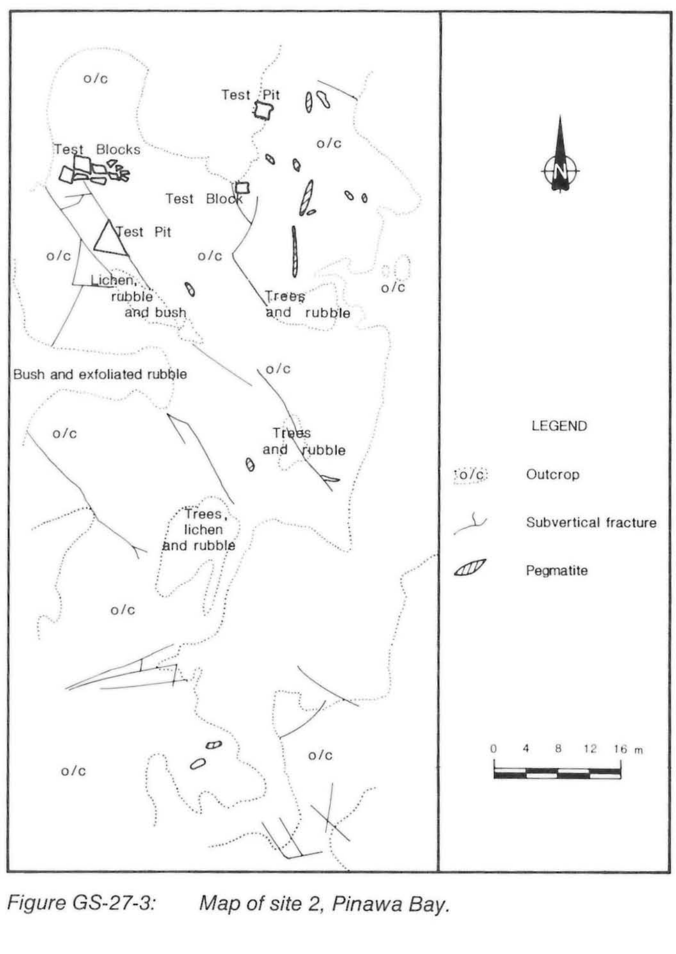

Figure GS-27-3: *Map of site 2, Pinawa Bay.*

SITES 4 and 5: LEE RIVER AREA

Site 4 is located near a garbage dump 3 km west of the Lee River bridge. Two joint sets trending northeast and northwest were noted. In the eastern portion of the mapped area several large pegmatitic pods, up to 1 m in diameter, were observed; in the north central area, two 5 cm thick pegmatitic dykes strike north-northwest. A 15 cm wide, 6 m long section of compositionally layered granite occurs in the northeast corner.

Site 5 contains a series of low-lying massive granite ridges. The two joint sets of these ridges trend north-northeast and west-northwest. Abundant schlieren development and minor pegmatites were observed.

SITE 6: PROVINCIAL ROAD 433

The rock of site 6 contains two joint sets with up to 20 m spacing; however, the outcrop contains many pegmatite pods and dykes and the rock has been altered to a deep red colour in small isolated areas near fractures.

Samples were taken to test the polishing characteristics and aesthetic appeal of the rock from each of the sites mapped. Copies of the joint maps are available at the Geological Services office.

BLACK ISLAND KAOLIN SAMPLING

Kaolin occurs on Black Island as a residual layer of altered Precambrian rock underlying the silica sand of the Ordovician Winnipeg Formation. During the 1985 field season several samples of this kaolin-rich layer were taken from two piles of clay scooped out of the Selkirk Silica quarry by backhoe (Watson and Gunter, 1985). These samples were sent to CANMET for sieve and chemical analyses. Tests show a decrease in SiO_2 and an increase in Al_2O_3 with decreasing grain size of the sample, indicating that the silica sand can be separated from the kaolin (Table GS-27-1).

In the 1986 summer season, a drilling program was undertaken to determine the thickness of the kaolin layer and to determine if extractable kaolin occurs within the silica sand presently being processed by Selkirk Silica. Fifteen holes were drilled in the Selkirk Silica Sand quarry on Black Island (Fig. GS-27-4) using a solid stem auger. Holes #2, 4, 9, 10, 12, 14 and 15 intersected the kaolinitic layer (Table GS-27-2). In those holes the kaolinitic layer grades from white kaolin to pale green clay to dark green chloritic clay to green schist. In the holes where kaolin is not present, the Winnipeg Formation sandstone is underlain by green chloritic clay. The variability in thickness of the kaolin layer, and its absence locally, indicate that the kaolin may occur in pockets controlled by topography. If this interpretation is correct then it will not be possible to determine the thickness of the kaolin layer without detailed drilling. Samples of kaolin and silica sand collected during the drilling program will be forwarded to CANMET for sieve and chemical analyses.

Figure GS-27-4: Location of drill holes in the Selkirk Silica Quarry on Black Island.

TABLE GS-27-1

CHEMICAL ANALYSIS OF SIZED FRACTIONS FROM A HEAD SAMPLE OF BLACK ISLAND KAOLIN (P.R.A. ANDREWS, 1986)

Size (μm)	Wt %	Analysis % SiO_2	Al_2O_3	K_2O	Fe_2O_3	TiO_2
+ 1190	4.9	84.9	8.0	0.47	0.97	0.19
-1190 + 420	6.9	85.1	8.5	0.56	0.55	0.20
- 420 + 210	11.1	87.5	8.3	0.56	0.31	0.20
- 210 + 105	10.6	86.0	8.5	0.58	0.30	0.22
- 105 + 44	10.9	83.1	9.7	0.67	0.41	0.28
- 44 + 13	2.8	78.3	12.2	0.87	0.50	0.35
- 13 + 10	6.3	74.3	14.5	1.05	0.55	0.40
- 10 + 7	3.4	63.6	21.6	1.55	0.60	0.53
- 7 + 4	16.7	54.2	28.6	2.09	0.66	0.75
- 4 + 2	20.9	47.3	33.5	2.35	0.78	0.76
- 2	5.7	45.2	34.1	2.05	0.77	0.67
TOTAL	100.0	(68.2)	(19.6)	(1.36)	(0.58)	(0.47)

TABLE GS-27-2

THICKNESS OF KAOLIN-BEARING LAYER IN BLACK ISLAND DRILL HOLES

Drill Hole	Hole Depth (m)	Approximate Depth to Kaolin (m)	Thickness of Kaolin-bearing layer (m)	Comments
1	6.25	not intersected	-	Hole drilled on dry settling pond*
2	8.67	5.0	0.15	Hole drilled on dry settling pond
3	6.32	not intersected	-	Hole drilled through sandstone on active surface of quarry; abandoned before intersecting any clay.
4	7.16	5.0	0.51	Hole drilled through sandstone on active surface of quarry.
5	7.16	5.0	0.20	Hole drilled through sandstone on active surface of quarry.
6	13.25	not intersected	-	Hole drilled through sandstone on active surface of quarry.
7	8.69	not intersected	-	Hole drilled on dry settling pond.
8	10.20	not intersected	-	Hole drilled on dry settling pond.
9	8.69	5.0	2.55	Hole drilled on dry settling pond.
10	7.16	5.0	1.1	Hole drilled on dry settling pond.
11	5.64	not intersected	-	Hole drilled on dry settling pond.
12	8.69	8.0	0.20	Hole drilled on dry settling pond.
13	2.55	not intersected	-	Hole drilled on dry settling pond; abandoned before intersecting clay.
14	5.64	5.0	1.06	Hole drilled through sandstone on active surface of quarry.
15	8.69	6.5	0.76	Hole drilled through sandstone on active surface of quarry.

* The dry settling ponds are areas that have had most of the silica sand quarried out, then used as settling ponds for effluent and then backfilled.

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GS-28 SUBSURFACE PRECAMBRIAN GEOLOGY OF SOUTHEASTERN MANITOBA SOUTH OF 49°30'

by C.R. McGregor

The Precambrian basement, between the eastern limit of Paleozoic (and Mesozoic) strata and the western outcrop limit of the Precambrian Shield in southeastern Manitoba (Fig. GS-28-1), is almost entirely covered by overburden, composed of Lake Agassiz till from a few centimetres to 140 m thick (see Teller et al., 1976). The map area includes the southern portions of 62H and 52E (Manitoba). The Precambrian geology of the area (Fig. GS-28-1) was compiled from 4 main sources: (1) diamond drill core logs; (2) water well records; (3) aeromagnetic signatures and trends; and (4) geological data from isolated bedrock exposures. In addition, an oil well test hole at Badger was reported to have cored Precambrian granite gneiss (Manitoba Energy and Mines files).

1) DIAMOND DRILL CORES

To date, 37 diamond drill holes have been completed. The data for 35 of them are recorded in the non-confidential and confidential assessment files with the Department of Energy and Mines; however, only the non-confidential holes are plotted on the map (Fig. GS-28-1). The other two holes were drilled by the Geological Services Branch (Weber, 1985).

2) WATER WELL RECORDS

Many water wells have been reported in the Manitoba Water Well Drillers Report (published each year since 1963) but only a few reached basement. This is due to the fact that the immediately overlying Lake Agassiz till consists partly of Precambrian material, some of which is boulder-sized and can be easily mistaken for the Precambrian basement. For this project, any hole intersecting more than 1 m of Precambrian material was considered to have encountered basement.

3) AEROMAGNETIC SIGNATURES AND TRENDS

On a regional scale, a strong correlation exists between individual geological units and their aeromagnetic signatures. The trend of the signature was extended into the subsurface Precambrian. The typical magnetic response of geological units in the area are as follows (with increasing magnitude):

60 300 — 60 600 gammas — metavolcanic and metasedimentary rocks (3a)
60 700 — 60 900 gammas — tonalite-granodiorite (8)
60 800 — 60 900 gammas — granite gneiss (5a)
60 900 — 61 500 gammas — granite (9)
60 900 — 61 500 gammas — amphibolite (4) (narrow curvilinear anomalies)
61 000 — 61 100 gammas — granodiorite-tonalite gneiss (5b)
61 000 — 61 500 gammas — migmatitic gneiss (6)

4) EXPOSED BEDROCK

The geology of the exposed Precambrian outcrops is simplified (after Janes, 1978). The eastern limit of Paleozoic (and Mesozoic) strata is based on the original data used for the Geological Map of Manitoba (Manitoba Mineral Resources Division, 1979) and on water well records from 1979 to 1985. The Subsurface Precambrian Geological Map of Southwest Manitoba map (McGregor, 1986) indicates that the area described in this paper lies within the Wabigoon domain of the Superior Province. Half of the area is underlain by greenstones, the remainder by granitoid rocks.

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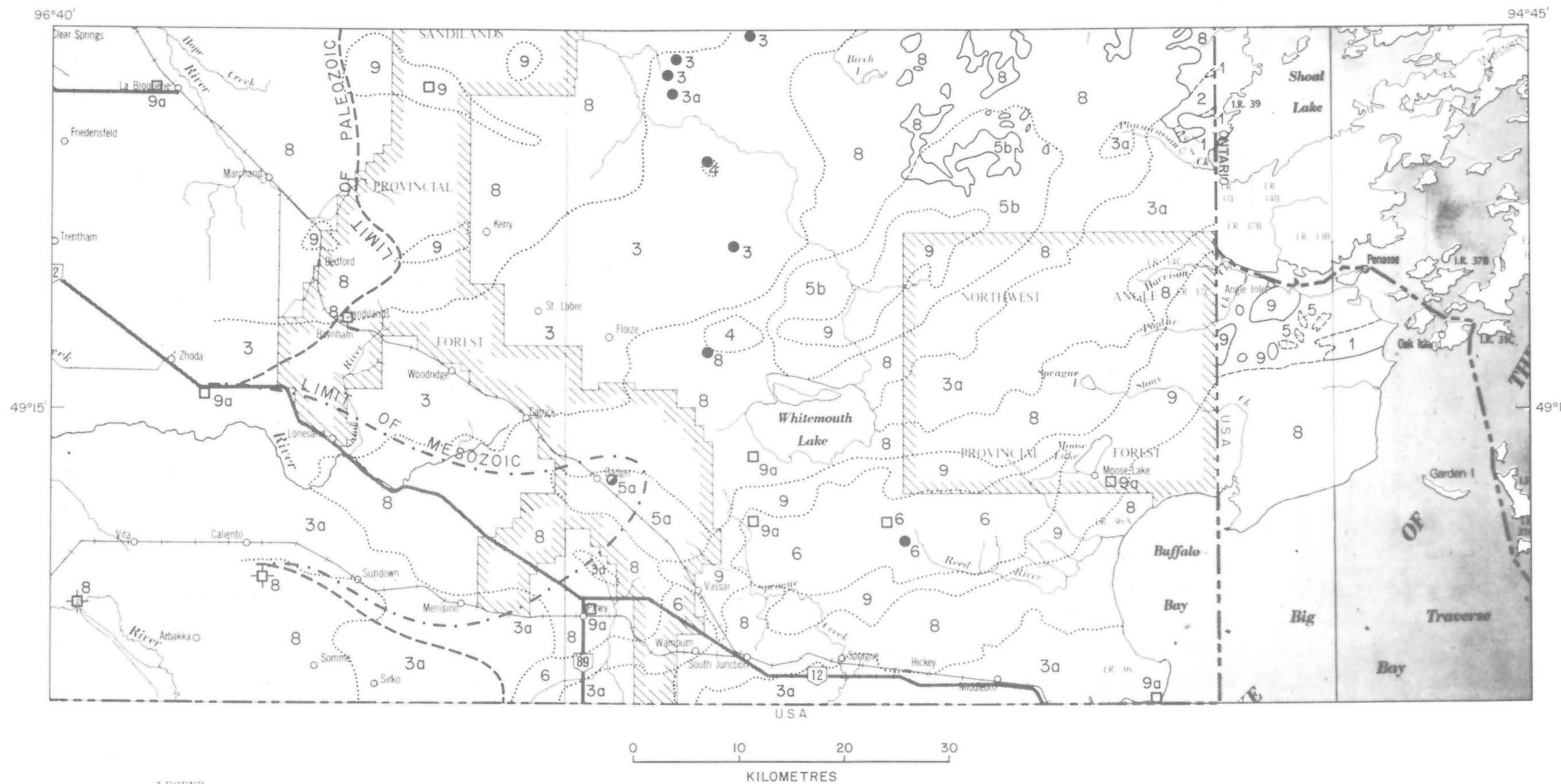

LEGEND
(the geological units are not necessarily in chronological order)

INTRUSIVE ROCKS

9 Granite
9a Undifferentiated granitoid rocks

8 Tonalite-granodiorite

7 Diorite-gabbro*

METAMORPHIC ROCKS

6 Migmatitic gneiss

5 Tonalite, granodiorite, granite and related gneiss;
5a granite gneiss
5b granodiorite-tonalite gneiss
5c granulite*
5d granitoid gneiss and metasedimentary gneiss*

4 Amphibolite (including serpentinized amphibolite, banded iron formation, quartzite and calc-silicate rocks

METASEDIMENTARY AND METAVOLCANIC ROCKS

3 Metasedimentary rocks;
3a Undifferentiated metasedimentary and metavolcanic rocks

2 Intermediate and felsic metavolcanic rocks

1 Mafic metavolcanic rocks;
1a Ultramafic rocks (serpentinized peridotite, serpentinite, pyroxenite)*

SYMBOLS

Geological boundary (defined or approximate in exposed areas)

Geological boundary (inferred from water well, diamond drill hole and aeromagnetic data)

Limit of Precambrian exposure including isolated outcrops

Limit of Paleozoic

Limit of Mesozoic

Fault*

Water wells: petrographic (chips; core)
logs/reports (chips, core)

Diamond drill cores (petrographic; logs/reports)

Oil well: logs/report (core)

Figure GS-28-1: *Subsurface Precambrian geology of southeastern Manitoba from water well, diamond drill hole and aeromagnetic data incuding isolated Precambrian outcrops. The geological information of the United States area is from Ojakangas et al., 1979 (The asterisks in the legend are units not shown on this map but on an adjacent map which is in preparation).*

GS-29 ADDITIONAL PRECAMBRIAN GEOLOGICAL INFORMATION ON THE BLACK ISLAND AREA BASED ON DIAMOND DRILL AND AEROMAGNETIC DATA

by C.R. McGregor

The 720 km^2 Black Island map sheet (62P/1NW, 8SW; Fig. GS-29-1) covers the north shore of Manigotagan peninsula, the east end of Black and Deer Islands and the east shore of Lake Winnipeg south of Rice River. The area west of Precambrian outcrops on Black and Deer Islands is underlain by Paleozoic cover rocks. To the east, the exposed Precambrian has been mapped at scales of 1:15 840 (Brown, 1981), 1:31 680 (Davies, 1951) and 1:250 000 (Ermanovics, 1970, 1981). The purpose of this project was to compile all geological information and data obtained from diamond drill holes and aeromagnetic maps.

DIAMOND DRILL HOLES

To date, 28 non-confidential and confidential diamond drill holes have been completed; however, only the non-confidential holes are plotted on the map. The holes were all drilled offshore close to the narrow belt of aeromagnetic high anomalies discussed below. Precambrian rocks intersected are shown in Figure GS-29-1.

AEROMAGNETIC DATA

The region can be subdivided into three areas each with a diagnostic aeromagnetic signature:

1. Western area with generally low magnetic signatures (60 600 — 60 900 gammas).
2. Central narrow northwest-trending belt of high magnetic signature (60 900-61 200 gammas) with aeromagnetically high anomalies (61 200-65 000 gammas); the belt is 2-4 km wide and is approximately 30 km long.
3. Eastern area with broad high magnetic signatures (60 900 — 61 200 gammas).

GENERAL GEOLOGY

The Precambrian rocks of the Black Island area are part of the Uchi subprovince of the Superior Province. The geological compilation (Fig. GS-29-1) shows the various Archean volcanosedimentary sequences and granitoid rocks mapped by Brown (1981) and Ermanovics (1970). The diamond drill hole and aeromagnetic data indicate that the central area of aeromagnetic highs coincides with iron formation, quartzite, schists, serpentinized dunite and peridotite (unit 9 of Brown, 1981) and also coincides with a unit where ultramafic rocks were intersected in drill holes farther north and west. Hence the data suggest that unit 9 extends much farther north and west than shown by Brown (1981). This unit is 35 km in length and curves at least another 10 km to the west, south of Black Island. Its width ranges from 0.4 to 2 km and the depth ranges from outcrops at Pipestone Islands (serpentinized peridotite) to 75 m under Phanerozoic cover.

The western area with low magnetic signature is thought to be underlain by Precambrian greenstones, including the exposed volcanosedimentary sequences of Brown (1981). The eastern high magnetic domain corresponds to exposed, primarily granodiorite-diorite rocks.

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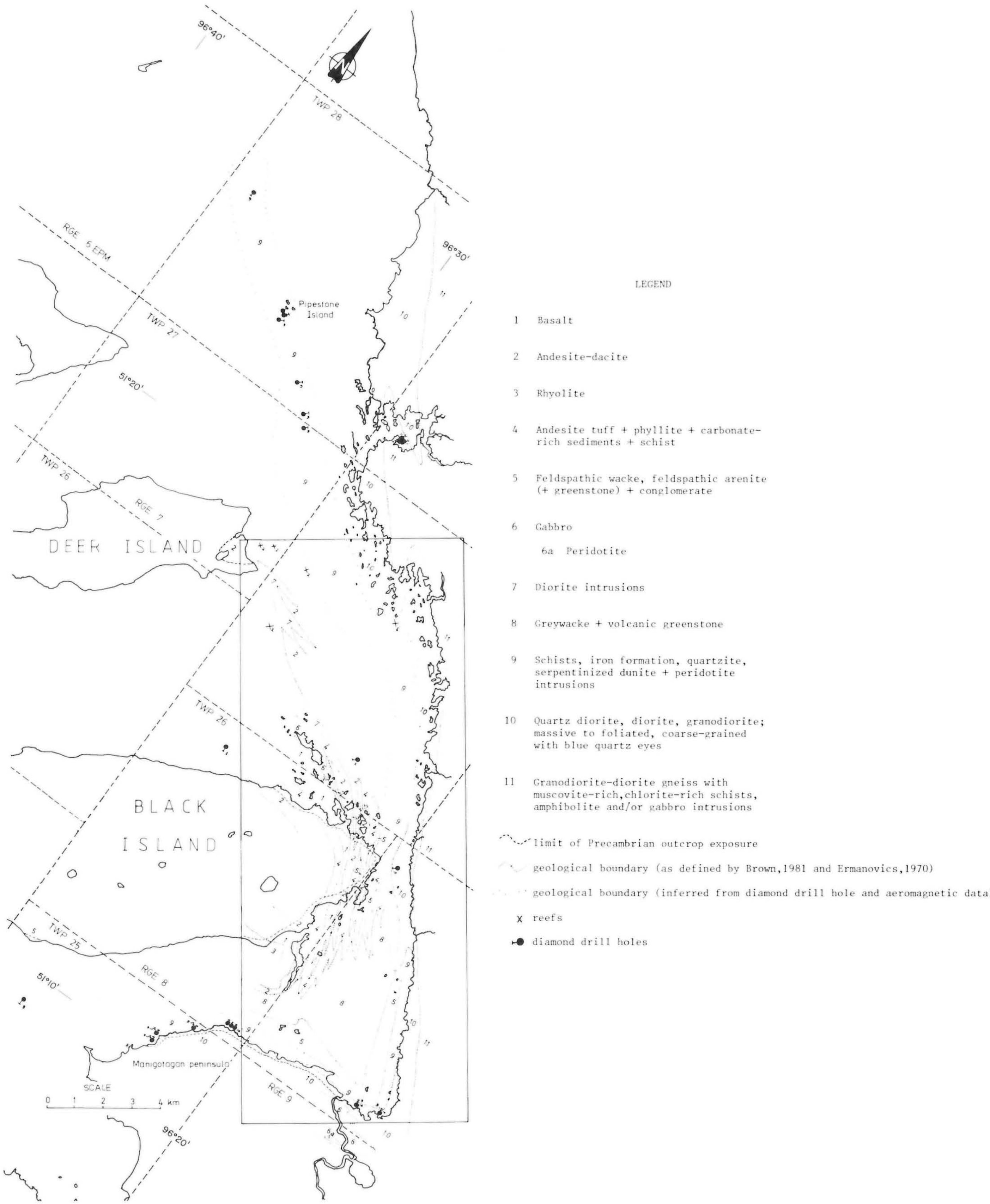

Figure GS-29-1: *Geology of the Black Island area. The volcanosedimentary sequence described in detail by Brown (1981) is outlined and is not necessarily in chronological order. According to Brown, the granitoid rocks (except unit 7) are presumed to be earlier than the volcanic and sedimentary rocks.*

GS-30 BUTTERFLY LAKE AREA
(part of NTS 63 I/6)

by M.T. Corkery

INTRODUCTION

Supracrustal rocks on Butterfly Lake and granitoid rocks to the north were mapped at a scale of 1:20 000 during two weeks of field work as part of the Cross Lake Supracrustal Project. As a result, the Pipestone Lake group metabasalts (formerly reported as **early supracrustal rocks** — Corkery, 1983, 1985; Corkery and Lenton, 1984) and Cross Lake group metasedimentary-metavolcanic rocks were traced as far as the east end of Butterfly Lake (Fig. GS-30-1). The supracrustal belt at Butterfly Lake is interpreted as a synclinal structure complicated by two major faulting events.

GENERAL GEOLOGY

The supracrustal belt at Butterfly Lake is bounded to the north by a 105° trending shear zone marking the contact with an extensive region of granitoid rocks. A second shear zone within the supracrustals, trending about 125°, occurs along the south shore of the lake (Fig. GS-30-1). This fault system is similar to major structures which control the distribution of supracrustals on Pipestone Lake. The widespread ductile to brittle deformation and regional upper greenschist to lower amphibolite grade of metamorphism have resulted in poor preservation of major stratigraphic features. However, the lithologic units are comparable to those described in the Cross Lake area, and previously defined stratigraphic relationships have been applied to the interpretation of the Butterfly Lake area. The supracrustal belt is interpreted as a synclinal structure with a thick south-facing sequence and a thin north-facing sequence restricted to the south shore of the lake. The axial surface of the synclinal structure is coincident with the southeast-trending (125°) shear zone.

Major lithologies in the south-facing sequence are a wedge of Pipestone Lake group metabasalts-metasediments, reaching 2000 m in thickness in the east, which are overlain by up to 400 m of Cross Lake group metasediments that comprise framework conglomerates, matrix-support conglomerates, quartz-rich metasandstone and greywacke metasandstone-metasiltstone. The thin north-facing sequence contains minor Pipestone Lake group metabasalt and an anorthosite-gabbro intrusion overlain by Cross Lake group rocks: predominantly felsic pyroclastic rocks and derived volcanogenic sediments, with metasiltstone, metasandstone, rare matrix-support conglomerate, and biotite-bearing

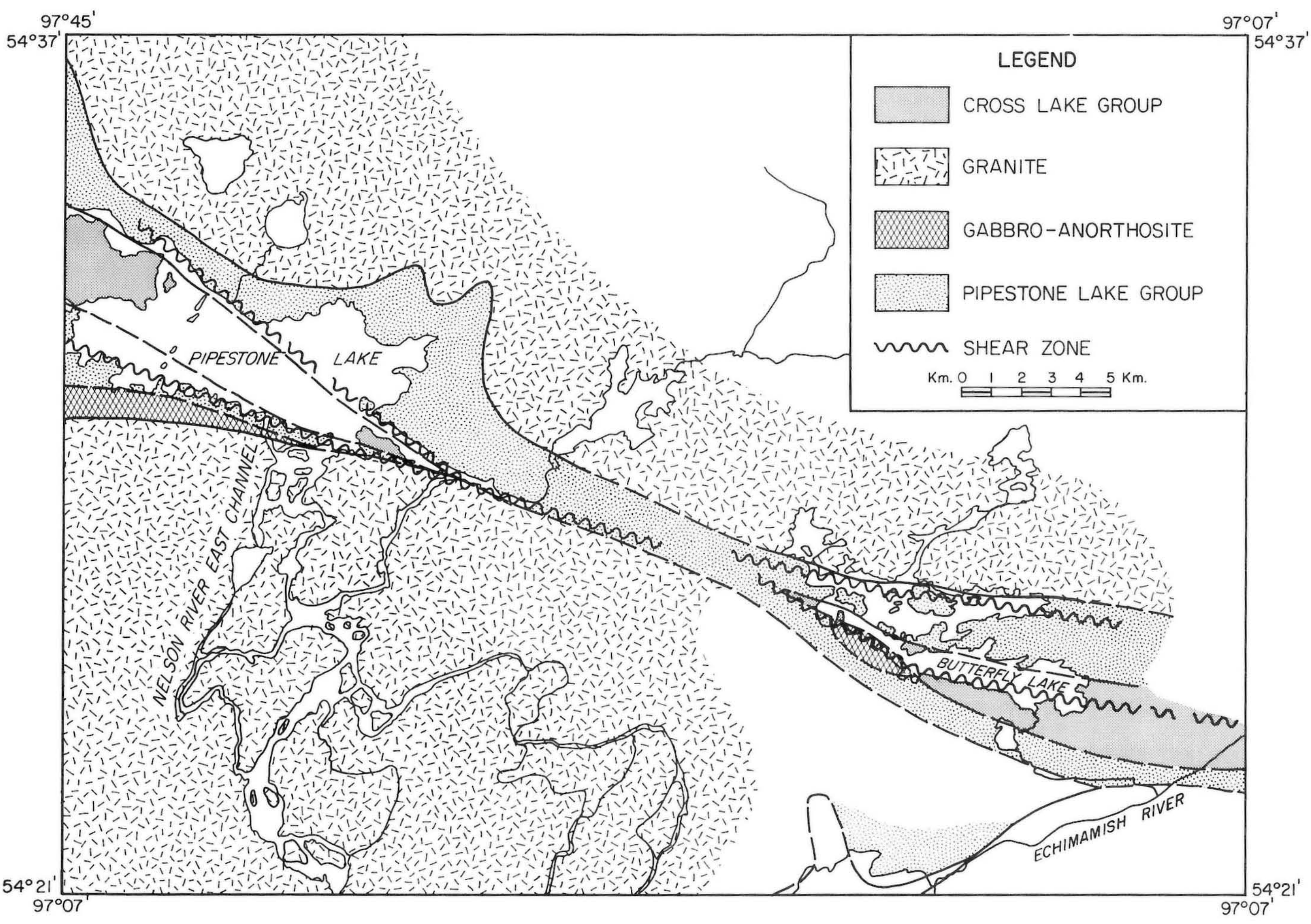

Figure GS-30-1: General geology of the Butterfly Lake — east Pipestone Lake area.

metabasalt and derived metasediments. Lack of correlation of the Cross Lake group lithologies across the fold axis is interpreted to indicate significant displacement along the southeast-trending fault which occupies the axial surface.

Late 030° and 060° faults cutting the 105°-119° regional layering and foliation have both dextral and sinistral offsets (see Preliminary Map 1986N-1). Discrete fault zones are best documented where they offset the granite-basalt contact and the 285°-trending mylonites in the basalt. However, most late fault zones are not exposed and have been inferred from outcrop distribution and structural data. A thick Molson dyke in the central area of the lake intruded one of these fault zones.

LITHOLOGIC UNITS

Supracrustal rocks at Butterfly Lake are similar to equivalent lithologies described from Cross Lake and Pipestone Lake (Corkery, 1983, 1985; Corkery and Lenton, 1984).

PIPESTONE LAKE GROUP

Basalt flows (1a) are aphyric, massive to strongly foliated, and typically display pillow structures or tectonic layering derived from pillow structures. Facing directions are rarely preserved in the north and west, and the few tops noted in the east-central portion of the lake face south. Plagioclase-phyric and glomerophyric pillowed and massive basalt flows (1b) interlayered with the aphyric flows are most abundant, although not restricted to the upper 200 m of the south-facing sequence of basalts. Euhedral to subhedral plagioclase crystals from 2-8 mm in size form 2-5% of the flows. Several pillowed flows with up to 1 cm aggregates of euhedral 2-3 mm plagioclase occur high in the section.

Highly recrystallized, mafic, volcanic-derived sediments (2a) with chert (2b) interbeds form rare, thin bedded sequences up to 1 m thick within the basalts (1). At the top of the basalt sequence and intruded by or overlying gabbro (3) (primary relationship sheared), 5-15 m of thin bedded to massive volcanogenic sediments (2a), with layered cherts up to 2 m thick, form a (relatively continuous) stratigraphic marker approximately 8 km in strike length.

Gabbro dykes and sills (3a) ranging from 1 m to greater than 15 m in thickness extensively intrude the central and upper portions of the basalt sequence. Although texturally diverse, the predominant types are plagioclase porphyritic and glomeroporphyritic gabbros with crystal populations similar in size and distribution to the 'phyric' basalts (1b), suggesting a synvolcanic origin for these gabbros. A large intrusion of anorthositic gabbro to anorthosite (3b) occurs on the south shore of the lake. Most rocks consist of 80-85% euhedral to subhedral, 5 mm — 2 cm plagioclase crystals in a coarse hornblende matrix (Fig. GS-30-2). One lenticular zone several metres long of bimodal anorthositic-gabbro, is similar to the megacrystic gabbro except that it contains scattered 3-5 cm spherical glomerocrysts. Massive anorthosite occurs as a minor phase on several outcrops.

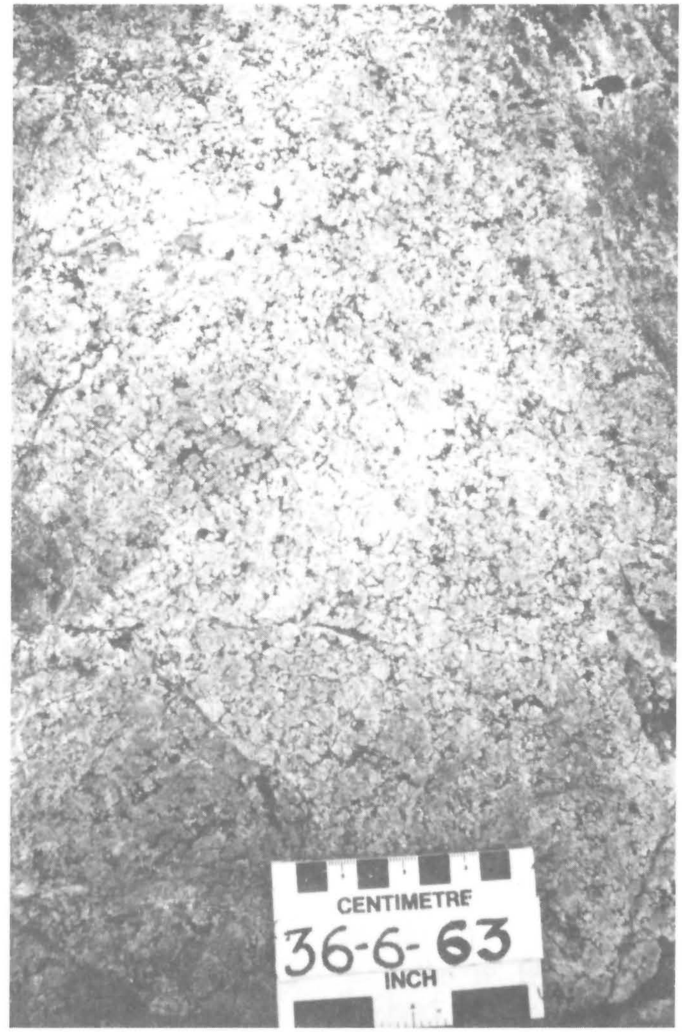

Figure GS-30-2: Porphyritic anorthositic gabbro (3).

GRANITIC INTRUSIVE ROCKS

Three phases of granitic rocks intrude the north flank of the supracrustal belt. Cream to pink weathering, grey-buff augen granodiorite (4a) is the oldest intrusive phase. This is intruded by more abundant, pink weathering, strongly foliated seriate-granite (4b). Dykes of pink, coarse grained to pegmatitic leucogranite (4c), up to 30 m thick, intrude the earlier phases. In one location, leucogranite (4c) contains up to 1% molybdenite.

CROSS LAKE GROUP

Polymictic, unsorted framework metaconglomerate (5) reaches a maximum thickness of 400 m in the central area of the lake. The unit is similar to the basal conglomerate on Pipestone Lake (unit 4a, Corkery, 1983) although in most outcrops bedding features are not observed. Clast composition is highly variable with various gabbro clasts predominant (Fig. GS-30-3). Crossbedded, quartz-rich and feldspathic metasandstone and pebbly metasandstone (6) occur to the east along strike from the metaconglomerates. In this area they overlie a thin basal metaconglomerate and are interbedded with framework metaconglomerate. Pebble-bearing beds and framework metaconglomerates become less abundant to the south, i.e. stratigraphically upwards. This unit is equivalent to sandstone-pebbly sandstone (unit 5, Corkery, 1983) at Cross Lake.

Felsic volcanic rocks and derived metasediments (7) are exposed extensively on the southeast shore of the lake. The felsic volcanics (7a, b) comprise quartz-feldspar porphyry, quartz-porphyry and rare aphyric metavolcanic rocks similar to the rhyodacites (unit 7, Corkery and Lenton, 1984) at Cross Lake. These rocks are invariably highly tectonized and primary characteristics are poorly preserved (Fig. GS-30-4). However, tuff, lapilli tuff and tuff breccia, as well as massive layers, appear to be present; the latter may represent flows or intrusive phases. More heterolithic metasediments (7c) (Fig. GS-30-5), derived predominantly from felsic volcanics, are interpreted as resedimented pyroclastic rocks.

Biotite-rich basalts (8) occur to the northeast of the felsic volcanics (7) and in one location are interlayered with felsic fragmental rocks. These basalts have a distinctive schistose fabric, weather dark grey and contain anhedral 3-5 mm feldspar aggregates. They are similar to shoshonitic basalts (unit 8d, Corkery, 1985) at Pipestone Lake. The chief variance from the Pipestone basalts is the occurrence of several pillowed flows in a 150 m section at the east end of the lake. Basalt-derived sandstone

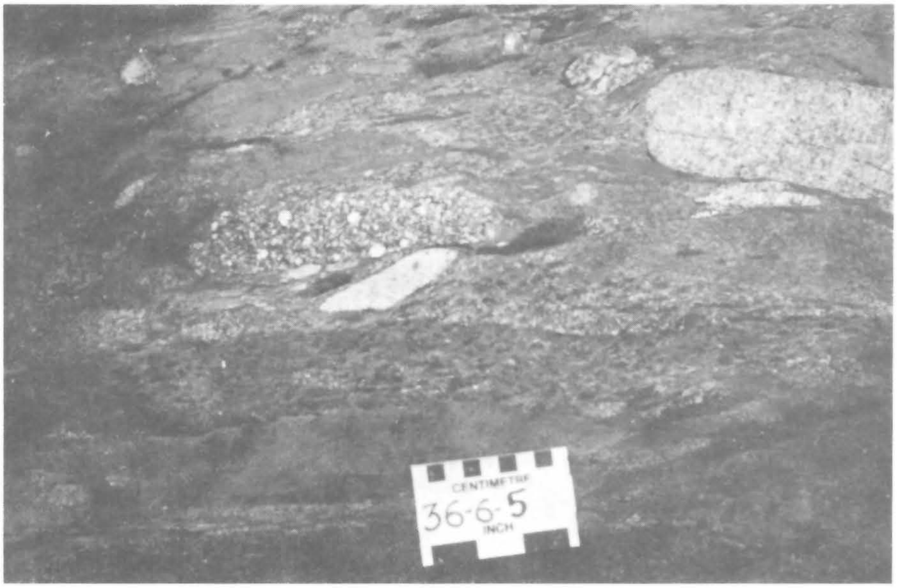

Figure GS-30-3: *Framework polymictic conglomerate (5).*

and oligomictic pebble conglomerate (8b) derived from the basalt (8a) occur north of the basalts and extend westward on points along the south shore of the lake where they are interlayered with felsic volcanic rocks.

Siltstone and fine grained sandstone (9) are interlayered with and overlie units 7 and 8b.

LATE INTRUSIVE ROCKS

Hornblende porphyritic gabbro dykes and sills intrude both the Pipestone Lake group and Cross Lake group rocks. Gabbro and country rocks show the same strongly developed schistosity.

The youngest unit in the area is a post-tectonic, Proterozoic mafic dyke of the Molson swarm. Minor 2-4 cm dykes occur in the vicinity of the major dyke.

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Figure GS-30-4: *Highly deformed felsic fragmental rock (7a).*

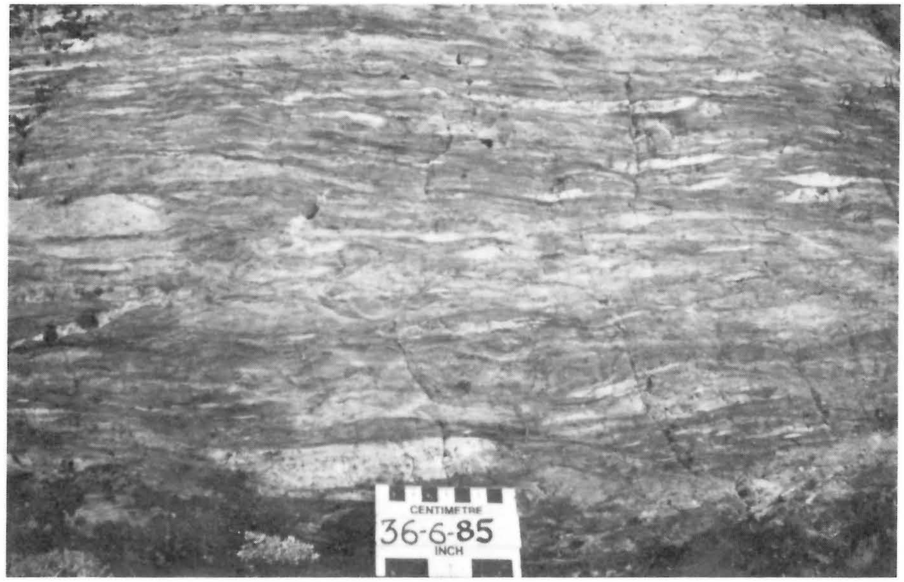

Figure GS-30-5: Conglomerate (7b) derived chiefly from felsic fragmental rocks.

GS-31 CROSS LAKE-PIPESTONE LAKE ANORTHOSITE STUDIES

by H.D.M. Cameron

INTRODUCTION

Investigation of anorthositic and gabbroic intrusions in the Cross Lake-Pipestone Lake area continued (Cameron, 1984, 1985) in conjunction with the Cross Lake mapping program (Lenton, Corkery and Cameron, GS-32, this volume). The objectives of this year's field work were:

1) to conduct additional mapping and geochemical sampling of the Pipestone Lake intrusive complex;
2) to complete the ground magnetometer survey south of Pipestone Lake;
3) to initiate mapping in the northern part of the "West Channel" anorthosite body (see McRitchie, Report GS-33, this volume) at Minago River and Drunken Lake.

PIPESTONE LAKE

The Pipestone Lake intrusive complex is a layered anorthosite and gabbro body up to 600 m thick, extending from the east shore of Cross Lake to the east end of Pipestone Lake. Work was begun in 1984 to study the complex and to evaluate titanium and vanadium-bearing massive magnetite and magnetite-bearing melagabbro layers which lie along the northern margin of the body (Cameron, 1984, 1985). Further mapping and sampling were carried out south of Pipestone Lake and to the west, between Pipestone and Cross Lakes, to provide additional detail and to refine geological boundaries. Magnetite-bearing melagabbro layers were traced from the east shore of Cross Lake to the east channel of the Nelson River. No significant new occurrences of massive magnetite were discovered.

The geology of the intrusive complex and other units is described in Cameron (1984, 1985).

MAGNETOMETER SURVEY

Magnetometer surveys were carried out over the central part of the Pipestone Lake intrusive complex during the 1984 and 1985 field seasons to better define the extent of magnetite-bearing layers within the body. Using the 1984 grid, the base line was reflagged this summer to 2400 m west, and crosslines were established at 150 m intervals. The crosslines were extended to 330 m south and 165 to 225 m north of the base line.

A Scintrex model MP2 proton precession magnetometer, with a sensitivity of 1 gamma, was used for the survey. Readings were taken at 15 m intervals on the crosslines and the base line. Duplicate readings and times were recorded at 75 m intervals. Diurnal fluctuations ranged from 0 to 30 gammas.

The results of the survey (Fig. GS-31-1) show two discontinuous magnetic highs separated by a low. Major peaks are less than 30 m wide. Massive magnetite layers, north of the base line, occupy a narrow band giving readings of 90 000 + gammas. The broader high to the south, with peaks of 70 000 + gammas, represents magnetite-bearing melagabbro. Readings of less than 65 000 gammas represent layers of anorthosite and leucogabbro between the magnetite-bearing units and in the southern half of the grid area. The contact with the **early supracrustal rocks** (metavolcanics) of the Pipestone Lake group (Corkery, 1983, 1985, 1986; Corkery and Lenton, 1984) closely follows the 63 000 gamma contour along the north side of the area, trending toward southwest at the west end of the grid.

MINAGO RIVER — "WEST CHANNEL" ANORTHOSITE

Mapping was begun south of Minago River and Drunken Lake to study the northern margin of the "West Channel" anorthosite body described by Bell (1978), Rousell (1965) and McRitchie (GS-33, this volume), and to establish its relationship to the Pipestone Lake intrusive complex. However, sporadic bedrock exposure and heavy lichen growth on most outcrops obscure the field relations in the northern part of the body.

Most of the area is underlain by coarse grained anorthositic gabbro which appears to have crystallized under conditions approaching granulite grade metamorphism. Leucogabbro, melagabbro, and megacrystic and oikocrystic anorthosite, which make up the Pipestone Lake body, are subordinate. Only one occurrence of magnetite-bearing melagabbro was observed. Megacrystic granodiorite and biotite tonalite of the Jenpeg complex (Lenton et al., GS-32, this volume) intrude the gabbro, and xenoliths of gabbro are found within the granodiorite north of the contact. Small Molson dykes occur throughout the area, intruding both the gabbros and the granodiorite.

UNIT DESCRIPTIONS

ANORTHOSITIC GABBRO

Coarse grained, white anorthositic gabbro comprising 2 mm — 1.5 cm plagioclase with less than 5% 2 mm — 2 cm hornblende clots, is the dominant rock type in the northern part of the "West Channel" body. Average grain size is 6 mm. Plagioclase is clear grey, showing some schiller, and resembles quartz on fresh surfaces. The rock is homogeneous and massive, with some local shearing.

Layers of disseminated 1-3 mm biotite and hornblende, 5 mm — 5 cm thick, occur in the western part of the body, south of Drunken Lake. At some locations these layers are garnetiferous and the surrounding anorthositic gabbro contains 1-2 mm garnets. Discontinuous layers of foliated medium- to coarse-grained melagabbro, 5-30 cm x 3 m, also occur in the Drunken Lake area. Schlieren and inclusions of fine- to medium-grained grey biotite tonalite gneiss are found in the northeastern part of the body.

Medium- to coarse-grained leucogabbro with a composition of 85% plagioclase and 15% hornblende is also present in some locations.

Veins and dykes of granodiorite to 2 m wide intrude the anorthositic gabbro.

BIOTITE TONALITE

White, medium- to coarse-grained biotite tonalite, associated with the Jenpeg megacrystic granodiorite (Lenton et al., GS-32, this volume) intrudes the anorthositic gabbro in the northeast. Grain size is 2-4 mm with some white feldspar megacrysts up to 1 cm. Magnetite and pyrite occur locally.

The tonalite contains schlieren and inclusions of biotite gneiss, amphibolite and melagabbro, xenoliths of leucogabbro and anorthosite from 30 cm — 2 m, and rare inclusions of megacrystic anorthosite with plagioclase up to 4 cm.

The tonalite is intruded by veins of pink pegmatite and coarse grained granodiorite.

MEGACRYSTIC GRANODIORITE

Megacrystic granodiorite intrudes the northern margin of the anorthositic gabbro. The granodiorite is medium- to coarse-grained, grey with pink *lits*, and contains about 15% pink feldspar megacrysts ranging from 8 mm to 4 cm. Joint surfaces show orange hematite staining, and epidote veining is common on shears and fractures.

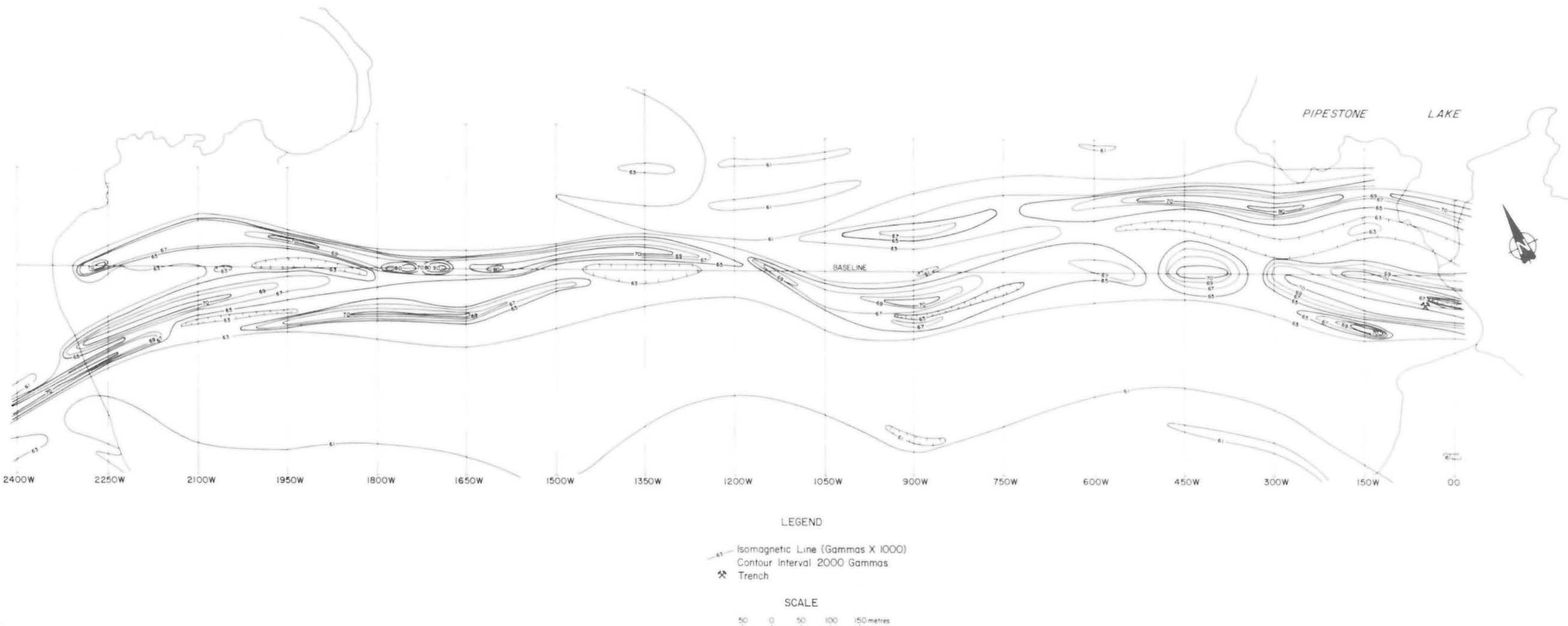

Figure GS-31-1: Isomagnetic contour map of the western grid area, Pipestone Lake intrusive complex.

At Drunken Lake the granodiorite contains rafts of fine- to medium-grained metagreywacke with white granitoid *lits* and abundant, pinhead to 1 cm garnets. Adjacent to the inclusions the granodiorite contains 4 mm garnets.

Along the contact with the anorthosite body, the granodiorite contains agmatized blocks of leucogabbro and anorthosite.

MOLSON DYKES

Dykes of fine grained mafic to ultramafic rock are the youngest unit in the area, intruding the anorthosite body and the granodiorite and tonalite. The dykes are generally 5-20 cm wide and trend 014° and 050°. One larger, coarser grained dyke approximately 5 m wide was observed south of Minago River in the central part of the area.

Further field work, preferably helicopter-supported, and detailed geochemical and petrographic analyses will be required in order to properly assess the affinity between the "West Channel" anorthosite body and the Pipestone Lake complex.

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GS-32 KISKITTOGISU-PLAYGREEN LAKES AREA
(parts of 63I/5, 12 and 63J/8, 9)

by P.G. Lenton, M.T. Corkery and H.D.M. Cameron

INTRODUCTION

Work originally planned for the western region of Cross Lake was postponed because of exceptionally high water levels on the Nelson River system downstream of the Jenpeg control structure at the west end of Cross Lake. Excessive runoff into the Lake Winnipeg basin raised water levels at Cross Lake by 2.5 m, thus covering much of the available exposure. Work was concentrated above Cross Lake in the forebay area of Jenpeg on northern Playgreen Lake and Kiskittogisu Lake. Water level, while still above historic levels, was 3 m below recent normal values exposing many areas examined at reconnaissance scale by Bell (1978). This produced a continuity between recent mapping on Cross Lake (Corkery, 1983, 1985; Corkery and Lenton, 1984; Cameron, 1984, 1985) and the work of McRitchie (Report GS-33, this volume).

Additional mapping was done on Cross Lake, predominantly in granitoid areas previously inaccessible due to low water levels. This work produced no fundamental changes to the previous preliminary maps of Corkery, 1983, 1985, and Corkery and Lenton, 1984. Further clarification of the intrusive history and relative ages of units in the Cross Lake area are described below.

The Playgreen-Kiskittogisu area is a region of diverse intrusive rocks which developed over a considerable period of time, as indicated in Table GS-32-1. This table is a compilation of current work and the recent mapping on Cross Lake between 1983 and 1985. One group of intrusions predates and one postdates the deposition of the Cross Lake Group of clastic metasediments. In general the older units are of batholithic size, represent a complex of related and non-related intrusions, and show an extensive tectonic history. The younger units are more restricted in areal extent, generally more homogeneous and exhibit a simpler tectonic history. The only units of extensive size that postdate the Cross Lake Group are the megacrystic granodiorite and tonalite of the Jenpeg complex. All major intrusive units locally contain rafts of amphibolites derived from the Pipestone Lake Group of mafic volcanic and volcanic-derived metasedimentary rocks, and gabbroic to anorthositic inclusions derived from the old mafic intrusive complexes.

TABLE GS-32-1
SUMMARY OF GEOLOGIC EVENTS

Minor shearing and mylonitization in 050°
Intrusion of the Molson dyke swarm
Syntectonic intrusion of differentiated granites and pegmatites; 030°, 050° and 270°
Major deformation of the supracrustal belts with syntectonic intrusion of Jenpeg complex, red granite and minor granitoid rocks; 030°, 050° and 290°
Intrusion of feldspar porphyry and gabbro-diorite plugs
Deposition of the Cross Lake Group
Unconformity
Intrusion of the major granitoid complexes (Playgreen, Whiskey Jack, Clearwater Bay, Eves Rapids)
Intrusion of the Nelson River and Pipestone Lake Anorthosite Complexes
Deposition of the Pipestone Lake Group

The old intrusive rocks have been grouped into 5 major intrusive complexes:

- Nelson River Anorthosite Complex
- Playgreen complex
- Whiskey Jack complex
- Clearwater Bay complex
- Eves Rapids complex

Contacts between complexes can be either intrusive or fault-related on block boundaries. Relative ages have been documented for all but the Eves Rapids Complex. Work on Cross Lake has shown that the youngest complex, Clearwater Bay, is in unconformable relationship to the Cross Lake Group. The Eves Rapids complex probably predates the Cross Lake Group as it exhibits a tectonic history similar to the other complexes.

UNIT DESCRIPTIONS

As many of the units encountered in the Playgreen-Kiskittogisu Lakes area have been previously described (Lenton and Anderson, 1983; Corkery, 1983, 1985; Corkery and Lenton, 1984) only new units will be dealt with here.

NELSON RIVER ANORTHOSITE COMPLEX

The large complex of gabbroic to anorthositic intrusions, previously described by Bell (1978), Cameron (1984, 1985) and in this volume by McRitchie (GS-33) and Cameron (GS-31), is restricted to zones of inclusion trains in the granitoid rocks. Gabbro and leucogabbro predominate over anorthosite and hornblendite inclusions. The trains are aligned in the dominant foliation plane, generally 050°, but the inclusions commonly retain the old 090° to 140° direction that represents the trend of the original anorthosite complex. The mafic rocks commonly occur as an agmatite in white leucocratic, coarse grained to pegmatitic tonalite. This agmatite is included as large blocks in the younger granitoids. The inclusions are extensively metamorphosed, and consist of white to grey plagioclase and coarse grained black hornblende. The relationship described by McRitchie (GS-33, this volume) of the anorthosite intruding tonalite gneisses was not observed in this area.

PLAYGREEN COMPLEX

This comprises separate tonalite intrusions. The oldest, a coarse grey augen tonalite with either hornblende or hornblende and biotite as mafic minerals, occurs only as inclusions in the younger tonalites. It contains rare amphibolitic to hornblendic inclusions. The dominant rock is a light grey biotite tonalite with smoky blue quartz. This commonly includes the augen tonalite. Locally this unit is porphyritic, with up to 5% of 4 mm grey plagioclase phenocrysts. The tonalite complex is extensively intruded and metasomatized by younger granitoids. In zones of extreme deformation the tonalites are reduced to a multicomponent tonalitic orthogneiss comprising a mixture of tonalites, migmatitic leucotonalite *lits*, various ages of pegmatites and younger granitoids, including rocks of the Clearwater Bay, Whiskey Jack and Jenpeg complexes.

JENPEG COMPLEX

The dominant rock through Kiskittogisu Lake and the west channel of the Nelson River as far north as the Jenpeg area of Cross Lake is a pink to grey, leucocratic, megacrystic, biotite granodiorite. It contains numerous rafts of the older intrusive complexes. The granodiorite varies locally in texture and composition. Biotite content ranges from less than

1% to 5%. Megacrysts of mottled pink and grey microcline are equant to tabular with a size range of 1-8 cm. They commonly are poikilitic with concentric layers of quartz, biotite and plagioclase inclusions. Megacrysts average 5% of the rock, but range from less than 1% to 30% (locally). The dominant rock in the vicinity of the Jenpeg Generating Station is an older, but related grey, medium grained to weakly megacrystic, biotite granodiorite to tonalite. It is more mafic, commonly schlieric and has 1-2% of tabular microcline megacrysts.

RED GRANITE

Red to pink coarse grained to pegmatitic seriate granite and related pegmatites are common throughout the area. It occurs as small plugs on Playgreen Lake but is common throughout the area as anastomosing dykes in most of the older units. It is quartz-rich, magnetiferous and contains traces of red garnet and rare tourmaline. It is the source of much of the pegmatitic veining in the area. Three minor intrusive units cut the red granite: a grey "spotted" granodiorite containing 1 cm oval aggregates of quartz and feldspar, a dark grey, aplitic granodiorite and one generation of weakly foliated mottled pink and white pegmatite and related aplite.

MOLSON DYKES

The youngest unit in the area is the Molson swarm of mafic to ultramafic dykes. Minor dykes ranging in width from 1 cm to several metres are common throughout the area (see McRitchie, GS-33, this volume). Although in general the dykes are weakly or not tectonized, in the major 050° deformation zones they are locally sheared and mylonitized. Several major dykes of 50-80 m thickness occur in the main tectonic zones that separate crustal blocks. These dykes show igneous layering with sedimentary structures such as crossbedding, scours and flow channels. The large dykes generally trend 050° or 030°.

STRUCTURE

The dominant structural pattern is controlled by major zones of brittle and ductile deformation. The oldest fabric is shown by metamorphic layering with parallel schistosity in a 090°-120° direction with steep variable dips. This is commonly transposed and disrupted by major faults at 030°-060°. These later faults represent block boundaries between crustal blocks. These are characterized by broad zones of cataclasis (up to 1 km wide) containing many discrete fault/mylonite zones. Linear fabrics have a consistent 30°-60° plunge to the northeast. This northeast faulting has two major components: 050°-060° zones of widespread cataclasis with subordinate mylonitization, and younger 020°-035° mylonites. These zones show a prolonged history of extension accompanied by intrusion of granitoid and mafic rocks, followed by compression and shearing. The youngest fabric is a weak 140° biotite schistosity that locally cuts the 050° shear direction.

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GS-33 NELSON RIVER ANORTHOSITE EVALUATION (parts of NTS areas 63J/8 and 9)

by W.D. McRitchie

INTRODUCTION

A potential shortage in the supply of metals such as chromium and platinum has recently stimulated a revival of interest in the large bodies of anorthosite (Nelson River Anorthosite Complex, Bell, 1978) known to occur in the Cross Lake region, northern Manitoba.

Under the auspices of the Canada-Manitoba Mineral Development Agreement, the Provincial Geological Services Branch is engaged in the documentation and evaluation of titanium and vanadium-bearing magnetite layers associated with anorthosite on Pipestone Lake, adjoining Cross Lake (Cameron, l984, 1985). This year investigations were expanded to encompass the larger West Channel anorthosite body (Bell, 1978), 25 km west of Pipestone Lake.

Earlier descriptions (Bell, 1978) of the Nelson River Anorthosite Complex were mainly based on shoreline exposures, with sparse coverage inland between Minago River and Kiskitto Lake. Though sampling was limited, Bell's petrographic descriptions are comprehensive and detailed, providing a thorough documentation of the lithologies encountered.

Accordingly, the current investigations aimed to:

a) augment Bell's reconnaissance level sampling,
b) catalogue further, compositional variations within the anorthosite suite
c) generate hitherto unavailable chemical data, to categorize the magmatic association of the complex, and to provide information on the alumina content of plagioclase-rich rocks,
d) evaluate earlier statements regarding the origin, timing of emplacement, structural setting and other field relationships of the anorthosites,
e) make a preliminary evaluation of the anorthosites as a source for building or dimension stone,
f) determine whether the main (West Channel) body contains chromitite seams similar to those reported from the Fiskenaesset anorthosite complex, Greenland (Gormsen, 1971), and
g) generate additional data on the Nelson River Anorthosite Complex thereby permitting a petrological and metallogenic comparison with similar associations elsewhere in the Precambrian.

A two week pilot sampling and mapping program was conducted over the "West Channel" anorthosite body as well as satellite bodies between Jenpeg and Kisipachewuk Rapids, and on Kiskitto Lake (Fig. GS-33-1).

The north (see Cameron, Report GS-31, this volume) east, west and south contacts of the main body were accessed by water, and this coverage was augmented by a 3 day — 78 station helicopter sampling of the more remote and poorly exposed central portions of the main anorthosite, and its associated granulites.

Although high water conditions on the Nelson River (216.4 m) seriously limited observations of the satellite bodies (some lenses noted by Bell were completely submerged), sufficient exposures remained to permit the initial documentation in the West Channel and Kiskittogisu Lake areas. The helicopter program more than doubled the density of sampling previously available for the West Channel body. Contacts of the anorthosite with the adjacent granulitic and tonalitic gneisses were adjusted slightly from those proposed by Bell.

Bell's (1978) threefold compositional breakdown into Porphyritic anorthosite (7a), Anorthosite (7b) and Gabbroic anorthosite (7c) appears valid as a first approximation; however, significant small-scale variations in composition, texture and layer type were observed on many outcrops and no statements can yet be made regarding regional stratigraphic or zonal relationships.

Local compositional variations were noted including bimodal and trimodal football, megacryst, and phenocryst-bearing porphyritic hornblende anorthosite, recrystallized derivative meta-anorthosite, and interlayered apparently comagmatic anorthosite and "Pikwitonei" enderbite, the latter indicating a close genetic link between these two lithologies.

The development of widespread garnet within the West Channel anorthosite along its eastern margin, near the Kiskitto-Minago drainage channel on Kiskitto Lake, and south of the Minago River (8 km west of Drunken Lake) again argues forcibly that the anorthosite and granulites occupied the same crustal setting during the Kenoran, and jointly experienced the granulite facies metamorphic events (M_1 and M_2), in direct conflict with the post-granulite emplacement advocated by Bell (1978).

The remarkable textural and compositional similarities observed throughout the region from Pipestone Lake to Minago River strongly support Bell's supposition that "the various bodies once formed a continous sill which has since been modified by metasomatic replacement" and segmentation through folding, axial rupture and dislocation along northeast-trending block faults such as those defined by Corkery and Lenton (1983, 1984, 1985) in the adjacent Cross Lake area.

The current work also suggests that the location of Hubregtse's (1980) combined M_1-M_2 orthopyroxene isograd (south of Minago River) should be moved at least 15 km eastwards to the west arm of Kiskittogisu Lake, where orthopyroxene was observed in axial mobilizate stringers in supracrustal amphibolites (at the old Kiskitto Lake outlet Hydro quarry site), and diatexitic garnet-biotite-plagioclase paragneisses were recorded 10 km south of the new Kiskitto Lake inlet pipe.

No significant mineral occurrences were noted in the area, although a sample from a 40 m long, 20 cm thick anorthosite layer containing disseminated sulphides has been submitted for platinum assay.

Near the centre of the West Channel body exceptionally coarse grained (up to 20 cm black plagioclase), unfoliated and massive anorthosite with widely spaced jointing (1-3 m) may have potential as a dimension stone.

Although in many respects (e.g. compositional and textural range, layering types and structural complexity) the Nelson River anorthosites resemble those described by Myers (1985) from the Fiskenaesset Complex in Greenland, at the time of writing no chromitite seams have been recognized in the Manitoba complex nor has it been possible to develop a stratigraphic model for the intrusion. Extensive swamps in the north-central part of the body will inevitably prevent complete documentation; however, additional traverses on the ground are expected to integrate the fragmentary coverage obtained to date, thereby expanding our current understanding of anorthosites within the northwest Superior Province.

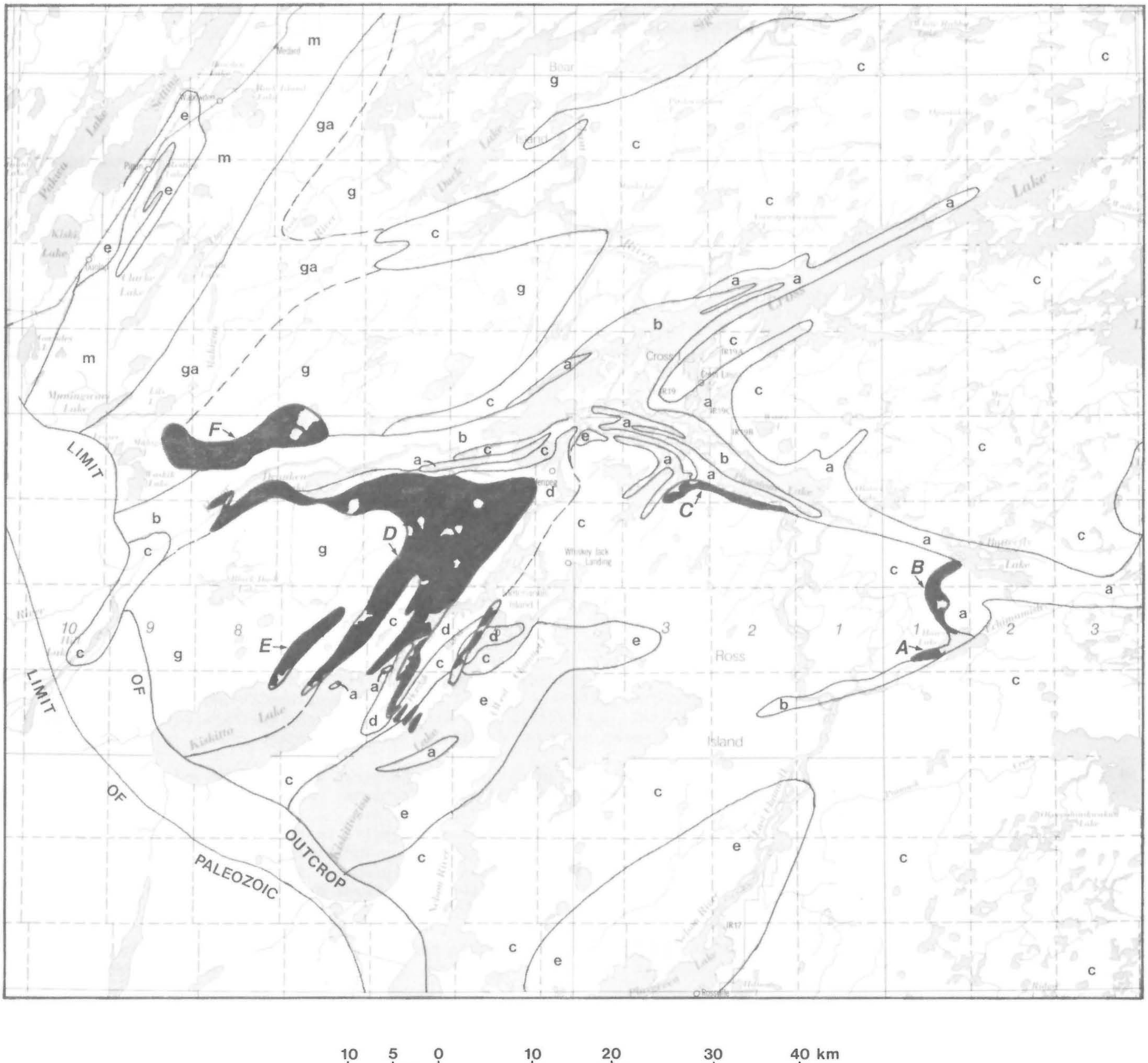
UNIT DESCRIPTIONS

SUPRACRUSTAL UNITS

Supracrustal units (other than anorthosite) are exceedingly rare in the Kiskitto region, and are restricted to:

(a) two occurrences of well layered amphibolite on an island in Kiskitto Lake and near the old Hydro quarry (at Kiskitto dam), and
(b) a single zone of diatexitic metasedimentary garnet-biotite gneisses, 10 km south of Kiskitto inlet pipe.

Both amphibolite occurrences are well layered and garnetiferous, that at the Kiskitto dam being 100 m thick. Layering from 1-100 cm thick, is marked by changes in grain size and hornblende content ranging from hornblende-plagioclase gneiss, through garnet amphibolite to thin horn-



A – Hairy Lake
B – Butterfly Lake
C – Pipestone Lake
D – West Channel
E – Kiskitto Lake
F – Minago River

a - metavolcanics
b - metasediments
c - granodiorite–tonalite gneiss
d - porphyroblastic granodiorite
e - granite
f - anorthosite (black)

g - granulite
ga - granulite with amphibolite overprint
m - migmatite

Figure GS-33-1: Anorthosite bodies of the Cross Lake region (geology modified from Bell, 1978).

blendites. Local sulphide concentrations are layer-bound and confined to hornblendites. The amphibolites are locally Z folded, and cut by anastomosing stringers of pegmatite mobilizate containing 1-4 cm orthopyroxene and hornblende clots, as well as younger granite dykes trending 070°.

The diatexitic paragneiss is coarsely blastic with intensely and symmetrically folded layering (3-20 cm) defined by variations in fine- to medium-grained quartz, plagioclase and biotite content. Ruby-red garnet occurs locally. White pegmatitic mobilizate *lits* and offshoot dykes are folded and boudinaged with the layering.

TABLE GS-33-1
ANORTHOSITIC ROCKS IN THE KISKITTO LAKE REGION

Rock Type	Description
Anorthosite	- (< 10% mafics) fine, medium, coarse and very coarse grained, massive and laminated units. Plagioclase ranges from 1-2 mm white to light grey, equant polygonal crystals, through 2-4 cm packed euhedral-equant and zoned crystals, to 20 cm megacrysts in a generally coarse grained (3-4 cm) matrix. Outcrops weather with a silkly white lustre; fresh surfaces display clear, grey-black feldspar with local blue peristerite.
Gabbroic anorthosite (10-22.5% mafics) and Anorthosite gabbro (22.5-35% mafics)	- ranges from anorthositic matrix with scattered 1-3 cm clots of hornblende, through interstitial hornblendic aggregates forming schlieric patches, to linked networks of oikocrystic hornblende or hornblendic mats interstitial to feldspar phenocrysts.
Porphyritic hornblende leucogabbro (< 35% mafics)	- unimodal, plagioclase-phyric or plagioclase megacrysts - bimodal plagioclase phenocrysts and megacrysts - trimodal plagioclase phenocrysts, megacrysts and glomeroporphyritic "medicine balls", all in hornblendic matrix
Gabbro (35-65% mafics)	- generally hornblendic, as thin layers (1-20 cm) interlayered with anorthosite or leucogabbro layers.
Melagabbro (65-90% mafics)	- rare 10-200 cm layers verging on hornblendite and interlayered with plagioclase-rich units.
Anorthosite breccia	- ranges from massive, unlayered anorthosite cross-latticed by in situ mobilizate stringers, through partially rotated blocks of anorthosite separated by a granular albitized matrix, to arrays of rhomboid anorthosite fragments separated by anastomosing networks of sheared granular anorthosite and younger mobilizate.
Anorthosite schollen and rafts in younger granitoid units	- isolated rafts and blocks of massive anorthosites as xenoliths and raft trains in younger tonalitic and granodiorite intrusions.
Meta-anorthosites and garnetiferous meta-gabbro	- massive chalky-white recrystallized granoblastic anorthosite with isolated to abundant layered garnet-rich segregations or individual 5 cm ruby-red blasts with euhedral outlines and plagioclase inclusions. Original igneous layering well preserved; gabbro altered to coarse grained granoblastic garnet-hornblende-feldspar granulite.
Cataclastic anorthosite	- partially to wholly cataclastic augen-anorthosite with rounded, isolated and beaded porphyroclasts of feldspar and blocks of anorthosite in finely ground mylonitic matrix.

ANORTHOSITE

The total area underlain by the West Channel body and the satellite lenses on the west channel amounts to 280 km^2.

The principal feature of anorthosite rocks in the Kiskitto Lake region are summarized in Table GS-33-1, and illustrated in Figures GS-33-2 to 21. Cameron (1984, 1985; and GS-31, this volume) provides additional descriptions of the anorthosite association from Pipestone Lake and the Minago River.

Previous field and petrographic descriptions (Bell, 1978) provide a good introduction to the anorthosites. The general subdivision into porphyritic hornblende anorthosite, and gabbroic anorthosite is a workable classification within which the regional attributes of the complex can be discussed.

In general porphyritic leucogabbro (less than 35% mafics) dominates the eastern lobe of the complex from Metchanais Channel to Kisipachewuk Rapids. Gabbroic anorthosite is most abundant in the northern, west-trending arm near the Minago River. Massive and coarse grained anorthosite is widespread northeast of Lochhead Lake. Interlayered gabbroic anorthosite, anorthositic gabbro and anorthosite breccia occupy the three southwest-trending lobes on Kiskitto Lake.

Almost all outcrops contain more than one compositional or textural variety. Accordingly, minor thin, massive and/or brecciated anorthosite layers also occur interbedded with porphyritic leucogabbro on the channel east of Kiskitto inlet pipe, subordinate thin porphyritic layers occur on Kiskitto Lake north shore and on the central islands, and brecciated massive anorthosite is common along the road from Jenpeg to Kiskitto.

Garnetiferous meta-anorthosite was encountered locally on the north shore of Kiskitto Lake (west of the drainage channel), and along the east flank of the West Channel body north of Kiskitto dam. Abundant garnet also occurs as abundant segregations and as local 10 cm blasts in strongly recrystallized meta-anorthosite 8 km west of Drunken Lake. Bell (1978) reports widespread garnet in the strongly recrystallized Minago River anorthosite body to the north.

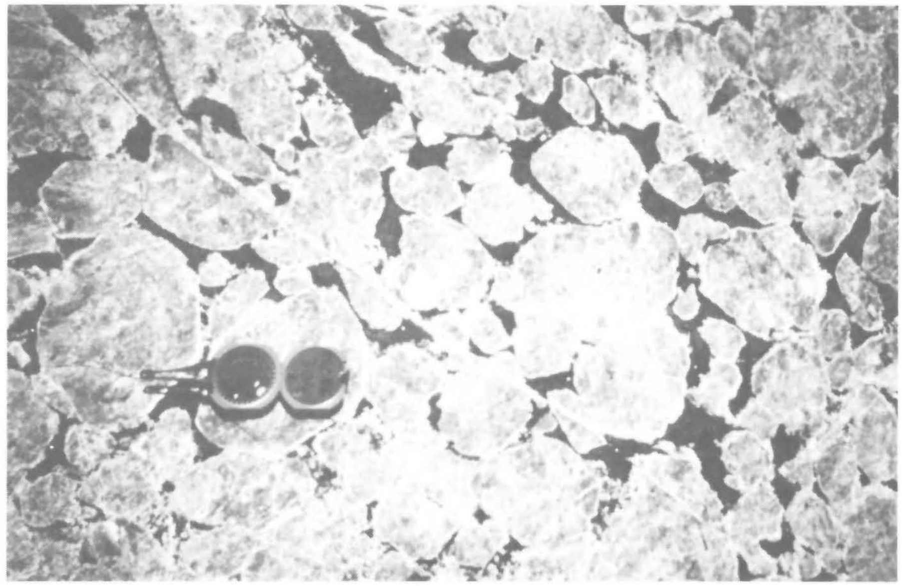


Figure GS-33-2: *Megacrystic leucogabbro with subhedral, equant, plagioclase megacrysts in hornblendic matrix; 04-86-304, 4 km northeast Kiskitto Lake inlet pipe. Note peripheral albitized rim around each megacryst and local carlsbad twinning.*

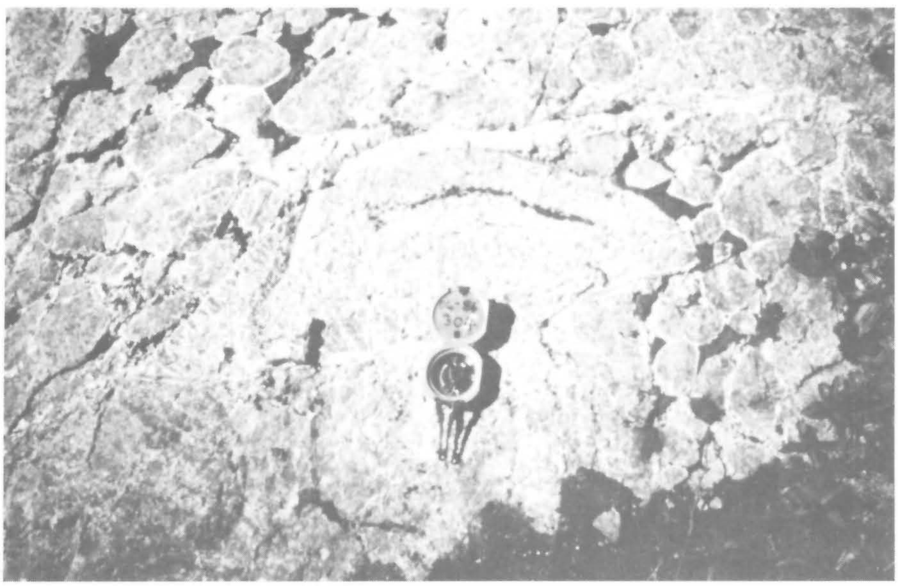


Figure GS-33-3: *'Medicine ball' glomerocrysts of plagioclase with concentric hornblende chadacryst rims and radial fractures, in megacrystic hornblende anorthosite with connected interstitial hornblende matrix, 04-86-304, 4 km northeast Kiskitto Lake inlet pipe.*

Figure GS-33-4: *Bimodal, megacrystic gabbroic anorthosite with isolated glomeroporphyritic 'medicine balls' of plagioclase feldspar, 04-86-304.*

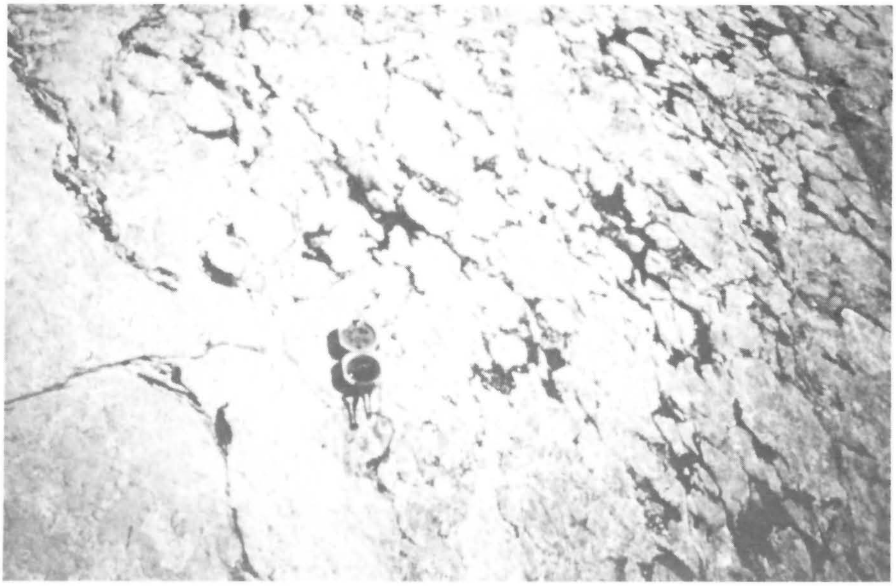


Figure GS-33-5: *Megacrystic gabbroic anorthosite grading into massive anorthosite at left of picture, 04-86-304.*

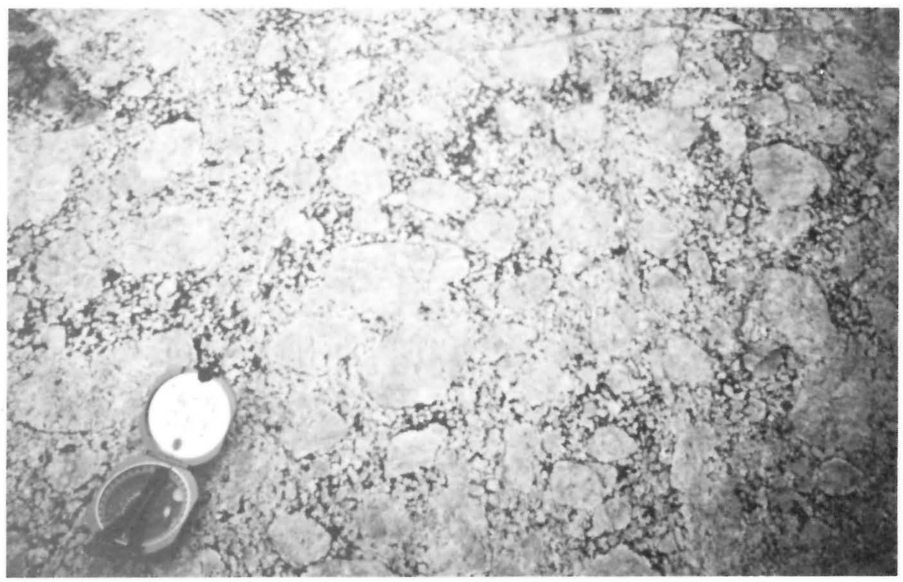


Figure GS-33-6: *Bimodal porphyritic gabbroic anorthosite with plagioclase megacrysts in matrix of hornblende and bean-sized plagioclase phenocrysts; 04-86-351, west shore of Horsfall Island, 2 km southeast of Kiskitto inlet pipe.*

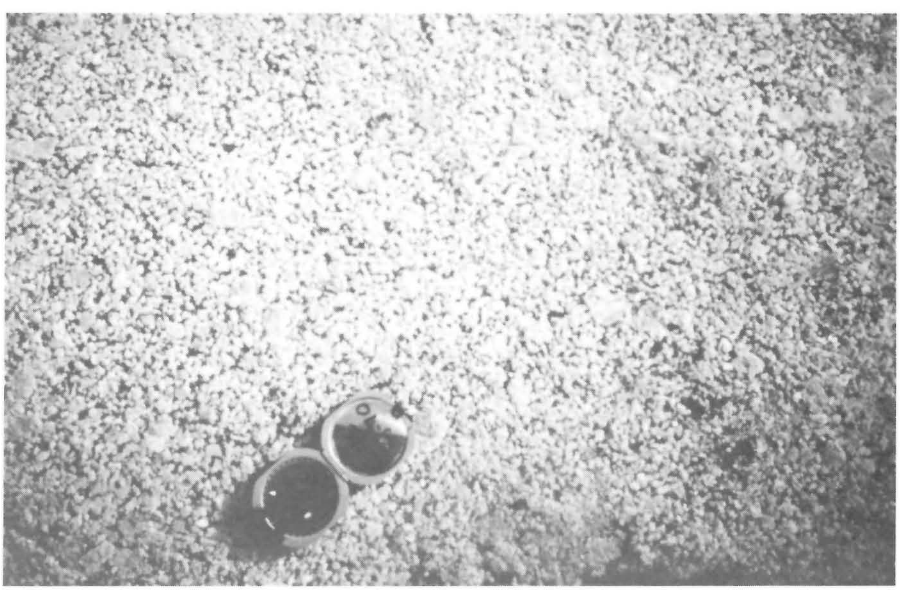


Figure GS-33-7: *Unimodal porphyritic leucogabbro with plagioclase phenocrysts in hornblendic matrix; 04-86-308, 4.75 km northeast Kiskitto Lake inlet pipe.*

Figure GS-33-8: *Local patches of porphyritic hornblende anorthosite interlayered with massive medium- to coarse-grained (1-2 cm plagioclase crystals) anorthosite; 04-86-526, 16 km west-southwest Jenpeg.*

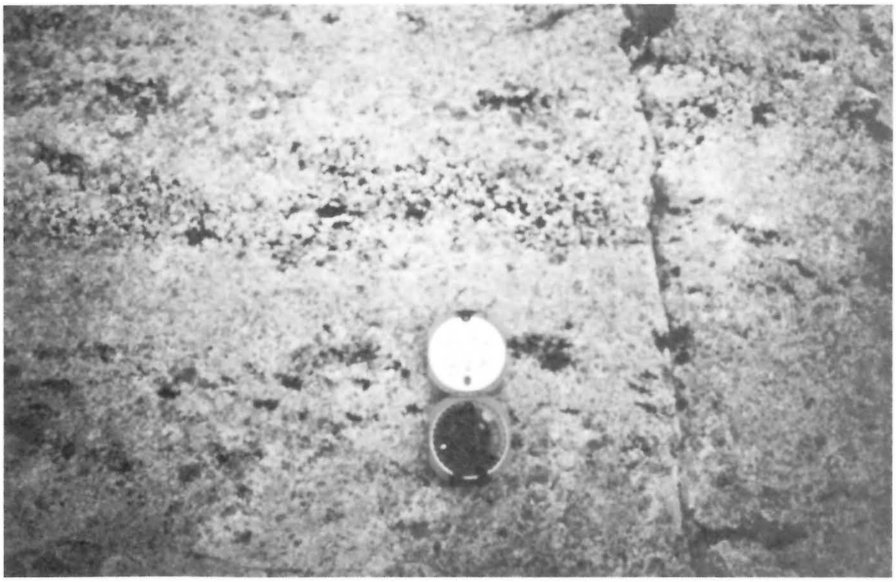


Figure GS-33-9: *Vague layering in massive anorthosite and anorthosite with dispersed clotted aggregates of hornblende. Note re-orientation of aggregates in axial foliation oblique to layering; 04-86-526, 16 km west-southwest Jenpeg.*

Granulitic units (enderbites and opdalites) were observed on both flanks of the apparently isolated lobe crossing the Kiskitto-Minago drainage channel. In several outcrops meta-anorthosite appears transitional with granulitic units. East of the drainage channel control structure anorthosite is interlayered with enderbite and appears to be comagmatic.

Initial petrographic studies on coarse grained anorthosites from the centre of the West Channel body indicate plagioclase anorthite contents in the range 70-81, with most feldspars exhibiting Huttenlocher intergrowths. Follow-up petrographic and chemical studies are being conducted to provide additional information on the mineralogy, chemical composition and affinities of the anorthosites (see Table GS-33-2).

MEGACRYSTIC BIOTITE GRANODIORITE AND GNEISSIC GRANODIORITE

Pink, grey and locally white weathering porphyritic granodiorite occurs as a prominent unit along the west channel of the Nelson River from Kisipachewuk Rapids to the Metchanais Channel. The intrusions strike 55° forming dykes which cut the older amphibolite, anorthosites and gabbros, as well as larger bodies containing rafts and skialiths of the supracrustal units including local hornblendite.

At Kiskitto dam, 10 km to the south, and at the northern end of Horsfall Island the granodiorite occurs in relatively massive cream, grey, and pink homogeneous bodies with abundant microcline megacrysts, rare inclusions and little foliation. Most outcrops are cross-latticed by thin pink granite and pegmatite stringers.

On the east flank of the main bodies, pink, cream, and white aplogranite and pegmatite form large dyke-like intrusions cutting the older units. Garnet occurs as prominent 1-2 cm clots in white pegmatite adjacent to the diatexitic paragneiss southwest of Horsfall Island.

Figure GS-33-10: Mafic layer in hornblende-clot anorthosite, showing smooth top and irregular (load casting?) base; 04-86-526, 16 km west-southwest Jenpeg.

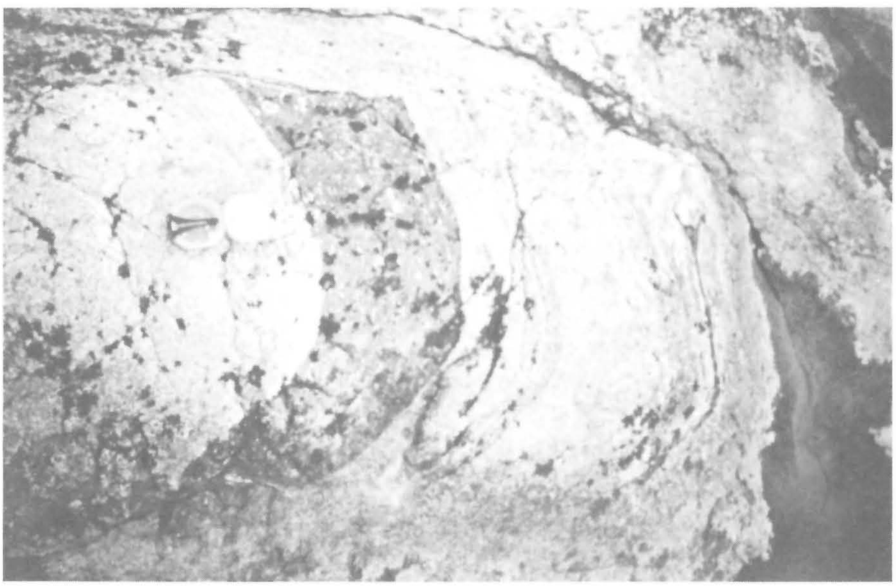


Figure GS-33-11: Plagioclase-phyric mafic layer in layered anorthosite; 04-86-428, north shore Kiskitto Lake, 2 km west of Kiskitto-Minago drainage channel.

Figure GS-33-12: Sharp, wavy contact between megacrystic gabbroic anorthosite unit and gabbropegmatite layer grading into bimodal megacryst and phenocryst-bearing anorthositic gabbro; note pockets of plagioclase phenocrysts immediately below thin bounding gabbro layer; 04-86-311, 5.5 km northeast Kiskitto inlet pipe.

Figure GS-33-13: Thin and regular interlayered metagabbro and meta-anorthosite; 04-86-574, 6.5 km west of Drunken Lake near south shore of Minago River.

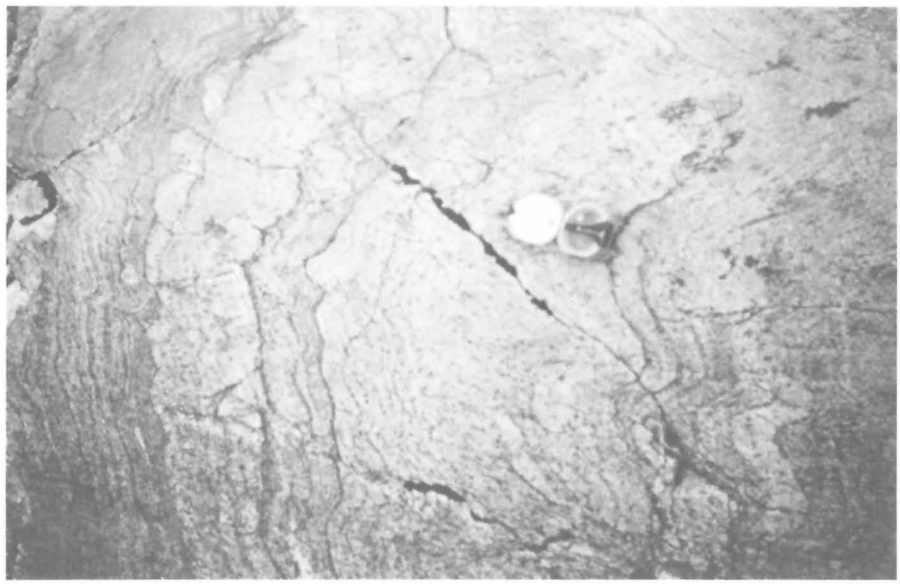


Figure GS-33-14: Thinly and regularly layered (textural) and laminated anorthosite; 04-86-428, north shore Kiskitto Lake, 2 km east of Kiskitto-Minago drainage channel.

Figure GS-33-15: Megacrystic leucogabbro, massive anorthosite and discontinuous, foliated thinly layered mafic and felsic units with shallow east-dipping axial planes; 04-86-304, 4 km northeast Kiskitto Lake inlet pipe. Note: flattened megacrysts adjacent to massive anorthosite.

TABLE GS-33-2
CHEMICAL ANALYSES OF ANORTHOSITES FROM THE WEST CHANNEL-KISKITTO LAKE REGION

Sample Number	04-86-304 -4	04-86-308	04-86-377 -2	04-86-408 -2	04-86-410 -5	04-86-455 -2	04-86-514 -4
SiO_2	48.2	46.7	47.6	49.5	60.1	51.4	49.8
Al_2O_3	28.0	21.2	25.4	28.3	24.0	26.6	29.2
Fe_2O_3	0.58	1.74	0.77	0.55	0.24	0.69	0.61
FeO	2.20	6.47	3.84	1.35	0.57	1.55	0.51
CaO	14.5	12.6	14.3	14.0	9.2	12.9	14.2
MgO	2.4	4.4	3.1	0.7	0.4	1.6	0.4
Na_2O	2.14	2.15	1.98	3.00	4.21	3.55	3.10
K_2O	0.41	0.50	0.43	0.40	0.54	0.53	0.43
TiO_2	0.11	0.92	0.30	0.12	0.07	0.11	0.08
P_2O_5	0.01	0.08	0.02	0.03	0.02	0.01	0.01
MnO	0.05	0.08	0.09	0.03	0.02	0.04	0.02
H_2O	0.66	1.05	0.62	0.55	0.33	0.41	0.39
S	0.00	0.03	0.00	0.00	0.00	0.00	0.01
CO_2	0.22	0.20	0.44	0.40	0.37	0.20	0.08
Other							
O=S	0.00	0.01	0.00	0.00	0.00	0.00	0.00
TOTAL	99.5	98.1	98.9	98.9	100.1	99.6	98.8
Repeat FeO (T)	2.85	8.40	4.70	1.96	0.84	2.32	1.19
ppm Cr	73	107	104	18	16	129	0

Sample Number	04-86-530 -1	04-86-538 -3	04-86-539 -1	04-86-539 -2	04-86-548 -3	04-86-575 -2
SiO_2	51.0	49.8	51.6	50.9	49.7	49.0
Al_2O_3	29.6	28.4	29.6	28.3	28.4	28.9
Fe_2O_3	0.30	0.50	0.22	0.42	0.59	0.49
FeO	0.57	1.45	0.43	1.16	1.74	0.92
CaO	13.8	14.1	13.2	13.8	13.5	16.0
MgO	0.4	1.2	0.3	0.8	1.0	0.7
Na_2O	3.42	2.98	3.43	2.87	3.12	2.63
K_2O	0.27	0.43	0.54	0.46	0.42	0.29
TiO_2	0.06	0.14	0.03	0.12	0.18	0.15
P_2O_5	0.06	0.03	0.02	0.01	0.02	0.02
MnO	0.01	0.03	0.01	0.03	0.04	0.02
H_2O	0.40	0.39	0.27	0.44	0.37	0.43
S	0.01	0.01	0.00	0.01	0.01	0.01
CO_2	0.34	0.10	0.10	0.17	0.14	0.25
Other						
O=S	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.2	99.6	99.7	99.5	99.2	99.8
Repeat FeO(T)	0.90	2.01	0.67	1.63	2.40	1.46
ppm Cr	12	37	17	16	16	18

Figure GS-33-16: Fold hinge in interlayered massive anorthosite and thin mafic units. Note different styles of boudinage and layer fragmentation with typical development of 'fold-hinge' breccia in massive anorthosite; 04-86-410, north shore Kiskitto Lake, 1 km west Kiskitto-Minago drainage channel.

Figure GS-33-17: Fold hinge in layered meta-anorthosites with syntectonic partially cataclastic axial pegmatite; 04-86-339, 2.2 km north-northeast Kiskitto inlet pipe.

Figure GS-33-18: *Brecciated anorthosite with rhomboid anorthosite blocks, and rafts of thinly layered tonalitic gneiss and amphibolite, in anastomosing network of quartz and potassium feldspar-bearing mobilizate, with subordinate white albite: 04-86-339, location as above.*

TONALITE GNEISS

Widespread, layered, foliated and locally laminated medium- to fine-grained grey and white, biotite- and hornblende-bearing tonalitic gneisses with minor potassium feldspar, occur adjacent to the anorthosites and throughout the West Channel and Kiskitto Lake region. Most are variable in composition and grain size, planar layered and strongly deformed with numerous cross-cutting pink stringers and veinlets of potassium feldspar-bearing granite and pegmatite. Thin amphibolite layers are common, although typically boudinaged and segmented. Field relationships suggest the anorthosites and blue-grey feldspar-bearing pegmatite dykes postdate and intrude the older tonalitic suite.

On Kiskitto Lake a single occurrence was noted where more massive weakly foliated gneissic tonalite appears intrusive in origin.

GRANULITIC GRANITOID UNITS, ENDERBITES AND OPDALITES

Greasy-green and honey-brown, highly foliated and weathered granulites are widespread in the west and southwest as well as within the northeast-trending lobe up to Lochhead Lake. Outcrops on Kiskitto Lake are highly foliated and heterogeneous with numerous tight symmetrical folds indicated by contorted mafic segregations, layers and aggregates. Adjacent to anorthosites, contacts appear transitional although complicated by numerous faults and dislocations parallel to the layering. Differentiation between enderbites and opdalites in the field was inconsistent and follow-up studies are proceeding. Northwest of Lochhead Lake numerous occurrences of medium grained, homogeneous equigranular quartzose granulitic granitoid gneiss appear to represent an originally extensive granitic body.

West of Black Duck Creek and Black Duck Lake, Hubregtse (1979) identified relict supracrustal gneisses containing garnet and local hornblende, together with rare orthopyroxene-sillimanite gneisses, indicating a more heterogeneous character to the Pikwitonei in this region.

Bell's field sheets, together with passing reference in the final report (Bell, 1978), indicate numerous scattered occurrences of plagioclase-rich meta-anorthosites throughout the granulite domain near Black Duck Lake. These may constitute structural outliers of the main west channel body or less metamorphosed and reconstituted relicts of a more extensive pre-granulite intrusive complex.

Figure GS-33-19: *'In situ' breakup of massive anorthositic gabbro with marginal albitization of blocks in pervasive feldspathic matrix; 04-86-403, north shore Kiskitto Lake, 3 km southeast Kiskitto-Minago drainage channel.*

Figure GS-33-20: Anorthosite cataclasite with large tectonic rafts of megacrystic anorthosite gabbro in syntectonic and cataclastic feldspathic matrix; 04-86-365, 2.8 km northwest of Kisipachewuk Rapids.

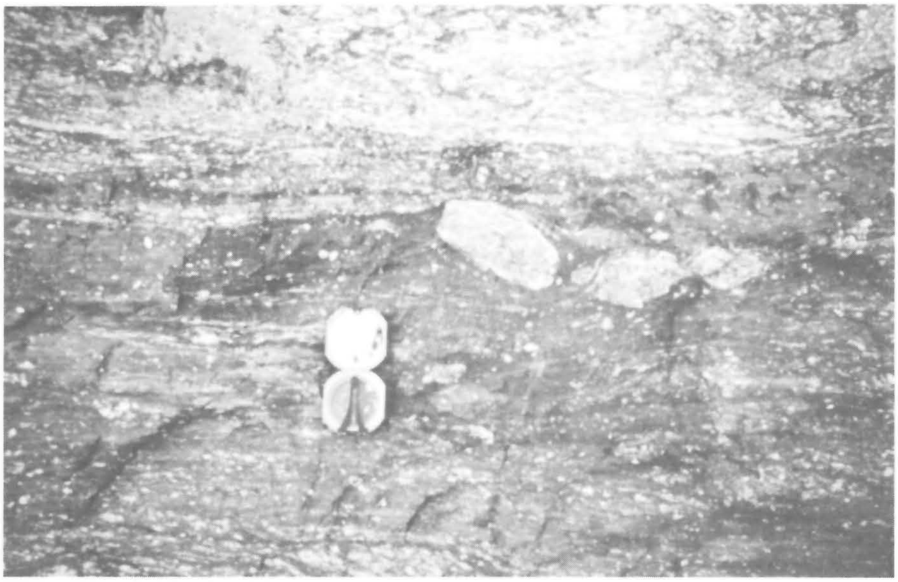


Figure GS-33-21: Mylonitic zone in highly sheared cataclastic anorthosite with isolated blocks of relict massive anorthosite; 04-86-412, north shore Kiskitto Lake 0.5 km west of Kiskitto-Minago drainage channel.

MOLSON DYKES

Late, linear, parallel-sided dykes with chilled margins, knife-edge contacts, and perpendicular cooling fractures were observed throughout the area (Fig. GS-33-22, 23).

Three principal orientations were noted (Fig. GS-33-24 and Table GS-33-3). The northeasterly-trending set displays moderate 45-70° dips to the northwest, an unusual feature for the Molson Swarm (see also Bell, 1978; Rousell, 1965; Scoates and Macek, 1978).

Most dykes are of limited width (4-100 cm) and occur in en echelon sets, some with offshoots perpendicular to the parent body.

Thick dykes (up to 80 m) contain coarse grained gabbroic and noritic cores, some of which display good igneous layering and trough banding. Numerous gabbro-pegmatite pods (up to 1 m) with internally radiating plumose amphibole fronds and hornblendic metasomatic haloes, were observed in a major northeast-trending dyke on Kiskitto Lake. The same unit displays ponding of smaller pegmatitic pods against the base of a mineral graded layer within the intrusion.

Most dykes are cut by hairline fractures which locally coalesce into 55°-trending slip surfaces with associated black chloritic alteration. Sulphides are restricted to minor films on joint surfaces.

STRUCTURE

From Kisipachewuk Rapids to Kiskitto Lake, most outcrops display strongly deformed hinge-zone sequences in which the constituent units are isoclinally and symmetrically folded with widespread breakup of layers, either through boudinage, discrete axial fractures, anastomosing axial shear zones, intense transposition, and emplacement of pegmatitic and granitic mobilizate, or intrusion of major granitic bodies.

The principal strike of the axial planes is to the northeast. Fold axes plunge 15°-40° northeast with shallow (15°-30°) southeast-dipping axial planes indicating vergence to the northwest.

Although traces of the original west to west-northwest trend of the early units are still locally discernible, the dominant structural pattern is dictated by subsequent dislocation of these sequences into northeast-

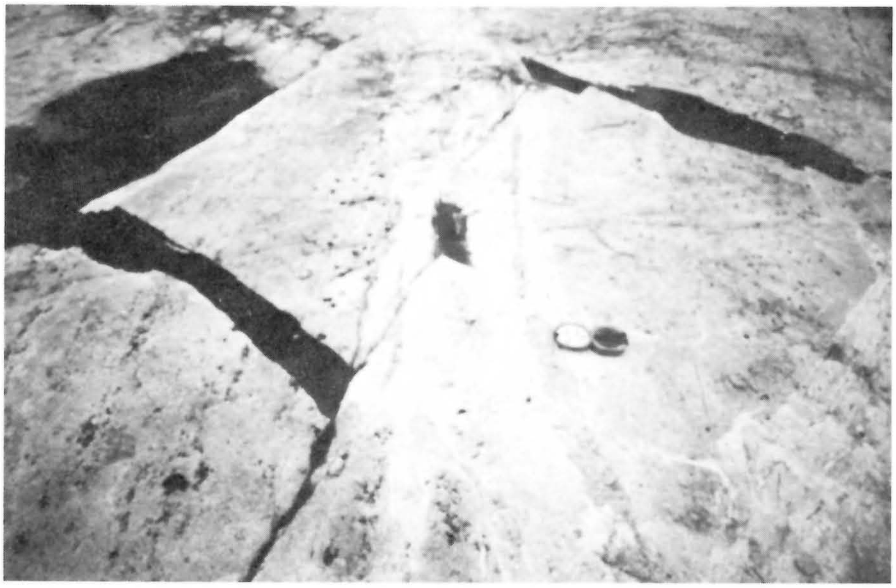


Figure GS-33-22: 30° trending older mafic dykes in hornblende-clot anorthosite 16 km west-southwest Jenpeg (04-86-526). Note consistent sinistral offsets along later 10° striking faults with associated syntectonic feldspathic mobilizate.

Figure GS-33-23: 8-20 cm thick Molson dyke (230/60°) with chilled contacts in massive anorthosite 5 km northeast of Lochhead Lake (04-86-554). 6 cm thick offshoots form en echelon dyke set striking 330°.

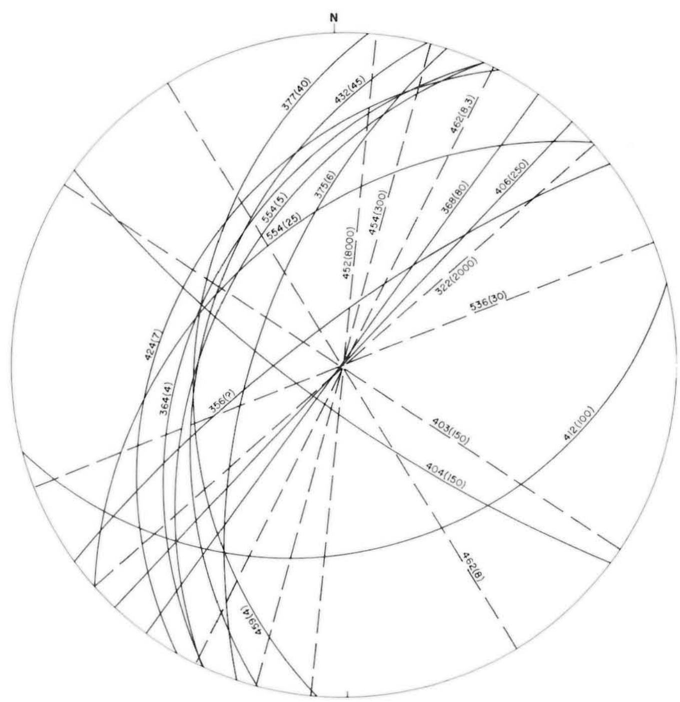


Figure GS-33-24: Molson dyke orientations, Kiskitto Lake region. Azimuth (thickness in cm). Solid line: detaplain inclination. Dotted line: dip not measurable.

TABLE GS-33-3

SEQUENCE OF STRUCTURAL AND INTRUSIVE EVENTS KISKITTO LAKE AND HORSFALL ISLAND REGION

Structural/Intrusive Element	Apparent Movement		Orientation
Pegmatite dykes (magnetite-bearing)	—		060 — 075°
Discrete hairline fractures with associated retrogression	sinistral sinistral and dextral unknown		090 and 320 000 — 010 050 — 060
Pseudotachylite zones and anastomosing ultra-mylonites, conjugate pseudotachylite veinlets	sinistral (up to 5 m sinistral)		030 — 075 007 and 324
Molson dykes		Set 1 Set 2 Set 3	190-230, dips 45-70 west 070, dips 45 to SE 05 — 330, steep to vertical
Cataclastic zones and intense shearing	Sinistral		270 — 290, dips to N
Discrete faults and zones of cataclasis	Dextral		300 — 320
Sheared syntectonic pegmatites	Sinistral (up to 2 m)		350 — 020
Late folds, open asymmetric; associated mineral lineation			Pl. 30-40 to E and SE
Early diabase/gabbro dykes			060 — 090
Early pegmatite dykes			055/75 and 250/60
Early folds with axial planar foliation, local axial rupturing and emplacement of syntectonic granite and pegmatite along hinge zones.			Pl. 15-40 to NE, axial planes dip 15-30SE
Emplacement of anorthosite			
Supracrustal metasedimentary and metavolcanic units			

trending, locally faulted, anticlinal and synclinal hinge zones, wedged between and intruded by the anastomosing, lensoid, syntectonic granitoid intrusions.

The lensoid anorthosite units between Kiskittogisu and Kiskitto Lakes, together with the lobed configuration of the main West Channel body, and scattered occurrences of anorthosite and meta-anorthosite in the 'sea' of enderbites surrounding the Black Duck Lake region and north of the Minago River, can all be attributed to tectonic segmentation of a single original sill-shaped anorthosite body, as originally proposed by Bell (1978).

An initial attempt has been made to organize the subsequent brittle cataclastic, and intrusive events into a temporal sequence (Table GS-33-3), which in most respects is compatible with that proposed by Hubregtse (1980).

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GS-34 LITHOLOGICAL INVESTIGATION IN INCO'S THOMPSON OPEN PIT MINE (part of 63P/12W)

by J.J. Macek

INTRODUCTION

Draining and dredging of Thompson Lake and subsequent development of INCO's Thompson open pit mine uncovered a metasedimentary sequence which is only sporadically exposed elsewhere in the Thompson belt. This provided an excellent and unique opportunity to collect detailed geological data from new exposures prior to their removal during mining operations. The author wishes to acknowledge the permission by INCO to start the work and to continue it over the next few years, and also the excellent support received from the geological management, technical staff and miners of the company. The manuscript benefited considerably from the critical reading and constructive suggestions of Merv Toderian, Rick Somerville, and Gary Sorenson of INCO Ltd., and also of my colleague, Werner Weber.

GEOLOGICAL DATA

The main focus of the work was to establish a complete lithological reference library as a basis for detailed comparisons of the metasedimentary sequence in the Thompson belt. About 40 m of rock samples were taken using a portable circular diamond saw. Collected samples are 0.3-1.2 m long and their average cross-sectional dimensions are 5 x 10 cm. The location of all samples is tied to the surveyed topographical points and thus to the 100 foot (30 m) mine grid. A strip approximately 60-80 m wide and 300 m long was mapped at a scale of 1:240 (Fig. GS-34-1). It contains the location of all collected samples and covers a cross-section through the lithological sequence from southeast to northwest. The major units are described in that order.

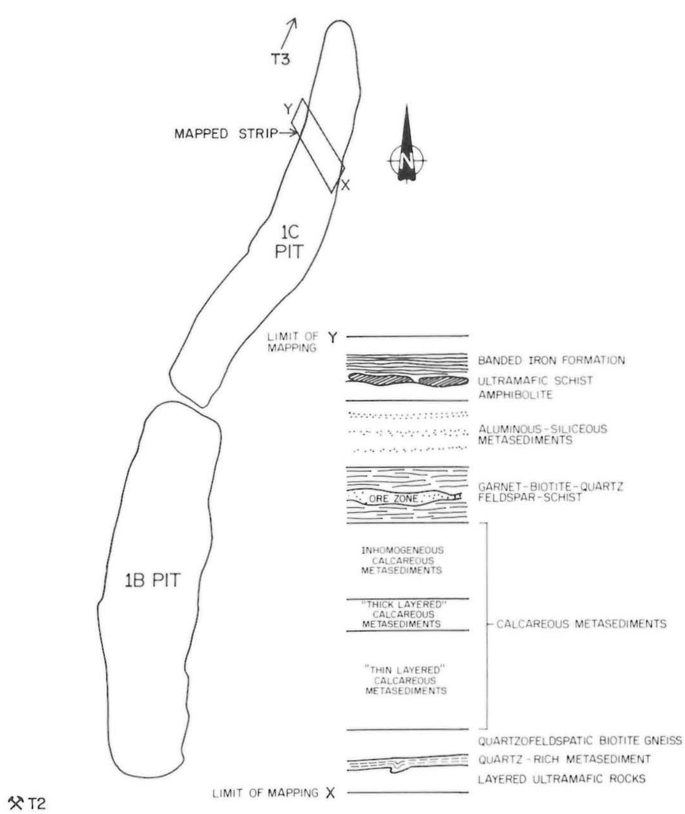


Figure GS-34-1: Sketch of the Thompson open pit mine with the location of the mapped area and sequence of major lithologic units encountered.

MAJOR LITHOLOGICAL UNITS

LAYERED ULTRAMAFIC ROCK

This is the first unit encountered on the southeast end of the mapped strip. It is located close to the stromatic multi-component migmatite farther to the east. It is a dark grey, weakly to strongly foliated, and in places rhythmically layered (3-10 cm) rock forming a subvertical tabular body. Observed layering dips 45° north.

A microscopic examination shows an aggregate of amphibole, magnetite dust, bastite, biotite partially replaced by a smaragd-green chlorite, minor yellow serpentine and carbonate. Some parts of the rock show a relict granoblastic-polygonal texture and mineralogy consisting of dark green spinel, olivine and orthopyroxene. Such mineralogy and texture is typical for granulite facies spinel-bearing olivine orthopyroxenites which are usually parts of pre-Kenoran, layered, mafic-ultramafic complexes scattered throughout the Pikwitonei granulite domain. However, further work is necessary to establish whether or not this ultramafic rock originated from a larger, mafic-ultramafic layered intrusion of Archean age.

QUARTZ-RICH METASEDIMENT
(Local name: Hanging wall quartzite)

Very fine grained, light beige, thin layered to laminated and intensely fractured quartzite is in folded and sheared contact with the ultramafic body. However, in other places (the B pit) similar rocks, although not fractured, are in sharp contact with multi-component migmatites.

Thin sections show intensely mylonitized textures. Quartz is fine grained and undulose and its modal content ranges between 70 and 85%. Microcline ranges between 15 and 25% and occurs as isolated grains or as saussuritized augen. Reddish biotite may be present up to 3%. Similar rocks in the B part of the pit are less sheared and their mineralogy shows the following variations: biotite (partially chloritized) — 1-15%; muscovite — 1-5%; microcline — 20-30%; and quartz — 55-80%. The original sedimentary texture is not preserved (Fig. GS-34-2).

QUARTZOFELDSPATHIC BIOTITE GNEISS

This gneiss is distinct in its appearance (Fig. GS-34-3). Grey, biotite (20-30%) — plagioclase (20%) — microcline (30-20%) — quartz (30%) gneiss contains pink stringers, lenses and pinch-and-swell feldspar mobilizate. Contacts with the neighbouring calcareous metasediments are sharp but in other places there is evidence for a tectonic contact. The occurrence of this gneiss in this location is rather exceptional and it is likely due to tectonism (M. Toderian, pers. comm.).

CALCAREOUS METASEDIMENTS

Calcareous metasediments form a layered, 60-80 m thick composite sequence. Units are highly variable in texture and composition. Several distinct types can be recognized.

"Thin-layered" calcareous metasediments
(Local name: Red green-buff layered skarn)

These metasediments consist mainly of continuous laminae and thin (1-10 cm) layers of various colours: grey-green, dark green, apple-green, grey, beige, reddish-beige and brick-red. The variation of colour

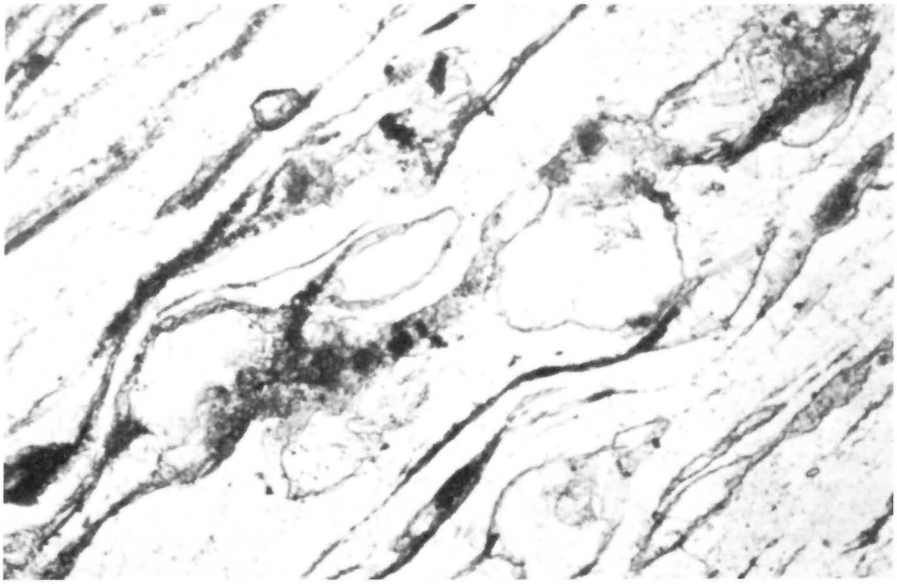
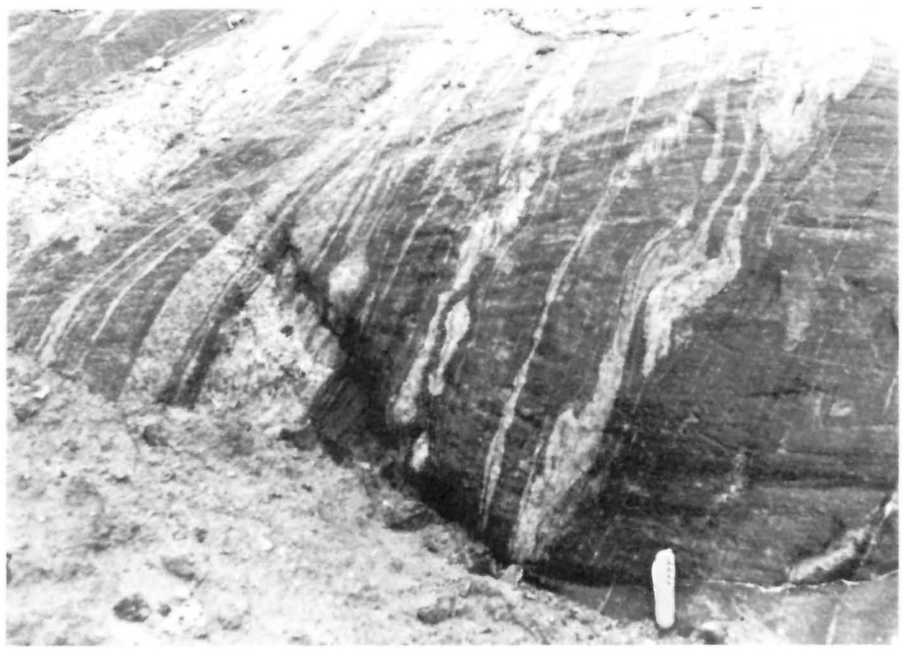


Figure GS-34-2: *Mylonitized quartz-rich metasediment with feldspar augen. Plane polarized light.*

Figure GS-34-3: *Quartzofeldspathic biotite gneiss.*



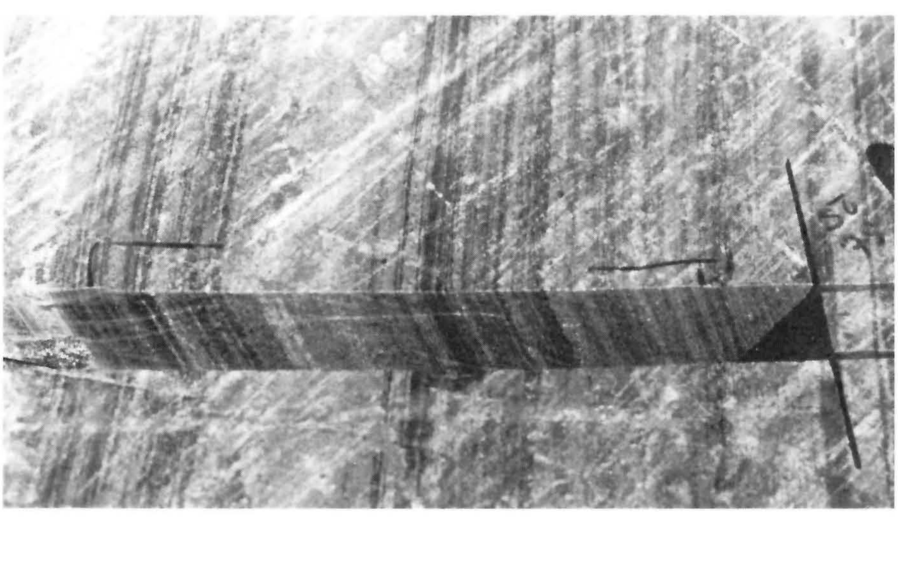


Figure GS-34-4: *"Thin-layered" calcareous metasediment.*

depends on the proportion of major minerals that form single layers: microcline, diopside, biotite, amphibole, sphene, carbonates, quartz and, to a lesser extent, plagioclase, scapolite, chlorite, opaques, epidote and accessories. Major minerals occur commonly within the following modal limits: biotite (5-25%), diopside (5-85%), microcline (10-70%), amphibole (2-30%), carbonate (3-45%), quartz (5-20%) and sphene (1-3%). Although the continuity of the layers gives the impression of a rhythmic deposition, detailed examination reveals that intense tight folding resulted in considerable thinning of layers and their repetition. Original sedimentary characteristics are thus obliterated (Fig. GS-34-4).

"Thick-layered" calcareous metasediments
(Local name: Blue-green banded skarn)

These metasediments comprise 2-50 cm thick pinch-and-swell layers of highly contrasting colour and composition (Fig. GS-34-5). The major colours are: dark brown with a purple tint, apple-green-beige and aquamarine blue. The dark brown layers consist of biotite (15-30%), feldspar (30-40%) and quartz (40-45%). The apple-green-beige layers consist of carbonate (50%), microcline (30%), quartz (10%) and minor colourless amphibole and biotite. Aquamarine blue layers are very soft and consist of carbonate (60%) and blue chlorite (40%). The sequence is characterized by boudinage of layers near steeply dipping folds. Several cavities were found which are partially filled with calcite and chlorite. Portions of this sequence are intensely sheared by a major fault.

Inhomogeneous calcareous metasediments
(Local name: Olivine-diopside-microcline skarn, marble)

This rock is conspicuous because of its highly inhomogeneous texture (Fig. GS-34-6). Texturally similar rock components occur as isolated blocks showing evidence of disruption, folding and differential deformation. Megacrysts of diopside rimmed by white carbonate are scattered throughout the rock. Modal composition is difficult to estimate. However, fine grained portions usually consist of carbonate (70-75%), olivine (20-25%) and about 5% of pale phlogopite or chlorite. Olivine is partially or completely serpentinized. Some portions lack olivine and consist of carbonate (90%) and phlogopite (10%).
Chondrodite occurs sporadically.

GARNET-BIOTITE-QUARTZ-FELDSPAR SCHIST

This unit consists of coarse grained, strongly foliated, intensely folded, purple-brown schist. Metamorphic layering on a scale of 1 to 10 mm is a characteristic feature. The main constituent minerals are: biotite (15-90%), garnet (1-10%), plagioclase (30-40%), microcline (30-35%),

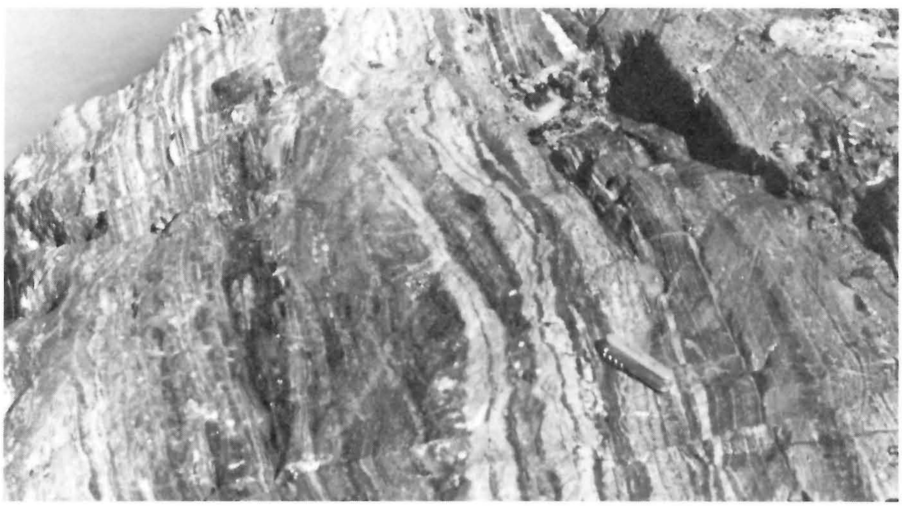


Figure GS-34-5: "Thick-layered" calcareous metasediment.

Figure GS-34-6: Inhomogeneous calcareous metasediment.

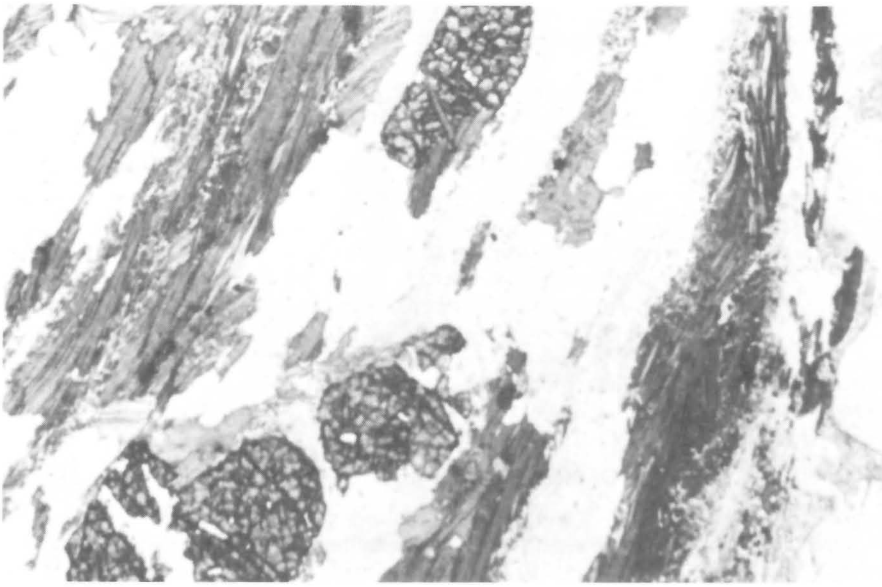


Figure GS-34-7: *Garnet-biotite-quartz-feldspar schist, fractured garnet and partially sheared biotite in a sheared portion of the schist. Plane polarized light.*

quartz (10-30%) and opaques (1-5%), complemented by sporadic occurrence of sillimanite, muscovite, amphibole, scapolite, sphene and chlorite (Fig. GS-34-7).

Garnet-biotite-quartz-feldspar schist hosts the ore zone of the Thompson mine. The contact zone between this schist and calcareous sediments is to a large extent obscured by biotite-bearing pegmatites (see Clark, GS-44, this volume). In places where the zone can be observed it contains an abundant amount of contorted inclusions and blocks of arkosic metaquartzites and layered calcareous metasediments.

ALUMINOUS-SILICEOUS METASEDIMENTS
(Local name: Footwall quartzite)

Two interlayered rock types are dominant in this composite unit (Fig. GS-34-8). An estimated 70 to 90% of the outcrop consists of very light grey, medium grained, massive (5-100 cm thick) layers of quartzofeldspathic rock with minor biotite. Modal variations are as follows: biotite (2-20%), quartz (30-70%), feldspar (15-40%), minor muscovite, and opaques.

These massive quartzofeldspathic rocks are interlayered with thin layers of grey, strongly foliated sillimanite-biotite-bearing quartzofeldspathic gneiss. Lens-shaped sillimanite knots form up to 20% of the gneiss; the rest consists of biotite (10-70%), muscovite (5-20%), quartz (20-40%), feldspars (10-30%) and minor opaques. The recrystallization obliterated any original microscopic sedimentary features.

AMPHIBOLITE

Amphibolite is in sharp contact with aluminous-siliceous metasediments. Its mineralogy consists of amphibole (60%), plagioclase (20%), quartz (5-10%) and biotite (5-10%).

ULTRAMAFIC SCHIST

In contact with the amphibolite is a layer of discontinued lenses of apple-green, strongly foliated ultramafic schist. Original mineralogy is replaced by aggregates of anthophyllite, chlorite, tremolite and carbonate. Where intruded by pegmatite a reaction zone of coarse grained biotite separates both rocks.

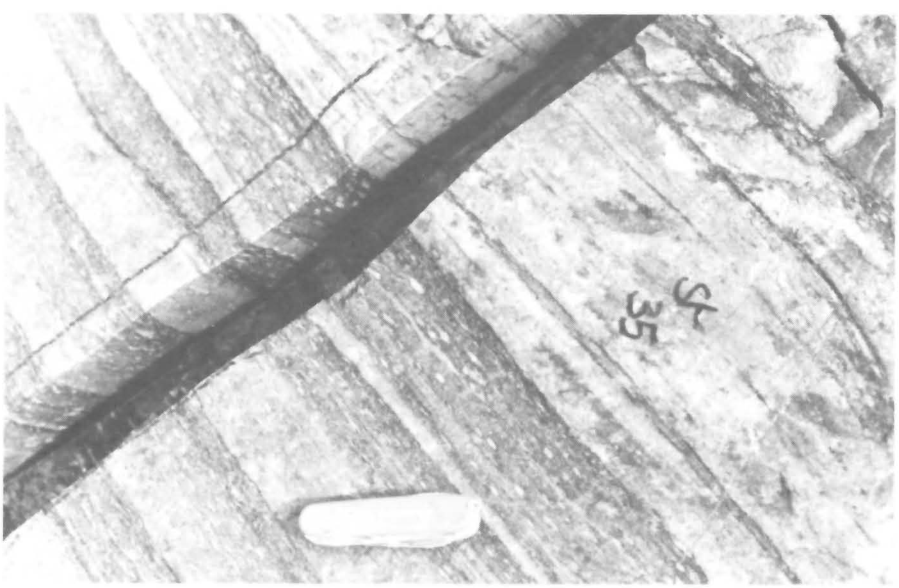


Figure GS-34-8: *Aluminous-siliceous metasediment.*

BANDED IRON FORMATION

The iron formation is the last unit encountered in the mapped strip. Layering ranges from thin laminae to 20 cm thick layers. The mineralogy consists of quartz, apatite trails, hornblende, biotite, garnet, magnetite, clinopyroxene, garnet and chlorite. Magnetite content is up to 30% in some layers.

STRUCTURAL NOTE

Routine structural data were collected during the mapping and their evaluation is in progress. The structural observations indicate that the metasedimentary sequence was subjected to complex, tight folding accompanied by shearing, faulting and mylonitization. A substantial portion of the outcrops are intruded by irregular pink and white pegmatites. Despite this irregularity in detail, a prevailing direction of pegmatite bodies appears to be north-northwest.

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GS-35 EVALUATION OF INDUSTRIAL MINERAL OCCURRENCES IN THE THOMPSON AREA

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

INTRODUCTION

A detailed examination of the "skarn" occurrences in the Thompson area was conducted to determine the volume, mineralogy and physical properties of this unit. Detailed maps were prepared of the occurrences at the Pipe Lake open pit and at the Manasan quarry. A stratigraphic sketch of the Thompson open pit has been prepared by Macek (GS-34, this volume). Samples were collected for strength and polishing tests (Fig. GS-35-1).

The quartzite body at the Manasan quarry has no chemical equivalents at either the Pipe Lake or in Thompson open pits; however, the quartz-rich rock exists in a less pure form in both of these localities. Bulk samples of quartzite were collected at the Manasan quarry to determine the chemical purity and variations in SiO_2 content. A detailed map has been made of the quartzite outcrop at the northwest end of the quarry (Fig. GS-35-1).

A reconnaissance of the Nelson House area was made in an attempt to locate exposures of cordierite-bearing pegmatite (Fig. GS-35-1). An investigation of the Ruttan Mine and the mine dumps was undertaken to determine if the alteration zone of the massive sulphide deposit contained concentrations of industrial minerals (Fig. GS-35-1.)

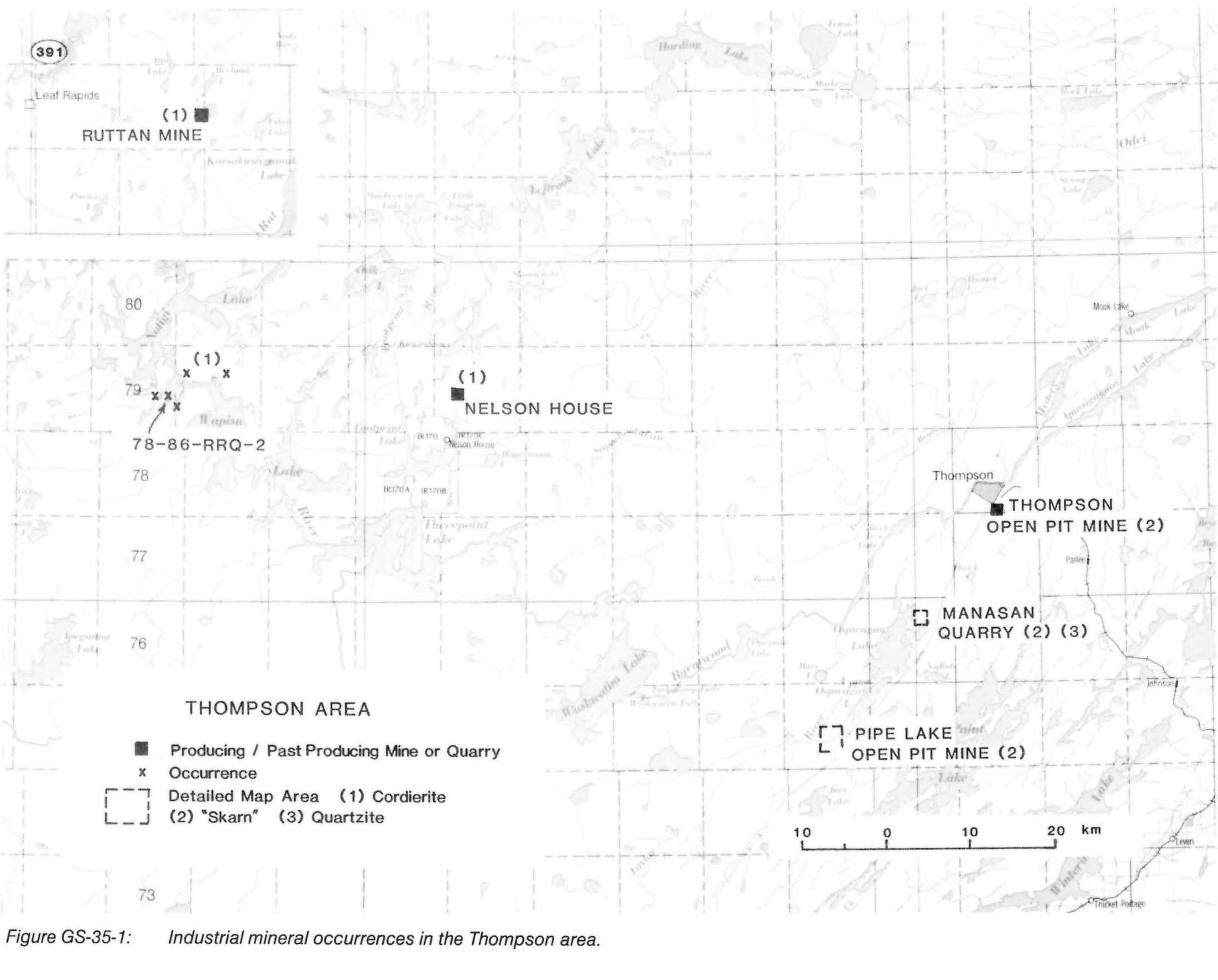


Figure GS-35-1: Industrial mineral occurrences in the Thompson area.

MARBLE

In the Thompson "Nickel Belt" chemical sedimentary rocks that include silicate and oxide iron formation, calc-silicate "skarn" and quartzite occur in a sedimentary sequence (Fig. GS-35-2). Several rock types, that include serpentinized alpine-type peridotite, intrude these sedimentary rocks (Stephenson, 1974).

Three distinct varieties of calc-silicate "skarn" are exposed in the Thompson area (Peredery, 1982). A clinopyroxene-clinoamphibole-biotite unit is a fine- to medium-grained, green to black, finely banded non-schistose rock with few fractures or planes of weakness. There are no obvious sulphides or iron staining in any of the exposures of this variety. Equivalent rock types occur in the Thompson open pit, the Manasan quarry and the Pipe Lake open pit.

A more carbonate-rich variety of the "skarn" contains abundant serpentine, white to cream coloured carbonate and locally abundant phlogopite, clinoamphibole and unaltered olivine. This type of "skarn" is fine- to medium-grained with moderate to weakly developed schistosity and has no obvious layering of the silicates. It contains few fractures or planes of weakness, has only trace amounts of sulphide and is not iron stained. This variety occurs in the Thompson open pit as an extensive, 20-30 m x 2 km, unit. Locally in the Thompson open pit, it contains veinlets and masses of millerite and unidentified sulphides. This variety of skarn also occurs in the Manasan quarry (Fig. GS-35-3) but does not contain any visible sulphides.

The third variety of "skarn" is a carbonate-rich marble (Fig. GS-35-4) with local concentrations of clinoamphibole-clinopyroxene and biotite. This variety contains equant buff to cream coloured carbonate grains and lens-like concentrations of clinoamphibole/clinopyroxene. One to 2 cm thick layers of fine grained biotite form distinct bands and complex patterns, but do not impart a plane of weakness to the rock. Locally this rock is porous with abundant 2-5 mm vugs that are not aligned but do contain local masses of pyrite.

The total thickness of each of these varieties is generally 10-20 m and they are of undetermined strike length. The intense structural disturbance of the rocks in this area makes calculation of volume in these deposits difficult without closely spaced drill intersections.

QUARTZITE

The quartzite at the Manasan quarry occurs in a horseshoe-shaped fold bounded by a calc-silicate "skarn" and a quartz-biotite gneiss (Fig.GS-35-5). The quartzite is grey, finely crystalline to massive and locally has a cherty appearance.

Samples were obtained adjacent to the quarry walls and consisted of 5 kg lots taken at 100 m intervals; in addition two locations within the quarry were sampled selectively. These samples will be chemically analyzed to determine if the Manasan quarry quartzite is a suitable source of lump silica.

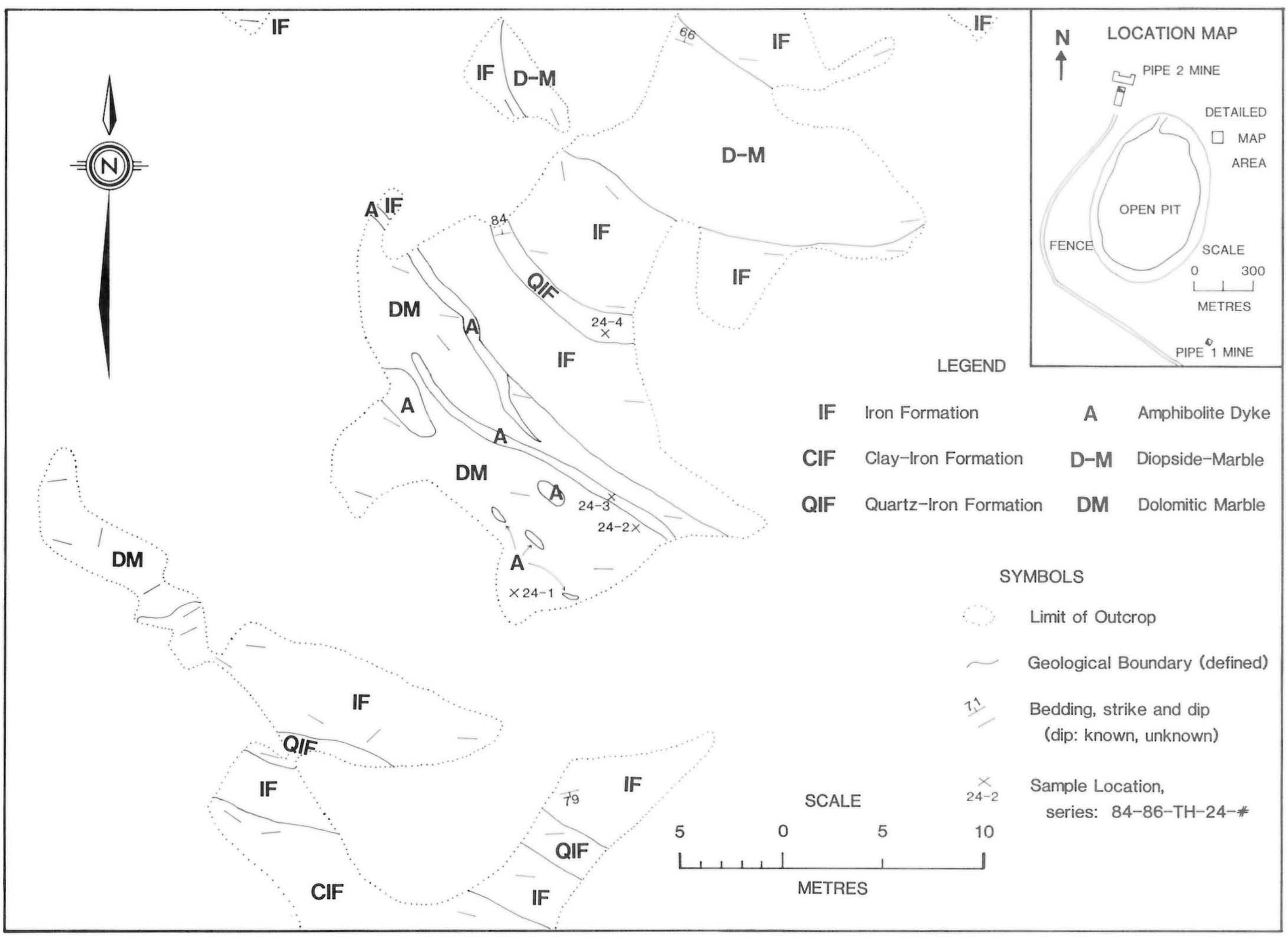
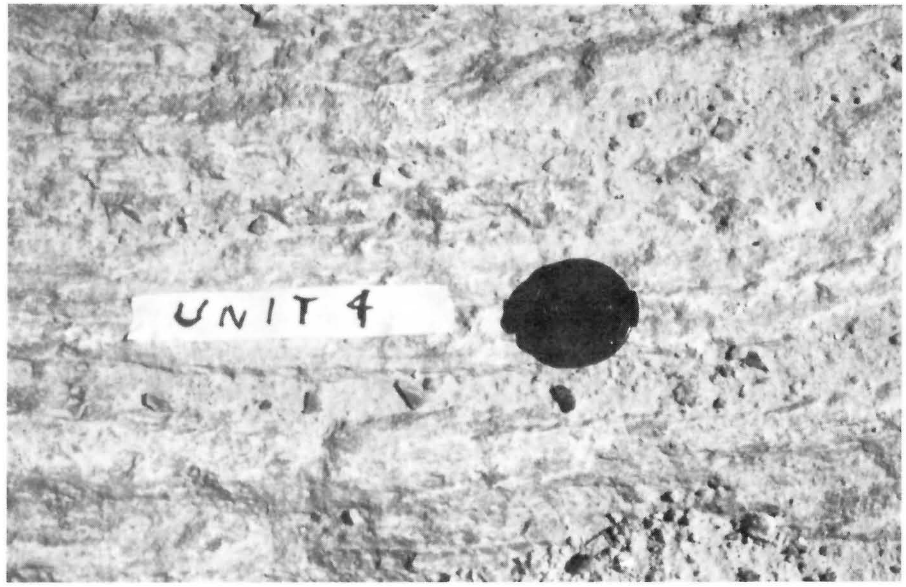


Figure GS-35-2: Portion of Pipe Lake open pit dolomitic marble.

Figure GS-35-3: *Manasan quarry serpentine marble.*



CORDIERITE

The volume of cordierite-bearing pegmatite was determined at the Nelson House road quarry (Gunter and Yamada, 1985). An area approximately 100 x 130 m adjacent to this quarry was examined to determine the abundance of cordierite, and the existence of cordierite undisturbed by blasting.

Adjacent to the quarry, cordierite occurs in patches ranging in size from 10 x 10 cm to 1 x 2 m. These lenses are sparsely distributed through the area, and are associated with quartz and pegmatite veins. The cordierite content is approximately 7 per cent of the surface area of these lenses. The cordierite is blue, anhedral to subhedral, with crystals ranging from 0.3 x 0.5 cm to 3.0 x 4.0 cm. The larger crystals are commonly fractured and poikilitic and may represent the cores of partially altered crystals.

The cordierite-rich pink pegmatite on the east face of the quarry is not exposed elsewhere on the surface. It appears that only a few cordierite crystals are not naturally fractured or fractured as a result of blasting.

The extent of cordierite in five road quarries around the Notigi Control Structure on the Rat River was determined (Fig. GS-35-6). The road quarries have been excavated in a quartz, biotite, garnet ± cordierite gneiss that is cut by pegmatites and quartz veins. Subhedral cordierite commonly occurs in the pegmatites. Quarry 78-86-RRQ-2 (see Fig. GS-35-1) contains pegmatites that commonly contain subhedral cordierite with minor euhedral cordierite crystals, similar to the Nelson House area.

RUTTAN MINE

The Ruttan Mine is located 22 km east of the town of Leaf Rapids (Fig. GS-35-1). The mineralization in this deposit occurs as a complex series of overlapping lenses of solid to disseminated sulphides of iron, copper and zinc. An alteration sequence has developed in both the hanging wall and the footwall of the deposit. The detailed petrology of these altered

Figure GS-35-4: *Pipe Lake open pit dolomitic marble. Fieldbook: 18 cm.*

rocks is not well known, thus the volume and distribution of the various mineralogical facies within the alteration zone are not available. The major subdivisions of the altered rocks are: (1) a chlorite schist; (2) a siliceous rock with minor chlorite, locally called a 'quartzite'; and (3) a biotite-sericite schist. The altered rocks contain an amphibolite grade metamorphic assemblage of magnetite-garnet-andalusite-cordierite. This assemblage is most abundant in the footwall chlorite and biotite-sericite schists. Magnetite is locally abundant as octahedrons up to 2 cm in diameter. Garnet, in 1-2 cm subhedral to anhedral crystals, is only locally abundant. Andalusite occurs locally in an andalusite-biotite rock. The andalusite crystals are anhedral to subhedral poikilitic grains that strongly resemble potassium feldspar. The cordierite occurs as masses, partially altered to pin-

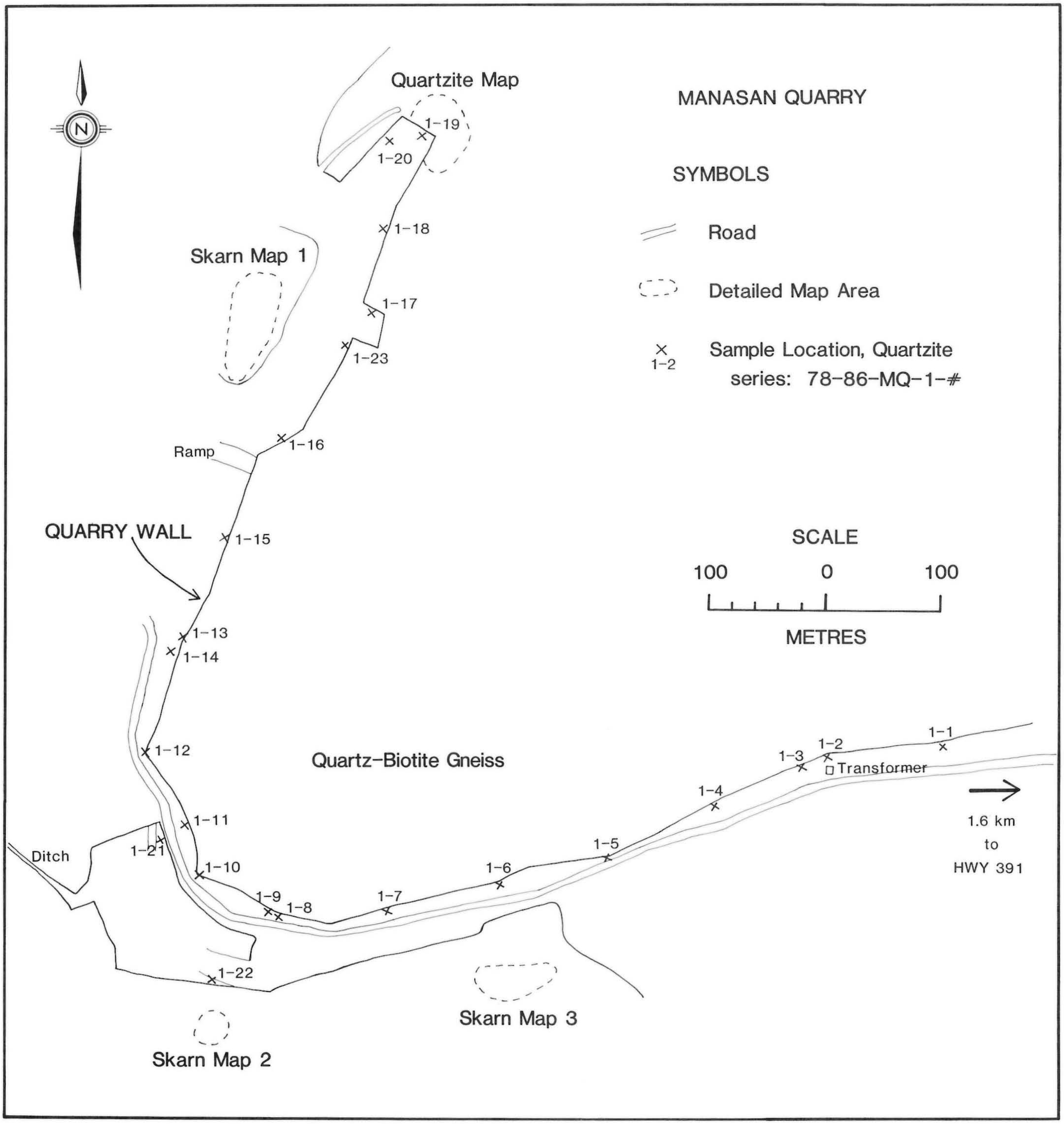


Figure GS-35-5: Manasan quarry (geology after Quirke et al., 1970).

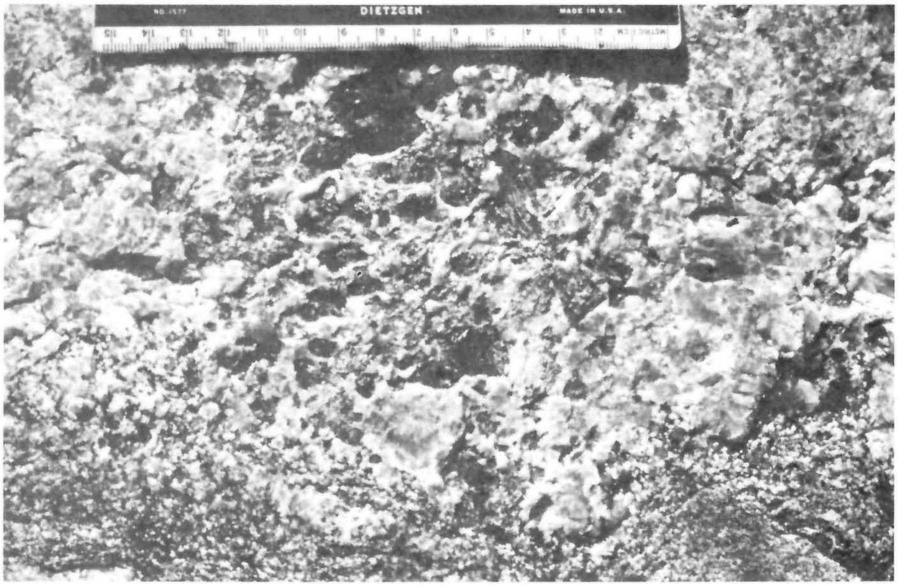


Figure GS-35-6: *A patch of subhedral cordierite crystals in a quartz vein at the Nelson House quarry.*

nite, and locally as abundant euhedral crystals up to 4 cm in diameter.

Veins and masses of quartz, carbonate and zeolites fill fractures in the ore zone. The quartz veins appear to represent the earlier stage of mobilization. One set of quartz veins contains chalcopyrite, pyrite, chlorite, cordierite and pyrrhotite. A second group of quartz veins, found only on the mine dumps, contains biotite, tourmaline, carbonate and apatite. Later veins, which follow joints, are filled with carbonate and the zeolites chabazite (X-ray diffraction), natrolite (visual identification) and possibly stilbite.

A late retrograde metamorphism, possibly represented by the zeolite vein fillings and similar to the retrograde metamorphic event mapped in the Lynn Lake area (Milligan, 1960), has altered much of the cordierite to pinnite and may have altered garnet to chlorite.

Two silicate mineral occurrences in the Ruttan deposit are of economic importance; the first is andalusite, which is locally abundant in the footwall of the east zone in altered metavolcanic rocks and less abundant in the cherty units within both ore zones. The andalusite is exposed underground in moderately large quantities but was observed only locally on the dumps as an andalusite-biotite rock. The second mineral of economic importance is euhedral cordierite (Fig. GS-35-7) which is uncommon but may be found in quartz mobilizate at the boundary between massive pyrrhotite and schist. The gem potential of these crystals will be determined by the cutting of test stones.

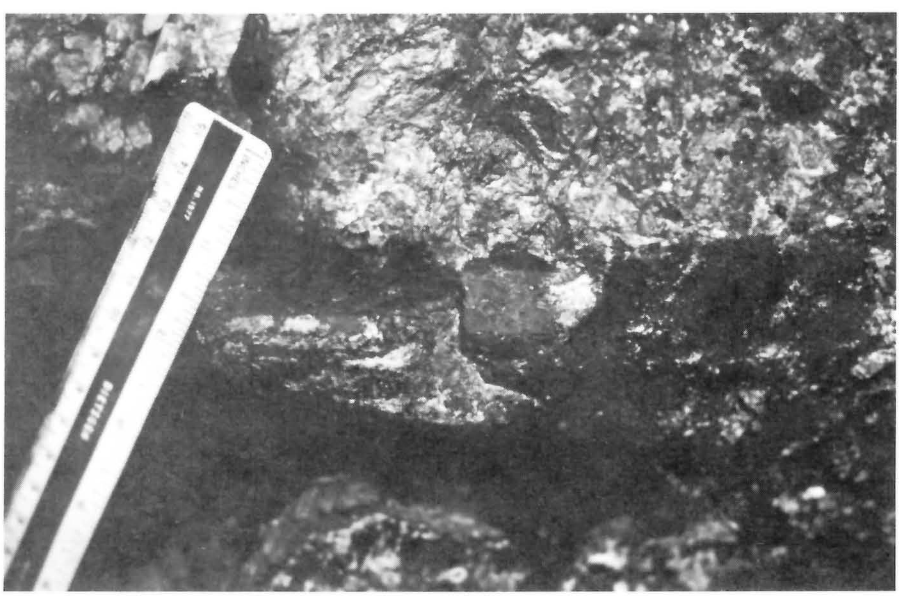


Figure GS-35-7: *Euhedral cordierite crystai (3 x 8 cm) with massive sulphide*

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GS-36 U-Pb GEOCHRONOLOGY PROGRAM: PIKWITONEI-THOMPSON-CROSS LAKE AREA

by T.Krogh,[1] L. Heaman,[1], N. Machado,[1] D. Davis[2] and W. Weber

INTRODUCTION

Since the fall of 1985, 23 zircon fractions have been analyzed, in addition to those reported earlier (Krogh et al., 1985). Results are discussed below.

During the 1986 field season 5 more units were sampled in the Thompson belt.

As an extension of the original project area 6 units from the Cross Lake area were sampled. These units will be analyzed by D. Davis: 1) to broaden the geochronological framework by including a well documented northern Superior greenstone belt; 2) to compare its magmatic, metamorphic and structural evolution with that of the higher grade (deeper crustal level) Pikwitonei granulites and that of the Churchill-Superior boundary zone; and 3) to determine potential causal relationships between events at different crustal levels and implications for mineralization (Clark and Weber, in press).

Preliminary U-Pb zircon ages determined from the Pikwitonei granulites were presented (Heaman et al., 1986); precise zircon ages of Molson dykes (Scoates and Macek, 1978) and the Fox River sill in the Churchill-Superior boundary zone (Scoates, in prep.) were presented (Machado et al., 1986) and will be published shortly (Heaman et al., in press).

PRELIMINARY INTERPRETATION OF U-Pb ZIRCON AGES (by W. Weber)

U-Pb zircon ages from the most extensively analyzed outcrops at Cauchon Lake (Fig. GS-36-1, locations 138, 477, 483) indicate that the M_2 granulite facies metamorphism took place at 2637 $\pm$ 2 Ma and an earlier metamorphic (and possibly magmatic) event (M_1?) at 2695 $\pm$ 3 Ma (Heaman et al., 1986). If U-Pb zircon data from all the locations and rock units at Cauchon Lake which were analyzed are considered, the data can be interpreted to record two distinct events, each having an approximately 20 Ma spread. The older event ranged from 2713 to 2695 Ma — and possibly down to 2684 Ma — and the younger event ranged from 2658 to 2637 Ma.

Results from geothermobarometry studies in the Cauchon Lake area (Mezger et al., 1986, and GS-43, this volume) indicate that the older event is probably associated with emplacement of heat-producing magmatic rocks, such as the schollen-enderbite in the Cauchon Lake area. A U-Pb zircon age of 2629 $\pm$ 1 Ma from postgranulite pegmatite (Mezger, pers. comm., 1986) implies that the younger granulite facies event (at 2637 Ma) was shortly followed by amphibolite grade conditions.

At Natawahunan Lake, where higher metamorphic conditions prevailed (Pactunk and Baer, 1986; Metzger et al., 1986) and where sapphirine was recently discovered (Mezger, pers. comm., 1986), U-Pb zircon data record two events, one at 2690 Ma and the other at 2669 Ma (Fig. GS-36-1, locations 14, 15). Additional analyses will be completed on rocks from this area.

At Sipiwesk Lake, where sapphirine assemblages indicate peak conditions of possibly 9 to 11 kb and 860° — 890° (Arima and Barnett, 1984), two events were also recorded by U-Pb zircon data, one at 2719 $\pm$ 5 Ma and one at 2681 $\pm$ 2 Ma (Fig. GS-36-1, locations 4-13).

The significance of the differing U-Pb age pairs throughout the granulite domain remains to be further investigated. However, the U-Pb data clearly indicate that volatiles enriched in uranium and zirconium circulated during two distinct high grade events allowing for the growth of zircons. Field and laboratory data also suggest that two events defined by U-Pb data of zircons can be correlated with structural and metamorphic features detectable in the field.

Indications of material older than 2.8 Ga years were not encountered, with the exception of one unit, a metatonalite at Cauchon Lake. U-Pb data of zircon cores from this metatonalite suggest it could be as old as 3.6 Ga.

The extension of the project into the adjacent greenstone belt terrain and presently ongoing geothermobarometry and fluid inclusion studies (Mezger et al., 1986; Vry and Brown, 1986) should provide further data for a better understanding of the crustal evolution of the northern Superior Province.

A U-Pb zircon age of 1884 $\pm$ 2 Ma was obtained (Machado et al., 1986) for the main gabbroic Molson dyke at Cross Lake (Fig. GS-36-1; location 32), which is part of the Nelson River dyke (Scoates and Macek, 1986), and a U-Pb zircon age of 1883 $\pm$ 2 Ma was obtained (Machado et al., 1986) for the (mafic-) ultramafic Cuthbert Lake dyke (Fig. GS-36-1, locations 5-13), which is also part of the Molson swarm (Scoates and Macek, 1986). These ages confirm earlier conclusions based on geochemical data (Scoates and Macek, 1978) that ultramafic and mafic Molson dykes are comagmatic. The equivalent age of 1883 +2/-1 Ma obtained from zircons of the Fox River sill (Machado et al., 1986; Fig. GS-36-1, location 6) also supports an earlier suggestion that komatiitic rocks of the Fox River belt along the northern margin of the Superior Province are comagmatic to the Molson Swarm and indicate rifting along its margin (Scoates, 1981; Baragar and Scoates, 1981). This implies that only 100 Ma passed between rifting along the Superior craton margin and high grade metamorphism (1786 +3/-2 Ma, Fig. GS-36-1, location 9; Krogh et al., 1985) at its western margin, during the terminal collision phase of the Trans-Hudson orogeny.

The age of 1884 Ma is younger than felsic volcanic rocks from the Lynn Lake domain (1910 $\pm$ 7 Ma; Baldwin et al., 1985) and synchronous or only slightly older than dated volcanic rocks of the Proterozoic greenstone belts of the Churchill River magmatic zone (1878 Ma, Baldwin et al., 1985; 1888 $\pm$ 12 to 1877 Ma $\pm$ 8, Bickford and Van Schmus, 1985). This suggests that, if a Wilson-type cycle is applied (cf. Green et al., 1985) to the Trans-Hudson orogen, that this rifting does not represent the initial break-up of the Archean protocraton.

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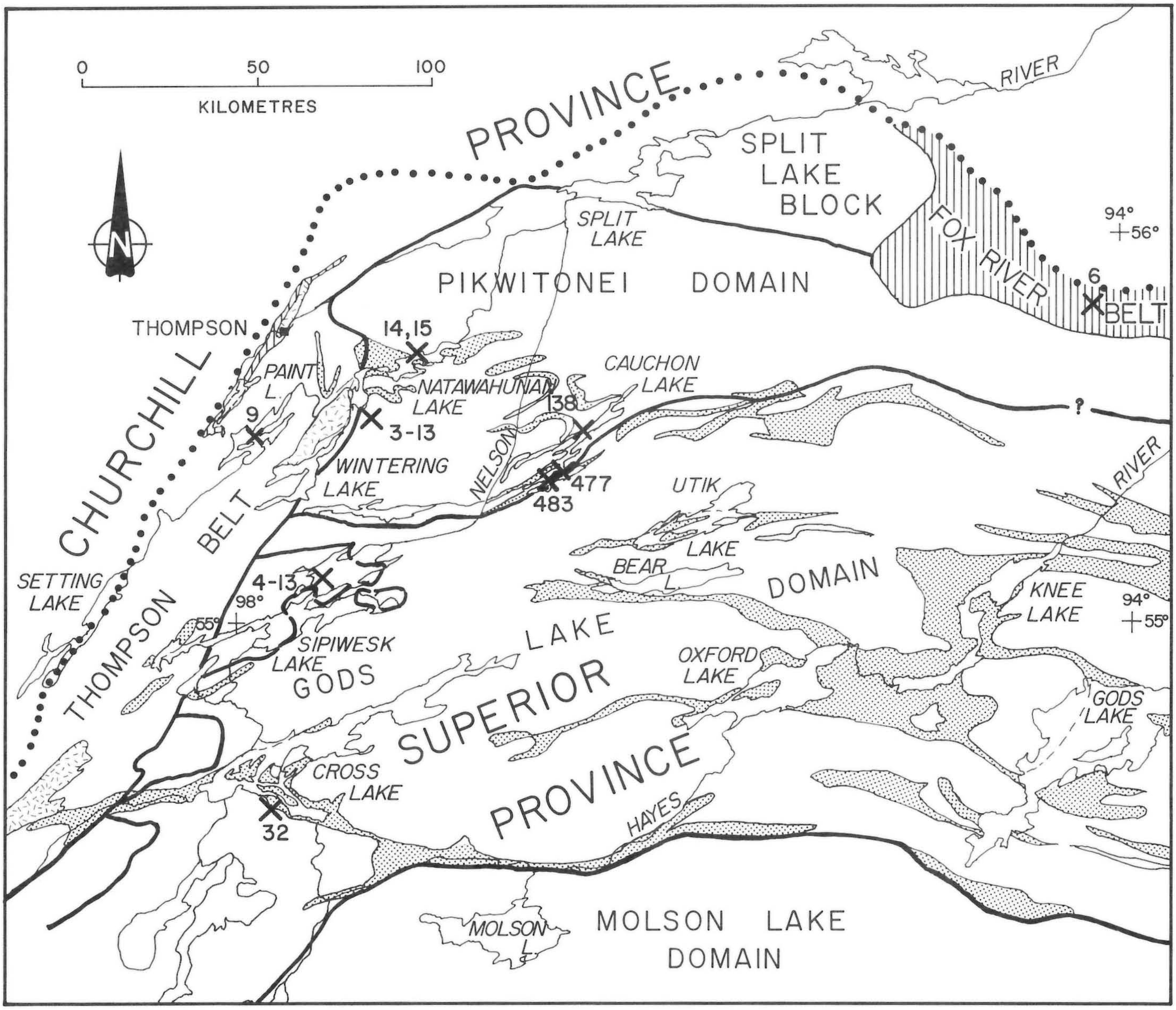

• • • • CHURCHILL - SUPERIOR PROVINCE BOUNDARY

DOMAIN BOUNDARY

X4-13 SAMPLE LOCATIONS FOR U-PB GEOCHRONOLGY DISCUSSED IN TEXT

PROTEROZOIC SUPRACRUSTALS

PROTEROZOIC GRANITOIDS

ARCHEAN SUPRACRUSTALS

Figure GS-36-1: Generalized geology of northwestern Superior Province and sample locations for U-Pb geochronology discussed in text.

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GS-37 GEOCHEMICAL CHARACTERIZATION OF MAFIC AND ULTRAMAFIC MAGMATISM ALONG THE CHURCHILL-SUPERIOR BOUNDARY ZONE

by N.M. Halden[1]

The main objective of this study is to geochemically characterize mafic and ultramafic volcanism associated with the Churchill-Superior boundary zone. Suggestions that the Churchill-Superior boundary zone represents a modified paleosuture zone (Green et al., 1985; Baragar and Scoates, 1981) raises the possibility that fragments of Proterozoic oceanic crust, or marginal basin type assemblages, may have been created prior to the Hudsonian orogeny. A probable place for the preservation of remnants of these lithologies would be the northwestern and northern margins of the Superior craton. A possible mechanism for their preservation would be in the form of tectonically isolated masses, e.g., thrust sheets, or large, relatively competent boudins. This would be consistent with models for similar orogenic events elsewhere (cf. the ca. 2000 Ma Svecokarelian orogeny; Bowes et al., 1984; Park et al., 1985).

Field studies of mafic and ultramafic rocks along the Superior margin have demonstrated the importance and dominance of marine volcanism in the make-up of these assemblages: at Ospwagan Lake (Stephenson, 1974; Macek and Russell, 1978); Moak Lake (Scoates and Macek, 1977); Assean Lake (Halden, in prep.); and in the Fox River belt (Scoates, 1981; Fig. GS-37-1). Sampling for geochemical analysis has

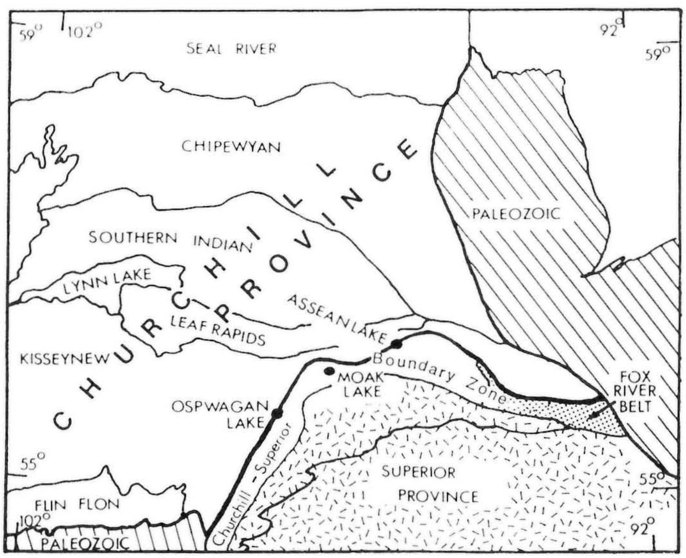

Figure GS-37-1: Sample location (dots) and major geological subdivisions and domains, northern Manitoba.

been concentrated at Ospwagan Lake (50 samples) and Assean Lake (80 samples). Five samples were retrieved from an isolated mass of mafic volcanic rocks, 6.4 km southwest of the Moak Lake mine site. Samples will be analyzed by X-ray fluorescence for major elements and selected trace elements (Rb, Sr, Y, Nb, Zr, Cu, Ni, Zn). An obvious extension of the analytical work will include the Fox River belt for systematic trace element analysis. Major element analyses already exist (Scoates, 1981).

The discrimination of mafic volcanism may be achieved in the manner described by Pearce and Cann (1973), and by Pearce and Norry (1979). This technique, when applied to the Toivalanmaki and Yla-Poskijarvi volcanic associations preserved in a thrust sheet as part of the Svecokarelian orogeny (Park, 1983), discriminated them as being associated with either ocean floor or island arc volcanism. The disparate occurrence of mafic and ultramafic volcanic rocks from the Fox River belt on the northern margin of the Superior Province to Ospwagan Lake in the southwest, in tectonically complex settings, may have obscured original geological associations. The systematic geochemical characterization of these rocks is, therefore, an important step in establishing their geological setting.

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GS-38 GEOLOGICAL INVESTIGATIONS AT PONASK LAKE (parts of NTS 63H/15 and 16)

by W. Weber

Ponask Lake was investigated briefly in order to conclude the Branch's geological surveys of the northern Superior greenstone belts under the Canada-Manitoba Mineral Development Agreement.

The main purpose of the survey was to evaluate previous mapping by the Geological Survey of Canada (Ermanovics, 1973) and to investigate whether potential exists for V, Ti mineralization in mafic intrusive rocks or platinum mineralization in mafic-ultramafic rocks. Results of the survey suggest that the mineral potential of the Ponask Lake area is minimal.

GENERAL GEOLOGY

Ponask Lake lies at the western end of a greenstone belt which includes Stevenson Lake and Island Lake to the east. Supracrustal rocks are similar to Hayes River Group type lower supracrustal rocks at Island Lake (cf. Gilbert, 1985). Rocks comparable to Island Lake Group were not encountered.

This summer's survey indicates that most areas previously mapped as metasedimentary rocks and tuffs (Ermanovics, 1973) are mylonites derived from amphibolites (mafic metavolcanics) intruded by felsic dykes. Mylonitization produced a layered metamorphic complex that looks similar to a tectonized argillite-siltstone-tuff sequence. The mylonites form an east-northeast- trending mylonite zone along the south shore of Ponask Lake which is offset by a slightly younger north-northeast-trending mylonite zone through the central part of the lake. To the south these mylonites grade into medium grained massive amphibolites intruded by quartz diorite dykes.

Rocks on the north shore are dominated by a tourmaline-bearing pegmatitic granite (Ponask Lake pegmatite, Ermanovics, 1973). It consists of several sills which are internally foliated and probably largely tectonically transposed into the northeast-trending structural grain. These sills intrude a sequence consisting of amphibolite (and possible metasediments) and quartz diorite (intruding amphibolite) to the north. With the exception of isolated, thin (maximum 1 m) tourmaline-bearing pegmatites within the pegmatitic granite, related pegmatites (with rare-element potential) were not encountered.

The quartz diorite forms batholiths underlying large areas north of the lake and are identical to quartz diorite in the Molson Lake batholithic domain (Weber et al., 1982). Ermanovics (1973) included the quartz diorite north of Ponask Lake in a "mafic metadiorite-quartz diorite" unit. However, with the exception of small mafic inclusions, mafic phases were not encountered. Thus, there is no evidence for V, Ti potential in this area. The ultramafic rocks investigated (designated as amphibolitized pyroxenite and serpentinite by Ermanovics, 1973) are coarse grained hornblendite within amphibolites and lithologies favourable for platinum, such as layered mafic ultramafic complexes, sulphide or magnetite-bearing layers, were not encountered.

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GS-39 MINERALIZED PEGMATITIC GRANITES AT RED SUCKER LAKE, MANITOBA

by L.W. Chackowsky[1] and P. Černy[1]

INTRODUCTION

A geochemically anomalous zone of pegmatitic granites, in part carrying considerable lithophile mineralization, has been defined at Red Sucker Lake based on field work done in 1984 to 1986 and on laboratory data collected in 1985 to 1986. The anomaly is defined by high whole-rock and K-feldspar values of Li, Rb and Cs, high Mn/Mn + Fe ratios in garnets, and by the occurrence of petalite, Nb-Ta oxide minerals and Rb, Cs-rich lithian ferromuscovite.

GEOLOGICAL SETTING

The pegmatitic granites and pegmatites are intruded into a 2-3 km wide east-trending belt of metavolcanic and metasedimentary rocks that extends from Red Sucker Lake to the Manitoba-Ontario border (Schledewitz and Kusmirski, 1979). The greenstone belt is one of many located in the Sachigo Subprovince of the Archean Superior Province in the Canadian Shield.

The oldest components of the belt are metavolcanic rocks and derived metasedimentary rocks of the Hayes River Group (Downie, 1936). These rocks occur in the southwestern part of the belt. They are overlain by metasedimentary rocks of the Oxford Group to the north and east. These are mostly garnetiferous biotite schists with subordinate arenaceous lithologies. East-trending tonalitic dykes intrude the metasedimentary rock.

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The youngest rocks of regional extent are granitic intrusions of batholithic proportions. They range from grey tonalites to granodiorites and pink granites. Together with tonalitic gneisses, they flank the greenstone belt from the north and south.

Thick deposits of glacial drift leave only extremely limited exposure; it is generally restricted to shorelines.

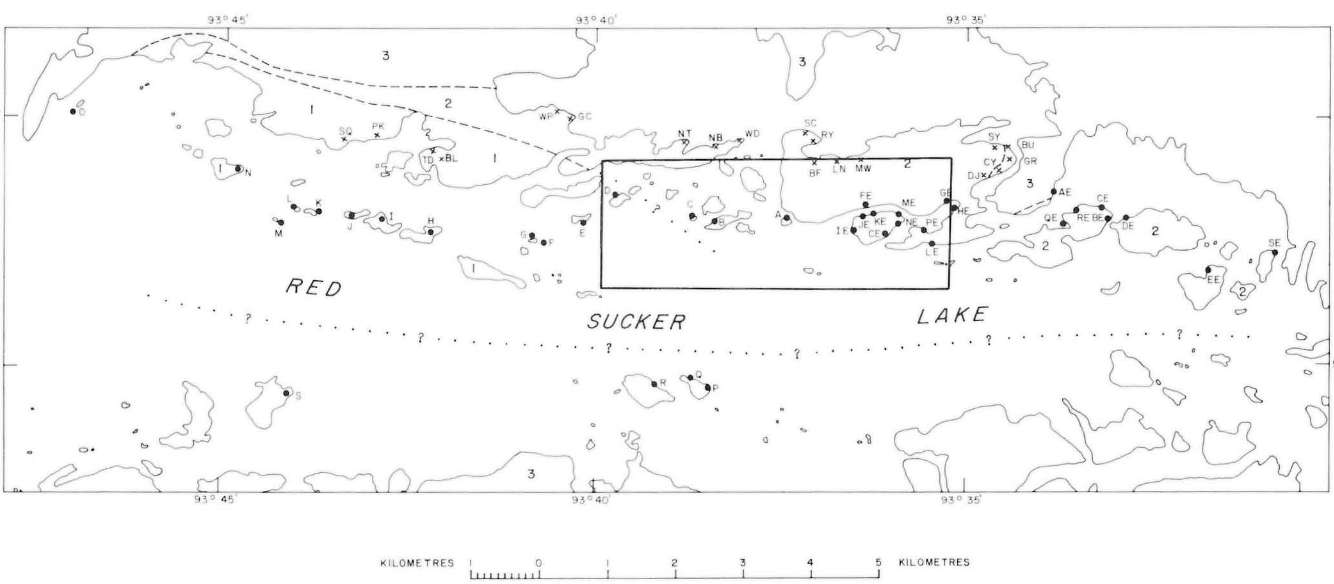
Pegmatitic granites at Red Sucker Lake occur in a long narrow east-striking zone that spans the entire length of the area (Fig. GS-39-1).

A long zone of pegmatites occurs north of and parallel to the pegmatitic granites, bounded by locations WP in the west to GR in the east (Fig. GS-39-1). These pegmatites are not mineralized and are geochemically the most primitive, least fractionated pegmatitic rocks in this area.

The other series of pegmatites outcrops at locations SQ, PK, BL and TD in the west (Fig. GS-39-1). In contrast to the northern series of pegmatites, these are the most highly fractionated rocks in the area. Mineralization at these locations includes quartz + spodumene pseudomorphs (commonly referred to as "squi") after petalite at location SQ, microlite at PK, Nb-bearing cassiterite at TD and beryl at BL.

PEGMATITIC GRANITES

Pegmatitic granites occur throughout the area in an east-trending belt that may partly follow an axial shear in the greenstone belt. Pegmatitic leucogranites are the most common type with lesser amounts of fine grained leucogranites and sodic aplites (Černý et al., 1981). The pegmatitic granite intrusions range from less than 1 m in width to several tens of metres and attain up to 100 m in length. Exposures are generally concor-



SYMBOLS :

- • PEGMATITIC GRANITES-INCLUDING PEGMATITIC LEUCOGRANITES, FINE GRAINED LEUCOGRANITES AND SODIC APLITES
- × PEGMATITES
- GEOLOGICAL BOUNDARY (APPROXIMATE, ASSUMED)

LEGEND:

1 HAYES RIVER GROUP : METABASALTS AND DERIVED METASEDIMENTS

2 OXFORD GROUP : METASEDIMENTS

3 GREY TONALITES AND GRANODIORITES, PINK GRANITES

Figure GS-39-1: Location of pegmatitic granites and pegmatites in the Red Sucker Lake field (after Chackowsky and Cerný, 1984). Rectangular outline shows the area covered in Figure GS-39-2.

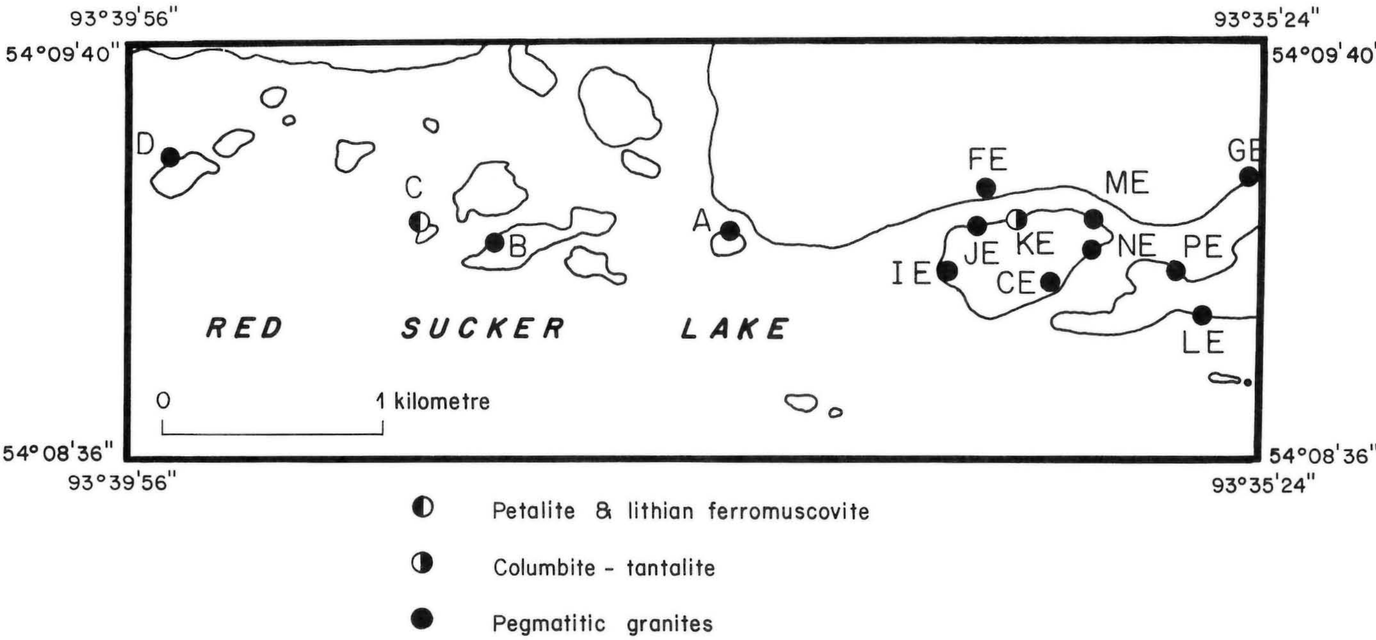


Figure GS-39-2: Central part of the Red Sucker Lake pegmatite field showing the localities of petalite, lithian ferromuscovite and columbite-tantalite.

dant to the schistosity of the country rocks. Shear banding, boudinage and ptygmatic folding occur in several outcrops.

These granites are dominantly composed of perthitic K-feldspar + quartz intergrowth, quartz, plagioclase and subordinate muscovite. Accessory minerals are represented by garnet, tourmaline, biotite, arsenopyrite and/or lollingite, chalcopyrite, molybdenite and apatite. Opaque minerals are rare. Schorl is a widespread accessory phase usually occurring along the margins of quartz cores and surrounding blocky K-feldspars in potassic pegmatite segregations. The pegmatitic leucogranites commonly contain megacrysts of graphic K-feldspar + quartz intergrowths up to 20 cm across. They are typically embedded in a finer grained matrix of quartz, feldspar, and muscovite, with accessory garnet, apatite and locally sulphides.

Sodic aplite commonly occurs as narrow layers intimately associated with the pegmatitic leucogranite. The aplite is commonly banded, with the darker bands enriched in garnet. In a few locations aplite predominates over pegmatitic leucogranite within the limits of exposed outcrop. Fine grained leucogranite is rare in the area. It occurs as small scattered exposures typically interlayered with pegmatitic leucogranites. They are composed of K-feldspar, quartz, plagioclase and subordinate muscovite with accessory biotite.

ACCESSORY RARE-ELEMENT MINERALS

The pegmatitic granites were sampled in order to obtain representative specimens of bulk rock, late blocky K-feldspar, garnet, and, where available, platy muscovite. During the course of sampling, blocky petalite and columbite-tantalite were found in several locations in the central part of the leucogranite belt at KE, IE, A, B and C (Fig. GS-39-2). Fine grained lithian muscovite associated with the petalite was separated from hand samples in the lab.

Petalite occurs in the pegmatitic leucogranite at locations A, B, C and IE, as tiny mm-sized grains in the fine grained matrix ranging continuously up to blocky megacrysts tens of centimetres in maximum dimension (Fig. GS-39-3). The crystals are equant to elongated, anhedral to

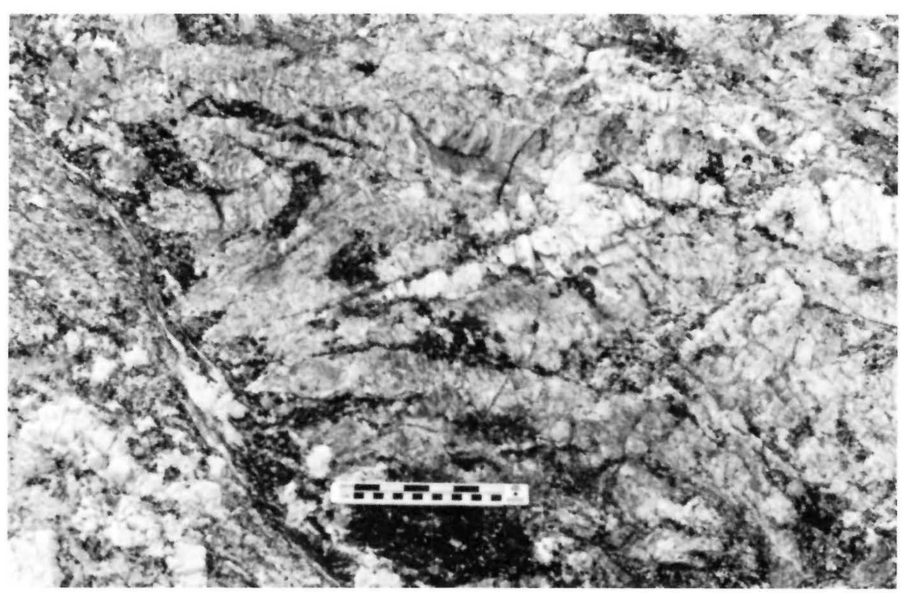


Figure GS-39-3: Mineralized pegmatitic leucogranite at location C; grey megacrysts of columnar to tabular petalite.

subhedral, range from white to dark grey and contain no visible inclusions. On outcrop surface, the dirty grey petalite is very inconspicuous and distinguished only by a relatively deep weathered relief, in contrast to the weathering-resistant and fresh-looking K-feldspar. On fresh broken surfaces the petalite is vitreous, translucent and pale grey to white, as opposed to the turbid to opaque, yellowish to white K-feldspar. Spodumene and spodumene + quartz intergrowths were not observed associated with the petalite, although minor amounts of spodumene were detected by X-ray powder diffraction of the pulverized rock samples.

The **lithian ferromuscovite** occurs at the petalite localities as dispersed, thin, fine grained light brown flakes in the matrix of the pegmatitic leucogranite. Enough material was separated from one hand sample from location B to permit a partial chemical analysis. The mica yielded 5.72 wt.% total Fe as Fe_2O_3, 1.3% Li_2O, 1.8% Rb, 0.6% Cs, and 110 ppm Be. It can be classified as lithian ferromuscovite.

Columbite-tantalite minerals have been found at locations A, B, IE and KE. They are very inconspicuous in outcrop and are generally very fine grained. They occur as irregular grains or thin plates, individual or in stringers, in the matrix of the pegmatitic leucogranites at locations A and B, and in the aplite at KE. The grain size ranges from less than 0.1 mm to 2 mm. Chemically they range from ferrocolumbites to manganotantalites as shown by the preliminary compositional data plotted in Figure GS-39-4.

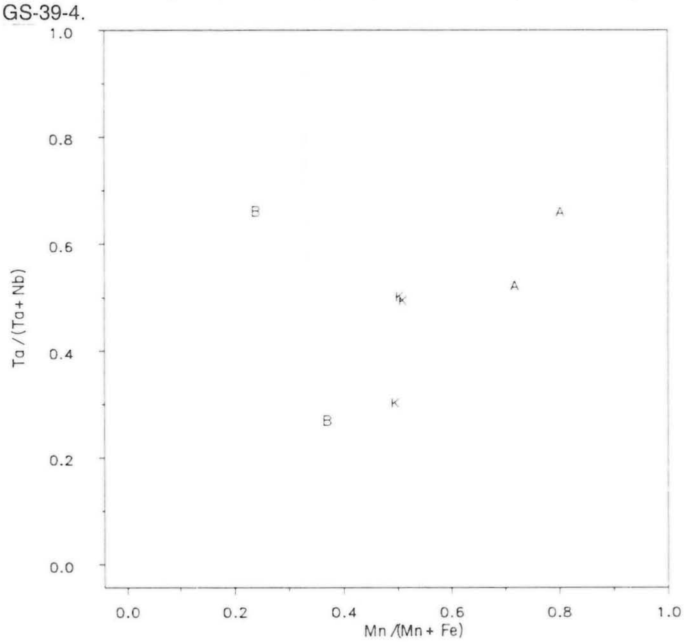


Figure GS-39-4: *Preliminary data on the compositions of accessory columbite-tantalite from the mineralized pegmatitic leucogranite (in atomic ratios of main components). Letter symbols mark the sampling locations (K stands for KE).*

One specimen, B-17-b, plots near the $FeTa_2O_6$ corner of Figure GS-39-4 and contains an internal zone bearing 11.0 wt.% SnO_2. This chemistry corresponds to either ixiolite or wodginite; however, this grain was too small for even single crystal X-ray diffraction work, and the true identity of this mineral remains obscured.

THE GEOCHEMICAL ANOMALY

Analytical work has shown that the petalite, lithian ferromuscovite and columbite-tantalite occurrences coincide with a sizeable geochemical anomaly approaching fractionation parameters of the most evolved rare-element pegmatites. The anomaly covers 16 separate outcrops spread over nine islands in the area from location G in the west to HE in the east (Fig. GS-39-1).

Figures GS-39-5 to -14 illustrate the geographical extent of the anomaly within the zone of pegmatitic granites, its shape, and variability

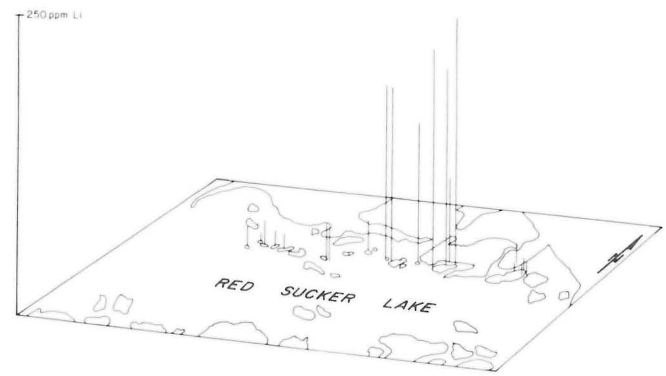


Figure GS-39-5: *The Li contents of blocky K-feldspar from the pegmatitic leucogranite. For Figures GS-9-5 to 14, columnar diagrams on the oblique topography projection correspond to the area shown in Figure GS-39-1.*

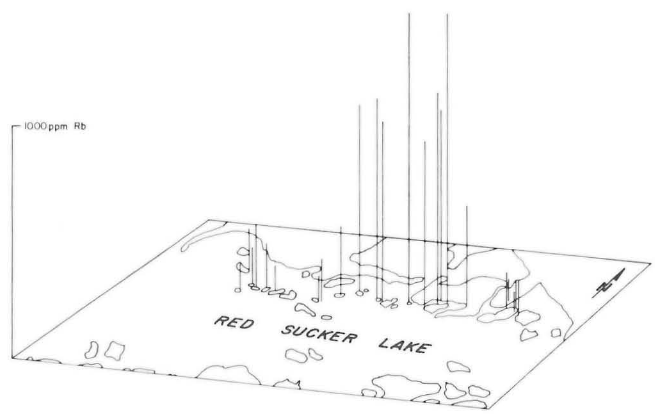


Figure GS-39-6: *The Rb contents of blocky K-feldspar from the pegmatitic leucogranite.*

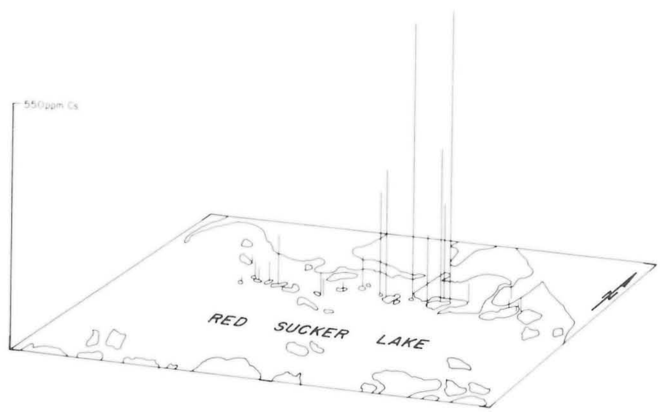


Figure GS-39-7: *The Cs contents of blocky K-feldspar from the pegmatitic leucogranite.*

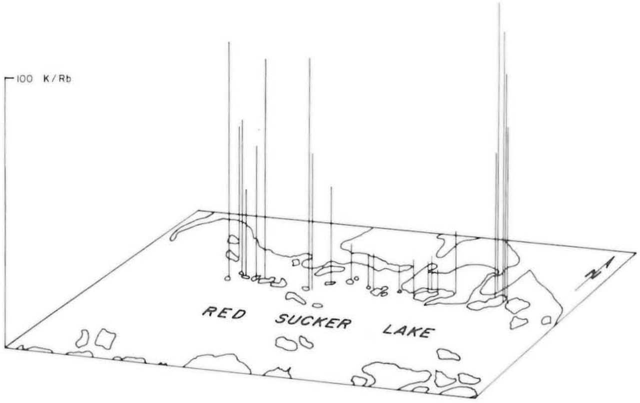


Figure GS-39-8: *The K/Rb ratios of blocky K-feldspar from the pegmatitic leucogranite.*

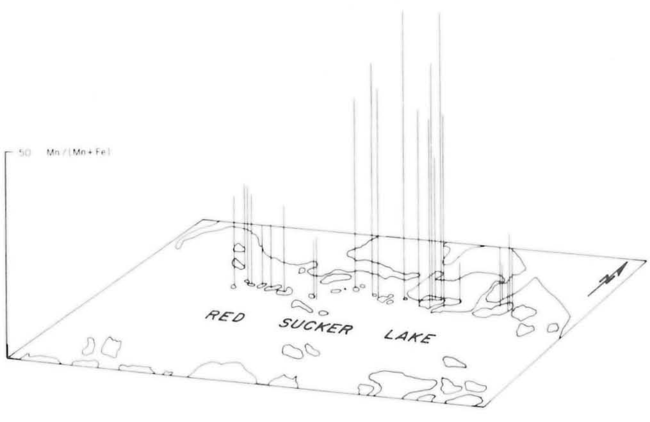


Figure GS-39-9: *The Mn/(Mn + Fe) ratios of blocky K-feldspar from the pegmatitic leucogranite.*

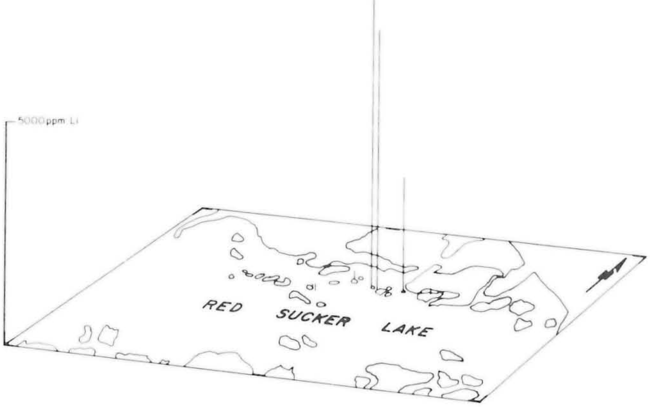


Figure GS-39-10: *The Li contents in whole-rock samples of the pegmatitic leucogranite.*

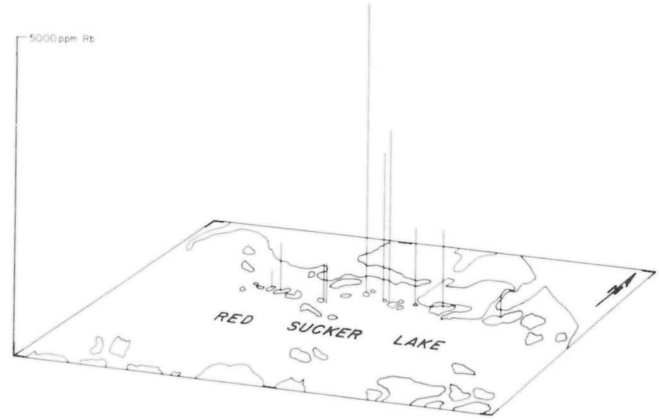


Figure GS-39-11: *The Rb contents in whole-rock samples of the pegmatitic leucogranite.*

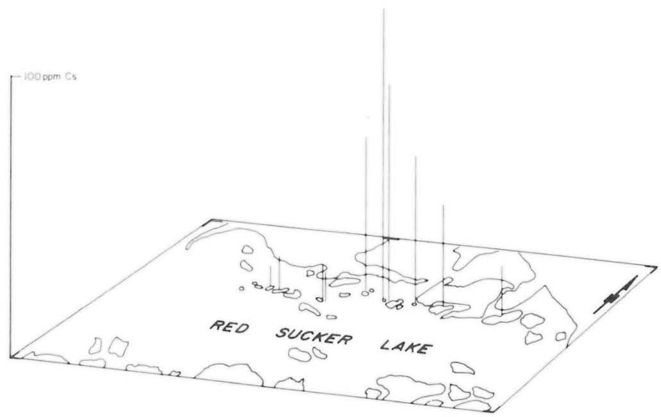


Figure GS-39-12: *The Cs contents in whole-rock samples of the pegmatitic leucogranite.*

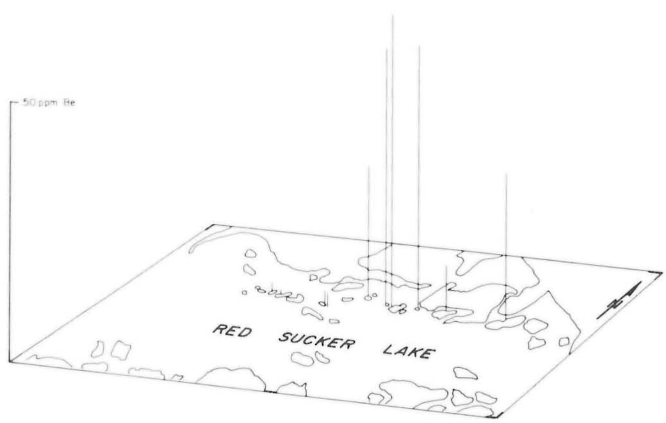


Figure GS-39-13: *The Be contents in whole-rock samples of the pegmatitic leucogranite.*

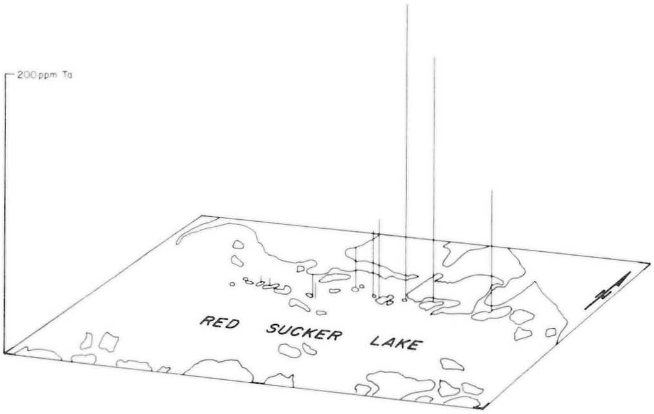


Figure GS-39-14: The Ta contents in whole-rock samples of the pegmatitic leucogranite.

in values of some of the different geochemical indicators pertinent to its characterization.

Table GS-39-1 summarizes the geochemical data characterizing the individual sampling locations in terms of K-feldspar, garnet and whole-rock compositions. It also provides comparison with the same data characterizing the most fractionated pegmatite of the Red Sucker Lake field (location SQ), and the Tanco deposit of southeastern Manitoba (Cerný, 1982).

Table GS-39-2 lists the whole-rock compositions of the petalite-, lithian ferromuscovite- and columbite-tantalite-bearing pegmatitic leucogranites (samples A, B, C, KE), and of non-mineralized pegmatitic leucogranites from other locations (D, F, I, J, QE). The pegmatitic granites at locations A, B, C and D were too inhomogeneous to take representative whole-rock samples due to the large quantities of rock that would be required (more than 100 kg). Instead, representative samples of the graphic K-feldspar megacrysts and the matrix were collected and modal analyses of the sample sites in terms of matrix vs. graphic K-feldspar megacrysts (vs. petalite megacrysts at locations B and C) were performed in the field. Normative mineral calculations on the analyses of the separate components were used to estimate the densities of the samples. Multiplying the estimated densities by the modal (volume) proportions of the phases yields their weight proportions which were used to determine the whole-rock compositions at the above-mentioned sample sites.

The pegmatitic granites closely correspond to their analogs from other fields of highly fractionated rare-element pegmatites (e.g. Cerný et al., 1981). On the average, they are silicic, peraluminous, with highly variable K_2O/Na_2O ratio, and depleted in Fe, Mg, Ca, Ba, Sr, Ni, Zr, Ti, V and S. In contrast, enrichment of Li, Rb, Cs, Ga, Sn, Nb and Ta is widespread, and the contents of Be and Y are locally increased. Low ratios of K/Rb, K/Cs, Rb/Cs, Rb/Ar, Al/Ga, Zr/Hf and Nb/Ta also are characteristic.

POTENTIAL FOR ECONOMIC MINERALIZATION

The existing data are not sufficient for a forecast of potential reserves of Li, Nb or Ta for a number of reasons. First, the character of the exposures does not permit interpolation of the total outcrop area of the mineralized pegmatitic leucogranite. Second, information on the vertical extent of the anomaly is not available. Third, the inhomogeneous nature of the pegmatitic leucogranite precludes interpolation from the sparse distribution of the widely scattered sample locations. Finally, the paucity

TABLE GS-39-1

GEOCHEMICAL CHARACTERISTICS OF THE ANOMALOUS ZONE

Location	K-feldspar					Garnet	Bulk Rock					
	Li	Rb	Cs	K/Rb	Rb/Cs	MnO / MnO + FeO	Li	Rb	Cs	Be	Nb	Ta
A	120	12 400	582	9	22	0.73	2 650	1 235	54	52	63	216
B	149	8 000	269	14	30	0.56	6 050	2 800	80	58	67	58
	-	-	-	-	-	-	[370]	[1 050]	[32]	[66]	[88]	[90]
C	149	8 700	217	13	41	0.61	6 780	2 400	108	51	66	48
	-	-	-	-	-	-	[400]	[1 150]	[45]	[76]	[113]	[150]
D	26	8 300	64	14	130	0.52	200	4 720	57	26	64	30
E	3	3 090	22	38	141	-	-	-	-	-	-	-
F	30	1 860	42	53	44	0.24	180	660	11	2.5	30	12
G	31	1 090	47	89	23	0.24	(120)	(620)	(13)	(2.5)	(61)	(17)
FE	73	8 500	199	13	43	0.41	-	-	-	-	-	-
HE	3	4 400	43	24	102	0.19	-	-	-	-	-	-
IE	189	7 440	157	15	49	0.53	-	-	-	-	-	-
KE	169	9 360	323	12	29	0.62	[140]	[1 270]	[37]	[9]	[78]	[180]
ME	250	5 500	260	20	21	0.48	-	-	-	-	-	-
NE	211	12 400	613	88	21	0.73	-	-	-	-	-	-
OE	-	-	-	-	-	0.51	-	-	-	-	-	-
PE	-	-	-	-	-	0.52	-	-	-	-	-	-
SQ	110	17 500	1 000	6	17	-	-	-	-	-	-	-
Tanco	200	18 000	900	8	18	-	-	-	-	-	-	-

All values in parts per million
No brackets - pegmatitic lencogranite
[ ] - sodic aplite
( ) - fine grained lencogranite
Tanco - approximate averages of data from all pegmatite units, not weighted for relative abundances.
SQ - averages of data from the central part of the pegmatite outcrop.

TABLE GS-39-2

CHEMICAL COMPOSITION OF THE MINERALIZED PEGMATITIC LEUCOGRANITES (A, B, C, KE) AND THEIR "BARREN" COUNTERPARTS.

	A	B	C	D	F-09	G-19	I	J-30	KE-24	QE-01
Wt. %:										
SiO_2	75.30	72.00	74.99	72.31	78.69	75.03	74.47	73.93	72.36	75.33
TiO_2	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.03	0.00	0.00
Al_2O_3	15.53	16.52	15.84	15.70	12.37	14.52	14.39	14.66	16.29	15.12
Fe_2O_3	0.04	0.17	0.18	0.38	0.23	0.44	0.07	0.27	0.02	0.21
FeO	0.09	0.27	0.21	0.46	0.50	0.71	0.82	0.62	0.16	0.27
MnO	0.23	0.08	0.19	0.08	0.09	0.11	0.13	0.07	0.27	0.22
MgO	0.10	0.03	0.18	0.09	0.15	0.16	0.11	0.17	0.08	0.03
CaO	0.27	0.10	0.10	0.08	0.20	0.34	0.24	0.79	0.33	0.22
Na_2O	5.52	3.26	2.59	2.86	2.96	3.82	3.38	4.68	7.33	5.64
K_2O	1.58	4.31	3.59	6.91	4.11	3.77	6.00	4.25	2.66	1.37
P_2O_5	0.09	0.05	0.06	0.05	0.04	0.03	0.05	0.30	0.20	0.10
CO_2	0.02	0.04	0.05	0.09	0.04	0.04	0.10	0.04	0.12	0.02
H_2O+	0.20	0.20	0.10	0.15	0.20	0.15	0.15	0.15	0.20	0.15
S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
F	0.01	0.14	0.07	0.12	0.05	0.07	0.03	0.01	0.02	0.01
	98.98	97.17	98.15	99.29	99.68	99.21	99.95	99.93	100.04	98.70
$-O=F_2$	-0.004	-0.06	-0.03	-0.05	-0.02	-0.03	-0.01	-0.004	-0.01	-0.004
	98.98	97.11	98.12	99.24	99.66	99.18	99.94	99.93	100.03	98.70
ppm:										
Ni	2	9	9	19	<1	1	3	<1	6	<1
Zn	29	122	110	129	49	54	37	29	<1	30
V	3	<1	<1	<1	<1	2	<1	3	<1	<1
Cr	19	13	12	17	23	18	16	10	21	14
Li	2650	6050	6880	221	100	124	39	23	143	8
Rb	1235	2800	2400	4723	662	616	795	364	1268	377
Cs	54	80	108	57	11	13	12	8	37	18
Be	52	58	51	26	3	3	1	3	9	29
Sr	14	27	27	45	5	1	5	12	20	13
Ba	26	77	55	63	46	65	34	74	58	65
Ga	54	86	73	93	42	60	35	28	102	71
U	3	2	2	4	2	5	3	13	2	5
Th	5	4	5	7	5	7	4	21	5	5
Zr	8	7	8	<2	6	5	4	40	16	16
Hf	2	2	2	1	<1	<1	<1	2	10	3
Sn	15	50	81	252	22	31	15	9	11	34
Nb	62	71	91	64	30	61	17	25	78	61
Ta	213	64	66	29	12	17	6	4	181	89
Y	<2	<2	<2	<2	<2	12	12	45	<2	<2

of outcrops on isolated islands does not permit a denser, more representative surface sampling.

Nevertheless, two kinds of parameters indicate a potential for economically significant mineralization. First, the areal extent of the mineral finds and of the geochemical anomaly, if underlain by a more or less continuous body of the petalite-bearing pegmatitic leucogranite, may represent a sizeable volume of mineralized rock. Second, the degree of geochemical fractionation attained in the central parts of the anomaly compares favourably with the fractionation of highly mineralized pegmatite deposits (cf. Tanco in Table GS-39-1), and with the most fractionated pegmatite in the Red Sucker Lake field, the SQ body in the northwest end of the field (Fig. GS-39-1, Table GS-39-1).

It should be noted that the anomalous mineralization within the pegmatitic leucogranite has no analog among other occurrences of fertile granites worldwide. It falls within the general type of deposits related to highly evolved pegmatitic cupolas of granitic intrusions of the Montebras and Echassieres type (Aubert, 1969; Burnol, 1974), but the mineralogy, geochemistry and textural style are unique.

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GS-40 STRATIGRAPHIC MAPPING AND STRATIGRAPHIC AND INDUSTRIAL MINERALS CORE HOLE PROGRAM

by H. R. McCabe

INTRODUCTION

The 1986 stratigraphic mapping program consisted of four projects. Sampling and core drilling for the Stonewall Formation were undertaken to attempt to define the position of the Ordovician-Silurian boundary in Manitoba. Additional drilling was carried out to obtain a detailed profile of a Winnipegosis reef and to establish a model for reef development. Outcrop mapping was completed for roads in the Clearwater Lake-Cormorant Lake-Moose Lake area, and drilling continued in conjunction with Project Cormorant, to determine the nature of Precambrian basement beneath the thin Phanerozoic cover in the area of the Cormorant map sheet. Also, five Precambrian sites were cored in southeastern Manitoba as part of a project to evaluate the quality of the granitic rocks as ornamental/dimension stone (see Section GS-27, this volume).

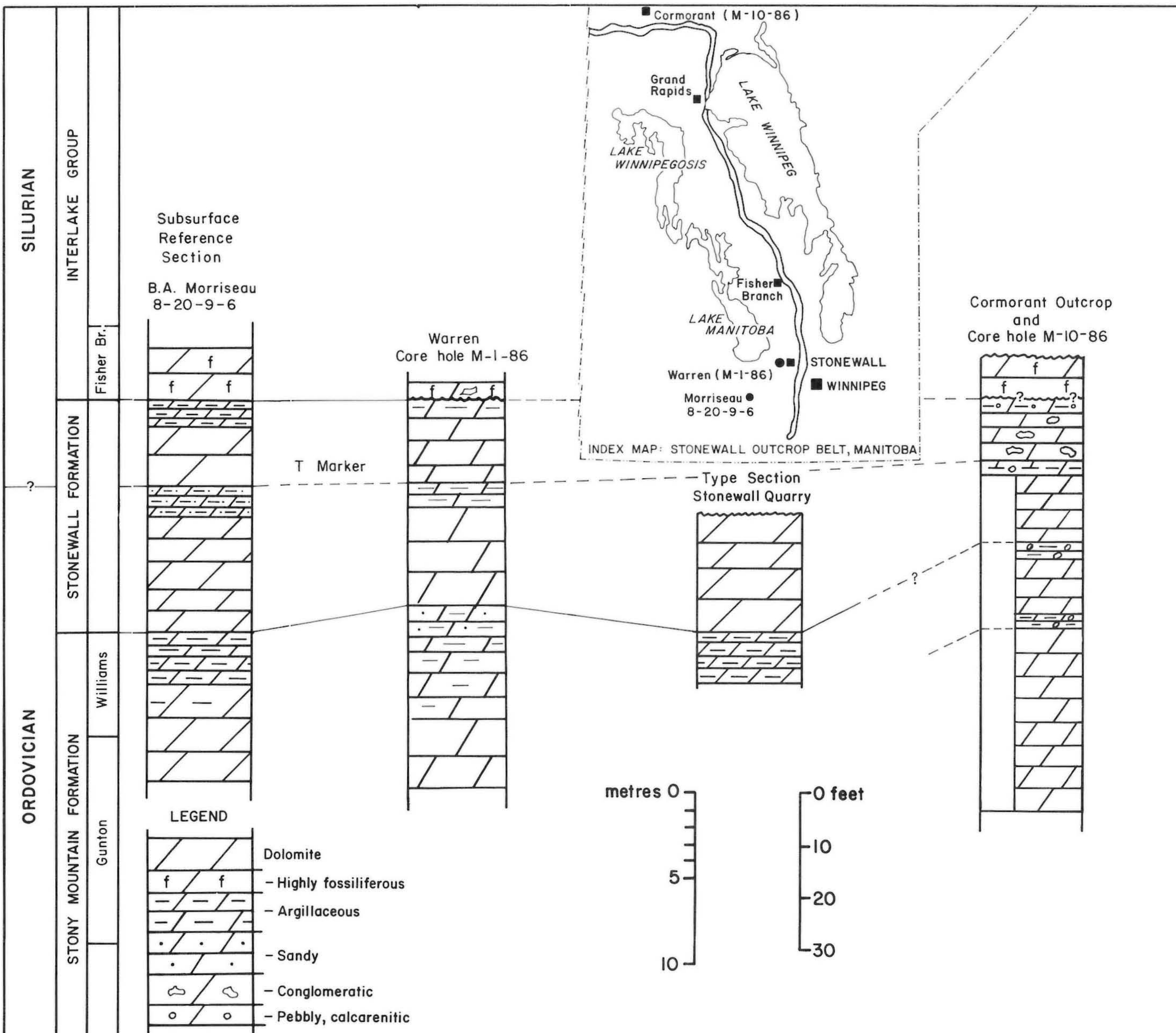


Figure GS-40-1: Surface-subsurface correlation, Stonewall Formation, Manitoba.

A. ORDOVICIAN-SILURIAN BOUNDARY STUDY

A preliminary submission was prepared for a circular to be issued by the Ordovician-Silurian Boundary Working Group (L.R.M. Cocks, pers. comm.), describing an outcrop section across what is believed to be the Ordovician-Silurian boundary in Manitoba. The "contact" is believed to occur within the Stonewall Formation. Earlier studies by Stearn (1956) determined that the fauna from the lower part of the Stonewall Formation, as found in outcrop at the type section at Stonewall, Manitoba, is Upper Ordovician in age. The Fisher Branch Formation, which overlies the Stonewall Formation, is of Silurian age and contains the distinctive and diagnostic *Virgiana decussata* fauna. The "contact" between Ordovician and Silurian thus occurs within the upper part of the Stonewall Formation, above the section preserved in outcrop at the Stonewall quarry.

Outcrops of the Stonewall are rare, and to the writer's knowledge the only section that is more or less completely exposed section occurs in a recent roadcut just south of the village of Cormorant (Tp. 60, Rge. 22; Fig. GS-40-1). Detailed faunal studies have not been made of this stratigraphic section, so the correlations are not yet confirmed. Consequently, in 1986 a detailed set of outcrop samples was obtained from the Stonewall strata at Cormorant, and two shallow stratigraphic core holes were completed through the unit. Outcrop samples and one of the cores are being sent to the Geological Survey of Canada for detailed microfossil determinations to accurately determine the age of the Stonewall strata and the position of the Ordovician-Silurian boundary.

In the northern area, the Upper Stonewall beds are conglomeratic, suggesting that a portion of the Upper Stonewall could have been eroded. To the south, conglomeratic zones are rare or absent suggesting that a more complete Ordovician-Silurian boundary sequence is preserved. To check this possibility, an additional core hole was drilled in the southern area, at Warren (M-1-86; 13-31-13-1W), where the complete Stonewall Formation was cored. This core also will be sent to Calgary for microfossil studies, to determine if a more complete Ordovician-Silurian boundary sequence is preserved in the southern area. Brindle (1960) suggested that the boundary occurs at the argillaceous T-marker near the middle of the Stonewall Formation.

B. WINNIPEGOSIS REEF CORE-HOLE PROFILE

Recent drilling in the stratigraphic core-hole program has obtained numerous cores of Winnipegosis reefs. However, most of the these holes are located on isolated reefs so that a detailed profile of a single reef could not be determined except as a hypothetical composite.

In 1975, core hole S-5-75 was located on the flank of an isolated "pinnacle-type" reef located just past the Steeprock Bridge (Fig. GS-40-2) on the Pelican Rapids road. This hole was located only 75 m from the centre of the reefal structure and cored the complete Winnipegosis section. As this reef is capped by Lower Dawson Bay strata, the complete Winnipegosis section is preserved. Earlier, a shallow hole (M-9-72) slightly farther off the flank of the structure had been drilled to the top of the Winnipegosis. In 1981, it was decided that this reef (referred to as the Steeprock Bridge Reef) provides one of the few locations where drilling access can provide a true reef profile. Core hole M-17-81 was drilled at an off-reef location and a preliminary cross-section was presented in the 1981 Report of Field Activities.

In 1986, two additional deep cores were drilled, one a re-drill of the shallow M-9-72 hole, providing a detailed 4-hole profile on the western flank of the Steeprock Bridge Reef (Fig. GS-40-2) at a spacing of roughly 100 m. The true-scale reef configuration is shown in Figure GS-40-2A and a more detailed stratigraphic presentation in Figure GS-40-2B. It has not yet been possible to locate a drill hole on the top of the dome (centre of reef) because of the steep flank dips of 20°, but hole M-18-77 was located exactly on the apex of a comparable dome on the Red Deer River and can be considered as representative of central-reef lithology. The progressive pinnacle-type buildup of the reef is well shown, and the detailed relation between the reef and interreef lithofacies provides information useful in estimating the mechanics of reefal buildup. The interreef lithologies consist of fine black argillaceous/bituminous laminated mudstone with interbeds of clean carbonate ranging from fine calcarenite to coarse fragmental. These calcarenite beds represent reef-derived detritus.

In hole M-17-81, farthest from the reef, lamination in both bituminous mudstones and calcarenites is subhorizontal, and the content and thickness of bituminous laminites is the highest of any of the four holes. The reef-derived detrital interbeds all appear to be relatively fine grained, although dolomitization has largely destroyed the primary textures. All of the above features are consistent with the distal off-reef location of the beds.

Hole M-8-86 shows a thicker Winnipegosis section, attributable largely to a thickening and coarsening of the reef-derived detrital beds. Angular clasts to 5 cm or more are common, and, where textures are discernible, consist largely of fine calcarenites, although some coral fragments have been noted. Dips are surprisingly steep, commonly 30°-45° but locally ranging up to almost 90°. These steep dips occur in the bituminous laminites in the upper part of the Winnipegosis sequence and appear to be associated with the coarser detrital interbeds, suggesting distortion associated with debris flows and/or primary dips and/or differential compaction of the bituminous component. Bituminous laminites near the base of the interreef sequence are subhorizontal. Rounded to streamlined "fragments" of fine calcarenite occur as scattered inclusions within the bituminous laminites suggesting, in part, soft sediment deformation.

In hole M-7-86 the Upper Winnipegosis thickens slightly, from 26 to 34 m (relative to M-8-86), but the thickness of bituminous strata decreases sharply, from 29 to only 5 m. The bituminous beds occur only at the base of the Upper Winnipegosis sequence and are overlain by a relatively massive sequence of dolomites showing very little preserved texture. These dolomites are finely crystalline, granular to subsaccharoidal and show only faint relict calcarenite to breccia texture and a faint suggestion of dips to 45°. The bituminous laminite section at the base of the sequence shows relatively uniform dips of ± 20°, decreasing to subhorizontal at the top.

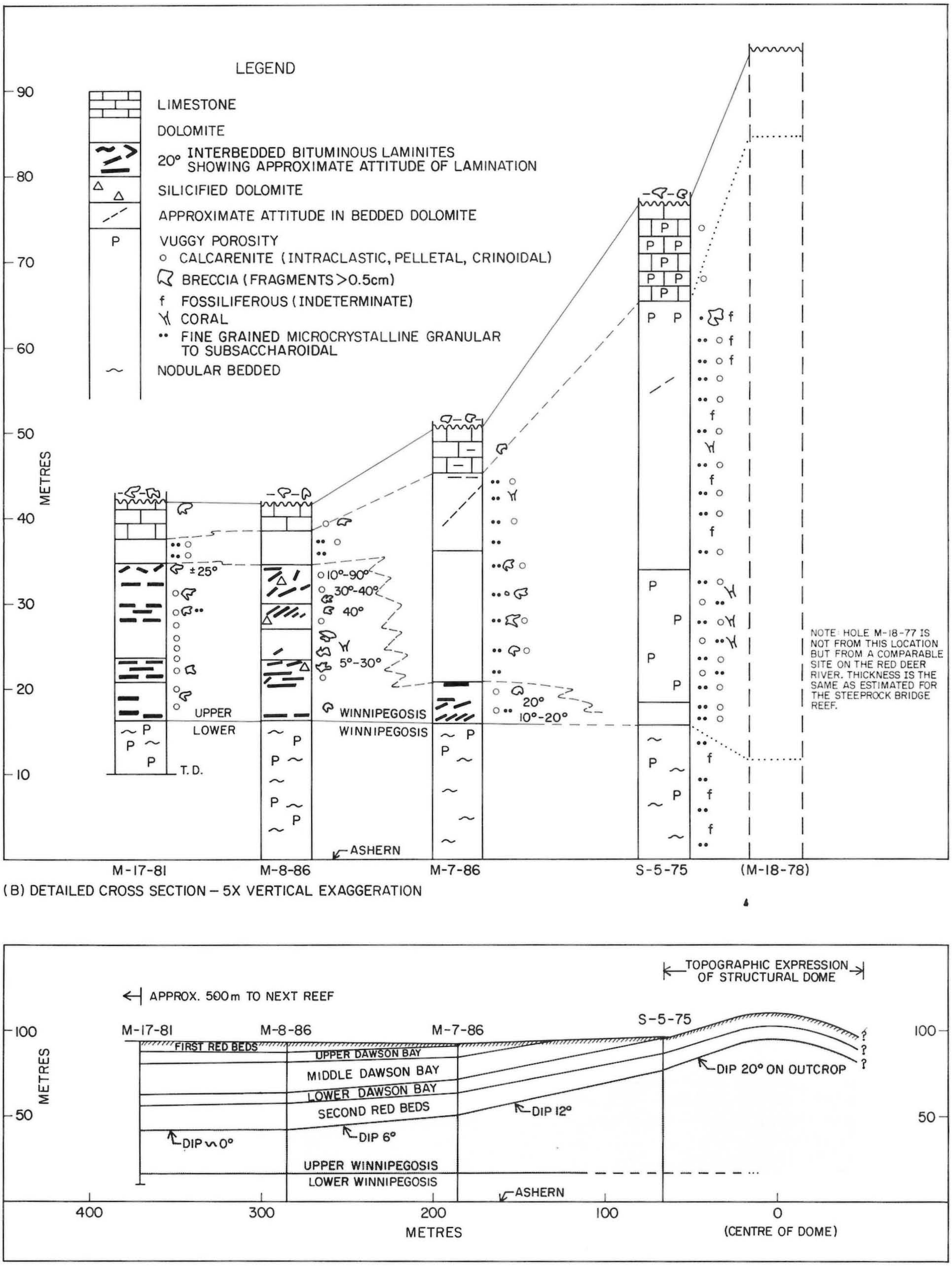
The S-5-75 core hole, located closest to the reef centre, shows a marked increase of 26 m in Upper Winnipegosis (reef) thickness, and an almost complete absence of the bituminous laminated beds. The "reefal" dolomites are relatively massive; faint traces of bedding suggest dips of ± 30°. Textures are poorly preserved, consisting predominantly of fine calcarenite, but with several zones showing a high fossil content with abundant corals and algal material, possibly in part bioconstructed framework.

Although the centre of the Steeprock Bridge Reef was not drilled, the lithology of the "reef core", on the basis of the M-18-77 hole located at the centre of a similar dome, probably is similar to that shown by the S-5-75 hole, but with no discernible break in lithology at the top of the Lower Winnipegosis platform. In the M-18-77 hole there is no evidence of any bituminous development; the "reef" lithology, except for more abundant fossils where primary textures are partially preserved, is similar to the platform lithology.

The above facies distribution suggests the following simplistic reef model for the pinnacle-type "reef" described above. Reef development initiated at very localized centres on the Lower Winnipegosis platform. The question of whether or not the Winnipegosis reefs are true bioherms (bioconstructed wave-resistant frameworks) cannot be answered with the presently available data, but the steep internal dips (± 45°), the local occurrence of coarse breccias in proximal reef flank beds, and the (sporadic) occurrence of coral-stromatoporoid-rich rocks all suggest that the buildups possibly comprise true bioherms.

In either case, rapid subsidence apparently gave rise to rapid local reef growth with concurrent development of relatively deep-water, starved-basin conditions in interreef areas, where black laminated bituminous mudstones were deposited. The reef-interreef relief defines an approximate water depth of about 50-55 m in the map area. Regional subsurface data for Manitoba suggest a maximum depth (relief) of about 95 m. Shedding of carbonate debris flows, during late stage lateral reef growth, resulted in an interfingering of reef detritus and bituminous laminites, with the detrital beds overstepping the interreef bituminous facies away from the reef.

The above model applies to the isolated pinnacle-type reefs of the



(A) TRUE-SCALE REEF PROFILE – NO VERTICAL EXAGGERATION

Figure GS-40-2: *Steeprock Bridge Reef profile, Winnipegosis Formation.*

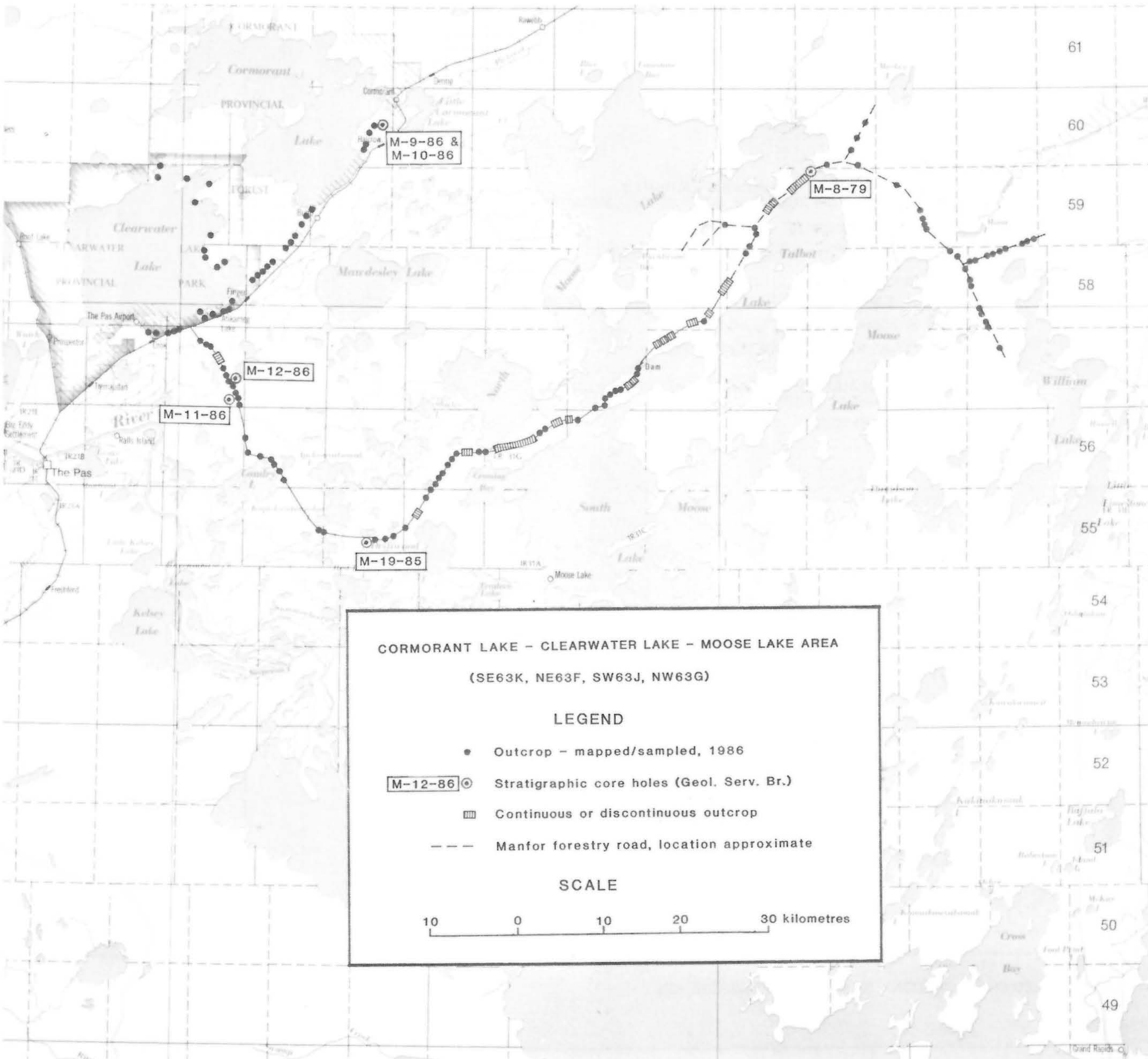


Figure GS-40-3: Stratigraphic mapping and core hole locations, 1986.

Dawson Bay area. However, other types of reefs are known for the Dawson Bay area, notably broad relatively flat-topped "platform-type" reefs ranging in size up to an apparent maximum of about 3 by 15 km. Also, the general configuration of the reefs is seen to change markedly along the Manitoba outcrop belt as the Winnipegosis facies changes from central basin type in the Dawson Bay area in the northwest to shelf edge in the Narrows area at the southeastern end of the outcrop belt. Although the configuration changes markedly, the limited internal structural and lithofacies data suggest a similar mode of origin, but with lateral reef growth becoming the dominant factor as the basin edge is approached.

Detailed petrographic studies must still be carried out to test and clarify the proposed reef model. The recent Home Oil Winnipegosis reef discovery in southern Saskatchewan shows the economic importance of such studies, and the regional depositional pattern for the Elk Point Basin suggests that a Winnipegosis reef facies comparable to that at the Home Oil discovery probably is developed at some point along the Devonian outcrop belt of Manitoba.

C. STRATIGRAPHIC MAPPING

In addition to detailed measuring and sampling of the Cormorant hill outcrop, noted in Section A, a total of 170 km of mapping of road outcrops was completed, including Cormorant Lake Road, Moose Lake Road as far as Moose Lake junction, and Talbot Lake forestry roads (Fig. GS-40-3). A total of 120 outcrops were examined and/or sampled. All outcrops except those near Cormorant are Silurian, and most occurrences are of the Lower Interlake East Arm dolomite. Precise correlations within the Silurian are difficult because of the general uniformity in lithology (all dolomite), but the shallow core hole drilling to date, including holes M-11-86 and M-12-86, should permit more accurate definition of the formations within the Silurian outcrop belt.

The above mapping completes Phanerozoic coverage for the Cormorant map sheet (63K) and provides additional data for the adjoining Wekusko Lake sheet (63J) and The Pas sheet (63F).

D. PROJECT CORMORANT

Further detailed evaluation of available geophysical and drill hole data (by Taiga Consultants Ltd.) for the sub-Paleozoic Precambrian geology of the Cormorant area showed a number of features that required ground truthing. A total of 10 core holes were drilled on these features, bringing the total number of "in-house" drill holes in the Cormorant area to 56. The Precambrian data for the 1986 holes are discussed in detail in Section GS-21 of this report, and the summary results are shown in Table GS-40-1.

Depths to Precambrian ranged from 6.7 m in the northern part of the map area to 60.5 m in the southern part, and the overburden generally was thin, not exceeding 8 m. The thickness of the zone of weathered Precambrian was, as expected, variable, ranging from 0.3 m to more than 18 m, but the exact contact relationships generally are obscured because of lost core at the unconformity. Core loss ranges from 0.5 to 3 m, and most of the loss is believed to occur in the weathered zone, although some loss may occur in the zone of basal Paleozoic sandstone.

The 1986 drilling was mostly of an infill nature as far as Phanerozoic geology is concerned, and all Paleozoic sections appeared normal, as did elevations on the Precambrian unconformity surface. No appreciable variation is indicated from the trends established by previous mapping (see Report of Field Activities, 1985; Fig. GS-43-2A).

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TABLE GS-40-1
SUMMARY OF CORE HOLE DATA

HOLE NO.	LOCATION AND ELEVATION	SYSTEM/FORMATION/MEMBER	INTERVAL METRES	SUMMARY LITHOLOGY
M-1-86 (Warren)	13-31-13-1W + 249.7 m		0.0 - 7.3	Overburden
		Silurian-Interlake	7.3 - 32.5	Dolomite, variable, dense to fossiliferous.
		Fisher Branch	32.5 - 40.7	Dolomite, fossiliferous, basal breccia.
		Ordovician/Silurian- Stonewall	40.7 - 46.4	Dolomite, fine grained, basal breccia.
			46.4 - 47.7	Dolomite, argillaceous.
			47.7 - 53.7	Dolomite, mottled, fossiliferous.
		Stony Mountain	53.7 - 60.0	Dolomite, reddish argillaceous, sandy.
		Gunton	60.0 - 70.5	Dolomite, fine grained, nodular.
		Penitentiary	70.5 - 72.6	Argillaceous dolomite, reddish mottled.
M-2-86 to M-6-86: Precambrian test holes; see Section GS-21, this report, for data.				
M-7-86 (Steeprock Bridge)	5-13-44-25W + 254.5 m	Devonian-Dawson Bay (upper)	0.0 - 4.4	Limestone, brownish, coarsely crystalline.
			4.4 - 7.8	Dolomite, brown, granular.
		(middle)	7.8 - 21.3	Calcareous shale to argillaceous limestone.
		(lower)	21.3 - 28.4	Limestone, fossiliferous.
		Second Red Beds	28.4 - 41.6	Dolomitic shale, grey to red, breccia.
		Winnipegosis (transition)	41.6 - 47.2	Limestone, fine grained, stylolitic.
		(Upper-reef flank)	47.2 - 71.3	Dolomite, fine calcarenite to fragmental.
			71.3 - 75.8	Interbedded black bituminous laminite.
		(Lower-platform)	75.8 - 92.2	Dolomite, brown, massive to nodular.
		Ashern	92.2 - 100.1	Dolomitic shale, grey to red.
		Silurian-Interlake	100.1 - 109.0	Dolomite.
M-8-86 (Steeprock Park)	8-14-44-25W + 254.6m		0.0 - 3.5	Overburden.
		Devonian-Souris River	3.5 - 6.7	Dolomite and shale.
		Dawson Bay (upper)	6.7 - 11.4	Limestone, coarsely crystalline.
			11.4 - 12.1	Dolomite, buff, granular.
		(middle)	12.1 - 29.5	Argillaceous limestone and calcareous shale.
		(lower)	29.5 - 36.3	Limestone, fossiliferous.
		Second Red Beds	36.3 - 51.9	Dolomitic shale, grey to red, breccia.
		Winnipegosis (Transition)	51.9 - 55.4	Limestone, coarsely crystalline, calcarenite, breccia.
		(Upper-reef flank)	55.4 - 59.0	Dolomite, buff, granular.
			59.0 - 77.5	Interbedded bituminous laminite, calcarenite and breccia.
		(Lower-platform)	77.5 - 93.7	Dolomite, white to buff, massive, vuggy, calcarenite.
		Ashern	93.7 - 102.6	Dolomitic shale, grey to red.
		Silurian-Interlake	102.6 - 105.8	Dolomite.
M-9-86 and M-10-86 (Cormorant Hill)	8-23-60-22W + 289 m	Silurian-Fisher Branch	0.0 - 0.9	Dolomite, buff, mottled, fossiliferous.
		Ordovician/Silurian - Stonewall	0.9 - 4.7	Dolomite, calcarenite, breccia.
			4.7 - 5.3	Reddish argillaceous dolomite.
			5.3 - 9.3	Dolomite, dense.

TABLE GS-40-1 (Cont'd)

HOLE NO.	LOCATION AND ELEVATION	SYSTEM/FORMATION/MEMBER	INTERVAL METRES	SUMMARY LITHOLOGY
		Stony Mountain -	9.3 - 10.0	Reddish argillaceous dolomite.
		Williams Member	10.0 - 13.5	Dolomite, dense, calcarenite.
			13.5 - 14.3	Reddish argillaceous dolomite.
		Gunton	14.3 - 32.4	Dolomite, fine grained dense, nodular bedded.
		Penitentiary/Gunn	32.4 - 40.8	Dolomite dense, reddish, burrow mottled.
		Red River-Fort Garry	40.8 - 51.2	Dolomite, variable, argillaceous, cherty.
		lower Red River	51.2 - 83.4	Dolomite, buff, mottled, massive, floating sand grains at base.
			83.4 - 84.3	Sandy dolomite to dolomitic sandstone.
M-11-86 (Moose Lake Road)	4-12-57-24W + 270 m	Silurian-Interlake	0.0 - 2.8	Dolomite, buff, dense.
		East Arm	2.8 - 17.3	Dolomite, variable, argillaceous and sandy interbeds. Loose sand at base.
M-12-86 (Moose Lake Road)	16-11-57-24W + 267 m	Silurian-East Arm	0.0 - 13.9	Dolomite, calcarenitic, fossiliferous, sandy and argillaceous at base.
M-13-86 (Site #46)	1-16-64-26W + 312 m (?)	Ordovician-Red River	1.5 - 18.9	Dolomite, mottled, massive, floating sand grains at base.
			18.9 - 20.5	Sandy dolomite to dolomitic sandstone, mottled.
		Precambrian	20.5 - 20.7	Lost 0.4 m.
			20.7 - 21.4	Weathered zone.
			21.4 - 44.6	Granitic gneiss.
M-14-86 (Site #41)	4-29-62-28W + 283 m		0.0 - 2.1	Overburden.
		Ordovician-Red River	2.1 - 20.0	Dolomite, massive, buff, mottled, floating sand grains at base.
			20.0 - 21.2	Sandy dolomite to dolomitic, sandstone, mottled.
		Precambrian	21.2 - 22.8	Lost core.
			22.8 - 25.2	Weathered zone.
			25.2 - 35.7	Pink granite.
M-15-86 (Site #47)	15-30-63-26W + 285 m		0.0 - 6.7	Overburden
		Precambrian	6.7 - 23.5	Pink granite, unweathered.
M-16-86 (Site #7)	15-26-62-28W + 294 m		0.0 - 7.7	Overburden
		Ordovician-Red River	7.7 - 35.5	Dolomite, massive, burrow mottled, sandy at base.
			35.5 - 36.8	Sandy dolomite to dolomitic sandstone, mottled.
		Precambrian	36.8 - 38.5	Lost core.
			38.5 - 39.1	Weathered zone.
			39.1 - 47.8	Granitoid gneisses.
M-17-86 (Site #34)	2-9-60-28W + 279 m	Ordovician-Stony Mountain		
		Gunton	0.0 - 2.7	Dolomite, buff, dense.
		Penitentiary/Gunn	2.7 - 14.9	Dolomite, buff to reddish, burrow mottled, fossiliferous.
		Red River-Fort Garry	14.9 - 24.0	Dolomite, variable, argillaceous and cherty.
		Lower Red River	24.0 - 61.0	Dolomite, nodular to mottled, burrowed, some chert, sandy at base.

TABLE GS-40-1 (Cont'd)

HOLE NO.	LOCATION AND ELEVATION	SYSTEM/FORMATION/MEMBER	INTERVAL METRES	SUMMARY LITHOLOGY
			61.0 - 61.5	Sandy dolomite to dolomitic sandstone, mottled.
		Winnipeg	61.5 - 63.2	Sandstone, medium grained, silty, argillaceous, pyritic (lost core 1.34 m).
		Precambrian	63.2 - 64.8	Lost core.
			64.8 - 65.8	Weathered zone.
			65.8 - 81.5	Granitic gneiss, pegmatitic granite.
M-18-86 (Site #38)	16-21-61-28W + 295 m		0.0 - 6.8	Overburden
		Ordovician-Stony Mountain	6.8 - 14.2	Dolomite, buff to reddish, massive.
		Red River-Fort Garry	14.2 - 28.4	Dolomite, variable, argillaceous, cherty.
		Lower Red River	28.4 - 54.9	Dolomite, buff, mottled, massive, sandy at base.
			54.9 - 55.3	Sandy dolomite to dolomitic sandstone, mottled.
		Winnipeg	55.3 - 57.2	Sandstone, friable, coarse grained (1.41 m lost core).
		Precambrian	57.2 - 58.4	Lost core.
			58.4 - 59.8	Weathered zone.
			59.8 - 90.7	Hornblende metadiorite.
M-19-86 (Site #37)	15-16-61-28W + 295 m		0.0 - 2.0	Overburden.
		Ordovician-Stony Mountain (Lower)	2.0 - 14.7	Dolomite, buff to reddish, burrow mottled. Thin breccia at base.
		Red River-Fort Garry	14.7 - 29.7	Dolomite, variable, argillaceous dense.
		Lower Red River	29.7 - 59.2	Dolomite, massive, buff, mottled, sandy at base.
			59.2 - 59.7	Sandy dolomite to dolomitic sandstone, mottled.
		Winnipeg	59.7 - 60.5	Sandstone, medium grained, argillaceous, pyritic.
		Precambrian	60.5 - 62.7	Lost core.
			62.7 - 63.5	Weathered zone.
			63.5 - 78.2	Diorite-granodiorite.
M-20-86 (Site #40)	9-21-62-28W + 289 m		0.0 - 3.7	Overburden.
		Ordovician-Red River	3.7 - 28.3	Dolomite, buff, mottled, massive.
			28.3 - 29.6	Sandy dolomite to dolomitic sandstone, mottled.
		Winnipeg	29.6 - 29.9	Sandstone, white, medium- to coarse-grained, friable, pyritic.
		Precambrian	29.9 - 32.3	Lost core.
			32.3 - 48.3	Weathered zone.
			48.3 - 75.4	Granitic gneiss.
M-21-86 (Site #42)	8-10-62-29W + 287 m		0.0 - 3.9	Overburden
		Ordovician-Red River	3.9 - 33.2	Dolomite, buff, massive, mottled and burrow mottled. Sandy at base.
			33.2 - 36.0	Sandy dolomite to dolomitic sandstone, mottled.
		Precambrian	36.0 - 37.7	Lost core.
			37.7 - 38.5	Weathered zone.
			38.5 - 42.0	Granitic gneisses.
M-22-86 (Site #49)	8-32-64-22W + 311 m (?)		0.0 - 3.2	Overburden.
		Ordovician-Red River	3.2 - 17.6	Dolomite, buff, mottled and burrow mottled. Sandy at base.
			17.6 - 18.1	Sandy dolomite to dolomitic sandstone, mottled, friable at base.
		Precambrian	18.1 - 18.6	Lost core.
			18.6 - 18.8	Weathered zone (porous).
			18.8 - 30.2	Granite.

GS-41 INDUSTRIAL MINERAL OCCURRENCES IN THE DUCK MOUNTAIN AREA

by B.E. Schmidtke

INTRODUCTION

Several industrial minerals occurrences have been recorded in the Duck Mountain area. Documentation of these occurrences was undertaken to establish a data base for the creation of an industrial minerals potential map, the first of several scheduled for southwest Manitoba.

GENERAL GEOLOGY

The Duck Mountain area is underlain by Mesozoic clastic and Paleozoic carbonate rocks (Fig. GS-41-1). These sedimentary beds have a gentle southwest dip. The easily weathered Jurassic and Cretaceous shales and sandstones of the eastern part of the map sheet have been eroded more than the resistant Upper Cretaceous shales of the central part forming the Manitoba Escarpment. Much of the area is covered by a thick blanket of Quaternary sediments that reach a maximum thickness of 260 m in the Duck Mountain highlands (E. Nielsen, pers. comm.). The bedrock geology of the area has been described by Tyrrell (1889), Wickenden (1945) and McNeil and Caldwell (1981).

During the 1986 field season industrial mineral occurrences in the northern half of the Duck Mountain map sheet NTS 62N were investigated. Most outcrops are found in the riverbanks east of the Manitoba Escarpment.

OIL SHALE

In the Duck Mountain area, oil shale occurs in the lower Favel Formation. The shale is dark greenish grey, weathers to a medium grey and contains white speckles of foraminiferal material (McNeil and Caldwell, 1981). The oil shale in this formation is known as the "second white specks zone" (Macauley, 1984). Several outcrops are well exposed in the banks of Sclater River east of Highway 10 (Fig. GS-41-1).

Shale outcrops on the north bank of Sclater River contain sections of both Assiniboine and Keld Members of the Favel Formation. Samples were taken from both members and from the metre thick Laurier Limestone that separates the two. The lower Keld Member, approximately 6 m thick, is a calcareous speckled shale interbedded with limestone and contains two, 5 cm thick, seams of bentonite. The basal 1.5 m of the Keld Member is a grey limestone with white speckles.

Shale samples were taken from a small 5 m high outcrop on the northeast bank of Pine River (Fig. GS-41-1). The shale is dark grey, speckled and gives off a petroliferous odour. The basal metre of the outcrop consists of interbedded limestones and shales.

SHALE

Shale is a raw material in many commodities, including brick and cement, where it is a source of silica and alumina. Samples of non-petroliferous shale were collected from an exposure of the Morden Member of the Vermilion River Formation on Swan River north of Benito, and from the Ashville Formation exposed on South Duck River and in a Highway 10 roadcut 12 km north of Sclater River (Fig. GS-41-1).

The Morden shale is dark brown-grey. Yellowish jarosite was observed in the 5 m high exposure. The dark grey Ashville shale at South Duck River is exposed in a hill near the bridge and at water level in several locations along South Duck River (Fig. GS-41-1). The exposure of the Ashville shale, on both sides of Highway 10, contains selenite crystals and jarosite. All exposures of these shales were sampled and will be chemically analyzed.

CLAY

Glacial clays, from deep basin deposits, are quarried in the Winnipeg area for use as expanded aggregate, as a source of alumina and silica for cement, and as a construction material. A similar deposit of clay occurs in the Benito-Kenville area in the northwest corner of the Duck Mountain map sheet (Nielsen et al., 1981). One metre of plastic, grey-brown clay is exposed beneath approximately 3 m of sand in a roadcut north of Benito. The bottom of the clay bed was not exposed.

LIGNITE

Isolated occurrences of carbonaceous shale in the Swan River Formation have been reported at several locations between Swan River and Dauphin. In the Duck Mountain area, three seams of mineable lignite were reported to occur on the banks of Pine River in 1936 (non-confidential industrial minerals files). Several pits were dug in the area (Fig. GS-41-1), but lignite was never produced because the seams are thin and the grade (11,000 kJ/kg wet and 18,000 kJ/kg dry) is low (non-confidential industrial minerals files). In 1986 the pits were mapped and samples were taken from the piles of carbonaceous shale near the pits.

SILICA SAND

Silica sand of the Cretaceous Swan River Formation was sampled and described by Watson (1985). Outcrops of silica sand adjacent to the lignite pits along Pine River were mapped in 1986. Chemical analysis of the sand yielded an average of 96.1% SiO_2 (Watson, 1985). Beneficiation tests undertaken by CANMET indicate that the Pine River sand has potential as a glass sand (Collings and Andrews, 1986). The averaged values for five tests are 98.91% SiO_2, 0.07% Fe_2O_3, 0.14% Al_2O_3 and 0.04% CaO + MgO. The results correspond to Johnson's specifications for silica sand used to produce green glass and window glass (Johnson, 1961).

PEAT

Sphagnum peat was previously extracted for use as insulation at Cowan, on Highway 10 just north of the NTS 62N map sheet. Glacial beach ridges trapped the drainage, and produced a large area of organic deposits in the northeast corner of the map sheet. Three locations were sampled with a peat auger (Fig. GS-41-2).

The horticulture industry requires sphagnum peat with a low degree of humification, i.e. H1 to H3 on the Van Post Scale. The three areas sampled are shallow, (0.3-1.5 m) deposits of reed and sedge peat with a humification degree of H5 to H6. A muddy liquid and pieces of organic matter escape between the fingers when the peat is squeezed. Site 3 is a drained deposit on which a secondary growth of poplar has replaced a burned tamarack forest. Local residents use this peat to improve their gardens and lawns; however, because it is a humified reed and sedge peat, it is of little commercial value for horticultural purposes.

LIMESTONE AND DOLOMITE

Limestone and dolomite samples were taken from two abandoned aggregate quarries on Highway 20 (Fig. GS-41-1). Limestone of the Devonian Dawson Bay Formation is exposed in the north pit. The quarry is flooded and the top of the limestone is 0.5 m below the surface of the water. The southern pit is in an exposure of the Sagemace Member of the Souris River Formation (Norris et al., 1982). Samples of orange-brown and red weathering dolomite from this quarry are characterized by calcite crystals in vugs. Argillaceous limestone outcrops and near-surface deposits occur near Point River on P.R. 271.

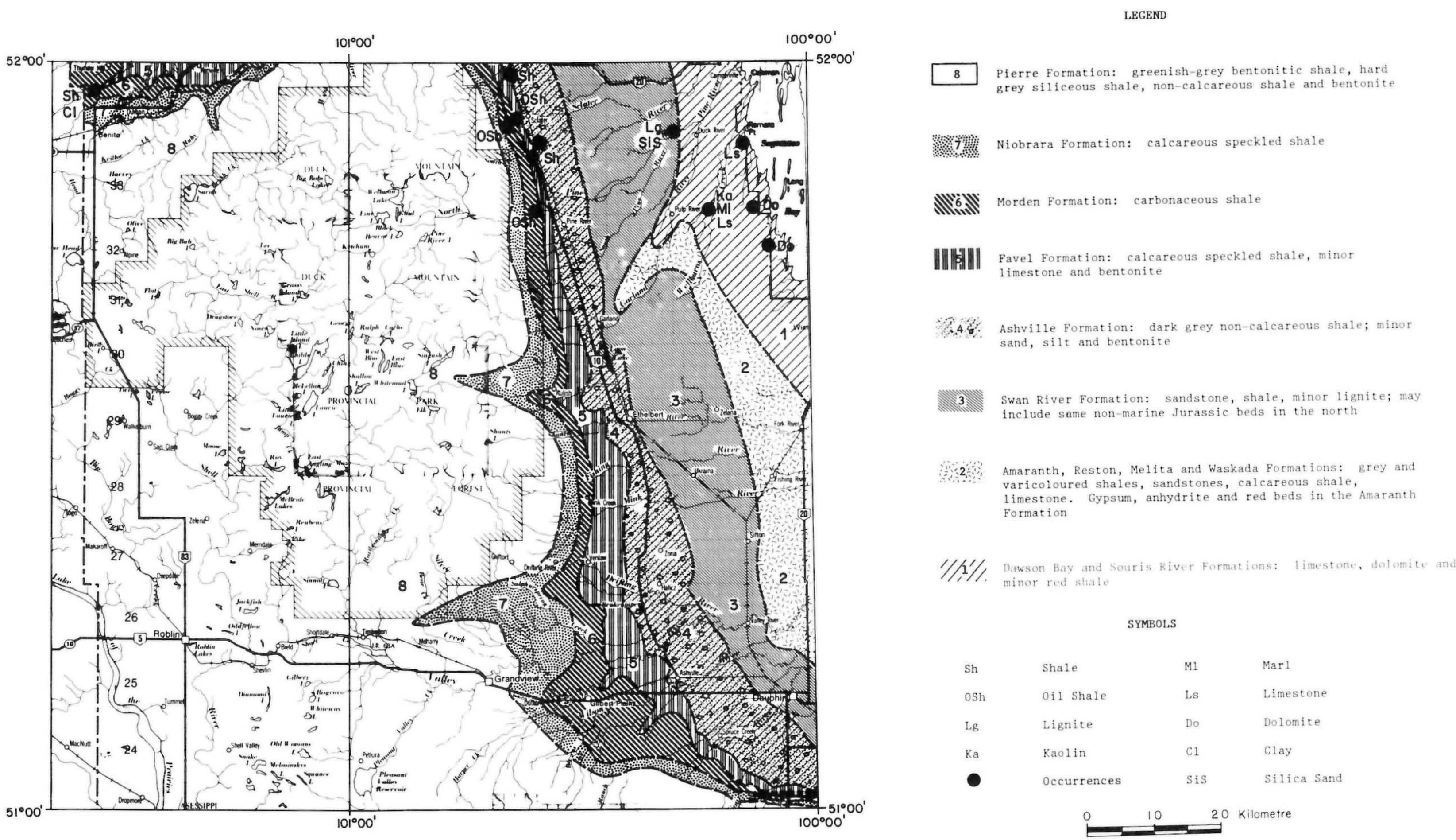
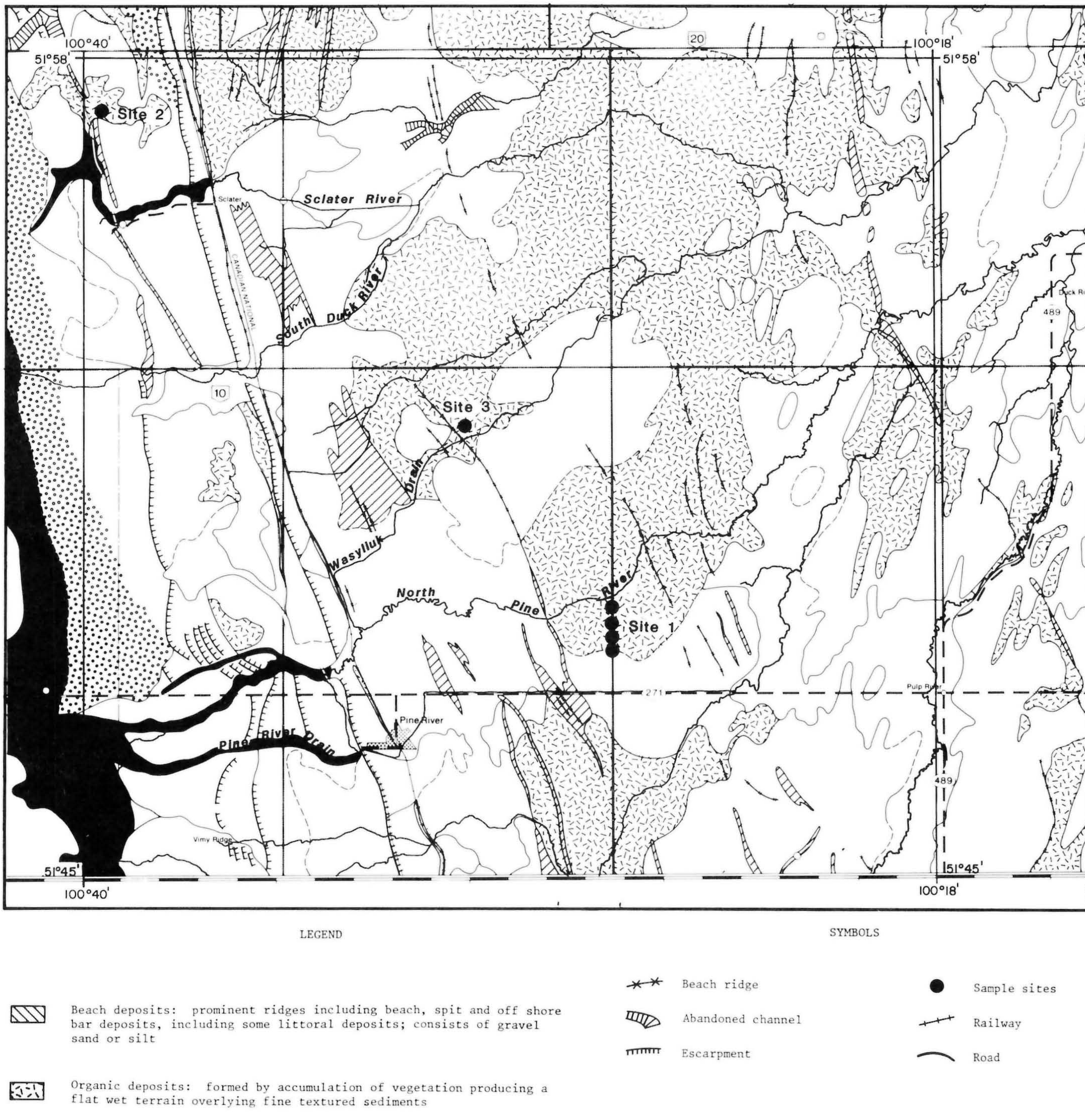


Figure GS-41-1: *Geology of the Duck Mountain area, NTS 62N, and locations of industrial minerals occurrences in the northern half. (Geology after Klassen et al., 1970 and McNeil and Caldwell, 1981).*



LEGEND

Beach deposits: prominent ridges including beach, spit and off shore bar deposits, including some littoral deposits; consists of gravel sand or silt

Organic deposits: formed by accumulation of vegetation producing a flat wet terrain overlying fine textured sediments

River alluvium deposits: stream sediment occurring along the flanks and bottoms of melt water channels and modern streams; includes gravel, sand and silt

Moraines: including end, lateral and terminal moraines

SYMBOLS

Beach ridge

Abandoned channel

Escarpment

Sample sites

Railway

Road

0 2 4 Kilometre

Figure GS-41-2: Organic deposits in the northeast corner of the Duck Mountain map sheet. Surficial geology after Nielsen.

KAOLIN

A small deposit of kaolin and marl of the Swan River Formation is located at Point River (Fig. GS-41-1). In 1963, L. Lindoe of Medicine Hat Brick and Clay Company Ltd. dug a test pit in the kaolin and drilled 19 holes in the immediate area (non-confidential assessment files). As a result of these tests he identified the occurrence of kaolin, stoneware clay and marl. Unfortunately, most of the kaolin was removed in digging the test pit and the stoneware clay pits were filled in during highway repairs two years ago. Consequently the kaolin and stoneware clay could not be sampled during this study. Analysis and temperature gradient tests of the kaolin indicate that it is a high quality clay; however, it contains a large amount of clastic quartz (Bannatyne, 1970). The deposit is considered too small to warrant further testing.

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GS-42 LANDSAT IMAGERY MAPS OF PEAT POTENTIAL IN THE GRINDSTONE POINT AREA

by R.J. Dixon[1] and B.E. Schmidtke

In 1985 thematic maps produced by digital image analysis of Landsat data of peat bog areas in southeast Manitoba were completed by the first author at the Manitoba Remote Sensing Centre. A final report, including these maps, is nearly completed (Stewart et al., in prep.). In 1986 mapping of the Grindstone Point area (NTS 62P) was initiated under the MDA.

Large areas of 62P are covered by the Julius Complex soil type characterized by deep acidic deposits of fibric sphagnum peat (Smith et al., 1975). Airphoto interpretation was conducted on sites with areal extents of approximately 1.6 x 10 km chosen in areas that are boggy, near roads and large bodies of water. The accessible sites were sampled with a peat auger by John Stewart of the Department of Botany, University of Manitoba .

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The data collected from the airphoto interpretation and the peat samples will be used to ground truth the thematic maps. Further work involves digital image analysis of Multispectral Scanner and Thematic Mapper data to produce the thematic maps.

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GS-43 INVESTIGATIONS OF METAMORPHISM IN THE PIKWITONEI DOMAIN

by K. Mezger[1], S.R. Bohlen[1] and G.N. Hanson[1]

INTRODUCTION

Investigations of the metamorphism in the Pikwitonei domain were initiated during the summer of 1985 and continued during the 1986 season. The area is of special interest because it exposes a continuous amphibolite to granulite facies sequence along the northwestern margin of the Superior Province, which is interpreted as a cross-section through the Archean continental crust (Hubregtse, 1980; Weber, 1984; Fountain and Salisbury, 1981). Samples were collected from Cauchon, Partridge Crop and Natawahunan Lakes. The goal of the project is to study the processes which lead to the formation of granulites, in particular to determine intensive parameters (i.e. pressure, temperature, activity of fluids) and the absolute times at which these conditions occurred using the closure temperature for the U-Pb systems in garnet.

Critical mineral assemblages from supracrustal rocks in the Natawahunan and Cauchon Lakes area include:

— Qtz-AKfs-Pl-Bt-Grt-Sil **or** Opx ± Cord ± Graph ± Po ± Rt ± Ilm
— Pl-AKfs-Bt-Sil-Hc-Grt ± Qtz **or** Cord ± Graph ± Ilm
— Pl-Bt-Grt-Opx ± Cpx ± Amph ± Qtz ± Ilm/Mag ± Rt
— Sapp-Opx-Bio-Pl-Rt-(Qtz)
— Grt-Scap-Plag-Qtz-Cpx-Amph

METAMORPHIC PRESSURES AND TEMPERATURES

Metamorphic temperatures were determined from co-existing plagioclase and alkali feldspar (Haselton et al., 1983) and the equilibria:

(1) hercynite + quartz = garnet + sillimanite (Bohlen et al., in press (a));
(2) hercynite + sillimanite = garnet + corundum (Bohlen et al., in press (b));

Pressures were derived from the equilibria:

(3) ilmenite + sillimanite = garnet + rutile + quartz (Bohlen et al., 1983a);
(4) ferrosilite + anorthite = grossular + almandine + quartz (Bohlen et al., 1983b).

During metamorphism, temperatures of 630°C were reached in the southern part of Cauchon Lake and 750°C in the northern part of the lake and at Prud'Homme Lake, at pressures of 6.4 kb. At Natawahunan, Partridge Crop and Buckingham Lakes temperatures of 800°C and pressures of 7.6 kb were attained (Fig. GS-43-1). These values correspond to an average geothermal gradient during metamorphism of 27°C/km in the southern part of Cauchon Lake near the opx-isograd (Weber, 1977) and 35°C/km in the granulite terrane from northern part of Cauchon Lake to the Natawahunan Lake area (Mezger et al., 1986). The P-T values determined in this study differ strongly from previous estimates of 9-12 kb and 800-1000°C (Hubregtse, 1978; Paktunc and Baer, 1986) but are consistent with the widespread occurrence of cordierite and sillimanite throughout the terrane. The elevated average geothermal gradient in the granulites suggests that heat transfer by melts and/or fluids was important during granulite grade metamorphism. Garnets from GRAIL assemblages (equilibrium 3) show an increase of Fe/Fe + Mg towards their rims.

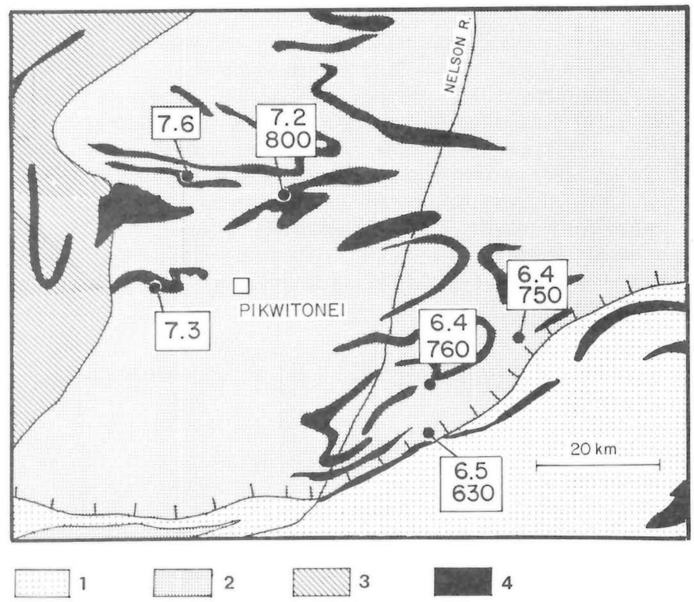

Figure GS-43-1: Metamorphic pressures and temperatures from the Pikwitonei domain: **1** *= Cross Lake subprovince;* **2** *= Pikwitonei granulite domain;* **3** *= Thompson belt;* **4** *= supracrustal units (after Geological Map of Manitoba, 1979).*

This type of zoning indicates isobaric to near-isobaric cooling after peak metamorphism. These data are consistent with the granulites having formed in an Andean-type continental margin (Bohlen et al., in press (b)).

AGES OF METAMORPHISM

Almandine-pyrope garnets from the area were investigated for their U and Pb concentrations, their Pb isotopic compositions and their potential use for dating of metamorphic events. The samples were taken from the amphibolite to granulite facies transition zone at Cauchon Lake.

Clear and inclusion-free garnet fragments, 30-100 mg, were analyzed. Pb concentrations range from 0.2 to 0.7 ppm and U from 0.1 to 0.5 ppm. Measured 206:204 ratios range from 52.9 to 474.0. These high 206:204 ratios make the garnets potentially useful for radiometric dating.

The Pb compositions were corrected for common Pb using leached potassium-feldspars co-existing with the garnets. Ages[2] of 2636 ± 2, 2640 ± 4, 2645 ± 10 and 2692 ± 3 were obtained (Mezger et al., in press). These ages are similar to the U-Pb ages of 2637 ± 2 and 2695 ± 2 determined on zircons from the same area (Heaman et al., 1986).

The ages, combined with the temperature and pressure information, suggest that these garnets, 2-5 mm in diameter, may have maintained closed system behaviour for U and Pb under upper amphibolite to granulite facies conditions. Thus, these garnets yield not only data on P and T conditions of metamorphism, but also absolute ages of medium to high grade metamorphic events. Age information deduced from garnets are critical for the deduction of quantitative P-T-time paths.

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[2]Ages are in Ma.

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GS-44 Rb-Sr GEOCHRONOLOGY OF THE CHURCHILL-SUPERIOR BOUNDARY ZONE AND THE CROSS LAKE AREA

by G.S. Clark[1]

This geochronology program includes selected samples from the Split Lake block and Thompson open pit within the Churchill-Superior boundary zone, and from Pipestone Lake (Cross Lake area) in the Gods Lake domain of the northern Superior Province. The rock units sampled and the purpose of the investigations are discussed below.

SPLIT LAKE BLOCK

FOX LAKE GRANITE

This is a medium grained, pink and grey granite composed of K-feldspar, plagioclase (oligoclase) and quartz, and subordinate hornblende, biotite and minor 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 its massive nature, this granite is considered to be Early Proterozoic in age, representing the youngest period of granite plutonism in the area (Corkery, 1985a). The purpose of this work is to define the Rb-Sr whole-rock age and determine, from the initial $^{87}Sr^{86}/Sr$ ratio, the probable genesis of the granite melt. The timing of this magmatism may be important for the understanding of the sulphide mineralization in the Thompson belt.

Field work and sampling were completed in June, 1986. A total of twenty-five samples have been processed and the Rb and Sr concentrations determined by X-ray fluorescence spectrometry. Isotopic measurements are in progress. The XRF analyses show that the granite is depleted in alkali elements, with maximum Rb/Sr ratios of about 0.1.

LAYERED HORNBLENDE GNEISS

This layered gneiss unit is considered to be one of the oldest units in the Split Lake block (Corkery, 1985A). It hosts all later intrusive rocks, including Molson dykes and Fox Lake granite. The gneiss has a relict granulite texture and this unit may be equivalent to granulites from the Pikwitonei domain. Sampling was completed in June, 1986. Twenty slabbed samples were obtained from 10 to 30 kg field samples. These have been pulverized and Rb and Sr concentrations determined from XRF analysis. Rb and Sr isotopic analyses are in progress.

THOMPSON OPEN PIT

LAYERED MIGMATITIC GNEISS

This gneiss is a Moak Lake gneiss type (Scoates et al., 1977) and probably represents an Archean granulite which was deformed and migmatized during the Hudsonian orogeny (Weber and Scoates, 1978). It is hoped that the Rb-Sr isotopic systematics will establish these temporal relationships and contribute to our understanding of the precursor of the gneiss.

Pegmatite samples of coarse biotite and K-feldspar have been collected for Rb-Sr mineral ages. As the intrusion of the pegmatite was controlled by late shearing, a minimum age for the shearing should be established.

CROSS LAKE AREA

MOLSON DYKE CONTACT METAMORPHIC ROCKS

Several samples of hornfels were collected from a contact zone of a large Molson dyke on Pipestone Lake (Corkery, 1985b). The samples include spotted and massive hornfels, collected from a single outcrop. Away from the contact zone, the rocks are medium grained, thick bedded, crossbedded metasandstone (Corkery, 1985b). The samples from the contact zone may yield a reset Rb-Sr age corresponding to the time of intrusion of the dyke. These results will be compared to ages for the Molson dyke obtained by other geochronological methods.

PSEUDOTACHYLITE

An attempt will be made to determine a Rb-Sr isochron age on pseudotachylite associated with, and derived from, metasedimentary rocks (metasandstones and metasiltstones). Some pseudotachylite parallels bedding, and some occurs in faults. The age would probably represent a minimum age of the latest faulting in the Cross Lake area. This will be compared to data for the Molson dyke contact metamorphic rocks.

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[1]Department of Geological Sciences, University of Manitoba, Winnipeg.

GS-45 U-Pb ZIRCON GEOCHRONOLOGY OF THE BIG SAND LAKE AREA, NORTHERN MANITOBA

By W. R. Van Schmus[1] and D. C. P. Schledewitz

SUMMARY

U-Pb zircon ages from igneous and meta-igneous units of the Chipewyan Batholith in the Big Sand Lake area, northern Manitoba, show that the main plutonic activity occurred about 1855 ± 10 Ma ago and that the plutons were intruded into crustal rocks about 1875-1880 Ma old. A post-orogenic dyke from the east edge of Reindeer Lake, at Paskwachi Bay, yielded a U-Pb zircon age of 1832 Ma, which indicates that major orogenic events had ceased at that time. The ages obtained for this region are virtually identical with those obtained for the western extension of this crustal domain in Saskatchewan (Van Schmus et al., in press; Lewry et al., in press).

RESULTS

Most of the region is underlain by granitic phases of the Chipewyan Batholith, a coarse, pink, porphyritic phase, a phase with rapakivi texture (unit 16)[2] and a dark, honey-brown, coarse grained phase (unit 12; Fig. GS-45-1, 2), which has been intruded by unit 6 and is therefore older. Zircons from one sample of the main pink phase (MAN84-4) yield a good chord with an upper intercept age of 1857 ± 9 Ma, and zircons from a sample of the rapakivi phase yield virtually the same result: 1854 ± 12 Ma (Fig. GS-45-2). The morphologies and appearance of the zircons, the relative distribution of magnetic fractions, the shift of air abraded points, and the values for the lower intercepts of the chords are all "normal", that is, they are similar to the behavior of zircons from most plutonic units of early Proterozoic age (e.g., Van Schmus et al., in press; Lewry et al., in press). Our zircon age is distinctly older than recent Rb-Sr ages of 1800 to 1815 Ma reported by Clark (1985) for similar units of the Chipewyan Batholith in Manitoba. We interpret the age of 1855 ± 10 Ma to date the time of crystallization of this phase of the batholith.

The dark, "monzogranite" phase (unit 12) of the batholith is intruded by the pink, porphyritic phase. However, zircons from this phase (MAN84-3, MAN84-5) do not behave "normally". In particular, data from a range of magnetic fractions all plot too close together to define a precise chord, as shown in Figure GS-45-3. Only when data from both samples are regressed together does a chord with a reasonable upper intercept result.Even in this case, however, the uncertainties are too large to allow precise interpretation. Thus, we conclude that the dark phase is probably essentially coeval with the pink, porphyritic phase, but we can not rule out the possibility that it is 10 to 20 Ma older.

We also attempted to define the age of a xenolith in the pink, porphyritic phase. Zircons from this sample (MAN84-1) have similar characteristics to those from the dark "monzogranite" in that they plot close to concordia and the chord they define also has a relatively shallow slope (Fig. GS-45-4). However, in this case there is enough spread in the magnetic fractions to define the chord. The upper intercept age on concordia, 1860 ± 17 Ma, is indistinguishable from the age of the host rock. Thus, the zircons from the xenolith do not indicate any substantially older crust in the region; it is not possible to determine from these results whether the xenolith is from a slightly earlier phase of the batholith or from rocks intruded by the batholith.

We separated zircons from a sample of thinly laminated, fine-grained granitic gneiss (unit 9) marginal to the batholith (Fig. GS-45-1). The zircons appear to represent a single population which would be consistent with an igneous protolith for the gneiss (felsic tuff or fine grained granite). The data for this sample define a relatively good chord, although

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[2]For complete legend and description of units see Schledewitz (1983).

TABLE GS-45-1

SUMMARY OF CONCORDIA INTERCEPT AGES

Sample No.: Unit 1		N	P	Model	Age[2] (+ 20)	L.I.
MAN84-1	Xenolith in porph. granite (16)	5	91	1	1860 + 17	1030
MAN84-3	Unit 12 — dark "monzogranite"	4	45	1	1845 + 52	1310
MAN84-4	Unit 16 — Chipewyan porph. granite	5	66	1	1857 + 9	600
MAN84-5	Unit 12 — Dark "monzogranite"	5	78	1	1845 + 180 - 17	1101
MAN84-5 and MAN84-3 combined		9	68	1	1861 + 60	1394
MAN84-6	Unit 9 (?) — felsic gneiss	5	4	2	1878 + 14	591
MAN84-7	Unit 16 — rapakivi phase	5	1	2	1854 + 12	450
MAN84-8	Unit 15 — Qtz diorite, Reindeer L.	4	6	2	1832 + 11	670

NOTES:
N = number of fractions
P = Probability of fit
Model = models of Ludwig (1980, 1983)
L.I. = lower intercept on concordia
Ages are in Ma

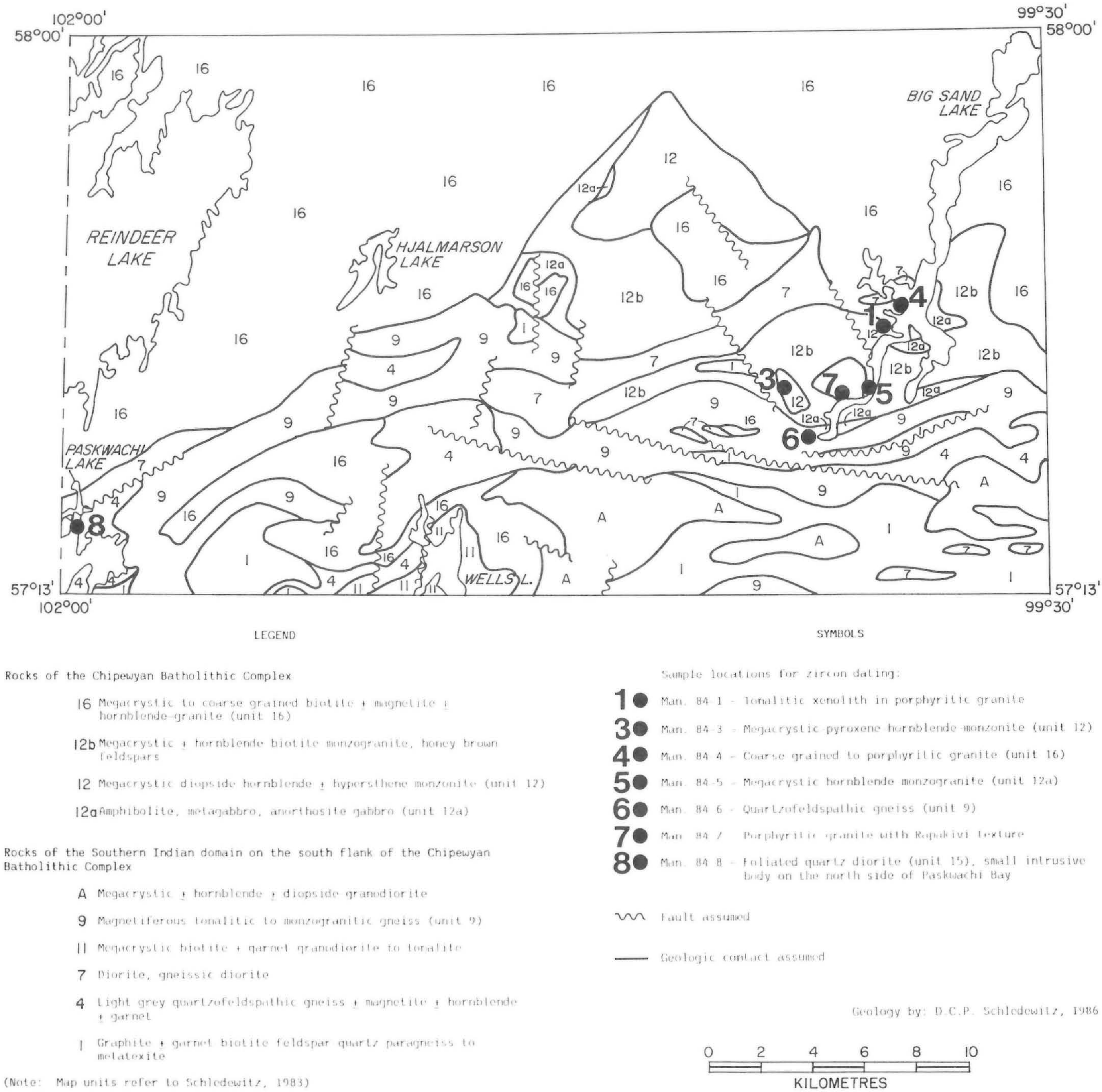

Figure GS-45-1: Generalized geological map of the study area showing the main lithologic units and sample localities. Modified after Schledewitz (1983).

the probability of fit is low and indicates some geologic component to the scatter. The upper intercept age of 1878 ± 14 Ma (Fig. GS-45-5) is not much higher than that for the granites of the batholith, indicating that the host rocks of the batholith are only slightly older. This age is virtually identical to zircon ages of rhyolites in the Rusty Lake belt, and zircon ages of granites in the Lynn Lake belt, 100-150 km to the southwest (Baldwin et al., 1985, in press) and suggests that the crustal rocks hosting the Chipewyan Batholith may be part of the same volcanic-plutonic orogenic suite.

We also report here the results from one sample outside the study area. This sample is a quartz-diorite dyke that intrudes a suite of tonalitic gneiss in the Paskwachi Bay region northwest of Lynn Lake Fig. GS-45-1). This dyke appears to post-date a major period of deformation, and its age of 1832 ± 11 Ma (Fig. GS-45-6) is consistent with this. However, a subsequent event is indicated by the fact that the dyke is deformed and recrystallized.

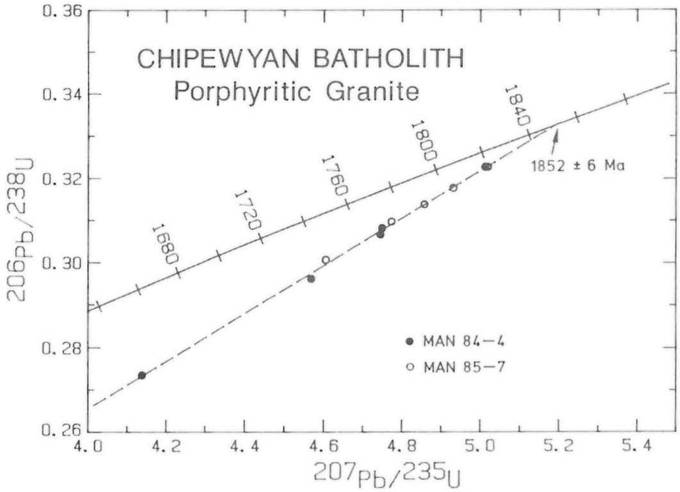

Figure GS-45-2: *U-Pb concordia diagram for zircons from the main granitic phase in the Big Sand Lake area (MAN84-4) and a rapakivi-textured phase of the same unit (MAN84-7). The zircons from MAN84-4 yield an intercept age of 1857 ± 9 Ma and those from MAN85-7 yield an age of 1854 ± 12 Ma. The difference is not considered significant and a mean age of 1855 ± 10 Ma is preferred for this unit.*

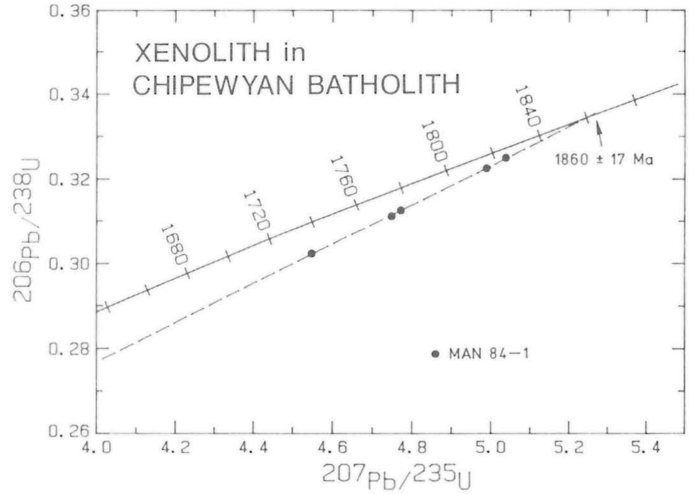

Figure GS-45-4: *U-Pb concordia diagram for zircons from a tonalitic xenolith (MAN84-1) in the coarse grained porphyritic granite of Unit 16. The zircons cluster near concordia but still define a chord with an upper intercept age of 1860 ± 17 Ma, suggesting that the xenolith may be from an earlier, but essentially coeval, phase of the plutonic complex.*

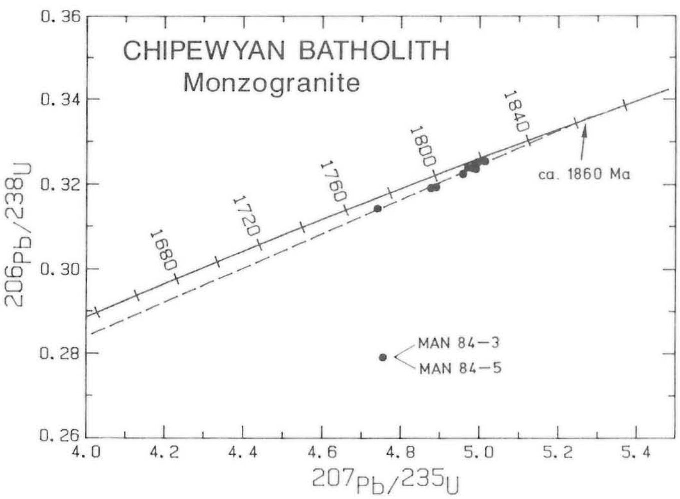

Figure GS-45-3: *U-Pb concordia diagram for zircons from the dark, "monzogranite" phase in the Big Sand Lake area. The zircon behavior is unusual in that fractions of significantly different magnetic susceptibility cluster. The tight clustering prevents definition of a precise line, but the data are consistent with an age of ca. 1860 Ma. See text for further discussion.*

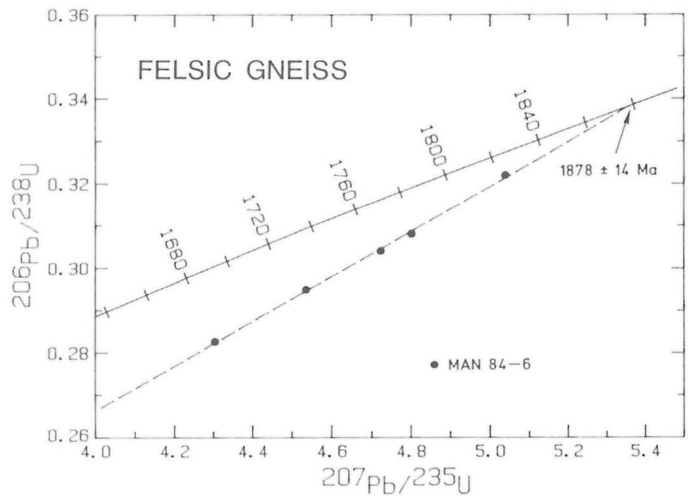

Figure GS-45-5: *U-Pb concordia diagram for zircons from a granitic gneiss marginal to the Chipewyan Batholith in the Big Sand Lake area. The upper intercept age of 1878 ± 14 Ma indicates that some of the host rocks for the batholith are only slightly older than the batholith itself.*

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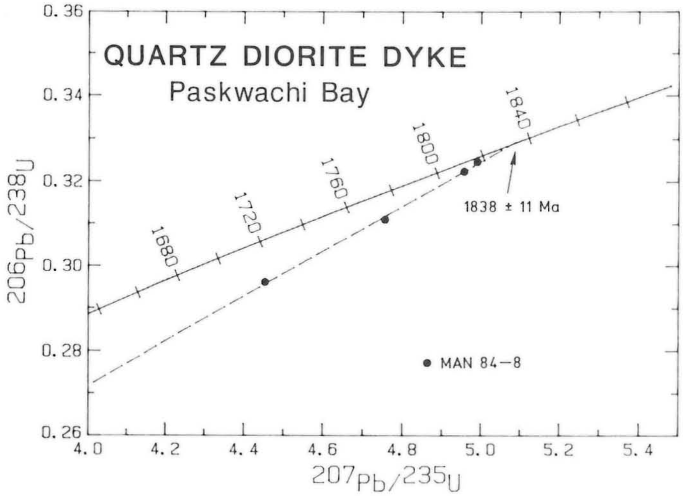

Figure GS-45-6: *U-Pb concordia diagram for zircons from a quartz diorite dyke near Paskwachi Bay, 125 km west of the study area. The age of 1832 ± 11 Ma indicates that this dyke is related to latter stages of plutonism in the general region.*

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MINES BRANCH

EXPLORATION SERVICES AND AGGREGATE RESOURCES

ES-1 MANITOBA'S PRECAMBRIAN DRILL CORE COLLECTION PROGRAM

by J.K. Filo and P.J. Doyle

INTRODUCTION AND HISTORY

Prior to 1970 the Mines Branch collected drill core as an aid to specific research projects. This early core was stored at the University of Manitoba.

In the early 1970s a small-scale core collection program was started to assist exploration companies and prospectors across the province. This small program has evolved into the present day Precambrian Core Library System.

The 1970s program was the responsibility of the Resident Geologist in The Pas. Core sheds were built in The Pas (1972), Thompson (1973) and Lynn Lake (1974). In Winnipeg, part of the Geological Services Branch rock laboratory was allocated for core storage in 1980.

Between 1971 and 1977, B. Esposito (1971-74) and R. Gonzalez (1975-77) collected 72 600 metres of core. The Resident Geologist position in The Pas was discontinued in 1977. From 1978 to 1982, 16 067 metres of core were collected periodically by various members of the Department (Mining Recorder, Claims Inspector, Geologists, etc.) and also delivered by various exploration companies. During the 1970s emphasis was given to core collection; however, because of limited staff and resources comprehensive cataloguing 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 that were achieved through the Thompson Job Creation Program early in the year, the work completed by departmental staff over the summer field season and selected core retrievals completed throughout the year. Most of the effort was directed toward the libraries in Lynn Lake and The Pas which underwent major reorganizations. Core racking and inventory procedures were standardized but much of the individual box relabelling was not completed. Twelve core retrievals were completed during 1983 which resulted in the addition of 24 329 metres of core to the provincial 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 108 049 metres. In 1984, twenty core collection projects were undertaken which resulted in the addition of 26 169 metres of core.

The 1985 program had two specific objectives. The first of these was the reorganization, relabelling and initiation of selected reduction of

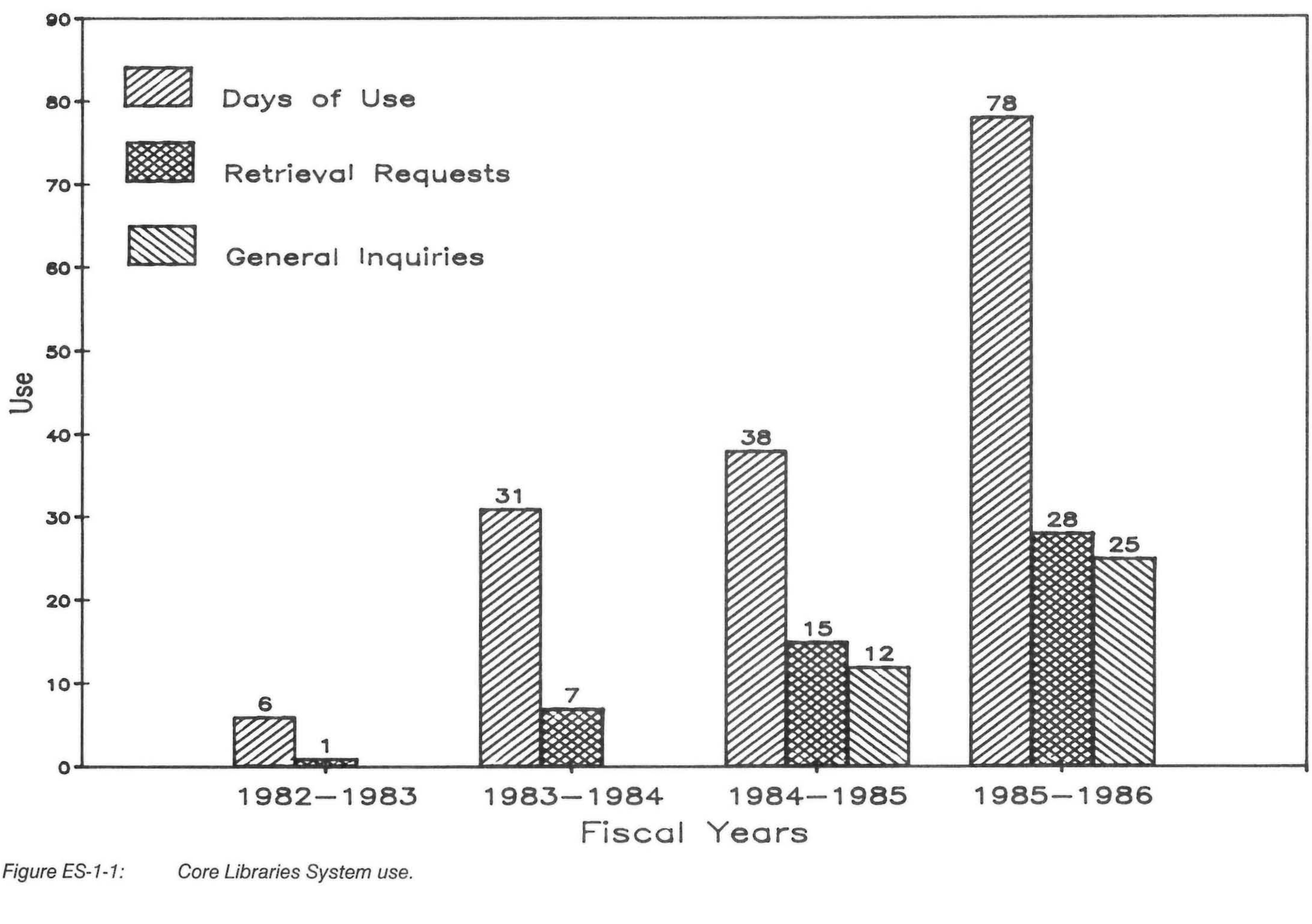


Figure ES-1-1: Core Libraries System use.

Figure ES-1-2: *Core rack construction — Thompson, June 1986.*

specific holdings. The second objective was to compile a master file system by hole and project, which would include drill logs, collar locations and other pertinent information for all the core stored in the library system as a prelude to computerization.

During both 1984 and 1985 significant increases in requests for service and library utilization were recorded (Fig. ES-1-1).

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 on-site 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.

1986 PROGRAM

During 1986, a series of ongoing retrieval projects were completed and work on the master file system was continued. The primary objective of the summer field program was to make optimum use of the limited space available in the three northern libraries. The program consisted of outside core rack construction, building renovation, core reduction, inventory reorganization, an update of library inventory records and core box labelling using new computer generated tags.

In Thompson, new storage capacity of 30 413 metres was created by the construction of four new racks, three of which were erected inside the Geological Services Branch warehouse and one in an outside compound between the buildings. The long term storage capacity of the Thompson facility was further increased by selective core reduction. A total of 4,782 boxes or 29 151 metres of core were reduced. The reduction and consolidation of the Thompson inventory required the handling of 27,805 boxes (Fig. ES-1-2).

At Lynn Lake, the construction of two outside racks expanded the library capacity by 31% or 18 507 metres. Manitoba Highways and Transportation, with the assistance of several local contractors, completed a program of drainage improvements, site grading and general site cleanup. Summer staff painted the building, reorganized the inventory and selectively reduced the holdings by 141 boxes or 860 metres (Fig. ES-1-3).

At The Pas library, 9,478 boxes were handled during core reduction and inventory reorganization activities. Selective reductions from the inventory resulted in the removal of 2,826 boxes or 17 227 metres.

Computer-generated core box labelling was implemented in 1986. This concept was introduced to reduce the time and effort associated with manual tagging using a tapewriter. As of September 1986, 4,630 boxes have been labelled with the new tags.

Figure ES-1-3: *Lynn Lake Core Library — August 1986.*

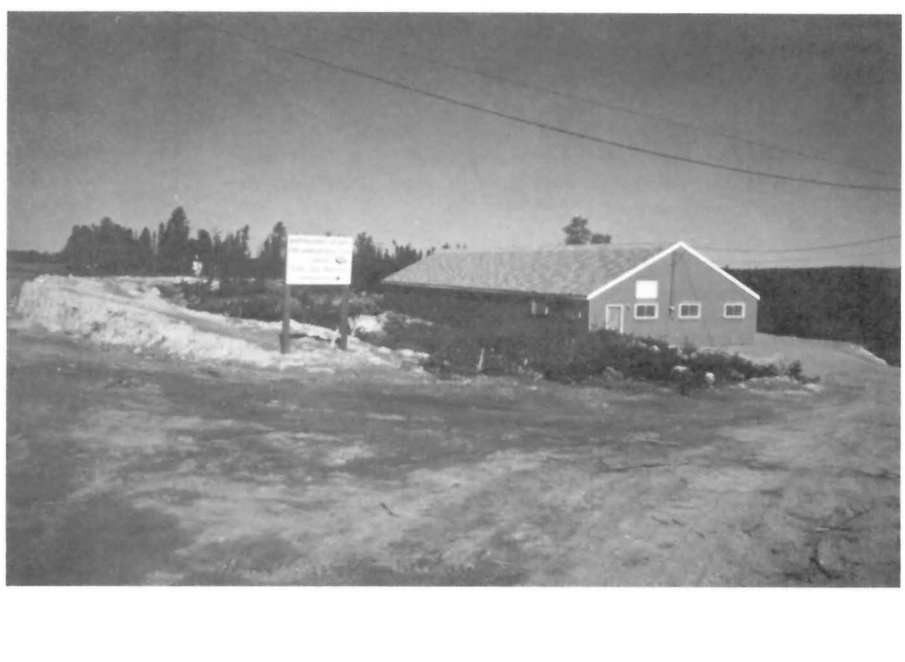


Figure ES-1-4: *Core retrieval — Oxford Lake, June 1986.*

With the high level of exploration activity continuing in the province, drill core staff compiled 529 person-days of field work. As of September 1, 1986, seven industry requests for collections have been completed resulting in the addition of 4 322 metres of core to the provincial storage system. Library use for the current fiscal year was 71 days during 12 visits (Fig. ES-1-4).

PRESENT HOLDINGS IN CORE LIBRARIES

The four libraries currently hold 169 285 metres of core.

(A) The Pas Library

This library, located in the Natural Resources Compound at Grace Lake, contains 71 323 metres of core collected from the Flin Flon-Snow Lake district. The present facility has an estimated capacity of 164 153 metres and is currently 43% full.

Current holdings include:

Dome Exploration: 1 project, 25 holes, 3 024 metres
Espina Copper: 2 projects, 36 holes, 1 585 metres
Granges Exploration: 33 projects, 344 holes, 17 044 metres
Hudson Bay Exploration: 40 projects, 222 holes, 20 280 metres
Manitoba Mineral Resources: 12 projects, 82 holes, 7 114 metres
Maverick Mountain Resources: 1 project, 110 holes, 10 284 metres

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) Lynn Lake Library (Fig. ES-1-5)

This building, situated on Eldon Lake near Parsons Airways floatplane base, houses 44 335 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 the facility is 77 468 metres. The volume of core stored currently occupies 57% of the total storage capacity of this facility.

Current holdings include:

BP-Selco: 1 project, 17 holes, 1 457 metres
Falconbridge Exploration: 2 projects, 8 holes, 847 metres
Granges Exploration: 9 projects, 140 holes, 11 107 metres
Hudson Bay Exploration: 7 projects, 60 holes, 4 584 metres

Manitoba Mineral Resources: 17 projects, 199 holes, 15 636 metres
S.M.D.C.: 12 projects, 44 holes, 4 285 metres
Sherritt Gordon Mines: 4 projects, 9 holes, 2 012 metres

Cyprus Exploration, Denison Mines, Gigantes Exploration, Keevil Mining Group, Knobby Lake Mines, McIntyre Mines, Rock Ore Exploration, Shell Canada Resources, and Yukon Antimony.

(C) Thompson Library (Fig. ES-1-6)

This library facility is located at the Burntwood River floatplane base. It has a capacity of 59 204 metres and with a current inventory of 27 987 metres of core is 47% full.

Current holdings include:

BP-Selco: 1 project, 7 holes, 1 728 metres
Canamax Resources: 27 projects, 202 holes, 11 869 metres
Cominco: 3 projects, 23 holes, 3 328 metres
Falconbridge Exploration: 3 projects, 14 holes, 2 573 metres
Granges Exploration: 3 projects, 8 holes, 3 085 metres
Hudson Bay Exploration: 2 projects, 6 holes, 2 067 metres
Nor-Acme Gold Mines: 1 project, 13 holes, 1 024 metres
Rio Algom Exploration: 1 project, 5 holes, 732 metres

Inco, Manitoba Hydro, and Nufort Resources.

(D) Winnipeg

The Winnipeg facility has no racked storage at present. Efforts are being made to alleviate this situation. The present inventory of 25 640 metres of core is piled neatly on pallets in an outside storage compound at the Brady Road site.

Current holdings include:

BP-Selco: 2 projects, 15 holes, 1 811 metres
Brinco: 1 project, 16 holes, 829 metres
Dumbarton Mines: 4 projects, 59 holes, 5 401 metres
Esso Minerals: 5 projects, 43 holes, 2 219 metres
Falconbridge Exploration: 5 projects, 44 holes, 6 120 metres
Manitoba Mineral Resources: 5 projects, 51 holes, 2 274 metres
Maskwa Nickel Chrome Mines: 2 projects, 11 holes, 695 metres

J. Donner, Exploration Operations Branch, Footloose Resources, S. Lesavage, Neepawa Iron Mines, Schmirf Exploration, 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:

P. Doyle, Special Projects Geologist
or
B. Esposito, Assessment Geologist
Exploration Services Section
Manitoba Energy and Mines
555 — 330 Graham Avenue
Winnipeg, Manitoba R3C 4E3
Phone: (204) 945-8204, 945-6535

Arrangements will then be made with appropriate local Government representatives who have keys to the northern 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

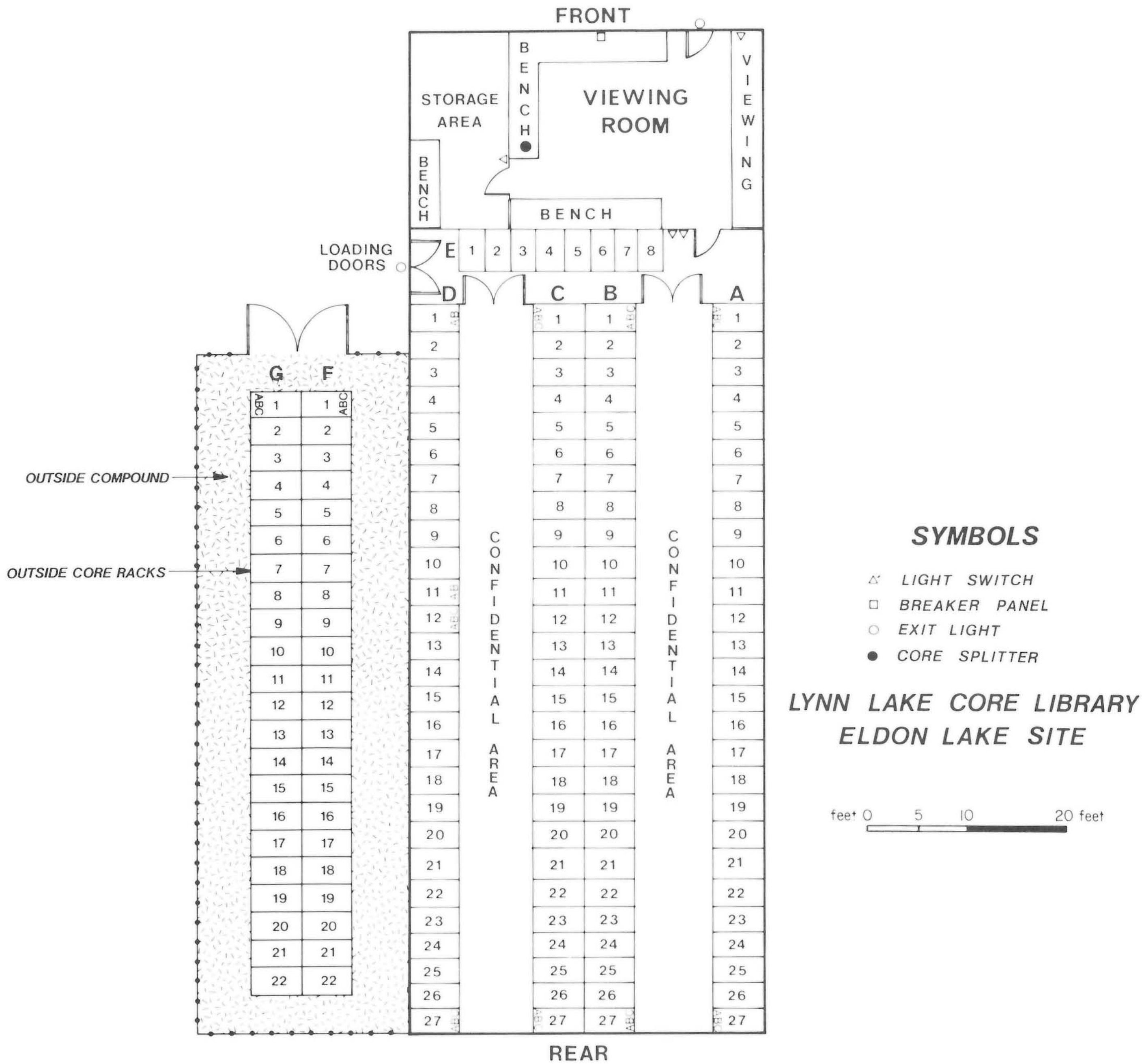


Figure ES-1-5: Lynn Lake Library floor plan.

Lynn Lake: Conservation Officer
Manitoba Natural Resources
675 Halstead Street
Lynn Lake, Manitoba ROB OWO
Phone: (204) 356-2413

Thompson: H. Schumacher or W. Comaskey
Manitoba Environment & 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 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 Special Projects 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 Winnipeg office staff. When sampling is carried out the assay results and pulps, if requested, must be forwarded to the Special Projects Core 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.

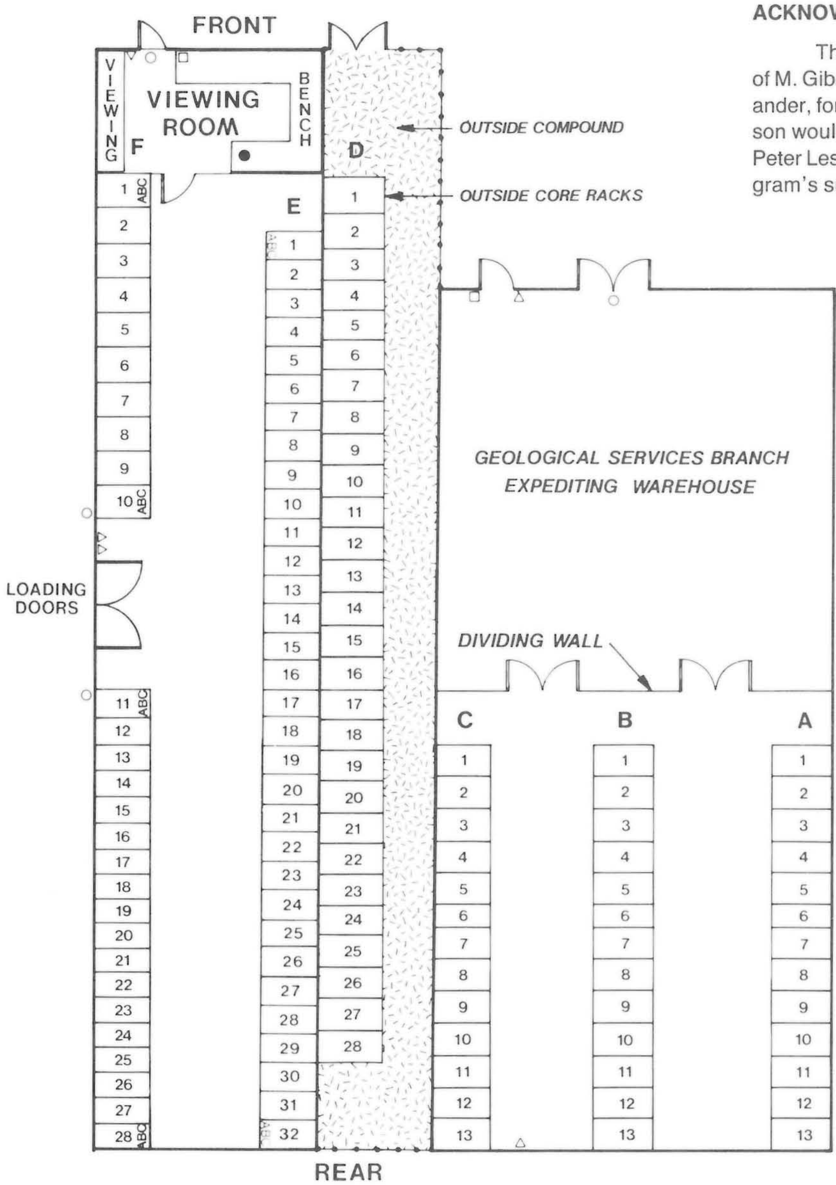
Local representatives will not give out door keys to users of core libraries. In special cases involving major inspections the Winnipeg-based staff will travel to the northern facility to assist the user.

Drill logs and plans as well as other open file assessment data are available for inspection in the Winnipeg office.

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 office.

ACKNOWLEDGEMENTS

The authors of this report wish to acknowledge the contributions of M. Gibbons, D. Meek, L. Norquay, G. Harris, C. Donnelly, and G. Alexander, for without their conscientious and diligent work the 1986 field season would not have been a success. The efforts by Anne Harasym and Peter Leskiw as office backup to the field operation contributed to the program's success.



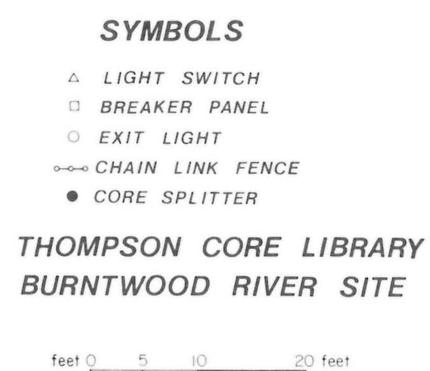


Figure ES-1-6: Thompson Library floor plan.

ES-2 COMPILATION, PROMOTION AND EXPLORATION SERVICES (MDA PROJECT 5.9)

by J.D. Bamburak, D.J. Richardson and P.D. Leskiw

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 implementation of a Bibliography of Manitoba Geology compilation project; reactivation of the Manitoba Mineral Inventory project; and significant improvement in the quality of displays and brochures.

COMPILATION

1. BIBLIOGRAPHY OF MANITOBA GEOLOGY

The bibliographic compilation project began in April 1985 and by November a draft containing 630 bibliographic citations from Departmental publications was available for viewing. A demonstration of computerized bibliographic retrievals by author and keywords was carried out at the Annual Meeting with Industry.

Bibliographic citations for all material published by the Geological Survey of Canada on Manitoba was started in January 1986. Open File Report OF86-1 "Bibliography of Manitoba Geology" (containing 3,600 citations from both Provincial and Federal sources in alphabetical order by author) was published in October 1986. Also, a demonstration of a Storage and Information Retrieval System (STAIRS) using the bibliography should be available for viewing at this year's Annual Meeting with Industry and at the Exploration Services counter in Room 540 — 330 Graham Avenue (Eaton Place).

During 1987, entries from periodical literature and theses will be added to the database. A second phase to the STAIRS database is planned for the latter part of 1987 which will permit on-line or hardcopy print-outs by author, year, NTS (National Topographic System) and/or by a subject keyword index.

2. MANITOBA MINERAL INVENTORY

A total of 103 mineral inventory cards of gold deposits and occurrences were updated during the period September 1985 to December 1985 bringing the total number of updated inventory cards to 166. Inventory file "Gold Mineral Inventory Update of the Rice Lake Greenstone Belt" was released on March 20, 1986. A complete inventory of Manitoba's gold deposits and occurrences is planned for release by March 1987. Mineral inventory cards describing base metal deposits and occurrences will be updated in the latter part of 1987.

From January to August 1986 staff of the Exploration Services Section and the Geological Services Branch worked jointly on publication ER86-1 "Gold in Manitoba". Work on the report was initiated in response to increased levels of gold exploration in the Province and the need for a general reference for Manitoba's gold deposits and occurrences. The "Gold in Manitoba" report will summarize: the history of gold exploration and production; the regional geology of Manitoba's gold districts; and detailed geology of former gold producers, deposits and occurrences. Publication of the report is planned for March 1987.

3. ASSESSMENT REPORT INDEX MAPS

Approximately 600 map mylars showing coverage of all assessment reports at a scale of 1:31 680 are stored in Exploration Services for reproduction or overlaying on Mining Recording's claim maps. Five-digit accession numbers within former mineral disposition outlines are shown on the maps; these numbers are cross-referenced in the new "Index to Non-confidential Assessment Reports" (OF86-5) by NTS Area, Holder and Claim Names. During the summer 144 of these mylars were updated using information contained in assessment reports recently transferred to non-confidential status. The update was carried out by a STEP student employed under the "Shad Valley" program.

Figure ES-2-1: Peter Leskiw at work on computerized bibliographic retrievals at 1985 Annual Meeting with Industry.

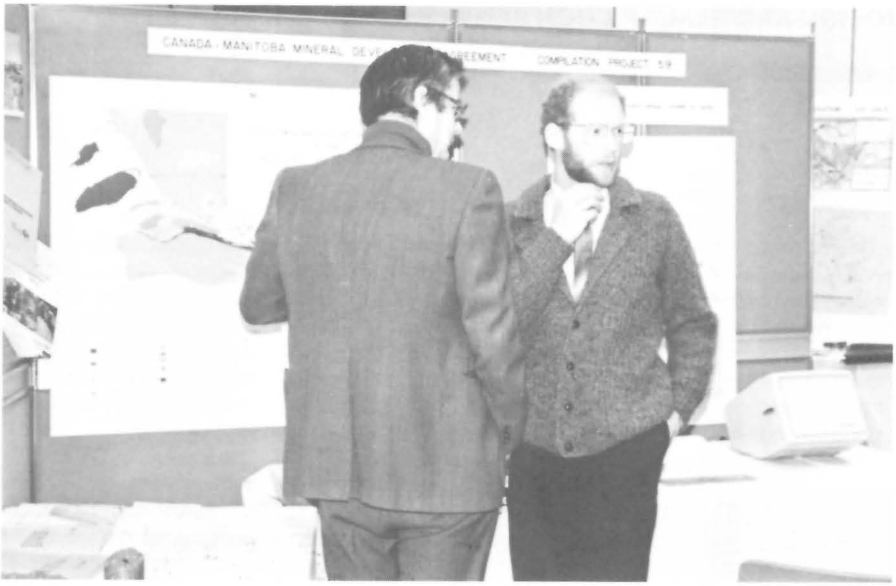


Figure ES-2-2: *Jack Richardson (right) in conversation with Erwin Hamilton at 1985 Annual Meeting with Industry.*

4. INDEX MAP SERIES

The Section stores and maintains sixteen 1:1 000 000 scale mylars portraying several different types of data. Nine mylars show outlines of permits and former exploration reservations and airborne permits. Six mylars outline map areas of geoscientific publications; during the summer two of these, showing outlines of final and preliminary publications, were updated.

PROMOTION

1. MONITORING EXPLORATION

During 1985-86, Exploration Services staff undertook 30 field trips; 87 person-days (excluding the drill core program); were spent in the field and 250 contacts were made with exploration personnel in on-going liaison and monitoring of exploration activity. From April to August 1986, an additional 44.5 person-days were spent in the field.

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. Three other events were: the Winnipeg Careers Symposium in February (a joint display with The Mining Association of Manitoba); Brandon Careers Symposium in March; and Brandon Science Fair in April.

3. ARTICLES

Staff wrote several articles describing the activities of exploration companies in the Province, including an annual review, "Mining Exploration in Manitoba 1985".

"Copper and Zinc in Manitoba", an educational publication, was updated. "Peering Beneath the Cover Rocks in Manitoba" was printed in the May 1986 issue of the Canadian Mining Journal and "Drill Core Collection and Storage Systems in Canada" in the Provincial Geologists Journal, 1985.

Figure ES-2-3: *Ifti Hosain (left) with Peter Doyle at Manitoba Energy and Mines' display at Prospectors and Developers Convention in Toronto, March 1986.*

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

The Section distributes free copies of the following bilingual booklets:

a. "Canada-Manitoba Mineral Development Agreement";
b. "Canada-Manitoba Mineral Development Agreement, First Annual Report 1984-85";
c. "Manitoba's Precambrian Drill Core Libraries Program";
d. "Developing Manitoba's Mineral Resources"; and
e. "Basal Till Investigation, Tracing Minerals Back to Bedrock."

Open File Reports (OF85-4, 85-5, 85-8, 85-11 and 86-2) and the first Bedrock Geology Compilation Map (64B), 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 1985-86" (Open File Report OF86-4) was released in August 1986. 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, 1986, and outlines projects scheduled for implementation during 1986-87.

During July and August the function of distributing Minerals Division publications was assisted to a great extent by a volunteer supplied under the "Manitoba Youth Volunteers in Government" program.

2. BROCHURES

The following brochures were revised in November 1985 and March 1986:

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 1986 a revised "Mineral and Exploration Services in Manitoba" brochure was released at the Prospectors and Developers Convention in Toronto.

AR-1 AGGREGATE RESOURCES IN THE LOCAL GOVERNMENT DISTRICT OF PARK (NORTH)

by M. Mihychuk

INTRODUCTION

An aggregate resources inventory was conducted in the Local Government District of Park (north) with the objective of determining location, quality and reserves of aggregate for resource management and land-use planning. Aggregate resources, including deposit quality and surficial geology, are shown on Preliminary Map 1986-PK, at a scale of 1:50 000 accompanying this report.

The study area is located west of Duck Mountain Provincial Park and comprises townships 29 and 30, ranges 28, 29A and 29 west of the Principal Meridian, bordering on Saskatchewan to the west (Fig. AR-1-1).

GENERAL GEOLOGY

The study area is within the Saskatchewan Plains, in the Duck Mountain upland physiographic region (Klassen, 1979). Upper Cretaceous shales of the Riding Mountain Formation underlie the study area, with up to 300 m of drift covering the bedrock surface.

The glacial geology has been mapped at a scale of 1:250 000 by Klassen (1979). The Zelena Formation, stratigraphically the youngest till unit, is widespread in the western and south central portions of the area. Till outcrops on the highlands and laminated silt and sand in the lower areas. This lacustrine sediment occurs in the northeast, blanketing the rolling topography, including the highest elevations of 677 m asl. Outwash sediments, primarily sand and gravel, are associated with meltwater channels, which dissect the area. Eskers, primarily sand, are relatively small and are associated with outwash systems. The Little Boggy Creek spillway channel joins the Shell River spillway in the centre of the study area. These channels dominate the landscape and provide the major source of aggregate materials.

METHODS

An extended method of grain size analysis was employed in the field for the coarse aggregate component, in the 8 cm (3 in.) to 2 cm (5/8 in.) range, to obtain reliable information on the coarser spectrum of grain size, which is a prime component of many end use products such as road base or concrete. The method avoids the difficulties of processing very large samples (see ASTM specifications, Table AR-1-1).

Depending on the coarseness of the deposit, a 50-150 kg sample was passed through 8, 4 and 2 cm screens (Fig. AR-1-2) with material coarser than 8 cm being disregarded. The total weight and the weight of each sieved fraction were recorded; a subsample of approximately 2 kg of the material passing 2 cm was retained for completion of the grain size analysis by conventional sieving methods.

Material coarser than 8 cm is too large to be sieved practically; however, an estimate of its content is required for evaluation of a deposit, as 8-16 cm material can be processed with a secondary crusher and coarser material can be processed through a primary crusher.

A point count method was used to measure the coarser material consisting of cobbles (8-16 cm) and clasts (16-32 cm). The number of stones within a 1 m² area were counted. As many as 11 one metre squares were counted at a single exposure, depending on the variability of the deposit.

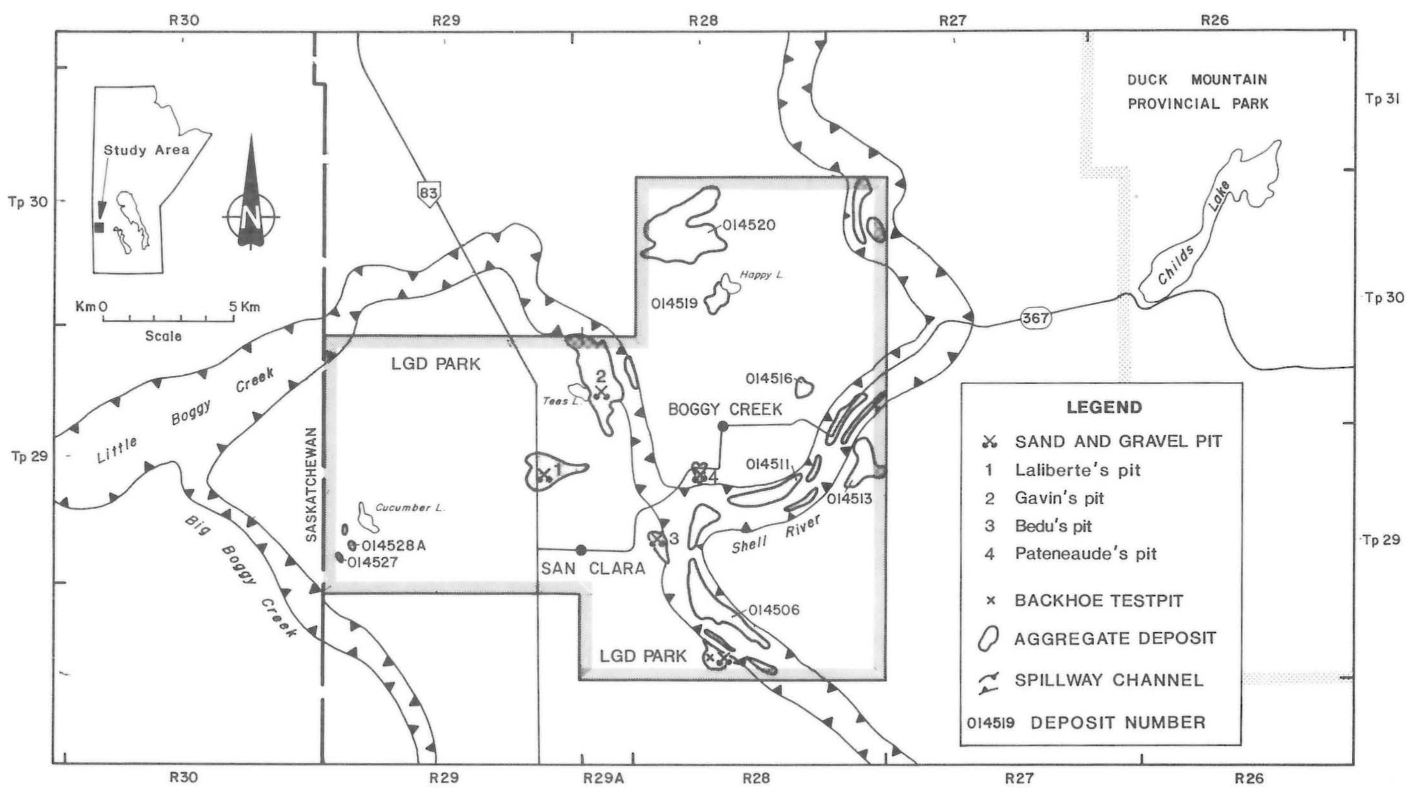


Figure AR-1-1: Location map and major deposits in the LGD of Park (north).

TABLE AR-1-1
SAMPLE SIZE FOR COARSE GRAIN SIZES IN AGGREGATES

Maximum Nominal Size of Aggregates	Approximate Minimum Mass of Field Samples, lb (kg)
Fine Aggregate	
No. 8 (2.36 mm)	25 (10)
No. 4 (4.75 mm)	25 (15)
Coarse Aggregate	
3/8 in. (9.5 mm)	25 (10)
1/2 in. (12.5 mm)	35 (15)
3/4 in. (19.0 mm)	35 (25)
1 in. (25.0 mm)	110 (50)
1 1/2 in. (38.1 mm)	165 (75)
2 in. (50 mm)	220 (100)
2 1/2 in. (63 mm)	275 (125)
3 in. (75 mm)	330 (150)
3 1/2 in. (90 mm)	385 (175)

from ASTM specification D75-71

Pebble counts, where the lithology is identified, were conducted on approximately 100 clasts, in the 2 to 4 cm range. This size was chosen as it is a major component of most end use products, such as road base; its composition directly affects the quality of the aggregate.

Pebbles were separated into 3 major groups: sedimentary lithologies including shale and carbonates; intrusive and metamorphic lithologies, primarily granites and some gneisses; and volcanic lithologies, generally dark coloured tuffs. The deleterious components were also separated into 3 groups: chert, ironstone, shale and weathered pebbles.

AGGREGATE RESOURCES

The LGD of Park (north) has an abundant supply of aggregate material, with 28 deposits identified (Fig. AR-1-1). Mining of the sand and gravel has been widespread with 12 active pits (mined within 5 years), 10 inactive sand and gravel pits and 5 localities where extraction is taking place along the road allowance.

CUCUMBER LAKE DEPOSITS

Three small deposits were identified 8.8 km west of Highway 83 near the Saskatchewan border. Aggregate deposits had not previously been identified in the township (29-29W). Morphologically, the deposits appear to be either a dissected esker or individual kames. The material is variable: deposit 014528A is sandy fine pebble gravel, whereas deposit 014527 is coarse pebble gravel. These deposits are 1.5-3.0 m in thickness.

LA LIBERTE PIT DEPOSIT

Located 3.2 km north of San Clara on Highway 83, this deposit was first mined in the 1950s and was used during the winter of 1985 for sanding purposes. There is 2.5 m of very sandy fine pebble gravel exposed in La Liberte's pit (NW13-29-29W). The material is too fine to be considered high quality; however, due to its prime location, the deposit is extensively mined with extraction of material from the road allowance occurring between sections 13 and 24, 29-29W. A small inactive pit in SE24-29-29W exposes coarse pebble gravel, material considerably coarser than the rest of the deposit.

SPILLWAY ASSOCIATED OUTWASH TRAINS

Outwash deposits on the margins of spillways have been identified along the Assiniboine, Shell and Boggy Creek spillway systems (Groom, 1985; Underwood McLellan, 1985). In the LGD OF Park (north), three deposits, 014525, 014510 and 014503, are on the west flank of the spillways and are the major source of production. Deposits west of the spillway valleys are in high demand because the material does not have to be transported through the valley.

Gavin's pit, NW1-30-29AW, in the Tees Lake deposit (014525) consists of 3.0 m of coarse pebble gravel, in cross-stratified well sorted beds. Screening of the stone coarser than 3.2 cm (1¼ in.) has resulted in several stockpiles of the material; it has not been crushed. The deposit extends north and south, with large undeveloped reserves that will be able to accommodate long-term mining.

Figure AR-1-2: Equipment including scale and sieves utilized in coarse aggregate field sieving.

Deposit 014510 has limited potential because reserves are nearing depletion. Bedu's pit 3.2 km east of San Clara is the largest sand and gravel pit in the LGD. Extraction of coarse pebble gravel is ongoing from the south face of the pit. The aggregate in the north and west portions of the deposit is generally depleted. Deleterious components include less than 0.5% shale; this is the only occurrence of shale observed in the study area.

The third deposit (014503), located in sections 4 and 5-29-28W, is composed of sandy fine pebble gravel. A pit was opened during the past summer and there has been local roadside excavation in two localities. Thickness varies in the deposit; in backhoe test pit PJ107 more than 5 m of fine pebble gravel was encounted, whereas in the pit the deposit thins to 1.5 m.

SPILLWAY TERRACES

Fourteen deposits occur in Little Boggy Creek and Shell River spillways. A limited amount of mining has occurred only in the Shell River spillway. The restricted mining activities appear to be the result of the marginal quality of the material and the difficulties of haulage up the steep grades of the valley side. In terms of development, deposit 014511 has the greatest potential, followed by deposit 014506, although the material in the latter deposit is very coarse and will require extensive screening and crushing to make effective utilization of the resource.

BOGGY CREEK AREA

Northeast of the spillway are 4 outwash deposits, all being mined to some degree. Deposit 014518 is located 2.4 km southwest of the village of Boggy Creek on the Childs Lake road, P.R. 367. Prime location and texture of the gravel has resulted in extensive use of the deposit. One large pit, known locally as Pateneaude's pit (NW29-29-28W), is active, and two smaller pits have been depleted. Mineable reserves extend southward.

The Happy Lake deposit (014519), 4.8 km north of Boggy Creek, has two pits, one inactive (NE17-39-28W) and one active (NW16-30-28W). Cobbly pebble gravel is exposed in the 2.5 m pit face at PK010. Screening of the 4 cm material is ongoing and has resulted in large amounts of this coarser material being left as waste.

Deposit 014516, located in SW11-30-28W, is similar to the Happy Lake deposit. Coarse material is being screened. This deposit (producing large piles of material considered generally deleterious) appears to be considerably less extensive than Happy Lake.

The Call of the Wild deposit, named after the Boggy Creek festival, is located in sections 29, 30 and 32-30-28W. Due to its adverse location, this deposit (014520) has had very limited mining, even though it has the potential of supplying large amounts of aggregate.

The Henderson deposit (014513) is the only other significant aggregate deposit. Two pits occur in the deposit, PK118 and a large pit east of the boundary road in the Duck Mountain forest reserve (not shown on the map). The deposit contains over 5 m of cobbly pebble gravel; however, its location has resulted in very limited usage.

Several unexploited small deposits occur related to meltwater channels occur in the study area.

CONCLUSIONS

A new method of measuring coarse aggregate that can be integrated with traditional sieving procedures was utilized, and appears to be functional.

The LGD of Park (north) contains large quantities of high quality aggregate that can fulfill local and probably regional needs for the near future. However, material that requires no processing, i.e. screening or crushing, is of limited supply and local mining methods will probably have to be modified.

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AR-2 AGGREGATE RESOURCES IN THE FLIN FLON-CRANBERRY PORTAGE AREA

by Heather Groom

INTRODUCTION

An aggregate resource inventory was carried out in the Flin Flon-Cranberry Portage area to provide a data base for future road construction and land-use planning. The survey covered eight 1:50 000 map sheets (63K/9 to 14 and 63N/2 and 3) and was limited to deposits accessible by road, forestry trail and rail line. Preliminary maps and gravel quality data will be available from the Mines Branch in early 1987.

Regional till sampling was also undertaken as part of a program in conjunction with E. Nielsen (Geological Services Branch) to outline the Quaternary history of The Pas-Flin Flon area. Ninety-two samples were collected. The less than 2 micron fraction of the till matrix will be analyzed for base metals. Selected samples will be analyzed for their carbonate content, pebble composition and grain size distribution.

BEDROCK GEOLOGY

The area is underlain by Ordovician carbonate bedrock in the south and Precambrian granitic, volcanic and metamorphic rocks in the north (Manitoba Mineral Resources Division, 1980). The edge of the Paleozoic is an irregular east-trending boundary lying at approximately 54°35'N latitude. Carbonate outliers are found north of this line.

Bedrock outcrops are abundant, particularly in the north. Surficial deposits are generally thin where overlying bedrock and thicker between and in the lee of bedrock knolls.

QUATERNARY GEOLOGY

Striation measurements in the northern part of the area are between 190° and 205° in the west and between 205° and 220° in the east. In the south, striae trend between 215° and 235°; in this area, cross-cutting relationships indicate the southwesterly ice flow was followed by westerly ice flow towards 265° (Fig. AR-2-1).

The till deposited on Precambrian bedrock is grey brown and has a sandy matrix. The till deposits are generally less than 2 m thick and are found on the lee side of bedrock knolls. With the exception of the extreme eastern part of the area, the northern tills do not contain carbonate erratics. However, isolated carbonate boulders are present at several sites up to 30 km north of the carbonate/Precambrian bedrock contact. As carbonate is absent in the tills in this area, the origin of these boulders is problematic.

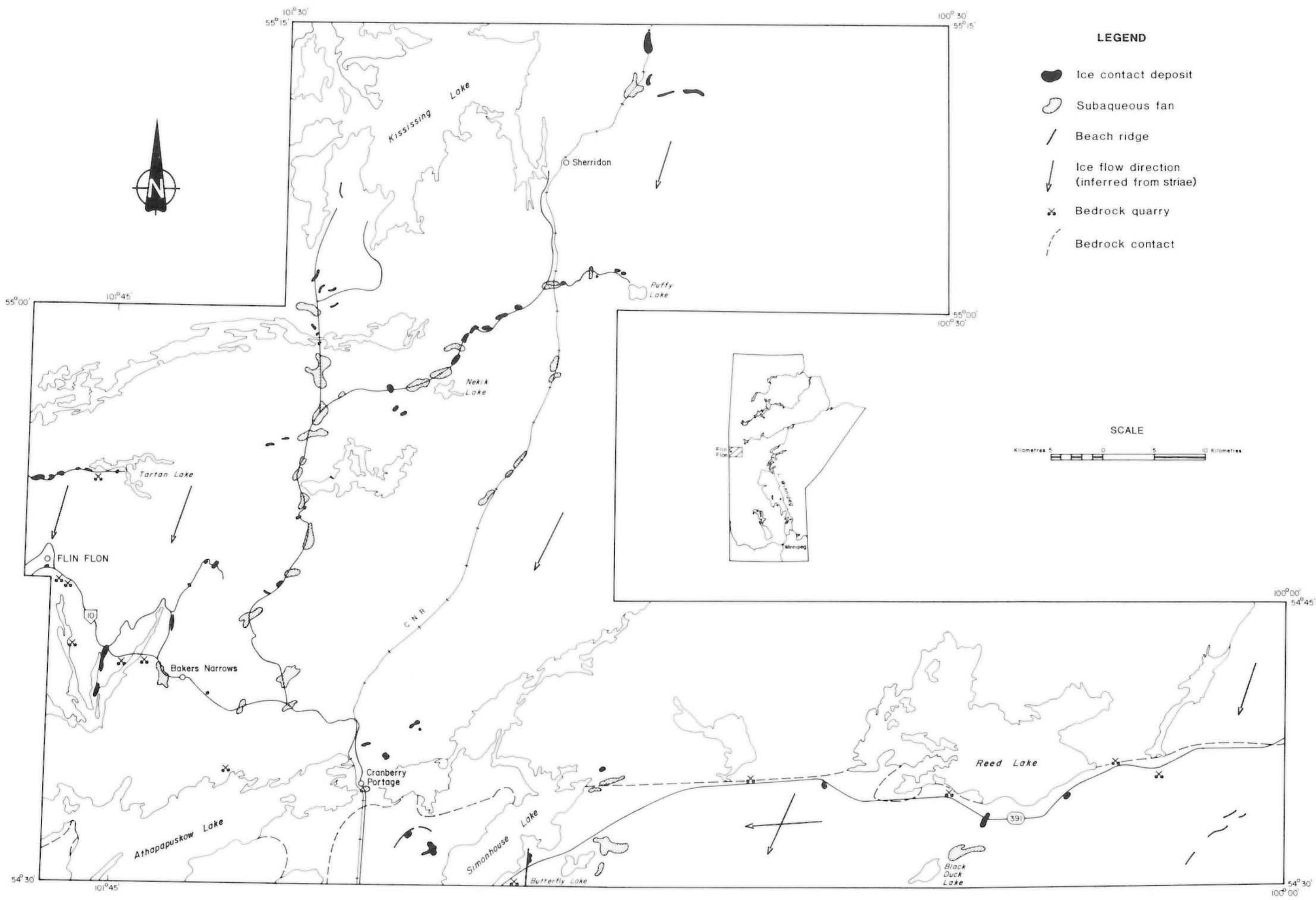

Figure AR-2-1: Location map of Flin Flon-Cranberry Portage area showing aggregate deposits, ice flow directions and bedrock quarries.

Figure AR-2-2: Ice contact deposit along Tartan Lake road (Sec. 3-68-29W).

In the western part of the area, the sandy till gradually becomes more calcareous and silty southwards from the Paleozoic contact. In the east, the transition from non-calcareous to calcareous till is more abrupt. Immediately south of the contact the till is characterized by sandy matrix and a clast content dominated by very angular carbonate cobbles and boulders.

Several outcrops of a silty, calcareous till occur also in the southeastern part of the area. This till is thought to be associated with the younger, westerly ice flow although stratigraphic evidence is lacking.

Lake Agassiz stood at the ice front during deglaciation. Subaqueous outwash fans, consisting of proximal gravels overlain by distal sands, mark ice frontal positions as the glacier retreated from the area. The crossbedded sand of the outwash fans is generally overlain by less than a metre of coarser grained, massive sand of lacustrine origin. The two sand units are locally separated by a thin unit of lag gravel.

Lake Agassiz beach ridges are notably absent and there are only two well developed beach deposits, both marking the 305 m lake level. Outcrops of Lake Agassiz silt and clay are scarce and rhythmically bedded lake clay was found at only one location.

AGGREGATE RESOURCES

There are four main sources of aggregate in the Flin Flon-Cranberry Portage area. Bedrock quarries supply crushed stone; sand and gravel reserves are found in ice contact deposits, subaqueous outwash fans and beach ridge deposits.

ICE CONTACT DEPOSITS

The ice contact deposits formed by meltwater flowing into cavities in the glacial ice that developed in the lee of bedrock obstructions. As a result, the deposits are of variable depth, depending on the configuration of the bedrock knoll they are deposited against, and are of limited areal extent. They are scattered across the area, primarily in the region of Precambrian bedrock. The material in this type of deposit is highly variable, ranging from till and boulders to beds of gravel, sand and silt, and clay.

Several of these deposits have been utilized, primarily for road construction, in areas without other sources of sand and gravel. All deposits used during construction of the Tartan Lake road (Twps. 67 and 68-20W) are of this type. Figure AR-2-2 shows a typical ice contact deposit (Sec. 3-68-29W).

SUBAQUEOUS OUTWASH FAN DEPOSITS

Subaqueous outwash fan deposits are found throughout the study area. They are composed primarily of sand; in most deposits the thickness of sand exceeded the 4 m depth of the backhoe test pits. However, where the gravel facies outcrops, it is extensively mined and these deposits are the major source of high quality sand and gravel for the area.

The deposit in Secs. 14 and 23-67-27W has more than 6 m of pebble gravel at the northern apex. The gravel thins rapidly to less than 1 m, overlying sand; the southern part of the deposit consists of more than 4 m of crossbedded sand. The material in the active pit in SE23-67-27W is used for road maintenance.

The deposit in Secs. 24 and 25-68-27W has at least 6 m of poorly sorted pebble and cobble gravel and well sorted beds of coarse sand and granules at its northern end; gravel continues below the water table at a depth of 6 m. The deposit fines southward where sand overlies bedrock to the west and till to the east. This deposit has been extensively mined; the large pit in SE25-68-27W has been active in the last year.

The deposit north of Nikik Lake (Twps. 68 and 69, Rges. 25W and 26W) is primarily sand and fine pebble gravel. Pit depths are limited by the water table. The exception is the pit in NW36-68-26W which has a high percentage of coarse pebble and fine cobble gravel. This pit was active this summer, the material being used to upgrade the Sherridon road.

The small deposit in Sec.4-70-24W is the major source of aggregate used to build the Puffy Lake road. The best quality material in this deposit has already been removed. Reserves remain to the north where 2 m of fine pebble gravel overlie 3 m of cobbly coarse pebble gravel and to the south where 2.5 m of very sandy pebble gravel overlies sand.

All the preceding deposits lie on Precambrian bedrock and consist of 100% Precambrian material. The following deposits lie on Paleozoic carbonate bedrock and the clast lithology ranges from 30 to 90% carbonate.

The deposit in Secs. 16 and 17-64-20W has been mined to depletion at the eastern end. The pits to the west have been recently active and there are large stockpiles on site. The pits show 3 m of well sorted sand and pebble gravel. Gravel reserves continue below the water table at 3 m. Backhoe pits in the unopened portion of the deposit to the west show 2.5 m of pebble gravel overlying sand.

The deposit in Secs. 14 to 17-64-24W is primarily sand with local gravel pockets. Several small pits in the gravel pockets all show from 2 to 3 m of well sorted pebble gravel; pit depths are limited by the water table. The water table was not present in the pit in SW15-64-24W. The pit exposed 4 m of sandy coarse pebble gravel overlying a metre of sand, in turn overlying stone-free clayey silt. Backhoe test pits show the gravel thins rapidly away from the central area of these gravel pockets; most showed less than 2 m of gravel overlying sand.

BEACH RIDGE DEPOSITS

Beach ridges form a minor component of the aggregate resources of the area. All occur in the south overlying the Paleozoic bedrock. None are currently utilized for gravel extraction.

The two best developed beach deposits flank till-capped bedrock hills.

The deposit in Sec. 2-64-25W consists of two beach levels, one 2.5 m higher than the other. Both ridges are formed of less than 2 m of well sorted sandy fine pebble gravel overlying silt and clay. The clast lithology is 85% carbonate. Littoral sand covers the area between the ridges.

The composition of the beach ridge running through Secs. 15, 22 and 23-64-26W is variable. In many places it is sand; where it is composed of gravel, backhoe pits show pebble gravel overlying stony lake clay. The pebble lithology is 28% carbonate. This deposit has been mined in the past and is near depletion in the SW 1/4 of Sec. 15.

BEDROCK QUARRIES

Due to the scarcity of high quality gravel deposits there are several bedrock quarries in the area.

The quarries in Precambrian bedrock are generally small; most are found along Highway 10 and have been used for causeway riprap and in the construction of the new segments of Highway 10 between Flin Flon and Cranberry Portage. The large quarry in Sec. 2-65-28W is used by the C.N.R. for railway ballast.

Five quarries are in carbonate bedrock, and all are past producers of crushed stone. The quarry in Sec. 3-64-25W has been recently active and large stockpiles are present on site. Information about the aggregate quality of the material from these quarries is given in C. Jones (AR-3, this volume).

CONCLUSION

Sand and gravel reserves in the Flin Flon-Cranberry Portage area are very limited. Most deposits are either sand or poor quality gravel. The high quality gravel deposits are of limited depth and areal extent. They are widely scattered across the area and none are located near developed centres where demand is greatest. As a result, bedrock quarries supply a large portion of the area's aggregate needs.

REFERENCE

Manitoba Mineral Resources Division
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AR-3 A PRELIMINARY ASSESSMENT OF SELECTED CARBONATE BEDROCK RESOURCES FOR AGGREGATE POTENTIAL

by C.W. Jones

INTRODUCTION

The bedrock sampling program, initiated in 1982 to determine the quality of selected bedrock sources, was expanded in 1986 to include additional information concerning carbonate bedrock in northern Manitoba (see Fig. AR-3-1). The objectives of the program are:

(1) to assess the aggregate potential of selected bedrock outcrops and quarries in Manitoba and thus provide data required for aggregate resource management purposes; and
(2) to aid in evaluation of potential sites for new quarries.

In 1986, 7 bulk samples of carbonate rock were collected from selected outcrops and quarries located in the Ordovician, Silurian and Devonian Formations in Manitoba. Engineering tests, in accordance with A.S.T.M. standards, including the Los Angeles Abrasion Test (C131), the Sodium Sulphate Soundness Test (C88) and the Absorption Test (C127), were conducted on each rock sample. The results and potential end uses of each sample, as determined by Underwood McLellan Ltd., are outlined in Table AR-3-1.

BEDROCK SAMPLING IN MANITOBA

Seven carbonate bedrock samples of Ordovician, Silurian and Devonian formations were collected to determine their suitability for aggregate. The samples collected represent portions of the geologic members or formations, and rock differing in quality may be present elsewhere in the unit. The location and description of samples are given below.

CJ86-1 Silurian Inwood Formation (SE 1/4-22-23-2W)
The sample was taken from a test pit exposed in a low escarpment. The test pit exposes 3 m of pale yellowish brown microcrystalline dolomite. The rock is flat-lying, slightly brittle and contains spheroidal raindrop-like organic impressions. The stone was mined prior to World War I for interior decorative stone.

CJ86-2 Silurian Cedar Lake Formation (SE 1/4-9-26-7W)
The sample was taken from the east wall of a quarry exposing 4 m of buff to pale yellowish brown dolomite. The rock is generally fine grained, dense and tough; locally, it displays an intricate network of solution channelling. The stone was mined for aggregate for Highway 6.

CJ86-3 Ordovician Red River Formation (SW 1/4-28-66-17W)
The sample was taken from the east wall of a quarry exposing approximately 5 m of a yellowish grey to light yellowish brown, mottled, streaked with maroon-red, dolomitic limestone. The rock is massive, dense and takes a good polish. The quarry is located in a flat-lying outlier located on the Precambrian Shield.

CJ86-4 Ordovician Stony Mountain Formation (15-60-22W)
The sample was taken from a quarry exposing 3 m of

TABLE AR-3-1

PHYSICAL PROPERTIES AND POTENTIAL END USES, ORDOVICIAN TO DEVONIAN CARBONATES

Sample Number	CJ86-1	CJ86-2	CJ86-3	CJ86-4	CJ86-5	CH86-6	CJ86-7
Los Angeles Abrasion loss %	27.5	18.64	22.10	25.25	36.12	25.53	28.88
Bulk Specific Gravity	2.64	2.68	2.80	2.74	2.57	2.77	2.56
Apparent Specific Gravity	2.77	2.71	2.81	2.77	2.64	2.79	2.60
Absorption	1.86	1.29	0.50	1.07	2.43	0.71	1.69
Porosity	4.92	3.44	1.41	2.87	6.25	1.97	4.33
Soundness loss							
a) 1 1/2" to 3/4"	0.78	1.55	0.18	1.03	1.29	0.07	5.78
b)3/4" to 3/8"	2.62	2.15	0.37	0.90	2.61	0.85	6.34
b) 3/8" to #4	15.47	4.23	1.17	3.26	9.83	1.89	11.95
Potential Uses							
Concrete	Marg.	Yes	Yes	Yes	No	Yes	Marg.
Bituminous	Marg.	Yes	Yes	Yes	No	Yes	Marg.
Base Course A	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Base Course B	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Surface Gravel	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ballast	No	No	Yes	No	No	Marg.	No

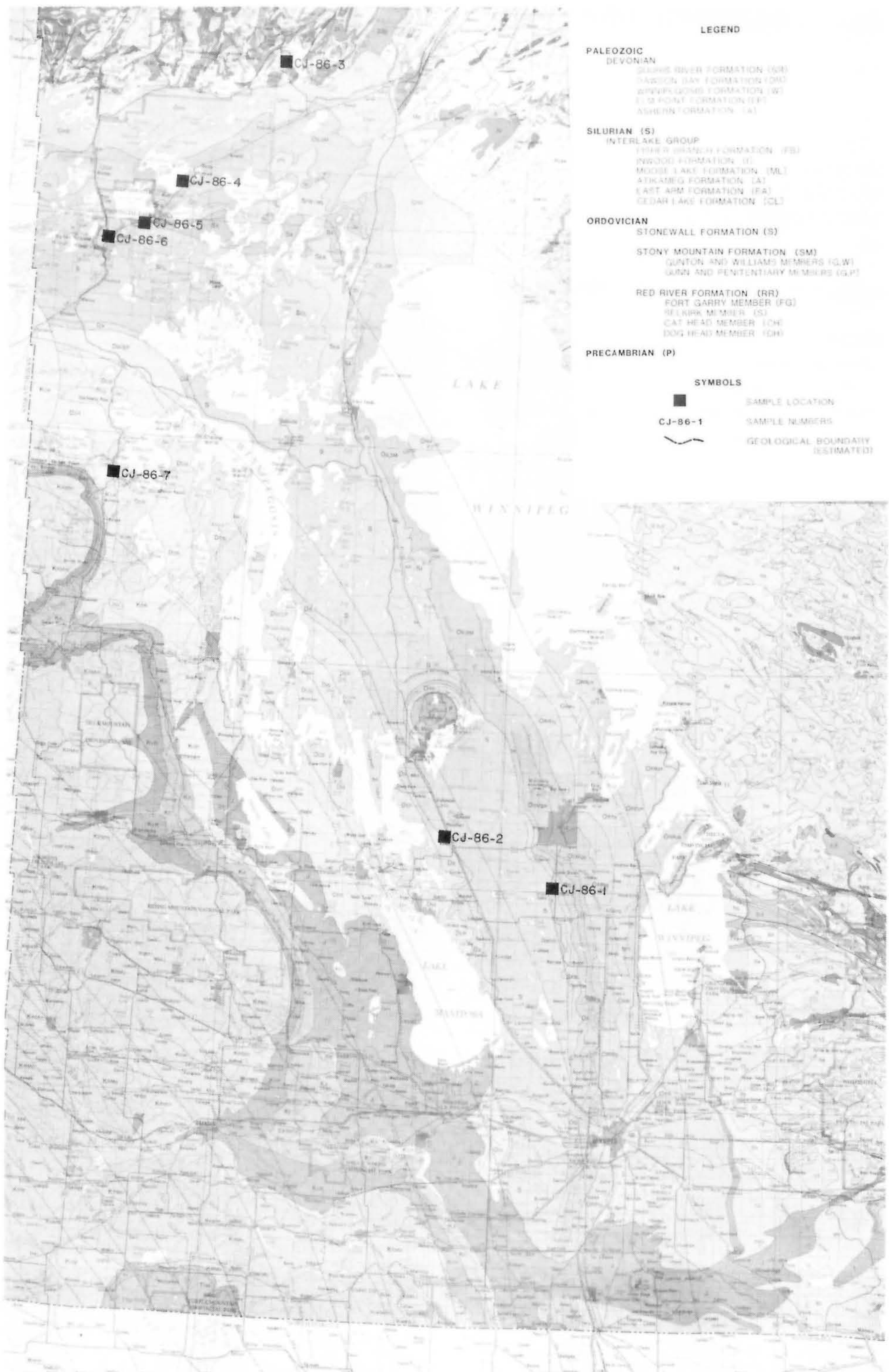

Figure AR-3-1: *Sample collection sites in Manitoba, 1986.*

pale yellowing brown to brownish grey dolomite. The rock is generally dense, tough and slightly granular, with abundant fossils that have developed into fossil-solution cavities.

CJ86-5 Silurian Inwood/Moose Lake Formations (11-58-24W)
The sample was taken from an outcrop exposing 2 m of pale yellowing brown, finely microcrystalline dolomite. The rock is generally dense but has some fossil debris giving it, in part, a fine pinpoint porosity.

CJ86-6 Silurian East Arm Formation (SW 1/4-35-56-26W)
The sample was taken from a quarry exposing 1 m of orange-brown dolomite overlying 1 m of brownish grey dolomite. The brownish grey dolomite is dense, hard, and breaks with a conchoidal fracture. The overlying orange-brown dolomite contains fossil solution cavities with small brachiopods and other fossil debris scattered throughout.

CJ86-7 Point Wilkins Member of the Devonian Souris River Formation
(S 1/2-32-44-25W)
The sample was taken from the second lift on the east wall of a quarry exposing a mottled buff micrite and biomicrite (high- calcium limestone). The rock is moderately hard and contains abundant fossil debris.

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AR-4 AGGREGATE RESOURCE MANAGEMENT IN MANITOBA

by C.W. Jones

INTRODUCTION

Aggregate resources (sand, gravel and crushed stone) are an essential ingredient required for building and road construction activities as well as other large-scale engineering projects such as pipelines, airports, and power plants. In Manitoba, the annual per capita consumption of aggregate in 1985 was approximately 15 tonnes. Based on volume, production of aggregate is the largest mineral extraction industry in Manitoba.

RESOURCE MANAGEMENT ACTIVITIES

The aggregate resource management program has been designed to facilitate aggregate resource conservation as well as to resolve land-use conflicts and other resource-related issues. The program, based upon Provincial Land Use Policy #13, Manitoba Regulation 217/80 of the Planning Act, is separated into four broad resource management activities: (1) the subdivision review process; (2) background studies, promoting the management of mineral resources for rural municipalities and local district planning boards (see Fig. AR-4-1); (3) review of Crown Land Transfers and resource-related issues; and (4) review of District Development Plans, zoning by-laws and amendments to ensure policies do not sterilize valuable, non-renewable aggregate resources. The objectives of mineral resources management are achieved through the legal instruments of land-use planning and control of development (Jones, 1983, 1984, 1985).

HIGHLIGHTS OF THE YEAR

- Background studies for aggregate resource management were prepared for R.M. of Russell, Town or Birtle, Selkirk and Area Planning District (five-year review), R.M. of Glenwood (in prep.), R.M. of Roblin (in prep.), R.M. of Shell River (in prep.), L.G.D. of Park (in prep.) and M.S.T.W. Planning District five-year review (in prep.). The background studies will be incorporated into Municipal Development Plans.

- Surficial geological mapping and aggregate inventories were initiated for L.G.D. of Park, R.M. of South Norfolk, L.G.D. of Reynolds, and The Pas-Flin Flon region.

- Approximately 500 subdivision applications were reviewed in order to ensure compliance with Provincial Land Use Policy #13, Development Plans, zoning by-laws and provisions of the Mines Act, of which approximately 10% required detailed investigation and resource planning recommendations.

- Review of approximately 1,000 Crown surface transfers in order to protect Crown mineral rights.

- Presentations of background studies including aggregate resource management policies of rural municipal councils and local district planning boards.

- Representation on Local Land Use Committees whose responsibility is to review local land-use related issues and provide recommendations.

- Review of amendments to development plans and basic planning statements to ensure proposed changes would not sterilize the resource.

- Response to several requests for technical assistance from government agencies, industry and the public.

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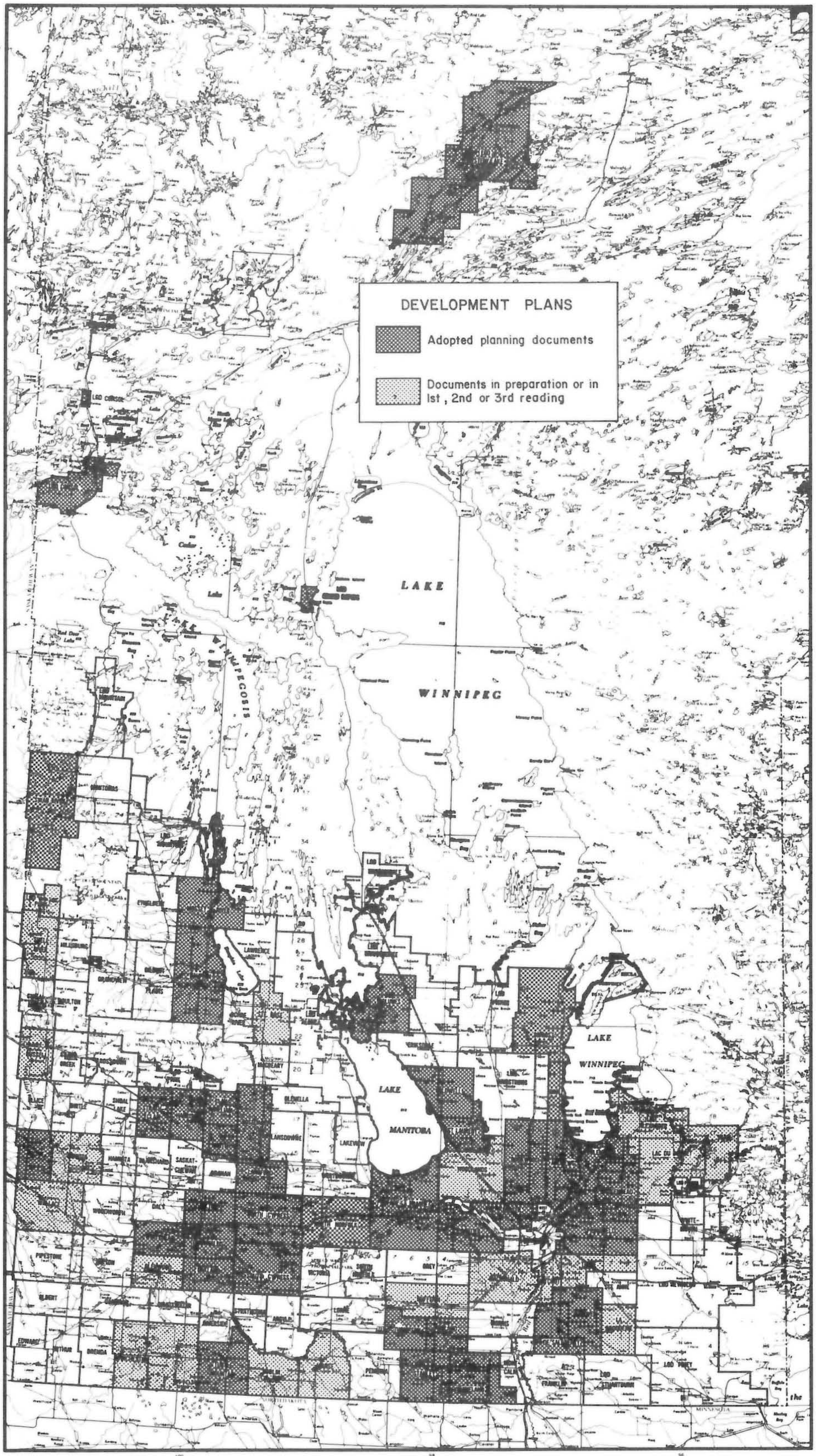

Figure AR-4-1: *Aggregate resources management activity in southern Manitoba.*

PUBLICATIONS RELEASED
(November 20, 1985 — November 21, 1986)

GEOLOGICAL REPORTS AND COMPILATION MAP

	Price
Corkery, M.T. 1985: eology of the Lower Nelson River Project Area; Geological Report GR82-1.	$25.00
Esposito, B. 1986: Copper and Zinc in Manitoba; Mineral Education Series.	No charge
Galarnyk, A. 1986: Oil in Manitoba; Mineral Education Series.	No charge
Gilbert, H.P. 1985: Geology of the Knee Lake-Gods Lake Area; Geological Report GR85-1B.	20.00
Manitoba Energy and Mines 1985: Report of Field Activities 1985.	5.00
Manitoba Energy and Mines 1986: Uhlman Lake — NTS area 64B, 1:250 000; Bedrock Geology Compilation Map 64B.	5.00
Manitoba Energy and Mines 1986: Granville Lake — NTS area 64C, 1:250 000; Bedrock Geology Compilation Map 64C.	5.00
Rodgers, M. 1986: Petroleum Geology of the Mississippian Mission Canyon Formation, Waskada Field, Southwestern Manitoba; Geology Petroleum Report PR1-85:	20.00
Schledewitz, D.C.P. 1986: Geology of the Cochrane and Seal Rivers Area; Geological Report 80-9.	30.00
Young, R.V. 1986: Sand and Gravel in Manitoba; Mineral Education Series	No charge

OPEN FILE REPORTS

	Price
Canada-Manitoba Mineral Development Agreement 1984-89 (ERDA) 1986: Sector A Geoscientific Activities Progress Report 1985-86; Open File Report OF86-4.	5.00
Esposito, B. 1986: Index to Non-Confidential Assessment Reports; Open File Report OF86-5.	15.00
Fedikow, M.A.F. 1985: Mercury Gas Surveys over Base and Precious Metal Mineral Deposits in the Lynn Lake and Snow Lake Areas, Manitoba; Open File Report OF85-11.	5.00
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Watson, D.M. 1985: Chromite Reserves of the Bird River Sill; Open File Report OF85-8.	5.00

AGGREGATE RESOURCES REPORTS

Groom, H.D. 1986: Aggregate Resources in the Rural Municipality of Miniota; Aggregate Report AR85-3.	11.00
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LIST OF PRELIMINARY MAPS — 1986

Geological Survey

		Scale
1986B-1	Bigstone Lake (Part of 53E/12) by K. L. Neale, J.G. Bardsley and R.M. Lemoine (Supersedes 1984B-1)	1:20 000
1986C-1	Subsurface Precambrian geological map of southwestern Manitoba. by C.R. McGregor	1:1 000 000
1986F-1	Schist Lake (Parts of 63K/12E and 12W) by E.C. Syme	1:15 840
1986F-2	Tartan Lake-Lac Aimee (Part of 63K/13) by H.P. Gilbert	1:15 840
1986I-1	Ponask Lake (Parts of 63H/15 and 16) by W. Weber	1:20 000
1986K-1	Kississing Lake (63N/3 West Half) by D.C.P. Schledewitz (supersedes 1985K-2)	1:20 000
1986K-2	Kississing Lake (63N/3 East Half) by D.C.P. Schledewitz (supersedes 1985K-2)	1:20 000
1986N-1	Butterfly Lake area (Part of 63-I/6) by M.T. Corkery	1:20 000
1986N-2	Kiskitto, Kiskittogisu and Playgreen Lakes (Parts of 63-I/5 and 12, 63J/7,8,9 and 10) by P.G. Lenton, W.D. McRitchie, M.T. Corkery and H.D.M. Cameron	1:50 000
1986R-1	Stormy Lake (Part of 52L/14SW) by D.J. Owens	1:1 000
1986R-2	Manigotagan River (Part of 52L/14SW) by D.M. Seneshen	1:1 000
1986S-1	Chisel-Morgan Lakes area (Part of 63K/16) by A.H. Bailes	1:15 840

Aggregate Resources

1986-PK	Aggregate resources in the Local Government District of Park (north) (Parts of 62N/5,6,11 and 12) by M. Mihychuk	1:50 000

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	Island-Stevenson Lakes; Barrington Lake, Tartan Lake
	P.G. Lenton	Cross Lake-Northern Superior Province — granite and pegmatite
	Dr. J.J. Macek	Thompson
	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 basement
Geological Compiler (Atlas)	D. Kowerchuk	Map compilations
Phanerozoic Geologist	Dr. H.R. McCabe	Southwest Manitoba and Interlake
Quaternary Geologist	Dr. E. Nielsen	Lynn Lake region, Interlake and southern Manitoba — Basal Till Studies
Mineral Investigations:		
Senior Mineral Deposit Geologist	Dr. G.H. Gale	Manitoba, specifically Flin Flon and Snow Lake
Mineral Deposit Geologists	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
Editorial & Cartographic Services:		
Geological Editor	B.B. Bannatyne	

MINES BRANCH

POSITION	PERSONNEL	AREA OF CURRENT INVOLVEMENT
Director	W.A. Bardswich	Manitoba
Aggregate Resources:		
Section Head	R.V. Young	Aggregate inventory R.M. of South Norfolk
Geologist	G.L.D. Matile	Aggregate inventory L.G.D. of Reynolds
	H.D. Groom	Aggregate inventory The Pas/Flin Flon
	M.A. Mihychuk	Aggregate inventory L.G.D. of Park (north)
Resource Management Geologist	C.W. Jones	Aggregate resources management Bedrock aggregate potential
Exploration Services:		
Section Head	W.D. Fogwill	Exploration activity in Manitoba
Assessment Geologist	B. Esposito	Assessment files
Special Projects Geologist	P.J. Doyle	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	P.D. Leskiw	Indices to Manitoba geoscience data; bibliography
Mineral Inventory Geologist	D.J. Richardson	Mineral deposit data