GP2/75

MANITOBA

DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT

MINERAL RESOURCES DIVISION

EXPLORATION AND GEOLOGICAL SURVEY BRANCH

GEOLOGICAL PAPER 2/75

SUMMARY OF GEOLOGICAL FIELDWORK 1975

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INTRODUCTION

In early 1975 the Geological Survey of the Manitoba Department of Mines, Resources and Environmental Management was regrouped to form an integral unit of the newly established Geological Services Branch of the Mineral Resources Division. The new Branch constitutes the previous geological survey section together with a consolidated laboratory services section, the latter acting in a support capacity to the Division's geological survey, exploration and evaluation activities.

Geological survey mapping projects continued at a relatively high level of activity in both the Churchill and Superior structural sectors of the Province. Although regionally oriented, the Seal River and Russell Lake projects made substantial steps towards correlating the geology over large areas by application and emphasis on a stratigraphic approach to their mapping, even in relatively high grade terrains. In this respect the known distribution of the Great Island Group has been considerably extended as has that of the older volcanic rocks of this region.

Several new bodies of Sickle Group arkoses have been found near Russell Lake in hitherto undifferentiated high grade gneisses of the Kisseynew gneiss belt. The ongoing delineation of the contact between the arkosic and greywacke groups continues to provide the most successful marker in correlating between the Lynn Lake, Flin Flon and Thompson regions and in establishing a basis from which a coherent stratigraphic framework can be formulated.

In the Ilford and Nelson River region the bounday between rocks of Churchill affinity and those of the much higher grade Superior granulite-migmatite-complex is now better defined along the Assean-Gull rapids fault zone. To the immediate south, the compositional variation of the granulite-stem rocks of the Pikwitonei Province has been further demonstrated but a full analysis is still hampered by a lack of outcrop and a complex deformational and metamorphic history.

The Fox River Sill investigation has extended to the immediate country rocks in order to further test the model proposed from an internal study of the intrusion. A provisional stratigraphic column of the region includes several apparently differentiated olivine and pyroxene-bearing dominantly pillowed flows.

At Utik Lake over 25 different flows have been identified in a volcanic pile 400 m thick, and excellent exposures have revealed many interesting primary structures rarely exposed in Archean Greenstone belts.

In southeastern Manitoba the acid flows and pyroclastic units of the Shoal Lake belt are now known to be much more extensive than was previously indicated and an intensive review of the Bird River Greenstone belt has revealed possible stratigraphic breaks in the succession that were hitherto unsuspected.

Drilling of the Phanerozoic cover in the Ponton area indicates a much thicker section of the Red River beds than was anticipated, together with a sandy dolomitic possibly transgressive facies at the base of the section rather than the true Winnipeg Sandstone.

Reports on the Burntwood, Guay-Wimapedi and Greenstone projects are in preparation and the final report and maps for the Kasmere Project are currently at the printers with release tentatively scheduled for the end of 1975.

October, 1975

W.D. McRitchie
Director
Geological Services

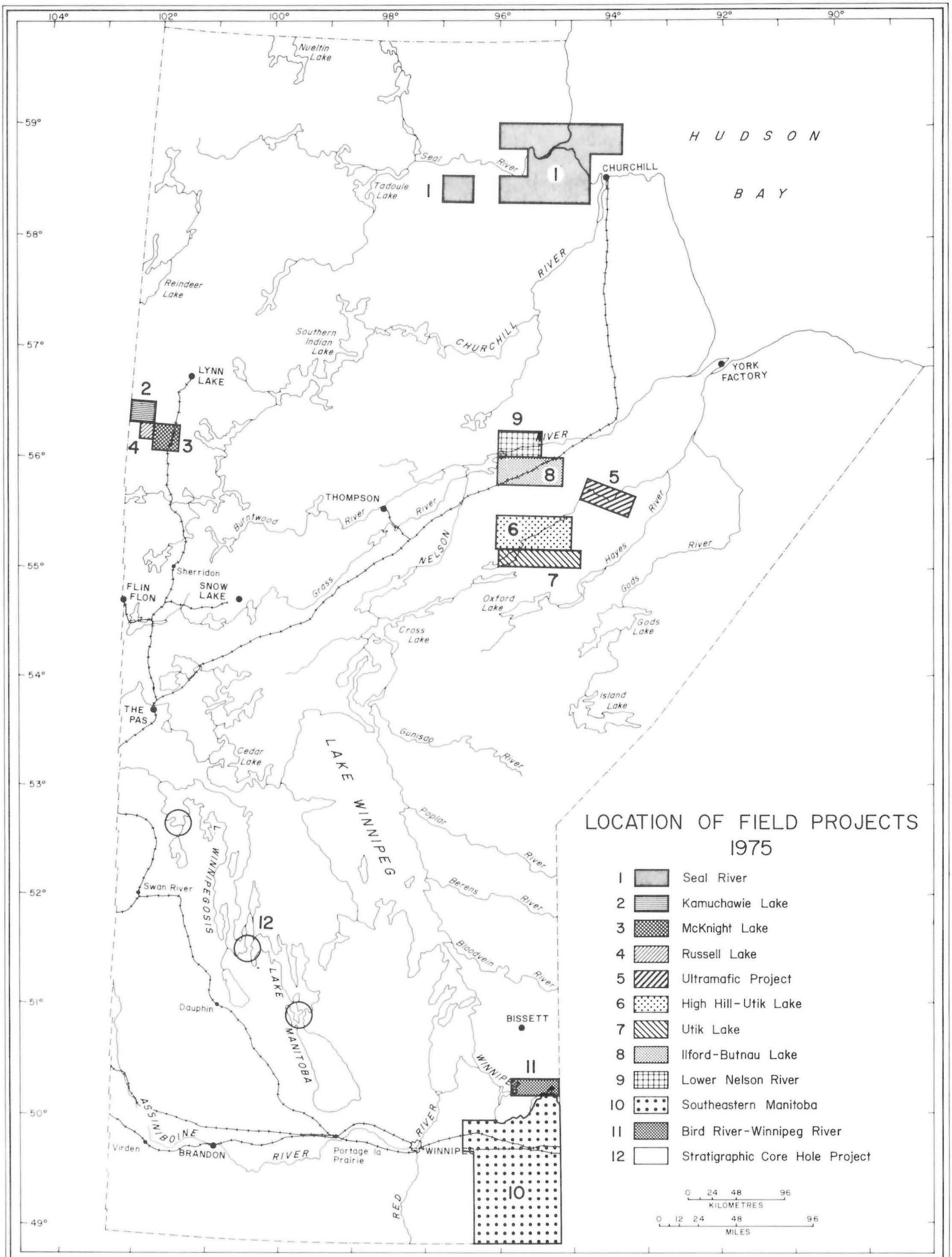

Figure 1 : Location of field projects 1975

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(1) SEAL RIVER PROJECT

(54I-15, 16; 64P-12; 54L-9, 10, 11, 12, 13, 14, 15 54M-2, 3, 4, 5, 6, 7)

By: D.C.P. Schledewitz

Mapping in the Seal River area was completed during the 1975 field season. Only minor changes and the addition of 6 rock types are needed to update the 1974 preliminary rock legend. Table 1-1 is the revised table of formations. The additional units identified are:

grey granodiorite (unit 6),

ultrabasic and serpentinite (unit 9),

red granite (unit 11),

polymictic conglomerate (unit 12),

quartzite interlayered with muscovite-garnet-andalusite schist (unit 15),

pink or white pegmatite and trondjhemite (unit 16)

The grey granodiorite occurs as a large body 47 km long and 23 km wide, in the eastern part of the area. The composition can vary locally to a diorite. The rock is mainly coarse grained massive to porphyritic and in some areas has a gneissic structure. The development of potassium feldspar porphyroblasts is sporadic with some areas showing a strongly granitized appearance where the potassium porphyroblasts are large and numerous. The granodiorite in many localities is cut by aplite and pegmatitic granite dykes and older quartz monzonite dykes. Other types of alteration such as chloritization of biotite occur in shear zones. A sheared zone of the more dioritic material displays an intense kaolinization of the feldspars, a grain size reduction of the biotite and disseminated pyrite.

The ultramafic rock was not observed in outcrop but the nature and trend of the rock type is based on the examination of frost shattered debris. The description of the rock type is further supplemented by diamond drilling completed by the Keevil Mining Group Limited in 1970. The rock in the drill core is described as a serpentinized peridotite with zones containing up to 15% magnetite. Sulphides were not reported nor were they observed in the field. The ultramafic body forms a narrow dyke wich lies north and west of Eppler Lake. It has a northeasterly arcuate trend, trending almost north at its northerly limits. Frost shattered serpentinite boulders and sand occur along a trend which coincides closely with a linear magnetic anomaly. The coincidence of the frost shattered serpentinite along the high magnetic trend adds greater confidence to the boundaries defined for the ultramafic dyke despite the presence of drift cover.

The red granite (unit 11) lies to the southeast of the map area just east and southeast of Duddles Lake. This granite is massive with coarse grains and phenocrysts of microcline. Quartz is also coarse grained and has a blueish white colouration.

The polymictic conglomerate (unit 12) occurs south of Robin Esker Lake, and just east of Gauntlet Lake. The clasts comprise massive to well layered siltstone, feldspar porphyry and greywacke. The matrix is of greywacke composition. The conglomerate may be contemporaneous with the volcanic rocks or alternatively may represent a basal conglomerate of the Great Island Group.

The quartzite and interlayered muscovite-garnet-andalusite schist (unit 15) occurs in the southwest corner of the map area and is of uncertain affinity. However, this rock type could be derived from the phyllite-quartzite sequence (unit 19) of the Great Island Group from the south to the northeast. The muscovite-garnet schist passes transitionally, with a gradual decrease in grain size, into a grey green phyllite with thin quartzite interbeds. This grey green phyllite has been equated with similar rocks of the Great Island Group (unit 19).

Pink and white pegmatites with white medium to coarse grained trondjhemite (unit 16) have a widespread occurrence in the southwest of the map area, south of Lovat Lake. The pegmatites contain sporadic garnet and characteristic large books of muscovite and/or biotite (up to 25 cms). Inclusion blocks of the muscovite-garnet-andalusite schist (15), psammitic gneiss and sheared basic dykes are common in the pegmatite along with the North Knife River. The trondjhemite commonly contains garnet and abundant inclusions of the muscovite-garnet-andalusite schist (15) and a more psammitic rock type. The

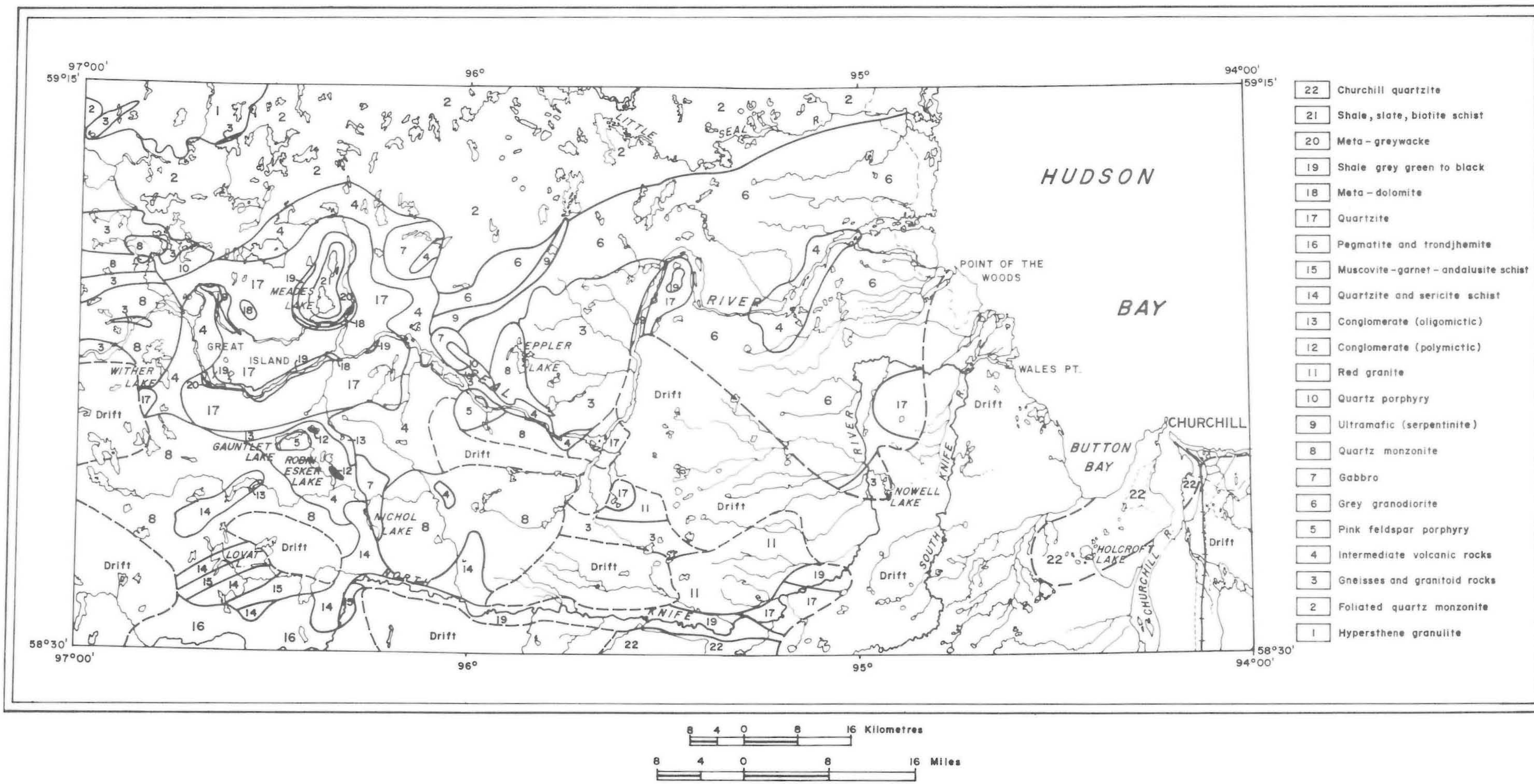

Figure 1-1 : Geology of the Seal River project area trondjhemite also occurs as inclusions in the pegmatite and sporadically shows development of pink potassium feldspar porphyroblasts. The relative proportions of pegmatite to trondjhemite are unknown because of the paucity of outcrop. However the widespread occurrence of the pegmatite suggests it is a major rock type in this area. The unit intrudes the muscovite-garnet & andalusite schist (15) which appears to be derived from the phyllitic rocks of the Great Island Group. If this is the case, the pegmatites and trondjhemites (16) represent a very late Hudsonian intrusive rock and may hold interest for uranium prospecting.

Volcanic and Meta-sedimentary Rocks

The volcanic rocks in the area of Great Island were found to extend south of Great Island to a point 4 miles south of Robin Esker Lake. (Figure 1-1). A second belt of volcanic rocks 47 km east of Great Island on the Seal River, is separated from the Great Island volcanic rocks by a variety of granitic and gneissic rocks. This second zone of volcanic rocks is 20 km long with a maximum width of 7 km. The layering dips steeply to the southeast. The sequence is made up of pillowed andesitic flows interlayered with well laminated tuffs of basic to intermediate composition. The tuffs are most abundant on the northwestern flank and at the southerly termination of the zone. A lenticular zone of rhyolite to rhyodacite flows occurs in the south half of the belt and makes up 8% of the volcanic rocks, however the more acid rock types may increase in volume down dip since the lenticular shape could represent a domal structure. Hornblendite in the central region of the volcanic zone coincides with a magnetic high which could delineate a basic or ultrabasic intrusive stock. The sequence of volcanic rocks is also clearly intruded by the surrounding grey granodiorite and minor quartz monzonite. It is conceivable that the Great Island volcanic rocks were continuous with the eastern occurrence of volcanics but subsequent intrusion of igneous rocks uplift and erosion have destroyed the continuity. This period of erosion was followed by the deposition of the sedimentary rocks of the Great Island Group.

A possible hiatus in the sequence between volcanic and sedimentary rocks is further supported if the meta-sedimentary rocks of unknown affinity (units 13 to 15) are equated with rocks of the Great Island Group (units 17 to 21). The widespread occurrence of rocks similar to the Great Island Group throughout the area and the transitional contact of the muscovite-garnet-andalusite-schist (15) with rocks of the Great Island Group type (unit 19), suggests that the map area was once covered by a sequence of sediments indicative of a low energy platform environment of deposition. This continuity has since been destroyed by deformation, uplift and erosion. The remnants of meta-sedimentary rocks overlie a variety of rock types. At Great Island they overlie a volcanic suite; in the southwest granitic rocks, and in the east along the Seal River, a complex of migmatitic rocks and part of a granodiorite complex. This diorite clearly intrudes the volcanic rocks to the east. Furthermore, there is evidence that the granodiorite itself has been intruded by more acid rocks. However, no such intrusions have been observed within the rocks of the Great Island Group. It appears therefore that a profound unconformity exists between the Great Island Group and the underlying rocks.

Mineralization

GREAT ISLAND GROUP

Barren syngenetic iron sulphides are present in the black pyritic shales (unit 19a) of the Great Island Group. The garnet amphibole schist is an iron formation containing thin beds of massive magnetite and zones of disseminated magnetite. Zones of barren iron sulphide also occur in the dense black garnetiferous zones of the iron formation.

Volcanic Rocks and Basic Intrusive Rocks

Disseminated pyrrhotite is common within the volcanic rocks with only minor chalcopyrite occurrences. The majority of these occurrences are barren. The most consistently mineralized volcanic rocks are the intermediate to basic tuffs that lie in the most easterly zone of volcanic rocks along the Seal River; .03 to .04 copper is present with .11% Zn. Other areas of consistent mineralization (.03 to .10 copper) occur in the basic volcanic rocks along the contact with the northern edge of the quartz monzonite (8) east of Nichol Lake. In general, the basic plugs and stocks of hornblendite throughout the area often bear up to .04 percent Cu.

TABLE 1-1 Table of Formations

Sand, Gravel, Till, Clay deposits, Boulders

Great unconformity

23	Diabase
22	Churchill quartzite
	GREAT ISLAND GROUP
21	Shale, slate, biotite schist
20	Meta-greywacke
19	Shale grey to black, green phyllite
b	Garnet-amphibole schist (iron formation)
a	Black pyritic shale
18	Meta-dolomite
17	Orthoquartzite, inter-bedded green silty shale

Unconformity

16	Pink or white pegmatite and white trondjhemite
15	Quartzite interlayered with musc. ± garnet + andal. schist
14	Quartzite with sericite schist or musc.-garnet-schist
13	Conglomerate (oligomictic)
12	Conglomerate (polymictic)
11	Red granite
10	Quartz porphyry
9	Ultramafic and serpentinite
8	Quartz monzonite
7	Gabbro
6	Grey granodiorite to diorite
5	Pink feldspar porphyry

4	Volcanic rocks
	Rhyolite, rhyodacite, dacite porphyritic in part
d	Intermediate lapilli tuff
c	Interlayered intermediate to basic tuff, andesite and dacite in part pillowed
b	Agglomerate, intermediate
a	Andesite, in part pillowed, minor basalt
3	Migmatites, gneisses and granitoid rocks
c	Amphibolite ± hypersthene
b	Granite gneiss ± hornblende
a	Biotite gneiss ± cordierite ± garnet ± sillimanite
2	Foliated quartz monzonite
1	Hypersthene granulite

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Nichol Lake; Man. Min. Res. Div. Prelim. Map. 1974S-1
Wither Lake; Man. Min. Res. Div. Prelim. Map. 1974S-2
Meades Lake; Man. Min. Res. Div. Prelim. Map. 1974S-3
Hebner Lake; Man. Min. Res. Div. Prelim. Map. 1974S-4
Kesselman Lake; Man. Min. Res. Div. Prelim. Map. 1974S-5
Button Bay; Man. Min. Res. Div. Prelim. Map. 1974S-6
Eppler Lake; Man. Min. Res. Div. Prelim. Map. 1974S-7
Churchill; Man. Min. Res. Div. Prelim. Map. 1974S-8

(2) RUSSELL LAKE PROJECTS

(64C-3, 4, 5)

Introduction

Mapping programmes in the McKnight and Kamuchawie Lake areas were augmented by an additional study of the southern end of Russell Lake. The entire programme in this region is directed toward the stratigraphic mapping of the contact between the greywacke derived gneisses of the Burntwood River Supergroup and the arkosic gneisses of the Sickle Group (Figure 2-1). Transitional relationships between the two groups were recorded in the adjacent Kadeniuk Lake region (Baldwin, 1974) together with indications of a possible sedimentary environment for copper mineralization in units of the transitional group.

W.D. McRitchie

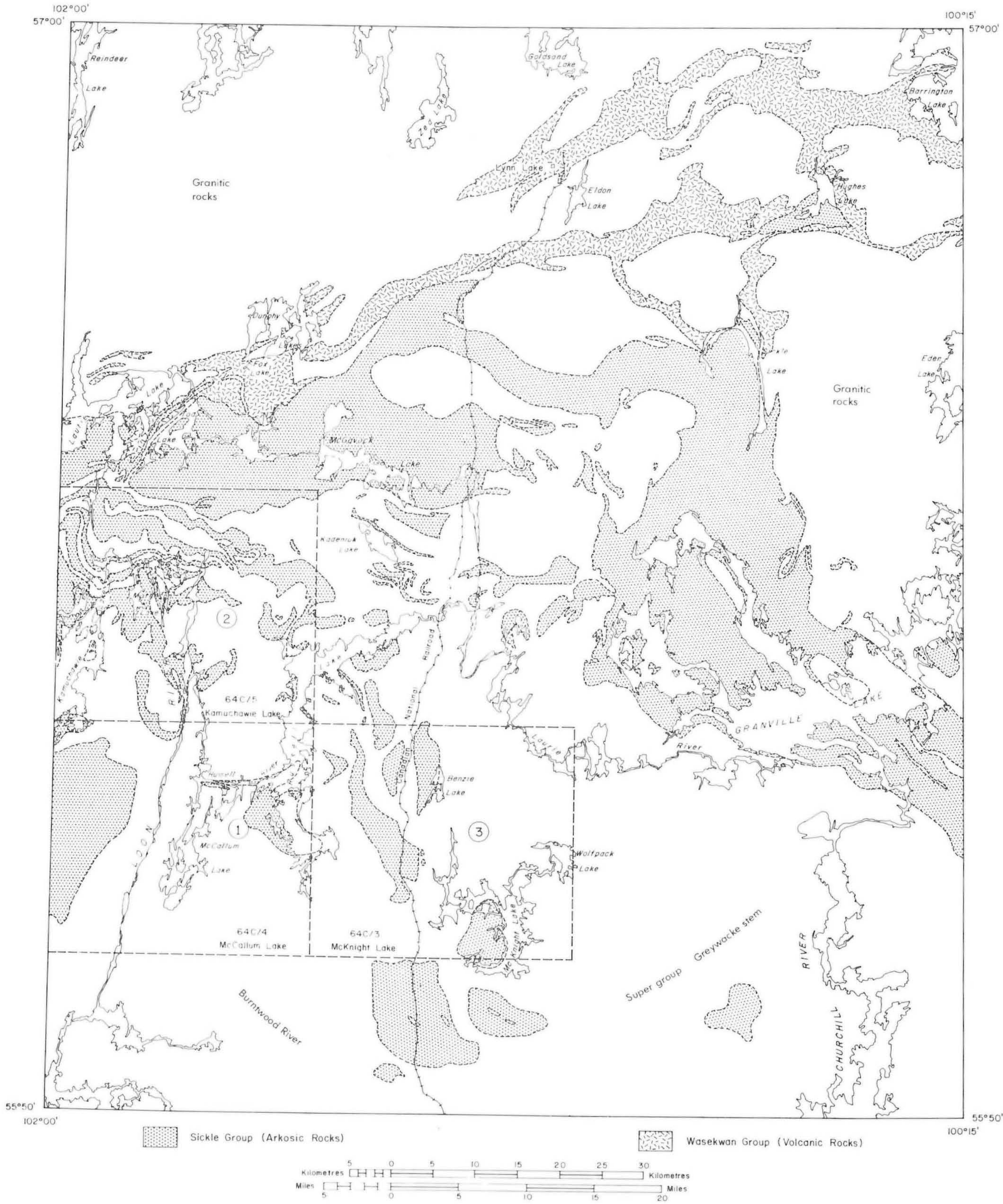

Figure 2-1 : Outline geology of the Lynn Lake-Russell Lake area

(3) GEOLOGY OF THE KAMUCHAWIE LAKE AREA

(64C-5)

By: H.V. Zwanzig and P. Wielezynski

Kamuchawie Lake (Figure 2-1) lies on the north flank of the Kisseynew metasedimentary gneissic belt (McRitchie, 1974, p. 19). Consolidated rocks comprise Aphebian metasediments and migmatities derived from greywacke, marlstone and arkose. They can be correlated with rocks in the Nelson House-Pukatawagan region.

The Kamuchawie Lake area is characterized by the appearance of a psammite-calc-silicate facies in the meta-greywacke and by persistent horizons in the greywacke with thin bodies of amphibolite. The amphibolite was apparently derived from volcanic rocks and gabbro. It extends along much of the north flank of the Kisseynew belt and may be connected to the narrow wedge of greenstone from the Lynn Lake belt at Laurie Lake, north of the map area.

All rocks have been metamorphosed to the upper amphibolite facies. They contain sillimanite plus potash feldspar. Garnet plus cordierite is locally abundant. The structure is complex and involved recumbent over-folding, cross folding and doming.

The greywacke-arkose contact and the amphibolites within the greywacke are mineralized.

Stratigraphy

The stratigraphic succession of sedimentary migmatites is clearly defined at Kamuchawie Lake. It consists of three groups which can be traced throughout the Kisseynew gneissic belt (McRitchie, 1974). They are:

Sickle Group	(unit 3): Arkose-migmatite
Burntwood River Supergroup	(unit 2): amphibolite group
	(unit 1): greywacke-migmatite group

The order of stratigraphic succession is indicated at Kamuchawie Lake by structures interpreted as graded bedding. Each group consists of several map-units given in Table 3-1. Only the main divisions in the Sickle Group are given in stratigraphic order but all units have fixed positions and they can be correlated with rocks in adjacent areas.

A structurally compressed succession of about 100 m of greywacke-migmatite is exposed in the Kamuchawie Lake area. Near the lake the proportion of vein material is low and graded bedding is apparent from the upward increase in biotite content in certain beds. Lenses of light green calc-silicate rock commonly lie near the base in the psammitic portion of the graded beds. The biotite schist at the top of the beds is interlaced with feldspathic mobilizate. These structures are interpreted to be derived from sediment-variations in turbidite beds.

Along the west shore of Kamuchawie Lake there is about 200 to 600 m of fine-grained, thin-bedded psammite, usually rich in calc-sillicate rock (unit lb). The unit is overlain and underlain by greywacke-migmatite (unit la). It is interpreted as an interturbidite succession of sandstone and calcareous siltstone. The rock grades into common greywacke-migmatite towards the Loon River and is absent east of the river. This transition is interpreted as a sedimentary facies change. A horizon rich in small amphibolite boudins (unit le) forms a second marker unit in the greywacke-migmatite sequence. A vesicular (?) top and local fragments indicate a volcanic origin for some bodies of 1e. Boudins commonly lie 150 to 500 m below the top of the greywacke group. This distribution indicates that the top of the greywacke group is not an unconformity.

The amphibolite group (unit 2) forms a continuous layer, 1 m to 350 m thick, consisting of amphibole-diopside-and quartz-rich rocks. They include sulphide iron formation (pyrrhotite, graphite ± pyrite ± chalcopyrite), calc-silicate rock, and oxide iron formation. The amphibolite group was probably derived from a sediment-starved succession containing mostly thin-bedded marlstone.

The Sickle Group conformably overlies the Burntwood River Supergroup. At the base, the arkose-migmatite is rich in hornblende and magnetite. Thin, hornblendic layers were apparently derived from interbeds of calcareous sandstone. They grade upward into biotite meta-arkose (unit 3b) and into a distinctive meta-arkose with sillimanite knots (unit 3c). The top of the Sickle Group is not exposed but there may be a unit of massive, garnetiferous arkose and greywacke exposed in a series of erosional remnants in the swampy terrain south of Murray Lake.

Plutonic Rocks

Irregular bodies of granitic rock occurs in various sizes throughout the Kamuchawie Lake area. They are subdivided into five compositions (IUGS recommended classification) that are combined into three units:

(unit	6a)	Monzogranite	(35 - 65 potash feldspar / total feldspar)
	6b)	Granodiorite	
	6c)	Syenogranite	(65 potash feldspar / total feldspar)
	5)	Tonalite	(>20 quartz)
	4)	Hornblende granodiorite	

Their distribution is related to the composition and structure of the host rock. The stocks at Kamuchawie Lake, along the Loon River and in the northeast corner of the map-area consist of white-weathering and pale pink monzogranite and granodiorite. They occur within outcrop belts of the greywacke group. The rocks contain biotite and small amounts of magnetite, chlorite or sillimanite. They are equigranular-medium to fine grained.

Sills of foliated granite and granodiorite commonly occur within the Sickle Group. Syenogranite is largely restricted to a single belt of meta-arkose. It is a red fine-grained equigranular rock, cntaining minor amounts of magnetite, sillimanite and muscovite.

Hornblende granodiorite forms a chain of stocks which mainly intrude the amphibolite group. The granodiorite contains biotite, hornblende and locally garnet.

Tonalite is generally restricted to sills and dykes which intrude the greywacke group. Characteristically it contains 35% or more quartz, with biotite ± hornblende.

Structure

The Kamuchawie Lake area is characterized by large isoclinal folds defined by outcrop belts of greywacke-migmatite, alternating with belts of arkose-migmatite. The folds form a northerly dipping stack of units along the north boundary of the area, but elsewhere they are refolded into abroad step-like pattern with a remarkable rectilinear geometry. Preliminary structural analysis indicates that there are three or four west-northwest-trending antiforms over whch are draped older isoclinal folds. Most folds extend along strike for 30 km but measure only 3 km in cross-section. The stratigraphic section in successive folds generally shows slight but persistent differences.

In the centre of the area a rectangular dome is developed in a greywacke-granite sill complex. Its mantle of arkose is the core of one of the early folds that is curved around the dome. The doming is related to granite emplacement along west-northwest trending belts in northeast-plunging stocks.

Mineralization

Twenty-five minor copper-showings were discovered in the Kamuchawie Lake area. Assay values range from traces to 0.2 copper, 0.06 zinc and 0.02 lead. The mineralization is strata bound along the Sickle-Burntwood River contact and in unit 1e amphibolite.

The best showing are in greywacke along the Sickle contact on the south side of the saddle-structure at Kamuchawie Lake (see preliminary maps). There mineral content is chalcopyrite ± pyrrhotite ± pyrite ± malachite and azurite. There are no showings along the north contact of the same structure but at Isbister Lake there are similar showings along the upright contact of the next major fold, at a higher structural level. Chalcopyrite occurs also in a rootless segment of the same fold on Matheson Lake.

In the isocline developed in hornblende greywacke exposed between Laurie Lake and Russell Lake there is abundant graphite and widely scattered pyrrhotite ± chalcopyrite. The showings are associated with gossan zones. Abundant pyrrhotite ± chalcopyrite occurs in amphibolite (unit 2) in the northern and western part of the area. Copper values are near 0.03 .

Several showings occur within the Burntwood River Supergroup. Minor Chalcopyrite and pyrite, ± pyrrhotite occur in unit 1e amphibolite between Russell Lake and the Loon River. The same unit containes only pyrite and pyrrhotite at Kamuchawie Lake.

Reference:

McRitchie, W.D.
1974: The Sickle-Waskewan Debate: a Review; Man. Mines Br., Geol. Paper 1/74.

TABLE 3-1: LITHOLOGIES

	Sickle Group
Unit 3d (1-5 m)	Amphibolite sills: coarse-grained, black hornblende-rock
	top not exposed
Unit 3c (up to 300 m)	Knotted arkose: pink and buff-weathering meta-arkose, arkose-migmatite with cream coloured faserkiesel (quartz-feldspar-magnetite-sillimanite knots, finely granular (0.5 - 1.0 mm), massive or layered with faserkiesel concentrations.
	first sillimanite
Unit 3b (300-500m)	Biotite arkose: grey or tan quartzofeldspathic restite with bright pink weathering veins of pegmatite, finely schistose (0.5 - 1.0 mm), massive or with biotite and magnetite concentrated along bedding planes; quartzitic green and red, epidote and hematite-bearing meta-arkose
	gradational
Unit 3a (unit 0-250 m)	Hornblende arkose: grey quartzofeldspathic gneiss and migmatite containing biotite and hornblende; biotite meta-arkose with 2-10 cm hornblende-bearing beds and lenses.
	conformable
	BURNTWOOD RIVER SUPERGROUP
	Amphibolite Group
Unit 2 (0-350 m)	(2a) layered amphibolite ± garnet; thin-layered dark and light green quartz-diopside rock ± calcite; homogeneous amphibolite; metagreywacke ± sulphides; iron formation; (2b) coarsely crystalline quartzite ± sulphides; fine grained, faintly bedded or massive feldspathic quartzite; arkose; (2c) hornblende-bearing meta-greywacke, gritty greywacke, biotite schist, subgreywacke.
	comformable
	Greywacke-migmatite Group
Unit 1 (1000 + m)	(1a) Greywacke-migmatite, generally garnetiferous and carbonaceous ± cordierite ± sillimanite, well bedded with sub-sequal psammite and pelite, relict graded bedding, laced with pegmatite veins; (1b) Greywacke-psammite with lenses of calc-silicate rock and local impure quartzite, generally garnet-free with 10% vein material of quartz-amphibole-feldspar or pegmatite, thin-bedded (2cm - 10cm); (1c) light grey, impure quartzite in 2-10 cm beds with meta-greywacke; (1d) Hornblende greywacke, garnet-free, psammitic; (13) Amphibolite-boudin greywacke, comprising units 1a or 1b with boudins and local sills of fine-grained amphibolite, 10 cm to 1 cm thick.

(4) GEOLOGY OF THE McKNIGHT LAKE AREA

64C-3

By: P.G. Lenton

Introduction

The McKnight Lake area (64C-3) (Figure 2-1) comprises approximately 860 sq. km. Mapping was conducted on a scale of two inches equals one mile. Access is good with abundant outcrop except for a north-south belt of swamp and glacial deposits along the west side of the C.N. rail line.

General Geology

The area is underlain mainly by migmatites derived from greywacke and arkose sediments. These metasedimentary rocks have been extensively intruded by plutonic rocks of predominantly granite composition.

Compositional layering in the metasedimentary rocks is well developed with the contacts between major units generally sharply defined. Where visible, the contact show no evidence of unconformity.

The metagreywacke and accompanying amphibolites have been assigned to the Burntwood River Supergroup (McRitchie, 1974) and the meta-arkose to the Sickle Group.

Rock Description

Greywacke Group

The migmatites which were derived from greywacke, comprise interlayered psammites, semi-pelites and pelites. The psammites are the dominant rock type representing about 60% of the greywacke exposures whereas pelites are farly rare. The mineralogy of the greywacke-restite is fairly constant, and comprises quartz, feldspar, biotite, ± garnet ± cordierite ± sillimanite. The mobilizate is represented by sills and dykes of medium grained to pegmatitic white or pink granite and granodiorite. Layering is sharply defined by variation in grain size and total mafic mineral content, and layers are often separated by thin biotite concentrations. Localized metasomatic growth of calc-silicate minerals in 5 to 50 cm lenticular concentrations is common in the psammites and semi-pelites. Thin layers of biotite-hornblende-feldspar amphibolite were noted, but their occurrence is sporadic.

Amphibolite Group

The top of the greywacke group is marked by a delicately layered para-amphibolite that ranges from 3 m to 35 m in thickness. This amphibolite is often interlayered with 10 cm layers of quartzite.

Mineralogy is variable within the amphibolite, with hornblende, feldspar and biotite-rich layers alternating with diopside, quartz, epidote layers. This produces a characteristic brownish black and pale green layering on a 1 to 3 cm scale. Occurrences of garnet in the hornblende layers are sporadic.

At Benzie Lake the layered para-amphibolite is not present at the top of the greywacke sequence, but is replaced by a coarse grained hornblende-biotite-plagioclase metagabbro interlayered with a medium grained mesocratic hornblende gneiss. The dark green to black metagabbro consists of 5 to 10 mm euhedral hornblende porphyroblasts in a fine grained, pale green interstitial matrix of plagioclase, amphibole, ± minor quartz. The metagabbro occurs as 10 m thick layers interlayered with 1 to 2 m layers of medium grained dark brown salt-and-pepper-texture gneiss consisting of equigranular hornblende, plagioclase, biotite ± minor quartz. This mafic unit is of variable thickness and never exceeds 70 m.

An orthopyroxene-bearing ultrabasic rock interlayered with mesocratic hornblende gneiss on Russell Lake is possibly related to the metagabbro.

Sickle Group

The Sickle Group comprises migmatite derived from interlayered arkoses, subarkoses, greywacke and subgreywackes along with associated granitic rocks.

At McKnight Lake the stratigraphic sequence above the amphibolite consists of a sillimanite-bearing arkose overlain by a pelitic to semi-pelitic greywacke, followed by a biotite arkose with little or no sillimanite which is in turn overlain by a garnet-bearing subgreywacke. The subgreywacke appears to be the highest unit in the Sickle succession and is only exposed at McKnight Lake. To the northwest the lower arkose (unit 3a) is absent and the pelitic greywacke (unit 3b) lies directly on top of the amphibolite. Further to the northwest near Russell Lake the pelite also disappears and the upper arkose unit directly overlies the amphibolite.

The meta-arkose comprises pinkish grey to white, medium grained migmatites. The proportion of coarse grained pink to red granitic mobilizate is variable. The composition of the restite is quite uniform and consists of quartz, plagioclase, potassium feldspar, biotite, magnetite, ± sillimanite ± minor garnet ± cordierite. Sillimanite occurs as either fine coatings on schistosity planes or as quartz sillimanite knots up to 30 cm long.

The metagreywacke grades from a garnet, cordierite, magnetite, sillimanite-bearing pelitic metatexite at the base up to a magnetite-free, garnet-bearing semi-pelitic metatexite. Variation in composition occurs gradationally over several metres so the rock generally is a homogeneous medium grained gneiss with low mobilizate content.

Plutonic Rocks

The central and western parts of the area contain several irregular biotite-granite and biotite-granodiorite bodies (unit 5). Generally the contacts with the surrounding metasedimentary rocks are gradational over a distance of 100 m or more. In several locations it is possible to trace a ghost stratigraphy within the intrusions based on the type of paragneiss inclusion. Areas of predominantly arkosic inclusions are commonly outlined by inclusions of layered paragneiss whereas the greywacke inclusions lie outside the amphibolite. This is most evident north of McKnight Lake and west of the Laurie River.

Southeast of McKnight Lake there are two small bodies of coarse-grained porphyritic hornblende-granite (unit 6). These bodies are of limited size and the contacts are gradational over 1 m with no inclusions of the country rock away from the contacts.

A small area of hornblende tonalite (unit 4) occurs on the C.N. rail line in the northern part of the area. This body is probably part of a hornblende quartz monzonite body in the Kadeniuk area (Baldwin, 1974). The areal extent of this body is uncertain because of glacial cover. This tonalite is medium grained, grey to brown with a strong schistosity. It contains numerous partially digested inclusions of greywacke metatexite.

There are numerous dykes and sills of white to pink, coarse grained, weakly foliated and/or non-foliated pegmatites. Many of these bodies show compositional zoning and appear to be late intrusive features comprising chemically simple alkaline pegmatites of limited areal extent.

Metamorphism

A metamorphic grade in the upper amphibolite facies predominates through the central and western parts of the area. Garnet is ubiquitous in the metagreywacke and is often accompanied by cordierite. Where present, sillimanite co-exists with potassium feldspar.

Between the Laurie River and Wolfpack Lake there is an area of apparently lower metamorphic grade. These rocks comprise greywacke derived schists similar to those in the west but differ in their very low mobilizate contents. Quartz veining is prominent. Garnet occurrence is sporadic and mainly restricted to the psammitic fractions.

Structural Geology

Two major periods of folding and one of faulting can be recognized in the area. A third period can be inferred from previous work (Baldwin, 1974).

Previous work in the Kisseynew gneissic belt as summarized by McRitchie (1974) has shown that the Sickle arkose group stratigraphically overlies the Burntwood River Supergroup. In the McKnight Lake area this relationship is inverted, which would imply a major nappe-like fold as the first recognisable folding event.

The morphology of the Sickle outliers shows a crossfold pattern with the earlier axis east-west and the later axis approximately northeast.

The last major tectonic event that can be recognized is a major north-south fault just east of the C.N. rail line. This fault, which is continuous into the Kadeniuk Lake area (Baldwin, 1974), appears to have both vertical and horizontal components of movement, and postdates the folding.

Mineralization

Occurrences of sulphide mineralization are restricted to the layered para-amphibolite. Here the sulphide assemblage is pyrite, pyrrhotite, ± minor arsenopyrite.

References:

Baldwin, D.A.
1974: The Geology of the Kadeniuk Lake area; **in** Summary of Geological Fieldwork, 1974; Man. Mines Br., Geol. Paper 2/74.

McRitchie, W.D.
1974: The Sickle-Waskewan Debate: a Review; Man. Mines Br., Geol. Paper 1/74.

(5) RUSSELL LAKE SOUTH

(Parts of 64C-3,4)

By: W.D. McRitchie

General Geology

The work on Russell Lake South (Figure 2-1) focussed entirely on a newly-discovered refolded flattened ellipsoidal outlier of Sickle arkosic gneiss. Excellent shoreline exposures provide a continuous sequence through the following conformable section:

Sickle Arkosic Group:

Interlayered psammitic and semipelitic quartz-rich sandy subgreywacke.
Massive amphibolite with associated porphyroblastic enstatite-bearing metaperidotite lenses.
Pink arkosic gneiss with amphibolite pods, lenses and boudins.
Interlayered pink arkosic gneiss and knotted faserkiesel-bearing arkosic gneiss, with sporadic amphibolite pods, lenses and boudins.
Delicately layered subarkosic gneiss.
Interlayered faserkiesel-bearing arkosic gneiss and pink arkosic gneiss.
Hornblende-bearing sandy subarkose.

Greywacke Group:

Thinly layered para amphibolite-meta iron formation with sporadic thin sulphide, diopside and/or garnet-rich layers.
Hornblende-bearing sandy subgreywacke (50-metre thick zone).
Psammitic and semipelitic greywacke gneiss with biotite and garnet and thin amphibolite layers.
Mesocratic hornblende gneiss with local polymictic fragmental phases and ultrabasic lenses (recrystallized andesitic tuff and breccias).
Psammitic and semipelitic greywacke gneiss with silty garnet-free/poor formations.
(Base of section)

Three folding episodes, emplacement of intrusive sills and late stage fracturing and faulting have resulted in extreme thickening and/or attenuation of most of the sequence. Graded bedding, observed in two outcrops of delicately layered gneissic greywacke turbidite, indicates tops toward the arkosic gneisses (McRitchie, 1975).

Rock Descrition

The metagreywacke sequence comprises interlayered psammitic and semi-pelitic biotite-garnet-plagioclase-quartz gneiss ± potassium feldspar ± sillimanite ± cordierite with sporadic silty garnet-poor formations. Layer thickness varies between 5-200 cms but is typically between 10-30 cms. White sills of feldspathic quartz-rich mobilizate comprise less than 5% of the sequence but exceed 80% around the three northeast and east pointing noses of the arkosic outlier. Minor rose or white quartz pods, veins and lenses are ubiquitous, the rose variety being more prominent than in the main Nelson House-Pukatawagan gneissic belt to the south. A unit of foliated, mesocratic, equigranular, homogeneous, plagioclase-hornblende gneiss outcrops on the south shore of the lake, within the greywacke sequence. A polymictic fragmental phase and an exceptionally coarse grained ultrabasic phase occur within the mesocratic gneiss on small islands near the most easterly extension of the unit on the south shore. The fragments vary in composition, are angular in section, up to 30 cms across and are stretched parallel to the regional lineation. Recrystallization of an andesitic tuff and breccia seems the most plausible origin for this unit which also occurs on an island in the centre of the south main bay of Russell Lake as four 2-10 metres thick layers inter-layered with greywacke gneiss. The greywacke gneisses immediately below the marker amphibolite and arkosic gneisses are hornblende-bearing and light brown in contrast to the typically grey weathering Burntwood River Supergroup.

The marker amphibolite (meta-iron formation) ranges in thickness from 0 to 100 metres, is typically thinly layered and appears consistently at the conformable contact between the greywacke and arkosic groups. Layering (0-30 cm) is prominent and defined by small variations in hornblende, plagioclase or diopside contents. Thin, light grey diopside-rich interlayers are common as are gossaned pyrite, pyrrhotite and locally arsenopyrite-bearing layers. Garnet is rare and occurs as milimetre size grains in a single 2-metre thick layer.

The arkosic gneisses comprise a pink weathering, interlayered (50-200 cms) sequence of feldspathic gneiss and feldspathic gneiss containing prominent sillimanite knots or rods (2 x 3 x 20 cms). A distinctive light grey weathering, delicately layered (1 mm-55 cm) subarkosic sillimanite-free formation, 100 metres thick, occurs within the pink arkosic gneisses and persists as an identifiable unit for over 9 kms.

Massive weakly layered amphibolite-hornblendite pods, lenses and boudins occur within this lower arkosic sequence and at its uppermost contact with buff weathering sandy sillimanite poor subgreywackes. The amphibolite at the contact is generally massive with only minor layering at its lowermost contact with a possibly fragmental pseudoconglomerate unit on the Russell River. Pseudo pillows in the contact amphibolite on islands in the Russell River are though to be the product of combined boudinage and metasomatic reaction between originally siliceous and carbonate-rich layers. Nineteen large lenses of porphyroblastic enstatite bearing metaperidotite were recorded in direct association with the "contact" amphibolite over a long-strike distance of more than 9 kms. The ultramafics range in composition from olivine and hornblende-bearing peridotite with large 2 cm knots of poikiloblastic enstatite, to equiangular orthopyroxene-free olivine-hornblende segregations, or lenses of anthophyllite. Spinel is commonly present with trace talc and serpentine. Textures are entirely metamorphic relfecting a high upper amphibolite facies recrystallization.

The structurally highest part of the arkosic sequence comprises grey weathering hornblende-bearing sandy psammitic subgreywacke interlayered with a semipelitic quartz-rich and rarely sillimanite-bearing subgreywacke.

Zoned calc silicate lenses, pods, boudins and layers are present as thin ($<$1 metre) units throughout the greywacke and arkosic groups; however, their colour and mineralogy varies with the composition of their host rock.

Intrusive rocks within the greywacke sequence are rare and comprise sills of equigranular homogeneous gneissic hornblende-bearing tonalite. In the arkosic group pink quartz monzonite, with minor associated pegmatite and aplite forms several large predominantly conformable sills, one of which occupies the core of the main structure. Contact zones comprise interlayered **lit-par-lit** sill complexes of sharply bounded and foliated aplitic quartz monzonite and either amphibolite or sillimanite-free arkosic gneiss.

Late northeast trending pegmatite dykes are generally white in the greywackes and pink in the arkosic group. Sillimanite and more rarely cordierite occur in most of the earlier pegmatite bodies.

Structure

The main Sickle outlier occurs as a highly flattened doubly Z folded cylinder plunging at shallow angles to the east. Lineations and early fold axes show a slight divergence in azimuth from 60° to 100° and plunge into and parallel to each of the east trending antiformal noses. The northwest wing of the structure is highly attenuated and may represent a nappe-like synformal pinch-out structure rather than a fold closure. Late asymetric S step folds plunge to the north, with north trending axial planes commonly ruptured and the site of pegmatite emplacement.

Metamorphism

Mineral assemblages are characteristic of the upper amphibolite facies with sillimanite common in the arkosic gneisses and more rare in the greywacke group where it commonly coexists with cordierite. Garnet-rich blastic mobilizate verging on diatexite is common at the northeastern end of the outlier in the surrounding greywacke gneisses. A second recrystallization event characterized by widespread development of muscovite appears coincident with the development of the axial planar foliation. Subsequent alteration is minor and associated with late stage faults and fractures.

Economic considerations

The widespread occurrence of thin gossan zones in the marker amphibolite is consistent with the pyrite, pyrrhotite and locally arsenopyrite mineralization of this horizon throughout its extent from Russell Lake through Granville Lake to Footprint and Threepoint lakes were possible meta-iron formation has also been recorded (McRitchie, 1971). The copper mineralization at Kadeniuk Lake occurs at a slightly different stratigraphic horizon but may indicate the presence of a regional zonation (Sabkha type) in which the dominantly ironbearing sulphides represent the more oceanic element.

The single unit of possible andesitic tuff and breccia in the greywacke group is the most southerly occurrence in this region of a Wasekwan volcanic and further supports the contemporaniety of the Wasekwan volcanism and Burntwood River Supergroup greywacke sedimentation.

The stratigraphic persistence of the ultramafic lenses in the arkosic sequence may indicate an originally extrusive origin for this unit and the associated massive amphibolites. The thorough recrystallization, however, precludes identification of suitably diagnostic original textures.

References:

Baldwin, D.

1974: Geology of the Kadeniuk Lake Area, **in** Summary of Geological Fieldwork; Min. Res. Div. Geol. Paper 2/74.

McRitchie, W.D.

1971: Preliminary Geological Investigations of the Nelson House-Pukatawagan Region, Manitoba. Mines Branch Geol. Paper 2/71.

1975: Russell Lake South; Man. Min. Res. Div., Prelim. Map 1975R-3.

(6) ULTRAMAFIC ROCK PROJECT

(53M-15, 16; 53N-11, 12, 13, 14)

By: R.F.J. Scoates

Outcrops of the Fox River sill, Fox River greenstone belt and enclosing gneissic rocks along the Fox, Sipanigo, Gowan and Stupart Rivers were examined during the 1975 field season.

The exposed rocks of the greenstone belt are dominantly pillowed and massive mafic volcanic flows. The rocks are massive and dip steeply to the north, and top directions determined from extremely well-preserved pillows are consistantly north. Some of the massive flows consist of a lower olivine-rich zone and an upper plagioclase and pyroxene-rich zone. These apparently differentiated flows range in thickness from 10 to 25 m. The pillowed flows are dominantly basaltic in composition although several pyroxenitic pillowed flows are known. Mafic volcanic breccias have been observed but are restricted in occurrence. Rhyolitic tuff occurs as a narrow layer (<100 m wide) in contact with the south marginal series of the Fox River sill.

Rocks of the south marginal series and lower central layered series of the Fox River sill are exposed in the Fox River approximately 1.6 km downstream from the confluence of the Fox and Sipanigo Rivers. The south marginal series comprises three cyclic repetitions (from south to north) of plagioclase-bearing lherzolite, plagioclase-bearing olivine websterite and olivine gabbro-norite. A hornblende and phlogopite-bearing picrite occurs adjacent to the rhyolitic tuff at the south contact and this unit grades over 10 m into plagioclase-bearing lherzolite. The lower centraly layered series rocks comprise serpentinized dunite and thin (10-15 m) olivine-bearing clinopyroxenite layers. The sequence of cycles indicates a north-facing series of layered rocks. Peridotite and feldspathic peridotite of the upper central layered series is exposed farther downstream on the Fox River and on the Stupart River.

The width of the Fox River greenstone belt in the main area of exposure on the Fox River is estimated to be 14 km. This estimate is based on outcrop mapping, diamond drill hole information and interpretation of aeromagnetic data. A tentative stratigraphic column is contained in Table 6-1.

The major limitation of Table 6-1 stems from the fact that apart from the exposure of the south and north contacts of the Fox River sill in diamond drill core, none of the other major unit contacts is exposed. The nature of the contacts of the Fox River greenstone belt and the enclosing crystalline rocks to the south and north is unknown.

Correlation of fieldwork data with diamond drill hole information collected from the International Nickel Company Limited is continuing.

TABLE 6-1

STRATIGRAPHIC COLUMN, FOX RIVER GREENSTONE BELT

North	Thickness in km	
		garnetiferous biotite and hornblende gneiss
		———contact not exposed———
	1.0-2.0?	argillites, shales and carbonaceous shales
		———contact not exposed———
	3.0-3.5	pillowed and massive mafic flows, some differentiated flows, some pillowed flows of pyroxenitic composition, minor tuffaceous rocks
		———intrusive contact———
	2.0	Fox River sill
		———intrusive contact———
	2.0-2.5	pillowed and massive mafic flows, some differentiated flows, minor tuffaceous rocks
		———contact not exposed———
	4.0-4.5?	argillites, marls, quartzites and iron formation, some differentiated flows in upper part
		———contact not exposed———
South		gneissic granite and amphibolite

(7) HIGH HILL — UTIK LAKE AREA

(Parts of 53M-5, 6, 11, 12, part of 63P-1)

By: W. Weber

The greenstones on High Hill Lake and along the Bigstone River east of High Hill Lake were investigated (Weber, 1975), as a continuation of the study of the northern Superior greenstone belts, started in 1974 (Weber, 1974). Shoreline exposures of this most northerly greenstone belt are less abundant than at Utik Lake and inland exposures are absent. Consequently the information collected is more fragmentary. The area was last mapped by Quinn (1955).

High Hill Lake area

The volcanic rocks exposed on the High Hill Lake and the Bigstone River are lithologically similar to the greenstones at Utik Lake, perhaps with the exception that sedimentary rocks are less frequently interlayered than at Utik Lake. The predominant volcanic rocks are basaltic, massive and pillowed flows, and gabbroic belts.

As on Utik Lake, iron silicate-magnetite-chert iron formation occurs both within the volcanic pile and at the top of the exposed volcanic pile, indicating oxidizing conditions and probably moderately deep to shallow water. The exposed iron formations coincide with linear aeromagnetic anomalies and the high aeromagnetic values between High Hill Lake and the Bigstone River are interpreted as the expression of similar iron formation. Locally, and particularly below the iron formation, metavolcanic rocks have been altered by fumarolic activity (Weber, 1974) to garnet or anthophyllite-bearing meta-basalts (Weber, 1975).

Similar lithological sequences, meta-basalt / iron formation / metasediments, were identified along the northern and southern margin of the belt at High Hill Lake and the southern margin of the belt near Ox Rapids on the Bigstone River. These, together with a few stratigraphic top indications, suggest that the greenstone belt is essentially an anticline abutting against late tectonic plutons (Figure 7-1). The older granitic and gneissic rocks north of the belt (unit 3, Figure 7-1) are intrusive into the meta-volcanic rocks and are probably related to the charnockitic migmatite complex mapped by J. Hubregtse (this paper) in the Ilford area, along the northern margin of the Superior Province.

The rocks of the High Hill Lake-Bigstone River area have been metamorphosed under conditions of the amphibolite facies. The metamorphism appears to have been of slightly higher grade than in the Utik Lake area, resulting in the coarser recrystallization textures of the meta-basaltic rocks. Despite this overprint pillow structures are hardly deformed and graded bedding is preserved in a few places. Gossan zones (Weber, 1975) were found to be commonly associated with the iron formation. However, only minor pyrite and/or pyrrhotite were encountered (see also Quinn, 1955) with the exception of boulders of massive pyrrhotite found on an island in High Hill Lake. A few gossans were observed in shearzones of mafic rocks. The gold mineralization reported by Quinn from the small lake between High Hill Lake and the Bigstone River occurs in such a quartz-filled shearzone.

References:

Quinn, H.A.

1955: Knee Lake, Manitoba; GSC Prelim. Map 55-8

Weber, W.

1974: Utik Lake-Bear Lake Project; **in** Summary of Geological Fieldwork, 1974; Man. Min. Res. Div., Geol. Paper 2/74

1975: High Hill Lake; Man. Min. Res. Div., Prelim. Map 1975U-1

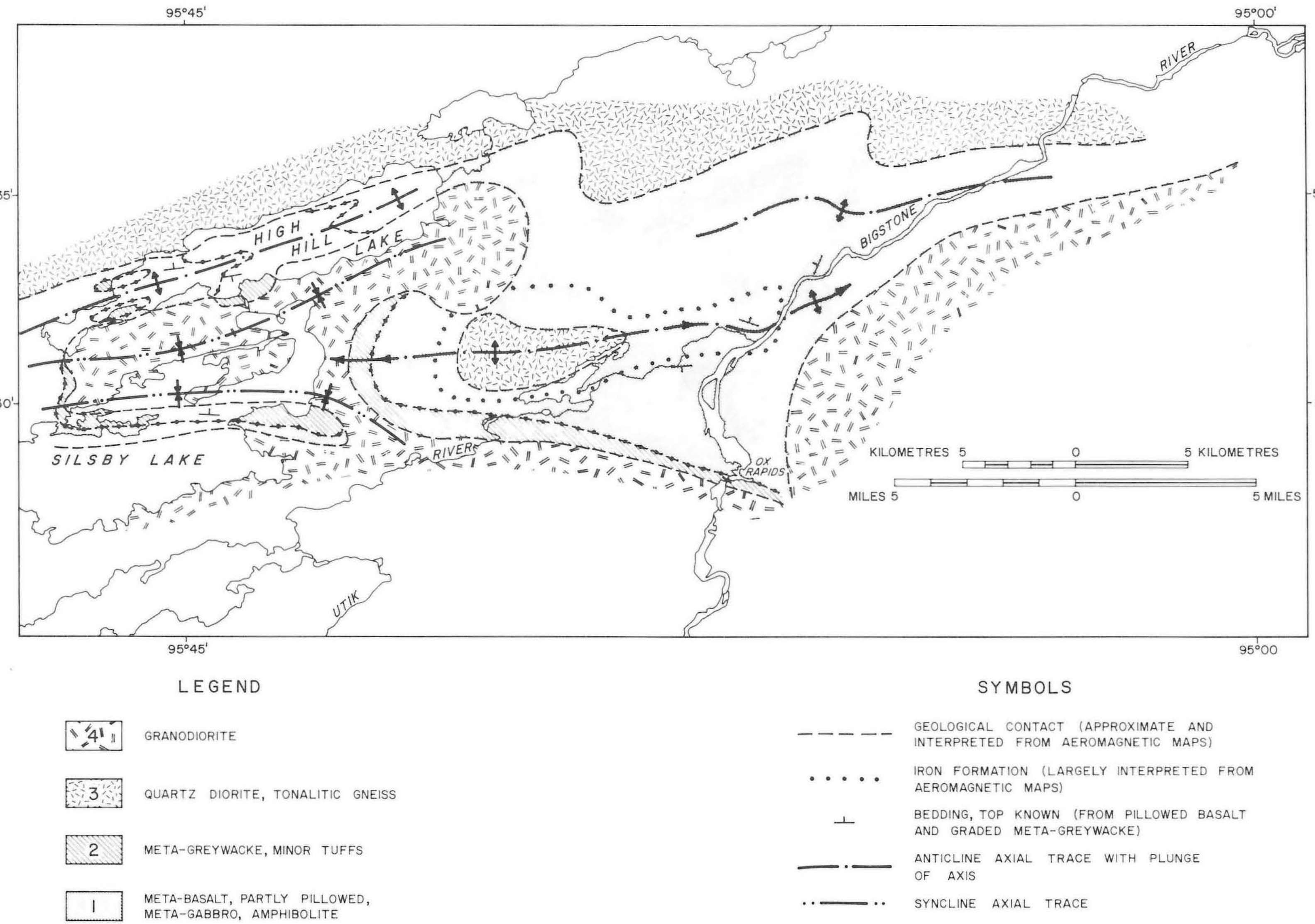

Figure 7-1: Tectonic map of the High Hill Lake-Bigstone River area (after Weber, 1975)

(8) VOLCANIC STRATIGRAPHY AT UTIK LAKE

By: R. Hargreaves

An approximate 500 m thick, early Precambrian metavolcanic sequence at Utik Lake, 80 miles east of Thompson, was mapped by the Manitoba Mines Branch in 1974 (Weber, 1974).

As part of this project, the author undertook detailed mapping of a 900 metre thick metabasalt and metagabbro sequence near the south edge of the belt. This sequence is well exposed on an island that was burnt by a forest fire in 1973. Detailed mapping was continued in 1975, concentrating on the stratigraphy of the interlayered massive and pillowed aphyric metabasalt. Porphyritic metabasalt separated by iron formation with accompanying alteration was also briefly investigated.

A pile of aphyric basalt is exposed over a thickness of approximately 400 m. A prominent zone (90 m thick) of predominantly pillowed basalt occurs at its base, along the northern shore of the island. This zone is overlain by a complex sequence of interlayered massive and pillowed flows.

Flow units vary in thickness from 10 m to 35 m. Individual massive flows can be broken into three major parts: (1) a basal pillowed zone; (2) a central coarser grained massive zone, and (3) a flow-top breccia. (Plate 8-1,2). The basal pillowed zone and the flow top breccia may be absent. Both zones vary in thickness independent of the actual flow thickness.

The basal pillowed zone which has a thickness equivalent to one or two pillows is interpreted as a reaction between hot lava and water. Injections of massive basalt extending from the central zone into the flow-top breccia were found in nearly all flow-top breccias overlying massive flows (Plate 8-2) and are analogous to "toothpaste" lava found in subaerial Aa flows. These injections result in an irregular upper surface of the central massive zone and a variable thickness of the flow-top breccia. The porous nature of such breccias results in considerable alteration within the matrix and in the massive injections.

The majority of massive flows exhibit a flat top regardless of the presence or absence of a flow top breccia. The base, however, conforms to the topography of the underlying flow. This is best exemplified where a massive flow overlies a pillowed cooling unit. Such pillowed units may have flat, slightly undulating upper surfaces or surfaces with up to 2 m relief. Pillowed flows overlying a massive flow exhibit flat based pillows (Figure 8-1). Where two massive flows are found in contact with each other, a flat contact surface is usually present.

Sea-water alteration characterized by a light green weathering occurs within fractures along the outer portions of pillows. Small pillows are most susceptible to such alteration (Figure 8-2). The alteration occurs as halos around interpillow voids or as lateral alteration zones roughly conformable to the direction of pillow elongation. L.D. Ayres (personal communication) suggests that such lateral zones may reflect a hiatus in volcanism between the extrusion of two separate pillowed cooling units.

The shape and form of pillows found within the study area fall into two classes. The first class fits the discrete-entity, balloon-type pillows, which are commonly described from Archean greenstone terrains (Figure 8-2). The other class of "pillow" is very irregular in its outline, and may have a squat horizontal cross-section up to 5 m long and 2 m wide (Figure 8-3). It could represent lava tunnels that fed the front of the flow. Other "pillows" resemble three or four inter-connected pillows. These are believed to have resulted from a process similar to the "digital advance of submarine pahoehoe" (Jones, 1968) which may have played a significant role in the development of entire pillowed flows.

The generally irregular shape of the flows, the discontinuous outcrop pattern and the presence of faults allowed lateral correlation of the thicker individual massive flows for not more than 200 m. Flows less than 10 m thick could not be traced laterally for any significant distance.

References:

Jones, J.G.
1968: Pillow Lava and Pahoehoe; Jour. Geol., Vo. 76, pp. 485-588.

Weber, W.
1974: Utik Lake-Bear Lake Project; **in** Summary of Geological Fieldwork, 1974; Man. Min. Res. Div. Geol. Paper 2/74:7

Plate8-1. Flow-top breccia. The light coloured angular fragments are derived from the brecciated altered flow top and from broken-up lava tongues having intruded the flow-top breccia. The dark matrix consists of angular clasts of various sizes derived largely from glassy volcanic material.

Plate 8-2. Top of massive basaltic flow overlain by flow-top breccia. Note the light colour of the flow top due to the chemical alteration by the interaction with sea water, and the intrusive relationship of the flow with its flow-top breccia.

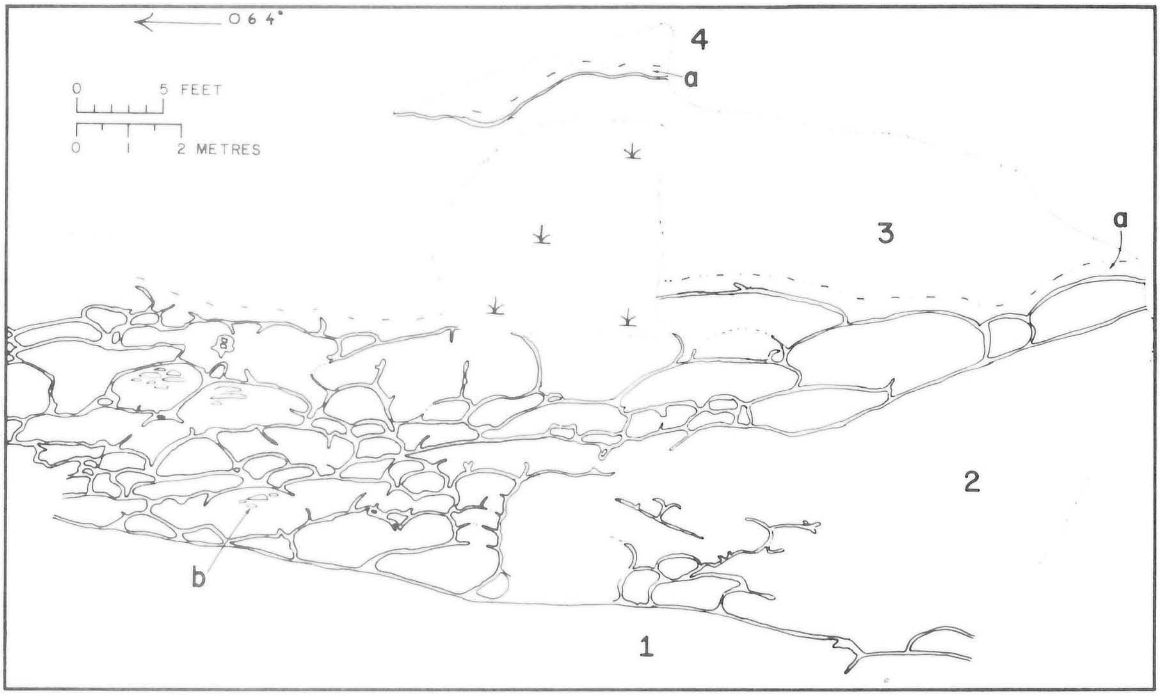

Figure 8-1. Pillowed flow (2) interlayered with massive flows (1, 3, 4). Note the flat surface of flow 1, the flat-based pillows of the overlaying flow (2) and the chilled base (a) of flow (3) and (4). Flow (2) apparently consists of the flank of a massive flow and a co-genetic pillowed "facies".

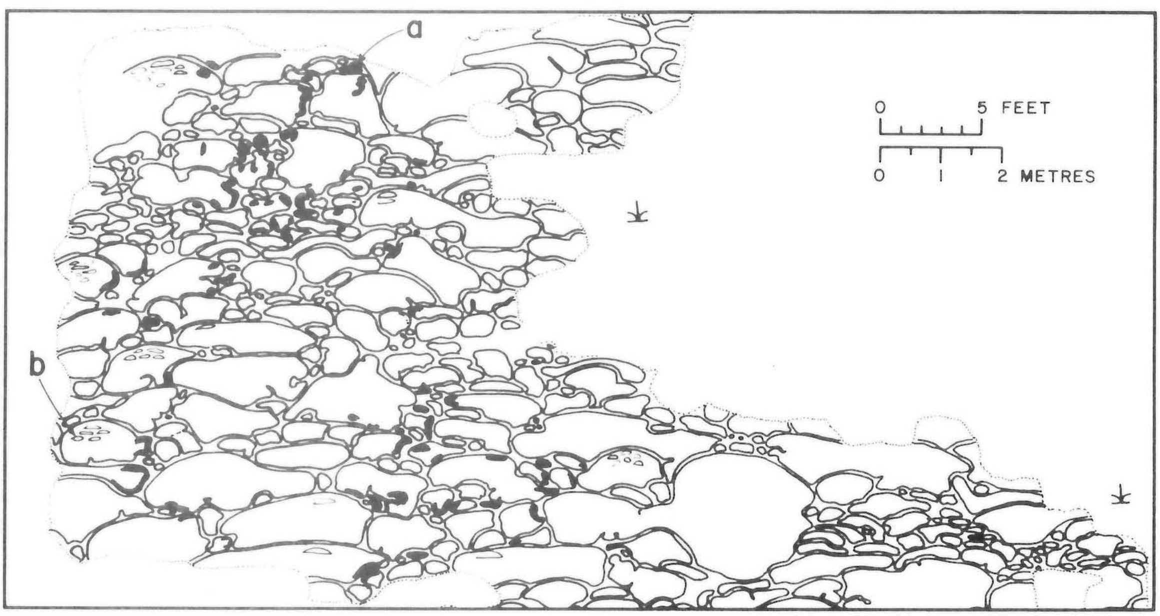

Figure 8-2. Flow basalt with "normal" pillow structures (discrete — entity, balloon-type pillows) with the exception of the "necked" pillows near the bottom. Note alteration (a) which preferentially affected small pillows and the margin of larger pillows. b — large cavities.

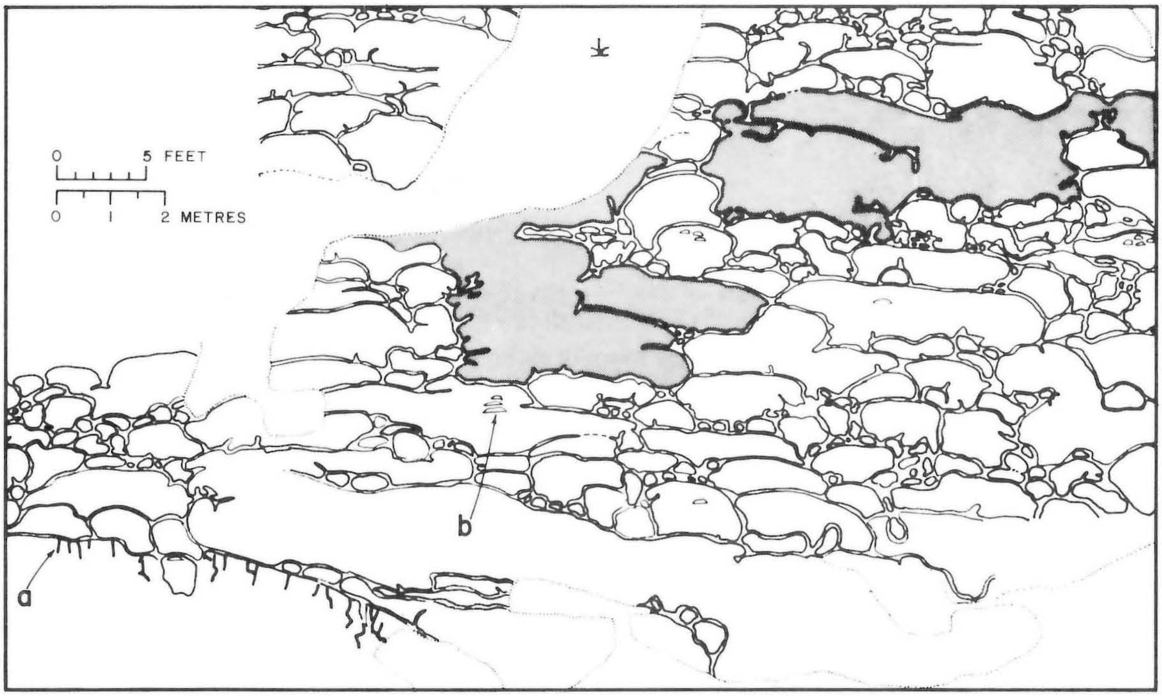

Figure 8-3. Top of massive flow overlain by pillowed flow. Note surface cooling cracks (a) in massive flow top. The squat shaped irregular "Pillows" (in grey) with discontinuous selvages may be interpreted as lava tunnels which fed the front of the flow. b — large cavities.

(9) NELSON RIVER-ILFORD AREA

(54D-3, 4, 5, 6 and Parts of 54D-11 and 12)

By: M.T. Corkery and J.J.M.W. Hubregtse

Introduction

A mapping program in the Nelson River-Ilford area was initiated to clarify such geological problems as:

1) the possible connection of the Fox River volcanic-sedimentary belt and the Thompson-Moak Lake-Assean Lake lineament;
2) the interpretation of high-grade rocks in the Nelson River-Ilford region in terms of the Superior-Churchill Province boundary problem;
3) the relationship of the high-grade rocks in the Nelson River-Ilford region to medium and low-grade greenstone belts and gneissic terrains (Elbers **et al.,** 1973; Weber, 1974) situated to the south; and
4) the nature of greenstone belts in the Nelson River-Ilford area (Quinn, 1961).

The map area examined is bounded by latitudes 56°00' and 56°35' and longitudes 95°00' and 96°00'. Distribution of rock types in the northern and southern portions is described by Corkery (this volume) and Hubregtse (this volume), respectively.

Bedrock exposure is poor east of 95°15' and north of the Nelson River due to thick glacial drift. In the southwest portion of the area exposure is slightly better. Areas of good outcrop were mapped on Moose Nose and Split Lakes and along the Nelson River from Clark Lake to Gull Rapids.

Further field work is required to answer the questions listed above, but a few preliminary statements can be made.

The previously suggested extension of the Fox River volcanic-sedimentary belt (Davies **et al.,** 1965) could not be verified in the map area, nor were any Fox River sill type ultramafics found. The mafic rocks encountered in the area have been interpreted as deep-seated igneous rocks, which have undergone a complex sequence of folding, faulting, migmatization and metamorphism, giving rise to the formation of the migmatite amphibolite/granulite facies terrain. A further period of granite intrusion and granitization was followed by the intrusion of diabase dykes.

Because of the deep-seated nature of the igneous rocks and the lack of metasediments, these rocks cannot be equated with the volcanic-sedimentary belts to the south (Elbers **et al.,** 1973; Weber, 1974).

Geological History

The order of geological events is given in Table 9-1

Metagabbros are recognized as the oldest rocks exposed. Where found in weakly deformed zones they exhibit a marked compositional layering of a yet to be determined origin. Hornblende dykes cut this layering.

With the addition of felsic rocks the highly variable migmatitic complex is formed. The felsic rocks are in many areas interpreted as a mobilizate fraction of the metagabbro. The proportion of felsic mobilizate to metagabbro restite fluctuates from outcrop to outcrop. In the more massive metagabbro zones concordant **lits** as thin as 1 cm., and isolated discordant pods of mobilizate are found, ranging in composition from tonalite to quartz diorite and locally anorthosite, rarely containing more than 1% K-feldspar. The other extreme consists of mobilizate masses with isolated, randomly oriented rafts of metagabbro; remnants of the hornblende dykes occur as peculiarly zoned ultramafic inclusions. Similar mixed rocks of this nature have been described in detail by Haugh (1969, pp. 21-30) from the Split Lake area farther west.

The migmatite complex consists of granulite facies and amphibolite facies rocks. The mineral assemblages indicative of the hornblende granulite facies are coexisting orthopyroxene (± clinopyroxene) < K-feldspar + plagioclase + quartz (± biotite) in contrast to the hornblende-biotite assemblage of the amphibolite facies felsic rocks. Coexisting garnet + clinopyroxene + sodic plagioclase (± hornblende) distinguishes the granulite facies metagabbros from the amphibolite facies equivalents in which the garnet-clinopyroxene pair is unstable.

The most common felsic rocks within the granulite facies areas are enderbites, sometimes garnet bearing, with rafts of garnet-diopside-hornblende-plagioclase gneisses. K-feldspar and pyroxene-bearing rocks, like opdalites, were also encountered. In rare instances the mobilizate comprises quartz mangerite or charnockite.

The granulite facies rocks tend to contain slightly more K-feldspar than equivalent amphibolite facies units, a relationship due to the reaction:

orthopyroxene + orthoclase + water —— biotite + quartz

which proceeds to the left with increasing grade of metamorphism.

Two phases of deformation (D^1 and D^2) produced the extensive, well layered and tightly folded migmatite complex. Localized retrograde metamorphism during deformation gave rise to the development of biotite-rich layers parallel to the plane of foliation, as a result of the break-down of pyroxene.

Granite intrusions which postdate D^2 are found in the eastern portions of the map area. Border zones containing rafts and partially assimilated rafts of the older layered gneiss, grade into **lit-par-lit** gneiss away from the centre of granites.

Gabbro bodies and a dilation dyke swam cut the granite and the migmatite complex. The larger gabbro bodies strike E-W, whereas the offshooting diabase dykes have a northwest trend. The gabbros and dykes intruded penecontemporaneously with the D^3 deformation. D^3 caused an E-W shearing throughout the area, which affected the granite and migmatite complex, and also resulted in boudinage of the larger gabbro bodies. Subsequently D^3 resulted in a large-scale sinistral E-W shearing movement, which gave rise to the emplacement of the northwest trending dilation dyke swarm. Rare quartz-feldspar porphyry dykes postdate the diabase dykes.

Prominent fault zones, like the Assean Lake and Split Lake faults (Haugh, 1969) were due to the latest recognizable phase of deformation (D^4). Both fault zones can be traced farther east across the map area. Cataclasis accompanied by strong retrograde metamorphism affected all rock types within the shear zones.

References:

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TABLE 9-1

Sequence of geological events in the Nelson River-Ilford area

D^4	faulting
	quartz feldspar porphyry
	——intrusive contact——
D^3	mylonitisation and cataclasis diabase and gabbro
	——intrusive contact——
	granite
	——intrusive contact——
D^1 & D^2	granulite and amphibolite facies events appearance of felsic rocks: formation of migmatite complex
	hornblende dyke
	——intrusive contact——
	layered gabbro

(10) ILFORD-BUTNAU LAKE AREA

(54D-3 and 54D-4)

By: J.J.M.W. Hubregtse

This contribution mainly deals with the distribution of the rock types described by Corkery and Hubregtse (this volume) and shown in Figure 10-1, and on preliminary maps 1975 N-1 and 1975 N-2 (Hubregtse, 1975a and 1975b).

Metagabbro and hornblende dyke

The metagabbro crops out as rafts in the migmatites, Garnet-bearing metagabbro is well exposed on Lakes E and F as large continuous bodies. Outcrops on Split Lake demonstrate the intrusive relationship of the hornblende dykes with layered metagabbro.

Migmatite, felsic mobilizates and layered gneiss

Weakly deformed migmatites were found scattered all over the map-area. Wide zones are exposed at Split Lake and Lakes E and F. Smaller areas of weakly deformed migmatite occur at Moose Nose Lake, Little Kettle Lake and Butnau Lake. Migmatites with high proportions of metagabbro rafts were mapped at the east end of Split Lake.

Most of the rocks in the Split Lake area were affected by amphibolite facies metamorphism. Consequently the felsic components of the migmatites are tonalites and quartz diorites.

Granulite facies conditions were prevalent in the rocks around Moose Nose Lake, McCusker Lake, Lakes E, F and G, Butnau Lake and Little Kettle Lake, resulting in migmatites with felsic components belonging to the charnockite-enderbite suite. Quartz-mangerite and charnockite have been found on Butnau Lake and Moose Nose Lake.

Massive and homogeneous enderbite and opdalite are exposed on Butnau Lake and ESE of Ilford. No mafic inclusions were found in these rocks, but compositionally and texturally they are similar to the felsic components of the migmatites elsewhere.

Layered gneisses, i.e., tightly folded migmatites, are well exposed at Split Lake and Moose Nose Lake. Scattered exposures indicate that most of the terrain west of Moose Nose Lake and north of the Aiken River is underlayed by layered gneiss. At Moose Nose Lake the phases of deformation that gave rise to the formation of the layered gneiss are believed to be accompanied by diaphtoresis of an originally granulite facies mineralogy.

Granite, gabbro and diabase, and quartz-feldspar porphyry

Granites occur east of 95°47' and become increasingly important eastwards. Wide zones of granitized migmatite and layered gneiss were mapped in 54D-3.

Gabbros and diabases are widespread. The gabbro may display grain sizes up to 2 cm, whereas the diabases are dense and very fine grained. Normally the dykes have chilled margins. A 200 m wide set of dykes crops out in the extreme northwest corner of 54D-4. The rocks consist of brown and green amphibole, giving the dykes a peculiar brown-green speckled appearance, in contrast to the usual back colour.

Quartz feldspar porphyry dykes were only found on Split Lake where they cut the diabases. The fine grained light-coloured porphyry dykes have wavy and irregular outlines, in contrast to the straight contacts of the diabase.

Structure and deformation

The first and second phase of deformation(D^1, D^2) both resulted in the transformation of the migmatites into layered gneisses. In the Ilford-Split Lake area the D^1 and D^2 structures trend approximately N and NE, respectively, but local variations are common. Where D^1 and D^2 do not interfere, it is difficult to assign the deformation to a particular phase. Where both phases are penetrative, a highly folded layered gneiss may result.

The D shearzones result in E-W shearzones which may deflect the older N-NE structures.

The prominent Split Lake faultzone (d^4) extends along the Aiken River, striking 100°.

Sulphide mineralization

Sulphide mineralization was noted at the south shore of Split Lake. Chalcopyrite, pyrite, pyrrhotite and graphite occur in a gossanned vein-type deposit in the felsic component of a migmatite. Assays of two samples reported 0.18% and 0.21% Cu, respectively. A sample from another gossan zone, located approximately 500 m NNE of the former, ran 0.04% Cu.

Molybdenite was identified in a gossan streak in homogeneous enderbite 5 km SE of Ilford.

References:

Hubregtse, J.J.M.W.

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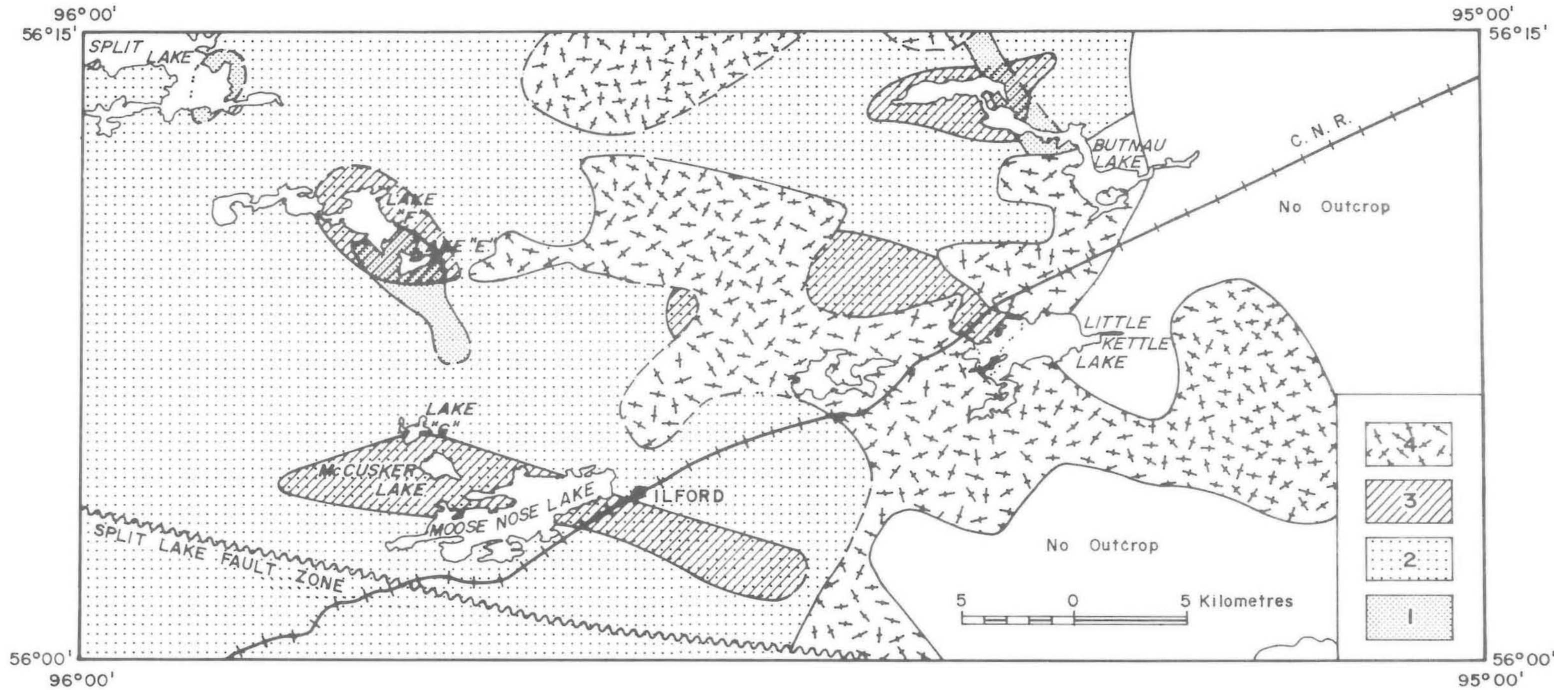

1 : Metagabbro and migmatites with < 50% felsic components

(1 and 2 Migmatite complex, mainly in amphibolite facies)

2 : Migmatites with > 50% felsic components

3 : Migmatite complex in granulite facies, containing garnet-diopside- hornblende-plagioclase granofels and gneiss, and members of the charnockite-enderbite suite

4 : Granite and granitized migmatites

Figure 10-1 : General geology of the Ilford-Butnau Lake area

(11) LOWER NELSON RIVER PROJECT

54D-5, 6, 11, 12

By: M.T. Corkery

Mapping conducted during a three-week field season in July 1975 examined the area bounded by latitudes 56°15' and 56°35' and longitudes 95°10' and 96°00'. With the exception of exposure along the Nelson River in the southern portion of the area, outcrops are rare.

The general geology discussed in the previous section can be applied to the Nelson River portion of this area. The distribution of the metagabbro, the migmatite complex and the granite is shown in Figure 11-1.

A limited number of exposures in the northern part of the map area are related to metasedimentary rocks in the Moose Lake area mapped by Haugh **et al.,** 1968. The most common rock type consists of pinkish grey magnetite-bearing meta-arkose and arkosic gneiss. One large ridge of plagioclase amphibolite with epidote-rich lenses and patches was found.

Mapping of the Moose Lake area and the Gull Rapids fault zone by Haugh **et al.,** 1968 and the author's mapping to the west indicate a major change in lithologies from metasedimentary rocks of Churchill affinity in the north and east to rocks of the Superior Province in the south and west. On the basis of these contrasting rock types and associated magnetic expression (Airborne Magnetic Map Sheets 2467G, 2468G, 2475G, 2476G), the fault zone observed at Gull Rapids can be extended westward to the Assean Lake fault, see figure 11-1.

Follow-up to previous geologic examinations in the Long Spruce-Kettle rapids area (Frohlinger, 1973 and 1974) extended the mapping. Further work in 1976 will complete this project.

References:

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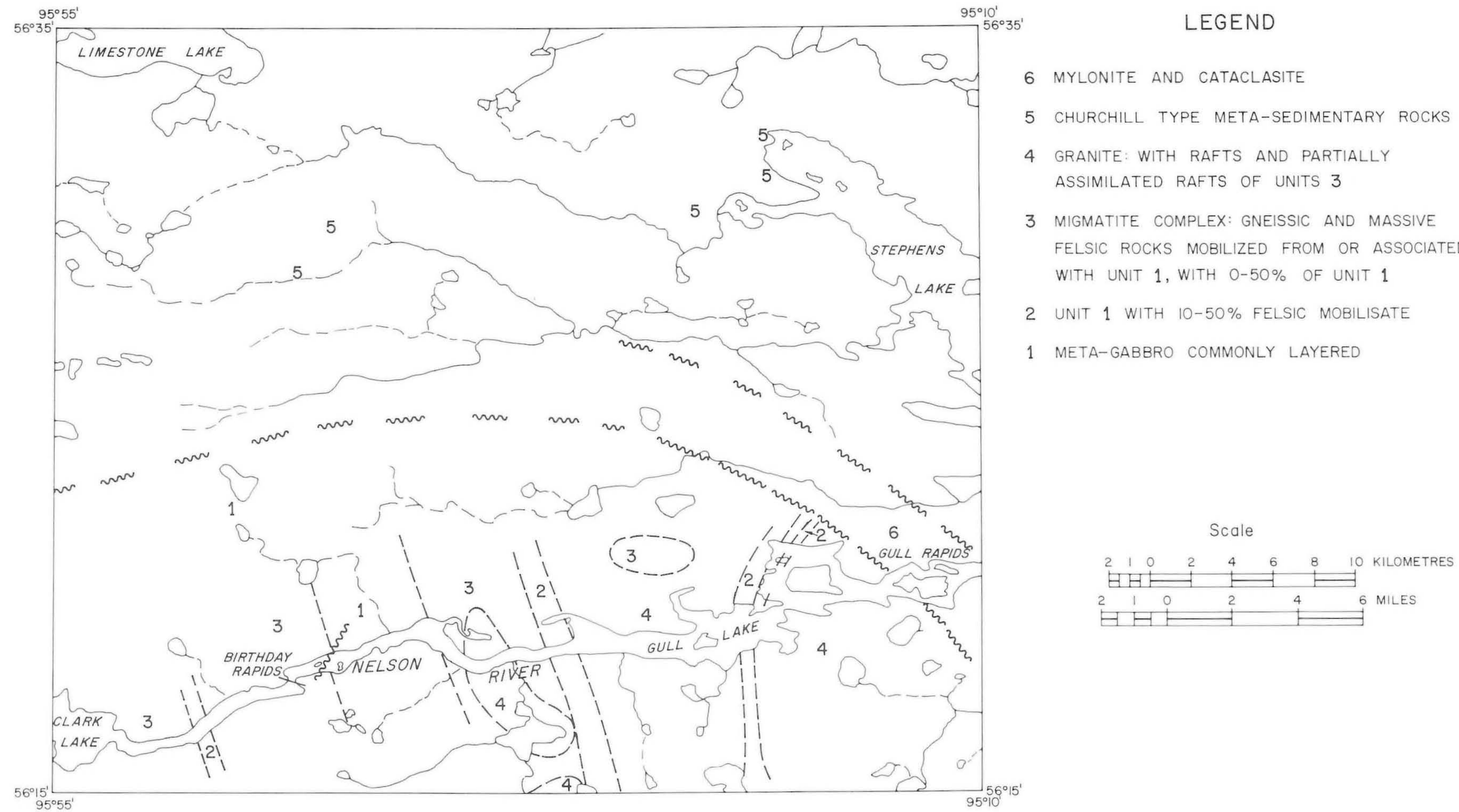

Figure II-1 : Outline geology of Clark Lake-Gull Rapids area

(12) SOUTHEASTERN MANITOBA

(Parts of 52E and 52L)

By: C.F. Lamb

Introduction

During the 1975 field season (Figure 12-1), geologic mapping was concentrated in the region from the Whitemouth-Rennie-West Hawk Lake area, south to the limit of Precambrian outcrop. This represents the second year of the Southeastern Manitoba Project (Lamb, 1974).

Mapping was conducted at a scale of one-half mile to the inch. Access to the areas south of Rennie and west of Shoal Lake was made possibly by the use of a helicopter. Other areas were accessible by truck and by boat.

Preliminary maps of the area include seven (1975 F-1, 2, 3, 4, 5, 6, 7) at one-half mile to the inch, and one compilation map (1975 F-8) at two miles to the inch.

General Geology

The consolidated rocks underlying the project area are Precambrian in age, and more specifically, Archean.

The metavolcanic-metasedimentary rocks have been metamorphosed to the upper greenschist to lower amphibolite facies, and are the oldest rocks in the area. They comrise parts of two major belts: (i) the Kenora belt and (ii) the Bird River belt. The geology of the Bird River belt is described by Trueman (this volume). The Kenora belt is split into three smaller belts as its extends westward into Manitoba (Lamb, 1975): a) Powawassan River, b) Indian Bay, and c) West Hawk Lake. The Powawassan River belt consists of basic volcanic flows bounded to the north by acidic proclastic rocks (tuff and breccia) and flows. The Indian Bay belt consists primarily of basic volcanics, but to the west changes to a sequence of rhyolite, dacite flows and acid pyroclastic rocks. The West Hask belt comprises a thick sequence of basalt and andesite, overlain by a sequence of clastic metasedimentary rocks.

The gneisses north and west of West Hawk Lake contain many mafic inclusions and discontinuous amphibolite layers, suggesting that the West Hawk volcanic-sedimentary sequence once extended farther north.

The metavolcanic-metasedimentary rocks and the gneisses have been intruded by granitic rocks, of predominantly granodioritic composition.

Economic Geology

Springer (1952) and Davies (1954) have previously outlined occurrences of gold, scheelite, molybdenum, lithium, uranium, and sulphides. Gold appears to be related to the Falcon Lake stock. Pegmatites exhibit a regional zonation in their content of scheelite, molybdenum, lithium and uranium and are spatially and probably genetically related to the Frances Lake porphyroblastic granodiorite. The sulphides in the clastic metasedimentary rocks are pyrite and marcasite, with pyrrhotite in shales and siltstones.

A few occurrences of generally massive and disseminated sulphides occur within the volcanic sequence of the West Hawk Lake belt. Assays from one locality yield values of 0.38% Cu and 0.19% Zn.

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Lamb, C.F.

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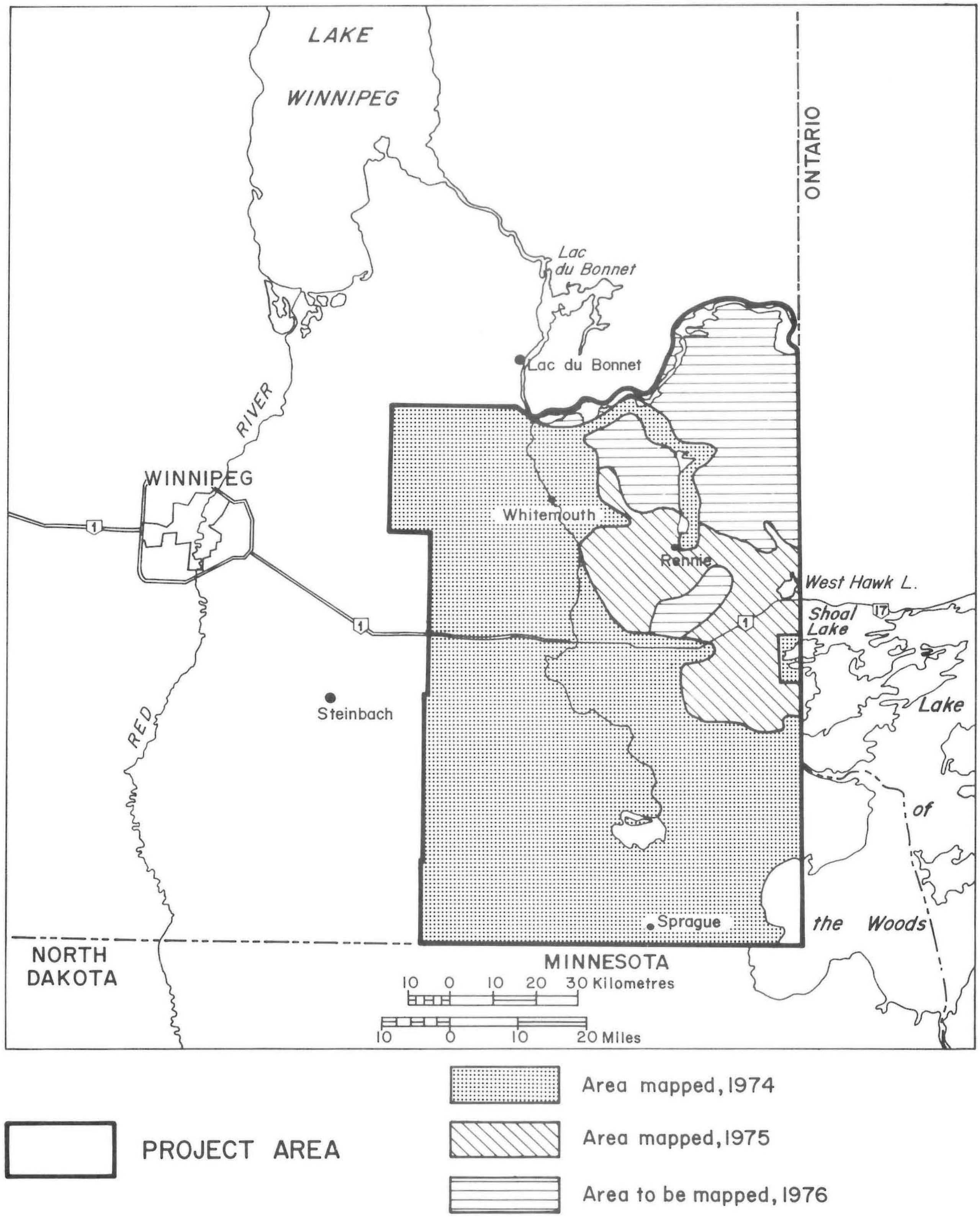

FIGURE 12-1 Location of project area showing current status of mapping

(13) BIRD RIVER — WINNIPEG RIVER AREA

(Parts of 52L-5, 6, 11, 12)

By: D.L. Trueman

Geological mapping of the Bird River greenstone belt, initiated in 1974, was continued in 1975 with the support of the Manitoba Mineral Resources Division. Work to date is incorporated with Preliminary Maps 1975F-9, 10 of the S.E. Manitoba project, and is currently ongoing.

General Geology

Archean supercrustal rocks of the Bird River greenstone belt have been separated into four principal subareas (Figure 13-1) on the basis of characteristic lithologies, structural style, and metamorphic grade.

Subarea I — Rock types comprise pillow metabasalt, amygdaloidal and porphyritic metabasalt, mafic tuff, hyaloclastite, agglomerate, minor porphyritic metadacite, and iron formation. Hypabyssal metagabbro sills, the Bird River sill (Trueman, 1970), small irregular metagabbro stocks, and late diabase and pegmatite dykes intrude the earlier metavolcanic and sedimentary rocks.

Structurally, the weakly schistose rocks of subarea I are disposed as an east striking, steeply south dipping, south facing sequence, transected by numerous north and northwest trending faults (Trueman and Macek, 1971).

Metamorphic assemblages of subarea I are stable greenschist grade.

Subarea II — Subarea II comprises a succession of metarhyolite and metadacite tuffs, lapilli tuffs, ashflow tuffs, porphyritic flows, agglomerate, and banded oxide iron formation.

An extensive unit of metaconglomerate, metasiltstone, and metagreywacke is also included in subarea II. This unit lies unconformably on the felsic basement rocks of subarea II, and contains detritus from all other units of the metavolcanic pile excepting rocks of subarea IV.

The felsic basement and epiclastic rocks are both cut by diabase and pegmatite sills and dykes which tend to occupy foliation or bedding surfaces.

Three structural events are recognized, and are best displayed by folding of the metaconglomerate (Preliminary Map F-10). Sequentially, the structural evolution appears to have been: folding about north trending axes, repeated folding on east trending axes, and a late flexure on northeast axes. The boundary between subarea I — subarea II is faulted.

Metamorphic assemblages are low pressure amphibolite grade, and from west to east the rocks exhibit a progressively greater degree of recrystallization.

Subarea III — Subarea III is a mixed unit of mafic through felsic metavolcanic rocks, interlayered on scales from less than one metre, to several hundreds of metres. Metavolcanic products include pillow amygdaloidal, and porphyritic basalt and andesite, fine to coarse clastic andesite, dacite, and rhyolite, dacite flows, agglomerate, lahar deposits of bi-modal composition, and several bands of both oxide and sulphide facies iron formation.

Intrusive rocks comprise four composite stocks, related dykes and sills, and concordant pegmatite and diabase dykes. The composite stocks consist of successive phases of gabbro, diorite, quartz-diorite, tuffsite and felsite, all of which carry inclusion material from the earlier phases.

All of the rocks of subarea III, excepting pegmatite and diabase, display a strong penetrative schistosity which, with bedding, trends east with a near vertical dip. There is no indication of major fold structures, and facing directions are uncertain.

Metamorphic assemblages are indicative of upper greenschist to amphibolite grades.

Subarea IV — Subarea IV comprises a thick metamorphosed greywacke — mudstone turbidite succession with basal iron formation, lying in angular unconformity above the layered sequences of subarea II. Similar rocks are also present as a small outlier in the Booster-Summerhill Lakes area (Preliminary Maps 1975F-9, 10).

Intrusive rocks in the turbidite succession include diabase dykes in foliation surfaces, concordant pegmatite sills, and pegmatite stocks.

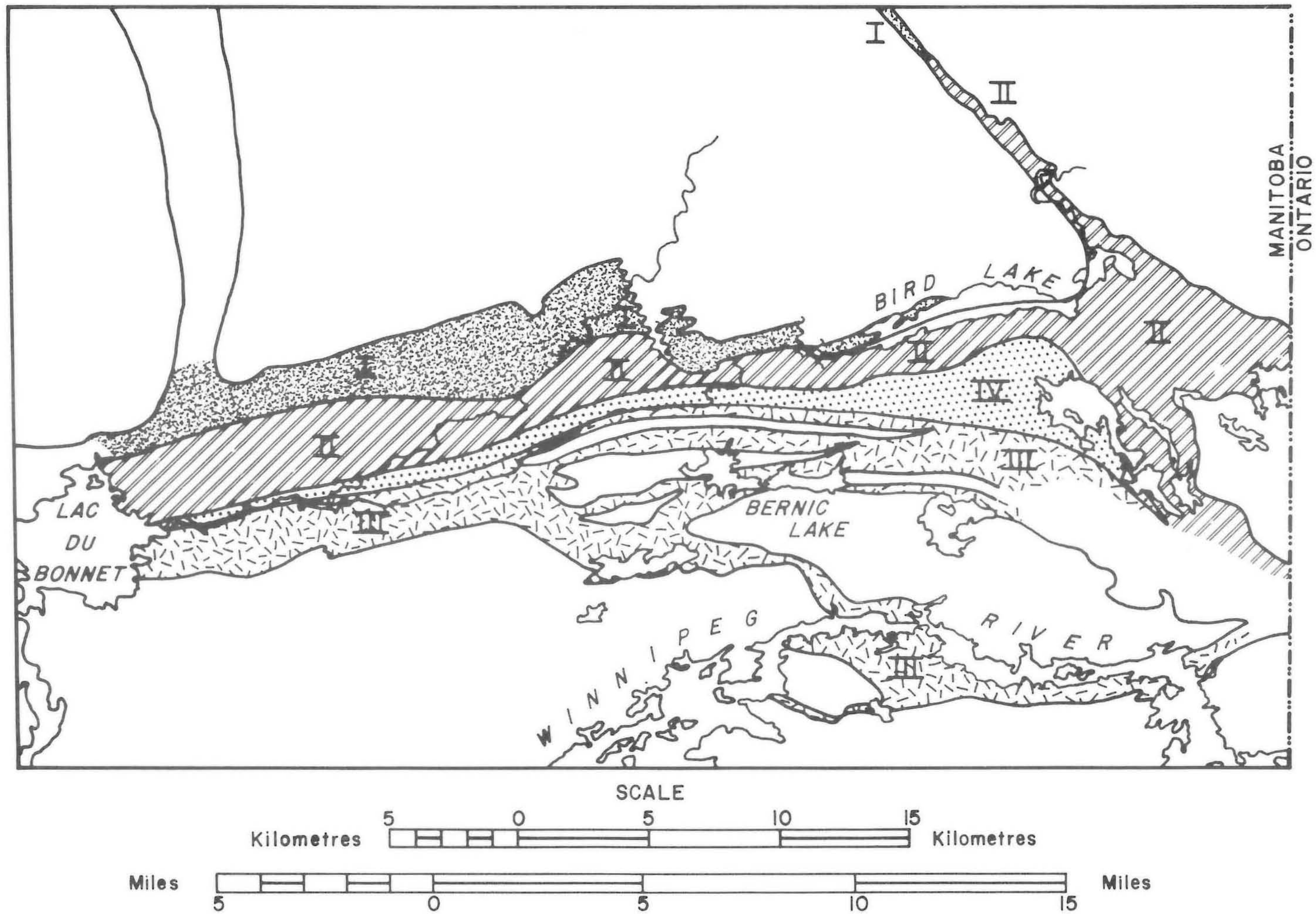

Figure 13-1 : Provisional subdivision of the Bird River Greenstone Belt into four subareas (see text for description)

The turbidite succession is folded in a series of northeast trending south plunging structures which are truncated at the boundary with subarea III. Bedding + folication in these rocks strike east to southeast with vertical to near horizontal dips, and facing directions generally consistent to the south.

Metamorphic assemblages in the turbidites are of greenschist to low pressure amphibolite grade.

References:

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1970: Geology of the Chrome and Page Properties. Bird River Sill; Man. Mines Br. Prelim. Map 1970-A-1.

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1971: Geology of the Bird River Sill; Man. Mines Br. Prelim. Map 1971-A-1.

(14) STRATIGRAPHIC CORE HOLE AND MAPPING PROGRAMS

By: H.R. McCabe

Only a limited amount of drilling was carried out during 1975. A total of 5 stratigraphic core holes were drilled for an aggregate of 56.47 metres of drilling. (Figure 1-1, Table 4-1). In addition, 3 holes totalling 66.11 metres were drilled for mineral exploration projects in the Precambrian area.

Hole M-1-75 was intended to intersect the uppermost Cretaceous beds below the Tertiary cap of Boissevain sandstone. These beds are present only in the immediate vicinity of Turtle Mountain, and are not known to occur in outcrop. This core hole comprised part of the long range project to obtain a complete composite section of the sedimentary formations of Manitoba, and was to have provided the first good lithologic samples of the uppermost Cretaceous beds. Unfortunately, these beds consist of soft, poorly consolidated silts which proved exceedingly difficult to core. Because of mechanical problems the hole had to be abandoned after penetrating only 0.57 metres of the silt beds. Plans are to redrill this location when weather and time permit, and when more suitable sampling methods are available. The data will be incorporated into the study of the Turtle Mountain map area by J. Bamburak.

Holes M-2-75 and M-3-75 were intended to provide further data for the structurally complex Winnipegosis-Toutes Aides area. Hole M-2-75 was located in an area where soil survey reports indicated thin drift cover. Preliminary hammer seismic studies provided uncertain results, but suggested approximately 9.14 metres of overburden. The core hole itersected 9.74 metres of hard compact till, and was abandoned at this point because of mechanical problems and extremely difficult drilling. Additional seismic surveys will be carried out and the hole possibly re-entered if the seismic results are favourable.

Hole M-3-75 was located on an outcrop for which lithologic correlations were uncertain. The hole intersected a structurally low section consisting of 12.45 metres of Souris River strata, bottoming in the "First Red Beds". There appears to be a correlation between structurally low areas and the occurrence of fresh water in water wells in this area. An attempt is being made to integrate water well data with data from the core hole and mapping programs.

Holes M-4-75 and M-5-75 were drilled beside and within the aggregate quarry at Ponton, in order to determine the remaining thickness of Red River dolomite beds in the area, and also to determine if the quartzose sandstones of the Winnipeg Formation are present in this area. The Red River beds proved to be thicker than expected, and M-4-75 penetrated 9.45 metres of dolomite and was bottomed while still in dolomite, because of mechanical problems. Hole M-5-75 was located on the quarry floor and intersected 14.02 metres of dolomite above probable Precambrian. The hole bottomed in soft, waxy, slightly micaceous clay that appears to be highly weathered Precambrian basement, but could possibly be Winnipeg shale. No Winnipeg sandstone was intersected, but the bottom 1.22 metres of Red River beds consist of a sandy dolomite grading to dolomitic sandstone. The presence of dolomite suggests that these beds represent a sandy transgressive facies at the base of the Red River Formation rather than true Winnipeg sandstone. The total Red River thickness at Ponton is approximately 17 metres, and this thickness possibly is representative of the remaining thickness of Red River dolomites all along their northern limit of occurrence, along P.R. 391, where they form a rather prominent north-facing escarpment along the contact with the Precambrian Shield.

No fieldwork was carried out in connection with the stratigraphic mapping program this summer, but compilation of data for the Devonian project continued, with construction of detailed cross-sections, and a statistical review of subsurface isopach and structure data for the Swan River area. These data show a distinct bimodal distribution for estimated Winnipegosis thicknesses, with maxima of thickness values at 30 metres and 87 metres. The lower value represents the normal inter-reef thickness, but the surprising feature is the concentration of high readings at approximately 87 metres, with a sparsity of intermediate values. These data strongly suggest a flat-topped, atoll-type reef configuration. Such a configuration would minimize the areal extent or frequency of reef flank (intermediate thickness) deposits. There is some difficulty in reconciling this pattern with the outcrop data obtained from the Dawson Bay area. Reflection seismic data obtained this summer may possibly help to clarify the picture.

TABLE 14-1

SUMMARY OF CORE HOLE DATA

Hole No.	Location & Elevation Metres (est.)	Formation/ Member	Internal Metres	Summary Lithology
M-17-75	SE4-1-3-19W +423.4 m M.S.L.	Boissevain Riding Mountain	0-9.24 9.24-9.81	Sand, unconsolidated Silt, unconsolidated
M-2-75	SE3-6-30-15W + 251.0 m M.S.L.	Overburden	0-10.42	Boulder till
M-3-75	EC8-19-30-16W + 255.6 m M.S.L.	Souris River "First Red"	0-5.33 5.33-9.80 9.80-12.45	Limestone, dense, algal. Dolomite, saccharoidal Shale and limestone
M-4-75	29-65-11W + 253 m M.S.L.	Red River	0.56-9.46	Dolomite, mottled
M-5-75	29-65-11W + 248 m M.S.L.	Red River	0-12.78 12.78-14.06	Dolomite Sandy dolomite to dolomite sandstone Clay, grey, micaceous (highly weathered basement?)