GP6/71

MANITOBA

DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT

MINES BRANCH

GEOLOGICAL PAPER 6/71

SUMMARY OF GEOLOGICAL FIELD WORK 1971

1971

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PREFACE

The greater portion of the Mines Branch geological activities in 1971 continued to be directed towards improving our knowledge of the Precambrian Shield in Manitoba. Three new major projects were begun in 1971. Two of them, the Kasmere and Burntwood projects, were based on reconnaissance feasibility surveys conducted in 1970, while the third, the Greenstones Project, was initiated in response to renewed interest in the base metal potential of the greenstone belts in the Gods-Oxford Lakes area. Detailed gravity surveys were conducted in conjunction with all three of these projects, by personnel from the University of Manitoba.

Reconnaissance appraisal surveys were carried out over most of those areas of the Churchill Province hitherto unmapped by the Mines Branch. These surveys were designed primarily to provide first-hand information on which to base the selection of future project areas.

Detailed field investigations in the File-Morton-Woosey Lakes area, immediately to the west of the Snow Lake base metal mining area, was largely completed. This work is of direct relevance to a number of outstanding problems in the entire Flin Flon-Snow Lake-Sherridon region.

A considerable amount of new data was obtained from ultramafic rocks in the Province, specifically from the Bird River sill, and the Gods Lake area. Suites of samples were also collected from the Pikwitonei dykes and the Manitoba Nickel Belt. Excessively high water prevented further examination of exposures of the Fox River sill.

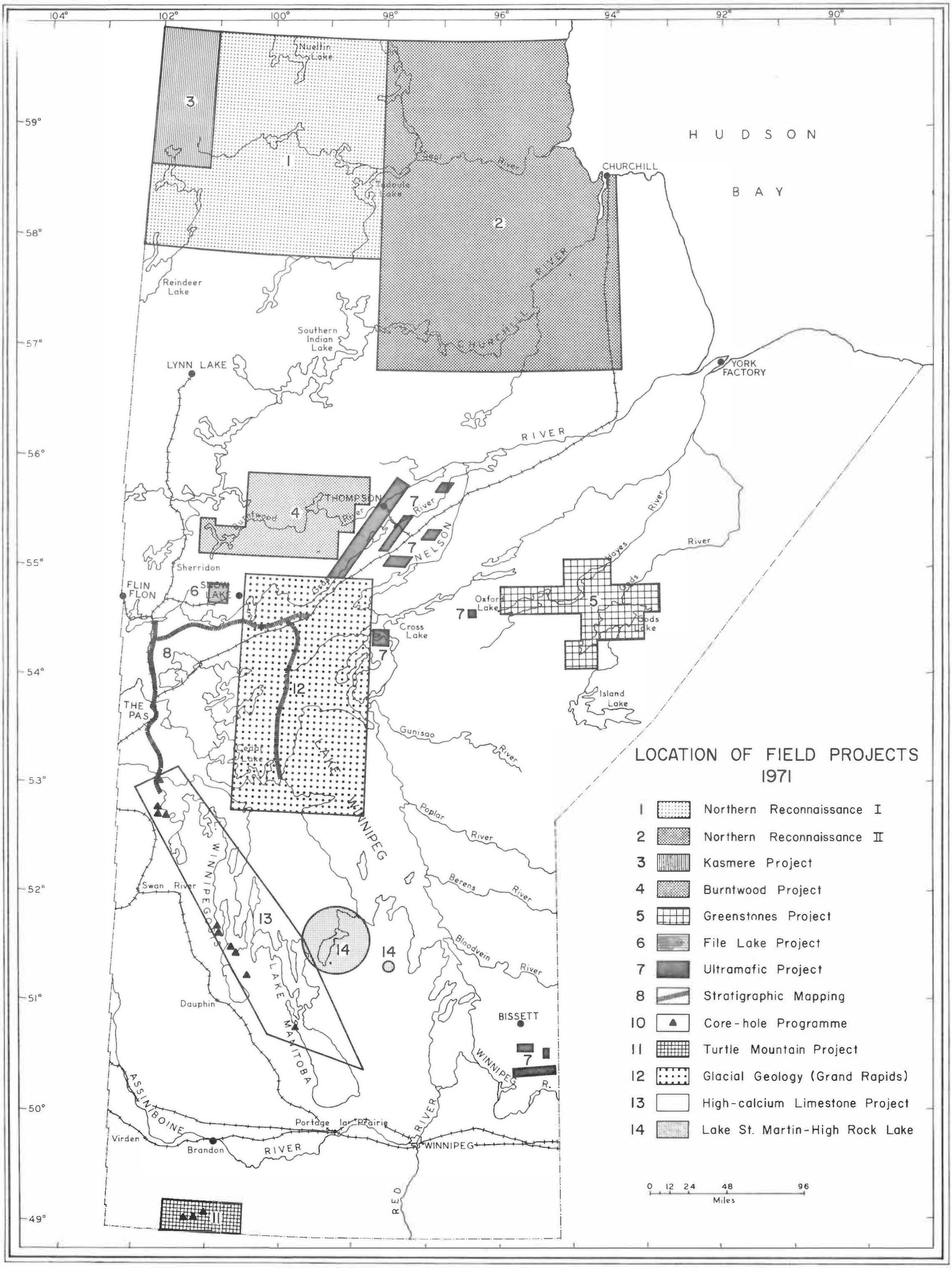
Stratigraphic studies of the Phanerozoic rocks in southwestern Manitoba, included mapping of newly exposed outcrops along the provincial highways north of Grand Rapids, and continued compilation of subsurface geologic data obtained from oil well drilling. Outcrops also were examined in the area of the Lake St. Martin crater structure, and in the vicinity of the Precambrian inlier near High Rock Lake.

The Mines Branch core hole programme was directed towards studies of Cenozoic strata in the Turtle Mountain area, and Devonian strata along the outcrop belt from Dawson Bay to the Lake Manitoba Narrows.

In the Turtle Mountain area, field mapping of the outcrops and collection of core and sidewall samples from six drill holes was completed. Chemical analyses of core, quarry, and outcrop samples, as well as detailed mapping, have supplied data for delineation of high-calcium limestone deposits in Paleozoic and Mesozoic strata.

Pleistocene deposits in the Grand Rapids-Ponton area were examined and sampled to provide data on the nature and origin of the glacial features in this area.

I. Haugh
Chief Geologist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12 Glacial Geology (Grand Rapids)
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14 Lake St. Martin-High Rock Lake
0 12 24 48 96
Miles
104° 102° 100° 98° 96° 94° 92° 90°
59° 58° 57° 56° 55° 54° 53° 52° 51° 50° 49°
HUDSON
BAY
CHURCHILL
YORK FACTORY
Nueltin Lake
Seal River
Tadoule Lake
CHURCHILL RIVER
Reindeer Lake
Southern Indian Lake
LYNN LAKE
RIVER
THOMPSON
Burntwood River
NELSON River
Sherridon
FLIN FLON
SNOW LAKE
Oxford Lake
Hayes River
Gods Lake
River
Cross Lake
Island Lake
THE PAS
Cedar Lake
LAKE WINNIPEG
Gunisao River
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(1) NORTHERN RECONNAISSANCE I

(64N, 640, 64K, 64J)

by W. Weber

A geological reconnaissance survey was undertaken during the 1971 field season between longitudes 98° and 102°, and latitudes 58° and 60° (Figure 1-1), to evaluate existing geological maps, and to select target areas for future Mines Branch mapping projects.

The survey showed that remapping is necessary. It appears to be worthwhile also in regards to the economic potential of the region.

A. General Evaluation

1. The existing geological maps reflect the reconnaissance nature of the original mapping. In many areas they lack detail, are misleading or incorrect:

a) In the western part of the region (Figure 1-1), some of the rock-units mapped by Fraser (1961) and Currie (1960) comprise several different rock-types which were not distinguished on the map. This applies to granitic as well as metasedimentary and metamorphic rocks (e.g., meta-diorite, hornblendite and hornblende-granite gneiss are all included in one unit.)

b) The maps of the eastern part of the region (Figure 1-1) by Davidson (1961, 1962) show more detail, but are misleading:

(i) the subdivision of rock-types is based largely on their mineralogical composition, rather than on true lithogtratigraphic units, e.g., pelitic schists and psammitic gneiss were subdivided into different units, whereas they are typically interlayered on the outcrop scale; or, high-grade sillimanite schists and associated, slightly retrogressive, equivalent rocks were divided into entirely different units; the latter were grouped with low-grade rocks.

(ii) hypersthene granite, as mapped by Davidson (1962), could not be verified.

(iii) large areas are shown incorrectly as granite, apparently on the basis of lake shore exposures. The lithology changes, however, further inland.

2. The southern part of the region (Figure 1-1), between latitude 58°00 and 58°30', and longitude 98° and 101°, which is "geologically unknown" on the existing geological maps (Currie, 1960; Davidson, 1961; Geological Map of Manitoba, 1965) will probably remain as one of the geologically least known regions of Manitoba.

This area contains only a few, widely scattered and small outcrops. A more detailed survey may reveal more outcrops than were seen during the present reconnaissance work and more than were mapped by Currie and Davidson. Additional outcrops might permit some interpretation of the geology, in parts of the area, from aeromagnetic maps. However, the low relief and lack of frost-heaved boulders (which assisted the mapping further north) would make further interpretation impossible.

B. Geology of the Reconnaissance Region

1. Lithology

a) The rocks in the reconnaissance region (Figure 1-1), are very similar to those of the Wollaston Lake belt in the Kasmere Lake area (see Weber, Lamb, Thomas, Schledewitz, this publication). They appear to form subsidiary belts, bounded by granitic diapirs, and branching off the main Wollaston Lake belt. Instead of the pronounced northeast trend of the main belt, however, the subsidiary belts strike east-northeast to east-southeast.

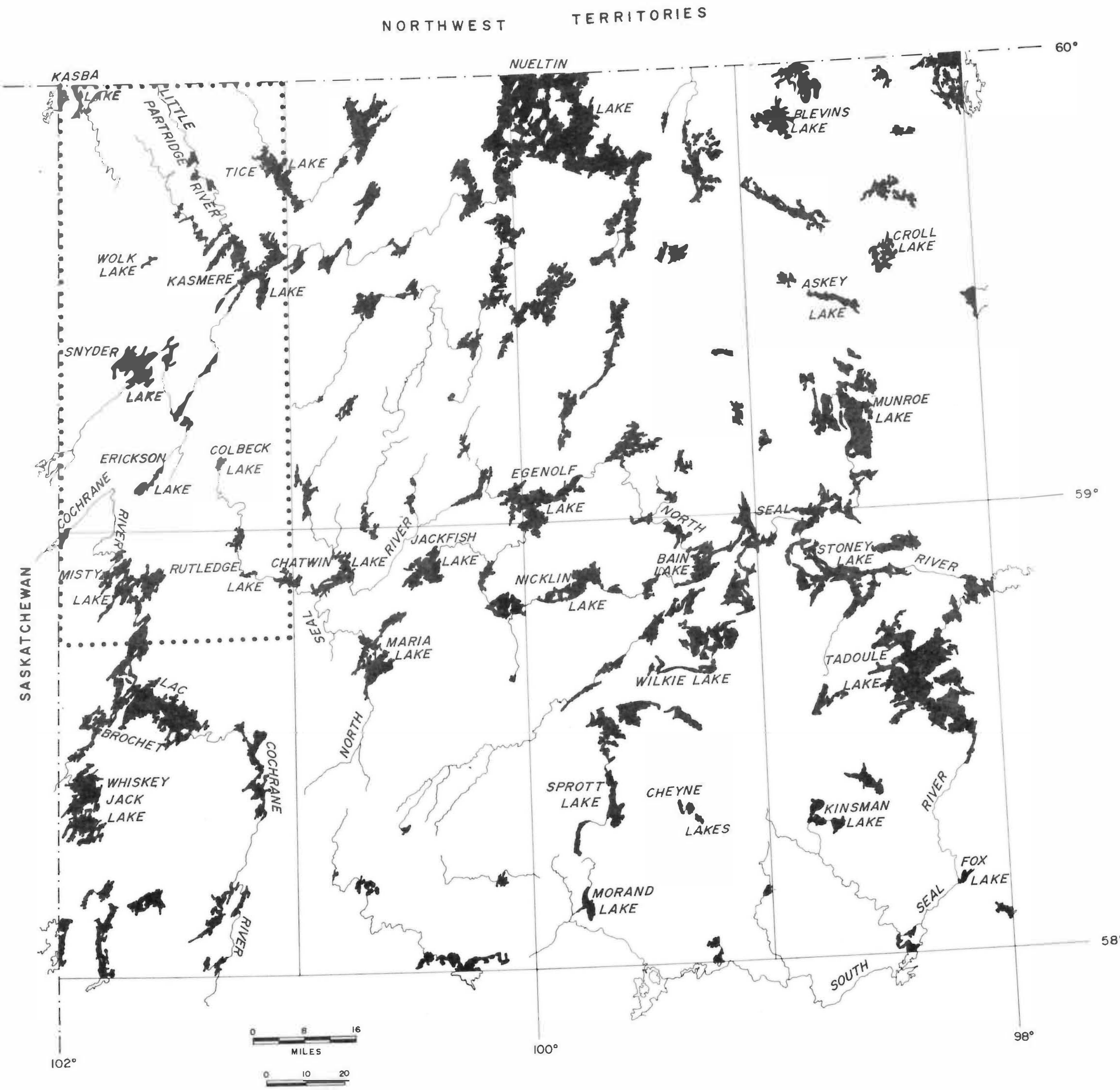

Figure I-I : Northern Reconnaissance Area I
(Dotted line : Kasmere Project Area)

The ratio of platform to off-shelf sediments is much greater in the subsidiary belts than in the main belt, e.g., arkose and quartzite are extensively developed between Munroe Lake and Nueltin Lake, and thick carbonate zones were observed west of Tadoule Lake and at Nueltin Lake (Figure 1-1). Calc-silicate rocks strike through Nueltin Lake, Blevins Lake, Stoney Lake and Tadoule Lake, and occur ten miles southwest of Stoney Lake (Figure 1-1).

b) Metasedimentary rocks north of Blevins Lake and at Askey Lake are possibly related to the Great Island Group which is exposed on the Seal River, 60 miles east of the 98th parallel.

c) Amphibolites and meta-gabbros are abundant in the Whiskey Jack Lake area and east along the Cochrane River (Figure 1-1). They contain traces of copper and nickel in the form of fairly regularly disseminated chalcopyrite and, less commonly, pyrrhotite. The interpretation of the aeromagnetic map suggests that meta-gabbro and amphibolite underlie much of the drift-covered area east of the Cochrane River.

2. Structure

The easterly trending metasedimentary belts show an approximately parallel orientation of fabric, lithological boundaries and axial planes of folds. Locally an east-west striking schistosity transects a primary bedding. Late, cataclastic and mylonite zones are superimposed on the foliation, and the interpretation of the related aeromagnetic expressions suggests apparent right lateral displacements of up to several miles on these zones.

3. Economic Geology

Two types of base-metal mineralizations have been noticed.

a) Sulphides associated with meta-gabbro noted in 1 (c) above.

b) Strata-bound mineralization in the calc-silicate rocks, partly as sulphides. Copper may be present in form of chalcocite, not readily apparent in hand specimen, but indicated by secondary malachite staining.

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(2) NORTHERN RECONNAISSANCE II

(64H, 64I, 64P, 54E, 54L, 54M)

by W. D. McRitchie

An appraisal of a large portion of northern Manitoba (Figure 2-1), hitherto unmapped in detail by the Manitoba Mines Branch, was made over a three-week period in July 1971. The area between latitudes 57° and 60° and longitudes 94° and 98° was investigated by aerial reconnaissance, shorelining along parts of the South Knife, Seal and Caribou Rivers, and ground traverses in the Seal River and Caribou regions. The study was primarily directed toward determining the extent of bedrock exposures, the quality of existing information, and future survey logistics. In most of the area, the existing geological information comprises Geological Survey of Canada 4 mile to the inch reconnaissance studies, in addition to earlier reconnaissance traverses conducted along the major waterways.

The region has been subdivided into four sub-areas (Figure 2-1) each of which has been tentatively assigned a priority level.

In sub-area A, a large proportion of the abundant bedrock occurrences are as yet unmapped, and the discovery, during this investigation, of a large peridotite-pyroxenite body on the southeast arm of Caribou Lake illustrates the incompleteness of the existing coverage. In the Seal River area, previous surveys appear to have been restricted to the immediate vicinity of the river. The occurrences of numerous sulphide zones and aeromagnetic anomalies, on and around Great Island, would appear to bear more intensive examination, as would the stratigraphy of the Great Island Group and its relation to the Churchill quartzites;

Sub-area B largely lies within the coastal plain of Hudson Bay, and is characterized by extensive frost-heaved boulder fields, with only minor in situ bedrock exposures. The existing coverage (Davison, 1966; Johnston, 1935; Bostock, 1969; Sanford *et al.*, 1968; Russell, 1952) is entirely of a reconnaissance nature, and could well be augmented by a more intensive helicopter-assisted grid sampling programme. Contacts are only locally traceable due to the frost action, but more extensive ground coverage is required in the Seal River valley, where isolated occurrences of volcanic rocks are as yet, incompletely mapped.

In sub-area C, large areas of unbroken drift preclude any major improvements in the existing coverage. The two narrow belts of outcrop, which follow the North Knife and Churchill River systems (see Geological Map of Manitoba for a good approximation), are however, incompletely mapped, and additional information could be obtained from these predominantly gneissic and granitic areas.

Bedrock exposures in sub-area D are entirely restricted to the immediate vicinities of the South Knife, Little Beaver and Churchill Rivers and the recent mapping by Bostock (1969), is considered to be largely definitive. Improvements in geological interpretation within the more extensive drift covered regions of sub-areas C and D will rely mainly on geophysical data, such as the extrapolation of known rock-types using filtered aeromagnetic data.

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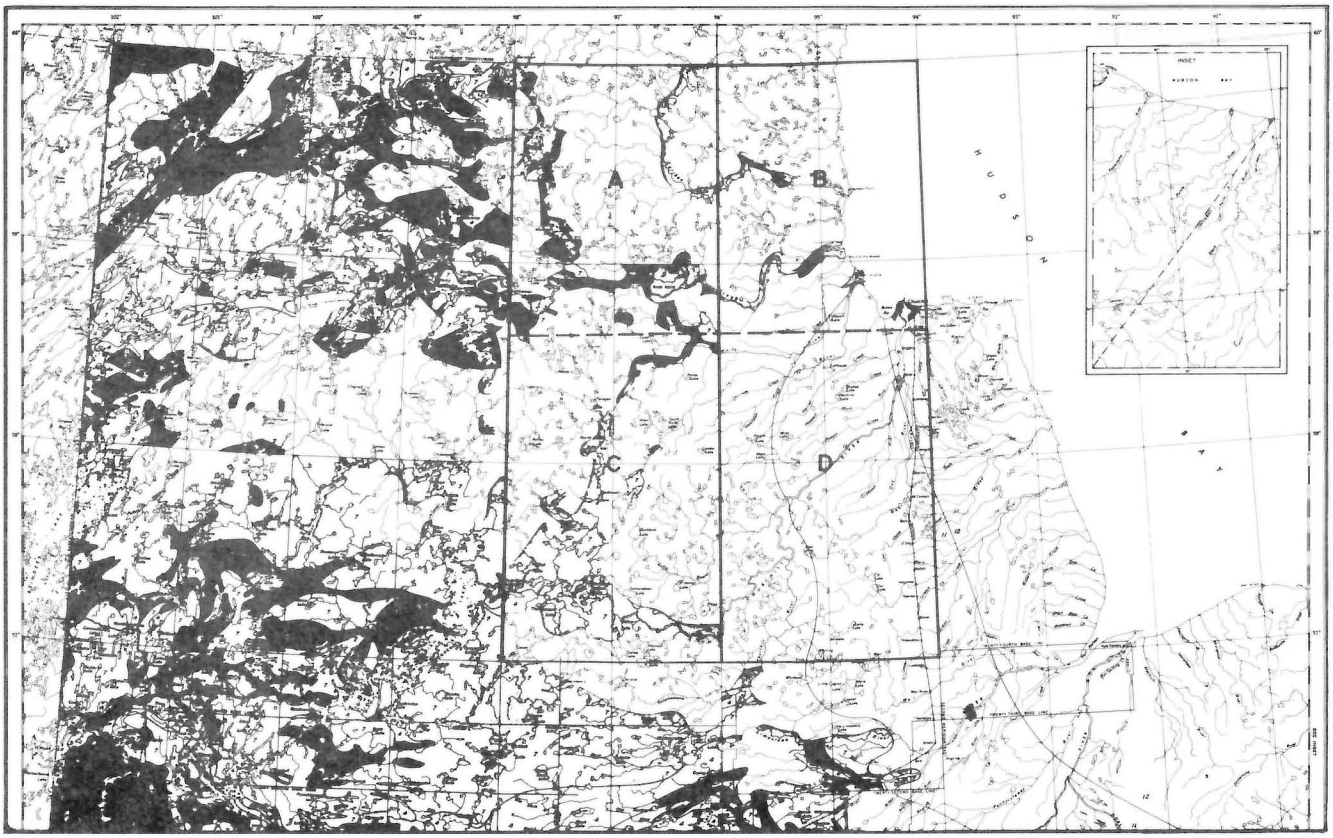

(Portion of Geological Map of Manitoba Map 65-1)

0 100
Miles

Figure 2-1 : Northern Reconnaissance Area II and subdivisions (A,B,C,D) indicating assigned priority levels.

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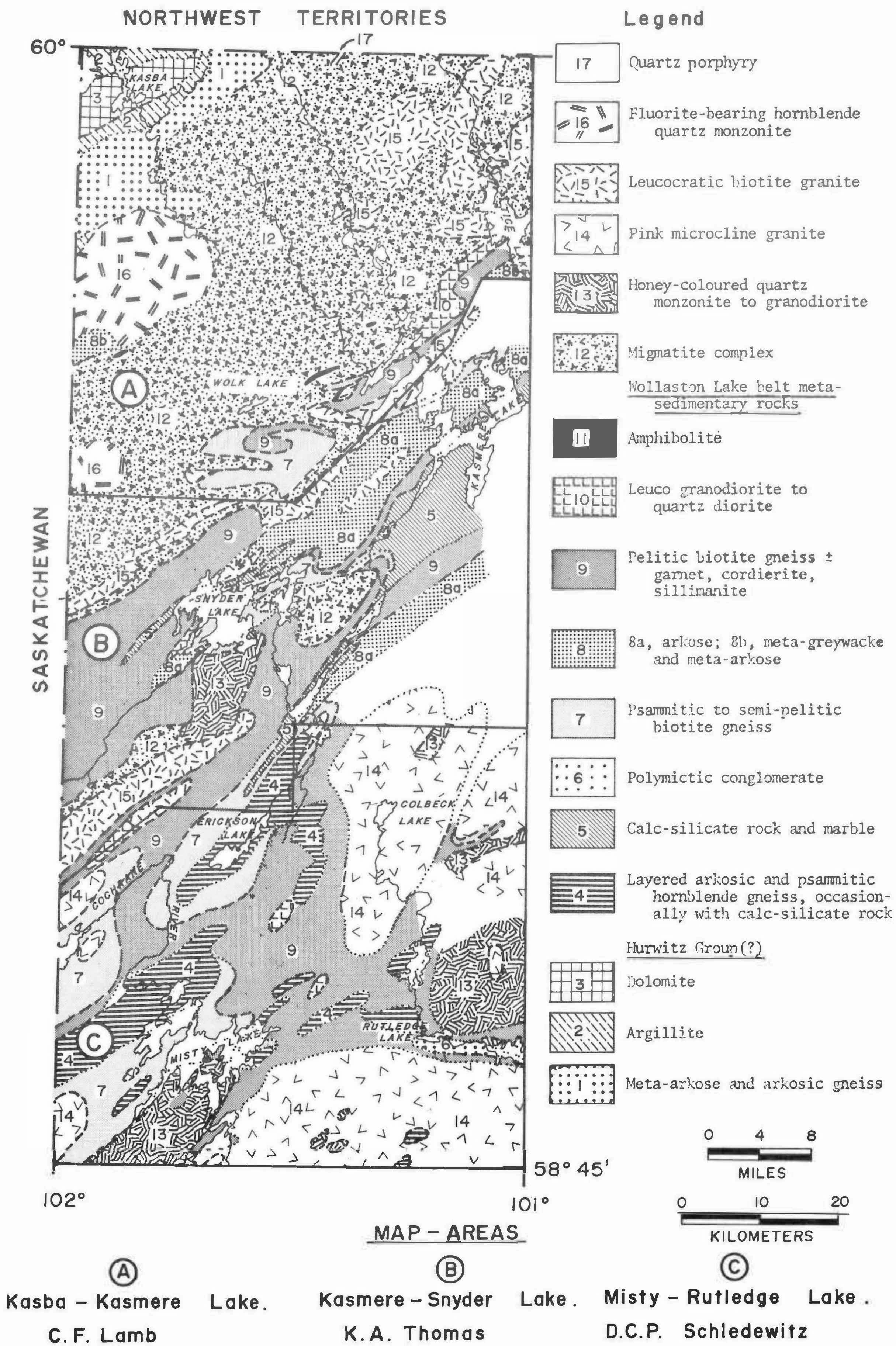

Figure 3-1 : Geology of the Kasmere Project Area.

(3) KASMERE PROJECT

INTRODUCTION

by W. Weber

Geological mapping of the entire 3,100 square mile project area (Figure 3-1) was essentially completed. Rapid coverage was achieved mainly because of the scarcity of outcrops in most of the region. The mapping was carried out by three field parties at a scale of one-half mile to the inch. The field crews were serviced by commercial and government aircraft from Lynn Lake.

On the basis of a reconnaissance survey, an extension of the project area is proposed for 1972, south to latitude 58^{o} and east to longitude 100^{o}.

At the beginning of the field season, outcrops were located from fixed-wing aircraft by flying lines on three miles spacing. About 85 per cent of the outcrops were located this way within three days. Additional ground between the lines was covered by helicopter, which was available for one month in the second half of the field season. Significant results of the project to date are as follows:

1. The geologically unknown areas on previous maps of the region (Fraser, 1961; Currie, 1960) were reduced by about one-half through the use of helicopter, mapping of frost-heaved boulders, and limited interpretation and extrapolation from aeromagnetic maps.
2. The detailed mapping revealed a variety of metasedimentary rocks indicative of platform sedimentation (arkose, conglomerate, carbonate) and of a deeper water environment (pelitic and psammitic rocks). Several types of granitic rocks were also recognized in the southeast and north. Those in the north are related to a broad northeasterly trending migmatite zone, constituting an area of partial anatexis.
3. Base metal mineralization appears to be strata-bound in the calc-silicate rocks.

References

Currie, K. L.

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

Fraser, J. A.

1961: Kasmere Lake, Manitoba; *Geol. Surv. Can.*, Map 31-1962.

THE KASBA-KASMERE LAKES AREA

(64N-12, 13, 14, and part of 11)

by C. F. Lamb

The Kasba-Kasmere Lakes area is located approximately 200 miles north of Lynn Lake, and is bounded by latitudes 59°30' and 60°00' and by longitudes 101°00' and 102°00' (Figure 3-1).

Approximately half the outcrops in the area were mapped by boat and foot traverses. The remainder were less accessible and were visited by helicopter.

General Geology

A sequence of well-preserved arkosic rocks (1), argillite (2) and dolomite (3) in the northwest part of the map-area (Figure 3-1) may belong to the Hurwitz Group as suggested by Fraser (1962). A large migmatite complex (12) separates these sedimentary rocks from the psammitic (7) and pelitic (9) gneisses of the Wollaston Lake belt. The migmatite complex has been intruded by irregular bodies of leucocratic granite and pegmatite (15). Two plugs of fluorite-bearing quartz monzonite (16) are the youngest intrusions in the area.

Structure

The rocks of the (?) Hurwitz Group are folded into a large scale synform. A younger set of minor folds appears to reflect a later period of deformation. An antiform-synform pair, plunging to the northeast are present in the migmatite complex (12).

Aeromagnetic Interpretation

Correlation of rock-units with the aeromagnetic maps is generally poor within the map-area. The fluorite-bearing quartz monzonite (16), however, show up as circular features with expressions of 2200 to 2400 gammas in the cores increasing to a maximum of 3000 gammas towards the margins of the plugs. Units 2 and 3 also have a characteristic magnetic expression.

Mineralization

Mineralization appears to be confined to the calc-silicate rocks (8b) and to the white pegmatite (10) associated with the pelitic gneiss (9). The calc-silicate rocks usually contain pyrite and/or pyrrhotite, and where intruded by white pegmatite, gossan zones may occur. The calc-silicate rocks are locally radioactive, giving an anomaly three or four times the background. Radioactive anomalies of about the same strength were observed locally in the white pegmatite (10).

References

Fraser, J. A.

1961: Kasmere Lake, Manitoba; *Geol. Surv. Can.*, Map 31-1962.

THE KASMERE-SNYDER LAKES AREA

(Parts of 64N-4, 5, 6 and part of 11)

by K. A. Thomas

Introduction

The area covered during the 1971 field season (Thomas, 1971) lies between latitudes 59°3'45" and 59°45' and longitudes 101°00' and 102°00' (Figure 3-1).

General Geology

Previous work by Fraser (1961), has been revised. Much of the bedrock mapped by Fraser as granites, granite gneisses and migmatites was found to consist of metasedimentary rocks. These have been intruded by granites and pegmatite, and form a northeasterly trending belt up to 18 miles wide, continuous with the Wollaston Lake fold belt.

The metasedimentary rocks in the map-area have been divided into five main units. Their mutual age relationships have not yet been determined.

(a) Hornblende-bearing arkosic and psammitic gneiss.
(b) Calc-silicate rock and marble.
(c) Psammitic to semi-pelitic biotite gneiss.
(d) Interlayered pelitic to psammitic biotite gneiss and calc-silicate rock.
(e) Pelitic biotite gneiss ± garnet, cordierite, sillimanite.

The metasedimentary rocks grade into a migmatite complex in the northwestern part of the map-area.

A quartz monzonite to granodiorite intrudes the pelitic biotite gneiss south of Snyder Lake. Two large bodies of biotite granite and pegamatite are intrusive into pelitic biotite gneiss and metatexite, near the southwest boundary and in the northwest corner of the map-area. Small granitic stocks and dykes occur throughout the area.

Metamorphism

The mineral assemblage sillimanite-cordierite-orthoclase-almandine, commonly present in the metasedimentary rocks, is indicative of the upper amphibolite facies of regional metamorphism under low-pressure conditions.

Local retrograde metamorphism has produced chlorite and muscovite.

Aeromagnetic Interpretation

Good correlation exists between the following rock units and their magnetic expressions:

(1) The pelitic and psammitic biotite gneisses and the calc-silicates are areas of low magnetic intensity (1800-2400 gammas).
(2) The hornblende-bearing arkosic gneisses are associated with higher magnetic intensity (2400-3000 gammas).
(3) The migmatite complex ranges from 2800 to 3300 gammas.

Structure

A dominant northeast trend is indicated by the regional foliation, the axial planes of the majority of minor folds, and most of the lithologic boundaries.

Two types of minor folds have been recognized:

(1) An early set of isoclinal folds, with axial planar foliation, which fold the layering.
(2) The second set folds both foliation and layering. These folds are asymmetric, relatively open folds with inter-limb angles from 80° to 120°. Their axial planes strike northeast.

Foliations with opposing dips define a series of synformal and antiformal folds within the metasedimentary rocks east of Fort Hall Lake. The lack of exposure in this area has made structural interpretation extremely difficult. Further interpretation of the present data may provide a more detailed structural picture.

Economic Geology

Two mineral occurrences were found:

(1) An outcrop located between the two southwest arms of Kasmere Lake shows yellow gummite exposed along a 30 metre long trench. The mineralization occurs in greyish white pegmatite which contains inclusions of pelitic gneiss. The pegmatite is in contact with pelitic biotite gneiss.

(2) On the west bank of the Thlewiaza River, approximately 2 km south-southwest of Kasmere Falls, massive to disseminated pyrrhotite and pyrite occur in calc-silicate rock. This property is presently held by Goldray Mines Ltd.

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1961: Kasmere Lake; *Geol. Surv. Can.*, Map 31-1962.

Thomas, K. A.
1971: Kasmere Lake, Thanout Lake, Snyder Lake, Erickson Lake; *Man. Mines Br.*, Preliminary Maps 1971 K-4, 5, 6, 7.

MISTY-RUTLEDGE LAKES AREA

(64K-13, 14, 64N-3 and Part of 4)

by D. C. P. Schledewitz

Introduction

The area mapped is shown in Figure 3-1. The geology of the area was previously described by J. A. Fraser (1962) and K. L. Currie (1960). Glacial deposits are extensive, and bedrock exposures comprise less than 5 per cent of the area.

General Geology

A sequence of Precambrian sediments ranging from arkoses to pelites with minor calcareous zones, have been subjected to polyphase deformation and metamorphism. The resulting paragneisses and metatexites have been intruded by intermediate to acid igneous rocks (see Figure 3-1).

Lithology

The eastern part of the map-area (Figure 3-1) consists mainly of microcline granite (unit 14) and quartz monzonite to granodiorite (unit 13). The latter occurs as large individual bodies and as inclusions in the microcline granite. Paragneisses (units 4, 6 and 7) occur as large inclusions in units 13 and 14 and as narrow linear troughs. The most significant of these is an appoximately east-trending belt with a dominant east-west fabric (Misty Lake-Nicklin Lake Belt; Money, 1968), which passes through Rutledge Lake. The belt bifurcates west of Rutledge Lake, with a narrow zone of paragneisses (units 4, 7, 9) branching off to northeast. Inclusions of pelitic gneiss (unit 9), with east-west planar structures, occur in the southern part of the large microcline granite body.

The western half of the area (Figure 3-1) comprises northeasterly striking paragneisses (units 4, 7, 9) which have undergone variable degrees of anatexis. White granodiorite (unit 10), which sporadically contains garnet and cordierite, is associated with the semi-pelitic or pelitic gneisses. In the southwest corner of the area, microcline granite (unit 14) forms a lobate body containing large, parallel to subparallel aligned inclusions of paragneiss (units 4, 7 and 9). Further east, an elongate northeast-trending body of quartz monzonite to granodiorite (unit 13) also contains similarly oriented inclusions. The layering in the paragneisses, and the orientation of the inclusion bodies are generally parallel and strike 225-250^{o}.

Structure and Metamorphism

The inter-relationship of the structural and metamorphic histories in the east and west halves of the area is not yet fully understood.

The probable tectonic history in the *western* half of the map-area can be summarized as follows:

S_0 Primary layering.

D_1 M_1 S_1 — D_1 is inferred from the development of a foliation (S_1) (schistosity and gneissosity) and parallel oriented porphyroblasts which have been deformed by a later period of deformation (D_2). M_1 is defined by the growth of cordierite, garnet and sillimanite, suggesting conditions of Abukuma-type cordierite-amphibolite facies metamorphism. Partial anatexis, and intrusion of granitic dykes and veins also occurred during M_1.

D_2 M_2 S_2 — D_2 is defined as the folding (F_2) of S_1 about northeast trending (225-235) axial planes, with the development of a moderate to strong, penetrative S_2 schistosity parallel to the F_2 axial planes. M_2 is defined by the recrystallization of cordierite, and the growth of plagioclase-quartz and microcline-quartz as porphyroblasts, and as rims overgrowing cordierite and garnet. Local recrystallization of cordierite may be due in part to "syn-D_2" emplacement of the quartz monzonite-granodiorite.

D_3 M_3 S_3 Further folding (F_3) about axial planes parallel or subparallel to F_2 axial planes. Development of a weak schistosity (S_3) at a low oblique angle to S_2 and rotation of porphyroblasts into the S_3 plane. S_3 strikes 255-265.

D_4 M_4 S_4 Shearing (D_4) in northeasterly and northerly directions, with the development of a cataclastic fabric (S_4). Retrogressive metamorphism (M_4) of cordierite and plagioclase-quartz porphyroblasts.

Economic Geology

A minor gossan with an orientation of 240/45NW occurs in a pyrite-bearing zone of silicification (UTM 6548370/362790), six miles southwest of Colbeck Lake. Mineralized float was observed approximately one and one-half miles north of the main part of Misty Lake (UTM 6533930/347750). Approximately 1 per cent of the boulders in the float are gabbroic, and contain 1-2 per cent pyrrhotite.

The airborne geophysical survey carried out by the Dynamic Petroleum Company Ltd. in the Rutledge Lake area, revealed a number of electromagnetic anomalies which can be correlated with the contact between the granitic rocks (unit 13 and 14) and the paragneisses (units 6 and 9). The contact runs from south of Rutledge Lake in a broad curve towards Misty Lake. A similar contact occurs north of Rutledge Lake but the anomalies along this contact are not as abundant.

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TABLE OF FORMATIONS

Map Unit	Rock-Type	Description
19	White pegmatite	Quartz, feldspar with grey-blue cores.
18	Meta-diabase	Dark grey, medium to coarse-grained.
14	Microcline granite	Medium to coarse-grained, pink; variable biotite content; weak to well-developed foliation; moderate magnetic signature.
13	Quartz monzonite to granodiorite	Olive green to honey-coloured feldspars; biotite 5%, variable contents of hornblende and/or magnetite; moderate to high magnetic signature.
10	White granodiorite	Plagioclase, quartz; variable microcline content; sporadic garnet and cordierite. This rock is mainly associated with units 7 and 9.
9	Garnet-cordierite gneiss	Grey; biotite, quartz, plagioclase; variable microcline content; sporadic garnet, sillimanite and cordierite. White granitic *lit* of plagioclase and quartz comprise 15 to 70% of the rock. Low magnetic signature.
7f	Quartzite	Grey to buff; variable actinolite content. Of minor occurrence in the area.
7	Psammitic to semi-pelitic gneiss	White to grey in colour; highly variable content of microcline; biotite variable, 5-15%; sporadic cordierite.
6	Polymictic conglomerate	Pink to dark grey; clasts range in composition from dark green, basic, hornblende-epidote pebbles to quartzite clasts. The compostion of the matrix ranges from acid to intermediate.
4	Arkosic gneiss and associated calc-silicate rocks	Pale pink to grey; contain hornblende and/or magnetite; relatively high magnetic signature.

(4) BURNTWOOD PROJECT

Introduction

by W. D. McRitchie

Two 5-man and one 6-man field parties, in the summer of 1971, completed the regional geological mapping of ten and one-half 30 minute NTS areas in the Nelson House region, Northern Manitoba (Figure 4-1). Additional mapping, mainly of the shoreline exposures in the Burntwood Lake region, was conducted by a two-man party (one and one-half 30 minute sheets), with a view to completing this coverage during 1972. This marks the end of the first phase of the Burntwood Project (McRitchie, 1971a). The results are presented as preliminary geological maps 1971G 1-13 (Baldwin, Frohlinger, Kendrick & McRitchie, 1971b) and in the following summary reports. A preliminary geological compilation is depicted in Figure 4-2, and a correlation of deformation among the three main sub-areas is shown in Table 4-1.

TABLE 4-1

Correlation of Deformational Episodes in the Nelson House-Burntwood Lake Regions

Burntwood Lake (McRitchie)	**Apeganau Lake (Baldwin)**		**Hall Lake (Frohlinger)**	
Faulting NNW-NE (conjugate)	Faulting NNW-NE (conjugate)		Faulting NNW-NE (conjugate)	
F_4? folding	F_4? folding	ENE-ESE faulting*	F_4? folding	ENE-ESE faulting*
F_3 folding	F_3 folding		F_3 folding	
Faulting NW-N	Faulting NW		Faulting NW	
F_2 folding	F_2 folding		F_2 folding	
—	—		F_{1A}? folding	
F_1 folding	F_1 folding		F_1 folding	

*ENE-ESE faulting post-dates the early NW fault set and pre-dates the later conjugate fault sets.

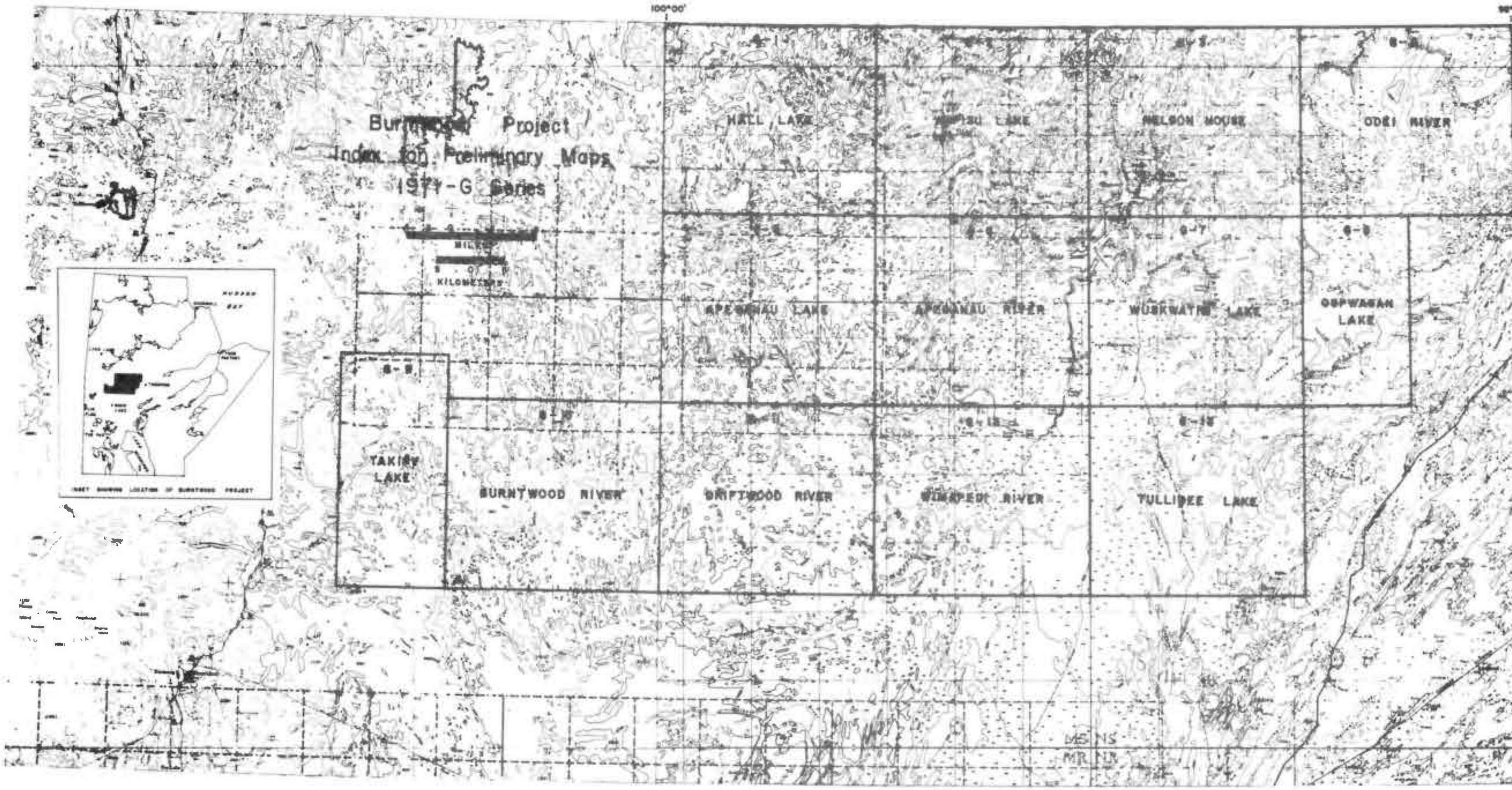


Figure 4-1 : Location of the Burntwood Project and Preliminary geological maps 1971 G, 1-13.

GEOLOGY OF THE NELSON HOUSE – BURNTWOOD LAKE AREA

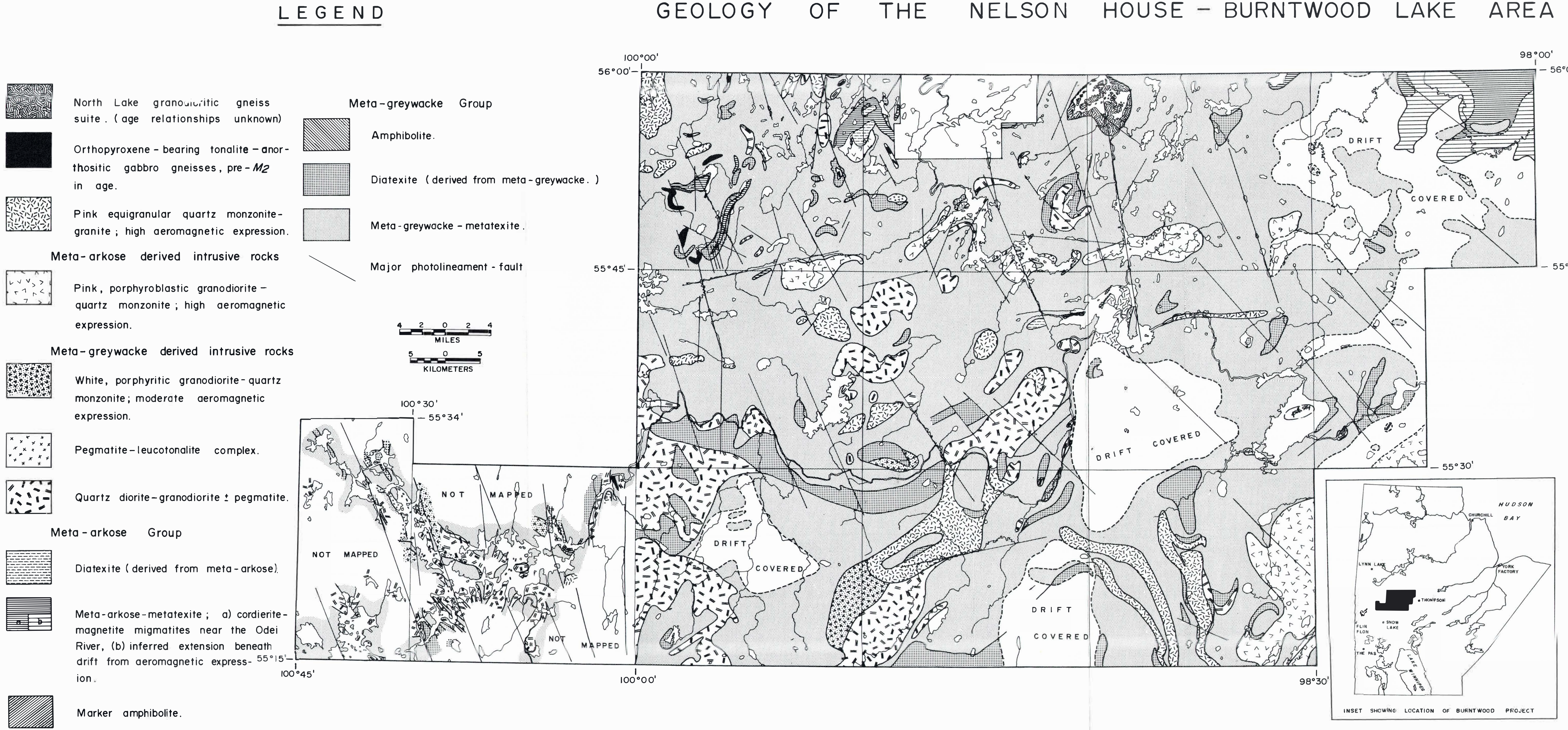


Fig. 4-2. Compilation derived from Manitoba Mines Branch Preliminary Maps 1971 G, 1-13 (Baldwin, Frohlinger, Kendrick, McRitchie.)

APEGANAU LAKE AREA

(630-5, 6, 11 and 12)

by D. A. Baldwin

Introduction

The area mapped during the 1971 field season comprises approximately 1200 square miles, bounded by latitude 55°15', the 20th base line, and longitudes 99°00' and 100°00' (Baldwin, 1971).

Mapping at a scale of one-half mile to the inch was carried out by standard pace and compass traverse methods. Considerable helicopter support was necessary because of poor access from the limited number of lakes and rivers in the area.

Outcrop is relatively abundant. Exposures are generally clean only on lake shores and in burnt over areas. Elsewhere thick moss and lichens obscure much of the geology.

A four mile to one inch geological compilation of the area is shown in Figure 4-3.

General Geology

Within the Burntwood Project, two distinct sedimentary groups have been defined; a meta-greywacke group and an arkosic group (Baldwin, 1971; Frohlinger, 1971). The arkosic group is not present in the Apeganau Lake area.

The meta-greywacke group comprises three rock-units with increasing anatectic fractions from < 25 per cent (paragneiss) through 25 per cent to 75 per cent (migmatite) to > 75 per cent (diatexite-anatexite).

The dominant rock-type in the map-area is migmatite (metatexite) derived from unit 1 (meta-greywacke-paragneiss) of the meta-greywacke group. With the exception of a few intrusive quartz monzonite bodies, the other intrusive rocks in the area are quartz diorite, granodiorite and pegmatite, all of which are anatectic derivatives of the migmatite.

Meta-greywacke Group

Unit 1 comprises well-bedded, interlayered psammite and semi-pelite with up to 25 per cent mobile fraction: calc-silcate layers are commonly present.

Migmatite or metatexite (unit 2) is characterized by metamorphic layering defined by layered concentrations of biotite and garnet, and a mobile fraction, the latter making up 25 per cent to 75 per cent of the rock. Primary layering is no longer distinguishable.

Diatexite and anatexite (unit 3) are characterized by 75 per cent or more mobilizate, and represent more advanced anatectic stages (phases) of unit 2. Psammite and calc-silicate rafts are locally abundant and biotite schlieren occur as relics of the semi-pelitic layers. Flow layering is generally parallel to the axial planes of folds in the restite.

Intrusive Rocks

Quartz diorite (unit 10) is a fine-grained white rock, with pegmatite phases, that occurs as sills and dykes. The rock typically contains sieved garnet clots which are commonly rimmed by feldspar.

Medium-grained, massive to weakly foliated, idiomorphic to gneissic granodiorite-quartz diorite (unit 11) contains widely disseminated garnets that are generally 4 to 5 mm diameter. Diffuse paragneiss and migmatite rafts are sporadically present.

Porphyritic granodiorite (unit 12) is commonly associated with unit 11, and is characterized by the abundance of plagioclase porphyroblasts, and only minor garnet. The plagioclase porphyroblasts are generally 8 to 12 mm across but some 4 cm crystals have been noted. The porphyroblasts may be flow-oriented. Garnets are locally associated with and present in partially resorbed xenoliths.

Quartz monzonite (unit 14) is typified by a magnetic expression that does not significantly differ from that of the surrounding gneisses. It is medium to coarse-grained and porphyritic to equigranular. Biotite, garnet and hornblende are the ferromagnesian constituents.

Unit 16 is a quartz monzonite-granodiorite. The rock may be gneissic to porphyritic and in many places is deeply weathered. It forms large bodies and has a magnetic expression equal to that of the enclosing gneisses.

A pegmatite complex (unit 17) generally contains minor discontinuous rafts of migmatite and common finer-grained leuco-tonalitic-granodioritic and quartz monzonitic phases. Many of the pegmatites in the complex are oriented parallel to the axial planes of major folds.

A fine to medium-grained, non-foliated and homogeneous quartz diorite is unit 18. It is typically garnet-free. The intrusion of this rock appears to be the last intrusive event in the area.

An ultramafic dyke consisting of diopside-plagioclase (An_{26})-biotite-quartz, intrudes unit 16 and has been subsequently deformed into open asymmetric 2-type folds probably during D_4.

TABLE 4-2

Summary of Deformation and Metamorphism

D_6		Regional N-S faulting, with accompanying retrogressive metamorphism. Intrusion of large quartz diorite dykes and stocks.
$D_5 \equiv F_4$?		Regional flexuring of F_3 axial traces.*
$D_4 \equiv F_3$		Open flexural-slip asymmetric folding of pre-existing structures.
	M_3	Recrystallization and annealing of cataclastic textures followed by further garnet growth in these zones.
D_3		Faulting in narrow well-defined zones or as a penetrative cataclastic foliation S_3.
	M_2	Main anatexis - mobilization and introduction of granodioritic and quartz dioritic intrusions. Recrystallization of M_1 cordierite and concentration of it in mobile fraction.
$D_2 \equiv F_2$		Intense asymmetric folding with development of penetrative strain-slip axial planar foliation (S_2). Deformation of M_1 garnets in S_2.
	M_1	Main regional metamorphic zonation; development of garnet, cordierite, and sillimanite in essentially static environment.
$D_1 \equiv F_1$		Intense isoclinal folding. Development of S_1.
	M_0	Initial recrystallization of sedimentary fabric.

* Recognized in Burntwood Lake area.

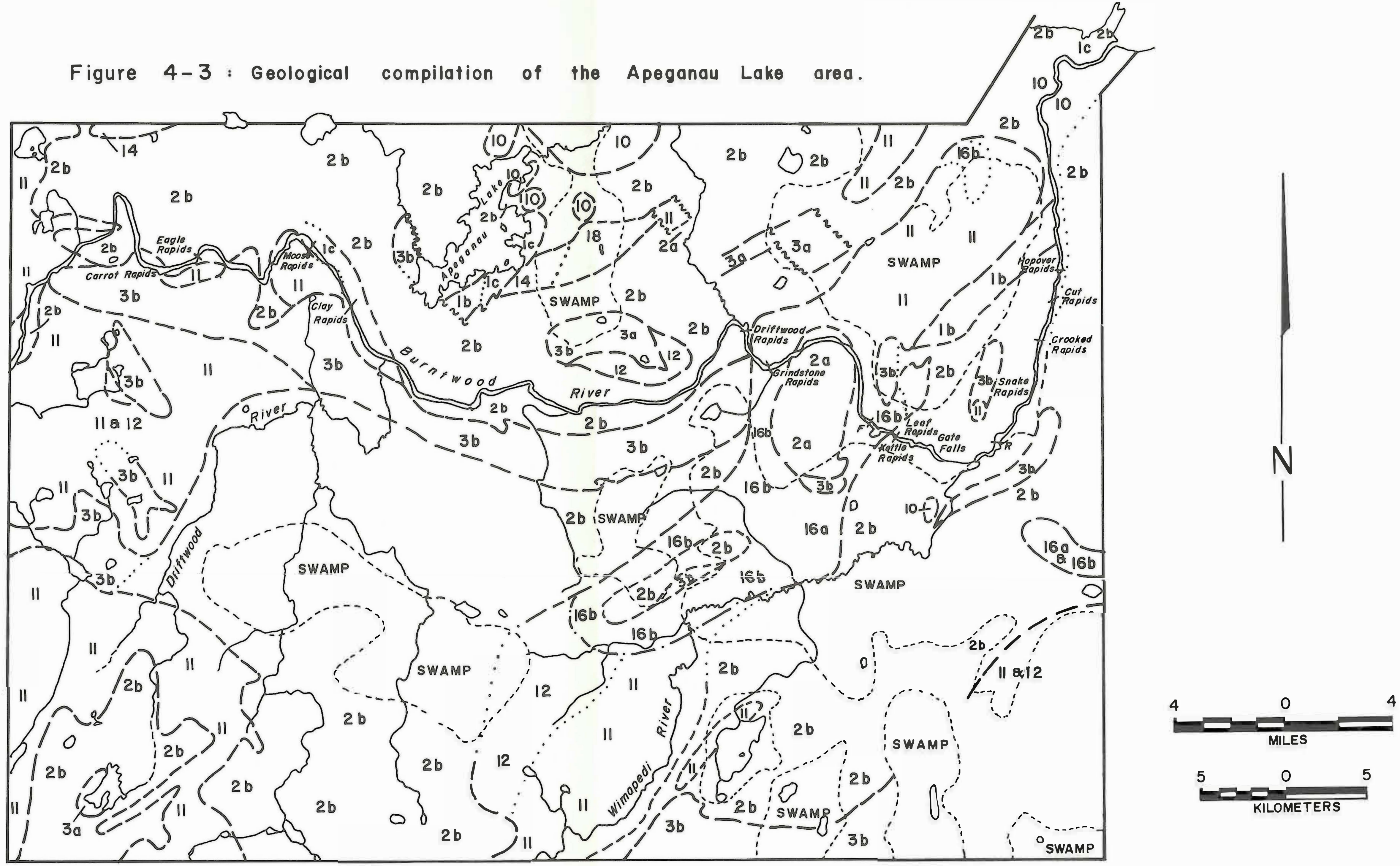
Structural Geology and Metamorphism

A preliminary summary of metamorphism and deformation is given in Table 4-2.

Mineral assemblages are characteristic of the middle to upper amphibolite facies. Indicator minerals are sillimanite, garnet and cordierite. Hypersthene occurs locally, with the assemblage amphibole, garnet, biotite, plagioclase (An_{30-35}) and quartz. At present, it is thought that the orthopyroxene is relict and not metamorphic (McRitchie, personal communication). The hypersthene is present in rocks that may be dykes and sills that are genetically related to early anorthositic intrusions (McRitchie, 1971).

One occurrence of a hypersthene-bearing granite was noted in the area. It occurs as a small body (not mappable) on the shoreline of Threepoint Lake (UTM co-ordinates 499250

Figure 4-3 : Geological compilation of the Apeganau Lake area.



LEGEND

Meta - Greywacke Group

1 Meta - Greywacke — Paragneiss
   b) without calc-silicate layers
   c) orthoquartzite

2 Migmatite (metatexite)
   a) with calc-silicate layers or boudins
   b) without calc-silicate layers or boudins

3 Diatexite — Anatexite
   a) with calc-silicate layers or boudins
   b) without calc-silicate layers or boudins

Intrusive Rocks

10 Quartz Diorite
11 Granodiorite — Quartz Diorite
12 Granodiorite (porphyritic)
14 Quartz Monzonite
16 a) Gneissic Quartz Monzonite
   b) Porphyritic Quartz Monzonite
18 Quartz Diorite (*Late*)

east by 6170225 north). The mineralogical composition of the rock is quartz, mesoperthite, minor garnet, magnetite, biotite and hypersthene. This rock may represent minor local development of granulite grade metamorphism.

Economic Geology

A single sulphide occurrence was recorded from drill core, found on the shore of a small lake in the extreme northwestern corner of the map-area.

The locality at which gold was previously reported (Quinn, 1955) has subsequently been concealed by vegetation.

Graphite was noted at a few localities within map-units 2 and 17.

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1971: Preliminary Geological Investigations of the Nelson House-Pukatawagan Region, Manitoba; (Burntwood Project); *Man. Mines Br.*, Geol. Paper 2/71.

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BURNTWOOD LAKE AREA

(63N-7E, -8, and Part of 10E)

by W. D. McRitchie

Shoreline exposures in the Burntwood Lake region were mapped during 1971 (McRitchie, 1971) as a prelude to complete mapping of the Takipy and Burntwood Lake map sheets (N.T.S. 63/N-7E, 8, 10) planned for 1972.

Geology

The following rock-units (Table 4-3), were encountered during the course of the present study. (Unit members are those shown on preliminary geological maps 1971G-9, 10 (McRitchie, 1971); missing numbers occur as units on other Burntwood Project preliminary maps 1971G 1-8, and 11-13).

TABLE 4-3. Rock-units in the Burntwood Lake area

INTRUSIVE ROCKS	18	Quartz diorite (late)
	17	Pegmatite complex
	15	Quartz monzonite-granite
	12	Porphyritic granodiorite-quartz monzonite
	11	Granodiorite-quartz diorite
	10	Quartz diorite
	9	Anorthositic gabbro with ultramafic phases
META-GREYWACKE GROUP	3	Diatexite a) with calc-silicate horizons; b) without calc-silicate horizons.
	2	Metatexite a) with calc-silicate horizons; b) without calc-silicate horizons; c) garnet-poor variety.
	1	Meta-greywacke-paragneiss a) with calc-silicate horizons; b) without calc-silicate horizons; c) orthoquartzite.

Meta-greywacke Group (1, 2, 3)

Throughout the region, the most common rock-type is a well-bedded interlayered psammitic to semi-pelitic meta-greywacke (unit 1) that has been variously recrystallized to middle or upper amphibolite facies assemblages. This rock-unit exhibits every graduation from well-bedded metasediment with <5 per cent granitic *lit* through metatexite (unit 2) to almost wholly anatectic diatexite (unit 3). Highly granitized and thinly layered, garnet-poor, migmatitic paragneisses and schists (unit 2c) occur in belts throughout the area.

Anorthositic gabbro (9)

A single tabular body of medium-grained, relatively homogeneous anorthositic gabbro was recorded on the Burntwood River (UTM Easting 433250, Northing 6149150). This northerly striking unit occurs concordantly within a high grade sequence of units 2 and 11. Eighty metres south of the river, a small two metre long ultramafic phase occurs in the highly foliated and folded marginal phases of the gabbro. A pre-F_2 deformation and M_2 metamorphism age is indicated by the intense marginal foliation, and the occurrence of numerous cross-cutting dykes and veins of anatectic mobilizate, derived from the surrounding metasedimentary gneisses.

Quartz diorite (10)

White, fine to medium-grained, homogeneous, equigranular quartz diorite occurs as sill-like complexes with abundant white pegmatite, and as larger irregularly shaped bodies, intrusive into the metasedimentary gneisses. It is characterized by inclusions of units 2 and 3, and the presence of discrete 1-4 cm sieved garnet clots, many of which are surrounded by a narrow feldspathic rim.

Quartz diorite-granodiorite (11)

White-grey, medium-grained, massive to weakly foliated, homogeneous, equigranular intrusive quartz diorite (gradational into unit 3) occurs as large batholithic bodies. Inclusions of units 1, 2 and 3, where present, are almost completely assimilated. This unit is thought to represent a more homogeneous variety of unit 10, derived and homogenized at greater depths. Exceptionally coarse-grained phases of units 1 and 2, and abundant unit 3, developed near the contacts of the main intrusive bodies, may be the result of pronounced contact metamorphism, or they may reflect a progressive thermal gradient culminating in complete anatexis.

Porphyritic granodiorite-quartz monzonite (12)

Porphyritic granodiorite occurs as large intrusive bodies within the gneisses, and as irregular dykes within units 11 and 10. The adjacent metasediments, mainly unit 3, commonly exhibit advanced stages of anatexis. The 1-4 cm Carlsbad twinned potassium feldspar phenocrysts are typically flow-oriented near the contact. Garnets occur only in (direct association with) rare diffuse rafts of units 1 and 2.

Quartz monzonite-granite (15)

This is a pink, fine to medium-grained, equigranular, homogeneous intrusive rock, with a moderately high aeromagnetic expression. It occurs as small isolated stocks which are commonly surrounded by amphibolitized metasediments that are penetrated by pink aplite and pegmatite dykes. Hornblende, magnetite, and biotite are the main ferromagnesian minerals present.

Pegmatite complex (17)

Wide zones, containing >85 per cent pegmatite, occur on the File River and the western arm of Burntwood Lake. Typically, they are in complex association with finer-grained leuco-tonalitic to/and leuco-quartz monzonitic phases, transitional with unit 10. Intensely folded discontinuous rafts of units 1, 2, and 3 indicate that the pegmatites in large part penetrate the axial planes of the F_2 folds.

Quartz diorite (18)

This white, fine-grained equigranular, homogeneous, massive, and garnet-free intrusive rock occurs as dykes and larger stocks which post-date the formation of an 'early' fault set. Inclusions of units 1, 2, 3, 10, 11 and 12 have been recorded on the Burntwood River downstream from Burntwood Lake. A one metre wide fault zone observed in a xenolith of unit 11, that is completely enveloped by the finer-grained quartz diorite. Unit 18 is very similar to unit 10 in both composition and appearance; the latter however appears to have been emplaced at a much earlier date in the evolution of the region.

Structure

It has been possible to establish the following sequence of events (see also Table 4-2 in Baldwin, this publication) within the area. The main metamorphic layering in the western part of the area strikes between 290 and 340 and dips more or less consistently to the northeast. In the east, a more variable and complex distribution of units indicates the presence of several cross-folds. Minor folds, reversals in dip, and refolded axial planar foliations are interpreted as indicating three possible major folding episodes, in addition to an early phase, so far identified only locally in small scale structures. F_1 comprises tight isoclinal folds which are refolded by the main F_2 phase and therefore pre-date the latter. During F_2, the interlayered psammitic and semi-pelitic greywacke sequences (including minor thin granitic *lit*), were folded into a series of tight asymmetric folds with westerly striking and northerly dipping axial planes. During this deformation the rocks developed a strongly penetrative axial planar foliation into which the earlier formed porphyroblasts were rotated. A series of broad open asymmetric folds (F_3), with a locally developed weak axial planar fabric, and almost horizontal axes, have been interpreted from small-scale structures and major reversals in dip, denoting north-northeasterly striking axial traces. In one locality (UTM Easting 418200, Northing 6137050) a 1 metre wide fault zone, with cataclastic augen textures, appears to be folded by an asymmetric S-fold of possible F_3 age. The F_3 axial traces exhibit a broad sinuous trace which may be interpreted either as the result of a gentle F_4 folding or a low F_3 symmetry. Linear fracture zones, with associated low grade retrogression (muscovite-chlorite), strike NW-NNE and displace all earlier structures with a consistent, apparent left lateral movement.

Metamorphism and Plutonism

Mineral assemblages occurring in metasedimentary unit 1 and anatectic derivatives, units 2 and 3, are characteristic of the middle to uppermost amphibolite facies. They include quartz, potassium feldspar, biotite, oligoclase-andesine, ± almandine, ± sillimanite, ± cordierite, ± diopside. A strict primary compositional control in the sediments dictates the presence and degree of development of the main metamorphic indicator minerals. Within some layers high concentrations of large sillimanite crystals (up to 18 cm in length) can be used as marker horizons to define otherwise concealed structures. Subsequent to an early phase of recrystallization, during which porphyroblasts of sillimanite, cordierite, almandine and K-feldspar were formed, the sediments were subjected to intense folding (F_2) and the development of a penetrative axial planar foliation. The early formed porphyroblasts were rotated into the plane of this later strain-slip foliation, which is defined in part by a secondary growth of biotite and fibrolite.

Elsewhere in the area every gradation from small eyelets of feldspar, around individual garnet crystals, to large volumes of anatectic material hundreds of metres across, are consistently emplaced down the axial planar foliation of the F_2 folds. The mobilizate ranges in composition from minor and major garnet-cordierite-bearing allochthonous granitic pegmatites to incipient medium-grained equigranular granodioritic fractions with automorphic textures. A complete sequence of differentiated derivatives has been recorded between these two extremes. A younger more differentiated leucocratic mobilizate (subparallel to the main axial foliation) generally cuts across an older para-autochthonous fraction which follows more closely the axial planes of the folds in the restite.

Post-F_2 north-northwesterly trending zones of penetrative cataclastic foliation are developed in zones throughout the area. They occur, in the more massive horizons, either as evenly spaced zones of schistosity lined with fibrolite, muscovite and hematite, or as narrow 1-3 metre wide faults. Within the faults an intensely cataclastic augen texture prevails. In this section, the fine-grained matrix appears recrystallized and annealed, with abundant disseminated biotite evenly distributed in an equigranular quartz-feldspar mosaic.

These 'early' fault zones and their associated foliation are post-dated in turn by periods of 1) pegmatite injection, 2) folding (F_3), 3) pegmatite injection, 4) quartz diorite dyke and stock intrusion, and 5) faulting.

Economic Geology

A number of small sulphide occurrences were noted during the present investigation (see McRitchie, 1971, for locations). Generally, they are less than 2 metres in width and consist predominantly of pyrite and pyrrhotite concentrations developed either in the late fault zones or within certain stratigraphically controlled sedimentary horizons. At the present time, these showings are not considered of economic interest. Several of the thicker zones have previously been investigated and trenched.

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HALL LAKE-WAPISU LAKE AREA

(630-13, 630-14 and parts of 630-10, 11, 12 and 15)

by Thomas G. Frohlinger

Introduction

The map-area is bounded by latitudes 55°38' and 56°00', and longitudes 98°52' and 100°00'. The settlement of Nelson House lies on the eastern edge of the map-area.

Approximately 1000 square miles were mapped at one-half mile to the inch during the 1971 field programme (Frohlinger, 1971; Frohlinger and Baldwin, 1971; Frohlinger and Kendrick, 1971; Baldwin and Frohlinger, 1971; Kendrick, Baldwin and Frohlinger, 1971). Pace and compass traversing was augmented by shoreline traverses and by helicopter support in less accessible areas.

Outcrops comprise 35-40 per cent of the surface area, but good exposure is limited to lake shores and burnt over areas. Access to the northern part of the map-area is afforded by the Lynn Lake-Thompson right-of-way and the Lynn Lake-Thompson powerline. The Rat River and Footprint River provide good water access in the east.

Adjoining areas have been mapped by D. A. Baldwin (this publication), G. Kendrick (this publication), Schledewitz (1970) and Elphick (1970). Previous work in the area by Quinn (1955) has been completely revised. Preliminary investigations, conducted by McRitchie (1971) were expanded and incorporated into the present studies.

General Geology

A list of rock-units present in the map-area is presented in Table 4-4. A generalized compilation map is shown in Figure 4-4. Age relationships have been tentatively established and are presented in Table 4-5.

The following is a description of rock-units in the map-area which have not been described elsewhere in this volume. (For description of units 1-3, 9-12, and 15-18 see Baldwin and McRitchie, this publication).

Amphibolite (4)

This unit comprises two subunits, (4a) meta-iron formation and (4b) undifferentiated amphibolite. The meta-iron formation occurs as a single body on Threepoint Lake (1971G-6) where it is composed of hornblende, diopside, plagioclase and quartz with finely disseminated pyrite and local garnet. 4b occurs as inclusions and as thin, discontinuous, concordant to semi-concordant layers within the meta-greywacke group rocks (1, 2 and 3) and their derivatives (10 and 11). In places it is mineralized (pyrite).

Marker Amphibolite (5)

The marker amphibolite is so named because its presence invariably marks a sudden transition from meta-greywacke group rocks and/or their derivatives to meta-arkose group rocks (6, 7 and 8) and/or their derivative (13). The amphibolite occurs as discontinuous layers of variable width (usually < 1 m-75 m, rarely up to 400 m) or as angular inclusions and discontinuous thin (<5 m) layers in unit 13. It weathers more easily than either the meta-greywacke or meta-arkose group rocks, thus exposures are rare. The best exposure is approximately two and one-quarter miles east-southeast of Hall Lake. Here the base of the amphibolite marks an angular unconformity between the meta-greywacke group and the meta-arkose group. The amphibolite contains two penetrative foliations (Plate 4-1) which are tentatively interpreted as part of D_2 and D_3 fabrics.

TABLE 4-4 — List of rock-units in the Hall Lake-Wapisu Lake area

20	**Ultramafic rocks**	
	"North" Lake Suite	
19	a)	hornblende, biotite granodiorite-quartz monzonite
	b)	amphibolite
	c)	hornblende gneiss
	Granitic Intrusive Rocks	
17	Pegmatite-aplite complex	
	b)	pink quartz monzonite-granite pegmatite-aplite
16	Quartz monzonite-granodiorite gneiss	
	c)	magnetite-bearing granodiorite gneiss
15	Quartz monzonite-granite	
14	Quartz monzonite	
13	Quartz monzonite-monzonite	
	b)	sheared, porphyritic quartz monzonite-monzonite
	c)	non-porphyritic quartz monzonite
11	Granodiorite-quartz diorite	
	a)	sheared, sericite-sillimanite granodiorite
10	Quartz diorite-granodiorite	
	a)	pegmatite quartz diorite-granodiorite
9	a)	orthopyroxene tonalite-diorite gneiss
	Meta-arkose Group	
8	Diatexite-anatexite	
7	Migmatite (metatexite)	
6	Meta-arkose paragneiss	
	a)	sub-arkose-greywacke
5	Marker Amphibolite	
	Meta-greywacke Group	
4	Amphibolite	
	a)	meta-iron formation
	b)	undifferentiated
3	Diatexite-anatexite	
	b)	lacking calc-silicate horizons
2	Migmatite (metatexite)	
	a)	with calc-silicate boudins
	b)	lacking calc-silicate boudins
1	Meta-greywacke-paragneiss	
	a)	with calc-silicate boudins
	b)	lacking calc-silicate boudins
	c)	orthoquartzite

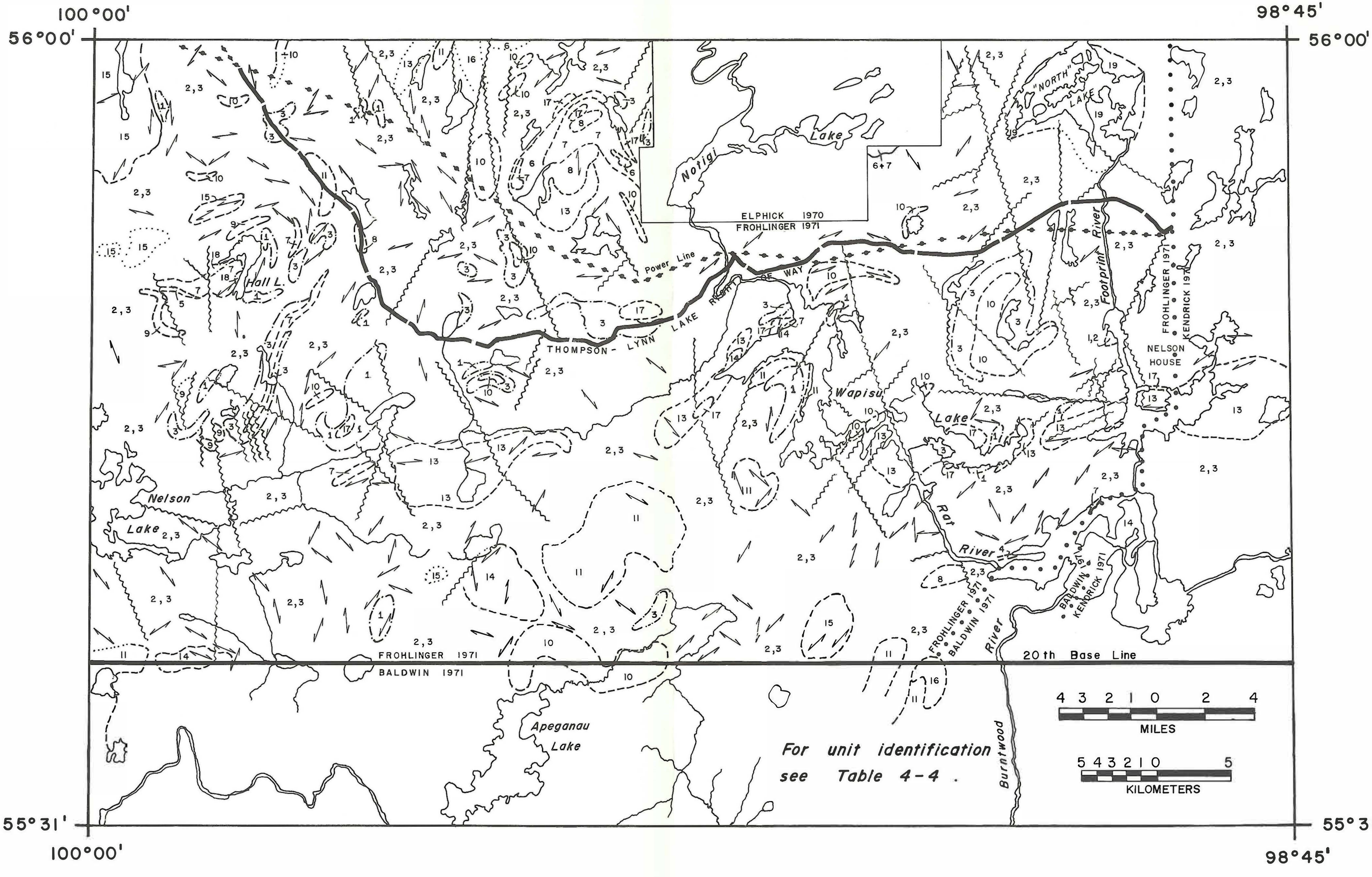


Figure 4-4 : Geological compilation of the Hall Lake – Wapisu Lake area.

Meta-arkose Group (6, 7 and 8)

This group comprises a series of layered and granitized meta-arkosic rocks. These rocks exhibit every gradation from bedded metasediment to almost wholly anatectic diatexite. Bedding consists of thin hornblende, epidote, potassium feldspar, magnetite layers alternating with thicker potassium feldspar, hornblende layers. Mobilizate fractions consist of hornblende and magnetite-bearing quartz monzonite to granite.

Orthopyroxene tonalite-diorite gneiss (9a)

White, buff to black, well foliated, granular gneisses are usually highly weathered. They contain orthopyroxene (? hypersthene), plagioclase and biotite with varying amounts of quartz (<5-20%), and occur in lensoid bodies most commonly near or at the noses of major folds. The presence of orthopyroxene (if metamorphic in origin) implies local granulite facies conditions. However, it is possible that the orthopyroxene is primary and these rocks represent metamorphosed anorthositic sills, which predate D_2.

Quartz-monzonite-monzonite (13)

This predominantly hornblende-bearing porphyritic quartz monzonite contains euhedral to subhedral potassium feldspar megacrysts. Local relict structures imply a metamorphic derivation of the rocks from the meta-arkosic rocks (6, 7 and 8). Where the quartz monzonite has been subjected to shear (13b) a marked reduction in magnetite content is noted (e.g., west of Nelson House). A similar reduction in the magnetite content is noted in the finer-grained phases (13c).

"North Lake" Suite (19)

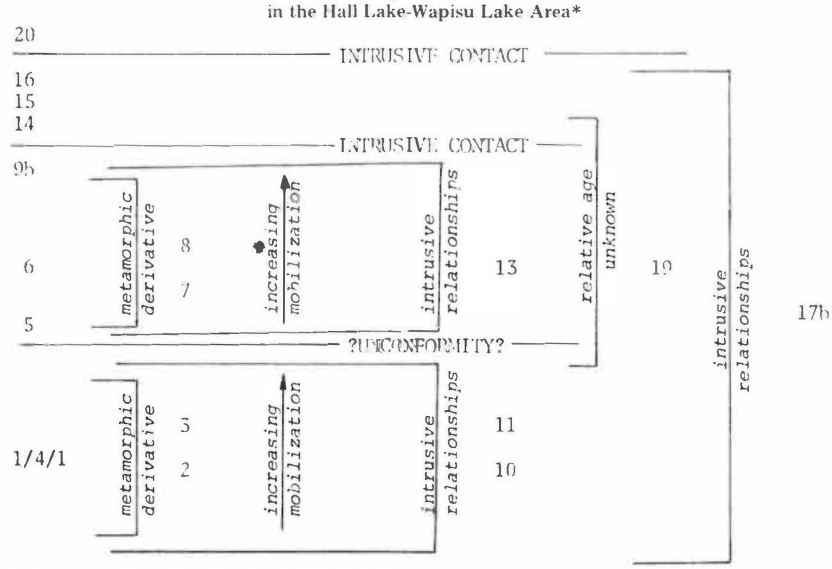
This gneissic sequence of recrystallized sediments occurs at "North Lake" (1971G-2 and 3). Texturally and compositionally, these rocks may belong to the subarkosic fraction of the meta-arkose group, but the aeromagnetic signature is characteristic of the meta-greywacke group. The relative age of this unit could not be determined and further investigations are warranted in the 1971 field season.

Ultramafic rocks (20)

A single occurrence of this unit was located at the south end of Hall Lake (1972G-1). Here exposure is limited and contact relationships are obscured. Continuity of this body along strike could not be established.

TABLE 4-5

Relative Ages of Rock-units
in the Hall Lake-Wapisu Lake Area*



*For names of rock-units refer to Table 4-4.

Metamorphism

The meta-greywacke group rocks (1, 2 and 3) and their anatectic derivatives (10 and 11) exhibit evidence of at least two upper amphibolite grade metamorphic events. These events occurred under conditions of high temperature and low pressure (< 4 kb) as evidenced by the widespread occurrence of two generations of cordierite, sillimanite and garnet. The first generation of these minerals occurs as lenses, elongated parallel to, and folded together with, a well-developed penetrative foliation. Veins, dykes, sills and irregular bodies of leucocractic mobilizate contain a later generation of cordierite, sillimanite and garnet. The later cordierite is deep blue to purple in colour, is much clearer than the early cordierites and occurs as irregular patches with no apparent preferred orientation. Sillimanite occurs as small needles within the cordierite. Garnets are euhedral and usually occur in clusters of crystals up to 5 cm in diameter.

The meta-arkosic (6, 7 and 8) group has been recrystallized and migmatized much the same as the meta-greywacke group. Widespread anatexis and the presence of hornblende and epidote indicates amphibolite facies metamorphism. Metamorphism of this group is tentatively interpreted as coinciding with M_2, the second event identified in the meta-greywacke group.

The presence of a final retrograde event is suggested by the presence of muscovite, chlorite, sericite and, in the more mafic rocks, talc.

The metamorphic events outlined above are summarized in Table 4-6.

Structure

Four distinct phases of folding and at least three of faulting have been interpreted in the map-area. The relative ages of the individual fold elements cannot be established on the basis of large scale preferred orientations because of the complex nature of the interference relationships. The genetic interaction of the penetrative structural elements associated with the individual folding phases is therefore of great importance in identifying the various folding episodes.

The earliest recognized folding event (F_1) resulted in tight, isoclinal to near isoclinal folding with an extremely well-developed axial planar foliation (S_1). F_1 closures are rare and are usually preserved only in calc-silicate boudins (Plate 4-2 and 4-3). The first generation garnet and cordierite-sillimanite knots are elongated parallel to S_1.

The second event (F_{1A}) resulted in a gentle, undulating refolding of S_1 by predominantly flexural slip along S_1. The F_{1A} fabric was largely obscured by the later more intense deformation and F_{1A} is now characterized by only locally recognizable concentric folding of elongated cordierite-sillimanite knots.

Structures developed in the third phase (F_2) are the dominant structures in the area. F_2 resulted in isoclinal folds with a locally well-developed strain slip axial planar foliation (S_2) (Plate 4-4). F_2 folds all earlier penetrative fabric elements and interference structures on the minor scale are numerous.

F_3, the last phase of folding, is characterized by gentle, open concentric folds of the F_2 axial planar foliation. Locally a poorly developed axial planar biotite schistosity accompanies the F_3 folds.

The earliest recognizable fault set (strike 140-160) post-dates F_2 and pre-dates F_3 folding. These faults are best developed about five miles southwest and about two and one-half miles west of Hall Lake.

The early faults are terminated by a set of easterly striking faults. These are exemplified by the Nelson Lake-Wapisu Lake lineament. The exact age of these faults cannot as yet be determined but they pre-date the last deformational event.

The last deformational event apparent in the map-area comprises a north-northeast conjugate fault set. This fault set cross-cuts and in some instances truncates the easterly faults thereby establishing their relative ages. The course of the Rat River follows one of these late faults between Wapisu Lake and Threepoint Lake. Major joint directions in all rock-units are subparallel to the late conjugate fault set.

Several phases of deformation were identified in the meta-arkosic units but at this time interpretation regarding these cannot be made.

Aeromagnetic Interpretation

The map-area (Federal-Provincial aeromagnetic maps 2569G, 2570G, 2577G, 2578G, 2585G, 2586G) is characterized by an overall low aeromagnetic signature (2300-2500 gammas) with local areas of high relief, high intensity (2600-3800 gammas) and small areas of very low ($<$ 2300 gammas) aeromagnetic signatures. A correlation between aeromagnetic expressions and the various lithologic units was partly established.

TABLE 4-6 — Structural and Metamorphic Synthesis

D_6	M_3	Conjugate (NNE) jointing and faulting accompanied by retrograde metamorphism.
D_5		East-west faulting, relative age unknown.
D_4		Gentle open folding (F_3) of S_2 with local development of S_3 axial planar schistosity.
D_3		Faulting (NW)
	M_2	Anatexis, with formation of large bodies of mobilizate and secondary generation of cordierite, sillimanite and garnet in meta-greywacke. Anatexis and formation of hornblende and epidote in the meta-arkosel.
D_2		Strain slip folding S_1 with recrystallization of biotite parallel to axial plane (S_2) and rotation of cordierite-sillimanite knots and garnet porphyroblasts into the *ab* plane. Late kinematic anatexis marks the onset of M_2, with some *'lit-par-lit'* injection parallel to axial planes.
D_{1A}		Gentle, concentric folding (F_{1A}) of S_1, the elongated cordierite-sillimanite knots, and garnet porphyroblasts.
D_1	M_1	Isoclinal folding (F_1) of S_0 (bedding) with accompanying growth of cordierite-sillimanite knots and garnet porphyroblasts. Anatexis and *'lit-par-lit'* injection of mobilized leucocratic material. Continuing deformation resulting in ptygmatic folding of *'lits'* and flattening of cordierite-sillimanite knots and garnet porphyroblasts in the *ab* plane (parallel to S_1).

Economic Geology

Most of the very few occurrences of sulphides noted in the map-area show evidence of prior exploration. The mineralization consists mainly of pyrite with minor pyrrhotite and in some instances traces of chalcopyrite. Samples from the sulphide zones are currently being analyzed. Graphite is a common constituent of the meta-greywacke group rocks (1, 2 and 3). Magnetite is a common accessory of the meta-arkose group rocks (6, 7 and 8) and their derivatives (13).

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Plate 4-1. Typical blotchy weathered surface and intersecting foliations in unit 5.

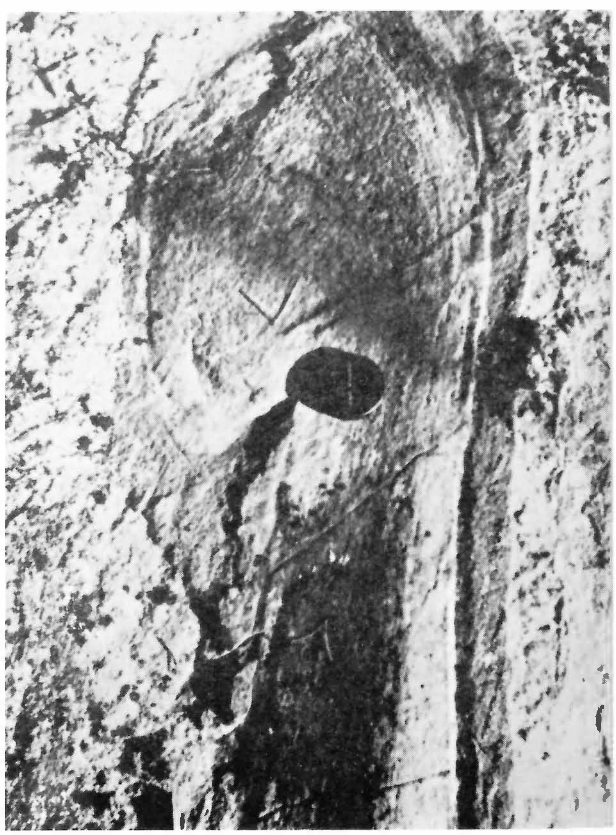

Plate 4-2. F_1 fold closure preserved in large mafic boudin.

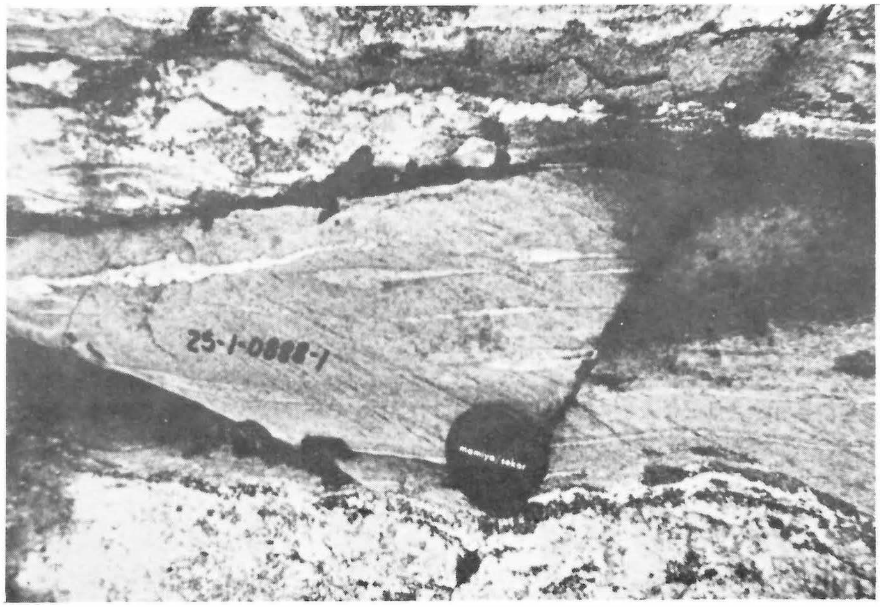

Plate 4-3. F_1 fold closures preserved in small calc-silicate remnants in unit 2a.

Plate 4-4. F_2 folds exhibiting axial planar strain slip cleavage in unit 2b. F_2 folds F_1 axial planar foliation.

WUSKWATIM LAKE AREA

(630 7, 9W, 16 and Parts of 10 and 15)

by G. Kendrick

Introduction

The area mapped during the 1971 field season comprises approximately 1200 square miles, bounded by longitudes 98°00' and 99°00', and latitudes 55°15' and 56°00'. Thompson lies approximately 13 miles east of the eastern boundary.

Access is provided mainly by the Burntwood River, which flows from west to east across the central portion of the map-area. Mapping at a scale of one-half mile to the inch was in part conducted by standard pace and compass traverse methods, supplemented by helicopter and float plane support in less accessible areas.

A wide, northeasterly trending tract of poorly drained swampy muskeg covers most of the area. Large deposits of sand and gravel occur at Partridge Crop Hill (long. 98°55' - lat. 55°34'), on the Lynn Lake-Thompson road allowance (long. 98°15' - lat. 55°55'), and at several other locations (see Kendrick, 1971). Bedrock exposures are sparse in the east and southwest but are more abundant in the northwestern and south-southeastern portions of the map-area.

General Geology

As most of the units occurring within the Burntwood Project area are described elsewhere in this publication (Baldwin, Frohlinger and McRitchie) only a brief summary of those peculiar to the Wuskwatim sub-area will be given here.

The most common rock-unit in the area comprises a metatexitic interlayered sequence of meta-greywacke (psammite-semi-pelite) and 25-75 per cent granitic and/or pegmatitic *lit* (unit 2). More mobilized diatexites (unit 3) containing rafts of unit 2, occur as large and small flow-layered quartz monzonite-leucotonalite/pegmatite lenses or irregularly shaped bodies. Discrete homogeneous equigranular granodiorite to quartz diorite (units 10 and 11) and porphyritic quartz monzonite (unit 12) intrusions, with rare rafts of units 1 and 2, have been mapped as separate units.

A repetitive series of thin discontinuous amphibolite layers (unit 5) was recorded within a sheared quartz monzonite (unit 13b) on Footprint Lake, close to the contact with the overlying meta-arkosic migmatites (unit 7) mapped on Threepoint Lake.

Distinctive coarse-grained cordierite and magnetite-rich metatexites (unit 7b), unique in the project area, occur solely in the Odei River region. Their magnetic expression has been used to define their limits.

The main intrusive units in the region are quartz monzonites. A large, red-pink porphyritic intrusion (unit 13) with a high relief and high intensity magnetic signature occurs on and to the northeast of Tulibee Lake.

Finer-grained pink, equigranular, homogeneous bodies with a moderately high aeromagnetic expression occur at three locations: on Threepoint Lake (unit 14) where the texture is typically granoblastic; west of Tulibee Lake, in three north to northwesterly trending belts (unit 15); and on Wuskwatim Lake (unit 16).

The small diabase dykes (unit 21) were recorded on a small lake north-northeast of Nelson House. They are fine-grained and consist mainly of clinopyroxene and plagioclase, with late accessory pyrite and pyrrhotite.

Structure

Several periods of deformation were noted within the area. Northeasterly trending cross-fold axes and two sets of relatively late faults, one northwesterly trending and a second less well developed set at approximately 45°, are most notable on a regional scale. Linear aeromagnetic highs associated with the northwesterly trending fractures may reflect the presence of 'late' diabase dykes.

Pleistocene Geology

Surficial clay, silt and sand lacustrine deposits of glacial Lake Agassiz mask the bedrock over much of the area. Three extensive tracts of beach sand and gravel may mark the positions of terminal moraines formed near the position of maximum advance of the Patrician ice sheet, prior to inundation by glacial Lake Agassiz. The most westerly of these sand and gravel beach deposits, at Partridge Crop Hill, exhibits prominent bench marks, and was probably formed from an esker-kame complex that was modified, as offshore beaches, by Lake Agassiz wave action. A discontinuous, sinuous esker ridge extends east from Partridge Crop Hill to longitude 98°10' - latitude 55°42' where it terminates at the southern end of a large north trending sand and gravel ridge. The most easterly sand and gravel beach deposit exhibits prominent benches and also kettle holes at co-ordinates 98°14'-55°48'. The third, well marked deposit occurs at co-ordinates 98°37' and 55°57'.

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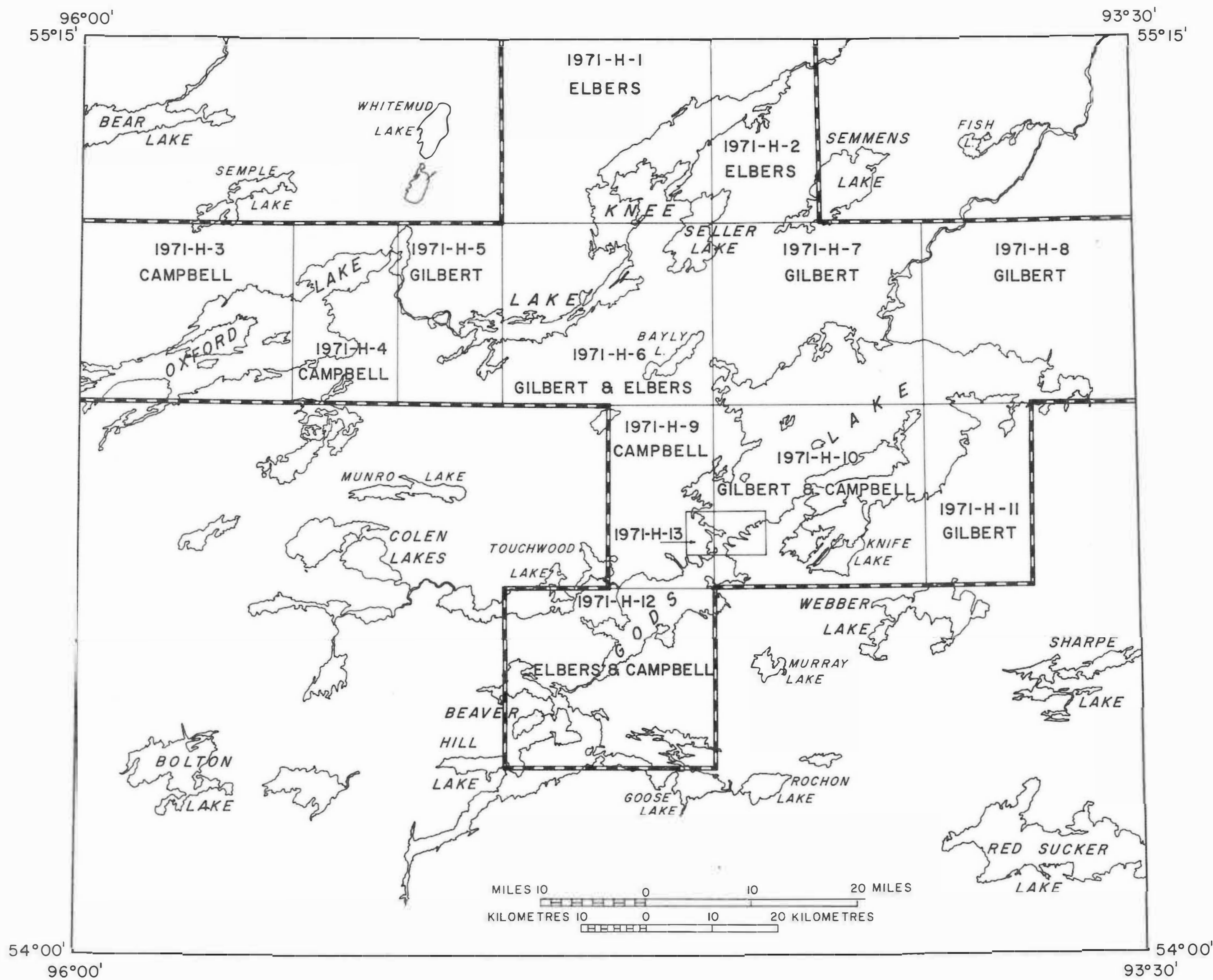
(5) GREENSTONES PROJECT

Introduction

by R. F. Jon Scoates

A new project, the Greenstones Project, was initiated in the Gods-Oxford-Knee Lakes area during the 1971 field season. The primary objective of this project is to determine the nature and evolution of Superior Province volcanic and sedimentary rocks utilizing the stratigraphy and structure of the various metavolcanic-metasedimentary sequences. The renewed interest in this area by mining and exploration companies renders an added impetus to the study. The past summer's work has been involved with the re-assessment of previous Manitoba Mines Branch and Geological Survey of Canada mapping, and with mapping in previously unmapped areas.



GREENSTONE PROJECT MAP LOCATIONS 1971

Figure 5-1

GENERAL GEOLOGY

by F. H. A. Campbell, F. J. Elbers and H. P. Gilbert

All, or parts, of nineteen, fifteen minute map-sheets were covered during the 1971 field season (Figure 5-1). Mapping on Goose, Beaver Hill, Gods, Knee, and Oxford Lakes was concentrated on the belts of metavolcanic and metasedimentary rocks.

Wright (1931) subdivided the volcanic and sedimentary rocks of the area into the Hayes River Group and the Oxford Group. Barry (1959, page 10) retained this classification and proposed a further subdivision of the Hayes River Group into a lower and upper unit.

The authors have found no definitive evidence of an unconformity between the Hayes River and the Oxford Groups. The Oxford does, however, contain thick sequences of pyroclastic rocks which indicate that volcanism was continuous, and not restricted to the Hayes River. For these reasons, the authors propose that the entire sequence be included in the Hayes River Group, with the former Oxford Group becoming the Oxford Lake Subgroup, and Barry's (1959) lower and upper units of the Hayes River becoming the Gods Lake and Knee Lake Subgroups respectively (Table 5-1).

TABLE 5-1. — Compilation of Previous and Proposed Stratigraphic Terminology

Wright (1931)	Barry (1959)		This Paper
Oxford Group	Oxford Group		Oxford Lake Subgroup
Hayes River Group	Hayes River Group	Upper	Knee Lake Subgroup
		Lower	Gods Lake Subgroup

Each subgroup contains extrusive intermediate to basic volcanic rocks. Rhyolite occurs within the Gods Lake Subgroup at Cinder Lake (Elbers and Gilbert, 1971), and a rhyolitic crystal tuff occurs in the Oxford Lake Subgroup at Gods Narrows (Campbell and Giesbrecht, 1971). Ultramafic intrusions occur at Oxford, Knee, Goose, and Beaver Hill Lakes. The rhyolitic and ultramafic rocks are considered to be the most economically significant.

The volcanics and sedimentary rocks are intruded by: (1) an early, possibly syn-volcanic sequence of composite plugs and sills, locally with ultramafic phases, and (2) late granite and granodiorite plutons and stocks which truncate the regional structure. At least three deformational events are presently recognized on a regional scale.

References

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1932: Oxford House area; Manitoba; in *Geol. Surv. Can.*, Summ. Rept., 1931, Pt. C. pp. 1-25.

(6) FILE-MORTON-WOOSEY LAKES AREA

(63K-16W; 63K-1SW)

by A. H. Bailes

The File-Morton-Woosey Lakes area is located ten miles west of the town of Snow Lake. Field studies in this area were begun in 1970 (Bailes, 1970) and continued during 1971, with the aim of examining in detail the following problems:

1) the relationship between the Kisseynew sedimentary gneisses and the Amisk-Missi volcanic and sedimentary rocks;
2) the stratigraphic 'control' of copper-zinc sulphide ore bodies;
3) the detailed tectonic history of the File-Morton-Woosey Lakes area.

An understanding of these problems is fundamental to elucidating the complex geological history of the entire Snow Lake-Flin Flon-Sherridon region. Briefly the following progress has been made to date.

Relationship between the Kisseynew sedimentary gneisses and the Amisk-Missi volcanic and sedimentary rocks

The Kisseynew sedimentary gneisses are stratigraphically equivalent to portions of the Amisk and Missi volcanic and sedimentary rocks. Specifically, the lower portion (Nokomis Group) of the Kisseynew gneisses is equivalent to Amisk sediments, and the upper portion (Sherridon Group) is likely equivalent to Missi sedimentary rocks. The Amisk sediments, and their metamorphosed equivalents are a repetitive sequence of greywacke and argillite, deposited by turbidity currents. They generally overlie the volcanic rocks, but locally contain some interlayered volcanic rocks, indicating they were probably deposited contemporaneously with volcanic activity elsewhere in the area. Missi sedimentary rocks, of which only highly metamorphosed derivatives are exposed in the File-Morton-Woosey Lakes area, are shallow water and relatively clean, homogeneous, detrital sediments.

Stratigraphic Control of Copper-Zinc Sulphide Ore Bodies

There is a very strong correlation between copper-zinc sulphide mineralization and acid intrusion and extrusive rocks in the Flin Flon and Snow Lake mining districts (Bailes, 1971a). Disseminated (and locally massive) sulphide mineralization is ubiquitously associated with these rocks in the File-Morton-Woosey Lakes area. A large, highly variable acid extrusive and intrusive complex west of Morton Lake has been traced up to the Dickstone mine, where it hosts the Dickstone copper-zinc ore body. This acid extrusive and intrusive complex, and a similar but mainly intrusive body, exposed on the islands in Morton Lake, could therefore have potential for additional copper-zinc sulphide deposits.

Three other possible environments for copper (-zinc) mineralization in the File-Morton-Woosey Lakes area are:

a) the two thin sedimentary horizons contained in the volcanic sequence west of Morton Lake. They appear to be closely associated with acid volcanism, and as such have potential for copper-zinc mineralization;
b) the base of large differentiated gabbroic sills in the File-Morton-Woosey Lakes area;
c) the contact between Amisk and Missi Group sedimentary rocks. Elsewhere, particularly in the Kisseynew sedimentary gneisses of the Batty Lake and Sherridon area, this contact has been found to be favourable for stratiform copper-zinc sulphide deposits (Bailes, 1971a). So far, no copper-zinc sulphide mineralization of this type has been discovered in the File-Morton-Woosey Lakes area.

Tectonic History of the File-Morton-Woosey Lakes Area

A tentative sequence of events is:

D_1 F_1 - Isoclinal similar folds with generally steeply dipping axial planes and steeply plunging axes.

S_1 - axial plane foliation of F_1 folds (usually a biotite schistosity) and the plane of flattening of deformed clasts.

L_1 - elongate deformed clasts contained in S_1, with long axes parallel to F_1 fold axes.

D_2 F_2 - major northeast trending domal structures associated with emplacement of granitoid complexes (units 19 and 20; Bailes, 1971b).

D_3 F_3 - tight chevron and similar folds, with steeply dipping east-northeasterly trending axial planes, and shallow plunging easterly trending axes.

S_3 - axial plane foliation of F_3 folds; commonly a biotite schistosity.

L_3 - linear metamorphic quartz-sillimanite aggregate, parallel to the F_3 fold axes.

D_4 S_4 - major northerly and northwesterly trending fracture systems, commonly accompanied by late pegmatite dykes, cataclastic zones, and local retrogressive greenschist facies metamorphism.

D_1, D_2, and D_3 post-date the Missi Group but pre-date intrusion of stocks and batholiths of quartz diorite and granodiorite of the Post-Missi Group. It is likely that D_1, D_2 and D_3 were closely related in time, representing pulses during a single orogenic epoch. The regional metamorphic climax was reached just prior to D_3, and in some instances overlapped into the D_3 event. The time relationship of the metamorphism is indicated by:

a) porphyroblastic metamorphic minerals are randomly oriented and have overprinted the S_1 foliation, indicating static growth which post-dated D_1;

b) the metamorphic isograds south of Corley Lake and along the northeast arm of File Lake, trend east and are undisturbed by major northerly trending F_1 and F_2 folds;

c) F_3 folds have deformed pre-existing metamorphic minerals, especially quartz-sillimanite nodules, and granitic *lit* developed parallel to S_1. In some instances, quartz-sillimanite nodules grow in the S_3 surface, and parallel to the F_3 fold axes, indicating a pre- to syn-D_3 age for the metamorphism.

Intrusion of the quartz diorite and granodiorite of the Post-Missi Group post-dated D_1, D_2 and D_3. However, the large Post-Missi batholith of quartz diorite and granodiorite west of File Lake is generally conformable with major structural features and has not significantly disturbed the east trending metamorphic mineral isograds. This may indicate that this batholith has stoped its way up into pre-existing domal structures, without significantly disturbing the surrounding rocks. Alternatively, its intrusion may have begun during (and perhaps contributed to) the earlier deformation cycles, but did not terminate until after the metamorphic climax and completion of the D_3 event. The latter explanation seems to be the more satisfactory at this stage.

The D_4 event post-dated intrusion of the Post-Missi Group. It is a relatively minor event which involved formation of a late fracture system, accompanied by local greenschist facies retrogressive alteration, intrusion of narrow pegmatite dykes, and formation of small cataclastic zones and some faults.

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1971b: File-Morton-Woosey Lakes area, Manitoba; *Man. Mines Br.*, Prelim. Maps 1971B-1, 1971B-2.

(7) ULTRAMAFIC ROCKS PROJECT

by R. F. Jon Scoates

During the summer of 1971, selected occurrences of ultramafic rocks, and areas considered favourable for finding ultramafic rock outcrops were examined. The field studies were confined to the Superior province and the Manitoba Nickel Belt. The studies included detailed geologic mapping of the Bird River sill (Trueman and Macek, 1971), reconnaissance work in the Gods Lake area, and collection of suites of ultramafic rock specimens from mines along the Manitoba Nickel Belt (figure 7-1).

Bird River Sill

Mapping of the Bird River sill (1)*, initiated in 1970, was extended in 1971 to cover the south limb, between Coppermine Bay on Lac du Bonnet and Bird Lake, and the north limb, from north of Maskwa Lake, to Euclid Lake (Trueman and Macek, *op. cit.*). A more precise distinction has been made between gabbroic rocks associated with the sill and gabbroic rocks related to the basic metavolcanic sequence. As a result, areas of gabbroic rocks which had previously been mapped as belonging to the Bird River sill (Springer, 1950; Davies, 1952), are now considered part of the basic metavolcanic suite of the Rice Lake Group. In addition, two separate bodies of altered clinopyroxenite and gabbro respectively, were identified in the area west of the Dumbarton Mines Limited property. These bodies were previously included in the Bird River sill, but their relationship to the rocks of the sill is not established.

Cross Lake-Pipestone Lake

Approximately 25 miles of shoreline on Cross Lake were examined in a search for outcrops of the Nelson River ultramafic dyke (Collett and Bell, 1971). No outcrops of ultramafic rocks were encountered, but a small gabbroic dyke (2) was found near the south end of Cross Lake (Figure 7-1).

A northeasterly trending gabbroic dyke (2) on Pipestone Lake - Rousell, 1965) was sampled in detail for comparison with the picritic and gabbroic dykes of the Pikwitonei subprovince (Scoates, 1969). Flow layering and contacts, indicative of multiple intrusion were observed in several of the dyke outcrops.

Oxford Lake-Carrot River

Two ultramafic bodies on the Carrot River (3), described by Barry (1960), were examined. The westernmost body (Figure 7-2), exposed on the north shore of the river, consists of serpentine and serpentinized peridotite. The rocks range from massive to foliated and the foliation direction varies from southeast to southwest. Fine-grained disseminated sulphides have an erratic distribution, and locally constitute five per cent of the rock. The sulphide content of the body probably averages less than two per cent. A one-pound grab sample, containing approximately three per cent sulphide, assayed 0.27 Ni, 0.01 Cu, and 0.01 Co. A few, narrow, cross-fibre asbestos veinlets were observed. However harsh picrolite veinlets, with associated magnetite and carbonate, are more common.

A second ultramafic body (3), approximately five miles east of the body described above, displays a crude zoning with a marginal pyroxenite to feldspathic pyroxenite, surrounding a highly serpentinized peridotite core. The body is in contact with a granodiorite-quartz diorite mass to the south, and a pillowed basic metavolcanic-gabbro sequence to the north.

*The numbers in the text refer to locations of the bodies in Figures 7-1 and 7-2.

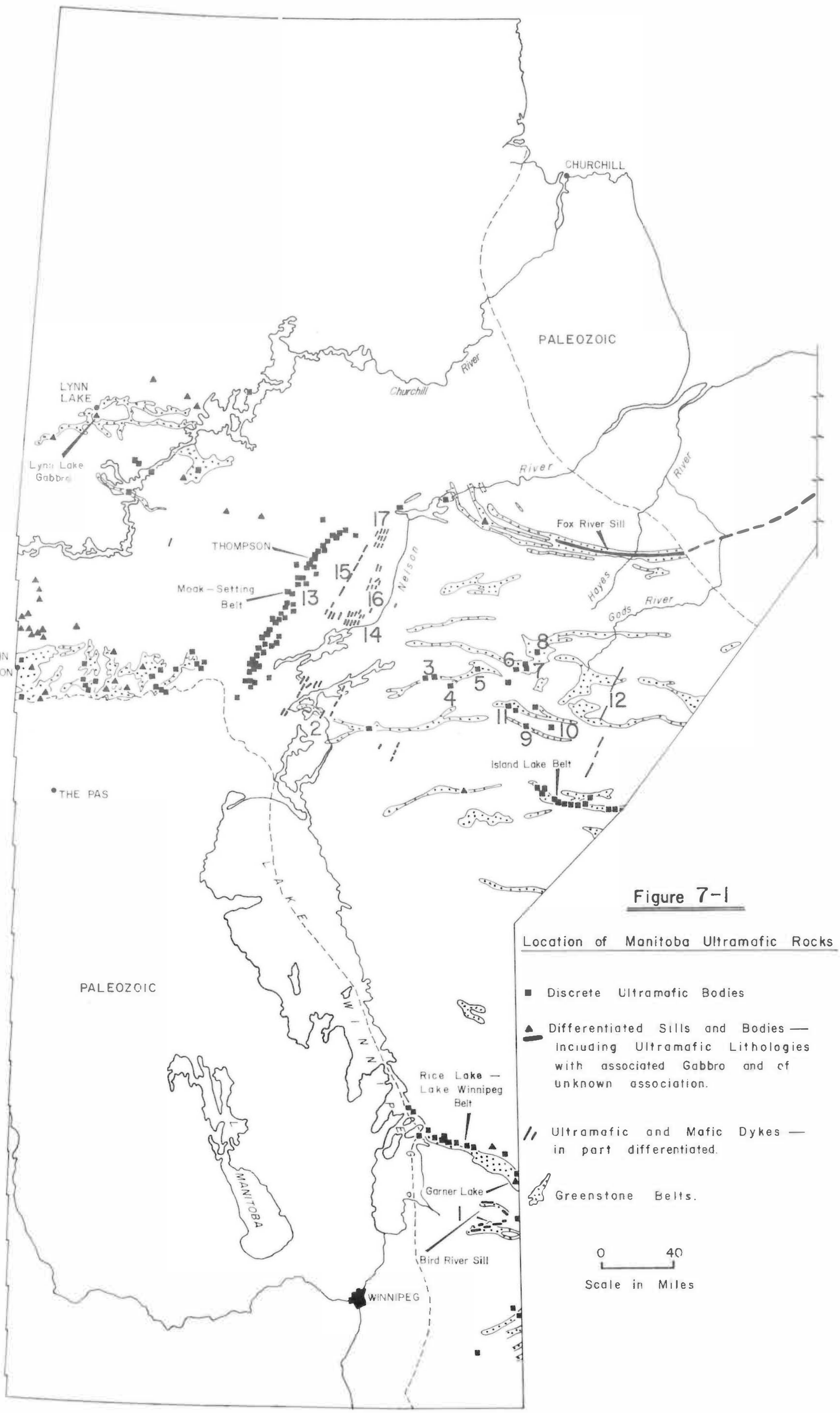

Figure 7-1

Location of Manitoba Ultramafic Rocks

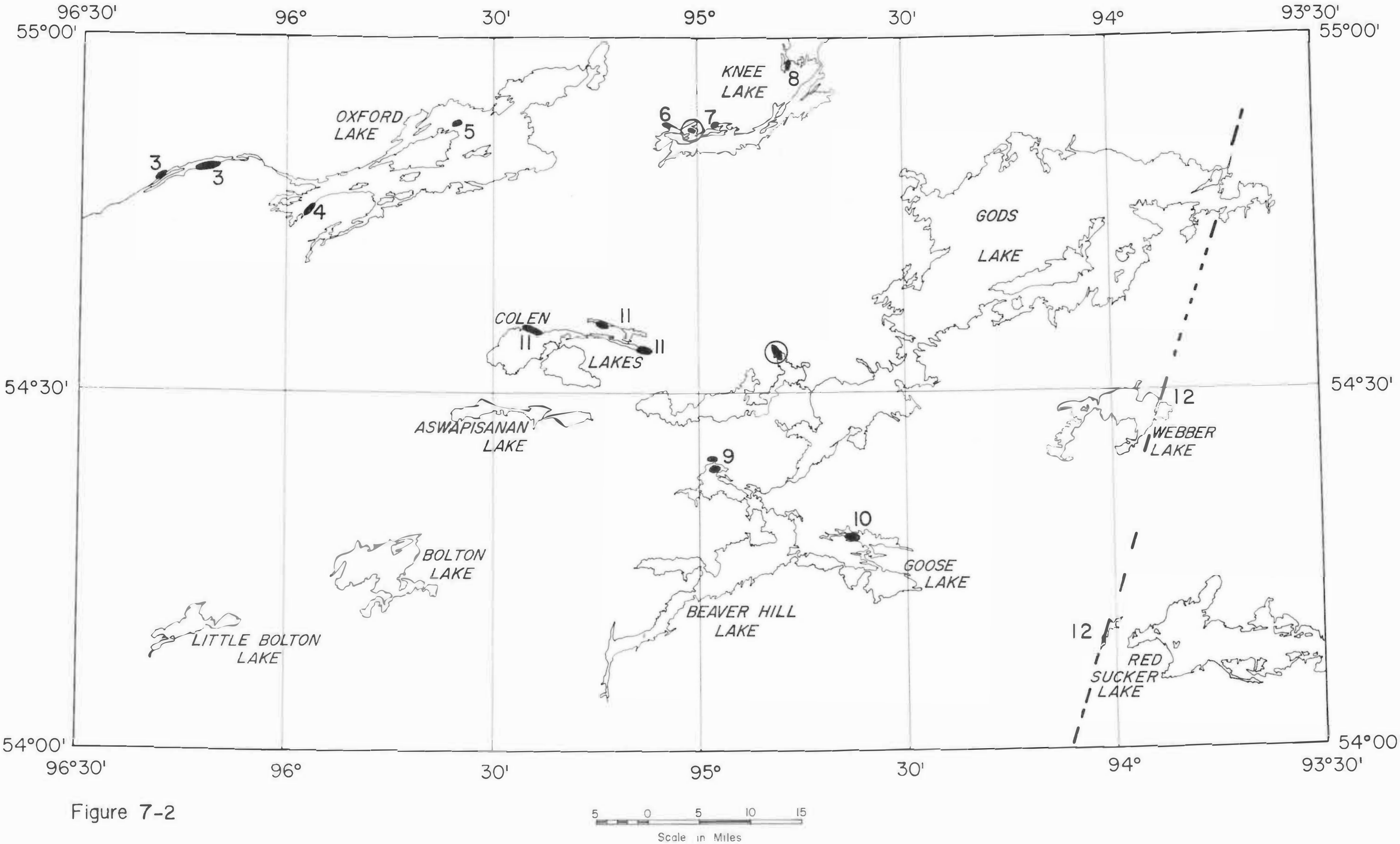

Figure 7-2

Location of Gods Lake Area Ultramafic and Gabbroic Rocks

Ultramafic and/or gabbroic rocks

Ultramafic rocks reported in cancelled assessment files

Two and possibly three bodies of ultramafic rock outcrop on islands and reefs along the south shore of Lynx Bay on Oxford Lake (4). The largest body appears to be approximately 2500 feet long and 600 feet wide at its widest point. It is in contact with meta-gabbro and metasediments to the northwest, and a granodiorite-quartz diorite complex to the south. The north contact is faulted and the south contact is not exposed. The lithology varies from serpentinite, serpentinized peridotite and serpentinized dunite, to, hematized, talc-serpentine rocks at the margins. Preserved primary textures are well displayed on highly polished outcrops. Disseminated sulphides are rare, and serpentine veinlets are entirely of the harsh picrolite variety.

The other two bodies outcrop on reefs and a small island southwest of the largest body. Serpentine-talc rocks with a reddish brown, pervasive hematite staining characterize these bodies.

A small ultramafic body (700 x 75 feet) outcrops on a small island, approximately one mile north of the northeast end of Carghill Island (5). The body is emplaced in a metavolcanic-meta-gabbro sequence and the contacts are faulted. Harsh picrolite and narrow cross-fibre asbestos veinlets were observed. Very fine-grained, disseminated sulphides are rare.

Knee Lake

A body at the west end of Knee Lake (south) is well exposed in an area of high outcrop (Figure 7-2). The body (6) displays a crude concentric zoning, with a central core of fine-grained serpentinite, an intermediate zone of medium-grained serpentinized peridotite-pyroxenite, and an outer zone of fine-grained serpentinite. The latter passes outwards into a narrow zone of strongly foliated serpentine-talc schist. Thin (1"-3") clinopyroxenite layers were noted on one shoreline outcrop. A narrow wedge of meta-greywacke and tuffaceous rocks appear to have been faulted into the central part of the body. Cross-fibre asbestos and harsh picrolite-magnetite veinlets are common near the margins of the body. Very fine-grained disseminated sulphides are developed sporadically throughout the body but do not exceed one per cent of the rock.

A small, highly serpentinized ultramafic mass is emplaced in intermediate to acid volcanics at the west end of Pain Killer Bay (7). The rocks range from serpentinized peridotite, with preserved primary textures, to serpentinite in which the primary textures have been obliterated. Numerous picrolite-carbonate-magnetite veinlets render a well developed box work effect on some outcrops. Very fine-grained, disseminated sulphides are rare.

The outcrop of serpentinized peridotite north of Pain Killer Bay, noted by Barry (1959), was not found.

A body of fine to medium-grained serpentinized peridotite, northwest of The Narrows on Knee Lake (8) was found by F. J. Elbers in the course of mapping in that area (Gilbert and Elbers, 1971).

Beaver Hill-Goose Lakes Area

Two new occurrences of ultramafic rocks were found in the Beaver Hill-Goose Lakes area by F. J. Elbers (1971), (Figure 7-2). The first of these is of ultramafic and mafic rocks, occupying a bay on the northwest part of Beaver Hill Lake (9). Ultramafic rocks outcrop on two small islands and on the northwestern tip of a larger island in the central part of the bay. The ultramafic rocks are layered and consist of serpentinized peridotite and dunite, serpentinized feldspathic peridotite and pyroxenite. The layers strike northwest, and dip either to the northeast or southwest. Another outcrop of serpentinized peridotite was found on a small inlet on the north side of the bay. Layering was not observed on this outcrop. Gabbroic rocks are found on almost all the other islands in the bay. The gabbro is medium-grained and light apple green in colour. Primary layering, with a northeasterly strike was observed on one gabbro outcrop in the western part of the bay. The gabbro is intruded by massive granitic rocks. Three fault sets of different ages, cut the body, and it is also apparent from the attitudes of the primary layering, that the body has been folded.

Fine-grained disseminated sulphides occur in both the ultramafic and gabbroic rocks, but rarely exceed one per cent.

The second occurrence of ultramafic rocks in this area is on Goose Lake (10). The central portion of the body is largely massive with poorly preserved primary textures. Numerous picrolite veinlets are present at the southern margin of the body.

Investigation of Aeromagnetic Anomalies—Gods Lake Area

Investigations were directed towards a number of aeromagnetic anomalies, east and west of Gods Lake, as representing potential bodies of ultramafic rock. One small body on the north shore of Colen Lake (11) was found utilizing this method (Figure 2). The body is highly recrystallized, and hornblende and serpentine comprise the major minerals. Small bodies of ultramafic rock on Reekie Lake and on a small lake north of Reekie Lake described by Barry (1962) were also sampled (11).

A gabbroic dyke, striking 020^{o}, and having a topographic and aeromagnetic expression extending for more than 100 miles, was investigated on the northeast shore of Webber Lake (12), and on a small lake two miles west of the west end of Red Sucker Lake. The dyke was examined because its strike and aeromagnetic anomaly are similar to those of the picritic dykes in the Pikwitonei subprovince, 100 miles to the west. The associated magnetic anomaly is caused by a high magnetite content.

Manitoba Nickel Belt

Suites of specimens of ultramafic rocks were collected from the Thompson, Pipe and Soab South mines of the International Nickel Company of Canada Limited, and the Manibridge Mine of Falconbridge Nickel Mines Limited (13). The outcrops of ultramafic rock on Mystery Lake were examined, and samples of ultramafic rocks were collected from the Moak Lake mine dump.

Pitwitonei Picritic Dykes

Suites of oriented specimens were collected from selected picritic, diabasic and gabbroic dyes of the Pikwitonei subprovince on Landing (14), Cuthbert (15), Pikwitonei (16) and Witchai (17) Lakes. The selection of these dykes was based on previous studies of these rocks, conducted in 1969. Studies on oriented samples will be directed toward elucidating the nature of intrusion and crystallization of mafic and ultramafic magmas.

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(8) STRATIGRAPHIC MAPPING

by H. R. McCabe

During July, a 10-day reconnaissance trip was made along Provincial Highway 6 north from Grand Rapids to Ponton, along Provincial Road 391 from Ponton to Highway 10, and along Highway 10 from Cranberry Portage to Swan River (see Figure 8-1). The purpose was to locate, sample, and briefly describe any newly exposed outcrops and road cuts of Ordovician, Silurian and Devonian strata. In addition, the section of Silurian strata exposed in the now-abandoned channel of the Saskatchewan River, at Grand Rapids, and the section in the large aggregate quarry opened up during construction of the Grand Rapids power project, were examined. The flow through the old river channel at Grand Rapids has been diverted through the power house and the former "Grand Canyon of the Saskatchewan" is now dry, except for periods of high reservoir level, when excess water may be passed through the spillway.

Detailed sample studies and correlation with available core hole data will be necessary before a more accurate geological interpretation of the area is possible, but the following general statements and preliminary interpretation can be made.

The area for almost 65 miles north of Grand Rapids consists of a relatively high bedrock plain, with almost continuous ditch outcrops along Highway 6. Prominent bedrock-controlled escarpments are present, ranging from five feet to more than 25 feet in relief; trends are generally north to slightly northeast but are very irregular. Where intersected along the highway, exposures along the escarpments are excellent, and detailed delineation of the outcrop belts should be possible.

The section exposed along the highway as far north as Mile 57 appears to be essentially a strike section. Strata consist primarily of microcrystalline to cryptocrystalline, dense to sublithographic dolomite with prominent stromatolite development and associated intraformational breccias. Sandy and silty marker beds occur at several horizons. These strata probably comprise the Inwood and Moose Lake Formations. Locally, in the vicinity of Mile 50, fossiliferous dolomite containing corals and brachiopods (cf. *Virgiana decussata* zone) may represent the Fisher Branch Formation. The section exposed at Mile 57, a topographically high area, is lithologically similar to the section in the aggregate quarry at Grand Rapids.

Topographically, the land rises from +750 feet M.S.L. at Grand Rapids to +960 feet M.S.L. east of William Lake, at Mile 57. This topographic rise is reflected in an eastward shift of the outcrop belt, approximately 12-15 miles east of the outcrop limits presently shown on the Geological Map of Manitoba (Map 65-1). The structural strike of the formations is almost due north; this contrasts with the easterly structure-outcrop trend through Clearwater and Moose Lakes, and confirms the existence of a sharp structural flexure in the William Lake area.

North of Mile 57 the strata appear to be Ordovician. In the vicinity of Mile 60, the slightly argillaceous dolomite is similar to the Stony Mountain Formation, and the mottled dolomite in the quarry at Mile 73 is identical to the Red River Formation of the northern area. No outcrops occur between Mile 73 and Ponton; the bedrock in this area is totally obscured by flat sandy Pleistocene outwash plains.

Along Provincial Road 391 from Ponton to Highway 10, abundant outcrop exposures occur from just east of the Wekusko junction as far west as Highway 10 (Figure 8-1). For most of this distance, the road traverses a strike section of the basal part of the Ordovician Red River Formation. The northern edge of the Paleozoic outcrop belt is marked, in most areas, by a prominent north-facing scarp. No exposures of the basal Paleozoic Winnipeg Formation (sand and shale), or the contact with Precambrian were seen along the road, but immediately south of Wekusko Lake, Red River dolomite and Precambrian graphitic schist are exposed in a road-cut. Examination showed, however, that the dolomite forming the scarp consists of a mass of huge slump blocks extending back for about ¼ mile from the road. The blocks are separated by crevasses 30 or more feet deep, still ice-floored in July.

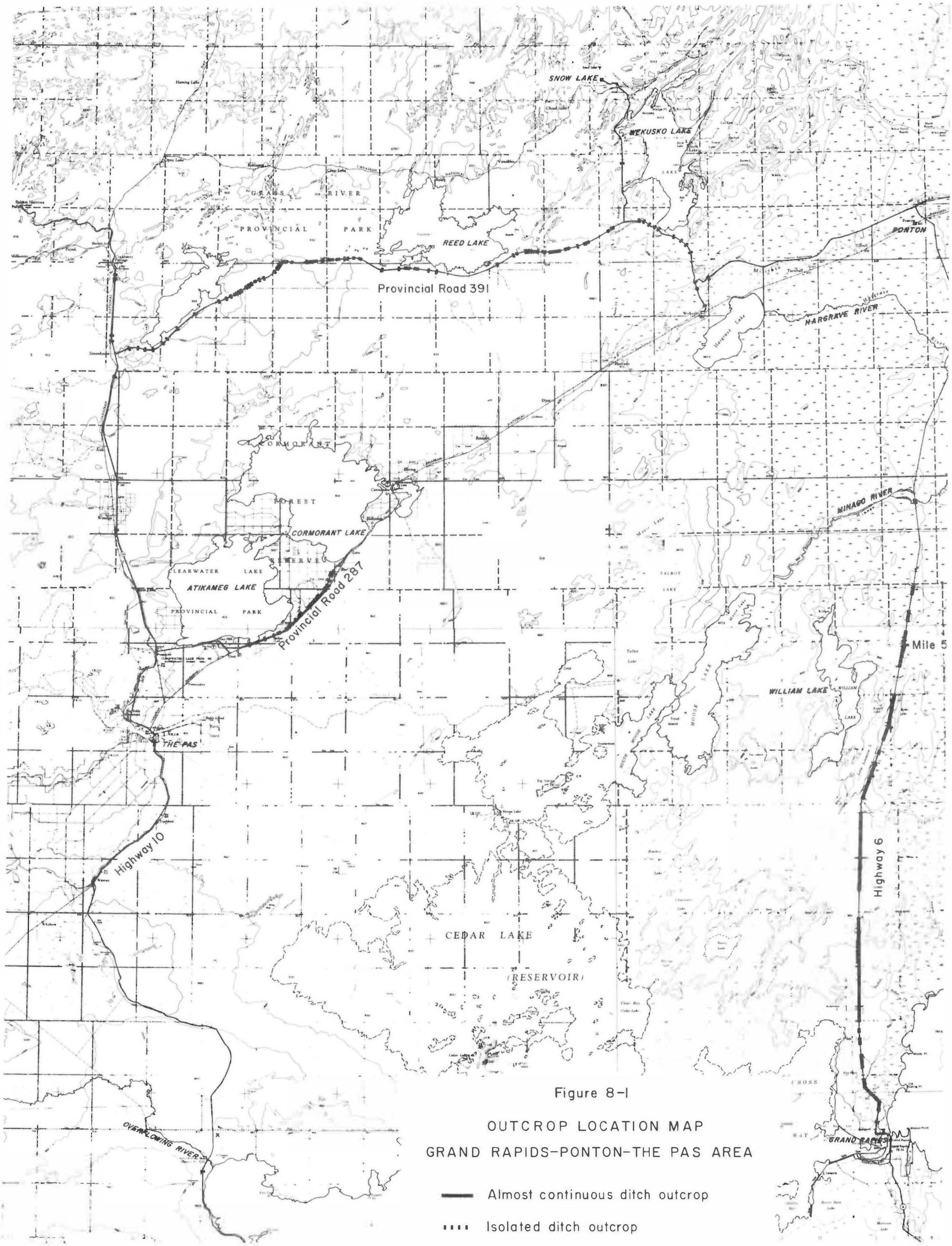

Figure 8-1

OUTCROP LOCATION MAP
GRAND RAPIDS–PONTON–THE PAS AREA

Almost continuous ditch outcrop

Isolated ditch outcrop

The flat-lying dolomite exposed in the road-cut, in apparent contact with the Precambrian, is also a slump block. It is possible that the dolomite scarp was initially underlain by a section of soft sand and shale of the Winnipeg Formation, and slumping may have resulted from erosion of this sand-shale sequence.

The Red River strata are lithologically similar throughout their exposure along Provincial Road 391, and consist of finely crystalline dense to slightly granular dolomite. Pronounced variations in colour and apparent bedding thickness are evident. Colours include pale mottled grey and buff, mottled buff and greyish red, and variably mottled bright reddish to yellowish. In many places the colour variation can be related to fractures and probably reflects recent oxidation-reduction effects. Similarly, the degree of bedding development, from almost massive to thin-bedded, reflects in part the effects of recent weathering.

The Red River dolomite exposed on the Snow Lake road comprises an outlier on a small topographic dome. Precambrian rocks are exposed on the flanks of this outlier. There is no evidence of slumping of the Red River strata and no sign of Winnipeg Formation sand or shale. This indicates that the Winnipeg is thin or absent in some areas near the present northern limit of Paleozoic strata.

Paleozoic outcrops are sparse along Highway 10 between Cranberry Portage and Dawson Bay. Mottled dolomite similar to the Red River Formation is exposed 2.5 miles south of Simonhouse Junction. Approximately twenty feet of section exposed south of Wanless contains several conglomeratic beds and has been correlated with the Stonewall Formation.

Extensive ditch outcrops occur along the recently constructed portion of Provincial Road 287, from the southeast part of Clearwater (Atikameg) Lake to Cormorant Lake. Strata exposed range from the Silurian Atikameg Formation down to the Ordovician Stonewall Formation.

South of The Pas, the first known outcrop occurs approximately three miles north of the Overflowing River, and one-quarter mile east of Highway 10, on a small topographic dome. The exposed section comprises 26 feet of dolomite of the Devonian Winnipegosis Formation. Ditch outcrops of lower Dawson Bay Formation occur 1.3 miles south of the Overflowing River. These outcrops had not been reported previously.

(9) SUBSURFACE STRATIGRAPHIC STUDIES

by H. R. McCabe

Formation tops were determined for twelve wells released from confidential file; data have been compiled and will be added to the Stratigraphic Map Series. A total of twelve wildcat wells and eleven development wells have been drilled to date in 1971. Core for eight wells, and samples for seven wells were processed and added to the core and sample library. Core for fourteen Mines Branch stratigraphic test holes was also added to the library, as well as samples for eighteen water well test holes, submitted by the Water Resources Branch.

Of particular interest was the first test hole in the Virden area, which encountered a 120-foot thick bed of salt in the Prairie Evaporite. The thickness of this bed is the same as the average structural relief in the oil field area, and lends support to the belief that the complex of structural lows bordering the fields is due to salt collapse.

The study of Ordovician and Silurian geology of the Interlake area by J. Cowan, based on stratigraphic core hole data, is in preparation.

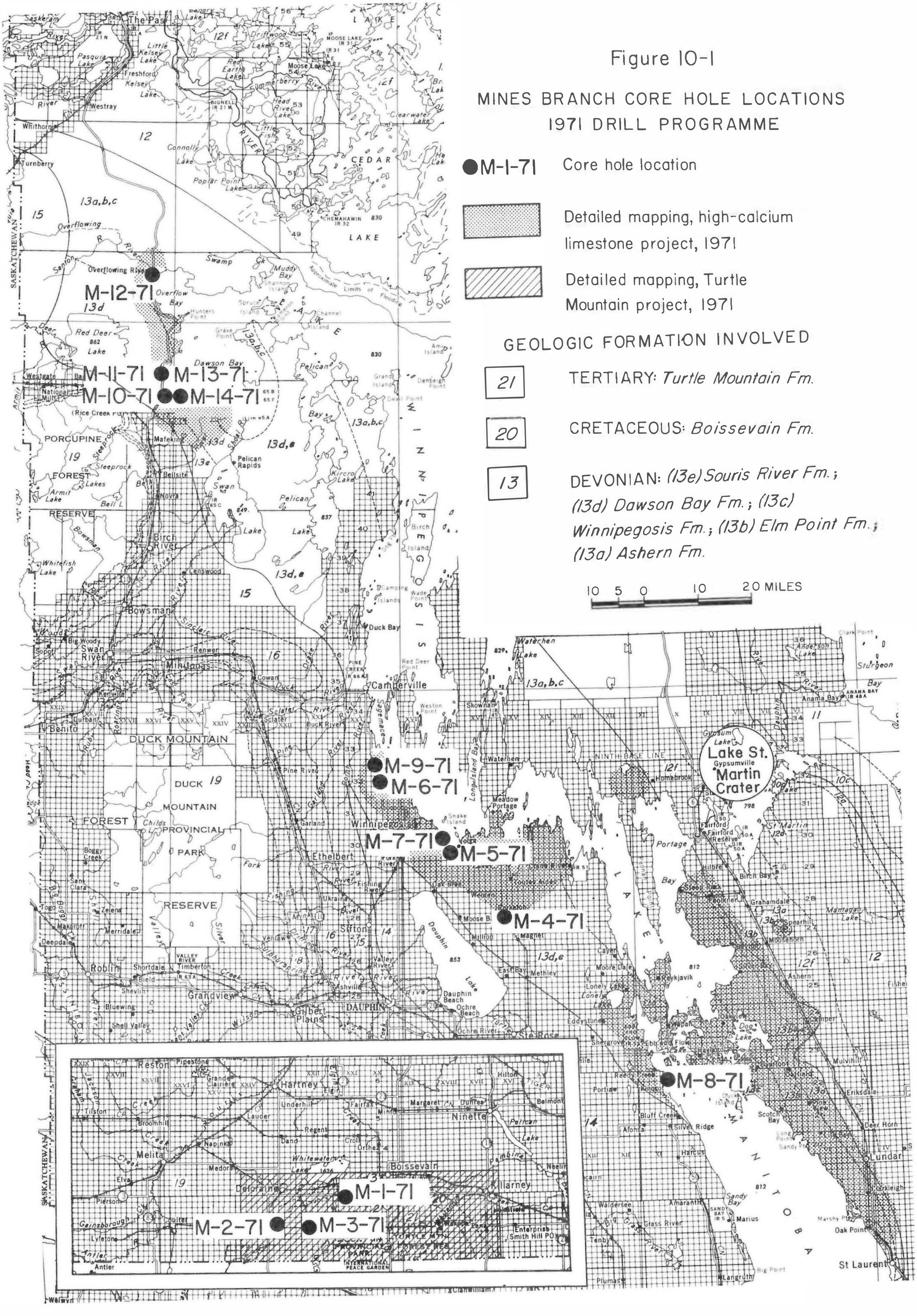
Figure 10-1
MINES BRANCH CORE HOLE LOCATIONS
1971 DRILL PROGRAMME
M-1-71 Core hole location
Detailed mapping, high-calcium limestone project, 1971
Detailed mapping, Turtle Mountain project, 1971
GEOLOGIC FORMATION INVOLVED
21 TERTIARY: Turtle Mountain Fm.
20 CRETACEOUS: Boissevain Fm.
13 DEVONIAN: (13e) Souris River Fm.; (13d) Dawson Bay Fm.; (13c) Winnipegosis Fm.; (13b) Elm Point Fm.; (13a) Ashern Fm.
10 5 0 10 20 MILES
M-12-71
M-11-71
M-13-71
M-10-71
M-14-71
M-9-71
M-6-71
M-7-71
M-5-71
M-4-71
M-8-71
M-1-71
M-2-71
M-3-71
Lake St. Martin Crater

(10) STRATIGRAPHIC AND INDUSTRIAL MINERALS CORE HOLE PROGRAMME

by H. R. McCabe and B. B. Bannatyne

During the period June-September 1971, the Mines Branch stratigraphic core hole programme was continued, utilizing a small portable diamond drill. A total of fourteen holes was drilled, for a total footage of 1,367 feet. Since the inception of this program in 1969, a cumulative total of 3,874 feet of core has been obtained from 38 holes.

There were three main objectives for the 1971 programme:

i) to obtain general stratigraphic information for late Cretaceous and Tertiary formations in the Turtle Mountain area. This material will provide basic data for a detailed study of the geology of the Turtle Mountain area by J. D. Bamburak (see section 11, this publication);

ii) to determine the distribution and quality of high-calcium limestone beds in Devonian strata of the Dawson Bay and Souris River Formations; these data will be included in a detailed study by B. B. Bannatyne (see section 13, this publication);

iii) to obtain general stratigraphic data as to the lithology and structure of Devonian strata along the outcrop belt from the Lake Manitoba Narrows to the north end of Dawson Bay.

A summary of the drilling results is given in Table 10-1, and hole locations are shown in Figure 10-1.

Correlation of the core hole data confirmed the presence of pronounced structural relief throughout the Devonian outcrop belt, and in addition, permitted more accurate delineation of the stratigraphic position of a number of outcrop sections.

TABLE 10-1 — SUMMARY OF CORE HOLE DATA

Hole No.	Location and Elevation	Formation	Interval	Summary Lithology
M-1-71	NW-13-33-2-21W 1768 feet	Boissevain	0-62	Kaolinized sand, silt, shale, sandstone, bluish sand
M-2-71	NE15-5-2-23W 1873 feet	Turtle Mtn.	0-113	Grey and black shale, silt, sandstone, lignite, white clay
M-3-71	NW15-32-1-22W 1969 feet	Turtle Mtn.	5-78	Siltstone, sandstone, olive shale
M-4-71	SW-3-17-28-16W	Dawson Bay	0-51	Limestone, dolomite
	855 feet	(Second Red)	51-78	Red mottled shale
		Winnipegosis	78-79.5	Dolomite
M-5-71	NE16-9-30-17W	Dawson Bay	4-28	Reddish mottled calcareous shale
	842 feet		28-63	Limestone
M-6-71	SE1-21-32-19W 860 feet	Souris River	0-45	Limestone, partly argillaceous, dolomitic
		(First Red)	45-99	Dolomite and dolomitic shale
		Dawson Bay	99-121	Limestone, dolomite
M-7-71	NE16-20-30-17W	Dawson Bay	0-45	Limestone, dolomite
	845 feet	(Second Red)	45-52	Dolomitic shale
M-8-71	NE6-25-22-11W	Dawson Bay	0-53	Limestone, dolomite
	822 feet	(Second Red)	53-79	Buff to red dolomitic shale
M-9-71	1-5-33-19W 865 feet	Winnipegosis (?)	0-154	Dolomite, minor shaly dolomite and limestone

M-10-71	4-21-44-25W 925 feet	Souris River	0-124	Limestone, argillaceous limestone, dolomite
		(First Red)	124-157	Red dolomitic shale
		Dawson Bay	157-162	Dolomite, limestone
M-11-71	SW-8-45-25W	Souris River	0-48	Limestone and argillaceous limestone
	900 feet	(First Red)	48-60	Red shale, limestone
M-12-71	SE12-7-48-25W 850 feet	Dawson Bay	0-17	Limestone, dolomitic limestone
		(Second Red)	17-48	Red and green dolomitic shale, breccia
		Winnipegosis	48-58.5	Dolomite
M-13-71	SW7-8-45-25W 900 feet	Souris River (First Red)	0-17	Buff limestone, red calcareous shale
		Dawson Bay	17-80	Limestone, calcareous shale
M-14-71	SW4-23-44-25W 920 feet	Souris River	0-68	Limestone (Pt. Wilkins Member)
			68-97	Argillaceous limestone
		(First Red)	97-127	Red shale, argillaceous dolomite
		Dawson Bay	127-202	Limestone, dolomitic limestone, calcareous shale

Hole M-4-71 intersected lower Dawson Bay strain in an area that was previously mapped as part of the Souris River outcrop belt. Hole M-5-71 showed that the red bed outcrop previously mapped as part of the First Red Beds of the Souris River Formation actually comprises part of the middle Dawson Bay red bed. Hole M-6-71 was collared in strata comprising the upper part of the Point Wilkins Member; previous faunal studies had placed this outcrop much closer to the base of the Souris River Formation.

Hole M-9-71 provided a highly anomalous core section. This location was believed to fall well within the outcrop belt of the Souris River Formation. The core, however, consists largely of dolomite with minor argillaceous and calcareous intervals. This lithology (without supporting faunal evidence) is not correlatable with either the Souris River or the Dawson Bay Formation, but is similar to the Winnipegosis dolomite, although the argillaceous and calcareous zones are somewhat anomalous. If these strata are part of the Winnipegosis Formation, this indicates an extremely thick Winnipegosis (reef) section, possibly in excess of 400 feet. Local structural relief, and hence irregularity of outcrop pattern, may thus be even greater than previously suggested.

Holes 11, 13 and 14 were drilled in an attempt to obtain a complete reference section for the Dawson Bay Formation in the Mafeking area. Holes 11 and 13 encountered badly fractured rock on the flank of a structural dome and had to be abandoned short of their objective. Hole 14 was located close to the edge of the Souris River outcrop belt but encountered an unexpectedly thick section (127 feet) of Souris River strata, including an excellent section of the Point Wilkins Member. Only the upper half of the Dawson Bay Formation was cored in this hold because of depth and time limitations, so a complete reference section of the Dawson Bay Formation has not yet been obtained for the Mafeking area.

In addition to the Mines Branch core holes, four mineral exploration core holes were drilled (by Husky Oil Co.) in the Mafeking-Red Deer River area. These provided highly anomalous sections, including a number of thick breccia zones. Correlation of these holes with the Mines Branch reference core holes may aid in the determination of the origin of the intense brecciation.

Hole M-12-71 intersected the lower part of the Dawson Bay Formation and the upper part of the Winnipegosis Formation. These data will permit more accurate delineation of the Devonian outcrop belts in an area where no previous data were available.

Pump tests of formation waters were made for most holes and the samples have been submitted for analysis. Several wells encountered artesian flows and required cement grouting. Hole M-12-71 surprisingly gave a slight artesian flow from the Winnipegosis beds, despite proximity to the Winnipegosis outcrops on Dawson Bay.

Drilling to date has provided an almost complete stratigraphic succession of Devonian Souris River and Dawson Bay beds for both the southern outcrop area (Lake Manitoba Narrows-Winnipegosis) and the northern outcrop area (Mafeking-Dawson Bay). However, a reference hole for the lower part of the Dawson Bay Formation is still required for the Mafeking area. Additional coring of the Winnipegosis Formation is also required to determine facies variations relative to reef development, especially distribution of the limestone facies.

Drilling has shown some highly anomalous structural features and associated outcrop patterns, for example in hole M-9-71; further drilling will be necessary to delineate more accurately the outcrop belts of the Devonian strata and the associated structural (salt collapse?) features. Future drilling may also be carried out in the Grand Rapids area to assist in more accurate mapping of the geologic boundaries. Special projects to evaluate possible industrial minerals deposits (lignite, high-calcium limestone, shale, silica sand, etc.) may also be undertaken.

Period	Epoch	Saskatchewan	North Dakota: Missouri Coteau	North Dakota: Turtle Mountains	Manitoba
Tertiary	Paleocene	RAVENSCRAG FM.	FORT UNION GROUP: SENTINEL BUTTE FM. TONGUE RIVER FM.	FORT UNION GROUP: SENTINEL BUTTE FM. TONGUE RIVER FM.	TURTLE MOUNTAIN FM.
Tertiary	Paleocene	RAVENSCRAG FM.	FORT UNION GROUP: CANNONBALL FM.	FORT UNION GROUP: CANNONBALL FM.	TURTLE MOUNTAIN FM.
Cretaceous	Upper Cretaceous	FRENCHMAN FM.	LANCE FM.: HELL CREEK FM.	?	
Cretaceous	Upper Cretaceous	BATTLE FM.	FOX HILLS SANDSTONE	FOX HILLS SANDSTONE	BOISSEVAIN FM.
Cretaceous	Upper Cretaceous	WHITEMUD FM.	FOX HILLS SANDSTONE	FOX HILLS SANDSTONE	BOISSEVAIN FM.
Cretaceous	Upper Cretaceous	EASTEND FM.	FOX HILLS SANDSTONE	FOX HILLS SANDSTONE	BOISSEVAIN FM.
Cretaceous	Upper Cretaceous	BEARPAW FM.	PIERRE SHALE	PIERRE SHALE	RIDING MOUNTAIN FM.: ODANAH MEMBER
Cretaceous	Upper Cretaceous	BEARPAW FM.	PIERRE SHALE	PIERRE SHALE	RIDING MOUNTAIN FM.: MILLWOOD MEMBER

Figure II–1 Correlation of Formations: Saskatchewan, North Dakota, and Manitoba.

(11) THE GEOLOGY OF TURTLE MOUNTAIN

by J. D. Bamburak

Turtle Mountain, in southwestern Manitoba, rises 800 feet above the surrounding plains and is topographically and geologically an outlier of the Missouri Coteau. Detailed and reconnaissance mapping during 1971 established the locations of up to fifty bedrock outcrops.

Three drill holes in 1971 intersected 62 feet of Boissevain Formation in hole M-1-71, and 106 feet and 78 feet of Turtle Mountain Formation in holes M-2-71 and M-3-71 respectively (see Table 10-1 and Figure 10-1).

The Boissevain Formation is an unconsolidated non-calcareous kaolinitic greenish-grey sand with minor sandstone, clay, silt, and discontinuous orange ironstone concretionary layers. Although fossil evidence for the age of the formarion has not yet been found, its relative position above the Odanah suggests that it is equivalent to the Eastend, Whitemud, and Battle Formations in Saskatchewan. Therefore an Upper Cretaceous age is assigned to the Boissevain Formation. The sands are usually cross-bedded and sometimes have ripple-marked bedding surfaces. The cross-bedding indicates the source area for the sand was in the west. In the past, some of the sandstone, with calcareous and ferruginous cement, has been used for construction of buildings in the vicinity of the town of Boissevain.

The Turtle Mountain Formation is a complex assemblage of silt, sand, and clay. Thin orange concretionary layers also are present. Fossil plant remains are preserved on bedding planes in the silts and clays. The presence of lignite at the base of the Turtle Mountain Formation suggests it may be equivalent to the Ravenscrag Formation of Saskatchewan and the Fort Union Group of North Dakota. Therefore a Tertiary Paleocene age is assigned to the Turtle Mountain Formation. Estimated thickness of the Turtle Mountain Formation is 480 feet. Formerly, lignite was mined on the west side of Turtle Mountain, but all operations ceased in 1943. Water well records have indicated the presence of lignite in sections 16 and 21, tp. 2, rge. 21WPM. Strip mining in this area however may not be feasible due to overburden thickness. A test for radioactivity on a selected lignite sample from the west side of Turtle Mountain, gave a reading 50 per cent above background.

An examination of Pleistocene deposits revealed that at least two tills, separated by a distinct boulder pavement, are present in the area. Holocene deposits usually contain animal bones; buffalo bones are common in the ravine walls at NW l.s. 16, sec. 5, tp. 2, rge 23WPM. A badland topography is slowly developing on the upper slopes of Turtle Mountain, due to the conversion of timberland to farmland, and to road construction. Deep gullies have been eroded during flash floods, and large quantities of alluvium have been deposited on the surrounding plains.

Structure contours and isopach maps have indicated that the strata of the Turtle Mountain area dip very gently to the south and west towards the center of the Williston Basin. This corresponds with measurements made on the northeast side of Turtle Mountain. However, measurements made on the west side indicate that the strata dip to the south and east. Therefore, it appears either that Turtle Mountain rests in a basin or in the axis of a trough, or that the dip to the south and east has been caused by ice thrusting.

Samples, collected during the summer of 1971, will be studied to determine texture, grain size, chemical composition, mineralogy and other characteristics. Samples have also been forwarded to Dr. Caldwell at the University of Saskatchewan for palynological and micropaleontological studies.

(12) A STUDY OF LATE GLACIAL DEPOSITS IN THE GRAND RAPIDS-PONTON AREA

by Susan Ringrose

(University of Winnipeg)

The Mines Branch supported a one-month field study of Pleistocene ridges and other glacial features of the Grand Rapids-Ponton area, to be followed by laboratory studies of samples.

After a preliminary air-photo interpretation that delineated ridge features in the area, ten traverses were made along selected grid lines to determine the landscape elements and to select samples for laboratory analysis. A preliminary survey revealed two distinct areas: the northern area, consisting of extensive drift deposits; and the southern area, consisting predominantly of limestone features. The location of the limestone ridges and other Pleistocene features are shown in Figure 12-1. Some of the limestone ridges are composed of large blocks of limestone overlying lacustrine clay; others may consist of limestock bedrock. Both show evidence of modification by wave action in glacial lakes. Two recent ridges at Grand Rapids and Long Point were sampled for comparison.

The northern area is covered predominantly by lacustrine clay. Other deposits include sand dunes, a beach ridge, and an end-moraine complex. The sand dunes were sampled intensively. One prominent beach ridge, the Minago ridge was also sampled in detail. The Minago River channel immediately to the north is a misfit stream; the bed and bank deposits suggest an intermediate but not a high velocity flow at a time when the valley was used as an overspill channel.

The Pipun ridge, formerly considered a beach ridge, is tentatively interpreted as an end-moraine complex, modified by water activity. It is composed of boulder clay, ice-contact stratified drift, and braided current-bedded channel deposits. The remaining deposits in the northern area are associated with the Pipun ridge and a similar feature at Soab Lake. These are sand deposits, two to twenty feet in thickness, which extend from north of Minago River to five miles north of Ponton. Tentatively the sands are classed as an outwash delta complex deposited in a glacial lake that had its southern shoreline at the Minago beach ridge. Laboratory analysis of the field samples is expected to clarify the relationships of the various deposits.

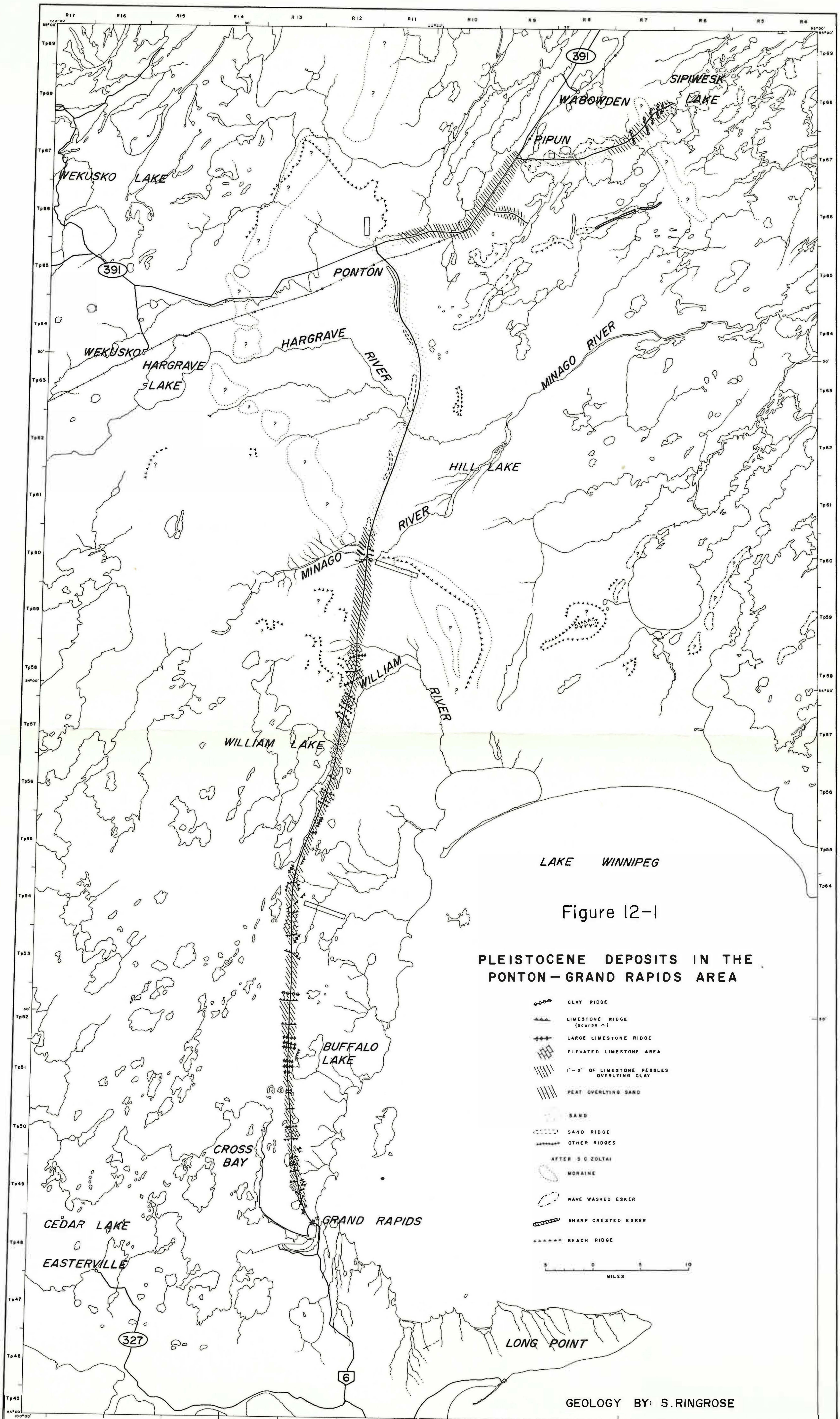

Figure 12-1

PLEISTOCENE DEPOSITS IN THE PONTON — GRAND RAPIDS AREA

(13) HIGH-CALCIUM LIMESTONE PROJECT

by B. B. Bannatyne

Field mapping was completed, and additional Manitoba Mines Branch core holes supplied valuable samples for analysis and correlation of the limestone zones of the Devonian section.

The Devonian outcrop area was mapped in detail from the southeast end of Lake Manitoba to the northwest end of Lake Winnipegosis (see Figure 10-1). Over 130 outcrop samples were collected, four operating high-calcium limestone operations were visited, and core from eleven drill holes was obtained. Numerous new outcrops were located, mainly with the aid of recent soils maps and in areas made accessible by new roads.

Preliminary conclusions from the year's work are:

1. The Elm Point Formation occurs as a series of generally isolated remnants, separated by areas underlain by thick drift deposits, overlying the Ashern Formation and/or the Silurian Interlake Group.

   In the area from The Narrows of Lake Manitoba southwards to Oak Point, the magnesia content of the Elm Point limestone is highly variable. The limestone can vary from good to poor quality stone within a distance of two miles or less, dependent upon both the amount of matrix and the magnesia content of the matrix. Sufficient data should be available to outline the area of better quality stone.

   In the area north from The Narrows as far as the northernmost outcrop at Basket Lake, the Elm Point limestone is of high quality, and a general northward decrease of magnesia content is indicated.

2. The Dawson Bay Formation, as exposed from Kinosota northwest to Overflowing River, has several zones of high-calcium limestone. Variations in thickness, and correlation of the limestone zones, are affected by several factors:
   a) the outcrop belt is roughly perpendicular to the isopach trend, resulting in a northward decrease in total thickness from approximately 200 feet to 150 feet.
   b) red shale marker horizons are not uniformly developed in the outcrop belt area.
   c) structural doming, probably the result of solution and removal of salt beds, occurs in areas of underlying reef structures. Considerable local structure was noted and is the cause of the complex pattern of the formational boundaries in the outcrop area.

3. The Souris River Formation, exposed from Winnipegosis northwest to the area two miles south of Red Deer River, has two separate high-calcium limestone zones. The non-argillaceous part of the lower zone is designated the Point Wilkins Member, and is quarried at Mafeking. Drill results indicate an upper zone, thirty feet in thickness and starting thirty feet higher in the section, part of which is in an abandoned quarry northwest of the town of Winnipegosis.

   The structural doming and complex outcrop belt patterns noted in the Dawson Bay Formation are present also in the Souris River Formation. Post-depositional dips of up to 33 degrees to the south were noted in the area 2.5 miles north of the Mafeking quarry.

4. An outcrop of limestone within the Lake St. Martin crater structure was examined and samples. It is interpreted as a remnant of the Devonian (?) limestone originally present in the area at the time of crater formation, and since preserved as large slump blocks inside the crater rim.

Selected High-Calcium Limestone Analyses, 1971

Formation:	**Red River**	**Elm Point**	**St. Martin Series**	**Dawson Bay Fm.**		**Souris River Fm.**
Analysis:	(1)	(2)	(3)	(4)	(5)	(6)
SiO_2	11.4	0.77	2.08	2.12	1.56	1.59
Al_2O_3	0.12	0.20	0.23	0.58	0.23	0.49
Fe_2O_3	0.17	0.19	0.25	0.33	0.23	0.21
CaO	45.68	53.85	53.83	52.83	54.58	54.04
MgO	2.72	1.30	0.96	0.90	0.30	0.65
Na_2O	0.02	0.03	trace	0.02	0.01	0.03
K_2O	0.55	0.09	0.16	0.34	0.07	0.16
P_2O_5	0.14	0.01	0.02	0.02	0.03	0.02
S	0.06	0.02	0.02	0.02	0.06	0.06
LOI	38.51	43.52	43.12	42.57	43.12	43.02
Total	99.35	99.98	100.67	99.73	100.19	100.27
$CaCO_3$	81.53	96.11	96.08	94.30	97.41	96.45
$MgCO_3$	5.69	2.70	2.01	1.88	0.63	1.36
Thickness	7 feet	16.5 feet	18 feet	24 feet	17.5 feet	64.5 feet

(1) Hole 69-2, NE¼ sec. 35, tp. 14, rge. 1W, Woodroyd area; depth; 391 to 398 feet; sample contained a chert nodule; Selkirk Member.

(2) Faulkner quarry, The Winnipeg Supply and Fuel Company Limited, surface to 16.5 feet, south face of quarry.

(3) Hole LSM No. 14, SW¼, sec. 4, tp. 33, rge. 9WPM, Gypsumville area; depth: 29 to 47 feet (average of two sample intervals; analysis from 29 to 38 feet was 54.27% CaO and 0.20% MgO).

(4) Basal part of Dawson Bay Fm.; hole M-4-71, SW corner l.s. 3, sec. 17, tp. 28, rge. 15WPM, east of Rorketon; depth: 0 to 24 feet; (top 8 feet analyzed 53.9% CaO, 0.47% MgO).

(5) Upper part of Dawson Bay Fm.; hole M-14-71, Steeprock River-Pelican Rapids road, depth: 127.2 to 144.7 feet.

(6) Point Wilkins Member; hole M-10-71, l.s. 4, sec. 21, tp. 44, rge. 25WPM; junction Hwy. 10 and Steeprock River Road; depth: 30 to 94.5 feet.

(14) LAKE ST. MARTIN AND HIGH ROCK LAKE PRECAMBRIAN INLIER

by H. R. McCabe and B. B. Bannatyne

A two-day trip was made to the Gypsumville area to check a number of outcrops within the Lake St. Martin crater structure. These outcrops had been noted in earlier mapping but no detailed descriptions were available. Sampling of these outcrops was necessary to ascertain if they fitted the structural pattern postulated for the crater (McCabe and Bannatyne, Mines Branch Geological Paper GP3/70).

Granite outcrop on the north rim of the crater (sec. 31, tp. 33, rge. 7WPM) was confirmed. It consists of what appears in hand specimen to be a relatively normal pink biotite granite, medium to coarse grained, massive to slightly gneissic, with no obvious shock features on a macroscopic scale. It is comparable to the granite outcrops on the eastern edge of the crater, and comprises part of the structurally uplifted basement rim.

Outcrops of "trachyandesite" were located in two areas east of Gypsum Lake (l.s. 5, sec. 24, tp. 33, rge 8WPM; l.s. 8, sec. 22, tp. 33, rge. 8WPM). The rock is generally similar to other occurrences of trachyandesite within the crater, although somewhat more vesicular. The vesicles have a roughly horizontal elongation, and vuggy crystalline quartz occurs as vesicle infill. Large red jasperoid inclusions are common in these outcrops, but had not been noted in previously described outcrops and drill core (McCabe and Bannatyne, *op. cit.*). Highly altered (shocked) granitic inclusions are also abundant.

Limestone outcrop was located in l.s. 5, sec. 25, tp. 33, rge. 8WPM. This outcrop consists of an unusual yellowish buff to red, highly fractured, fossiliferous high-calcium limestone (Bannatyne, this publication). It cannot be correlated (lithologically) with the Silurian dolomites that form the country rock surrounding the crater structure. Most likely it represents a large slump block of late Paleozoic (Devonian ?) limestone immediately within the crater rim, comparable to the limestones encountered in holes LSM-1, 6, and 14 (McCabe and Bannatyne, *op. cit.*).

Petrographic studies of these outcrop samples will be made, but the preliminary examination indicates that they conform closely with the previously postulated geology of the crater structure. In the future, stratigraphic core hole drilling may be attempted to further clarify the crater structure, and determine the distribution of high-calcium limestone and silica sand on the flanks of the crater.

Samples of the Precambrian inlier in sec. 5, tp. 29, rge. 2WPM, north of High Rock Lake, were obtained during a helicopter flight, by courtesy of John Selwyn, Canada Cement Lafarge Limited. Two separate outcrop areas, separated by a well-defined, curving valley are present. The eastern, higher outcrop has a steep cliff of granitic rock, facing the smaller westerly ridge; samples were taken from the southeast slope of this eastern outcrop area. Two types were collected:

1) fresh leucocratic medium to coarse-grained biotite quartz diorite with minor hornblende, as bedrock;
2) finer-grained, brownish red-stained biotite quartz diorite, as float.

Associated with the diorite found as float, are veinlets or stringers, up to several inches in width, of reddish brown, massive, slightly friable and porous granitic microbreccia. Microscopic features directly attributable to shock metamorphism were not observed (i.e., planar features, thetomorphic minerals). The microbreccia appears highly abnormal for a Precambrian rock, but closely resembles some of the microbreccias found within the Lake St. Martin crater. Although the microbreccia was found only in loose float, the unusual nature of the float and its local abundance suggest that it has been derived from a nearby source. A strong possibility thus exists that the High Rock Lake Precambrian inlier also is the result of a crypto-explosion event.

Because of the extensive swamps in this area, and the broad belt of reeds and muskeg around the shores of High Rock Lake, this area is readily accessible only by helicopter.