MANITOBA

DEPARTMENT OF ENERGY AND MINES

MINERAL RESOURCES DIVISION

REPORT OF FIELD ACTIVITIES 1980

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TABLE OF CONTENTS

GEOLOGICAL SERVICES BRANCH

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

MINES BRANCH — AGGREGATE RESOURCES SECTION

GEOLOGICAL SERVICES BRANCH

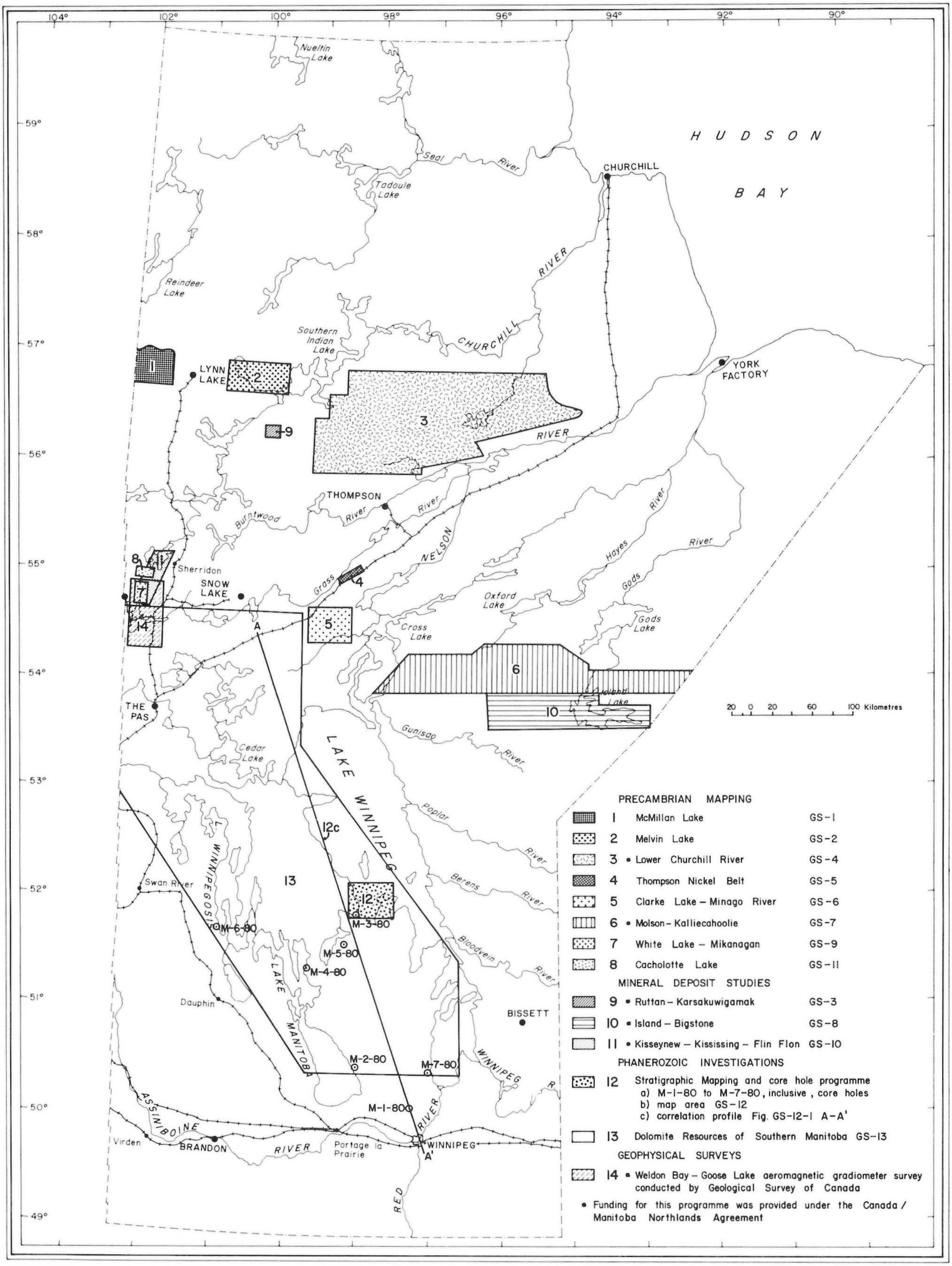

FIGURE GS-1: Location of Field Projects 1980.

INTRODUCTION AND SUMMARY

The Geological Services Branch undertook a wide range of projects this year including geological mapping, mineral deposit investigations, stratigraphic core hole drilling, and industrial mineral appraisals. 1:100 000 scale geological mapping programmes in the Lower Churchill River area and Molson-Kalliecahoolie Lakes area, in this their second and final year, were again facilitated through cost-shared funding made available under the Federal/Provincial Northlands Mineral Initiatives Subagreement. These programmes, the mineral deposit investigations, and geophysical surveys (such as the airborne gradiometer survey of the Weldon Bay-Goose Lake area undertaken this year by the Geological Survey of Canada) are heavily if not totally dependent on the availability of cost-shared funding and incur expenditures that are substantially beyond the traditional level of Provincial funding.

Past undertakings at this accelerated level of activity, made possible through previous (1974-1979) Federal/Provincial Agreements, have resulted in the wide range of publications that are being released this year. Similarly this Agreement facilitated the attainment of the Province-wide map coverage necessary to compile the new 1:1 000 000 scale Geological and Mineral Maps of Manitoba.

The second year of surveys in the sparsely exposed Lower Churchill River-Assean Lake area saw the virtual completion of coverage for the entire project area although minor gaps still remain in the Limestone River corridor. Five major east-trending lithologic belts were delineated. Two plutonic belts were identified which separate the eastward continuations of three belts of supracrustal rocks; the Kisseynew Sedimentary Gneiss Belt, the Rusty Lake Greenstone Belt and the Reindeer Lake-Southern Indian Lake sedimentary gneisses. Low water levels on Gauer Lake greatly assisted (and protracted) the mapping of previously non-existent shoreline exposures as a result of which much new information was obtained on the relatively well preserved low grade metavolcanic and metasedimentary supracrustal rocks on, and to the north of, the lake. The broad experience of the personnel engaged in the project when brought to bear on Assean Lake resulted in a reinterpretation of rocks in this area and the identification of widespread "Churchill-like" greywacke, volcanic, and arkosic units on the northwest shore. The nature of the Churchill-Superior Boundary between Pearson and Split Lakes remains as an unresolved problem requiring still further investigation, but the presence of both Archean and Aphebian rocks in this zone of possible imbrication now appears much more certain, and a review and a re-interpretation of the entire boundary zone will be completed within the next 3 - 5 years.

Detailed stratigraphically oriented mapping programmes continued in the Barrington Lake and White Lake-Mikanagan Lake areas. A 2 900 m section of felsic to mafic greywacke, siltstone and derived gneiss extensively intruded by granitoid rocks occurs at Magrath and "Pistol" Lakes. Basaltic interlayers occur in the northern part of this section and approximately 400 m of predominantly basaltic volcanic rocks occur to the north. The volcanic sections of MacBride Lake, north of MacBride Lake and the section at "Pistol" Lake are each litho-stratigraphically distinct, although the southern MacBride section resembles that encountered further west on southern Barrington Lake.

In the Flin Flon region the outcrop by outcrop inspection of the greenstones has highlighted the widespread occurrence of faulting parallel to much of the regional layering and foliation. Between the faults each block is characterized by a unique stratigraphic sequence which cannot be correlated with that in adjacent blocks and accordingly future mapping in the Flin Flon belt will have as its major objective the correlation of stratigraphy between major fault blocks and the development of a composite and coherent regional volcanic stratigraphy. On the northern flank of the Kisseynew belt 1:50 000 scale mapping was completed in the McMillan Lake area and a 1:250 000 compilation map of this entire NTS area (64C) is scheduled for the immediate future.

Mineral deposit studies in the southern part of the Kisseynew Sedimentary Gneiss Belt resulted in the recognition of three types of stratabound mineral occurrences, namely:

(1) Cu-Zn of the Sherridon-type in association with quartzo-feldspathic metasediments;
(2) Zn-Pb $\pm$ Cu occurrences of the Kisseynew Lake-type in association with a graphite and garnet-bearing biotitic quartz gneiss; and
(3) a sulphide stratum $\pm$ graphite in association with layered amphibolite.

At Ruttan heavy moss and lichen cover hampered the earlier work in the greenstone belt but the investigation has gained new impetus thanks to extensive stripping of the outcrops, the opening up of numerous new trails by Sherritt-Gordon Mines Ltd., and the Branch's acquisition of an "all terrain" vehicle. The subdivision of the greenstone into four fault bounded blocks with contrasting lithologies, facing directions, and structural attitudes is now readily apparent and the high degree of preservation of many of the primary structures has provided a basis for detailed studies not only on the setting of the mineralization but also on the nature and variation of the volcanogenic lithologies.

Regional mapping of the southern Pikwitonei Granulite Domain, the Thompson belt and the western arm of the Cross Lake Greenstone Belt continued this year into the Clarke Lake-Wabowden and Minago River area.

In the Thompson Nickel Belt the ongoing detailed 1:25 000 scale mapping program this year focused on Halfway Lake as a result of which migmatites and Moak Lake gneisses on Halfway Lake were correlated with similar units previously observed on Moak, Ospwagan and Paint Lakes. Retrogressively metamorphosed gneisses were identified as remnant blocks of the less altered rocks in the Sipiwesk and Wintering Lakes area. Dykes and sill-like bodies of plagioclase amphibolite on Halfway Lake are tentatively interpreted as reoriented representatives of the Molson Dyke Swarm that have been tectonically and metamorphically modified by the Thompsonian event which, in these areas, is characterized as a low-temperature penetrative deformation accompanied by various degrees of potassium metasomatism.

The contact zone of the Island Lake Group sediments with the underlying Hayes River Group volcanic rocks was investigated along strike in the Island Lake, Bigstone, Ponask and Stevenson Lakes district for at least 160 km. The lowermost part of the Island Lake Group, i.e., within the first 300 m above the contact, contains not only ultramafic volcanic rocks but also a gold deposit and these rocks are now considered to be an important stratigraphic unit in which to explore for nickel, copper and gold deposits.

Mapping in the Molson Lake-Kalliecahoolie Lake area confirmed the presence of an extensive igneous complex comprising, in large part, granodiorite which has intruded tonalite, tonalite gneiss and leucotonalite. The formation of this complex was postdated by the emplacement of a mafic dyke swarm and deformation which led to easterly and northwesterly shear belts and folding in the igneous complex and flanking supracrustal rocks. Late tectonic granite and aplite stocks and dykes display the highest radiometric background values.

The stratigraphic mapping and core hole programmes involved drilling of seven holes for a total of 1 095 m, largely in the south Interlake area. The cores provided data for the industrial minerals inventory of dolomite resources, correlation data for Silurian and Upper Ordovician strata, and lithofacies data for lower Ordovician strata. Re-mapping of exposures on Lake Winnipeg, north of the Narrows, provided data for correlation with the drill results. A single Devonian test north of the town of Winnipegosis provided lithofacies and structural data relative to reef distribution (and also provided the first (trace) occurrences of sphalerite mineralization in Paleozoic strata).

The field investigations were augmented by two working-field trips the objective of which was to demonstrate and review for the benefit of company geologists, working in the Kisseynew gneiss belt, the lithologic variations, stratigraphy and occurrences of mineralization in the area. Geologists from eight companies took part in the July session and, as a result of last minute cancellations, a reduced group containing only five company representatives took part in a slightly modified re-run of the tour in August.

An airborne gradiometer survey of the Weldon Bay-Goose Lake area was undertaken by the Geological Survey of Canada as part of the Geophysical activities conducted under the cost-shared Canada/Manitoba Northlands Mineral Initiatives Subagreement. The survey was flown over a three-week period from mid-July to the end of the first week in August and resulted in a total of 10 000 line km of gradiometer and total field recordings flown at a 300 m line spacing and an altitude of 152 m. The regional nature of the survey will provide a highly discriminating and standardized airborne magnetic data base with which the well exposed gneisses of the Kisseynew Lake region, and greenstones of the Flin Flon region can can be correlated and (in the latter case) extrapolated southwards beneath the Paleozoic cover rocks. Results of the survey should be forthcoming in early 1981 and will be made available as 1:20 000 gradiometer and total field maps together with 1:125 000 colour composites of the entire survey area.

A total of 21 Preliminary Maps were prepared as a result of this year's field work and will be made available at the Branch's Annual Meeting with Industry on November 20, 1980, together with this Report on Field Activities, revised index maps, and a new 1:100 000 scale Mineral Map of Manitoba. The Mineral Map is the second in this publication series and displays the distribution of base and precious metal, non-metallic, industrial mineral, petroleum, lignite and potash deposits in the Province on a geological backdrop that has been derived and simplified from the Geological Map of Manitoba 79-2. Because the mineral data illustrated on the map represents in large part a statement of the present status of mineral exploitation and documentation in the Province, it is proposed to re-issue the map with revisions on a 3 - 5 yearly basis.

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Director
Geological Services Branch

Winnipeg
September 1980

GS-1 GEOLOGY OF THE McMILLAN LAKE AREA

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

by H.D.M. Cameron

INTRODUCTION

A thirteen-week geological mapping program was conducted at a scale of 1:50 000 in the area extending from the Manitoba-Saskatchewan provincial boundary to Vandekerckhove Lake, south of Provincial Road 394. The objectives of the program were to complete the geologic coverage west of Lynn Lake and to determine the extent of the metasedimentary gneisses reported by McRitchie (1976).

Exposures of bedrock are restricted mainly to a few large ridges and to the shorelines of the larger lakes. Elsewhere only scattered outcrops protrude through the glacial drift which blankets the area.

GENERAL GEOLOGY

Most of the map-area is underlain by a shallow-dipping body of magnetiferous tonalite (Fig. GS-1-1). Narrow screens and rafts of metagreywacke occur along the shores of Whitesand Bay and southwestern Mackie Lake and at the north and south ends of Vandekerchkove Lake. These screens are generally interposed between sills of white pegmatite. South of Whitesand Bay a large area of metagreywacke extends eastward from the provincial boundary toward Tenklei Lake. Porphyritic quartz monzonite occurs south of the metagreywacke in the southwest corner of the area and a large body of coarse porphyroblastic quartz diorite lies on the east side of Vandekerckhove Lake and along Highway 394.

ROCK UNIT DESCRIPTIONS

UNIT 1 METAGREYWACKE

Interlayered fine grained grey psammitic gneiss and migmatite, (unit 1a) and medium grained grey pelitic gneiss (unit 1b) occur as screens 20 cm to 6 m thick between sills of white pegmatite (unit 8a) and as small sporadic rafts and boudins in the tonalite (unit 4a). Small zoned calc-silicate boudins are common in the psammitic gneiss and screens and boudins of amphibolite occur within the metagreywacke near the contact with the tonalite (unit 4a). The pelite contains numerous muscovite-sillimanite *faserkiesel* up to 3 cm long and biotite-sillimanite intergrowths along the tonalitic *lit*. It is usually found as layers 5 cm to 2 m thick in the psammitic gneiss. The large body of greywacke south of Whitesand Bay consists mainly of the pelitic gneiss with psammitic interlayers.

The metagreywackes of Whitesand Bay and Vandekerckhove Lake are similar to the rocks east of Zed Lake but differ from the Burntwood River Metamorphic Suite because they are garnet-free in all but a few localities and contain no visible cordierite.

UNIT 2: LAYERED AMPHIBOLITE

Within the metagreywacke, near the contact with the tonalite, is a unit of amphibolite up to 15 m thick. It is composed of 1 to 30 cm layers of fine grained mafic and calc-silicate rocks. Smaller isolated boudins of amphibolite also occur within the psammitic gneiss and with rafts of metagreywacke in the tonalite in the northwestern part of the area. A larger ridge of amphibolite gneiss up to 500 m wide lies 9 km south of Zed Lake, 5 km south of the nearest accessible outcrop of unit 1. To the south and west of these locations are a few isolated exposures of a fine grained hornblende diorite and hornblende-plagioclase gneiss (unit 2b).

UNIT 3: SILICATE IRON FORMATION

On the northwest shore of the large island at the north end of Whitesand Bay a series of 2 x 6 m pods of rusty silicate iron formation occur within the metagreywacke. These are exposed over a distance of approximately 60 m and probably represent a boudinaged layer of meta-iron formation. The unit weathers from deep reddish purple to rusty orange and has patches of a pronounced blue-black bloom. The pods are zoned, having coarse grained massive amphibolitic cores with disseminated pyrite and pyrrhotite surrounded by up to 1 m of siliceous rock containing boudinaged quartz layers 1 mm to 3 cm thick. This zone is fine grained and contains quartz, green amphibole, small garnets, graphite, and scattered sulphides. An outer garnet-rich rim is 1 to 15 cm thick. One smaller pod is composed entirely of garnet and quartz. The metagreywacke host is a rust-stained semipelite with abundant garnets up to 8 mm in size.

UNIT 4: TONALITE

A large body of medium- to coarse-grained magnetite-bearing tonalite (unit 4a) dominates the northern and central parts of the area. It varies from massive and homogeneous near McMillan Lake to gneissic in the northeast and northwest adjacent to the metasedimentary screens. Here it commonly contains numerous schlieren and small partly digested rafts and boudins of metagreywacke and amphibolite. In the northern part of Whitesand Bay the tonalite contains xenoliths of an older mesocratic quartz diorite (unit 4b) which postdates the metasedimentary gneisses. The tonalite (unit 4a) contains abundant magnetite porphyroblasts from 1 to 8 mm in size and is cut by dykes of pink pegmatite which also contain magnetite. However, the unit has no well defined aeromagnetic expression which could be used to determine its full extent. The tonalite is locally hornblendic and very rarely contains garnet. In the northern Whitesand Bay area the tonalite has been migmatized and has well developed white *lit*. Typical foliations have very shallow dips, ranging from 7 to 30°. These tend to steepen up to 60 to 80° in the more gneissic areas.

North of Vandekerckhove Lake granitic and pegmatitic veining in the magnetite-bearing tonalite have produced an injection gneiss (unit 4c). The rock probably approaches granodiorite in composition.

The biotite tonalite (unit 4d) of central Vandekerckhove Lake is fine grained, homogeneous and equigranular and contains no magnetite. This grey to buff weathering unit is locally gneissic and is cut be veins of white pegmatite and aplite.

UNIT 5: PORPHYROBLASTIC QUARTZ MONZONITE

Porphyroblastic quartz monzonite occurs in two locations in the map-area. It is fine- to medium-grained and has megacrysts of potassium feldspar approaching 2 cm in size. This unit also contains magnetite and is commonly hornblendic. In the southeastern part of the area it contains xenoliths of a fine grained homogeneous equigranular leucogranite (unit 7a). The quartz monzonite lies south of the metagreywacke and very rarely contains rafts of metasedimentary rocks. A smaller body of unit 5 is found in the tonalite in the southwestern part of Vandekerckhove Lake. Here it is more homogeneous and is cut by veins of pink pegmatite.

UNIT 6: PORPHYROBLASTIC QUARTZ DIORITE

A coarse grained mesocratic quartz diorite outcrops on central and eastern Vandekerckhove Lake and along Highway 394 north of Zed Lake. It contains plagioclase porphyroblasts up to 15 mm in size and is cut by a well developed network of white aplitic and pegmatitic

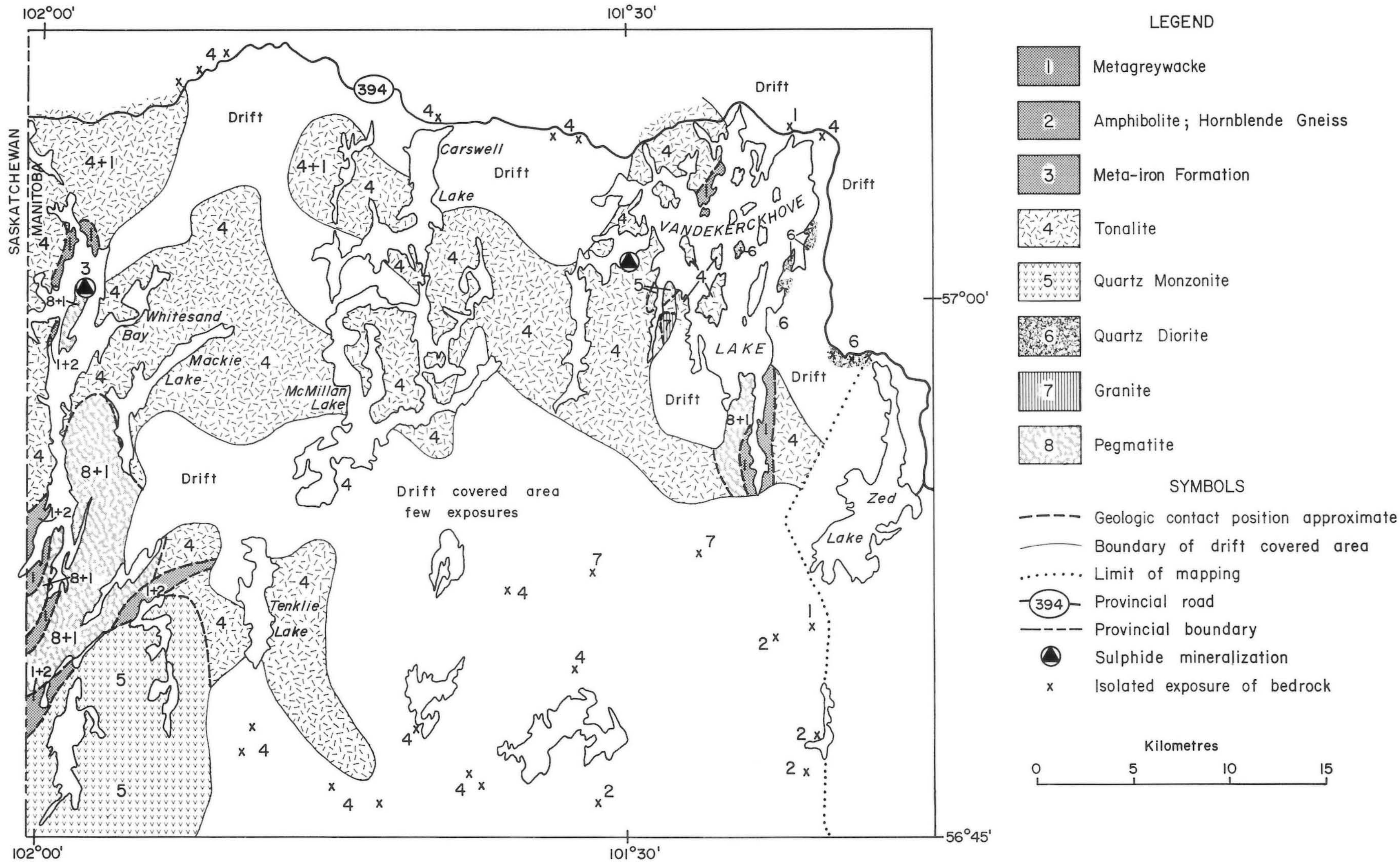

FIGURE GS-1-1: General Geology of the McMillan Lake Area.

veins. Small sporadic rafts of metagreywacke and tonalite are present in unit 6 along the east shore of the lake.

UNIT 7: GRANITE

A small elliptical body of fine grained pink leucogranite (unit 7a) similar in appearance to some of the aplitic veining in the tonalite is found on southwestern Vandekerckhove Lake. Two widely separated exposures of coarse grained pink magnetite-bearing granite (unit 7b) were noted southwest of Zed Lake.

UNIT 8: PEGMATITE

Large sills of white pegmatite (unit 8a) are associated with the metagreywacke at Whitesand Bay and Vandekerckhove Lake. These vary in size from 1 m thick to 500 m wide ridges containing small rafts of metagreywacke and separating the larger screens of sedimentary gneisses. Locally the pegmatite contains muscovite, sillimanite and garnet particularly when adjacent to rafts of pelitic gneiss.

Pink perthitic pegmatite dykes and veins (unit 8b) are generally associated with the magnetiferous tonalite (unit 4a) and contain clots of magnetite up to 4 cm in size.

MINERALIZATION

Aside from the silicate iron formation (unit 3) on Whitesand Bay, only one other gossan was noted in the area: on the west arm of Vandekerckhove Lake is a zone of rusty weathering rock approximately 4 m wide and 60 m long. The unit is dark, fine grained and quartz-rich. It contains abundant massive and disseminated sulphides, including pyrrhotite and some chalcopyrite. The rock is deeply weathered rusty yellow to dark reddish purple with a blue-black bloom on the surface of the more massive zones. The only other exposures within 2 km of the outcrop are tonalite and pegmatite and there are no indications of the relationship of the gossan to the surrounding rocks.

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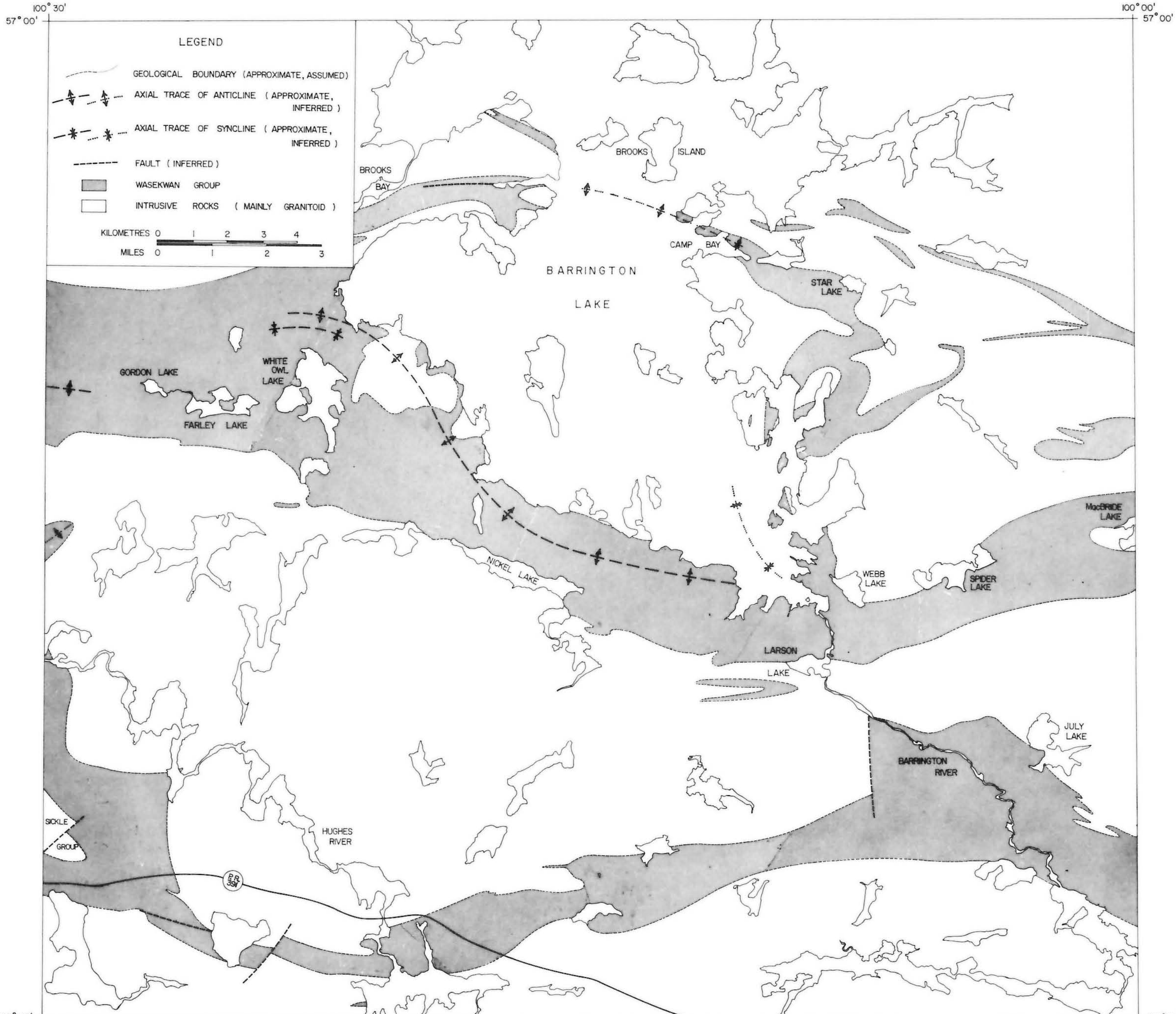

FIGURE GS-2-1: Distribution of Wasekwan Group rocks and structural geology in the Barrington Lake Area.

GS-2 MELVIN LAKE PROJECT

(64B/13 & 64C/16)

by H.P. Gilbert

INTRODUCTION

Mapping of the eastern end of the Lynn Lake greenstone belt was completed this season. Mapping was conducted in the Farley Lake area and the southern part of the Barrington Lake area to provide continuity between the areas mapped to the west (Syme and Gilbert, 1977; Syme, 1977) and the Fraser Lake area to the east. The mapping at Barrington Lake was directed towards stratigraphic comparison with the Wasekwan section further west (report in preparation), and investigation of the stratigraphic and structural relationships between the volcanic sections at Barrington Lake (Fig. GS-2-1, and Prelim. Map 1980L-1).

The volcanic section at southern Barrington Lake was mapped eastwards through MacBride Lake to the eastern extremity of the belt east of "Elbow Lake" (Prelim. Maps 1980L-1 & 1980L-2). The volcanic belt to the south ("Barrington River igneous complex" — Kilburn, 1956) was mapped from its eastern extremity at Opachuanau Lake as far as Hughes River in the west. Field work conducted in 1979 and 1980 is the basis for mapping of these two belts. Mapping of the plutonic rocks is based on current work and information from earlier publications (Stanton, 1948; Crombie, 1948; Kilburn, 1956; Milligan, 1960; and Hinds, 1972).

The principal features identified this season are as follows:

(1) A syncline-anticline fold structure trends northwest to west in the predominantly tuffaceous section north of White Owl and Farley Lakes. The major body of iron formation west of Farley Lake has been repeatedly folded.

(2) The volcanic section at southern MacBride Lake is similar to the section further west at southern Barrington Lake, except for the occurrence of greywacke/siltstone interlayers in the area south of MacBride Lake.

(3) The volcanic sections south of MacBride Lake, north of MacBride Lake, and the section at "Pistol Lake" are each litho-stratigraphically distinct.

(4) A major body of conglomerate similar to the formation extending along the north side of the Lynn Lake greenstone belt has been mapped in the "Elbow Lake" area east of Magrath Lake.

(5) A 2900 m section of felsic to mafic greywacke, siltstone, and derived gneiss extensively intruded by granitoid rocks occurs at Magrath and "Pistol" Lakes. Basaltic interlayers occur in the northern part of this section, and approximately 400 m of predominantly basaltic volcanic rocks occur to the north.

(6) The metamorphic grade of Wasekwan Group rocks in the Fraser Lake area is higher than that in the Barrington Lake area; staurolite and anthophyllite occur sporadically, and garnet is extensive in the Fraser Lake area; volcanic and sedimentary rocks are extensively intruded and assimilated by granitoid intrusions.

BARRINGTON LAKE AREA (64C/16)

STRATIGRAPHY

The Wasekwan section in the Farley Lake area is comprised largely of mafic volcanic flows and flow-breccias, mafic tuff and lapilli tuff, and minor pyroclastic breccia. Breccia types were recognized on the basis of matrix texture, clastic composition, and stratigraphic association, as described previously (Gilbert, 1979a, p. 10-12). A north to northeast-facing section of pillow basalt extends from White Owl Lake to the area northwest of Gordon Lake. This unit is on-strike with sporadic occurrences of pillows extending west as far as Huet Lake 25 km to the west (Syme and Gilbert, 1977). Mafic tuffs comprise more than 50 percent of the section in the areas north of Farley and White Owl Lakes; these rocks face north at the eastern extremity of Barrington Lake. The tuffs are intimately interlayered with basalt, which occurs as shallow intrusive bodies north of White Owl Lake. Epidotic alteration of mafic flows is locally extensive, especially in pillowed units and in flow-breccias. Mafic volcanics south of Farley Lake are locally strongly silicified; these rocks are interlayered with amphibolitic schist, probably derived from mafic tuff and breccia.

A major body of iron formation extends through Gordon and Farley Lakes; the associated magnetic anomaly indicates a total strike length of 6.25 km from the west shore of White Owl Lake to the area northwest of Gordon Lake (Barrington Lake area, Questor INPUT Survey Map, 1977). The maximum width of the magnetic anomaly is 1.5 km, but only 450 m of iron formation are exposed as outcrop. Intense folding has probably resulted in a considerable increase of the original thickness of the iron formation, as noted by Stanton (1948). The magnetiferous rocks comprise banded chert, argillite, siltstone and massive magnetite. Very fine grained magnetiferous amphibolite is a minor component. Nodular structure consisting of 1 - 5 mm ovoid bodies with red hematitic cores and white felsic rims occurs in the northern part of the formation.

Minor felsic volcanic units occur in the Farley Lake area and within the Wasekwan Group throughout the Barrington Lake area. An intrusive origin is locally indicated for the felsic rocks where contact relationships are definitive. These units are generally quartz- and plagioclase-phyric; aphyric rocks are not common. Rare fragmental structure in some units indicates a depositional origin.

Two volcanic sections have been mapped on the peninsula west of Brooks Island in the central part of Barrington Lake. The more southern section consists largely of mafic flows and amygdaloidal flow-breccias, with interlayers of rhyolite, conglomerate, greywacke and siltstone in the southern 200 m of the section. A prominent topographic lineament follows an inferred east-trending shear zone in the section; a 60 m thick formation of garnetiferous schist and gneiss occurs north of the lineament. These rocks are commonly mineralized with pyrite and locally magnetite, and the garnetiferous section contains a substantial body of Cu-bearing sulphides (reported to be 15 ft. thick, and 350 ft. along strike — Northern Miner, April 13th, 1972). A volcanic origin is indicated by relict breccia structure, sporadic pseudomorphs and rare amygdales in the garnetiferous rocks, but some schists may have a metasedimentary origin. The northwest-trending volcanic section on Brooks peninsula consists of basalt with minor porphyritic felsic volcanic bodies, intruded and partly assimilated by hornblende-quartz diorite and related diorite. Granodiorite and pink pegmatite postdate the quartz diorite. Very fine- to fine-grained felsitic rocks occur south of this mafic volcanic section, and similar rocks occur at the northeastern end of the more southern volcanic section on the peninsula.

A volcanic section extending through Camp Bay consists of well layered intermediate to mafic tuff, breccia, and basalt with subordinate felsic volcanic units. The southern margin of the Camp Bay section consists of basaltic enclaves within hornblende-quartz diorite and diorite. Strongly attenuated coarse volcanic breccia in this section at Star Lake comprises the northernmost unit of the Webb Lake-Star Lake section (Gilbert, 1979a). Basalt and mafic flow-breccia are predominant in the area south of Star Lake; felsic volcanic rocks are well developed over a 700 m thick section 2 km south-southwest of Star Lake. Felsic breccias were recognized in several units. A body of fine grained hornblende-quartz diorite to felsite intrudes the section 2.5 km south of Star Lake. Enclaves of mafic volcanic breccia are locally altered to garnetiferous schist within this body, and a 100 m thick garnetiferous formation at the northeast side of the intrusion contains schist and gneiss derived from both mafic volcanic rocks and the quartz diorite. Aphyric and plagioclase-phyric diabase dykes intrude the quartz diorite and felsite.

The volcanic belt trending west from July Lake (Prelim. Map 1980L-1) is considerably more metamorphosed than the sections at Barrington Lake. Minor intrusions of biotite- and hornblende-bearing quartz diorite and diorite are locally predominant in the belt south of July Lake, and the mafic volcanics are granitized and recrystallized to amphibolite devoid of primary structures. At least 100 m of siliceous siltstone and extrusive and intrusive felsic volcanic rocks occur at the south margin of the belt 3 km east of Hughes River on P.R. 391.

STRUCTURE

Structural information in the area north and west of White Owl Lake is consistent with the structural interpretation of the area north of Nickel Lake (Gilbert, 1979a, p. 10). The major anticline mapped north of Nickel Lake extends northwest to the west end of Barrington Lake. Limited structural data indicate a synclinal axis approximately 500 - 800 m south of the anticline and minor structures in the iron formation west of Gordon Lake indicate repeated folding in that section. An anticlinal structure has been mapped in the mafic volcanic rocks south of the iron formation (Syme and Gilbert, 1977).

The Webb Lake-Star Lake section is continuous with the White Owl-Larson Lakes section and a synclinal structure is indicated between these sections by west-facing pillow basalt northwest of Webb Lake and northeast-facing tuffs north of Nickel Lake.

The volcanic sections in the northern part of the Barrington Lake area cannot be related on a litho-stratigraphic basis, but the trends of these sections indicate the Camp Bay section may be continuous with volcanic rocks on Brooks peninsula. One intepretation is based on the possible equivalence between the Camp Bay section and the section on the southern side of Brooks peninsula. The massive basalt — quartz diorite — diorite sections at the north side of Brooks peninsula and southeast of Camp Bay, occurring to the north and south of the Camp Bay section respectively, may be related across a possible fold structure within the latter section (Fig. GS-2-1).

ECONOMIC GEOLOGY

Several types of sulphide mineralization occur within the volcanic sections at Barrington Lake. Pyrite, pyrrhotite, and less commonly chalcopyrite occur in narrow zones (less than 1 m) within the mafic volcanics, commonly associated with silification. Similar mineralization is locally associated with minor units of siltstone, argillite, or felsic volcanics interlayered with the mafic volcanic rocks. Gabbro and hornblendite are also host to these sulphides locally. Molybdenite, pyrite, pyrrhotite and chalcopyrite are concentrated in quartz veins and felsitic dykes approximately 700 m north of the north shore of Webb Lake (Caribou Claim, 1930). The sulphides are also present in the host rock (amygdaloidal mafic flow-breccia) but are most abundant in the quartz and felsitic intrusive bodies.

TABLE GS-2-1

Geological history of intrusive rocks in the Fraser Lake area

Intrusive Phases	Composition	Lithology and Field Relationships
I	Hornblende-quartz diorite, diorite Biotite-quartz diorite, tonalite, minor related porphyritic phases	Gneissoid, ± aggregates of hornblende or plagioclase Gneissoid, ± plagioclase ± quartz phenocrysts; ± micaceous aggregates ± rare garnet; may in part post-date hornblende-quartz diorite
II	Biotite-granodiorite to granite; minor tonalite	Massive to gneissoid; generally porphyritic with microcline ± quartz phenocrysts; intrusions are discordant to foliation of phase I rocks
III	Biotite granite	Massive, medium- to coarse-grained
IVA	Diabase, amphibolite, hornblendite, related chloritic schist	Massive to foliated; ± hornblende phenocrysts or pseudomorphs ± biotite aggregates; dykes are discordant to regional foliation of conglomerate at "Elbow Lake"
IVB	Gabbronorite, diorite, pegmatitic diorite; minor related tonalitic and granophyric phases; minor hornblendite	Massive to foliated; generally containing biotite (5 - 10%) as dissemination or as sporadic blades or aggregates; ± plagioclase phenocrysts or aggregates. (Age relationship between IVA and IVB unknown)
V	Felsic to intermediate plagioclase ± quartz porphyry, felsite	Massive to gneissoid. May include older phases pre-dating phase II.
VIA VIB VIC	Pink pegmatite and aplite White pegmatite White alaskite	Massive minor intrusions; mutual age relationships unknown

FRASER LAKE AREA (64B/13)

The volcanic rocks at southern Barrington Lake (White Owl Lake-Larson Lake section) extend eastwards through Spider Lake to the south shore of MacBride Lake (Prelim. Maps 1980L-1 and 1980L-2). This section, comprised mainly of mafic flow and fragmental rocks, is not comparable to the volcanics exposed north of MacBride Lake which consist of mafic crystal- and lapilli-tuffs with interlayers of garnetiferous schist and gneiss. The two sections are separated by massive granodioritic to granitic rocks which underlie the central and eastern parts of MacBride Lake, and occur extensively in the areas to the east and south (Fig. GS-2-2). Minor granitoid intrusions are insignificant in the volcanic sections at MacBride Lake, in contrast to the section extending from "Pistol Lake" to "Elbow Lake", which contains a diverse assemblage of volcanic and sedimentary rocks extensively intruded by several tonalitic, granitic and dioritic phases. The volcanic section north of MacBride Lake is not comparable with the "Pistol Lake" section (immediately to the east) where mafic flow and tuffs to the north are interlayered with feldspathic greywacke to the south. Details of the geology between these sections is obscured by drift. The east-trending volcanic belt immediately north of Barrington River is also extensively intruded and granitized by plutonic rocks. This belt is comprised almost exclusively of mafic volcanic rocks with rare sedimentary interlayers. The intrusive history of the area is summarized in Table GS-2-1.

MacBRIDE LAKE AREA

The Wasekwan Group rocks at southern MacBride Lake consist largely of mafic flows, related flow-breccia and intermediate to mafic pyroclastic breccia and tuffs (Prelim. Map 1980L-2). The section includes subordinate interlayers of greywacke and siltstone (up to 25 m thick) and felsic volcanic rocks (up to 70 m thick). The felsic volcanics occur as sills and probable flows: one fragmental deposit was identified. The basaltic rocks are locally garnetiferous, and volcanic breccia and tuff are commonly strongly foliated and altered to gneiss and schist.

Mafic tuff, lapilli tuff and pyroclastic breccia are well preserved north of MacBride Lake east of north MacBride River. The section contains subordinate interlayers of basalt, intermediate to felsic tuff and volcanic breccia, and garnetiferous schist and gneiss. A minor interlayer of paragneiss west of MacBride River contains staurolite and garnet, indicating a slightly higher metamorphic grade than in than in the southern Barrington Lake area. Graded bedding in the section east of the river indicates tops to the east-northeast; a possible southwest-facing layer would indicate an anticlinal structure in this section (Fig. GS-2-2).

"PISTOL LAKE" AREA

Mafic volcanic rocks are dominant in the northern part of the "Pistol Lake" section. These rocks are generally recrystallized to amphibolite devoid of primary structures, but tuffs and flows (with rare amygdales and possible pillow structure) can locally be distinguished. Intermediate to mafic tuffs and lapilli tuffs, and minor felsic volcanic breccia, cobble-conglomerate and greywacke occur together with basalt close to the northern end of "Pistol Lake". Feldspathic greywacke is interlayered with amphibolite further south, and greywacke-derived gneiss is the predominant host-rock at southern "Pistol Lake". Several felsitic units occur within greywacke enclaves within granodiorite-granite in the area south of "Pistol Lake". Siltstone and argillite (± garnet) are locally interlayered (at a scale of 5 mm to 2 cm) and rare calc-silicate units occur in the sedimentary rocks. These are variously altered to paragneiss with concordant feldspathic and quartz stringers. Tonalitic and quartz dioritic intrusions are extensive resulting in migmatite with alternating units of amphibolite, greywacke-gneiss and intrusive rocks (at a scale of 10 cm to 25 m). The host-rocks are variously assimilated by the intrusives which contain abundant xenoliths and schlieren. Diorite is locally extensive, possibly representing a hybrid product of quartz diorite with assimilated mafic volcanic rocks. Hornblende-quartz diorite is associated with amphibolitic host rocks, whereas biotite-quartz diorite occurs in conjunction with greywacke. The migmatite is intruded by later porphyritic granodiorite-granite (Phase II, Table GS-2-1). The latter intrusions are locally slightly foliated but generally massive and discordant in contrast to the tonalitic units in the migmatite, which are gneissoid and generally parallel to the regional foliation trend.

A gabbroic intrusion approximately 330 m thick intrudes the granodiorite-granite 1.5 km south-southwest of the south end of "Pistol Lake" (Phase IVB, Table GS-2-1). The intrusion is flanked by mesocratic granodiorite to the north and south, and apparently intrudes the granodiorite-granite further north. A minor body of very coarse grained hornblendite with sporadic 1 cm blades of biotite occurs in the granodiorite 500 m north of the gabbro. Massive pink pegmatite and aplite dykes intrude the granodiorite-granite and the gabbro. Rare diabase dykes also occur in the granodiorite-granite.

MAGRATH LAKE- "ELBOW LAKE" AREA

Migmatite derived from sedimentary and mafic volcanic rocks extends southeast from "Pistol Lake" to the west shore of Magrath Lake where the section consists predominantly of intermediate to felsic paragneiss with subordinate units of pelitic gneiss, basalt, and felsite (± plagioclase ± quartz phenocrysts) intruded by quartz diorite and porphyritic granodiorite. Porphyroblasts of plagioclase, muscovite and staurolite occur in one semi-pelitic member. Several amphibolitic dykes and one hornblendite unit intrude the paragneiss, and a minor gabbro body occurs in the northern part of the section, where basalt is predominant. Gabbro is less extensive in this area than indicated by Kilburn (1956). Enclaves of Wasekwan Group rocks occur in the granitoid terrane east of northern Magrath Lake. These rocks comprise the northern end of the section and include basalt, intermediate to mafic crystal- and lapilli-tuff and greywacke intruded by porphyritic rhyolite units up to 7 m thick.

A mafic volcanic body in the southern part of Magrath Lake consists predominantly of tuff and lapilli tuff intruded by porphyritic basalt (with hornblende ± plagioclase phenocrysts). This body is at least 90 m wide and 450 m long; basaltic flow-breccia 750 m to the west-northwest is probably part of the same volcanic body. Micaceous and hornblendic greywacke underlies the southern shore of Magrath Lake. These rocks are more mafic than the majority of the paragneisses in the section to the north; minor pelitic units and fine grained amphibolite of possible volcanic origin occur within the greywacke at southern Magrath Lake.

A major body of cobble-/boulder-conglomerate up to 1 675 m wide and at least 5.2 km long extends from the area just east of Magrath Lake to the area east of "Elbow Lake". The conglomerate is pervaded by minor intrusions of granodiorite and pegmatite which comprise 5 - 10 percent of the body. Clast types include felsic volcanic rocks and fine grained tonalite (generally predominant), medium grained tonalite-granodiorite (± incipient quartz eyes), quartz porphyry, fine grained intermediate sedimentary and volcanic rocks, amphibolite and biotitite; sporadic clasts of amygdaloidal basalt, epidote, quartz, hornblendite, and strongly foliated hornblende-quartz diorite occur locally. Chert and magnetiferous chert clasts are locally conspicuous just west of central "Elbow Lake", and occur sporadically in the body further west and southwest. Subangular clast shapes are locally preserved but generally the rock is strongly deformed, and gradational to banded gneiss at the margins of the body. Epidotic stringers and irregular zones are widespread. The conglomerate is characterized by an intermediate to mafic hornblende greywacke matrix; biotite greywacke occurs at a few localities, and the matrix is locally quartzitic just west of central "Elbow Lake". Minor greywacke interlayers are common in the "Elbow Lake" area and a 400 m thick greywacke section occurs within the conglomerate body south of "Elbow Lake". The conglomerate is generally unsorted and devoid of

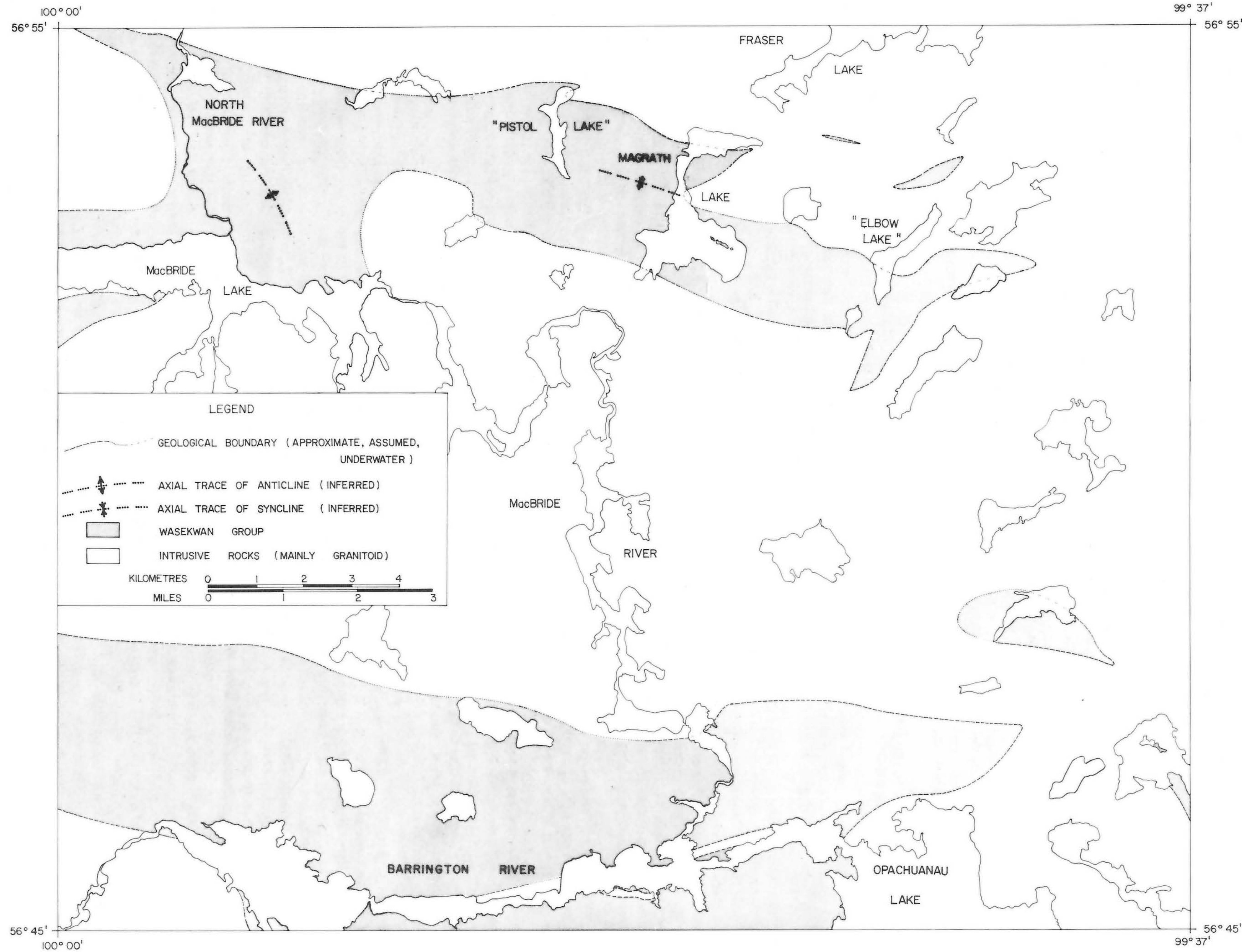

FIGURE GS-2-2: Distribution of Wasekwan Group rocks and structural geology in the Fraser Lake Area.

layering; graded bedding in rare pebbly lenses 1 km west of "Elbow Lake" faces north-northeast. The conglomerate body is flanked to the north and south by basalt, mafic tuff, greywacke and related paragneiss with very fine grained felsitic and felsic porphyry interlayers. Folds in the conglomerate foliation are predominantly S-shaped throughout the body but sporadic Z-folds occur in both the northern and southern parts of the conglomerate. The plunge on these folds is vertical or steep to the west or northwest. The conglomerate body may therefore plunge west beneath younger rocks at Magrath Lake, comprising the southern limb of a possible synclinal structure to the north (Fig. GS-2-2). The lithologic and metamorphic character of the conglomerate at "Elbow Lake" is very similar to that of the major conglomerate body extending along the northern margin of the Lynn Lake greenstone belt further west. The latter conglomerate was mapped as far east as northern Barrington Lake, 33 km northwest of "Elbow Lake" (Gilbert, 1979b).

BARRINGTON RIVER AREA

Volcanic rocks just north of Barrington River consist of aphyric and plagioclase-phyric basalt, largely recrystallized to amphibolite, and variously assimilated by extensive intrusions of tonalite, quartz diorite and diorite. Migmatite is extensive in this section; agmatitic and nebulitic structure is typical and banded tonalitic/dioritic gneiss occurs in strongly deformed areas. Basaltic units are generally 10 cm to 20 m thick (up to 75 m). Rare interlayers of fine grained intermediate micaceous gneiss (50 cm to 2 m thick) are probably of sedimentary origin. A 400 m thick section of basalt occurs at the northeastern end of the belt, north of Opachuanau Lake. The northern part of this section contains abundant concordant intrusions of intermediate garnetiferous gneiss derived from quartz porphyry. Minor intrusions of massive pink granodiorite, granite and pegmatite postdating the migmatization are ubiquitous throughout the area north of Barrington River.

The southern shore of Barrington River is underlain by psammitic and semi-pelitic paragneisses intruded by tonalitic to granitic and pegmatitic rocks. Anthophyllite and garnet occur in some semi-pelitic units, which locally contain slatey pelitic beds. A 15 m thick amphibolite unit of probable intrusive origin occurs in the western part of the section.

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GS-3 RUTTAN LAKE, KARSAKUWIGAMAK LAKE, EAGLE LAKE PROJECT

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

by D.A. Baldwin

INTRODUCTION

A thirteen-week geological mapping program was conducted to complete the mapping in the project area and carry out detailed work where existing data was insufficient to meet the objectives of the investigation (Baldwin, 1979).

Since the end of the 1979 field season, access to the area has been greatly increased. As part of their exploration program in the area Sherritt Gordon Mines Ltd., have made several trails in the area that are suitable for travel by "all-terrain vehicle". An eight-wheel "Argo", capable of transporting four people, was utilized to increase mobility of the field crew and to provide easy access to areas that previously were very difficult and expensive to reach.

The results of this field season's mapping are combined with 1979 results and displayed on Preliminary Maps 1980R-1 and 1980R-2.

The more important findings resulting from this season's mapping are:

1) the identification of two major faults that trend northeast;
2) the position of the east-trending fault (Baldwin, 1979) has been re-defined and extended to the east boundary of the project area;
3) many of the rocks previously interpreted to be mafic volcanic flows (Steeves and Lamb, 1972; Gilbert, 1974; Baldwin, 1979) have been reinterpreted to be intrusive rocks because of the homogeneous nature of the rocks and the absence of flow structures;
4) the eastward continuation of the horizon in which the Ruttan Mine occurs;
5) the documentation of the stratigraphy and facies variations in the Northern Fault Block;
6) the documentation of the stratigraphic position of sulphide facies iron formation in the Northern Fault Block;
7) the degree of preservation of primary sedimentary and volcanic structures in the area;
8) the further delineation of the contact between plutonic and volcanic derived rocks south of Ruttan Lake;
9) the identification of oxide facies iron formation and alteration in volcanic and volcanic derived rocks east of Darrol Lake.

Delineation of the stratigraphy, flow contacts and flow morphology in the Karsakuwigamak Fault Block remains incomplete. The completion of mapping and data collection in this part of the area will be given top priority during the 1981 field season.

This report outlines the major structural elements in the project area and briefly describes the volcanic and volcanic-derived lithologies encountered in the four fault blocks.

STRUCTURAL GEOLOGY

The main structural elements in the area are three major faults identified as Fault 1, Fault 2 and Fault 3 in Figure GS-3-1. They divide the map area into four fault blocks; the Northern Block; the Ruttan Block; the Karsakuwigamak Lake Block and the Eastern Block (Fig. GS-3-1). The faults have not been observed in outcrop. Their position is inferred from discontinuities in the stratigraphy, lithological contrasts, conflicting facing directions and dips of bedding, and from a discontinuity of trends on the aeromagnetic maps. Fault 1 and Fault 2 are truncated by Fault 3. Displacement of Fault 1 after the emplacement of the plutons south of Esker Lake was left lateral and a minimum of 1 km (Prelim. Map 1980R-1). The sense of movement and displacements on Faults 2 and 3 is unknown.

Reliable younging directions and bedding in all but the Eastern Block indicates monoclinal structures that are steeply dipping. In the Northern Block strata dip steeply to the south and young to the north; the Ruttan Block strata dip and young to the south and southeast. The strata in the Karsakuwigamak Lake Block dip and young to the north. The facing direction of the Eastern Block is unknown.

Stratigraphic relationships between the fault blocks is unknown.

Geological relationships between the rocks in the southwest corner of the map area and the rocks in the Ruttan Block and the Karsakuwigamak Lake Block have not been determined because of the absence of reliable younging directions and the abundance of plutonic rocks.

GEOLOGY OF THE FAULT BLOCKS

NORTHERN BLOCK

The rocks in this fault block are volcanic derived conglomerates, sandstones and siltstones, polymictic volcanic and plutonic derived conglomerates and greywackes. Two units of mafic volcanic flow rocks occur at different stratigraphic levels in the sedimentary succession. The sedimentary rocks and mafic flow rocks are intruded by mafic and intermediate sills and dykes. Effects of deformation and metamorphism are not observed in the outcrops except very locally where a strong shear foliation is developed in zones parallel to bedding and where clasts in conglomerate are flattened in the plane of bedding and foliation.

The rocks can be divided into three distinct map units that form a continuous north-facing stratigraphic succession. The base of the succession is truncated by Fault 3.

The lowermost map unit in this succession comprises volcanic derived conglomerates, sandstones and siltstones that are organized into Bouma divisions. Beds vary in thickness from 1.5 to 12 m. The composition of the rocks, clast size in the conglomerates, and bed thickness, change both vertically and laterally in the unit. From south to north and west to east the rocks intertongue and change in composition from mafic through arkosic metasediment to greywacke (Prelim. Maps 1980R-1 and 1980R-2). Clast size and bed thickness in the conglomerates decrease from south to north and west to east. Bed thickness and areal distribution of siltstones increases from south to north and west to east. Conglomerate beds are characteristically reversely graded at their base followed by normal grading toward the top of the bed and in many cases pass upward into sandstone. They are both matrix or clast-supported, and/or grade from clast supported to matrix supported both vertically and laterally in individual beds. Clasts are angular to rounded and vary from 30 cm to less than 1 cm in diameter. The clasts in the conglomerates are undeformed. Sandstone beds have normal graded bedding and locally parallel laminations and cross-bedding have been observed. The siltstones are thinly bedded and many have a 1 to 3 mm grit layer at their base. Primary sedimentary structures are numerous, particularly in the mafic siltstones and are extraordinarily well preserved. Graded bedding, rip-ups, small-scale scours and abundant soft sediment load structures are present. Flame structures are numerous and their tips are all tilted or slightly bent toward the east. Concentrically zoned, spherical, 2 to 3 mm diameter structures in the rock are probably primary concretions. Locally they transect the bedding planes.

The stratigraphically lower mafic flow unit is characterized by plagioclase-phyric and aphanitic basalt. The flows are organized and grade from massive through pillow lava to pillow breccia and hyaloclastite. The unit is thickest in the west where pillow lava represents 60 percent of the flows. To the east the flows are thinner and pillow breccia and hyaloclastite are dominant. Flow thickness varies from 1 m to about 25 m. The other flow unit is dominantly aphyric with subordinate plagioclase-phyric members. In this unit pillow lava is absent and the flows grade from massive lava to pillow breccia and hyaloclastite. In the west pillow breccia and hyaloclastite are subordinate to massive lava whereas in the east massive lava is subordinate to pillow breccia and hyaloclastite.

Pillows and pillow breccia are little deformed if deformed at all, and locally concentric cooling cracks are preserved. Vesicles are rounded to slightly elliptical and concentrated in the upper parts of pillows. Pillow breccia has angular, rounded and amoeboid shapes.

Dykes and sills are mafic to intermediate. They have sharp contacts with the sedimentary rocks and the contacts are commonly anastomosing. A zone of quartz-filled amygdales is characteristically developed next to the inner edge of chilled margins. Soft sediment folding and bedding dislocations in the sediments against and close to the intrusive contacts further supports the concept that the dykes and sills were emplaced when the sediments were still soft, with minimal confining pressure.

These exceptionally well preserved, virtually undeformed and unmetamorphosed rocks in the lowermost map unit in the Northern Block have a minimum stratigraphic thickness of 3.5 km.

The next stratigraphically higher map unit in the Northern Block is a volcanic and plutonic derived polymictic conglomerate that is interbedded with subordinate arkosic-greywacke sandstone. Plutonic clasts are generally much larger than the volcanic clasts. They are rounded, 30 to 7 cm in diameter and are a foliated hornblende tonalite similar to the Opachuanau gneiss (Hinds, 1972) that outcrops on the northwest shore of the Churchill River west of Rusty Lake (Zwanzig, pers. comm. 1980). Volcanic clasts are, in order of abundance, intermediate, felsic and mafic in composition. They are generally elliptical and 15 to 0.5 cm in diameter. Quartz clasts are rounded and less than 4 cm in diameter. Clasts of chert and cherty iron formation are common, and rare clasts of sedimentary rock are present. Conglomerate beds are graded and generally matrix-supported, but clast-supported beds have been observed. The beds are thicker (up to 15 m) and coarser at the base of the unit and in the west of the area. Towards the top of the unit to the east the beds get progressively thinner (maximum of 4 m) and the clasts smaller. The matrix of the conglomerate is arkosic-greywacke. Beds of arkosic-greywacke sandstone are massive. Some are normally graded and contain clasts of volcanic rocks, less than 1.5 cm in diameter at the base of the bed. In the west these beds have a maximum thickness of 3 m and in the east a maximum thickness of 7 m. This interbedded unit of conglomerate and arkosic-greywacke sandstone is 800 m thick in the west and in the east has a minimum thickness of 1.6 km.

Overlying the interbedded polymictic conglomerate arkosic-greywacke sandstone unit is a unit of greywacke that contains two members of siliceous sulphide facies iron formation. Exposures of the unit are few in the west and only one exposure has been found in the east. The rocks in this unit have been much more deformed than those in either of the two lower stratigraphic units in the fault block. Although bedding is generally preserved, reliable younging directions have not been documented. The rock is grey to brownish-grey on weathered surface and dark grey on fresh surface. Alignment of biotite defines a foliation parallel to bedding. The siliceous sulphide facies iron formations have a rusty weathering surface. They are composed of 15 to 20 per cent disseminated pyrite and pyrrhotite in a massive rock that is very siliceous, fine grained and contains minor biotite and plagioclase feldspar. Banded chert has been observed in two outcrops.

Continuity of the unit in the project area is interpreted from geophysical data (Questor INPUT Survey 1968; H.B.E.D., E.M. Survey 1961) and diamond drill hole data (H.B.E.D. 1961) contained in the Manitoba Mineral Resources Division cancelled assessment files.

A polymictic volcanic and plutonic derived conglomerate interbedded with arkosic sandstone that outcrops south and west of Eagle Lake (Prelim. Map 1980R-2) is the uppermost stratigraphic unit in the Northern Fault Block that is exposed in the project area. The rocks are deformed and have been folded around the east end of a granitic pluton that occupies the area north of Eagle Lake. North and west of the pluton there are no outcrops thus the outcrop pattern and distribution of the unit in these areas is unknown.

Volcanic clasts in this conglomerate are intermediate, felsic and mafic in composition; intermediate compositions are most abundant. The majority of plutonic clasts are tonalite; a few quartz monzonite clasts have been observed. Quartz clasts are also present. All of the clasts have been flattened in the plane of the foliation which is parallel to bedding. Plutonic, felsic volcanic and quartz clasts, on outcrop surface, have a length to width ratio of about 5:1, the length to width ratio of other clasts is about 8:1. Felsic volcanic and intermediate volcanic clasts are up to 15 cm in length, whereas plutonic clasts range up to 9 cm; mafic volcanic clasts up to 7 cm and quartz clasts up to 2 cm. The matrix of the conglomerate beds is hornblende-bearing arkose. The hornblende forms prismatic crystals up to 3 mm long. Conglomerate beds are from 2 to 20 m thick. The arkosic sandstone is identical to the matrix of the conglomerate. The beds are massive and from 0.5 to 8 m thick. Primary sedimentary features have not been observed thus facing direction is unknown.

In summary, with the exception of two relatively thin mafic flow units and small gabbroic and intermediate intrusive bodies, the Northern Fault Block is made up of epiclastic rocks. The rocks in the lowermost unit in the fault block were probably transported by turbidity currents. The distribution of the rocks, particularly the conglomerates, and current indicators (flame structures and rip-ups) indicate that transport was from west to east. This is also evidenced by the distribution of flow features in the two mafic flow units.

EASTERN BLOCK

In this block the area that contains outcrop is approximately 8 km^2. Outcrop in the area is sparse and is lichen and moss covered. Except by helicopter, the area is inaccessible. As a result, the rocks in this area have not been studied in as much detail as the rocks in other parts of the project area. Top indicators have not been observed thus the facing direction in the block is unknown.

The rocks in this fault block are massive mafic plagioclase-and hornblende-phyric rocks, felsic volcanic flow rocks and volcanic derived sedimentary rocks.

The massive mafic plagioclase- and hornblende-phyric rocks are fine- to medium-grained. The phenocrysts of plagioclase are euhedral to subhedral, 1 to 2 mm in diameter and the hornblende phenocrysts are euhedral to subhedral and 2 to 3 mm. Locally, the rocks are amygdaloidal. The amygdales are quartz-filled, round to elliptical and from 3 mm to 2.5 cm in diameter. Local poorly developed pillow-like structures are observed and in one outcrop a massive mafic rock, overlain by a 2 m zone of fine grained mafic rock (that appears to be flow laminated) is in turn overlain by a 3 m zone that appears rubbly or brecciated. Flow contacts were not observed. The outcrops are such poor quality that positive identification of flow features could not be made nor could a pattern be distinguished in the distribution of amygdales. Consequently, an extrusive or intrusive origin for these mafic plagioclase and hornblende-phyric rocks has not been determined.

The felsic volcanic rocks are white, massive, flow banded and fragmental rhyolite or dacite. The massive rocks are very fine grained, contain 1 mm euhedral plagioclase phenocrysts and have

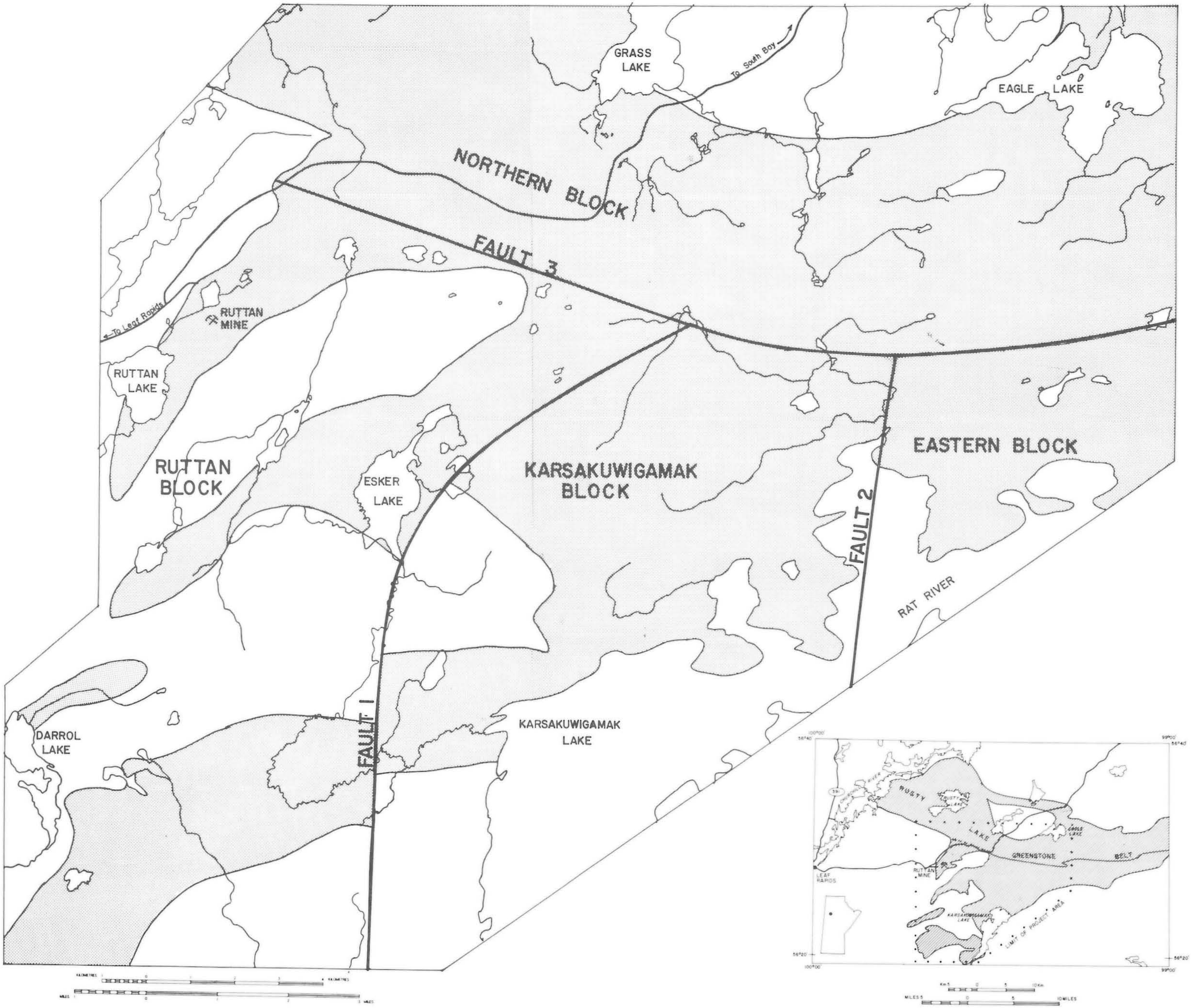

FIGURE GS-3-1: Generalized map of the project area showing the location of the major faults and the fault blocks; and the distribution of volcanic rocks (patterned area) and plutonic rocks. The geographic location of the Rusty Lake Greenstone Belt and the limits of the project area are shown in the inset.

conchoidal fracture. Flow banding is distinguished by colour variation from white to pale pink to dark grey, and aphanitic texture. Individual bands are less than 1 mm to 1.5 cm thick and flow folding is present locally. In the fragmental rocks, fragments and matrix are the same composition but the matrix does not have plagioclase phenocrysts. Fragments are generally angular but up to 5 per cent are rounded. The average size of the fragments is 7 to 10 cm, minimum size is 3 mm and the maximum is 60 cm. They are flattened and have a 4:1 length to width ratio on outcrop surface. The fragmental rocks may be autoclastic and occur as 4 to 5 m thick beds interbedded with massive and flow banded rock. The felsic volcanic units are 150 to 160 m thick and probably represent single flows. The observed distribution of the rocks across the strike of a unit from south to north is as follows: (1) 75 to 100 m of the massive rock; (2) 25 to 40 m consisting of 4 to 5 m thick beds of fragmental rock interbedded with 10 to 15 m thick beds of massive rock; (3) 20 to 30 m consisting of 4 to 5 m thick beds of fragmental rock interbedded with 1.0 to 1.5 m thick beds of flow banded rocks. This organization in the felsic volcanic units is not observed on a single outcrop and has been compiled from observations made on several outcrops. If correct and the units represent a single flow then the stratigraphic younging direction in the Eastern Fault Block is to the north.

The volcanic derived sedimentary rocks are conglomerates and interbedded conglomerates and siltstones. There are three units of volcanic derived sedimentary rocks in the Eastern Fault Block (Prelim. Map 1980R-2). The most southern unit consists of intermediate siltstones that are interbedded with conglomerate. The siltstones are fine grained, green to brown, thinly layered (1 to 4 cm). They form members in the unit that are generally about 2 m thick. The conglomerates are composed of intermediate to felsic clasts supported in a fine grained intermediate matrix. The clasts which are all elongated in the plane of layering, are less than 1 cm and are unsorted. They form beds that are 1 to 2 m thick. Younging criteria have not been observed. The unit is approximately 200 m thick.

The sedimentary unit that occurs in about the centre of the fault block is a volcanic derived conglomerate. It is composed of mafic, intermediate and felsic clasts, in order of abundance, set in a light green, fine grained mafic matrix. The clasts are matrix supported, unsorted, rounded to angular and from less than 1 cm up to 60 cm. The larger fragments are mafic in composition and one such fragment contains a fragment of plagioclase-phyric mafic rock. The unit is approximately 25 m thick.

The volcanic derived sedimentary unit that occurs in the northern part of the fault block is poorly exposed and is best described as a lapilli-stone. Fragments are angular to subrounded, 3 to 7 mm, intermediate and mafic in composition, set in a very fine grained intermediate matrix. Fragments make up 65 to 70 per cent of the rock. The unit is uniform throughout and is approximately 50 to 60 m thick.

KARSAKUWIGAMAK LAKE BLOCK

The rocks in the Karsakuwigamak Lake Block are felsic volcanic flows and their derived volcaniclastic rocks, dioritic to gabbroic intrusive rocks and subordinate epiclastic volcanic derived conglomerates and siltstones and mafic volcanic flows.

Felsic volcanic flows are white, pale pink or very light grey. They are massive and flow banded and autoclastic breccia is common. Textures are aphanitic, aphanitic with quartz phenocrysts, aphanitic with feldspar phenocrysts or aphanitic with quartz and feldspar phenocrysts. In the north of the fault block, felsic flow rocks are vesicular. Texture appears to be uniform throughout any one flow. The flows are in the order of 60 to 100 m thick and at least 3 to 4 km in length. Many of these flows are overlain by felsic tuffs and flanked by derived volcaniclastic rocks. The relationship between the flows and the volcaniclastic rocks has yet to be determined.

Continuity of stratigraphy in the fault block is interrupted by dioritic and gabbroic intrusive rocks. The dioritic rocks are generally equigranular and homogeneous consisting of euhedral to subhedral 2 mm plagioclase and hornblende with minor quartz and biotite. These rocks appear to form sills. The gabbroic rocks occur as sills and as discordant bodies several km^2 in area. They are coarse grained to fine grained, generally black to very dark green and are hypidiomorphic-granular. Hornblende is the mafic mineral and occurs as euhedral to subhedral stubby crystals. At a few localities, the hornblende appears to be a pseudomorph of pyroxene.

The volcanic derived conglomerates in the fault block are composed of intermediate and felsic clasts supported in a fine grained matrix that is intermediate in composition. Clasts are rounded to elliptical, 0.5 to 8 cm in diameter and are matrix supported. Bedding is defined by clast sorting and variations in the proportion of matrix to clasts. The beds are 1 to 7 m thick. Conglomerate units are several tens of metres thick. Siltstones are generally associated with and overlie the conglomerates. They form units that are less than 10 m thick. Beds vary in thickness from 2 to 20 cm. Many beds have a gritty base that is composed of 1 mm plagioclase and/or plagioclase and hornblende that grades into siltstone. The siltstones are intermediate in composition.

One unit of mafic volcanic flow rock has been identified in this fault block. It is located to the west and east of and passes through the lake immediately northeast of Karsakuwigamak Lake (Prelim. Map 1980R-2). In the east the flows are thin (1.5 to 3 m). Massive equigranular basalt represents 75 to 80 per cent of an individual flow. The remainder of the flow is a breccia in which the breccia fragments have the same equigranular texture observed in the massive parts of the flow. The breccia fragments are rounded to elliptical, 4 to 12 cm in diameter and set in a fine grained tuffaceous matrix. The breccia is overlain by 5 to 20 cm of laminated tuffaceous material, that resembles the breccia matrix. In the west the flows comprise massive lava, pillow lava, pillow breccia and tuff. One 7 m thick flow comprises 2 m of massive plagioclase-phyric lava, 3 m of vesicular plagioclase-phyric pillow lava, 2 m of plagioclase-phyric vesicular pillow breccia and 5 cm of mafic tuff. The unit has a maximum thickness of approximately 70 m.

RUTTAN BLOCK

Rocks in the Ruttan Block in the Ruttan Mine area and east to Fault 1 are volcanic derived epiclastic greywacke, siltstone, conglomerate and mafic volcanic flows and derived breccia. Bedding characteristics and primary structures in the epiclastic rocks are the same as have been described for epiclastic rocks in the Northern Block. Current indicators indicate transport from east to west. The mafic flow rocks are aphyric and plagioclase-phyric. The unit of mafic volcanic flow rocks that occurs stratigraphically below the Ruttan Mine is aphyric and is everywhere intruded by gabbroic to dioritic intrusive rocks and complete flows have not been observed. Nevertheless, outcrops of pillow lava, pillow breccia and massive aphyric rock are numerous. From east to west the amount of breccia relative to pillow and massive lava increases. The unit of mafic volcanic flow rocks that is stratigraphically higher in the section than the Ruttan Mine is plagioclase-phyric and in the east complete flows are well exposed. The flows vary in thickness from 5 to 10 m; have a 0.5 to 3 cm chilled zone at their base; a massive zone that is overlain by flow breccia, or pillow breccia followed by a zone of hyaloclastite. From east to west there appears to be an increase in the amount of breccia in the flows.

The unit in the immediate footwall of the Ruttan Mine is a grey, massive, non-bedded volcaniclastic rock that contains fine grained felsic volcanic fragments that are up to 7 cm set in a homogeneous 1 to 2 mm quartz, plagioclase and biotite matrix that is greywacke in composition.

In the remainder of the Ruttan Block outcrops of volcanic rocks are sparse, lichen covered or have a thick moss and soil cover. Furthermore, intrusive rocks are abundant and stratigraphic relationships are interrupted or obscured. Therefore, the mapping in this part of the fault block is very interpretive.

West and north of Esker Lake complete flows and flow contacts, in rocks mapped as mafic volcanic have not been observed. In many of the outcrops a mafic breccia in a mafic matrix is observed, and the breccia fragments are the same composition and have the same porphyritic texture as do the massive mafic rocks in the immediate vicinity. Most of the rocks in these areas are massive. In a few outcrops gradational changes in grain size across the outcrop has been observed. This may represent differentiation within a flow or within an intrusive rock.

Felsic volcanic rocks south of Ruttan Lake are the best exposed rocks in this part of the fault block. They are light grey, pink or pale pink on weathered surface and pinkish-grey on fresh surface, aphanitic and contain 1 mm feldspar phenocrysts. The rocks are massive, flow banded and fragmental. The amount of fragmental rock increases toward the unnamed Lake between Ruttan Lake and Esker Lake. Flow banding is 1 mm to 2 cm and is distinguished by colour variation on weathered surfaces. Flow folding in the flow banded rocks has been observed.

The sedimentary rocks that occur on the southeast shore and extending southwest of this same unnamed lake comprise interbedded conglomerate and sandstone overlain to the east by siltstone. The conglomerate beds are 1 to 4 m thick, contain felsic, intermediate and mafic volcanic clasts that are from 4 mm to 20 cm in long dimension on outcrop surface and have a 3:1 length to width ratio. The clasts are supported in an intermediate fine grained matrix. The interbedded sandstones are greywacke to arkose in composition; beds are 30 cm to about 70 cm thick and massive. The siltstone is greywacke to arkose in composition. Beds are 2 to 10 cm thick and a few have a gritty base.

The volcanic and volcanic derived rocks east and south of Darrol Lake are deformed and metamorphosed to a greater degree than the rocks elsewhere in the project area. A strong schistosity defined by hornblende in mafic rocks and biotite in sedimentary rocks is present everywhere in this part of the area. Staurolite, garnet and andalusite are common in greywacke sediments.

Nevertheless, local primary flow features are preserved. At one locality south of the hook-shaped lake east of Darrol Lake two complete flows are exposed. The flows are aphyric and 2.5 to 3 m thick. They both have a chilled zone less than 1 cm thick at their basal contact, and a 60 cm to 1 m thick flow breccia at the flow top. The matrix of the flow breccia in the 3 m thick flow is altered to epidote and the matrix and breccia fragments in the 2.5 m thick flow are altered to epidote. Immediately north of the small lake south of Darrol Lake repeated textural and grain size variations may indicate that the mafic rocks are flows. Here, three members, each approximately 5 m thick, have the following features. Hornblende aggregates 4 cm across are uniformly distributed in a matrix of 1 to 2 mm hornblende and plagioclase, and occupy about 65% of each member. The aggregates get progressively smaller in the remaining 25% of the member and grade into a fine grained 10 to 15 cm thick hornblende-chlorite schist. Contacts between the members are sharp and at one of them a 1.5 cm thick very fine grained chloritic rock occurs between hornblende-chlorite schist and the rock that contains the 4 cm hornblende aggregates.

Sedimentary rocks in this part of the area are greywacke, biotite-amphibole-quartz schist, and non-bedded tuffaceous rocks of intermediate composition. Primary features have not been observed.

Banded oxide facies iron formation and chert are associated with altered greywacke sediments. The greywacke sediments are silicified and contain sillimanite, anthophyllite and garnet. Locally chlorite is present. Andalusite and staurolite, although present, are components of the regional metamorphic mineral assemblage. The iron formation consists of bands of magnetite 0.5 to 20 cm thick interlayered with chert and siliceous greywacke. Chert bands are less than 3 cm thick. The banded iron formation was only observed in association with altered sedimentary rocks.

ECONOMIC GEOLOGY

As part of the Federal/Provincial Northlands Agreement, a report on the mineralization in the project area will be prepared during the winter of 1980-81.

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GS-4 LOWER CHURCHILL RIVER PROJECT: SOUTH HALF

(64A, 64B southeast and northeast)

by M. Timothy Corkery and Paul G. Lenton

INTRODUCTION

Geological mapping of NTS sheet 64A and parts of 64B and 54D was undertaken during a thirteen-week field program. This work completes the field mapping program initiated in 1979 to provide geologic maps at a scale of 1:100 000 for 64A, 64B east half, 64H and parts of 54D and 54E (Fig. GS-4-1). A portion of 64A not covered during the initial field season was mapped in late September and information was not available for publication in this report; however, the geologic information is included on Preliminary Map 1980M-3, NTS 64A-NW.

Within the map area contained in NTS 64B bush outcrops and lakes with extensive bedrock exposure are available. Detailed mapping of lake and river shorelines was implemented by boat traverses with extensive helicopter and ground traversing used to extend the mapping between lakes. The amount of bedrock exposure decreases rapidly to the east in the Split Lake map sheet (64A), with exposure restricted mainly to small lakes and rivers. Shoreline mapping on numerous lakes and helicopter traverses were utilized in this area.

Rock types encountered in the southern portion of the Lower Churchill River Project area are similar to those observed in the Churchill River region (Corkery and Lenton, 1979) and, consequently, field descriptions of these rock types will not be included here. This report will focus mainly on the extensive areas of supracrustal rocks that were observed across the southern portion of the area and on the segment of the Churchill-Superior boundary zone that occupies the southeast corner of the area.

GENERAL GEOLOGY

The major portion of the map area falls within the Churchill Province. This area is subdivided into a series of generally east trending belts of major intrusive and supracrustal geologic associations. The southeastern corner of the area, the Assean Lake-Orr Lake area, contains a complex boundary zone between the Superior and Churchill Geologic Provinces.

The Churchill segment of the map area can be subdivided into five major belts, Figure GS-4-2. In the Mynarski-Pearson Lakes region a series of metasedimentary gneisses, migmatites and associated intrusive rocks represent the eastward continuation of the north flank of the Kisseynew Sedimentary Gneiss Belt. To the north of the belt an intrusive suite dominated in the west by biotite or hornblende-biotite granodiorites and granites and in the east by

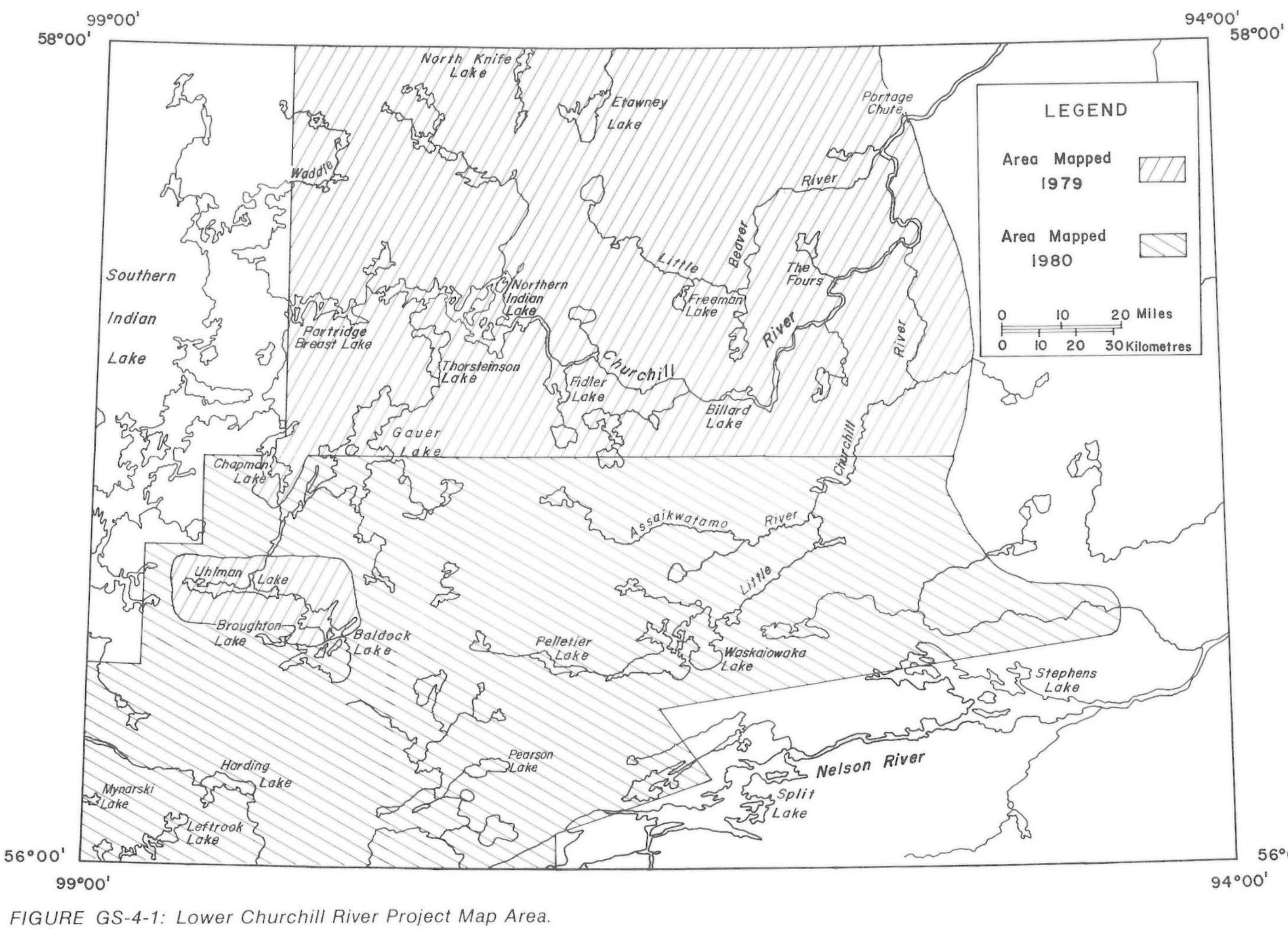

FIGURE GS-4-1: Lower Churchill River Project Map Area.

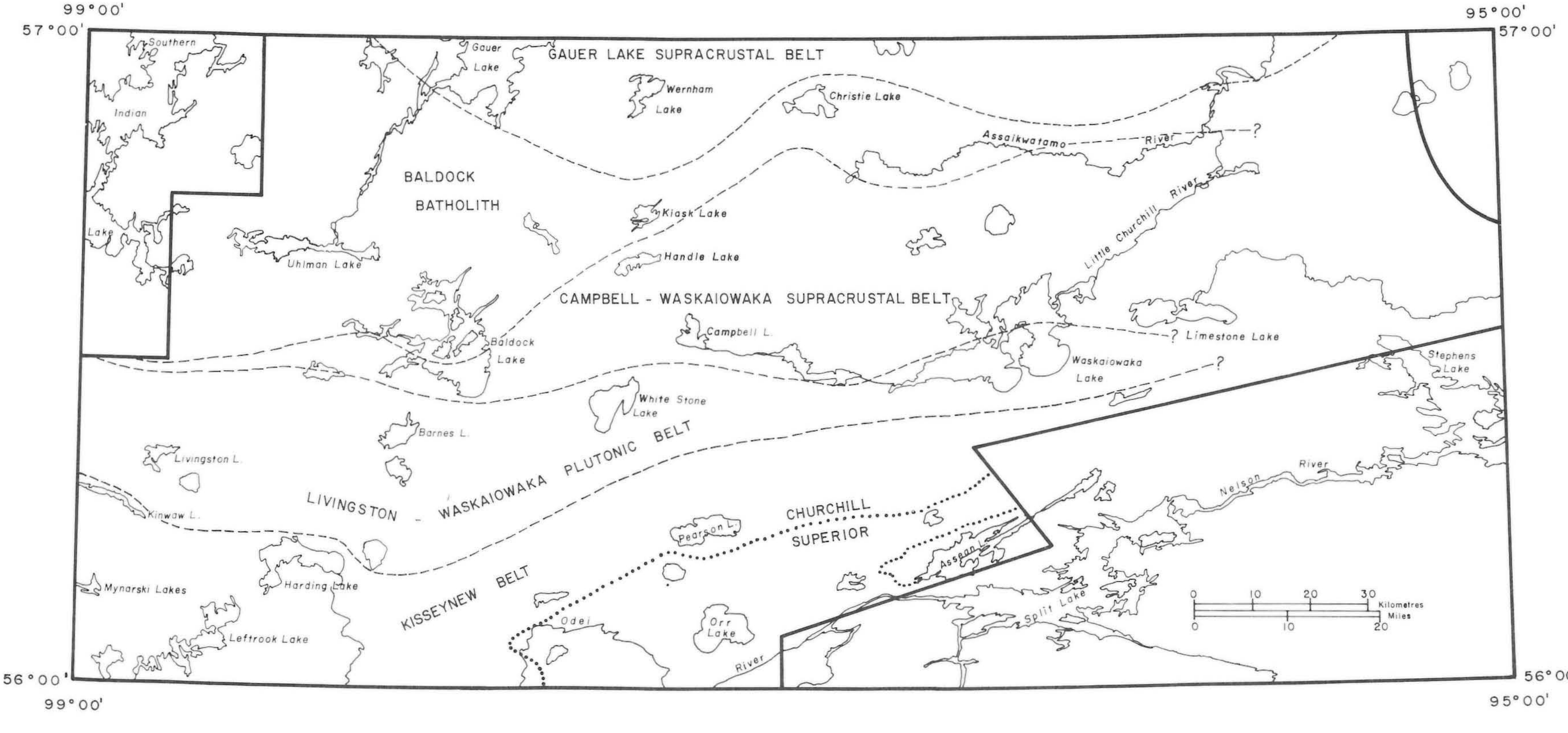

FIGURE GS-4-2: Major lithologic belts of the southern portion of the Lower Churchill River Project area.

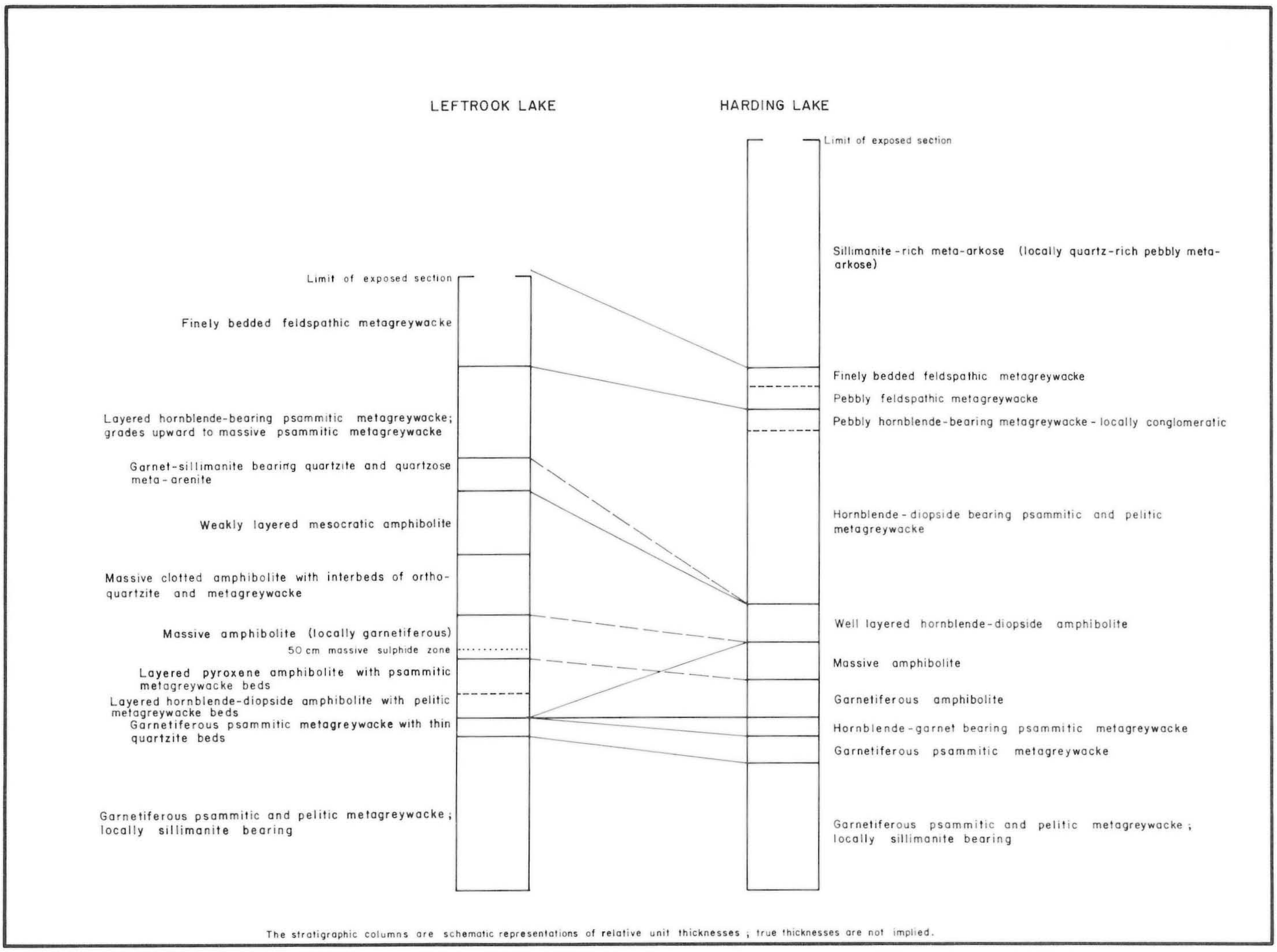

FIGURE GS-4-3: Schematic stratigraphic sections for the supracrustal rocks exposed on Leftrook and Harding Lakes.

granites forms the Livingston-Waskaiowaka Lakes Plutonic Belt. A narrow belt of metasedimentary and metavolcanic rocks marking the eastern extension of the Rusty Lake Greenstone Belt passes through the southern portion of Baldock Lake. The belt broadens to the east through the Campbell Lake-central Waskaiowaka Lake region where metagreywacke, amphibolites and numerous related intrusive rocks are the dominant rock types. The Baldock Batholith covers an extensive region from the western boundary of the project area through the area between Baldock and Gauer Lakes. It appears to be continuous into the Christie Lake-Assaikwatamo River area. The most northerly belt consists of the migmatites on Gauer Lake which are associated with the Partridge Breast Lake metasedimentary belt (Corkery and Lenton, 1979).

Kisseynew Supracrustal Belt

The generalized three fold subdivision of the Kisseynew gneisses into Burntwood Metamorphic Suite* metagreywacke and Sickle Metamorphic Suite* metagreywacke and meta-arkose separated by a sequence of amphibolites is valid for this belt. Rocks of the Burntwood Suite are dominant in the south with Sickle Suite rocks lying along the intrusive contact with the Livingston-Waskaiowaka Plutonic Belt in the north.

Detailed stratigraphic sections were examined on Leftrook Lake and Harding Lake (Fig. GS-4-3). Although the sections observed differ in detail in the two locations a generalized sequence comprises a transition from a thick section of metagreywacke into a complex and varied sequence of amphibolitic gneisses. These are overlain, in order, by hornblende-rich psammitic gneiss, magnetiferous wackes and sillimanite-rich arkoses and wackes. The section examined on Leftrook Lake exhibited excellent detail of the transition from the Burntwood Suite to the Sickle Suite, but only the lower portion of the Sickle stratigraphy is exposed. On Harding Lake deformation has attenuated the transitional sequence but the section exposed contains more of the Sickle section than is exposed to the west. Many of the units mapped appear to be local features and the stratigraphic sections show considerable lateral variation. Mynarski, Leftrook and Harding Lakes all lie on the south margin of the same belt of Sickle Suite rocks at approximately 20 km intervals but show remarkable variations in sections. Quartzites and quartzose meta-arenites occur on Leftrook Lake but are absent on Harding Lake yet can be correlated with a garnetiferous quartzofeldspathic gneiss on Mynarski Lake (Elphick, 1972). The metaconglomerates and pebbly metagreywackes mapped on Harding Lake were not encountered anywhere else in the Mynarski-Pearson region.

*terminology under revision

Assean-Orr Lake Area

A segment of the Churchill-Superior boundary zone is exposed in shoreline outcrops on Assean Lake. A complex series of fault bounded slices of Churchill supracrustal rocks, reworked Archean gneisses of Superior Province affinity, and tonalitic gneisses of unknown affinity were encountered here. Broad linear to slightly arcuate cataclastic zones with associated thin mylonitic zones occur as relatively continuous features interrupting the geologic continuity. These generally trend 030°, 060°, and 090° and are cut by north-trending minor faults. The complexity of these fault zones has prohibited the establishing of a time sequence and only some major relationships are described here.

Superior Province association rocks are the same units mapped on Split Lake (Corkery, 1977) and consist of:

1. Clotted granodiorite: A medium grained grey to dark grey granodiorite with mafic knots up to 5 mm wide consisting of amphibole, biotite and minor garnet. Numerous inclusions of amphibolite and altered ultramafic rock occur in the granodiorite.
2. Tonalite gneisses and amphibolite gneisses: These vary from massive layered greenish-grey and white gneisses to highly foliated gneisses which have been reworked during the Hudsonian orogeny.
3. Amphibolite and layered amphibolite: Massive to compositionally layered non-foliated hornblende-plagioclase hornfels.
4. Gabbro dykes.
5. Fox Lake granite.

These units are recognized in Burntwood Bay and west along the shore of Assean Lake. Most units can be traced into the major cataclastic zones of the southeast side of Assean Lake. They occur in all stages of cataclasis and can be mapped into the mylonite zones.

A block of Churchill supracrustal rocks occupies the central portion of Assean Lake and can be traced from the southwest shore through Lindal Bay to the northeast.

Burntwood River Metamorphic Suite garnetiferous and locally staurolite-bearing metagreywacke gneisses form the base of the section. These are overlain by a variable sequence of amphibolites containing the typical layered hornblende-diopside granofels and more massive, sulphide-bearing amphibolites which in the Lindal Bay area have a volcanic origin. These amphibolites have been extensively drilled by a number of companies and showings of sulphide mineralization in gossan zones exist at the Lindal vein and the Dunbrack vein (described in Haugh, 1969). The amphibolites are overlain by Sickle Suite metasedimentary gneisses in a few localities at the southwest end of the lake. The Sickle Suite rocks generally border the cataclastic zones and are poorly preserved.

A series of leucotonalites and related amphibolites observed in the central portion of the lake appear to be individual slices between the fault zones and in some cases may intrude the Churchill supracrustal rocks. Their affinity to either Churchill Province or Superior Province rock types has not been established.

METAMORPHISM

Metamorphic grade throughout most of the area attained uppermost amphibolite grades. Partial melting is evident in most of the supracrustal rocks. The degree of partial anatexis ranges from metatexites averaging 20 to 30 volume% granitic component in the Mynarski-Pearson region to extensive areas of diatexites (60% or more granitic component) and schlieric anatexites in the south Baldock-Campbell Belt. Many of the older intrusive units show evidence of partial anatexis.

Two isolated areas of lower metamorphic grade were encountered. From central Gauer Lake north to Partridge Breast Lake (Corkery and Lenton, 1979) an area of lower to middle amphibolite grade rocks completely lacks an anatectic component. In the southeast part of the area extensive exposures on Assean Lake are of middle amphibolite grade staurolite-bearing metagreywackes. These are the only staurolite-bearing rocks encountered in this area.

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GS-5 THOMPSON NICKEL BELT PROJECT

(Parts of 63 O/1, 2)

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

INTRODUCTION

Geological mapping (1:25 000) of the Thompson Nickel Belt continued in the Halfway Lake area as part of an ongoing study of the Churchill-Superior boundary zone. Halfway Lake is approximately 22 km long and 3 km wide. It possesses a complex shoreline with long peninsulas and contains numerous islands. The quality of outcrop is variable and ranges from poor to excellent. Preliminary correlations with some rock types from Moak, Ospwagan, Paint and Liz Lakes has been attempted with some success. The following text concentrates on geological aspects observed on those parts of the shoreline which are well exposed. Age relationships are not implied by the order in which the units are discussed. The rocks are described from the most mafic to the most leucocratic types.

AMPHIBOLITE (1)

Amphibolites have been divided into sill and/or dyke-like plagioclase amphibolite (1a), garnet-bearing amphibolite (1b) and amphibolite with internal structure (1c). At least one of the amphibolites has a different age and different origin from the others.

Plagioclase amphibolites (dyke/sill-like) (1a)

Plagioclase amphibolites (1a) occur as sill and/or dyke-like masses in units 2, 3, 6a and 6b. They are commonly uniform in thickness, colour and texture. They range from 3 to 100 cm thick and thickness is constant over the outcrop length. Some are segmented or boudinaged, and some are folded.

The dark grey colour is uniform across the sill/dyke-like bodies except for contacts where the concentration of amphibole up to 4 mm wide gives rise to a dark green to black rock. Bodies that are more attenuated possess a less intense colour and range from dark grey to slightly lighter shades.

Contacts are always sharp. Some contacts are discordant up to 5° with the foliation of the host gneiss. This discordancy might reflect an original discordancy and therefore suggests that those discordant plagioclase amphibolites were originally dyke-like in form. Some of these bodies might, therefore, belong to the Molson swarm, recognized in the adjacent Pitwitonei region (Hubregtse, 1978, 1979; Scoates and Macek, 1978).

Garnet-bearing amphibolites (1b)

Garnet-bearing amphibolites (1b) form inclusions, lenses and small bodies rarely exceeding 5 m in size. They are irregularly distributed in migmatites (6) and in fault and shear zones in unit 3. In those rare examples that display compositional layering, the textures are similar to those of the metagabbro complex of Paint Lake (Macek and Russell, 1978). The main difference is that large bodies of the Paint Lake type were not found on Halfway Lake.

Amphibolites with internal structures (1c)

These amphibolites form a series of larger bodies in a zone 7 km long, in the middle of the southwest half of the lake. They are closely associated with foliated granitic gneiss (4). The weathered surface is inhomogeneous with bands of dark, multi-hued shades of green. The colour is dependent on the mineralogical composition of the bands, the most common minerals being amphibole (55-60%), and plagioclase (40-45%), with variable amounts of quartz, epidote, clinopyroxene, garnet and sulphides. The rock is fine grained and lineated and seldomly displays a strong foliation. Compositional bands may be straight, curved or contorted into complicated patterns. Similar structural features were observed at Liz Lake (Macek and Russell, 1978) where they are associated with pillowed structures. However, the original nature of the bands remains obscure and it is not known what kind of deformed volcanic structures they represent. Thus this amphibolite is interpreted to be of metavolcanic origin.

These ampibolites also contain strings, pods and contorted veins of quartzofeldspathic mobilizate that in colour and grain size is similar to mobilizate observed on Paint and Liz Lakes, except that it does not contain orthopyroxene. Some amphibolites with internal structure are interlayered with fine grained, well foliated plagioclase (70%)-quartz (20-25%)-biotite (5-10%) gneiss that weathers brownish-yellow and is white to light blue on the fresh surface. The layers are 5 to 150 cm wide, and form up to 40 per cent of the outcrop by volume. In a few places, the fine grained gneiss is intrusive into the amphibolite. The fine grained gneiss is only associated with this amphibolite and larger bodies were not found.

HORNBLENDE-PORPHYROBLASTIC, HORNBLENDE-BIOTITE-FELDSPAR GNEISS (2)

The mafic gneiss forms a large, nearly homogeneous body which is exposed for 5.5 km along the southeast shoreline of the lake. The rock weathers dark greyish-green with a variable pinkish tint depending on the amount of potassium-feldspar present. It is dark greenish-grey with a pinkish tint on the fresh surface. The hornblende porphyroblasts range from 3 to 10 mm long and contribute a distinctive spotty character to the rock. The stubby hornblende crystals are regularly disseminated in the rock and are elongated parallel to the foliation. Many hornblende cross-sections display a rectangular to elliptical brownish core with dark green rim on the fresh surface, and this is tentatively interpreted as a bastite alteration of original orthopyroxene. This suggests that the rock possibly reached granulite facies of metamorphism. Porphyroblasts form 15 to 20 per cent of the total volume of the rock.

The groundmass consists of slightly elongated grains of feldspar (30%), hornblende (20%) and biotite (5 - 10%), 1 to 3 mm in size.

Potassium-feldspar is commonly associated with quartz and occurs as augen, string-like lenses and pinch-and-swell horizons. The string-like lenses and the pinch-and-swell horizons are 1 to 3 cm thick and nearly regularly distributed parallel to the foliation in 10 to 15 cm intervals. The potassium-feldspar is considered to represent a period of potash metasomatism. Pink pegmatite dykes, veins, nests and lenses are common, amphibolite inclusions are rare. Only one dyke-like body of homogeneous plagioclase-amphibolite, was found in this unit (see Fig. GS-5-1).

The contacts between this unit and the other units are not exposed; however, on the basis of the observed intensity of shearing and cataclasis they are presumed to be tectonic. This unit is interpreted to be retrogressed and metasomatized mafic granulite gneiss. A unit at the south end of Paint Lake that is characterized by large potassium-feldspar porphyroblasts (Charbonneau, Scoates and Macek, 1979) may also represent metasomatized mafic granulite; however, there is no unit on Moak, Ospwagan and Paint Lakes that would be texturally comparable with this rock.

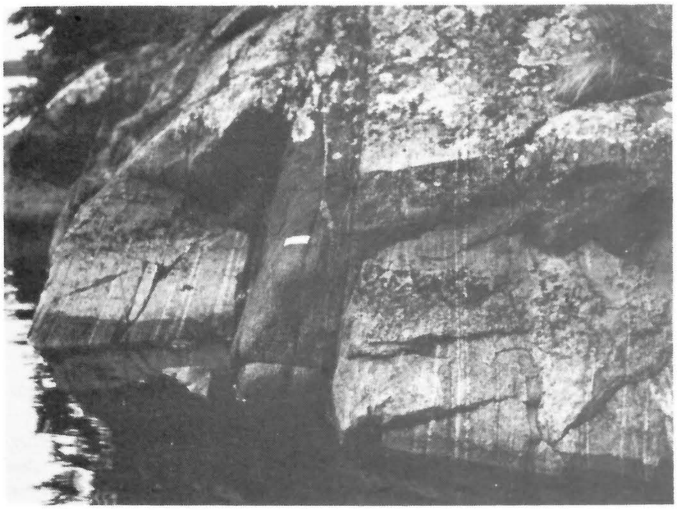


FIGURE GS-5-1: Hornblende porphyroblastic, hornblende-biotite-feldspar gneiss (unit 2) with plagioclase amphibolite (unit 1a).

FIGURE GS-5-2: Plagioclase-quartz-biotite-garnet (± magnetite) gneiss (unit 3) with plagioclase amphibolite (unit 1a).

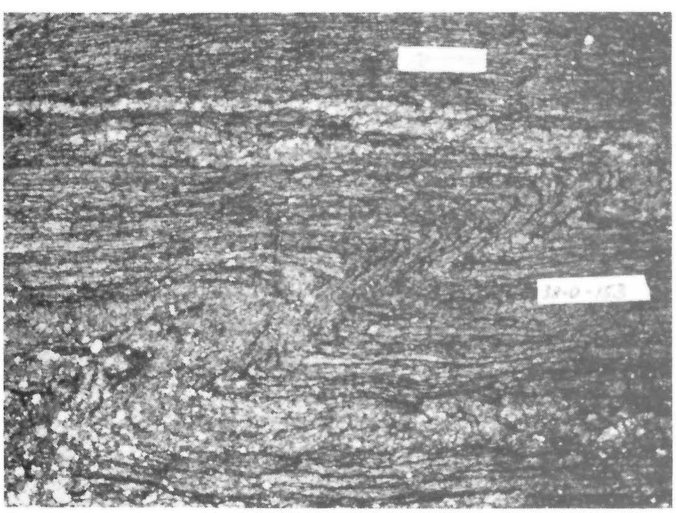
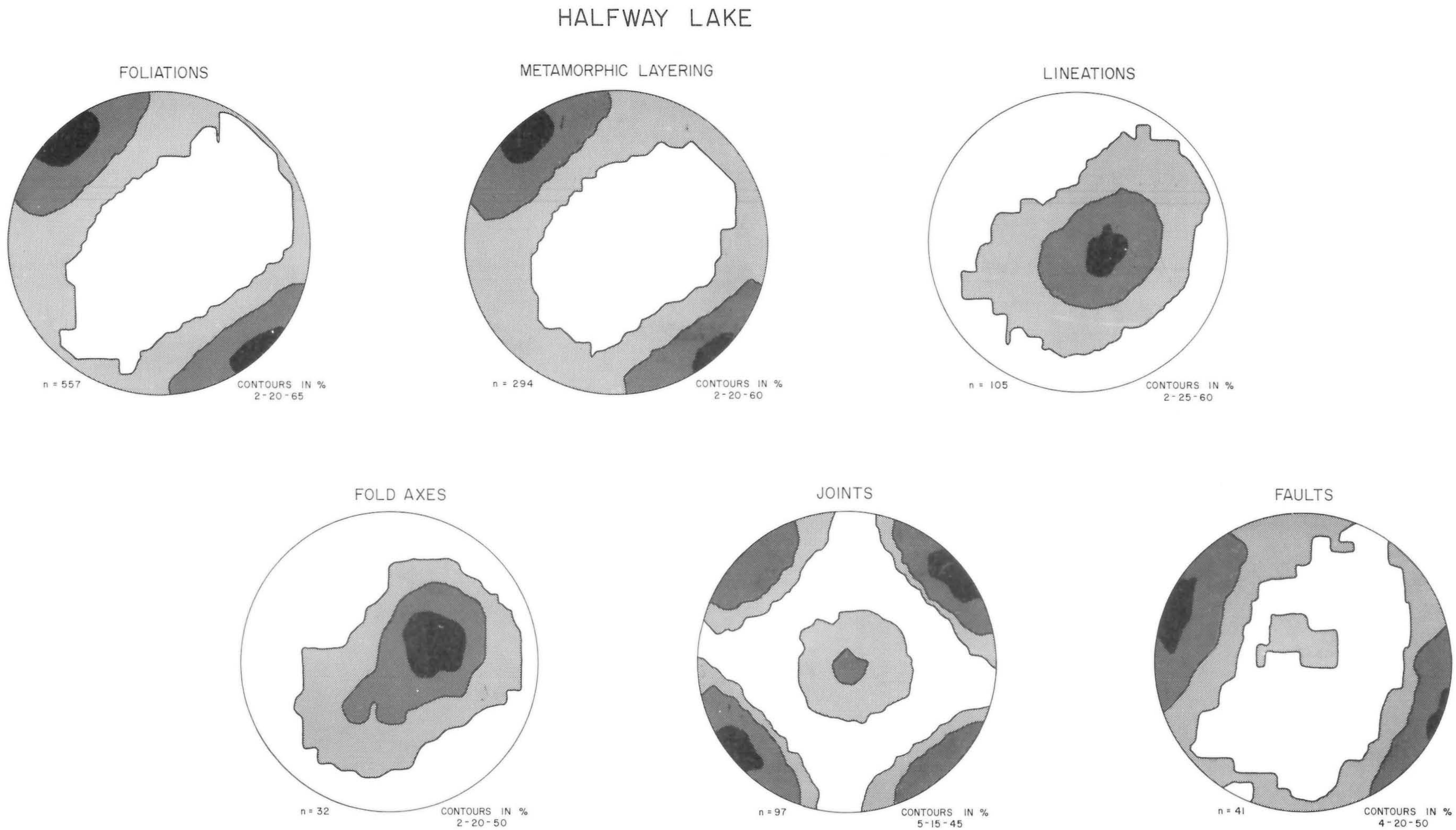


FIGURE GS-5-3: Bluish-grey stromatic, cataclastic gneiss (unit 6d).



STRUCTURAL ELEMENTS

	POLES	STRIKE/DIP		POLES	STRIKE/DIP
FOLIATIONS	319/88	049/88	JOINTS	315/87	045/87
METAMORPHIC LAYERING	319/86	049/86		050/90	140/90
LINEATIONS	110/74			175/04	265/04
FOLD AXES	068/62		FAULTS	290/86	020/86

FIGURE GS-5-4: Stereograms of basic structural elements with a record of angular coordinates of the main maxima.

PLAGIOCLASE-QUARTZ-BIOTITE-GARNET (± MAGNETITE) GNEISS (3)

The gneiss forms a series of outcrops for 7.5 km along the middle of the northwest shoreline of Halfway Lake. The gneiss is homogeneous on the outcrop scale; however, in detail it consists of diffuse, nebulitic bands of variable biotite content. The rock is light honey-brown on the weathered surface, and greyish-white with short black streaks formed by biotite on the fresh surface. A variable pinkish tint may be present depending on the content of potassium-feldspar.

The rock which is medium grained (individual crystals ranging from 1 to 3 mm) and well foliated consists of plagioclase (40%), quartz (30%), biotite (20%), garnet (1-5%), magnetite (0-3%) and variable amount of potassium-feldspar. Quartz and plagioclase occur as isometric to slightly elliptical grains that form an interlocking granular texture. Biotite which forms almost equally spaced streaks or clusters of subparallel flakes, 3 to 5 mm in length, does not cover the foliation plane continuously. The size and shape of the short streaks and clusters suggests that biotite may have formed after hornblende. The presence of disseminated and fine grained garnet (1 mm), and magnetite (1-8 mm), together with the characteristic textural features, suggest that the biotite clusters might be pseudomorphic remnants of original pyroxenes and that the gneiss once reached the granulite facies of metamorphism. Since similar rocks still in granulite facies were observed at Sipiwesk Lake (Hubregtse, 1977, 1978) it is tentatively concluded that this unit might be retrogressed Pikwitonei leucocratic granulite gneiss. The nebulitic character of the rocks suggests a high degree of homogenization at high P-T conditions.

Mafic inclusions are rare except for sill and/or dyke-like bodies of plagioclase-amphibolites (1a) (Fig. GS-5-2). Some outcrops are free of them whereas some display swarms of 3-9 members. The plagioclase amphibolites display sharp contacts, have constant width on outcrop scale and possess even grain size and texture. These observations indicate deformation of these rocks under low P-T conditions which is incompatible with the observed textures of the host gneiss. This suggests that these sill/dyke-like amphibolite bodies postdate the granulite facies metamorphism and the migmatization suffered by the host rocks.

The gneiss unit was subject to a varying degree of penetrative cataclastic deformation as is evident from a number of shear, cataclastic and pseudotachylite zones accompanied by the potash metasomatism. The content of potassium-feldspar gradually increases with the intensity of deformation and it is distributed throughout the rock giving it a pinkish tint. In places pearl and augen textures are present as a result of metasomatism and deformation. With an increased intensity of penetrative deformation, the habit of biotite changes from short streaks and clusters and it becomes more evenly distributed in the foliation plane. This is commonly associated with a decrease in the garnet and magnetite content and some outcrops are found where garnet and magnetite are absent.

The fresh surface becomes bluish-grey with pink bands of potassium-feldspar. The rock is then a cataclastic, stromatic blue-grey gneiss. Rocks that are almost identical have been observed at Moak, Mystery, Ospwagan and Paint Lakes where they have been termed "Moak Lake Gneiss" (Scoates, Macek and Russell, 1977). At Paint Lake this gneiss forms a significant component of the multicomponent migmatite (Macek and Russell, 1978). In other outcrops the gradual increase in potassium-feldspar content gives

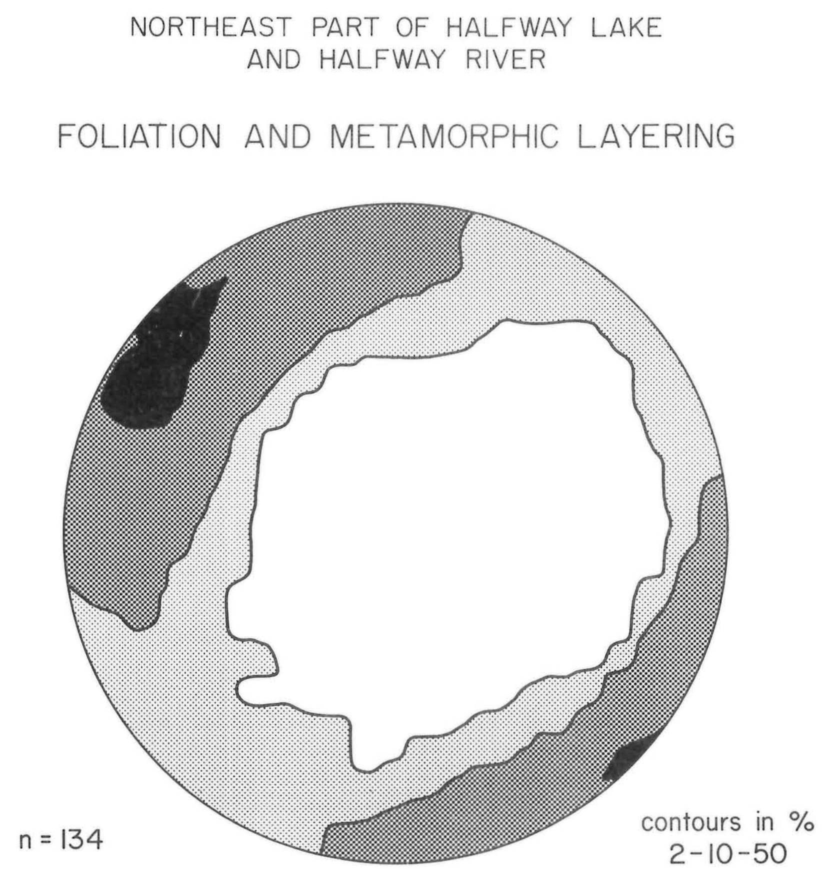


FIGURE GS-5-5: Stereogram of combined foliation and metamorphic layering from the northeast part of Halfway Lake and Halfway River.

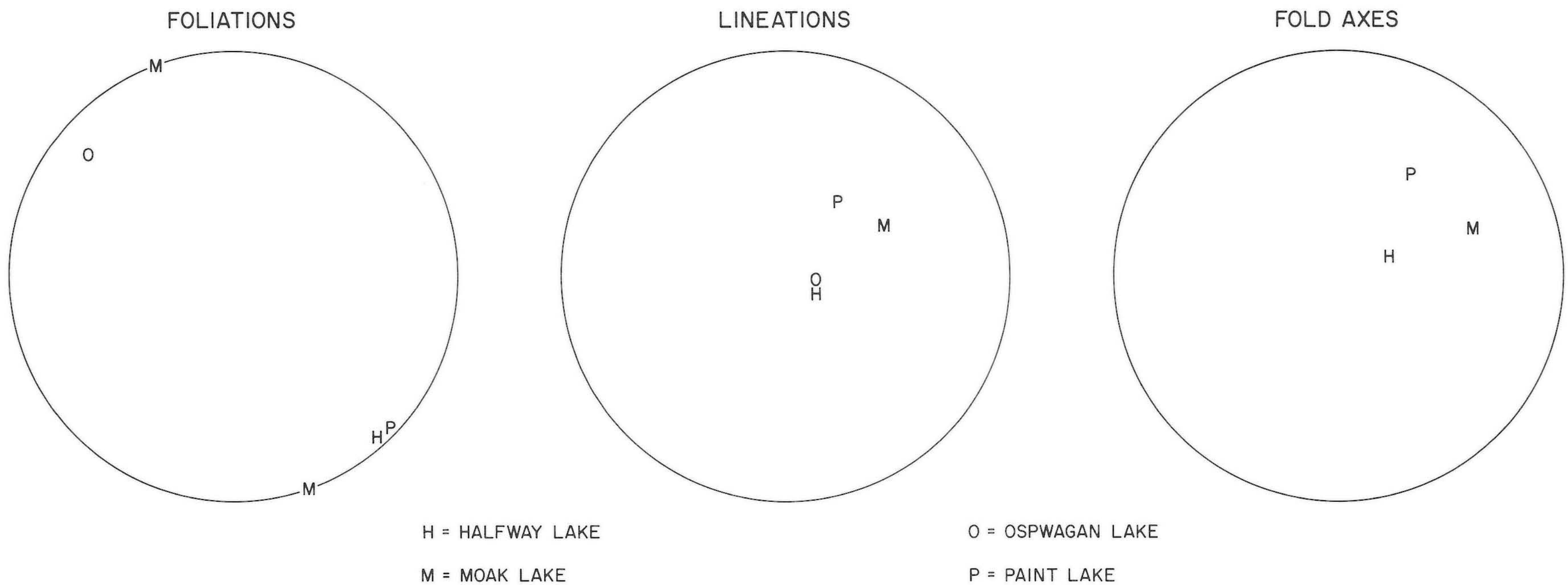


FIGURE GS-5-6: Comparison of the main structural elements from Halfway, Moak, Ospwagan and Paint Lakes on the Wolf net. The structural data are from Moak Lake type gneisses and migmatites.

rise to poorly foliated granitoid rocks. In other cases, various types of augen gneiss have been observed.

PINK, GRANITIC GNEISS (4)

A series of small elongated bodies of granitic gneiss are exposed in the middle of the southwest half of the lake. Most of the outcrops are homogeneous with very few faint schlieren that are slightly enriched in biotite. The rock is pink on weathered and fresh surfaces, fine to medium grained and poorly foliated for the most part. It consists of feldspars (60-65%), quartz (25-30%) and biotite (10%). Pegmatite nests and veins are common. The pink, granitic gneiss is closely associated with the zone of the amphibolites of proposed metavolcanic origin (1c).

GREY, HORNBLENDE-BIOTITE GNEISS (5)

The gneiss is exposed on a few islands and reefs in the middle of the northeast half of the lake. The rock is grey to very light beige on the weathered surface and very light grey with a pinkish tint on the fresh surface. It is medium grained and well to poorly foliated. It consists of plagioclase (40%), quartz (30%), hornblende (15%), biotite (15%) ± potassium-feldspar. No xenoliths or inclusions were observed. Few pegmatite veins and nests are present.

MIGMATITE (6)

The migmatites are similar to those previously described from Paint Lake (Macek and Russell, 1978) and comprise various gneissic components including one similar to Moak Lake gneiss. Leucocratic rocks and amphibolitic inclusions are the other significant components. The migmatites are exposed dominantly in the northeast part of the lake, and at different locations in the rest of the lake. They consist of various structural types including agmatite and schollen structures (6a), stromatic and/or folded structures (6b); cataclastic and mylonitic structures (6c). Individual outcrops usually display one dominant structural type of migmatite but in some outcrops two or three types are present. Some outcrops are homogeneous gneiss of the Moak Lake type; however, if an area several kilometres in size is considered, these outcrops form part of a large-scale migmatite. These Moak Lake type gneisses are medium grained, bluish-grey stromatic cataclastic rocks that are composed of plagioclase-quartz-biotite (± hornblende, ± garnet, ± potassium-feldspar). These rocks grade into migmatites on the one hand or retrogressed granulite gneiss on the other hand. They seem to be a result of tectonic modification accompanied by variable intensity of potash metasomatism at rather low P-T conditions. They are designated as (6d) (see Fig. GS-5-3). Highly siliceous, commonly layered and very fine grained rocks of very limited occurrence are designated (6e). These rocks are interpreted as ultramylonites.

PEGMATITE (7)

Pegmatites intrude all units and vary in colour from white to pink, with the latter being the most common. They commonly intrude foliation planes, fault and shear zones and form irregular bodies. Some possess a weak foliation.

STRUCTURAL GEOLOGY

Statistical treatment of the basic structural data collected from Halfway Lake is represented by Figure GS-5-4, together with the average angular coordinates of the main maxima.

The metamorphic layering is almost parallel with the foliation. A gradual change in strike, indicated by a girdle connecting the main maxima on the circumference of the stereoplot, represents a major fold, which is responsible for the shape of the Halfway River at the northeast end of the lake. Structural data on the map (Macek, 1980) document this fold in two places. This major structure is interpreted as an overturned antiform with an axial plane 048°/82°, and steeply plunging axis 062°/78° (derived from a stereoplot representing 134 stations — Fig. GS-5-5).

A preliminary comparison of the foliations, lineations, and fold axes from Moak, Ospwagan, Paint and Halfway Lakes is represented by Figure GS-5-6. The poles of the most distinct maxima are plotted into the Wolf net in order to see undistorted angular relationships. These data indicate that the Thompson Nickel Belt consists of structurally different blocks that reacted differently to the stress field or fields related to the Thompsonian event.

SUMMARY OF OBSERVATIONS ON HALFWAY LAKE

1. The textural, structural and mineralogical observations made on the outcrops of units 1c, 2 and 3 suggest that these rocks were at high P-T conditions which likely reached granulite facies conditions of metamorphism at some time in their history. These rocks represent relict blocks that have been modified by later events yet retain features diagnostic of their earlier high P-T metamorphism.
2. The margin of unit 1c shows evidence of partial melting and migmatization under moderate to high P-T conditions. Units 6a and 6b are derived at least in part from units 2 and 3 and from a suite of metavolcanic rocks.
3. Unit 1a is considered to be younger than the age of migmatization of the host rocks. It is possible that this unit may be related to the Molson dyke swarm (Scoates and Mecek, 1978; and Hubregtse, 1979), a suite of mafic and ultramafic dykes of possible Aphebian age that are found in the adjacent Pikwitonei region. If this is the case, the host rocks would be Archean. This would support arguments of Hubregtse (1979) for the area to the east where he finds that the Molson dykes separate rocks that have suffered the Kenoran orogeny from rocks that have suffered the later overprinting (Hudsonian?) event.
4. Unit 1a and all host rocks were reoriented by penetrative deformation under low P-T conditions, into the northeast "Thompsonian" direction. The reorientation was accompanied by cataclasis and shearing in some areas and also by extensive potash metasomatism which is more pronounced on Halfway Lake than on Paint Lake.
5. The overprinting event (Thompsonian event) in the Halfway Lake area is characterized by low temperature penetrative deformation, extensive potash metasomatism and retrogression. The water necessary for retrogression could be associated with the potash metasomatism.

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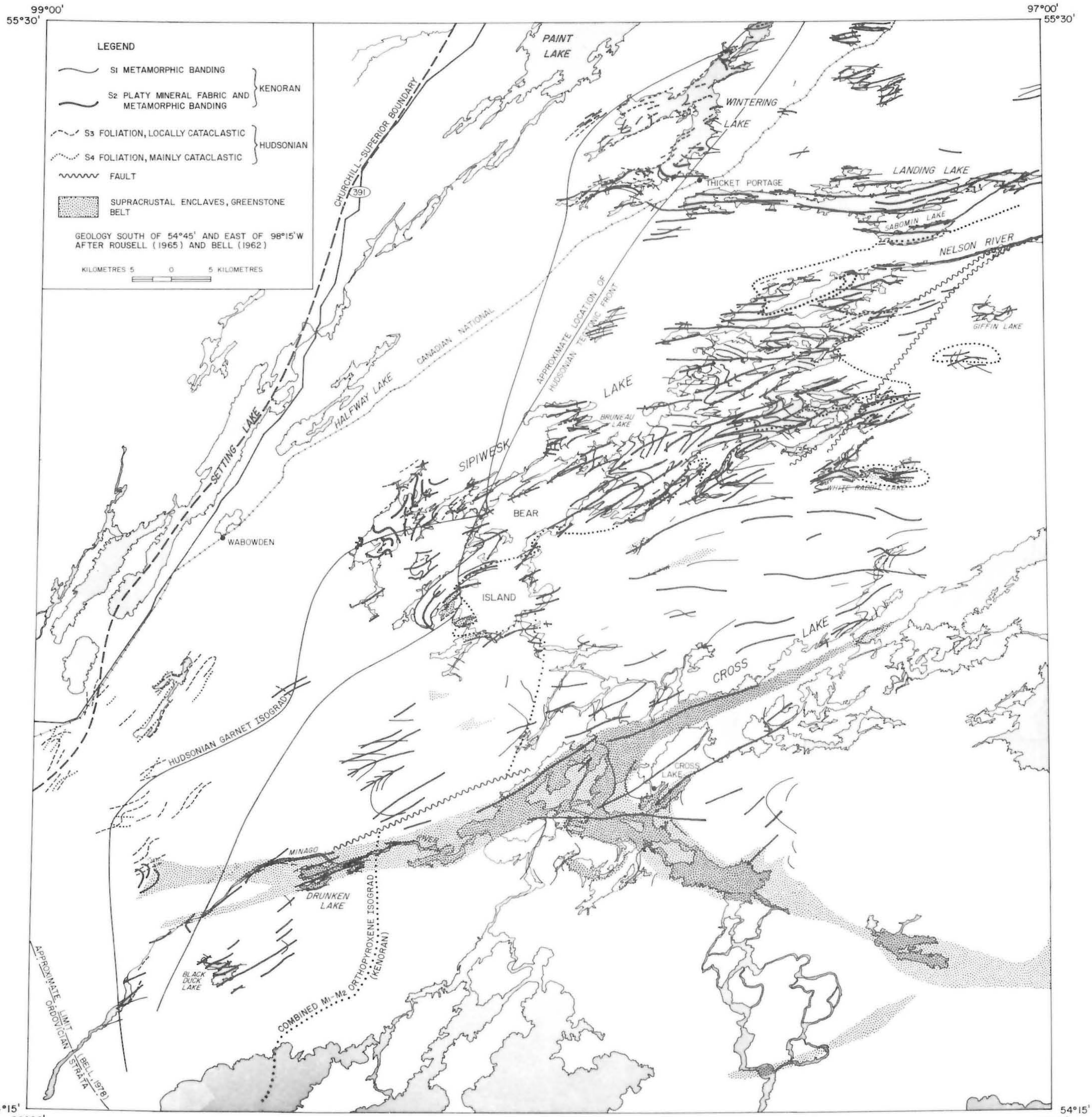

FIGURE GS-6-1: Structural map of southern Pikwitonei Granulite Domain and Thompson Mobile Belt. Superior-Churchill Boundary after Geological Map of Manitoba (Manitoba Mineral Resources Division, 1979).

GS-6 CLARKE LAKE-MINAGO RIVER AREA

(63J/10 and parts of 63J/9 & 15)

by J.J.M.W. Hubregtse

INTRODUCTION

Mapping of the southernmost exposed part of the Archean granulite facies Pikwitonei region and the Thompson Mobile Belt (Hubregtse, 1979 and 1980a) was continued in the Wabowden-Ponton-Minago River area during this field summer (Hubregtse, 1980b, c). This area covers the complete transition from Archean granulite to the southeast, through retrograded and reoriented Archean gneisses in the Thompson Mobile Belt with an attendant increase of Aphebian felsic plutonic components, to the Aphebian supracrustal and plutonic rocks of the Churchill Province in the Gormley Lake-Setting Lake area. A second late-Hudsonian deformational event (D_4) becomes increasingly manifest northwest of Muhigan Lake. Detailed lithologies and a metamorphic and structural history of the Pikwitonei region and the Thompson Mobile Belt are given in earlier reports (Hubregtse, 1977, 1978, 1979 and 1980a).

Anorthosite exposures at Pipestone Lake, the Minago River, Bruneau Lake and Sipiwesk Lake were reinvestigated and sampled for isotope and REE analyses, as part of a joint anorthosite research project with W.C. Phinney and co-workers (NASA, Houston).

MAP SHEET 63J/9 (DRUNKEN LAKE)

The area north of the Minago River is underlain by Archean granulites and subordinate amphibolite facies gneisses, which are similar to those of the Sipiwesk Lake-Landing Lake region (Hubregtse, 1977, 1978). The gneisses were not affected by Hudsonian retrograde metamorphism. The large bend in the road to Jenpeg follows higher ground which mimics an underlying large-scale F_2-fold, of which the southern limb is truncated by an east-northeast-trending late D_2-shearzone. The deflection of the orthopyroxene isograd in this area suggests right-lateral movement along the shear zone (Fig. GS-6-1). However, Bell's mapping (1978) of the Minago River anorthosite indicates a left-lateral displacement. F_3-folds and S_3-tectonites become evident near the northwest corner of the map sheet in the Muhigan River area, where also Hudsonian metasomatism of Archean gneisses was documented, similar to that described from western Sipiwesk Lake (Hubregtse, 1978). A garnet-bearing Molson diabase dyke at the Muhigan River confirms the Hudsonian (M_3) metamorphic zonation mapped in adjacent areas (Fig. GS-6-1).

MAP SHEET 63J/10 (MUHIGAN LAKE)

Kenoran amphibolites, garnet amphibolites, flaser metagabbros and biotite-quartz-feldspar gneisses were documented at eastern Waskik Lake and southern Muhigan Lake. These rocks are similar to the supracrustal gneisses mapped at Drunken Lake (Hubregtse, 1979) and appear to constitute the westernmost extremity of the Cross Lake greenstone belt. No granulites occur in this map-area north of the Minago River.

All Archean rocks in this area were involved in the Hudsonian orogeny. The Lily Lake-Waskik Lake area is underlain by migmatitic S_3-tectonites composed of, originally potash feldspar-poor, granitized Archean gneisses and pre-D_3 Aphebian fine-to medium-grained metaleucotonalite, metagabbro (Molson diabase) and increasing volumes of pre- and post-D_3 granite, granodiorite and pegmatite towards the northwest. The area between the Superior-Churchill boundary and Muningwari Lake is underlain by alternating large-scale layers of late-Hudsonian (post-D_3) granitic to leucotonalitic plutonic, locally magnetite-bearing rocks and potash feldspar-enriched S_3-tectonites, which were granitized during the pre-D_3 plutonic event and subsequently regranitized by the post-D_3 intrusives.

Large-scale D_3-structures prevail in the southern part (Waskik Lake). Younger large-scale D_4-structures underlie the area north of Fraser Lake, while older Kenoran D_2-structures occur towards the south and east. This tectonic zonation of the edge of the Superior Province reflects the increase of structural complexity with time towards the Superior-Churchill boundary. A similar but narrower spaced zonation occurs in the Wintering Lake-Paint Lake region (Hubregtse, 1978; Charbonneau *et al.*, 1979). F_3-fold axes plunge generally moderately steeply to the northeast, while F_4-fold axes plunge commonly moderately steeply to the southwest. Increasing D_4-strain towards the northwest leads to transposition of the earlier F_3-fabric into the S_4-direction. Since a conspicuous marker horizon is lacking, it becomes increasingly more difficult to identify the two structural elements, particularly in the Clarke Lake-Manibridge area.

Molson dykes provide an excellent marker horizon separating Kenoran (D_1 and D_2) from Hudsonian (D_3 and D_4) deformational events. Unfortunately the commonly equigranular diabase dykes become increasingly more difficult to recognize towards the Superior-Churchill boundary zone as structural complexity increases. Sporadic pre-D_3 plagioclase-phyric diabase dykes occur at Hill Lake and similar dykes were mapped at Lily Lake and the Manibridge mine site. These dykes may well be a variety of the Molson swarm. Because of their conspicuous porphyritic texture they stand out considerably better in the S_3 and S_4-tectonites, than the equigranular Molson dykes. Therefore, the occurrence of plagioclase-phyric diabase in the migmatite gneisses at the Manibridge mine site may suggest the presence of an Archean component. However, Kenoran structures are generally completely erased by the late-Hudsonian orogeny in the area north of Waskik Lake, and therefore direct structural and petrographic field evidence for an Archean component in the Hudsonian tectonites of the Clarke Lake-Manibridge area is lacking. Coats and Brummer's (1971) claim that the country rocks surrounding the Manibridge nickel deposit contain retrograde Archean granulites could not be verified.

The D_4-event in this map sheet-area also resulted in the obliteration of the M_3-Hudsonian metamorphic zonation as it was mapped in the western segment of the Pikwitonei Granulite Domain and the Thompson Mobile Belt (Hubregtse, 1978, 1979 and 1980a) in the Sipiwesk Lake-Wintering Lake area. Molson dykes just reach garnet amphibolite facies before they become retrograded and lose their textural and intrusive characteristics in the zone of high D_4-strain.

GORMLEY LAKE-HIGHWAY 391 REGION (CHURCHILL PROVINCE)

A sequence of migmatite and locally extensively mobilized metasedimentary gneiss underlies the area west of the Superior-Churchill boundary. It includes brown, garnet-biotite gneiss with sporadic well-preserved primary layering, and characteristic white, garnet-quartz-plagioclase-potash feldspar mobilizate, in which the garnets are frequently replaced by biotite pseudomorphs. It is concluded that the metamorphic grade was higher at the Churchill side during the late-Hudsonian event, since garnet is not found at the Superior side of the boundary. Other major rock types are leucocratic granitic gneiss with sporadic garnet and potash feldspar porphyroblasts, and fine-grained dense dark quartz-rich biotite-plagioclase paragneiss of which the latter is frequently interlayered with coarse-grained red, quartz-plagioclase pegmatite mobilizate streaks.

Gormley Lake is underlain by a large-scale D_4-fold. Whether the older folded structural element is the equivalent of S_3 of the Superior Province remains to be answered.

Coarse-grained hornblende monzonitic augengneiss occurs along the western shore of the small lake south of Gormley Lake and seems to mark the Superior-Churchill boundary fault zone. The augengneiss separates the metasedimentary gneisses of Gormley Lake from Thompson belt type migmatitic tectonites directly to the south.

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GS-7 MOLSON LAKE-KALLIECAHOOLIE LAKE PROJECT

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

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

Field work in the Molson-Kalliecahoolie Lake project area (Weber and Schledewitz, 1979) was completed this summer.

The purpose of the 2 year project was: (a) to upgrade the geological mapping in this well exposed granitoid terrane to a scale of 1:100 000 and (b) to evaluate a chain of URP anomalies which were detected during an aerial Gamma-ray survey in 1977 (G.S.C. Maps 35963G, 36153G, 36253G).

W. Weber and K. Chase (1980), completed mapping between 96° and 98° longitude and D.C.P. Schledewitz (1980) finalized the coverage between 93° and 96° longitude (Fig. GS-7-1). Previous mapping was conducted by Bell (1961), Currie (1960) and Downie (1936) at the scale of 1:250 000.

Whereas the 1979 fieldwork was concentrated on the shorelines of the larger lakes, e.g. Molson Lake, Beaver Hill Lake, etc., the 1980 data are based on surveys of the many small lakes which characterize the area. Fixed wing accessible lakes were mapped during 1 to 4 day fly camps. A 50-hour helicopter programme covered the less accessible areas.

In some regions, which contain 80 to 90% well exposed bedrock, less than 1% of the rocks were actually examined and certain features, such as mineralization, may have been left undetected. However, a denser coverage would probably not change the present interpretation of the geological history or the spectrum of rock units.

GENERAL GEOLOGY

Table GS-7-1 lists the main rock units which occur in the project area and indicates their age relationships. This legend is similar to last year's. The 1980 mapping has confirmed the distribution of the major rock types (Weber and Schledewitz, op. cit.) and the geological history, as presented in Table GS-7-2.

The supracrustal rock in unit 1 make up a discontinuous greenstone belt along the northern margin of the project area, from the Nelson River to Red Sucker Lake (Fig. GS-7-1). The variation of the lithologies in the different segments of the belt are listed in Table GS-7-3. The largest greenstone segment lies between Beaver Hill Lake and Rochon Lake. It also shows the greatest variety of lithologies. This segment defines a complex asymmetric Z fold. The northeast limb is bounded on the southwest by a mylonite zone. The south limb is an east trending upright isoclinal fold limb. The Red Sucker greenstone belt segment is offset right laterally from the Beaver Hill Lake-Rochon Lake belt. Aeromagnetic signatures over the drift covered area between these two segments suggest the presence of granitoid rocks and that the segments are not connected. Supracrustal rocks also form a chain of small lenses in the granitoid terrane from Aswapiswanan Lake toward Molson Lake and little Playgreen Lake.

Metabasalt (1a, 1b) makes up most of the supracrustal rocks in the discontinuous greenstone belt. At Logan Lake pillow structures are well preserved. In many places, however, pillow structures can only be inferred in discontinuously layered amphibolite which contains dark hornblendite streaks (representing original pillow selvages) and quartz-calc-silicate±garnet lenses which represent original intra-pillow material. Banded iron formation at Logan Lake is interlayered with mafic flows. Glomeroporphyritic gabbro (1d') at Logan Lake is genetically related to the "football" gabbro at Pipestone Lake. Anorthosite (1e) was observed at Hairy Lake. Its relationship with the supracrustal rocks is not exposed. Feldspar porphyry (1f) is restricted to Logan Lake and west of Aswapiswanan Lake.

Conglomerate (1h) appears to lie unconformably on rocks of unit 1a-1g, as exposed at Red Sucker Lake. Conglomerate and greywacke along the Echimamish River are likely also unconformable over the basic metavolcanics in this area. A correlative unconformity between amphibolite, and quartzite and greywacke-type metasedimentary rocks is exposed at the Nelson River. This unconformity is probably correlative with that between the Hayes River Group and the Oxford Lake Group in the Oxford-Knee Lakes area.

Tonalite gneisses to migmatites and agmatitic amphibolites (2) intruded by tonalites (3) form the southern margin of the eastern half of the project area. This belt is offset by 2 fault zones (Figure GS-7-1). Unit 2 also occurs marginal to the discontinuous greenstone belt along the northern margin of this project area. These amphibolites appear to be higher grade equivalents of the metabasalts (1a, 1b). Magnetiferous quartzo-feldspathic gneiss (2d) also might represent altered metavolcanic rocks. The interlayering between tonalitic rocks and amphibolites (2a, 2b) along the northern greenstone belt and north of the Island Lake belt is largely the result of tectonic interleafing.

The early plutonic rocks (units 3 and 4) make up most of the project area. The main plutonic phase was originally tonalitic. Leucotonalite (3d) represents a late magmatic differentiate which cross-cuts the earlier, more mafic hornblende±biotite-bearing, coarser grained phases. Late-magmatic potassium metasomatism affected parts of the plutonic rocks and produced potassium megacrysts in some rocks (unit 3e, 4a) and the presently observed range in composition from tonalite to granite.

Recrystallized mafic dykes (5) are widespread between Molson Lake and Joint Lake. They intrude units 1 to 4. Dykes less than 0.5 m in width are hornblende±pyroxene porphyroblastic, fine-to medium-grained metagabbro to amphibolite. Wider dykes are coarse grained hornblende±pyroxene gabbro with a finer grained, chilled margin which is mineralogically and texturally similar to the narrow dykes. These dykes postdate the major folding in the discontinuous greenstone belt, but are weakly deformed or cataclastic in places, in contrast to the younger Molson dykes, which are not deformed. The igneous texture is generally well preserved, as in the Molson dykes. However, the mineralogy is largely recrystallized. Primary pyroxene may be preserved. The dykes may show igneous differentiation into plagioclase-rich and plagioclase-poor layers. They are intruded by dykes of units 7 and 8. It is tentatively concluded that these dykes are between 2.5 and 2.7 b.y. old, based on the observed relationships, and the presently known radiometric ages of the major periods of deformation and metamorphism in the northern Superior Province (Weber and Scoates, 1978).

The late granitic rocks include metasomatic gneisses (6), granites (7) and the youngest granitic rocks, pegmatites, aplites and alaskites of unit 8. Granite dykes, and the dykes of unit 8 show features suggesting that they are replacement bodies formed by hydrothermal, increasingly potassium-rich solutions, along pre-existing fractures. Associated potassium metasomatism resulted in *lit par lit* veining, the formation of interstitial or porphyroblastic potassium feldspar and the transformation of hornblende to biotite. The latter led to release of iron and to "pinking" of all the metasomatized rocks.

Dykes of the Molson Swarm (9) strike north-northeast. At Molson Lake, they contain plagioclase-rich differentiates as pods and dykelets, as well as pegmatoid dykelets. These pegmatoid dykelets appear to have formed through mobilization of pre-existing pegmatites during intrusion of the Molson dykes.

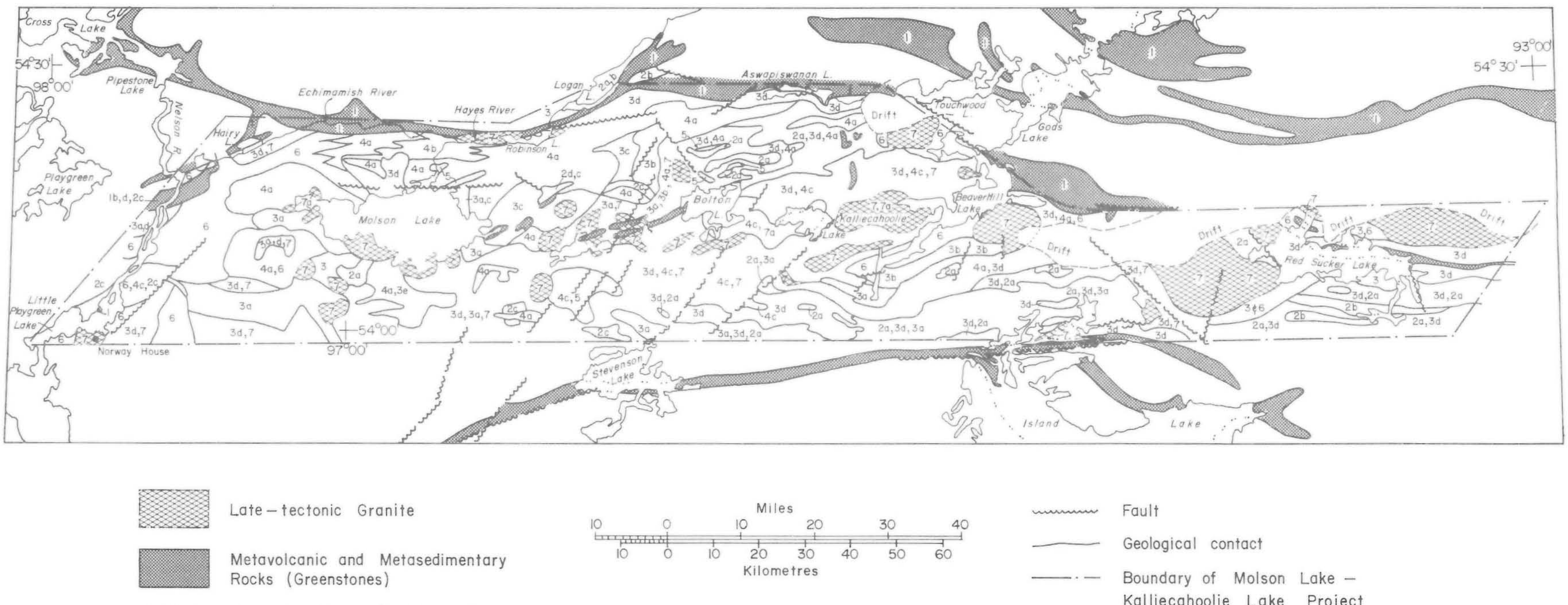

FIGURE GS-7-1: Geology of the Molson Lake-Kalliecahoolie Lake Area.

ASSESSMENT OF URP SURVEY

An Exploranium GR-310 digital gamma-ray spectrometer and a McPhar TV-1 scintillometer were used to check some of the rock types and URP anomalies. Last year's observation that potassium feldspar-rich rocks, e.g. granite, alaskite, pegmatite and granodiorite (4c) give the highest total count and uranium readings was confirmed. This correlation is also evident from the URP maps. The maps showing equivalent uranium, equivalent potassium and total count are similar. They are a reflection of the distribution of the potassium feldspar concentration in the rocks in the areas of good (greater than 50 per cent) exposure. However, in the area west of Molson Lake, where potassium feldspar-rich rocks are poorly exposed, the maps show low equivalent uranium and equivalent potassium, and the URP map does not reflect the composition of the bedrock. Thus, the URP map obviously reflects a combination of outcrop frequency and potassium feldspar content in the bedrock.

The highest total count gamma-ray readings (12 000 to 18 000 cpm) in the western part of the project area (with the McPhar TV-1) were obtained in fractures at the following locations (Weber and Chase, 1980):

1) 13 km SE of Robinson Lake (UTM 6016800N/675200E)
2) 10 km ESE of Molson Lake (UTM 5999400N/667100E)
3) 10 km SSE of Logan Lake (UTM 6027400N/685300E)

These readings are equivalent to approximately 30 to 45 ppm U.

MINERALIZATION

Traces of pyrite and chalcopyrite are ubiquitous in deformed and sheared metagabbros of units 1 and 5. A very pronounced rust zone occurs within sheared basic rocks in a mylonite zone 1.8 km west of the old power house at Kanuchuan Rapids, at the northwest end of Beaver Hill Lake (Schledewitz, 1980). Banded iron formation at Logan Lake locally contains sulphides (pyrite). Disseminated to semi-massive pyrite also occurs in several rusty zones, which were exposed due to the extremely low lake level, in altered ('silicified') mafic volcanic rocks at Logan Lake and south of Logan Lake in unit 2d. Some of the showings north of the Echimamish River (Tanton, 1937), including the Pb-Zn showing, were examined. They were found to be associated also with silicified mafic volcanic rocks and not with iron formation as suggested in Tanton's map. Fractures giving 18 000 cpm (total count), 13 km southeast of Robinson Lake, contain pyrite and a weak yellow staining which is possibly related to alteration of uraniferous minerals. This location coincides closely with a peak in eU and eU/Th ratio on the URP flightlines and might warrant further investigation.

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TABLE GS-7-1

TABLE OF FORMATIONS, MOLSON LAKE-KALLIECAHOOLIE LAKE PROJECT

PRECAMBRIAN

Proterozoic

9 Gabbro and diabase dyke (Molson Swarm)

Archean

Late Granitic Rocks

8 Pegmatite, alaskite, aplite

7 Granite, pink, medium- to coarse-grained, massive, locally porphyritic

7a white granite

Hybrid gneiss

6 Porphyritic granodiorite and tonalitic gneiss with mafic inclusions and pink granite sills and dykes

Recrystallized mafic (to ultramafic) dykes

5 Metagabbro

5a pyroxene and or hornblende porphyroblastic metagabbro to amphibolite

Early plutonic rocks

4a megacrystic granodiorite (granite, 4a)

4b porphyroblastic and or gneissic grandiorite, augengneiss

4c medium- to coarse-grained granodiorite

4d white pegmatite

3a medium- to coarse-grained foliated hornblende (± biotite) tonalite to granodiorite, partly porphyritic (3a')

3b fine- to coarse biotite (-hornblende) clot granodiorite to granite

3c biotite tonalite to granodiorite

3d leucotonalite

3e porphyroblastic granodiorite

Metamorphic rocks and migmatites

2a tonalite, tonalitic gneiss, minor amphibolite (up to 20%), flaser gneiss with minor amphibolite (2a')

2b tonalite, tonalitic gneiss interlayered with amphibolite (20-50%)

2c plagioclase porphyritic amphibolite to metagabbro, generally with agmatitic or *lit par lit* leucosome

2d magnetiferous quartzofeldspathic gneiss

Metavolcanic and related intrusive rocks, metasedimentary rocks

1a metabasalt, massive or pillowed, locally biotite-hornblende schist

1b metabasalt, fine grained amphibolite, sporadically interlayered with diopside-plagioclase layers

1c intermediate tuffaceous (?) rocks, layers of acicular amphibole, quartzofeldspathic layers and muscovite-biotite-quartz-feldspar schist (± garnet, cordierite), garnet-biotite schist (1c'), biotite psammite (1c')

1d metagabbro, ultramafic rocks, glomero-porphyritic metagabbro (1d')

1e anorthosite

1f feldspar porphyry

1g quartz porphyry

1h polymictic conglomerate

1i metagreywacke

1j meta-arkose to subgreywacke

TABLE GS-7-2

GEOLOGIC EVENTS IN THE MOLSON LAKE-BOLTON LAKE-RED SUCKER LAKE REGION

Phase IV

Diabase to gabbro dykes of the Molson Swarm

Phase III

Late-kinematic granites aplites and pegmatites

D_2 — Major shearing along north-westerly and easterly trends; asymmetric folds vary from open to moderate closure with localized isoclinal upright to steeply over-turned folds, with resultant narrow shear zones in areas of tight folding.

M_2 — Lower to middle amphibolite facies metamorphism in the gneiss terrane.
— Potassium metasomatism.
— Contact metamorphism.

S_2 — Gneissosity to metamorphic layer-ing in narrow shear zones.
— Cataclastic foliation.
— Platey quartz, biotite and amphibole realignment.

Basic dykes

Granodiorite dykes

Phase II

Granodiorite batholiths sills and *lit*

Leucotonalites and tonalites

D_1 — Structure and style within the metavolcanic suite uncertain, con-sidered to be open folds and faulting, within the tonalite gneiss and migmatite structures are typified by easterly-trending antiforms with moderate plunge and synforms which are upright isoclinal folds of variable plunge.

M_1 — Greenschist (to amphibolite) facies metamorphism in supracrustal rocks.
— Amphibolite facies metamorphism in tonalitic gneiss zones.

S_1 — Gneissosity and meta-morphic layering in tonalite complex.

Phase I

— Clastic sediments*
— Unconformity
— Feldspar porphyry
— Gabbro and ultramafic sills and dykes
— Mafic flows, minor felsic flows, volcanogenic sedi-ments

*Relationship between clastic sedimentary rocks and intrusive rocks of Phase II is not exposed. Clastic sedimentary rocks might be younger than Phase II (as e.g. in the Island Lake greenstone belt)

TABLE GS-7-3: VARIATION AND SUCCESSION OF SUPRACRUSTAL ROCKS BETWEEN ECHIMAMISH RIVER AND RED SUCKER LAKE

Echimamish River	Robinson Lake-Logan Lake	Aswapiswanan Lake-Touchwood Lake	Beaver Hill Lake-Rochon Lake	Red Sucker Lake-Pierce Lake
(Maximum thickness 5 km)	(Maximum thickness 2 km)	(Maximum thickness 2.5 km)	(Maximum thickness 4 km)	(Maximum thickness 1.5 km)
— Greywacke (1i) — Polymictic conglomerate (1h) — unconformity? — — Anorthosite (1e) (Hairy Lake) — Gabbro (1d) — Basalt, pillowed and massive (1a, 1b)	— Feldspar porph. (1f) — Gabbro (1d) } Logan Lake only — Basalt, pillowed and massive (1a, 1b)	— Feldspar porphyry (1f), abundant (10 to 250 m thick) — Gabbo (1d), abundant — Minor intermediate tuffaceous rocks (1c) — Basalt, pillowed and massive (1a, 1b)	— Crossbedded quartzite (1j) to subgreywacke — Gabbro to ultramafic sills (1d) abundant at northwest end of the belt — Impure quartzite to greywacke (1i), andalusite-bearing schist to phyllite (1c) — Intermediate tuffaceous rocks and garnet muscovite schist (1c) — Rhyolite or quartz porphyry (1g) — Intermediate tuffaceous rocks interlayered with pillow basalt (1a) — Basalt, pillowed and massive (1a, 1b)	— Crossbedded quartzite (1j) — Conglomerate, subgreywacke matrix (1h) — unconformity — — Gabbro (1d) — Interlayered intermediate dense grey tuffaceous rocks, garnet-rich, layered quartzofeldspathic rock, quartz ± cordierite biotite schist (1c) — Basalt, pillowed and massive (1a, 1b)

GS-8 STRATIGRAPHIC INVESTIGATIONS OF THE ISLAND, STEVENSON, PONASK, BIGSTONE AND KNIGHT LAKES AREAS AND OF THE ISLAND LAKE GOLD MINE

by Peter Theyer

INTRODUCTION

The nature and stratigraphic setting of ultramafic lenses in the Island Lake Greenstone Belt and adjacent areas (Bigstone Lake, Knight Lake, Stevenson-Ponask Lake) was investigated. This report concentrates on the stratigraphic setting of the ultramafic bodies. Their locations have been recorded by Theyer (1980), with the exception of a newly found ultramafic body in eastern Island Lake, (see Fig. GS-8-3) and a dunite occurrence on Picket Lake (R. Herd, pers. comm.). A petrographic and chemical investigation of these bodies will be based on a series of samples taken from each occurrence.

These studies were initiated following the recognition that ultramafic rocks, some of probable extrusive origin, occur at or near the interface between volcanic rocks (Hayes River Group) and overlying detrital sediments (Island Lake Group). The rocks at or near this interface are potential hosts for mineralization associated with ultramafic rocks such as nickel, copper and possibly gold (?) (Theyer, 1978, 1979, 1980).

STRATIGRAPHY

Volcanic rocks (Hayes River Group)

Mafic volcanic rocks, which include massive and pillowed flows and layered tuffs, form the stratigraphically lowest part of the greenstone belt in this area. The stratigraphic base has not been recognized and is considered to have been obliterated by granitoid intrusions. Intervolcanic detrital sediments, contrary to previous descriptions, (Wright, 1928; Quinn, 1960; Godard, 1963a, b) are restricted to layers of rounded siliceous pebbles a few metres thick in the eastern part of the Island Lake area. A large part of Bigstone Lake is underlain by flow breccia, blue-grey pelitic slate (that locally grades into protoquartzite), and several outcrops of polymictic conglomerate and breccia, containing pebbles, cobbles and boulders of acid volcanics and quartz porphyry in a siliceous detrital matrix.

Sedimentary rocks (Island Lake Group)

A highly varied group of sediments conformably overlies the volcanic rocks. Angular unconformities between these two rock units are restricted to very localized erosional channels in the uppermost volcanic layer. Evidence of a gradational concordant contact between the two groups can be seen in the central Island Lake area (see Fig. GS-8-1) where mafic tuffs are interlayered with black siliceous slate which grades into thick beds of black slate that is a typical component of the Island Lake Group. Previous descriptions of the sedimentary group are abundant; (Wright, 1928, 1932; Quinn and Meinert, 1959; Quinn, 1960; Godard, 1963a, b), however, these authors concentrated on descriptions of polymictic conglomerates, a facies of the Island Lake Group restricted both in area and volume (see Fig. GS-8-1). The complete stratigraphy of this group and consequently its exact outline, as well as its relationship to the underlying volcanic and igneous rocks, were never clearly defined. This resulted in a number of maps with different locations of the contacts. Godard, sums up this dilemma as follows:

> "however, the possibility still exists that some, or all of these rocks[1] may belong to the upper part of the Hayes River Group" (Godard, 1963, p. 16).

The Island Lake Group contains sediments ranging from tuff with slate interlayers, chert, black slate, greywacke, arkose, subarkose, protoquartzite, and conglomerate. Variations between different stratigraphic units can either be abrupt or gradational, e.g. black slate abruptly replaced by polymictic conglomerate or tuff gradationally replaced by black pelite.

SCHEMATIC STRATIGRAPHIC COLUMNS

A series of six schematic stratigraphic columns, is shown from east to west in Figure GS-8-2 (see also Fig. GS-8-1).

Eastern Island Lake (Column 1)

Column 1 shows one of the most complete sections of the Island Lake Group. This sequence begins with banded, partly foliated volcanic rocks which are followed by a sequence of black slates that are partially exposed over an apparent thickness of at least 500 m. White quartz nodules and boudins, remnants of disrupted quartz veins, are abundant in the basal part of the slate. Interfingering and overlying the uppermost portion of the black slate are finely banded 2 to 3 m thick greywacke layers which in turn are overlain by an approximately 10 m thick layer of polymictic conglomerate of the type described by Wright (1928) as being typical of the Island Lake "Series". Towards the stratigraphic top, the conglomerate becomes progressively finer grained and enriched in silica, grading from greywacke into quartzwacke and protoquartzite within a few metres. Cherty bands are intercalated with quartzwacke and sporadic layers of oligomictic quartz pebble conglomerate. These fine grained, silica-rich detritals are exposed over a width of at least 300 m across strike, interrupted by sporadic 1 - 2 m thick layers of black slate. A newly found ultramafic body (see Fig. GS-8-3) is thought to lie within this stratigraphic position. This sequence is capped by a polymictic conglomerate.

Central Island Lake (Column II)

The structural geology of this area is poorly understood and complicated by the intrusion of a gabbroic body, which lies along a tectonic contact with ultramafic rocks, and is folded into the siliceous wacke of the Island Lake Group. Nevertheless, it appears that the sequence at Eastern Island Lake is repeated here; namely, mafic pillowed volcanic rocks are overlain by a layer of black slate which grades into quartz wacke and protoquartzite, topped by an approximately 3 m thick layer of finely banded chert. Exact relationships between the chert and the infolded gabbro are unknown. The chert is interpreted to be overlain by an approximately 150 m thick layer of protoquartzite and arkose. Ultramafic rocks occurring in this location are joined by black slate to the north and an intrusive gabbro to the south. The black slate is approximately 150 m thick, and grades into quartzite which is overlain by polymictic conglomerate, i.e. the uppermost layer of the Island Lake Group.

West Central Island Lake (Column III)

Approximately 1 - 2 m thick chert layers overlying mafic volcanic rocks indicate the waning of volcanism and the start of sedimentation. The cherts are overlain by an assemblage comprising quartz wacke, protoquartzite, quartz pebble conglomerate, black slate, greywacke and a volcanic ultramafic lense. This assemblage is topped by an extensive, thick layer of polymictic conglomerate. The base of the Island Lake Group, which in the eastern and central area is almost exclusively composed of mafic volcanics, is largely made up of quartz porphyry in western Island Lake. Evidence of old

[1]which Godard mapped as Island Lake Group

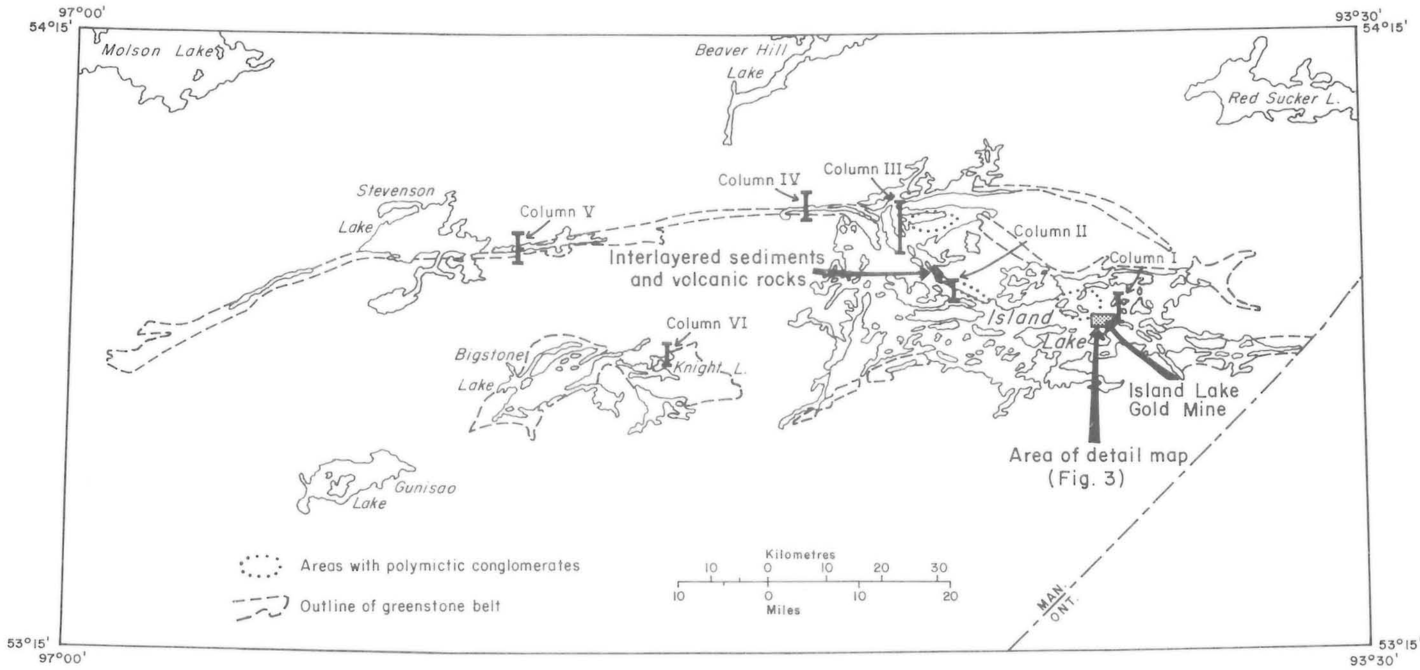

FIGURE GS-8-1: Schematic map indicating: Location and area of field program, 1980; approximate area included in stratigraphic columns; location of the Island Lake Gold mine and area of detailed map (Fig. GS-8-3).

erosional surfaces in the quartz porphyry, in instances showing erosional pockets and cracks filled with a light greenish pyritic sandstone, were found in two outcrops. The quartz porphyries were the source of a large quantity of pebbles found in the series of polymictic conglomerates.

Western Island Lake, Collins Bay, Stevenson Lake, Ponask Lake (Columns IV and V)

The stratigraphy of the Island Lake Group in its western prolongation remains more or less unchanged in its arrangement and petrographic composition. A sequence of quartz wackes and siliceous slates overlies mafic volcanic rocks. The major facies changes in the western prolongation is the almost complete disappearance of the polymictic conglomerate and black slate. The Island Lake Group is represented here by a monotonous series of quartz wackes and protoquartzites. In Eastern Stevenson Lake conglomerate was found in a small lense, overlying eroded quartz porphyry and sporadic layers of quartz pebbles in quartzwacke.

Knight Lake

A stratigraphic column through the eastern part of Knight Lake shows a stratigraphic succession which is typical of the Island Lake Group, containing quartzwacke, protoquartzite and siliceous pelite interlayered with black slate and lenses of polymictic conglomerate. The nature of the contact between these rocks and the volcanic rocks is unknown.

Bigstone Lake

Although a correlation between the stratigraphy of Island Lake and that of Bigstone Lake has been proposed by McIntosh (1938), Quinn (1960), Ermanovics, et al (1975) and Herd and Ermanovics (1976), neither the composition of the conglomerates nor the stratigraphic position of the sediments (which are both underlain and overlain by volcanic rocks), are comparable to the Island Lake Group. It appears more likely that the sediments on Bigstone Lake represent a separate group of intravolcanic detrital rocks.

ISLAND LAKE GOLD MINE

History (Excerpt from McMurchy, 1944)

Gold mineralization was delineated in Eastern Island Lake (see Fig. GS-8-1) by approximately 1 500 m of drilling during 1931-32. The individual islands will be called for identification purposes: West, Centre, Mine and East Islands. Gold Island which contains the ore zone is a small island between Centre and Mine Islands (See Fig. GS-8-3). The shaft, mill concentrator and powerhouse were located on Mine Island. Access to the orebody was established by a shaft of approximately 83 m depth with levels at approximately 42 m and 73 m. Subsequent underground exploration during 1933 and 1934 failed to delineate a substantial orebody. However, production until the end of 1934 was reported by the company to amount to approximately 6 870 tonnes of ore grading 17.2 grams/tonnes (0.6 ounces/ton) of gold. Operations were finally suspended in March, 1935 due to the lack of mineable ore.

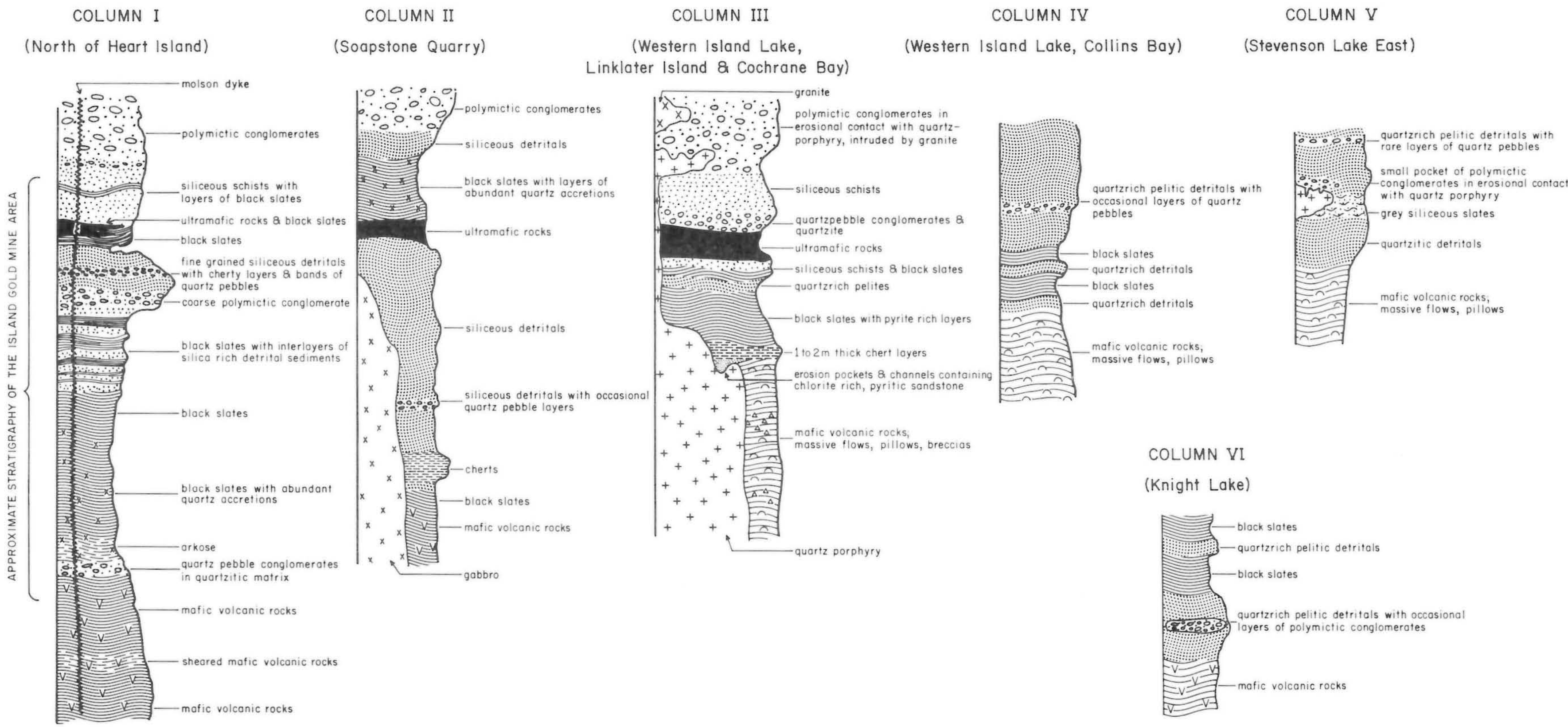

FIGURE GS-8-2: Schematic stratigraphic columns of the Island Lake area.

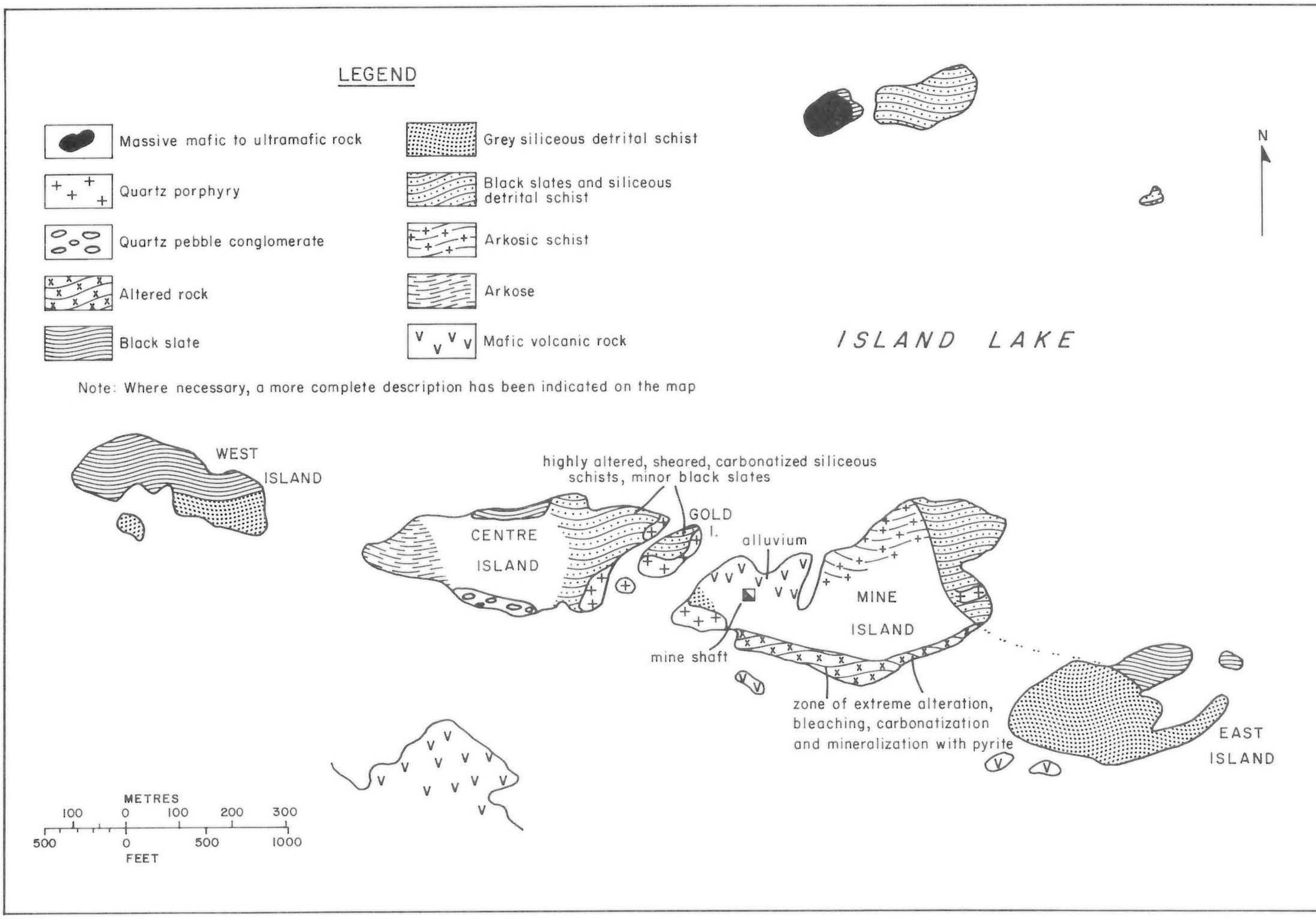

FIGURE GS-8-3: Geological sketch map of the Island Lake Gold Mine and surroundings.

Geology

Details of the geology are shown on a sketch map (Fig. GS-8-3). Mafic volcanic rocks underlie the islands to the south of West, Centre, Mine and East Islands. These islands, however, are underlain by an assemblage of detrital sediments and quartz porphyry. The sediments include (in approximately decreasing order of abundance): arkose, quartzwacke, protoquartzite, black slate and rare quartz-pebble conglomerate. An extensively altered zone of bleached, carbonatized, siliceous schist containing shear blocks of quartz porphyry, pervasively mineralized with pyrite, underlies most of the south shore of Mine Island. Gold Island and the eastern part of Centre Island are underlain by unaltered, quartz porphyry. Fine grained, dark grey, massive quartzite, hosting rare quartz pebbles of up to 10 cm in diameter underlies the southwestern shore of Centre Island. The rest of this island is composed of light green arkose containing rare quartz pebble beds, black slate and gabbro. West Island is composed of siliceous detrital sediments and black slate. East Island has a similar composition, however, the southern half of this island is bleached and altered, thus being interpreted as the eastern prolongation of the Mine Island alteration zone.

Stratigraphy

This rock assemblage, hosting the Island Lake gold mine, is part of the lower Island Lake Group. The stratigraphic interval in which these rocks occur is highlighted in Column I (Fig. GS-8-2).

Discussion

The ore, supposedly located in "gold-bearing quartz" (McMurchy, 1944, p. 7) was found under "Gold Island" underlain mainly by very fresh looking, partially sheared and folded pink quartz porphyry and altered bleached siliceous schist. Small interlayers are very dense and appear to be chert. The majority of the muck pile contains intensely altered, bleached and deformed siliceous schist, which appears to be derived from sheared quartz porphyry. The remainder is made up of quartzite with abundant pyrite interlayers and some black slate. It is thus interpreted that the gold mineralization was located in strongly altered siliceous schist, quartzite, and black slate, that experienced intense shearing, bleaching, carbonatization in parts, and pervasive pyrite mineralization. This assemblage was intruded by quartz porphyry of possibly different ages, since only some show intense deformation while others are fresh. This assemblage is highly favourable for the location of gold mineralization according to Pyke (1975), Karvinen (1978, 1980). It is also located at the site of a facies change from volcanic to sedimentary rocks considered to be significant in the siting of gold deposits (Karvinen, 1980). The lower part of these sediments are hosts to stratabound ultramafic extrusive rocks at least in part, (Theyer, 1978, 1979, 1980). A connection between ultramafic rocks and gold mineralization may be speculative, however, it finds worldwide support (Pyke, 1980). Thus a new occurrence of ultramafic rocks found some 700 m north of Gold Island, surrounded by black shales of the lower Island Lake Group may be of significance to this mineralization.

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GS-9 WHITE LAKE-MIKANAGAN LAKE PROJECT

(Parts of 63K/12 and 13)

by Alan H. Bailes and Eric C. Syme

INTRODUCTION

Mapping at a scale of 1:15 840 was completed during the 1980 field season for the White Lake-Mikanagan Lake Project area (Fig. GS-9-1, Prelim. Map 1980-W1). This report includes an outline of the major structural components of the area, brief descriptions of the main rock units encountered during this year's mapping, and changes to stratigraphy previously established (Bailes and Syme, 1979). Systematic sampling for chemical analysis was also completed for the thicker stratigraphic successions and major intrusive bodies; analyses will be reported at a later date.

Four volcanogenic massive sulphide deposits (White Lake, Cuprus, Centennial and Sourdough Bay) are located in the project area. Their position in the local volcanic stratigraphy has been identified. The White Lake and Cuprus deposits occur on one zone and the Centennial and Sourdough Bay deposits occur on another zone. Structural complexities preclude correlation of the two ore-bearing zones.

STRUCTURAL SETTING

A series of through-going faults divide the volcanic succession into five distinct blocks (Fig. GS-9-1). A major fold, the Northeast Arm syncline (Fig. GS-9-1), occurs in the Bear Lake block. In other blocks the stratigraphy is either homoclinal (Bakers Narrows, Sourdough Bay, Scottie Lake and Manistikwan Lake Blocks) or broken up by a series of intersecting major and minor faults (Whitefish Lake-Mikanagan Lake Block). A zone of close-spaced subparallel faults extends from west of Bakers Narrows, through the Pineroot River to Whitefish and Mikanagan Lakes.

Each block has a unique stratigraphic sequence which is not repeated in other blocks. This precludes the development of a coherent volcanic stratigraphy for the entire map area. However, further detailed work is planned for adjacent areas and may identify repetition of some of the major units and permit the development of a regional stratigraphy.

The absence of schistosity associated with some of the major faults indicates that they probably formed early and at a high structural level. They are commonly subparallel to the stratigraphy, locally abruptly cut up or down section, and are imbricated; the Northeast Arm fault is associated with a major, short limbed fold. These features suggest that the faults may have originally been thrust surfaces. Strong schistosity associated with some faults may reflect reactivation during later deformation, at deeper structural levels.

DESCRIPTION OF STRUCTURAL BLOCKS

Supracrustal rocks in the map area belong to the Amisk and Missi Groups of the Aphebian Flin Flon volcanic belt. The Amisk Group is intruded by large gabbro sills and small bodies of felsic granitoid rocks. Metamorphic grade is approximately middle greenschist facies. Primary structures and textures are generally well preserved.

BEAR LAKE BLOCK

The stratigraphy has been described previously for the Bear Lake Block (Bailes and Syme, 1979). Minor changes, noted below, were made to accommodate the data collected in the 1980 field season. Representative stratigraphic sections of the Bear Lake Block are shown in Fig. GS-9-2.

The stratigraphic thickness of unit 1 subaqueous intermediate flows has been extended to a total thickness of 3.3 km. The Inlet Arm fault has removed an unknown thickness from the base of unit 1; despite this truncation it is the thickest unit identified in the map area. Flows of unit 1 are similar to a thick sequence of flows overlying the Flin Flon orebody and exposed in the Hidden Lake syncline (Stockwell, 1960).

A re-examination of unit 2 intermediate subaqueous pyroclastics has indicated the presence of a subtle internal stratigraphy which includes four subunits not previously reported. The internal stratigraphy, from base to top, includes: (1) fine grained intermediate to felsic tuff characterized by vague bedding and small phenoclasts of quartz, (2) vaguely bedded to massive, intermediate to felsic, pumice-lump bearing tuff, and (3) vaguely bedded to well bedded intermediate lapilli tuff. The White Lake and Cuprus Cu-Zn sulphide deposits directly overlie the intermediate lapilli tuff and are hosted by graphitic mudstones with minor chert (unit 4). South of the White Lake Mine, on new Highway 10, the four new subunits of unit 2 occur in the hinge zone of a tight syncline; these subunits are not present north of the highway. They differ from the main pyroclastic sequence in that they are dominantly sedimentary and thin-bedded. The uppermost unit (2g) consists of interbedded intermediate tuff, felsic tuff, chert, jasper and minor sulphide layers. There is a general upward decrease in pyroclast size, and an increase in regularity of bedding, from the base to the top of unit 2.

The pyroclastic origin of unit 7 bedded intermediate tuff (with turbidite-like bed zonation) has been confirmed by microscopic identification of bubble-wall shards and pumice granules. Pyrite-bearing mudstones, graphitic mudstones and chert formerly identified as a separate unit are now included at the top of unit 7 because they contain interbeds of tuff. These fine grained sediments (unit 7e) and a carbonate-rich mudstone (unit 7f) were deposited during the gradual cessation of the pyroclastic activity represented by unit 7.

SCOTTIE LAKE BLOCK

Few changes have been made in the stratigraphy within the Scottie Lake Block, as described by Bailes and Syme (1979). However, two previously unrecognized faults (Figs. GS-9-1 & 2) are interpreted to occur within the block, one near the base and one near the top. The lower fault separates the main volcanic sequence (units 10, 12) from a dominantly felsic plutonic terrane (unit 44) containing screens of dacite (unit 11) and intermediate flows (unit 12). The upper fault is parallel to stratigraphy and occurs between units 13 and 14. The fault is identified by schistose zones in unit 14, the truncation of a northwest-trending fault at Whitefish Lake, and the presence of strongly foliated quartz-megacrystic tonalites which occur preferentially along the fault.

Unit 12 has been slightly expanded to include rare pyroxene-phyric flows that occur south of new Highway 10 and in the Scottie Lake area. The top of the sequence of rusty-brown weathering aphyric flows (units 12a, b) is marked by a thin subunit of fine grained sediments (unit 12e). Microscopic examination of unit 12a shows these flows to be characterized by skeletal crystals of pyroxene (pseudomorphed by actinolite) and plagioclase (pseudomorphed by albite).

Unit 13 remains as described (Bailes and Syme, 1979), apart from the recognition of copper-bearing stratiform sulphides associated with subunit 13d. The sulphides are exposed in a road-cut on new Highway 10 and may be approximately equivalent to the

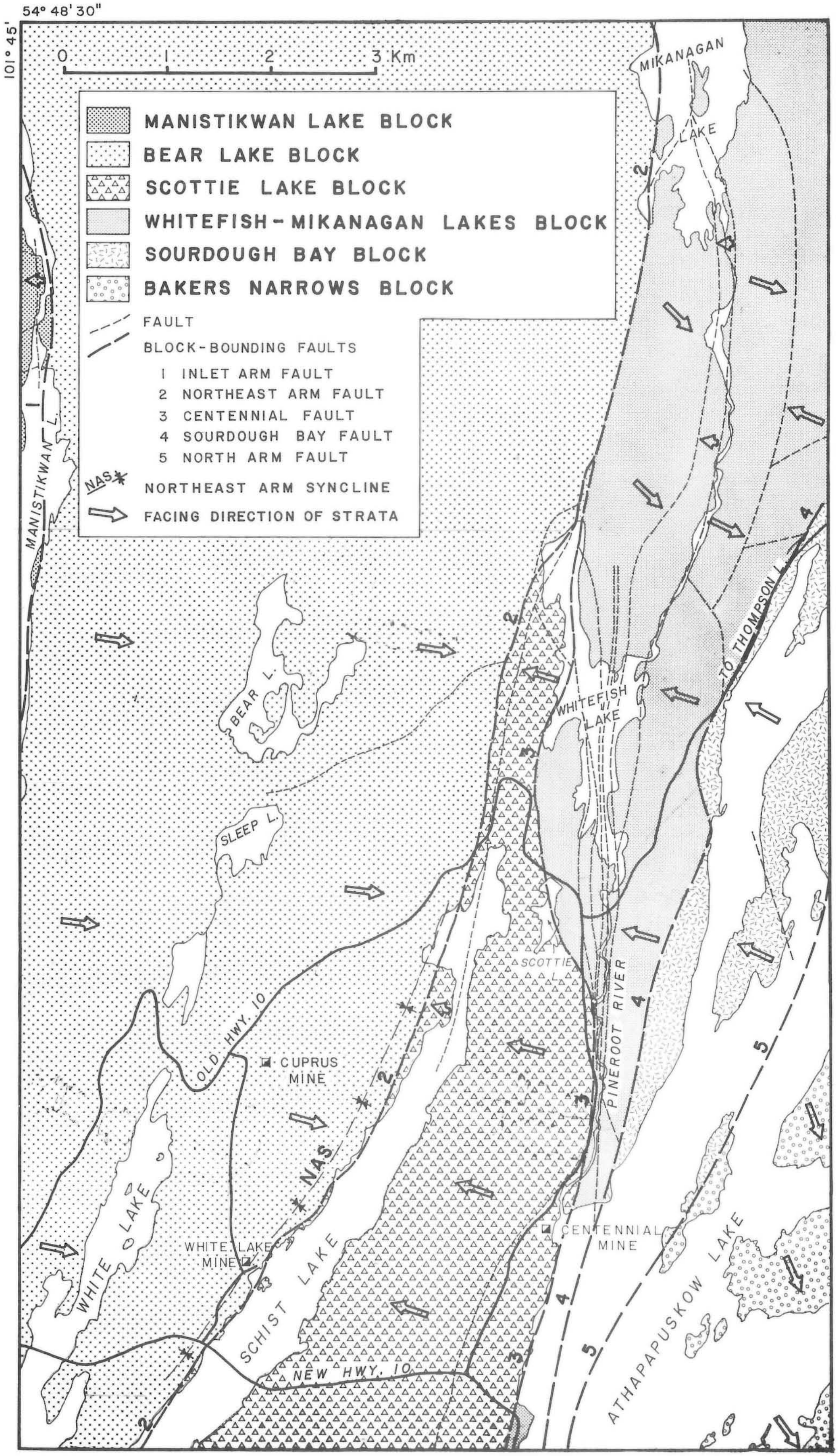


FIGURE GS-9-1: Major faults and fault blocks, White Lake-Mikanagan Lake area.

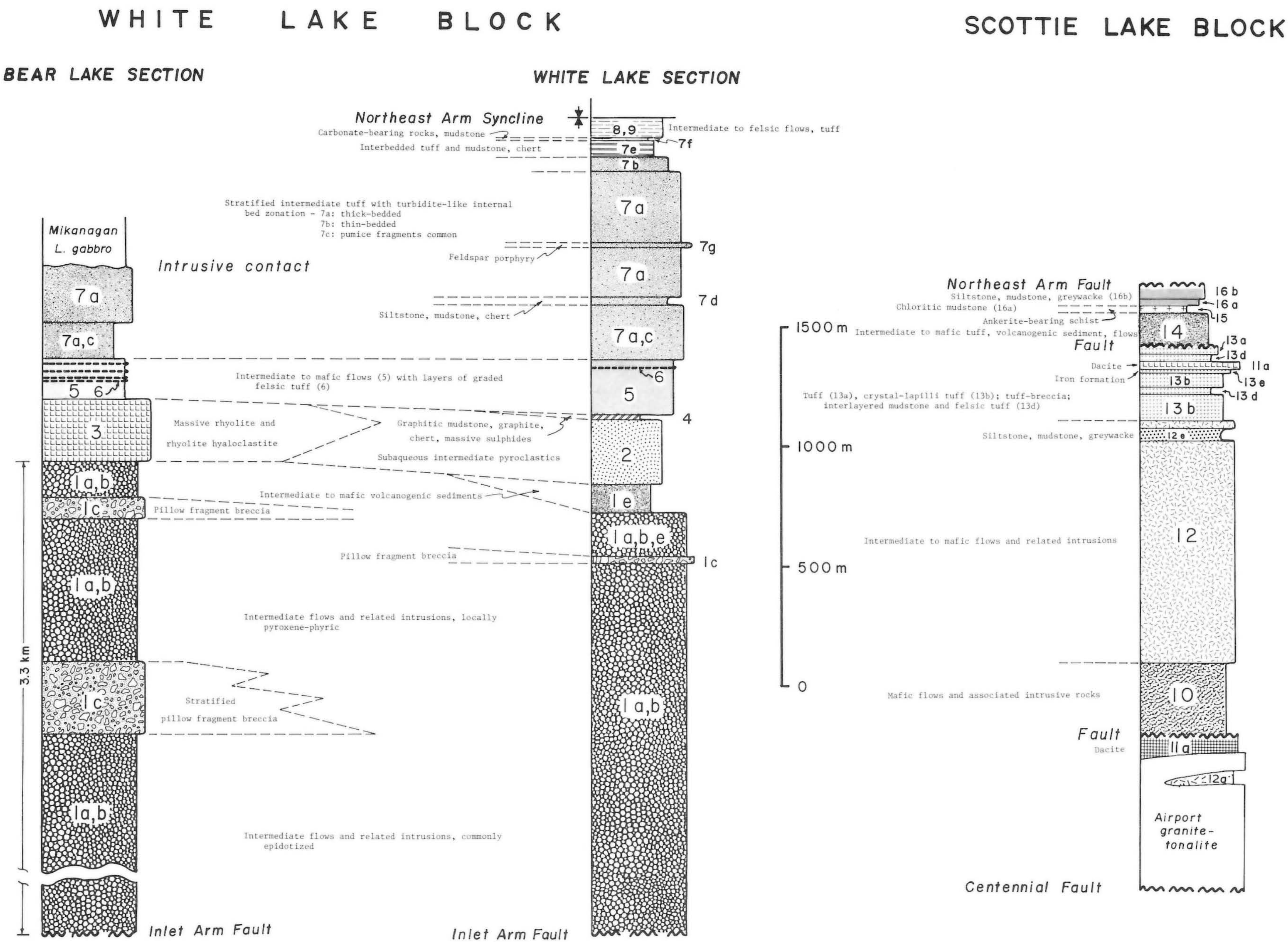


FIGURE GS-9-2: Representative stratigraphic sections, Bear Lake and Scottie Lake Blocks. Gabbro sills have been omitted.

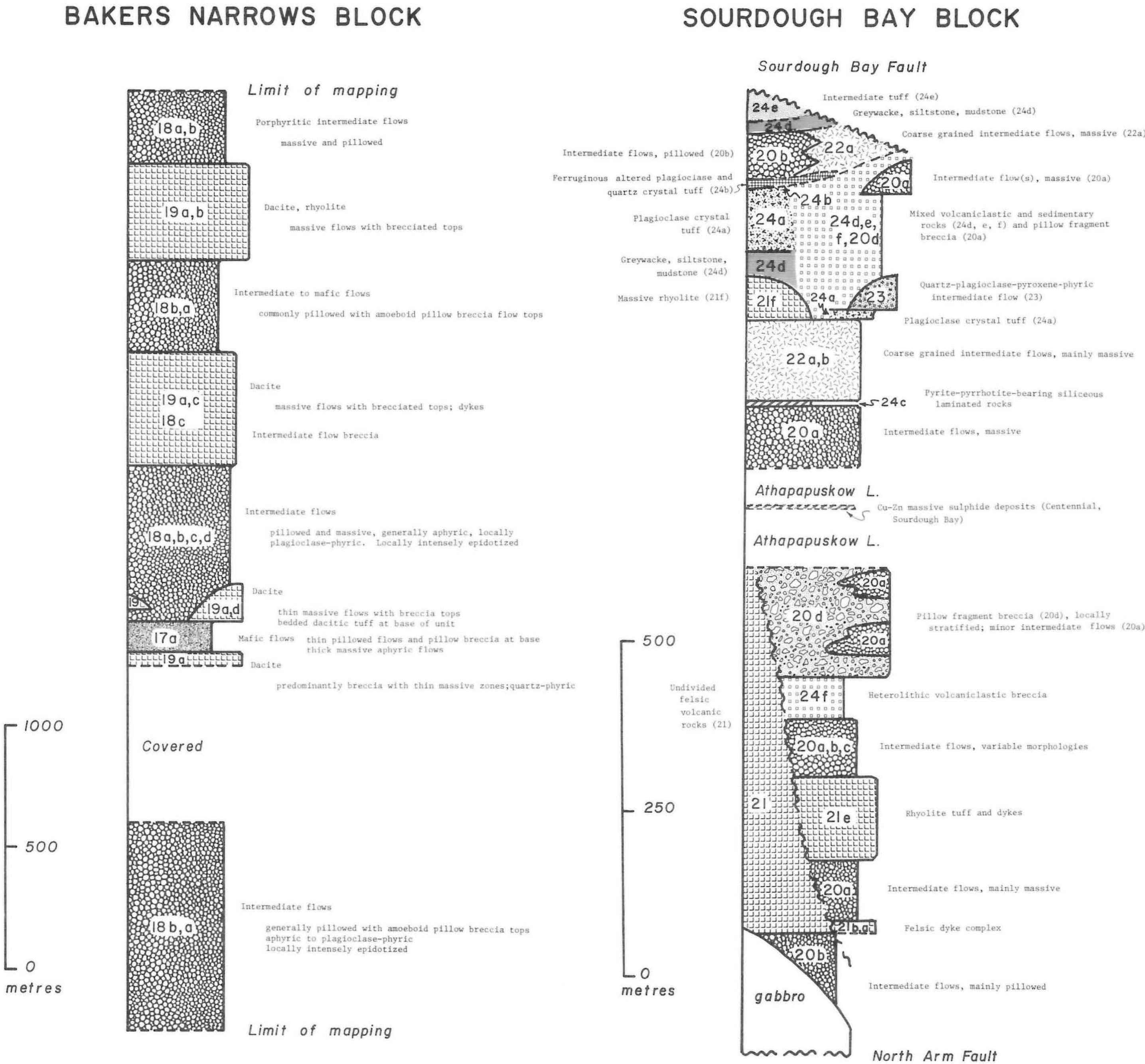


FIGURE GS-9-3: Representative stratigraphic sections, Bakers Narrows and Sourdough Bay Blocks. Gabbro sills have been omitted.

Levasseur showing at the north end of Schist Lake.

The Northeast Arm fault forms the western boundary of the Scottie Lake Block (Fig. GS-9-1) and has been traced from the southern to northern margins of the map area. This fault has truncated most of the east limb of the Northeast Arm syncline, removing almost 4 km of the Bear Lake section. South of Mikanagan Lake it truncates southwest-trending beds of unit 28, and locally cuts into the upper part of the Mikanagan Lake mafic sill (unit 40).

BAKERS NARROWS BLOCK

The Bakers Narrows Block consists of at least 3.8 km of homoclinal, southeast-facing strata truncated at a high angle to the west by the North Arm fault (Fig. GS-9-1). The main components of this block are subaqueous intermediate flows (unit 18), dacite flows (unit 19), and mafic flows (unit 17); the sequence is shown in Figure GS-9-3. This stratigraphic sequence is characterized by the almost total absence of pyroclastic and epiclastic materials.

SOURDOUGH BAY BLOCK

The Sourdough Bay Block is economically important in that it contains the Centennial, Sourdough Bay and Pine Bay massive Cu-Zn sulphide deposits. Stratigraphy of this block, including the approximate position of the sulphide zones, is shown in Figure GS-9-3. The block is bounded on the east by the North Arm fault and on the west by the Sourdough Bay fault (Fig. GS-9-1).

The block is characterized by a basal felsic volcanic complex (predominantly dacitic composition) overlain by thin units of subaqueous intermediate flows, volcaniclastic rocks, and sedimentary rocks. At the Centennial Mine the sulphide zone is associated with felsic pyroclastic rocks and pyritic sediments (Price, 1977; Provins, 1980) which do not outcrop at surface. The Sourdough Bay deposit and its host rocks do not outcrop but the zone is contained between a unit of pillow breccia (unit 20d) and overlying equigranular intermediate flows (unit 20a).

The felsic volcanic complex (unit 21) can be correlated to the northeast with highly altered and locally mineralized felsic rocks containing the Baker-Patton showing. The unit is best exposed on the southeast side of the peninsula between Sourdough Bay and the North Arm, where massive quartz-phyric dykes intrude strongly deformed dacitic pyroclastics.

The volcaniclastic and sedimentary rocks (unit 24) consist of a heterogeneous sequence of interbedded tuff, crystal tuff, graded greywacke-siltstone-mudstone, coarse heterolithic volcanic breccia and carbonate-rich sediments. They can be traced along strike to the northeast into a sequence dominated by subaqueous intermediate flows and pillow-fragment breccia.

WHITEFISH LAKE-MIKANAGAN LAKE BLOCK

The Whitefish Lake-Mikanagan Lake Block is characterized by a series of fault-bounded slices. The slices are homoclinal with variable facing directions and different stratigraphic components. This fault block differs from others in the map area in that it alone contains Missi Group strata, typically within narrow, fault-bounded slices. In addition this block contains volcanic and intrusive rocks rich in pyroxene and plagioclase phenocrysts. In the western half of the block the units strike at a high angle to fault trends. A heterogeneous suite of small, irregular, porphyritic intrusions (units 38, 41, 45, 46, 47) occur in this block.

East of the Pineroot River subaqueous intermediate flows (units 25 to 27) and volcanic conglomerate (unit 31) are dominant. In west-facing fault slices most of the flows are pyroxene-phyric (unit 25). A distinctive pale brown weathering unit of aphyric to weakly plagioclase-phyric intermediate pillowed flows (unit 26) occurs in an east-facing fault slice. Volcanic conglomerate (unit 31) occurs prominently in two west-facing slices, associated with pyroxene-phyric flows (unit 25). It is up to 570 m thick and is underlain by pyroxene-phyric intermediate flows and overlain by felsic volcanic rocks. The conglomerate is matrix- to clast-supported and contains a variety of subangular to rounded pebble- to boulder-sized clasts of pyroxene-phyric flow and dyke rocks. Larger clasts are typically joint-bounded with rounded corners. Beds in the conglomerate are very thick and massive, and only in exceptional exposures can bed contacts be identified. This deposit is texturally immature with some of the characteristics of debris flows.

A sequence of well bedded intermediate and mafic pyroxene and plagioclase crystal tuff and subordinate lapilli tuff occurs west of the Pineroot River. These rocks face southeast in a thick fault slice and face west in a thin fault sliver; the thicker sequence may be folded. The beds range in thickness from a few centimetres to several meters and are typically graded with parallel-laminated tops.

The Missi Group unconformably overlies Amisk Group volcanic rocks. Hematiferous regoliths developed on the volcanics are exposed near Scottie Lake and north of Whitefish Lake. Amisk pillowed flows appear to top away from the Missi at the Scottie Lake unconformity, indicating there may have been a period of deformation prior to deposition of the Missi Group.

The Missi Group consists of immature, trough cross-bedded, fluviatile sands, gravels and conglomerates. Mauve weathering varieties contain abundant hematiferous clasts, granules and cement whereas the grey varieties lack the abundant intergranular hematite and contain fewer hematiferous clasts.

MANISTIKWAN LAKE BLOCK

Only a small portion of the west-facing Manistikwan Lake Block is exposed along the west margin of the map area. It is separated from the east-facing Bear Lake Block by the Inlet Arm fault. Where the fault is exposed on Manistikwan Lake it is expressed by a 2 m-wide zone of intense schistosity.

Rocks in the block comprise thick subaqueous felsic flows (unit 33), gabbroic-textured intermediate to mafic flows (unit 34) and minor greywacke, siltstone and mudstone (unit 35). The felsic flows consist of massive portions with intimately associated tuffaceous rocks (Fig. GS-9-4). These flows show some of the features of subaqueous rhyolite flows described by de Rosen-Spence *et al.* (1980). Gabbroic-textured rocks (unit 34) are typically massive with grain size up to 1 mm; gradation upward to finer grained rocks and intercalation with compositionally similar pillowed units suggests that they are thick flows. These flows are intercalated with the felsic flows of unit 33.

Early east-trending faults truncate one of the major felsic flows. These early faults are truncated by the Inlet Arm fault, and may be synvolcanic features.

INTRUSIVE ROCKS

In the map area there are five major intrusive suites, some of which predate the major bounding faults and some of which postdate these faults. They include large differentiated gabbro sills, part of a felsic granitoid pluton and high-level porphyritic intermediate-felsic bodies.

WHITE LAKE INTRUSIONS

There are three mafic sills in the Bear Lake Block which show similar lithologies and zonation. Two of the sills have well developed zonation and top to the east, whereas one of the sills has a poor zonation and tops to the west. The largest and best-zoned sill is 330 m thick, with the following zones (from base to top):

(1) "brown" gabbro: medium grained, brown-weathering, with 50% equant, 1 - 2 mm amphibole, and 50% light brown weathering, epidotized plagioclase. Igneous layering occurs in the brown gabbro at or near its contact with the green gabbro;

(2) "green" gabbro: medium grained, dark green to black weathering, with up to 60% equant 1 - 2 mm amphibole and 40 - 50% strongly hematized plagioclase;

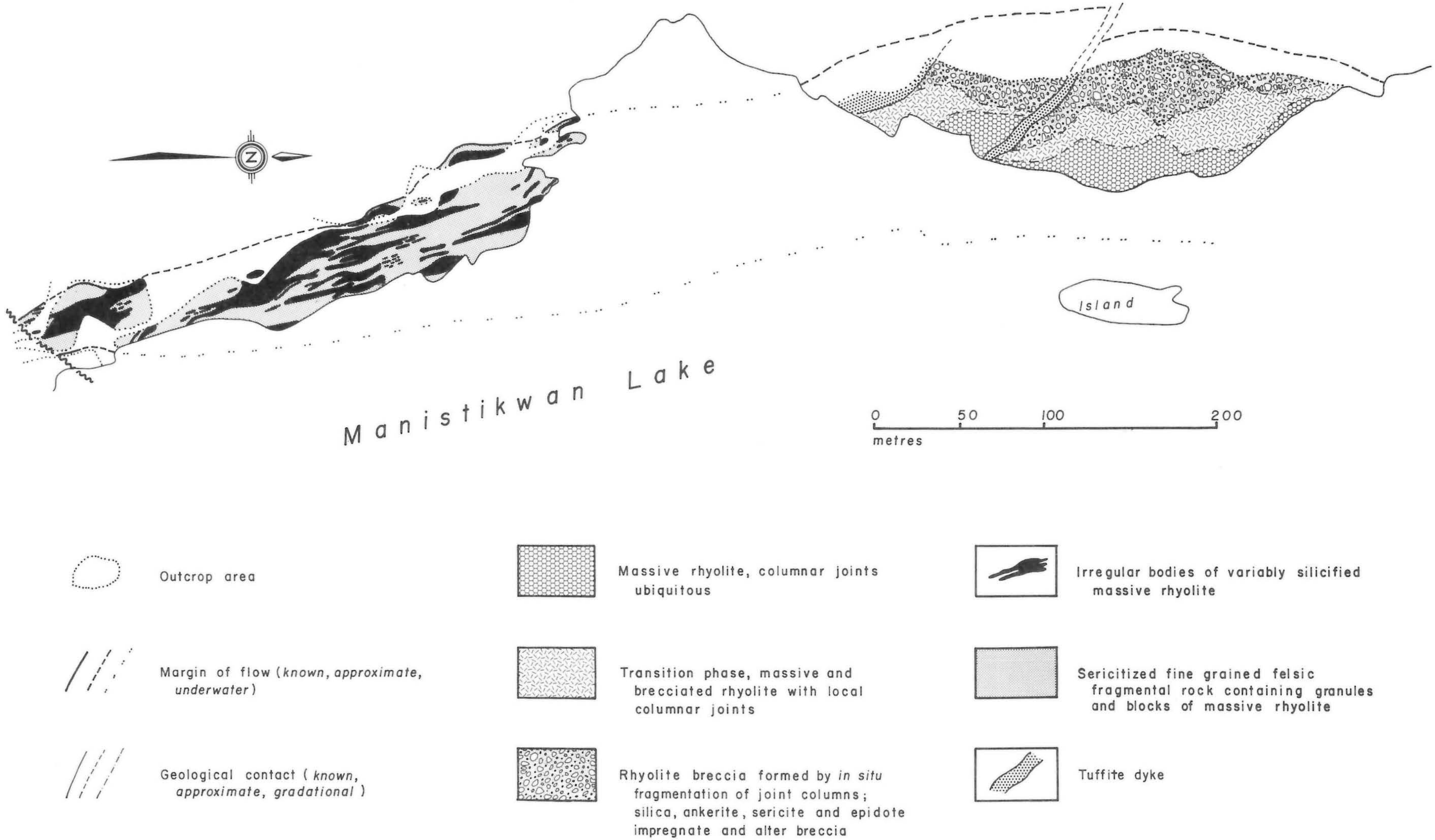
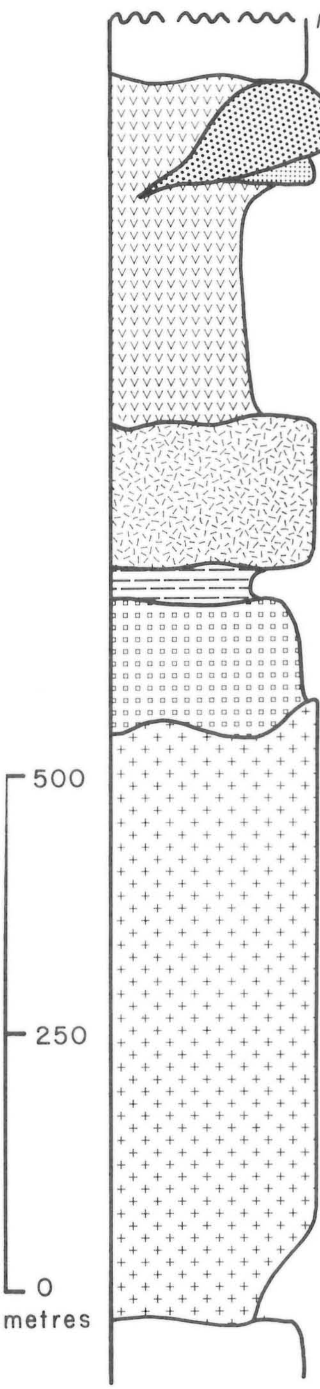


FIGURE GS-9-4: Organization of felsic flow (data from S. Peloquin, 1980), Manistikwan Lake Block.

MIKANAGAN LAKE SILL



	GRAIN SIZE (mm)	PRIMARY MINERALOGY Min. %	STRUCTURES, TEXTURES
White tonalite	2	QZ 30-45 PG 45-50 AB 5-15	equigranular to quartz-phyric locally magnetite-bearing locally intrusive into quartz diorite
Rusty-brown tonalite	to 4	QZ 25	locally gradational with white tonalite
Quartz diorite	2-6	QZ 5-15 PG 60-70 PX 25	rubbly-weathering outcrops large, tablet-shaped plagioclase crystals locally up to 10% magnetite pyroxene prisms to 5 cm long in coarse-grained phase
Red-brown gabbro	1-2	PG 50 PX 50	equigranular, with lath-shaped plagioclase locally up to 10% magnetite magnetiferous layers at base
Transition gabbro	1-2	PG 50, PX 50	igneous layering; podiform mafic pegmatoids
Porphyritic gabbro	px to 10 matrix 1-2	PX PHENS 15	massive pyroxene phenocrysts in a gabbroic matrix
Light brown gabbro	1-2	PG 40-50 PX 50-60	massive, homogeneous, equigranular clinopyroxene partly replaced by tremolite ± chlorite plagioclase completely replaced by epidote subophitic texture
	0.5-1		fine grained marginal zone
	< 0.5		chilled contact

FIGURE GS-9-5: Main zones in Mikanagan Lake mafic sill.

(3) quartz diorite: medium to fine grained, grey and green weathering, with 20% biotite and chlorite, 5 - 10% quartz, 50 - 60% tablet-shaped plagioclase, and 10 - 15% granophyric quartz-plagioclase intergrowth.

MIKANAGAN LAKE INTRUSIONS

Three gabbro bodies belonging to this suite occur in the map area and extend into the adjacent area to the north. They include a 1.2 km thick, strongly differentiated east-facing sill, a 2.7 km thick apparently homogeneous sill or pluton, and a 360 m thick, strongly differentiated west-facing sill. The sequence in the 1.2 km thick sill is shown schematically in Figure GS-9-5.

WHITEFISH LAKE MAFIC INTRUSIONS

A group of apparently related intrusions, ranging from peridotite and pyroxenite to tonalite in composition, occur in the Scottie Lake Block and Whitefish Lake-Mikanagan Lake Block, west of Whitefish Lake. They appear to form both composite and compound sills. This is the only intrusive suite in the map area that contains ultramafic phases.

AIRPORT GRANITE TO TONALITE

A fault-bounded slice of dominantly felsic plutonic rocks occurs south of the Centennial Mine and extends out of the map area to the south. The predominant lithology is an equigranular, 1 - 2 mm, orange-buff to white weathering granite composed of 30% quartz, 40% white feldspar and 30% pale pink feldspar. It locally contains phenocrysts of quartz and plagioclase. Small irregular dykes or pyroxene-phyric gabbro locally intrude the granite.

WHITEFISH LAKE QUARTZ MONZODIORITE

This porphyritic intrusion is 2 900 m long and 300 to 600 m wide. It is intruded along and cross-cuts several major faults in the Whitefish-Mikanagan Lake Block and is therefore a late intrusion not related to Amisk volcanism. The body and related Cu-Mo sulphide mineralization are described by Baldwin (1980).

The interior of the intrusion is equigranular (1 - 2 mm) to weakly feldspar-phyric, and quartz monzodiorite in composition. Marginal phases and dykes are densely feldspar-phyric and contain numerous Amisk Group xenoliths. Volcanic rocks near the margin of the body are commonly rusty-weathering, weakly pyritized and epidotized. Portions of the intrusion are noticeably altered; the nature of the alteration is described by Baldwin (1980).

CONCLUSIONS

Mapping completed in 1980 has established that the basic structural pattern in this part of the Flin Flon volcanic belt is dominated by fault-bounded blocks. Each block is characterized by a unique stratigraphic sequence which cannot be correlated with that in adjacent blocks. Significant movement must have occurred on these faults to juxtapose unrelated stratigraphic components. At least some of the faults are post-Missi but appear to predate some of the intrusive activity. Further mapping in the Flin Flon area will have as a major objective the correlation of stratigraphy *between* major fault blocks and the development of a coherent regional volcanic stratigraphy.

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GS-10 — MINERAL DEPOSIT STUDIES — FLIN FLON/KISSEYNEW

by G.H. Gale

INTRODUCTION

The 1980 field season was devoted mainly to: (1) the detailed examination of mineral occurrences in the sedimentary gneiss terrane immediately north of the Flin Flon Greenstone Belt to provide a data base for metallogenic studies in the Kisseynew Sedimentary Gneiss Belt, and (2) the continuation of mineral deposit investigations in the Flin Flon region of the Flin Flon Greenstone Belt.

Mineral occurrences on Kisseynew Lake, Kississing Lake, Star Lake and Batty Lake (Fig. GS-10-1) were examined and where warranted mapped in detail. In addition, the geology of parts of these lakes was reconnoitered to establish regional controls for the mineral deposit types identified. In the Flin Flon region investigations included an examination of selected mineral occurrences, detailed sampling of the Mud Lake and Baker Patton alteration zones and mapping of the rocks in the immediate footwall to the Flin Flon Mine.

The main features of the investigation in the Kisseynew Sedimentary Gneiss Terrane are presented here. Detailed maps of other occurrences will be deposited in a Mineral Deposit Open File and be made available upon request.

WELDON BAY AREA

The geological setting and genesis of mineral occurrences in the Weldon Bay area (Fig. GS-10-1) are of interest since this area contains the junction between the Kisseynew Sedimentary Gneiss Belt to the north and the Flin Flon Greenstone Belt to the south. Kalliokoski (1953) considered mineral occurrences in the Weldon Bay area to "occur along the Weldon Bay fault zone". Assessment file reports in the Mineral Resources Division indicate that narrow intersections of sphalerite-pyrite mineralization have been encountered in drill holes put down on the electromagnetic conductor associated with this occurrence. Detailed mapping of known showings in the area revealed that the sphalerite mineralization is stratabound and hosted by sedimentary rocks — the vein-like nature of the sphalerite mineralization is due to local mobilization rather than emplacement along fault zones.

The geology of the sphalerite mineralization is shown in Figure GS-10-3. The 50 m thick unit of white to buff-weathering layered rocks south of the trenches appears to have been considered a mylonite by Kalliokoski (1953). This rock has laminated and massive layers 10 - 40 cm thick that are often separated by pelitic layers a few cm thick. It contains occasional quartz crystals (1 - 2 mm in diameter) and whereas some layers have a buff colour and a feldspathic appearance, others are silicic and have a cherty appearance. Several kilometres east along strike there are several outcrops of a white weathering feldspar-bearing massive rock that appears to be a felsic volcanic flow and the layered silicic rocks in Figure GS-10-3 could be tuffs, ash and/or chert associated with this volcanic event. In addition to the stratabound distal exhalative sphalerite mineralization described above, three other types of mineralization are present in the Weldon Bay area. These are: (a) stratabound pyrite and pyrrhotite (disseminated to near solid sulphide) associated with quartz-rich sediments of garnet-biotite-quartz gneiss in close proximity to massive and layered amphibolities; (b) stratabound pyrite-chalcopyrite mineralization in layered, streaky (calcareous?) adjacent to garnet-biotite-quartz gneiss; and (c) chalcopyrite mobilizate in a pegmatite associated with a gabbroic intrusive. Information on these occurrences are summarized in Table GS-10-1 and their possible stratigraphic relationships shown in Figure GS-10-4.

KISSISSING LAKE AREA

Investigations in this area were conducted on both regional and detailed scales. These studies have illustrated the need for a remapping and reinterpretation of the geology and stratigraphy of this area as existing geological maps are inadequate in projecting the extension of mineralized units.

Yakushavich Island — Collins Point

Two distinct types of mineralization are present in this area (Fig. GS-10-5) namely, Type I Zn-Pb-Cu mineralization with minor iron sulphide (10 - 20% Py-Po) and, Type IIa Py-Po mineralization with trace Zn-Cu.

The type I mineral occurrences occur wholly within a garnet-biotite-quartz gneiss which is generally quartz-rich and contains minor feldspar. This metasedimentary gneiss is thinly layered (10 - 30 cm average layer thickness) and individual layers are locally laminated (1 - 10 mm laminae). The rock is generally psammitic with semipelitic layers common, however, pelitic layers are rare and where present are only a few centimetres thick. Graphite is a common constituent. Disseminated (1 - 5%) pyrite is scattered throughout the rock and imparts a distinctive rusty appearance to the unit that it can be referred to locally as the rusty weathering gneiss (cf. Tuckwell, 1979). This unit is readily distinguishable from the quartzofeldspathic rocks and "typical" greywacke.

The mineralization occurs as stratabound disseminated to near solid sulphide. A cordierite-biotite-anthophyllite rock in close proximity to the mineralization is similar to metamorphosed alteration products resulting from hydrothermal exhalative activity observed elsewhere. Quartz-rich (cherty) layers overlying the occurrence on Yakushavich Island (Fig. GS-10-7) are probably exhalative products and suggest a normal sequence at this locality, however, a definite cross-cutting relationship between the underlying metasedimentary rocks and the alteration product has not been established and thus a stratigraphic sequence cannot be definitely established at this time.

The sulphide mineralization at K1 on Yakushavich Island comprises a 25 cm or more thick layer or near solid sulphide consisting of sphalerite, pyrite, and chalcopyrite. A Collins Point near solid sphalerite, disseminated galena (10%) and disseminated sphalerite in quartz-rich rocks (chert), biotite-garnet-anthophyllite rocks, and near solid pyrite-pyrrhotite-sphalerite are present in rubble derived from trenches cut into the gossan zone.

The Type II occurrences consist of disseminated to near solid pyrite and/or pyrrhotite in association with a quartz-rich layer a few tens of centimetres in thickness. The sulphide-bearing layers are stratabound and can be traced long strike for several hundred metres and occur at the stratigraphic position over distance of several kilometres. This type of mineralization occurs either within the layered garnet-bearing amphibolite (K49) or at its contact with the stratigraphically underlying garnet-biotite-quartz gneiss (Fig. GS-10-8).

A third type of mineralization (Locality K52) consists of galena-bearing quartz-feldspar pegmatite and near solid pyrrhotite-pyrite-sphalerite. This occurrence is hosted by garnet-biotite-quartz gneiss and probably occupies a stratigraphic position similar to that of the Collins Point occurrence (K51).

The sequence at Collins Point (Fig. GS-10-9) appears to be overturned with respect to that on Yakushavich Island (Fig. GS-10-6). This would indicate the presence of large recumbent isoclinal or nappe structures in this area which can be expected to produce repetitions of "favourable units" on both a local and regional scale.

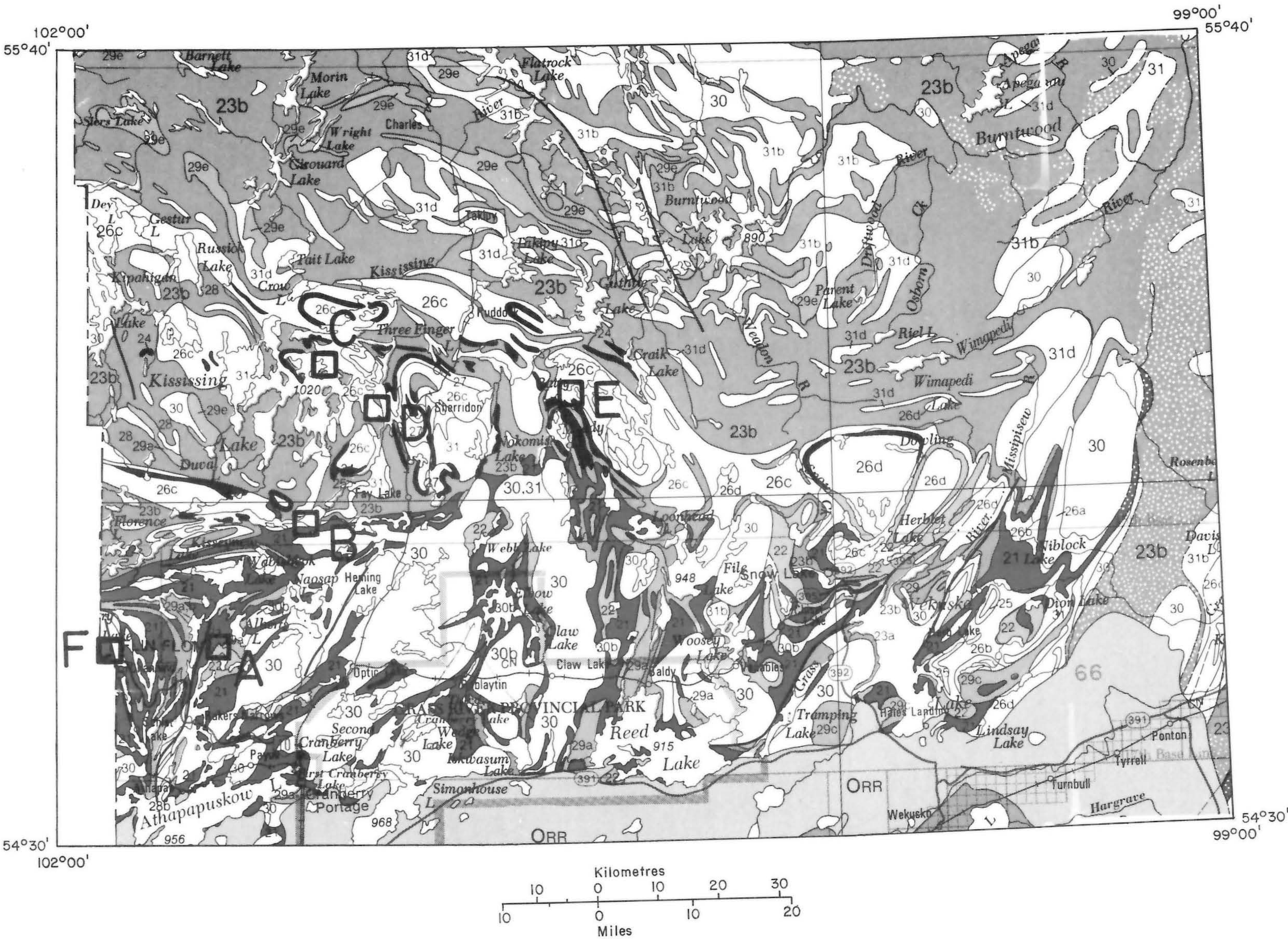

FIGURE GS-10-1: Location map for the Flin Flon-Kisseynew Areas. A. Mud Lake and Baker Patton area; B. Weldon Bay area; C. Yakushavich Island and Collins Point area; D. Ideal and Maltman Lake area; E. Batty Lake area; F. Flin Flon mine area. Geological base from Manitoba Mineral Resources Division 1979. Geological Map of Manitoba, Scale 1:1 000 000, Map 79-2.

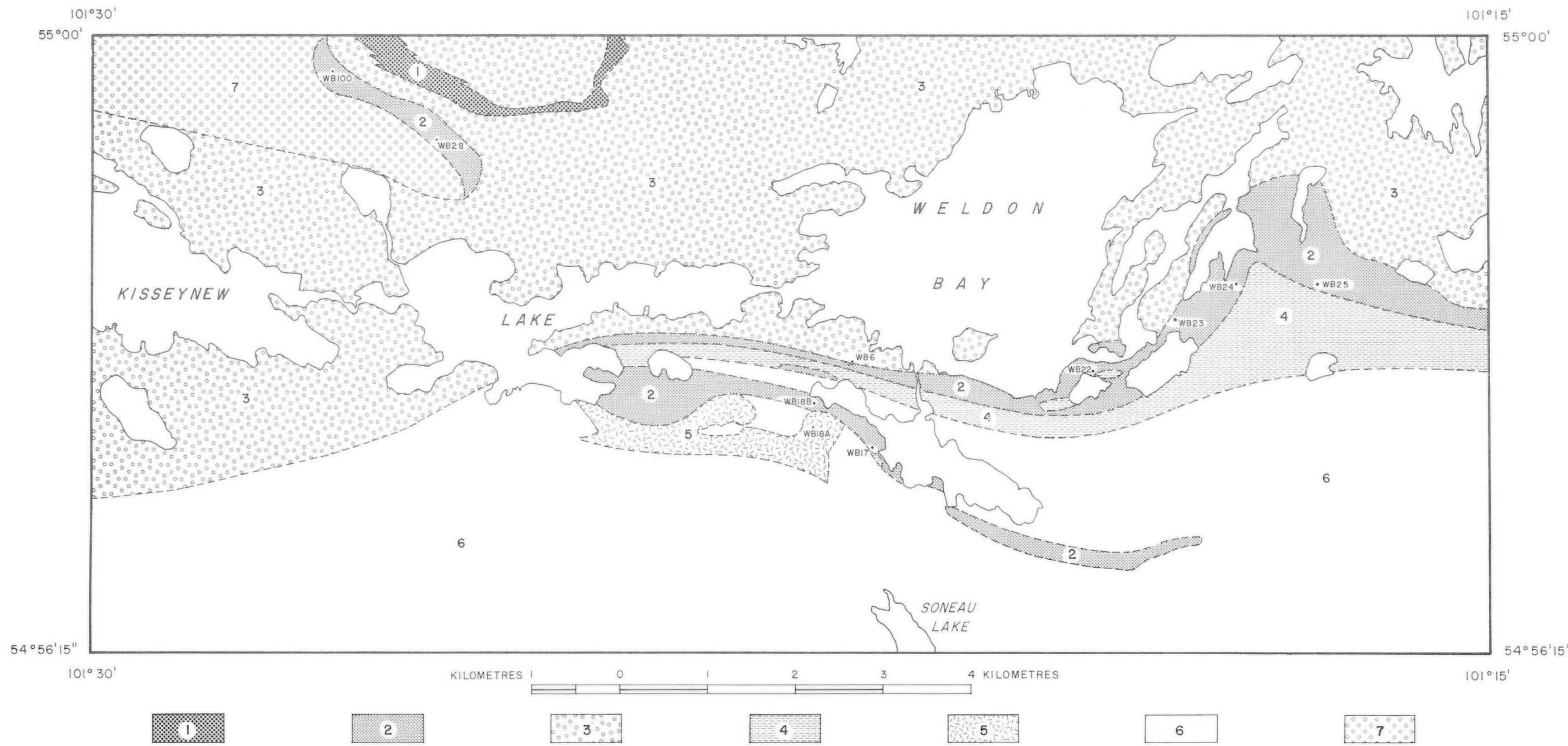

FIGURE GS-10-2: *Simplified geology of the Weldon Bay area with location of mineral occurrences. Geology modified after Kalliokoski (1953). Legend: 1. Layered 'quartz-rich' hornblende-quartz gneiss; 2. Dominantly layered amphibolite, garnetiferous in northwest corner, locally massive and gabbroic; 3. Quartzofeldspathic gneisses, commonly magnetite-bearing; 4. 'Quartz-rich' biotite-quartz gneiss, contains thin amphibolite layers (at WB 22 — possible felsic volcanic rocks); 5. Gabbro; 6. Undifferentiated intrusive rocks; 7. Garnet-biotite bearing gneissic metagreywacke.*

Ideal The 60 cm thick near solid sulphide (Sp-GA-Cp-Py-Po) mineralization at the Ideal deposit (K68) is underlain by an anthophyllite-rich rock (alteration zone) and overlain by a quartzitic (cherty) layer. Minor sphalerite mineralization with associated alteration (biotite-garnet-anthophyllite) present south of the main sulphide zone may represent a second mineralized layer or merely a part of the alteration zone associated with the sphalerite-rich sulphide layer.

The rocks overlying this sulphide layer are the rusty weathering garnet-biotite-quartz gneiss which in turn is overlain by garnetiferous amphibolite (Fig. GS-10-10). The footwall rocks include garnet-biotite-quartz gneiss and a thinly layered (1 - 2 cm) dark green rock with approximately 40% hornblende and 60% quartz.

Maltman Lake Several trenches have been cut in disseminated to near solid iron sulphide (Po ± Py) and quartzose layers that are hosted by garnet-amphibolite. Only traces of sphalerite and chalcopyrite have been found in these trenches. The occurrences are stratigraphically equivalent to those at locality K26 on Yakushavich Island. These rocks are underlain by the rusty weathering garnet-biotite-quartz gneiss to the west and the hornblende-bearing quartzofeldspathic and calc-silicate-bearing rocks to the east.

Sherridon Mine Detailed mapping in the Sherridon area (Froese and Goetz, 1980; and Goetz, 1980) indicate that the immediate host to the Sherridon massive sulphide Cu-Zn deposit are quartzofeldspathic-and calc-silicate-bearing gneisses. On the basis of preliminary investigations in the area (GS-10-11) it appears that the host rocks to the Sherridon deposit represent a different stratigraphic position from that of the garnet-biotite-quartz gneiss hosting the Ideal and Yakushavich Island occurrences. The relative stratigraphic positions of these two types of mineralization is still uncertain.

A gahnite-bearing quartzite layer (chert) occurring on the south side of an alteration product (gr-bt-cd-ay rock) without any obvious cross-cutting relationships suggests that stratigraphic tops are towards the south at the Cold Lake occurrence (K75-6). Metal zoning in the Sherridon west orebody indicates stratigraphic tops towards the north (P. Goetz, pers. comm., 1980 Goetz, 1980). These opposing top determinations would appear to confirm the presence of the F_1 structure interpreted by Tuckwell (1979) but the structure now has to be considered of a synformal rather than antiformal nature. Stratigraphic relationships in the Sherridon areas are still considered to be somewhat enigmatic in that the alteration products have not been observed in cross-cutting relationship with their host rocks and metal zoning on the Sherridon west orebody, which is distal to its exhalative vent, may not necessarily be indicative of stratigraphic tops. Further mineral deposit studies are warranted in this area.

Batty Lake Area Mineral occurrences on Star Lake and Batty Lake (Fig. GS-10-13) were examined and a reconnaissance made of the major geological units shown by Robertson (1951). The mineral occurrences examined are documented in Table GS-10-1 and their relationships shown schematically in Figure GS-10-12.

A unit of garnet-biotite-quartz gneiss in the Batty Lake area appears to be equivalent to that of the rocks hosting the sphalerite-galena mineralization in the Kississing area. These rocks appear to underlie (structurally) the rocks which host the Sherridon deposit (Robertson, 1951).

CONCLUSIONS

Mineral occurrences in the southern part of the Kisseynew Sedimentary Gneiss Belt include:

1. Stratabound Cu-Zn deposits of the Sherridon area in association with quartzofeldspathic and calc-silicate-bearing metasedimentary rocks.
2. Stratabound Zn-Pb±Cu deposits in a garnet-biotite-quartz gneiss (commonly graphitic) which is generally rusty-weathering.
3. Stratabound pyrrhotite and/or pyrite mineralization at the contact with or enclosed within a layered amphibolite. This mineralization commonly contains graphite but only trace amounts of sphalerite and chalcopyrite.
4. Traces of sulphide minerals (cp, py, po, ga, sp) occur in late stage pegmatites as local mobilizates.

Only the stratabound Cu-Zn and the Zn-Pb±Cu deposit types are considered to have the potential to contain economically viable deposits.

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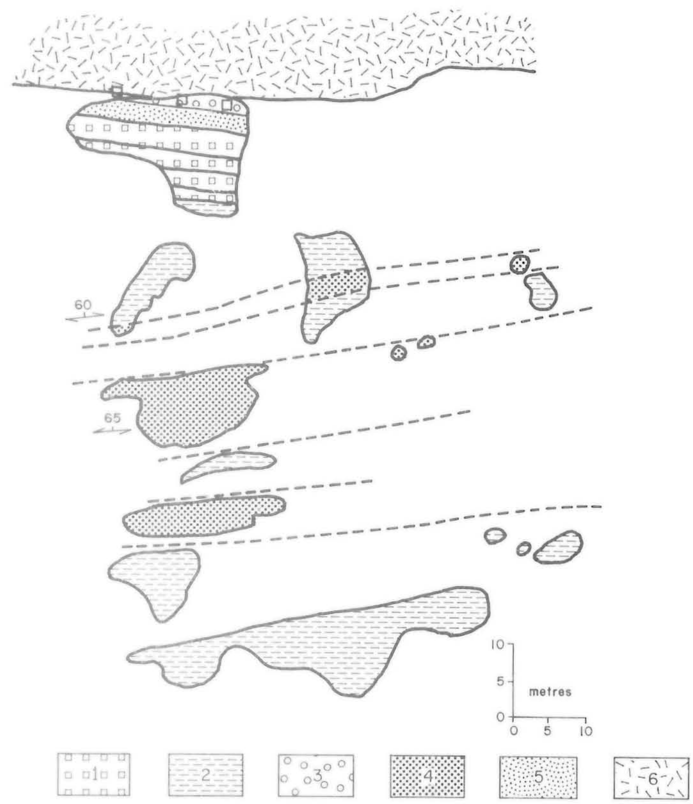
FIGURE GS-10-3: Geology of the Weldon Bay sphalerite occurrence (WB 6). Legend: 1. Interlayered white to buff, quartzitic and quartzofeldspathic rocks of volcanogenic (?) sedimentary origin; 2. Garnet-biotite-quartz gneiss with quartzitic, pelitic and thin amphibolite layers; 3. Quartz-sericite-pyrite schist with sphalerite; 4. Layered amphibolite; 5. Biotite-quartz gneiss; 6. Fine grained layered amphibolite and medium grained gabbroic rocks.



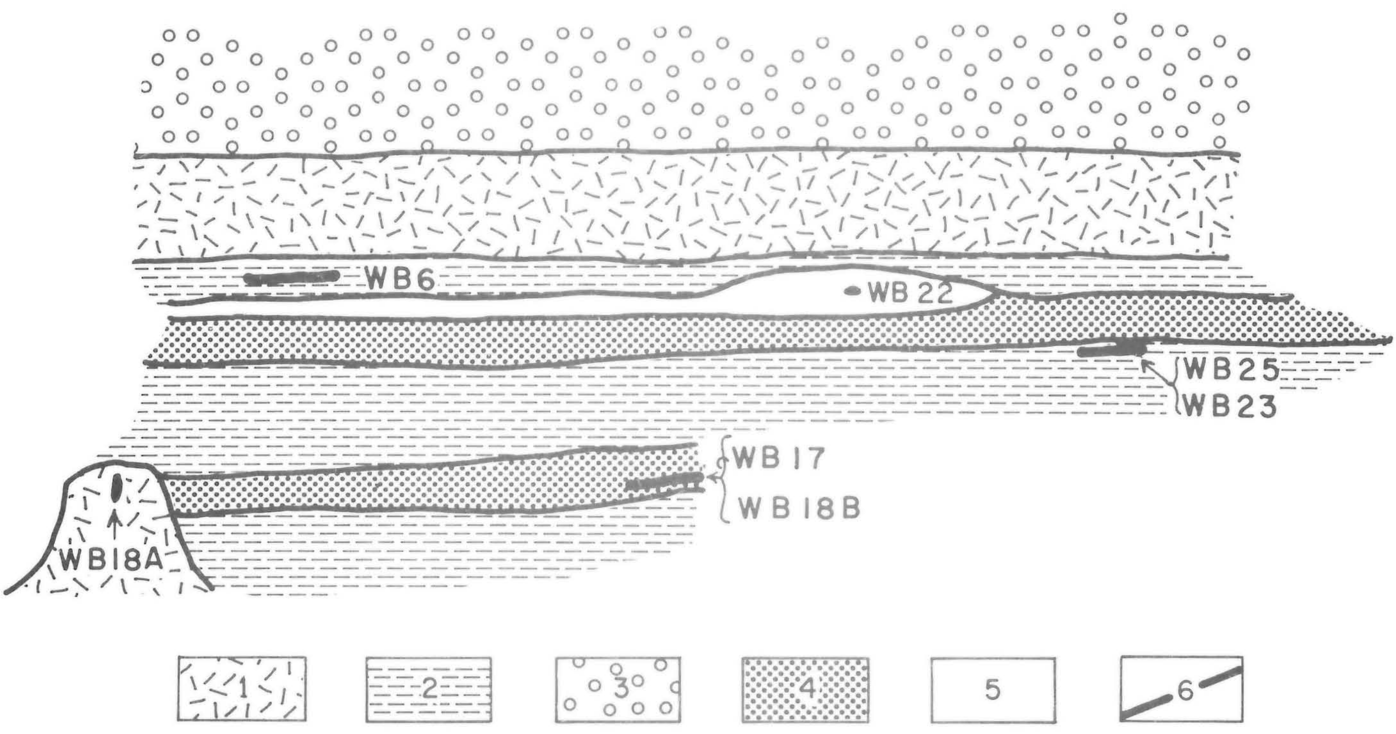


FIGURE GS-10-4: Schematic section illustrating the relative position of mineral occurrences in the Weldon Bay area. Legend: 1. Gabbro; 2. Garnet-biotite-quartz gneiss; 3. Quartzofeldspathic gneisses + magnetite; 4. Layered amphibolite; 5. Felsic sedimentary rocks and felsic lavas; 6. Mineral occurrences, numbers refer to Table GS-10-1.

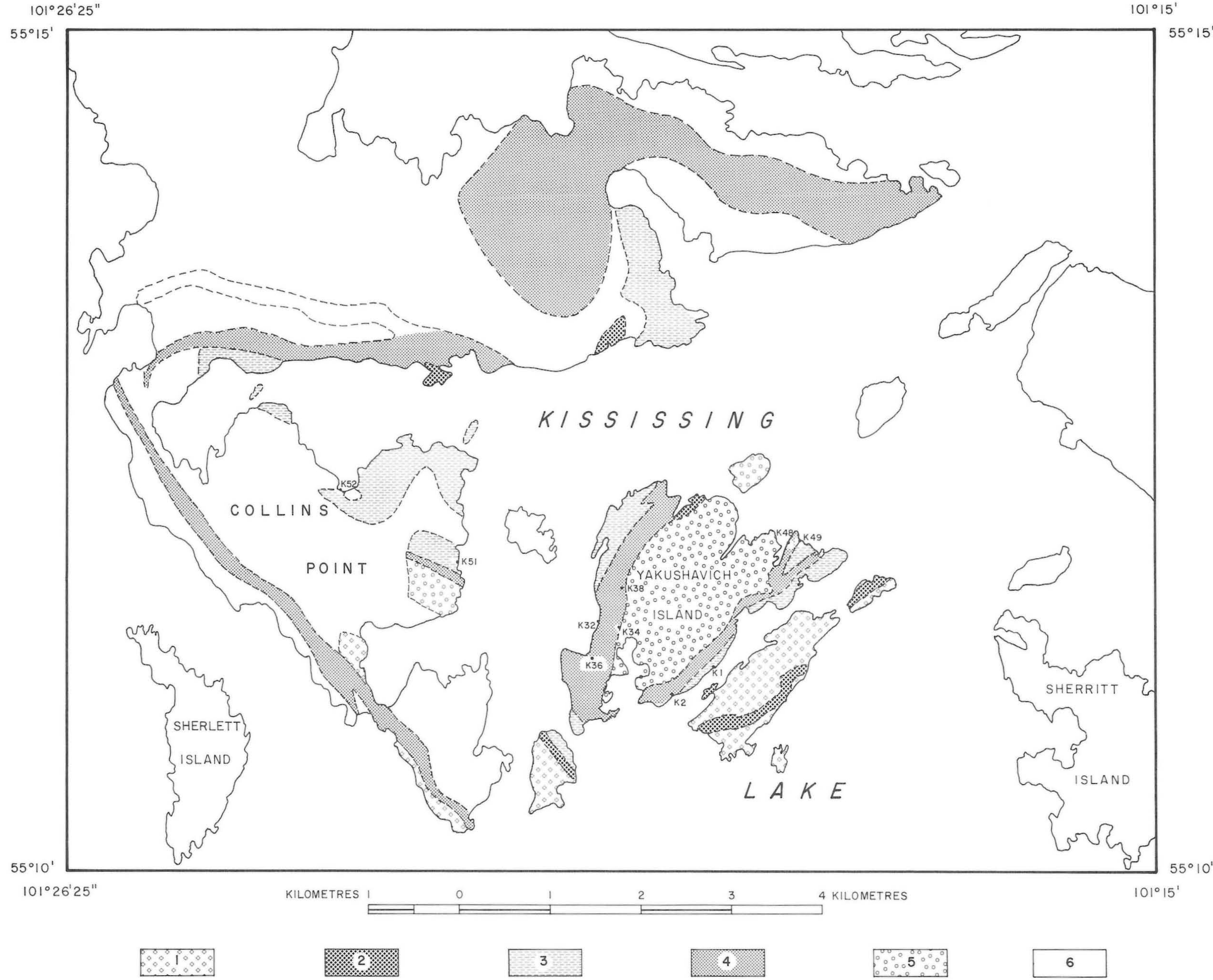


FIGURE GS-10-5: *General geology of Yakushavich Island and Collins Point area (modified after Frarey, 1961). Legends: 1. Greywacke; 2. Layered 'quartz-rich' hornblende-quartz gneiss; 3. Biotite-quartz gneiss±garnet±graphite, generally rusty weathering; 4. Layered garnetiferous amphibolite; 5. Hornblende-bearing quartzofeldspathic gneisses with calc-silicate layers and magnetite; commonly interlayered area with biotite-quartz gneiss; 6. Undifferentiated rocks.*

TABLE GS-10-1

ORDER OF EVENTS

WINTERING LAKE-WESTERN SIPIWESK LAKE

- emplacement of granite and pegmatite
- formation of rare pseudotachylyte
- D_{3B} — renewed shearing within S_3 tectonic zones
- greenish-grey lamprophyre
- D_{3A} — intense shearing and (blasto) mylonitization formation of well-layered gneisses (S_3 tectonites), profound reworking of Archean gneisses
- formation of M_3 migmatites
- metasomatism of Archean gneisses
- pegmatite, tonalite and granodiorite
- local anatexis of older migmatites

(M_3: greenish-grey lamprophyre to metasomatism of Archean gneisses)

— HUDSONIAN FRONT —

LANDING LAKE-EASTERN AND CENTRAL SIPIWESK LAKE-BEAR ISLAND-BULGER LAKE-CROSS LAKE

- formation of pseudotachylyte
- northeast-trending faults and mylonites
- reactivation of D_2 shear belts, sporadic deformation of Molson dykes; weak metamorphism noticeable in Molson dykes only

M_3 amphibolite facies metamorphism in the Wintering and western Sipiwesk Lakes area only

— HUDSONIAN OROGENY —

- emplacement of Molson diabase swarm
- north-northwest-trending mylonites
- D_{2B} — formation of east-northeast-trending late D_2 shear belts, augen gneisses and mylonites, attenuation of S_2 fabric
- granitization and recrystallization of migmatites between Sipiwesk Lake and Cross Lake
- growth of post-S_2 garnet and local retrogression
- D_{2A} — formation of planar and planolinear quartz fabric (S_2)
- formation of M_2 migmatites
- intrusion of quartz-monzonite, pegmatite, granite, minor tonalite and monzo-diorite
- intrusion of (leuco-) gabbro — leucoenderbite — opdalite dykes and sills (central Sipiwesk Lake)
- derivation of quartz-feldspar (-orthopyroxene/hornblende) mobilizate from pre-M_1 migmatites
- intrusion of hornblendite dykes

M_2 (hornblende) granulite facies and amphibolite facies metamorphism

- D_{1B} — local isoclinal folding of S_1
- D_{1A} — formation of metamorphic banding S_1
- derivation of K-feldspar-rich felsic mobilizate

M_1 amphibolite facies and possibly hornblende granulite facies metamorphism, lower grade metamorphism in the Cross Lake area

- plagiophyric mafic dykes (Bulger Lake dykes)
- formation of pre-M_1 migmatites
- intrusion of tonalite, granodiorite and minor quartz diorite (enderbite?)
- emplacement of layered gabbro-pyroxenite-peridotite (northwestern part of map-area)
- intrusion of hypabyssal plagiophyric gabbro and anorthosite in the greenstones
- deposition of greenstones (massive and pillowed basalts, sediments, iron formations, dacites and porphyries (southern part of map-area))

— KENORAN OROGENY —

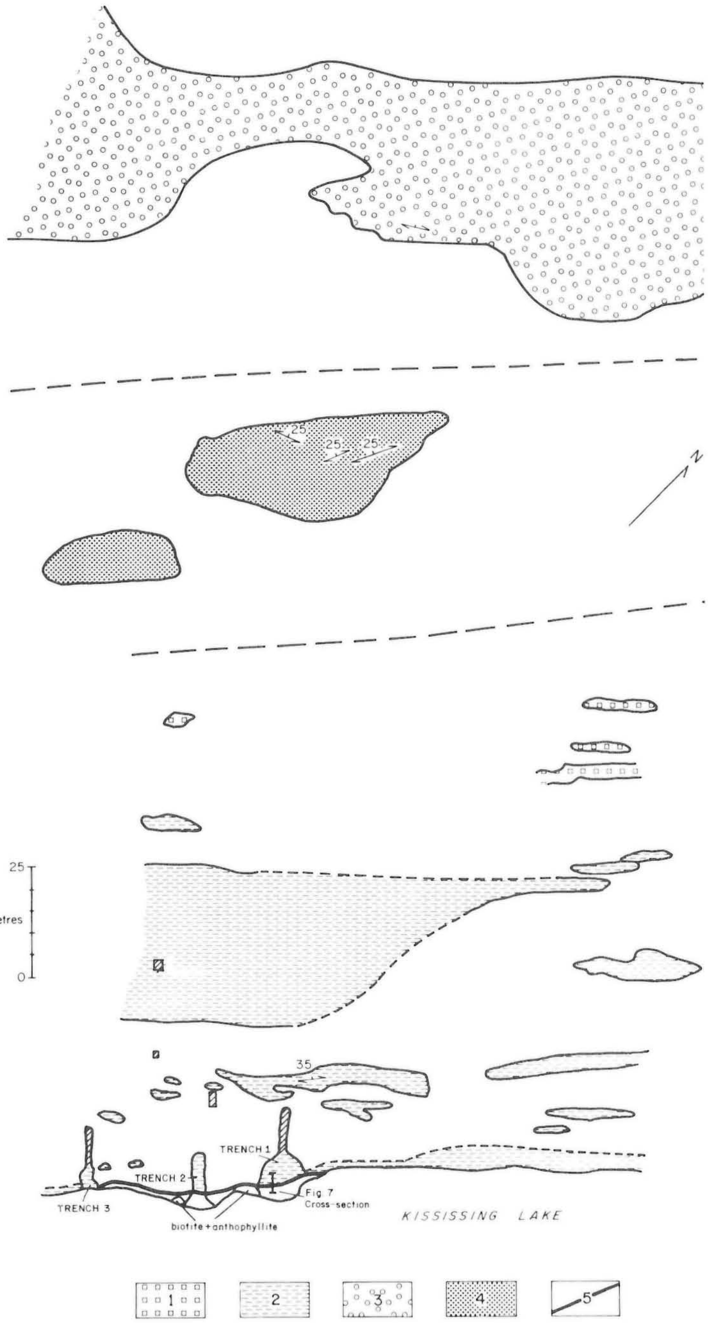


FIGURE GS-10-6: Geology of the K1 mineral occurrences, Yakushavich Island. Legend: 1. Pegmatite; 2. Garnet-biotite-quartz gneiss±graphite; 3. Quartzo-feldspathic gneiss with calc-silicate layers; 4. Layered garnetiferous amphibolite; 5. Sulphide layer.

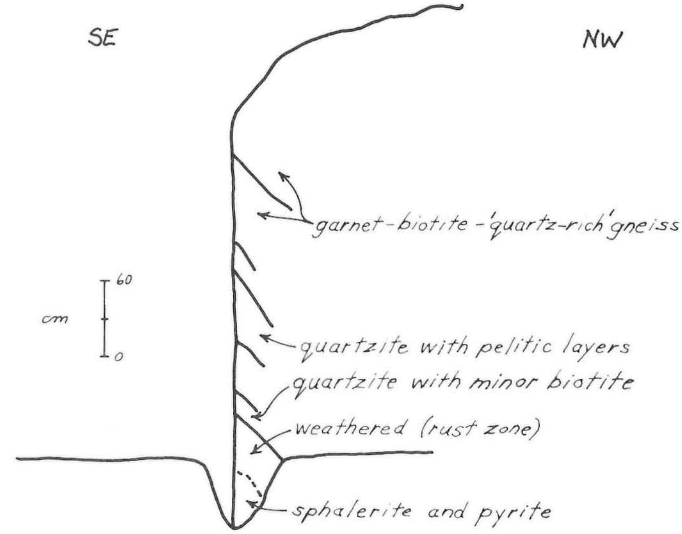


FIGURE GS-10-7: Geological cross-section at trench 1, locality K1, Yakushavich Island.

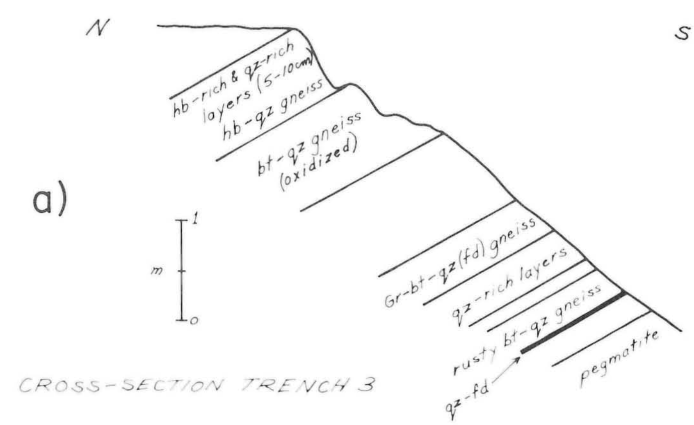


FIGURE GS-10-8a: Geological detail of trench 3, locality K 2.

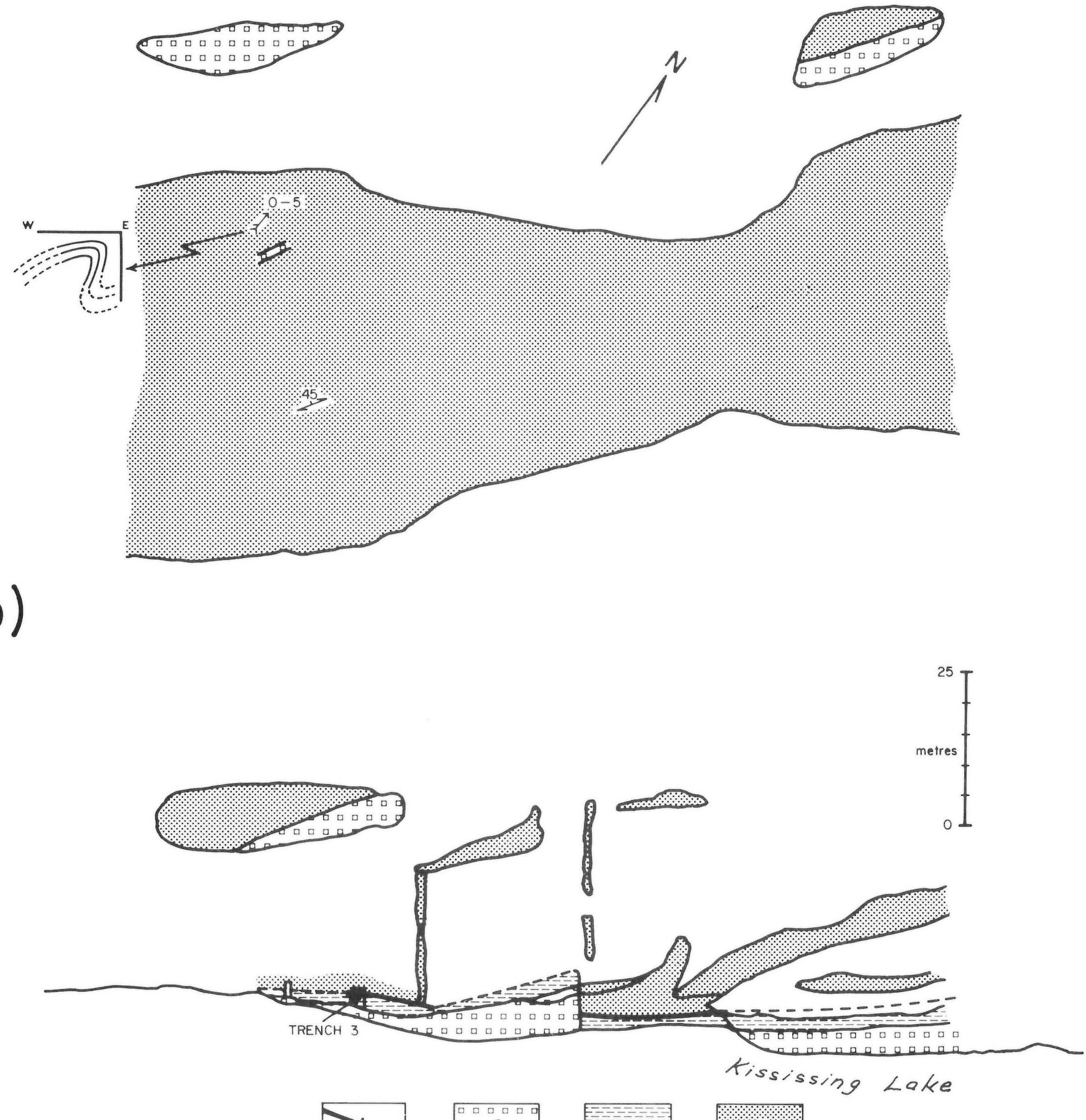


FIGURE GS-10-8b: Geological map of locality K 2, Yakushavich Island. Legend: 1. Sulphide layer; 2. Pegmatite; 3. Garnet-biotite-quartz gneiss±graphite; 4. Layered amphibolite.

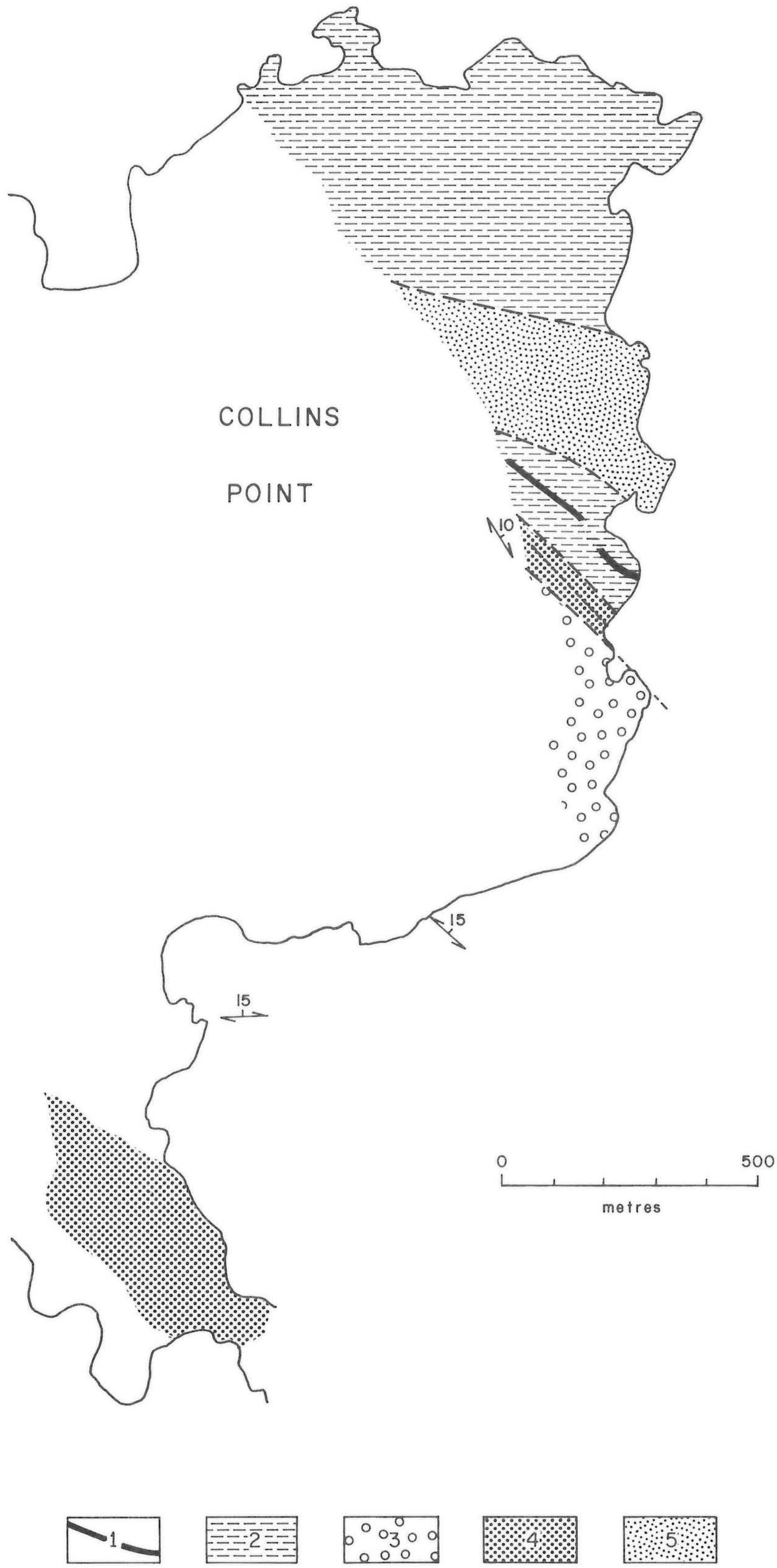


FIGURE GS-10-9: Geology of the Collins Point area (K 51). Legend: 1. Sulphide layer; 2. Biotite-quartz gneiss±garnet±graphite; 3. Quartzofeldspathic gneiss±hornblende±magnetite, contains minor calc-silicate layers; 4. Layered amphibolite; 5. Granite.

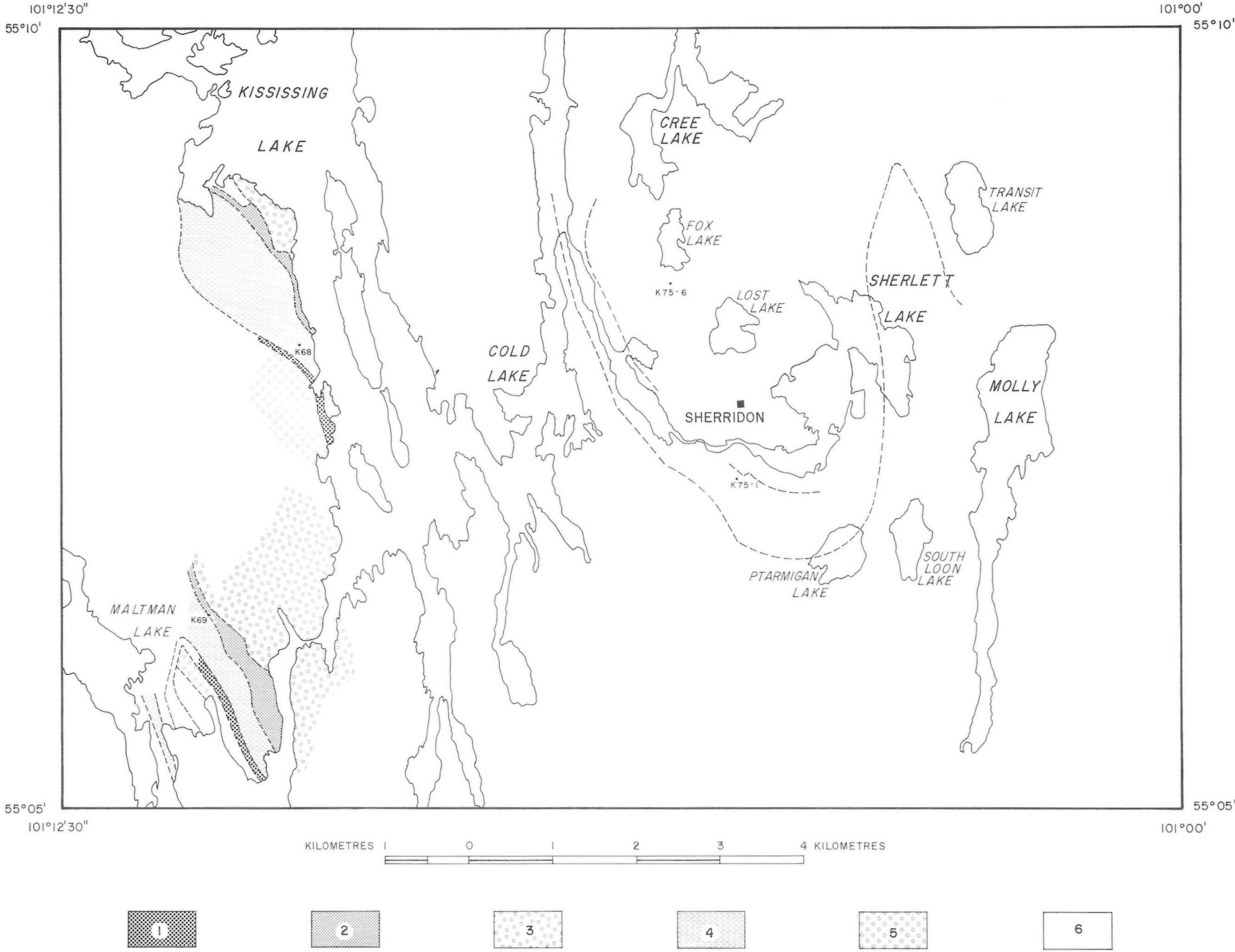


FIGURE GS-10-10: Location of the Ideal (K 68), Maltman Lake (K 69), Sherridon (K 75-1) and Cold Lake (K 75-6) occurrences. Legend: 1. Layered amphibolite; 2. Layered garnetiferous amphibolite; 3. Quartzofeldspathic gneiss with minor calc-silicate layers; 4. Biotite-quartz gneiss±garnet±graphite; 5. Garnet-biotite gneissic greywacke; 6. Undifferentiated rocks.

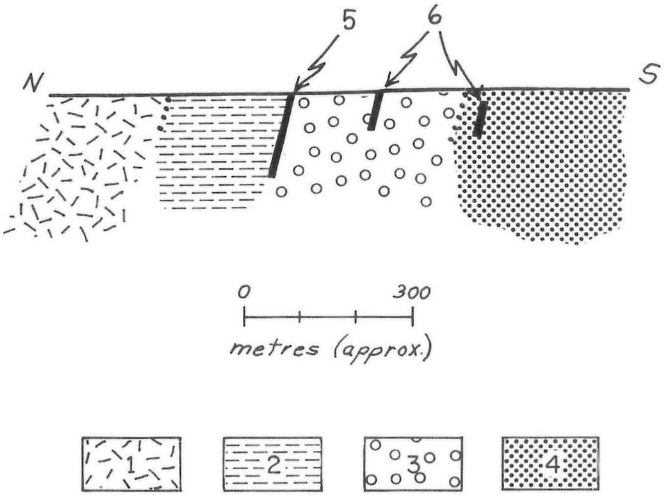


FIGURE GS-10-11: Schematic section through the Sherridon East ore zone. Legend: 1. Garnet-feldspar-hornblende gneiss with anastomosing alteration vein network of garnet and hornblende; 2. Sillimanite-bearing biotite-quartz gneiss, rusty weathering; 3. Quartz-feldspathic gneiss with calc-silicate layers — in part rusty weathering; 4. Layered amphibolite; 5. Sherridon East Mine; 6. Sulphide stratum (± graphite).

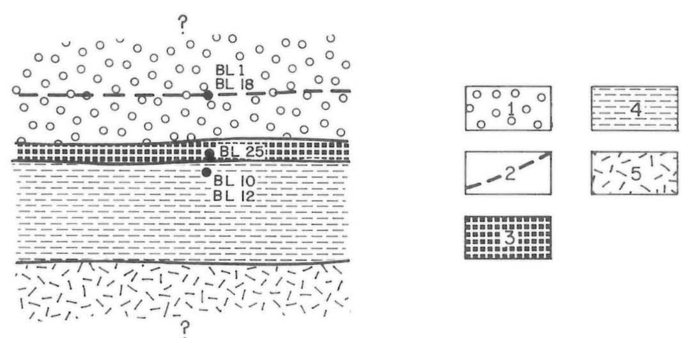


FIGURE GS-10-12: Schematic representation of relative position of mineral occurrences in the Batty Lake and Star Lake areas. Stratigraphic top uncertain. N.B. Locality BL18 is considered to be at the same stratigraphic position as the Sherridon Mine (Robertson, 1953). Legend: 1. Quartzose and arkosic gneisses; 2. Biotite-garnet-cordierite-anthophyllite gneiss; 3. Limey hornblende-rich gneisses; 4. Biotite-quartz gneiss±graphite± garnet; 5. Amphibolite.

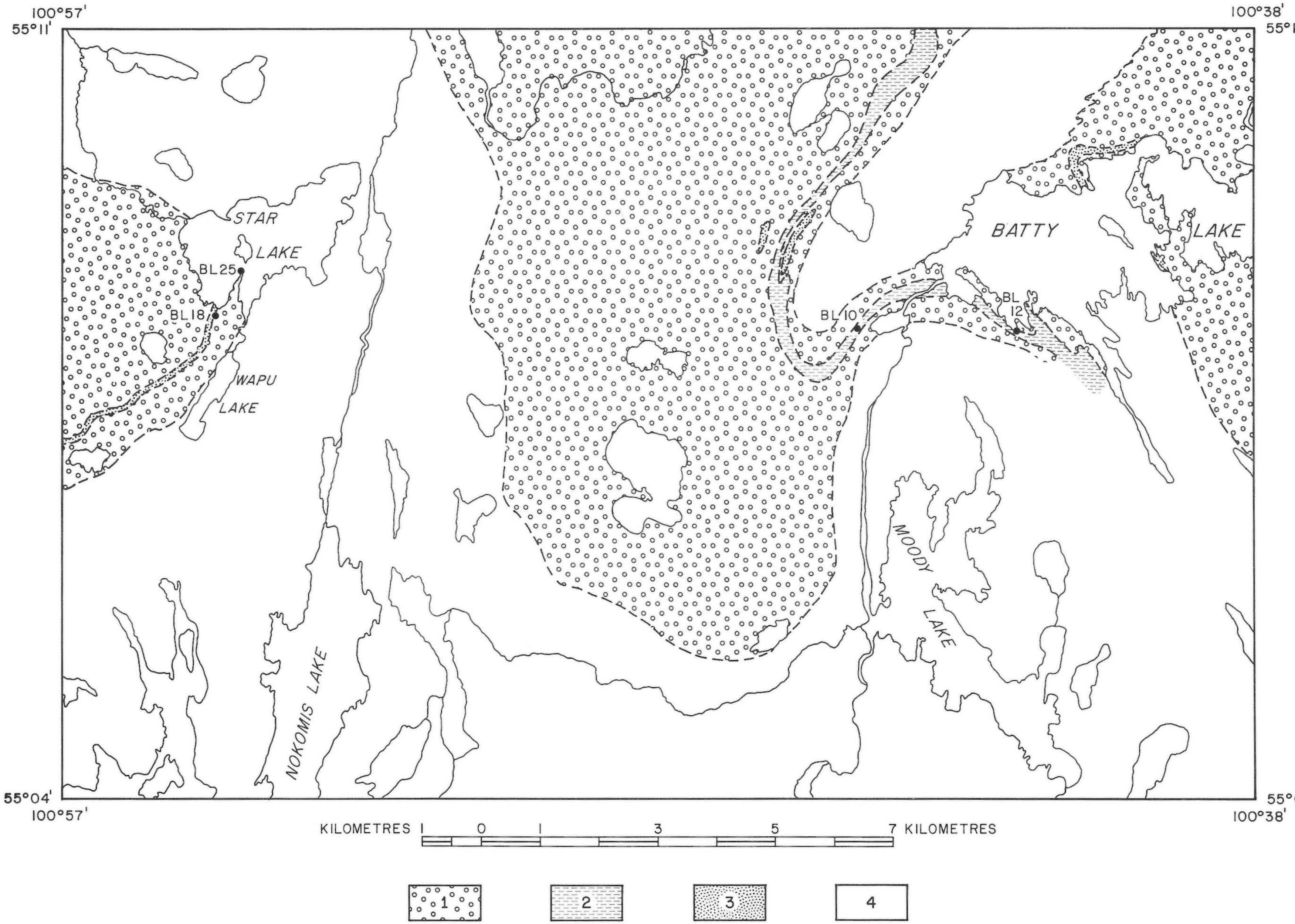


FIGURE GS-10-13: Locality map for the Batty Lake area. Geology simplified from Robertson (1953): 1. Quartzose and arkosic gneisses; 2. Biotite-quartz gneiss±graphite±garnet; 3. Biotite-garnet-quartz-anthophyllite±cordierite gneiss; 4. Undifferentiated rocks.

TABLE GS-10-1

Summary data for Mineral Occurrences in the Weldon Bay (WB), Kississing Lake (K), and Batty Lake (BL) areas

		Type of Occurrence	Nature of Mineralization	Host Rocks	Thickness	Comment
WB 6	63K/14	1 x 2 x 4 m trench 1 x 2 x 4 m trench 1 x 2 x 3 m trench Several ddh. or EM anomaly.	Near solid sphalerite plus disseminated py in a sericite-quartz schist layer — 4 m thick.	Massive and layered amphibolite and gr-bt-qz gneiss with felsic tuff/ sediment.	10 cm of NSS 4 m if dissem. pyrite. pyrite.	Kalliokoski (1953)
WB 7	63K/14	2 x 2 x 4 m trench	25 - 30% Py, trace cp, minor gr plus qz in a 25 cm thick layer and 1 - 5% py + po + cp.	Garnetiferous amphibolite and streaky calcareous amphibolite.	1.5 m of disseminated and semi-massive sulphide.	Kalliokoski (1953)
WB 18	63K/14	0.5 x 1 x 3 m trench	Trace cp and scattered po lenses (10 x 10 x 15 cm) in pegmatite.	Gabbro	—	Kalliokoski (1953)
WB 18B	63K/14	0.5 x 2 x 3 m trench	25 - 30% cp in a gr-qz layer.	Gr-amphibolite	30 cm.	
WB 23	63K/14	2 x 2 x 17 m trench	10 - 15% py in a quartzose sediment.	Bt-qz gneiss and a light grey quartzose gneiss.	8 m	Kalliokoski (1953)
WB 24	63K/14	1 x 1 x 6 m trench (filled)	?	Amphibolite	—	Kalliokoski (1953)
WB 25	63K/14	2 x 1.5 x 9 m trench	70 cm. Near solid layer of po with tr. cp. Disseminated po and py in quartzose sediment	Siliceous gr-bt-qz gneiss and amphibolite	2 m	Kalliokoski (1953)
WB 28	63K/14	0.5 x 0.5 x 2 m trench	Trace py in rusty quartzose layer.	Gr-amphibolite	15 cm	Kalliokoski (1953)
WB 100	63K/14	Outcrop	Rusty weathering zone with 25 cm thick quartzose layer with 10 - 15% py.	Layered gr-amphibolite	40 cm	
K 1	63N/3	Several trenches, several ddh. and outcrop.	Near solid sulphide (sp, py) and bt-ay alteration.	Rusty weathering bt-qz gneiss	50 cm.	Frarey (1961)
K 2	63N/3	Several trenches and outcrops.	Disseminated (1 - 5%) py and po in quartzose layers and pegmatite.	Amphibolite (above) hb-bt-gz gneiss.	1 m	Frarey (1961)
K 34	63N/3	1 x 1 x 5 m trench 0.5 x 1 x 7 m trench and outcrop.	Rusty weathering hb-qz layer with 1 - 2% py.	Layered amphibolite	40 cm	Frarey (1961)
K 35	63N/3	Outcrop	Rusty weathering with trace py.	Layered gr-amphibolite and calc-silicate layers.	60 cm	Frarey (1961)
K 36	63N/3	1.5 x 3 x 5 m trench 1 x 1 x 4 m trench and outcrop.	10% Po in hb-bearing quartzose layer.	Layered amphibolite.	140 cm	Frarey (1961)
K 37	63N/3	Outcrop	Trace to 10% po in rusty weathering hb-fd-qz layer (rusty weathering zone traced along strike from K 36).	Layered amphibolite	120 cm	Frarey (1961)

TABLE GS-10-1 (Continued)

			Type of Occurrence	Nature of Mineralization	Host Rocks	Thickness	Comment
K	38	63N/3	2 x 2 x 3 m trench and outcrop.	1% cp, and malachite in bt-fd-qz pegmatite.	Amphibolite	40 cm	Frarey (1961)
K	48	63N/3	2 x 2 x 7 m trench	Rusty weathering gr-amphibolite, intensely weathered and friable.	Layered gr-amphibolite	30 cm	Frarey (1961)
K	49	63N/3	Four trenches and outcrop.	1 - 20% po in rusty weathering layers; minor quartz veining and pegmatite.	Layered amphibolite	50 cm	Frarey (1961)
K	51	63N/3	14 trenches	Disseminated to near solid sulphide (sp, sa, py, po) in quartzose layers (sulphides obtained only from trench rubble). Traced for 500 m along strike.	Rusty weathering bt-qz gneiss.	10 - 50 cm	Frarey (1961)
K	52	63N/3	Four trenches	Disseminated near solid ga and po associated with a qz-fd pegmatite. (Probably along strike continuation of mineralized zone at K 51).	Rusty weathering bt-qz gneiss.	30 cm	Frarey (1961)
K	68	63N/3	A number of trenches, two shafts, several ddh and outcrop.	60 cm near solid sulphide layer (sp, ga, py, cp), scattered outcrops of bt-ay±cd and gr + trace py, po, cp.	Rusty weathering bt-qz gneiss.	10 - 20 cm	Frarey (1961)
K	69	63N/3	Four trenches	Disseminated (1 - 50%) py in several amphibolite layers and a 40 cm thick layer of hb + qz with 20% po.	Layered amphibolite	60 cm	Tuckwell (1979)
K	75-6		0.5 x 1 x 12 m trench 1 x 1 x 10 m trench and outcrop	5% ghanite in a 250 cm quartzose layer and gr-ay-cd (?) alteration.	Quartzitic gneisses with calc-silicate layers	10 m	
BL	1	63N/2	3 x 4 x 15 m trench and several outcrops	Gr-cd-ay-qz rock with minor py, po, cp.	Quartzitic gneiss and mt-fd-qz gneiss.	3 - 5 m	Locality 8 of Robertson (1951)
BL	10	63N/2	0.5 x 1 x 4 m trench and 0.5 x 1 x 5 m trench	3 - 5% py + tr. po in a quartz-rich sediment at contact.	Bt-qz gneiss and amphibolite	0.6 m	Locality of Robertson (1951)
BL	12	63N/2	Outcrop	5 - 10% py and 1 - 2% gf in layers 1 - 15 cm thick	Bt-qz gneiss with graphite	1 m	
BL	18	63N/2	Outcrop	Gr-cd-qy-qz rock with trace y	Quartzitic meta-sediments	3 - 5 m	Unit 8 of Robertson (1951)
BL	25	63N/2	0.5 x 1 x m trench (filled)	?	Calc silicate layers and hb-bearing quartz-rich layers	?	Locality 1 of Robertson (1951)

Abbreviations: py = pyrite, po = pyrrhotite, cp = chalcopyrite, sp = sphalerite, ga = galena, qz = quartz, bt = biotite, gr = garnet, ay = anthophyllite, cd = cordierite, hb = hornblende, fd = feldspar, mt = magnetite, gf = graphite, NSS = near solid sulphide, tr = trace, ddh = diamond drill hole.

GS-11 CACHOLOTTE LAKE

(Parts of 63K/13, 14 and 63N/3, 4)

By W. David McRitchie

A two-week reconnaissance was undertaken in the Cacholotte Lake area (Fig. GS-11-1) to provide information:

a) on the extent of the greywacke and quartzofeldspathic suites in the area;
b) to attempt a correlation between the apparently incompatible 1 mile geological maps in the Duval Lake (Pollock 1964), Collins Point (Frarey, 1948) Sherridon (Bateman & Harrison, 1945) Mikanagan (Bateman & Harrison, 1943) and Weldon Bay (Kalliokoski, 1952) areas;
c) to assess the degree to which the lithologic subdivisions and sequences (stratigraphy) developed elsewhere in the Kisseynew gneiss belt applied to this region; and
d) to provide an up-to-date data base and logistical assessment of the region for 1:50 000 mapping programme proposed for the period 1982-84, inclusive.

The investigation was greatly facilitated by a network of dirt roads opened up by Manitoba Forest Products Ltd., and by access from Kisseynew Lake and Kississing River. Concurrent investigations by G. Gale on the regional setting of base metal mineralization in the area and by E. Froese (Geological Survey of Canada) on the metamorphism in and around Weldon Bay are reported on elsewhere. An initial overview of the region was kindly provided in the field by representatives of Cominco Ltd.

GENERAL GEOLOGY

The area is dominated by a 270 - 290° structural trend that is manifested in parallel to sub-parallel foliation, axial traces, layering, mesoscopic fault sets and major fractures (Figs. GS-11-1 and GS-11-2). As a consequence, cross strike lithologic sequences are to be used with caution and commonly may not represent the sequence of original stratigraphic superposition. Four major groups of rocks can be identified:

a) biotite, garnet-biotite, and garnet-biotite ± staurolite ± sillimanite, semipelitic and pelitic metagreywacke-metamudstone paragneisses — Duval Lake schist, etc.
b) conglomerate-quartzite-quartz arenite with basal garnet amphibolite;
c) mixed amphibolitic wackes, metagabbro, gabbro and hornblende-biotite schists;
d) quartzofeldspathic gneisses, minor meta-arkose, calc-silicate units and thin conglomerate near inferred base of section.

A single top determination obtained from a size gradation of angular flakey intraclasts near the base of the main conglomerate (b) would imply an order of superposition (a) to (d) that corresponds to the stratigraphic relationships inferred between the greywacke suite (Nokomis Group), transitional amphibolite, and arkosic suite (Sherridon Group) elsewhere in the Kisseynew Sedimentary Gneiss Belt.

Garnet-biotite paragneiss

The metagreywacke and metamudstone derived paragneisses form an extensive belt in the north of the area where Pollock (1964) has referred to them as the Nokomis Group and Duval Lake schists. Three varieties are typical:

a) plagioclase-quartz-biotite schist;
b) plagioclase-quartz-biotite-garnet schist

and a less common (c) plagioclase-quartz-giotite garnet-staurolite schist ± sillimanite.

The unit is prominently layered (Fig. GS-11-3) with finer grained siliceous psammitic units alternating with strongly foliated and blastic pelites. Near the junction of the Duval Lake and Kississing Lake roads the proportion of quartzofeldspathic mobilizate and degree of recrystallization increases markedly and to the east the rocks become increasingly migmatitic with abundant granitic and pegmatitic *lit*.

A second much narrower belt of garnet-biotite and biotite gneisses containing euhedral garnet porphyroblasts occurs to the south of the Duval Lake road and Kississing River. No staurolite was observed in this area; however, sillimanite occurs sporadically as small fibrolite bundles in the more foliated pelite layers.

Conglomerate and amphibolite

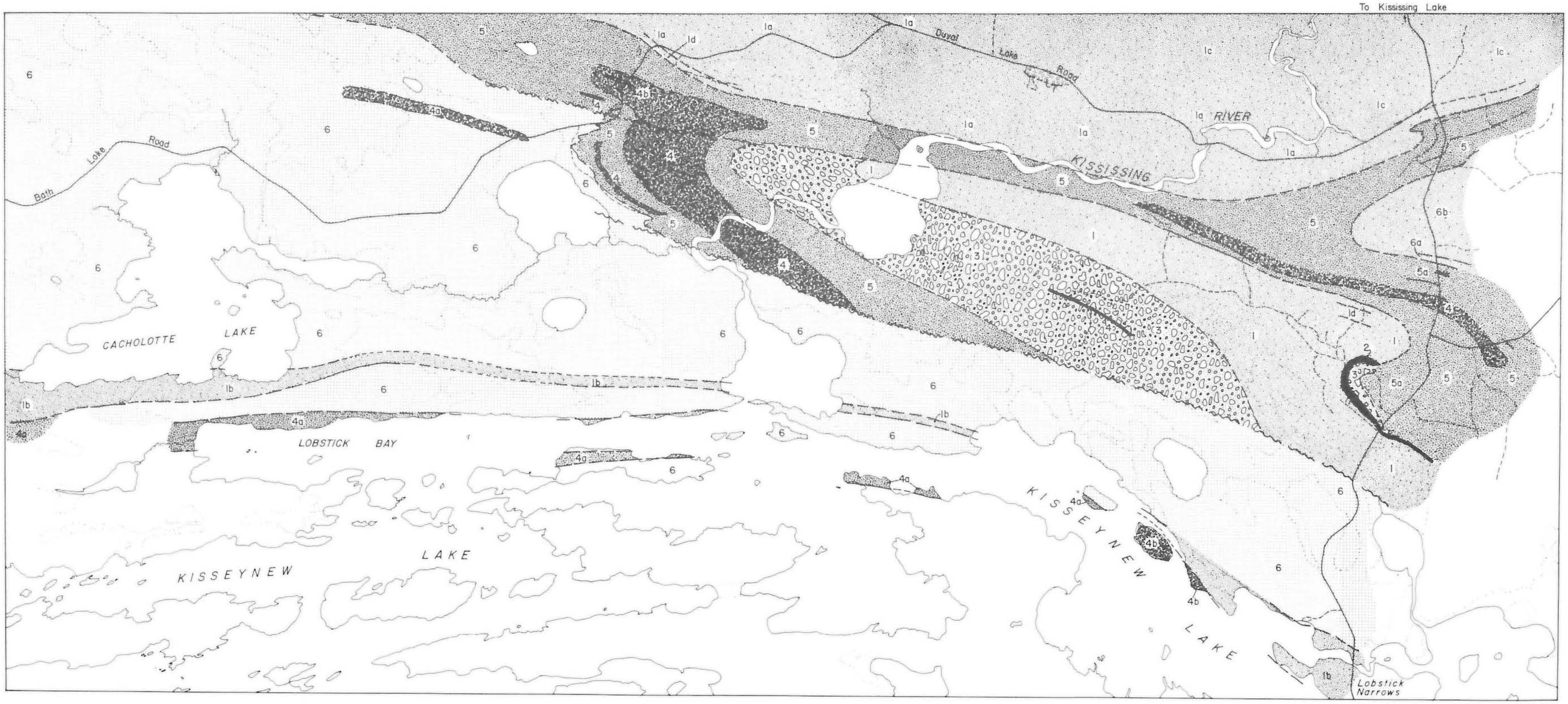
A well layered garnet amphibolite with a pronounced gossan zone is exposed in direct contact with the garnet-biotite gneisses in a major fold hinge zone 3 km due north of Lobstick Narrows. Immediately above and to the east of the amphibolite a 10 m thick coarse grained quartzite (86% quartz, 7% plagioclase, 6% hornblende, 1% biotite) lies at the base of a much thicker development of pebble and cobble conglomerate interlayered with laminated and possibly cross-and festoon-bedded coarse grained garnet-bearing quartz-arenite. Beds range from 20 cm to 3 m in thickness with elongate flattened clasts of cream coloured aphanitic dacite composition, quartzite, vein quartz and lithic wacke ranging in size from 1 - 20 cms in length and up to 4 cms thick (Figs. GS-11-4 & 5).

A much more extensive development of the conglomerate (> 4 sq. km) lies on the south flank of the garnet-biotite gneisses and intersects the Kississing River at, and on the lake immediately downstream from, the first rapids downriver from Kisseynew Lake.

The quartzose composition of the conglomerate, repeated interlayering of conglomerate and grit or arenite beds, coarse granularity of the quartz arenite layers, and ubiquitous lamination (defining possible cross and festoon bedding planes) all indicate a high energy possibly fluviatile or deltaic origin for this unit that contrasts markedly with the delicate turbidite-like interlayering of the garnet-biotite gneiss. The overall composition and texture of the conglomerate resemble in many respects the basal phase of the Missi Group observed in the Flin Flon region.

Amphibolite

The amphibolite suite in the area exhibits a great variety of textures and structures. These range from delicately laminated readily identified metasedimentary hornblende and quartz-bearing wackes, through highly foliated biotite-rich schists of undetermined origin and metagabbros with a well preserved igneous texture, to a distinctive variety of hornblende-quartz-plagioclase amphibolite characterized by a streaked appearance caused by numerous irregular flat elongate lenses and prisms of lighter coloured more feldspathic rock (see also Pollock, 1964). Coarse grained better preserved sections of the streaked amphibolite display a bimodal association of tabular leucocrysts (2 - 5 cm) that resemble pre-existing feldspar phenocrysts set in a hornblende-rich matrix of more interstitial-igneous aspect. The unit is characteristically located near the centre of the main amphibolite unit and has been mapped by Pollock (1964) as a continuous layer for over 20 km to the west. A thin "sill" is also present within the core of the main conglomerate to the east and north and, accordingly, this element of the amphibolites is interpreted as a relict of a pretectonic feldsparphyric leucogabbroic high level intrusion.



- 7 — Granitoid rocks
- 6 — Quartzo-feldspathic gneiss (Sherridon Group)
  - a) pink arkosic gneiss and conglomerate
  - b) garnet- biotite-bearing subwacke
- 5 — Hornblende-quartz wackes, hornblende-biotite schist
  - a) calc-silicate-rich subarkosic gneiss
- 4 — Streaked amphibolite, meta-plagioclase-phyric gabbro
  - a) amphibolite with minor garnet
  - b) hornblende gabbro
- 3 — Conglomerate-quartzite-quartz arenite
- 2 — Layered garnet amphibolite
- 1 — Garnet- biotite-bearing metagreywacke
  - a) Duval Lake schist (Nokomis Group)
  - b) garnet- biotite- hornblende-bearing metagreywacke
  - c) migmatitic derivative
  - d) siliceous-biotite gneiss

Contacts, defined and inferred

Fault

Road; MANFOR dirt road (unserviced)

0 0.5 1 2 3

Kilometres

FIGURE GS-11-1: General Geology of the Cacholotte Lake/Lobstick Narrows Area.

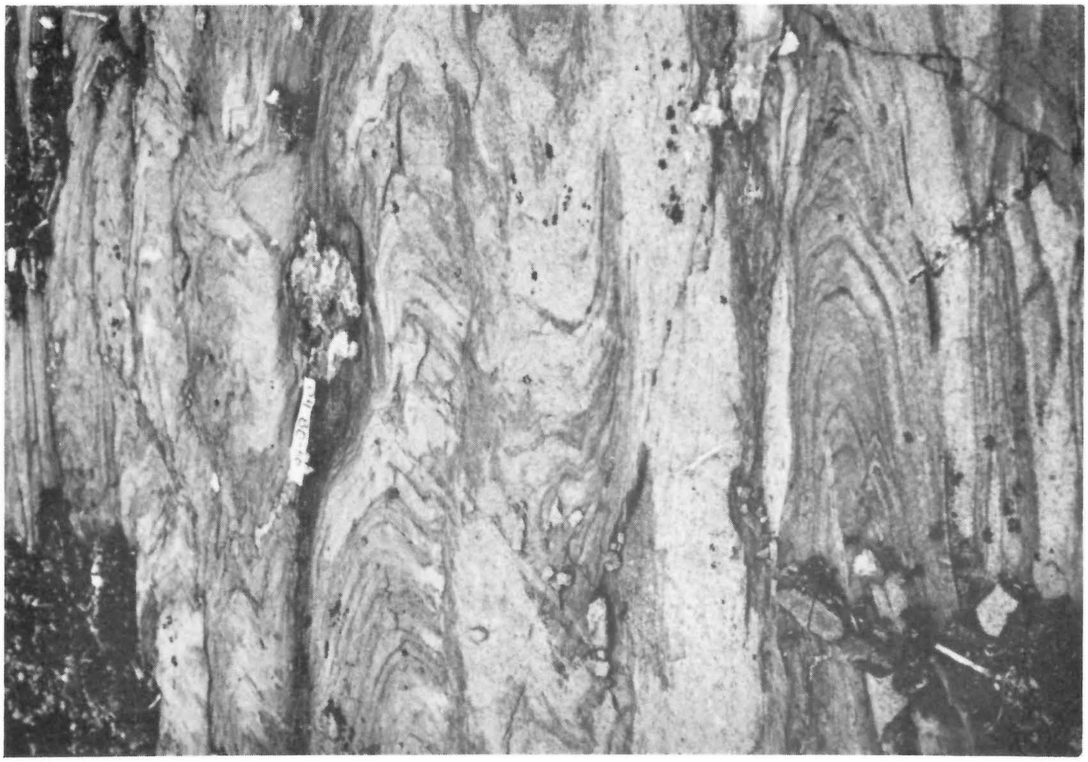


FIGURE GS-11-2: Subparallel imbricate dislocations in tightly folded laminated quartz-arenite from the main conglomerate unit 4.6 km northwest of Lobstick Narrows, Kisseynew Lake.

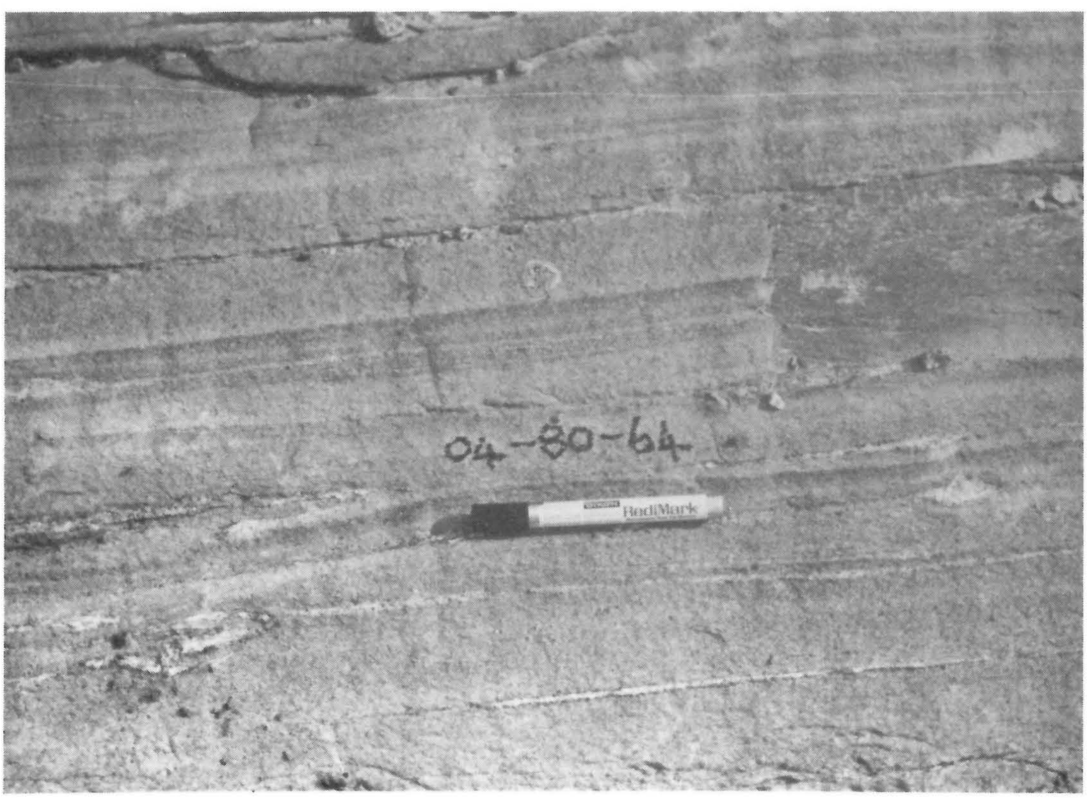


FIGURE GS-11-3: Well defined layering in the garnet- and biotite-bearing semipelitic metagreywacke 4.5 km north-northwest of Lobstick Narrows.

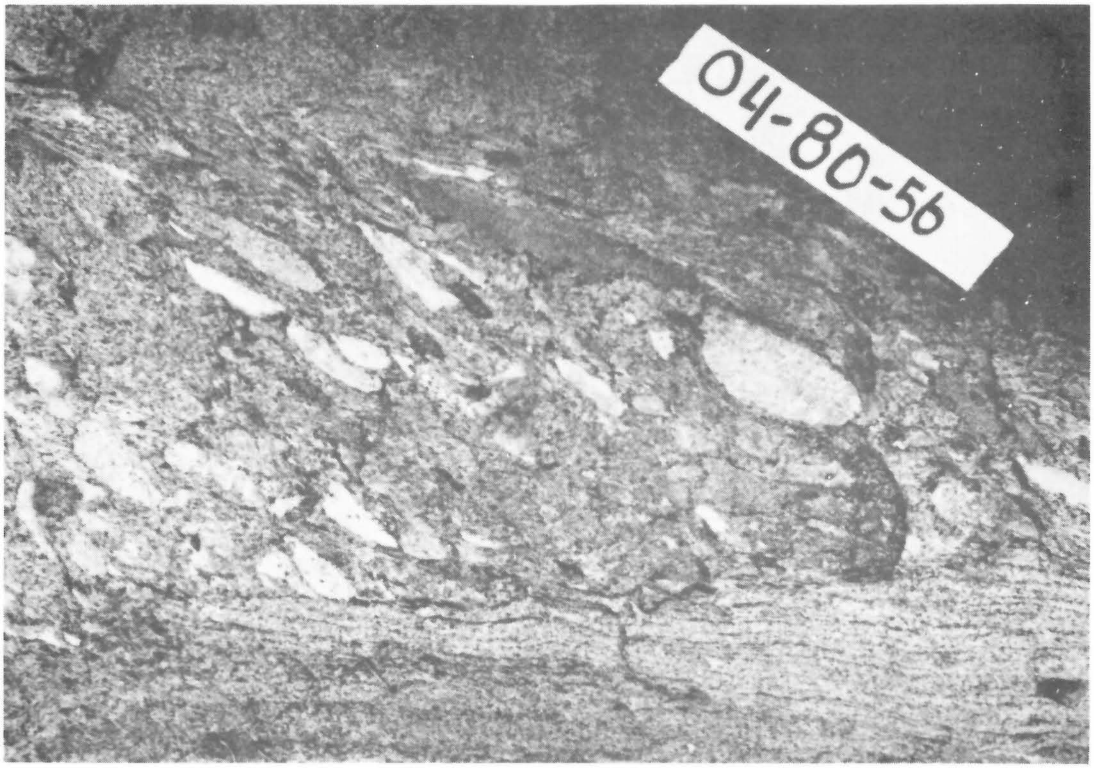


FIGURE GS-11-4: Conglomerate 4.5 km northwest of Lobstick Narrows.

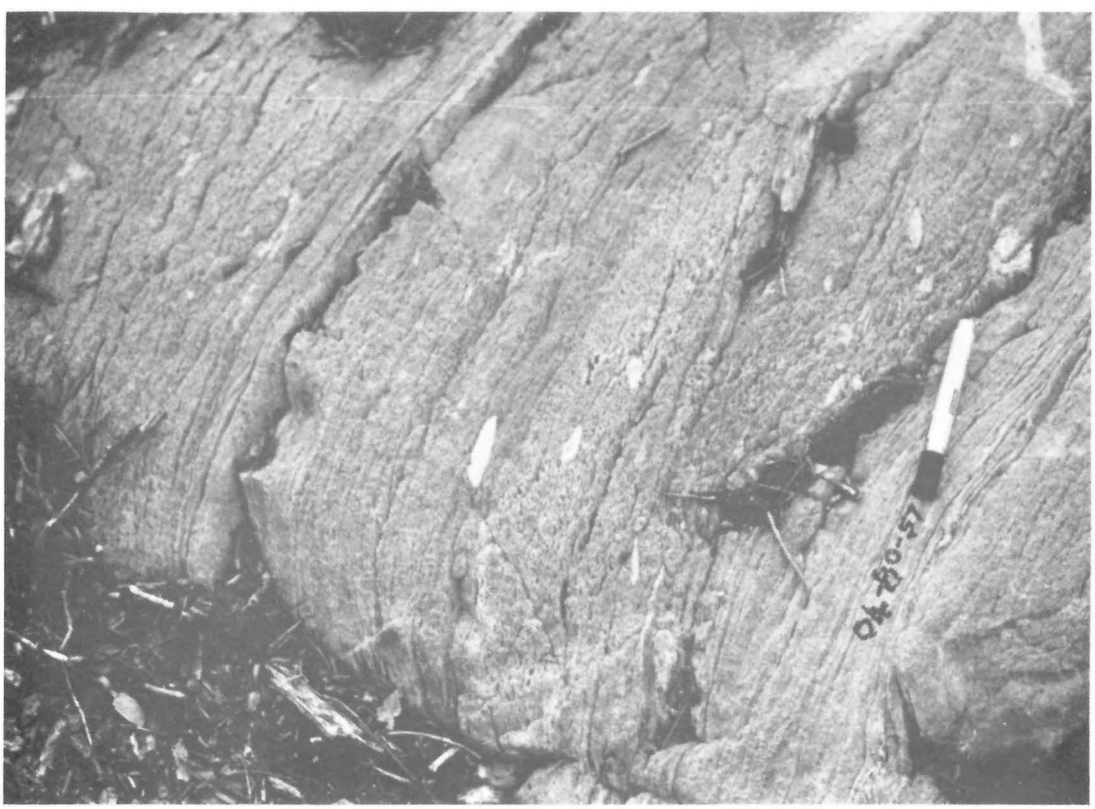


FIGURE GS-11-5: Pebble and cobble conglomerate interlayered with coarsely laminated garnet-bearing quartz-arenite 4.5 km northwest of Lobstick Narrows.

Quartzofeldspathic gneisses

The major part of the southwestern area is underlain by a complexly folded sequence of quartzose biotite- and muscovite-bearing paragneisses with very minor interlayered amphibolite and more common luridly zoned calc-silicate layers. In an isolated synclinal hinge zone 3.5 km north of Lobstick Narrows the lowermost section of possibly correlative gneisses contains delicately layered calc-silicate-rich units, overlain by thin fine grained pink psammitic quartzites and meta-arkoses with minor thin conglomerate layers which are in turn overlain by buff and cream coloured feldspathic wackes and garnet-bearing wackes.

In the west of the area on the Cacholotte Lake road a gap in the exposed sections occupies the interval between thinly layered buff and cream coloured wackes (lying to the west of delicately laminated hornblende wackes and conglomerate), and buff weathering garnet-bearing quartzofeldspathic gneisses to the west. Elsewhere the quartzofeldspathic suite is most commonly represented by interlayered light grey medium grained moderately foliated siliceous quartz-plagioclase-microcline-biotite and muscovite-bearing paragneiss with locally prominent faserkiesel-bearing layers in which the quartz- and sillimanite-bearing knots commonly range up to 1 x 4 cm although they may locally attain lengths of up to 14 cm. Magnetite is typical and on Cacholotte Lake was observed to form "placers" in local cross-bedded layers. Pollock (1964) has mapped this unit as a continuous formation extending to the Saskatchewan border 20 km to the west.

A garnet-rich biotite- and hornblende-bearing wacke forms a prominent marker unit which was traced along the south side of Cacholotte Lake, east to intersect the Kississing River, and thence further east, in isolated and widely spaced outcroppings, to Lobstick Narrows where it forms a prominent series of exposures at the bridge over the narrows. This unit superficially resembles the Nokomis garnet-biotite gneiss and has been mapped as such by Pollock (1964). However, the clotted and aggregated texture of the garnet blasts, absence of graphite, presence of hornblende and lack of alternating psammitic and semipelitic layering suggest that this unit should not be correlated with the Nokomis but rather represents a separate formation within the arkosic suite and higher in the overall section than the main "greywacke" suite.

Quartzofeldspathic paragneisses with persistent, yet thin, amphibolite formations dominate the area to the south and on Kisseynew Lake where, together with sheet-like granitoid units, they are broadly folded into the Kisseynew Lake domal structure.

SUMMARY

The subdivision of units in this area into garnet-biotite-gneisses — mixed conglomerate, quartzites, and amphibolites — and quartzofeldspathic gneisses can in a general way be correlated with the "greywacke suite — amphibolite — arkosic suite" classification used elsewhere in the Kisseynew belt. However, in detail many of the subunits appear unique to the Cacholotte-Lobstick area and much more extensive detailed mapping remains before confident correlations can be drawn between the Duval, Sherridon, Wabishkok and Heming Lake areas. Mesoscopic structures point to the existence of widespread imbrication and dislocations parallel to the strike of the major formations. Similarly, shallow axial planar foliations, near horizontal fold axes, and near horizontal bedding may be taken to indicate the presence of major, thrusting, recumbent folds and décollement. Accordingly, regional correlations and stratigraphic inferences based on a simple comparison of apparently contiguous lithologic sequences, must be treated with caution, unless it can be clearly and convincingly shown that the reference sections are not broken by structural discontinuities.

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GS-12 STRATIGRAPHIC MAPPING AND CORE HOLE PROGRAM

SOUTHWEST MANITOBA

by H.R. McCabe

INTRODUCTION

Work was carried out on a number of continuing projects. Two drill holes (M-1-80 and M-7-80) (Table GS-12-1, Fig. GS-1) were drilled to acquire additional information for the industrial minerals dolomite resources project (see Bannatyne, GS-13, this report). Two deep core holes (M-2-80 and M-4-80) were completed along the western edge of the Paleozoic outcrop belt, in the south Interlake area, to provide data for regional correlation of Silurian strata, and for determination of facies changes in Ordovician strata. Two shallower holes (M-3-80 and M-5-80) were completed in the south Interlake area to clarify specific correlation problems, some of which arose during compilation of the new Geological Map of Manitoba, and some of which became evident during compilation of entries for the revised Lexicon of Geologic Names for Western Canada.

One hole was drilled in the Devonian outcrop belt, northwest of the town of Winnipegosis, to obtain structural and lithofacies control relative to reef distribution. All core hole data are shown in Table GS-12-1. The total of 1095 m of core is the highest attained to date in the drill program.

Geological mapping involved examination of outcrops on the west shore of Lake Winnipeg, from Cat Head north to Carscallen Point, in an attempt to correlate the outcrop stratigraphy with core from hole M-3-80, and so define more precisely the stratigraphic subdivisions of the Red River Formation.

DEEP HOLE CORRELATION PROJECT

Hole M-2-80 (288 m) at the Oak Point Quarry, near the south end of Lake Manitoba, and hole M-4-80 (279 m) just north of Steep Rock, near the northern end of Lake Manitoba, are the deepest holes yet attempted in the core hole program. The depths approach the limits of capacity of the drill rig (300 m), but the holes were completed easily with no problems, indicating that core for the complete Ordovician-Silurian carbonate succession can be obtained throughout the entire extent of the outcrop belt. Several earlier core holes had been drilled in the south Interlake area, including one at Oak Point (69-1), but recovery in these holes was poor — less than 50% for most intervals. Inasmuch as correlation of Silurian and upper Ordovician strata is based largely on a series of thin argillaceous/sandy marker beds, reliable correlation of these early holes was almost impossible, as most marker beds were not recovered. Holes M-2-80 and M-4-80, however, provided excellent recovery, and all significant marker beds were recovered, permitting close correlation with gamma-ray logs for oil well test holes in the same general area. A marker bed correlation profile can now be made, with a reasonable degree of confidence, from the northern limit of Silurian occurrence to the southern limit of the outcrop belt, in the vicinity of Inwood (Fig. GS-1). Considerable lateral variation in lithology is evident between marker beds, and it is now possible to suggest some definite revisions to the stratigraphic subdivision of the Silurian succession.

The deep correlation holes also indicate marked facies changes in the Ordovician strata. These changes can now be defined in general terms, at least inasmuch as they affect correlations and stratigraphic terminology particularly with respect to the Cat Head and Selkirk Members of the Red River Formation, and the Gunn and Penitentiary Members of the Stony Mountain Formation (see following section).

Devonian test hole M-6-80 was located so as to provide deep structural and stratigraphic data regarding Winnipegosis reef distribution. No structural data were available for the area between the south end of Lake Winnipegosis (hole M-6-76) and Swan Lake (hole M-7-78). The presence of salt springs and structural domes is known throughout most of the area, and both are known to reflect the presence of buried Winnipegosis reefs, but no accurate estimate of reef thickness was possible because of the lack of structural control to the base of the Devonian. Hole M-9-79 attempted to core a structurally high reef site, but had to be abandoned because of extreme artesian flow. Hole M-6-80 was located at a newly opened quarry only 10 km south of Hole M-9-80; quarry beds were correlated as Souris River, indicating that the site was a structurally low inter-reef location (despite the occurrence of brine springs a few hundred metres to the north, indicative of local reef development). Drill results confirmed the inter-reef setting. Winnipegosis beds total only 27.7 m, a typical inter-reef thickness, including 18.9 m of lower Winnipegosis platform beds and 6.4 m of upper Winnipegosis bituminous laminites. The 2.4 m transition zone of dolomite, limestone and breccia at the top of the Winnipegosis was found to contain small amounts of dark brown to honey-coloured sphalerite (identified by x-ray) in some of the vugs. To the writer's knowledge, this is the first confirmed, in-situ identification of sphalerite in Paleozoic strata of Manitoba. (It is also interesting to note that a sample submitted for identification, and reportedly obtained from the quarry at the site of hole M-9-79, was found to consist of Barite — also a first in Paleozoic strata.)

The upper Devonian section in hole M-6-80 is almost normal down to the lower part of the Dawson Bay, except for a breccia zone at the base of the Souris River Formation, which probably results from solution of an evaporite bed known to occur at this stratigraphic position in deeper parts of the basin. The lower part of the Dawson Bay and Second Red Beds is highly brecciated, with inclusion of some stratigraphically higher Dawson Bay beds in the breccia. This breccia zone undoubtedly is the result of solution of a minimum of 75 m of Prairie Evaporite salt beds at this site.

Structural extrapolation of data from hole M-6-80 to hole M-9-79 indicates that the Winnipegosis reef thickness at M-9-79 is approximately 105 m. Surprisingly, this is the second thickest known or estimated reef development in Manitoba, surpassed only by the 107 m reported for the Swan River 9-1-37-28 test, and there is reason to believe that the thickness in the Swan River well is anomalous and may result from local tectonic subsidence during Winnipegosis time. Such subsidence appears unlikely, however, in the vicinity of the M-6-80 hole, inasmuch as the structural elevation of the Ashern conforms precisely with that predicted by the regional structure contour map (Strat Map DA-1).

STRATIGRAPHIC REVISIONS

Data from this summer's core hole program combined with previous drilling and with structural extrapolations used in compilation of the revised Geological Map of Manitoba (Map 79-2) will lead to a number of significant changes in definition or usage of certain stratigraphic units in Manitoba. As noted previously, these revisions will be included in a revised Lexicon. Briefly, the principal changes are, in ascending stratigraphic sequence:

a) Cat Head Member: Correlation of the type outcrop section of the Cat Head Member with core for the Anama Bay hole M-3-80, located 40 km west of Cat Head, shows conclusively that the type Cat Head comprises a medial unit within the Red River succession, overlying the mottled dolomitic limestone of the Dog Head Member,

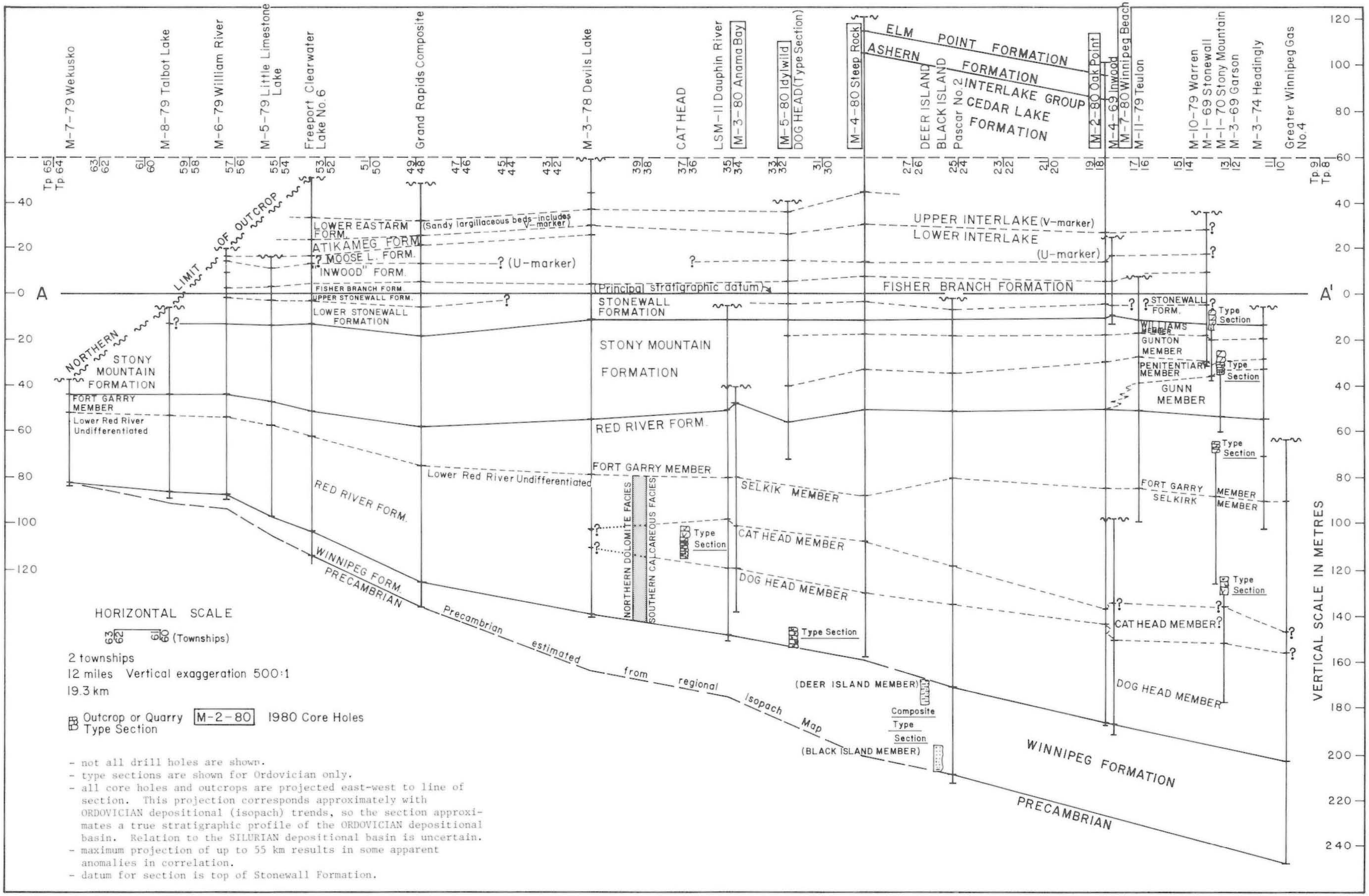

FIGURE GS-12-1: North-south correlation profile, Lower Paleozoic formations, southwestern Manitoba.

and overlain by the dolomite and dolomitic limestone of the Selkirk Member and the dolomites and shaly dolomites of the Fort Garry Member — the uppermost unit of the Red River. Sinclair's (1959) proposal that the Cat Head beds comprise the uppermost part of the Red River is incorrect, and faunal studies placing the Cat Head fauna at the top of the Red River succession (e.g. G.S.C. Bulletin 202) are also incorrect.

Data for numerous other core holes (e.g. Fig. GS-12-1) show that the Cat Head generally is a mappable unit over that portion of the outcrop belt between Cat Head and Winnipeg. North of Cat Head the entire Red River succession becomes dolomitized and the Cat Head beds are no longer distinguishable. South of about Winnipeg, the degree of dolomitization of the Cat Head decreases to the point where it is no longer distinguishable from the underlying and overlying mottled dolomitic limestones of the Dog Head and Selkirk Members. Lithologic changes in the Cat Head (and also in the overlying Selkirk) are, however, somewhat erratic, so that, in some local areas, delineation of the Cat Head may not be possible (e.g. hole M-7-80).

Occurrences of Cat Head, reported at the north end of Lake Winnipeg are Fort Garry rather than Cat Head; the overlying beds are Stony Mountain rather than Selkirk, as correctly stated by Sinclair (op. cit.).

b) Selkirk Member: As noted above, the Selkirk Member overlies the Cat Head Member and underlies the Fort Garry Member of the Red River Formation (Fig. GS-12-1), it is *not* equivalent to the Dog Head, as proposed by Sinclair (op. cit.). Remapping of the area from Anama Bay to Carscallen Point, coupled with data from core hole M-3-80, indicate that all occurrences correlated with the Selkirk (Upper Mottled) Member in early mapping of this area (Dowling, 1900; Baillie, 1952) actually belong to the Stony Mountain Formation. The revised Geological Map 79-2 incorrectly correlated these beds with the Fort Garry Member. The structural extrapolation used for the Geological Map indicated that these strata were higher than Selkirk, but the writer had insufficient data to place them as high as Stony Mountain. Outcrops north of Carscallen Point were not examined, but almost certainly are Stony Mountain, or higher, rather than Selkirk. The only true Selkirk outcrops, thus, are those at the Garson Quarries (Tyndall Stone), East Selkirk, Koostatak and the recently opened Winnipeg Beach Quarry (hole M-7-80).

Because of the revised correlation of most of the reported "Selkirk" outcrops, faunal data based on material obtained from these early studies will be partly incorrect. Most of the faunal data, however, relate to the Garson quarries, where the Selkirk Member is correctly identified. It should also be noted that a large faunal gap exists in the middle part of the Ordovician outcrop sequence of Manitoba, because of lack of exposure and the above noted correlation errors. Until recently no outcrops, and hence no faunal data, have been available for the upper half of the Selkirk Member, the entire Fort Garry Member, and most of the Gunn Member (Fig. GS-12-1). This "missing" interval represents approximately 76 m of stratigraphic section out of a total Ordovician section of only about 228 m. Conodont studies presently being undertaken by C.R. Barnes will provide data for at least a portion of this interval.

Available core hole data indicate that the lithology of the Selkirk Member is highly variable, ranging from high-calcium limestone to dolomitic limestone to dolomite and cherty dolomite. Hole M-7-80 is particularly anomalous in that the entire Selkirk section is totally dolomitized. Further drilling will be necessary to determine the pattern of lithofacies change in the Selkirk.

c) Lower Stony Mountain, Gunn and Penitentiary Members: An abundance of core hole data obtained over the last 10 years has shown that the "Stony Mountain Shale" or Gunn Member shows a rapid northward facies change to mottled argillaceous dolomite essentially identical to the type Penitentiary Member (e.g. Cowan, 1971). The rapidity of this change is evidenced by hole M-1-80 (located only 10 km north of the type section of the Gunn Member) which shows a pronounced increase in degree of dolomitization, and decrease in shale content. Continued use of the terms Gunn and Penitentiary seems valid, but the facies equivalency of the two units must be realized. A lack of knowledge of these facies changes is the reason for many of the early miscorrelations of Ordovician strata; all of the earlier reported "Selkirk" outcrops, from Cat Head to the north end of Lake Winnipeg, *and their reported fauna*, are in fact Stony Mountain.

d) Inwood Formation: The type section of the "Inwood" is not Inwood. In subdividing the Silurian Interlake Group of the outcrop belt, Stearn (1956) defined all of the upper units (Cedar Lake, East Arm, Atikameg and Moose Lake) in the northern part of the outcrop belt, where exposures are excellent and stratigraphic superposition indisputable. The lower units of the Interlake (Inwood and Fisher Branch), are exposed in the northern area, at Grand Rapids, in known stratigraphic succession, but exposures were difficult to access, and incomplete. Consequently, Stearn chose to define the type sections of these lower units in the southern Interlake area, where the access and exposures are somewhat better, but where the occurrences are relatively isolated and the stratigraphic positions not well defined.

Recent core hole drilling has shown that the type section of the Inwood Formation at the Inwood Quarry is stratigraphically higher than estimated by Stearn; the quarry beds and nearby "Inwood" strata are approximately equivalent to the Moose Lake and Atikameg of the northern area. Precise correlation between the two areas is not yet defined, but the errors in correlation appear certain, although *some* of the "Inwood" occurrences in the south are stratigraphically equivalent to the northern Inwood. Other core data suggest that interbeds of fossiliferous Fisher Branch-type lithology may occur within the lower part of the "Inwood" succession. On the basis of the above, the name "Inwood", probably should be abandoned and a new Formation named for those beds referred to as "Inwood" in the Grand Rapids area.

The significance of the above revisions lies not as much in the effect on the Silurian outcrop geology of Manitoba as in the faunal implications. The faunal succession defined by Stearn provides a reference section for the entire western Canada sedimentary basin, and the above-noted errors in correlation have resulted in some errors in faunal sequencing and correlation. A number of faunal inconsistencies, noted by Stearn, appear explainable in the light of the proposed revised correlations, but until further drilling of the remaining Silurian outcrops has been completed, and the relative stratigraphic positions of the reported fauna established, it is not possible to indicate a revised faunal sequence for the Lower Silurian strata.

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TABLE GS-12-1 SUMMARY OF CORE HOLE DATA

Hole No.	Location and Elevation	System/Formation/Member	Interval (metres)	Summary Lithology
		Ordovician-Stony Mountain -		
M-1-80	1-17-14-2E	Gunton	0 - 3.4	Dolomite, mottled
(Stonewall)	(+ 246.9 m)	Penitentiary	3.4 - 10.2	Dolomite, argillaceous, burrow mottled.
		Gunn	10.2 - 28.6	Dolomitic shale and calcitic dolomite.
		Red River-Fort Garry	28.6 - 62.7	- 30.9 Limestone and calcitic dolomite.
				- 39.8 Cherty dolomite
				- 43.5 Cherty limestone
				- 44.7 Intraclastic argillaceous dolomite.
				- 62.7 Dolomite, fine-grained, mottled to laminated.
		Selkirk	62.7 - 81.45	Limestone and mottled dolomitic limestone, cherty.
M-2-80	4-18-18-4W	Devonian-Elm Point	0 - 5.75	Limestone, mottled, partly dolomitic.
(Oak Point)	(+ 251.5 m)	Ashern	5.75 - 16.0	Red and grey dolomitic shale, breccia.
		Silurian-Interlake	16.0 - 100.5	Dolomite, sublithographic to fossil-fragmental.
				(17 - 20) Limestone, partly dolomitic
				(71 - 74) Shaly, V-marker
				(88 - 90) Argillaceous, U-marker
		Ordovician-Stonewall	100.5 - 111.8	Dolomite, sublithographic, medial argillaceous sandy marker.
		Stony Mountain-Williams	111.8 - 118.6	Dolomite with argillaceous interbeds.
		Gunton	118.6 - 130.15	Dolomite, mottled, nodular.
		Penitentiary/Gunn	130.15 - 151.2	Argillaceous dolomite.
		Red River-Fort Garry	151.2 - 185.7	Dolomite, minor limestone and shaly beds.
		Selkirk	185.7 - 237.2	Dolomite and mottled dolomitic limestone.
		Cat Head	237.2 - 243.9	Dolomite, mottled and banded.
		Dog Head	243.9 - 286.88	Mottled dolomitic limestone.
		Winnipeg	286.88 - 287.58	Shale, silty, hematite oolites.
M-3-80	10-27-34-5W	Overburden	0 - 2.75	
(Anama Bay)	(+ 219.5 m)	Ordovician-Stony Mountain		
		Penitentiary/Gunn	2.75 - 9.3	Dolomite, slightly argillaceous, mottled.
		Red River-Fort Garry	9.3 - 42.0	Dolomite, minor chert and shaly beds, mottled to laminated.
		Selkirk	42.0 - 62.5	Dolomite, partly calcareous, cherty.
		Cat Head	62.5 - 80.5	Dolomite, cherty, banded.
		Dog Head	80.5 - 100.0	Mottled dolomitic limestone.
		Winnipeg	(Estimated 105)	
M-4-80	10-3-29-10W	Devonian-Elm Point	0 - 6.1	Limestone, high-calcium.
(Steep Rock)	(+ 249.9 m)		6.1 - 6.4	Dolomite.
		Ashern	6.4 - 16.6	Dolomitic shale, red to grey.
		Silurian-Interlake	16.6 - 121.2	Dolomite, sublithographic to fossiliferous fragmental and intraclastic.
				(89 - 91) Argillaceous, V-marker.
				(107 - 109) Argillaceous, U-marker.
		Ordovician-Stonewall	121.2 - 133.65	Dolomite, fine grained, minor chert, medial argillaceous marker.
		Stony Mountain-Williams	133.65 - 138.6	Dolomite, partly argillaceous, silty.
		Gunton	138.6 - 153.9	Dolomite, nodular, mottled.
		Penitentiary/Gunn	153.9 - 171.7	Argillaceous dolomite, reddish mottled.
		Red River-Fort Garry	171.7 - 208.5	Dolomite, variable, some cherty and argillaceous.
		Selkirk	208.5 - 228.1	Dolomitic limestone, banded to mottled, in part cherty.
		Cat Head	228.1 - 250.3	Dolomite, cherty, laminated.
		Dog Head	250.3 - 278.6	Mottled dolomitic limestone.
		Winnipeg	(Estimated 280)	
M-5-80	SW 10-15-31-6W	Silurian-Interlake	0 - 41.2	Dolomite, sublithographic to granular, in part fragmental to fossiliferous.
(Idylwild)	(+ 286.5 m)			(5.0 - 14.65) Argillaceous sandy silty interbeds; V-marker, Lower East Arm.
				(26.6 - 28.8) Argillaceous and silty; U-marker.
				(35.6 - 41.2) Fossiliferous; Fisher Branch.
		Ordovician-Stonewall	41.2 - 53.1	Dolomite, medial sandy argillaceous breccia.
		Stony Mountain-Williams	53.1 - 59.6	Dolomite, argillaceous silty interbeds.
		Gunton	59.6 - 80.9	Dolomite, mottled, nodular.
		Penitentiary/Gunn	80.9 - 96.4	Dolomite, argillaceous, burrow mottled.
		Red River-Fort Garry	96.4 - 111.85	Dolomite and argillaceous dolomite, mottled and laminated.
M-6-80	SE 1-5-33-19W	Devonian-Souris River-Sagemace	0 - 20.4	Dolomite, fine grained, banded.
(Pine River	(+ 262.1 m)		20.4 - 33.7	Shale, dolomitic shale, limestone, breccia.
Road)		Point Wilkins	33.7 - 49.4	Dolomite, vuggy, fossiliferous, cherty, minor breccia.
			49.4 - 59.6	Shale breccia, limestone, dolomite (First Red Beds).
		Dawson Bay	59.6 - 72.2	Limestone, partly dolomitized, fossiliferous.
			72.2 - 84.4	Calcareous shale, purplish-red, fossiliferous.
			84.4 - 92.5	Limestone, brachipod biomicrite, partly dolomitic.
			92.5 - 110.8	Polymict collapse breccia. Shale, limestone, dolomite. Includes Second Red Beds.
		Winnipegosis	110.8 - 113.2	Transition zone. Dolomite breccia, porous, partly laminated. Limestone, fine vuggy, trace sphalerite, pyrite.
			113.2 - 119.6	Upper Member. Dolomite, partly bituminous laminated, partly fine vuggy (birdseye) porosity. Inter-reef facies.
			119.6 - 138.5	Lower Member. Platform facies. Dolomite, vuggy, mottled, nodular.
		Ashern	138.5 - 142.5	Dolomitic shale, reddish-brown, pyritic.
M-7-80	14-6-18-4E	Ordovician-Red River-Selkirk/Cat Head	0 - 36.0	Dolomite, yellowish-buff, mottled, chert nodules and silicified fossils.
(Winnipeg	(+ 228.6 m)		36.0 - 52.3	Dolomite, slightly darker, streaked and mottled, some chert. (Possibly Cat Head equivalent but almost indistinguishable from overlying).
Beach)		Dog Head	52.3 - 81.0	Mottled dolomitic limestone.
			81.0 - 89.05	As above the increasing argillaceous bands.
		Winnipeg	89.05 - 91.2	Shale, dark olive-brown, limonite oolites.
			91.2 - 93.6	Argillaceous sandstone, burrowed texture.

GS-13 DOLOMITE RESOURCES OF SOUTHERN MANITOBA

(62 I, J, N, O, P; 63B, C, F, G, J, K)

By B.B. Bannatyne

INTRODUCTION

Dolomite from the Ordovician, Silurian, and Devonian formations in southern Manitoba has been quarried for more than a century. It has been burned for lime and quarried as a source of building stone, concrete aggregate, crushed stone, 'marble', railway ballast, rubble and rip rap. The final report will describe the dolomite resources of the province, and will include maps indicating outcrops, quarries, and areas of near-surface dolomite.

In 1979, a series of 12 preliminary maps (DR 1979-1 to 12), showing depth to bedrock, geology and bedrock topography, was released, and similar maps of the southern Interlake (parts of 62 I, J and O) were prepared. These maps were used in the contracted study of aggregate resources of the southern Interlake (James F. MacLaren Limited, 1980). This year, similar information has been compiled for the outcrop belt of Paleozoic carbonate rocks extending from Gimli to Cranberry Portage, as shown in the Index Map of Field Projects (Fig. GS-1).

GEOLOGICAL FIELD WORK

In 1980, selected outcrops and most of the dolomite quarries in the map area were examined. Large reserves of dolomite exist, particularly in the central and northern Interlake. New quarries are opened almost every year in that area, primarily as a source of crushed stone for roads.

Quarries from which 'marble' was once produced were examined at Hodgson, Broad Valley and Cormorant Lake, and rock that takes a brilliant polish was collected from quarries near Snow Lake and Wekusko. A variety of textures and colours (shades of buff, yellow, orange, pink, purple and red) occur, and examples of polished specimens are on display at the Mineral Resources Division.

In addition to field work, the stratigraphic and industrial minerals core hole program (H. McCabe, this report GS-12) is a source of new information on the distribution of dolomite in the province. Between 1976 and 1980, nineteen holes have been drilled specifically for information on dolomite resources in the Winnipeg-Stonewall-Teulon areas. Two holes, M-1-80 and M-7-80 (Table GS-12-1), were drilled in 1980. Hole M-1-80, located 6 km northeast of Stonewall, confirmed the extension into that area of the Gunton Member, from which a few hundred thousand tonnes are quarried annually east of Stonewall. An unexpected result shown in that hole is the abrupt thickening of argillaceous dolomite (Penitentiary-type facies) and thinning of the calcareous shale (Gunn-type facies) in the lower half of the Stony Mountain Formation.

Hole M-7-80 was drilled beside a quarry, opened in late 1979, 5 km west of Winnipeg Beach. It intersected more than 30 m of completely dolomitized colour-mottled rock in the Selkirk Member; the equivalent section in hole M-3-79, located 15 km to the south, consisted of mottled dolomitic limestone, including the Tyndall stone interval.

WORK IN PROGRESS

Much new information has become available and an attempt is being made to incorporate it into maps outlining dolomite resources. Major sources of data are:

1. Quarries — notably along Highways 6, 20 and 10, and Provincial Roads 391, 392 and 287.
2. Mineral Resources Division core holes and other drill core available for study — over 100 cores available.
3. Water Resources Division — depths to bedrock (about 2 000 wells in the limestone-dolomite areas are drilled per year).
4. Soils Survey Maps — Preliminary or published maps are available for all the Paleozoic area, outlining many thousands of km^2 of outcrop and near-surface bedrock.

Previously published works, among them reports by Goudge (1944), Baillie (1951a, 1951b, 1952), Stearn (1956), McCabe (1971, 1979), and Bannatyne (1975), and theses by Smith (1963), Cowan (1978), and Wallace (1979), have provided the established geological background for the Dolomite Resources Project. Dolomitic limestones (Kendall, 1977) are included in the project.

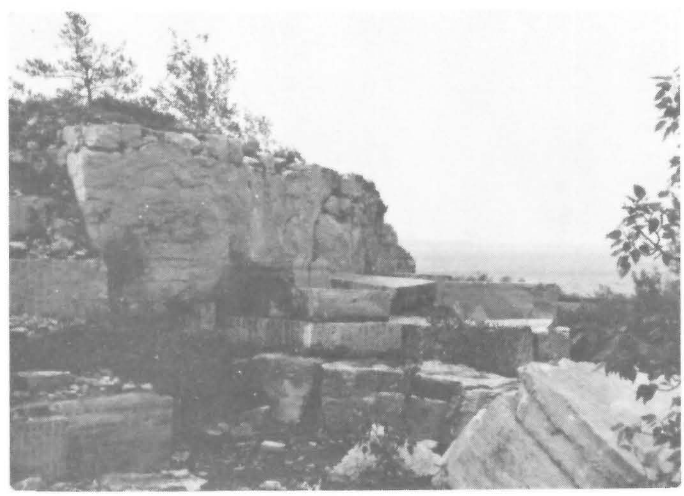

FIGURE GS-13-1: Thick dolomite of the Ordovician Stony Mountain Formation exposed in an abandoned 'marble' quarry at 'Mile 39' of the Hudson Bay Railway, near Cormorant Lake.

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LIST OF PRELIMINARY GEOLOGICAL MAPS — 1980

1980K-1	Molson Lake, East Half (63I/1, 2, 7, 8) by W. Weber and K. Chase (Revised 1979K-1)	1:100 000
1980K-2	Molson Lake, West Half (63I/3, 4, parts of 5, 6) by W. Weber and K. Chase (Revised 1979K-2)	1:100 000
1980K-3	Oxford House, Southwest (53L/3, 4, 5, 6) by D.C.P. Schledewitz and K. Chase (Revised 1979K-3)	1:100 000
1980K-4	Oxford House, Southeast (53L/1, 2 and part of 7) by D.C.P. Schledewitz (Revised 1979K-4)	1:100 000
1980K-5	Stull Lake, Southwest (53K/3, 4) by D.C.P. Schledewitz (Revised 1979K-5)	1:100 000
1980L-1	Barrington Lake (64C/16) by H.P. Gilbert (Revised 1979L-1)	1: 50 000
1980L-2	Fraser Lake (64B/13) by H.P. Gilbert	1: 50 000
1980L-3	McMillan Lake (64C/13 and part of 64C/14) by H.D.M. Cameron	1: 50 000
1980L-4	Carswell Lake (Parts of 64F/3, 4) by H.D.M. Cameron	1: 50 000
1980M-1	Split Lake, Southeast (64A/1, 2, 7, 8) by M.T. Corkery, P.G. Lenton, A. Holloway and A. Wilson	1:100 000
1980M-2	Split Lake, Southwest (64A/3, 4, 5, 6) by M.T. Corkery, P.G. Lenton, A. Holloway and A. Wilson	1:100 000
1980M-3	Split Lake, Northwest (64A/11, 12, 13, 14) by M.T. Corkery, P.G. Lenton, A. Holloway and A. Wilson	1:100 000
1980M-4	Uhlman Lake, Southeast (64B/1, 2, 7, 8) by M.T. Corkery, P.G. Lenton, A. Holloway and A. Wilson	1:100 000
1980M-5	Uhlman Lake, Northeast (64B/9, 10, 15, 16) by M.T. Corkery, P.G. Lenton, A. Holloway and A. Wilson	1:100 000
1980M-6	Gauer Lake (Parts of 64A/13, 64B/16 and 64H/4) by M.T. Corkery, P.G. Lenton, A. Holloway and A. Wilson	1:100 000
1980N-1	Drunken Lake, West Half (63J/9) by J.J.M.W. Hubregtse	1: 50 000
1980N-2	Muhigan Lake (63J/10 and part of 63J/15) by J.J.M.W. Hubregtse	1: 50 000
1980R-1	Pemichigamau Lake and Opachuanau Lake (Parts of 64B/5, 12) by D.A. Baldwin (Revised 1979 R-1)	1: 20 000
1980R-2	Earp Lake and Issett Lake (Parts of 64B/6, 11) by D.A. Baldwin (Revised 1979 R-2)	1: 20 000
1980T-1	Halfway Lake (63 O/1, 2) by J.J. Macek	1: 25 000
1980W-1	White Lake-Mikanagan Lake (Parts of 63K/12, 13) by A.H. Bailes and E.C. Syme (Revised 1979W-1)	1: 20 000

MANITOBA GEOLOGICAL SURVEY

993 Century Street, Winnipeg Man. R3H 0W4

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

ACKNOWLEDGEMENTS

The contributions made the Geological staff in the compilation of their reports and preliminary maps are gratefully acknowledged as are the untiring efforts of the clerical support staff in preparing the initial and final drafts of the manuscript. This year's fall releases will follow a year in which many of the reports arising from the previous DREE and NREP programs have been finalized and, if not already released, those remaining, should be available as publications before the end of this fiscal year. Many of these projects present a Provincial overview or Province-wide data base that required considerable input from the Drafting Section. Their dedication and continued efforts in the preparation of the final maps and figures contained within the reports is much appreciated. P. Buonpensiere and L. Franceschet match the quality of last year's Geological Map of Manitoba, in this year's release of the 1:1 000 000 scale Mineral Map. The display and organization of the data on Mineral deposits and Industrial Minerals on the Mineral Map was undertaken by J.D. Bamburak and B.B. Bannatyne in a manner that greatly facilitates an appreciation of the Province's mineral localities in relation to the geology.

W.D. McRitchie

MINES BRANCH

Aggregate Resources Section

AR-1 LATE QUATERNARY HISTORY OF PART OF THE LOWER NELSON RIVER

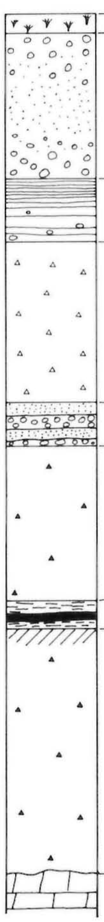
By Erik Nielsen

Surficial geological mapping was carried out in the Gillam area as part of the aggregate resources inventory program. Emphasis was given to the glacial stratigraphy along the Nelson River downstream from Gillam as many of the known exposures in that area will be underwater shortly due to dam construction.

The texture, mode of deposition, origin and age of the lithosomes exposed along the Nelson River between Longspruce and Sundance is summarized in the generalized stratigraphic column shown in Figure AR-1-1.

The record exposed along the lower Nelson River is believed to be the most complete late Quaternary stratigraphic section uncovered in Manitoba to date. The earliest deposited till is black in colour, compact and the pebble fabric and striations on the underlying bedrock indicate it was deposited by ice moving towards the northwest. In the few exposures where this till outcrops, the upper surface is deeply weathered or overlain by nonglacial beds of sand, silt, clay and organic detritus including wood fragments 10 to 20 cm in length. The paleosol and nonglacial organic beds are tentatively correlated with the Missinaibi Formation which outcrops in the Hudson Bay and James Bay Lowlands, along the Hayes River in Manitoba, and throughout northern Ontario. The till overlying the paleosol and the organic beds is also black in colour, compact, and contains relatively few clasts. This till, termed the middle till, is indistinguishable from the lower till with one possible exception, the presence of shell fragments in the middle till. The pebble fabric and striations indicate that this till was also deposited by ice flowing from an easterly or southeasterly direction. Shell fragments from the middle till have been identified by F.J.E. Wagner as *Hiatella arctica* (Linné), *Portlandia (Yoldiella)* sp., *Macoma* sp., *Mya* sp., *Astarte* sp., and possibly *Mya pseudoarenaria* (Schlesch). This faunal assemblage is similar to the one found in Hudson Bay today suggesting that the ice which deposited the middle till was eroding beds of interglacial rank. The lowest till must therefore be of Illinoian age, the paleosol and equivalent organic beds are from the Sangamon Interglacial and the overlying middle till is of early Wisconsin age.

The middle till is separated from the overlying hill by stratified gravel, sand and silt deposits devoid of organic sediments. These nonorganic deposits are of wide extent and have been recorded by Netterville (1974) on the Hayes River 60 km to the southeast. These nonglacial beds are thought to represent a short lived interstadial. The till stratigraphy above these interstadial beds is complex. The upper till is brownish in colour and shows aqua till, flow till and basal



Texture and Structure	Mode of Formation	Depositional Environment	Correlation	Age ^{14}C yrs. B.P.
				-0
Organic	Growth of peat and lichen	Swamp	Recent	-6,000
Interbedded gravel, sand, silt and minor clay with marine fossils.	Marine transgression and regression	Marine	Tyrrell Sea	-8,000(?)
Varved silt and clay with occasional dropstones.	Annual accumulation of fine sediment in a proglacial lake.	Lacustrine	Lake Agassiz	-8,300
Sorted and unsorted gravel, sand, silt and clay, compacted and uncompacted, bedded and unbedded, deformed and undeformed, generally brown in colour.	Subglacial lodgement Proglacial mud slides, proximal glaciolacustrine and glaciofluvial.	Glacial and near glacial	Wisconsin Glaciation	-?
Interbedded sand and gravel.	Fluvial	Non glacial		-?
Unsorted gravel, sand, silt and clay dark gray to black in colour, compact, with shell fragments.	Subglacial lodgement	Glacial		-110,000
Interbedded sand, silt, clay and organics	Infilling of small lakes and accumulation of organics	Nonglacial	Sangamon Interglacial	-?
Unsorted gravel, sand, silt and clay, dark gray to black in colour, compact. Upper surface extensively weathered	Subglacial lodgement and extensive subareal exposure	Glacial	Illinoian Glaciation	-?
Bedrock				

FIGURE AR-1-1: Generalized stratigraphy along the Lower Nelson River.

till facies indicating a complex sequence of ice marginal fluctuations along an ice front which intermittently floated and grounded in a proglacial lake. Laboratory analysis will determine whether there is one or two glacial advances represented by this complex till sequence.

The upper and middle till units represent the Wisconsin glaciation, during which time the area remained ice covered except for a short period after the deposition of the middle till.

The distribution of erratics derived from the Circum-Ungava Proterozoic Belt (Fig. AR-1-2) as well as, striae and till fabric measurements indicate that the tills, regardless of age, outcropping along the Nelson River between Gillam and 94° west were deposited by ice coming from the Labradorean sector of the Laurentide ice sheet. There is very little evidence of Keewatin ice having flowed across this area.

The Lower Nelson River probably became ice free prior to 8,300 yrs. B.P. which is relatively early with respect to the rest of the Hudson Bay area (Wagner, 1967).

After the final retreat of the ice, the area was innundated by the last vestiges of Lake Agassiz. Varved silt and clay representing at least 50 years were deposited over most of the area.

Incursion of the Tyrrell Sea into the area about 8,000 yrs. B.P. resulted in the deposition of datable near shore deposits which overlie the varved clay. An upper marine limit of 122 m a.s.l. in this area compared to marine limits of 183 m a.s.l. to the north and 152 m a.s.l. to the southeast of the area suggest the lower Nelson River area experienced as much as 61 m of unrecorded rebound prior to the formation of the marine limit. Early deglaciation as a result of calving of the ice front into Lake Agassiz would have lead to relatively early post glacial rebound in this area compared to the rest of the Hudson Bay region.

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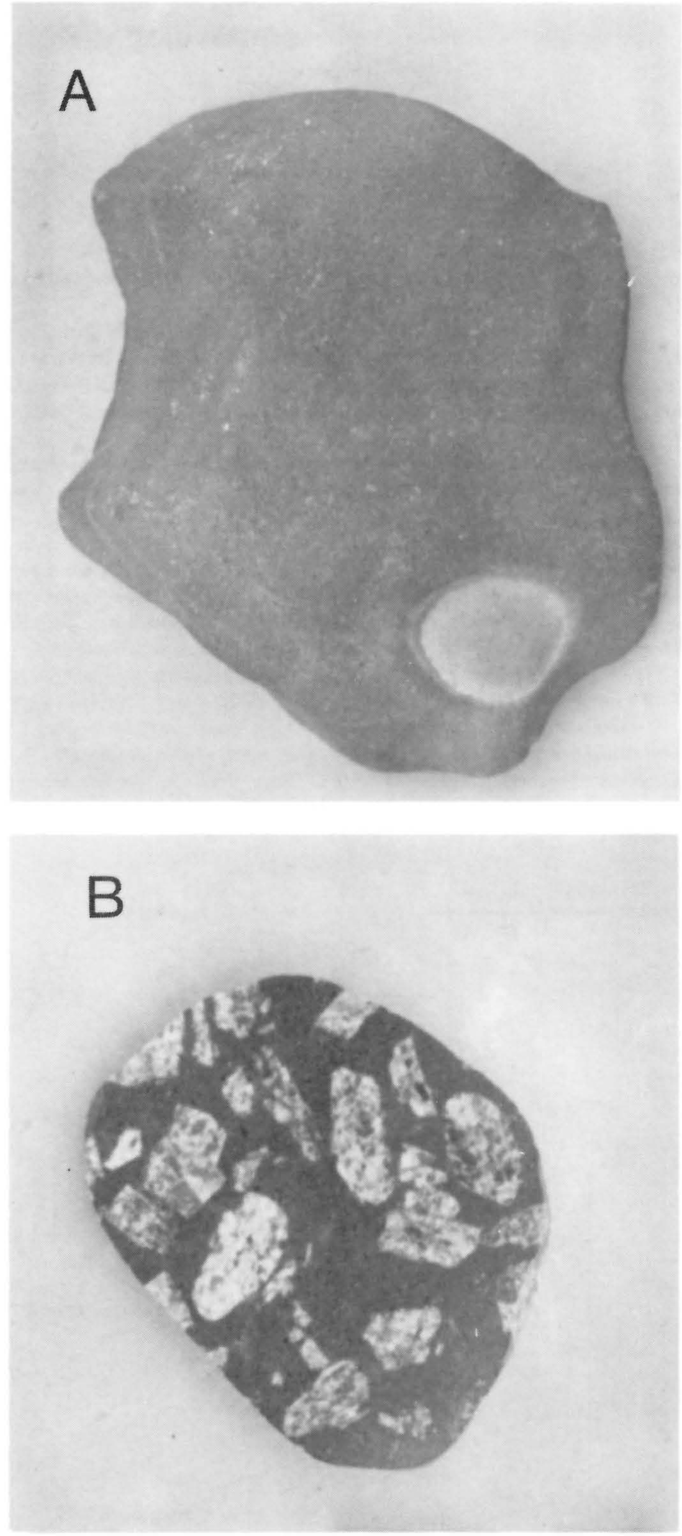

FIGURE AR-1-2: (A) Greywacke with distinctive concretion, from the Omarolluk Formation which outcrops between the Belcher Islands and Quebec in southeastern Hudson Bay. (B) Dark green porphyritic basalt from the Manitounuk Group which outcrops in northwestern Quebec.

AR-2 I. THE SURFICIAL GEOLOGY OF THE SOUTH RIDING MOUNTAIN PLANNING DISTRICT

By H. Groom

The South Riding Mountain study area consists of the Rural Municipalities of Strathclair, Harrison and Clanwilliam and the Local Government District of Park. It lies between latitudes 50° 19′ and 50° 43′ N and longitudes 99° 41′ and 100° 31′ W in the western part of the province immediately south of Riding Mountain National Park. It covers 2 300 km² (Fig. AR-2-1).

The purpose of the study was to map the surficial geology of the area and to provide detailed aggregate resource information to the South Riding Mountain Planning District. Preliminary maps delineating the surficial deposits are available at a scale of 1:50 000 (series 1980 SRM 1-4).

The South Riding Mountain study area lies west of the Manitoba Escarpment at the Second Prairie Level. It can be divided into two physiographic regions. The Riding Mountain Uplands generally lie above the 550 m contour and cover the northeastern two-thirds of the map area. The Assiniboine River Plain lies below this contour and forms the remaining portion of the district. The topography on the uplands is that of an hummocky stagnation moraine. Numerous kettle lakes and sloughs dot the area and the relief is high, often exceeding 10 m. The relief on the plain is more subdued and rarely exceeds 8 m. The topography is rolling and lakes and sloughs are again frequent.

The bedrock consists of shales of the Upper Cretaceous Riding Mountain Formation, predominantly the hard, siliceous shale of the Odanah member (Bannatyne, 1970). The bedrock is rarely exposed except in a few road and stream cuts along the Minnedosa River Valley.

SURFICIAL GEOLOGY

The oldest recognized till in the area is the Minnedosa till named by Klassen (Klassen, 1966). This till is yellow brown to grey brown, compact, jointed and manganese stained along the joints. It was not seen in outcrop at the surface but was identified in several roadcuts where it underlies younger till.

There are two surface tills in the planning district: the Lennard till on the plain and the Zelena on the uplands. Lithologically and physically they are very similar. They are loose, structureless, slightly clayey, yellow brown to grey brown in colour and contain shale, precambrian and carbonate pebbles in the coarse fraction. Klassen (1979) differentiates them on the basis of the carbonate content of the matrix; the Lennard contains 14 to 19 percent carbonate while the Zelena contains between 26 and 36 percent.

The knolls and ridges of the plain are composed entirely of till but on the uplands the hummocks occasionally comprise till underlying stratified silt, sand or sand and gravel.

Two large kame moraines are found on the uplands. One is 8 km long and trends northward along the western edge of Bottle Lake. The other extends west from the first kame moraine for 13 km to the Minnedosa River. These features are up to 25 m high and consist primarily of coarse sand and shaley pebble gravel.

Two roughly triangular glaciofluvial outwash plains cover a large portion of the upland area. One lies northwest of the Minnedosa River below Heron Creek and the other lies east of the

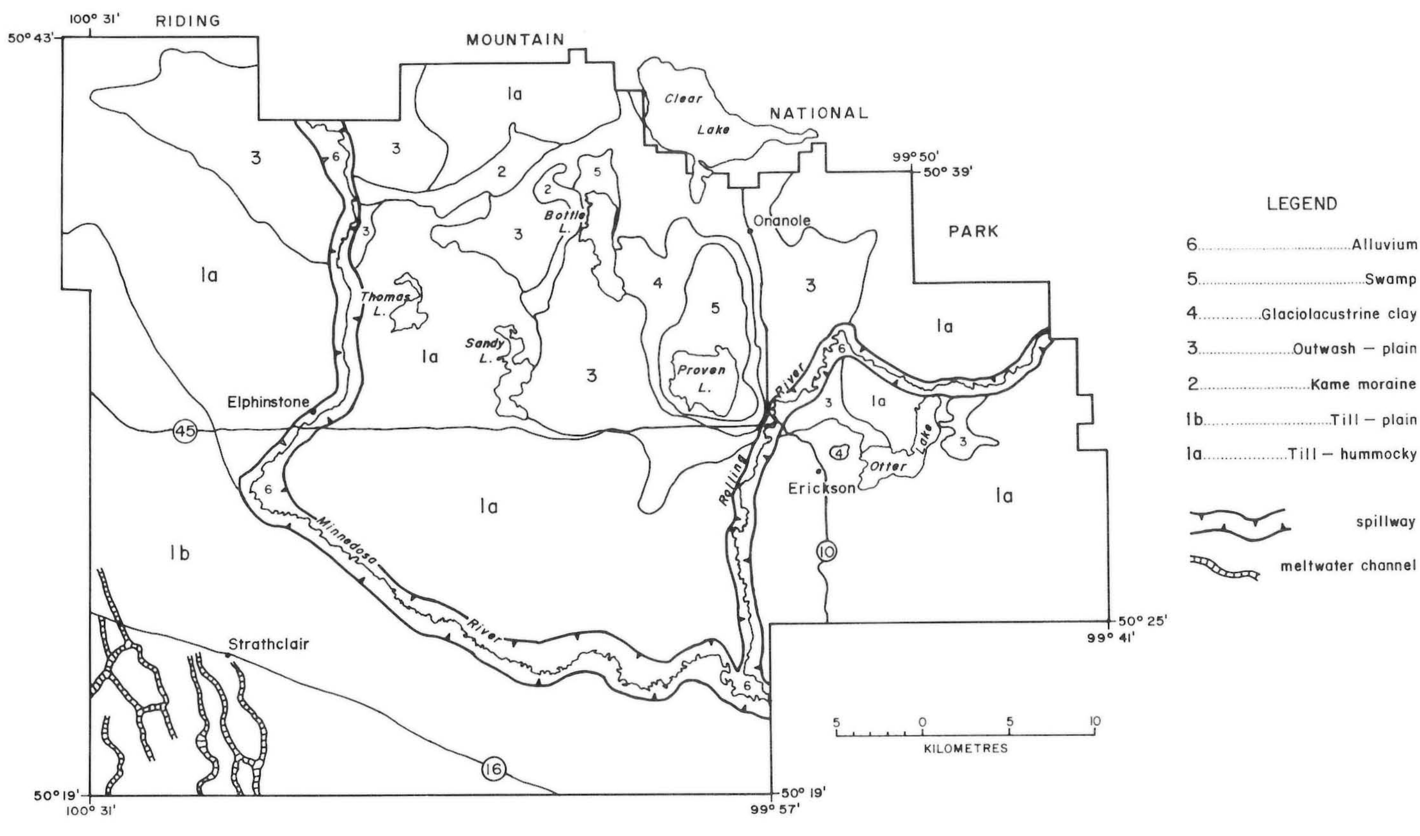

FIGURE AR-2-1: Surficial Geology, South Riding Mountain Area.

Minnedosa River between Clear Lake and Proven Lake. The surface of these outwash plains is hummocky with relief up to 10 m although locally they are gently rolling. The northern plain consists largely of coarse, shaley gravel in the west and grades into sand and silt to the east along the Minnedosa River. The eastern outwash plain also consists of coarse, shaley gravel at its northern extent near Clear Lake and grades into sand and silt towards the south. The material within the hummocks is often faulted indicating the outwash was laid down over ice which later melted away producing the faulting and the rolling topography. A third outwash plain, east of Otter Lake, is much smaller in areal extent and its surface is more level than the plains to the west. It is comprised of 3 to 5 m of shale rich pebble gravel.

The Minnedosa and Rolling River valleys are spillways that carried meltwater from the area during the last deglaciation. Their terraces, particularly along the Minnedosa, are often comprised of thick accumulations of sand and gravel. The deposits are usually very shaley but occasionally the shale content is as little as 15%.

On the till plain near Strathclair is found a series of meltwater channels much smaller than the spillways. Two exposures in the channels indicate that they are floored by shallow deposits of shaley fine pebble gravel.

Deposits of glaciolacustrine clays occur in a large area around Proven Lake and in a much smaller area near Erickson. In both of these areas the terrain is flat. They consist of yellow silt grading into yellow silty clay that is jointed and manganese stained and overlies a grey, lacustrine clay of unknown origin.

Drainage is not yet well established and with the exception of deposits on the spillway floors there is little alluvium in the area. Organic deposits, on the other hand, are very common. There are large swamps around Proven and Bottle Lakes and along the banks of the creeks. Most of the small kettle lakes and sloughs are fringed with hay meadows or swamp deposits consisting of muck and peat.

ECONOMIC GEOLOGY

The South Riding Moutain Planning District has an abundance of aggregate resources. The kame moraines, outwash plains and terraces are presently being extensively mined. There are numerous small pits, particularly on the uplands, where minor amounts of sand and gravel have been extracted in the past but the pits have since revegetated. The largest active pits occur in the coarse phase of the outwash south of Clear Lake, in the outwash east of Otter Lake and in the terraces of the Minnedosa River. While there is an abundance of sand and gravel in the District, very little is of high quality as the shale content is generally between 20 and 50 percent. When there is a need for shale free gravel contractors usually go outside the district to Russell or the Arden Ridge.

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II. SAND AND GRAVEL PITS

By M. Radwanski

This project was undertaken to inventory, analyse and classify existing sand and gravel pits in the South Riding Mountain Planning District and to provide data for pit management and ultimate pit rehabilitation. During 38 days of fieldwork, 106 pits were identified, and site conditions were examined and photographed. Figure AR-2-2 indicates the study area and pit locations.

Data was collected concerning land area disturbed by mining operations at each site, amount of aggregate removed, whether aggregate was remaining and quality of this material, adjacent land uses and vegetation surface rights and under rights ownership, and age and state of the mining operation.

Five categories of the state of the mining operation were developed as follows:

1. **Active** — a pit that is being mined.
2. **Rehabilitated** — a pit where planned excavation and progressive reshaping of the mine landscape have occurred, based on the objectives of:
   i) ensuring public safety;
   ii) protecting the environment;
   iii) optimizing the productivity of the post mining landscape for some social or economic purpose; and
   iv) efficiently utilizing the available resource.
3. **Abandoned, depleted** — a pit where mining has been discontinued because the quarry mineral of economic value has been mined out.
4. **Abandoned, not depleted** — a pit where mining has been discontinued for reasons other than that the quarry mineral of economic value has been mined out.
5. **Abandoned, reclaimed** — a pit where mining has been discontinued and revegetation has occurred naturally, but where no active rehabilitation has been carried out.

Based upon the analysis of the data, three classes of pits were derived:

i) Pits which are regulated under Part VI of Manitoba Regulation 226/76 (1976) under the Manitoba Mines Act (1973) which governs the rehabilitation of commercial pits and quarries. Pits in this classification were mined after January 1, 1977, and are commercial operations. (Greater than 2 000 cubic yards of

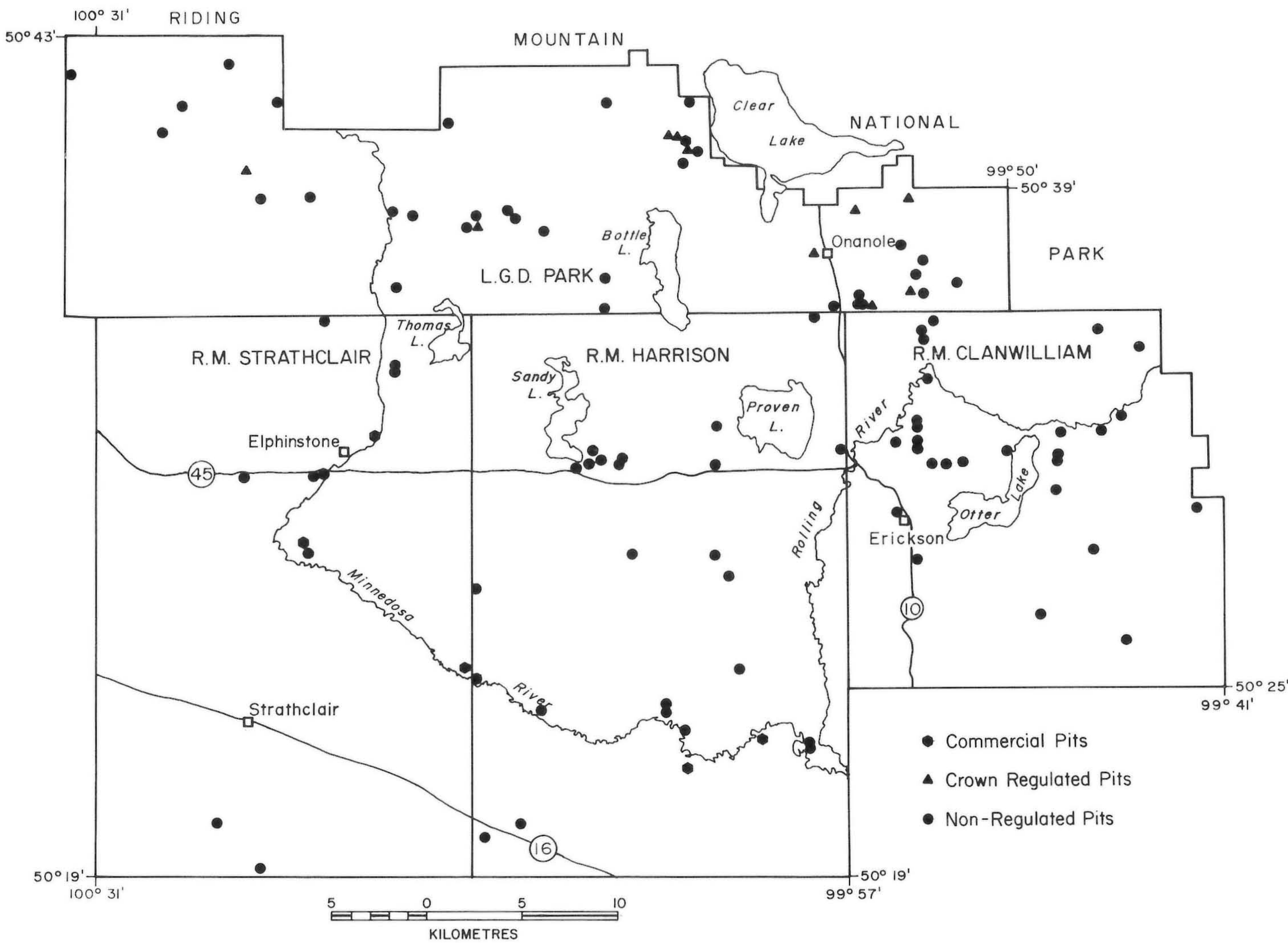

FIGURE AR-2-2: Sand and Gravel Pits in the South Riding Mountain Planning District quarry mineral mined per year).

ii) Pits which are regulated under Part II of Regulation 226/76, which governs the removal of Crown minerals from Crown lands.

iii) Pits which are not subject to regulation under 226/76.

From the classification and analysis of the sand and gravel pits in the South Riding Mountain Planning District recommendations and strategies for the management and rehabilitation of pits are being prepared. These will be presented to the Planning District Board for incorporation into the District's land use and development plans; and where pits are subject to Provincial regulation, the strategies will provide input in the Division's aggregate resources management program.

AR-3 QUATERNARY GEOLOGY AND AGGREGATE RESOURCES OF THE R.M. OF BROKENHEAD

By Glenn Conley

INTRODUCTION

Field mapping was undertaken in the Rural Municipality of Brokenhead with three objectives:

1) to delineate and catalogue aggregate deposits to serve as a reference for land use planning;
2) to attempt to locate new deposits of silica sand, and;
3) to map the surficial geology to obtain a better understanding of the Quaternary stratigraphy.

BEDROCK GEOLOGY

The R.M. of Brokenhead is underlain by Precambrian and Ordovician bedrock. The Precambrian bedrock, primarily granite and granite gneisses underlie the eastern portion of the area and outcrops 2.5 km west of the hamlet of Allegra and 2.5 km north of the hamlet of Lowland. The Ordovician bedrock consists of the Winnipeg Formation and the overlying Red River Formation. The Winnipeg Formation consists of beds of well rounded and well sorted, frosted quartz grains, capped by shale. The subcrop of the Winnipeg Formation has been mapped by Bannatyne (1980) as a narrow belt stretching from the hamlet of Brokenhead in the north to St. Ouens in the south. The upper shale layer outcrops two miles east of the hamlet of Ladywood. The Red River Formation outcrops near the hamlet of Garson where it is quarried for use as a building stone, widely known as Tyndall stone. In the western part of the study area, the Red River Formation lies relatively close to the surface and the undulating nature of the surface is thought to be a reflection of the eroded bedrock surface.

QUATERNARY GEOLOGY

The oldest Quaternary unit is thought to be a body of silica rich sand located in the topographically high area, approximately 6 km west of Dencross near PTH 317 (LSD 15-9-15-7E and LSD 11-9-15-7E). The silica rich sand forms the floor and the lower 5 - 6 metres of an 8 metre deep pit. The sand which is very fine grained, well sorted, and cross-bedded, is overlain by a 0.3 metre thick cobble lag which in turn, is overlain by 2 metres of oxidized sand. The silica rich sand, which assays at an average of 86.3% silica with only a trace of carbonate, has a paleocurrent direction of 110° - 180°. Folds and faults in the bedded sand suggest deposition in a glaciofluvial environment. Examination of the surface markings of the overlying cobble lag indicates it is the remains of a till sheet which has

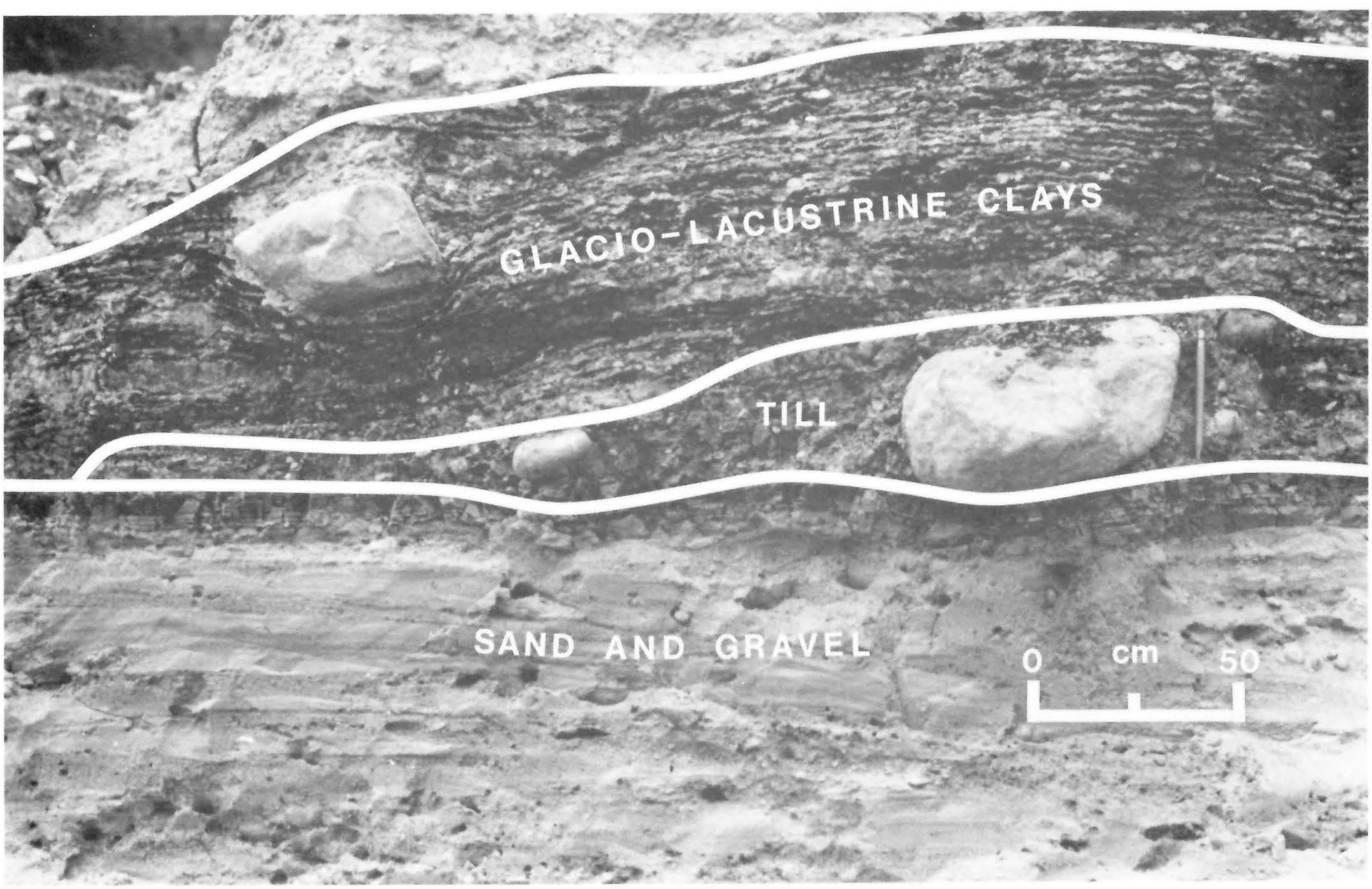

FIGURE AR-3-1: Section from a gravel pit in an esker. Contact between till and esker sediments is sharp. An ice rafted dropstone has caused deformation of the varves both below and above the stone.

subsequently been eroded. The presence in the lag of distinctive unmetamorphosed greywacke clasts which were derived from the area around the Belcher Islands in Hudson Bay indicate that the till was deposited by ice advancing from the Labradorean sector of the Laurentide ice sheet.

Exposures along Traverse Bay on Lake Winnipeg show that the silica rich sand there is overlain by a second till of northwestern provenance. The gravel lag is therefore the remains of two glacial advances. The Beausejour silica pit (NE 35-12-7E) also contains silica rich sand which assay at 86.8% silica with only a trace of carbonate. Although both deposits are of similar composition and at similar elevations, further work is necessary to determine if they were deposited contemporaneously. The Beausejour deposit is being mined hydraulically from a depth of 10 metres below the water table.

A very hard, compact till, with a clayey matrix and few clasts was observed near Bunker Hill (NW 24-12-8E) in the southeast corner at the study area. The grey till is overlain by sand and gravel containing beds of very well sorted granules in clast support. Cross bedding indicates a paleocurrent direction of 155°. This lower grey till is correlated with the Belair till as described by McPherson (1970). This is the only outcrop of this till in the R.M. of Brokenhead.

An upper, beige, sandy, carbonate till is observed at or near the surface throughout the study area (Fig. AR-3-1). This till was deposited by the Keewatin ice advance and is tentatively correlated with the Libau till described by McPherson (1970). Five eskers are correlated with this till because of their west to east orientation and paleocurrent directions. The eskers are highly variable in composition, ranging from fine sand to medium coarse sand and gravel. The eskers are usually capped by till, varying from several centimetres to several metres in thickness.

Other aggregate resources associated with the upper till sheet are the numerous beaches marking major still stands of Lake Agassiz as it receeded from the area. Most of the beaches consist of sand or pebbly sand with the exception of the most northerly beaches above an elevation of 236 metres. The eastern zone of the R.M. of Brokenhead consists of glaciolacustrine clays and silts deposited in Lake Agassiz and comprise the most recent Quaternary deposits.

ECONOMIC GEOLOGY

High quality aggregate resources are found associated with glaciofluvial deposits near Bunker Hill and beach deposits along the northwest boundary of the municipality. A large beach deposit near Cloverleaf could provide substantial aggregate materials in the south, however, this deposit is sterilized by the presence of the CNR main line.

The eskers, where they outcrop are largely depleted. However, extensive sections of the eskers are buried beneath clay and till and aggregate resource evaluation in these areas will have to await further investigation.

Silica rich sand was observed at two locations in the north central portion of the municipality. These deposits were observed in ditch sections and further work is required to determine the extent and quality of the deposits.

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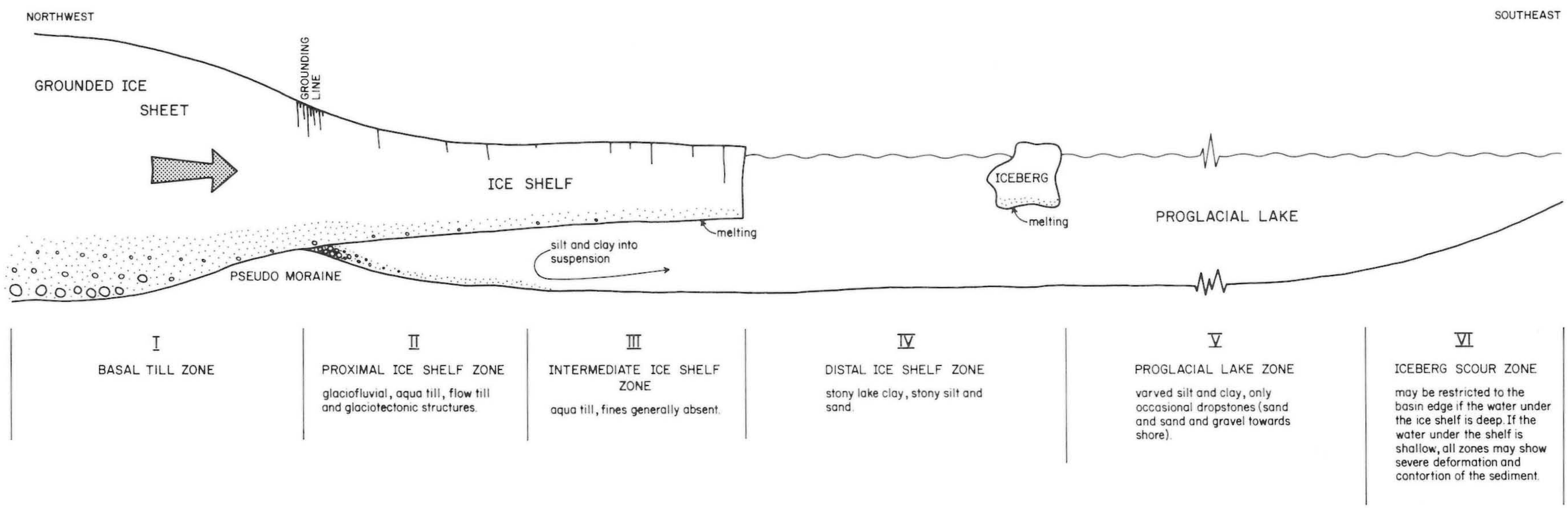

FIGURE AR-4-1: Model of Late Wisconsinan Glaciolacustrine Deposition in Southeast Manitoba.

AR-4 QUATERNARY MAPPING AND LATE WISCONSINAN GLACIOLACUSTRINE DEPOSITION IN THE MUNICIPAL SURVEYS AREA OF SOUTHEASTERN MANITOBA

By Gaywood Matile and Erik Nielsen

INTRODUCTION

The Municipal Surveys mapping project, started in 1979, was continued in the municipalities of La Broquerie and De Salaberry. Both areas are too distant to serve as gravel sources for Winnipeg markets and appear to have sufficient sand and gravel reserves for local consumption. Quaternary geology maps will be produced at 1:50 000 and will serve as a reference for land use planning within the municipalities.

The Bird's Hill esker-delta complex in the municipality of Springfield was also mapped. Land use planning in the Bird's Hill area is especially important because it's proximity to Winnipeg makes it a highly desirable area both for residential building and for sand and gravel extraction. Mapping in this area was carried out at a scale of 1:15 840 and will be published at 1:20 000. Resistivity work was done with the Geonics EM31 which provides an average resistivity value to a depth of 6 metres, with the assumption that sand and gravel which does not show up within 6 metres of the surface is sub-economic. Approximately 90 kilometres of resistivity data was gathered. A backhoe survey was done as follow up to the resistivity survey.

Of notable importance are gypsum "rosettes" which were encountered in a backhoe pit, NW31-11-5E, in the Bird's Hill area. At 2.7 to 4.0 metres, the crystals were encountered in layers of uniform size, generally less than 2 centimetres. At 4.0 metres, the arrangement of crystals became random and crystal size increased to 7 centimetres in diameter. The crystals are transparent and generally of good quality. This find has initiated further research into the authigenesis of gypsum in the Winnipeg area.

LATE WISCONSINAN GLACIOLACUSTRINE DEPOSITION IN SOUTHEASTERN MANITOBA

Keewatin ice from the northwest was the last advance to affect southeastern Manitoba. Fenton and Teller (1980) describe three Keewatin till sheets in this area which are all discontinuous and highly variable in composition. Keewatin ice retreating from the Lake Agassiz basin blocked it's northern outlet and formed the northern shore of Lake Agassiz. Lake depths in excess of 200 metres were common and therefore it is not unreasonable to assume that the ice margin was often floating, forming an ice shelf.

The ice shelf model for deposition in a glaciolacustrine environment (see Fig. AR-4-1) describes six environments, five of which are depositional and a sixth, which is a zone of scouring. The size and configuration of the ice shelf would have been controlled by local relief, as topographic highs supporting the shelf would prevent

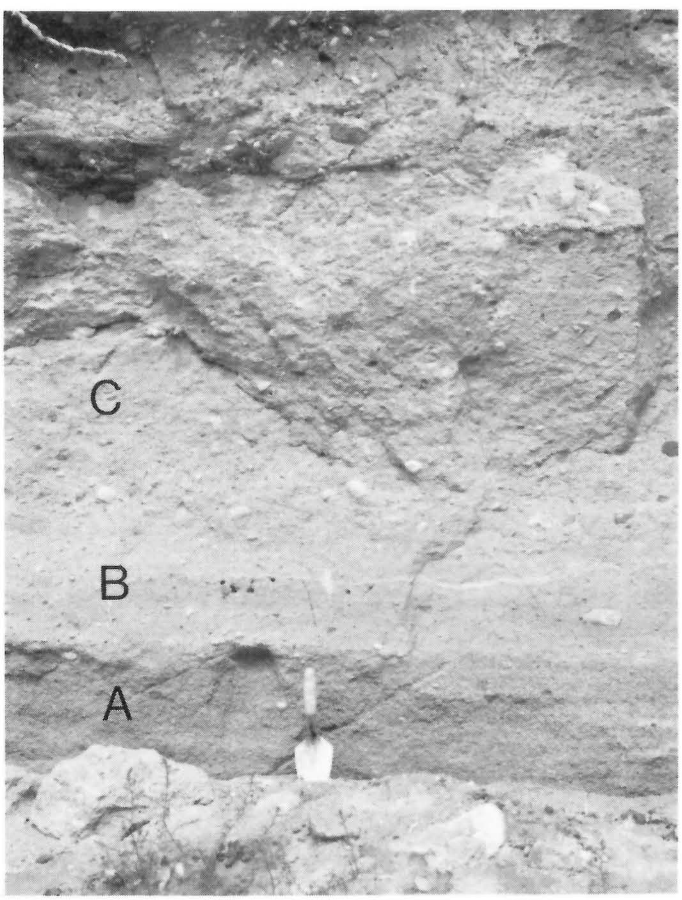

FIGURE AR-4-2: Detail of Zone II (A & B) and Zone I, from the Municipality of Hanover, Quaternary Map AR80-4. A is glaciofluvial sand, B is aquatill and C is basal till.

it from breaking up and floating away. This model predicts much of the observed variability in the glacial deposits in southeastern Manitoba.

ZONE I

The basal till zone is composed of homogeneous, unstratified and overcompacted glacial sediment deposited as basal lodgement till in a sub-glacial environment. This till, like the rest of the sediment, is high in carbonate due to the incorporation of Paleozoic dolomite and limestone bedrock from central Manitoba, over which the ice advanced.

Zone II

The proximal ice shelf zone is an environment dominated by glaciofluvial deposits. A backhoe pit on Highway 59 just south of St. Malo typifies the sediment in this zone; a very hard basal till at a depth of 3.0 metres is overlain by cross-bedded sand interbedded with flow till, and capped by a metre of coarse boulder rich gravel. This zone is important as most of the economic sand and gravel in the area comes from this facies.

Zone III

The intermediate ice shelf zone is composed primarily of aqua till. Lake water in contact with the base of the ice shelf caused melting of the sediment rich basal ice. Due to the slow settling velocity of silt and clay, the fines went into suspension and were removed by bottom currents leaving unconsolidated, usually unstratified, poorly sorted, gravelly sand. This material may be highly variable in sorting, texture, and structure.

Zone IV

The distal ice zone is a deep basinal environment where the fines from below the ice shelf were deposited. Due to the proximity of the ice shelf, ice rafted detritus is present in the stratified silt and clay of this zone.

Zone V

The proglacial lake zone is further from the ice shelf, and therefore little ice rafted detritus is to be found here. It is composed of rhythmically interbedded silt and clay deposited as varves and as turbidites.

Zone VI

The iceberg scour zone is composed of deformed proglacial lake sediments. The iceberg scours throughout southeastern and south central Manitoba supply ample evidence that calving was a major mechanism of ablation during the final retreat of the Keewatin ice.

Fluctuations in the level of Lake Agassiz affected the point of grounding and probably the rate at which ice was calving from the margin. A rise in lake level would move the grounding line northward, shifting the sedimentary facies described in Figure AR-4-1 to the north. Similarly, a drop in lake level would cause the facies to move to the southeast and an apparent glacial advance would be recorded (Fig. AR-4-2).

The sediment facies described above are found throughout much of the municipal surveys area. The area covered by the ice shelf at any one time was probably very small compared to the area of the proglacial lake and the area of basal till deposition. Zones II and III are therefore believed to be of relatively limited areal extent compared with the other facies.

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PRELIMINARY MAPS, SURFICIAL GEOLOGY OF THE SOUTH RIDING MOUNTAIN AREA

1980SRM-1	Elphinstone (62K/9) by H. Groom and M. Radwanski	1:50 000
1980SRM-2	Wasagaming (62J/12) by H. Groom and M. Radwanski	1:50 000
1980SRM-3	Clanwilliam (62J/5) by H. Groom and M. Radwanski	1:50 000
1980SRM-4	Newdale (62K/8) by H. Groom and M. Radwanski	1:50 000