GP 4/69

MANITOBA MINES BRANCH
DEPARTMENT OF MINES AND NATURAL RESOURCES

SUMMARY OF GEOLOGICAL FIELDWORK 1969

Geological Paper 4/69

Winnipeg 1969

PREFACE

The following summaries of geological fieldwork carried out by the Geological Division of the Manitoba Mines Branch are intended to be interesting and informative. Their objective is to acquaint the mineral exploration industry with the observations of our personnel during the previous field season as rapidly as possible. Under this circumstance it is possible that geological theories or opinions may alter with further observation and study.

Precambrian field investigations were expanded in 1969 with the commencement of a major project in the Southern Indian Lake area, east of Lynn Lake. Eight additional field crews led by Mines Branch geologists began work on this project, which is designed to map an area of approximately 6,000 square miles over a two year period (1969-1971), at a scale of one-half mile to the inch. The geological programme was preceded by an airborne electromagnetic and magnetic survey over 4,000 square miles of the total project area. The initial purpose of this survey, in addition to assisting the geological interpretation of the area, was to attempt to define regions of possible economic potential, and thus impart direction to the project from the outset.

Special projects on the ultramafic rocks in the Province and on the Manitoba Nickel Belt were also begun in 1969. These are continuing projects.

Mapping in the Wimapedi Lake area, north of Snow Lake, neared completion. Further studies emphasizing the economic aspects of this region will complete the field work in 1970.

In the Setting Lake area, mapping of the Pakwa Lake and Pistol Lake (East half) sheets was completed in 1969.

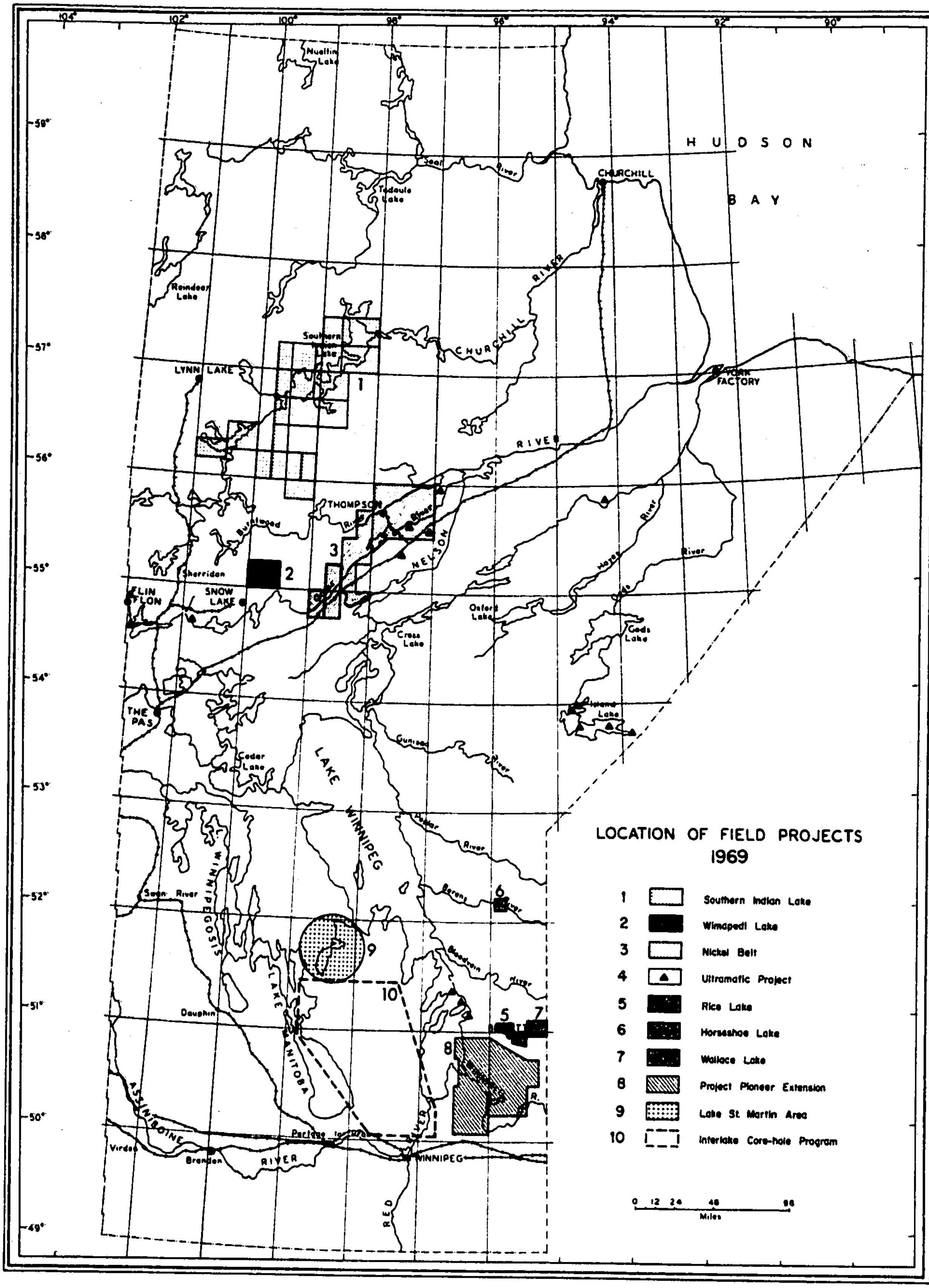
In concluding the field operations of Project Pioneer several detailed investigations and field checks were made within the main greenstone belt. A brief programme was conducted in the Manigotagan gneissic belt to test the validity of conclusions developed from the analysis of data collected 1966-1968. The studies made during the project were then put into a regional perspective by a reconnaissance survey of the hitherto unmapped country to the South. A short comparative study was also made in the Horseshoe Lake area near Little Grand Rapids.

Compilation of subsurface geological data from oil well test holes continued. Preliminary examination of core from the Lake St. Martin area (F.R.E.D. Manpower Corps driller training program) has indicated the presence of a crater or explosion structure of late Palaeozoic (Permian ?) age, and additional F.R.E.D. drilling in the south Interlake area has provided the first complete stratigraphic core section for this area.

A stratigraphic core hole program, utilizing a small portable diamond drilling rig, was initiated by the Mines Branch in order to obtain stratigraphic and industrial minerals data in areas of poor outcrop, and to clarify specific geological problems.

A report on the Clays and Shales of Manitoba was completed and is being readied for publication. Cores obtained from the Interlake drilling programmes were examined for industrial minerals potential.

J. S. Roper
Director of Mines



HUDSON
BAY
CHURCHILL
Nueltin Lake
Seal River
Tadoule Lake
Reindeer Lake
Southern Indian Lake
CHURCHILL RIVER
LYNN LAKE
YORK FACTORY
NELSON RIVER
THOMPSON
Burntwood River
Hayes River
Sherridan
SNOW LAKE
FLIN FLON
Oxford Lake
Cross Lake
Gods Lake
THE PAS
Island Lake
Cedar Lake
Gunisao River
LAKE WINNIPEG
Poplar River
Berens River
LAKE WINNIPEGOSIS
Swan River
Bloodvein River
Dauphin
LAKE MANITOBA
ASSINIBOINE RIVER
Portage la Prairie
Virden
Brandon
WINNIPEG
RED RIVER
LOCATION OF FIELD PROJECTS
1969
1 Southern Indian Lake
2 Wimapedi Lake
3 Nickel Belt
4 Ultramafic Project
5 Rice Lake
6 Horseshoe Lake
7 Wallace Lake
8 Project Pioneer Extension
9 Lake St. Martin Area
10 Interlake Core-hole Program
0 12 24 48 96
Miles

TABLE OF CONTENTS

(1) SOUTHERN INDIAN LAKE PROJECT

Introduction

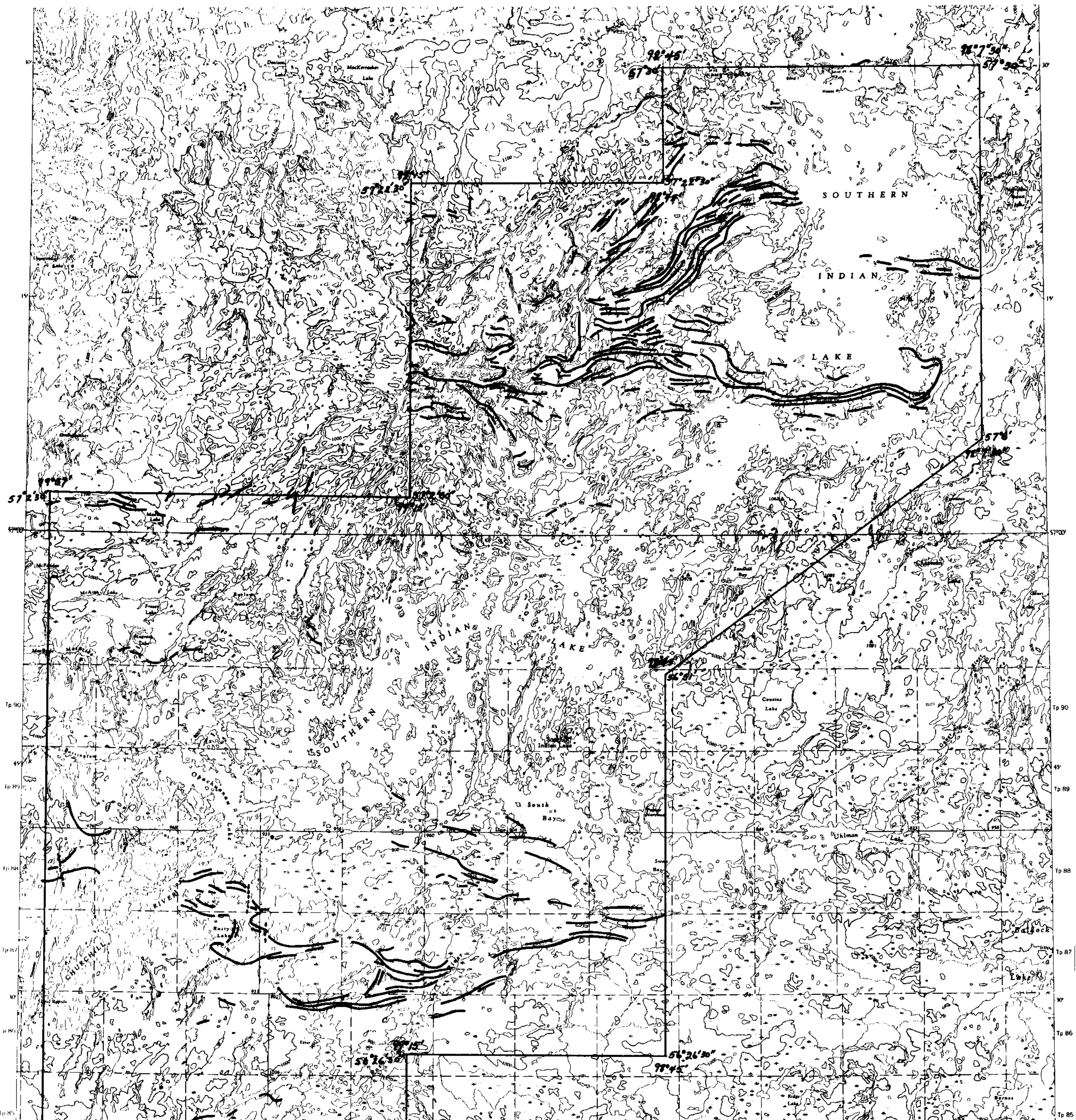
by I. Haugh

An area in excess of 4,000 square miles, including Southern Indian Lake, Granville Lake, and the Rat River drainage basin, was examined during the 1969 field season by a group of eight field parties, led by Mines Branch geologists. The individual reports of these eight geologists, on their respective areas, appear below. Geological mapping was carried out at a scale of one-half mile to the inch.

Division of the total project area among the eight field crews, was based on geological factors rather than on strict geographical co-ordinates. This permitted greater geological continuity in individual map-areas, and an appreciation by each geologist of a comprehensive rather than a fragmentary picture of the regional geology. Each field party operated independently, but maintained liaison with parties in adjoining areas, to ensure correlation across mutual boundaries, and promote cohesiveness of the overall project.

The field crews were serviced from Lynn Lake by fixed-wing aircraft. Helicopter support for the mapping was available for almost the entire field season. The bulk of the work, however, was done by boat, canoe, and pace and compass traverses.

The geological investigations were preceded by an airborne electromagnetic and magnetic survey over 4,000 square miles of the total project area. The survey was flown by Questor Surveys Limited, in the fall of 1968, using a Mark V INPUT electromagnetic system and a Barringer AM-101 nuclear precession magnetometer. Flight lines were spaced at one-quarter mile intervals, and the survey was flown in a north-south direction. A total of just over 4,400 anomalies were picked from the data, and their locations and pertinent features indicated on a series of thirteen anomaly maps. These maps and the survey records were released on June 27th, 1969. Contoured magnetic maps of the survey area were released on October 8th, 1969. The release of the INPUT anomaly maps, and the earlier announcement by Sherritt Gordon Mines Limited, of the discovery of a major copper-zinc deposit at Ruttan Lake,



SOUTHERN INDIAN LAKE PROJECT

INPUT - Anomaly Trend Map

0 4 8 12 16 20 Miles

Figure 1-1

by C. D. Anderson, 1969

together contributed to a dramatic increase in staking and exploration activity in the project area.

The bedrock conductors, defined by the INPUT E.M. survey, were examined in the field, where exposure permitted. Descriptions of these conducting zones are given in the individual reports that follow. Figure 1 - 1 is an INPUT anomaly trend map of the survey area, prepared by C. D. Anderson of the University of Manitoba. This map is of value in interpreting the geological structure of the area when used in conjunction with the geological data and aeromagnetic maps.

Field studies carried out in 1969, were designed to gain an overall impression of the entire project area. This allowed only a broad reconnaissance in some regions, but where possible, more detailed work was undertaken. Completion of the mapping, additional work in problem areas, and a continued assessment of the economic potential of the area, are proposed for the 1970 field season.

SICKLE-WASEKWAN CONTACT, GRANVILLE LAKE

(Parts of 64 C - 2 and 64 C - 7)

by F. H. A. Campbell

Introduction

The primary purpose of the project is a detailed remapping of the contact relationships between the Sickle and the Wasekwan Groups.

Mapping was carried out at a scale of one-half mile to one inch. The majority of the mapping was done by shorelining, with supplementary traversing. Traverses were made along strike to delineate contacts and any variations in lithology and/or grain size.

The entire area has been mapped previously by Barry (1965), Pollock (1966), Godard (1966), and Cranstone (1968). The four map sheets meet at approximately the center of the area (Preliminary Map 1969E-1). Both the northern and southern limits of the map-area are arbitrary boundaries.

General Geology

Approximately 75 per cent of the area is underlain by metasediments of the Sickle Group and Wasekwan Group. Group has been substituted for "series" when referring to Sickle and Wasekwan rocks, following the procedure outlined in the Code of Stratigraphic Nomenclature, Articles 9 and 9f (1961).

In the vicinity of Granville Lake, the Sickle and the Wasekwan Groups are easily distinguished on the basis of colour, grain size, and characteristic stratigraphy. The Sickle sediments are predominantly buff grey to reddish grey weathering feldspathic greywacke and arkose, with minor laminated siltstone and amphibolite-biotite-plagioclase gneiss. One continuous band of coarse-grained amphibolite-biotite gneiss with relict pillow structures occurs close to the southwest contact of the Sickle Group. The Wasekwan Group, on the other hand, is a sequence of fine to medium-grained, dark grey weathering, locally massive, volcanic wackes, with minor horizons of fine-grained greywacke and siltstone. Locally, possibly pyroclastic breccias and flows are present.

Top determinations of graded bedding and cross-stratification indicate that both Groups are overturned to the north.

The contact between the Sickle and the Wasekwan is delineated by a thin basal boulder conglomerate in the eastern part of the area, and a thin pebble-conglomerate or conglomeratic greywacke in the west. The two are distinct lithologic units.

The lower, boulder conglomerate, is composed predominantly of felsic volcanic and sedimentary clasts up to one meter in size, but generally less than 256 mm. Matrix is extremely sparse, always less than 10 per cent, and commonly less than 5 per cent. Many of the clasts are angular, and the unit is very poorly sorted. Most of the clasts have been derived from the Wasekwan sediments. These are easily recognized by their colour, mineralogy, and relict layering.

Locally the Wasekwan sediments contain metamorphic aggregations of quartz, plagioclase, amphibole and garnet. These are up to 30 cm in diameter, and are elongated in the plane of the foliation. They are invariably zoned, with a rim of quartz-plagioclase-carbonate, and a core of amphibole and garnet. Their colour, zoned appearance, and distinctive weathering pattern makes them easily distinguishable in outcrop. Variably sized clasts of this material occur in the basal conglomerate. They are not common but are the most distinctive clasts within the unit.

Near the base of the lower conglomerate, the matrix commonly contains quartz-muscovite porphyroblasts. Some have magnetite cores. These porphyroblasts are elliptical in plain view, up to 10 mm in diameter, and are elongated down the dip of the foliation.

There is a stratigraphically upward variation in the percentage of matrix present in the basal conglomerate. At isolated localities, up to 25 per cent matrix is present near the contact, rapidly decreasing to 5 - 10 per cent upwards. An overall sense of grading is nowhere present.

The contact between the conglomerate and the Wasekwan sediments is exposed at only two localities in the map-area. One of these is on the peninsula directly south of the Pickerel Narrows settlement; the other is on the small bay to the northwest, on the same shoreline. The former contact is abrupt, with the conglomerate directly overlying the Wasekwan rocks. At the latter, the contact appears gradational, with fine-grained greywackes interbedded with thin beds of conglomerate passing upwards into the basal conglomerate.

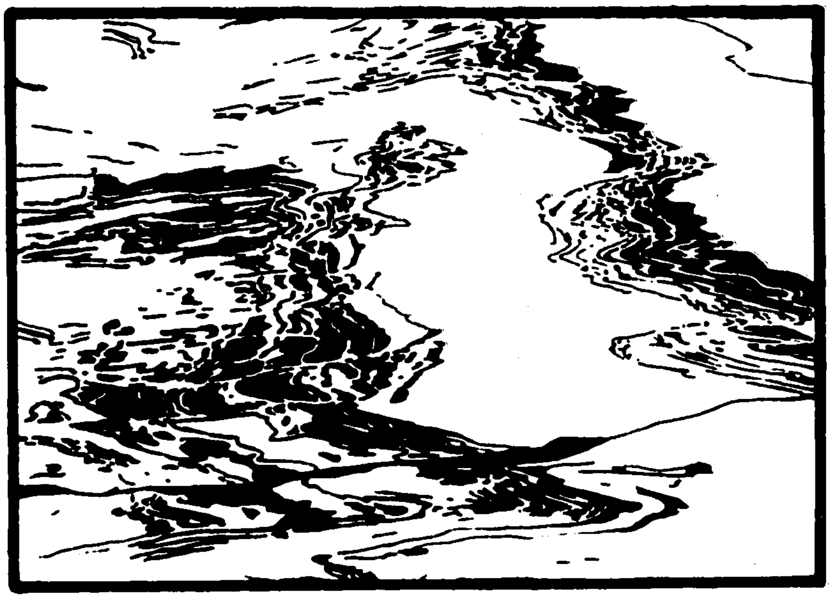
In the eastern part of the area, the basal conglomerates and upper pebble conglomerate are separated by approximately 15-30 meters of fine-grained greywacke and minor grit. In the central part of the map area, the two are apparently in direct contact. Further west, the lower conglomerate is exposed on the shore of the small bay on the south side of Metcalfe Bay. The upper conglomerate is exposed inland, but the intervening rocks are not exposed. The upper conglomerate is thickest in the central part of the map-area, on the shore of the inlet off the main body of Granville Lake.

The stratigraphically higher conglomerate is distinctly different from the basal, boulder conglomerate. The predominant clast type found in the former is a pinkish, fine-grained quartz-eye granodiorite; minor arkose and quartz pebbles also occur. The clasts in both conglomerates are stretched in the foliation, which parallels the bedding in the Sickle Group at all localities. The percentage of matrix is much higher in the upper conglomerate than in the lower. The clasts increase slightly in size to the west, but the percentage of matrix remains essentially constant.

The upper conglomerate appears very similar to that mapped as the basal conglomerate at Beaucage Lake and at Black Trout Lake. Minor scour channels occur at the base of the unit, but any clasts derived from the basal conglomerate were not recognized.

On the south shore of Granville Lake both conglomerates are displaced by a small fault. Near the fault is a small body of metagabbro (?). The gabbro intrusive cuts the finely laminated Wasekwan siltstones and greywackes at this locality. It does not intrude into the basal conglomerate, and the conglomerate does not contain any recognizable clasts of gabbro.

The bedding in the Wasekwan rocks is at a distinct angle to the bedding in the Sickle sediments. A penetrative foliation which is parallel to the bedding in the Sickle is therefore oblique to the bedding in the Wasekwan. Differential slip on the foliation planes has deformed the Wasekwan bedding into shear folds (Fig. 1-2). On the other hand, such shearing in the conglomerate was parallel to the bedding. The clasts are flattened within the bedding planes and elongated parallel to the axes of the folds in the Wasekwan. Some deformation of the clasts by shear has produced "feathered" edges.



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SHEAR FOLDS IN WASEKWAN SEDIMENTS
NEAR SICKLE - WASEKWAN CONTACT

Figure 1-2

An angular unconformity between the Sickle Group and the Wasekwan Group is not well defined in this area. Locally, however, there is evidence of a disconformity, best summarized as follows:

A) There is angular discordance between the two groups, but only on a local scale. This is accentuated by the shear folds in the Wasekwan at the locality previously discussed.
B) There is evidence of post-Wasekwan, pre-Sickle basic intrusion at some localities.
C) Locally, the Wasekwan sediments are truncated by the basal conglomerate.
D) The matrix of the conglomerate near its base appears to have been derived from the volcaniclastic greywackes of the Wasekwan.
E) Clasts of laminated and porphyroblastic Wasekwan sediments are common in the basal conglomerate. Metamorphic aggregations also occur as clasts.
F) Interbedded conglomerate and grit resting with apparent conformity on the Wasekwan sediments contain recognizable clasts of the latter.
G) Greywacke and grit which separates the two conglomerates in the east pinches out, or was not deposited, to the west.
H) The basal, boulder conglomerate is apparently truncated by the upper conglomerate, possibly indicative of a transgressive relationship over broadly warped Wasekwan sediments.

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TURNBULL LAKE AREA

B64 C - 8)

by F. H. A. Campbell

Introduction

The Turnbull Lake Area, N.T.S. area 64 C - 8, lies between longitudes 100° 00' and 100° 30', and latitudes 56° 15' and 56° and 30'. The area is approximately 40 miles southeast of Lynn Lake.

To date, the western half and part of the eastern half, of the map-area has been completed.

Mapping was carried out at a scale of one-half mile to the inch, by shorelining the lakes, and by pace and compass traverses. Both were augmented by helicopter support for inaccessible areas. A preliminary map is available (Map 1969E - 2) and the final map will accompany the report when the mapping program and interpretation have been completed.

General Geology

The area has been mapped previously by Henderson (1932), Norman (1933), and Downie (1935), at a scale of four miles to one inch. Map 344A, published by the Geological Survey of Canada, is a compilation of their work.

Over seventy-five per cent of the rocks of the area are granitic, with thick sections of metasediments in the southwest and east (see Figure 1 - 3).

The structure and geology of the southwestern part of the map-area is dominated by a dome in the metasediments produced by a small granite-granodiorite pluton. The western part of this structure is shown on the Watt Lake (East) map (Cranstone, 1968). The granodiorite is medium to coarse-grained, weakly foliated, and weathers a light grey to buff white. It is rimmed by a sheared, porphyritic, granitized gneiss. The contact, where exposed, is sharp. The granodiorite is possibly intrusive into the gneisses.

The granitized gneisses are succeeded by a zone composed predominantly of massive pink pegmatite, with minor discontinuous horizons of metasediment.

Between the pegmatite and the granitized gneiss is a thin section of interlayered amphibolite and biotite gneiss. The thickness of this horizon varies from 50 feet to 100 feet. Its dark grey to black colour, and commonly stained appearance, make it an excellent marker horizon. The amphibolite is composed of fine laths of hornblende, with minor plagioclase and quartz. The biotite gneiss consists of fine flakes of biotite in a matrix composed of plagioclase and quartz. The quartz in both rock types probably resulted from silicification during metamorphism. The interlayered nature of the unit suggests that it may be a metamorphosed volcanic wacke. These three units, granitized gneiss, pegmatite, and amphibolite-biotite gneiss, have been traced from the extreme southeast corner of the Watt Lake map-area, around the eastern end of the dome, referred to above, and along the northeast side of the dome.

The metasediments in the southwestern part of the map area are structurally continuous from the Watt Lake (East) map area, (Cranstone, 1968), Cranstone (op. cit.) and previous authors, have referred to these sediments as part of the Sickle Series. The sediments have been subjected to upper amphibolite facies metamorphism, and are locally migmatitic. The metasediments are predominantly light greenish grey feldspathic greywackes and subgreywackes, with subordinate dark grey siltstones and pinkish grey arkose. The strata are thin to medium-thick bedded (McKee and Weir, 1953). Bedding plane contacts are defined by abrupt changes in grain size and slight variations in colour. No top determinations were possible with any degree of confidence in this part of the sequence.

These metasediments contain a thick zone of injected migmatite and granitized greywacke, which parallels the northwest regional trend. The migmatite is composed of approximately 40 per cent light grey and pink granite. The remainder is granitized greywacke and massive pink pegmatite. The pegmatites are ubiquitous, in most cases intruded parallel to the foliation. However, the pegmatite generally follows the outline of folds, where the foliation has been contorted. These pegmatites frequently contain large masses of very pure magnetite, apparently derived from the granitized paragneisses.

The contacts of the migmatite with the metasediments are exposed in only two locations, both on the north shore of Granville Lake. At the northeastern contact, the migmatite is in direct contact with feldspathic greywacke, containing large quartz-muscovite-sillimanite porphyroblasts. A similar porphyroblastic zone lies south of the migmatite but separated from it by a non-porphyroblastic greywacke.

GENERALIZED REGIONAL GEOLOGY, TURNBULL LAKE AREA.

LEGEND

6 Granite.

5A Granite and granodiorite complex.

5B Diorite and granodiorite.

4 Granodiorite - granite dome complex.

3 Sickle Group.

2 Pyroxenite and minor diorite.

1 Wasekwan Group.

Figure 1-3

In most cases, the porphyroblasts are confined to individual beds. This mode of occurrence indicates that they are controlled by the original composition of the sediment. In some beds, however, they have developed across the bedding planes.

The Sickle Group metasediments are separated from the more basic metasediments of the eastern part of the map-area by a complex of coarse-grained light grey cataclastic granodiorite, intruded by a fine-grained massive pink and light grey granite.

The more basic metasediments in the eastern part of the area are fine to medium-grained greywackes, with minor well-laminated siltstone. They are intruded by amphibolites and pyroxenites containing metasedimentary inclusions. The overall basic appearance of the sediments, together with the basic intrusives, indicate to the author that they are probably derived from the Wasekwan Group or its equivalents. These sediments are apparently equivalent to those which crop out to the northwest at Stag Lake. However, the two areas are separated by approximately two miles of swamp, with very sparse exposure. Where exposed, however, the sediments in the swamp are similar to those which crop out on Granville Lake and on Stag Lake. There are also isolated exposures of fine-grained well-foliated diorite, massive fine-grained pink granite, and pegmatite. The diorite may have been derived from the metasediments.

The southwestern contact of the Wasekwan-type sediments is very well-defined on the Federal-Provincial aeromagnetic map of the area. Its northern contact, on the south side of Granville Lake is similarly well defined. The contact of the Wasekwan with the granite and granodiorite to the south almost exactly coincides with the 2600 gamma contour between Granville Lake and Stag Lake. The contact of the sediments and the massive granite to the north, however, is not defined on the aeromagnetic map.

On the western shore of Stag Lake, the metasediments are apparently in fault contact with the massive coarse-grained pink and light grey granite.

A small pyroxenite body is continuous across Stag Lake, and has been traced approximately 2000 feet inland to the east. Minor pyroxenite also crops out on the islands in Granville Lake. The pyroxenite is closely associated with a fine-grained, light grey, massive diorite. The pyroxenite also outcrops as a large mass on the western shore of Stag Lake, but traverses have failed to locate the body further to the west. The pyroxenite is defined by a slight high on the aeromagnetic map, in the regional low of the Wasekwan. The diorite on the north trending arm of Stag Lake, appears as a nearly circular low.

Isolated outcrops of fine-grained metasediment have been located west of Stag Lake. These can probably be correlated with the Wasekwan metasediments to the east. However, the sediments do not appear to continue into the Watt Lake Area. Cranstone (1968) has mapped pink granodiorite as far as the northern and eastern boundaries of the Watt Lake Area (East Half).

A massive, fine-grained, pinkish and light grey granodiorite and granite is intrusive into the metasediments near the northern boundary of the map-area. This granodiorite contains recognizable inclusions of Wasekwan sediments. Field evidence indicates that this is the latest intrusion in the area.

In the extreme eastern part of the area, well-foliated and massive diorite with dykes of fine-grained massive pink granite, is continuous to the eastern boundary of the area mapped.

Economic Geology

No mineralization of economic significance was located during the course of the field season.

Isolated occurrences of chalcopyrite in pegmatites are scattered throughout the area.

Mineralization is most common in the interlayered amphibolite and biotite gneiss sequence, located on the flank of the granite dome complex in the extreme southwestern corner of the map-area. In places these rocks contain minor massive or disseminated pyrite, with local chalcopyrite and subordinate pyrrhotite. All the sulphide locations are shown on Preliminary Map 1969E-2.

Structural Geology

The one recognizable major structural feature of the area is the dome in the southwestern part of the map-area. In addition to this dome the repititive lithologies on either side of the migmatized zone suggests that there may be another major structure present to the northeast. The evidence is insufficient at present to warrant including it on the map.

Major structural trends in the remainder of the area consist of lineaments determined from air photographs. When investigated in the field, these proved to be only local shear zones, with no discernible displacement. Most have been accentuated by the last ice advance.

Aeromagnetic Interpretation

Interpretation of the aeromagnetic maps of the region is relatively straightforward. The Sickle and the Wasekwan metasediments both are shown as "lows" relative to the granitic rocks of the area. The contact between the Sickle and the sheared granodiorite is very well defined as a strong linear, trending northwest across the southwestern corner of the map-area. The two isolated magnetic highs near the contact are both in the granodiorite, and may possibly be granitized remnants of amphibolite, or locally magnetic metasediments.

The magnetic high at the extreme northwestern corner of the map-area is entirely contained within the massive pink granite. There is no explanation at present for this anomaly.

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MYNARSKI-NOTIGI LAKES AREA
(64 B - 3 and 63 O - 14)
by S. C. Elphick

Introduction

The area mapped during the summer of 1969, is approximately delineated by latitudes 55° 52' N to 56° 15' N and longitudes 99° 00' W to 99° 20' W. The corresponding preliminary maps of the area at a scale of two inches to the mile are 1969E-3, 1969E-4 and 1969E-5. Within this area outcrop is good, although generally restricted to high ground and the lake shores. Geological contacts are mostly obscured, for, as a general rule, these follow depressions between outcrops, and are covered by overburden. Many of the linear depressions also probably mask small faults, although these were not recorded as such unless displacement on surrounding units could be proved.

General Geology

The units in the area were divided in the field into 'magnetiferous' and 'non-magnetiferous' types, on the basis of readily distinguished magnetite content, using a small hand magnet. This subdivision agrees well with general magnetic patterns in the area, and allows interpretation of some of the structure using the one mile to the inch Federal-Provincial aeromagnetic maps.

'Non-magnetiferous' units

Pelitic gneisses*

Type A

This is the most extensive unit in this classification, and is found mainly in the centre of the area. On outcrop it is pale grey in colour, highly migmatitic, and in hand specimen has a distinctly granular texture. The lit are of white, plagioclase-quartz-biotite granite, medium-grained, and generally equigranular. The biotite is present in subordinate quantities, generally less than 5 per cent.

The pelitic rock itself is fine-grained, and is an equigranular

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* The term pelitic is used in a metamorphic context and refers to a metamorphosed aluminous sediment.

mosaic of quartz and plagioclase, with subordinate amounts of K-feldspar in some layers. The biotite leaves wrap around the boundaries of the other grains. Cordierite is an intermittent component, and where present is always associated with sillimanite. The latter forms wisps and lenses of fine needles, often contained within the cordierite grains. Common in these gneisses are garnet porphyroblasts, up to 1 cm diameter. The full assemblage for a typical pelite, in decreasing volume content, is:

Plagioclase
Quartz
Biotite
Garnet — Mafic content less than 30 per cent
Cordierite
Sillimanite

In certain areas the pelitic gneisses have a rusty brown weathered surface, associated with a small graphite content. These are interpreted as old shear zones, and account for the E.M. anomalies on the west central part of the area, as recorded on the Questor Survey results.

Type B

This unit is basically similar to the type A gneisses but carries red granite lit, composed of microcline, quartz, some plagioclase, and subordinate biotite. The pelitic rock itself is dark grey to black, and richer in mafics than the type A gneisses. It carries more cordierite than the latter, and appears richer in sillimanite. This unit only appears in the central part of the area.

Note on cordierite occurrences: Cordierite is found in the pelitic units, as above, but also appears in some of the diffuse granitoid veins, showing these to be contemporaneous with the migration of magnesium and iron during the highest phase of metamorphism. This also accounts for the garnet found associated with the cordierite in these veins.

Amphibolites

Type A

Layers of amphibolite, varying in width from a few tens of feet to several hundred feet, are found throughout the area. Several thin layers are found in the pelite, and one continuous layer delineates a major fold to the southeast of Mynarski Lake. The amphibolite is well-layered, usually with greenish diopside-rich bands and lenses. Associated with these bands are minor amounts of disseminated sulphide.

Type B

This unit is similar to the normal amphibolite, but carries continuous thin calcite-rich layers, ranging in width from half an inch to six inches. These are soft and easily weathered, giving the outcrop its characteristic ridged surface, with a relief of an inch or more. This unit is only found at the northeast end of Notigi Lake.

Acid gneisses

Type A

These are white weathering, well-layered gneisses with layers, approximately one inch thick, delineated by thin biotite-rich partings. The biotite content is variable, so that the colour on fresh surface varies from white to pale grey. On shoreline outcrops, the biotitic layers weather out slightly, giving the gneisses a ribbed surface. The rock consists of a fine-grained equigranular mosaic of quartz and plagioclase, with minor biotite and scattered brownish pink grains of garnet, up to 1 mm in diameter. Thin blades of sillimanite are common in the acid gneiss, usually lying within the layering, and apparently related to shearing. The acid gneiss is common on central Mynarski Lake, and forms one member of the sequence in the fold to the southeast of central Mynarski Lake. Both the general composition of the gneiss, and the characteristic garnets, indicate that this unit is related to the pelitic gneisses.

Type B

These gneisses have the same migmatitic character as the pelitic gneisses but differ in having a much lower mafic content and hence a lighter, almost white, colour. The gneisses are composed dominantly of plagioclase and quartz, with very minor biotite and garnet. The garnet is characteristically very fine-grained, up to 1 mm in diameter, and brownish pink in colour. Diffuse lit in the gneisses consist of inequigranular white granite. The only extensive outcrop of this unit is on the northeast shore of central Mynarski Lake.

Arkosic gneisses

This unit is restricted to the central and western edge of the area. On outcrop it is light grey to light pinkish grey, fine-grained, and massive, generally showing a weak schistosity. It consists of an inequigranular aggregate of plagioclase, microcline, quartz, and biotite. The outcrop usually shows thin veins of red granite, and small fractures with pink edges, showing the effects of potash metasomatism. Occasional thin blades of sillimanite are seen, but these are typical. This unit may be related to the succeeding two units by a facies change, as this unit occupies the same relative position in the overall sequence.

Microcline gneiss

This unit, found along the northwest side of Notigi Lake, is a fine to medium-grained microcline-quartz-plagioclase gneiss, with subordinate biotite, and in some outcrops, muscovite. Microcline and plagioclase are usually segregated into alternating light pink and buff layers, up to two inches wide, giving the rock a good gneissic layering. This unit also carries sporadic blades of sillimanite.

Hornblende-plagioclase gneiss

This unit occurs only to the north of central Mynarski Lake, where it forms long ridges of outcrop. The gneiss is moderately equigranular and medium-grained containing with plagioclase, quartz, approximately 30 per cent hornblende, and subordinate biotite. It weathers white and has a coarse "salt and pepper" texture. The gneiss is slightly schistose due to the alignment of the hornblende.

"Magnetiferous" units

Biotite-plagioclase gneiss

This is a variable plagioclase-K-feldspar-quartz-megnetite-biotite gneiss, showing a wide variation in biotite and magnetite content and a corresponding colour variation on weathered surface between buff yellow and light brown. On weathered surfaces it has a characteristic fine-grained sandy appearance, and resembles a well cemented sandstone. The gneiss is poorly layered, except for intermittent biotite-rich partings. In these darker layers, the magnetite content approaches 5 per cent. This unit is found in the fold to the southeast of central Mynarski Lake, and as a wide belt enclosing most of Notigi Lake. The boundaries with the next unit, the hornblende-epidote gneiss, are gradational. Much of the hornblende-epidote gneiss actually contains thin layers of the biotite-plagioclase gneiss, such that the boundary between these units was placed to connect outcrops with an equal percentage of each unit.

Hornblende-epidote gneiss

This is one of the most distinctive members of the paragneiss sequence. It composes an equigranular mosaic of hornblende, epidote, microcline, plagioclase, and quartz with the epidote-hornblende and plagioclase-K-feldspar segregated into alternate pale green and pink layers. This layering is well-developed but the relation between the two types of layers is not clear. The plagioclase seems to be associated with the hornblende. This unit carries minor magnetite and so is classed as 'magnetiferous'. The hornblende-epidote gneiss forms the inner member of the sequence defining the fold to the southeast of central Mynarski Lake.

Arkosic gneiss

This unit is a light grey to light buff grey weathering gneiss, showing moderate gneissic banding on weathered outcrop surfaces, due to a subtle variation in plagioclase content. In hand specimen however it appears massive. It consists of a fine-grained equigranular mosaic of plagioclase, quartz and microcline, with subordinate biotite and magnetite. It is distinguished by its grain size, equigranular texture and the low but persistent magnetite content. It is found only in the northern part of the map-area, above Mynarski Lakes.

Biotite-hornblende-magnetite gneisses and schists

Biotite-hornblende-magnetite gneiss

This is moderately foliated, dark grey to black gneiss comprising subequigranular mosaic of quartz, plagioclase, and microcline, hornblende, magnetite and biotite. Total mafic content is approximately 40 per cent, with over 5 per cent magnetite in some samples. This unit is found only to the north of Mynarski Lakes, interlayered with the biotite-plagioclase gneiss, and hornblende-epidote gneiss.

Hornblende-magnetite schist

The hornblende-magnetite schist is found only as a thin band following the outcrop edge of the granite mass in the northeast corner of the map-area. The schist is a coarse-grained, dark grey to black weathering rock, with a well developed schistosity, defined by a linear orientation of the long-bladed hornblende crystals, that is, an L-tectonite. The hornblende is set in a matrix of plagioclase and minor quartz. Widely disseminated magnetite in the schist shows no obvious relationship to the other minerals. The magnetite content is generally less than 5 per cent, ranging up to a maximum of 10 per cent at some localities. This unit may be a reaction product between the granite to the west and the highly magnetiferous units to the east.

Magnetiferous white granite

This granite is found only in the northwest corner of the map-area. It is medium-grained equigranular mosaic of plagioclase and quartz, with minor biotite, hornblende and magnetite. The average grain size is approximately 3 mm. The granite is usually massive and weathers white. In some areas however, it shows a poorly defined schistosity. The magnetite occurs as small, euhedral crystals, disseminated throughout the rock, with an average content between 1 and 5 per cent. This magnetite was probably derived from the surrounding gneisses.

Tonalite

This is a distinctive, white, inequigranular rock, composed of plagioclase and quartz, with minor biotite. Grain size is variable, from medium-grain to pegmatitic, often on the same outcrop. The pegmatitic phases crystallized at a late-stage, after emplacement of the main granite mass, but before reaction had ceased. The only extensive outcrop is formed as a plug in the central part of the map-area.

Microcline granite

This rock type occurs throughout the area, mostly as concordant sills and less commonly in the form of small dykes. Cross-cutting relationships of the dykes indicate that this unit is younger than all others with the probable exception of the diabase sill on western Mynarski Lake.

The granite is red to bright pink, inequigranular and commonly contains large pegmatitic patches. It is composed of microcline and quartz, with minor plagioclase. The microcline content is usually between 60 and 70 per cent. Biotite is generally the only mafic constituent, although muscovite is locally common. The surrounding country rocks usually show extensive potash metasomatism.

Ultramafic intrusion

A metamorphosed ultramafic sill outcrops on the southeast side of central Mynarski Lake. The sill appears to be layered, with an original composition ranging from pyroxenite to hornblende-biotite-quartz diorite. It has been converted into a hornblendite with relict clinopyroxene and olivine in the more mafic layers. A complete description of the sill is given by Carlson (1962).

Metadiabase

A slightly metamorphosed diabase sill occurs on eastern Mynarski Lake. It is fine-grained, dark grey on outcrop, massive and well-jointed. A more complete description of the metadiabase is given by Carlson (1962).

Structural Geology

The area is typified by dome and basin folding superimposed on an early isoclinal fold period. The domal type of folding is well-displayed in the southern part of the Mynarski Lake (East Half) map sheet (Preliminary Map 1969E-4). The early isoclinal folding is reflected by the general northwesterly regional foliation trend. This event is probably represented by a set of folds plunging at shallow angles to the east. The second period of folding is exemplified by the large fold outcropping on Fold Lake. The axis of this fold plunges 30 - 40° to 035. A third fold direction is suspected, but not yet definitely proved.

Magnetic maps of the Mynarski Lake area indicate a major structural or sedimentary break. The general trend of the magnetic highs to the north of Mynarski Lake is to the northeast, while the foliation and magnetic trends to the south of the lake system are to the northwest. The main folding patterns are self-evident from the maps, especially in the southern half of the Mynarski Lake sheet (Preliminary Map 1969E-4). The large-scale fold around Notigi Lake, with the nose outcropping on Fold Lake, to the northeast is interpreted as a refolded fold. The strike of the original axial plane was to the east. The axial plane of the later superimposed fold strikes north-northeast and dips steeply. This accounts for the apparent duplication of units round Notigi Lake. This interpretation however is highly tentative.

Economic Geology

No deposits of economic interest were found during the field work. Electromagnetic anomalies in the area defined by Questor Surveys INPUT survey were checked, and found to correspond to graphitic shears within the pelitic gneisses. The ultramafic sill is barren. The only reported mineral occurrence of any economic interest is a small silver prospect on the southern shore of Notigi Lake, which was checked and found to be a narrow, slightly mineralized quartz vein.

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RAT LAKE AREA

(64 B - 4)

by D. C. P. Schledewitz

Introduction

The area of investigation lies between latitudes 56° 00' and 56° 18' and longitudes 99° 55' and 100° 00' and comprises approximately 500 square miles, (N.T.S. area 64 B - 4).

The 1969 field work was essentially confined to an investigation of the shore lines of the lakes and rivers. Pace and compass traverses for additional control were conducted inland. Helicopter supported traverses were carried out south and southwest of Rat Lake. Preliminary Maps covering the area are 1969E - 5, 1969E - 6 and 1969E - 7.

General Geology

A sedimentary cover that has been folded, refolded, metamorphosed to the upper amphibolite facies, and intruded by granodiorite and granites, now exists as three bands in the map-area. Two of these have an easterly trend, one of them through Pemichigamau Lake and the other along the Reading River. The third band trends southeast and occupies the southern portion of the map-area.

The true stratigraphic sequence of the metasedimentary cover has not been determined at the present time. The following is a brief description of the metasedimentary units and rocks.

(a) Pelitic gneisses, biotite-garnet (cordierite-graphite)-plagioclase-quartz gneisses. This unit has a distinctive outcrop appearance due to its migmatitic and highly folded character. The white quartz and plagioclase quartz lit, which comprise up to 25 - 30 per cent of the rock, commonly have a boudined appearance in cross-section and display ptygmatic folding. There is a distinct contrast between the biotite-bearing layers and the whiter lit, in both colour and weathering relief. This unit appears to be correlatable with the pelitic gneisses described by S. C. Elphick (this publication).

(b) Amphibolites - These range from a weakly foliated granular rock, to a well-layered amphibolite, in which pale green plagioclase diopsidic boudined layers, alternate with black, fine to medium-grained hornblende-rich layers.

Of minor occurrence but worthy of mention because of its distinctive appearance is a highly calcitic amphibolite. The calcitic layers are 1 inch to 4 inch layers of coarse to medium-grained calcite containing knots of hornblende and plagioclase. These layers occur in a dense fine-grained amphibolite and weather out to give a three-dimensional exposure of minor folds.

(c) Interlayered arkosic and quartzo-feldspathic gneisses - These are buff to grey or reddish grey in color. The buff arkosic rocks contain as much as 10 per cent sillimanite, either in the form of elongate lenses or as thin planar smears that show intense shearing. All these rocks contain varying proportions of pink to buff granite lit which commonly display ptygmatic folding. In areas of intense shearing, such as the northerly trending arm at the western end of Rat Lake, the granite lit are particularly abundant, forming a migmatized equivalent of the quartzo-feldspathic gneisses.

(d) Magnetiferous biotite-plagioclase-K-feldspar-quartz-gneiss - This is a fine-grained biotite and magnetite-rich gneiss. Weathered surfaces are medium to dark grey in color and have a rough, slightly pitted appearance.

(e) Microcline gneiss - This is a deep pink to reddish pink fine to medium-grained well-layered microcline gneiss. The layering is defined by thin bands of biotite, approximately 1 mm wide, and by variations in grain size. The microcline gneiss is commonly associated with a well-layered hornblende-epidote-magnetite-K-feldspar gneiss.

(f) Feldspathic quartzites - This unit consists of fine-grained pink to grey feldspathic quartzites with a well-defined layering and clastic texture. Possible crossbedding and load cast structures were observed in these rocks at Pemichigamau Lake.

Intrusive rocks

Granites

The three metasedimentary bands are separated by granitic intrusions of two distinct types:

(i) White to light pink, medium to fine-grained biotite-magnetite granite. The magnetite occurs as spheroids, usually coarser grained than the rest of the rock. This granite is essentially confined to the north half of the map-area.

(ii) Dark pink, medium-grained to pegmatitic biotite-microcline granite to granite gneiss. This granite has a well-defined foliation except in the coarse-grained and pegmatitic portions. It occurs as elongate stocks on the northern edge and within the most southerly metasedimentary band.

Granodiorite and tonalite

Two bodies of intermediate composition are shown on Preliminary Map 1969E - 6. One of these, near the centre of the map-sheet, has a granodioritic composition and is possibly intrusive. At its contact with the magnetiferous granite, the potassium-feldspar in the granodiorite becomes deep pink in color. This alteration has also taken place where the granodiorite is sheared.

The granodiorite appears to be intruded by the magnetiferous granite. Altered blocks of the granodiorite were found in the magnetiferous granite at its contact with the granodiorite. The contact between the granodiorite and the metasedimentary rocks is not well exposed.

The second body has a tonalitic composition. It has a granular appearance and contains an abundance of hornblende-plagioclase-quartz pegmatite veins. A weakly developed foliation in the tonalite is parallel to that in the adjacent quartzo-feldspathic rocks. The origin of this unit and its relationship to the surrounding rocks is uncertain. It is, however, intruded by the younger magnetiferous granite.

Aeromagnetic Interpretation

A good correlation exists between the various lithologic units and their magnetic expression on the Federal-Provincial aeromagnetic maps of the area (2387G, 2388G, 2395G and 2396G):

(i) The dark grey magnetiferous plagioclase-K-feldspar-quartz gneiss, and the well-layered grey to pink magnetiferous feldspathic quartzite correlate with linear zones of high magnetitic intensity (3,100 - 3,500 gammas).

(ii) The grey to buff arkosic and quartzo-feldspathic gneisses, are generally associated with magnetic intensity of 2,900 - 3,100 gammas.

(iii) The pelitic gneisses can be correlated with areas of lowest magnetic intensity, ranging from 2,200 to 2,600 gammas.

(iv) The magnetiferous granite is characterized by a non-linear magnetic pattern, with the magnetic intensity ranging from 2,600 to 2,900 gammas.

Structural Geology

The structural continuity in the area as well as the continuity of the metasedimentary units, has been disrupted by the large bodies of granitic rocks. Intrusion of the granite rocks also appears to have modified pre-existing structures.

1) Isoclinal folding, about steeply dipping, easterly trending axial planes is indicated by minor folds in the quartzo-feldspathic rocks. The strike of the axial planes varies between 075 and 100. The folds plunge to the east at moderate angles. The regional foliation probably developed parallel to the axial plane direction of the early, easterly trending isoclinal folds. Crystallization of granite lit in the magmatites, parallel to the foliation, has produced a secondary layering which is oblique to the original layering at the hinges of the isoclinal folds. Elsewhere the foliation and layering are parallel. Sedimentary layering on Pemichigamau Lake, for example, is parallel to the foliation.

The easterly trending regional foliation has been deflected at the west end of Pemichigamau Lake to a north-northwesterly direction as a result of later folding. No definite layering could be identified in this area, so that the relationship of the foliation to original sedimentary layering is uncertain.

The Reading River metasedimentary band has been refolded into a series of major S-folds. In the area where the river enters Rat Lake, the structural picture is further complicated by the transposition of layering parallel to the axial plane direction of the S-folds. Sillimanite knots in the folded arkosic rocks show a strong preferred orientation parallel to this axial plane direction.

2) In the southern half of the map-area, the foliation trend is to the northwest. A prominent shear direction also parallels this foliation trend. The long linear northwest trending central portion of Rat Lake appears to be controlled by this northwesterly shear direction. Minor folds

in this area have moderate to steep plunges, and axial planes which also strike to the northwest.

3) At the western edge of Preliminary Map 1969E - 6 (64 B - 4, East Half). A strong northerly trending shear direction crosses the northwest trend. The long northerly trending arm of the southern part of Rat Lake appears to follow this prominent shear direction. Foliation planes and the axial planes of minor folds in the metasediments along the west shore of this arm, strike in a north to northwesterly direction. In places, however, there appears to have been a transpoistion of layering into parallelism with this northerly trending shear direction.

The large "U" shaped island in Rat Lake is located at the intersection of the north and northwest shear directions. The metasediments on the island are complexly folded and intensely sheared. On the southern tip of the island, a cataclasite has been produced from the arkosic and pelitic rocks. The dominant foliation and fold direction on the island however, appears to be northwest.

4) A northeasterly trend appears to be present in the western part of the area (Preliminary Map 1969E - 7). Information in this area was collected from widely spaced exposures, but the foliation pattern is suggestive of folding about northeastward striking axial planes.

In parts of the area, a pattern of basin and dome folding is evident from the foliation trends, and is apparent on aerial photographs of the area, and on aeromagnetic map 2387G. This structural pattern may have resulted from the interference of folding about northeast and northwest striking axial planes.

5) In the southern part of Preliminary Map 1969E - 5 (Mynarski Lake) the structure along the Rat River appears to have been affected by emplacement of the white magnetiferous granite.

Economic Geology

A large number of anomalies defined by the Questor INPUT electromagnetic survey in the area were investigated. Sulphide and graphite occurrences found in the field could all be related to E.M. anomalies.

A zinc sulphide occurrence at longitude 99° 33' 29" and latitude 56 ° 11' 32" can be correlated with a 4 and 5 channel anomaly with direct magnetic correlation. The sphalerite occurs in veins and pods within a joint set in a monzonitic to granitic body, which intrudes a sheared and foliated rock with a granodioritic to dioritic composition. The joints are very steep to vertical and strike 240 to 290.

At longitude 99° 30' 10" and latitude 56° 07' 25", a 4 channel anomaly, with direct magnetic correlation, is possibly related in part to disseminated pyrrhotite in a silicified amphibolite. Approximately 3 to 5 per cent pyrrhotite is present. However, it is likely that the anomaly is also caused by disseminated graphite in pelitic gneiss, and associated quartz veins. The pelitic gneiss is in contact with the amphibolite at this point.

At a point 1.1 miles east of this anomaly, 2 and 3 channel anomalies along the south side of the Rat River are located over a similar minor pyrrhotite occurrence in an amphibolite, which is again associated with graphitic pelitic gneiss.

Anomaly trends south of the Suwannee River (Preliminary Map 1969E - 7) and east of the Rat River (Preliminary Map 1969E - 5), appear to be associated with graphitic zones in the pelitic gneiss.

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THE OPACHUANAU LAKE-RUTTAN LAKE-ISSETT LAKE-SWAN BAY AREA

(Parts of 64 B - 5, 10, 11, 12)

by M. A. Steeves

Introduction

A portion of the geology of the Opachuanau Lake-Ruttan Lake-Issett Lake-Swan Bay area was mapped in the 1969 field season as part of the Southern Indian Lake project (Preliminary Maps 1969E - 8, E - 9, E - 10, E - 11). Previous mapping in the area at a scale of one mile to the inch was done by Burwash (1962), Pearse (1964), Milligan (1964) and Bristol (1966). A preliminary reconnaissance map at a scale of 4 miles to the inch and covering the entire present map-area was published by the Geological Survey of Canada (Wright, 1953).

Geologic mapping in areas north of the twenty-third base line on the Opachuanau and Issett Lake map-sheets (64 B - 12 and 64 B - 11) was done by R. W. Hinds (1969) and on the Swan Bay map-sheet (64 B - 10) by T. G. Frohlinger (1969). The discovery of the Ruttan Lake base metal deposit has focussed attention on the economic importance of the Rusty and Ruttan Lakes area.

General Geology

The Rusty Lake greenstone belt

The oldest rocks in the map-area appear to be a group of volcanic rocks and derived sedimentary rocks. These rocks have previously been grouped with the Wasekwan Series of the Lynn Lake district by Burwash (1962). This classification was followed by Pearse (1964), Milligan (1964) and Bristol (1966). Field relations between the Wasekwan volcanic and sedimentary rocks suggest that the volcanic rocks are the older, but this interpretation is by no means final.

(a) Volcanic rocks (1)*

The Wasekwan volcanic rocks are highly schistose to almost massive black to greenish fine-grained rocks. A preliminary study of thin sections reveals that most of them have a basaltic composition. Mafic minerals commonly exceed 50 per cent. The most abundant mafic mineral is hornblende

* Numbers in parentheses refer to map-units on Preliminary Maps 1969E - 8, E - 9 and E-10.

although up to 20 per cent biotite may be present especially in the more andesitic parts of the sequence.

Rocks of rhyolitic-dacitic composition also exist in the volcanic sequence. These invariably are associated with pyroclastic rocks and occur as small lens-like bodies that in most cases are not mappable. The largest of the rhyolite-dacite lenses occurs along the contact between the volcanic and sedimentary rocks south of Rusty Lake. These more acidic volcanic rocks are composed mainly of potash feldspar, sodic plagioclase and quartz, and show evidence of at least partial recrystallization.

(b) Sedimentary rocks

Wasekwan Series (2)

The sedimentary rocks of the Wasekwan Series are, for the most part, poorly exposed and almost all are recrystallized. The major part of the sedimentary sequence is made up of acid to intermediate tuffaceous rocks; fine to medium-grained dark green schists that have been locally recrystallized to amphibolites; and fine-grained black quartz-biotite schists. The amphibolitic rocks are probably the metamorphosed equivalents of volcaniclastic rocks and greywackes. The quartz-biotite schists were probably derived from a more argillaceous sedimentary rock. Minor bands of conglomerate, recognizable meta-arkoses and quartzites are also found in this sequence, but seldom constitute mappable units.

Biotite-muscovite-schist (4)

Only one unit of what Burwash (1962) and Bristol (1966) called the Sickle series of sedimentary rocks was mapped by the writer. This is a biotite-muscovite schist that runs eastward from the eastern shore of Opachuanau Lake, south of the twenty-third base line, into the western portion of the Issett Lake map-sheet. This rock type is medium-grained and very dark grey in color. In addition to biotite and muscovite it contains quartz, plagioclase and potash feldspar.

(c) Intrusive rocks

Small irregular plugs of hornblende diorite and quartz diorite (map-unit 3) probably constitute the earliest intrusive rocks in the map-area. These rocks are foliated and have been affected by at least one period of folding. The dominant mafic mineral in these coarse-grained dark grey rocks is hornblende, which appears to have been altered at least in part to a fibrous amphibole.

The main body of quartz diorite (unit 5), located in the central portion of the Issett Lake map-sheet and the western edge of the Rusty Lake sheet, does not come in contact with map-unit 3. The quartz diorite is poorly foliated except near the contacts, and several parts of the batholitic body are massive. The main mafic mineral in this rock is biotite which forms lenticular clots. Neither the biotite nor the hornblende has suffered extensive alteration. Minor zones of quartz monzonite, granodiorite and granite also occur in this unit.

The only mafic intrusive rocks observed by the writer were the small ultramafic plugs in the Swan Bay area and the zoned gabbro dyke on the west shore of Rusty Lake (map-unit 9). Hornblende is the dominant mafic mineral in both rock types, much of it apparently forming pseudomorphs after pyroxene.

At least two separate ages of granite exist in the region. The older granite is a coarse-grained pink biotite-hornblende granite (10b) covering the southern portion of the Pemichimigau and Earp Lake (Milligan, 1964) map-sheets and the southwest corner of the Rusty Lake sheet. A lighter coloured, almost white biotite granite (10c) is found in the central portion of the Pemichimigau Lake sheet. Its relationship to map-units 3 and 10b are not clear, as no contacts were observed during the field mapping.

Younger granitic rocks (11) are located in the Swan Bay area. They are pink biotite granites that are coarse-grained and almost completely massive. A zone of quartz diorite (11b) exists between the granitic rocks and the gneisses and probably represents a contact phase of the granite (11a). Units 11a and 11b correspond to units 4c and 3a respectively, on the Swan Bay map-sheet.

(d) Paragneiss (6a)

These gneisses are found along the twenty-third base line in the Rusty Lake and Issett Lake sheets where they seem to bend around the quartz diorite batholith (unit 5). Poor exposure at contacts prevented the writer from determing their age relationships to this batholith. The biotite-hornblende-feldspar-quartz gneiss (6a) is a greyish white, medium to coarse-grained rock that exhibits good lit-par-lit layering as well as a marked gneissosity.

(e) Pegmatite (12)

Pegmatite occurs mostly in dykes, although a fairly large plug outcrops just south of the twenty-third base line on the Issett Lake map-sheet. Two distinct varieties of pegmatite occur: a white albite pegmatite and a pink perthitic orthoclase pegmatite. Both types may contain muscovite or biotite but seldom both. At least two ages of orthoclase pegmatite occur but age relationships between it and the albite-bearing variety are unknown. Unit 12 corresponds to unit 6 on the Swan Bay map-sheet.

(f) Diabase (13)

Two fairly large diabase dykes are present just east of Ruttan Lake. Smaller dykes were observed in the paragneisses and in the Wasekwan Series. The diabase is black in color and ranges in grain size from aphanitic to coarse-grained. Pearse (1964) states that pyroxene is the most abundant mafic mineral.

Metamorphism

The metamorphic grade of the rocks in the Rusty Lake greenstone belt varies from the upper greenschist to the lower amphibolite facies. In the gneissic terrains, north of the greenstone belt and further east towards Swan Bay, the rocks were probably metamorphosed to at least the middle amphibolite facies.

Structural Geology

Very few primary structures were encountered in the map-area. In places, relict bedding, pillow structures and amygdales have survived metamorphism, but are too deformed to use for top determinations.

Two types of minor folds were recognized in the Opachuanau Lake-Ruttan Lake-Issett Lake-Swan Bay area. The first type comprises an easterly plunging series of folds which are predominantly similar in style. The inter-limb angle in these folds is generally less than 45 degrees. Minor folds of the second type are more open and plunge to the north, some of them are almost perfectly concentric. One major fold has also been defined. This is an easterly plunging antiformal fold encompassing Rusty Lake.

Most of the minor faults in the area trend in a northeast to northwest direction with right lateral apparent movement. Minor shear zones are also present and these trend in a more easterly direction. The sense of movement in these shears is not known. No major faulting can be proven conclusively at this time.

Economic Geology

All the rocks in the Rusty Lake-Ruttan Lake-Issett Lake-Swan Bay area contain at least some mineralization with the exception of the pegmatites.

The rocks of the Wasekwan Series are the most heavily mineralized, with pyrite and pyrrhotite the dominant sulphides and minor amounts of chalcopyrite. The mineralization occurs mostly in thin tuffaceous beds or intercalated sedimentary horizons in the volcanic sequence and in certain horizons in the sedimentary part of the sequence.

The Ruttan Lake copper-zinc deposit is located in the southern part of the Rusty Lake greenstone belt near the contact of the basic volcanic rocks with a small band of hornblende diorite. The main ore zone as reported in The Northern Miner (July 31, 1969) is approximately 2,800 feet long and 85 feet wide with an estimate of 24,000 tons of ore per vertical foot. The south zone is 1,150 feet long and 58 feet wide with 6,000 tons of ore per vertical foot. The south zone branches off the main zone, and parallels the main zone near the east end of the deposit. Both ore horizons dip 65 degrees to the south and plunge to the east. The reported average grades are 1.26 per cent copper and 2.98 per cent zinc in shallow diamond drill holes; and 1.29 per cent copper and 1.87 per cent zinc for deeper holes. The Ruttan Lake deposit corresponds to a 6 channel anomaly on the Questor INPUT Electromagnetic Survey.

The gneisses and intrusive rocks also show some mineralization, but this usually takes the form of disseminated pyrite.

In the Opachuanau and Issett Lake areas, two prominent electromagnetic anomaly trends have been defined from the Questor INPUT Electromagnetic Survey of the Southern Indian Lake area. One of these trends follows a south to southeast direction and corresponds approximately to the folded mineralized horizon which Burwash (1962) referred to as a pyrrhotite-bearing tuff. This horizon is located to the east of Rusty Lake.

The second major anomaly trends further to the east, follows an elliptical form and may correspond to a series of shear zones. In this area, pyrite was the only sulphide observed on the outcrop. Much of the area is drift covered.

Although anomalies south of Swan Bay were not examined during the 1969 field season, a number of isolated anomalies were checked on the shoreline of South Bay and Swan Bay. These were found to correspond to small shear zones containing pyrite and pyrrhotite.

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OPACHUANAU LAKE–SOUTHERN INDIAN LAKE AREA

(Parts of 64 B - 4, 11, 12, 13, 14)

by R. W. Hinds

Introduction

The area mapped during the 1969 field season comprises a triangular segment including the south shore of Southern Indian Lake as far east as 99° 15' and the central and northern part of Opachuanau Lake as far west as 99° 40'. The southern boundary of the area is defined by the 23rd base line. Portions of the triangular map-area are included on Manitoba Mines Branch Preliminary Maps 1969E-9, E-10, E-13, E-14, and E-15. The northern edge of the map-area is defined by a prominent linear magnetic high which continues to the northwest and southeast beyond the present map-area.

Approximately one-third of the map-area is covered by the waters of Opachuanau Lake and Southern Indian Lake. The shoreline and islands of the two lakes offer an almost continuous band of outcrop. An extremely low water level on the lakes during the summer of 1969 allowed examination of many outcrops not seen during previous mapping. Large areas of outcrop are associated with the large granite batholith in the northern corner of the area, and with the easterly trending gneissic belt east of Opachuanau Lake. All the shoreline outcrops were examined and traverses were run at half mile intervals inland.

General Geology

The southern part of the map-area consists of an easterly trending Kisseynew-type paragneiss belt, flanked on the north and south by biotite granite. There is a bulge in the gneissic belt, produced by the intrusion of a granite body in an area now mainly covered by the northern part of Opachuanau Lake. The northern and southern edges of the gneissic belt are separated from the biotite granite by quartz diorite and/or acid gneiss bands.

The present area is contained in an area previously mapped at a scale of four miles to the inch by Wright (1953). Portions of the area are also covered by Manitoba Mines Branch one inch to one mile maps by Tedlie (1958), Burwash (1962), and Bristol (1966). The previous work has been revised where necessary, and an improved division and correlation of lithologic units attempted. Adjoining areas to the north and south were mapped by K. Thomas and M. Steeves respectively. Simultanecus mapping of boundary areas with these colleagues has ensured continuity and correlation to the north and south.

Hornblende-plagioclase schist; quartz-feldspar-biotite schists

Schists in the Opachuanau Lake area and constituting part of the easterly trending Kisseynew-type paragneiss belt, appear to be the oldest rocks in the area. The main band of schistose rock occurs one-half mile north of the 23rd base line and outcrops on both the east and west shores of Opachuanau Lake. This band is a hornblende-rich plagioclase schist with abundant epidote and garnetconcentrations. It is separated from finely banded quartz-feldspar-biotite schists to the south, by a few feet of granite pebble conglomerate. The finely banded quartz-feldspar-biotite schists can be followed across the entire map-area in an easterly direction. The hornblende-plagioclase schists on the other hand grade to the east of Opachuanau Lake into a hornblende-feldspar-quartz gneiss.

Intermediate gneisses

Hornblende and biotite-rich intermediate gneisses constitute the largest portion of rocks in the eastern part of the Kisseynew-type gneissic belt. The predominate intermediate gneiss is a medium-grained hornblende-biotite-feldspar-quartz gneiss. Amphibolite bands with epidote concentrations are associated with the hornblende-rich gneiss. The biotite-hornblende-feldspar-quartz gneiss occurs in areas close to granite bodies or acid gneisses, forming a band at both the northern and southern edge of the belt.

Mafic and ultramafic rocks

Small outcrops of coarse-grained amphibole-rich ultramafic rock were encountered at four localities in the easterly trending gneissic belt. The rocks at all four localities have a similar mineralogy but differ in their degree of alteration. Preliminary thin section examination of one body on the east shore of Opachuanau Lake shows large amphibole crystals up to 2 cm in size extensively altered to biotite. Less than 10 per cent feldspar and quartz are present. The two outcrops on Southern Indian Lake occur along strike from one another. An outcrop mapped by Tedlie, of possibly the same rock type, is located three miles further to the northwest, but also approximately along strike. The ultramafic band on Southern Indian Lake occurs within, or at the margin of a hornblende-rich schist which in turn is flanked on both sides by quartz diorite. The two ultramafic occurrences on Opachuanau Lake cannot be traced along strike to any other outcrop. They are presumed to be discontinuous bands parallel to the foliation. Contact relationships seen on the outcrop in the extreme northeast corner of Opachuanau Lake suggest an intrusive relationship.

An intrusive plug of uralized gabbro in the southeast corner of the Grandmother Lake area (64G - 4 SE) was sampled to determine the homogeneity of the body. The extent of the body seems to be less than previously mapped (Quinn 1955). An ultramafic zone consisting mainly of pyroxenite and anorthosite occurs in the southern part of the plug. Up to 3 per cent sulphides, mainly pyrite and minor chalcopyrite, are locally found in the ultramafic section. The gabbro appears to intrude the surrounding acid gneisses but its age relationship to the adjacent granite is at present not clear.

Quartz diorite

The quartz diorite occurs as bands up to two miles wide between the Kisseynew-type gneisses and the granite or acid gneisses. It has a similar mineral assemblage to the hornblende-biotite-feldspar-quartz gneiss but is homogeneous. The quartz diorite gradually becomes foliated as it approaches the gneisses. The contact is gradational and difficult to place. Near the acid gneiss or granite contact, granitic dykes intrude the quartz diorite, gradually increasing in abundance until the quartz diorite becomes separated into inclusions within the acid gneisses.

Acid gneisses; gneissic granite

The acid gneisses and gneissic granite occur at the margins of the granite batholiths. They are formed by the intermixing of the granite and the intermediate gneisses or quartz diorite. The prevalent rock types in this unit are gneissic granite with inclusions of quartz diorite; coarse-grained grey pegmatite; light grey, fine-grained foliated biotite granite; and a porphyritic gneissic granite. Some irregular amphibolite bands occur in the acid gneisses along the contact of the northern granite batholith.

Biotite granite

The three large batholiths of biotite granite all contain a similar medium-grained light pink phase. The northern, and largest granite mass examined, contains little pegmatite but has large zones of grey granite. The granite underlying most of the northern part of Opachuanau Lake contains large masses of very coarse-grained muscovite and biotite pegmatite. The granite body examined along the 23rd base line is homogeneous, medium-grained and light pink with very little associated pegmatite. The age relationships among the three granites was not seen in the area mapped.

Pegmatites

Pegmatite intrusions are most common in an area around Opachuanau Lake and extending into the gneissic belt to the east. The pegmatites around Opachuanau Lake contain muscovite crystals up to 5 cm in length. A large pegmatite zone extends in a northeasterly direction for four miles from the south shore of Southern Indian Lake to the eastern shore of Opachuanau Lake. This zone outcrops as a line of relatively high, bald, rounded outcrops in which up to 25 per cent gneissic inclusions are present.

Structural Geology

The regional foliation in the area has a predominant easterly trend as defined in the Kisseynew-type gneissic belt. The foliation changes to a southeasterly direction north of Opachuanau Lake, possibly because of the intrusion of the granite body underlying Opachuanau Lake. A large synform has been defined near the centre of the gneissic belt, east of Opachuanau Lake and north of the 23rd base line, by a change in strike of the steeply dipping foliation planes. The axis of the synform is contained within the narrow strip of finely banded acid gneisses and schists along the entire gneissic belt.

Aeromagnetic interpretation

The easterly trending gneissic belt is defined by a magnetic high approximately 400 gammas above the magnetic field over the three surrounding granite bodies. The Opachuanau Lake granite has a sharp contact with the surrounding gneisses and schists and can be easily projected beneath the lake. The splitting and folding of the gneissic belt by the Opachuanau granite can be traced on aeromagnetic maps beyond the present map-area to the west. The cause of linear magnetic feature with discontinuous highs, that defines the northeastern extent of mapping, could not be determined at any point during the mapping. The most likely possibility is that it may be a fault zone intruded by a discontinuous basic dyke.

Economic Geology

Sulphide occurrences in the main part of the map-area are limited to a small number of outcrops of acid gneisses. The sulphides occur only in trace amounts. The sulphides associated with the McBen Lake gabbro, occur in a uralized gabbro very similar to the Lynn Lake Gabbro. Further investigations are being carried out on this gabbro.

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SOUTHERN INDIAN LAKE (SOUTHWEST) AREA

(Parts of 64 B - 13 and 14, and parts of 64 G - 3 and 4)

by K. A. Thomas

Introduction

Mapping has been commenced in an area of approximately 400 square miles, on the southwest side of Southern Indian Lake, bounded by longitudes 99° 02' and 99° 42' and latitudes 56° 46' and 57° 11' (parts of National Topographic Series sheets 64 B - 13, 64 B - 14, 64 G - 3 and 64 G - 4).

Preliminary Maps covering the area are 1969E-13, 14, 15 and 16. Adjoining areas to the south and east were mapped concurrently by R. W. Hinds and T. G. Frohlinger respectively.

The topography of the area consists of a series of rocky ridges and hills separated by low drift covered areas. Rock outcrops are most abundant along lake shores and river banks. The ridges and hills generally consist of granititic rocks, whereas the intervening low lying areas, and long bays or inlets, are underlain by rocks of sedimentary origin.

General Geology

The oldest rocks in the area, and covered by Preliminary Map 1969E-13, are the paragneisses. These contain interlayered metagreywacke, metaquartzite and biotite schist. Amphibolites have also been included in this unit where they appear to have an obvious sedimentary origin. These rocks have been injected by granitic material and partially granitized.

Two distinctive types of more highly granitized gneisses have been recognized in the area.

(a) Lit-par-lit type biotite-feldspar-quartz gneisses occurring in the northeastern part of the map-area (Preliminary Map 1969E-16). The granitic layers in these gneisses are up to 1.5 inches wide.

(b) Biotite-feldspar-quartz gneiss containing 25 - 75 per cent injected or segregated granitic material occurring throughout the central part of the map-area (Preliminary Maps 1969E-13 and E-16). The limits of 25 and 75 per cent granitic material were arbitrarily chosen for mapping purposes. Gneissic granite and minor quartzite, amphibolite and hornblende-biotite gneiss are included in this unit. Some outcrops show small blocks of gneissic rock partially assimilated by massive granite.

Two granitic complexes occur in the northeast and the southwest parts of the area.

(a) A large batholith of pink, porphyritic granite occurs in the northeast part of the area. This rock is massive and contains potash feldspar phenocrysts approximately 2 inches long. Finer-grained, more gneissic granite forms the outer part of this batholith. The granite here contains more mafic material due to the assimilation of the bordering biotite-feldspar-quartz gneiss. Quartz diorite and diorite phases occur throughout the granite but are too limited in extent to form mappable units.

(b) In the southwestern part of the areathe large granitic complex consists of a central core of pink granite surrounded by zones of grey granite, quartz diorite and gneissic granite (Preliminary Map 1969E-14 and E-15). The pink granite weathers from a pale pink to a greyish pink. The fresh surface is darker pink and sometimes red in color. The granite is massive in its central portion but a distinct foliation is developed towards the margins accompanied by an increase in mafic content. Inclusions of assimilated paragneiss increase within the gneissic granite towards the margins of the complex. The gneissic granite eventually grades into paragneiss as the proportion of granite decreases.

Pegmatites occur throughout the granitic rocks. The feldspar-quartz-biotite pegmatites associated with the porphyritic granite are unzoned, fairly uniform in texture and composition and weakly foliated. The pegmatites associated with the southeastern granitic complex are zoned with an aplitic marginal zone and a central zone containing potash feldspar crystals approximately 2 inches long. None of the pegmatites in the map-area is large enough to form a mappable unit.

Structural Geology

No primary structures were identified in the older gneissic rocks.

Minor folds and mullion structures occur locally in the northern part of the area.

The large batholith of pink porphyritic granite is a dome with the foliation in the surrounding gneisses wrapped around it.

Several prominent topographic lineaments occur in the map-area. These are generally in the form of long valleys with steep cliff faces on the valley sides. The lineaments can be traced for several miles on aerial photographs and may coincide with faults. Shearing has been observed along the valley walls.

Economic Geology

No major occurrences of economic minerals have been found in the map-area. One minor occurrence in the area covered by Preliminary Map 1969E - 16 consisted of pyrite and traces of pyrrhotite disseminated throughout a granitized interlayered sequence of paragneisses and amphibolite.

Three miles southeast of Barlow Lake a second minor occurrence consists of traces of disseminated pyrite in biotite-feldspar-quartz gneiss (Preliminary Map 1969E - 13).

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SOUTHERN INDIAN LAKE - CENTRAL PORTION

64B-15, 64G-2 and 7; and parts of 64B-10, 11, 14 and 64G-3

by Thomas G. Frohlinger

Introduction:

The map area is bounded by latitudes 56° 41' and 57° 21', and longitudes 98° 38' and 99° 10'. The northern two-thirds of the area falls within NTS map sheet 64G (Big Sand Lake); the southern one-third in the NTS map sheet 64B (Uhlman Lake). The settlement of South Indian Lake lies in the south-central part of the map area.

During the 1969 field program, approximately 800 square miles were examined and mapped at one-half mile to the inch. Preliminary Maps (1969E series) of the area are available at the same scale. The following maps cover the area: 1969E -10, -11, -12, -17, and -20. These are adjoined by 1969E - 13 and 16 to the west mapped by K. A. Thomas and R. W. Hinds, and 1969E -18 and -19 mapped by J. Cranstone, to the east.

Previous work in the area by Quinn (1959) has been completely revised. Other work by Wright (1953) and Davison (1968) was found to be suitable for incorporation into the present project with some revision and expansion.

Outcrops are largely limited to the lake shore. In 1969, however, this shoreline exposure was excellent due to unusually low water conditions. Away from the shore, thick glacial overburden obscures the rocks, although locally, and especially in the granites, exposure was good.

General Geology:

Initially the rocks were broken down into seven gross units for field classification. The subunits and the age relationships are tentative, pending further examination of specimens.

Paragneisses: These are essentially biotite-feldspar-quartz gneisses which have been subdivided into two units on the basis of relative amounts of mobilized granite present. The migmatite or granitized paragneiss phase contains greater than 40 per cent injected or segregated granitic material. The contact between the migmatitic and the non-granitized faction is gradational, irregular and often indistinct. The non-migmatitic phase is well layered (though primary layering is rarely recognized with any degree of certainty), well-foliated, folded, sheared and slightly granitized. It is composed of 5-20 per cent biotite; 30-50 per cent feldspar; 20-40 per cent quartz and locally contains amphibole or pyroxene. Where present, the amphibole is confined to discrete layers (primary ?) and may comprise up to 60 per cent of the gneiss, with a corresponding reduction in the feldspar and biotite content. Commonly the gneiss is garnetiferous with light pink, clear, fractured, subhedral to euhedral garnet crystals up to 1 cm. in diameter or in clumps up to 3 cm. in diameter. Locally the gneiss is graphite-bearing, with the graphite distributed along the foliation planes in lenses or thin sheets up to 2 cm. in diameter.

Amphibolites: This unit consists of fine to medium-grained, light to dark green, well foliated fissile amphibolites. Their origin is questionable though they are probably derived from volcanic rocks or possibly interlayered medium-grained sediments and fine-grained volcanics. The rock is composed of 40-80 per cent hornbelende and other associated amphiboles, 10-40 per cent quartz; 5-20 percent epidote and/or clinopyroxene and minor feldspar. Where the quartz exceeds 15 per cent it is possibly a result of local silicification. The epidote and clinopyroxene, which occur in discontinuous thin layers and lenses in a hornblende and quartz groundmass, may be stretched remnants of vesicles and amygdales. At one location, approximately 6 miles southeast of Pine Lake a highly silicified portion of the amphibolite sequence shows stretched pillow structures. These pillows show excellent selvage edges and are stretched such that their axes are in ratios greater than 10:1. In other localities the amphibolites contain largely digested inclusions of what appear to be paragneiss. The amphibolites found on the west shore of Southern Indian Lake and those found on the shore of Pine Lake appear to be the same unit, as they are identical both in mineralogy and texture. Spatial correlation will be attempted during the 1970 field season. The amphibolite is locally mineralized. Mineralization consists of very finely disseminated pyrrhotite and pyrite comprising less than 1 per cent of the rock.

Granite gneiss. The granite gneiss is a poorly layered, well-foliated pink and grey gneiss of granitic composition, resembling the paragneisses. The granite gneiss appears to be a true orthogneiss, as it contains angular, seemingly igneous inclusions of amphibolite which clearly crosscut the gneissic foliation. Without these inclusions, this unit could not be differentiated from the earlier paragneisses. The granite gneiss occurs as thin belts associated with granite stocks.

Ultramafic rocks. These occur in isolated irregular stocks, dykes and sills, with only a few large enough to be mappable. They are variable in grain size, dark green to black and are primarily composed of hornblende and clinopyroxene with local serpentine fracture-fillings. Chlorite alteration is also present. It is possible that these are highly altered phases of the amphibolites.

Granites. The granites which comprise about 50 per cent of the map area were divided into four groups on the basis of texture, composition and their mutual spatial relations. The four divisions are (a) gneissic granite; (b) porphyritic granite; (c) pink granite; (d) grey granite.

(a) Gneissic granite. This is light grey, medium to fine-grained, granoblastic granite with poorly developed mica foliation. The rock is composed of 5-10 per cent biotite; 50-70 per cent white feldspar and 20-40 per cent quartz, locally approaching granodioritic composition. It occurs as stocks and dykes often with assimilated inclusions of paragneiss and amphibolite.

(b) Porphyritic granite. A medium to coarse-grained, locally foliated and lineated, pink granite containing subhedral to euhedral feldspar porphyroblasts up to 5 cm. long in a groundmass of biotite, quartz and minor feldspar. Where foliated, the foliation is marked by a preferred elongation of the tabular feldspar phenocrysts and to a lesser extent, the biotite basal cleavage planes. The granite occurs as stocks and dykes and is relatively uniform throughout the map-area, often with angular, granitized inclusions of diorite, gneissic granite, amphibolite and paragneiss.

(c) Pink granite. The pink granite is fine to medium-grained, granoblastic and essentially massive, occuring as stocks and dykes injected into the porphyritic granite and paragneisses. It is light to dark pink and composed of 30-50 per cent pink feldspar, 20-30 per cent white feldspar, 10-30 per cent quartz and 3-10 per cent biotite. The more biotitic phases are poorly foliated. The orientation of the foliation is highly variable.

(d) Grey granite. This is a medium to coarse-grained, locally foliated, light grey granite, composed of approximately 40 per cent white feldspar, 20 per cent pink feldspar, 15 per cent biotite and 25 per cent quartz. It is locally porphyritic with porphyroblasts of white feldspar up to 1.5 cm. It occurs as thin dykes and small stocks intruded and injected into the earlier granites.

Diorite and Tonalite. These rocks, of pre- and post-granite age, are medium to coarse-grained, grey to black, poorly foliated to massive, and occur as inclusions, dykes, irregular stocks and sills. They are composed of 25-40 per cent biotite; 20-40 per cent plagioclase, feldspar; 10-20 per cent black hornblende and locally up to 20 per cent quartz.

The paragenesis of these rocks is questionable and four hypothesis regarding their origin are compatible with the field occurrences.

(a) The diorites are igneous and intrusive e.g. the stock on Pine Lake (Preliminary Map 1969E-17) which has a good magnetic high associated with it;

(b) The diorites are merely highly altered and remobilized paragneisses, as for example in the case of the diorite lens west of Long Point and other smaller sill-like bodies in the migmatites on the western margin of the map-area.

(c) The diorites are igneous and intrusive and have been remobilized, such that their original igneous textures have been altered. The large inclusions of diorite in the granites on the Cousins Lake sheet (Preliminary Map 1969E-12) appear to be of this type.

(d) The diorites are a mixture of the above three, and distinction in the field among these is impossible, since they all appear to be similar in texture and composition.

The tonalite where present appears to be a contact phase formed through the assimilation of paragneisses by the granites.

Pegmatite. At least three ages of pegmatite have been recognized in the map-area, as shown by cross-cutting relationships among the pegmatite, paragneisses and the granites. The pegmatites, which are ubiquitous in the area are usually pink, and have a granitic composition, with feldspar phencrysts up to 15 cm. in length. Less common is the occurrence of white pegmatite, also of granitic composition, with phenocrysts up to 30 cm. Two genetic types of pegmatite are recognized: (1) injected pegmatite with sharp contacts; (2) "secretion pegmatite" with gradational and indistinct contacts. There is no noticeable compositional difference between the two genetic types. The dominant mafic mineral in all the pegmatites is biotite. Muscovite occurs only in the South Bay area, where it is much more abundant than the biotite.

Diabase and Lamprophyre. These are late stage injections found only as isolated, thin dark brown and dark grey dykes up to 20 feet thick occurring in the amphibolite and granites. The diabase is very fine-grained to aphanitic, and shows chilled contacts where injected along pre-existing joint planes in the amphibolites. It is composed of 60 per cent pyroxene, some of which is pseudomorphic after olivine, and 40 per cent plagioclase feldspar with a composition of andesine. Lamprophyre dykes were found only in the granites. The lamprophyre consists of porphyroblasts of hornblende and biotite up to 1 cm. in size, set in a very fine-grained groundmass of similar composition.

Metamorphism. Mineral assemblages occurring in the map area are all indicative of the almandine-amphibolite facies. Three subfacies are recognized.

(a) Staurolite-almandine subfacies
    (i) hornblende-plagioclase-epidote-quartz-biotite
    (ii) hornblende-plagioclase-diopside

(b) Sillimanite-almandine-muscovite subfacies
    (i) quartz-almandine-muscovite-biotite-plagioclase
    (ii) quartz-muscovite-sillimanite-plagioclase

(c) Sillimanite-almandine-orthoclase subfacies
(i) quartz-orthoclase-plagioclase-almandine-biotite
(ii) quartz-orthoclase-plagioclase-biotite
(iii) hornblende-plagioclase-diopside-quartz

The dominant metamorphic grade lies within the upper almandine-amphibolite facies i.e. (b) and (c). It is probable that the lower grade, staurolite-almandine subfacies is retrogressive. In particular the retrograde metamorphic effect is indicated at the northern amphibolite-paragneiss contact by the appearance of tremolite and chlorite.

Thus possible conditions during metamorphism, as exemplified by the metamorphic facies present, were:

(1) temperature 550°-750°C

(2) pressure 4,000-8,000 bars

(3) high water pressure as indicated by the prevalance of amphibole and mica.

Structure

Structural interpretations, dependent as they are on adequate correlation between rock units, were made extremely difficult by a lack of exposure. Thus any interpretation of the sequence of tectonic events must be done on the basis of minor structures, which in all probability reflect the large scale features.

The rocks in the area can be divided intc three gross structural units: (a) massive to very poorly foliated; (b) well foliated, poorly or non-layered; (c) well foliated, well layered.

(a) Massive to very poorly foliated: This group includes the granites, pegmatites, lamprophyres, diabase and the massive diorites. Foliation, where present, is weak and appears to have no consistent pattern.

(b) Well foliated, poorly or non-layered: This group comprises the orthogneisses, diorites and most of the amphibolites. The foliation consists of a well developed, steep to moderately dipping schistosity, marked by mica in the orthogneisses and diorites and by hornblende in the amphibolite. Locally cataclastic foliation has been recognized.

(c) Well foliated, well lineated: This unit consists of the paragneisses and associated migmatites. The layering consists of interlayered thin (1cm-10cm), granular quartzo-feldspathic, and mafic rich layers. The foliation is identical to that in unit (b) and is with a few exceptions parallel to the layering. The layering and the foliation is found to intersect only in or near the noses of the early folds.

Two periods of folding were noted and a third suspected on the basis of abundant minor folds. Initially folding was similar, tight to isoclinal, with axial planar mica foliation developing contemporaneously with the folding. The fold axes trend northeast to east and have a moderate to steep plunge. Axial planes strike northeast to east and dip steeply towards both north and south. These folds are now marked by folded layering, though the layers are not necessarily primary. The second folds are concentric, relatively open folds with inter-limb angles ranging between 50-120°. These structures fold both foliation and layering, and in rare instances they fold a lineation formed by the intersection of layering and the axial plane foliation of the first generation folds. The trends of the fold axes and axial planes are less constant than for the earlier folds, ranging between a southeasterly and southwesterly direction. The fold axes have a shallow to moderate plunge, while the axial planes of these folds have shallow to moderate dips. A third period of folding is suspected, since a lineation, believed to be formed in the grey granite by the second folds, is folded in some locations. An apparent distortion of some second generation folds may also have been caused by later folding.

No large scale faulting was directly observed in the field due to the lack of exposure and an absence of adequate marker-horizons. Numerous photolineaments (some up to 6 miles long) are present in the area and some of these may correlate with faults. In the southern part of the area (Preliminary Map 1969E-12 (southwest) and Preliminary Map 1969E-10 (northeast) the lineaments trend north-northeast and north-northwest. In the north (Preliminary Map 1969E-17 and Preliminary Map 1969E-20) only a northeast trending lineaments were noted. Some of the lineaments can probably be attributed to jointing, since they are subparallel to a dominant joint direction in the area.

Small faults with lateral displacements up to 4 feet are common, especially in the granites, where they are marked by offset pegmatite veins and dykes. Shear zones up to 10 feet in width were noted in the paragneisses, amphibolites and granites. The sense of movement in the shear zones could not be determined.

Economic Geology:

No mineralization of economic significance was encountered during the 1969 field season. The airborne Input electromagnetic survey of the area shows a large number of anomalies and trends. Some of these (especially on Shallow Lake, Preliminary Map 1969E-20) appear to be caused by graphite, distributed along shallow to moderately dipping foliations planes in the paragneisses. Others in the same area could not be investigated due to lack of exposure. A small number of the e.m. anomalies are associated with exposed mineralization.

Numerous small mineralized shear zones, with no associated anomalies indicated on the electromagnetic maps, were also encountered in the area. All sulphide occurrences encountered are appropriately marked on the Preliminary Maps. The sulphides which comprise up to 20 per cent of these zones consist largely of pyrite and pyrrhotite with minor chalcopyrite. Assays for grab samples from ten of the mineralized shear zones in the area are given in Table 1-1.

Less than 1 per cent of finely disseminated pyrite and pyrrhotite is present throughout the amphibolite unit.

Very few quartz veins were encountered in the area, mostly in the granites, where all veins examined were found to be barren.

Small amounts of magnetite and possibly ilmenite occur in some of the pegmatites as subhedral crystals up to 1 cm. in length. The high magnetic background associated with some of the granites suggests that they too may carry finely disseminated magnetite though none was recognized in the field.

During the latter part of June and the early part of July 1969,

TABLE I-1

	Sample Identification	Questor Anomaly - Identification			Copper*	Nickel	Sample Weight in Pounds
		Line	Anomaly	Intensity			
1	25-9-0069-1B	75 S	K260	6 channel	0.04	0.02	1.75
	25-9-0069-2B	75 S	K260	6 channel	0.05	0.08	2.0
2	25-9-0089-3B	none associated			0.13	0.05	2.5
3	25-9-0106-2B	87 S	TT	3 channel	0.03	trace	2.0
4	25-9-0111-2B	none associated			trace	trace	0.75
5	25-9-0114-1B	none associated			trace	trace	1.0
6	25-9-0153-1B	none associated			0.03	trace	2.25
	25-9-0153-2B	none associated			0.02	trace	1.0
7	25-9-0157-1B	86 S	MM	4 channel	trace	trace	2.0
	25-9-0157-2B	86 S	MM	4 channel	trace	trace	1.25
8	25-9-2585-3B	none associated			0.03	trace	0.5
9	25-9-2593-2D	none associated			trace	0.05	2.25
10	25-9-2636-3B	none associated			0.07	0.02	1.5

* assays conducted in accordance with section 46 of the Regulations under "The Mines Act" by the Mines Branch Laboratory, Province of Manitoba.

extensive staking occurred in the area. A total of 25 claim blocks were staked.

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Davison, W. L. 1969: Personal communication.

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Pine Lake and part of Mulcahy Lake (east half); Preliminary Map 1969E-17; Manitoba Mines Br.

Nutter Lake; Preliminary Map 1969E-20; Manitoba Mines Br.

Quinn, H. A. 1959: Big Sand Lake, Manitoba; Geol. Surv. Can. Map 45 - 1959.

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Steeves, M. A. and Frohlinger, T. G. 1969: Swan Bay; Preliminary Map 1969E-11; Manitoba Mines Br.

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TORRANCE LAKE AND MISSI RAPID AREA
(64G-1, 8 and parts of 64G-2 and 7)

by J. R. Cranstone

Introduction

The area covered during the 1969 field season lies between longitudes 98° 00' and 98° 40' and latitudes 57° 00' and 57° 30', encompassing the northeast part of Southern Indian Lake. (N.T.S. sheets 64G-1, 8 and the eastern parts of 64G-2 and 7).

Approximately 650 square miles were mapped, at a scale of one-half mile to the inch. Figure 1 - 4 shows the area covered during the 1969 field season together with the area which will be mapped in 1970.

Previous maps covering the area at a scale of one inch to four miles, were prepared by the Geological Survey of Canada (Wright 1953, Quinn 1960). More recently a further reconnaissance of parts of the area was undertaken by Davison (1969).

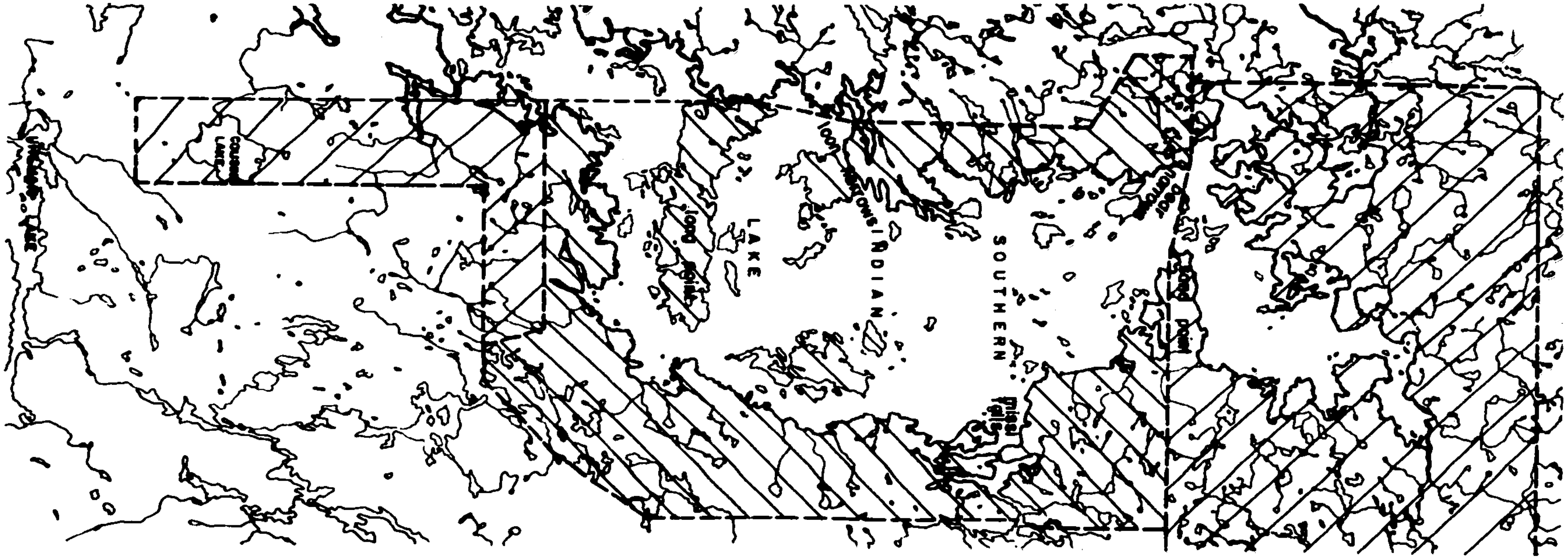
Due to a lack of inland outcrop, the present work was confined mainly to shoreline mapping. Inland traversing was done largely by helicopter, using a 2,000 foot flight-line spacing. Conventional pace and compass traverse methods were used where enough outcrop was available. Essentially all inland outcrops were visited. As part of the mapping programme, all electromagnetic anomalies outlined by Questor Surveys airborne Input survey, conducted in 1968, were examined.

Preliminary maps of the area covered in 1969 are available. These are: 1969E-18 and 1969E-19 of the 1969E series. To the west, these adjoin maps 1969E-17 and 1969E-20, mapped by T. G. Frohlinger.

General Geology

A thick cover of mixed sand, silt, clay and till obscures bedrock in most of the map-area. Outcrop is generally restricted to the shoreline of Southern Indian Lake, and to a few smaller lakes in the area. The only appreciable amount of inland outcrop is found in the porphyritic quartz-monzonite, south of Long Point.

An original sedimentary sequence has been largely upgraded to



TORRANCE LAKE — MISSI RAPID AREA

AREA MAPPED, 1969

AREA TO BE MAPPED, 1970

0 2 4 8 16
MILES

Figure 1-4

schists and paragneisses by granitic intrusion, and regional metamorphism to the upper amphibolite facies. Prior to the regional metamorphism and granitic intrusion, mafic sills were emplaced parallel to an early (bedding ?). At least three stages of major tectonism have affected rocks in the area.

Metasedimentary rocks, paragneisses

Biotite paragneisses, consisting of variably granitized biotite-plagioclase-orthoclase and biotite-quartz-plagioclase gneisses and schists, constitute a large portion of the map-area. Infrequently, primary layering is preserved.

Recognizable metasedimentary rocks, consisting of metaconglomerate, meta-arkose and metasandstone, occur in considerable quantities within the biotite paragneisses on the east shore of Southern Indian Lake south of Missi Rapids; and in lesser amounts south of the east end of Long Point, and near Loon Narrows.

The biotite gneisses and metasedimentary rocks, found on the east shore of Southern Indian Lake south of Missi Rapids, and east of Missi Falls, are commonly sillimanite-bearing, and, in places, contain both sillimanite and garnet.

Garnetiferous plagioclase-biotite-quartz gneisses and migmatites, found on, and near, Long Point, represent very highly granitized paragneisses in which large amounts of mobilization, segregation and injection of granitic material has occurred. The mobilized fraction, usually of granodiorite composition, commonly is concentrated to form sizeable zones of homogeneous "granitoid" material. In the area south of the east end of Long Point, cordierite as well as garnet is found in this unit.

Biotite-poor granitoid paragneisses (metamorphic granites) occupy a large area surrounding Missi Falls, and a smaller area south of Bear Narrows. These rocks commonly have a homogeneous, apparently intrusive, character. Normally, a large proportion of granitized paragneiss schlieren is present, with a granite fraction that is in large part pegmatitic. Boundaries of the granitoid gneiss are readily located from aeromagnetic maps by the change from the characteristic magnetic depression of the granitoid gneiss, with a low magnetic gradient, to the numerous magnetic highs and steep magnetic gradients typical of the biotite paragneisses.

Mafic intrusive rocks

Mafic intrusive rocks in the map-area appear to pre-date the granite intrusions.

Medium to coarse-grained hornblende gabbro occurs as small concordant bodies throughout the map-area. Commonly, amphibole in the gabbro is pseudomorphic after pyroxene. Hornblendite and diorite phases are locally developed. A contact phase, consisting of hybrid gabbroic rocks, has, in a few places formed by the partial or complete assimilation of paragneiss by the gabbro. More commonly the gabbro shows a mappable outer hybrid zone produced by alteration and intermixing during later granitic intrusion.

Fine to medium-grained, porphyritic and non-porphyritic, biotite-rich, diorite to gabbro sills are commonly found in the biotite paragneisses and to a lesser extent in the plagioclase paragneisses. These apparently represent smaller intrusions related to the larger hornblende gabbro bodies. Preservation of intrusive relationships is rare, making a distinction between these sills and the basic sedimentary gneisses and sedimentary amphibolites difficult.

Granitic intrusive rocks

Coarse-grained to porphyritic, commonly massive, quartz monzonite occupies the area south of Long Point and is apparently the northern extremity of a large granitic batholithic body to the south, described by Wright (1953). Smaller, and probably related prophyritic quartz monzonite bodies, occur in the vicinity of Loon Narrows and on the islands west of Missi Falls. Fine-grained granite and pegmatite dykes cut this unit.

Along contacts of the porphyritic quartz monzonite with paragneiss, a medium-grained, well foliated, buff to white hornblende-bearing quartz monzonite unit is commonly present. Because of this association, the hornblende-bearing quartz monzonite appearsto be a contact phase of the porphyritic quartz monzonite. A large body of this same hornblende-bearing unit however, showing no apparent spatial relationship to the porphyritic quartz monzonite, occurs on the large island north-northeast of the east end of Long Point.

Fine to medium-grained granite occurs as dykes and sills in the paragneisses and porphyritic quartz monzonite, and is in turn cut by pegmatites. Small bodies of this biotite-poor granite are found south of the east end of Long Point, near Loon Narrows, and in the islands north-northeast of the east end of Long Point.

A plug of non-foliated pegmatitic quartz monzonite intrudes the hinge region of an antiform on the east shore of Southern Indian Lake. A lack of pegmatite dykes, as well as the complete lack of foliation in this unit, suggest that it is probably the youngest intrusion in the area, other than some of the pegmatites.

White to pink pegmatites appear to be the youngest rocks in the map-area. Although the pegmatites are mineralogically similar, crosscutting relationships among them suggest different ages. Pegmatite generation can probably be attributed to partial melting during metamorphism, and to synchronous or later intrusion of the derived material into the adjacent rocks.

Structural Geology

A structural interpretation is made extremely difficult by the lack of inland outcrop, as well as by the large water-covered area. The area has been affected by at least two period of regional folding. Mineralization occurred prior to the last period of folding.

Two major shear directions are present in the map-area. The more common shear zones, occurring throughout the map-area, have an easterly trend, are generally steeply dipping, and parallel the foliation. A second, steeply dipping and northwesterly trending set of shears is found near Missi

Rapids. Throughout the map-area, pegmatite dykes were intruded parallel to the northwest shear zones. A complete lack of mineralization in shear zones cutting the porphyritic quartz monzonite, indicates that mineralization was pre-or syn-intrusion of the porphyritic quartz monzonite. A general lack of mineralization in the northwesterly trending shear zones implies a younger age for this set, although minor mineralization does occur in two northwesterly trending shear zones near Missi Falls.

Two types of minor folds have been recognized:

(1) an early, now isoclinal, set of folds, with axial planes essentially parallel to the regional foliation;

(2) folds with a more open style, axial planes at a small angle to the regional foliation and plunging to the northeast. In places, these folds have refolded the earlier and tighter minor folds.

Microcrenulations, deformed porphyroblasts and deformed phenocrysts uniformly plunge to the northeast to east at angles between 20 and 50 degrees. The linear structures and the late minor folds appear to be related.

The bedded metaconglomerates, meta-arkoses and meta-sandstones found in the biotite paragneisses on the east shore of Southern Indian Lake, define a major antiform whose axial trace trends approximately east-southeast. Aeromagnetic maps confirm the presence of this fold. The limbs of the antiform are highly attenuated and parallel to the foliation, while at the hinge of the fold, little deformation has occurred. A repetition of conglomerate layers in the hinge region of the antiform, suggests the presence of one or more earlier and refolded isoclinal folds.

Folded foliations, aeromagnetic trends, and E.M. anomaly trends, indicate the presence of a second tight major fold, also with an east-southeasterly trending axial trace, in the area east of Long Point. The relationship of this fold to the antiform to the north is not clear, but it is unlikely that both could have formed during the same tectonic event.

Foliations with opposing dips define a synformal axial trace within the biotite paragneisses north of Loon Narrows. To the east, this fold apparently becomes isoclinal, with foliations on both sides of the axial trace dipping to the north.

Additional information and further interpretation of the present data should provide a more detailed structural picture.

Economic Geology

Essentially all the E. M. anomalies outlined by the Questor Surveys airborne Input survey and examined in the field, showed signs of shearing and mineralization. All sulphide occurrences are confined to the biotite and plagioclase gneisses. Most of the showings consist of iron-stained shear zones carrying disseminated pyrite and minor pyrrhotite and chalcopyrite. Narrow bands of massive sulphide occur in two of these zones, on the east shore of Southern Indian Lake south of Missi Rapids, and in a zone south of Bear Narrows.

Release of the E. M. anomaly maps precipitated the staking of a considerable number of the conducting zones.

Further studies of samples of mineralized material will be carried out and the results published in forthcoming reports.

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(2) GUAY LAKE-WIMAPEDI LAKE AREA

(63 N - 1E; 63 O - 4)

by A. H. Bailes

Introduction

The Guay Lake-Wimapedi Lake area is located north and northeast of the town of Snow Lake (Figure 2 - 1). Mapping of this area was commenced in the summer of 1968. During the summer of 1969 mapping of all but a small portion of 63 O - 4 was completed. Preliminary Maps (1969B - 1, B - 2, B - 3) of the Guay Lake-Wimapedi Lake area are available. The mapping has been done at a scale of 1 inch to 2,640 feet and 1 inch to 3,000 feet and will be reduced to 1 inch to 1 mile for final publication. Standard pace and compass mapping methods augmented by helicopter support to reach inaccessible areas have been used.

The field mapping program will be finished in the summer of 1970 and a final report and map should be completed some time in 1971. The 1970 field program will include completion of the mapping, re-examination of problem areas, and some detailed mapping in the Guay Lake area, with a view to solving some of the problems relating to metamorphic petrology and structural geology.

General Geology

The project area has been previously mapped at a scale of 1 inch to 4 miles by Harrison (1947) and by Quinn (1953). The areas to the south and west have been mapped at a scale of 1 inch to 1 mile (Armstrong, 1941; Frarey, 1948; Harrison, 1949; Kornik, 1968).

Rock exposure in the Guay Lake-Wimapedi Lake areas is generally excellent. For most of the map-area, there is over 60 per cent rock exposure and many of the outcrops in the southern one third of the map-area have been burned clean by forest fires. The high percentage of clean outcrop has allowed accurate location of boundaries between units. However, as there is so much rock exposure it has not been feasible to examine all the major outcrops, and in places it has often been necessary to project geological contacts through outcrops that have not been examined. The gradational boun-

General Geology Snow Lake area

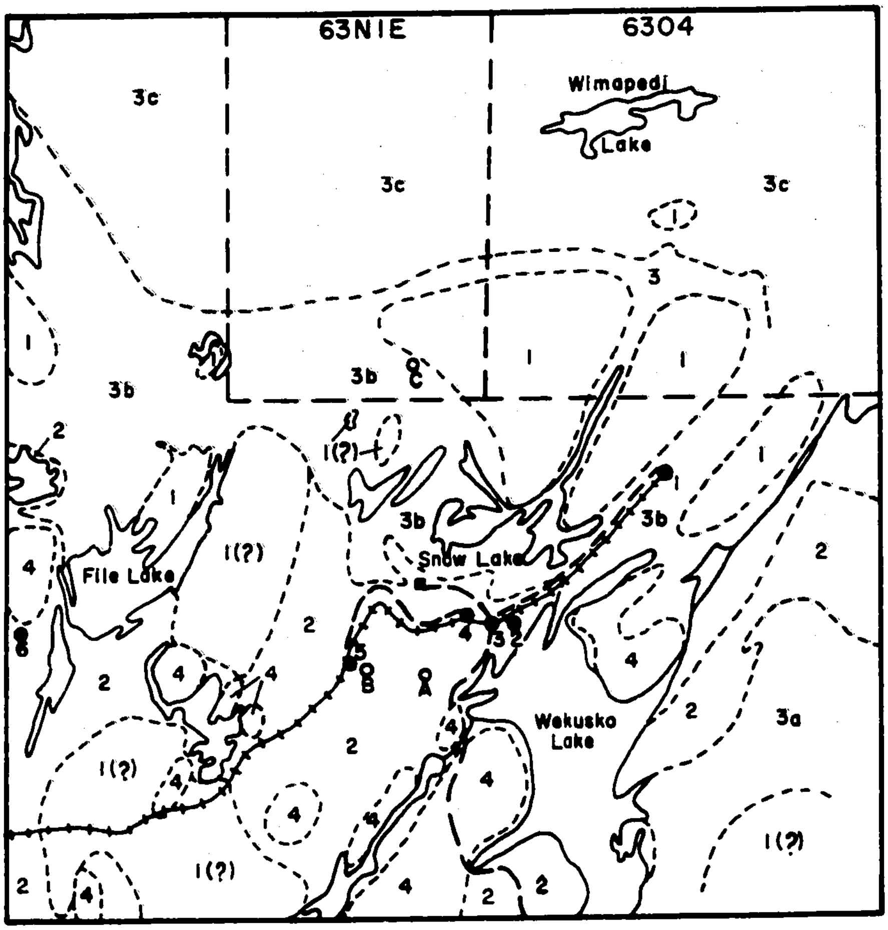


Figure 2-1   Scale: 1 inch = 8 miles

LEGEND
(Snow Lake area)

4 Granitic rocks (generally coarsely porphyritic)

3 c) Migmatite gneisses
b) Paragneisses
a) Arkosic and pelitic sedimentary rocks

2 Volcanic rocks with minor sedimentary material

1 Granitoid gneisses

MINING PROPERTIES

X Producing and Developing Mines

1 Osborne Lake
2 Little Stall Lake
3 Stall Lake
4 Anderson Lake
5 Chisel Lake
6 Dickstone

O Other Deposits

A Joannie zone
B Ghost Lake
C Wim Zone

SYMBOLS

------- Geological contact

Railroad

Road

Boundary of Guay Lake-Wimapedi Lake project area (63N-1E - 1968; 630-4 - 1969)

TABLE 2 - 1

Table of Formations

(Guay Lake-Wimapedi Lake area)

RECENT AND PLEISTOCENE			clay, silt, sand
			UNCONFORMITY
PRECAMBRIAN	GRANITIC ROCKS	5c	Pegmatite
		5b	White quartz monzonite and granodiorite with inclusions of unit 4
		5a	White quartz monzonite and granodiorite
	PARAGNEISSES	4	Grey pelitic gneiss with pyralspite garnets, lit-par-lit migmatitic gneisses
		3	Basic hornblende-plagioclase gneisses
		2	Buff or light grey arkosic to quartzitic magnetite bearing paragneisses
			??? UNCONFORMITY ???
	GRANITOID GNEISSES	1c	Pink magnetite-bearing granitoid gneisses
		1b	White granitoid gneisses with bands and inclusions of basic gneiss
		1a	White siliceous magnetite-bearing granitoid gneisses

daries between the migmatitic gneisses (4) and the granodiorite (5), combined with a high percentage of moss covered outcrops for these units, has made interpretation difficult for the northern portion of the Guay Lake-Wimapedi Lake area.

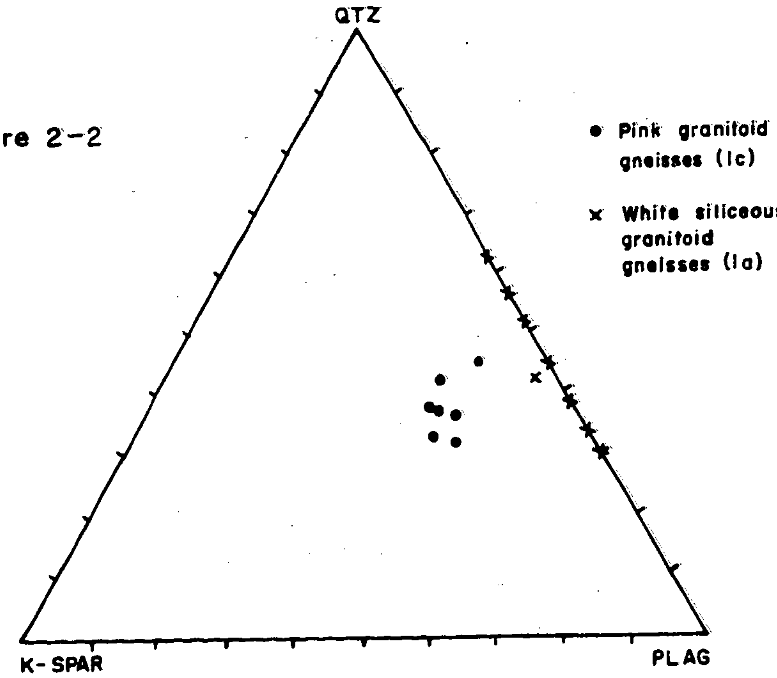
The mappable units of the Guay Lake-Wimapedi Lake area are listed in Table 2 - 1. The gneisses can be subdivided into two categories. The first category is a group of coarse-grained granitoid gneisses, unit 1, that are exposed in the cores of dome structures. The second category of gneisses is a group of finer-grained paragneisses units 2, 3 and 4, which appear to overlie the granitoid gneisses.

Unit 1 is a sequence of medium to coarse grained, in part well-layered, highly granitized gneisses. The subunits 1a and 1c are very uniform. Unit 1b is equivalent to unit 1a except that it contains numerous thin layers and inclusions of basic gneiss (Plate 2 - 1). A plot of the quartz, potassium feldspar and plagioclase content of unit 1a and 1c are shown in Figure 2 - 2. The pink granitoid gneisses (1c) are the compositional equivalent of granodiorite while the siliceous granitoid gneisses (1b) clearly have a sedimentary origin. Previously these granitoid gneisses have been categorized as granites and gneissic granites (Armstrong, 1941, Frarey, 1948). This is a misleading interpretation in view of their heterogeneous layered character. In Figure 2-1 other granitic bodies in the Snow Lake area have been designated as granitoid gneisses. The only rocks of this type examined by the author were in the Guay Lake-Wimapedi Lake area, but the geological setting and air photo expression of many of the other bodies previously mapped as granites, suggests that these could also be domes of highly granitized gneisses. The relationship of the granitoid gneisses to the surrounding paragneisses is not properly understood. Three possible interpretations are given below:

i) The granitoid gneisses are an older sequence of 'basement gneisses' that have been domed up by large scale interference folding.

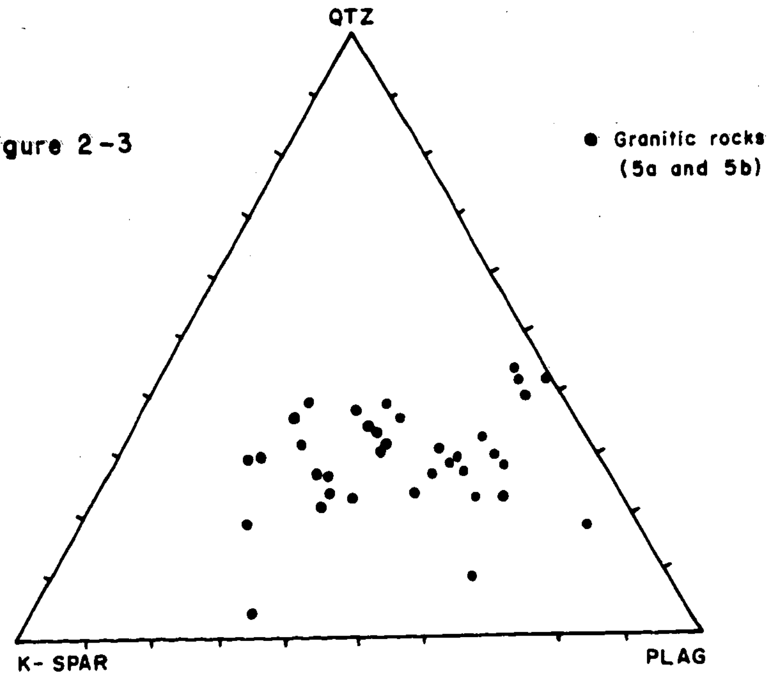
ii) The granitoid gneisses are partially remobilized basement or highly granitized paragneisses, that have domed up the surrounding paragneisses by diapiric action.

Figure 2-2



Modal analyses of granitoid gneisses (I) of Guay Lake area (63N-IE)

Figure 2-3



Modal analyses of granitic gneisses (5) of Guay Lake area (63N-IE)

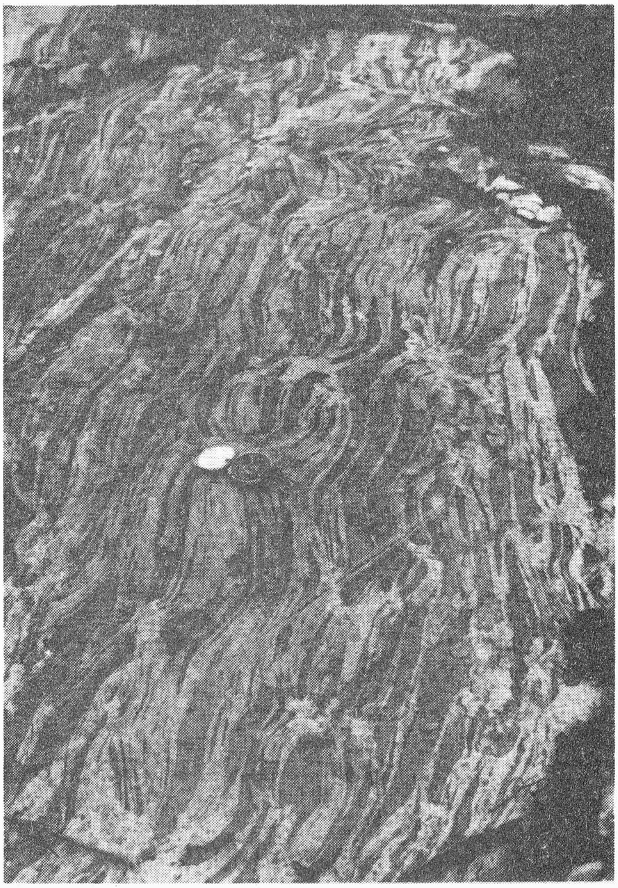


PLATE 2 - 1
Inclusions of basic gneiss (unit 1b)

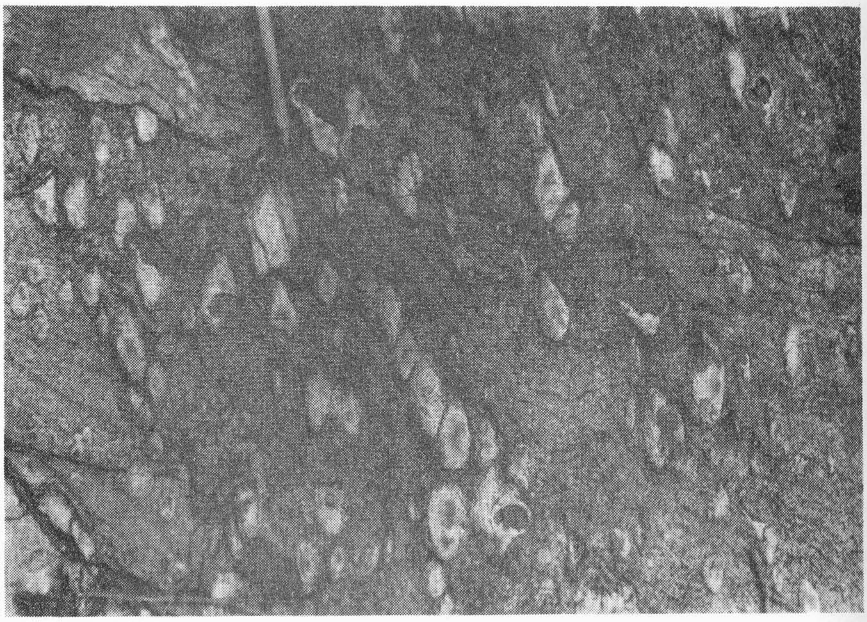


PLATE 2 - 2
Quartz-sillimanite nodules (often with cores of pyralspite garnet) in unit 2

iii) The granitoid gneisses, which are similar in composition to the surrounding paragneisses (especially unit 2), are simply selectively granitized equivalents of the paragneisses.

The paragneisses have been divided into three units, 2, 3 and 4. Unit 2 is a homogeneous series of magnetite-bearing arkosic to orthoquartzitic fine to medium-grained biotite gneisses. From west to east this unit becomes more siliceous. In the eastern portion of the Guay Lake-Wimapedi Lake area this unit is characterized by numerous elongate nodules of quartz and sillimanite (Plate 2 - 2).

The basic gneisses of unit 3 are variable. Generally they are composed of equal proportions of hornblende and plagioclase,with minor amounts of K-feldspar, biotite, and garnet. The basic gneiss bands vary from a few tens of feet to a few hundred feet in thickness, but are continuous laterally for considerable distances and are therefore excellent marker horizons. Although basic gneisses occur within both units 2 and 4 they are typically found at or near the contacts between units 2 and 4 and between units 1 and 2. The basic gneisses are possibly the metamorphosed equivalents of basic volcanic flows butthe remarkable continuity of such relatively narrow bands over large distances is not altogether consistent with this hypothesis. It is possible that they were derived from basic tuffaceous layers, or were produced by reaction between carbonate-rich layers and the surrounding pelitic rocks during metamorphism, by a mechanism suggested by Orville (1969).

Unit 4 is a monotonous sequence of garnet and biotite-rich pelitic gneisses. The pelitic gneisses are a thinly layered sequence, but when considered as a unit they are very homogeneous. Large mauve pyralspite garnet porphyroblasts are characteristic of this unit. Cordierite is also a common constitutent, and although difficult to identify in the field, it has been recognized in thin section of these rocks. A gradual increase in metamorphic grade towards the north has caused partial melting of the pelitic gneisses and extensive development of migmatites. In the northern portions of the Guay Lake-Wimapedi Lake area the granite (5b) and pelitic gneisses (4) are so completely intermixed, that it is difficult to distinguish between the granitic and gneissic components.

The granitic rocks of unit 5 comprise three varieties, 5a, 5b and 5c. Units 5a and 5b are both gneissic biotite-bearing white quartz monzonites and granodiorites (Figure 2-3). Unit 5a appears to be an uncontaminated version of 5b; the latter contains partially digested remnants of unit 4. The exact relationship between units 5a and 4 is difficult to determine. Two possible alternative relationships are given below:

i) Unit 5a is a 'purified' distillate which has been derived through concentration of material from partial melting of unit 4.

ii) Unit 5a is an intrusive granite body which has triggered granitization and migmatization of the pelitic gneisses of unit 4. Unit 5a could be intrusive at this level but have been derived from melting of the pelitic gneisses at a lower level in the crust.

Unit 5c consists of pegmatite which cuts across all other units in the area. In places it forms concordant bodies, but generally occurs as dykes along north-south trending fractures. Late movement on these fractures has resulted in sheared and cataclastic margins of many of the pegmatite dykes (Plate 2 - 4).

Metamorphism

The rocks of the Guay Lake-Wimapedi Lake area have generally been metamorphosed to the almandine-amphibolite facies. In the Snow Lake area to the south, Harrison (1948) noted that the grade of metamorphism increased towards the north, and in one area on File Lake he was able to recognize a typical Barrovian-type progression of isograd minerals (chlorite-biotite-garnet-staurolite-kyanite-sillimanite). In rocks of the Guay Lake-Wimapedi Lake area, in rocks of suitable composition, sillimanite, cordierite, and orthopyroxene were found. Paralspite garnet, biotite, hornblende, plagioclase, and K-feldspar occur throughout the area. Orthopyroxene is rare, and was identified in a few thin sections of amphibole plagioclase gneiss. Its occurrence is taken to indicate granulite facies metamorphism. Sillimanite commonly occurs in nodules with quartz and muscovite. These nodules vary in size from a few millimeters to several centimeters in size. They are ellipsoidal in shape and occur in the plane of the foliation with their

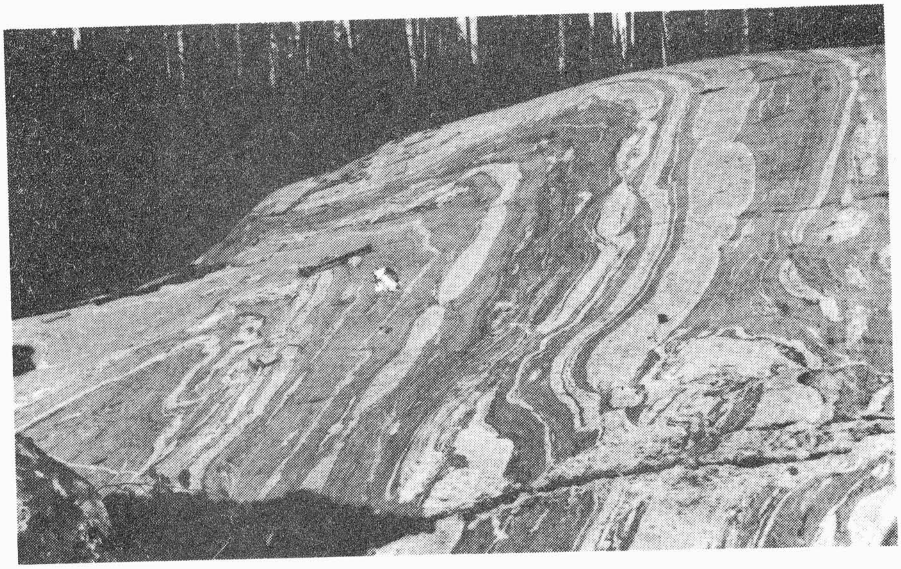


PLATE 2 - 3

Folded and boudinaged <u>lit</u> of granite (5b) in pelitic gneisses (4)

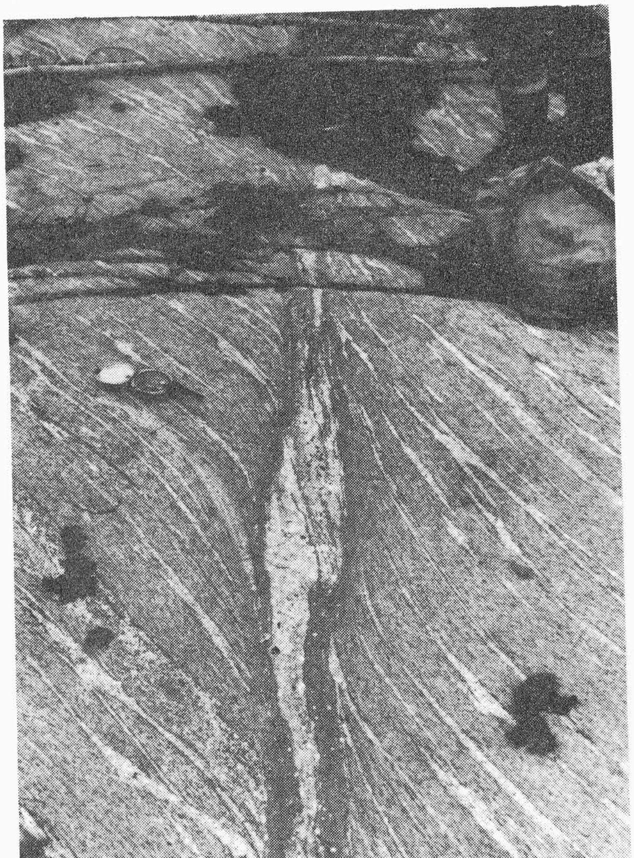


PLATE 2 - 4

Sheared pegmatite dyke, with deformation of the foliation in the host gneisses indicating an apparent right lateral movement parallel to the sheared dyke long axes parallel to one another, and defining a prominent lineation. Cordierite has been identified in both the basic gneisses (3) and the pelitic gneisses (4). It also occurs as prominent clusters in granite bodies (5b), enclosed in migmatitic cordierite-bearing gneisses. Garnet is uniquitous in the Guay Lake-Wimapedi Lake area. Mauve pyralspite garnets are characteristic of unit 4 where they average about 10 per cent of this unit. These pelitic gneisses contain graphite which has kept the oxygen fugacity low and probably accounts for the lack of magnetite and the widespread occurrence of the almandine garnets in this unit. The pelitic gneisses have a uniform low aeromagnetic expression in contrast to the magnetiferous units 1 and 2. A green, probably calcium-rich garnet, is often found in the basic (amphibole) gneisses.

The grade of metamorphism in the Guay Lake-Wimapedi Lake area was sufficient to produce migmatites and granitic bodies by partial melting. Derivation of the granites (5b) by anatectic processes is suggested by the common occurrence of mauve garnets, typical of the pelitic gneisses from which they appear to be derived, and the less common occurrence of sillimanite and cordierite in these granites.

Structural Geology

The rocks of the Guay Lake-Wimapedi Lake area have been complexly deformed. As yet the structural history of this area is not fully understood but it is clear that two or more phases of folding have affected the rocks. In the northern migmatite complex the predominant folds are tight, and have northerly dipping axial surfaces. The axes of these overturned folds plunge at shallow to moderate angles to the east and west. The *lit* of granite parallel the original layering in these gneisses and accentuate it. The granite appears to have been introduced syntectonically with the folding described above, and is itself tightly folded (Plate 2 - 3).

The southern granitoid gneisses are exposed in domes which tend to be overturned to the south. The overturning of these domes is probably caused by the easterly trending folding. In the southern portion of the map-area northerly trending folds can also be distinguished. These are open to moderately tight folds with steep axial surfaces and axes that plunge at shallow to moderate angles to the north. The domes of granitoid gneisses were probably produced by interference of the two sets of folds described above. In some instances it appears that two phases of folding are inadequate to have caused some of the observed structures and more than two phases of folding may be represented in the area.

Faulting is not a major structural feature of the Guay Lake-Wimapedi Lake area. The rocks were probably deformed in a semi-plastic state, and tended to flow and fold rather than rupture. Some large linear swamps might possibly be regarded as topographic expressions of faults but as they parallel the strike there is no apparent displacement of the units and the existence of the faults is in doubt. There are also numerous northerly trending air photo linears that reflect a prominent fracture system. The fractures are late tectonic features and have little, if any, displacement on them. They are typically intruded by pegmatite dykes (Plate 2 - 4).

Economic Geology

Surface exposures of sulphide mineralization are rare. However rocks in the southern part of the Guay Lake-Wimapedi Lake area are similar to those in which the copper-zinc sulphide deposits of the Snow Lake area occur. The major differences are a much lower percentage of volcanic material, and a higher grade of metamorphism in the Guay Lake-Wimapedi Lake area.

Many of the sulphide deposits in the Snow Lake region and in the nearby Sherridon and Batty Lake areas are related to particular stratigraphic horizons within the paragneisses. In the Sherridon and Batty Lake areas the contact between the Sherridon and Nokomis series, (Units 2 and 4, in the Guay Lake-Wimapedi Lake area) has been observed to be a favourable horizon for the occurrence of sulphide mineralization (Robertson, 1953). In the Sherridon and Batty Lake areas graphitic and limey rocks, typically occur at this contact. Calcareous horizons are commonly associated with the sulphide deposits of the Snow Lake area.

It is probable that the calcareous and graphitic layers in the paragneisses represent chemical sediments deposited under anaerobic conditions with little or no influx of detrital material. Under such conditions of deposition syngenetic sulphide bodies could be produced. This is a possible explanation of the origin of many of the sulphide deposits in the Snow Lake area. By this hypothesis it follows that calcareous and graphitic horizons would be favourable sites for sulphide mineralization. Since calcareous material, under high grades of metamorphism may react with surrounding pelitic sediments to form thin layered amphibolites, by a process described by Orville (1969), amphibolite bands should also be considered favourable for sulphide mineralization.

From the above discussion, it is clear several factors have an important bearing on the copper-zinc sulphide deposits in the region. These factors are: (i) the stratigraphy of the gneisses; (ii) the nature of the vulcanism in the Snow Lake area; (iii) the effects of metamorphism on the rocks of the area; and (iv) the structural history of the area. Further studies will be directed towards obtaining a better understanding of these problems.

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(3) PAKWA LAKE AND PISTOL LAKE (east half) AREAS

(63J - 15, 63O - 2E)

by D. A. Cranstone and D. J. Toogood

Introduction

Geological mapping of this 520 square mile area, which includes the village of Wabowden, was commenced in 1968 and completed in 1969. The map-area consists of three fifteen minute map-sheets: Pakwa Lake (63J - 15), and Pistol Lake (east half: 63O - 2E). The Pakwa Lake area is bounded by longitudes 98°30' and 99°00'W and latitudes 54°45' and 55°00'N; the Pistol Lake area (east half) by longitudes 98°30' and 98°45'W and latitudes 55°00' and 55°15'N. The map-area lies along the northwest side of the boundary zone between the Churchill and Superior tectonic provinces of the Canadian Shield. It covers a portion of the Manitoba Nickel Belt, and contains four known nickel deposits. The map-area is about four miles southwest of the Soab Mine of the International Nickel Company of Canada Ltd. and 3 miles northeast of the new Manibridge Mine of Falconbridge Nickel Mines Ltd.

The southeastern portion of the Pistol Lake area, and all but the southwestern portion of the Pakwa Lake area, were mapped by D. A. Cranstone during the 1968 field season. The remainder was mapped in 1969 by D. J. Toogood who acted as seasonal party chief, with some additional work by D. A. Cranstone. The 1969 field work was done by canoe and pace and compass traverses, supplemented by helicopter support. The Pistol Lake area was previously mapped at a scale of four miles to the inch by Quinn (1954), and the Pakwa Lake area by Bell (Wekusko area, in preparation). Both areas have been mapped at a scale of two miles to the inch by Rance (1966). Preliminary results of the mapping by Cranstone and Toogood have been published as Manitoba Mines Branch Preliminary Maps 1969 D-1 and 1969 D-2. The reader is referred to these two preliminary maps and accompanying marginal notes.

General Geology and Metamorphism

The amount of bedrock exposure in the map-area is variable, ranging from as much as 50 per cent outcrop in some areas north of Setting Lake, to very poor exposure in an area of approximately 100 square miles in the southeastern corner of the map-area, where no more than a dozen small outcrops were found.

The dominant geological feature of the map-area, is the north-eastern striking cataclastic fault zone, which underlies Setting Lake. This zone consists of a vertically dipping mylonites and related cataclastic rocks, at least 3,000 and possibly as much as 5,000 feet thick. A network of smaller subsidiary fault zones accompany the major fault zone. The subsidiary zones, which are subparallel to the major zone, are narrow and poorly exposed, and therefore difficult to trace. The major fault zone forms the boundary between two lithologically dissimilar crustal blocks. Southeast of the fault zone, the predominant rock type is a layered granitoid plagioclase-quartz-hornblende-biotite gneiss, with a granodioritic composition. It contains an average of about 5 per cent plagioclase amphibolite, as bands and remnants, and is extensively permeated by a complex network of granitic and pegmatitic rock. Southwest of Wabowden, and south of Halfway Lake, the gneiss has been intruded by stocks of hornblende monzonite, which have themselves been extensively intruded by a network of veins and lit of coarse alaskitic granite and pegmatite. A 5,000 foot thick layer of gneissic biotite granite occurs west of Clarke Lake.

Northwest of the Setting Lake fault zone, the predominant rock types are a mixture of the following rock types: massive to gneissic pink granites; grey pelitic metasedimentary rocks, paragneisses, and their granitized equivalents; and less abundant plagioclase amphibolite (probably metamorphosed mafic tuffaceous sediments and lavas).

The genesis of the granitic rocks northwest of Setting Lake is uncertain. In the Pistol Lake map-area, some of the granites have an intrusive relationship to the metasediments. However, in the Pakwa Lake area, in the vicinity of Pakwa and Mitishto Lakes, there is conclusive evidence for transformation of the paragneisses into pink augen granites by potash metasomatism. This is seen in the progressive gradation of the paragneisses along and across strike, into metasomatic augen gneisses and granites. These augen gneisses and granites, in turn seem to grade across strike in a northerly direction, into massive and strongly foliated orange-pink granites. The latter however display intrusive contact relations in the Pistol Lake map-area, as described above.

Granitization processes have also transformed metasedimentary gneisses into a variety of granitized gneisses and migmatite. The most highly granitized rocks actually consist of fine-grained grey feldspar-quartz-biotite granite, which usually displays a ghost foliation and mineral layering. The granite also contains diffuse, and in places distinct, remnants of paragneiss.

The rocks of the Pakwa-Pistol Lakes area south of Setting Lake, have been metamorphosed to the almandine-amphibolite facies. To the north of the Setting Lake fault zone the grade ranges from greenschist facies (biotite or garnet zone) to upper almandine-amphibolite facies (sillimanite zone). The lowest grade rocks are found along the northwest side of Setting Lake, immediately adjacent to the Setting Lake fault zone. A more detailed study of metamorphism of the entire Nickel Belt, including the Pakwa-Pistol Lakes map-area, is in progress.

Structural Geology

The major structural feature of the Pakwa-Pistol Lakes area is the Setting Lake fault zone. This zone outcrops as mylonite in the northeastern half of Setting Lake, but is almost completely under water in the southwestern part of the lake. Southwest of Setting Lake, the fault is marked by a 3,000 foot thick zone of fine-grained and probably cataclastic rocks, derived in part, from hornblende monzonite. However, microscopic examination will be required to definitely establish the cataclastic nature of this zone.

For further information on the geology of the Pakwa-Pistol Lakes area, and its regional setting, the reader is referred to Cranstone (1968); to Preliminary Maps 1969 D-1 and 1969 D-2 by Cranstone and Toogood; and to the paper by D. A. Cranstone on the Manitoba Nickel Belt elsewhere in this publication.

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(3) MANITOBA NICKEL BELT

by D. A. Cranstone

Introduction

The writer is currently engaged in a study of the Moak Lake-Setting Lake nickel area of northern Manitoba. The object of this project is to provide a clearer understanding of the regional and local geological setting of the ultramafic rocks and nickel deposits of the Nickel Belt. It is anticipated that the study will cover the belt from the edge of the Paleozoic rocks, southwest of Wabowden, to Assean and Split Lakes in the northeast. The majority of the field work in 1969 was concentrated between Kiski Lake in the southwest and Moak Lake in the northeast. It should be emphasized that at the present incomplete stage of the study, any results which are presented are tentative and incomplete, and may be subject to considerable revision in the future.

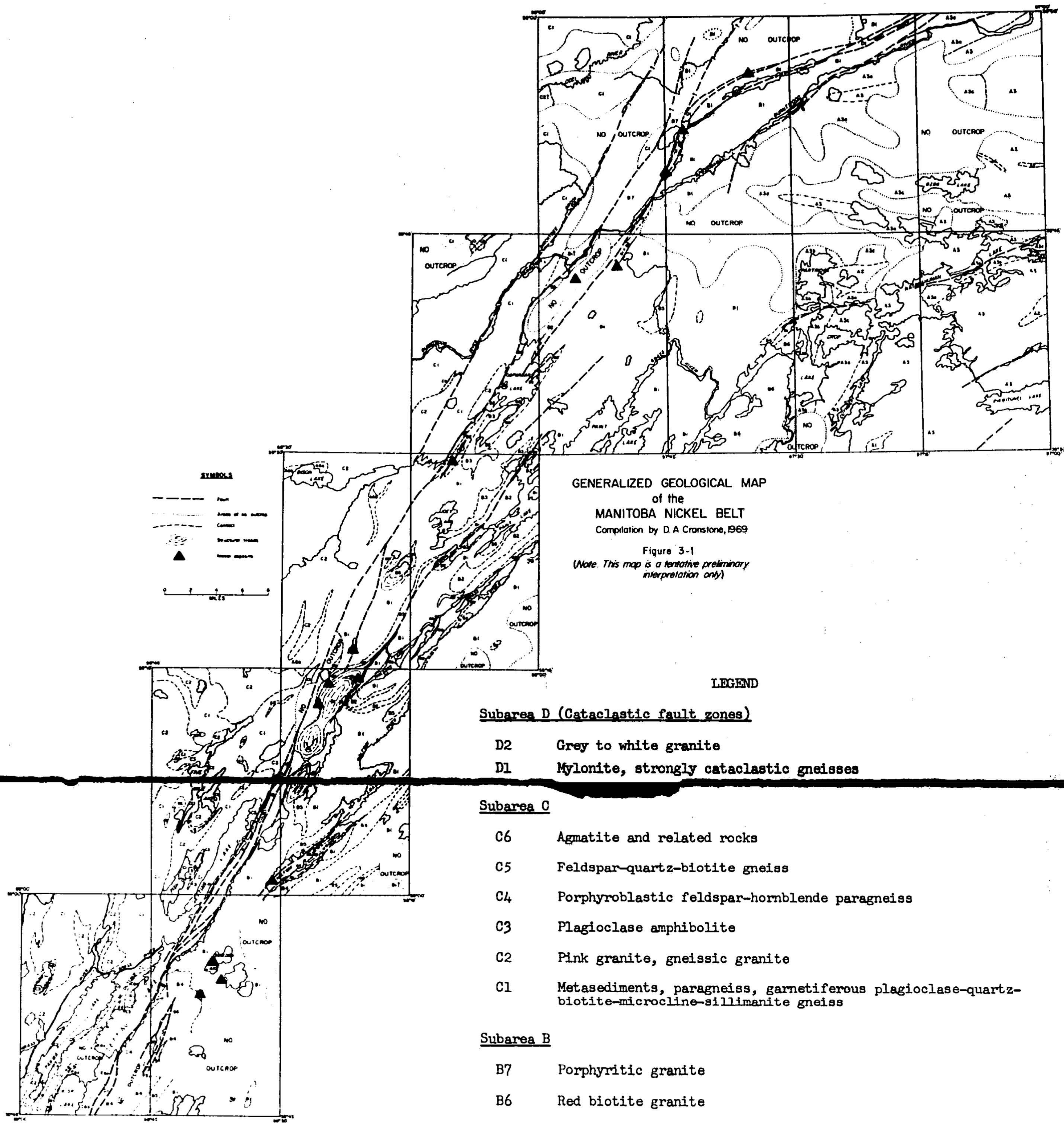
General Geology and Metamorphism

Figure 3-1 is a tentative, generalized geological map of a portion of the Nickel Belt. This map is based on previous geological mapping by the Manitoba Mines Branch with modifications by the present writer based on 1969 field observations.

The map-area has been divided into three subareas, which are represented on the map by the letters A, B, and C. These letters have been used to prefix and thus distinguish the numbering of individual map-units in each subarea. A chronological sequence is not implied by the order of the letters and numerals. Known nickel deposits are indicated on the map, but ultramafic rocks are not shown. The locations of ultramafic bodies can be obtained from Zurbrigg (1963), Coats (1966) and Scoates (1969).

Subarea A consists primarily of pyroxene granites (A3) and pyroxene granulites (A2), as well as related rocks (A3a, A3b) which may be retrograded equivalents of map-unit A3.

Pyroxene granites and other pyroxene granulites, can be traced southwest from Partridge Crop Lake, at least as far as the west end of Sipiwesk Lake. The contact between these pyroxene granulite facies rocks



GENERALIZED GEOLOGICAL MAP
of the
MANITOBA NICKEL BELT
Compilation by D.A. Cranstone, 1969

Figure 3-1

(Note. This map is a tentative preliminary interpretation only)

LEGEND

<u>Subarea D (Cataclastic fault zones)</u>

D2	Grey to white granite
D1	Mylonite, strongly cataclastic gneisses

<u>Subarea C</u>

C6	Agmatite and related rocks
C5	Feldspar-quartz-biotite gneiss
C4	Porphyroblastic feldspar-hornblende paragneiss
C3	Plagioclase amphibolite
C2	Pink granite, gneissic granite
C1	Metasediments, paragneiss, garnetiferous plagioclase-quartz-biotite-microcline-sillimanite gneiss

<u>Subarea B</u>

B7	Porphyritic granite
B6	Red biotite granite
B5	Granites and intensely granitized gneisses
B4	Hornblende monzonite
B3	Plagioclase amphibolite, amphibolitic schists, and related rocks. Possibly of volcanic origin
B2	Paragneiss and pyroxene-bearing granulites; quartzo-feldspathic metasediments
B1	Granodiorite gneiss

<u>Subarea A</u>

A3b	Granodioritic gneisses of indeterminate origin. May possibly be derived from A3 and A3a, or B1
A3a	Retrograded pyroxene granites. Includes some cataclastic rocks derived from retrograded A3
A3	Pyroxene granite
A2	Mafic pyroxene granulites
A1	Quartz-plagioclase-garnet gneiss

(subarea A) and the rocks of subarea B runs southwest from Partridge Crop Lake and continues beyond the present map-area (Figure 3-1). The contact passes approximately 7 miles southeast of Halfway Lake, with pyroxene granulites of subarea A possibly underlying the southeast corner of the Halfway Lake map-area. From Apussigamasi Lake to the northeast corner of the map-area, the contact between subareas A and B consists of a cataclastic fault zone. The nature of this contact is not clear elsewhere in the area, and further work on this problem is planned at Partridge Crop Lake for 1970.

Subarea B lies between subareas A and C. The contact with subarea C is a cataclastic fault zone. The predominant rock type in subarea B is a fine-grained grey layered granitoid granodioritic gneiss (B1), which in many areas contains relatively narrow irregular bands and remnants of plagioclase amphibolite. Map-unit B1 is not completely homogeneous, but shows some variation throughout the map-area. It may be possible therefore to further subdivide this map-unit. Subarea B also includes the following rock types: paragneiss and (?) pyroxene-bearing granulites (B2); plagioclase amphibolite and amphibolitic schists (B3) which may include some volcanic rocks, for example at Ospwagan Lake; hornblende monzonite (B4); and various granites (B5 and B6). Map-unit B5 comprises a wide variety of granitic rocks, including some intrusive granites. It consists primarily however of highly granitized gneisses which locally show relict gneissic layering. Most of the granitic rocks of map-unit B5 are distinctly different from the granites (C2) of subarea C. In earlier Mines Branch mapping however, no distinction was made between these two map-units. In the area between Thompson and Ospwagan Lake, map-unit B1 includes quartzo-feldspathic and quartzose metasedimentary rocks and paragneisses, which are not well exposed. At the northeast end of Paint Lake at least some of the rocks included in this map unit, are actually the same rocks shown as paragneisses and pyroxene-bearing granulites (B2) at the southwest end of Paint Lake. Further work is planned for 1970, with the intention of revising the geological interpretation around Paint Lake. More work is also needed to determine the relationship between the pyroxene-bearing rocks in the vicinity of Paint Lake, and the pyroxene granulites of subarea A.

Subarea C consists predominantly of massive to foliated pink granites, and pelitic metasedimentary rocks with derived paragneisses. The least metamorphosed of the metasedimentary rocks occur along the north side of Setting Lake, where pebble beds are preserved. Further to the northwest of Setting Lake, these metasedimentary rocks grade into paragneisses, granitized paragneisses, and migmatites, many of which contain distinctive mauve garnets. Granitic material occurs in these rocks as irregular sills and lit. In the area northwest of Thompson and Ospwagan Lake, the same metasedimentary rocks are represented by garnetiferous plagioclase-quartz-biotite-microcline-sillimanite-(cordierite)-(magnetite) gneisses, containing complexly intermixed white granitic material and the same characteristic mauve garnets. Less extensive rock types occurring in subarea C are plagioclase amphibolite (of probable volcanic origin, map-unit C3); porphyroblastic feldspar-hornblende paragneiss (C4); feldspar-quartz-biotite gneiss (C5); and agmatite. Rocks mapped as agmatite are of two varieties (C6a and C6b), found at Kiski Lake and south of Bison Lake respectively.

Structural Geology

The structure of the area is complex. The most notable structural feature is the existence of the three distinct subareas A, B, and C.

Subarea B contains a number of elongate northeasterly trending domes and basins presumably formed by two periods of folding.

Structural interpretation, particularly in subareas B and C, is complicated by a series of northeasterly trending subparallel vertical faults. Only a few of these faults are indicated in Figure 3-1, and many others are known or suspected to occur in the area. Notable mylonitic cataclastic zones, thousands of feet thick occur in the area. Rock types in these zones range from ultramylonites to crushed gneisses. A major cataclastic zone consisting of crushed gneisses several thousand feet thick, underlies the Odei River from Moak Lake to Assean and Split Lakes, and is an extension of the Assean Lake and Split Lake fault zones (Haugh, 1969). The Moak Lake serpentinite apparently occurs in a zone of mylonitic gneisses which is probably a branch of the Odei River fault. This zone swings southwest through Mystery Lake, Mystery Creek, the Burntwood River, passing just north of the Thompson Mine, and underlying Ospwagan Lake. Wide mylonite zones occur in paragneisses in the open pit at the Pipe Mine; and the continuation of the same fault zone underlies Setting Lake, where the mylonite zone is at least 3,000 feet thick. Other faults, such as those at the Soab Mine and underlying the Grass River and Pisew Falls are not mylonitic, but consist of sheared and broken schistose rock, with characteristic crumbly limonitic weathering. More than one period of faulting has probably occurred in the area.

Economic Geology

A spatial and genetic correlation of faults, ultramafic rocks, and nickel-bearing sulfide deposits is known along the nickel belt. All nickel deposits, and nearly all of the ultramafic (serpentinized peridotite) bodies known to the writer occur in subarea B (Figure 3-1). There is a good possibility that the fault which underlies Mystery Lake splits immediately to the north of the lake, with one branch fault swinging east through the Moak Lake mine and one or more branch faults continuing northeast along the Mystery Lake trend. This tentative interpretation is supported by the lithology of the few outcrops which occur north of Mystery Lake and by a magnetic trend which is evident from Geological Survey of Canada Map 1D-1967, (Residual magnetic anomaly map).

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(4) ULTRAMAFIC PROJECT

by R. F. Jon Scoates

During the summer of 1969 selected occurrences of ultramafic rocks were examined (Figure 4 - 1). The following are brief descriptions of these occurrences.

Embury Lake

Two small ultramafic bodies on the northwest end of Embury Lake have been examined. For convenience these bodies are referred to as Embury #1 and Embury #2. The bodies are in contact with pre-Missi series sediments and derived schists and post-Missi diorite amphibolite and gabbro (Tanton, 1941a).

Embury #1 is approximately 900' north of the northwest end of Embury Lake. It forms an outcrop area approximately 200 x 300 feet, which rises 40 to 50 feet above the surrounding low ground. The body, an altered clinopyroxenite, displays intense alteration near its margins. A two foot zone of talc-carbonate schist marks the north contact of the body with a 70 foot wide rusty, fine grained cataclasite. The alteration of the primary clinopyroxene takes the form of tremolite-carbonate-talc assemblages.

Embury #2 is 1,100 feet north of the north shore of Embury Lake on the northwest end of a small unnamed lake. The outcrop area is approximately 400 x 500 feet. The weathered surface ranges from orange buff to light grey buff in colour. The north and south contact areas of the ultramafic are strongly foliated and are both marked by a sheared breccia. The foliated matrix and fragments of the north contact zone are both a talc-carbonate serpentinite. The strongly foliated serpentinite and rounded serpentinite inclusions occupy a zone adjacent to the contact, approximately 100 feet wide. The rocks in this zone have been completely recrystallized to a talc-carbonate serpentinite and relict primary textures do not appear to be preserved. Subhedral to euhedral reddish brown disseminated chromite is common and makes up less than 5 per cent of the rock.

Serpentinized peridotite and altered clinopyroxenite are found in the central part of the body. The rocks are massive and do not show signs

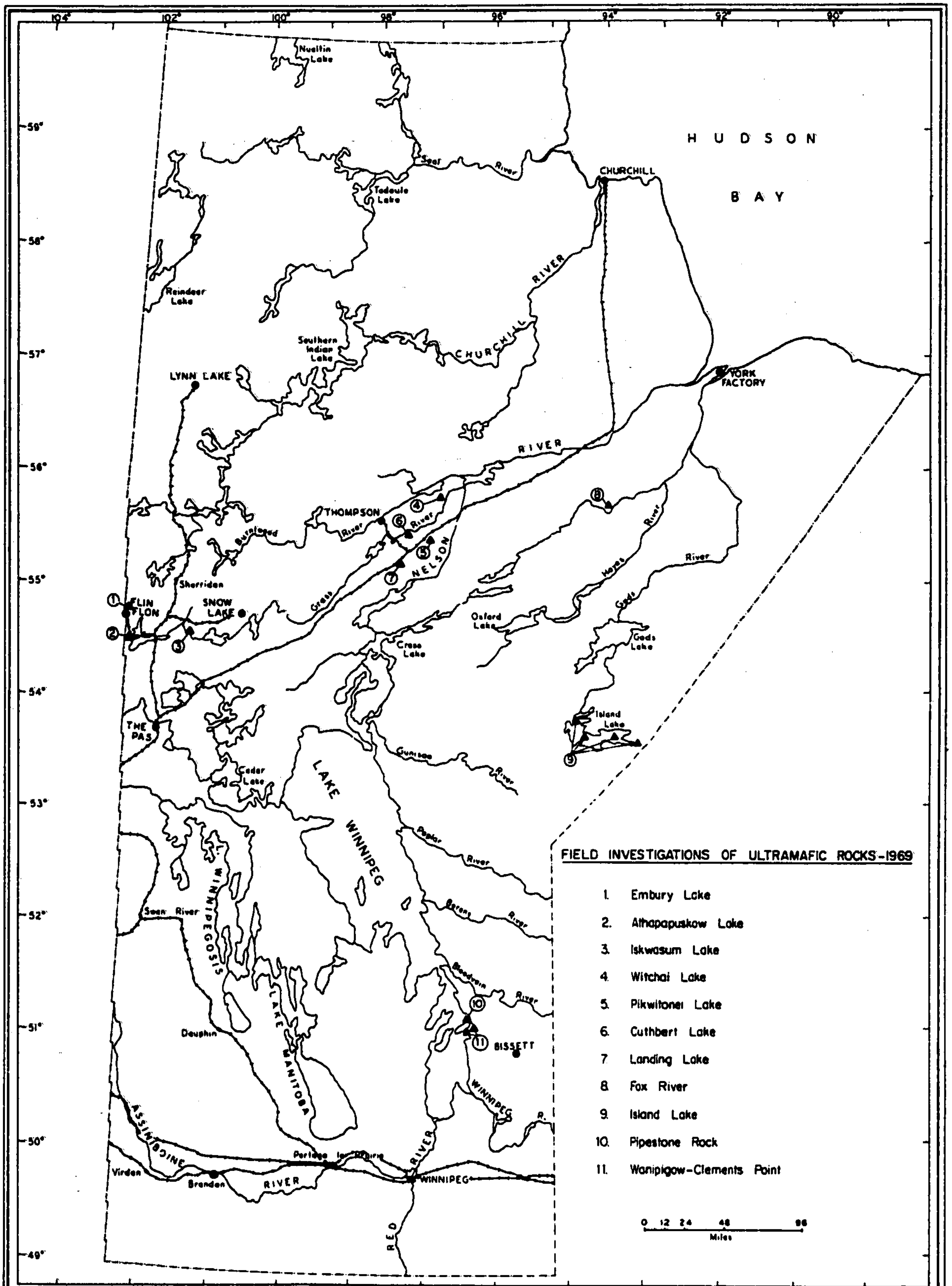
HUDSON
BAY
CHURCHILL
YORK FACTORY
Nueltin Lake
Seal River
Tadoule Lake
Reindeer Lake
CHURCHILL RIVER
Southern Indian Lake
LYNN LAKE
NELSON RIVER
THOMPSON
Burntwood
Grass River
Sherridon
FLIN FLON
SNOW LAKE
Oxford Lake
Hayes River
Gods River
Gods Lake
Cross Lake
THE PAS
Island Lake
Gunisao River
Cedar Lake
LAKE WINNIPEG
Poplar River
Berens River
Bloodvein River
BISSETT
WINNIPEG R.
L. WINNIPEGOSIS
Swan River
Dauphin
LAKE MANITOBA
ASSINIBOINE RIVER
Portage la Prairie
Virden
Brandon
WINNIPEG
RED RIVER
FIELD INVESTIGATIONS OF ULTRAMAFIC ROCKS - 1969
1. Embury Lake
2. Athapapuskow Lake
3. Iskwasum Lake
4. Witchai Lake
5. Pikwitonei Lake
6. Cuthbert Lake
7. Landing Lake
8. Fox River
9. Island Lake
10. Pipestone Rock
11. Wanipigow-Clements Point
0 12 24 48 96
Miles

Figure 4-1

of deformation. Relict textures are preserved in the serpentinized peridotite and relict clinopyroxenes are preserved in the altered clinopyroxenite.

The south contact is also marked by a breccia zone, however here, the breccia fragments are clastic sediments and altered gabbros. The matrix is a strongly foliated talc-carbonate serpentinite.

The relation between the altered primary lithologies in Embury #2 is not known. A two inch layer or dyke of serpentinite was observed in the altered clinopyroxenite in a loose slab.

Although the two Embury Lake bodies are compositionally different they have similar features which include the strongly foliated and highly altered marginal rocks.

In both bodies sulphides are rare; a few disseminated, fine grained crystals of pyrrhotite being observed in a hand specimen from Embury #1. The two foot zone of talc schist noted at the north contact of Embury #2 has been mentioned. A visual estimate of the composition of the talc schist is as follows:

Talc	60 - 70%
Carbonate	20 - 25%
Serpentine	5%
Magnetite	3%

Schist Lake

The ultramafic body at the south end of Schist Lake shown on G.S.C. Map 633A (Tanton, 1941b) was found upon examination to be a highly altered gabbro. The rock weathers a rusty brown colour and this surface can be easily mistaken for the weathered surface of a serpentinized peridotite.

Athapapuskow Lake

The ultramafic body exposed on an island at the west end of Athapapuskow Lake, also shown on G.S.C. Map 633A, has been found to be dominantly an altered pyroxenite. All of the outcrops are ultramafic in character, with the exception of what appears to be an inclusion of fine grained gabbro on the southeast side of the island. The rocks, for the most part, are altered, two-pyroxene pyroxenites with a varying ratio of ortho- to clinopyroxene. The alteration products are assemblages of tremolite, serpentine, talc and carbonate. The pyroxenites weather buff to grey buff and have a characteristic knobby surface.

An outcrop of serpentinized peridotite occurs on the southwest side of the island. Serpentinization of the peridotite is complete and relict textures appear to be well preserved. A partially altered olivine clinopyroxenite was found approximately 500 feet east of this peridotite. The relation between the primary units is not known because of the lack of good exposure.

Two small test pits were found, one on the northeast side and one on the southwest side of the island. A number of veinlets of coarse hard crossfibre asbestos were observed in some of the pit material.

Sulphide minerals were not noted.

Chisel Lake

A traverse was run across the Chisel Lake metaperidotite (Williams, 1966). The metaperidotite is essentially a massive, homogeneous rock with a characteristic reddish brown to buff weathered surface. The rock has a spotted appearance on the weathered surface due to large altered pyroxenes. Some variation in the percentage of pyroxene was noted, however no layered structures were found.

The contact between the metaperidotite and the overlying gabbro is not exposed. The gabbro is a massive, medium grained rock with a grey green weathered surface. It has a typical salt and pepper texture. The gabbro bears little resemblance in mineralogy, colour, grain size or texture to the metaperidotite.

Iskwasum Lake

The ultramafic rocks on Iskwasum Lake and along the Grass River are a series of discrete talc-serpentine bodies. The bodies are characterized by selvages of hematized talc-serpentine schist. The rocks display grey buff to orange buff weathered surfaces which are usually deeply pitted; the pits originating through solution of carbonate. Contacts between the ultramafic bodies and the enclosing gabbro-basic volcanic sequence are not exposed.

The bodies appear to be ellipsoidal in shape and range in size from 1000 x 5000 feet up to 1000 x 16000 feet.

Each body displays a selvage of talc schist and talc-serpentine schist. The talc-serpentine selvages are estimated to range in thickness from 50 to 200 feet. Hematization of the talc schist is common.

In a few areas exposures of apple green serpentinite are observed. It is suggested that the bodies consist of a core of apple green serpentinite enclosed in talc-serpentine schist.

Sulphide minerals are rare. The development of coarse talc crystals are noted in a number of areas in association with the talc schists and talc-serpentine schists.

Witchai-Pikwitonei-Landing Lakes

Straight walled mafic and ultramafic dykes are characteristic of the Pikwitonei subprovince. They have a dominant northeasterly strike and cut across intermediate to acid gneisses and gneissic granites. The dykes range in width from several inches to 600 feet and the Cuthbert Lake dyke attains a length of 24 miles (McDonald, 1960). At one location on Witchai Lake three ages of mafic dykes are recorded.

Two types of dykes are recognized in the field on a basis of composition and texture; 1) ultramafic dykes and 2) gabbro-diabasic gabbro dykes. Within each group there is a considerable range in composition. The ultramafic dykes are essentially pyroxene, hornblende, plagioclase, olivine bearing rocks and compositionally they range from peridotite, feldspathic peridotite, pyroxenite, and hornblendite to picrite. Hornblende-pyroxene picrite is an estimated average composition for the ultramafic dykes.

The gabbro-diabasic gabbro dykes are assemblages of hornblende, pyroxene and plagioclase. Their compositional range does not appear to be as great as the ultramafic group, although norites and granophyre bearing gabbros have been recognized.

The larger ultramafic and gabbro dykes display fine grained margins where the dykes have chilled against the country rocks. Some of the larger ultramafic dykes are compositionally zoned across their width; hornblende, pyroxene and olivine tending to be more abundant at the dyke centres, and plagioclase being more abundant at the margins. Some dykes therefore have ultramafic central areas and gabbroic margins.

Sulphide minerals which are generally rare, are mainly pyrrhotite and chalcopyrite.

Fox River Sill

A portion of a layered ultramafic-mafic sill is exposed in rapids of the Fox River approximately one mile downstream from the confluence of the Fox and Sipanigo Rivers. The sill is intrusive into and conformable with a series of basic pillowed volcanics. The layering of the sill and the bedding of the pillowed volcanics strike a few degrees south of east and dip vertically. The pillows display tops to the north and the base of the sill faces north and roof faces south. This is contrary to a published report (Quinn, 1955) which refers to the south side as the sill base.

Approximately 3100 feet of the upper part of the sill is exposed along the rapids. Four miles downstream from the base of the rapids and approximately one half mile downstream from the confluence of the Fox and Gowan Rivers an outcrop of serpentinite occurs along the west shore of the river. One quarter mile downstream from this point the northernmost outcrop of the sill is found exposed on an island in the river. The southern half of the island is peridotite, the northern half feldspathic peridotite. The sill base is not exposed and occurs between the island outcrop and an outcrop of basalt some 700 feet north of the island. The overall thickness of the sill is estimated to be 7000 feet.

Twenty-seven layers consisting of six units are provisionally assigned to the 7000 feet of the sill (Table 4 - 1). The layers are numbered from the base to the roof and it should be noted that only two outcrops have been recorded for the bottom 4000 feet of the sill. An estimate of the number of missing layers has not been made, however it is likely that the missing section consists of alternating layers of serpentinite and pyroxenite.

TABLE 4 - 1

Provisional Geologic Section - Fox River Sill

Lithology	Layer Number	Unit Number	Estimated thickness in feet	Cumulative total thickness	
Basic pillowed volcanics			?		
Thinly bedded fine grained feldspathic quartzite			75		
Gabbro	27	6	375		
Feldspathic peridotite	26	5	75		
Websterite	25	4	35		
Gabbro	24	6	45		UPPER
Feldspathic peridotite	23	5	20		LAYERED
Gabbro	22	6	20		SERIES
Websterite	21	4	15		
Peridotite	20	3	60		
Pyroxenite	19	2	35		
Gabbro	18	6	135	815	
Pyroxenite	17	2	30		
Peridotite	16	3	140		
Pyroxenite	15	2	105		
Serpentinite	14	1	250		
Pyroxenite	13	2	20		
Serpentinite	12	1	115		MAIN
Pyroxenite	11	2	20		LAYERED
Serpentinite	10	1	205		SERIES
Pyroxenite	9	2	25		
Serpentinite	8	1	750		
Pyroxenite	7	2	45		
Serpentinite	6	1	480		
Pyroxenite	5	2	40		
Serpentinite	4	1	?	3040	
2000 Feet of Section Not Exposed			2000	5040	
Serpentinite	3	1	?		
Peridotite	2	3	?		
Feldspathic peridotite	1	5	?	7000	
Basic pillowed volcanics			?		

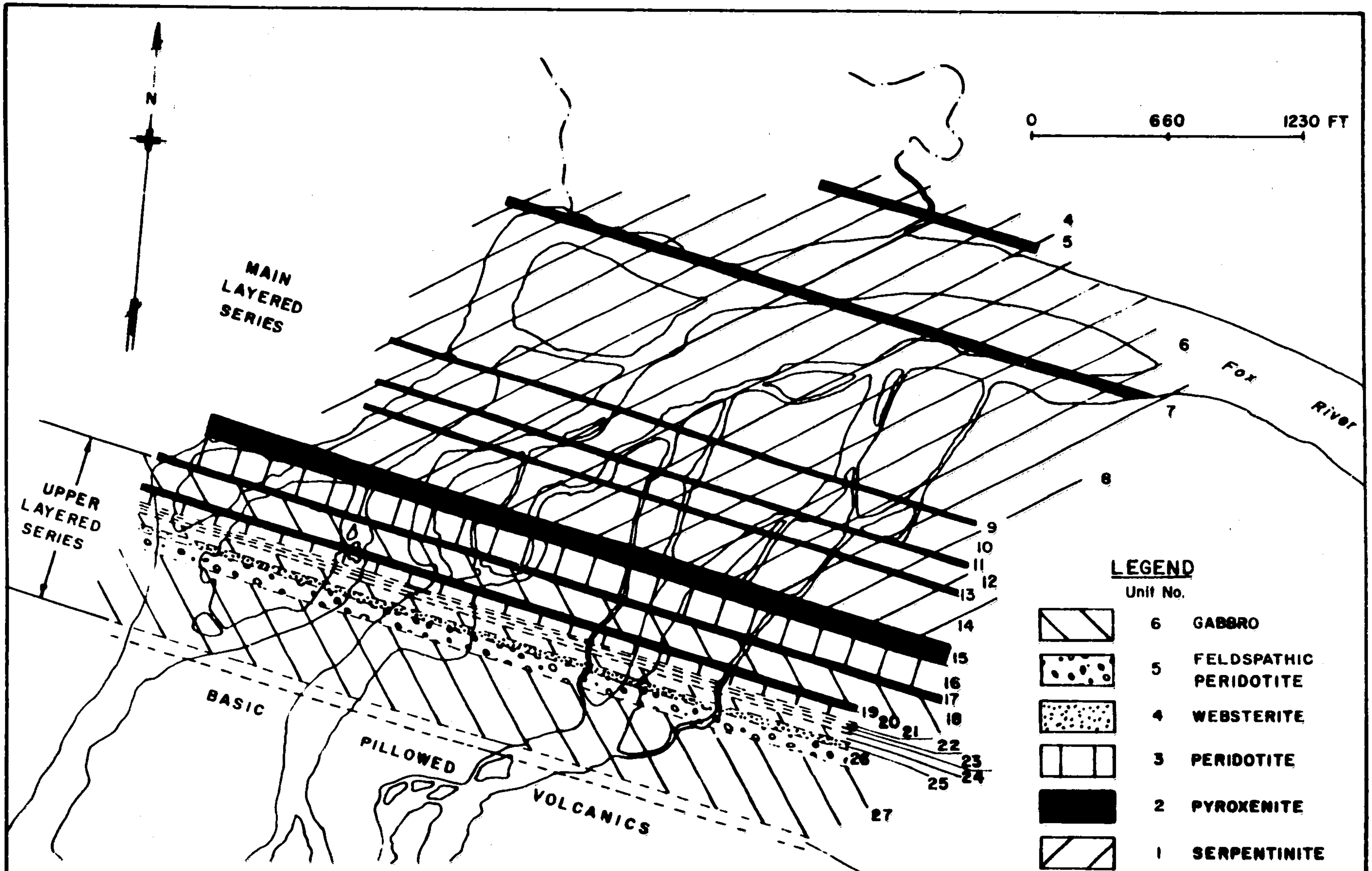

Figure 4-2 UPPER 3000 FEET - FOX RIVER SILL

The sill has been divided into an Upper Layered Series and a Main Layered Series; the contact between these two series being placed at the basal contact of the lowest gabbro layer (18). The Main Layered Series consists dominantly of alternating layers of serpentinite and pyroxenite; the Upper Layered Series consists mainly of gabbro and interlayered pyroxenite, websterite, feldspathic peridotite and peridotite.

A preliminary map has been made of the 3100 feet of the sill exposed in the rapids (Figure 4 - 2). Control for the position and strike of pyroxenite layers 9, 11 and 13 is excellent as these layers occur as resistant bands which form waterfalls at intervals along the rapids. Control along strike is poor for much of the Upper Layered Series, and the layering is assumed to parallel the direction of pyroxenite layers 9, 11 and 13. Where the roof contact of the sill is exposed and contact is seen to be folded into a series of open concentric Z folds. The roof contact is therefore probably not a straight line as presented on the map.

Sulphide minerals are rare with the exception of disseminated pyrrhotite in pyroxenite layer 5.

Unit 1 - serpentinite (serpentinized dunite)

Individual serpentinite layers are among the thickest of the sill and range from 100 to 750 feet thick. The serpentinites are extremely weathered and as a result, exposures are poor. The rocks are massive and apple green in colour and contain many crosscutting serpentine veinlets ($\pm$ disseminated magnetite) which render a boxwork affect to many of the outcrops. Very fine grained disseminated magnetite is a common accessory. The serpentinites are considered to be serpentinized dunites.

Unit 2 - pyroxenite

Pyroxenite layers form narrow resistant ridges in the low lying serpentinites and range in thickness from 20 to 100 feet. These resistant layers form topographic linears in the shape of waterfalls and can be traced across the width of the rapids for distances up to 1500 feet. The pyroxenites weather grey to grey buff in colour and are massive and fresh in appearance. Crosscutting serpentine veinlets are present but not as common as in the serpentinites.

Unit 3 - serpentinized peridotite

Serpentinized peridotite is a highly weathered grey buff to buff coloured rock, which has a dark greenish black fresh surface. Exposures of peridotite are highly weathered and consequently rare. The primary texture appears to be well preserved on the fresh surface; medium to coarse grained pyroxene crystals occurring in a fine grained matte of serpentine. Fine grained magnetite is a common accessory mineral.

Unit 4 - websterite

Websterite layers are restricted to the Upper Layered Series and form resistant bands similar to the pyroxenite layers previously described. The websterite weathers dark grey and is mottled brown and green on the fresh surface. It appears to contain approximately equal amounts of ortho- and clinopyroxene.

Unit 5 - serpentinized feldspathic peridotite

Serpentinized feldspathic peridotite weathers grey buff to buff and the fresh surface is dark greenish black to black. It is distinguished from peridotite by its plagioclase content; the plagioclase occurring as fine grained white to greenish white crystals.

Unit 6 - gabbro

Gabbros are grey weathering, and are brownish grey on fresh surface. They are generally medium grained rocks with the exception of layer 22 which is coarse grained. Orthopyroxene is the dominant mafic mineral. The uppermost gabbro unit, layer 27, displays a 50 foot, fine grained chilled margin against the fine grained feldspathic quartzite which forms the roof contact. Small (2 - 5 cm) inclusions of the feldspathic quartzite are found in the gabbro within 10 feet of the upper contact.

Island Lake

Eleven occurrences of ultramafic rocks, examined in the Island Lake-Sagawitchawan Bay area, are designated as serpentinites. The rocks, in general, weather dark green to buff and range from massive to foliated in structure. Veinlets of serpentine and cross fibre asbestos are common as well as irregular patches and regular veinlets of carbonate ± magnetite.

A small ultramafic body exposed on an island south of Whiteway Island displays the only lithologic variation observed in the Island Lake group of serpentinites. The northwest side of the island is serpentinized peridotite which grades into a black massive serpentinite which in turn grades into a foliated apple green serpentinite. Disseminated pyrrhotite and chalcopyrite were noted in all three lithologies.

East side of Lake Winnipeg

Four bodies of serpentinite were examined along the east shore of Lake Winnipeg. The northernmost body, Pipestone Rock, is a dark grey buff to buff massive to foliated serpentinite. Crosscutting talc-serpentine-carbonate veinlets are common.

A mile and one half southeast of Pipestone Rock is a small reef of foliated serpentinite. The weathered surface of this body is distinctive in being extremely knobby. Coarse, green, parallel fibre serpentine is common as well as many crosscutting serpentine-carbonate veinlets.

An occurrence of talc-serpentine schist associated with thinly bedded iron formation occurs in Wanipigow Bay approximately one mile east of the mouth of the Wanipigow River. Several outcrops of relatively pure talc schist were observed.

A reef of sheared serpentinite one half mile north of Clement Point is characterized by many talc-carbonate-serpentine veinlets.

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(5 & 6) PROJECT PIONEER

(Parts of 52L-11, 14, 52M-4, 53D-4, 62P-1)

by W. Weber

A. During the 1969 field season some critical locations south of Long Lake were visited in concluding the fieldwork for Project Pioneer. Publications will include, maps of the gneissic belt, 69-1 to 4 to be published early in 1970, and a map of the Long Lake-Gem Lake area with a report ready for publication by the summer of 1970.

B. The main topographical lineaments of the central quartz diorite east of Bissett were briefly investigated by helicopter. It would appear that the main lineaments, which are approximately NE striking and are slightly curved in the eastern part of the pluton, are caused by two intersecting joint sets, one shallow and the other steeply dipping.

The southeast to east striking lineaments in the southern part of the pluton are cataclastic zones of microbrecciation, contained partly within shear zones that are up to 500 feet wide.

C. Traverses were made in the area between Bissett and Wanipigow Lake to investigate the western limits of the San Antonio Formation, as an extension of the mapping started in 1966.

The most westerly outcrops of San Antonio Formation occur approximately 6 miles NW and W of Bissett. (Figure 5 - 1). The area shown by N. Church as San Antonio Formation extending from there to the west side of Wanipigow Lake (Summary of Fieldwork 1968) is a typical sequence of the Rice Lake Group sediments.

The San Antonio Formation consists mainly of immature, poorly sorted arkose, which is in part pebbly, and contains interlayered conglomerate lenses. These sediments represent essentially subaerial alluvial fan deposits. The sediments of the Rice Lake Group are a subaqueous sequence of submature and well sorted deposits. They consist predominantly of interlayered partly graded greywacke and argillites, minor chert and conglomerate horizons and iron

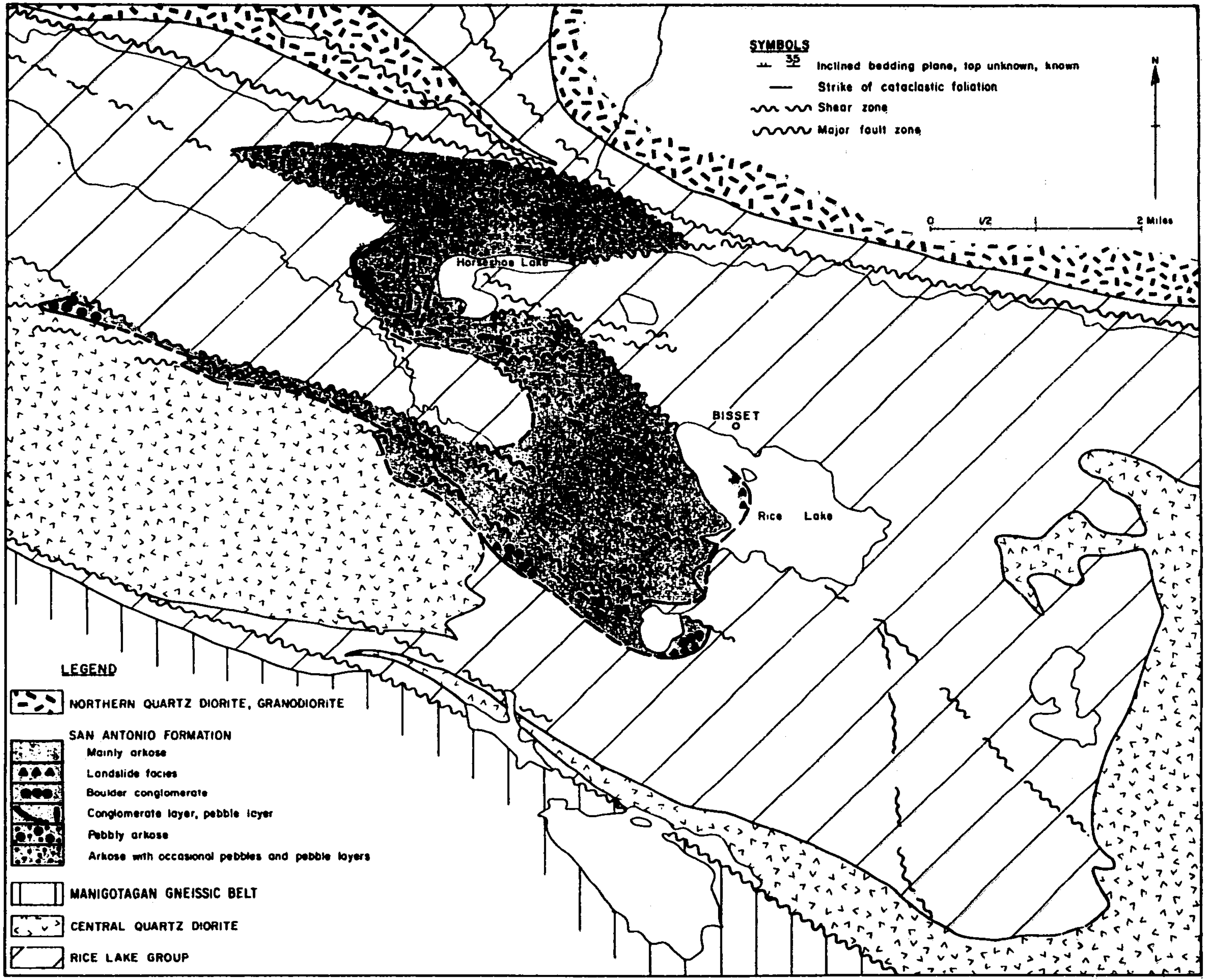

Figure 5-1 Map of the SAN ANTONIO FORMATION in the RICE LAKE area (partly based on J. F. Davies, 1963)

formation. The latter is particularly well developed near the base of the section. In contrast to the San Antonio Formation the sediments of the Rice Lake Group are characteristic of sedimentation in a geosynclinal trough.

The San Antonio Formation is younger than the quartz diorite pluton to the south which is overlain by fragmental San Antonio Formation with abundant identical quartz diorite blocks and boulders (see also C. H. Stockwell 1938, 1944 and J.F. Davies 1953, 1963).

The San Antonio Formation represents a relatively small sedimentary basin between uplifted blocks both to the south and northwest or north. This is illustrated by the distribution of the fragmental phases of the San Antonio Formation (Figure 5 -1). The uplift (or tilting) at the southern margin must have happened abruptly as is indicated by the coarse landslide material and boulder conglomerates that occur along the southern contact (this coarse fragmental facies might be more widespread than indicated on Figure 5 - 1 but is not visible due to lack of outcrop and was probably not continuous originally). The landslide facies consists of unsorted quartz diorite material from grit to block size. The distribution of the landslide material seems to indicate that the quartz diorite plutons east and west of Bissett were a single body at a higher level. The San Antonio Formation NW of Rice Lake differs from the southern portion in that there are microcline grains in the arkose matrix and other characteristic rock types as pebbles, mainly greenish sericite schist, pink aplite granite and quartz (potash feldspar does not appear to occur in the Rice Lake Group sediments neither as clastic grains nor in granitoid pebbles which are tonalitic in composition). There is no rock exposure in the vicinity of the San Antonio Formation from which these pebbles could be derived but the fault zones north of Bissett appear to have caused major displacements in a horizontal direction (see W. D. McRitchie in this report) and may be also in a vertical direction and therefore removed the original source rocks of the San Antonio Formation. Alternatively, the northern quartz diorites and granodiorites have replaced the original source rock if they are younger than the San Antonio Formation as postulated by A. Turek (1968).

The interpretation of the structure of the San Antonio Formation is not as simple as has been suggested by previous authors (Stockwell, Davies). Good bedding planes indicating tops are too rare to confirm for example the anticlinal axis through Horseshoe Lake. The detailed work of Jim Arthur who started a Master's thesis in the southern part of the San Antonio Formation revealed that it was deformed into a series of steplike fairly open folds with shallow dipping limbs to the north and steeply dipping limbs to the south. The predominant structural feature of the San Antonio Formation is a penetrative cataclastic foliation which runs approximately E-W and which was caused by a regional shearing. It produced passive slip folds in the conglomerate band southwest of Horseshoe Lake. It also completely reoriented and flattened pebbles regardless of their primary layering which is for example N-S near Horseshoe Lake (see Figure 5 - 1). This shearing may also have been responsible for the folded outcrop pattern between Horseshoe Lake and Rice Lake. Rather narrow shear zones running in a southeasterly direction, are probably younger and seem to have caused major displacements. Besides these three different types of deformations the topography of the Rice Lake Group before the deposition of the San Antonio Formation might be partly responsible for its outcrop pattern.

D. A short visit was made to I. Ermanovics, leader of the G. S. C. party, which was mapping the area between the east shore of Lake Winnipeg and the Manitoba border between the 52nd and 53rd parallel. We briefly investigated the volcanic rocks on Horseshoe Lake, 160 miles NW of Winnipeg. They are dacites with porphyritic feldspar and quartz and differ from the volcanic rocks of the Rice

Lake belt in that they were progressively metamorphosed and recrystallized during a regional thermal metamorphism. These metadacites are massive in the centre of the area, and become more sheared towards the south, where they are interlayered with metasediments and contain some pyroclastic horizons. The volcanic rocks are intruded by leucocratic granites in a few localities.

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(7 & 8) PROJECT PIONEER

(Parts of:- 52L-5, 12, 13; 52M-3; 62I-1, 8, 9, 16)

by W. D. McRitchie

A three part programme was undertaken during the months of June, July and August with the following objectives:-

Region 7 Index Map	1)	A detailed re-examination of the Wallace Lake-Siderock Lake greenstone belt and its relation to the main Rice Lake-Beresford Lake greenstone belt.
	2)	A verification of petrographic and structural syntheses (1966-68) made in establishing a metamorphic history for the Manigotagan gneissic belt.
Region 8 Index Map	3)	A reconnaissance survey of the hitherto unmapped shield exposures stretching South from the Sandy River to Lac du Bonnet and west to the overlying palaeozoics.

1) Wallace Lake-Siderock Lake

A summary table of the geological formations, compiled from Russell, G. A. (1948) and Stockwell, C. H. (1945) and modified as a result of the current investigations is as follows:

	Wallace Lake	Siderock Lake
Intrusives	Wanipigow diorite and gabbro	
	Granodiorite and Quartz diorite	Granodiorite and Quartz diorite
	Older gabbro	Older gabbro
Metasediment & Metavolcanic	Arkose, grit, quartzite, conglomerate	Argillite and thin basaltic flows
	Iron Formation	Iron Formation
	Chert, limestone graphitic slate	Graphitic slate and greywacke
	Quartzite, greywacke	Thick sedimentary breccia and greywackes derived from intermediate volcanics
	Basic volcanics, pillow lavas	

GEOLOGICAL OUTLINE MAP

REINSTATEMENT OF BLOCK TO NORTH OF WALLACE LAKE - SIDEROCK LAKE FAULT

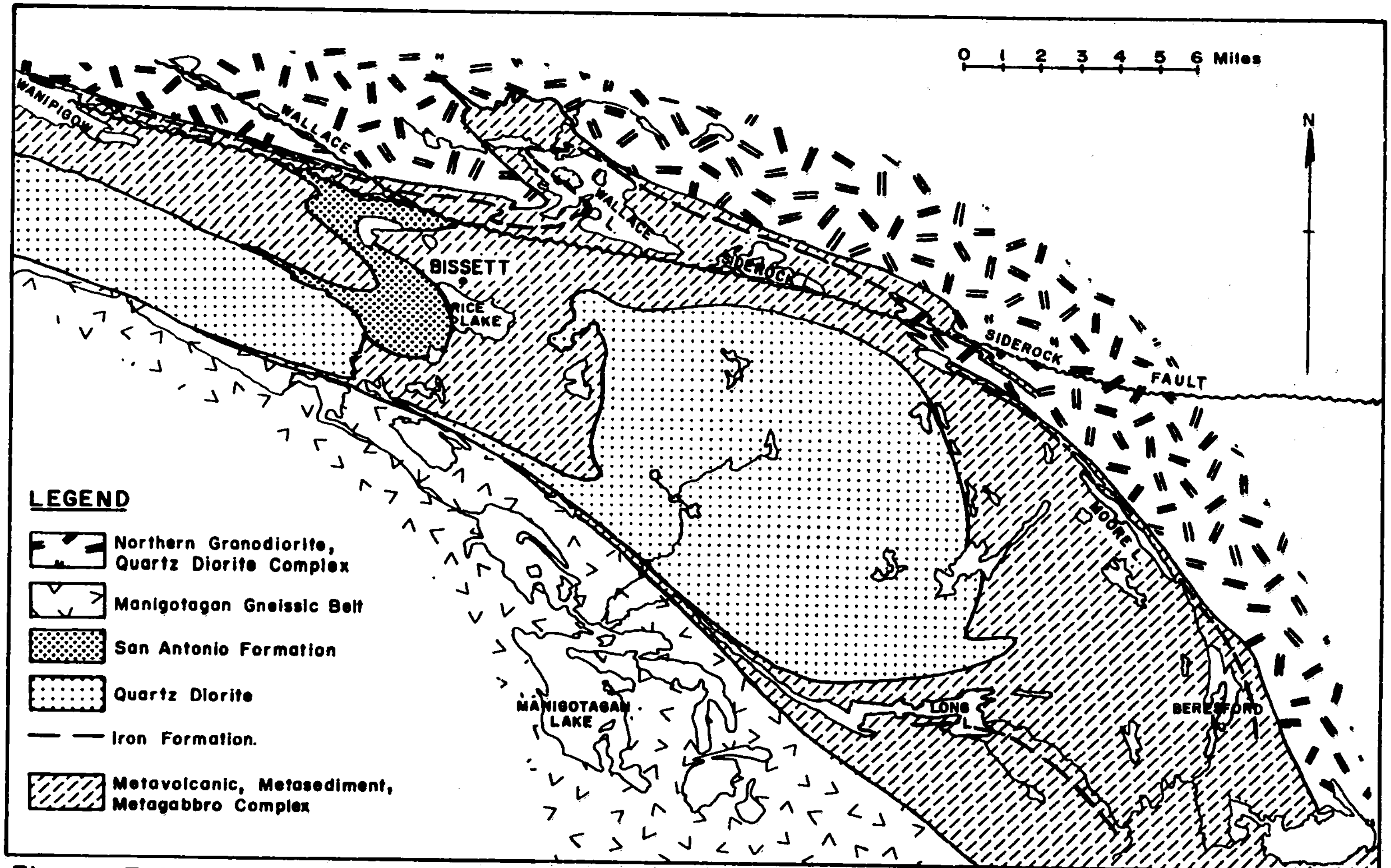

Figure 7-1

Particular attention was paid to mapping the northern intrusive contact and the southern faulted contact of the greenstones. Within the belt the iron formation proved to be an excellent marker horizon traceable both in outcrop and from ground magnetic interpretation from Limestone Hill in the west to the Ontario border in the east. Correlation of lithologies and structures on both sides of the fault is possible, indicating a 10-mile dextral lateral displacement along the line of this fracture. As an example, the iron formation to the north of the fault may then be correlated in the east with that which extends through Moore Lake to Beresford Lake and in the west with that outcropping to the N. W. of Horseshoe Lake and extending westward along the northern shore of Wanipigow Lake.

2) Manigotagan gneissic belt

In collaboration with W. Weber the following outline history of deformation and metamorphism in the gneissic belt has been established.

(D represents deformation; F represents fabric)

	D_5	Narrow ultramylonites
Mineralization	D_{4A}	Kink folds associated with opening of late regional fracture and joints
Mineralization	D_4	Extensive sheared zones and mylonites
	D_3	Local open folds, mainly S, with incipient strain slip cleavage in some units
	F_2	Intense foliation superimposed parallel to axial planes of D_2 folds - matrix coarsening
	D_2	Regional Z folding
	F_1	Main recrystallization and regional metamorphic zonation from greenschist facies in the greenstone belt to upper amphibolite facies in the gneissic belt
	D_1	Isoclinal folding
	F_0	Original fabric (not observed)

An initial correlation with structures in the greenstone belt has been made.

3) Sandy River-Lac du Bonnet (Operation Extension)

During parts of July and August an area 2,000 square miles in extent was mapped on a reconnaissance basis with the able assistance of D. James. Canoe, helicopter, fixed wing and road traverses were made throughout the region, access in the north being greatly facilitated by numerous logging roads belonging to the Abitibi Paper Co. of Canada Ltd., and in the south by an intricate network of provincial roads.

The following lithologies were encountered; unit numbers with reference to the legend on Manitoba Mines Branch preliminary reconnaissance maps 1969F-1 to 1969F-7.

Metasediment, metavolcanic, metagabbro (1)

A complexly interlayered sequence of quartzites, argillites, siltstones, volcanic conglomerates and pillow lavas which extend to the west from the Bird River greenstone belt (Davies, 1952) outcrop on the northeast shore of Lac du Bonnet. Highly folded and intruded by gabbro (2) dykes and sills, these units may be traced northwards to Anson Lake and thence, much intruded by granodiorite dykes (7) through Round Lake to the Maskwa River. Here, swinging round the nose of a large fold they are deflected eastwards to join up with the Maskwa River-Cat Lake greenstone belt. No ultramafics were encountered during the survey, other than the peridotite at Cat Creek, but a strong magnetic expression near Anson Lake may indicate a favorable location.

Paragneiss (3) Migmatite (4)

Mainly developed within the Manigotagan belt (Weber and McRitchie, 1969) the paragneisses and migmatites are most commonly interlayered with white pegmatites (6) and their associated white granodioritic phases. Cordierite, sillimanite and garnet are locally present and in the vicinity of Black River several partially anatectic derivatives contain large porphyroblasts of plagioclase feldspar. Amphibolite layers and boudins are common associates of these strongly folded and metamorphosed metasediments.

Grey quartz dioritic and granodioritic gneiss (5)

Extensively developed in the southwestern region and occurring as long strongly folded isoclinal layers in the Manigotagan gneissic belt, the grey granodioritic gneiss is believed to have been originally sedimentary in origin. In the southwest a large mass of the well layered and foliated biotite gneiss contains abundant amphibolite dykes and sills and is locally intruded by units 7, 10, 11 and 12. Pink pegmatites and aplites are ubiquitous. Near Great Falls a small fault within the gneisses, now represented by a recrystallized biotite schist, displaces the original layering but is itself cut by pink pegmatites associated with the intrusion of unit 12.

Grey granodiorite (7)

This weakly foliated hornblende and biotite-bearing intrusive occurs as a large eye-shaped pluton, in part centered on Maskwa Lake. To the west of Anson Lake it is massive, marginally foliated and contains numerous small ovoid inclusions of amphibolite and metasediment. West of Great Falls large xenoliths of recrystallized metasediment and pillow lava are incorporated within a leucocratic phase of the granodiorite. Intrusive contacts are well displayed with unit (1) north and east of Lac du Bonnet and with unit (5) on the road between Stead and St. George.

Granite-granitized gneiss complex (8)

North of the Black River Indian Reservation a large poorly exposed region is composed entirely of pink, massive, equigranular, intrusive granite (8A) and grey to pink foliated granitized gneiss (8B). Little is known about the relationship between this unit and the others within the region other than a close similarity between units (8B) and (5).

Black Lake granite-quartz monzonite (9)

Mapped as a single pluton this large 'Y' shaped unit displays considerable regional variation in its composition. At and to the east of Black Lake a white relatively equigranular quartz monzonite phase is characteristic. Between Black Lake and Terminal Lake frequent porphyritic horizons appear with large euhedral phenocrysts of potash feldspar and the colour is decidedly pink. From Terminal Lake to west of Poplar Lake a massive porphyritic phase predominates and the composition becomes progressively more granodioritic. Where the short arms of the 'Y' cross the Pine Falls-Manigotagan road the unit is represented by strongly veined, porphyroblastic, layered and foliated grey granodioritic gneisses. A discrete pod of the porphyroblastic granodiorite, strongly cross latticed by pink pegmatites and with an associated hornblende diorite phase, outcrops to the south of the Black River, west of Highway 304. Its position correlates closely with a magnetic high.

White Leucogranodiorite (10)

Due east of Highway 304 and the Black River Indian Reservation an oval stock of white leucogranodiorite, drawn out parallel to the regional trend, is intruded into a mixed series of highly folded migmatites resting in skialithic granodiorite, and well layered and foliated granodioritic gneisses. A partially transgressive igneous contact is marked by local patchy concentrations of white quartz monzonite pegmatite and rotated xenoliths of the older country rock. The leucogranodiorite is massive, homogeneous and locally contains clots of biotite.

Alaskite (11)

North and west of Maskwa Lake a lenticular body of pink leuco-granitic alaskite intrudes units 1, 3, 7, and 9. Detailed examination indicates intrusion in units 1 and 3 up the vertical axial planes of shallowly plunging folds and subsequent emplacement in the crests and troughs of the folded metasediments. Near the contacts, large rafts of the country rock are 'suspended' in a coarse grained pink pegmatitic phase of the alaskite. Within the body infrequent zones of 'ghost' layering are preserved as are numerous small ovoid xenoliths of recrystallized metasediment and amphibolite.

Pink microcline granite-quartz monzonite (Cold Springs Pluton) (12).

The youngest and largest pluton in the area, this unit may be traced in outcrops from Lamprey Falls on the Winnipeg River (Davies, 1957) fifty miles WSW to the palaeozoic unconformity and thence by its magnetic expressions another ten miles toward Tyndall. The maximum width of the unit between Springwell and the Cold Springs quarry is in the order of ten to twelve miles. East of Lac du Bonnet extensive outcrops are numerous but to the west only scattered rounded hillocks protrude through the 50' - 100' thick glacial drift. Mineralogical, textural and structural variation within the pluton indicate that it is a flat sheet like intrusion dipping to the northwest.

<u>A SSE-NNW cross section</u> yields the following succession:-

Maximum zone width on map uncorrected for dip of pluton		
NNW		
No known limit	F	Distal zone of pink pegmatites and aplites cutting units 5 and 7.
16 miles	E	Outer contact zone with numerous two phase hypabyssal intrusives containing both microcline granite and quartz monzonite cutting units 5 and 7.
3 miles	D	Inner contact zone with unassimilated xenoliths of 1, 5 and 7 in microcline granite.
½ mile	C	Zone of contamination and xenolith assimilation
9 miles	B	Main central zone of homogeneous quartz monzonite
1 mile	A	Basal contact zone with pegmatites and aplites cutting unit (5)
SSE		

Zones C, D, E, and F are most extensively developed to the NW in a belt which is now the course of the Winnipeg River. Contact metamorphism related to the main pluton is limited in unit (1) to local recrystallization of garnet, biotite and actinolite.

<u>Structure</u>

East of a line running from Point du Bois to the Black River Indian Reservation the main trend of the regional foliation and layering is slightly north of west. To the west of this axis a regional swing is indicated both from field evidence and magnetic expression to a more south-westerly strike. Several large regional S folds in the layering and foliation, notably those at the mouth of the Black River and at Round Lake, are in accordance with this structural pattern. It is interesting to note that the most extensive expressions of igneous activity associated with the proposed roof of the Cold Springs pluton also coincide with this axis.

Locally within the Manigotagan gneissic belt and within the sediments and volcanics of the Maskwa and Bird River regions intense small scale folds were recorded with varying degrees of plunge and orientation (re. stereographic projections presented with preliminary reconnaissance maps 1969F-1 to 1969F-6).

Intense shearing and retrogression are associated with a westerly striking fault zone which extends from Black Lake to Lake Winnipeg. A lateral dextral movement of 1¼ miles is inferred from unit boundary displacements.

Restricted mineralization was recorded in unit (3) at the mouth of the Black River, and in unit (1) on Lac du Bonnet, at Anson and Round Lakes and near Cat Creek in a region extensively prospected in the past.

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(9) LAKE ST. MARTIN - A CRYPTO-EXPLOSION OR CRATER STRUCTURE

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

Preliminary studies were carried out on the core hole data obtained during the 1968 driller training programme sponsored by the F.R.E.D. Manpower Corps. The complex of granitic, volcanic, and breccia rocks occurring in the structurally disturbed area northwest of Lake St. Martin (Figure 9-1) are now believed to comprise a crypto-explosion or crater structure similar to crater structures described from other areas in Canada such as Mistastin Lake, Labrador, and Clearwater Lake, Quebec.

A field trip was made to the area east of Gypsum Lake, in the company of Dr. K.L. Currie of the Geological Survey of Canada in order to check on the reported volcanic outcrops, and to collect samples for palaeomagnetic studies which are being carried out by Dr. Currie. Dr. Currie also examined the available core and indicated that gneissic rocks cored in LSM #4 and exposed in nearby outcrops showed strong shock metamorphic features including deformation lamellae and tentative identification of maskelynite and lechatelierite. He also suggested that the general configuration and lithology was quite similar to the Mistastin Crater. He interprets the Lake St. Martin structure as being of volcanic origin.

Samples and thin sections of the core also were sent to Dr. M.R. Dence of the Dominion Observatory, who confirmed the presence of strong shock metamorphic features, and also noted the similarity to the Mistastin and Clearwater craters. However, he would attribute the crater to meteor impact rather than a volcanic eruption.

The following aspects of the structure are known or inferred from the available core hole and outcrop data. However, it must be stressed that only limited data are available and no firm conclusions can yet be made as to the extent and origin of such a complex structure.

1) The structurally disturbed area appears to be roughly circular in outline. Federal-Provincial Aeromagnetic maps (4183G, 4184G, 4199G, 4200G) show a prominent magnetic low, roughly circular, and coincident with the disturbed area.

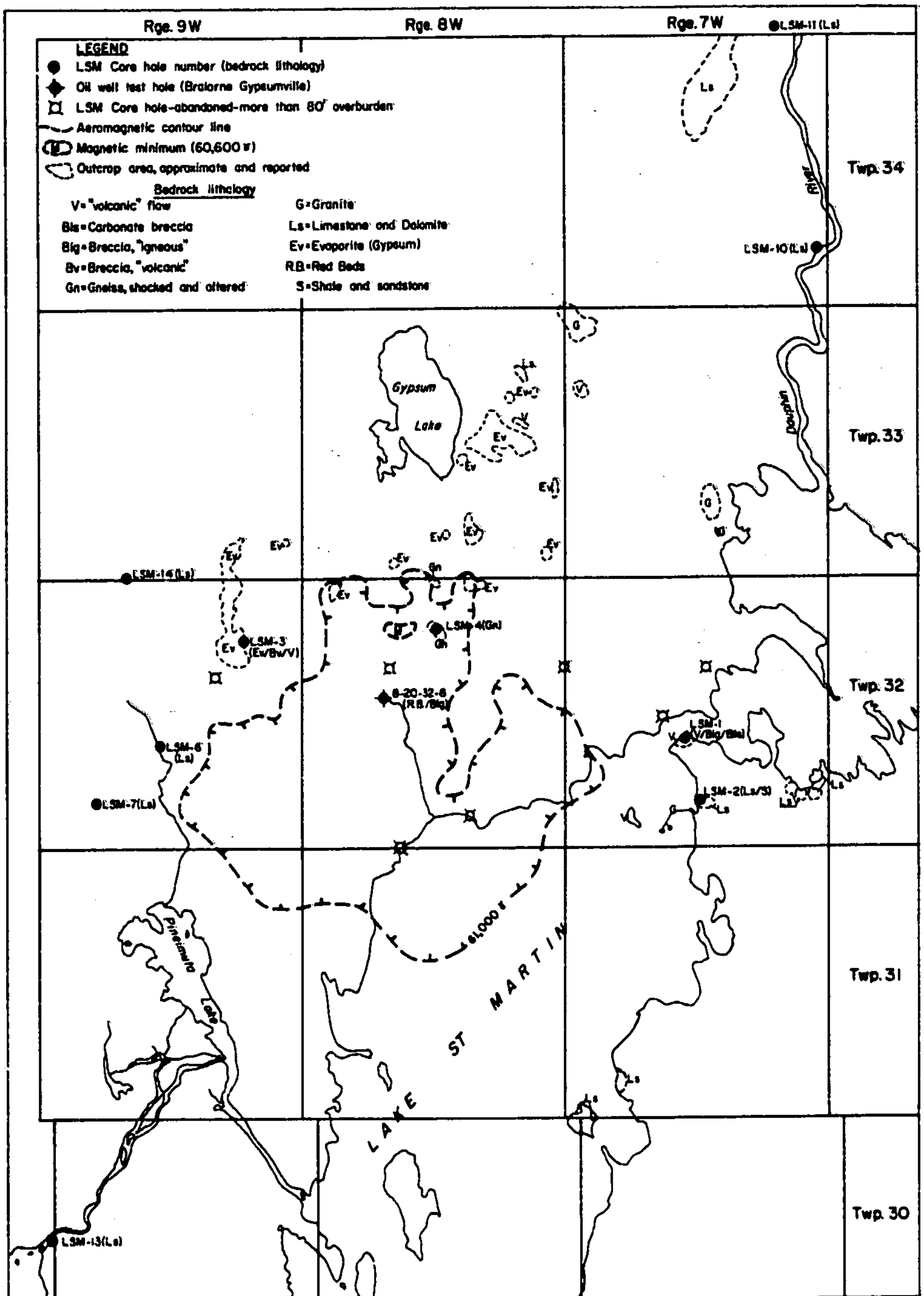


Figure 9-1 GEOLOGY of the LAKE ST. MARTIN AREA

2) A central area consists of a highly "shocked" and apparently hydrothermally altered gneissic rock. The intensity of alteration decreases with depth. (LSM #4, T. D. 396 feet).

3) On the southeast flank of the crater there is a rim of structurally uplifted basal Palaeozoic, and Precambrian granitic rocks which are at least 700 feet above expected regional elevation. Structurally disturbed and probably uplifted carbonate rocks also occur on the southwest flank of the structure (LSM #6, #7) but these holes were not deep enough to penetrate basement.

4) Between the gneissic centre and the uplifted "crater rim", there is a complex of breccia beds, brecciated carbonate rocks, and fine grained igneous ("flow") rock. The "flow" rocks are sparsely to strongly visicular, andestic in composition, and homogeneous in appearance. The fragments in the breccia beds are, in some areas, predominantly granitic (Bralorne, LSM #1) and, in other areas, predominantly volcanic or of mixed lithology (LSM #3). The breccia beds occur both below and above the "flow" rocks.

The carbonate breccia is known only from LSM #1 where it underlies a section of "flow" rock and "granitic breccia". The lithology varies from limestone to calcareous shale and dolomite, but any given interval shows a relatively uniform lithology and is essentially a monomict or mosaic breccia. These are not sedimentary breccias.

5) The carbonate breccia rocks are almost certainly of Palaeozoic age and were brecciated during crater formation, but their lithology differs considerably from that of the Lower Palaeozoic strata of adjacent areas. The high calcium limestones and red shales possibly represent later Palaeozoic (Devonian ?) beds which were present in the area at the time of crater formation and were incorporated into the crater structure, but later removed from adjacent areas by post-Crater pre-Red Bed erosion.

6) A sequence of essentially flat lying, normal sedimentary red beds and evaporite strata overlie the breccia-"flow" rock sequence with marked unconformity. Intervals of polymict breccia containing angular fragments of carbonate, granitic and volcanic rocks occur

within a sequence of fine grained, reddish, argillaceous and dolomitic siltstones and sandstones. The red bed-evaporite sequence is lithologically similar to and probably correlatable with the Jura-Triassic Amaranth Formation of southwestern Manitoba.

7) The age of the structure is reasonably well established as probable late Palaeozoic (Permian ?). K-Ar determinations on the "flow" rocks gave an indicated age of 200 - 250 m.y., and Rb-Sr determinations on the "volcanic" breccia beds gave an indicated age of 250 - 400 m.y. Lower and possibly middle Palaeozoic strata are involved in the structure, and the red bed-evaporite sequence of probable Jura-Triassic age overlies the structure unconformably.

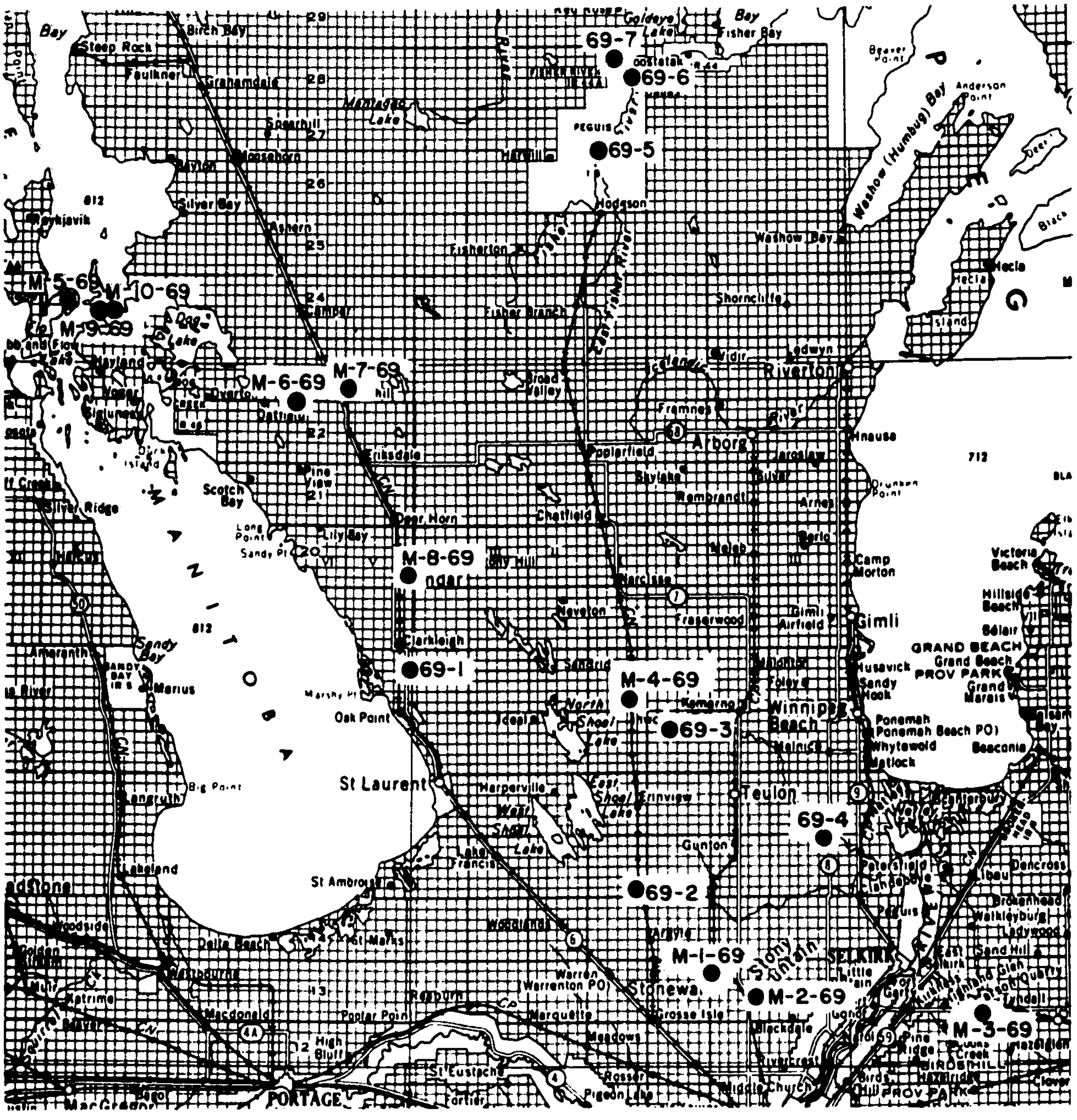
(10) INTERLAKE CORE-HOLE PROGRAMS

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

Two stratigraphic core hole programs were carried out during 1969 in the general south Interlake area, extending from Garson to the Lake Manitoba Narrows (Figure 10-1). During the period January-April, the driller training program sponsored by the F.R.E.D. Manpower Corps was continued in the area south of Gypsumville, and a total of 7 holes recovered 2597 feet of drill core. A series of 4 holes across the south end of the Interlake Area has given a complete composite section of the Ordovician, Silurian and lower Devonian strata in this area. In addition, 3 holes were drilled in the area of the Peguis Indian Reserve in an attempt to determine the nature of the small isolated Precambrian occurrence in Twp. 29, Rge. 2W. A normal stratigraphic sequence was encountered with no evidence of any structural or stratigraphic anomaly.

During the summer, a core hole program was carried out by the Mines Branch using a small portable diamond drilling rig (with a rated depth capacity of 450 feet), operated by 1 Lab Technician and 1 summer assistant. A total of 10 holes were drilled, recovering 1077 feet of core. The program was in part experimental to determine the economics, operating problems and capability of the rig. Results were judged satisfactory on all counts, although poor ground conditions did pose some problems and limited depth penetration in some areas.

The cores from both the Mines Branch and F.R.E.D. programs have been placed in the "core library" and studies are being undertaken. In addition a graduate thesis at the University of Manitoba is being initiated, with the object of defining more accurately the correlations, type sections, lithologies and lithofacies of the Lower Palaeozoic formations.



M–1–69 to M–10–69 Mines Branch Core Holes   69–1 to 69–7 F.R.E.D. Core Holes

Fig. 10–1 Core Hole Locations – Interlake Core Hole Programs

(11) INDUSTRIAL MINERALS - 1969

by B. B. Bannatyne

1) Drill program results:

The results of the F.R.E.D. drill programs in the Interlake area and of the Winkie drill program were evaluated for industrial minerals potential.

Lake St. Martin (LSM) #1, vertical:

A zone of high calcium limestone, consisting of a brecciated carbonate rock in a calcareous matrix, was intersected from a depth of 234.5 to 258 feet. Analysis of a sample from 239 feet showed:

SiO_2	1.15%	Na_2O	Nil
Al_2O_3	0.3%	K_2O	0.07%
Fe_2O_3	0.18%	TiO_2	0.01%
FeO	0.20%	P_2O_5	0.01%
CaO	54.0%	CO_2	42.45%
MgO	1.10%	H_2O	0.79%

Total: 100.26%

LSM #2 (bearing: 330°; dip: 45°):

This drill hole penetrated dolomitic limestone in the basal part of the Red River Formation from near surface to a depth of 53 feet, shale with interbedded sand in the Winnipeg Formation from 54 to 69 feet, and silica sand also of the Winnipeg Formation, from 69 to 95 feet, at which depth the hole was abandoned; the complete silica sand section was not penetrated. It is probable that silica sand is present at a shallow depth in the area immediately north of LSM #2; samples of sand were not recovered.

LSM #3 (vertical):

This hole is located on top of the south face of the east arm of the old quarry north of Gypsumville. A complete section of the evaporite (gypsum and anhydrite) was cored from surface to a depth of 138 feet.

LSM #6 (vertical):

Analysis of samples from the interval 194 feet to 220 feet indicated a very pure dolomite.

SiO_2	0.3%	Na_2O	Nil
Al_2O_3	Nil	K_2O	0.10%
Fe_2O_3	0.95%	TiO_2	Nil
FeO	0.41%	P_2O_5	Nil
CaO	31.1%	MnO	0.02%
MgO	20.7%	CO_2	45.7%
		H_2O	0.52%

Total: 99.80%

Hole 69-1: Oak Point quarry

In the Spearhill and Steep Rock areas the Elm Point Formation contains high calcium limestone. In the area of Oak Point, the rocks exposed in the quarry have too high a magnesia content to be used in Portland cement. The drill intersected the Elm Point Formation to a depth of 26 feet; the section of rock below the quarry, from stain tests on selected samples, also appears to have too high a content of dolomite.

Hole 69-2:

Some of the whitest dolomite yet found in Manitoba was intersected at a depth of 105 to 112 feet, and is tentatively placed in the Inwood Formation of the Interlake Group.

Limestone in the Ordovician Red River Formation:

At present, all the high calcium limestone produced in Manitoba is from Devonian formations. It has been known for several years that some thin limestone beds are present in the predominantly dolomite unit, up to 120 feet thick, in the uppermost part of the Red River Formation. Some or all of these limestone beds have been intersected in the following drill holes: 69-2, 69-3, 69-5, and M-2-69. These cores will be studied to determine the thickness, extent, and quality of the limestone beds.

2) Report on clays and shales of Manitoba:

The manuscript of a report on the clays and shales of Manitoba has been completed. The report presents the results of firing tests, chemical analyses, and mineralogical analyses of the various deposits in the province; these include bentonitic, bituminous, calcareous, carbonaceous, illitic, kaolinitic, and siliceous shales, as well as various surface clays that are slightly to highly calcareous. The history and present state of the clay products industry in Manitoba is reviewed.

The deposits of most economic interest are:

a) Clay deposit, east shore of Deer Island

White kaolinitic clay in the -325 mesh size is suitable for ceramic whitewares.

b) Shale in Winnipeg Formation

Green shale that fires reddish brown is suitable for face brick.

c) Jurassic-Cretaceous kaolinitic shales

Red-burning shales, stoneware clays, and impure kaolin are present in an area south of Ste. Rose du Lac and were discovered in exploration drilling by Medicine Hat Brick and Tile Company Limited in 1963 and 1964. They will be the major raw materials in the company's new plant east of Lockport, scheduled for production in the summer of 1970. The materials are suitable for face brick, drain tile, flue lining and sewer pipe.

Other occurrences of the stoneware clays of the Swan River Group are known east of Duck Mountain and along Swan River.

d) Kaolin north of Arborg

Kaolin is present, mixed with silica sand and other clays, in a channel deposit of Cretaceous age 14 miles northwest of Arborg.

e) Boissevain Formation

Kaolinitic shale from the Boissevain Formation is exposed in an outcrop in 3-3-21 WPM. Tests indicate the material is a low duty refractory clay.

(12) STRATIGRAPHIC STUDIES

by H. R. McCabe

Most of the stratigraphic studies are projects of a continuing nature. Determination of subsurface geological data for all oil well test holes continued, with data for 19 field wells and 32 wildcat wells released from the confidential files. This included data for the Kaskattama #1 test hole, the first deep test in the Hudson Bay area. These data are now being incorporated into the structure contour-isopach maps of the Stratigraphic Map Series. Work has not yet been completed on the maps of the Jurassic strata, but maps are available for all other formations. Compilation of the above data for a report on structure and stratigraphic anomalies in the Palaeozoic formations of southwestern Manitoba also continued.

Additions to the Mines Branch core and sample library, to October 31, included samples for 45 oil wells and core for 20 oil wells. A total of 3700 feet of Palaeozoic core obtained from the F.R.E.D. and Mines Branch Interlake core hole programs (Section 10) was also added to the core library.

Exploratory drilling in southwestern Manitoba, to October 31, resulted in completion of 11 new producing wells, all field development or offset wells, and all producing from Mississippian formations. In addition, 25 dry holes were drilled and 35 shallow structure test holes were completed, mostly in the Elm Creek, Carberry, Shilo and Brandon-Rivers areas. The structure test holes were designed primarily to test for stratigraphic pinch-out traps in Ashville (Muddy) Sand.

No further drilling was carried out in the Manitoba portion of the Hudson Bay Basin, but one offshore well was drilled by Aquitaine, indicating continued interest in this major new exploration area. No commercial shows were reported.

Preliminary work was started on preparation of field trip guides for the G.A.C. '70 conference in Winnipeg. These guides are planned to cover many of the larger, accessible, Palaeozoic and Mesozoic outcrops in southwestern Manitoba.

Other stratigraphic studies included the Lake St. Martin Project (Section 9) and the Interlake Core Hole Programs (Section 10).

(13) AN OCCURRENCE OF GALENA IN FLOAT - WINNIPEG AREA

by H. R. McCabe

A small, well rounded pebble of almost pure galena, approximately 1" x 1½" x ½" was found in a cultivated field in the NE. ¼ sec. 26, tp. 14, rge. 1 EPM, near the town of Balmoral, 22 miles northwest of Winnipeg. The pebble was a dull brownish grey on the outside and was noticed only because of its extreme heaviness. The following are the results of tests carried out on the sample.

Assay: Pb 78% Ag 8.46 oz./ton

Spectrographic analysis (G.S.C. Ottawa, semi-quantitative):-

Pb	- major	Mg	$<$ .01
Si	$<$ .02	Zn	2.0
Al	$<$ .01	Cu	.05
Fe	.03	Ag	.03
Ca	.01		

Pb isotope analysis (G.S.C., Ottawa):-

Pb^{204}	$1.348 \pm .010$	$Pb^{206}/Pb^{204} = 18.48$
Pb^{206}	24.91 ± 0.04	$Pb^{207}/Pb^{204} = 15.68$
Pb^{207}	21.13 ± 0.03	$Pb^{208}/Pb^{204} = 39.03$
Pb^{208}	52.61 ± 0.05	

Visual examination of the sample indicated pure galena, medium grained (av. 1-2 mm), with cleavage surfaces showing irregular or deformed faces.

The above data suggest, but are not diagnostic of, a Post-Precambrian origin for the galena, possibly similar to the Pine Point deposits. The source area for the galena, however, is indeterminate. No producing mines in Manitoba contain any appreciable amount of massive galena. The direction of glacial movement in the area is uncertain because of the proximity to the juncture of two main ice sheets - Keewatin and Patrician. Indicated directions of ice movement in the Balmoral area vary from NW-SE to NE-SW.