# GEOLOGY AND ECONOMIC POTENTIAL OF FELSIC METAVOLCANIC AND SUBVOLCANIC INTRUSIVE ROCKS, OFF LAKE – PINEWOOD LAKE AREA, NORTHWESTERN ONTARIO

L. D. AYRES

LORNE AYRES GEOLOGICAL CONSULTING,
1120 ABRAHAM DRIVE,
P.O. BOX 965,
TOFINO, BC
V0R 2Z0

and

ANDREW TIMS

NORTHERN MINERAL EXPLORATION SERVICES
THUNDER BAY, ONTARIO



REPORT PREPARED FOR RAINY RIVER RESOURCES LTD.

JANUARY 23, 2007

## TABLE OF CONTENTS



## APPENDICES



## LIST OF TABLES

## GEOLOGICAL MAPS



## RESIDUAL MAGNETIC INTENSITY MAPS

**SUMMARY**

Field mapping during May, June, and September, 2006, was focused on determination of the genesis and distribution of felsic metavolcanic units previously mapped by Blackburn (1976) and Fletcher and Irvine (1955). These felsic units overlie, and also occur in, the upper part of a lower mafic metavolcanic, pillowed and nonpillowed, lava flow sequence that was intruded by metagabbro. In general, rock units trend northeast, have a subvertical dip, and face southeast in a homoclinal sequence that is disrupted by faults. The width of the total metavolcanic sequence is at least 9 km, but the original thickness is unknown because of extensive flattening in the rock units. The eastern part of the felsic metavolcanic sequence was not examined because it is outside of the claim block staked by Rainy River Resources, and previous workers have shown that volcanic textures and structures were largely destroyed by metamorphism (Blackburn, 1976) making genetic interpretations difficult, if not impossible.

The felsic metavolcanic sequence, as previously mapped, actually comprises two distinct lithologies: felsic volcaniclastic units, and subvolcanic, quartz- ± plagioclase-phyric, felsic intrusions. The felsic volcaniclastic rocks form two, geographically distinct sequences: the Clearwater Lake sequence in the north and the Pinewood Lake sequence in the south. Each of these sequences is at least 2 km wide. Although there is a gap in mapping between the Pinewood Lake sequence and the caldera sequence intersected by drilling in Richardson Township to the west, the mapped part of the Pinewood Lake sequence is probably the upper part of the sequence in Richardson Township. The Clearwater Lake and Pinewood Lake volcaniclastic sequences are lithologically similar, and they are dominantly polymictic, clast-supported, felsic volcanic, pebble to cobble, and locally boulder conglomerate. Although flattening makes determination of original clast shapes difficult, many clasts were originally rounded. More than 95% of the clast population is felsic volcanic, and these clasts form 2 distinct subpopulations: white weathering and grey weathering. Both subpopulations contain medium-grained, quartz ± plagioclase crystals, and crystal abundance is variable within beds indicating that the source terrain was produced by a number of felsic eruptions. Mafic clasts are sparse, but ubiquitous, indicating a long-lived, mafic volcanic terrain in the source area. Beds are thick, and bed planes are typically gradational represented amalgamated beds.

Minor components in the felsic volcaniclastic sequences are polymictic, matrix-supported, felsic volcanic conglomerate, pebbly sandstone, and felsic volcanic, lithic sandstone. Rare felsic lava flows or domes were observed in both sequences, and there are minor, possible pyroclastic flow deposits in the Clearwater Lake sequence.

The felsic intrusions are mostly concentrated near Off Lake where the Off Lake felsic dike complex is at least 9 km long and 4.5 km wide. Hundreds to thousands of dikes that are generally <5 m wide form about 85% of the complex; the other component of the complex is mafic metavolcanic lava flow and metagabbro blocks, megablocks, and septa that appear to be in

original stratigraphic position. The dike complex was emplaced in the upper part of the lower mafic metavolcanic sequence; it is separated from the Clearwater Lake felsic volcaniclastic sequence on the east by about 800 m of mafic units and from the Pinewood Lake felsic volcaniclastic sequence on the south by a major fault.

The lower mafic metavolcanic sequence apparently represents a large, subaqueous basaltic volcano. In the later stages of mafic volcanism, a submarine edifice developed near what is now Burnt Narrows of Clearwater Lake. This edifice is indicated by a thick zone of interdigitation with the overlying Clearwater Lake felsic volcaniclastic sequence, which was apparently deposited on a north-facing slope in a basin that deepened northward. The interdigitated contact indicates a period of alternating, bimodal, mafic and felsic eruptions. Both volcaniclastic sequences appear to be largely mass flow deposits that were deposited subaqueously, but were derived from a heterogeneous, subaerial, felsic source, probably stratovolcanoes. The Off Lake felsic dike complex was probably the magma chamber that fed these felsic eruptions; this magma chamber developed in a part of the volcano where mafic magma chambers, now indicated by metagabbro intrusions, had existed previously.

A major complication in the volcano stratigraphy is the geographic separation of the two volcaniclastic sequences, which, on the basis of lithologic similarity and relationship to the lower mafic metavolcanic sequence, should be the same unit. The Pinewood Lake sequence in the south is separated from the Clearwater Lake sequence in the north by the Off Lake felsic dike complex and mafic units that occur between the dike complex and the Clearwater Lake sequence. It is inferred that the separation is a result of more than 10 km displacement along the Potts fault that forms the south boundary of the Off Lake felsic dike complex. This is a relatively early, possibly synvolcanic fault that is truncated by the syntectonic Fleming-Kingsford granitoid batholith on the southeast side of the greenstone belt. This could have been initially an early, gravity-induced, normal fault along which the Pinewood Lake sequence, including the gold-bearing, caldera sequence in Richardson Township, was down dropped relative to the Off Lake felsic dike complex. However, the amount of displacement suggests additional, later tectonic movement along the Potts fault. Other synvolcanic normal faults were documented in the Clearwater Lake felsic volcaniclastic sequence.

Reconstructing fault movement, it is possible that the caldera sequence in Richardson Township was originally much closer to the Off Lake felsic dike complex. The dike complex may have been the magmatic source for caldera volcanism and mineralization.

Although mafic metavolcanic units and metagabbro were examined only briefly, several pyrite occurrences were found in altered mafic metavolcanic units in the area where mafic units are interdigitated with the Clearwater Lake felsic volcaniclastic sequence. Many of these occurrences are in a relatively small area, and may be spatially related to the Off Lake fault. A small outcrop of uncertain genesis, but possibly oxide-facies iron formation, contains more than 0.5% copper.

Only minor sulphide mineralization was observed in the Clearwater Lake felsic volcaniclastic sequence. Anomalous values of economically important elements were obtained only from sparse, sulphide-facies, iron formation clasts in conglomerate (gold), and from a rusty shear zone (copper). In the mapped part of the Pinewood Lake felsic volcaniclastic sequence, pyrite mineralization is more widespread, but no anomalous metal values were obtained from assays of grab samples.

The most widespread mineralization is in the Off Lake felsic dike complex, which has some attributes of porphyry-type mineralization. The most economically important mineralization is in the upper (northeast) part of the complex and includes 1) gold-silver-copper-zinc-lead mineralization on the Stares option; this occurs in a composite felsic porphyritic dike in metagabbro that was originally the roof of the felsic magma chamber; 2) copper mineralization deeper in the magma chamber near the northwest shore of Off Lake; this mineralization may be related to the Off Lake fault; and 3) gold mineralization in felsic dikes in the central part of the complex; the highest gold value obtained from grab samples was 2.918 g/t. Overall, the Off Lake felsic dike complex is the focus of mineralization, and it was possibly the magmatic source of mineralization, both near Off Lake and in the Richardson Township caldera. Future exploration in the mapped area should be focused on the Off Lake felsic dike complex and immediately adjacent country rocks.

## INTRODUCTION

The gold property of Rainy River Resources in Richardson Township is in a east-trending, south-facing, subvertically dipping, Archean, subaqueously deposited, felsic volcaniclastic sequence that has been extensively examined in drill core and outcrop (Ayres, 1997; 2005a, b, c, d; 2006). The host sequence, which is dominantly intercalated felsic pyroclastic flow deposits and polymictic, felsic volcanic, pebble to boulder conglomerate with less abundant felsic lava flows and domes, has been metamorphosed to greenschist metamorphic grade. Mapping by the Ontario Geological Survey has shown that the felsic sequence extends eastward and northeastward into Mather, Potts, Menary, Fleming, and Senn Townships, but the trend of the units changes to northeasterly ((Fig. 2; Blackburn, 1976; Fletcher and Irvine, 1955). In 2006, an exploration program was initiated to search for gold and other mineralization in this extension of the felsic sequence.

As part of the exploration program, the author spent 38½ days in May, June, and September, 2006, mapping metavolcanic and metasedimentary units between Mather Township in the south and central Clearwater (formerly Burditt) Lake in the north. There is a gap of about 5 km between the area mapped in 2006 and previously examined exposures in Richardson Township (Ayres, 1997), but exposure in this gap is poor.

The area mapped is about 19 km long and as much as 4 km wide. The centre of the mapped area is about 30 km north of Emo, Ontario (Fig. 1). There is good access to most of the area by Highway 615 that extends east and north from Highway 71 and by the Off Lake Road that extends north from Emo and joins the north part of Highway 615 at Off Lake Corner (Fig. 2). From Highway 615, numerous roads, logging roads, and trails provide closer access to many outcrop areas. Boats can be rented at Clearwater Lake, Off Lake, and Spring Lake and provide access to outcrops on, and near, the shores of these lakes.

Mapping was done on acetate overlays attached to 1:20,000 aerial photographs that were flown for the Ontario Ministry of Natural Resources in 1995. Base maps were provided by It should be stressed that outcrop areas shown on these maps are only those outcrops examined during the present survey. As can be seen by comparing the accompanying maps with that of Blackburn (1976), no attempt has been made to show all outcrops, particularly west of Clearwater Lake, where there are large areas of outcrop. The author was capably assisted in the fieldwork by William Averill in May and June and by Kevin Schram and Bill Tilley in September. Rainy River Resources, and the 2 resulting geological maps are produced at a scale of 1:20,000.

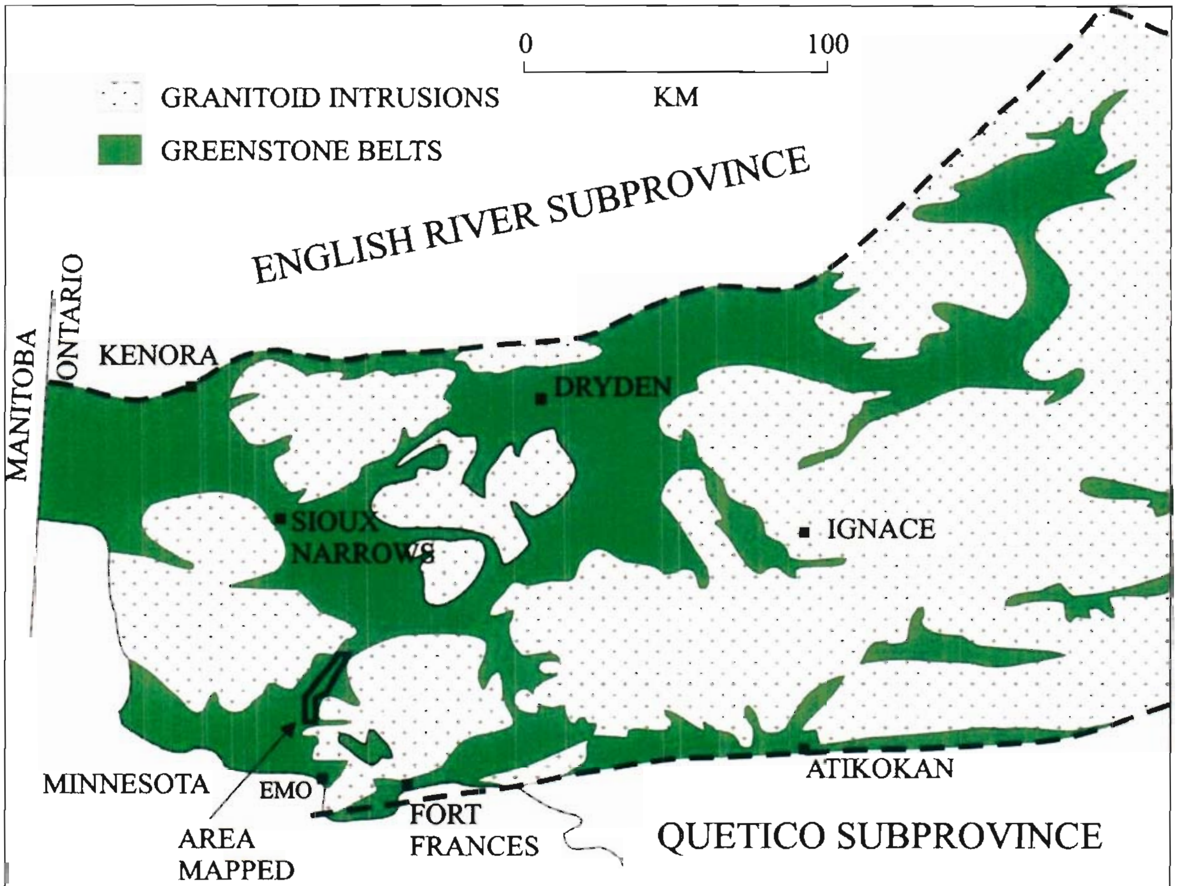



Fig. 1. Map of the western part of the Wabigoon Subprovince of the Archean Superior Province in Ontario showing distribution of greenstone belts and granitoid intrusions (after Blackburn *et al.*, 1991). Area mapped in detail is outlined by heavy black lines.

The purpose of the mapping was to examine felsic metavolcanic rock units mapped by Fletcher and Irvine (1955) and Blackburn (1976). Their mapping was of a reconnaissance nature with the results being published at a scale of 1:63,360 and they provided limited information about the genesis of the rock units. The new mapping focused on 1) the identification and distribution of felsic metavolcanic and metamorphosed, porphyritic, felsic intrusive rock units classified, where possible, on the basis of genesis; 2) the stratigraphic and genetic relationship between the felsic metavolcanic units, which form two geographically distinct sequences; 3) the relationship between the felsic metavolcanic sequences, the metamorphosed felsic intrusive units, and the underlying mafic metavolcanic units (Fig. 2); 4) the relationship of these felsic units to those in

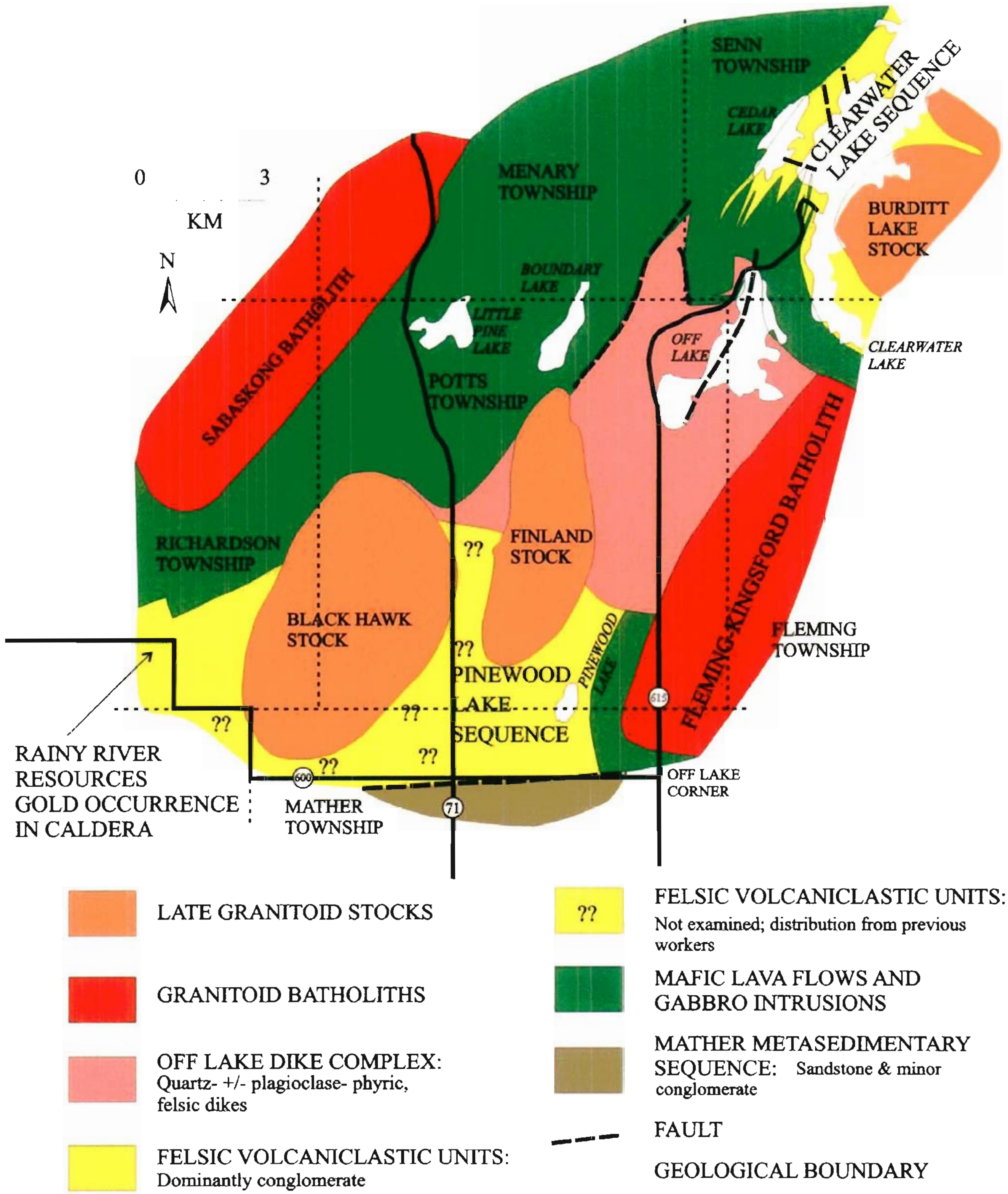



Fig. 2.. Sketch map showing location of units defined during the present survey as well as those mapped by Blackburn (1976) and Fletcher and Irvine (1955). Township boundaries, highways, and major lakes are also shown.

River Resources and on other areas of potential economic interest (accompanying maps). Mafic metavolcanic and other units were examined only where they occur adjacent to felsic units. Geographically, the focus of the mapping was on inland outcrops because shoreline outcrops are mostly steep slopes where rock units are poorly exposed. In many places, travel in the forest is difficult because 1) much of the forest was logged 10 to 20 years ago and, in places, more recently, and 2) where not logged, the forest is over mature and there are numerous blown-down trees.

## REGIONAL GEOLOGY

The map area is in the southwestern part of the Wabigoon greenstone-granitoid subprovince of the Archean Superior Province of the Canadian Shield (Fig. 1). In this part of the subprovince, anastomosing greenstone belts surround younger, amoeboid granitoid batholiths. The area mapped is in a narrow segment of the greenstone belt between two large batholiths (Figs. 1, 2).

### *Geological Setting of Pinewood Lake – Clearwater Lake Area*

In the region covered by claims held by Rainy River Resources, a northeast-trending greenstone belt that has a minimum width of 10 km (Fig. 1) is bordered by granitoid intrusions. The greenstone belt consists of a south- to southeast-facing, subvertically dipping, homoclinal, metavolcanic-metasedimentary sequence that comprises a lower sequence of mafic lava flows in the northwest overlain by felsic volcaniclastic rocks (Fig. 2; Table 1; Blackburn, 1976). East of Pinewood Lake, there is another mafic metavolcanic sequence that may overlie the felsic volcaniclastic units, but the age relationship is uncertain. The volcaniclastic rocks are dominantly polymictic, clast-supported, felsic volcanic, pebble to cobble and locally boulder conglomerate with less abundant felsic volcanic lithic sandstone, pebbly sandstone, and polymictic, matrix-supported conglomerate. There are minor intercalated felsic lava flows, oligomictic conglomerate, and possible pyroclastic flow deposits. In the south part of the area, felsic volcaniclastic rocks are in fault contact with arenitic sandstone (Fletcher and Irvine, 1955) that is more quartzose than sandstone within the felsic volcaniclastic sequence. The metavolcanic sequence was intruded by metamorphosed, synvolcanic plutons including gabbro sills and dikes, and various quartz- and plagioclase-phyric, felsic dikes and sills, including the Off Lake felsic dike complex, which is 4.5 km wide and 9 km long (Fig. 2). Many of these synvolcanic plutons were not recognized during the earlier reconnaissance surveys (Fletcher and Irvine, 1955; Blackburn, 1976). There are also two, previously unrecognized, smaller, porphyritic, felsic intrusions of unknown extent.

The metavolcanic-metasedimentary sequence is bounded on the northwest by the younger Sabaskong granitoid batholith (Fig. 2), on the southeast by the Fleming-Kingsford granitoid batholith (Fig. 2), and on the east by the Jackfish Lake complex (east of Fig. 2), a dioritic

The metavolcanic-metasedimentary sequence is bounded on the northwest by the younger Sabaskong granitoid batholith (Fig. 2), on the southeast by the Fleming-Kingsford granitoid batholith (Fig. 2), and on the east by the Jackfish Lake complex (east of Fig. 2), a dioritic to granitic pluton; all of these plutons are interpreted to be syntectonic (Blackburn, 1976). Three, late tectonic plutons of monzonitic to quartz monzonitic composition, the Burditt Lake, Finland, and Black Hawk stocks, intruded the greenstone belt (Fig. 2). Metamorphic grade is greenschist facies except adjacent to the plutons where metamorphic grade is amphibolite facies. The metamorphic overprint is most extensive in the southeastern part of the mapped area. Within the mapped area, there are several, northwest-trending, Proterozoic diabase dikes (Blackburn, 1976), but these were neither mapped nor examined during the present survey.

Although most of the metavolcanic-metasedimentary rocks are in a northeast-trending and southeast-facing, homoclinal sequence, there are structural complications between Off and Clearwater Lakes. Here, the felsic volcaniclastic sequence and part of the underlying mafic lava flow sequence have been bent into a southeasterly trend and there are two geographically distinct, felsic volcaniclastic sequences (Fig. 2). The felsic volcaniclastic sequence that can be traced eastward from Richardson Township to northeast of Pinewood Lake, and here termed the Pinewood Lake sequence, is truncated on the north by the Off Lake felsic dike complex (Fig. 2). On the north side of the dike complex, which is about 9 km long, felsic dikes are in contact with a 0.8- to 1-km-wide, southeast-trending, mafic metavolcanic sequence that is overlain by a second, felsic volcaniclastic sequence, here termed the Clearwater Lake sequence. The Pinewood and Clearwater Lake felsic volcaniclastic sequences are lithologically similar, although they differ in details, and the two sequences may be part of a single sequence now separated by a fault. The felsic sequence east of Clearwater Lake was not examined during the present survey because 1) the eastern boundary of the claim group held by Rainy River Resources is on the east shore of Clearwater Lake, and 2) previous work by Blackburn (1976) indicated that primary textures and structures in this part of the felsic sequence had been largely destroyed by metamorphism.

Table 1. Stratigraphy of the Off Lake area (modified after Blackburn, (1976), and Fletcher and Irvine (1955)). Units given here are those shown on the accompanying maps or described in report.

LATE TECTONIC GRANITOID STOCKS

Granodiorite, quartz monzonite, monzonite

*Intrusive contact*

SYNTECTONIC GRANITOID BATHOLITHS

Trondhjemite to granodiorite

*Intrusive contact (?)*

SUBVOLCANIC INTRUSIONS

BEADLE LAKE PLUTON

Monzonite to granodiorite with numerous mafic xenoliths

*Intrusive contact (?)*

MAFIC TO INTERMEDIATE DIKES

*Intrusive contact*

QUARTZ- +/- PLAGIOCLASE-PHYRIC FELSIC INTRUSIONS

Off Lake dike complex
Buckhorn Point pluton
Potts pluton
Isolated dikes in metavolcanic sequences

*Intrusive contact*

METAGABBRO

Equigranular and plagioclase-megacrystic gabbro; probably several ages of intrusion

*Intrusive contact*

UPPER MAFIC METAVOLCANIC SEQUENCE (?)

Gneissic lava flows

| PINEWOOD LAKE FELSIC VOLCANICLASTIC SEQUENCE | CLEARWATER LAKE FELSIC VOLCANICLASTIC SEQUENCE | | MATHER METASEDIMENTARY SEQUENCE |
|---|---|---|---|
| Polymictic, clast- to locally matrix-supported, felsic volcanic, pebble to cobble conglomerate, minor pebbly sandstone and lithic sandstone, minor felsic lava flows | Polymictic, clast- to locally matrix-supported, felsic volcanic, pebble to boulder conglomerate, minor pebbly sandstone and lithic sandstone, minor felsic lava flows and possible felsic pyroclastic flow deposits, rare oligomictic conglomerate, mudstone, and chert | Fault Contact | Arenite |

LOWER MAFIC METAVOLCANIC SEQUENCE

Pillowed and non-pillowed, basalt lava flows, minor pillow breccia, and rare heterolithic lapilli-tuff to tuff-breccia, and oxide-facies iron formation

**Mafic To Intermediate Metavolcanic Sequence**

On the basis of mapping by Blackburn (1976), the lower mafic sequence is 2.5 to 6 km wide (Fig. 2) and consists of pillowed to nonpillowed lava flows, some of which contain centimetre-size, plagioclase megacrysts. The variation in width is probably a result of removal of the lower part of the sequence by intrusion of the Sabaskong batholith on the northwest. Subvolcanic metagabbro sills and dikes are common in parts of the mafic sequence. Although recognized by Blackburn (1976), he did not map these intrusions because of the reconnaissance nature of his survey. During the present survey, the mafic sequence, including metagabbro intrusions, was examined only briefly close to the contact with felsic units. The most extensive examination of the mafic sequence was west of Burnt Narrows of Clearwater Lake where the mafic and felsic sequences are interdigitated (Fig. 2; Menary Township map). Intermediate metavolcanic units were observed locally in mafic tongues within felsic volcaniclastic units.

A second mafic sequence with a minimum width of 250 m occurs in the southeast between the Pinewood Lake felsic volcaniclastic sequence and the Fleming-Kingsford batholith (Fig. 2; Potts Township map). This is a gneissic, amphibolite-grade, mafic unit of uncertain genesis that was mapped previously as a mafic metasedimentary unit (Fletcher and Irvine, 1955), and a mafic metavolcanic unit (Blackburn, 1976). Blackburn (1976) mapped a second mafic metavolcanic sequence, as much as 1.5 km wide, east of the Clearwater Lake felsic volcaniclastic sequence. These eastern mafic sequences could be either an upper mafic metavolcanic sequence (Table 1), or a repetition of the lower mafic metavolcanic sequence on the east limb of a synclinal fold (see Structure).

Mafic Lava Flows

Where observed, mafic lava flows generally weather green to dark green, but, locally, particularly where there are minor faults in the sequence, the mafic unit weathers pale green to pale brown to pale grey. This lighter coloured unit may be either more intermediate or an altered mafic unit. Mafic lava flows include both pillowed and nonpillowed facies. Pillowed facies are typically interlayered with nonpillowed facies, but contacts between the two facies were observed only rarely. In most places, it could not be determined whether the two facies are parts of single lava flows or separate lava flows. However, in several places, nonpillowed and pillowed lava flows appear to be interlayered with sharp contacts between nonpillowed and pillowed flows. Nonpillowed flows are at least 10 m thick and have a maximum grain size of 1 mm; the increase in grain size away from flow contacts is very gradual. In sequences of nonpillowed flows, there are brecciated zones that are probably flow-top and flow-base breccias.

In the pillowed facies, pillows vary from equant to flattened >3:1; the degree of flattening is greatest in larger pillows, and some, or all, of the flattening may be a primary feature of the pillows. Pillows are as much as 1 m wide, but pillow size is variable from outcrop to outcrop.

Pillow selvages are typically 1 to 2 cm wide, but selvage width ranges from <5 mm to 2.5 cm; amygdules are locally concentrated immediately inside the selvage . Rarely, gas cavities were observed in the inferred upper part of pillows. In spite of the flattening, pillow shapes along with the shape and location of gas cavities can be used to determine facing directions provided that there are sufficiently large and clean exposures. In most places, facing directions are to the southeast (Blackburn, 1976), but, at about 439400E; 5420200N on the hydro line, well-defined pillows indicate facing directions to both the northwest and southeast. This local reversal of facing directions is probably the result of small-scale isoclinal folding. Rarely pillow orientation has been rotated by movement along faults.

At several localities, pillow lobes or megapillows at least 2 m thick and 5 m long are overlain by either breccia or by smaller pillows (Fig. 3). Pillow buds, 10 to 20 cm long, extend outward from the upper surface of the large lobes. Where breccia is present, it pinches and swells and has a maximum thickness of 50 cm; fragments in the breccia vary from angular to rounded to slightly amoeboid, and they range in size from 3 to 20 cm. Where smaller pillows are present, the pillows are ovoid to amoeboid, and they occur in a bedded hyaloclastite matrix.

At one location, about 250 m west of the boat launch on Clearwater Lake at the termination of Highway 615 (441100E; 5420200N), pillows are overlain by a 2-m-wide, massive, mafic unit that apparently lacks pillows. Within this massive unit, there are concordant fragmental zones as much as 40 cm wide that consist of rounded, 1- to 3-cm-wide, mafic fragments in a magnetite-rich, mafic matrix. The fragmental zones, which form about 35% of this massive unit, could be the result of early weathering. This mafic unit is overlain by felsic volcanic pebbly sandstone. This outcrop is in the interdigitating contact zone between the lower mafic metavolcanic sequence and overlying Clearwater Lake felsic volcaniclastic sequence (Menary Township map).

*Mafic Fragmental Units*

Mafic fragmental units that are as much as 10 m wide were observed only rarely, and they include heterolithic, mafic lapilli-tuff to tuff-breccia and monolithic, pillow breccia. A single heterolithic unit was observed (439340E; 5420400N); this unit occurs between pillowed mafic lava flows and contains both mafic and felsic clasts. Mafic clasts dominate, and they are typically flattened 2:1 to 8:1. More resistant, white-weathering, quartz-phyric, felsic clasts are variable in abundance and form <1 to 10% of the unit; they are typically angular to subangular and are as much as 60 cm in diameter. Bedding is defined by variations in fragment size and in abundance of felsic clasts. Bed contacts are relatively abrupt.

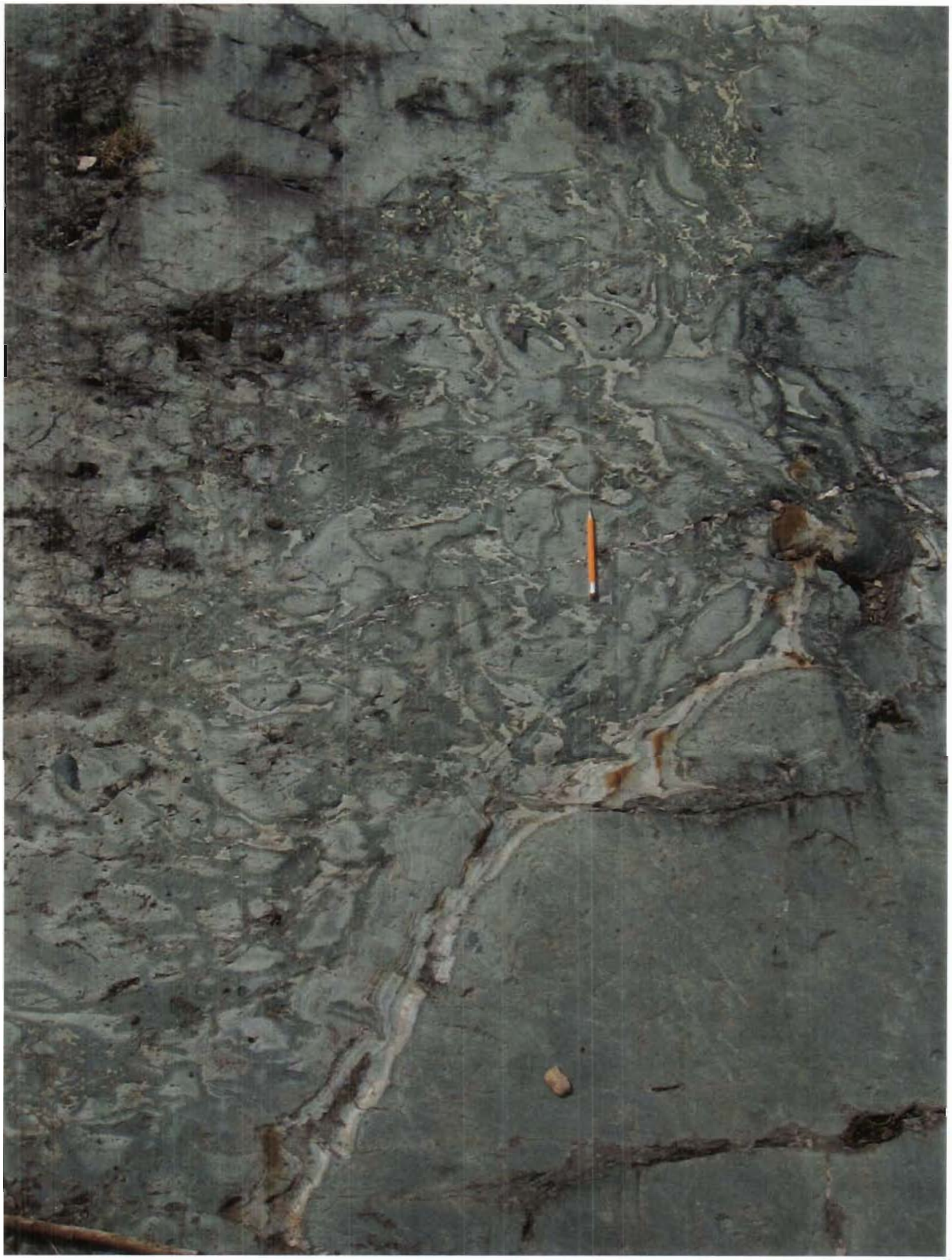


Fig. 3. Mafic megapillow or pillow lobe on right is underlain (?) by small pillows within a hyaloclastite matrix. Some small pillows are buds from the megapillow. Lower mafic metavolcanic sequence (438760E; 5419840N).

Mafic, broken-pillow breccia was observed at one locality within a sequence of pillowed mafic flows. The pillow breccia is fragment supported and contains 15 to 20% matrix (Fig. 4). Fragments are generally <15 cm long and <5 cm wide, and degree of flattening is minor. Fragments are typically angular or, where they include part of a pillow margin, they have a partly angular and partly rounded shape. Partial pillow margins can be recognized by curved shapes, concentrations of <1-mm amygdules in the outer 1 cm, and a poorly preserved, darker selvage <5 mm wide. The amygdules, which range in abundance from 5 to 10%, occur on the inside of the selvage. In some of the larger fragments, there are local amoeboid-like reentrants. A single, intact, amoeboid pillow was recognized within the breccia; the pillow is 140 cm long and 35 cm wide with 5-cm-wide tongues extending at least 30 cm away from the pillow.

*Possible Iron Formation*

A single outcrop of possible oxide-facies iron formation was observed on the south side of Highway 615 (439290E; 5417942N). This outcrop, which is <5 m wide and poorly exposed, is on the margin of the Off Lake felsic dike complex, and it appears to be in the mafic metavolcanic sequence although no mafic metavolcanic units were found in the small outcrop. The possible iron formation is a very fine grained, pale-grey to blue-grey, relatively hard unit; the blue-grey component is magnetite rich and the pale-grey component is siliceous. This unit is considered to be iron formation because of the high magnetite content and apparent layering defined by variations in magnetic intensity. However, the possibility that this unit is a silicified volcanic unit cannot be discounted.

*Intermediate Metavolcanic Units*

Poorly exposed, lichen- and moss-covered, intermediate metavolcanic units were observed in isolated outcrops between Burnt Narrows of Clearwater Lake and Cedar Lake. These units are 1 to 40 m wide and contacts with other lithologies were observed only rarely. Intermediate units weather pale brown to pale grey green, and they contain 10 to 25% mafic minerals. Most exposures lack visible crystals, but, in places, there are 1 to 2%, 1- to 5-mm, quartz crystals, and, more rarely, plagioclase crystals. In places, the unit appears to contain flattened clasts, 5 to 10 cm wide, but there is no visible compositional difference among clasts or between clasts and possible matrix; in other places, the unit appears to be pillowed with 20- to 50-cm-wide, poorly defined pillow lobes. The intermediate units occur mostly in tongues in the interdigitating transition zone between the lower mafic metavolcanic sequence and the overlying Clearwater Lake felsic volcaniclastic sequence.

*Gneissic Mafic Metavolcanic Unit*

Gneissosity is well defined in this unit, which occurs east of Pinewood Lake and has a minimum outcrop width of 250 m, by 1) changes in grain size from 0.2 to 1 mm, and locally 1.5

Fig. 4. Mafic, broken-pillow breccia in lower mafic metavolcanic sequence (438600E; 5419760N). Partial pillow selvages, where present, are dark grey.

### *Gneissic Mafic Metavolcanic Unit*

Gneissosity is well defined in this unit, which occurs east of Pinewood Lake and has a minimum outcrop width of 250 m, by 1) changes in grain size from 0.2 to 1 mm, and locally 1.5 mm, 2) changes in colour from pale brown to dark green, 3) changes in abundance of mafic minerals, dominantly hornblende, from 20 to 75%, and 4) changes in the ratio of biotite to hornblende. Layers have sharp boundaries, and they range in width from 1 mm to 5 cm, and locally to as much as 20 cm; many of the thicker layers have a less well defined, internal layering. The layers are very continuous and they resemble bedding, but they are most likely a result of metamorphic differentiation in a mafic volcanic sequence (cf. Evans and Leake, 1960). Because of the gneissosity, no primary volcanic structures are preserved in this sequence. It is inferred to be lava flows because 1) there is no evidence of fragmental textures, 2) the coarsest layers appear to have relict igneous textures, and 3) metagabbro intrusions in the gneissic unit are still recognizable, in spite of amphibolite metamorphic grade; in the metagabbro, gneissosity is weakly developed and the original medium-grained texture is preserved although recrystallized. The contact of this unit with the Pinewood Lake felsic volcaniclastic sequence on the west is poorly exposed but appears to be gradational. It is a transition zone at least 40 m wide of interlayered mafic and felsic units; the felsic units appear to be dominantly lithic sandstone. The contact with the Fleming-Kingsford batholith on the east is not exposed, but, based on the abundance of granitoid dikes along the east side of the mafic outcrops (see section on granitoid intrusions), the batholith contact is, at most, several hundred metres east of the mafic outcrops.

Felsic Volcanoclastic Sequences

Blackburn (1976) recognized 6 felsic metavolcanic sequences that occur in 2 geographically distinct areas; he designated these F1 to F6 (Fig. 5). His F1 and F6 sequences correspond to the Clearwater Lake felsic volcaniclastic sequence of the present report. His F4 and F5 sequences correspond to the Pinewood Lake felsic volcaniclastic sequence of the present report, and this sequence extends from Pinewood Lake to Richardson Township (Figs. 2, 5); this sequence has also been termed the Dobie and Tait volcanic sequence by Fletcher and Irvine (1955). Blackburn's (1976) F2 and F3 sequences correspond to the Off Lake felsic dike complex of the present report (Figs. 2, 5). Blackburn (1976) recognized that his F2 and F3 sequences were, at least in part, intrusions, but, because of the reconnaissance nature of his mapping, he was unable to properly delineate the dike complex.

The Clearwater Lake felsic volcaniclastic sequence is well exposed west of the central part of Clearwater Lake. Examination of the sequence in this area was largely along four measured stratigraphic sections (Figs. 22, 23, 24, 25, 26, 27) supplemented by examination of shoreline exposures on Clearwater and Cedar Lakes and some inland outcrops; no attempt was made to examine all outcrops.

In the Pinewood Lake felsic volcaniclastic sequence, on the other hand, where outcrops are more sparse, all outcrops east of Highway 71 were examined except for outcrops between Finland and the Finland Stock and a single outcrop near Highway 71 (cf. Blackburn, 1976 and the accompanying Potts Township map). The outcrops near Finland are between mapped exposures of the Pinewood Lake sequence and the Off Lake felsic dike complex, and these outcrops may be part of either the Pinewood Lake sequence or the Off Lake dike complex. Between the Richardson Township gold property and Highway 71, Fletcher and Irvine (1955) mapped 5 felsic metavolcanic outcrops that appear to represent the continuation of the Pinewood Lake sequence west to Richardson Township. Because of time constraints, these outcrops were not examined during the present survey.

Because of the intrusive nature and complexity of the Off Lake felsic dike complex, most outcrops of the complex were examined and mapped except along the east margin of the complex east of Off Lake. Porphyritic felsic dikes that are compositionally and texturally similar to the Off Lake complex are widespread in the lower mafic lava flow sequence. These dikes were examined only briefly along a logging road between Highway 71 and Preachers Lake.

*Lithology*

The Clearwater Lake and Pinewood Lake felsic volcaniclastic sequences are lithologically similar, and the lithologies found in these two sequences will be described together. The dominant lithology in both sequences is polymictic, clast-supported, felsic volcanic, pebble to cobble and locally boulder conglomerate that has white to locally pale-grey, pale-brown, or pale-pink weathering. Most of the conglomerate contains <5% biotite and/or chlorite and <5% sericite. Intercalated within the conglomerate are local beds and intervals of felsic volcanic, lithic sandstone, pebbly sandstone, and polymictic, matrix-supported, felsic volcanic conglomerate as well as minor oligomictic, felsic volcanic conglomerate, felsic lava flows or domes, and possible felsic pyroclastic flow deposits. Clasts in the conglomerate are invariably flattened although the degree of flattening is variable from place to place and over short distances; degree of flattening, as measured on horizontal outcrop surfaces, ranges from slight to 20:1 (Fig. 6). In addition to flattening, all clasts are stretched in a subvertical direction producing a steeply plunging lineation. Clast sizes reported in this report, and used to name rock units, are based on examination of horizontal outcrop surfaces, which are sections through the stretched clasts and are not true sizes. The designation of the unit as conglomerate is based on the observation that, in most outcrops, some clasts are either subrounded or rounded, or, where flattened, have rounded ends (Fig. 7); such clasts were observed either throughout an outcrop or every several metres across an outcrop. In many places, only a few clasts have a sufficiently low degree of flattening to determine primary shapes. Where the degree of flattening is low, clasts vary in shape from rounded to subangular and locally angular (Figs. 8, 9, 10). The ratio of rounded and subrounded to subangular and angular clasts is variable: in many beds, rounded and subrounded clasts dominate, but, in some beds, the abundance of subangular clasts is approximately equal to, or greater than, the abundance of subrounded and rounded clasts. Very few angular clasts were observed, but, on the shore of, and south of Cedar Lake, in the lowermost part of the Clearwater volcaniclastic sequence, there are sparse beds or bed sets several metres wide, in which most clasts are subangular to angular and are as much as 20 cm wide. These beds also contain some rounded clasts, including rare chert clasts. Other than clast shape, and, in some beds, a higher proportion of grey-weathering felsic clasts, these beds are identical to adjacent units in which most clasts are rounded.

Blackburn (1976) mapped the volcaniclastic units as heterolithic tuff, lapilli-tuff, lapillistone, and breccia. The author's work confirms that the units are indeed heterolithic and composed of volcanic clasts. However, the ubiquitous rounding of clasts indicates a high degree of reworking that is not compatible with direct volcanic deposition, or volcanic deposition followed by limited downslope movement, a necessary characteristic of pyroclastic rocks (Fisher and Schmincke, 1984). The degree of reworking is more compatible with a sedimentary origin of the

Fig. 6. Flattened, white- and pale-grey-weathering, felsic volcanic clasts in polymictic, clast-supported, pebble to cobble conglomerate in Clearwater Lake felsic volcaniclastic sequence. Polymictic designation is based on variations in quartz-crystal content; palest grey clast in lower right has higher abundance of quartz crystals (grey) than other clasts.

Fig. 7. Flattened, white-weathering and minor grey-weathering felsic clasts in polymictic, felsic Lake felsic volcanic, pebble to cobble conglomerate in Pinewood Lake felsic volcaniclastic sequence (435025E; 5407820N). Clasts are difficult to identify because of flattening and abundance of white-weathering clasts. However, some flattened clasts, as for example below pencil, have rounded ends.

Fig. 8. Subrounded to subangular clasts in polymictic, clast-supported, felsic volcanic, pebble to cobble conglomerate in Clearwater Lake felsic volcaniclastic sequence at top of section 2 (Fig. 23, 27). Most clasts are white-weathering and felsic, but there are sparse grey-weathering felsic clasts.

volcaniclastic units, although the source terrane was volcanic. A similar interpretation was made for heterolithic volcaniclastic rocks at the gold property of Rainy River Resources in Richardson Township (Ayres, 2005c, d, 2006).

***Polymictic, clast-supported, felsic volcanic, pebble to boulder conglomerate:*** This unit is dominantly pebble to cobble conglomerate in which clasts are almost entirely volcanic. Clasts range in composition from felsic to mafic, although, except for rare beds, more than 95% of clasts are felsic and only rare intermediate clasts were identified. Where weakly deformed, clasts commonly range in length from 5 mm to 25 cm, but clast size is variable from place to place as a function of both bedding and regional variations. Maximum observed clast size is 45 cm wide and >1 m long. The conglomerate is clast supported, and, in most units, less than 15% matrix could be identified; in some places, no matrix could be identified. Locally, particularly in areas where there is interbedded matrix-supported conglomerate, the matrix content of clast-supported conglomerate is as high as 25%. Where matrix is visible, it contains trace to 15% visible quartz sand grains that are as much as 7 mm in diameter. The conglomerate varies from well sorted to poorly sorted (Figs. 8, 9, 10).

Fig. 9. A pocket of pebbly sandstone matrix between cobbles and boulders in polymictic, clast-supported, felsic volcanic, cobble to boulder conglomerate, Clearwater Lake felsic volcaniclastic sequence (441260E;5421820N). Clasts are felsic volcanic, rounded to subrounded, and white weathering.

Fig. 10. Rounded to subangular, white and grey-weathering, felsic volcanic clasts in polymictic, clast supported, felsic vol, pebble to cobble conglomerate, Clearwater Lake felsic volcaniclastic sequence at top of section 2 (Fig. 6). Quartz xtals (grey) vary in abundance among the various white clasts.

Two distinct types of felsic clasts were identified by differences in weathering colour: white and pale grey to grey green (Figs. 6, 7, 8, 9, 10, 11). Each of these felsic clast types is texturally variable defining the polymictic nature of the conglomerate and the compositional andtextural heterogeneity of the source terrane. White-weathering, leucocratic, felsic clasts, the dominant clast type, contain trace to 5% and locally as much as 10%, 1- to 3-, and locally as much as 7-mm-diameter, quartz crystals (Figs. 6, 10). Where clasts are strongly flattened, quartz crystals are only weakly deformed on horizontal outcrop surfaces, and many crystals are equant; maximum elongation of deformed crystals on outcrop surfaces is 2:1. However, in places, quartz crystals that are equant on outcrop surfaces have a well-developed subvertical elongation and lineation. Many quartz crystals appear to lack recrystallization, but, in places, particularly in higher metamorphic grade parts of the sequences, quartz crystals are recrystallized and are

Fig. 11. Flattened, polymictic, clast-supported, felsic volcanic, cobble conglomerate in Clearwater Lake felsic volcaniclastic sequence (441740E; 5422700N). Both white and grey-weathering felsic clasts are present, and some of the grey clasts, which are distinguished by white plagioclase crystals, are less flattened than white clasts. Note the well-rounded grey clast in lower right.

difficult to recognize. Where least deformed, many of the white-weathering clasts also contain as much as 15%, 1- to 5-mm, equant to tabular, plagioclase crystals; recognition of plagioclase crystals is variable from place to place, possibly reflecting variations in the degree of recrystallization.

Felsic clasts that weather pale grey to grey to grey green contain 5 to 10%, and possibly as much as 15% chlorite; these clasts are variable in abundance and form 0 to more than 50% of the clast population (Figs. 6. 7, 8, 9, 10, 11). In rare units, several tens of metres wide, grey-green clasts dominate and form as much as 80% of the clast population; these rare units are spatially associated with intermediate metavolcanic tongues between Clearwater Lake and the south part of Cedar Lake. Grey-weathering clasts contain trace to 4%, 1- to 4-mm quartz and 4 to 10%, 1- to 6-mm, equant to tabular, plagioclase crystals; plagioclase crystals are less deformed and more readily identified that those in the white-weathering, more felsic clasts (Figs. 10, 11). In many places, the grey-weathering clasts are more highly deformed than adjacent white-weathering clasts (Fig. 6), although, in some places, the degree of deformation of all clasts is similar, and, rarely, grey-weathering clasts are less deformed (Fig. 11).

Many, if not all, of the quartz and plagioclase crystals in felsic clasts are phenocrysts within clasts derived from disrupted magma or lava flows, but some could be pyrogenic crystals within clasts derived from pyroclastic flow deposits. Because the genesis of individual clasts could not be determined from field examination, the term crystal will be used in this report for all medium-grained quartz and plagioclase grains within fine-grained groundmass or matrix (see also Ayres, 2005a).

Locally, particularly in beds that have a higher abundance of grey-weathering clasts, there are sparse, 2- to 75-cm-long, slightly elongated, rusty patches. Some of the patches represent single, pyrite-bearing pebbles, cobbles, and boulders, whereas others extend across several clasts, although the rusty weathering is, in places, centered on a specific clast. The rusty patches are commonly recessive weathering, and, as such, they are difficult to properly examine and sample. Locally, where rusty weathering clasts could be sampled, they contain as much as 80% pyrite that, in places, forms a matrix to recrystallized chert fragments. Such clasts are probably derived from sulphide-facies iron formation. These clasts have a restricted stratigraphic distribution; they were found only in the Clearwater Lake felsic volcaniclastic sequence both in tongues near the base of the sequence and in a 75-m-wide stratigraphic interval near the middle of the sequence (Fig. 23).

Mafic clasts, which are internally fine grained, generally form <1% of the clast population (Fig. 12), but, locally, there is as much as 5% mafic clasts, and, in rare beds, >50% mafic clasts; mafic clasts are most abundant in beds that have a higher abundance of grey-weathering felsic clasts, but they were not observed everywhere. Where present, mafic clasts are as much as 30 by 60 cm in size, but, in many beds, the average size of mafic clasts is less than that of felsic clasts (Fig. 12). The fine grain size of mafic clasts indicates derivation from mafic volcanic units. clasts, but they were not observed everywhere. Where present, mafic clasts are as much as 30 by 60 cm in size, but, in many beds, the average size of mafic clasts is less than that of felsic clasts (Fig. 12). The fine grain size of mafic clasts indicates derivation from mafic volcanic units.

Fig. 12. Rounded mafic volcanic pebble (centre) and an intermediate volcanic conglomerate cobble (top left; under pencil) in polymictic, clast-supported, felsic volcanic, pebble to cobble conglomerate in Clearwater Lake felsic volcaniclastic sequence. Felsic clasts are rounded to subangular and are dominantly white weathering.

Rare clast types include chert, metagabbro, a single angular clast of vein quartz, a single fine- to medium-grained, felsic clast that was apparently derived from an intrusion, and a single, grey-weathering, intermediate to felsic volcanic, pebble conglomerate clast (Fig. 12). The conglomerate clast is 15 by 25 cm in size, and it contains rounded to subrounded, 2-mm to 2-cm, intermediate volcanic clasts that contain rare quartz and plagioclase crystals.

A bimodal conglomerate comprising felsic and mafic clasts was observed at one locality on a logging road close to the hydro line (439493E; 5420236N). This conglomerate appears to be a narrow tongue of the Clearwater Lake felsic volcaniclastic sequence within mafic lava flows. About 25 to 35% of the clasts are white-weathering, subrounded to subangular, and felsic, and these clasts contain <1 to 10% quartz crystals that vary in abundance and size from clast to clast; the largest crystal is 8 mm in diameter. The felsic clasts are flattened about 2:1, and clasts range in width from 3 to 15 cm. The abundance of felsic clasts is variable from place to place possibly indicating gradational or amalgamated bedding. The other clasts are mafic; clast boundaries are difficult to identify, but grain size differences among clasts indicate that the mafic component is pebbles and cobbles rather than a mafic matrix. There are also sparse, sulphide-rich clasts, including a boulder that is 30 by 75 cm in size. This boulder is largely massive pyrite that contains angular to partly rounded fragments of recrystallized chert as much as 10 cm across; these are probably broken chert beds in a sulphide-facies, iron formation clast.

There are local and regional variations in 1) clast size, 2) quartz-crystal content of both white- and grey-weathering felsic clasts, 3) the ratio of white- to grey-weathering felsic clasts, and 4) the abundance of mafic and sulphide-bearing clasts. These variations define beds as well as regional variations in the conglomerate. Bed contacts were rarely observed, but small-scale variations in the above parameters indicate the presence of metre-scale, thick to very thick, gradational or amalgamated beds; foliation is subparallel to bedding. Where bed contacts were observed, they typically bound thinner, finer beds within the conglomerate. Within individual beds, quartz crystal content of felsic clasts is variable indicating that, although almost all clasts are felsic, 1) the conglomerate is polymictic, and 2) the clasts, although probably very similar in chemical composition, were derived from a variety of sources in a felsic terrain that was texturally variable and heterogeneous.

On a more regional scale, maximum quartz-crystal content of clasts ranges from 5% to 10% and, in the Clearwater Lake felsic volcaniclastic sequence, the abundance of grey-weathering clasts ranges from 0 to more than 20%. Overall, in the Clearwater Lake sequence, grey-weathering clasts are most abundant in the upper part of the sequence, although, at any given location, there may be beds with >10% grey-weathering clasts. Variations in the ratio of grey- and white-weathering clasts allow the recognition of two distinct types of conglomerate in the Clearwater Lake sequence: conglomerate in which most, or all, clasts are white-weathering (units 3a, b, c, on accompanying maps), and conglomerate with >10%, grey-weathering, felsic clasts (units 3d, e, f, on accompanying maps). In the Pinewood Lake felsic volcaniclastic sequence, most conglomerate contains >10% grey-weathering clasts.

In places, a high degree of flattening precludes identification of original clast shapes and such units have been designated as possible conglomerate. Flattening, combined with the high abundance of white-weathering felsic clasts, also makes it difficult to identify clast boundaries, and, in some beds, <10% of the clasts are recognizable. The most recognizable clasts are the most felsic, white-weathering clasts that are most resistant to deformation, and, where present, mafic clasts. Locally, where mafic clasts and grey felsic clasts are rare or absent, and the degree of flattening is high, boundaries of individual clasts could not be identified although variations in quartz-crystal content over distances of several centimetres indicate the polymictic nature of the unit. However, there are places where the overall quartz-crystal content of the conglomerate is low, and clast recognition is difficult or impossible. Flattened clasts are typically less than 5 cm wide, and the widest observed, highly flattened clast is 25 cm.

In the southern part of the Clearwater Lake felsic volcaniclastic sequence, east of Clearwater Lake and south of Burnt Narrows (Menary Township map), grey clasts are rare or absent, and all clasts are strongly flattened with the degree of flattening generally 2:1 to >5:1. In this part of the sequence, there is only limited evidence of the original clastic nature of the unit, and original clast shapes could not be determined. In some outcrops, there are vague indications of clasts in the form of a 1- to 5-cm-wide, blotchy to lenticular weathering pattern. There are also small-scale variations in quartz-crystal abundance that may represent clasts, but many quartz crystals are difficult to identify, possibly because of recrystallization produced by the nearby Burditt Lake stock to the east. Poorly exposed, lichen- and moss-covered outcrops and a slabby nature of some outcrops also hamper lithologic recognition. For this reason, which was also noted by Blackburn (1976), very little mapping was done south of Burnt Narrows.

In the southeastern part of the Pinewood Lake felsic volcaniclastic sequence, clast recognition is hampered by amphibolite-facies metamorphism and a high degree of clast flattening, which, in places, is 10:1 to 20:1. In this area, sparse recognizable clasts are separated by a more uniform felsic component that has a vague, streaky, lensy pattern on weathered surfaces; the lenses are defined by slight colour variations from white to pale grey, by differences in metamorphic grain size, which ranges from 0.2 to 1 mm, and probably also by slight differences in mafic-mineral content. These lenses probably represent strongly flattened felsic clasts, the boundaries of which have merged together.

At about 441613E; 5422709N, on section 2 (Figs. 23, 27), an angular mafic volcanic block and several felsic lobes were observed in cobble to boulder conglomerate. The blocks and lobes occur within an area of about 90 $m^2$ in a stratigraphic interval about 9 m wide (Fig. 13). The mafic volcanic block (Fig. 14), which is 4.4 m by 1.2 m in size, has margins that vary from sharp and straight to irregular and interdigitating with the conglomerate. Interdigitations occur over a width of 10 cm, and small, rounded, felsic pebbles appear to be incorporated in the margin of the block (Fig. 15); interdigitations are on the northwest, presumably lower side of the block. The interdigitations are partly the result of deformation, but, prior to deformation, the marginal zone may have been a mixture of small mafic fragments spalled from the lower surface of the block and mixed with pebbles in the conglomerate. During deformation and metamorphism, boundaries between mafic fragments merged together, and individual fragments are no longer recognizable. Internally, the mafic block contains at least 2, more foliated zones that contain as much as 15%, 0.5- to 2-mm, magnetite; these zones are truncated at the margins of the block and were apparently present before incorporation of the block into the conglomerate; they may be the result of synvolcanic, hydrothermal alteration in the source region. Conglomerate along strike of foliation from the block contains a higher abundance of flattened mafic cobbles than conglomerate elsewhere.

In the same location as, but east of, the mafic block, and presumably stratigraphically higher, there are two or possibly three, quartz-phyric, felsic lenses (Fig. 13). The uncertainty in the number of lenses reflects the possibility that, in three dimensions, the smallest lens may be connected to the adjacent larger lens. The 2 larger lenses are 4.5 and more than 5 m long respectively, but the end of one lens is not exposed; maximum widths of the larger lenses are 140

Fig. 14. Large mafic volcanic block in polymictic, clast-supported, felsic volcanic, cobble to boulder conglomerate, Clearwater Lake felsic volcaniclastic sequence (Fig. 13; 41613E; 5422709N).

and 70 cm (Fig. 13). The lenses are approximately concordant with foliation, and they have sharp to somewhat diffuse, curving contacts (Fig. 16); the ends of the lenses are wedge shaped. The lenses have variably developed, 1- to 10-mm-wide, interconnected fractures defined by fine-grained seams; the fractures are most abundant at lens margins where they outline lenticular areas 10 to 20 cm long and 3 to 8 cm wide. Where well developed, the lenticular pattern makes identification of contacts difficult; the original fractures probably had a more orthogonal habit, but they have been modified by deformation. The felsic lenses are compositionally and texturally identical, and they contain 7 to 8%, 1- to 7-mm, quartz phenocrysts and 5 to 7%, 1- to 5-mm, plagioclase phenocrysts. They are texturally and compositionally similar to some felsic clasts in the host conglomerate; such felsic clasts appear to be most abundant (10%) near the lenses. Immediately adjacent to the large lenses, the primary shapes of these crystal-rich clasts could not

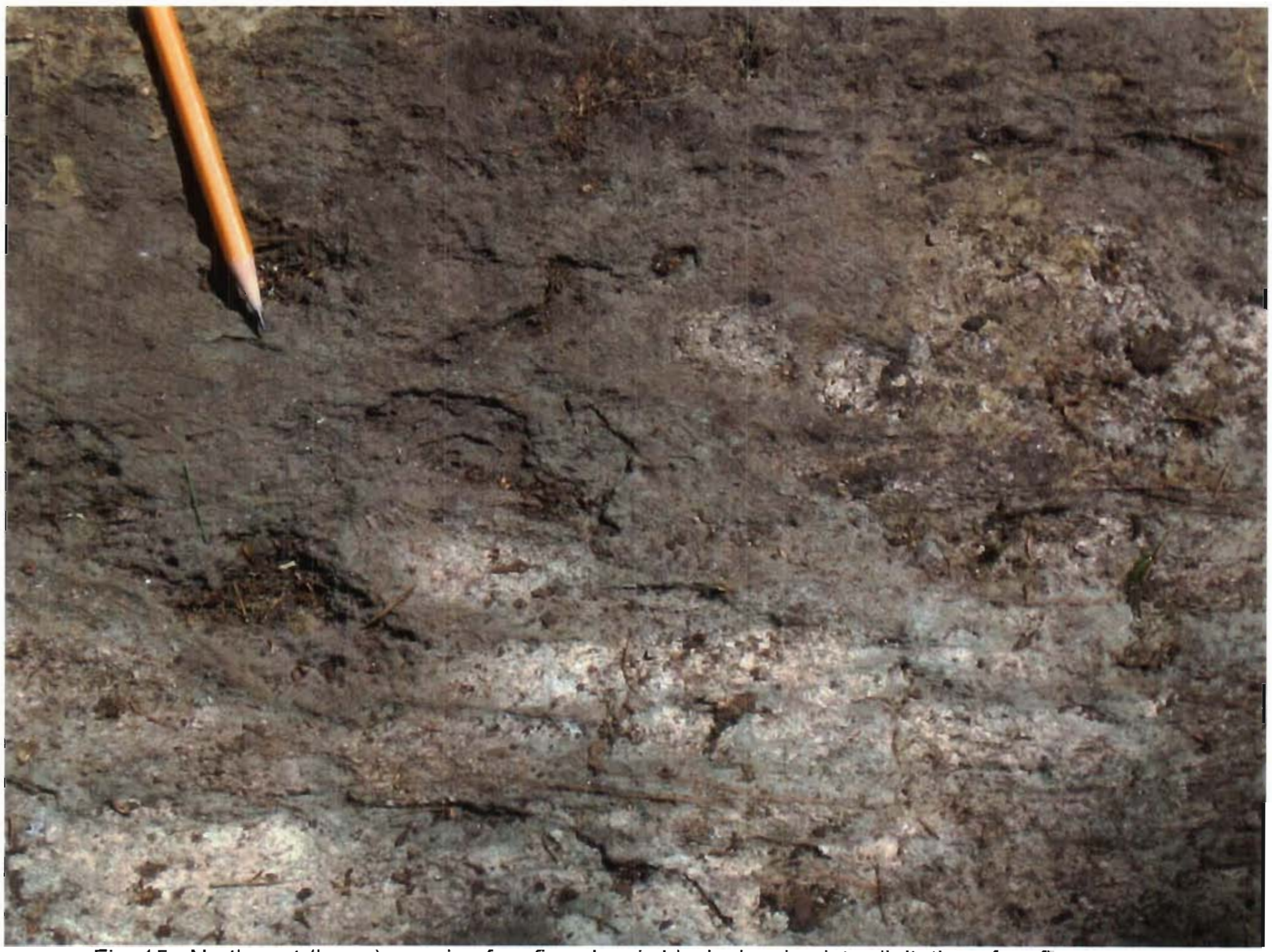


Fig. 15. Northwest (lower) margin of mafic volcanic block showing interdigitation of mafic and felsic components and apparent incorporation of felsic pebbles in mafic material. See text for explanation.

plagioclase phenocrysts. They are texturally and compositionally similar to some felsic clasts in the host conglomerate; such felsic clasts appear to be most abundant (10%) near the lenses. Immediately adjacent to the large lenses, the primary shapes of these crystal-rich clasts could not

be determined, but several metres away from the lenses, the clasts, which are flattened 4:1, have rounded ends.

The mafic block appears to be a large slump block. This would indicate a relatively nearby source, possibly a fault scarp on the flank of a volcanic edifice that exposed part of an underlying mafic sequence. The origin of the felsic lenses is less certain. They could be early intrusions, but the shapes (Fig. 13) and the spatial association of the lenses within a stratigraphic distance of 7 m are more compatible with detached flow lobes. However, the presence of flow lobes within a conglomerate is anomalous, unless there is a nearby, undiscovered dome from

Fig. 16. Margin of western felsic lens (above) in contact with polymictic, felsic volcanic, cobble to boulder conglomerate (below), Clearwater Lake felsic volcaniclastic sequence (Fig. 13). Contact is just below pencil.

which the lobes flowed or slid. Such a dome was sought but was not located. On the northeast, where outcrop density is reasonably good, no evidence of a dome was found. On the southwest, several tens of metres from the mafic block, there is an early fault, and conglomerate observed southwest of the fault does not appear to correlate with the block- and lobe-bearing unit. In spite of the absence of a recognizable dome in outcrops examined, the spatial association of the lenses with the large mafic slump block would appear to indicate a nearby felsic edifice, possibly outside of the plane of the present exposure, on which some mafic units were exposed by faults. Such an edifice, which included active felsic domes or lava flows, could have been the source of clasts in adjacent conglomerate. Thus, both the mafic block and felsic lenses probably arrived in the present location by slumping.

***Oligomictic to polymictic, clast- to matrix-supported, felsic volcanic, cobble conglomerate:*** This is a rare lithology that was observed at several places in the Clearwater Lake felsic volcaniclastic sequence but not in the Pinewood Lake felsic volcaniclastic sequence; maximum width of the unit is 30 m. It is characterized by a more uniform clast population than the previously described conglomerate: more than 40%, and, in places, more than 90% of the clasts, all of which are felsic and mostly white-weathering, are texturally and compositionally uniform. These clasts contain 1 to 10%, 1- to 5-mm, and locally as much as 7-mm quartz crystals; quartz-crystal content of these clasts is uniform within individual units but differs from unit to unit. The other felsic clasts in the unit are heterogeneous with varying quartz-crystal contents. Because of the uniformity of many clasts, it is very difficult to identify clast boundaries. Where recognizable, some clasts are rounded and are as much as 20 cm wide; degree of clast flattening appears to be relatively minor. Because of problems in clast recognition, it is also difficult to identify matrix, but the conglomerate appears to vary from clast supported to matrix supported. Locally, patchily developed breccia was observed. The breccia comprises 1- to 10-cm long, rounded to subangular fragments and <5% matrix. It could not be determined whether the breccia is confined to individual clasts and developed prior to, or during, incorporation of clasts into the conglomerate or whether it is a later structure superimposed on the conglomerate. Although some outcrops of this unit are polymictic, this unit is characterized by more clasts of a single type than the typical polymictic, felsic volcanic conglomerate, and it appears to have a more restricted provenance, which may be nearby lava flows. At least one of the oligomictic to polymictic conglomerate units is close to a felsic lava flow.

***Polymictic, matrix-supported, felsic volcanic, pebble to boulder conglomerate:*** This lithology, which is mostly pebble to cobble conglomerate, is interbedded with clast-supported conglomerate and pebbly sandstone, and locally with sandstone. It is most abundant in the upper part of the Clearwater Lake felsic volcaniclastic sequence, where it is the dominant lithology in intervals as much as 75 m wide. It is less abundant in the Pinewood Lake felsic volcaniclastic sequence. Matrix-supported conglomerate is similar to clast-supported, polymictic, felsic volcanic conglomerate in terms of clast composition, shape, and size, but it differs in the presence of a recognizable felsic volcanic, lithic sandstone matrix that separates and supports the clasts.

Beds that are 0.5 to 1 m wide can be defined by variations in clast size and abundance; no bed contacts were observed and beds are probably amalgamated. In most beds, maximum clast width is 15 cm, and the largest clast observed is 60 by 140 cm. Clast abundance ranges from 10 to 70%, but it is generally between 25 and 60%. Most clasts are white-weathering, felsic volcanic clasts that contain trace to 5%, and rarely as much as 10%, quartz crystals, but there are also some grey-weathering felsic clasts that contain quartz crystals, and there are sparse mafic clasts. The degree of clast flattening is variable from place to place, and it is partly a function of clast size; larger clasts are generally less flattened than smaller clasts. Clast boundaries vary from well defined to poorly defined. Where flattening is <3:1, original subrounded to less commonly subangular shapes are preserved.

The matrix is typically pebbly sandstone to lithic sandstone that contains trace to 10%, 1- to 5-mm, quartz sand grains. Mafic mineral content of the matrix ranges from 5 to 25%. In some places, the matrix contains paler lenses as much as several millimeters wide that may be flattened, coarse, lithic sand grains, granules, and small pebbles.

At one locality in the Clearwater Lake felsic volcaniclastic sequence on the southwest side of Buckhorn Point (442550E; 5423480N), several, 1-m-wide, coarse sandstone beds contain <10%, dispersed, flattened but rounded, felsic cobbles and boulders that are as much as 18 cm wide and 70 cm long, and sparse mafic cobbles as much as 14 cm wide and 30 cm long. These beds are bimodal in particle size; no pebbles were observed. The beds are separated by 10- to 15-cm-wide sets of fine- to coarse-sandstone beds in which beds are 1 to 2 cm wide. Locally, lenticular beds of clast-supported, boulder conglomerate, as much as 40 cm wide, occur within the sequence of interbedded sandstone and sandstone with dispersed clasts.

In several thick beds, there are symmetrical, reverse to normal gradations in clast abundance and size. In these beds, the largest and most abundant clasts are about one third of the bed width above the northwest, presumably lower contacts. Some of the matrix-supported conglomerate, particularly those beds with symmetrical grading and bimodal clast sizes, are probably debris flow deposits. The location of the coarsest clasts in the lower part of the bed would indicate a southeast-facing direction.

***Felsic volcanic, pebbly sandstone:*** White- to pale-grey-green-weathering, pebbly sandstone occurs as interbeds in sandstone and matrix-supported conglomerate, and locally in clast-supported conglomerate; it only rarely forms mappable units. Beds are as much as 2 m wide; bed contacts vary from sharp to gradational although most beds are amalgamated with gradational contacts. Where bed planes were observed, foliation is subparallel to bedding.

The sandstone contains <3% chlorite, 3 to 10%, 1- to 5-mm, visible, quartz sand grains, and 5 to 15%, 0.5- to 4-mm, plagioclase sand grains that are equant to tabular, and subrounded to angular; they appear to be plagioclase crystals that were only slightly modified by erosion and transport. The bulk of the sandstone is probably flattened lithic grains, but these are rarely recognizable on surface exposures. The smallest, readily recognizable clasts are lenticular granules and small pebbles that are >2 mm wide and have a flattening of <2:1 to 5:1 on horizontal outcrop surfaces; flattening in the vertical dimension appears to be greater than 20:1.

Pebbles are generally flattened and are dominantly felsic volcanic; they include both white- and grey-weathering varieties. Chert clasts were observed locally. Where degree of clast flattening is high, some of the grey-weathering felsic clasts are difficult to distinguish from matrix. Maximum pebble width is 8 cm, but in many beds, maximum width is only 2 cm. Where the degree of flattening is slight, pebbles are rounded to subangular. The distinction between pebbly sandstone and matrix-supported conglomerate is both clast abundance and clast size. In pebbly sandstone, there are 5 to 25% pebbles. Where cobbles are observed, the unit is generally conglomerate that contains >25% pebbles and cobbles.

***Felsic volcanic, lithic sandstone:*** This is a white- to pale-grey-weathering, commonly well bedded, fine to coarse sandstone that is best exposed at, and north of, Buckhorn Point in the Clearwater Lake felsic volcaniclastic sequence and west of Pinewood Lake in the Pinewood Lake felsic volcaniclastic sequence (see accompanying maps). Sandstone forms discrete, mappable units as much as 150 m, and possibly as much as 300 m wide. The sandstone units contain interbeds of pebbly sandstone and more rarely interbeds of both clast-supported and matrix-supported conglomerate; interbeds are as much as 2 m wide.

In most of the medium to coarse sandstone, clastic texture is preserved; however, in the southern part of the Pinewood Lake felsic volcaniclastic sequence, where metamorphic grade is amphibolite facies, primary textures are preserved only in the coarsest sandstone. Where best preserved, coarse sandstone contains 5 to 40%, visible, quartz sand grains. Plagioclase sand grains are also a major component; plagioclase grains are commonly angular to subangular, and, in places, they are tabular in shape. Locally, there are as much as 5%, flattened, felsic pebbles and small cobbles that contain 2 to 3%, 1- to 4-mm, quartz crystals and 10 to 15%, 1- to 5-mm, plagioclase crystals; the clasts are 0.5 to 6 cm wide. Where least deformed, the pebbles and small cobbles are subangular to rounded. Locally, the clasts form trains that are 10 to 20 cm wide and contain 10 to 30% clasts. These trains are, in part, matrix-supported conglomerate, and they define bed orientation.

Bedding planes are generally sharp and are defined by interbeds of fine, medium, and coarse sandstone (Fig. 17); in places, fine sandstone beds are internally laminated. Where observed, beds range in width from 1 to 40 cm, and finer beds are generally narrower than coarser beds. In places, beds are disrupted by small-scale faults. In some of the coarser sandstone, amalgamated bedding is defined by variations across strike in the abundance of visible quartz and plagioclase grains.

The sandstone is a moderately variable unit, particularly in the Clearwater Lake felsic volcaniclastic sequence. In places, interbedded, 5- to 15-cm-wide, fine- to coarse-sandstone beds form bed sets at least 40 cm wide that are intercalated with beds of clast-supported conglomerate. In other places, fine- to coarse-sandstone bed sets several tens of metres wide contain only minor conglomerate interbeds. In still other places, there are bed sets of interbedded, 0.4- to 10-cm-wide, fine and medium sandstone beds, in which some fine sandstone beds <1 cm wide are laminated. These bed sets are generally <10 cm wide, but are locally as much as 1 m wide, and they are interbedded with more abundant, 30-cm-wide, coarse sandstone

Fig. 17. Interbedded, fine and medium sandstone in the Clearwater Lake felsic volcaniclastic sequence (443900E; 5423900N).

beds that contains as much as 10%, <1-cm-long flattened pebbles. Locally, bed sets of thinly bedded sandstone are intercalated with more massive sandstone beds that are as much as 1 m wide. Rarely, coarse sandstone beds within a sequence of medium sandstone are disrupted.

Some sandstone beds are graded, but there is no consistent facing direction. In some beds, there is apparent normal grading consisting of a lower, massive but size-graded, coarser sandstone, which forms 70 to 80% of the beds, and an upper, finer, in places laminated, sandstone. In other beds, there is symmetrical grading with the coarsest sandstone in the centre of the bed, and fining in both directions away from the centre. If the grain gradation is the result of turbidity current processes, then there are both northwest- and southeast-facing beds, and facing directions of beds change over distances of less than 1 m. In fact, in places, adjacent beds have different apparent facing directions. In some places, there appears to be more northwest- than southeast-facing beds, but, in other places, most beds appear to face southeast. The rapid changes in apparent facing direction could be the result of closely spaced isoclinal folds. However, the occurrence of symmetrical grading in some beds suggests that the grain gradation is not the result of turbidity current processes, and, thus, the gradation is not a reliable indicator of facing direction or folding.

Reexamination of one outcrop (442900E; 5423960N) in the Clearwater Lake felsic volcaniclastic sequence following some rain washing of stripped outcrop revealed delicate scours and low-angle cross beds in some sandstone beds. The scours and cross-beds have amplitudes of 5 to 10 cm, and they indicate northwest facing. Other outcrops should be reexamined to check for other structures that could indicate facing directions.

At one outcrop north of Buckhorn Point in the Clearwater Lake felsic volcaniclastic sequence, the sandstone contains 3, lenticular structures that are either coarse sandstone blocks or felsic volcanic blocks; the lenses are 30 cm wide and 1 to 2 m long. These lenses, one of which is almost circular on outcrop surface, occur within a 3 m long and 1 m wide area. Texturally, the lenses contain 5 to 8%, quartz crystals and 10%, equant to tabular, plagioclase crystals; both types of crystals are as much as 5 mm long. The plagioclase crystals appear to be too subhedral to be sand grains, and the lenses are inferred to be felsic volcanic blocks; they texturally resemble clasts observed in conglomerate elsewhere. Two of the lenses are separated by a 2- to 5-cm-wide, finer sandstone bed that merges laterally with adjacent sandstone. Regardless of whether the lenses are coarse sandstone or felsic volcanic, they are probably slump blocks. They are thus analogous to the slump blocks found in conglomerate farther southwest (Fig. 13).

***Mudstone and chert:*** Mudstone was observed at a single locality in the Clearwater Lake felsic volcaniclastic sequence on the hydro line north of Spring Lake (439680E; 5419840N); the mudstone unit is 2 m wide. Mudstone beds, 1 mm to 10 cm wide, form about 40% of this unit, and they are interbedded with fine to medium sandstone beds, 2 mm to 12 cm wide, and locally with white chert beds as much as 2 cm wide. The thicker mudstone and sandstone beds are internally laminated. The uppermost 10 to 20 cm of the mudstone-sandstone sequence is contorted with recumbent isoclinal folds and some brecciation. In places, beds are truncated by overlying coarse sandstone, and, in one place, coarse sandstone has penetrated about 5 cm into a crack in the brecciated mudstone and sandstone; this relationship indicates that the mudstone and sandstone units face southeastward. The contortion is probably a result of soft-sediment deformation and slumping. The mudstone-sandstone interval overlies conglomerate and is overlain by interbedded coarse sandstone and conglomerate in which bed planes vary from sharp to gradational. The first of the overlying conglomerate beds is a matrix-supported pebble conglomerate that contains 50 to 60% clasts, most of which are mudstone, in a coarse sandstone matrix.

***Felsic pyroclastic flow deposits(?):*** Several possible felsic pyroclastic flow deposits were observed in the Clearwater Lake felsic volcaniclastic sequence, but none were observed in the Pinewood Lake felsic volcaniclastic sequence. The possible pyroclastic flow deposits, which range in width from 10 to 100 m, include both white-weathering and grey-green-weathering units (Figs. 23, 24). White-weathering units, which are generally poorly exposed and <40 m wide, are leucocratic and strongly foliated; they contain 2 to 3%, and locally as much as 5%, 1- to 3-mm, and locally as much as 5-mm, quartz crystals, and, locally, they contain sparse, 1- to 4-mm, plagioclase crystals. These white-weathering units are characterized by 1) distinct, concordant, internal boundaries across which there are subtle variations in abundance and size of quartz crystals; 2) poorly defined, rounded to ovoid areas, 1 to 5 cm long, that are compositionally and texturally similar to the host and may be cognate, felsic lithic clasts; and 3) sparse, possible accessory or accidental lithic clasts that include rounded to ovoid felsic patches as much as 6 cm long and containing as much as 10%, 6-mm, quartz crystals, and rare, angular, 1-cm-long, mafic clasts. Where best exposed, the units contain white to very pale brown lenses that are as much as 2 mm wide and several centimetres long; these could be flattened pumice. Locally, the units have anastomosing, interconnected, fractures that are now subparallel to foliation; the fractures, which are defined by darker seams <2 mm wide, are 0.5 to 5 cm apart.

The thickest, possible pyroclastic flow deposit, which is 100 m wide, is well exposed west of Clearwater Lake. This is a relatively uniform, strongly foliated and lineated unit that varies in weathering colour from grey white to pale grey green and contains 5 to 10%, 1- to 5-mm, quartz crystals and 8 to 10%, 1- to 5-mm, equant to tabular, plagioclase crystals. The main micaceous mineral is sericite, but the unit also contains <2% chlorite. Crystal content appears to be relatively uniform throughout the unit, although there are local, patchy variations in quartz-crystal content. The unit also contains flattened, intermediate volcanic fragments that are as much as 30 cm long and 7 cm wide and vary in shape from lenticular with wedge-shaped ends to ovoid to sausage shaped with rounded ends (Fig. 18); angular clasts were observed locally. The fragments are present everywhere in the unit although the distribution of fragments is somewhat variable from place to place; maximum fragment abundance is 5%. In places, the unit has a wispy, lenticular structure with 5 to 10%, wispy, green lenses, 0.5 to 2 mm wide; these lenses could be collapsed pumice or they could be the result of deformation.

Both upper and lower contacts of the grey-green unit were observed. The northwest, assumed lower contact, is a fault trending 030°. The fault is a 1- to 3-cm-wide, sharply bounded zone in which the degree of schistosity is greater than elsewhere. In the marginal several metres of the possible pyroclastic flow deposit, colour progressively changes toward the margins from grey green to dirty white, and plagioclase crystals become more difficult to identify. The southeastern, presumed upper contact, is sharp and slightly sinuous, and it varies in trend from 040° to 050° over a distance of several tens of metres; the contact is slightly discordant to foliation, which here has a trend of 035°. Conglomerate immediately adjacent to the possible pyroclastic flow deposit on the southeast does not contain any clasts that are texturally comparable to the possible pyroclastic flow deposit. However, many of the grey-weathering clasts found throughout the conglomerate are somewhat similar to the possible pyroclastic flow deposit. This possible pyroclastic flow deposit was observed in a single fault block, within which it

Fig. 18. Grey-green, possible felsic pyroclastic flow deposit contains flattened, ovoid to sausage-shaped, intermediate volcanic fragments. Clearwater Lake felsic volcaniclastic sequence in section 3 (Figs. 24, 27; 441850E; 5423100N).

was traced laterally for 700 m (Fig. 24; Menary Township map). Texturally similar, grey-green-weathering units that contain rare felsic clasts but lack the intermediate clasts were locally observed elsewhere in the Clearwater Lake felsic volcaniclastic sequence; these other units are <20 m wide.

The origin of the grey-green-weathering unit is uncertain. It could be a sill or a pyroclastic flow deposit. If the unit is a sill, it contains xenoliths that were derived from intermediate volcanic units elsewhere in the sequence such as those observed on the southeast shore of Cedar Lake and at the east end of the portage from Clearwater to Cedar Lakes. No other fragment types were observed. In this context, it should be noted that sparse, narrow, semi-concordant, pale-grey-green-weathering intrusions that are texturally similar to this unit have been observed farther southeast in the Clearwater Lake felsic volcaniclastic sequence, but they do not contain the intermediate fragments that characterize the possible pyroclastic flow deposit.

Alternatively, the unit could be a pyroclastic flow deposit. Possible pumice was observed, but no cognate fragments were observed. The high proportion of accidental intermediate fragments is unusual in a pyroclastic flow deposit except for near-vent deposits (Wright and Walker, 1977; Walker, 1985); these fragments could have been ripped from wall rocks of the magma chamber that hosted the magma at depth during eruption to produce the pyroclastic flow deposit. Tentatively the unit is inferred to be a pyroclastic flow deposit because of 1) the presence of possible pumice 2) the uniform fine grain size of the matrix, and 3) lack of any evidence of intrusion along the well-exposed upper contact.

***Felsic lava flows or domes:*** White-weathering, quartz-phyric, felsic lava flows or domes were found locally in both the Clearwater Lake and Pinewood Lake felsic volcaniclastic sequences. The flows or flow sequences range in width from 22 to 200 m; exposure is spotty and individual flows were traced laterally for only 250 m. The lava flows contain 1 to 8%, 1- to 5-mm quartz phenocrysts, and some flows contain 0 to 20%, 1- to 4-mm, plagioclase phenocrysts. Lava flows are typically partly brecciated with a central, massive zone in which rare fragments are outlined by sparse, discontinuous, partly connected fractures defined by 0.1- to 0.2-mm-wide, darker seams. The fractures increase in abundance away from the central zone. These more abundant fractures have been deformed into an anastomosing, semi-concordant network, and fracture spacing is 0.5 to 4 cm (Fig. 19). The darker seams that outline fragments are probably a combination of matrix and alteration. The central massive zone grades into upper and lower fragmental zones in which fragments are texturally and compositionally identical.

The best exposed lava flow is on the west shore of Clearwater Lake at the Pipestone Air base (441000E; 5421290N). This flow or dome is at least 200 m wide, but the southeastern edge is beneath Clearwater Lake. The best exposed part of the outcrop is the upper breccia zone, which was illustrated by Blackburn (1976, photo 5), although he identified the unit as a pyroclastic breccia. The upper breccia consists of both well rounded and angular, white-weathering, felsic fragments that are texturally and compositionally identical (Fig. 20); there are also sparse intermediate fragments. The felsic fragments contain 10 to 12%, 2- to 8-mm, quartz phenocrysts and 8 to 10%, 1- to 5-mm, plagioclase phenocrysts. The breccia is a chaotic jumble of fragments that are generally touching; in any location, fragments range in width from <1 cm to 40 cm; degree of fragment flattening ranges from 0 to 3:1. Some of the larger fragments have reentrants filled with matrix. Matrix abundance is variable from place to place, and this variation is partly a function of range in fragment size at any given place; the wider the fragment size variation, the lower the matrix content. The matrix is pale grey green and contains 10%, 1- to 5-mm, quartz crystals.

In the breccia, rounded fragments appear to be more abundant than angular fragments; fragment rounding probably occurred by milling during flow advance. In places, the two fragment shapes are intermixed (Fig. 20); however, in most of the breccia, angular and rounded fragments occur in

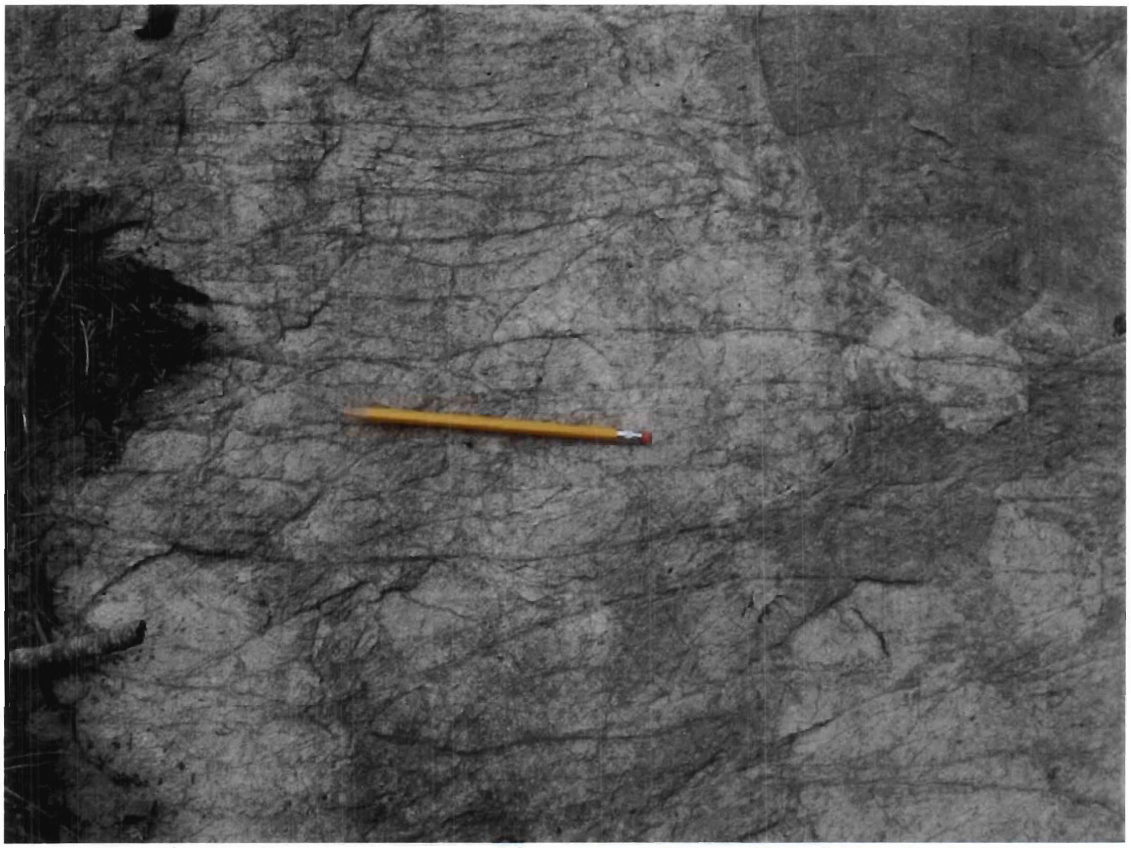


Fig. 19. Flattened brecciated zone in a felsic lava flow or dome, Pinewood Lake felsic volcaniclastic sequence (434040E; 5407340N). Fragments are outlined by the darker grey seams. Darker grey area in upper right is the result of spalling of the weathered surface.

Fig. 20. Subrounded to angular, texturally identical fragments in the upper breccia of a felsic lava flow or dome, Clearwater Lake felsic volcaniclastic sequence (441000E; 5421290N). Matrix (darker grey) abundance here is somewhat higher than elsewhere.

discrete layers or patches several metres wide. Concentrations of rounded and angular fragments cannot be traced far enough across lichen-covered parts of the outcrop to determine whether the different clast shapes form distinct layers. Mineral foliation is weakly developed in the breccia, but, within many fragments, and on the long sides of elongated fragments, there are 0.5- to 3-mm-wide, discontinuous, subparallel, brown, sericitic seams. The seams within fragments are interconnected and appear to be early fractures that may have been emphasized by early alteration; these fractures are most common in the larger fragments. In places, fragments smaller than 1.5 cm are pale grey rather than white and boundaries are not as sharp; this change in colour and boundary definition may be a result of early alteration.

To the northwest, away from the lake, the flow is moss covered and exposure is poor. The breccia appears to grade northwestward into a fractured zone that contains anastomosing fractures defined by sericitic seams; the seams are several millimetres wide and have a spacing of 1 to 10 cm. Locally, discontinuous matrix seams as much as 2 cm wide fill larger fractures.

This flow or dome can be traced discontinuously along strike for only 250 m because of poor exposure to the southwest. On the northeast, the flow or dome is truncated by a fault that trends about 115°. To the southwest, along the road to the air base, the flow narrows to 40 m, and it is underlain and overlain by polymictic, felsic volcanic, pebble to fine cobble conglomerate. The lower part of the flow here is fractured with slightly darker seams defining fractures; there are some rounded clasts. The conglomerate adjacent to the lava flow or dome contains some clasts that are texturally similar to the lava flow, these are most abundant on the east or inferred upper side of the flow.

In the Pinewood Lake felsic volcaniclastic sequence, a 130-m-wide, brecciated to massive, felsic lava flow, or, more likely, a sequence of flows, was found on several nearby outcrops, but there is not sufficient exposure to trace the sequence laterally. This flow sequence comprises interlayered massive and brecciated intervals. In the brecciated intervals, fragments are flattened, and original fragment shapes and matrix abundances could not be determined; however, most fragments are texturally and compositionally identical. Brecciated intervals contain 5 to 10% matrix that partly surrounds fragments that are flattened 2:1 to 4:1 and range in width from 0.5 to 10 cm. The matrix occurs as 0.5- to 5-mm-wide seams that form an incomplete network around fragments (similar to that shown in Fig. 19); there are local matrix pockets that are as much as 1.5 cm wide and parallel foliation direction. Within this flow sequence, which is bordered on both sides by conglomerate, there are zones as much as several metres wide in which the texture appears to be clastic. There is no apparent difference in quartz crystal content between these zones and other parts of the flow. These possible clastic zones could be intercalated sandstone beds or parts of the lava flow where the degree of recrystallization is lower. The presence of possible sandstone interbeds is supported by the recognition of a single polymictic, felsic volcanic, pebble conglomerate interbed. Such interbeds indicate that this unit is a sequence of several flows.

*Boundary Relations and Stratigraphy of the Clearwater Lake Felsic Volcaniclastic Sequence*

***Boundary relations:*** In the area between Beadle Lake and Burnt Narrows of Clearwater Lake, the contact between the Clearwater Lake felsic volcaniclastic sequence and underlying lower mafic metavolcanic sequence is inferred to be interdigitating over a stratigraphic width of 1.7, and possibly as much as 2.2 km (Fig. 21B; Menary Township map). In the zone of interdigitation, which has a lateral extent of about 3 km, tongues of both pillowed and nonpillowed mafic lava flows intruded by metagabbro narrow northeastward and are intercalated with 7 or 8, southwestward-narrowing, felsic tongues that range in width from several metres to more than 200 m. The exact number of felsic tongues is uncertain because of incomplete mapping and low outcrop density is some parts of the contact zone. Within the tongues, facing directions determined from pillow shapes and gas cavities in mafic lava flows and sedimentary structures in sandstone are generally to the southeast although there are local northwest- to north-facing pillows that probably indicate some small-scale isoclinal folding in the zone of interdigitation. Where observed, contacts between felsic and mafic units in the zone of interdigitation vary from stratigraphic to faulted; faults are concordant with stratigraphy.

The general, southeasterly facing direction of pillows within the mafic tongues and in lava flows west of Cedar Lake (Blackburn, 1976) is the only good evidence that the Clearwater Lake felsic volcaniclastic sequence faces southeast and stratigraphically overlies the lower mafic lava flow sequence (Fig. 21). Within the Clearwater Lake sequence, possible southeast-facing directions were determined only rarely, and the reliability of these indicators ranges from medium to high. These indicators include 1) symmetrical grading in two matrix-supported conglomerate beds of possible debris flow origin; 2) truncation of mudstone beds by overlying sandstone and downward penetration of sandstone into cracks in mudstone; 3) asymmetry of breccia zones in the felsic lava flow or dome at the Pipestone Air base on the shore of Clearwater Lake; and 4) nature of the contacts on the large mafic block in conglomerate (Figs. 13, 14, 15). Except for the truncation of mudstone, these facing indicators are not shown on the accompanying Menary Township map because the reliability of these indicators is not as high as that of other indicators such as pillow shape; however, all facing indicators are shown on Fig.. 21B. An opposite, northwest-facing direction was obtained from scours and cross beds in felsic volcanic, lithic sandstone north of Buckhorn Point; this is additional evidence of isoclinal folding within the map area.

On Blackburn's (1976) map, many of the felsic tongues are shown as lenticular units that were inferred to be completely enclosed within mafic metavolcanic units (Fig. 21A). On the basis of the 2006 mapping, there are only 2 volcaniclastic lenses that appear to be completely enclosed within mafic metavolcanic units (Fig. 21B). Both of these lenses are low in the sequence. Mapping in this part of the area is incomplete, and these lenses, particularly in the third dimension, may be connected to the Clearwater Lake felsic volcaniclastic sequence. The lowermost, felsic lens shown by Blackburn (1976), which is considerably lower stratigraphically and is well within the mafic metavolcanic sequence (Fig. 21A), was quickly examined in an area of poor exposure. Where examined between Beadle and Preachers Lakes, this felsic unit appears to be a sill-like intrusion. It is a texturally uniform, white-weathering unit that contains 5 to 8%, 2- to 5-mm, quartz crystals and 10 to 15%, 2- to 4-mm, blocky, plagioclase crystals. In places, the texture has a clastic appearance, but no lithic grains could be identified. Although this unit could be a sandstone, it is most likely an intrusion because of the textural uniformity and lack of visible lithic grains.

Also in this area, south of Cedar Lake, Blackburn (1976) showed a right angle bend in the contact between the Clearwater Lake felsic volcaniclastic sequence (his F1 sequence) and underlying mafic units (Fig. 21A); the contact has a double S configuration, and it was inferred to be offset by a fault. As a result of this bend and fault, the basal contact of the Clearwater Lake sequence was inferred to have been displaced about 1.5 km southeastward.

Exposure in the area of the right angle bend in the contact is poor, but the author's mapping has shown that there are two problems with Blackburn's (1976) mapping. 1) Many outcrops mapped by Blackburn (1976) as felsic metavolcanic immediately west of Burnt Narrows are either mafic lava flows, metagabbro, or intercalated mafic lava flows and felsic volcaniclastic units. 2) The area where the mafic to felsic contact was inferred to be bent is the area now inferred to be a zone of interdigitating mafic and felsic units.

The contact between the Clearwater Lake felsic volcaniclastic sequence and underlying mafic lava flows, as mapped by Blackburn (1976) north of Cedar Lake, is straight and concordant with foliation direction. This contact was not examined during the present survey. However, there is some evidence that the contact in this locality, and possibly extending southwest to the central part of Cedar Lake, is a fault. This evidence includes 1) a well-defined topographic lineament along the contact, 2) a marked increase in degree of clast flattening in the Clearwater Lake sequence near the contact, 3) shearing along the contact observed by Blackburn (1976), and 4) local brecciation, pink colouration, and strong foliation in a quartz-phyric, fine-grained, subvolcanic, felsic intrusion adjacent to the contact at the north edge of the Menary Township map (442840E; 5424700N). In the brecciated intrusion, foliation attitude in adjacent blocks is different indicating that brecciation occurred after foliation development. Degree of deformation decreases away from the contact, and the colour changes from pink to cream.

***Stratigraphy:*** The stratigraphy of the Clearwater Lake felsic volcaniclastic sequence is uncertain because of faults and a paucity of facing indicators. The sequence was examined for a strike length of 4 km north of Burnt Narrows; the width of the sequence here is about 2 km. South of Burnt Narrows only a few outcrops were examined because textures have been largely destroyed by deformation and metamorphism, and lithologic identification is difficult to impossible. The eastern part of the sequence, on the east side of Clearwater Lake was also not examined because 1) the sequence is adjacent to the late tectonic, Burditt Lake stock, 2) Blackburn (1976) noted that textures were poorly preserved, and 3) most of this area is beyond the Rainy River Resources claim group. The total width of the Clearwater Lake felsic volcaniclastic sequence, as mapped by Blackburn (1976), is about 3.5 km; the greatest width is east of Clearwater Lake, but only a single facing indicator was reported here (Blackburn (1976), and the internal structure and stratigraphy of this part of the sequence are unknown. East of the mapped area, the Clearwater Lake sequence is bounded on the east by a thin mafic metavolcanic unit that separates it from the Jackfish Lake intrusive complex.

In the central part of the Clearwater Lake felsic volcaniclastic sequence, north of Burnt Narrows, four stratigraphic sections were examined in detail (Figs. 22, 23, 24, 25, 26, 27). Datum used for the stratigraphic columns is the inferred location of the contact with the underlying mafic metavolcanic sequence. Distances given in the stratigraphic columns (Figs. 22, 23, 24, 25, 26) represent the width of the units as measured on horizontal outcrop surface. No correction was made for the dip of units because, other than in the sandstone, no bedding dips were measurable, and, in the sandstone, dips are greater than 75°. These widths are not stratigraphic thicknesses; because of the strong flattening of clasts, original stratigraphic thicknesses cannot be measured properly.

The stratigraphic sections cover a lateral distance of only 1.3 km, but the most striking feature of the sections is the lack of correlation of some units. For example, the very distinctive,

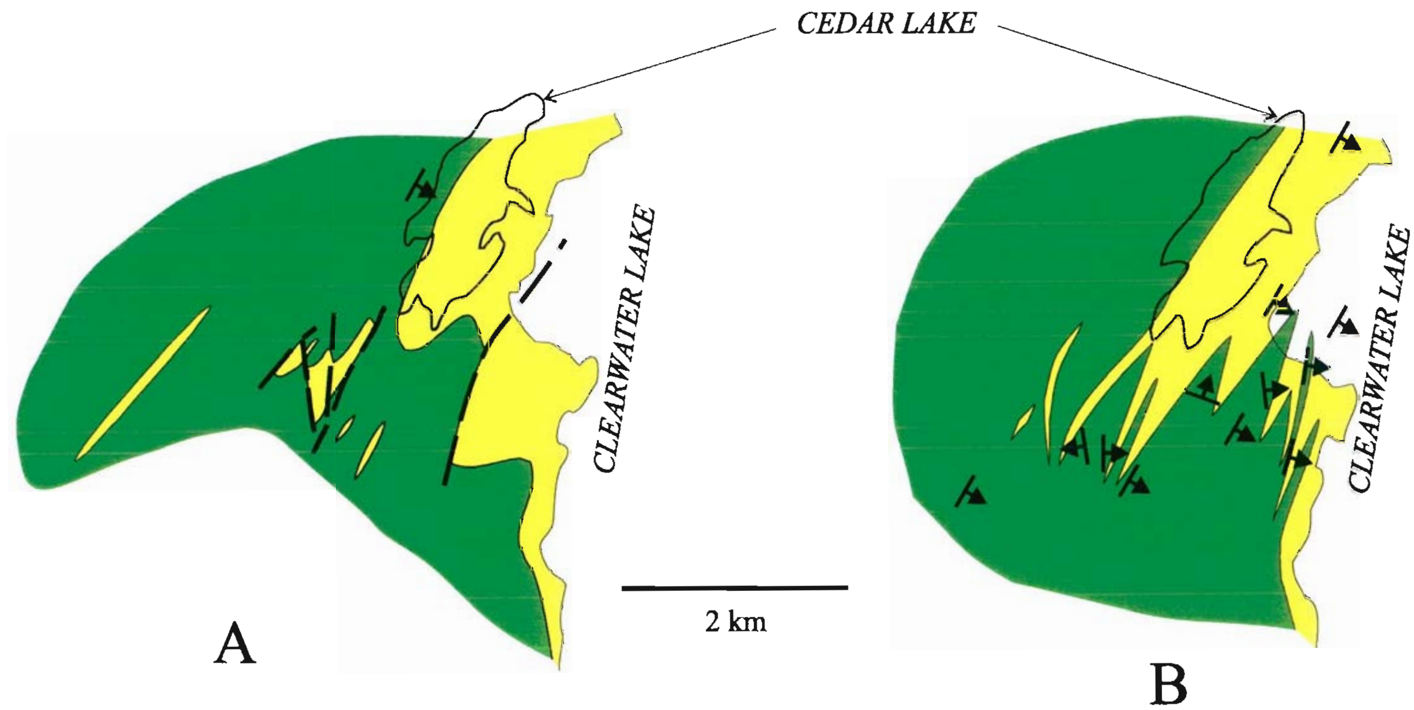



Fig. 21 . Sketch maps comparing two interpretations of boundary relations between the Clearwater Lake felsic volcaniclastic sequence (yellow) and the underlying mafic metavolcanic sequence (green). A. Interpretation of Blackburn (1976). B. Interpretation based on 2006 mapping. Dashed lines are faults. Arrows indicate facing directions observed by Blackburn (1976) and during the present survey. Some facing directions shown on B are not shown on the accompanying Menary Township map because degree of certainty in these facing directions is only moderate.

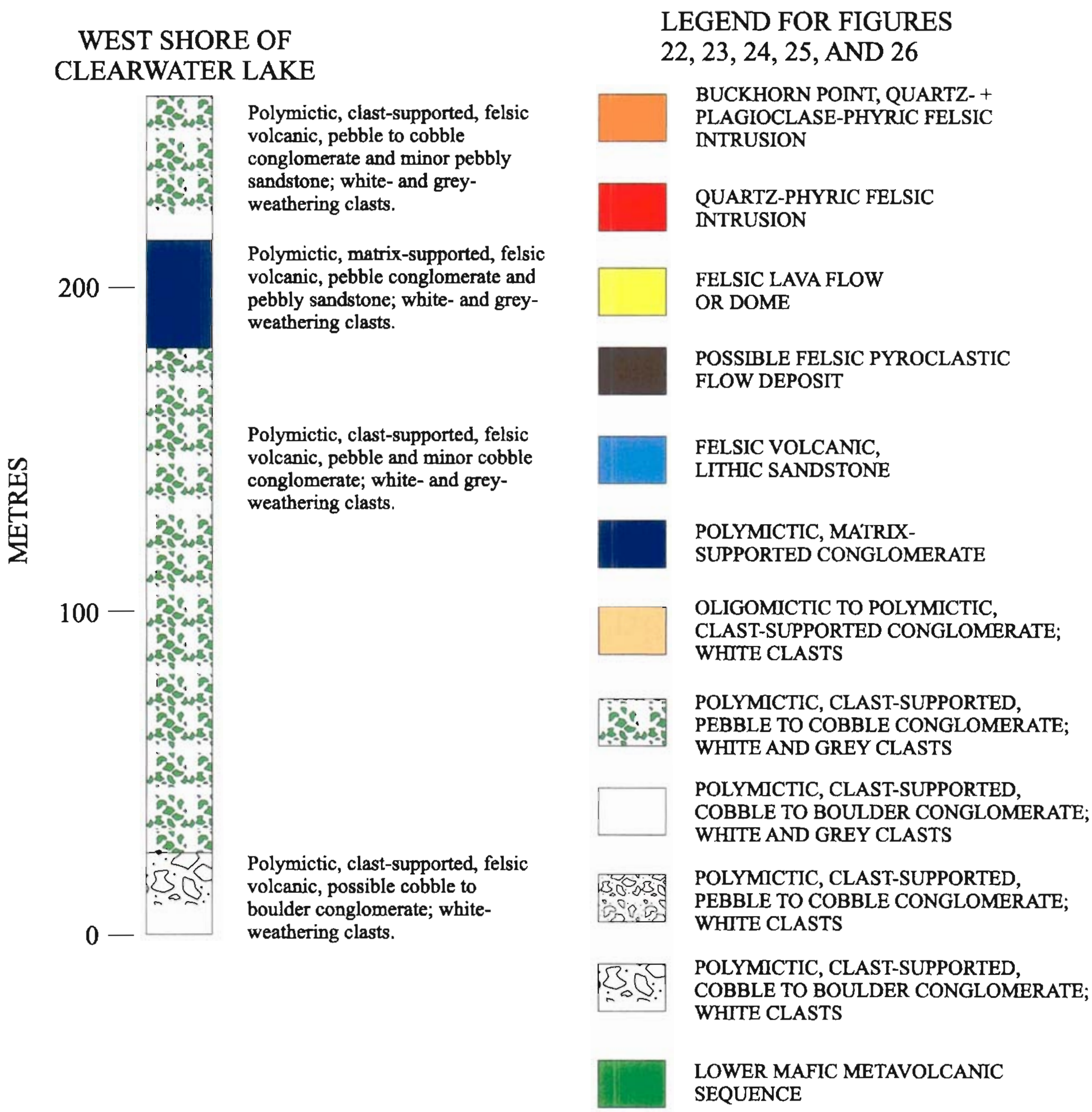



Fig. 22. Stratigraphic section 1 through the lower part of the Clearwater Lake, felsic volcaniclastic sequence. Location is on Fig. 27. Section measured by pacing across almost continuous outcrop. Legend applies to all stratigraphic columns (Figs. 22, 23, 24, 25, and 26).

100-m-wide, grey-green-weathering, possible felsic pyroclastic flow deposit in section 3 (Fig. 24), was not observed in adjacent sections and appears to be in a fault block (Fig. 26). Also, the width of clast-supported conglomerate in section 4 is much less than that observed in sections only 1 km to the southwest (Figs. 25, 26).

The Clearwater Lake felsic volcaniclastic sequence is dominantly polymictic, clast-supported, felsic volcanic, pebble to cobble conglomerate. Boulder conglomerate occurs sporadically, but it is most abundant in the upper part of the sequence near Clearwater Lake. Two types of felsic clasts were observed in the conglomerate: white weathering and pale grey weathering. The proportion of the two types of felsic clasts varies from bed to bed, but, in general, there is an upward increase in the abundance of grey-weathering clasts. In the lower part of all measured sections, and in outcrops along much of the east shore of Cedar Lake, felsic clasts in the conglomerate are almost entirely white weathering. Higher in the sequence, white-weathering clasts still dominate, but the abundance of grey-weathering clasts is greater than 10%. Mafic clasts occur throughout the sequence, but they appear to be more abundant in the upper part of the sequence where they are associated with a higher abundance of pale-grey-weathering clasts.

Matrix-supported conglomerate was observed in all sections, but it was not observed in the lower 400 m of the sequence. In the southwestern part of the sequence, matrix-supported conglomerate and associated pebbly sandstone are relatively minor, and they occur as beds and bed sets interbedded in clast-supported conglomerate; there is no obvious upward change in the overall nature of the conglomerate. However, in section 4 near Buckhorn Point (Fig. 25) in the northeastern part of the mapped area, there is an upward change from clast-supported conglomerate to matrix-supported conglomerate and pebbly sandstone to felsic volcanic, lithic sandstone. Sandstone is the dominant component in the upper part of this section; this sandstone unit is at least 200 m wide, but the true width is uncertain because the unit is interrupted by the Buckhorn Point, quartz- and plagioclase-phyric, felsic intrusion (Fig. 25). Sandstone is also common north of Buckhorn Point (Menary Township map). About 1 km to the southwest, clast-supported conglomerate occurs in the stratigraphic interval occupied by sandstone at Buckhorn Point (Fig. 26). Sandstone was observed only rarely southwest of Buckhorn Point.

Several felsic lava flows or domes and white-weathering, possible pyroclastic flow deposits were observed in, and southwest of, section 2 (Fig. 23). These were traced laterally for only short distances because the focus of the field investigations in the area occupied by the Clearwater Lake felsic volcaniclastic sequence was measured sections, not mapping. With further work these units could probably be traced laterally, although faults truncate some of the units. These units are a minor component of the Clearwater Lake sequence and occur sporadically within the sequence.

The presence of sandstone in the northeastern part of the sequence may indicate an overall northeastward, lateral fining of the Clearwater Lake felsic volcaniclastic sequence. However, such fining cannot be documented because of the large area of lake cover between

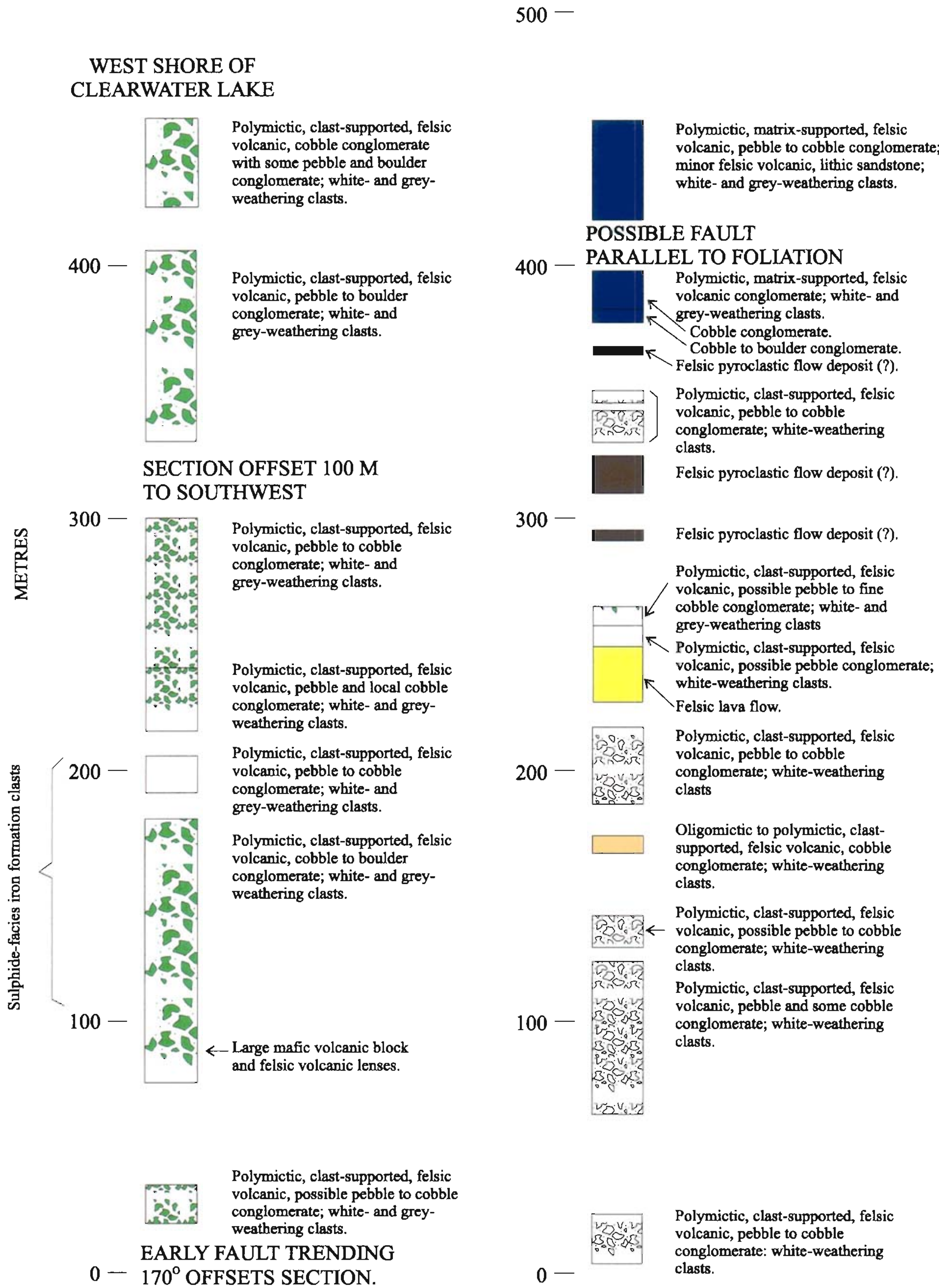



Fig. 23. Section 2 through the lower part of the Clearwater Lake felsic volcaniclastic sequence. Section location is on Fig. 27, and legend is on Fig. 22. Stratigraphic widths were measured by a combination of pacing and chaining. The zero point of the right column is the inferred contact with the lower mafic metavolcanic sequence, and the top is an early fault. The left column continues the section above the early fault. Units in the two columns do not correlate.

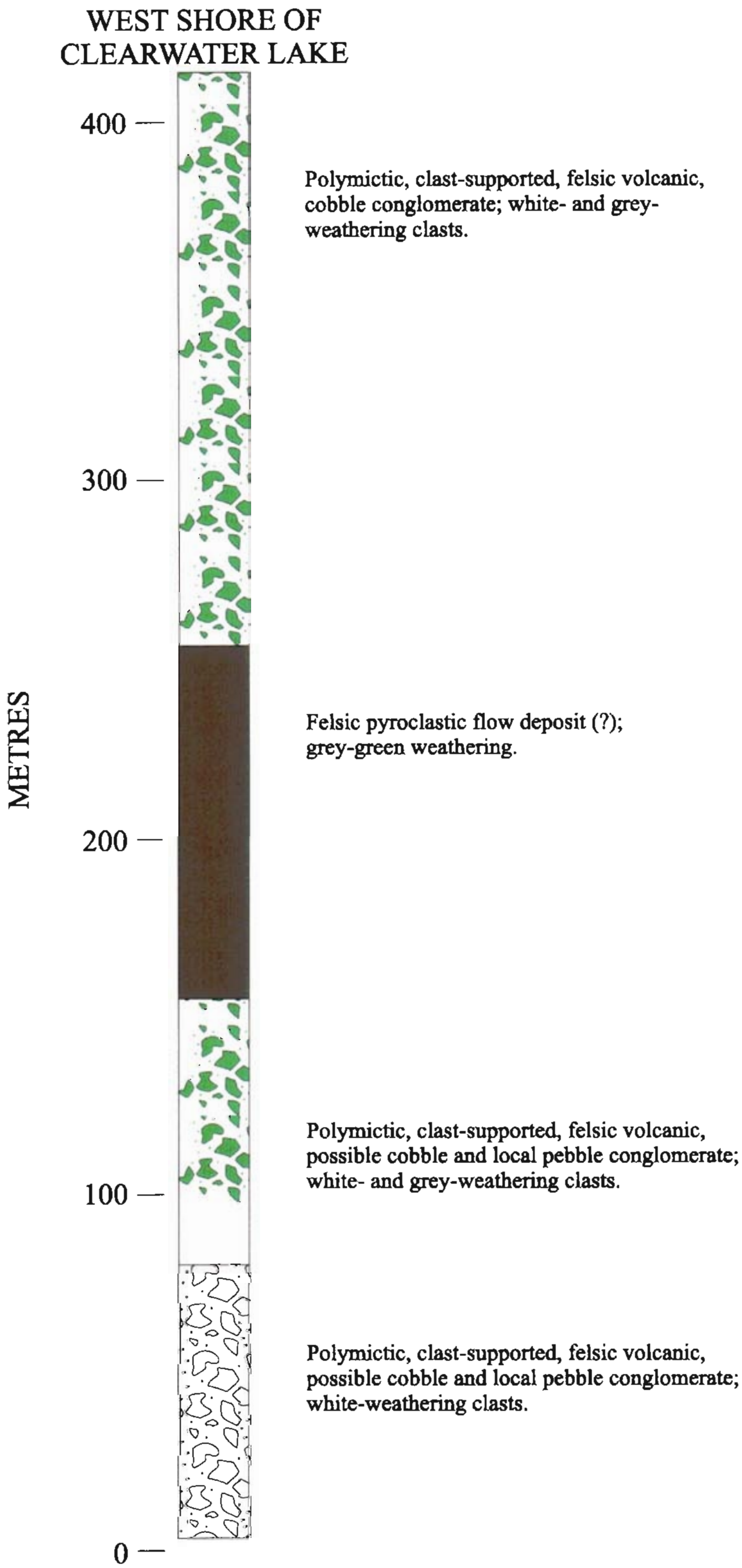



Fig. 24. Stratigraphic section 3 through the lower part of the Clearwater Lake felsic volcaniclastic sequence; location is on Fig. 27, and legend is on Fig. 27 . This is an approximate stratigraphic section with unit widths measured from aerial photographs after examination and mapping of outcrops.

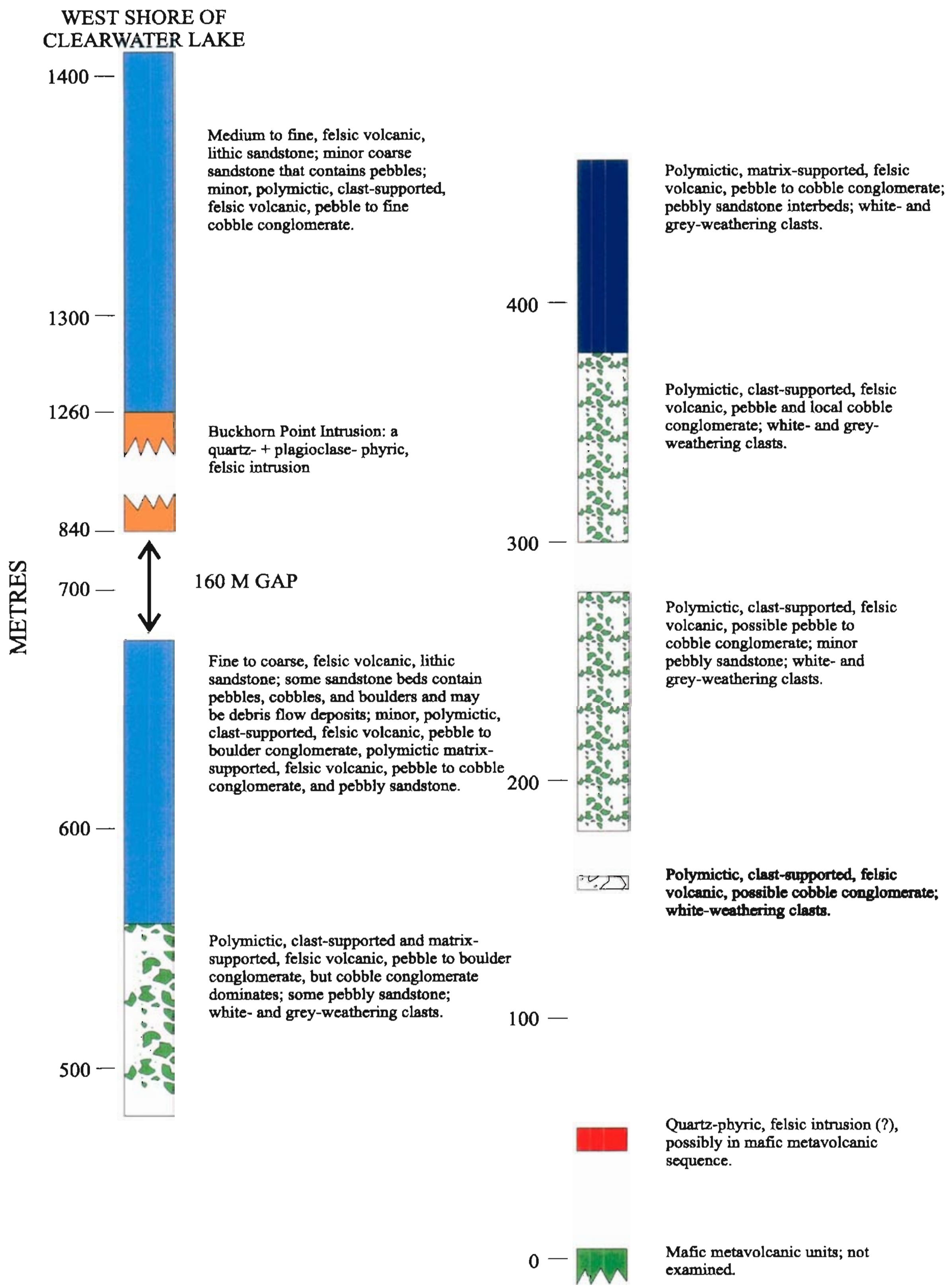



Fig. 25. Stratigraphic section 4 through the lower part of the Clearwater Lake felsic volcaniclastic sequence. Section location is on Fig. 27, and legend is on Fig. 22 . This is an approximate stratigraphic section with unit widths measured from aerial photographs after examination and mapping of outcrops.

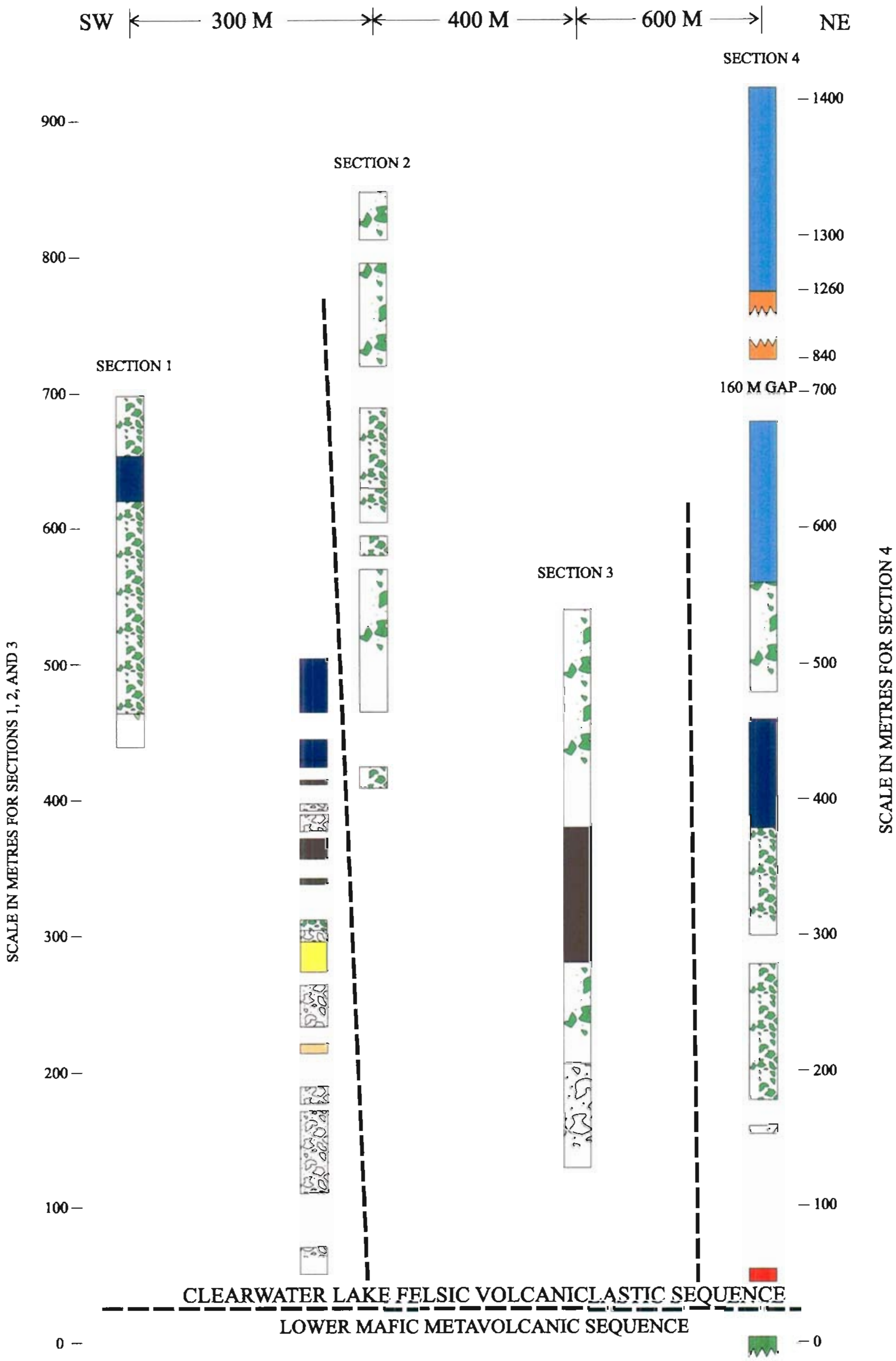



Fig. 26. Measured sections through the lower part of the Clearwater Lake felsic volcaniclastic sequence. See Fig. 27 for locations, Fig. 22 for legend, and Figs. 22, 23, 24, and 25 for unit descriptions. Datum is the inferred base of the sequence where it overlies the lower mafic metavolcanic sequence; this contact is apparently a fault. The top of the sections is the west shore of Clearwater Lake..

Buckhorn Point and Burnt Narrows (Menary Township map), and, as noted below, the presence of faults in the sequence. There is also some evidence of southwestward fining adjacent to the lower mafic metavolcanic sequence. In the zone of interdigitation, tongues of the Clearwater Lake sequence contain sandstone, and conglomerate in the tongues appears to be somewhat finer than conglomerate in the main part of the sequence.

The lack of correlation of units, other than clast-supported conglomerate, the dominant lithology, between measured sections over a lateral distance of only 1.3 km (Fig. 26), indicates the presence of major faults within the Clearwater Lake felsic volcaniclastic sequence. One such fault was located in section 2 (Fig. 23) and a second fault probably occurs between sections 3 and 4 (Fig. 26; Menary Township map). Although not actually observed in outcrop, the fault in section 2 was located by an abrupt change in lithologies along the foliation strike in a well exposed outcrop; the fault is in a moss-covered area 10 to 15 m wide, and the probable trend of the fault is 170°. On the basis of Blackburn's (1976) mapping, neither of these faults offset the contact between lower mafic metavolcanic units in the northwest and the Clearwater Lake felsic volcaniclastic sequence in the southeast. The lack of offset of this contact is further evidence that the contact is a later fault, possibly a thrust fault. The two faults that offset the Clearwater Lake sequence are probably early, synvolcanic faults. It is also possible that the faults are normal faults, with the northeast sides moved downward relative to the southwest sides. Such movement, combined with a later thrust fault, could account for the northeastward thinning of clast-supported conglomerate and overall fining of the sequence observed when comparing the four measured sections. Other early faults may occur in the sequence, such as the east-southeast-trending fault that truncated the felsic lava flow or dome at the Pipestone Air base (441000E; 5421290N), but more mapping would be needed to locate these faults and to verify the nature of movement on the faults.

Lithologies on the various islands south of Buckhorn Point are generally similar to those observed in the measured sections. However, because of the faults in the Clearwater Lake felsic volcaniclastic sequence, exposures on the islands cannot be related to the various measured sections. Exposure on some of the islands is very good, particularly near cottages, but on other islands, exposure is poor.

*Boundary Relations and Stratigraphy of the Pinewood Lake Felsic Volcaniclastic Sequence*

***Boundary relations:*** In the area mapped, the Pinewood Lake felsic volcaniclastic sequence is separated from the underlying mafic metavolcanic sequence by the Off Lake felsic dike complex and by the younger, late tectonic, Black Hawk stock. In Richardson Township, however, about 5 km west of the mapped area, the Pinewood Lake sequence overlies the mafic

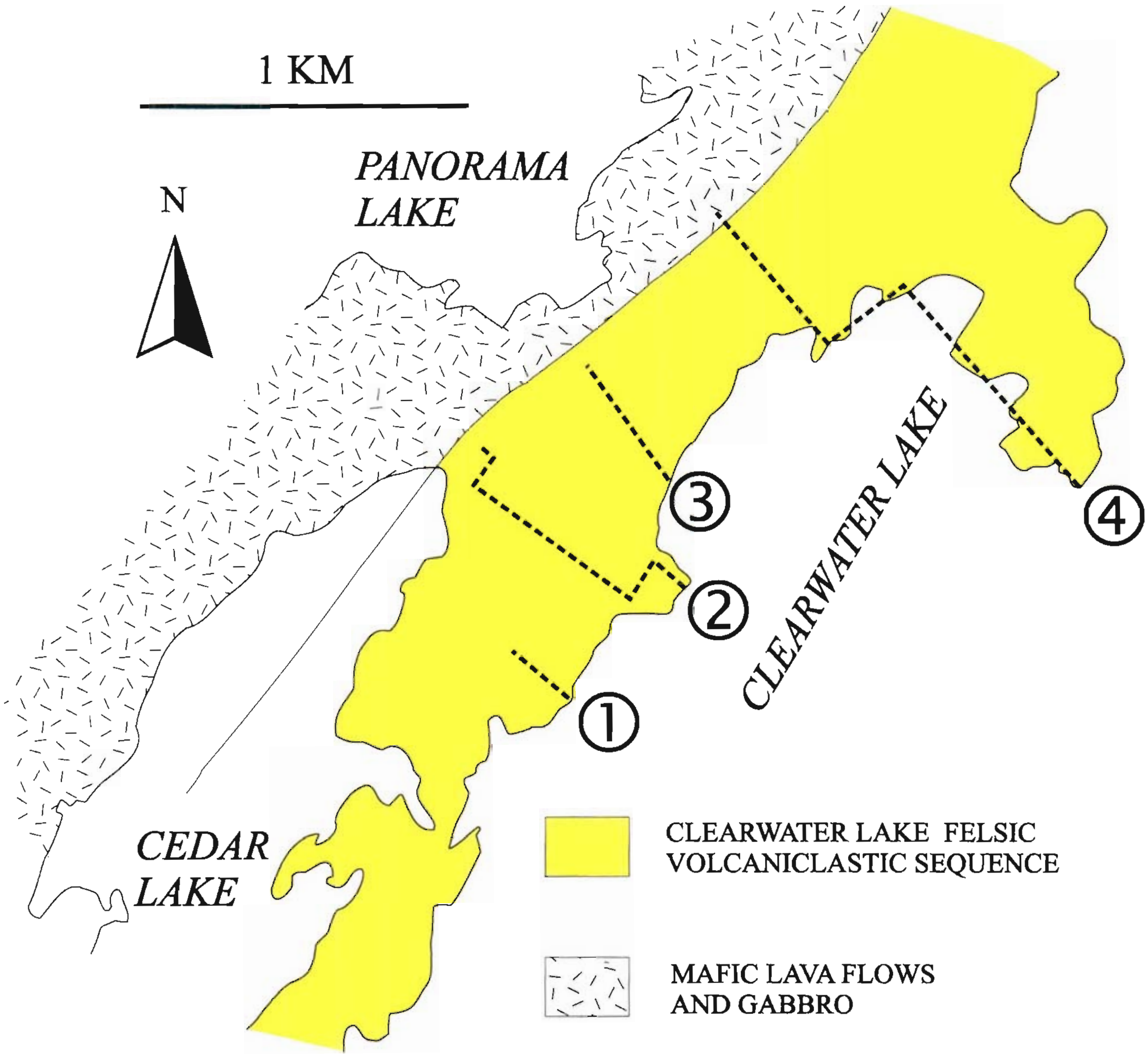



Fig. 27. Location of the four stratigraphic sections through the Clearwater Lake felsic volcaniclastic sequence. Sections are in Figures 22, 23, 24, 25, and 26.

lava flow sequence (Fig. 2; Ayres, 2005a, d, 2006). As discussed later in the structure section, the boundary between the Pinewood Lake sequence and the Off Lake complex is inferred to be a fault, here termed the Potts fault. The location of this fault is uncertain, and it is not shown on the accompanying Potts Township map. Near Highway 615, between Off Lake Corner and Highway 71, the northerly trending, Pinewood Lake sequence is in fault contact with the easterly trending Mather metasedimentary sequence of Fletcher and Irvine (1955). The Pinewood Lake sequence is bounded on the east by a 250- to 500-m-wide, gneissic, mafic metavolcanic unit that separates the Pinewood Lake sequence from the Fleming-Kingsford batholith. The contact between this mafic unit and felsic volcaniclastic units on the west is poorly exposed but appears to be gradational. It is a transition zone at least 40 m wide comprising interlayered mafic and felsic units; the felsic units appear to be dominantly arenitic sandstone.

***Stratigraphy:*** The stratigraphy of the Pinewood Lake felsic volcaniclastic sequence is poorly defined because of low outcrop density and a higher degree of deformation and metamorphism in the southeastern part of the sequence. No facing directions were observed in any of the outcrops examined. Where best exposed, the sequence is about 2 km wide, but the inferred width of the sequence, based on more scattered outcrops, is about 5 km.

In the southeastern part of the Pinewood Lake sequence, lithologic identification is hampered by amphibolite-facies metamorphic grade, strong deformation in the form of both flattening of clasts and abrupt to gradual bends in foliation, and minor granitoid intrusions. In the southernmost 500 m, near the Mather metasedimentary sequence, clasts are commonly strongly flattened, with degree of flattening ranging from 10:1 to 20:1; in such exposures, primary clast shapes could not be determined, and, in many places, only a few clast boundaries could be recognized. The most readily recognizable clasts are mafic volcanic clasts and some of the whitest-weathering felsic clasts. In most places, the author is relatively confident about identification of lithologies, but, in a few places, there is a relatively high degree of uncertainly in lithologic identifications. The metamorphic grade and degree of deformation decrease northward and westward.

In general, the mapped part of the Pinewood Lake felsic volcaniclastic sequence, particularly the eastern, best exposed part, is finer than that at either Clearwater Lake or Richardson Township. The sequence is dominantly polymictic, clast-supported, felsic volcanic, pebble conglomerate with interbeds of cobble conglomerate. Within this conglomerate, there are local interbeds, and, in places, mappable units of polymictic, matrix-supported, felsic volcanic, pebble conglomerate that are commonly associated with felsic volcanic, pebbly sandstone and medium to coarse lithic sandstone. There is a single mappable unit of lithic sandstone and pebbly sandstone that is about 150 m wide and can be traced laterally for 3 km. Felsic lava flows were identified in several outcrops, but these could not be traced laterally because of paucity of outcrop; there appears to be at least two lava flows in the sequence. No pyroclastic flow deposits were recognized.

In the south part of the Pinewood Lake felsic volcaniclastic sequence, near the Mather metasedimentary sequence, flattened clasts are generally <5 cm long, and they are smaller than clasts farther north; there is also a higher abundance of sandstone interbeds. The sandstone increases in abundance southward and dominates in the southernmost outcrop. This sandstone component has very similar bed types and grain size as sandstone in two outcrops of the Mather metasedimentary sequence that were examined along Highway 615. However, there are also major differences between sandstone in the Pinewood Lake and Mather sequences: 1) the abundance of quartz sand grains appears to be lower in Pinewood Lake sandstone than in Mather sandstone, and 2) there is a change in bedding attitude from northerly in the Pinewood Lake sequence to easterly in the Mather sequence.

***Relationship to the felsic volcaniclastic sequence in Richardson Township:*** On the basis of mapping by Fletcher and Irvine (1955), the Pinewood Lake felsic volcaniclastic sequence is contiguous with, but probably stratigraphically higher than, the felsic volcaniclastic sequence that hosts gold mineralization in Richardson Township (Fig. 2); the gold occurrence is about 5 km west of Highway 71, which is the west edge of the 2006 mapping. The area between Highway 71 and previously examined outcrops in Richardson Township (Ayres, 1997) has only sparse outcrops, and this area was not examined during the present survey. Relationships between the mapped part of the Pinewood Lake felsic volcaniclastic sequence and that in Richardson Township are also complicated by the late tectonic Black Hawk stock (Fig. 2).

The mapped part of the Pinewood Lake felsic volcaniclastic sequence has many lithologic similarities with the felsic volcaniclastic sequence intersected by drill holes in Richardson Township (Ayres, 2005a, b, d, e; 2006). These include 1) the predominance of polymictic, clast-supported, felsic volcanic conglomerate, 2) the dominance of felsic volcanic clasts that are texturally and compositionally variable, 3) the occurrence of intercalated felsic lava flows or domes and minor lithic sandstone, and 4) the strong flattening of clasts. There are also lithologic differences including 1) the paucity of mafic volcanic clasts in Richardson Township relative to the mapped part of the Pinewood Lake sequence, 2) larger clasts in much of the drilled part of the sequence in Richardson Township, 3) the common occurrence of thick pyroclastic flow deposits in Richardson Township and absence in the mapped part of the Pinewood Lake sequence, 4) the local presence of intercalated mafic lava flows in the sequence in Richardson Township and 5) the presence of a caldera in Richardson Township. The lithologic similarities support the physical continuity of the Pinewood Lake felsic volcaniclastic sequence around the south part of the Black Hawk stock into Richardson Township. The differences, on the other hand, support the inferred higher stratigraphic position of the mapped part of the Pinewood Lake sequence based on distance from the underlying mafic lava flow sequence.

***Relationship to the Clearwater Lake felsic volcaniclastic sequence:*** The Pinewood Lake felsic volcaniclastic sequence is separated from the Clearwater Lake felsic volcaniclastic sequence by the Off Lake felsic dike complex and a southeasterly trending mafic metavolcanic unit (Fig. 2). In spite of this separation, both sequences appear to overlie the southeast-facing, mafic metavolcanic flow sequence that forms the northwest side of the greenstone belt. The present physical separation of the two sequences is probably a result of displacement along the Potts fault (Fig. 37; see Structure and Stratigraphic Reconstruction sections). It is thus inferred that the two sequences were originally part of a single felsic volcaniclastic sequence that extended from Richardson Township to Senn Township.

This interpretation is supported by the many similarities between the two sequences. 1) Both sequences are dominantly polymictic, clast-supported, felsic volcanic conglomerate. 2) In both sequences, clasts are dominantly felsic volcanic but are texturally and compositionally variable. 3) Both white- and grey-weathering felsic clasts are present with white-weathering clasts dominating. 4) Sparse mafic volcanic clasts are present in both sequences. 5) Interbeds and mappable units of matrix-supported, felsic volcanic conglomerate and felsic volcanic, lithic sandstone occur in both sequences. 6) Sparse felsic lava flows or domes were identified in both sequences.

There are also lithologic differences between the two sequences. 1) The conglomerate in the mapped part of the Pinewood Lake sequence is dominantly pebble conglomerate and is finer than the pebble to cobble and local boulder conglomerate that characterize the Clearwater Lake sequence. 2) In the lower part of the Clearwater Lake sequence, grey-weathering felsic clasts are rare, but grey weathering clasts are common throughout the mapped part of the Pinewood Lake sequence. 3) Possible felsic pyroclastic flow deposits were identified in the Clearwater Lake sequence, but were not observed in the mapped part of the Pinewood Lake sequence. These lithologic differences may be a result of different stratigraphic positions; the mapped part of the Pinewood Lake sequence may be stratigraphically higher than the Clearwater Lake sequence. The Clearwater Lake sequence may be stratigraphically equivalent to the felsic volcaniclastic sequence that hosts the gold mineralization in Richardson Township, but outside of the caldera defined in Richardson Township.

*Mather Metasedimentary Sequence*

Only two outcrops of this sequence were examined, and both of these are along Highway 615, west of Off Lake Corner (Potts Township map), where metamorphic grade is amphibolite facies. Where examined, this is a white- to pale-grey- to locally rusty brown-weathering, quartzo-feldspathic unit that has an average grain size of 0.5 mm and contains about 5% biotite and variable amounts of muscovite; it is probably an arenite. Much of the sequence appears to be an intercalation of 1) thinly bedded, finer sandstone bed sets that are as much as 1 m wide and have internal 0.5- to 5-cm wide beds, and 2) more massive, coarser sandstone beds that are generally 10 to 100 cm wide, but are locally several metres wide. Bed contacts are generally sharp and are defined by abrupt changes in grain size. In the coarser beds, there is relict clastic texture defined by grains as large as 2 mm; the coarser beds contain at least 40% quartz but only minor muscovite. Medium sandstone beds, the dominant component, contain as much as 10% muscovite. There are vague hints of grain gradation in some of the thinner beds, but the gradation is too vague to use in determination of facing directions.

Bedding generally trends 075 to 145°, and the bedding trend varies slightly from place to place as a result of warping. Locally the bedding trend is markedly different ranging from 170 to 020°, presumably reflecting larger folds. Changes in strike orientation generally appear to be progressive rather than abrupt, indicating large-scale, rather than small-scale folds. Dip is much more consistent and is generally about 80° south. Locally S folds, Z folds, and isoclinal folds were observed in outcrop; these have amplitudes of 50 cm, and, in the isoclinal folds, the axial plane is parallel to bedding.

*Subvolvanic Intrusions*

Subvolcanic intrusions are a ubiquitous component of the mapped area. Although Blackburn (1976) recognized that these intrusions were present, he did not map them because of the reconnaissance nature of his survey. There are two major types of subvolcanic plutons: 1) metagabbro, and 2) metamorphosed, quartz- ± plagioclase-phyric, felsic intrusions. Metamorphic grade is greenschist facies except adjacent to the Fleming-Kingsford granitoid batholith where there is an amphibolite-facies contact aureole.

Most of the metagabbro intrusions are in the mafic lava flow sequence, but minor intrusions occur in both the Clearwater Lake and Pinewood Lake felsic volcaniclastic sequences. Metagabbro intrusions in the mafic lava flow sequence were examined only briefly where they are adjacent to felsic units, the focus of the present mapping. Metagabbro forms dikes, sills, and small stock-like bodies.

Subvolcanic felsic intrusions, on the other hand, were examined in more detail because they host mineralization and were originally mapped by Blackburn (1976) as felsic metavolcanic units (his F2 and F3 units). The felsic intrusions occur mostly as metre-scale dikes, although there are two larger intrusions at Buckhorn Point of Clearwater Lake and in Potts Township. The felsic dikes occur throughout both the lower mafic lava flow and the felsic volcaniclastic sequences, and they are younger than the metagabbro. Felsic dikes occur as both isolated intrusions and, near Off Lake, as a concentration forming a dike complex. Minor, younger, metamorphosed, intermediate to mafic dikes were found intruded into felsic dikes.

*METAGABBRO*

Metagabbro intrusions, many of which are semi-concordant and range in width from 1 cm to more than 1 km, were observed in mafic lava flow sequences, both felsic volcaniclastic sequences, and the Mather metasedimentary sequence. Although most of these intrusions contain 40 to 60% plagioclase, the intrusions vary in composition from leucogabbro with about

80% plagioclase to plagioclase-free pyroxenite. Metapyroxenite was observed only along the hydro line on the Stares option south of Highway 615 (440529E; 5418372N); the metapyroxenite has an average grain size of 5 mm, but some grains are as much as 1 cm in diameter. In wider greenschist-facies intrusions, primary textures are well preserved by pseudomorphs and foliation is absent, but narrow intrusions are recrystallized and foliated. In the amphibolite-facies aureole adjacent to the Fleming-Kingsford batholith, where degree of recrystallization is higher, original textures are moderately preserved by mineral aggregates. Metagabbro here is typically garnetiferous, weakly to strongly foliated, and locally gneissic.

In intrusions wider than 5 m, which were observed in the lower mafic lava flow sequence, as blocks in the Off Lake felsic dike complex, in parts of the Pinewood Lake felsic volcaniclastic sequence, and in the Mather metasedimentary sequence, grain size typically increases to 1 mm about 1 m away from chilled contacts; grain size in the centre of the intrusion is typically 1.5 to 2 mm, and it is locally as coarse as 5 mm. Rarely, there are sharply bounded, pegmatitic patches that vary in shape from ovoid to sheet-like; the patches are as much as 20 cm long and have a grain size of as much as 1 cm. The rapid increase in grain size away from contacts enables metagabbro intrusions to be distinguished from thick, nonpillowed, mafic lava flows in which grain size changes away from contacts are more gradual. The larger metagabbro intrusions are variably magnetic, and, in places, they contain as much as 5% interstitial quartz.

Locally, the metagabbro contains ovoid to lenticular, leucodiorite and leucogabbro xenoliths that contain 20 to 25% mafic minerals and have a grain size of 1 mm. The xenoliths are 3 to 8 cm wide and have slightly gradational boundaries. At one locality (438600E; 5418750N), metagabbro contains a poorly exposed pebbly sandstone xenolith at least 1.5 m wide and 3 m long. This xenolith is intruded by a 3-cm-wide, early felsic dike that is apparently truncated by the metagabbro.

Narrow intrusions are most common in the Clearwater Lake felsic volcaniclastic sequence. Typically, these dikes range in width from 1 cm to 1.5 m, and they are generally <10° discordant to the foliation in the host rock; the foliation is superimposed on the dikes. Many dikes pinch and swell, are somewhat sinuous, and locally are boudinaged with quartz pods occurring between boudins. One narrow dike was observed to pinch out on outcrop. Contacts are sharp and vary from straight to sinuous to zigzag to irregular and interdigitating; in places, contacts appear to be folded. Rare country rock xenoliths were observed in dikes; the xenoliths have been flattened and are now parallel to the regional foliation. The semi-concordant habit of the dikes may be a result of rotation during deformation.

In the higher metamorphic grade, Pinewood Lake felsic volcaniclastic sequence, narrow dikes are less abundant. Locally, bedding and foliation are bent adjacent to metagabbro dikes in this sequence.

Some metagabbro intrusions contain 5- to 10-mm-long, and locally as much as 4-cm-long, rounded to tabular, plagioclase megacrysts (Fig. 28). Tabular megacrysts typically have rounded corners. Where present, megacrysts are generally concentrated in distinct, gradationally bounded zones 0.5 to 4 m wide; these zones contain 10 to 40% megacrysts. Outside of these zones, megacryst abundance is 1 to 3%. In the amphibolite-facies zone, some megacrysts are deformed and lenticular.

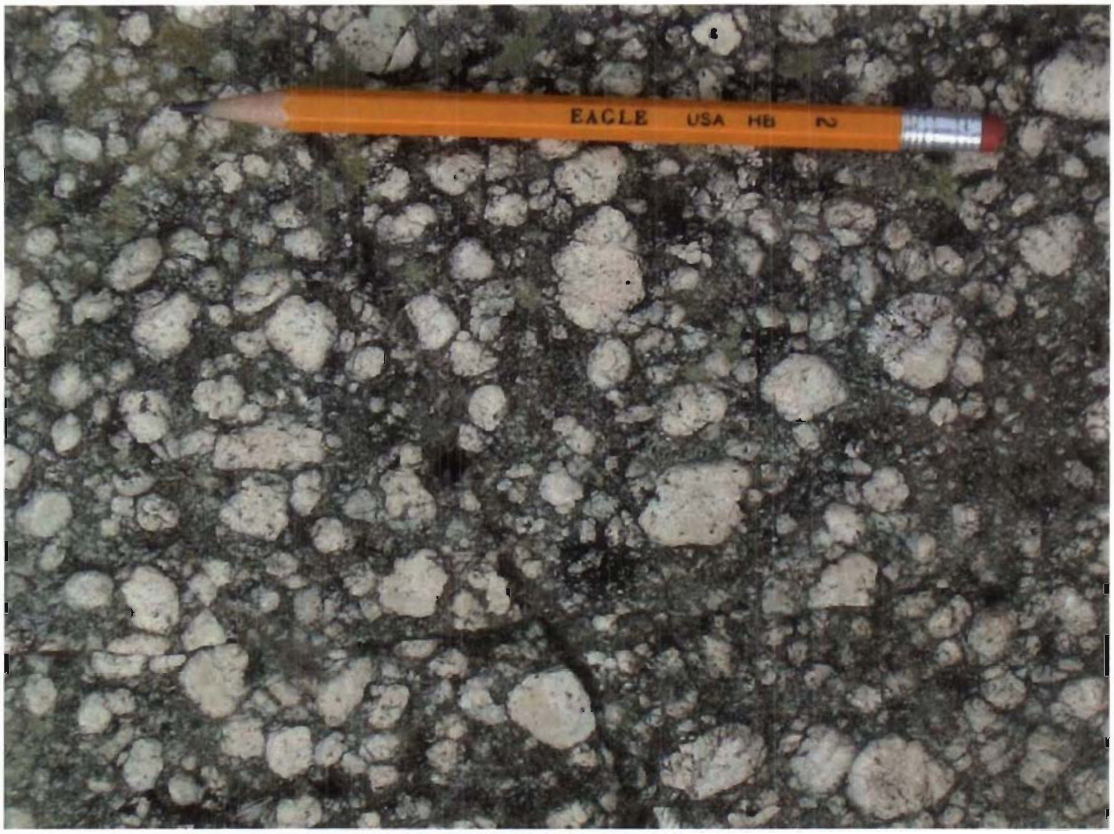



Fig. 28. Plagioclase megacrysts in a metagabbro intrusion in the lower mafic metavolcanic sequence (438650E; 5419750N).

Locally, the larger metagabbro intrusions have a nodular structure that probably represents equant, pyroxene oikocrysts that have been replaced by actinolite ± chlorite pseudomorphs. The possible oikocrysts are 0.5 to 5 cm in diameter and form 25 to 40% of the unit in zones as much as 20 m wide. Where the metagabbro is foliated, the oikocrysts are slightly flattened. Most intrusions are not layered, but local layering is defined by variations in abundance of plagioclase megacrysts and, on a smaller scale, by variations in grain size and mafic mineral content; smaller-scale layers are 2 to 20 cm wide.

There are several ages of metagabbro intrusions. This is indicated by 1) a chilled, 20-cm-wide, metagabbro dike within a larger equigranular metagabbro intrusion, and 2) the presence of plagioclase megacrysts in some intrusions but not in others; megacryst-free and megacryst-bearing intrusions are adjacent to each other but appear to have slightly different trends.

Contacts were not defined because the focus of the work was not on these intrusions, but there is sufficient outcrop to map out both types of intrusions.

## QUARTZ- ± PLAGIOCLASE-PHYRIC, FELSIC DIKES

### Isolated Dikes in Lower Mafic Metavolcanic Sequence

White-weathering, porphyritic felsic dikes are common in parts of the lower mafic metavolcanic sequence, but the abundance and distribution of the dikes is not known. A rapid examination was made of dikes along a logging road between Highway 71 and Preachers Lake (Menary Township map). Porphyritic felsic dikes are present in almost every outcrop, and they contain sparse to 3%, 1- to 3-mm, quartz phenocrysts and, in places, plagioclase phenocrysts. Most dikes contain only minor mafic minerals, but there are local grey-weathering, quartz- and plagioclase-phyric dikes that contain 5 to 15% mafic minerals; mafic mineral content is variable among these dikes. Some of the more mafic dikes contain 1 to 2%, 1- to 4-mm, hornblende phenocrysts. There are rare aphyric dikes.

Although felsic dikes are ubiquitous in the area examined, dike abundance is generally <5%, but, in places, dikes dominate in zones as much as 25 m wide. Dikes range in width from 30 cm to 5 m and are locally as much as 25 m wide. Within the wider dikes, internal contacts were locally observed, and there are variations in abundance of quartz and plagioclase phenocrysts indicating that the wider dikes are composite. In composite dikes, younger intrusions are chilled against older intrusions (Fig. 29), and the outermost part of the chilled margin is laminated; grain size increases rapidly away from the chilled margin. External dike contacts are chilled and straight to somewhat irregular to zigzag in trend; some dikes pinch and swell. Where contacts are irregular or zigzag, the amplitude of the irregularities is generally 5 to 30 cm, and small apophyses locally extend outward from a dike into the wall rock. Locally an early dike is crosscut by a later dike. In places, the dikes contain angular mafic xenoliths as much as 10 cm long. Dike trends vary from 175° through 000° to 035° near the Off Lake felsic dike complex, but farther to the west, there is a wider variation in dike trends.

### Isolated Felsic Dikes in Felsic Volcaniclastic Sequences

White- to locally pale-grey-green-weathering, leucocratic, quartz- ± plagioclase-phyric, felsic dikes were observed only rarely in the felsic volcaniclastic sequences. Where observed in the Clearwater Lake sequence, dikes are 0.2 to 5 m, and rarely as much as 40 m wide and are slightly discordant to the trend of the foliation. Contacts are sharp and straight to curved to sinuous, and, locally, contacts are interdigitating to irregular on a scale of 5 to 10 cm. Phenocryst abundance among the dikes is highly variable, and a few dikes are apparently aphyric. The dikes

Fig. 29. Chilled, weakly laminated contact of a grey, quartz- + plagioclase-phyric felsic dike phase (above hammer head) against an older, pale grey, quartz- + plagioclase-phyric phase within a composite felsic dike that intruded the lower mafic metavolcanic sequence on a logging road between Highway 71 and Preachers Lake (437900E; 5418800N).

contain 0 to 15%, 1- to 4-mm, plagioclase phenocrysts and trace to 8%, 1- to 3-mm, quartz phenocrysts that are difficult to discern, particularly compared to the ease of identification of quartz crystals in clasts in adjacent conglomerate. Groundmass is very fine grained and recrystallized. Wider dikes have distinct chilled contacts that are defined by both finer groundmass grain size and 5- to 15-cm-wide laminated zones. Felsic to intermediate xenoliths, 1 to 3 cm wide, were locally observed in the dikes. Some dikes are internally fractured: anastomosing fractures are defined by grey, sericitic, more schistose seams and lenses that range in width from <1 mm to 5 cm.

Pale-grey-green-weathering dikes are rare, and they were observed only at the south end of Cedar Lake in the Clearwater Lake felsic volcaniclastic sequence; the dikes contain sparse mafic xenoliths. The dikes are texturally similar to the grey-green, possible pyroclastic flow deposits observed in the Clearwater Lake sequence, but contacts are definitely discordant, truncating clasts in conglomerate country rocks.

In the Pinewood Lake felsic volcaniclastic sequence, only rare felsic dikes were observed. The largest intrusion is a pale-grey-weathering, locally garnetiferous, amphibolite-facies, quartz-phyric, composite dike on a logging road east of the south end of Pinewood Lake;

the intrusion is at the edge of a conglomerate outcrop and is at least 20 m wide (436160E; 5408200N). This intrusion may have been also intersected farther north by diamond drill hole PW97-02 (Appendix 3). The composite dike contains <1 to 10%, 1- to 5-, and locally as much as 8-mm, rounded to elongated, recrystallized, quartz phenocrysts; where elongated, the index of elongation is 2:1. The abundance and size of phenocrysts are variable across the outcrop, and changes in crystal abundance are relatively abrupt with contacts varying from sharp to gradational over 10 cm; some contacts are concordant faults. Contacts defined by abrupt changes in phenocryst abundance are subparallel and are within 15° of the foliation direction; they indicate the composite nature of the intrusion. Foliation intensity is variable, and foliation is best developed where phenocryst abundance is low and phenocrysts are more flattened. The intrusion contains rare, lenticular, medium-grey xenoliths that have a grain size of 0.5 to 1 mm and contain 15 to 20% mafic minerals. The composite dike was intruded by narrow metagabbro dikes.

Locally, isolated, 1- to 10-m-wide dikes of the quartz-phyric unit were found in felsic volcaniclastic units, gneissic mafic metavolcanic units, and metagabbro east and northeast of Pinewood Lake. Some of these isolated dikes contain 15 to 20%, 2- to 3-mm, recrystallized plagioclase phenocrysts. Unlike the larger composite dike, which was intruded by metagabbro, these smaller dikes intruded metagabbro forming a stockwork of 1- to 10-cm-wide dikes; in the stockwork, angular corners on metagabbro blocks are well preserved. The different intrusive relationships between the quartz-phyric intrusion and metagabbro indicate a range of ages for these intrusions.

In Lot 5, Concession VI of Mather Township (433700E; 5407080N), there is a younger plagioclase-phyric dike in strongly flattened conglomerate of the Pinewood Lake felsic volcaniclastic sequence. The plagioclase-phyric unit has sinuous, discordant contacts, lacks the foliation that characterizes the host conglomerate, and contains 20 to 30%, 1- to 4-mm, plagioclase phenocrysts; no quartz phenocrysts were observed.

### Buckhorn Point Intrusion

The shape of this pluton, which forms most of Buckhorn Point, is unknown because no outcrop was observed other than on Buckhorn Point, but inferred contacts are semi-concordant. The intrusion has a minimum width of 420 m, the width of the closely spaced outcrops, and a maximum width of 580 m, defined by the closest outcrops of the Clearwater Lake felsic volcaniclastic sequence. Neither contact was observed, but the southeastern contact was located within a distance of 10 to 15 m.

This intrusion is a relatively uniform, white-weathering unit that is grey on fresh surfaces. It generally contains 5 to 10%, 1- to 4-mm, and locally as much as 6-mm, equant quartz phenocrysts and 10 to 20%, 1- to 5-mm, and locally as much as 6-mm, subhedral plagioclase phenocrysts that vary in shape from equant to tabular with an elongation of 2:1. There are some patchy variations in abundance of quartz phenocrysts that occur over distances of only several centimetres, but no internal contacts were observed. The plagioclase phenocrysts typically have shiny cleavage planes, and the plagioclase is less recrystallized than most of that observed in the volcaniclastic units or in the Off Lake felsic dike complex. In places, it is difficult to distinguish plagioclase phenocrysts from groundmass, which has a grain size of about 0.5 mm. The unit varies from massive to foliated, but, where present, the degree of foliation development is much less than in felsic volcaniclastic units. Rare, rounded to angular, 2- to 4-cm-wide, mafic xenoliths were observed.

Locally, the intrusion contains diffusely bounded breccia zones that range in width from 0.3 to 1 m (Figs. 30, 31). Brown matrix forms 15 to 25% of the breccia, and it fills irregular interconnected fractures that are as much as 7 cm wide; the fractures have diverse trends but are approximately perpendicular to the overall trend of the breccia zones. The matrix is very fine grained, but it contain about 5%, 1- to 3-mm, quartz grains and 5%, 1- to 3-mm, plagioclase grains.

Potts Intrusion

This intrusion is represented by a single, isolated, 400-m-long outcrop at the east end of Westra Road, east of Highway 71 (Potts Township map); the size of the intrusion is unknown because of lack of nearby outcrop. This is a white- to pale-brown- to locally pinkish-orange-weathering, metamorphosed, quartz- ± plagioclase-phyric to equigranular unit that is generally weakly foliated. In most places, it contains 5 to 8%, 1- to 4-mm, rounded, equant, quartz phenocrysts, and, locally, particularly in the south part of the outcrop, it also contains as much as 15%, 5- to 10-mm, plagioclase phenocrysts. In most places, quartz phenocrysts are readily identified, but, in other places, phenocrysts are difficult to recognize. Phenocryst abundance appears to vary by a factor of as much as two across the outcrop, and, locally, sharp, chilled contacts were observed between two different phases that differ in overall grain size and in size of quartz phenocrysts; these contacts are irregular and have diverse orientations. In the central part of the outcrop, the unit appears to be equigranular with an original grain size of 2 to 4 mm. The groundmass is a very fine grained, quartzo-feldspathic aggregate that contains 3 to 5% biotite, but, based on the size of biotite aggregates, the original grain size was 0.5 to 3 mm and was variable across the outcrop. The present very fine grain size is a result of greenschist-facies metamorphism. The intrusion contains sparse, metagabbro xenoliths that are as much as 50 cm wide and have a 1- to 2-mm grain size that is uniform across the xenolith. Along the northwest

Fig. 30. Diffusely bounded, brecciated zone in the subvolcanic, quartz- + plagioclase-phyric, Buckhorn Point intrusion (442860E; 5423300N). The irregular brown material is the matrix. See Figure 31 for more detail.

edge of the outcrop, the intrusion has a lenticular weathering pattern defined by 1- to 4-mm-wide lenses; this is probably a sheared phase of the intrusion. Off Lake Felsic Dike Complex

The Off Lake felsic dike complex is a composite, subvolcanic pluton that is about 9 km long and 4.5 km wide. The complex was originally mapped as felsic metavolcanic units by Blackburn (1976; his F2 and F3 sequences; Fig. 5), although Blackburn (1976) did note that the rock units here might be intrusions. From the field work done to date there is no apparent reason for separating the rock units of zones F2 and F3. The rock units are the same on both sides of the assumed zone boundary, and they are continuous across the boundary.

The Off Lake felsic dike complex was intruded into the lower mafic metavolcanic lava flow sequence and metagabbro intrusions on the north and west, but the northwest margin is, at least in part, a fault; the east margin is the younger Fleming-Kingsford batholith. The boundary with the Pinewood Lake felsic volcaniclastic sequence on the south was not observed and is poorly defined because of paucity of outcrop and intrusion of the younger Finland stock. As discussed later in the report (sections on Contacts with Country Rocks, Faults, and Stratigraphic Reconstruction), the south boundary may be an intrusive contact, a fault contact, or an intrusive contact modified by faults. Outcrop density is variable: there is good outcrop control in the

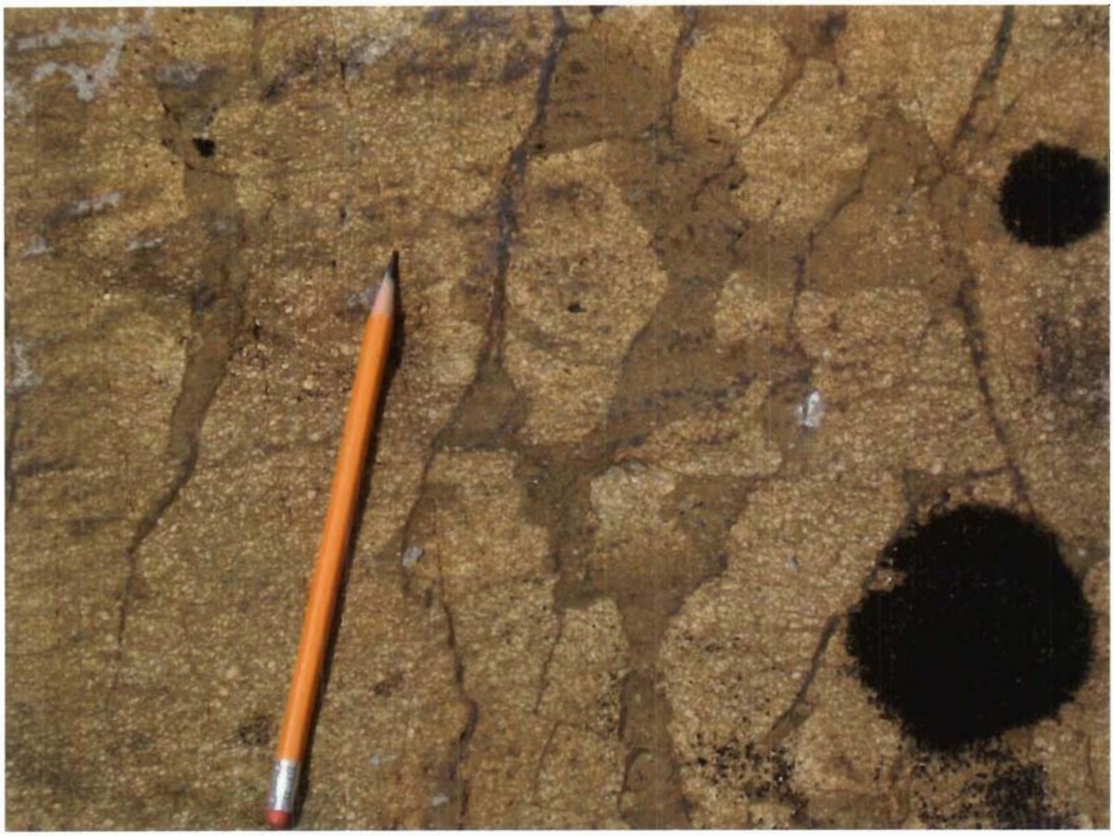


Fig. 31. Close-up of brecciated zone in the subvolcanic, quartz- and plagioclase-phyric, Buckhorn Point intrusion. Photograph was taken close to lake level at a slightly different location from Figure 30, and the overall brown colour is a result of reaction with the lake water. Black spots on right are dried moss.

north and south-central parts of the complex, but other areas lack outcrop. It should be noted that outcrops east of Highway 615 on the Potts Township map accompanying this report were not mapped during the present survey; they are shown on Blackburn's (1976) map.

The complex comprises hundreds to thousands of white-weathering, felsic, porphyritic, commonly leucocratic, dike-like intrusions that generally contain quartz and plagioclase phenocrysts although some phases appear to be aphyric. Internal, chilled contacts between various phases that differ in abundance of quartz and plagioclase phenocrysts, and the ease of recognition of plagioclase and, in places, quartz phenocrysts indicate the composite nature of the pluton. However, the dike-like aspect of individual phases is an inference based on 1) observed parallelism of phase boundaries, 2) the local observation of both contacts of a phase, and 3) the morphology of felsic intrusions in adjacent mafic country rocks.

Within the complex there are large blocks, septa, and mappable megablocks of metagabbro and metabasalt. Many of the megablocks are only partly defined because of either incomplete exposure or incomplete mapping of available outcrops. Small xenoliths are rare in the porphyritic dikes, and many, if not all, of the blocks, megablocks, and septa appear to be residual areas of the pre-porphyry stratigraphy that were not intruded by the porphyritic felsic dikes. This hypothesis is supported by the local observation of pillows in mafic metavolcanic megablocks; the pillows have the same general orientation and facing direction as flows outside of the complex. Boundaries between blocks, megablocks, septa, and porphyritic felsic dikes are typically gradational over several tens of metres, and are marked by progressive, but rapid, increase or decrease in the abundance of well-defined, felsic dikes. Away from contact zones, blocks, megablocks, and septa typically contain <10% porphyritic felsic dikes.

***Felsic porphyritic dikes:*** The dikes are generally white-weathering, but weathered surfaces are locally pale grey, pale-grey green, pale buff, pale cream, or pink. They are quartz-, quartz- + plagioclase-, and locally plagioclase-phyric units that contain 0 to 12%, but mostly 1 to 3%, 1- to 5-mm, rounded to angular, quartz phenocrysts and, in many places, also contain 1 to 20%, 2- to 6-mm, equant to tabular, plagioclase phenocrysts. In some places where quartz-phenocryst content is low, phenocrysts are smaller, with a maximum size of 3 mm. Locally, the dikes also contain as much as 5%, 1- to 3-mm, mafic grains or aggregates that are probably recrystallized mafic phenocrysts. Rarely the dikes appear to be aphyric and fine grained, and these dikes are generally more recrystallized than porphyritic dikes. Contacts are chilled, and groundmass grain size in the interior of dikes ranges from very fine grained to as much as 1 mm; grain size in the dike interior increases as a function of dike width. The groundmass contains trace to 5% mafic minerals.

The ease of recognition of quartz and plagioclase phenocrysts is variable within the complex. The phenocrysts vary from well defined to poorly defined, vague, and almost indistinguishable from the groundmass; this variability probably reflects varying degrees of recrystallization. In places, the abundance of recognizable quartz phenocrysts and degree of recrystallization are variable on a scale of several metres, but, in other places, they appear to be uniform over tens of metres. Within some relatively small areas, the degree of recrystallization of quartz phenocrysts varies from none to complete. Where recrystallized, quartz phenocrysts generally retain circular shapes on outcrop surfaces, but, locally, they are flattened as much as 2:1.

Plagioclase phenocrysts appear to be more recrystallized than quartz phenocrysts, and plagioclase phenocrysts are probably more common than recognized from examination of surface exposures because they are masked by recrystallization. Where identified, the phenocrysts vary from well defined and readily identified to poorly defined, rounded or lenticular aggregates; plagioclase-phenocryst abundance appears to vary from place to place. Locally, where plagioclase phenocrysts are not readily recognized on weathered surfaces, they can be identified by cleavage flashes on broken surfaces. In some dikes, plagioclase phenocrysts are well defined only in chilled margins; in the interior of these dikes, phenocrysts have been partly to completely destroyed by recrystallization.

The dike-like nature of the components of the Off Lake complex can be confirmed at the margins of the complex where the dikes are within mafic country rocks, or in large mafic blocks, megablocks, and septa within the complex. In such places, dikes range in width from 10 cm to more than 10 m, although most are <5 m wide. At several localities on the Stares option at the northeast corner of Off Lake, pinch-and-swell dikes are as narrow as 1 cm. In places, these narrow dikes form a stockwork enclosing angular mafic xenoliths, and these dikes also contain small, angular, mafic xenoliths stoped from the wall rock.

The dikes have sharp, chilled contacts against mafic units (Fig. 32); rarely contacts are faults (Fig. 33). In places, the outer 5 cm of chilled contacts is layered on a scale of 1 to 10 mm; the layering commonly bends to follow irregularities in the contact. Chilled contacts are generally steeply dipping, and undulating to sinuous to irregular to zigzag to locally interdigitating (Figs. 32, 33). Sinuosity of, and irregularities in, contacts vary in scale from place to place; along contacts, irregularities occur over distances that range from 10 cm to tens of metres; in amplitude, they range from 5 to 50 cm. Most of the irregularities are the result of intrusion along several intersecting joint sets, but some are 5- to 50-cm displacements along faults (Figs. 32, 33). Irregularities include wedge-like apophyses as much as 1 m long, angular reentrants along two joint sets, and curving undulations (Figs. 32, 33). Interdigitating contacts are probably the result of later deformation of an originally irregular or joint-controlled contact.

Most dikes are not straight, and measured contacts generally vary in orientation from -170° through 000° to 050° (Fig. 34), comparable in trend to dikes in the lower mafic metavolcanic sequence west of the Off Lake felsic dike complex. The greatest concentration of dike trends is between 020 and 030° (Fig. 34), parallel to the regional stratigraphic trend; thus, most of the intrusions are probably sills. A few contacts have other orientations, particularly where contacts zigzag following two joint sets, and there is a minor concentration of contact trends between -140° and -160° (Fig. 34). In any given area, dike orientation varies from relatively uniform to highly variable. Where contacts zigzag, both mafic country rocks and felsic dikes have rounded to pointed terminations at reentrant corners (Fig. 32). At one location near the northeast contact of the dike complex (439760E; 5419460N), 10-cm- to 4-m-wide, quartz-phyric felsic dikes in metagabbro are folded into curved shapes, and 1-m-wide dikes are folded into isoclinal, S-shaped folds. At this location, there is no consistency to fold shapes suggesting that each dike was deformed independently of other dikes. In nearby outcrops, some dikes have curving contacts with the contact trend changing as much as 40° along a smooth curve. Locally dikes are sinuous.

Locally, contacts between a felsic dike and a metagabbro block are confusing because, close to the contact, the metagabbro contains apparent xenoliths of a porphyritic felsic phase and appears to have intruded the felsic dike. However, the metagabbro has a grain size of 1 to 2 mm at the contact, and it is too coarse grained to have intruded the felsic phase. The apparent felsic xenoliths may represent apophyses that are connected to the adjacent felsic phase above or below the plane of present exposure. Alternatively, the apparent felsic xenoliths could be broken

Fig. 32. Sinuous to zigzag contact between quartz-phyric, felsic dike and mafic metavolcanic septum at north tip of the Off Lake felsic dike complex (438360E; 5420000N). Note narrow felsic apophyses that slightly separates tip of mafic septum. Quarter for scale (arrow in right centre).

felsic dikelets within deformed metagabbro or pieces of a younger felsic dike incorporated into adjacent metagabbro by deformation along the contact. Evidence of contact deformation is supported by local finer-grained, contact zones in metagabbro adjacent to the felsic unit; these finer-grained zones are too narrow to be chilled contacts. Sharp contacts between two porphyritic felsic phases were only rarely observed in outcrop, but they were commonly observed in drill core (Appendix 3). In some places, these adjacent phases differ in 1) phenocryst content, 2) degree of recrystallization and, consequently,

in ease of recognition of quartz phenocrysts, 3) presence or absence of recognizable plagioclase phenocrysts, and 4) colour of weathered surface, but, in other places, there is very little textural difference between two adjacent phases. Contacts between phases are sharp and

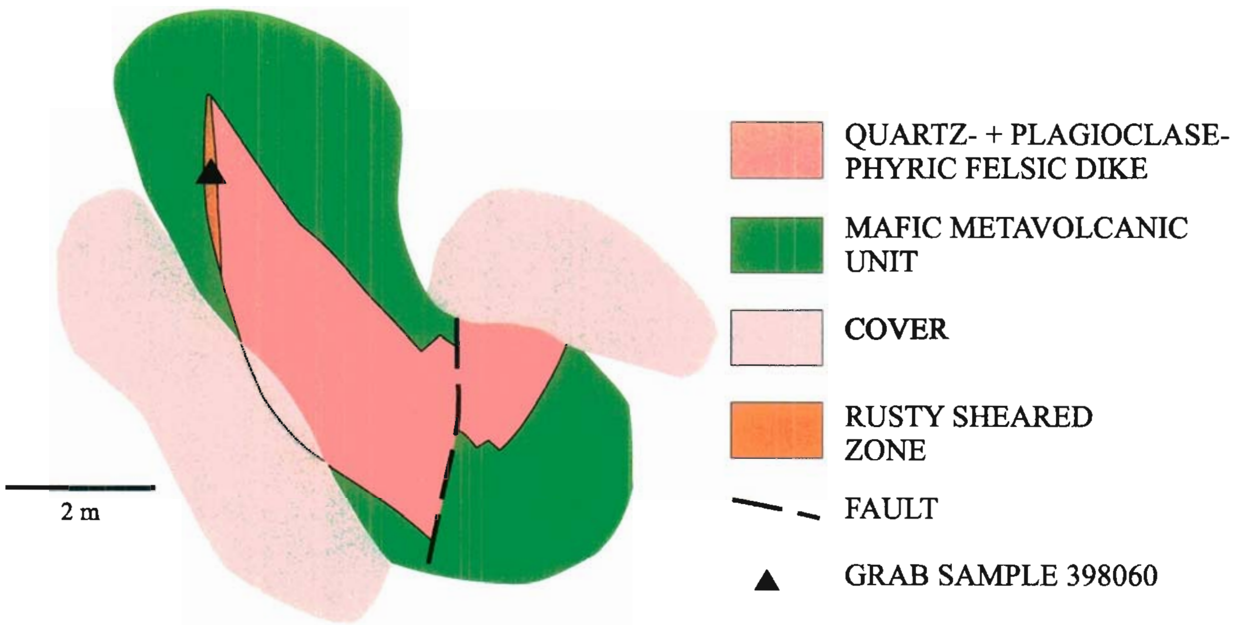



Fig. 33. Sketch map of porphyritic felsic dike in mafic metavolcanic septum of the Off Lake felsic dike complex to show complexity of contacts. Grab sample collected at 438583E; 5416550N west of Off Lake is from a rusty, possibly sheared zone at contact.

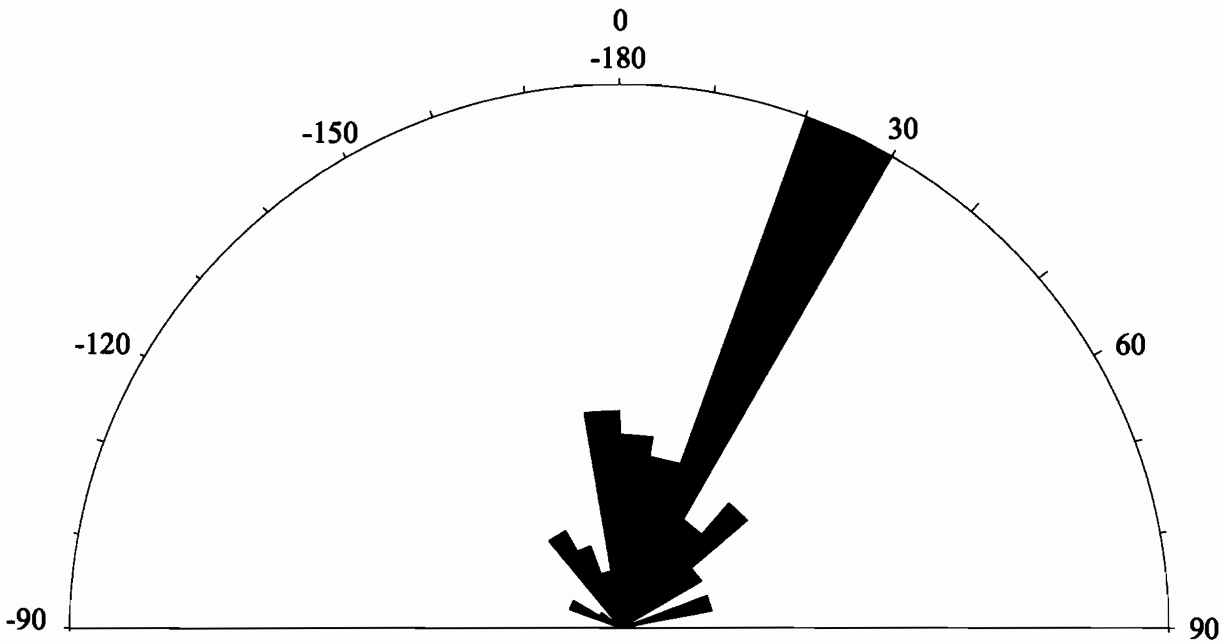



Fig. 34. Half rose diagram plot of trends of contacts of quartz- +/- plagioclase-phyric, felsic dikes in the Off Lake felsic dike complex. Plot is based on 73 measurements.

irregular to zigzag, with the younger phase chilled against the older phase (Figs. 35, 36). Where both contacts are visible, younger phases range in width from 1 to 3 m, but where only one side of a phase is observed, many phases are wider than this. Younger phases are typically less recrystallized than older phases and have better preserved phenocrysts, particularly plagioclase phenocrysts. Other evidence of the composite nature of the porphyritic felsic dikes is the local presence of rounded to angular xenoliths of an older dike phase in a younger phase; these xenoliths are generally 10 to 30 cm long. Some of the xenoliths are a more mafic quartz-phyric phase that contains 1 to 2%, 2- to 5-mm, quartz phenocrysts and 8 to 10% biotite.

Locally, felsic dikes that occur within country rocks and large mafic blocks, megablocks, and septa are also composite; a good example is the composite dike on the Stares option at the northeast corner of Off Lake near the northeast margin of the dike complex. This dike is about 50 m wide, and it can be traced for about 600 m along strike; internal contacts were seen on both outcrop and in drill core (Appendix 3). These composite dikes have external zigzag contacts with zigs and zags on a scale of several metres, but the overall trend is straight to slightly curved.

Fig. 35. A grey, ~1-m-wide, quartz- + plagioclase-phyric, felsic dike (under pencil) intruded into a pale-grey to white, quartz-phyric phase of the Off Lake felsic dike complex near a large metagabbro megablock (438040E; 5417700N). A close up of the slightly sinuous contact is shown in Figure 36.

Where phase boundaries were not observed, the composite nature of the intrusion can be inferred by textural variations across distances of only a few metres. These variations include 1) differences in abundance of quartz and plagioclase phenocrysts, 2) presence or absence of quartz and/or plagioclase phenocrysts, 3) local presence of mafic phenocrysts, 4) variations in degree of recrystallization of quartz and plagioclase phenocrysts, and in resultant ease of recognition of phenocrysts, and 5) variations in roughness of weathered surfaces.

The felsic dikes of the Off Lake complex vary from relatively undeformed, in which case they either lack foliation or have poorly developed foliation, to strongly deformed and well foliated; weak deformation dominates. In places, there are 30-cm to several-metre-wide zones that have a well developed anastomosing shear foliation with a 1- to 5-mm spacing of shear planes. These zones of shear foliation have sharp contacts with massive to weakly foliated units. The sheared and massive components may be separate phases with the massive component being younger, or the highly sheared zones could be faults, which may have developed within discrete phases.

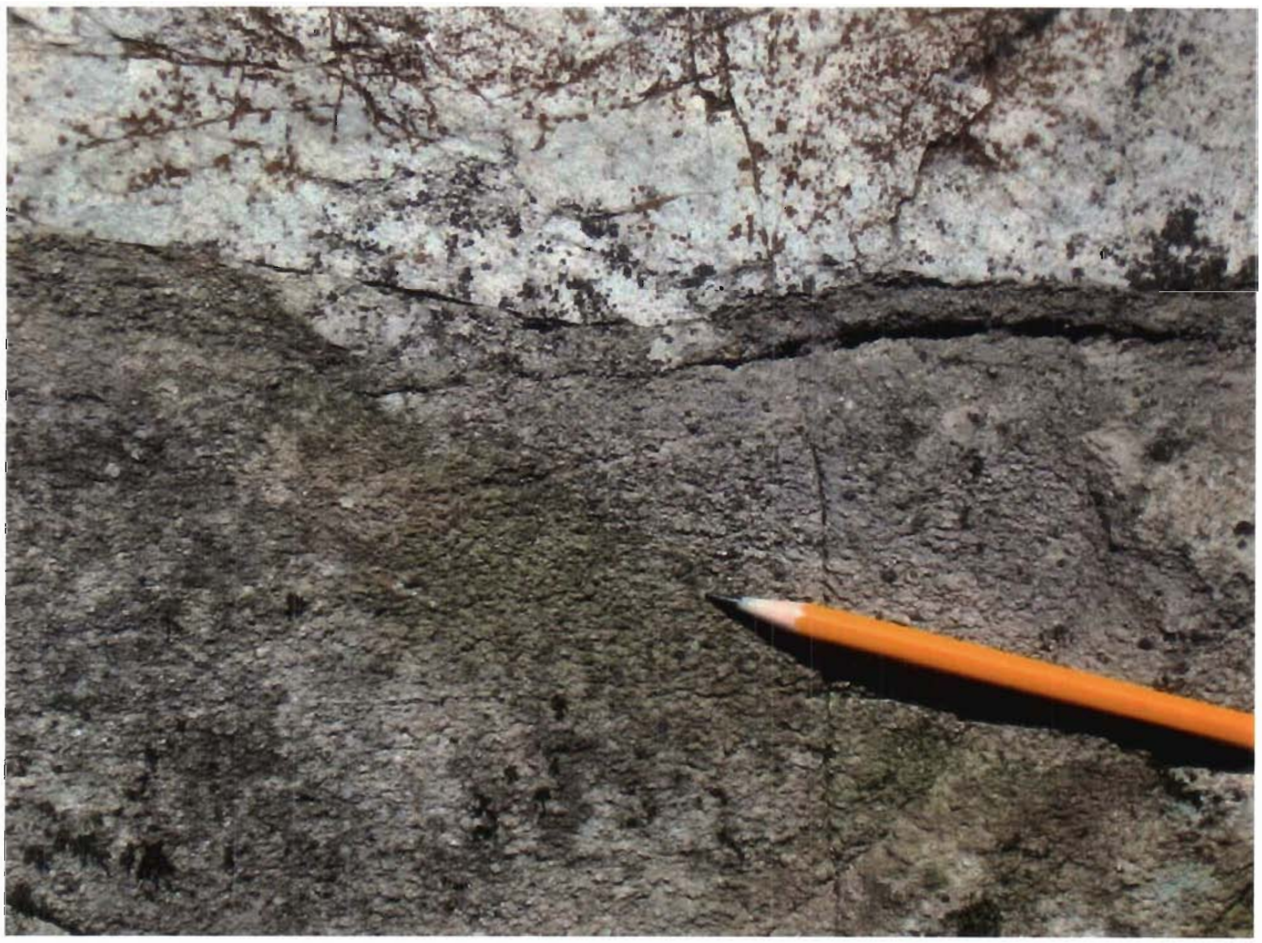


Fig. 36. Close up of the slightly sinuous, chilled contact between a younger, grey, quartz- + plagioclase-phyric, felsic phase, and an older, white, quartz-phyric phase of the Off Lake felsic dike complex. Overview of the contact is in Figure 35.

In many places, the felsic dikes are fractured with diversely oriented, straight to slightly curving fractures that have a spacing of 0.5 to >10 cm. Some fractures are filled by veins of chlorite ± quartz, quartz + epidote, and quartz ± unidentified minerals, but most fractures are empty; where present, veins are as much as 2 mm, and locally as much as 5 mm wide. Although fractures have diverse orientations, the orientations are not random. In many places, the fractures occur as three or four sets, but, in other places, particularly near possible faults, the fractures are mostly semi-concordant and anastomosing with less common discordant fractures. Associated with the fractures, the felsic dikes are variably altered, and the colour of the fresh surface ranges from reddish to greenish to pale grey. The rock is bleached adjacent to some quartz ± chlorite veins.

There are local zones of intense fracturing in the felsic dikes where the rock has a brecciated appearance. Brecciation is particularly evident west of the north end of Off Lake where a plagioclase- ± quartz-phyric unit has, in places, a clastic-like appearance as a result of brecciation (439240E; 5418250N). This brecciated unit, which is at least 50 m wide, is in contact with a mafic metavolcanic unit on the west, and there is possibly a fault boundary on the east. This unit contains both sharply defined zones and gradational patches of brecciation that contain 5 to 15%, 1- to 4-cm-wide, rounded fragments; the fragments are texturally identical to each other and to the matrix, although plagioclase phenocrysts in the matrix are less well defined. The brecciated zones occur within, and the brecciated patches grade into, fractured rock that contains straight to curved fractures that outline fragment-like features, 3 to 15 cm wide, but with little visible matrix; this, in turn, grades into relatively massive rock. Foliation in this brecciated unit is poorly developed, and, where foliation was observed, plagioclase phenocrysts are largely destroyed by recrystallization; locally the foliation is folded.

Near the late tectonic, Finland stock, the felsic dikes vary in weathering colour from white to pink. The pink-weathering component, which is relatively minor, appears to be a distinct, albeit strongly altered dike phase that contains epidote veins. This pink phase has chilled contacts against mafic metavolcanic blocks; the chilled margins contain 2- to 5-mm-long, quartz and plagioclase phenocrysts, but the interior of the pink dikes appears to be equigranular and medium grained. The contact with the mafic metavolcanic block is distinctly different from that normally observed, and it is a stockwork of diversely oriented pink dikelets that extend as much as 40 cm into the mafic block; the dikelets, which are chilled, range in width from 1 mm to 20 cm. Away from the contact, the pink-weathering phase contains angular mafic metavolcanic xenoliths that are as much as 20 cm wide and 35 cm long. In addition to this distinct phase, which may be related to the Finland stock, the more typical quartz- ± plagioclase-phyric dikes in this area commonly have a pinkish weathering; this again may be a function of proximity to the Finland stock.

A texturally different felsic dike was observed on Highway 615 (439290E; 5417942N). This dike, which is 1.5 to 2 m wide, contains 3 to 5%, 2- to 6-mm, quartz phenocrysts and 30 to 35%, 2- to 6-mm, plagioclase phenocrysts in a fine-grained groundmass; in places the plagioclase phenocrysts are almost touching. Within the dike, there are green minerals, possibly fuchsite or malachite, along fractures, and the adjacent country rocks contain copper mineralization (see Economic Geology section).

***The Off Lake felsic dike complex in the contact aureole of the Fleming-Kingsford granitoid batholith:*** In a 1500- to 2000-m-wide zone adjacent to the Fleming-Kingsford batholith in the southeastern part of the mapped area, there is a distinct, amphibolite-facies, contact metamorphic overprint on the Off Lake felsic dike complex. In this aureole, the dike complex is a white to pale-grey to pale-pink, weakly to moderately foliated, recrystallized, granular, quartzo-feldspathic unit that has a grain size of 0.2 to 0.5 mm, and locally 1 mm, and contains 2 to 5% mafic minerals. Recrystallized quartz phenocrysts that vary in shape from spherical to lenticular were commonly observed in much of the northwestern, outer part of the contact aureole farthest from the batholith, but they were observed only locally in the southeastern, inner part of the aureole; recrystallized plagioclase phenocrysts were observed only rarely in the aureole. In the outer part of the aureole, the unit is texturally variable in terms of ease of recognition and abundance of quartz phenocrysts with variations occurring on a scale of several metres. This variation probably reflects the composite nature of the complex, as observed to the northwest where metamorphic grade is greenschist facies, but only a single sharp, chilled contact was observed between phases.

Locally, the felsic dike complex has a distinct granitoid texture and comprises 1- to 3-mm, recrystallized quartz, feldspar, and minor mafic minerals; this granitoid-like appearance could be a coarser metamorphic texture, which was subsequently recrystallized by a later metamorphic event, or an early, recrystallized phase of the adjacent batholith. Farther south, recrystallized granitoid dikes are common in mafic metavolcanic and felsic volcaniclastic country rocks near the batholith. Rarely, distinct, relatively straight but discontinuous, pink, aplite dikes about 5 cm wide were observed in the metamorphic aureole, and these could be genetically related to the batholith. Aplite dikes were rarely observed farther away from the batholith.

***Mafic blocks, megablocks, and septa:*** Massive to well foliated mafic blocks, megablocks, and septa, which comprise both mafic metavolcanic lava flows and metagabbro intrusions, form about 15% of the outcrop area of the Off Lake felsic dike complex. The mafic blocks, megablocks, and septa generally range in width from <2 cm to 30 m, but some are as much as 400 m wide and 1.5 km long; on horizontal outcrop surfaces, shapes vary from equidimensional to lenticular, but the nature of the vertical dimension is unknown. As used in this report, the difference between blocks and septa is lateral continuity along strike; the length of septa is at least three times the width whereas blocks have a lesser length to width ratio. Megablocks and the larger septa are mappable. Although trends of septa are variable (see accompanying maps), the average trend is north to north-northeast, similar to the average trend of felsic dike contacts (Fig. 34). Septa generally do not have the continuity shown by Blackburn (1976) because many are truncated abruptly by porphyritic felsic dikes.

Individual felsic dikes generally contain only rare mafic to locally intermediate xenoliths that were apparently derived from the country rock. These xenoliths vary from angular to rounded to lenticular, and they range in width from 0.5 to 50 cm; locally they are as much as 1 m wide. In places, the xenoliths are confined to dike margins. The blocks, megablocks, and septa, on the other hand, appear to be residual country rock that is more or less in original position; these are surrounded by felsic dikes. Using the lithology of the blocks and megablocks as a guide to preexisting stratigraphy in the area now occupied by the Off Lake felsic dike complex, a metagabbro intrusion at least 400 m wide dominates in the north, and the metagabbro is bordered on both sides by mafic lava flows. Metagabbro and mafic lava flows occur in the same relative stratigraphic position north of the dike complex. Farther south, megablocks and septa are dominantly mafic metavolcanic lava flows with minor metagabbro on the east. Although the megablocks and septa represent residual country rock stratigraphy, intrusion of the dikes would have inflated the thickness of the sequence at least 400%.

Boundaries between felsic dikes and blocks, megablocks, and septa vary from sharp to gradational over 10 to 30 m. In the gradational transition zone, which is a mixture of mafic and felsic units, there is an outward change from a mafic block, megablock, or septum that typically contains trace to 10% felsic dikes to felsic dikes that generally contain only sparse mafic blocks and septa. Except for the transition zones, the Off Lake dike complex normally comprises either mafic blocks, megablocks, and septa with <10% felsic dikes or felsic dikes with <10% mafic blocks and septa. Wider areas of felsic dikes that contain >10% mafic units occur locally; in these wider mixed zones, there is as much as 30% mafic blocks and septa that are generally <5 m wide. There are also local wider areas where mafic metavolcanic units dominate, and there are 30 to 45% felsic dikes; these mixed areas are most common close to the contact between the felsic dike complex and mafic metavolcanic country rocks. In some mafic metavolcanic blocks, there are sparse layered intervals, at least 0.5 m wide, that are associated with increased contents of epidote and subparallel quartz veins as much as 5 mm wide; these appear to be the result of alteration.

***Possible felsic volcaniclastic septa and blocks:*** No felsic volcaniclastic septa or blocks were positively identified in the Off Lake felsic dike complex, even near the south contact with the Pinewood Lake felsic volcaniclastic sequence. However, there are several, narrow, texturally distinct, felsic zones in the complex, the genesis of which could not be determined; some or all of these could be felsic volcaniclastic septa. To complicate the situation, the possible septa are mostly within the amphibolite-facies part of the complex: these features could be either septa or structures resulting from deformation and metamorphism. These possible septa include units that, in places, could be metasandstone and, in other places, metaconglomerate.

Possible amphibolite-facies, metasandstone septa occur as sparse, finer grained, sharply bounded zones and patches that are as much as 20 cm wide and lack visible quartz crystals, which are present in adjacent coarser parts of the dike complex. Some of the finer zones have an internal layering with 1- to 3-cm-wide layers that resemble relict bedding. Although these layered zones could be metasedimentary septa between dikes, they could also be fault zones or narrow, aphyric dikes.

Possible amphibolite-facies, metaconglomerate septa contain sparse, slightly whiter, lenticular structures that are typically 0.5 to 4 cm wide and 4 to 10 cm long and have rounded ends. In most places, the lenticular structures are compositionally and texturally similar to the surrounding rock, but, in the southernmost outcrop of the Off Lake complex near Highway 615 (437500E; 5411450N), the quartz-crystal content of the lenses ranges from trace to 8%. The lenses could be deformed clasts, or they could be the result of deformation and metamorphism of the dike complex. Of these possible septa, the one found in the southernmost outcrop and close to the Pinewood Lake felsic volcaniclastic sequence is the most likely to be conglomerate, but, because of the high metamorphic grade, identification is not certain.

In the greenschist-facies part of the Off Lake felsic dike complex, poor evidence of metaconglomerate septa or blocks was observed at two places. 1) In an outcrop immediately adjacent to Highway 615 (437620E; 5413150N), near the boundary of the greenschist and amphibolite facies, an equidimensional, clast-like pattern is outlined by discontinuous but partly connected mafic seams; the mafic seams are as much as 5 cm wide and >20 cm long. This pattern is probably the result of fracturing and alteration of felsic dikes, possibly combined with some deformed mafic xenoliths. This pattern occurs only locally; elsewhere the dikes are either uniform without fractures or there is a more obvious fracture pattern. 2) In a single outcrop north of Highway 615 (438220E; 5418100N), a concordant zone, about 40 m wide, resembles flattened, pebble to cobble conglomerate in which all clasts are white weathering. In this zone, only some apparent clasts can be defined by slight differences in degree of whiteness, in degree of foliation intensity, and in variations in abundance of quartz (1 to 5%) and plagioclase (0 to 15%) crystals. The apparent clasts are flattened about 3:1 and range in width from 2 to 20 cm; some have rounded ends. Within the possible conglomerate, there are some, more massive zones that are one- to several-metres-wide, younger dikes. These dikes have sharp, undulating, chilled contacts and contain only sparse, 1- to 3-mm, quartz phenocrysts. This possible conglomerate septum is adjacent to a fault, and this, in conjunction with the restricted occurrence and the poorly defined nature of the apparent clasts, suggest that this concordant zone is just a more deformed part of the dike complex in which older phases are more deformed than younger phases; an early fracture pattern may have been deformed into the lenticular structure that resembles clasts. The apparent small-scale differences in crystal contents may be a result of variable degrees of recrystallization. In summary, the possible metasedimentary blocks and septa are probably just more deformed parts of the dike complex.

***Contacts with country rocks:*** West and north of Off Lake, boundaries between the dike complex and mafic metavolcanic and metagabbroic country rocks are well defined, but are, in part, modified by faults (Menary Township map). Where faults are absent, the contact varies from relatively sharp to gradational and from straight to irregular. The contact north of Preachers Lake is relatively sharp with sparse felsic dikes in country rocks and sparse mafic septa in the dike complex. Gradational contacts, on the other hand, are zones as much as 200 m wide of intermixed country rocks and semi-concordant, quartz- + plagioclase-phyric, felsic dikes, and such contacts are well exposed west of the south end of Off Lake. An irregular contact is best defined between Off Lake and Spring Lake where an apophysis of dikes extends into country rocks.

As described previously (section on Isolated Dikes in Lower Mafic Metavolcanic Sequence), narrow felsic dikes that are texturally and compositionally similar to dikes in the Off Lake felsic dike complex occur in the lower mafic metavolcanic sequence below the dike complex. The similarity of these dikes with those in the Off Lake complex support a genetic relationship. Minor felsic dikes also occur above the complex in mafic metavolcanic and metagabbroic country rocks, but the upper contact has been defined only near the north end of Off Lake. Most of these dikes, one of which is as much as 50 m wide and contains sulphide and gold mineralization (see Economic Geology section), are less than 500 m above the contact.

The southern boundary of the Off Lake felsic dike complex with the Pinewood Lake felsic volcaniclastic sequence is poorly defined because of sparse outcrop in critical areas. Outcrops immediately east of Highway 71 near Finland were not mapped, but these may have an important bearing on location of the contact. As discussed in the section on Structure, this boundary is inferred to be a fault that has been named the Potts fault.

*Minor Felsic to Mafic IntrusionsS*

Local, aphyric to porphyritic, felsic to intermediate dikes as much as 5 m wide were observed in the metavolcanic sequences and locally in metagabbro. These dikes have sharp, straight to undulating, chilled contacts and a maximum grain size of 1 mm in the centre of the dike. The dikes contain about 15 to 20% chlorite, biotite, and hornblende, and some appear to lack quartz. Porphyritic dikes contain sparse, 1- to 3-mm, quartz phenocrysts, and 2 to 5%, 1- to 3-mm, plagioclase phenocrysts. The relative age of these dikes to the Off Lake felsic dike complex is unknown.

Rarely, quartz- ± plagioclase-phyric, felsic dikes, including those in the Off Lake felsic dike complex, were intruded by more mafic, aphyric, discordant dikes that are metamorphosed, contain 5 to 60% mafic minerals, and are as much as 2 m wide; locally these late dikes are slightly rusty. Contacts are chilled, but grain size in the centre of the dikes is 0.5 mm. A few dikes contain 2 to 3% hornblende phenocrysts. Locally the dikes contain <1-cm-long, felsic xenoliths derived from adjacent, older felsic dikes. The late dikes are massive to foliated and contacts are slightly undulating to sinuous to irregular because of superimposed deformation;

locally contacts zigzag because of emplacement along intersecting fractures. Dike trends are similar to those of the felsic dikes. A single, 1.5-m-wide, late metagabbro dike was observed; adjacent to this dike there are rare, rounded, xenolith-like apophyses of metagabbro in the felsic country rock. These apophyses are about 1 cm wide and occur within 2 cm of the dike contact. Although these apophyses look like mafic xenoliths in the adjacent felsic dike, they are considered to be sections through apophyses that are, in the third dimension, connected to the younger mafic dike. More obvious apophyses as much as 10 cm wide extend outward as much as 30 cm from several of the other late dikes.

### *Granitoid Intrusions*

#### BEADLE LAKE INTRUSION

As mapped by Blackburn (1976), the Beadle Lake intrusion is an east-trending, 1300-m-long by 900-m-wide pluton emplaced in the lower mafic metavolcanic sequence. A single outcrop of this pluton, on the west side of Beadle Lake, was examined to see if the pluton is related to felsic volcanism rather than being syntectonic as inferred by Blackburn (1976). Where examined, and probably elsewhere based on Blackburn's (1976) mapping, the pluton is an intrusion breccia consisting of angular to locally rounded xenoliths in a granitoid matrix. Xenolith abundance is variable with as much as 60% xenoliths in some places; xenoliths are as much as several metres wide. The xenoliths are mostly mafic metavolcanic country rocks, but there are also metagabbro xenoliths as well as altered somewhat recrystallized gabbro xenoliths that were not derived from country rock and may be an early phase of the pluton. The xenoliths are jumbled, with xenoliths of different textures side by side. Some xenoliths are internally fractured with granitoid apophyses as much as 5 cm wide partly penetrating xenoliths, or, in places, separating adjacent pieces that have a jigsaw fit.

The granitoid matrix is pink to grey and contains 1 to 6% chlorite and 3 to 5% quartz phenocrysts that are as much as 3 mm in size. Groundmass grain size is 1 to 1.5 mm. In places, pink, more leucocratic granitoid dikes intruded the dominant grey component. The age of this pluton cannot be determined from the limited data. However, the quartz-phyric nature of the pluton and abundance of xenoliths suggests that it could be a late subvolcanic pluton rather than a syntectonic pluton.

#### SYNTECTONIC INTRUSIONS

The syntectonic granitoid intrusions that border the greenstone belt were not examined during the present survey. However, along the southeastern edge of the mapped part of the greenstone belt, narrow granitoid dikes occur in a distinct zone adjacent to the Fleming-Kingsford batholith. The zone of dike intrusion ranges in width from 3 km in the south to 1 km in the north, and the dikes occur in the Mather metasedimentary sequence, the eastern part of the Pinewood Lake felsic volcaniclastic sequence, the mafic metavolcanic unit east of the Pinewood Lake sequence, and metagabbro intrusions within these sequences; dikes were observed only rarely in the Off Lake felsic dike complex. Dike abundance ranges from <1 to 50%, although, in most places, abundance is <5%; abundance increases towards the Fleming-Kingsford batholith. Because of the high abundance of dikes in the easternmost outcrops of the greenstone belt, the western boundary of the Fleming-Kingsford batholith, as mapped by previous workers (Fletcher and Irvine, 1955; Blackburn, 1976), has been shifted about 300 m eastward.

The granitoid dikes are relatively leucocratic, commonly white-weathering to locally pink-weathering, and concordant to more commonly discordant; in places, dikes are as much as 40° discordant, but the degree of concordancy increases toward the batholith. Dikes range in width from several centimetres to more than 15 m; however, most dikes are <50 cm wide. The dikes lack chilled margins, are commonly foliated, and appear to be recrystallized; grain size is typically 0.5 to 1 mm. Most dikes are relatively straight, except for minor offset along faults, but, locally, the dikes are folded. The dikes locally bifurcate. Where both white- and pink-weathering dikes are present, white-weathering dikes predate pink-weathering dikes. Where metagabbro intruded the Pinewood Lake felsic volcaniclastic sequence, granitoid dikes are much less abundant in the metagabbro than in the felsic volcaniclastic rocks. Rarely, there are pink pegmatite dikes that are as much as 50 cm wide and have a grain size of as much as 10 cm.

## LATE TECTONIC INTRUSIONS

There are three late tectonic stocks in the Off Lake area; from west to east, these are the Black Hawk, Finland, and Burditt Lake stocks (Fig. 2; Blackburn, 1976). Only the Finland stock was examined during the present survey, and this examination was confined to two small outcrops within the stock and dikes from the stock emplaced in the adjacent Off Lake felsic dike complex. The outcrops were examined because they are not on Blackburn's (1976) map. Where examined, the Finland stock is a pink, granitoid unit that has a grain size of 2 to 3 mm and contains 15 to 30% quartz and 0 to 3%, 8- to 10-mm-long, potassic feldspar phenocrysts. Phenocrysts were observed in only one of the outcrops, which is in the centre of the stock; the granitoid unit here is massive. In the other outcrop, which is at the northeast margin of the stock, the granitoid unit is equigranular, massive to foliated, and altered. Foliation and alteration in this outcrop may be related to a fault.

Within 100 m of the Finland stock, pink granitoid dikes at least several metres wide were observed in the Off Lake felsic dike complex. These dikes have a grain size of 1 to 2 mm and contain 20 to 25% quartz as well as sparse, 5- to 8-mm-long, potassic feldspar phenocrysts. Texturally, these dikes are similar to the Finland stock, although somewhat finer grained. Aplite and pegmatite dikes, which are generally 10 to 20 cm wide, also occur in the Off Lake dike complex and were observed farther from the stock than granitoid dikes.

## METAMORPHISM

In most of the mapped part of the greenstone belt, metamorphic grade is greenschist facies, and, as a result, some primary textures are preserved by either primary minerals or pseudomorphs. However, textural preservation is spotty, and many primary textures and structures were destroyed by metamorphism and accompanying deformation. The best preserved primary textures are quartz crystals and phenocrysts in volcanic and subvolcanic units, but even these are masked by recrystallization in some places. Clastic textures, although modified by deformation, are variably preserved in conglomerate and sandstone..

Metamorphic grade increases southeastward and is amphibolite facies in the Mather metasedimentary sequence, and in the eastern parts of the Pinewood Lake felsic volcaniclastic sequence and the Off Lake felsic dike complex (see previous description). In amphibolite-facies metaconglomerate, clasts are highly flattened, and the clastic nature of the unit is best defined by trace to 2% and rarely as much as 5% mafic clasts; many of the mafic clasts are garnetiferous. Between the mafic clasts is a more uniform felsic component that has a vague, streaky, lensy pattern on weathered surfaces; the lenses, which may be highly deformed clasts, are defined by slight colour variations from white to pale grey, by differences in metamorphic grain size, which ranges from 0.2 to 1 mm, and probably also by slight differences in mafic-mineral content. Clast recognition is most difficult in pebble conglomerate, but, even in the highly deformed, amphibolite-grade conglomerate, sparse rounded clasts could be identified. Where exposure is good, 5 to 25%, sharply bounded, felsic clasts can be defined within a more uniform felsic component that is probably also flattened clasts. In the amphibolite-facies zone, quartz crystals are commonly recrystallized, which hampers crystal recognition. Mafic metavolcanic units in the amphibolite-facies zone are gneissic. The amphibolite-facies metamorphism is probably the result of proximity to the Fleming-Kingsford granitoid intrusion to the east and/or to the increased metamorphic grade of the Quetico Subprovince to the south.

There is a contact metamorphic aureole adjacent to the late tectonic Burditt Lake stock. Effects of this contact metamorphism were observed on islands in Clearwater Lake where, in volcaniclastic rocks, there is a slight increase in grain size producing a more granular texture. No contact metamorphic effects were observed near the late tectonic Finland stock, but outcrop here is sparse. In the Off Lake felsic dike complex near the Finland stock, however, there is local pinkish colouration that may be the result of intrusion of the stock.

## AEROMAGNETIC EXPRESSION

On maps showing residual aeromagnetic intensity (Geo-Digit-Ex, 2006a, b; see accompanying maps), there is some correlation between geologic units and magnetic intensity. In the metavolcanic sequence, the largest positive anomalies are in the mafic units, particularly in the upper 1 km of the lower mafic sequence northeast of the Finland stock, and in mafic units along the east side of the Off Lake felsic dike complex. Although only the margins of this magnetic zone were examined during the present survey, the magnetic high appears to correspond with numerous, magnetite-bearing, metagabbro intrusions in the mafic metavolcanic sequence. A single small outcrop of possible iron formation on Highway 615 (439290E; 5417942N) also corresponds with a magnetic high, and this possible iron formation, which is copper bearing, may be more extensive north and west of the highway.

The Clearwater Lake felsic volcaniclastic sequence has a relatively uniform and low magnetic expression, as does much of the Pinewood Lake felsic volcaniclastic sequence. In the Pinewood Lake sequence, however, there is a single, linear, semi-concordant, magnetic high west of Pinewood Lake. The cause of this magnetic feature is unknown, although it does partly correspond with a metasandstone unit mapped in this area. Mr. Watts, a local resident, told the author that he thought there had been some diamond drilling north of his property, which is Lot 3, Concession VI, Mather Township. As described by Mr. Watts, this drilling would have been in, or close to, the aeromagnetic anomaly. The gneissic mafic metavolcanic unit between the Pinewood Lake felsic volcaniclastic sequence and the Fleming-Kingsford batholith is also characterized by a magnetic high; this anomaly extends northward, with decreased intensity into the Off Lake felsic dike complex (Geo-Digit-Ex, 2006a). Both of these positive magnetic anomalies terminate abruptly on the south near the contact with the Mather metasedimentary sequence.

The Off Lake felsic dike complex has a distinctive, irregular, aeromagnetic expression characterized by circular to linear magnetic highs superimposed on an overall low, magnetic intensity background. Where outcrop is abundant, magnetic highs generally correspond to areas where mafic megablocks and large septa are more abundant than elsewhere, but there is only rarely a good correlation between magnetic highs and individual megablocks and large septa. The good general correlation but poor specific correlation may reflect, at least in part, an increase in size or abundance of megablocks and septa with depth.

Many of the other magnetic highs are over areas of the Off Lake felsic dike complex where there is either no outcrop or outcrop density is low, and these highs may indicate that many megablocks and large septa are covered by overburden. For example, a linear magnetic anomaly that is 100 to 500 m west of the Fleming-Kingsford batholith and more than 2 km long extends from a mapped metagabbro septum at the south end to another mapped metagabbro septum at the north end. Outcrops east of Highway 615 between the two septa were not mapped, but Blackburn (1976) does not show any mafic units in outcrops along this magnetic trend. However, closer examination of these outcrops might reveal metagabbro blocks. On the aeromagnetic map (Geo-Digit-Ex, 2006a), this anomaly appears to be a continuation of the anomaly that corresponds with the gneissic mafic metavolcanic sequence east of the Pinewood Lake felsic volcaniclastic sequence. However, as noted previously, there appears to be a fault between the Off Lake felsic dike complex and the Pinewood Lake felsic volcaniclastic sequence and associated mafic metavolcanic units, and the correlation of these two anomalies is probably a coincidence..

Granitoid intrusions have variable magnetic intensity. Only the syntectonic Fleming-Kingsford batholith and the late tectonic Black Hawk stock can be defined by higher magnetic intensities. The small, easterly trending, Beadle Lake intrusion, which was inferred to be syntectonic (Blackburn, 1976), corresponds with a magnetic high, but this magnetic high is much larger than the surface expression of the intrusion, and the trend of the anomaly is perpendicular to the mapped extent of the intrusion (cf. Blackburn, 1976 and Geo-Digit-Ex, 2006b). The magnetic expression of the intrusion may be a result of the large abundance of mafic xenoliths. Alternatively, the intrusion may be larger at depth with a more northerly trend, or the location of the intrusion within the anomaly may be a coincidence.

## STRUCTURE

### FOLIATION AND LINEATION

All of the felsic volcaniclastic units are well foliated to locally schistose and most are lineated, but the intensity of foliation and lineation is variable. Foliation is defined by clast elongation, mineral alignment, and a slaty cleavage, and, where bedding was observed, foliation is generally subparallel to bedding and to lithologic contacts; foliation is locally kinked or folded. Foliation generally trends north-northeast to northeast except along the southwest shore of Clearwater Lake where foliation trend in the Clearwater Lake felsic volcaniclastic sequence is more northerly, and in the southeast part of the Pinewood Lake felsic volcaniclastic sequence where the trend ranges from east to north. In the south part of Clearwater Lake, the change in foliation trend appears to be related to a southeasterly bend in metavolcanic formations in this area. Also in the Clearwater Lake felsic volcaniclastic sequence, foliation intensity is greater along the northeast shore of Cedar Lake than between Cedar Lake and Clearwater Lake or on the shore of Clearwater Lake. This may reflect proximity to a fault along the base of the Clearwater Lake sequence in this area (Menary Township map). Where the intensity of foliation is strong, both here and in the southeastern part of the Pinewood Lake sequence, recognition of clasts, matrix, and the overall nature of the unit is difficult.

In the southeast part of the Pinewood Lake felsic volcaniclastic sequence and the adjacent Mather metasedimentary sequence, foliation trend is variable but is generally easterly to east-southeasterly. In places, the trend is relatively constant, with local folding of the foliation, but, in other places, major changes in foliation direction of as much as 90° occur over short distances; these changes appear to reflect relatively open folds with wave lengths of several tens of metres. In addition to these folds, there is a more gentle warping of the foliation that occurs on the same scale and is represented by changes in foliation orientation of about 10°. Locally, there are abrupt changes in foliation orientation of as much as 70° at faults that are <1 cm wide; these changes may be the result of drag along faults or fault displacement of a fold. There are places where no reliable strike measurements could be made because the strike changes over 5 m.

Adjacent to the Mather metasedimentary sequence, easterly trending foliation in the Pinewood Lake felsic volcaniclastic sequence appears to be at a high angle to bedding, and the foliation appears to be related to a fault that juxtaposed the Mather metasedimentary sequence against the Pinewood Lake sequence. Easterly trending foliation in the Mather metasedimentary sequence, on the other hand, parallels bedding.

Lineation was not measured during the present survey. Lineation is defined by elongation of clasts, mineral orientation, and, in places, elongation of quartz crystals. Where observed, lineation has a steep plunge.

In the subvolcanic Off Lake felsic dike complex, foliation intensity is again variable, but, in most places, the dikes are poorly foliated to massive. Where observed, foliation trends north northeast, parallel to foliation in metavolcanic country rocks.

## FAULTS

Minor faults were observed locally throughout the mapped area. These include discordant to semi-concordant, small-scale structures that are <1 cm wide and offset unit boundaries by several centimetres to several metres (Fig. 33); these faults complicate recognition of the characteristics of the volcaniclastic units. In the Pinewood Lake felsic volcaniclastic sequence, these minor faults offset all rock units, including the youngest granitoid dikes, and some faults are now occupied by granitoid dikes; thus, not all faults are related to the same tectonic event. In places, minor faults caused abrupt changes in the orientation of foliation.

There are also concordant to semi-concordant, strongly foliated zones that form the boundaries between units or occur within units; locally these faults are as much as 40° discordant to the regional foliation trend, and, in places, offset lithologic units. Most of these strongly foliated zones are <0.5 m wide and have sharp to locally gradational boundaries with adjacent units, but some are several metres wide. Locally, drag folds occur in the foliation adjacent to minor faults. Rarely, faults are defined by discordant breccia zones that are as much as 40 cm wide, contain rounded to angular fragments <1 to 10 cm long, and contain 10 to 15% matrix that, in places, is sericitic, and, in other places, is quartz-rich.

More major, map-scale faults are recognized by 1) steep cliffs and gullies along the sides of which there is increased intensity of foliation in zones as much as several tens of metres wide, 2) wide zones where foliation is discordant to bedding attitude, 3) small-scale faults that are near and subparallel to inferred major faults, 4) abrupt lithology changes, 5) changes in bedding attitude, and 6) schistose, altered zones several metres wide. Where identified, most major faults vary in trend from north northeast, parallel to lithologic boundaries to north northwest and discordant, but some have a more easterly trend. Some of the faults were probably initiated during volcanism. Two north-northwest-trending, synvolcanic faults were identified in the

Clearwater Lake felsic volcaniclastic sequence by offset of lithologic units; these early faults are truncated by a later fault at the base of the Clearwater Lake sequence.

A major. east-trending fault forms the boundary between the Pinewood Lake felsic volcaniclastic sequence on the north and the Mather metasedimentary sequence on the south. Although the Mather metasedimentary sequence is lithologically similar to the closest outcrop of the Pinewood Lake sequence, a fault at the boundary is indicated by 1) an apparently higher quartz content in sandstone of the Mather sequence relative to that in the Pinewood Lake sequence, 2) a change in bedding attitude from northerly in the Pinewood Lake sequence to easterly in the Mather sequence, and 3) easterly trending, in places contorted foliation in the southern part of the Pinewood Lake sequence; this foliation is discordant to bedding.

*Potts fault*

A very important structure in the mapped area is the boundary between the Off Lake felsic dike complex in the north and the Pinewood Lake felsic volcaniclastic sequence in the south. The nature of this boundary is critical for understanding volcano development (see section on Stratigraphic Reconstruction) and the relationship between the Clearwater Lake and Pinewood Lake felsic volcaniclastic sequences. Possible explanations for the southern boundary are an intrusive boundary, a fault, or an intrusive boundary modified by a fault.

Any explanation of the nature of the southern boundary must be in agreement with the following facts: 1) no felsic volcaniclastic blocks, megablocks, or septa were positively identified in the Off Lake felsic dike complex, 2) although inflated by dike intrusion, ghost stratigraphy defined by megablocks and large septa of mafic metavolcanic units and metagabbro within the Off Lake complex indicate that mafic units, similar to those mapped north of Off Lake, originally extended to the centre of the Potts Township map sheet, close to the southern boundary of the dike complex, 3) a large mafic metavolcanic septum occurs east of the late tectonic Finland stock and only 1 km north of the inferred location of the southern boundary of the dike complex, and 4) north of the Fleming-Kingsford batholith, mafic metavolcanic lava flows intruded by metagabbro occur above the dike complex. Although an intrusive contact between the older Pinewood Lake felsic volcaniclastic sequence and younger Off Lake felsic dike complex is the simplest explanation for the southern boundary, it is not compatible with the four facts listed above. Intrusion of the dike complex would not have resulted in an abrupt boundary between mafic units in the northeast and felsic volcaniclastic units in the southwest.

Such an abrupt boundary is more compatible with a fault between the mafic and felsic sequences, and a fault boundary is also compatible with the other facts mentioned above. The age of the fault relative to intrusion of the Off Lake felsic dike complex is uncertain. The fault could 1) postdate emplacement of the dike complex, 2) predate emplacement of the dike complex and possibly partly controlled the southern limit of dike emplacement, or 3) predate dike emplacement with some additional movement during or after dike emplacement. Of these possibilities, a post-dike fault is probably most compatible with the relatively abrupt change from the Off Lake felsic dike complex to the Pinewood Lake felsic volcaniclastic sequence.

The location of this fault, which has been termed the Potts fault, is poorly defined because of paucity of outcrop and lack of mapping near Finland, and the fault is not shown on the Potts Township map. The eastern part of the Potts fault is between 2 outcrops, about 600 m apart, near the Fleming-Kingsford batholith, but farther west, between the Finland and Black Hawk stocks, the fault is somewhere in a 3-km-wide interval. Possible limits on the location of the Potts fault are shown on Figure 37.

Between the Black Hawk stock and the Fleming-Kingsford batholith, the upper contact of the lower mafic metavolcanic sequence has been displaced at least 6 km dextrally along this fault. Fault displacement could be 2 to 3 times more than this amount but precise relationships were obscured by intrusion of the Fleming-Kingsford batholith, which truncated the Potts fault, and removed the southeastern part of the Off Lake dike complex. Emplacement of the batholith also appears to have distorted the metavolcanic sequences, and it may have caused some, or all, of the southeasterly bending of the mafic metavolcanic and Clearwater Lake felsic volcaniclastic sequences east of Off Lake. Although not shown on Figure 37, a fault of this magnitude would have extended farther west either into the lower mafic metavolcanic sequence. As discussed later under Stratigraphic Reconstruction, movement on the Potts fault may have segmented a single felsic volcaniclastic sequence into the two geographically distinct sequences, Clearwater Lake and Pinewood Lake, now found in this part of the greenstone belt.

*The Off Lake fault*

A north-northeast-trending fault is inferred beneath Off Lake (Fig. 37) and may be an economically important structure. Immediately north of Off Lake, the fault is well defined by a combination of features including gullies, stratigraphic offset, increased degree of foliation, and schistose, altered zones. On the north side of Highway 615, the fault is marked by an abrupt contact between a metagabbro block and a quartz-phyric felsic dike; at the contact, the felsic dike is highly altered with a 2-m-wide, quartz-rich zone that contains abundant fuchsite (identified by Blackburn, 1976). Rocks in a 20 to 30-m-wide zone are strongly foliated. The fault may extend north as far as Cedar Lake, but outcrops in this area were not examined. On the east side of the bay that forms the southwest end of Off Lake, the southern part of the fault is inferred from quartz veins, minor faults, and alteration observed in gold-bearing, quartz- ± plagioclase-phyric dikes of the Off Lake felsic dike complex in outcrops close to the lake at the top of a steep hill. Within the outcrop, there is a 1.5-m-wide fault zone that trends 020° and is defined by closely spaced, parallel, foliation or fracture planes; this fault is parallel to the inferred major fault. The fracture planes have a spacing of 1 to 5 mm, and there are numerous, <1-cm-wide, concordant quartz veins within this fault zone. Other narrower fault zones with trends between 010° and 020° occur

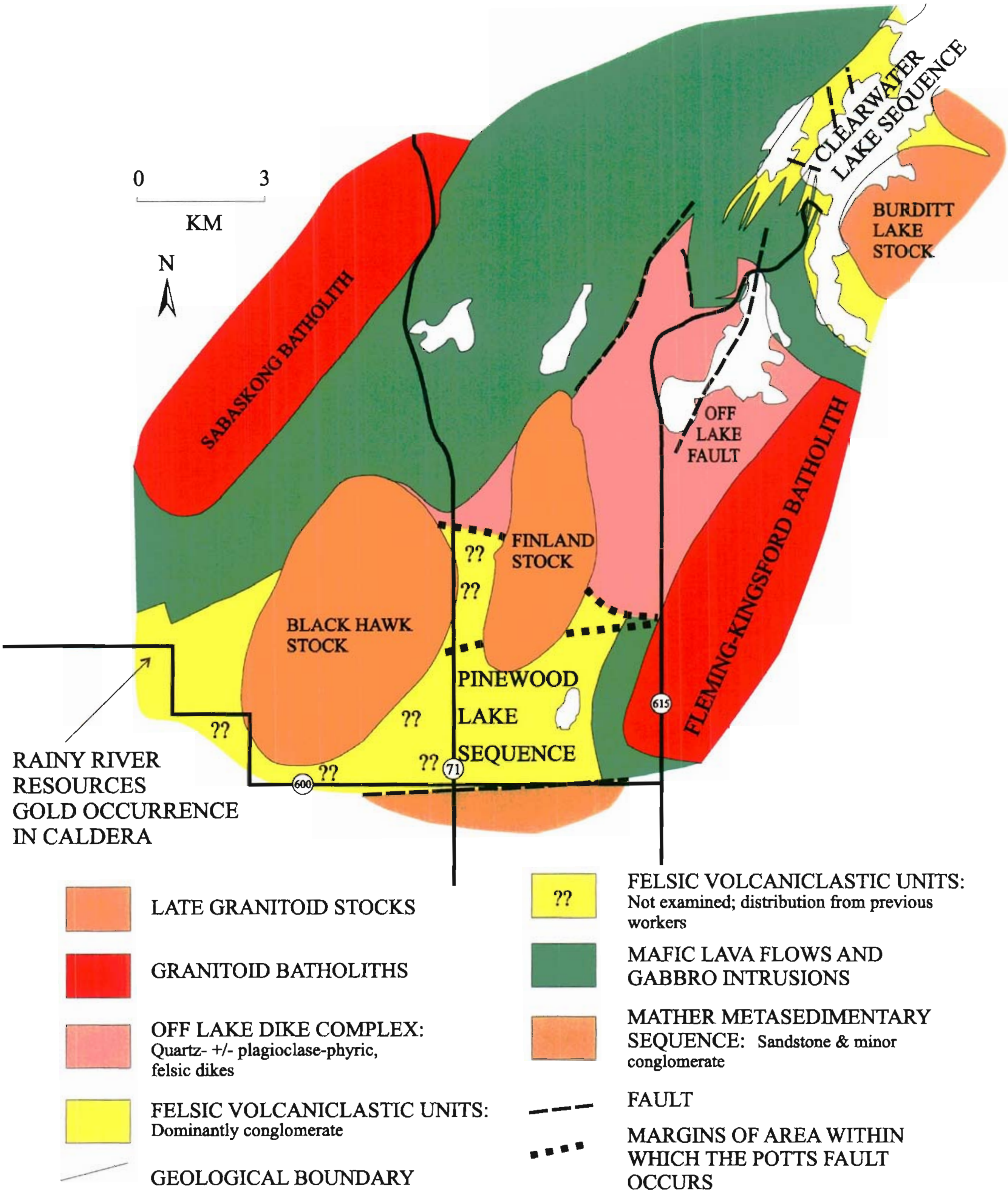



Fig. 37. Sketch map showing location of units defined during the present survey as well as those mapped by Blackburn (1976) and Fletcher and Irvine (1955). The Potts fault, the inferred boundary between the Off Lake felsic dike complex and the Pinewood Lake felsic volcaniclastic sequence, was not precisely located, but it is within the area between the two dotted lines east of the Black Hawk stock.

in nearby outcrops to the east. Also in this area, which is part of the amphibolite-facies aureole of the Fleming-Kingsford granitoid batholith, there is pink alteration associated with quartz ± epidote veins that are several millimetres wide. The pink alteration is a gradational zone, 1 to 10 cm wide adjacent to the veins. The pink alteration zones have the appearance of dikelets because the pink colour highlights aspects of the texture that are not readily visible in the more typical white dikes.

In addition to gold in quartz- ± plagioclase-phyric felsic dikes near the fault, the extension of the fault beneath Off Lake is spatially associated with copper mineralization along the west shore of the lake, and with copper, zinc, lead, gold, and silver mineralization at the Stares option at the northeast corner of the lake. The possible extension of the fault between Off Lake and Cedar Lakes is spatially associated with numerous pyrite occurrences. This spatial association is described in more detail in the Economic Geology section.

## FOLDS

Minor folds of both lithologic units and foliation were rarely observed in outcrops of both the metavolcanic sequence and the Off Lake felsic dike complex. Although not directly observed, larger, but still small-scale, probably isoclinal, folds can be inferred by local reversals in facing directions derived from pillow shapes in the lower mafic metavolcanic sequence and sedimentary structures in the Clearwater Lake felsic volcaniclastic sequence.

The regional fold pattern is uncertain. Facing directions mapped during the present survey and by Blackburn (1976) indicate that the lower mafic metavolcanic sequence and the lower parts of the overlying Clearwater Lake and Pinewood Lake felsic volcaniclastic sequences form a subvertically dipping, homoclinal sequence that has a general northeast trend and faces southeast. This sequence could be the northwest limb of an early isoclinal syncline. In the northwestern part of Richardson Township, west of the mapped area, a south-trending syncline and anticline were recognized by Blackburn (1976) in the mafic metavolcanic sequence (Fig. 5); these are probably younger folds, possibly related to emplacement of the Sabaskong batholith.

Other than local reversals in facing directions mentioned previously, there is no direct evidence of a major synclinal structure. No facing directions were found in the mapped, eastern part of the Pinewood Lake felsic volcaniclastic sequence, and the eastern part of the Clearwater Lake felsic volcaniclastic sequence was not examined. Blackburn (1976) reported a single east-facing structure on the east side of Clearwater Lake, but this measurement is close to the large, late tectonic Burditt Lake stock, and it may not be a reliable indicator of regional facing directions.

The only evidence of a possible synclinal fold is a mafic metavolcanic sequence on the east side of the Pinewood Lake felsic volcaniclastic sequence adjacent to the younger Fleming-Kingsford batholith (Figs. 2, 37), and on the east side of the Clearwater Lake felsic volcaniclastic sequence adjacent to the younger Jackfish Lake complex (Fig. 5; Blackburn, 1976). No facing directions were obtained from these mafic units, which are amphibolite-facies metamorphic grade. The lithologic symmetry of the greenstone belt, which, from the Sabaskong batholith in the northwest to the Fleming-Kingsford batholith and Jackfish Lake complex in the east, is mafic, felsic, and mafic, could represent a synclinal fold. The fold axis would be in the centre of the felsic volcaniclastic sequences, and the eastern mafic units would be a folded equivalent of the lower mafic metavolcanic sequence. Alternatively, the eastern mafic units could overlie the felsic volcaniclastic sequences, and all of the metavolcanic units could be part of a single homoclinal sequence. Such a repetition of mafic units has been observed in many greenstone belts of the Wabigoon subprovince (Blackburn et al., 1991). At the present time, one cannot choose between the two models.

## STRATIGRAPHIC RECONSTRUCTION AND A MODEL FOR VOLCANO EVOLUTION

Because of the relatively small size of the mapped area in relationship to the size of the greenstone belt, any model for volcano development is partly speculative. There are two key parameters that must be compatible with any model for the Off Lake volcano. 1) The Clearwater Lake and Pinewood Lake felsic volcaniclastic sequences are lithologically similar and both sequences stratigraphically overlie the lower mafic metavolcanic sequence. On the basis of lithologic similarity and stratigraphic position, the two felsic sequences should correlate and probably be part of a single sequence. Yet, the two volcaniclastic sequences are separated by the Off Lake felsic dike complex and a northwest-trending mafic metavolcanic unit. 2) Although not exposed, the Potts fault, which forms the boundary between the Off Lake felsic dike complex in the north and the Pinewood Lake felsic volcaniclastic sequence on the south, is a major structure with more than 5 km of dextral movement. Because of paucity of data, the following reconstruction excludes the Mather metasedimentary sequence.

### LOWER MAFIC METAVOLCANIC SEQUENCE

The ubiquitous occurrence of pillows in many places indicates that the mafic volcanism was subaqueous. The form of the early mafic volcano is uncertain; it could have been either a lava plain or a shield volcano. By the late stages of mafic volcanism, however, the volcano had a distinct submarine edifice, possibly a shield volcano (Fig. 38A); this is indicated by the interdigitation of mafic lava flows and felsic volcaniclastic units of the Clearwater Lake felsic volcaniclastic sequence near the south end of Cedar Lake. This interdigitating zone is inferred to represent a primary northward slope (present attitudes) in the mafic sequence.

### CLEARWATER LAKE AND PINEWOOD LAKE FELSIC VOLCANICLASTIC SEQUENCES

The two volcaniclastic sequences are very similar in lithology and probably also in genesis. The bulk of these sequences, particularly the conglomerate, are probably mass-flow deposits; this interpretation is supported by the coarseness of the deposits, thick beds, and typical amalgamated bedding as well as the occurrence in section 2 of the Clearwater Lake felsic volcaniclastic sequence of a large mafic block and several felsic flow lobes (Figs. 13, 23). Transport distances were probably relatively short, although there was sufficient transport to produce the observed rounding and mixing of clasts. An anomalous feature of the conglomerate units is the low matrix content in many beds; this implies transportation down relatively steep slopes.

The depositional environment was apparently subaqueous as indicated by pillows in mafic flows interfingered with the southern part of the Clearwater Lake sequence and by indications of subaqueous deposition found in the lower part of the Pinewood Lake sequence intersected by drill holes in Richardson Township (Ayres, 2005b; 2006). The source region, however, was probably subaerial, because the ubiquitous clast rounding and mixing could not have been produced in an entirely subaqueous environment (e.g. Car and Ayres, 1991). A similar origin was inferred for coarse volcaniclastic units encountered in drill holes in Richardson Township (Ayres, 2005b; 2006).

The interdigitating nature of the southern contact indicates that the Clearwater Lake felsic volcaniclastic sequence was deposited on the northern slope of the mafic edifice. Deposition was probably in a basin that deepened northward (Fig. 38B). Near Buckhorn Point, about 3 km northeast of the inferred mafic slope, there is an upward fining of clast size, increase in matrix content of conglomerate, and better development of bedding (Fig. 25). These characteristics suggest a decrease in relief of the source area or possibly increasing distances from the source terrain, and decreasing rates of sedimentation. The upward fining near Buckhorn Point may correspond with a northeastward decrease in particle size in the Clearwater Lake sequence (Fig. 26), but any lateral change cannot be documented because critical areas are covered by Clearwater Lake, and there is an unknown amount of offset along subvolcanic faults on the west side of Clearwater Lake (see section below on Early Faults).

Sandstone and local mudstone occur also in some of the felsic volcaniclastic fingers interdigitated with the lower mafic metavolcanic sequence, and many of the fingers have a finer particle size than deposits deeper in the basin. The reason for this localized southward fining is uncertain, but it may mean that the coarser mass flows moved through this region to be deposited deeper in the basin on a more gentle slope.

Clasts in the conglomerate are almost entirely felsic volcanic, but, within individual beds, clasts are texturally diverse. This indicates that clasts were derived from a felsic source that was probably produced by a number of felsic eruptions from continually evolving magma chambers. As discussed elsewhere for that part of the Pinewood Lake felsic volcaniclastic sequence intersected by drilling in Richardson Township, the felsic source was probably subaerial stratovolcanoes produced by vulcanian eruptions (Ayres, 2005b, 2006). The centre of these felsic eruptions is unknown, although it could be near the Richardson Township

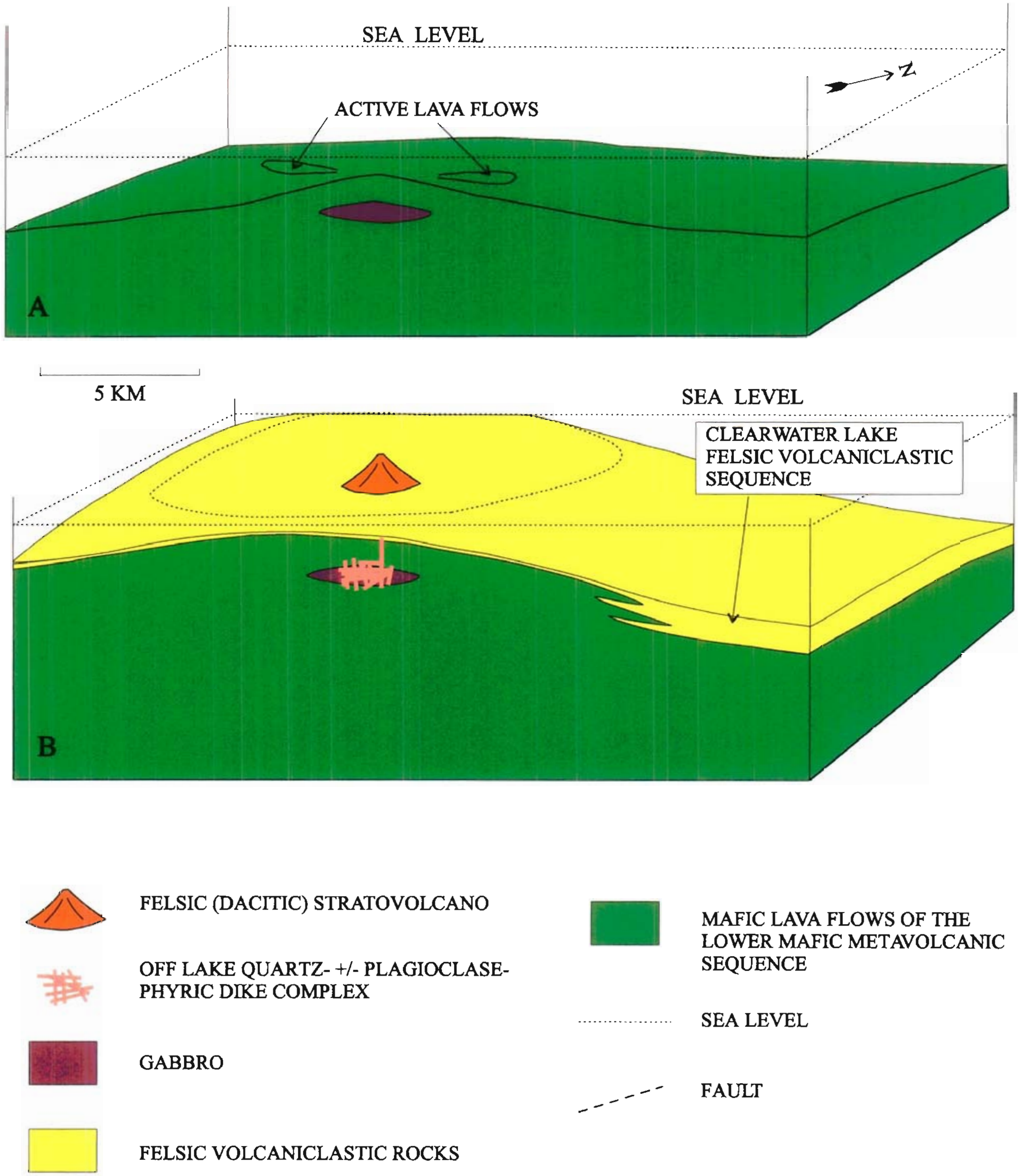



Fig. 38. Four stages in the evolution of the Off Lake volcano. The front face of the block diagrams corresponds to the present erosional plane through the metavolcaniic sequences. A. Eruption of basalt flows of the lower mafic metavolcanic sequence resulted in a submarine edifice. Upper level gabbro magma chamber fed these flows. B. Early stage in the eruption of felsic volcaniclastic sequences from subaerial dacitic stratovolcanoes. Fluctuating dacitic and basaltic volcanism resulted in interdigitation on flank of volcano. Off Lake dike complex was an upper magma chamber feeding dacitic volcanism.

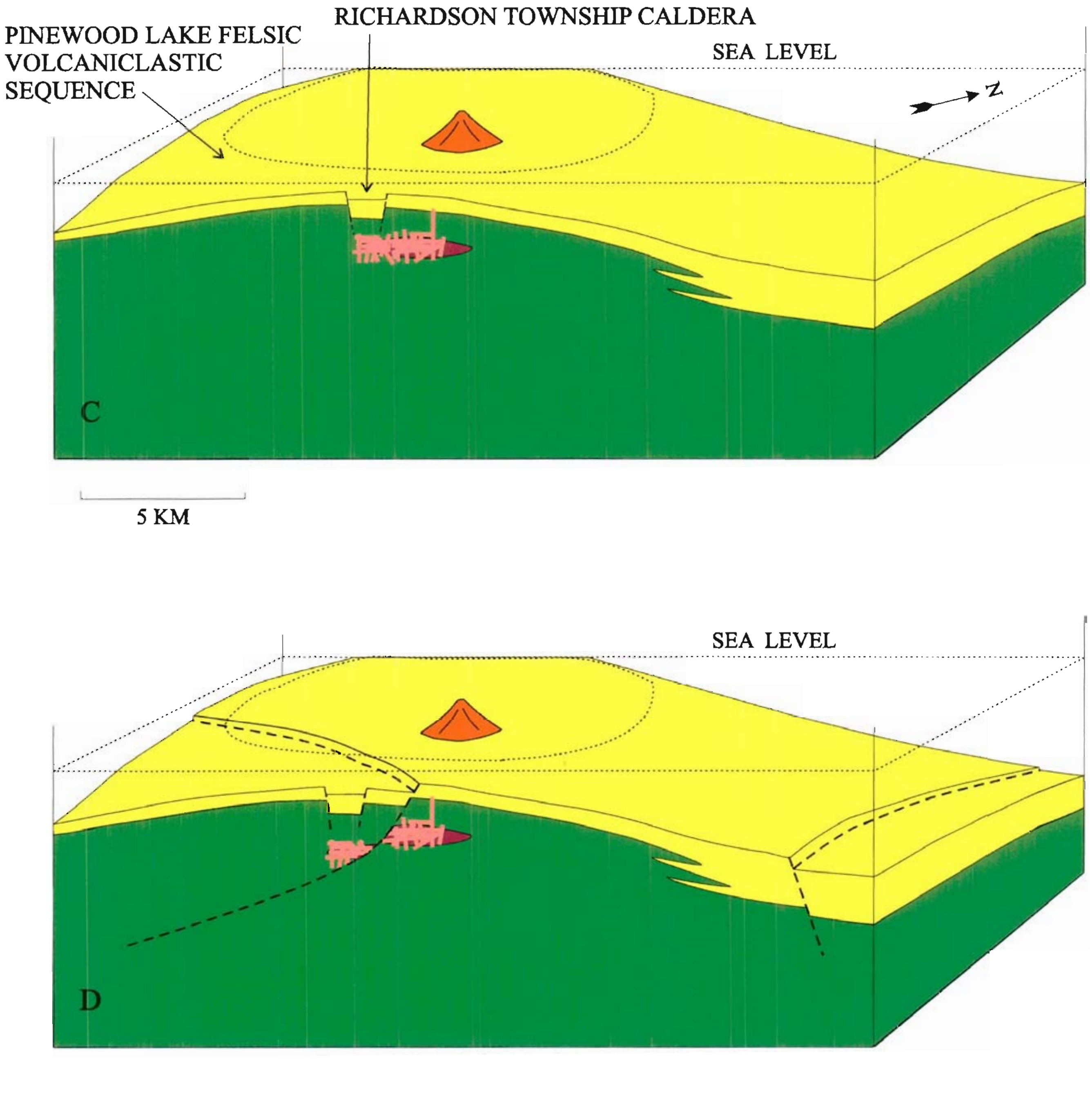



Fig. 38 (continued). Four stages in the evolution of the Off Lake volcano. C. Submarine caldera forms on upper slope of volcano. Off Lake dike complex is inferred to expand in size. D. Normal faults develop on flanks of volcano because of gravitational instability. Fault on left side is in initial stage of development. Eventually caldera is moved 10 to 15 km away from the original location.

caldera described by Ayres (2005a, b, c, d; 2006). At the present time, the caldera is 18 to 20 km southwest of the south end of the Clearwater Lake felsic volcaniclastic sequence (Figs. 2, 37), but, as described later, the distance during volcanism may have been less.

Unlike conglomerate in the caldera in Richardson Township, the Clearwater Lake felsic volcaniclastic sequence and the mapped part of the Pinewood Lake felsic volcaniclastic sequence, which is probably stratigraphically higher than the caldera sequence in Richardson Township, contain about 1% mafic volcanic clasts along with sparse clasts of sulphide-facies iron formation, and rare clasts of metagabbro, chert, vein quartz, and felsic intrusions. The presence of the ubiquitous mafic clasts indicates that there was a long-term, mafic volcanic component in the provenance terrain. This could have been the original mafic edifice exposed in fault scarps or stream gullies, or mafic blocks ripped from vent walls and explosively ejected by felsic vulcanian eruptions. The large, altered, mafic volcanic block found in section 2 of the Clearwater Lake sequence (Fig. 13) was probably derived from a scarp exposed by a fault. Whatever the source of the mafic volcanic clasts, this source did not contribute detritus to the caldera-fill sequence in Richardson Township. Sulphide-facies iron formation clasts, which are stratigraphically restricted, could have been derived from hot spring deposits in the felsic source terrain.

Visual inspection of rock units combined with chemical analyses presented by Blackburn (1976) indicate that the volcanism was compositionally bimodal and was dominantly basalt and dacite to rhyolite. Blackburn (1976) gave four chemical analyses of his felsic metavolcanic units. Of these, one sample from the north end of Off Lake is part of the Off Lake felsic dike complex, two samples are from outcrops near Finland that have not yet been mapped, but could be part of the dike complex, and the fourth sample is from an unknown lithology in Richardson Township, probably outcrops east of Highway 600 and east of the caldera. Thus Blackburn's (1976) samples may not be representative of the felsic volcanism.

The stratigraphic relationship between the lower mafic metavolcanic sequence and the Clearwater Lake felsic volcaniclastic sequence indicate that 1) early mafic volcanism was followed by felsic volcanism, 2) mafic and felsic magma coexisted during the middle stages of volcano evolution because mafic and felsic units are interfingered at the south end of the Clearwater Lake sequence, and 3) mafic volcanism then ceased but felsic volcanism continued. This interfingering indicates fluctuating rates of essentially contemporaneous mafic and felsic volcanism. Because of density contrasts, mafic magma will not rise through felsic magma, although it will rise through adjacent solid wall rocks (Bacon, 1985). Thus, either the felsic and mafic eruptions were from different vents, or from a single vent that produced alternating mafic and felsic eruptions with sufficient time between eruptions for felsic magma chambers to solidify before the next mafic event. The first alternative is preferred because the paucity of mafic clasts in conglomerate suggests that the mafic vents were subaqueous, possibly on the flank of the volcano, whereas the felsic vents were subaerial. Furthermore, there is very little evidence of metagabbro intruded into felsic dikes.

At a late stage in volcano development, felsic volcanism may have been succeeded by renewed mafic volcanism to produce the sequence that now forms the eastern margin of the greenstone belt. This interpretation is problematic because no facing directions have been recorded in the eastern parts of the felsic volcaniclastic sequences or in the eastern mafic metavolcanic sequence, and this eastern mafic sequence could be the folded equivalent of the lower mafic metavolcanic sequence (see previous section on Folds).

## OFF LAKE FELSIC DIKE COMPLEX

The Off Lake felsic dike complex probably represents a felsic magma chamber (Figs. 38B, C). This interpretation is supported by 1) the dimensions of the complex, 2) the hundreds to thousands of metre-scale felsic dikes that form about 85% of the complex, 3) the internal contacts among dike phases, 4) the large size of some megablocks, 5) the preservation of ghost mafic stratigraphy, and 6) the relatively abrupt yet gradational contacts between dikes and blocks, megablocks, and septa. The dike complex occurs in the upper part of the lower mafic metavolcanic sequence, and contacts between the dike complex and country rocks are also abrupt yet gradational over about 100 m. At the present time, the dike complex is at least 800 m below the base of the Clearwater Lake felsic volcaniclastic sequence, but, because of the strong flattening observed in clasts, the original distance is unknown. The felsic dikes are texturally and probably compositionally similar to many of the felsic clasts in the volcaniclastic sequences, and the Off Lake felsic dike complex could be the margin of the magma chamber that fed felsic vulcanian eruptions elsewhere on the volcano, beyond the section now exposed by erosion.

Although the mafic country rocks have been examined only briefly, metagabbro is abundant in country rocks adjacent to, and as megablocks within, the north part of the Off Lake felsic dike complex. The coincidence of metagabbro and porphyritic felsic dikes may imply that the intrusive complex was initially a gabbro magma chamber and then a felsic magma chamber. Both the mafic and felsic magmas may have been feeders to overlying volcanic units.

There is a spatial and possibly a genetic relationship between the location of the Off Lake felsic dike complex and associated metagabbro plutons, and an inferred northeastward slope (present directions) in the mafic metavolcanic sequence east and north of the inferred magma chamber. As discussed previously, this inferred slope probably represents the subaqueous flank of a mafic edifice. The inferred slope may be partly a result of uplift generated by emplacement of the subvolcanic magma chambers.

## SPATIAL AND GENETIC RELATIONSHIPS BETWEEN THE CLEARWATER LAKE AND PINEWOOD LAKE FELSIC VOLCANICLASTIC SEQUENCES

As discussed previously, the two volcaniclastic sequences, including that intersected by drill holes in Richardson Township to the west of the mapped area, are lithologically very similar. Furthermore, both sequences overlie the lower mafic metavolcanic sequence and are more than

2 km wide. Although now separated by the Off Lake felsic dike complex and by a southeast-trending mafic metavolcanic unit as much as 1 km wide, the 2 volcaniclastic sequences were probably originally part of a single sequence that overlay all flanks of the mafic edifice. The present separation of the units is inferred to be the result of dextral fault displacement with the southern block having moved west relative to the northern block along the Potts fault.

Prior to displacement along this fault, which may have been initiated as a synvolcanic normal fault, the caldera sequence in Richardson Township may have been much closer to the present location of the Clearwater Lake felsic volcaniclastic sequence and the Off Lake felsic dike complex (Fig. 38C). The Off Lake dike complex, the southern extent of which is unknown because of the fault movement, could have been the magmatic source of caldera volcanism and associated gold, silver, and zinc mineralization. This proposed relationship is supported by the presence of gold, silver, copper, zinc, and lead mineralization in the upper part of the Off Lake felsic dike complex (see Economic Geology).

The proposed spatial and genetic relationship between the Richardson Township caldera and the Off Lake felsic dike complex is obviously speculative because it is difficult to make a three-dimensional reconstruction with only two-dimensional information. It should also be noted that, because fault movement is three dimensional, the original position of the caldera may not have been in the same vertical plane as the present section through the Off Lake felsic dike complex as now shown on Figure 38C, D. Any reconstruction of the original spatial relationship between the caldera and the Off Lake felsic dike complex is also hampered by the later emplacement of the 4-km-wide, Black Hawk stock (Fig. 37); emplacement of the stock may have caused further westward movement of the caldera.

If this spatial and genetic interpretation of the relationship between the caldera and the Off Lake felsic dike complex is correct, then the Feeder porphyry in Richardson Township, which intruded mafic metavolcanic lava flows below the caldera, is not the magmatic source for volcanism and mineralization. As observed on the single exposure, the Feeder porphyry appears to be a single phase, subvolcanic pluton.

When the author first examined the Richardson Township property for Nuinsco Resources (Ayres, 1997), he noted that there was a discrepancy between the trend of units in the caldera and the trend of units in the underlying mafic metavolcanic sequence. The caldera sequence has an easterly trend, but the mafic metavolcanic sequence is folded into a south-plunging, anticlinal structure adjacent to the Sabaskong batholith (Fig. 5; Blackburn, 1976). This discrepancy would be resolved if there is a fault in the mafic metavolcanic sequence below the caldera.

## EARLY FAULTS IN THE CLEARWATER LAKE FELSIC VOLCANICLASTIC SEQUENCE

In the Clearwater Lake felsic volcaniclastic sequence, there are two, and possibly more, north-trending, early faults (Figs. 23, 26) that are probably synvolcanic. The amount of displacement on these faults is uncertain but is in the order of hundreds of metres. On the basis of the thickness of clast-supported conglomerate in the measured sections (Fig. 26), movement on these faults appears to have been sinistral, and, relative to the original configuration of the volcano, movement was normal with northern blocks down dropped relative to southern blocks (Fig. 38D). These normal faults, and possibly even the normal fault that forms the south contact of the Off Lake felsic dike complex, may be synvolcanic faults along which the outer parts of the volcano subsided because of gravitational instability. Displacement on the fault that forms the south boundary of the Off Lake felsic dike complex is probably greater than that induced by gravity collapse, and some of the movement may be a result of tectonic reactivation.

The synvolcanic faults in the Clearwater Lake felsic volcaniclastic sequence are truncated by a semi-concordant fault at the base of the sequence. To date, this fault has been recognized only north of Cedar Lake, but outcrops on the shore of, and immediately south of, Cedar Lake were examined only briefly.

## ECONOMIC GEOLOGY

The emphasis of the present survey was to determine the distribution, genesis, and economic potential of the various felsic metavolcanic units mapped in the Off Lake region by Blackburn (1976) and Fletcher and Irvine (1955). Because a prospecting team was supposed to work in the area during the summer of 2006, previously known mineral showings (Baker, 2006, Blackburn, 1976; Fletcher and Irvine, 1955) were not examined except where encountered accidentally during the survey. Previously known mineral showings were also not sampled, because proper sampling requires more careful examination of the exposures. The only exception to this generalization was the Stares option (claim 3019809 at the northeast corner of Off Lake), where two old drill holes were relogged and a cursory examination was made of the surface showings.

During the course of the present survey, sulphide mineralization was encountered at a number of places (see accompanying geological maps). These mineralized areas were described and 49 samples were collected for assay (Tables 2 to 6, and Appendix 1). In addition, Cj. Baker collected 4 samples from sulphide mineralization discovered by the author (Table 4 and Appendix 1). In the remainder of this section, only that mineralization examined by the author is described. Previous exploration work and known showings are described by Baker (2006), Blackburn (1976), and Fletcher and Irvine (1955), and the present report should be used in conjunction with those reports.

### *Quartz Veins*

White to locally rusty quartz veins occur locally throughout the metavolcanic sequence. In the felsic volcaniclastic sequences, white quartz veins, which range from continuous to lenticular and concordant to discordant, occur individually or in sets of several veins; vein sets are as much as several metres wide. Most veins are <10 cm wide, but locally veins are as much as 30 cm wide. White quartz veins were examined only briefly in passing. Most veins appear to lack any visible sulphide mineralization, and these veins were not sampled.

In the lower mafic metavolcanic sequence and the two felsic volcaniclastic sequences, rusty quartz veins that contain minor pyrite were observed only rarely. Most of these veins, which range from continuous to lenticular and concordant to as much as 20° discordant, are <10 cm wide; maximum observed width is 30 cm. Grab samples were collected from two, narrow, rusty quartz veins that were observed in the Clearwater Lake felsic volcaniclastic sequence; these samples are partly vein and partly wall rock (samples 398053 and 398056; Table 3). Minor copper values were obtained from an 8-cm-wide, slightly discordant, rusty shear zone that contains local, <5-mm-wide, quartz lenses (sample 398053, Table 3). In 50-cm-wide zones on either side of this shear zone, there are local rusty lenses parallel to the foliation.

In the Off Lake felsic dike complex, abundant white to locally rusty quartz veins were observed at two locations: 1) at the south end of Off Lake close to the Off Lake fault, and 2) in Lot 4, Concession III, Potts Township, which is owned by Leroy Cunningham. None of these veins were sampled, although grab samples were collected from pyrite-bearing wall rock at both locations (samples 398070, 398268, and 398269, Table 5). All samples contain anomalous gold and copper values with the sample from the south end of Off Lake containing 2.918 g/t gold (sample 398070, Table 5).

At the location immediately east of the south end of Off Lake, the dike complex contains about 10%, milky white, glassy quartz veins that are <1 to 40 cm wide and form anastomosing networks with a general trend of 165±15°. Locally, closely spaced veins have the appearance of matrix to a breccia. Where veins are numerous, the rock unit is pink, but away from veins the rock unit is white. In places, there are two distinct vein trends, 160° and 015°, and some veins abruptly change from one trend to the other. Locally, the veins are rusty and the adjacent rock unit is gold-bearing and contains 1 to 3%, 0.5- to 2-mm, euhedral pyrite (sample 398070, Table 5; 438501E; 5415153N). The abundant quartz veins are probably related to the Off Lake fault.

At the Potts Township location, numerous, slightly rusty quartz veins were observed in two outcrops about 400 m apart (436633E; 5411883N and 436667E; 5412250N). In the southern outcrop, the veins are on the west side of the outcrop and appear to form a generally northerly trending zone as much as 10 m wide; within this zone, individual veins are as much as 1 m wide and have diverse trends. In the northern, considerably smaller outcrop, the veins are widespread across the outcrop, but again have diverse trends. These veins were examined only briefly, and no attempt was made to define trends and widths of individual veins or vein zones. To do so will require considerable stripping.

**Lower Mafic Metavolcanic Sequence**

The mafic units, both metavolcanic and metagabbro, were examined only briefly near felsic units, and, thus, information on sulphide mineralization is limited to these few exposures. Pyrite mineralization in the mafic units appears to be most abundant in the zone where the lower mafic metavolcanic sequence and the Clearwater Lake felsic volcaniclastic sequence are interdigitated. However, this generalization may be misleading because the zone of interdigitation was examined in more detail than other areas underlain by mafic units.

Pillowed mafic flows locally contain trace to 1% disseminated pyrite that, where most abundant, results in a rusty weathered surface. In places, the pyrite is preferentially associated with quartz + ankerite veins and alteration that can be recognized by changes in the colour of the weathered surface. Greenschist-facies mafic flows normally have a green, weathered surface, but the altered ankerite-rich units weather pale grey to grey green to pale green to almost white; the altered units were identified as mafic because pillows, which resemble those in less altered, mafic flows are locally visible. The altered units contain as much as 2% pyrite, and they are most abundant in the vicinity of the microwave tower located on the road to the Clearwater-Off Lake garbage disposal site (440600E; 5420600N).

Within a radius of 600 m of the tower, 8 mineralized zones, which have higher than background pyrite contents, have been discovered to date in an area of sparse outcrop; these zones appear to occur in both mafic metavolcanic rocks and intercalated felsic volcaniclastic units or narrow felsic intrusions. However, recognition of host lithologies in this area is uncertain because of rusty weathering and alteration. Seven of these zones were examined by the author and three were sampled (samples 398057 and 398061 to 398065; Table 2); other zones have been sampled by Cj Baker and by the prospector employed for several days in August, 2006. Of the samples collected by the author, none contain anomalous values of economically important elements (Table 2).

At 2 spatially associated showings in a poorly exposed, altered outcrop 280 m northeast of the microwave tower (440760 to 440800E; 5420760 to 5420720N), 1 to 2% disseminated pyrite occurs in altered, pale-green, mafic metavolcanic units and as much as 10% disseminated pyrite occurs in intercalated, white-weathering, altered felsic units. The highest pyrite abundances may be associated with a >10-cm-wide, quartz vein, but this relationship is uncertain because of poor exposure. The felsic units contain sparse, poorly defined, quartz and plagioclase crystals. Scattered across the top of the outcrop, where pyrite mineralization is present, are a number of angular, very rusty weathering, felsic blocks that contain 5 to 10% pyrite; the blocks were derived from either a metavolcanic or a fine-grained intrusion source. The blocks are 10 to 25 cm in size and occur over an area that is about 5 m in diameter; they appear to be too scattered to be from a single, larger, shattered block. The blocks do not contain anomalous values of economically important elements (samples 398063, 398064, and 398065; Table 2).

At the junction of Highway 615 and Hughes Road (439290E; 5417942N), a small outcrop of uncertain genesis contains 1 to 20% pyrite as disseminations, as anastomosing lenses and aggregates, and as veins along fractures; both malachite and azurite were observed, and assay values of >0.5% copper were obtained from grab samples (samples 398066, 398067, and 398068; Table 2). The host rock is a very fine-grained, pale-grey to blue-grey, relatively hard unit; the blue-grey component is magnetic. The host rock is probably oxide-facies iron formation although it could be a silicified volcanic unit.

In the gneissic mafic metavolcanic unit on the east side of the Pinewood Lake felsic volcaniclastic sequence, there is local rusty weathering that is, in part associated with granitoid sills as much as 8 cm wide. This gneissic unit is also magnetic, and, in places, the magnetism caused compass deviations of as much as 90°. The southwestern margin of this unit was drilled in 1997 to test an electromagnetic anomaly (Appendix 3; see below under Evidence of Previous Exploration Work).

Metagabbro intrusions more than 10 m wide locally have patchy rusty weathering produced by minor disseminated pyrite. This lithology was sampled only rarely, and most of the samples are from blocks and megablocks in, or adjacent to, the Off Lake felsic dike complex (see below). One sample of rusty metagabbro that is not spatially associated with the Off Lake dike complex was collected from a trench at 434051E; 5407313N; this sample (sample 398259; Table 4) did not contain any anomalous values of economically important elements.

**Clearwater Lake Felsic Volcaniclastic Sequence**

In polymictic, felsic volcanic conglomerate, particularly in beds that have a higher abundance of grey-weathering felsic clasts, there are locally sparse, 2- to 75-cm-long, slightly elongated, rusty patches. Some of the patches represent single, sulphide-mineral-bearing pebbles, cobbles, and locally boulders, whereas others extend across several clasts, although the rusty weathering is, in places, centered on a specific clast. Many of the rusty patches are recessive weathering, and, as such, are difficult to properly examine and sample. Locally, where rusty weathering clasts could be sampled, they are siliceous, and some contain as much as 80% pyrite that forms a matrix to recrystallized chert fragments. The rusty weathering clasts were probably derived from sulphide-facies iron formation. Of four sampled clasts, three contain anomalous values of gold, two have anomalous values of zinc, and one has an anomalous value of copper (samples 398051, 398052, 398075, and 398076; Table 3). Sulphide-mineral-bearing

Table 2. Assays of selected elements in grab samples collected from the lower mafic metavolcanic sequence; includes mafic units, possible felsic intrusions, and iron formation; excludes blocks, megablocks, and septa in the Off Lake felsic dike complex. Complete assay data are in Appendix 1.

| Sample | Easting | Northing | Description | Au ppb | Ag ppm | Cu ppm | Mo ppm | Ni ppm | Pb ppm | Zn ppm |
|---|---|---|---|---|---|---|---|---|---|---|
| 398057 | 440760 | 5420080 | Pillowed, mafic lava flow contains <1% disseminated pyrite, and 1% pyrite associated with <5-mm-wide, quartz + ankerite veins | 16 | <1 | 277 | 40 | 91 | 23 | 159 |
| 398061 | 440760 | 5420760 | Ankeritic mafic metavolcanic unit with 1% pyrite | 74 | <1 | 71 | 13 | 104 | <1 | 109 |
| 398062 | 440800 | 5420720 | Poorly exposed, felsic metavolcanic unit or intrusion contains minor quartz and plagioclase crystals and as much as 10% pyrite | 70 | <1 | 110 | 75 | 35 | 10 | 316 |
| 398063 | 440801 | 5420720 | Float near 398062; felsic metavolcanic unit or intrusion containing quartz crystals; 5-10% pyrite | 47 | <1 | 13 | 46 | 41 | 7 | 346 |
| 398064 | 440802 | 5420720 | Float near 398062; felsic metavolcanic unit or intrusion containing quartz crystals; 5-10% pyrite | 56 | <1 | 148 | 80 | 15 | 28 | 293 |
| 398065 | 440803 | 5420720 | Float near 398062; 75% rusty quartz vein, 25% felsic metavolcanic unit or intrusion; minor pyrite in both | 36 | <1 | 144 | 32 | 12 | <1 | 162 |
| 398066 | 439290 | 5417942 | Non-magnetic, siliceous, felsic unit interbedded with, and possibly part of oxide-facies, iron formation; 5-8% pyrite, disseminated and in fractures; azurite staining | 140 | <1 | >5,000 | 8 | 64 | <1 | 44 |
| 398067 | 439291 | 5417942 | Magnetic, siliceous, felsic unit, possibly oxide-facies iron formation; minor pyrite and malachite staining. | 42 | <1 | 1253 | 39 | 46 | <1 | 17 |
| 398068 | 439292 | 5417942 | Magnetic, siliceous, felsic unit, possibly oxide-facies iron formation; 10-15% pyrite | 98 | 2 | 2224 | 38 | 90 | 2 | 47 |
| 398079 | 440529 | 5418372 | Metapyroxenite contains 3-8% pyrite that is disseminated and in fractures | 8 | <1 | 746 | 10 | 164 | 6 | 10 |

Table 3. Assays of selected elements in grab samples collected from the Clearwater Lake felsic volcaniclastic sequence. Complete assay data are in Appendix 1.

| Sample | Easting | Northing | Description | Au ppb | Ag ppm | Cu ppm | Mo ppm | Ni ppm | Pb ppm | Zn ppm |
|---|---|---|---|---|---|---|---|---|---|---|
| 398051 | 441610 | 5422674 | Rusty area surrounding recessively weathered, rusty clast in conglomerate | 339 | <1 | 43 | 18 | 12 | 17 | 108 |
| 398052 | 441652 | 5422668 | Rusty clast in conglomerate; possibly sulphide-facies iron formation | 28 | 1 | 83 | 19 | 23 | 15 | 129 |
| 398053 | 441436 | 5422766 | Rusty shear zone in conglomerate; 8 cm wide; contains quartz lenses | 17 | <1 | 547 | 1 | 171 | 15 | 464 |
| 398054 | 442098 | 5422594 | Rusty zone in conglomerate; 1 m wide | 13 | <1 | 21 | 8 | 7 | 13 | 28 |
| 398055 | 440892 | 5422312 | Rusty zone in conglomerate; 10 cm wide | 10 | <1 | 69 | 58 | 181 | 15 | 88 |
| 398056 | 441251 | 5421895 | Rusty zone in conglomerate associated with 3- to 6-cm-wide, concordant quartz vein; 25% quartz | 6 | <1 | 39 | 14 | 16 | 8 | 63 |
| 398074 | 439172 | 5420647 | Leached rusty patch in pebble to boulder conglomerate, no visible sulphide minerals | 31 | <1 | 21 | 14 | 6 | 25 | 14 |
| 398075 | 439192 | 5420486 | Sulphide-facies, iron formation cobble in pebble conglomerate; 50% pyrite, 50% quartz | 452 | 5 | 142 | 76 | 232 | 172 | 6 |
| 398076 | 439493 | 5420286 | Massive pyrite from sulphide-facies, iron formation boulder in conglomerate | 148 | 7 | 52 | 65 | 377 | 149 | 6 |

clasts have a restricted distribution; they were found in the lowermost tongue of the Clearwater Lake sequence, in a felsic volcaniclastic lens below this tongue, and in an interval about 75 m wide in the middle of the sequence (section 2; Fig. 23).

In the conglomerate, there are also local, irregular patches and concordant lenses or layers of rusty weathering that mask the nature of the clasts and matrix; these are as much as 2 m wide. Rusty weathering is least well developed on white-weathering clasts, but it could not be determined whether the rusty weathering is related to individual clasts or to a group of clasts and/or intervening matrix. Rock below the rusty weathered surface is commonly highly leached, but, in places, trace to 2%, disseminated, fine-grained pyrite was observed. Three grab samples were collected from these zones, but none contained anomalous values of economically important elements (samples 398054, 398055, and 3980074; Table 3).

About 200 m north of the microwave tower (440500E; 5420800N), within the area of abundant mineralized mafic metavolcanic units (see Economic Geology; Lower Mafic Metavolcanic Sequence), a pyrite-bearing showing was discovered by Cj Baker and has since been stripped. The showing, which contains disseminated to almost massive pyrite, is in a thin, felsic volcanic, lithic sandstone to pebbly sandstone unit that is probably a thin finger of the Clearwater Lake felsic volcaniclastic sequence. The sandstone is bounded on the northwest by pillowed mafic flows, although the contact is not exposed, and on the southeast by a fault gully. The fault trends about 050° whereas bedding in the sandstone trends 095°, parallel to pillow orientation in the lava flows to the northwest. Bedding here is defined by differences in particle size and in pyrite abundance. Where not obscured by rust, the sandstone is a white- to pale-grey-weathering unit that contains as much as 1%, 2- to 4-mm, quartz crystals in some, but not all beds. Beds range in thickness from 1 to 30 cm, and some beds have sharp bed planes; the thicker beds are generally the coarsest. Some 0.5- to 2-cm-long, flattened, felsic clasts were tentatively identified in the coarser beds. Bedding is offset by right-lateral faults that parallel, and are best developed near, the fault gully. Pyrite appears to be dominantly in the thinner, finer beds, and the coarsest and thickest beds have the lowest pyrite content. This showing was sampled by Cj Baker.

**Pinewood Lake Felsic Volcaniclastic Sequence**

Within both conglomerate and the less abundant sandstone units, there are local concordant to patchy, rusty weathering zones that are 20 cm to several metres wide. Many of these could not be properly sampled because they are recessive weathering and the rock is leached, but, where sampled, they are siliceous zones that contain 1 to 10% disseminated pyrite. The zones appear to be laterally discontinuous, but, in places, the apparent lack of continuity is the result of small-scale offset along faults and granitoid dikes, which presumably also occupy faults. These mineralized zones appear to be most abundant west and southwest of the south end of Pinewood Lake. In general, the mineralized zones and patches are either isolated in the conglomerate, or several zones occur close together; where several zones are close together, there is, in places, patchy rusty weathering and low pyrite abundances in the rock between the zones. Many of the rusty weathering zones have been sampled by other workers. Eleven samples were collected from these zones by the author and Cj Baker. However, except for 3 samples that contained 100 to 200 ppm copper (samples 398251, 398250, and 398301; Table 4), none of the samples contained anomalous values of economically important elements (Table 4).

There is some evidence of sulphide-mineral-bearing clasts, possibly sulphide-facies iron formation, in conglomerate of the Pinewood Lake sequence. Evidence includes the following. 1) Locally in conglomerate, the patchy rusty weathering is spatially associated with specific clasts. 2) In the single conglomerate outcrop examined on the west side of Highway 71 (Potts Township map; 432700E; 5409350N), there are sparse rusty patches that are associated with specific, possibly sulphide-mineral-bearing clasts; these are recessive weathering and could not be sampled. 3) At about 436320E; 5409955N, a rusty weathering patch contains a 2-cm-wide, rounded area that contains at least 40% pyrite; this could not be sampled. Although other clasts in this vicinity are strongly flattened, the rounded area may be a less deformed, sulphide-rich clast.

No sulphide mineralization was observed in the two outcrops of this sequence that were examined. There are, however, local, concordant, white, quartz veins and pods that are as much as 20 cm wide.

## Potts Intrusion

The subvolcanic Potts felsic intrusion is exposed in a single outcrop. In the northern and central parts of this outcrop, there are local, variably developed, rusty weathering patches that occur over areas as much as 10 m wide. Rusty weathering is associated with 2 to 3%, fine-grained, disseminated pyrite and, locally, with quartz veins that are as much as 20 cm wide. Three grab samples collected by the author between 434008 and 434024E and 5408584 and 5408671N did not contain any anomalous values of economically important elements (samples 398253, 398254, and 398255; Table 4).

### Off Lake Felsic Dike Complex

The dike complex is characterized by 1) widespread pyrite mineralization, 2) anomalous values of gold, copper, and zinc in many places, and 3) in the eastern part of Off Lake, more restricted, concentrated values of gold, silver, copper, zinc, and lead. The complex, including immediately adjacent country rocks, appears to be the best exploration target in the mapped area. A total of 19 grab samples were collected from the complex for assay; of these, 13 samples were from felsic dikes, 3 from mafic metavolcanic septa, and 3 from metagabbro blocks and megablocks (Table 5). Some of the samples from narrow mafic septa contain material from adjacent felsic dikes.

Table 4. Assays of selected elements in grab samples collected from the Pinewood Lake felsic volcaniclastic sequence, including the Potts felsic intrusion. The lower four samples were collected by Cj Baker from mineralized areas originally located by the author during mapping. Complete assay data are in Appendix 1.

| Sample | Easting | Northing | Description | Au ppb | Ag ppm | Cu ppm | Mo ppm | Ni ppm | Pb ppm | Zn ppm |
|---|---|---|---|---|---|---|---|---|---|---|
| 398251 | 434912 | 5408274 | Rusty weathering, 40- to 50-cm-wide, concordant, siliceous zone in lithic sandstone; 5-10% pyrite | 9 | <1 | 162 | 14 | 20 | 22 | 13 |
| 398252 | 434914 | 5408266 | Rusty weathering, 1-m-wide, concordant, siliceous zone in lithic sandstone; 5% disseminated pyrite | <5 | <1 | 21 | 9 | 5 | 14 | 6 |
| 398253 | 434008 | 5408584 | Rusty weathering zone in equigranular phase of Potts intrusion; minor pyrite | <5 | <1 | 83 | 31 | 44 | 14 | 54 |
| 398254 | 434008 | 5408584 | Rusty weathering zone in equigranular phase of Potts intrusion; 2-3% pyrite | <5 | <1 | 66 | 38 | 65 | 17 | 63 |
| 398255 | 434024 | 5408671 | Rusty weathering zone in equigranular phase of Potts intrusion; 1-2% disseminated pyrite | <5 | <1 | 17 | 10 | 11 | 13 | 38 |
| 398256 | 434872 | 5408445 | Concordant, 10- to 20-cm-wide, rusty weathering, leached zone in pebble conglomerate; no visible sulphide minerals | <5 | <1 | 10 | 9 | 8 | 12 | 12 |
| 398257 | 434882 | 5408440 | Diffuse, rusty weathering zone in pebble conglomerate; 1-2% disseminated pyrite | <5 | <1 | 25 | 13 | 31 | 16 | 70 |
| 398258 | 434038 | 5407343 | Rusty weathering zone, 1 to 2 m wide, in pebble conglomerate; 1-2% disseminated pyrite | 9 | <1 | 23 | 9 | 14 | 11 | 29 |
| 398259 | 434051 | 5407313 | Rusty metagabbro dike in conglomerate; sample is from an old trench; minor pyrite | 13 | <1 | 67 | 15 | 29 | 18 | 44 |
| 398260 | 436324 | 5409959 | 2-m-wide, rusty weathering zone in pebble conglomerate; 5-10% pyrite | 18 | <1 | 41 | 13 | 19 | 12 | 42 |
| 398261 | 433740 | 5407081 | Small, rusty weathering patch in pebble conglomerate; patch appears to be related to a specific clast; minor pyrite | 16 | <1 | 20 | 19 | 16 | 19 | 72 |
| **Samples collected by Cj Baker** | | | | | | | | | | |
| 398250 | 434455 | 5406958 | Concordant, 20- to 30-cm-wide, rusty weathering zone in pebble to cobble conglomerite; traces of pyrite | 9 | <1 | 108 | 21 | 27 | 18 | 73 |
| 398301 | 434897 | 5407838 | A 20 by 50 cm, rusty weathering lens in pebble to cobble conglomerate that contains pyrite | <5 | <1 | 106 | 13 | 11 | 17 | 34 |
| 398302 | 434783 | 5408087 | 50-cm-wide, concordant, rusty weathering zone in pebble to cobble conglomerate that contains pyrite in seams | 21 | <1 | 40 | 45 | 13 | 39 | 29 |
| 398303 | 434643 | 5408132 | 20-cm-wide, concordant, rusty weathering zone in pebble to cobble conglomerate that contains pyrite in seams; may be faulted part of 398302 layer | <5 | <1 | 36 | 12 | 12 | 16 | 32 |

**Mather Metasedimentary Sequence**

***Quartz- ± plagioclase-phyric, felsic dikes:*** The porphyritic felsic dikes typically contain <1 to 5%, and locally as much as 10 to 15% pyrite that occurs as disseminated single grains and local aggregates and as veinlets. Pyrite abundance is variable from place to place, and grab samples (Table 5) were generally collected from areas of highest observed pyrite content. In all large outcrops, ovoid to irregular, rusty weathering patches that are several centimetres to 50 cm long have developed where pyrite is present. In some areas, there is little apparent difference in pyrite content of the rock unit beneath rusty weathering patches and adjacent non-rusty rock, but, in other places, pyrite content is much greater under rusty patches. Rarely, the surface rust is associated with zones of more intense foliation, and, in places, it is associated with irregular, discontinuous quartz veins that are as much as 5 cm wide and are locally rusty. On many outcrops, the rusty weathering is most commonly observed because of widespread, rusty weathering blocks on top of the outcrops. Many of the rusty areas have been sampled by previous generations of prospectors and mappers.

In addition to disseminations, pyrite also occurs locally in anastomosing, interconnected fractures, and in wall rock immediately adjacent to fractures. The fractures, and the pyrite associated with fractures, are 1 to 5 mm, and rarely as much as 4 cm wide, and they contain as much as 5% pyrite. Pyrite in fractures is commonly in quartz + pyrite or quartz + sericite + chlorite + pyrite veins, but it also occurs without associated minerals. These fractures are not related to later quartz veins that are <5 mm wide and are subparallel to the pyrite-bearing fractures. Pyrite mineralization is also associated with 1- to 10-cm-wide, sericitic, shear zones that are sharply bounded and have diverse trends. These shear zones are relatively straight for short distances, but then abruptly bend to a different trend.

In places, the highest disseminated pyrite content appears to be in areas that have the lowest abundance of recognizable quartz phenocrysts. Such dike phases may represent phenocryst-poor magma, or these phases may have undergone a greater degree of recrystallization masking phenocrysts. They could thus be older phases, and the pyrite could be mainly in older phases. Any such age interpretation requires further verification from logging of core from future drill holes; phase boundaries and age relations among phases are more evident in drill core than in outcrop. Locally, the pyrite is concentrated in 10- to 40-cm-wide, discrete zones; these could be sulphide-mineral-rich, dike phases similar to dikes intersected in diamond drill hole NS95-01 (Appendix 3) on the Stares option. Some of the shear zones described in the previous paragraph that have abrupt bends may also be discrete dike phases.

***Mafic blocks, megablocks, and septa:*** All large exposures of mafic metavolcanic and metagabbro blocks, megablocks, and septa have patchy rusty weathering related to pyrite that is both disseminated and in fractures. Metagabbro blocks, megablocks, and septa generally contain only minor disseminated pyrite and, in places, pyrrhotite, but, locally, there is as much as 4% pyrite that occurs as 1- to 5-mm-long blebs and in fractures. In places, the pyrite has resulted in rusty weathering, but many areas that contain as much as 1% pyrite are not rusty. Disseminated pyrite occurs also in shear zones that are as much as 30 cm wide and were found both within mafic metavolcanic blocks and at contacts between porphyritic felsic dikes and mafic metavolcanic and metagabbro blocks. In places, pyrite is associated with equant xenoliths within felsic dikes and with mafic layers that occur within, or between, felsic dikes; these layers are probably deformed xenoliths or septa, and some of the layers are only 5 mm wide. Where associated with xenoliths, the pyrite mineralization generally occurs in the felsic dikes adjacent to the xenoliths, but, locally, pyrite is preferentially in the mafic xenoliths.

***Assay data:*** Of the 13 grab samples collected from felsic dikes, 4 have anomalous values of gold with 2 samples containing >1 g/t gold, and 2 of these samples have anomalous values of copper (samples 398070, 398073, 398268, and 398269; Table 5). The two samples with >1 g/t gold (samples 398070 and 398073; Table 5) are both from the south part of Off Lake relatively close to the Off Lake fault. Sample 398070, which has the highest gold content, 2.918 g/t, is immediately east of the fault in a zone of abundant quartz veins (see previous section on Quartz Veins). It should be noted that this sample is south of the south boundary of the Rainy River Resources' claim group. The two other samples that have anomalous gold values (samples 398268 and 398269) are from outcrops that contain abundant quartz veins (see previous section on Quartz Veins); these outcrops are in Lot 4, Concession III, Potts Township on property owned by Leroy Cunningham.

Of the 6 samples collected from mafic blocks, megablocks and septa, 2 have anomalous but low values of gold (samples 398060 and 398266; Table 5), and 3 samples have anomalous values of silver and copper (samples 398060, 398077, and 398266; Table 5). One of the samples (sample 398077; Table 5) that has anomalous values of silver and copper also has anomalous values of zinc. These anomalous samples are scattered through the complex.

***Fuchsite-rich zone:*** Along the north side of Highway 615 at the north end of Off Lake, the Off Lake felsic dike complex consists of interlayered felsic dikes and less abundant metagabbro blocks or septa. Within these outcrops, a 2-m-wide, northerly trending, green, fuchsite-rich zone (Blackburn, 1976) marks the contact between a highly altered, well foliated, porphyritic dike on the west and a foliated metagabbro block on the east. The fuchsitic zone is moderately well foliated, although this is not obvious because the zone is quartz-rich. This zone may be a fault; felsic dikes and metagabbro blocks on either side of the zone are more strongly foliated than elsewhere. Felsic dikes near the fuchsite-rich zone have a variable pyrite content, but, in places, there is 15 to 20% pyrite. Metagabbro blocks near the fuchsite-rich zone contain 2 to 10% pyrite including some massive lenses that are several centimetres wide. Overall, the pyrite content of rubbly outcrops at the north end of Off Lake is higher than elsewhere in the dike complex. No samples were collected from this area, which is on private property, but the poorly exposed, rubbly outcrops should be prospected and properly sampled.

***Stares option:*** The claim (3019809; Menary Township map) optioned from the Stares brothers straddles Highway 615 at the northeast corner of Off Lake. Considerable previous work has been done on this property (Baker, 2006), including two diamond drill holes drilled by Nuinsco Resources in 1995 (Fig. 39). Core from these drill holes is stored at the Rainy River Resources' core storage site in Richardson Township, and the core has been relogged by the author (Appendix 3). Prior to prospecting work in 2006, the known showings were on the hydro line: 1) the main showing 100 to 200 m south of the highway, and 2) a small exposure in the ditch on the north side of the highway. The main showing was stripped and channel sampled by previous workers, and, although now somewhat masked by surface rust, the outcrop is still relatively clean; exposure is poor close to the highway. The showing on the north side of Highway 615 is exposed for a width of only 50 cm and a length of several metres at the bottom of a gravel bank in the ditch beside the highway; this exposure was stripped in 2006. Observations reported here are based on 1) a brief examination of previously known showings, 2) relogging of the two drill holes, and 3) mapping along the hydro line. No samples were collected from the two main showings, but grab samples were collected from three other showings on the property. Since the 2006 mapping, prospecting has uncovered additional showings both on, and east of, the hydro line.

The Stares claim covers the northeast corner of the Off Lake felsic dike complex and extends eastward into mafic metavolcanic and metagabbro roof rocks, which were intruded by quartz- ± plagioclase-phyric, felsic dikes related to the complex. The best exposed outcrop is along the hydro line right of way, which bisects the claim.

Along the hydro line on the Stares claim, both mafic units and less abundant felsic dikes contain ubiquitous disseminated pyrite that ranges in abundance from 1 to 5%. Mineralization discovered prior to 2006 on the Stares claim, both south and north of Highway 615, is in, or adjacent to, a north-trending, 50- to 60-m-wide, composite, porphyritic felsic dike within metagabbro and lesser mafic metavolcanic units. The dike is 50 to 250 m stratigraphically above (east of) the top of a northeastern lobe of the Off Lake felsic dike complex in the apparent roof of the complex, and it is considered to be part of the complex. Contacts between the composite dike and metagabbro country rocks are sharp although narrow felsic dikes do occur in the country rocks and narrow metagabbro septa occur in the composite dike (Fig. 39).

On outcrop, the composite nature of the felsic dike is defined by local, sharp, internal contacts and by variations in phenocryst abundance. The composite nature of the dike, however, is best defined in drill core by sharp, chilled contacts between porphyritic, felsic phases that range in width from 40 cm to more than 9 m, and differ in abundance of quartz and plagioclase phenocrysts (Appendix 3). There are also wider intersections of quartz- ± plagioclase-phyric felsic units in which there are variations in phenocryst abundance but no internal contacts were observed. These intersections are probably still composite, but contacts are masked by alteration and recrystallization. Metagabbro blocks or septa as much as 3 m wide occur between some of the felsic phases (Fig. 39).

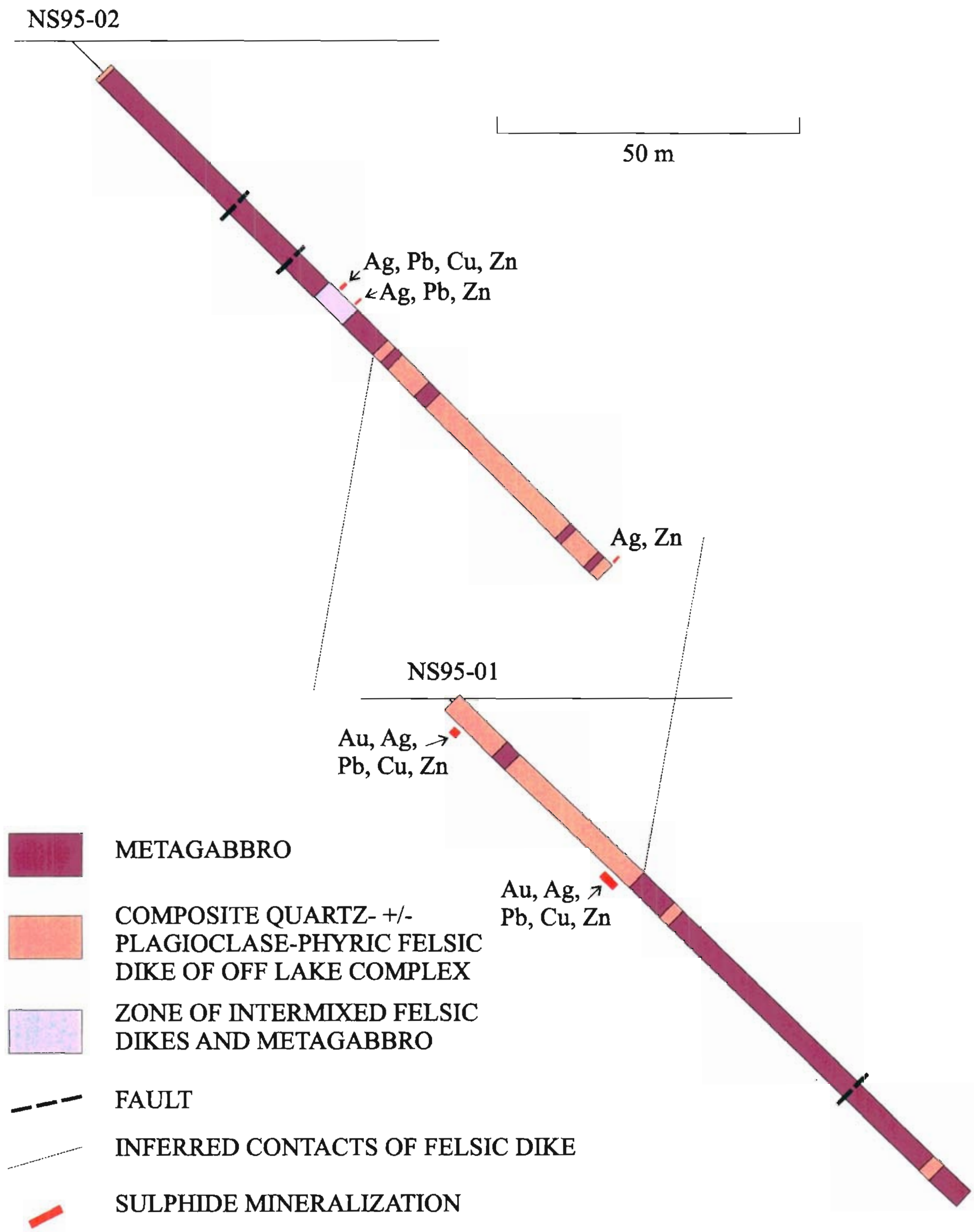



Fig. 39. Simplified lithologic logs and distribution of sulphide mineralization in two diamond drill holes drilled for Nuinsco Resources on the claim currently held by the Stares brothers and optioned by Rainy River Resources. Drill hole collars were not located, but holes are about 175 m apart, in a north-south direction; drill holes are aligned relative to the surface exposures of the composite felsic dike, which trends 170°. Inclination variations in drill holes, which were <5°, were not incorporated in the diagram.

The composite felsic dike varies from massive to highly fractured and is, in places, almost brecciated; increased degree of fracturing is, in places, but not everywhere, related to increased abundance of sulphide minerals. The dike phases generally lack foliation, but there are local zones where there is recognizable foliation; some of these foliated zones have higher pyrite contents than adjacent rock. Alteration is ubiquitous in the dike although this was generally observed only in drill core; it consists of chlorite enrichment, bleaching, silicification, and calcite veining. On outcrop, silicification can be documented by a greater degree of preservation of glacial polish adjacent to some mineralized zones.

The main mineralization at the Stares option, in the stripped area, is close to the east contact of the composite dike near metagabbro country rocks; in this area, there is, from north to south, a slight eastward change in the trend of the contact between the composite dike and country rocks (Menary Township map). Cursory examination of the north part of the main showing, where mineralization appears to be less abundant, suggests that the mineralized zone is here farther away from the dike contact. Although outcrop is poor close to the highway, the showing on the north side of the highway appears to be in the west-central part of the composite dike.

At the main showing, the dominant mineralization is in quartz-phyric, felsic phases of the composite dike in which metre-scale, concordant, rusty zones with higher gold, silver, pyrite, sphalerite, chalcopyrite, and galena abundance alternate with zones that are only weakly mineralized. The alternation in abundance of mineralization appears to correspond to different dike phases. Highly mineralized zones have deformed fractures that resemble foliation. Within 20 m of the east contact with the metagabbro, altered, chlorite-enriched, 2- to 3-m-wide, metagabbro septa also contain pyrite and minor sphalerite mineralization. Overall dip of the mineralized zones is 80° west.

Away from the main stripped showing, pyrite content ranges from 1 to 5%, and the higher pyrite contents are generally in discrete zones that are <30 cm wide and are spatially associated with increased fracture intensity. Most of the rusty, pyrite-rich zones here trend between 010° and 030°, but the zones have variable trends, and some appear to zigzag. The pyrite-rich zones vary from 1) discrete, linear features that have a central crack as control and are generally <30 cm wide, to 2) more diffuse, linear zones that do not have any obvious structural control, although structures may be partly hidden by the rusty weathering, to 3) patches that again lack any obvious structural control on mineralization. The more diffuse zones are as much as 3 m wide.

In 1995, Nuinsco Resources drilled a hole (NS95-01) beneath the main showing and intersected gold, silver, copper, zinc, and lead mineralization similar to that observed on surface at a vertical depth of 30 m (Fig. 39; Appendix 3). This drill hole was collared in the composite dike, and other mineralization was encountered only 3 m below the drill collar (Fig. 39; Appendix 3).

Because of the small exposure, very little information was collected from the outcrop of the showing on the north side of Highway 615. However, Nuinsco Resources' drill hole NS95-02, which was apparently drilled under this showing, intersected pyrite, chalcopyrite, sphalerite, galena, and silver mineralization about 10 m west of the composite dike; gold values here are low. Mineralization is in 2, 60- to 90-cm-wide (measured along core axis), quartz-phyric felsic dikes in metagabbro. The dikes, in turn, are in a 6- to 7-m-wide zone where dikes are more abundant than metagabbro (Fig. 39; Appendix 3). At the bottom of the drill hole, about 40 m (true width) from the west contact, low grade sphalerite and silver mineralization was again intersected. This drill hole did not reach the east contact of the dike, where mineralization occurs at the main showing south of the highway, and did not apparently encounter the mineralization exposed on surface on the north side of the highway.

The mineralized zones intersected in the two drill holes does not correlate. The northern drill hole, NS95-02, was not drilled deep enough to intersect any mineralization that may be present near the east contact of the composite dike (Fig. 39; Appendix 3). The southern drill hole, NS95-01, on the other hand, was collared too far east to intersect mineralization on the west side of the composite dike as intersected in drill hole NS95-02 (Fig. 39; Appendix 3). Mineralization intersected near the top of drill hole NS95-01 could correspond to mineralization exposed on the north side of the highway, but, as noted above, this mineralization was not intersected by drill hole NS95-02. Mineralization in the two drill holes differ markedly in the abundance of gold (Fig. 39; Appendix 3). The two Nuinsco drill holes did not properly test the mineralization in this area.

Three other showings on the Stares option were sampled (samples 398077 and 398078, Table 5; sample 398079, Table 2). On the hydro line north of Highway 615 (440174E; 5419041N), 2 to 4% pyrite occurs in a 40-cm-wide, rusty zone in metagabbro adjacent to a 5-m-wide, quartz-phyric, felsic dike that contains only minor pyrite; the rusty zone is finer grained and better foliated than other parts of the metagabbro, possibly as a result of movement along the contact. A sample from this occurrence (398077) contains anomalous silver, copper, and zinc (Table 5). This minor showing is several tens of metres west of the composite felsic dike, and it could be related to mineralization intersected in the top part of drill hole NS95-02 (Fig. 39).

On the hydro line south of Highway 615 (440421E; 5418666N), in metagabbro east of the composite felsic dike, pyrite occurs at the contact between two porphyritic felsic dikes. The mineralization is in a 30-cm-wide, rusty zone developed in the older dike adjacent to the younger dike; this zone contains 2 to 4% pyrite. Quartz phenocrysts are more recrystallized in the older dike than in the younger dike. This sample (398078; Table 5) does not contain any anomalous values of economically important elements. The third sample (sample 398079; Table 2) is also on the hydro line south of Highway 615 in the south part of the Stares claim (440529E; 5418372N). Here, metapyroxenite adjacent to a 1-m-wide, quartz-phyric, felsic dike contains 3 to 8% pyrite and anomalous copper values. The pyrite occurs as both disseminations and 1- to 2-mm-wide veins along fractures; pyrite distribution is variable in this zone. This zone is about 75 m east of the inferred location of the composite felsic dike.

Table 5. Assays of selected elements in grab samples collected from the Off Lake felsic dike complex, including mafic blocks, megablocks, and septa. Complete assay data are in Appendix 1.

| Sample | Easting | Northing | Description | Au ppb | Ag ppm | Cu ppm | Mo ppm | Ni ppm | Pb ppm | Zn ppm |
|---|---|---|---|---|---|---|---|---|---|---|
| 398058 | 437928 | 5417825 | Metagabbro megablock in composite, porphyritic felsic intrusion; 1% pyrite | 46 | <1 | 78 | 30 | 11 | <1 | 153 |
| 398059 | 438067 | 5416967 | Rusty patch in quartz- + plagioclase-phyric, felsic intrusion, adjacent to milky quartz vein; minor pyrite | 48 | <1 | 10 | 6 | 7 | <1 | 49 |
| 398060 | 438583 | 5416550 | 50% quartz- + plagioclase-phyric felsic intrusion + 50% mafic metavolcanic septum; disseminated pyrite | 110 | 8 | 673 | 43 | 17 | <1 | 33 |
| 398069 | 437404 | 5416553 | Quartz- + plagioclase-phyric felsic dike; 5% pyrite | 25 | <1 | 2 | 8 | 32 | <1 | 35 |
| 398070 | 438501 | 5415153 | Quartz-phyric, granoblastic, amphibolite-facies, felsic dike; 1-2% pyrite | 2918 | <1 | 64 | 8 | 10 | <1 | 12 |
| 398071 | 436884 | 5416705 | Quartz-phyric, felsic intrusion; 3-5% pyrite | 40 | <1 | 3 | 5 | 15 | <1 | 15 |
| 398072 | 436481 | 5415959 | Quartz-phyric felsic intrusion; 1-2% pyrite, disseminated and along fractures | 86 | <1 | 54 | 4 | 16 | <1 | 12 |
| 398073 | 439341 | 5416100 | Quartz-phyric felsic intrusion; 2-3% pyrite, disseminated and along fractures | 1400 | <1 | 20 | 16 | 5 | <1 | 11 |
| 398077 | 440174 | 5419041 | Metagabbro at contact with quartz-phyric felsic dike; 2-4% pyrite and minor chalcopyrite | 25 | 11 | 783 | 34 | 50 | 44 | 570 |
| 398078 | 440421 | 5418666 | Quartz-phyric felsic dike at contact with younger quartz-phyric felsic dike; 2-4% pyrite | 20 | <1 | 118 | 30 | 32 | 64 | 124 |
| 398080 | 435960 | 5415457 | Quartz-phyric felsic intrusion contains 2-3% pyrite that is disseminated and along fractures | 9 | <1 | 20 | 8 | 34 | <1 | 29 |
| 398262 | 436528 | 5414143 | 5-mm-wide, mafic septum in quartz-phyric, felsic intrusion contains 10% pyrite; sample is mostly adjacent felsic intrusion; <1% pyrite in total sample | 25 | <1 | 88 | 17 | 22 | 13 | 42 |
| 398263 | 436476 | 5414050 | Metagabbro xenolith that contains 5-10% pyrite is 70% of sample; remainder is quartz-phyric felsic intrusion that contains 1% pyrite | 18 | <1 | 69 | 27 | 47 | 14 | 106 |
| 398264 | 436249 | 5414095 | Quartz-phyric felsic intrusion; 1% pyrite | 13 | <1 | 18 | 13 | 21 | 4 | 65 |
| 398265 | 436330 | 5413794 | Quartz-phyric felsic intrusion; 5% pyrite | 23 | <1 | 52 | 245 | 19 | 6 | 74 |
| 398266 | 436855 | 5412520 | Mafic metavolcanic septum; 3-4% disseminated pyrite | 125 | 4 | 1337 | 42 | 64 | 26 | 111 |
| 398267 | 436967 | 5412299 | Quartz-phyric, felsic dike contains 2-3% pyrite; sample is adjacent to a 3-cm-wide mafic septum | 88 | <1 | 37 | 22 | 12 | 3 | 57 |

Table 5. Assays of selected elements in grab samples collected from the Off Lake felsic dike complex, including mafic blocks, megablocks, and septa. Complete assay data are in Appendix 1.

| Sample | Easting | Northing | Description | Au ppb | Ag ppm | Cu ppm | Mo ppm | Ni ppm | Pb ppm | Zn ppm |
|---|---|---|---|---|---|---|---|---|---|---|
| Table 5 (continued) | | | | | | | | | | |
| 398268 | 436682 | 5411847 | Quartz-phyric felsic intrusion contains 2% pyrite that is disseminated and in fractures | 185 | 2 | 1406 | 6 | 10 | <1 | 55 |
| 398269 | 436667 | 5412250 | Quartz-phyric felsic intrusion contains 5-10% pyrite that is disseminated and in aggregates associated with sericitic shear | 304 | 2 | 1494 | 17 | 16 | 9 | 81 |

***Controls on mineralization in the Off Lake felsic dike complex:*** Pyrite mineralization occurs throughout the Off Lake felsic dike complex. To date, however, economically important mineralization, including gold, silver, copper, zinc, and lead, has been found only in the eastern, or upper, part of the complex. The mineralization is dominantly in porphyritic felsic dikes, both in the main part of the complex and in subsidiary dikes within roof rocks. In detail, within a small area, as for example at the Stares option, not all dikes are equally mineralized, and the bulk of the mineralization is restricted to a few dikes. At the present time, there is not sufficient information to determine whether there are any compositional or age controls on the abundance of sulphide minerals in individual dikes. The association of mineralization with felsic dikes, along with the wide distribution and habit of the mineralization, indicates that mineralization is genetically related to the felsic magma emplaced within the subvolcanic magma chamber now represented by the Off Lake felsic dike complex. This has some attributes of porphyry-type mineralization.

The upper part of the magma chamber appears to have been the most favourable place for mineralization. This is represented by the eastern part of the complex, where, to date, the highest grade mineralization has been found. The composite dike that hosts mineralization at the Stares option is in the roof of the magma chamber. It must be stressed, however, that some parts of the complex are poorly exposed, some of the roof zone has not yet been mapped, and a large part of the eastern part of the complex is covered by Off Lake.

Although certain porphyritic, felsic, dike phases appear to be the dominant control on location of mineralization, the Off Lake fault may be a secondary control. Evidence for this fault occurs at the north and south ends of Off Lake (see Structure section), but the location of the fault under the lake is conjectural. The amount of horizontal offset along this fault appears to be limited, but the fault has a spatial association with mineralization, most of which was not examined during the present survey. The main mineralization associated with this fault is 1) copper occurrences along the northwest shore of Off Lake and beneath the lake close to this shore (Baker, 2006; Blackburn, 1976); some of these have been tested previously by diamond drilling and 2) gold within porphyritic felsic dikes near the southeast shore of Off Lake as described previously (see also Table 5). Furthermore, the fault may extend northward to Cedar Lake through an area that was not mapped, and the projected extension of the fault would be only 300 to 400 m west of, and stratigraphically below, the location of the microwave tower, in the vicinity of which there are a number of pyrite occurrences (see previous descriptions).

### Beadle Lake Pluton

In the single outcrop of the Beadle Lake pluton that was examined, 0.5- to 1-mm pyrite is ubiquitous in both xenoliths and granitoid matrix, but appears to be more abundant in xenoliths than in matrix. Pyrite also occurs locally in <1-mm-wide quartz veins that fill fractures. No samples were collected from this pluton.

**Evidence of Previous Exploration Work**

During the course of the present survey, evidence of old exploration work was found at several places. The old workings, except for those on the Stares option described previously, are noted in Table 6, and some are described below.

In an outcrop at 434051E; 5407313N in Lot 5, Concession VI, Mather Township, several old trenches were observed (Table 6). These trenches are in rusty weathering metagabbro and in a felsic unit that could be either a conglomerate septum or a felsic intrusion. Minor pyrite was observed, but the only sample collected did not contain anomalous values of economically important elements (sample 398259; Table 4). However, the trenches were examined only briefly, and a prospector should carefully examine this outcrop. Trench locations were flagged. Fletcher and Irvine (1955) did not record these trenches, which may mean that the trenching is post 1953, the date of their mapping.

Fletcher and Irvine (1955) did, however, describe a pit that exposed a gold-bearing quartz vein on Lot 6, Concession VI, Mather Township. This pit was not located by Cj Baker, who searched for it, and, on aerial photographs, no outcrop is apparent in the mapped location of the pit. Either the pit was mislocated by Fletcher and Irvine (1955), and should be in Lot 5, or the outcrop is too small to show up on aerial photographs. An additional search should be made for the pit, and trenches at 434051E; 5407313N should be cleaned out so they can be compared to the description given by Fletcher and Irvine (1955).

East of the south end of Pinewood Lake, at least 5 diamond drill holes have been drilled by several companies (Baker, 2006). The initial target was found by an airborne geophysical survey, and this was followed by ground geophysical surveys. Mineralized units were not observed on outcrop. Core from 4 holes drilled in 1997 was originally stored at Finland on a property where the house was demolished in 2006. In September, 2006, this core was moved to the Rainy River Resources core shack in Richardson Township so that it could be relogged and, if necessary, resampled. It is now stored near the core shack. Drill collars have not been found, although the base line is still visible in places (Table 6). Some of the core is in poor shape: some core boxes are missing, and the core in other boxes is jumbled. Thus, only parts of the core could be relogged (Appendix 3).

One of the holes, PW02-97, was drilled at an azimuth of 270°, apparently to collect geological information; it intersected a quartz- + plagioclase-phyric dike complex, possibly the unit observed in outcrop near 436160E; 5405200N. The other 3 holes were drilled at azimuths of 090° and 045° into the geophysical anomaly. These drill holes intersected gneissic mafic metavolcanic units that contain sparse intercalated metasandstone, and quartz- + plagioclase-phyric felsic dikes and granitoid dikes; this is probably the west edge of the mafic unit that was mapped east of the Pinewood Lake felsic volcaniclastic sequence. The only mineralization observed was pyrite and pyrrhotite, and these sulphide minerals occur in the gneissic mafic metavolcanic unit, in granitoid dikes, and in a brecciated siliceous unit of uncertain genesis

Table 6. Old exploration workings found during field mapping, excluding workings on the Stares option.

| Easting | Northing | Description | Sample, if any |
|---|---|---|---|
| 439414 | 5418264 | An old trench follows a quartz vein that trends 090/70N, west of tourist camp on west shore of Off Lake. Vein is at least 30 cm wide and is slightly rusty. Vein is in mafic metavolcanic unit at margin of Off Lake felsic dike complex, and quartz-phyric felsic dikes occur near the trench. Previous exploration in this area was decribed by Blackburn (1976). | none |
| 438740 | 5416300 | Several old trenches were developed in a mafic metavolcanic septum in the Off Lake felsic dike complex; outcrop is on the shore of Off Lake. Minor quartz- + plagioclase-phyric dikes occur in the outcrop, which contains as much as 5% pyrite and has variably developed rusty weathering and local malachite. No samples were taken from this outcrop, which should be cleaned and prospected. This outcrop is close to diamond drilling described by Blackburn (1976). | none |
| 438560 | 5414520 | A small pit was observed in the southeast corner of a small metagabbro outcrop that is part of a septum in the Off Lake felsic dike complex. No sulphide mineralization or quartz veins were observed. | none |
| 434051 | 5407313 | Two, overgrown trenches were observed in Lot 5, Concession VI, Mather Township, just north of Highway 615. On the basis of rusty rubble piled along the side of the trench, the northern trench is in a north-trending metagabbro dike that intruded pebble conglomerate of the Pinewood Lake felsic volcaniclastic sequence. Minor pyrite was observed in the rubble; sample is from this trench, which is 2 to 3 m long. The southern trench is in an area of poor exposure within well foliated. metagabbro, but, on the basis of rubble along the side of the trench, the trench is in a felsic unit of uncertain genesis, possibly a conglomerate septum or an early felsic intrusion. Trench locations were flagged. | 398259, Table 4 |
| 436320 | 5408880 | Old, northerly trending baseline crosses outcrop. In places, the baseline can be followed easily. | |

(Appendix 3). The sulphide minerals form disseminations, concordant aggregates, and lenses and veins as much as 5 mm wide along the foliation; locally, sulphide minerals occur also in concordant quartz veins that are as much as 1 cm wide. The sulphide minerals are badly tarnished, and any chalcopyrite and/or sphalerite in the drill core may have been overlooked. Pyrite abundance is generally low, but, locally, there is 5 to 10% pyrite in 2- to 5-cm-wide intervals, and there is a single 1.5-cm-wide interval that contains 50 to 60% pyrrhotite and pyrite. Sulphide-mineral-rich intervals occur in zones as much as 5.7 m wide. No assay data are available for these drill holes.

## RECOMMENDATIONS FOR FUTURE WORK

Potentially, the most important mineralization found to date is in, or associated with, the Off Lake felsic dike complex, a former subvolcanic magma chamber. Most of my recommendations will focus on the complex.

### LAND ACQUISITION

Claims held by Rainy River Resources cover only the margins of the northern part of the Off Lake felsic dike complex, although, importantly, most of the northeastern part of the complex is within the claim group. Most of the remainder of the complex is private property except for several claims held by another mineral exploration company. Prior to further, major exploration work on the Off Lake complex, as recommended below, additional land should be optioned, particularly in the eastern part of the complex. Because of the abundance of quartz veins and indications of gold and copper in porphyritic felsic dikes, Lot 4, Concession III, Potts Township should also be optioned.

### SURFACE PROSPECTING AND STRIPPING

1. Additional prospecting should be done in the eastern part of the complex and in adjacent country rocks, particularly 1) along the northwest side where there are known copper occurrences, 2) in the upper part of the complex and in the roof rocks, north and east of the lake, including the Stares option, and 3) south of the lake where gold values were obtained.
2. Although, to date, only pyrite has been discovered, the area between Off Lake and Cedar Lake should also be thoroughly prospected because of 1) the high abundance of pyrite occurrences, and 2) the possible control of the Off Lake fault on mineralization.
3. There should be a particular focus on, and near, the composite dike that hosts much of the mineralization on the Stares option. If possible (and I do not know what is possible on a hydro right of way), the area between the present stripping and the upper edge of the steep hill on the south side of, and adjacent to, the highway should be stripped to test

for continuity of mineralization already discovered. Also, the poorly exposed area on the north side of the highway should be stripped or trenched for a distance of 40 to 50 m to the edge of the first big outcrop. The objective of the stripping would be to examine the continuity of mineralization and to better determine the location of mineralization relative to contacts of the composite dike. Alternatively, some of this information could be obtained by diamond drilling (see below).

4. Outcrops in Lot 4, Concession III, Potts Township should be stripped.
5. Trenches discovered in Lot 5, Concession VI, Mather Township, should be cleaned out to better examine the mineralization in this outcrop. An additional search should be made for the pit in Lot 6, Concession VI, Mather Township, that was reported to contain a gold-bearing quartz vein (Fletcher and Irvine, 1955).

TILL SAMPLING

Although some till sampling was done in 2006, I do not have the results. Thus my recommendation here may be, in part, redundant. It is recommended that a reconnaissance till sampling program be undertaken across the Off Lake felsic dike complex because of the possibility of gold mineralization in the complex.

GEOPHYSICAL SURVEY

Depending on the results of surface prospecting along the northwest side of Off Lake, a modern, ground, geophysical survey should be done over the northeast lobe of Off Lake. The purpose of the survey would be delineation of anomalies that may be related to copper mineralization, or to other gold-silver-copper-zinc-lead occurrences similar to that on the Stares option.

SAMPLING

If not yet done, mineralized sections of the core from diamond drill holes east of Pinewood Lake should be resampled. The stripped showings on the Stares option should be channel sampled, possibly using the previous sites.

DIAMOND DRILLING

Although possibly premature, diamond drilling could be done at the Stares option. Drilling done by Nuinsco Resources in 1995 did not satisfactorily test the mineralization. All new holes should be collared and drilled such that they extend completely through the composite felsic dike as well as wall rocks on both sides of the dike. Initial holes should be drilled at an azimuth of 090°. Possible hole locations are 1) immediately north of the highway to repeat Nuinsco hole NS95-02, but extending completely across the composite dike, 2) underneath Nuinsco hole NS95-01 to intersect the west contact of the composite dike and at least 20 m of metagabbro wall rock west of the dike; this hole could be extended east to intersect new mineralization discovered in August, 2006 east of the composite dike, 3) about 100 m south of NS95-01, and 4) midway between NS95-01 and NS95-02. Depending on the assay results from surface and earlier drill holes, another hole could be drilled above NS95-01 to intersect the new ly discovered mineralization at a shallower depth.

GEOLOGICAL MAPPING

1. To better constrain the Potts fault, which forms the south boundary of the Off Lake felsic dike complex, felsic outcrops between the Finland and Black Hawk stocks should be mapped.
2. To better understand the relationship of the Pinewood Lake felsic volcaniclastic sequence to the felsic volcaniclastic sequence in Richardson Township, outcrops near Highway 600 should be mapped. Outcrops in Richardson Township between Highway 600 and the Black Hawk stock, east of the 17 zone, should also be mapped to see if they could be related to the Off Lake felsic dike complex. My examination of these outcrops in 1997 (Ayres, 1997) was not in sufficient detail to determine the genesis of these outcrops. Outcrop examination could be supplemented by relogging several of the holes drilled by Nuinsco Resources in this area (see Ayres, 2006).
3. More mapping should be done east of Off Lake and between Off Lake and Cedar Lake to better constrain the margins of the Off Lake felsic dike complex and the possible northward extension of the Off Lake fault.
4. Outcrops of the Off Lake felsic dike complex between Highway 615 and the Fleming-Kingsford batholith should be mapped to better constrain the southern extension of the Off Lake fault.

## REFERENCES


Ayres, L.D., 1997, A volcanological investigation of rock units, structures, and gold mineralization, Richardson Property, Rainy River Project, Nuinsco Resources Ltd.: unpublished report prepared for Nuinsco Resources Ltd., 43p.

Ayres, L.D., 2005a, Relogging of diamond drill holes, Richardson Township property, northwestern Ontario, formerly owned by Nuinsco Resources Ltd.: unpublished report prepared for 608457 BC Ltd., 148 p.

Ayres, L.D., 2005b, Relogging of diamond drill holes, Richardson Township property, northwestern Ontario, formerly owned by Nuinsco Resources Ltd.: Second phase of program: unpublished report prepared for 608457 BC Ltd., 132 p.

Ayres, L.D., 2005c, Relogging of diamond drill holes, Richardson Township property of Rainy River Resources Ltd., northwestern Ontario: Third phase of program: unpublished report prepared for Rainy River Resources Ltd., 349 p.

Ayres, 2005d, Summary of structural features related to the caldera model and gold mineralization, Richardson Township property of Rainy River Resources Limited, Northwester Ontario: unpublished report prepared for Rainy River Resources Ltd., 13 p.

Ayres, L. D., 2006, Relogging of diamond drill holes, Richardson Township property of Rainy River Resources Ltd., Northwestern Ontario: Fourth phase of program: unpublished report prepared for Rainy River Resources Ltd., 203 p.

Bacon, C.R., 1985, Implications of silicic vent patterns for the presence of large crustal magma chambers: Journal of Geophysical Research, v. 90, p. 11243-11252.

Baker, C.J., 2006, Compilation report and exploration recommendations for Rainy River Resources Limited - Off Lake property: Rainy River Resources, Internal Report, 26 p.

Blackburn, C.E., 1976, Geology of the Off Lake - Burditt Lake area, District of Rainy River: Ontario Division of Mines, Geological Report 140, 62 p.

Blackburn, C.E., Johns, G.W., Ayer, J., and Davis, D.W., 1991, Wabigoon Subprovince: in Thurston, P.C, Williams, H.R., Sutcliffe, R.H., and Stott, G.M., Geology of Ontario: Ontario Geological Survey, Special Volume 4, Part 1, p. 303-381.

Car, D., and Ayres, L.D., 1991, A thick dacitic debris flow sequence, Lake of the Woods greenstone terrane, central Canada: resedimented products of Archean vulcanian, plinian and dome-building eruptions: Precambrian Research, v. 50, p. 239-60.

Evans, B.W., and Leake, B.E., 1960, The composition and origin of striped amphibolites from Connemara, Ireland: Journal of Petrology, v. 1, p. 337-363.

Fisher, R.V. and Schmincke, H.-U., 1984, Pyroclastic rocks: Springer-Verlag, Berlin, 472p.

Fletcher, G.L., and Irvine, T.N., 1955, Geology of the Emo area: Ontario Department of Mines, v. 63, pt. 5, 36p.

Geo-Digit-Ex, 2006a, Residual magnetic intensity, GEOTEM II AEM anomalies, Potts Township/Off Lake Project: unpublished map prepared for Rainy River Resources.

Geo-Digit-Ex, 2006b, Residual magnetic intensity, GEOTEM II AEM anomalies, Menary Township/Off Lake Project: unpublished map prepared for Rainy River Resources.

Walker, G.P.L., 1985, Origin of coarse lithic breccias near ignimbrite source vents: Journal of Volcanology and Geothermal Research, v. 25, p. 157-171.

Wright, J.V., and Walker, G.P.L., 1977, The ignimbrite source problem: significance of a co-ignimbrite lag-fall deposit: Geology, v. 5, p. 729-733.

# APPENDIX 1

ASSAYS OF GRAB SAMPLES COLLECTED BY THE AUTHOR

DURING FIELD MAPPING,

MAY, JUNE, AND SEPTEMBER, 2006

INCLUDES

FOUR SAMPLES COLLECTED BY CJ BAKER

FROM MINERALIZED AREAS DISCOVERED

BY THE AUTHOR

**Appendix 1** Assays of grab samples collected by the author during field mapping, May, June, and September, 2006. Rock unit code. CL = Clearwater Lake felsic volcaniclastic sequence, LM = lower mafic metavolcanic sequence, OF = Off Lake felsic dike complex; PL = Pinewood Lake felsic volcaniclastic sequence.

Sheet 1 — Appendix 1, Sheet 1

| Rock unit | Sample | Easting | Northing | Description | Au ppb | Ag ppm | Al % | As ppm | B ppm | Ba ppm | Be ppm | Ca % | Cd ppm | Co ppm | Cr ppm | Sample | Cu ppm | Fe % | K % | Li ppm | Mg % | Mo ppm | Na % | Ni ppm | P ppm | Pb ppm | Sb ppm | Se ppm | Si % | Sn ppm | Sr ppm | Ti ppm | Tl ppm | V ppm | W ppm | Y ppm | Zn ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CL | 398051 | 441610 | 5422674 | Rusty area surrounding recessively weathered, rusty clast in conglomerate | 339 | <1 | 1.2 | 3 | 82 | 78 | 4 | 0.03 | <4 | <1 | 169 | 398051 | 43 | 9.59 | 0.19 | 7 | 0.4 | 18 | 0.1 | 12 | 657 | 17 | <5 | <5 | 0.04 | <10 | 45 | <100 | <1 | 39 | 64 | <1 | 108 |
| CL | 398052 | 441652 | 5422668 | Rusty clast in conglomerate; possibly sulphide-facies iron formation | 28 | 1 | 1.3 | <2 | 76 | 121 | 2 | 0.11 | <4 | 1 | 171 | 398052 | 83 | 3.66 | 0.35 | 10 | 0.5 | 19 | 0.1 | 23 | 722 | 15 | <5 | 9 | 0.03 | <10 | 84 | <100 | <1 | 19 | 24 | <1 | 129 |
| CL | 398053 | 441436 | 5422766 | Rusty shear zone in conglomerate; 8 cm wide, contains quartz lenses | 17 | <1 | 2.5 | 3 | 91 | 28 | 3 | 1.04 | <4 | 15 | 456 | 398053 | 547 | 6.77 | 0.21 | 10 | 1.8 | 1 | 0.1 | 171 | 473 | 15 | <5 | 19 | 0.05 | <10 | 12 | 5094 | <1 | 144 | 42 | 7 | 464 |
| CL | 398054 | 442098 | 5422594 | Rusty zone in conglomerate; 1 m wide | 13 | <1 | 0.8 | 15 | 46 | 40 | <1 | 0.14 | 5 | 5 | 142 | 398054 | 21 | 6.27 | 0.24 | 1 | 0.3 | 8 | 0 | 7 | 487 | 13 | <5 | <5 | 0.03 | <10 | 42 | 1366 | <1 | 23 | <10 | <1 | 28 |
| CL | 398055 | 440892 | 5422312 | Rusty zone in conglomerate, 10 cm wide | 10 | <1 | 2 | 38 | 47 | 43 | <1 | 6.48 | 9 | 37 | 338 | 398055 | 69 | 9.4 | 0.19 | 26 | 2.9 | 58 | 0 | 181 | 1324 | 15 | <5 | <5 | 0.04 | <10 | 490 | <100 | 1 | 38 | <10 | 5 | 88 |
| CL | 398056 | 441251 | 5421895 | Rusty zone in conglomerate associated with 3- to 6-cm-wide, concordant quartz vein, 25% quartz | 6 | <1 | 1.5 | 3 | 42 | 35 | <1 | 0.18 | <4 | 11 | 260 | 398056 | 39 | 3.76 | 0.11 | 16 | 0.9 | 14 | 0 | 16 | 457 | 8 | <5 | <5 | 0.03 | <10 | 23 | 1318 | <1 | 22 | <10 | 1 | 63 |
| LM | 398057 | 440760 | 5420080 | Pillowed, mafic lava flow contains <1% disseminated pyrite, and 1% pyrite associated with <5-mm-wide, quartz + ankerite veins | 16 | <1 | 5.3 | 16 | 45 | 29 | 2 | 4.16 | 18 | 69 | 104 | 398057 | 277 | >10.00 | 0.06 | 38 | 1.5 | 40 | 0 | 91 | 969 | 23 | <5 | <5 | 0.07 | <10 | 34 | 1264 | 2 | 266 | <10 | 4 | 159 |
| OL | 398058 | 437928 | 5417825 | Metagabbro megablock in composite, porphyritic felsic intrusion; 1% pyrite | 46 | <1 | 3.2 | <2 | <10 | 99 | <1 | 4.10 | 13 | 58 | 94 | 398058 | 78 | >10.00 | 0.23 | 2 | 1.7 | 30 | 0.2 | 11 | 807 | <1 | <5 | <5 | 0.21 | <10 | 31 | 5243 | <1 | 281 | <10 | 20 | 153 |
| OL | 398059 | 438067 | 5416967 | Rusty patch in quartz- + plagioclase-phyric, felsic intrusion, adjacent to milky quartz vein; minor pyrite | 48 | <1 | 1.2 | <2 | <10 | 120 | <1 | 0.28 | <4 | 8 | 102 | 398059 | 10 | 4.36 | 0.42 | <1 | 0.6 | 6 | 0 | 7 | 512 | <1 | <5 | <5 | 0.06 | <10 | 98 | 1499 | <1 | 17 | <10 | <1 | 49 |
| OL | 398060 | 438583 | 5416550 | 50% quartz- + plagioclase-phyric felsic intrusion + 50% mafic metavolcanic septum; disseminated pyrite | 110 | 8 | 1.40 | <2 | <10 | 51 | <1 | 1.53 | 8 | 34 | 116 | 398060 | 673 | 8.23 | 0.22 | <1 | 1.1 | 43 | 0.2 | 17 | 605 | <1 | <5 | <5 | 0.23 | <10 | 47 | 5579 | <1 | 101 | <10 | 9 | 33 |
| LM | 398061 | 440760 | 5420760 | Ankeritic mafic metavolcanic unit with 1% pyrite | 74 | <1 | 4.6 | 7 | <10 | 134 | <1 | 2.77 | 12 | 80 | 446 | 398061 | 71 | >10.00 | <0.01 | 22 | 4.8 | 13 | 0.1 | 104 | 338 | <1 | <5 | <5 | 0.16 | <10 | 24 | 169 | <1 | 289 | <10 | 2 | 109 |
| LM | 398062 | 440800 | 5420720 | Poorly exposed, felsic metavolcanic unit or intrusion contains minor quartz and plagioclase crystals and as much as 10% pyrite | 70 | <1 | 5.8 | 42 | <10 | 170 | 4 | 0.06 | 28 | 47 | 237 | 398062 | 110 | >10.00 | 0.23 | <1 | 2.8 | 75 | 0 | 35 | 758 | 10 | <5 | <5 | 0.20 | <10 | 12 | 403 | <1 | 124 | <10 | 2 | 316 |
| LM | 398063 | 440801 | 5420720 | Float near 398062; felsic metavolcanic unit or intrusion containing quartz crystals; 5-10% pyrite | 47 | <1 | 5.3 | 12 | <10 | 55 | 2 | 0.90 | 19 | 34 | 107 | 398063 | 13 | >10.00 | 0.08 | 22 | 2.6 | 46 | 0 | 41 | 500 | 7 | <5 | <5 | 0.15 | <10 | 8 | 143 | <1 | 96 | <10 | 5 | 346 |
| LM | 398064 | 440802 | 5420720 | Float near 398062, felsic metavolcanic unit or intrusion containing quartz crystals; 5-10% pyrite | 56 | <1 | 6.2 | 26 | <10 | 25 | 3 | 0.02 | 31 | 19 | 167 | 398064 | 148 | >10.00 | 0.07 | <1 | 3.1 | 80 | 0 | 15 | 506 | 28 | <5 | <5 | 0.24 | <10 | <3 | 596 | <1 | 106 | <10 | 2 | 293 |
| LM | 398065 | 440803 | 5420720 | Float near 398062; 75% rusty quartz vein, 25% felsic metavolcanic unit or intrusion, minor pyrite in both | 36 | <1 | 2.6 | <2 | <10 | 41 | <1 | 0.02 | 12 | 11 | 458 | 398065 | 144 | >10.00 | 0.03 | <1 | 1.3 | 32 | 0 | 12 | 324 | <1 | <5 | <5 | 0.30 | <10 | <3 | 289 | <1 | 63 | <10 | 1 | 162 |
| LM | 398066 | 439290 | 5417942 | Non-magnetic, siliceous, felsic unit interbedded with, and possibly part of, oxide-facies, iron formation; 5-8% pyrite, disseminated and in fractures, azurite staining | 140 | <1 | 1.7 | <2 | <10 | 66 | <1 | 2.80 | 7 | 32 | 176 | 398066 | >5,000 | 3.88 | 0.18 | 9 | 1.7 | 8 | 0.1 | 64 | 1067 | <1 | <5 | <5 | 0.21 | <10 | 122 | 7944 | <1 | 130 | <10 | 13 | 44 |
| LM | 398067 | 439291 | 5417942 | Magnetic, siliceous, felsic unit, possibly oxide-facies iron formation, minor pyrite and malachite staining | 42 | <1 | 1.3 | <2 | <10 | 19 | <1 | 2.72 | 14 | 36 | 220 | 398067 | 1253 | >10.00 | 0.02 | <1 | 0.7 | 39 | 0.1 | 46 | 765 | <1 | <5 | <5 | 0.14 | <10 | 151 | 10,000 | <1 | 227 | <10 | 19 | 17 |
| LM | 398068 | 439292 | 5417942 | Magnetic, siliceous, felsic unit, possibly oxide-facies iron formation, 10-15% pyrite | 98 | 2 | 2.4 | <2 | <10 | 16 | 1 | 3.14 | 16 | 253 | 173 | 398068 | 2224 | >10.00 | <0.01 | 3 | 1.4 | 38 | 0 | 90 | 833 | 2 | <5 | <5 | 0.14 | <10 | 274 | 8774 | <1 | 178 | <10 | 11 | 47 |
| OL | 398069 | 437404 | 5416553 | Quartz- + plagioclase-phyric felsic dike, 5% pyrite | 25 | <1 | 1.1 | 4 | 45 | 103 | 1 | 1.24 | <4 | 11 | 171 | 398069 | 2 | 1.89 | 0.44 | 13 | 1 | 8 | 0.1 | 32 | 863 | <1 | <5 | <5 | 0.08 | <10 | 82 | 796 | <1 | 20 | <10 | 2 | 35 |
| OL | 398070 | 438501 | 5415153 | Quartz-phyric, granoblastic, amphibolite-facies, felsic dike; 1-2% pyrite | 2918 | <1 | 0.5 | 3 | 49 | 20 | <1 | 0.16 | <4 | 4 | 238 | 398070 | 64 | 1.11 | 0.11 | 4 | 0.4 | 8 | 0.1 | 10 | 276 | <1 | <5 | <5 | 0.08 | <10 | 26 | 529 | <1 | 13 | <10 | <1 | 12 |
| OL | 398071 | 436884 | 5416705 | Quartz-phyric, felsic intrusion, 3-5% pyrite | 40 | <1 | 0.6 | 6 | 46 | 43 | <1 | 1.08 | <4 | 7 | 192 | 398071 | 3 | 1.51 | 0.15 | 7 | 0.5 | 5 | 0.1 | 15 | 469 | <1 | <5 | <5 | 0.06 | <10 | 24 | 324 | <1 | 5 | <10 | 1 | 15 |
| OL | 398072 | 436481 | 5415959 | Quartz-phyric felsic intrusion; 1-2% pyrite, disseminated and along fractures. | 86 | <1 | 0.5 | 4 | 46 | 14 | <1 | 0.36 | <4 | 20 | 157 | 398072 | 54 | 1.2 | 0.07 | 7 | 0.5 | 4 | 0.1 | 16 | 374 | <1 | <5 | <5 | 0.04 | <10 | 16 | 572 | <1 | 16 | <10 | 1 | 12 |
| OL | 398073 | 439341 | 5416100 | Quartz-phyric felsic intrusion; 2-3% pyrite, disseminated and along fractures | 1400 | <1 | 0.3 | 4 | 45 | 40 | <1 | 0.13 | <4 | 4 | 123 | 398073 | 20 | 0.61 | 0.17 | 2 | 0.1 | 16 | 0 | 5 | 329 | <1 | <5 | <5 | 0.04 | <10 | 13 | 121 | <1 | <2 | <10 | 1 | 11 |

| Rock unit | Sample | Easting | Northing | Description | Au ppb | Ag ppm | Al % | As ppm | B ppm | Ba ppm | Be ppm | Ca % | Cd ppm | Co ppm | Cr ppm | Sample | Cu ppm | Fe % | K % | Li ppm | Mg % | Mo ppm | Na % | Ni ppm | P ppm | Pb ppm | Sb ppm | Se ppm | Si % | Sn ppm | Sr ppm | Ti ppm | Tl ppm | V ppm | W ppm | Y ppm | Zn ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CL | 398074 | 439172 | 5420647 | Leached, rusty patch in pebble to boulder conglomerate, no visible sulphide minerals | 31 | <1 | 0.4 | 41 | 36 | 45 | 3 | 0.02 | 11 | 3 | 111 | 398074 | 21 | >10.00 | 0.16 | <1 | 0 | 14 | 0 | 6 | 519 | 25 | <5 | <5 | 0.04 | <10 | 48 | <100 | 3 | 26 | <10 | <1 | 14 |
| CL | 398075 | 439192 | 5420486 | Sulphide-facies, iron formation cobble in pebble conglomerate; 50% pyrite and 50% quartz | 452 | 5 | 0.1 | 291 | 51 | 8 | 11 | 0.15 | 48 | 205 | 208 | 398075 | 142 | >10.00 | 0.01 | <1 | 0 | 76 | 0 | 232 | <100 | 172 | 8 | <5 | 0.04 | <10 | 6 | <100 | 16 | 19 | <10 | <1 | 6 |
| CL | 398076 | 439493 | 5420286 | Massive pyrite from sulphide-facies, iron formation boulder in conglomerate | 148 | 7 | 0 | 261 | 44 | 6 | 13 | 0.06 | 62 | 169 | 197 | 398076 | 52 | >10.00 | <0.01 | <1 | 0.01 | 65 | 0 | 377 | <100 | 149 | 8 | 6 | 0.02 | <10 | <3 | <100 | 10 | 18 | <10 | <1 | 6 |
| OL | 398077 | 440174 | 5419041 | Metagabbro at contact with quartz-phyric felsic dike; 2-4% pyrite and minor chalcopyrite | 25 | 11 | 5.1 | 21 | 44 | 43 | 4 | 0.4 | 17 | 54 | 149 | 398077 | 783 | >10.00 | 0.26 | 39 | 2.7 | 34 | 0 | 50 | 856 | 44 | <5 | <5 | 0.12 | <10 | 15 | 2246 | 5 | 228 | 11 | 8 | 570 |
| OL | 398078 | 440421 | 5418666 | Quartz-phyric felsic dike at contact with younger quartz-phyric felsic dike; 2-4% pyrite | 20 | <1 | 4 | 12 | 37 | 25 | 2 | 0.28 | 9 | 18 | 71 | 398078 | 118 | 8.46 | 0.09 | 91 | 3 | 30 | 0 | 32 | 847 | 64 | <5 | <5 | 0.11 | <10 | 13 | 1949 | <1 | 63 | <10 | 5 | 124 |
| LM | 398079 | 440529 | 5418372 | Metapyroxenite containing 3-8% pyrite that is disseminated and in fractures | 8 | <1 | 0.5 | 8 | 38 | 51 | 2 | 1.24 | 6 | 264 | 112 | 398079 | 746 | 5.32 | 0.05 | 2 | 0.8 | 10 | 0 | 164 | 207 | 6 | <5 | <5 | 0.29 | <10 | 26 | 442 | <1 | 21 | <10 | 1 | 10 |
| OL | 398080 | 435960 | 5415457 | Quartz-phyric felsic intrusion contains 2-3% pyrite that is disseminated and along fractures | 9 | <1 | 0.9 | <2 | 50 | 62 | 1 | 0.46 | <4 | 19 | 139 | 398080 | 20 | 2.3 | 0.14 | 17 | 0.9 | 8 | 0.1 | 34 | 1060 | <1 | <5 | <5 | 0.03 | <10 | 38 | 988 | <1 | 37 | <10 | 3 | 29 |
| PL | 398251 | 434912 | 5408274 | Rusty weathering, 40- to 50-cm-wide, concordant, siliceous zone in lithic sandstone; 5-10% pyrite | 9 | <1 | 1.4 | 7 | 46 | 100 | 1 | 0.77 | 7 | 23 | 402 | 398251 | 162 | 5.42 | 0.29 | 6 | 0.2 | 14 | 0.1 | 20 | 531 | 22 | <5 | <5 | 0.07 | <10 | 97 | 1833 | 4 | 33 | <10 | 1 | 13 |
| PL | 398252 | 434914 | 5408266 | Rusty weathering, 1-m-wide, concordant, siliceous zone in lithic sandstone; 5% disseminated pyrite | <5 | <1 | 0.5 | 3 | 48 | 68 | <1 | 0.05 | <4 | 5 | 167 | 398252 | 21 | 2.95 | 0.43 | 4 | 0.1 | 9 | 0.1 | 5 | 398 | 14 | <5 | <5 | 0.06 | <10 | 83 | 420 | <1 | 10 | <10 | <1 | 6 |
| PL | 398253 | 434008 | 5408584 | Rusty weathering zone in equigranular phase of Potts intrusion, minor pyrite | <5 | <1 | 1.9 | 7 | 74 | 17 | 1 | 1.55 | 7 | 29 | 270 | 398253 | 83 | 4.91 | 0.14 | 15 | 0.8 | 31 | 0.1 | 44 | 437 | 14 | <5 | <5 | 0.16 | <10 | 71 | 2616 | <1 | 78 | <10 | 5 | 54 |
| PL | 398254 | 434008 | 5408584 | Rusty weathering zone in equigranular phase of Potts intrusion, 2-3% pyrite | <5 | <1 | 2 | 9 | 73 | 26 | 1 | 1.84 | 6 | 41 | 281 | 398254 | 66 | 4.87 | 0.2 | 20 | 1 | 38 | 0.1 | 65 | 469 | 17 | <5 | <5 | 0.13 | <10 | 77 | 2850 | <1 | 108 | <10 | 7 | 63 |
| PL | 398255 | 434024 | 5408671 | Rusty weathering zone in equigranular phase of Potts intrusion; 1-2% disseminated pyrite | <5 | <1 | 0.6 | 5 | 67 | 25 | <1 | 0.94 | <4 | 12 | 241 | 398255 | 17 | 2.42 | 0.16 | 6 | 0.3 | 10 | 0.1 | 11 | 444 | 13 | <5 | <5 | 0.09 | <10 | 27 | 2020 | <1 | 25 | <10 | 4 | 38 |
| PL | 398256 | 434872 | 5408445 | Concordant, 10- to 20-cm-wide, rusty weathering, leached zone in pebble conglomerate; no visible sulphide minerals | <5 | <1 | 0.7 | 6 | 59 | 74 | <1 | 0.22 | <4 | 4 | 224 | 398256 | 10 | 2.18 | 0.3 | 4 | 0.1 | 9 | 0.2 | 8 | 207 | 12 | <5 | <5 | 0.05 | <10 | 63 | 499 | <1 | 12 | <10 | 1 | 12 |
| PL | 398257 | 434882 | 5408440 | Diffuse, rusty weathering zone in pebble conglomerate; 1-2% disseminated pyrite | <5 | <1 | 1.8 | 5 | 59 | 64 | 1 | 0.51 | 6 | 15 | 193 | 398257 | 25 | 4.4 | 0.37 | 16 | 0.7 | 13 | 0.1 | 31 | 419 | 16 | <5 | <5 | 0.08 | <10 | 30 | 1480 | <1 | 39 | <10 | 2 | 70 |
| PL | 398258 | 434038 | 5407343 | Rusty weathering zone, 1 to 2 m wide, in pebble conglomerate; 1-2% disseminated pyrite | 9 | <1 | 1.1 | 5 | 61 | 61 | <1 | 0.12 | <4 | 9 | 175 | 398258 | 23 | 2.13 | 0.64 | 19 | 0.6 | 9 | 0.1 | 14 | 310 | 11 | <5 | <5 | 0.06 | <10 | 13 | 1673 | <1 | 41 | <10 | 2 | 29 |
| PL | 398259 | 434051 | 5407313 | Rusty metagabbro dike in conglomerate; sample is from an old trench; minor pyrite | 13 | <1 | 2.1 | 8 | 61 | 52 | 1 | 1.79 | 7 | 23 | 250 | 398259 | 67 | 5.73 | 0.27 | 20 | 1 | 15 | 0.2 | 29 | 314 | 18 | <5 | <5 | 0.18 | <10 | 24 | 2123 | <1 | 95 | <10 | 7 | 44 |
| PL | 398260 | 436324 | 5409959 | 2-m-wide, rusty weathering zone in pebble conglomerate, 5-10% pyrite | 18 | <1 | 1.3 | 6 | <10 | 195 | 1 | 0.42 | 6 | 14 | 413 | 398260 | 41 | 5.25 | 0.49 | 13 | 0.8 | 13 | 0.1 | 19 | 523 | 12 | <5 | <5 | 0.03 | <10 | 30 | 1018 | <1 | 37 | <10 | 3 | 42 |
| PL | 398261 | 433740 | 5407081 | Small, rusty weathering patch in pebble conglomerate, patch appears to be related to a specific clast; minor pyrite | 16 | <1 | 1.8 | 14 | <10 | 176 | 2 | 0.3 | 10 | 12 | 302 | 398261 | 20 | 8.53 | 0.58 | 14 | 1 | 19 | 0.1 | 16 | 753 | 19 | <5 | <5 | 0.06 | <10 | 40 | 1991 | <1 | 79 | <10 | 3 | 72 |
| OL | 398262 | 436528 | 5414143 | 5-mm-wide, mafic septum in quartz-phyric, felsic intrusion contains 10% pyrite, sample is mostly adjacent felsic intrusion: <1% pyrite in total sample | 25 | <1 | 1.9 | 7 | <10 | 48 | 2 | 0.25 | 8 | 24 | 477 | 398262 | 88 | 7.1 | 0.11 | 23 | 1.2 | 17 | 0.1 | 22 | 475 | 13 | <5 | <5 | 0.06 | <10 | 48 | 643 | <1 | 58 | <10 | 2 | 42 |
| OL | 398263 | 436476 | 5414050 | Metagabbro xenolith that contains 5-10% pyrite is 70% of sample; remainder is quartz-phyric felsic intrusion that contains 1% pyrite | 18 | <1 | 2.7 | 7 | <10 | 173 | 2 | 0.59 | 10 | 125 | 340 | 398263 | 69 | 8.78 | 0.74 | 37 | 2.6 | 27 | 0.1 | 47 | 1068 | 14 | <5 | <5 | 0.09 | <10 | 28 | 1219 | <1 | 99 | <10 | 3 | 106 |
| OL | 398264 | 436249 | 5414095 | Quartz-phyric felsic intrusion; 1% pyrite | 13 | <1 | 2.4 | 9 | <10 | 175 | 1 | 0.37 | 6 | 12 | 413 | 398264 | 18 | 4.8 | 0.61 | 21 | 1.4 | 13 | 0.1 | 21 | 581 | 4 | <5 | <5 | 0.06 | <10 | 41 | 1182 | <1 | 69 | <10 | 3 | 65 |
| OL | 398265 | 436330 | 5413794 | Quartz-phyric felsic intrusion, 5% pyrite | 23 | <1 | 2.2 | 9 | <10 | 93 | 2 | 0.12 | 7 | 93 | 245 | 398265 | 52 | 6.17 | 0.36 | 19 | 1.1 | 245 | 0.1 | 19 | 412 | 6 | <5 | <5 | 0.02 | <10 | 22 | 362 | <1 | 23 | <10 | 2 | 74 |
| OL | 398266 | 436855 | 5412520 | Mafic metavolcanic septum; 3-4% disseminated pyrite | 125 | 4 | 3.4 | 12 | <10 | 10 | 3 | 1.78 | 17 | 84 | 209 | 398266 | 1337 | >10.00 | 0.11 | 26 | 2.2 | 42 | 0.2 | 64 | 650 | 26 | <5 | <5 | 0.09 | <10 | 23 | 3917 | <1 | 115 | <10 | 6 | 111 |
| OL | 398267 | 436967 | 5412299 | Quartz-phyric, felsic dike contains 2-3% pyrite; sample is adjacent to a 3-cm-wide mafic septum | 88 | <1 | 1.5 | <2 | <10 | 111 | <1 | 0.29 | <4 | 21 | 317 | 398267 | 37 | 3.23 | 0.6 | 16 | 0.9 | 22 | 0.1 | 12 | 377 | 3 | <5 | <5 | 0.02 | <10 | 25 | 866 | <1 | 28 | <10 | 2 | 57 |

| Rock unit | Sample | Easting | Northing | Description | Au ppb | Ag ppm | Al % | As ppm | B ppm | Ba ppm | Be ppm | Ca % | Cd ppm | Co ppm | Cr ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OL | 398268 | 436682 | 5411847 | Quartz-phyric felsic intrusion contains 2% pyrite that is disseminated and in fractures | 185 | 2 | 0.8 | <2 | <10 | 71 | <1 | 0 07 | <4 | 6 | 401 |
| OL | 398269 | 436667 | 5412250 | Quartz-phyric felsic intrusion contains 5-10% pyrite that is disseminated and in aggregates associated with sericitic shear | 304 | 2 | 2 5 | 6 | <10 | 209 | 2 | 0 14 | 7 | 22 | 471 |
| | **Samples collected by Cj Baker from mineralized zones discovered by the author during field mapping** | | | | | | | | | | | | | | |
| PL | 398250 | 434455 | 5406958 | Concordant, 20- to 30-cm-wide, rusty weathering zone in pebble to cobble conglomerite; traces of pyrite | 9 | <1 | 3.2 | 9 | 54 | 188 | 2 | 1.65 | 8 | 23 | 171 |
| PL | 398301 | 434897 | 5407838 | A 20 by 50 cm, rusty weathering lens in pebble to cobble conglomerate contains pyrite | <5 | <1 | 1 3 | 4 | 40 | 83 | 1 | 0.13 | 5 | 5 | 216 |
| PL | 398302 | 434783 | 5408087 | 50-cm-wide, concordant, rusty weathering zone in pebble to cobble conglomerate contains pyrite in seams | 21 | <1 | 0.9 | 17 | 41 | 106 | 4 | 0.25 | 17 | 15 | 206 |
| PL | 398303 | 434643 | 5408132 | 20-cm-wide, concordant, rusty weathering zone in pebble to cobble conglomerate contains pyrite in seams, may be faulted part of 398302 layer | <5 | <1 | 1.2 | 6 | 52 | 59 | <1 | 0 21 | 5 | 8 | 267 |

| Sample | Cu ppm | Fe % | K % | Li ppm | Mg % | Mo ppm | Na % | Ni ppm | P ppm | Pb ppm | Sb ppm | Se ppm | Si % | Sn ppm | Sr ppm | Ti ppm | Tl ppm | V ppm | W ppm | Y ppm | Zn ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 398268 | 1406 | 1 97 | 0.26 | 5 | 0.4 | 6 | 0 | 10 | 309 | <1 | <5 | <5 | 0.02 | <10 | 25 | <100 | <1 | 7 | <10 | 1 | 55 |
| 398269 | 1494 | 6.34 | 1 29 | 37 | 1.4 | 17 | 0 1 | 16 | 342 | 9 | <5 | <5 | 0 02 | <10 | 34 | 1133 | <1 | 29 | <10 | 2 | 81 |
| 398250 | 108 | 6.36 | 0.75 | 49 | 1.9 | 21 | 0.1 | 27 | 324 | 18 | <5 | <5 | 0.15 | <10 | 20 | 2839 | <1 | 129 | <10 | 4 | 73 |
| 398301 | 106 | 4 38 | 0.21 | 13 | 0.8 | 13 | 0 1 | 11 | 417 | 17 | <5 | <5 | 0.11 | <10 | 43 | 367 | <1 | 29 | <10 | 1 | 34 |
| 398302 | 40 | >10.00 | 0.33 | 5 | 0.3 | 45 | 0.1 | 13 | 843 | 39 | <5 | <5 | 0.11 | <10 | 52 | 1207 | 1 | 31 | <10 | <1 | 29 |
| 398303 | 36 | 4.14 | 0.19 | 11 | 0 3 | 12 | 0.1 | 12 | 474 | 16 | <5 | <5 | 0 07 | <10 | 51 | 1134 | <1 | 32 | <10 | 1 | 32 |

# APPENDIX 2

LIST OF REPRESENTATIVE ROCK SAMPLES COLLECTED DURING

THE FIELD MAPPING PROGRAM,

MAY, JUNE, AND SEPTEMBER, 2006

## REPRESENTATIVE ROCK SAMPLES

(stored under drafting table)

### CLEARWATER LAKE FELSIC VOLCANICLASTIC SEQUENCE (F1 FELSIC METAVOLCANIC SEQUENCE OF BLACKBURN (1976))

OF-A1 Polymictic, felsic volcanic, cobble conglomerate with white- and grey-weathering felsic clasts

OF-A4 Possible felsic pyroclastic flow deposit with obvious plagioclase crystals and grey-green weathering

OF-A5 Possible pyroclastic flow deposit with white weathering

OF-A7 Pebbly, felsic volcanic, lithic sandstone

OF-A8 Felsic volcanic, lithic sandstone

OF-A9 Quartz- and plagioclase-phyric, felsic intrusion of Buckhorn Point

OF-A13 Quartz- and plagioclase-phyric fragment and minor matrix from autoclastic, brecciated upper(?) part of a felsic lava flow or dome

OF-A36 Possible felsic volcanic or felsic intrusive unit that contains sparse quartz and plagioclase crystals; this is host to pyrite mineralization in assayed sample 398062

### OFF LAKE QUARTZ- ± PLAGIOCLASE-PHYRIC FELSIC DIKE COMPLEX (F2 FELSIC METAVOLCANIC SEQUENCE OF BLACKBURN (1976))

OF-A17 White-weathering, quartz- and plagioclase-phyric, felsic intrusion

OF-A18 White-weathering, quartz-phyric, felsic intrusion

OF-A19 Pale-grey-green-weathering, quartz- and plagioclase-phyric, felsic intrusion

OF-A20 Felsitic, aphyric, felsic intrusion

OF-A21 Plagioclase-phyric, felsic intrusion

OF-A22 Medium-grained, metagabbro from megablock in felsic dike complex

OF-A23 Coarse-grained to pegmatitic metagabbro from megablock in felsic dike complex

OF-A25 White-weathering, quartz- and plagioclase-phyric, felsic intrusion

OF-A26 White-weathering, quartz- and plagioclase-phyric, felsic to intermediate intrusion

OF-A27 White-weathering, quartz-, plagioclase, and mafic-phyric, felsic intrusion; a dike in mafic metavolcanic sequence below the felsic dike complex

OF-A28 Leucogabbro or diorite from a block in the felsic dike complex

OF-A37 Close-packed, quartz- and plagioclase-phyric dike that intruded possible oxide-facies iron formation adjacent to Off Lake felsic dike complex

OF-A43 Recrystallized granitoid phase in contact metamorphic aureole of the Fleming-Kingsford granitoid batholith

**PINEWOOD LAKE FELSIC VOLCANICLASTIC SEQUENCE (F4 FELSIC METAVOLCANIC SEQUENCE OF BLACKBURN (1976))**

OF-A61 Polymictic, felsic volcanic, pebble conglomerate with only minor flattening of clasts; contains garnetiferous, melanogabbro clasts

**BEADLE LAKE INTRUSION; POSSIBLY LATE SUBVOLCANIC INTRUSION**

OF-A15 Gabbro xenolith cut by a pink, leucocratic phase of the Beadle Lake intrusion

OF-A16 Grey phase of the Beadle Lake intrusion that contains mafic metavolcanic xenoliths

# APPENDIX 3

LOGS OF DIAMOND DRILL HOLES

FROM

OFF LAKE AND PINEWOOD LAKE

RELOGGED IN JUNE AND SEPTEMBER, 2006

## NUINSCO DRILL HOLES UNDER POWER LINE AT NORTH END OF OFF LAKE

Drill Hole: **NS95-01** Relogged by: L. D. Ayres Date: June 19, 2006

Southern drill hole Initial inclination: -45° Initial bearing: 090°

0-0.7 m Casing

0.7-43.1 m **Composite, quartz-phyric, felsic intrusion with minor metagabbro blocks**

In most of the intrusions, the only phenocrysts observed are quartz, and these are variably recrystallized. As a result, in some intrusions the phenocrysts are readily recognized whereas in other intrusions they can be recognized only with great difficulty. There is local evidence for the presence of plagioclase phenocrysts, and many of the intrusions may contain plagioclase phenocrysts that have been destroyed by recrystallization.

0.7-2.6 m **Quartz-phyric felsic intrusion**

This is a pale-grey unit that contains about 1%, visible, 1- to 5-mm, rounded, quartz phenocrysts that are partly recrystallized; in many places it is difficult to distinguish phenocrysts from groundmass. The lower contact is sharp and is apparently chilled, and it appears to be at a 20° angle to the foliation. Local plagioclase grains as much as 1 mm long were observed, but there is no evidence of larger phenocrysts. There is minor, 1-mm garnet. Sparse ferruginous calcite veins as much as 2 mm wide occur throughout the unit.

**Mineralization**

The unit contains 2 to 5%, disseminated pyrite and pyrrhotite, most of which occurs as <1-mm grains and aggregates. There are rare, discontinuous aggregates along fractures. There is rare sphalerite associated with pyrite and pyrrhotite.

2.6-4.1 m **Quartz-phyric felsic intrusion**

This is a more foliated unit than those on either side; foliation is 45° to core axis. The unit is pale grey with a variably developed, rusty weathering that is not the result of carbonate but probably reflects the increased sulphide-mineral content of the unit. There is 2 to 3%, 1- to 5-mm, quartz phenocrysts, many of which are flattened as much as 5:1.

**Mineralization**

This unit contains 1 to 2%, fine-grained disseminated pyrite as well as discontinuous, pyrite + pyrrhotite aggregates and veinlets that are parallel to the foliation; the aggregates are as much as 1 cm wide although most are <2 mm wide. In places, particularly in wider aggregates, there is some associated sphalerite.

**3.54 to 4.04 m: 100 ppb Au; 0.278% Zn**

4.1-5.0 m **Quartz-phyric felsic intrusion**

This is a pale-grey to white unit that contains 2 to 4%, 1-mm, quartz phenocrysts. The upper contact is chilled and is at an angle of about 30° to the foliation. The lower contact is missing and is marked by a 10-cm-long, wooden block in the core box; this contact is probably a fault because there is an increase in foliation intensity in the lower 20 cm of the unit and a 5-mm-wide, concordant, quartz + calcite vein at the end of the lowermost piece of core.

The character of the rock unit is quite jumbled, almost as if some pieces of core are out of place. The unit varies from pale grey and foliated to white, more altered, and, in places, brecciated.

**Mineralization**
The unit has a variable sulphide-mineral content. There is <1% pyrite in pale-grey segments, but as much as 25% pyrite + sphalerite in some white segments; individual segments are 5 to 20 cm long. The habit of the sulphide minerals varies from disseminated to irregular aggregates to interconnected but discontinuous veinlets several millimetres wide to massive veins that are as much as 1.5 cm wide. High sulphide-mineral contents occur in segments that range in length from 2 to 5 cm.

**4.04 to 4.59 m: 3.15 g/t Au; 27.6 g/t Ag; 0.143% Pb; 0.219% Cu; 0.71% Zn**

**4.59 to 4.89 m: 1.24 g/t Au; 14 g/t Ag; 0.183% Pb; 0.134% Cu; 0.275% Zn**

**4.89 to 5.64 m: mostly from next lower unit**

5.0-5.7 m **Quartz-phyric felsic intrusion**
This is a pale-grey to white, sulphide-mineral-rich unit that contains 1 to 2%, commonly flattened, quartz phenocrysts that are 1 to 3 mm long. The lower contact of the unit is sharp, 30° discordant to the foliation, and apparently chilled. The unit is variably silicified with concordant quartz lenses and layers that are as much as 5 mm wide in whiter segments of the unit. The unit is moderately well foliated; foliation is 45 to 70° to the core axis, and the foliation attitude is variable from place to place.

**Mineralization**
The unit contains 5 to 10%, pyrite + chalcopyrite + sphalerite that occurs as discontinuous, semi-concordant, interconnected veins that occur both in foliation planes and in fractures; in places the fractures produce a crackled appearance.

**4.89 to 5.64 m: 6.89 g/t Au; 17.2 g/t Ag; 0.062% Pb; 0.265% Cu; 1.26% Zn**

5.7-11.4 m **Sparsely quartz-phyric felsic intrusion**
This is a pale-brown to buff to almost white, mottled unit that has darker residual mottles surrounded by lighter-coloured alteration; the mottles are as much as 10 cm wide. The unit contains only sparse (<<1%), 1- to 3-mm, visible quartz phenocrysts. Within both the darker and lighter parts of the unit, there are chlorite-enriched, diversely oriented, veins, patches, and lenses that are as much as 5 mm wide. The lower contact is missing and has been replaced by a 10-cm-long wooden block.

**Mineralization**
The unit contains 1 to 3%, disseminated pyrite and there are also pyrite ± sphalerite concentrations that are as much as 5 mm wide. Most concentrations are concordant but some are discordant. Some concentrations contains quartz + calcite and/or chlorite.

8.8 m **Metagabbro xenolith (?)**
This is a 5-cm-wide mafic unit. Contacts with the adjacent quartz-phyric felsic units are sharp and concordant, and there is no evidence of chilling in the mafic unit; the grain size of 0.5 mm in the mafic unit is consistent right to the contacts. In the margins of the possible xenolith and extending as much as 5 mm away from the contacts, there are rounded, xenolith-like felsic blebs that are as much as 5 mm long. The blebs are inferred to be apophyses of the felsic intrusion that, in the third dimension are connected to the adjacent intrusion; the contact between the

felsic and mafic units is thus irregular and similar to contacts observed deeper in the drill hole and on surface.

11.4-13.9 m **Metagabbro block**

This is a non-magnetic unit that has a relatively uniform grain size of 1 to 2 mm. At the lower contact, the unit is apparently finer grained adjacent to a quartz-phyric felsic intrusion, but 1-mm grains are still visible, and the apparent finer grain size is probably an artifact of alteration resulting from intrusion of the felsic unit. The lower contact is subparallel to the core axis; it is visible, discontinuously, for 60 cm. In detail, the contact is irregular with both sharp reentrants and rounded protrusions of felsic material; the protrusions are as much as several centimeters long and wide. Calcite veins as much as 3 mm wide are common.

**Mineralization**

The unit contains rare disseminated pyrite.

13.9-14.8 m **Quartz- and plagioclase-phyric felsic intrusion**

This is a grey unit that contains both sparse quartz phenocrysts and 5 to 10%, 1- to 4-mm, plagioclase phenocrysts. Quartz phenocrysts are difficult to recognize; plagioclase phenocrysts were observed only in the chilled margins of the intrusion. The lower contact is irregular on a scale of 10 cm. The unit is finely mottled with 1- to 8-mm, more chloritic mottles. There are local chlorite and calcite veins.

**Mineralization**

The unit contains 2 to 3%, disseminated pyrite and local, discordant, pyrite + quartz veins.

14.8-15.0 m **Metagabbro block**

This unit has minor calcite veins.

15.0-15.4 m **Plagioclase-phyric felsic intrusion**

This appears to be similar to the unit encountered between 13.9 and 14.8 m. Plagioclase phenocrysts were observed only in the lower 10 cm, which appears to be chilled. No quartz phenocrysts were observed.

**Mineralization**

The unit contains 1 to 2% pyrite that occurs as disseminations and as discontinuous concentrations along fractures; the concentrations are as much as 2 mm wide.

15.4-16.2 m **Metagabbro block**

This unit, most of which has a grain size of 2 mm, has local, irregular, more-plagioclase-rich and coarser (as much as 5 mm) zones that have gradational contacts; these zones are 2 to >5 cm wide. The lower contact is discordant to the foliation. The unit contains calcite veins.

16.2-24.8 m **Quartz-phyric felsic intrusion**

This is a pale-grey unit that contains <1%, 1- to 4-mm, quartz phenocrysts that are partly to completely recrystallized and are difficult to recognize. Phenocrysts are most obvious in the upper 1.5 m of the unit. There is local chlorite alteration in the form of diversely oriented, chlorite ± calcite veins that are as much as 5 mm wide. There is also as much as 5%, 3- to 5-, and locally as much as 10-mm, irregular chloritic aggregates. There is also a variably developed alteration in the form of white to pale-grey layers and blotches that are, in part, spatially related to chlorite veins. Locally, the unit has a fine fracture pattern defined by a network of <1-mm-wide, quartz veinlets.

**Mineralization**
The unit contains 3 to 5% pyrite as disseminations, as discontinuous, semi-concordant to discordant aggregates that are as much as 3 mm wide, and as chlorite + calcite + pyrite veins that are as much as 5 mm wide. There is minor pyrrhotite and rare sphalerite.

24.8-27.5 m **Quartz-phyric felsic intrusion**
This is a grey unit that is less altered than preceding unit. It contains 3 to 4%, 1- to 4-mm, quartz phenocrysts that are relatively easy to identify. Upper contact is sharp and chilled; the lower contact is missing. The unit has a poorly developed, blotchy, pale-grey alteration as well as 2 to 8%, 1- to 5-mm, chloritic spots.

**Mineralization**
The unit contains 1 to 2% disseminated pyrite. There are also sparse, discordant, wall-rock replacement concentrations that are as much as 2 m wide.

27.5-36.6 m **Quartz-phyric felsic intrusion**
This is similar to the quartz-phyric felsic intrusion that was intersected between 16.2 and 24.8 m. Quartz phenocrysts are present, but they are very difficult to recognize; phenocryst abundance could not be determined. The unit has variably developed, blotchy, white alteration and variably developed chloritic alteration in the form of 2- to 8-mm aggregates that form as much as 10% of the unit but are best developed in 1- to 2-m-long, gradationally bounded segments. The unit contains trace to 5%, 1- to 2-mm garnet.

There are 2 distinct intervals, 10 to 20 cm long, in which phenocryst texture is sharply defined, and, in one of these intervals, 5 to 10%, 2- to 4-mm, plagioclase phenocrysts can be recognized. These intervals have sharp boundaries. The intervals could represent narrow dikes or they could just be less intensely altered zones.

28.8-29.4 m **Metagabbro block**
This unit has a grain size of 1 mm, and it is more strongly foliated that the adjacent felsic unit.

30.4 m **Metagabbro block**
This is a 10-cm-wide, strongly foliated metagabbro.

**Mineralization**
The felsic intrusion generally contains <1% disseminated pyrite. Locally, there is as much as 5% pyrite associated with more intense chloritic alteration, which occurs as discordant veins as much as 1 cm wide. The metagabbro blocks contain 2 to 5% pyrite + pyrrhotite that occur mostly as discontinuous lenses along the foliation. In places, the mineralization is associated with chlorite and calcite.

36.6-43.1 m **Quartz-phyric felsic intrusion**
This is a grey to pale-grey unit that contains sparse, recognizable, pale-blue, 1- to 5-mm, quartz phenocrysts. In places, the unit has a granular texture with a grain size of 0.5 to 1 mm, and there are recognizable plagioclase laths of this size. There is trace to 5% garnet. There are local chloritic spots and white alteration as well as local calcite veins. The upper contact is broken, but the lower contact appears to be chilled.

**Mineralization**
Most of the unit contains <1% pyrite but in the lower 1 m, much of which is strongly fractured, there is 5 to 10% pyrite + sphalerite as 0.5- to 2-m-wide veinlets that form a semi-concordant network filling a deformed fracture system.

**38.6 to 42.35 m: the unit contains 2.4 to 13 g/t Ag and 0.101 to 0.61% Zn, but Au values are low.**

**42.35 to 42.77 m: 3.94 g/t Au; 21.8 g/t Ag; 0.309% Pb; 0.153% Cu; 2.44% Zn**

43.1-118.9 m **Large metagabbro block or septum intruded by sparse felsic intrusions**

43.1-50.4 m **Metagabbro**
This unit has a relatively uniform grain size of 1 mm except at the upper contact where the felsic intrusion is chilled against the metagabbro. There are local chlorite-rich alteration layers that are as much as several centimetres wide and are associated with calcite veins. The alteration increases downward, and it is most intense in the lower 1.5 m. There are also biotitic alteration layers of similar width.

**Mineralization**
The unit generally contains <1% pyrite + pyrrhotite ± sphalerite, but locally there is as much as 5% sulphide minerals in intervals as much as 5 cm wide. In places, the sulphide minerals are associated with quartz.

**44.29 to 45.72 m: 0.4% Zn but values of other metals are low**

50.4-52.0 m **Quartz-phyric felsic intrusion**
This is a grey unit that contains <1%, 1- to 4-mm, quartz phenocrysts that are readily identified. The unit has sharp, chilled contacts that are discordant to the foliation. There is variable, pale-grey alteration that occurs as 5–mm spots and associated with diversely oriented fractures.

**Mineralization**
The unit contains rare pyrite.

52.0-118.9 m **Metagabbro**
This unit has a 1- to 2-mm grain size and a moderate to weak foliation that is 45° to the core axis. In places, the unit has layered to patchy alteration consisting of fine-grained chlorite that has obliterated original textures. Altered areas contain local garnet that is as much as 5 mm in diameter. There are variably developed, straight, semi-concordant to discordant, quartz and calcite veins; quartz veins are as much as 1 cm wide, and, in places, they occur in chloritic alteration zones.

From about 101 to 105 m, there are 2 to 3%, deformed white blotches that might be deformed plagioclase megacrysts.

59.9-60.1 m **Quartz-and plagioclase-phyric felsic intrusion**
This is a dike that is 45° discordant to foliation. It contains <1%, recognizable, 2- to 5-mm, recrystallized quartz phenocrysts and locally there are relicts of 1- to 5-mm, plagioclase phenocrysts. The dike contains only rare pyrite.

87.0 m **Aphyric felsic intrusion**
This is a 3-cm-wide dikelet. No phenocrysts were recognized. The dikelet contains 15 to 20% pyrite + pyrrhotite, but it was not sampled by Nuinsco.

92.8 m **Brecciated zone, possibly a late fault**
This is a 4-cm-wide, discordant zone that contains angular wall rock fragments cemented by calcite and pyrite.

110.5-112.5 m **Quartz-phyric felsic intrusion**
This is a dike that contains 5 to 8%, readily recognized, 2- to 5-mm, quartz phenocrysts. No plagioclase phenocrysts were observed. The dike contains 1 to 2% disseminated pyrite.

**Mineralization**
The metagabbro generally contains <1% pyrite + pyrrhotite, but locally there is as much as 5% sulphide minerals in 5-cm-wide zones. Some of the higher sulphide mineral abundances are in quartz veins.

118.9 m End of hole.

**NUINSCO DRILL HOLES UNDER POWER LINE AT NORTH END OF OFF LAKE**

| | | |
|---|---|---|
| Drill Hole: **NS95-02** | Relogged by: L. D. Ayres | Date: June 26, 28, 2006 |
| Northern drill hole | Initial inclination: -45° | Initial bearing: 090° |

**Note: This drill hole was not drilled far enough into the felsic intrusion. In drill hole NS95-01, and in outcrop, the main mineralization is adjacent to the footwall (eastern) metagabbro. The present drill hole was collared in the western, hanging wall metagabbro, which, on surface, is separated from the eastern metagabbro by 50 to 60 m of porphyritic felsic intrusion; this drill hole did not reach the eastern metagabbro.**

0-6.9 m

Casing

There is a discrepancy between the Nuinsco drill logs and the distances marked on end of core box re depth of casing. I have used the drill log distances.

6.9-7.8 m

**Quartz-phyric felsic intrusion**

This is a grey unit that contains about 1%, 2- to 4-mm, variably recrystallized, quartz phenocrysts. There is local fracturing with some of the fractures filled by calcite veins that are as much as 1 mm wide. The lower contact is chilled, and it is approximately perpendicular to poorly developed foliation in adjacent metagabbro.

**Mineralization**

The unit contains only minor pyrite.

7.8-58.5 m

**Metagabbro**

Most of this unit has a grain size of 1 to 2 mm, even adjacent to the upper contact with a quartz-phyric intrusion. However, the texture is variable throughout the unit ranging from well preserved, interlocking, equigranular, 1- to 2-mm texture to fine-grained and recrystallized to locally a 3- to 4-mm, primary texture. The fine-grained component, which is generally more chloritic, is in discrete intervals that range in width from 5 to 70 cm; within these intervals, there is increased intensity of foliation and quartz + calcite veins as much as 10 cm wide. In the wider, fine-grained intervals, there are 5- to 10-cm-wide zones in which original texture is well preserved. Away from the fine-grained intervals, which are probably intervals of increased deformation and recrystallization, there are also quartz and calcite veins, but they are less abundant and narrower (mostly <5 mm wide), and the calcite veins are generally straighter. Quartz veins are, in general, more irregular and discontinuous than calcite veins. Foliation is poorly developed except in the discrete finer-grained intervals where it is 60° to core axis.

At 47.1 to 47.4 and 47.6 to 47.8 m, there are grey, felsic intervals that lack visible quartz crystals but contain 5 to 8%, 1- to 2-mm, altered garnet. Contacts of the lower felsic interval are broken, but in the upper interval, the upper contact is a 1-cm-wide, quartz + calcite vein whereas the lower contact is sharp and apparently concordant. These intervals may be alteration zones or they could be felsic dikes in which quartz phenocrysts have been destroyed by recrystallization.

37.7-38.6 m

**Zones of brecciation, possibly faults**

Within this interval, there are several, 5- to 10-cm-wide zones of brecciation in which angular fragments are cemented by quartz and calcite. Local, narrower breccia zones occur elsewhere.

50.5 m

**Zone of strong schistosity, possibly a fault**

This is a 4-cm-wide interval that is 20° to the core axis. The interval is 20% broken quartz veins and unbroken calcite veins, and it contains 5% pyrrhotite. This is a deformed breccia zone.

**Mineralization**

This unit contains <1%, sulphide minerals except in local, 1- to 5-cm-wide intervals where there is as much as 15% pyrite + minor sphalerite, pyrrhotite, and chalcopyrite associated with quartz veins. Most of the sulphide minerals are in veins in the finer-grained intervals, but some also occur in quartz ± calcite veins in medium-grained metagabbro; these latter veins have 1- to 2-cm-wide, finer grained envelopes. Sulphide minerals also occur locally in vein networks that are as much as several centimetres wide and either lack quartz and calcite or contain only minor quartz and/or calcite. Metal values are low.

58.5-59.7 m

**Quartz-phyric felsic intrusion**

This is a grey unit that has poorly defined, paler-grey, blotchy alteration. It contains 2 to 3%, 2- to 4-mm, poorly defined quartz phenocrysts. The unit has a spotted appearance because of 20 to 30%, 1- to 5-mm, spheres that appear to be more chloritic than the rest of the rock. Both upper and lower contacts are sharp and apparently chilled although the lower contact is broken. The lower 20 cm contains 2 to 3%, 1- to 2-mm garnet, but, otherwise, appears to be identical to the rest of the unit; there is no evidence of a contact between the garnetiferous and non-garnetiferous components. There are minor, straight to irregular, calcite veins that are as much as 5 mm wide.

**Mineralization**

The unit contains only minor pyrite.

59.7-60.6 m

**Metagabbro**

This unit has a grain size of 1 mm, but the unit is largely recrystallized. There is locally 2 to 3%, 1- to 3-mm garnet.

**Mineralization**

Most of the unit contains only minor pyrite and pyrrhotite, but, in the lower 20 to 30 cm, there is 5 to 10% pyrrhotite and minor pyrite in a network of narrow veins; this mineralization may be related to that in the underlying unit.

60.6-61.3 m

**Quartz-phyric felsic intrusion**

This unit contains 5%, 2- to 4-mm, quartz phenocrysts that are well defined. It is grey to pale grey with variably developed fractures that are filled by narrow sulphide-mineral ± calcite veins. The unit lacks visible foliation. The upper contact is a 2-cm-wide breccia zone cemented by calcite; the lower contact is broken.

**Mineralization**

The unit contains 10 to 15% sulphide minerals with pyrrhotite > sphalerite > pyrite > chalcopyrite. The sulphide minerals occur as a network of irregular, interconnected veins that are as much as 5 mm wide. The veins vary from being diversely oriented to being largely subparallel over 10 cm-long intervals. There are also local chloritic veins that are as much as 1 cm wide and contain pyrrhotite; these are crossed by sulphide-mineral veins.

**60.62 to 61.02 m: 135 ppb Au; 47.8 g/t Ag; 0.447% Pb; 0.101% Cu; 1.43% Zn**
**61.02 to 61.22 m: 70 ppb Au; 8.2 g/t Ag; 0.161% Pb; 0.385% Zn**

| | |
|---|---|
| 61.3-61.6 m | **Metagabbro**<br>Unit is weakly foliated at 45° to core axis.<br><br>**Mineralization**<br>The unit contains 5% pyrrhotite as 1- to 5-mm, disseminated aggregates and in local veins that are as much as 2 mm wide. There are also sphalerite + calcite veins and pyrrhotite + sphalerite + calcite + quartz veins that are as much as 5 mm wide. See next unit for assay data. |
| 61.6-62.2 m | **Quartz-phyric felsic intrusion**<br>This is a grey to locally pale-grey unit that contains 3 to 4%, 2- to 4-mm, well-defined, quartz phenocrysts. The unit is variably fractured; fracturing is most intense near the chilled upper contact. There are irregular, interconnected chlorite veins in the upper 10 cm; these are as much as 1 cm wide and contain pyrrhotite and pyrite. The upper contact is chilled and discordant whereas the lower contact is chilled and concordant with foliation in adjacent metagabbro.<br><br>**Mineralization**<br>This unit contains 1 to 10% sulphide minerals with most of the sulphide minerals being in the upper 10 cm; sulphide-mineral abundance decreases downward in this unit. Sulphide minerals include pyrite + pyrrhotite + sphalerite as aggregates and interconnected veins that are as much as 5 mm wide. Less commonly, sulphide minerals occur in calcite veins that are as much as 1 cm wide.<br><br>**61.22 to 61.98 m: 200 ppb Au; 13.2 g/t Ag; 0.525% Pb; 0.88% Zn**<br>This sampled interval includes parts of two quartz-phyric intrusive units as well as an intervening metagabbro septum or block. |
| 62.2-62.35 m | **Metagabbro**<br>This interval is moderately foliated. It contains local 1- to 2-mm garnet and 5% calcite veins that are as much as 5 mm wide.<br><br>**Mineralization**<br>The unit contains 1% pyrrhotite + pyrite in 1- to 3-mm aggregates. |
| 62.35-63.6 m | **Quartz-phyric felsic intrusino**<br>This is a grey to pale-grey unit that contains 3 to 4%, 2- to 4-mm, quartz phenocrysts. The central 75% of the unit is spotted because of the presence of 15 to 20%, 1- to 5-mm, spheres that have increased chlorite content. Both contacts are chilled.<br><br>**Mineralization**<br>The unit contains <1% pyrite except at the lower contact where there is a 1-cm-wide, calcite + sphalerite + galena vein. |
| 63.6-64.1 m | **Metagabbro**<br>This interval has a 2 mm grain size and is not foliated. It contains local, rounded, 3- to 4-mm, quartz crystals in the upper 10 cm.<br><br>**Mineralization**<br>The unit contains 1 to 2% pyrrhotite + pyrite that occur as aggregates as much as 5 mm wide and locally in fractures. At the upper contact, there is a 2- to 3-cm-wide zone that contains 10 to 20%, sphalerite + galena associated with calcite.<br><br>**63.76 to 64.01 m: 90 ppb Au; 4.4 g/t Ag; 0.307% Pb; 0.84% Zn** |

64.1-64.5 m **Quartz- and plagioclase-phyric felsic intrusion**
This is a grey unit that contains 1%, 2- to 4-mm, quartz phenocrysts and 15 to 20%, partly recrystallized, 2- to 5-mm, plagioclase phenocrysts. Both contacts appear to be chilled, and they are marked by 1-cm-wide zones of increased actinolite ± chlorite content; the margins contain 5 to 10% mafic minerals as compared to the more normal <2% mafic minerals in the interior of the unit. There is local, blotchy, white alteration and, in places, 1 to 2%, 1-mm garnet. There are local, more chloritic spheres that are as much as 5 mm wide.

**Mineralization**
The unit contains <1% pyrite.

64.5-71.8 m **Metagabbro**
This is a massive unit with a grain size of 2 mm. There are local chloritic zones, 1 to 4 cm wide, that are marginal to calcite + pyrrhotite + pyrite veins; these chloritic zones are as much as 10 cm wide although most are <1 cm wide. There are also other, narrower calcite veins that lack chloritic envelopes.

67.3 m **A 3-cm-wide, apparently aphyric, felsic intrusion**

**Mineralization**
There are only rare sulphide minerals except in, and adjacent to, calcite veins.

71.8-73.7 m **Plagioclase-phyric(?) felsic intrusion**
This is a grey unit. No quartz phenocrysts were observed, but there are indications of 15 to 20%, 2- to 4-mm, plagioclase phenocrysts. Both contacts are sharp and chilled, but the lower contact is irregular and scalloped with an amplitude of 20 cm in drill core.

72.7 m **Quartz vein**
This is a 3-cm-wide vein that contains 1 to 2% pyrrhotite + pyrite, and there is 5% pyrrhotite + pyrite in 5- to 10-mm-wide, more chloritic wall rock zones marginal to the vein.

**Mineralization**
The unit contains 1 to 3%, disseminated, 1- to 3-mm aggregates of pyrrhotite + pyrite.

73.7-75.7 m **Metagabbro**
This is a relatively massive unit. There are local calcite veins. Some veins, which are as much as 5 mm wide, contain 1 to 5% pyrrhotite + pyrite and have marginal chlorite enrichment in wall rocks; other veins, which are as much as 1 cm wide, lack sulphide minerals and chlorite enrichment, and these are, in part, in brecciated zones.

**Mineralization**
There are only rare sulphide minerals in this unit except for local calcite + pyrrhotite + pyrite veins that are as much as 5 mm wide and contain 1 to 5% sulphide minerals.

75.7-81.8 m **Quartz-phyric felsic intrusion**
This is a grey unit that contains 1 to 3%, 1- to 5-mm, quartz phenocrysts; there appears to be slight variations in quartz-phenocryst content from place to place. There are at least two phases in this interval because a sharp, internal contact was observed at 77.7 m. In places, the unit has an ovoid pattern with 2- to 5-mm-long

ovoids that may be relics of plagioclase phenocrysts, or the pattern could be a fine crackling. There is also a variably developed spotted pattern that appears to be the result of chlorite enrichment. The spots are spherical to ovoid, are 1 to 5 mm long, and form 5 to 20% of the unit.

**Mineralization**
Most of the unit contains <1% pyrite + pyrrhotite, but locally there is 3 to 4% pyrite + pyrrhotite in fractures, and there are rare calcite + sphalerite veins that contain 5 to 15% sphalerite and are as much as 1 cm wide; there is chlorite enrichment along the margins of these veins.

81.8-84.1 m **Metagabbro**
This unit is relatively massive and contains some calcite veins that are as much as 15 mm wide. There are also quartz + calcite veins that are as much as 2 cm wide; these are, in part, associated with minor brecciation.

**Mineralization**
This unit contains 1 to 5% pyrrhotite + pyrite + rare chalcopyrite in aggregates that are as much as 5 by 15 mm.

84.1-115.8 m **Quartz-phyric felsic intrusion**
This is a grey unit with variably developed, blotchy white alteration. It contains trace to 3%, 2- to 4-mm, quartz phenocrysts. There is an apparent variation in quartz-phenocryst content through the unit; this may reflect a real variation in phenocryst content related to different phases, or it may reflect differences in the degree of recrystallization and corresponding ease of recognition of phenocrysts. There are definitely some variations in the degree of phenocryst recrystallization across the unit. No phase boundaries were identified. There is locally developed fracturing in this unit. There are local chloritic veins and associated spots that are generally confined to 1- to 2-m-long intervals; the veins are 0.5 to 3 mm wide and the spots are 1 to 5 mm wide and form as much as 15% of the unit. In places, there is as much as 5%, 1- to 3-mm garnet, but most of the unit lacks garnet. Locally, there is as much as 0.5%, 1-mm magnetite.

108.9-109.5 m **Quartz vein**
There is only rare pyrite in the vein, but there is 5 to 10% pyrite in 5- to 10-mm-wide zones in the marginal wall rock.

**Mineralization**
The unit contains 1 to 3% pyrite + pyrrhotite as disseminated grains and aggregates that are as much as 3 mm wide. There are also local, discontinuous, 1- to 2-mm-wide, pyrite + pyrrhotite veins in fractures. Rarely, there is 10 to 15% pyrite + pyrrhotite + galena + sphalerite in, or associated with, calcite veins that are as much as 1 cm wide.

**Between 84.7 and 106.12 m, 7 samples ranging in length from 0.3 to 1.23 m contain >0.1% Zn and 0 to 4.2 g/t Ag; values of other metals are low.**

115.8-116.8 m **Metagabbro**
This unit has a grain size of 2 mm even at the contacts with felsic intrusions.

**Mineralization**
This unit contains 1 to 5% pyrrhotite + pyrite, and, in one place, magnetite and possibly sphalerite. The sulphide minerals occur disseminated and in fractures that are as much as 3 mm wide and, in places, also contain calcite.

116.8-120.4 m

**Aphyric(?) felsic intrusion**
This is a fine-grained, grey to mottled white unit. No phenocrysts were identified although there are local, 2- to 3-mm-long ovoids that may be recrystallized plagioclase phenocrysts. Locally, there are 10 to 15%, 1- to 5-mm, chloritic spots.

**Mineralization**
The unit contains minor disseminated pyrite.

120.4-122.4 m

**Metagabbro**

**Mineralization**
This unit contains 1 to 5% pyrite + pyrrhotite in aggregates and in discontinuous veins that are as much as 2 mm wide and occur in fractures.

122.4-124.97 m

**Quartz- and mafic-phyric, felsic intrusion**
In this grey unit, there are 1%, variably recrystallized, quartz phenocrysts. Where quartz phenocrysts are best preserved, there are also 1 to 2%, 1- to 3-mm, recrystallized, mafic phenocrysts. The unit also contains as much as 20% chloritic spots, but these are absent in parts of the unit.

**Mineralization**
The unit contains 1 to 5% pyrite + pyrrhotite. The highest abundance of sulphide minerals is in the lower 2 m of the drill hole where quartz phenocrysts are best recognized; some sphalerite occurs here. The sulphide minerals occur disseminated and as veins in fractures; the veins are as much as 3 mm wide and contain calcite ± quartz ± chlorite.

**124.47 to 124.97 m: 2.4 g/t Ag; 0.117% Zn**

124.97 m

End of hole.

## COMMENTS ON PINEWOOD LAKE DRILL HOLES

**MISSING CORE:**

When the core was laid out for examination, it was evident that some core boxes were missing. For the 4 drill holes, at least 13 boxes of core could not be found. No hole is complete. At the same time, 6 core boxes that were present could not be logged. In 2 of these boxes, labels at the ends of the boxes were no longer legible, there were no reliable distance markers in the core boxes, and end core pieces could not be matched with core in other boxes. In the other 4 boxes, the core was jumbled and considerable core was missing from the boxes. Counting these 6 core boxes, there are at least 7 core boxes that are missing completely. At the core storage site in Finland, where the core was cross-piled outside, there is no evidence of dumped core. The missing core presumably disappeared since 1997 when the core boxes were stored at Finland.

Among the missing core are mineralized sections in drill holes PW02-97 and PW03-97. In drill hole PW04-97, the core box containing the main mineralized section was found, but the core in this box is jumbled and could not be logged although some comments have been made about mineralization and lithologies.

**DRILL HOLE LOCATIONS:**

The three drill holes that were drilled on azimuths of 045° and 090°, PW01-97, PW03-97, and PW04-97, all intersected a gneissic mafic metavolcanic unit that outcrops on a ridge east of the logging road used for access. My mapping indicates that the west edge of the outcrop ridge is close to the west boundary of the mafic metavolcanic unit. These three drill holes were all apparently collared close to, but west of, the ridge and considerably closer to the ridge than indicated on the drill plan.

**CORE STORAGE:**

At the suggestion of Wally Raynor, the Pinewood drill core is now stored, in a cross pile, at the Rainy River core storage site. New box labels will be attached to the core boxes. Because assay values for samples collected during the original logging of the core in 1997 do not appear to be available, mineralized sections of these drill holes should be resampled.

Drill Hole: **PW01-97** Relogged by: L. D. Ayres Date: September 27, 28, 2006

**Location: 450 m west and 35 m south of post number 1, former claim 1178388.**

Initial Inclination: -50° Initial Bearing: 045°

**Purpose: To drill an EM conductor located by an old Noranda geophysical survey.**

0-3.04 m Casing

3.04-19.5 m **Gneissic mafic metavolcanic unit**

Gneissosity at 60° to core axis is variably developed, apparently as a function of grain size, which ranges from 0.2 to 1.5 mm; the coarser the grain size the less well developed the gneissosity. The coarser grain sizes are a relict texture defined by aggregates of finer metamorphic minerals. Unit is well foliated with foliation parallel to gneissosity. Gneissic layers range in width from 1 mm to 5 cm, and locally wider; they are defined by variations in the ratio of plagioclase to mafic minerals and the ratio of biotite to amphibole. Mafic-mineral content generally ranges from 20 to 70%, but, in places, it is lower or higher than this range. There are minor garnet grains as large as 5 mm. In the more leucocratic layers, which are pale grey, biotite dominates over amphibole. Amphibole dominates in the more mafic layers, which are dark green. In places, the layers resemble bedding, and they were so described in the original drill logs. One of the more leucocratic, biotitic layers is 12 cm wide.

17.1-19.5 m **Granitoid sills**

In this interval, there are 1 to 2%, 2-mm- to 2-cm-wide, white to grey, granitoid sills that contain about 5% biotite and have a grain size of about 1 mm.

**Mineralization**

Most of the unit contains only minor, fine, disseminated pyrite, but locally there is as much as 10% pyrite that mostly occurs as lenses as much as 2 mm wide along the foliation; pyrite locally occurs in concordant quartz veins that are as much as 1 cm wide. The highest pyrite contents are in the sampled intervals, which are

7.0 to 8.16 m
8.66 to 9.86 m
10.77 to 11.64 m
11.9 to 12.7 m.

Assay records are not available.

The highest pyrite concentrations, which are 5 to 10%, in the sampled intervals are in 2- to 5-cm-wide sections.

The unit between 8.16 and 8.66 m, 9.86 and 10.16 m, and 12.7 and 15.5 m is sawn but was not sent for assay.

**NOTE:** Between 17.5 and 36.6 m, some core is missing. In some core boxes, only 1 or 2 pieces are missing, but, in other boxes, as much as 10% of the core is missing. There are also some pieces of core that are out of place; these have been ignored in the present relogging.

19.5-20.7 m **Granitoid dike**

This is a pale-grey, massive, granitoid intrusion that contains 5% biotite and has a grain size of 2 mm. Contacts are discordant; lower contact appears to be a fault.

20.7-22.4 m **Gneissic mafic metavolcanic unit**

Relict grain size ranges from 0.5 to 2 mm. The unit is gneissic where finer grained and poorly foliated where coarser grained. In places, the coarser parts of this unit resemble metagabbro, but the unit is too narrow to properly classify.

**Mineralization**

The unit contains rare pyrite.

22.4-23.0 m **Diorite intrusion**

This is an unmetamorphosed intrusion. The upper contact is concordant; grain size is 1 mm at the contact and increases to 2 mm away from the contact. This unit contains 25 to 30% hornblende, and it may contain quartz, although no quartz was positively identified.

23.0-24.0 m **Granitoid unit**

This is a pale-grey unit that contains more than 20% quartz. At the margins, the unit contains 5% biotite and has a grain size of 2 to 3 mm but grain size increases to 1 cm in the centre of the intrusion where there is <1% biotite.

24.0-25.5 m **Quartzo-feldspathic unit of uncertain genesis**

This is a grey, foliated unit that has a grain size of 0.5 to 1 mm and contains 10 to 15% biotite. In most places, the unit has a relatively uniform texture. Within the unit, there are local, slightly coarser, slightly more leucocratic, gradational patches that have a more poorly developed foliation.

It is intruded by several, 2- to 5-cm-wide, discordant, pale-grey, granitoid dikes.

The genesis of this unit is uncertain, in part because of the amphibolite facies metamorphic grade. The unit could be metasandstone or part of a felsic intrusive complex as identified deeper in hole.

**Mineralization**

This unit contains rare pyrite.

25.5-26.7 m **Granitoid unit**

This is a grey intrusion that has a maximum grain size of 2 to 3 mm and contains 10% biotite and more than 10% quartz. The upper contact is gradational with the previous unit, and the contact is marked by a progressive increase in grain size, decrease in biotite content, and loss of foliation. The lower contact is abrupt with a grain size of 2- to 3-mm at the contact.

26.7-29.0 m **Quartzo-feldspathic unit of uncertain genesis**

This is similar to the unit encountered at 24.0 to 25.5 m, including the presence of several gradational patches that are as much as 5 cm wide; the patches are slightly coarser, are more poorly foliated, and contain slightly less biotite. Within this unit, there are also sharply bounded, pale-grey, <5-mm- to 5-cm-wide, granitoid dikes.

**Mineralization**

This unit contains rare pyrite.

29.0-32.5 m **Granitoid intrusion**

This is a massive unit that contains 8% biotite and more than 10% quartz. Contacts are sharp. There is an increase in grain size away from the upper contact with grain size increasing from 1 to 3 mm; there is no change in grain size at the lower contact. From 31.2 to 31.9 m, there is a leucocratic central zone that contains <1% biotite.

**Mineralization**
In the leucocratic central zone, there is as much as 5% pyrite in veins that are as much as 2 mm wide; the veins occur in fractures of diverse orientations.

31.5 to 32.0 m: assay sample; no records available.

32.5-34.5 m **Gneissic mafic metavolcanic unit**
This unit has a variable grain size ranging from 0.5 to 3 mm, a variably developed gneissosity ranging from absent to well developed, and a variable mafic mineral content ranging from 45 to 85%. In places, there is as much as 5% garnet. In the coarser parts, the grain size is a relict texture defined by aggregates of finer minerals. There is a 4-cm-wide, discordant quartz vein that contains 2% biotite.

34.5-38.3 m **Granitoid unit**
This is a medium- to coarse-grained, grey to slightly pink granitoid unit that contains 20 to 30% quartz and has a variable biotite content ranging from <1 to 8%. Variations in biotite content are patchy.

38.3-46.7 m **Gneissic mafic metavolcanic unit**
Relict grain size ranges from 0.3 to 2 mm among layers, and it is one of the major parameters in defining gneissic layers. Layers, which are generally 0.5 to 3 cm wide, also differ in abundance of mafic minerals. The unit is well foliated except in the coarsest layers, which are massive. Layers vary from continuous to lenticular.

39.5-40.0 m **Granitoid unit**
This is a grey unit that contains 10 to 15% biotite and more than 10% quartz; grain size is 2 to 3 mm. The upper contact is concordant but the lower contact is somewhat discordant.

40.3-40.9 m **Granitoid unit**
This is a pale-grey, concordant unit that contains 8 to 10% biotite at the margins but <3% biotite in the centre. Grain size at the margins is 2 to 3 mm and grain size in the centre is 3 to 4 mm. Contacts between the margins and more leucocratic central zone, which is in the lower part of the unit, are gradational.

41.5-41.8 m **Granitoid unit**
This is a concordant grey unit that has a grain size of 2 to 3 mm and contains 10 to 15% biotite and more than 15% quartz.

42.0 m **Granitoid unit**
This is a 2- to 5-cm-wide, grey unit that contains 5% biotite.

**Mineralization**
The unit contains rare pyrite.

46.7-46.8 m **Granitoid unit**
This is a grey unit that contains 5 to 7% biotite and >20% quartz; grain size is 2 to 3 mm. Upper contact, which is 45° to core axis, is discordant to the 60° foliation in the country rocks. In a 1-cm-wide zone at the contact, foliation in the country rock is parallel to the contact.

**NOTE:** From 46.8 to about 73.4 m, the core was not found. At about 73.4 m, there is a single core box with reliable metric distances marked on the core, but about 5% of the core is missing from this box. No assay samples were taken from the missing core boxes during the original logging.

73.4-75.1 m **Quartz- and plagioclase-phyric, felsic dikes**

This is a pale-grey, foliated, quartzo-feldspathic unit that has a grain size of 0.5 to 1 mm and contains 5 to 8% biotite that appears to vary in abundance from place to place. The unit contains 3 to 5%, 2- to 5-mm, ovoid, white aggregates that are probably recrystallized plagioclase phenocrysts. There are also more subtle, grey, recrystallized quartz phenocrysts of similar size. Within the unit, there are several abrupt changes in biotite content and grain size that probably represent internal contacts.

75.1-76.1 m **Gneissic mafic metavolcanic unit**

Gneissosity is poorly developed in this unit, which has a relict grain size of 2 mm and contains more than 60% mafic minerals.

**Mineralization**

This unit contains rare pyrite.

76.1-76.8 m **Quartz- and plagioclase-phyric, felsic intrusions**

This is similar to the unit encountered from 73.4 to 75.1 m. Upper contact is discordant; lower contact is concordant.

76.8-77.1 m **Mafic metavolcanic unit (?)**

Both contacts of this foliated unit are concordant and are 5- to 20-mm-wide, quartz veins. The unit is more strongly foliated than other mafic intervals and has a higher content of mafic minerals at the contacts, which may be faults. Grain size is 1 mm.

**Mineralization**

This unit contains rare pyrite.

77.1-77.6 m **Quartz- and plagioclase-phyric, felsic intrusions**

This is similar to the unit encountered from 73.4 to 75.1 m. There is possible chilling at the upper contact.

**NOTE:** From 77.6 m to the end of the hole at 88.38 m, the core is missing. No assay samples were taken from the missing core boxes during the original logging.

Drill Hole: **PW02-97** Relogged by: L. D. Ayres Date: September 26, 2006

**Location: 700 m west and 105 m south of post number 1, former claim 1178388.**

Initial Inclination: -50° Initial Bearing: 270°

**Purpose: To determine rock units; no known conductor.**

0-22.36 m Overburden.

22.36-82.25 m **Quartz- and plagioclase-phyric, felsic intrusion; probable dike complex**

This is a dark-grey to locally grey, fine-grained, quartzo-feldspathic unit that contains 3 to 5% biotite and has a grain size of 0.5 mm. The unit has a poorly developed foliation that is not recognizable everywhere, and the orientation of the foliation is variable from place to place ranging from 45 to 70° to core axis. Observed variations in colour from dark grey to grey appear to reflect differences in degree of alteration with grey parts being more altered. There are ubiquitous, albeit very subtle and difficult to recognize, 2- to 5-mm-long, ovoid aggregates of quartz that appear to be recrystallized quartz phenocrysts. In many places, quartz phenocrysts are difficult to identify; however, there appears to be variations in phenocryst abundance from place to place with abundance ranging from 1 to 5%. In the most altered parts of the core, where the colour is almost pale grey to pinkish grey, there are poorly defined, 2- to 5-mm-long, white aggregates that may be recrystallized plagioclase phenocrysts. Where observed, the possible plagioclase phenocrysts form as much as 20% of the unit, and they occur in intervals that are typically several tens of centimetres long. Boundaries of the plagioclase-phenocryst-bearing intervals are gradational over several centimetres. No other internal boundaries were observed. At first glance, there appears to be textural variations within the interval, but most of these are alteration and related colour differences; the exception are variations in quartz-phenocryst content. The overall rock texture appears to be relatively uniform.

At 66.5 m, there is a marked increase in alteration intensity. From 66.5 to 69.0 m, the alteration is patchy, but below 69.0 m, all of the unit is altered to varying degrees. The alteration zone is characterized by more intense foliation. Quartz phenocrysts are still recognizable, but they are flattened 2:1. Where strongly altered and foliated, the texture has a more granitoid appearance, but quartz phenocrysts are still present and the unit is porphyritic.

There are local, <1-mm-wide, calcite veins at 70° to core axis; these veins fill subparallel fractures that have a spacing of 5 to 15 mm. The veins occur in 1- to 2-m-long intervals and they are associated with slightly paler coloured, probably more altered parts of the unit.

The origin of this unit is uncertain. It is most likely a quartz- ± plagioclase-phyric, felsic dike complex metamorphosed to amphibolite facies. However, the possibility that it is metasandstone cannot be dismissed.

Within this unit, there are numerous, seemingly younger, pink, leucocratic granitoid sills and possibly some dikes that have a grain size of 2 to 3 mm and contain 20 to 25% visible quartz. The sills have sharp contacts and most are subparallel to foliation, but there is no evidence of chilling at contacts. The sills and dikes occur at the following locations:

24.72 m: 5-cm-wide dike at 20° to core axis

27.28 m:2-cm-wide sill at 45° to core axis.

28.69 m:2-cm-wide dike at 60° to core axis is truncated by a fault.

28.76 m:1.5-cm-wide sill at 45° to core axis has 5-mm-wide apophyses.

28.90 m:2-cm-wide sill at 45° to core axis.

30.58 to 31.15 m: sill at 40° to core axis.

36.64 to 37.64 m: pegmatite sill at 40° to core axis.

41.1 m: 5-mm-wide dike at 30° to core axis.

43.18 m: >5-cm-wide dike at 30° to core axis; some of dike is missing.

45.2 m: 7-cm-wide sill at 45° to core axis. This is a 2-phase sill: the upper 1.5 cm is porphyritic with 5-mm, potassic feldspar phenocrysts.

46.37 m:>5-cm-wide sill at 45° to core axis; part of sill is missing.

47.34 m: 5-cm-wide sill at 45° to core axis; contacts are irregular.

54.0 m: 1-cm-wide dike at 20° to core axis.

62.5 m: 1-cm-wide leucogranite sill at 45° to core axis.

63.1 to 63.2 m: a pod-like unit with contacts that are not parallel.

63.4 to 64.7 m: leucogranite sill at 45° to core axis; a 2-cm-wide, wall-rock xenolith occurs near bottom contact.

66.2 m: 5-mm-wide sill at 45° to core axis.

66.3 m: 5-mm-wide sill at 45° to core axis.

73.7 to 73.8 m: leucogranite sill at 45° to core axis appears to truncate a quartz vein.

76.7 to 77.0 m: leucogranite dike; upper contact is interdigitating; lower contact is straight and 60° to core axis.

78.9 to 79.0 m: leucogranite sill at 45° to core axis.

80.0 m: 1-cm-wide, leucogranite sill at 45° to core axis.

80.2 to 80.6 m: leucogranite sill at 45° to core axis.

80.8 m: 5-mm-wide leucogranite sill.

81.0 m: 5-mm-wide leucogranite sill.

81.4 m: 1-cm-wide leucogranite sill.

23.55-24.13 m **Late breccia zone**
This is a pale-pink, more altered zone. Breccia fragments are separated by chloritic seams that form about 5% of the zone.

55.8 m **Mafic dike, septum, or xenolith**
This is a 4-mm-wide unit that is 45° to the core axis.

56.0 m **Mafic dike, septum, or xenolith**
This is a 2-mm-wide unit that is also 45° to the core axis, but the orientation is 10 to 20° different from that of the unit at 55.8 m.

58.7-59.0 m **Breccia zone**
This is a zone of late brecciation very similar to that at 23.55 to 24.13 m.

59.0-59.4 m **Possible fault**
This is a zone of more intense foliation and alteration, within which there are some concordant, epidote + quartz + chlorite veins as much as 1.5 cm wide. Foliation is 45° to core axis.

79.8-82.25 m **Highly altered and brecciated zone**
This is a late breccia defined by semi-concordant fractures that are filled by quartz. This quartz matrix forms 5 to 10% of the breccia and occupies fractures between fragments that have been moved only slightly. Fracture fillings are 0.1 to 5 mm wide and fracture spacing is 0.5 to 10 cm. The alteration in this interval is pale pink to pinkish buff, and the only relict textures are recrystallized quartz phenocrysts. There are only trace amounts of mafic minerals. In the strongly altered interval, there are several sharp contacts; units on both sides of these contacts contain recrystallized quartz phenocrysts, but they differ in mafic mineral content and degree of foliation development; these are probably phase boundaries.

There are local zones of brecciation, several centimetres wide, above the main breccia zone.

The widest leucogranite sill in the breccia zone (80.2 to 80.6 m) is incipiently brecciated.

**Mineralization**
The unit contains trace to 2% disseminated pyrite. Pyrite content increases downward, and, where more abundant, it occurs both disseminated and in <1-mm-wide, lenticular aggregates along foliation. Locally there is as much as 5% pyrite, but the average abundance is 1 to 2%. There is only rare pyrite below 75 m.

From 65.77 to 66.5 m, the core is sawn, but it was not sampled. This interval contains 3 to 4% pyrite. Core between 78.8 and 79.2 m, and between 79.8 and 81.3 m was also sawn but not sampled.

**NOTE:** From 37.0 to 46.37 m, considerable core is missing from the core boxes.

82.25-83.7 m **Fault (?)**
In this interval the core is a finely ground, dark-green powder.

83.7-84.4 m **Brecciated cherty unit, possibly quartz-phyric felsic intrusion.**
Core in this interval is badly broken. The interval is a pale-grey to grey, siliceous, leucocratic, brecciated unit that is generally similar to the previous

breccia although it differs in colour. Breccia fragments are also more aligned and there is a foliation in the matrix, which, in places, is as much as 1 cm wide. In spite of this fabric, many fragments are angular. There are sparse quartz crystals in the fragments, and there is local garnet in the matrix. Except for the quartz crystals, this unit looks like chert. However, the presence of quartz crystals suggests that the unit may be an altered, brecciated, quartz-phyric, felsic intrusion.

**NOTE:** Core between 84.4 and 91.7 m, the end of the hole, could not be found. Within this interval, 2 samples were taken for assay during the original logging: 87.91 to 88.42 m, and 88.42 to 88.93 m. These sampled intervals could not be examined, but the original logs report 5 to 8% pyrite in these intervals.

Drill Hole: **PW03-97** Relogged by: L. D. Ayres Date: September 27, 2006

**Location: 88 m east and 550 m north of post number 3, former claim 1178387.**

Initial Inclination: -50° Initial Bearing: 090°

**Purpose: To test horizontal loop and vertical loop EM conductor from old Noranda assessment files.**

0-14.68 m Overburden.

14.68-14.8 m **Granitoid unit**

This is a white unit that has a grain size of 1 to 1.5 mm and contains 5% biotite and 20 to 25% quartz. Contact is 15° to core axis.

14.8-15.1 m **Metasandstone (?)**

This is grey, strongly foliated unit that has a grain size of 0.5 to 1 mm. Foliation is 40° to core axis. The unit contains about 10% biotite and there are slight variations in biotite content across the unit on a scale of 1 to 2 cm; this could be relict bedding. In part, the biotite is concentrated in 0.5-mm-wide lenses that are as much as several centimetres long. There are local quartz crystals that are as much as 1.5 mm in diameter.

**Mineralization**

The unit contains minor pyrite near the lower contact. The pyrite occurs in a 1- to 2-mm-wide, discordant vein that has offshoots parallel to foliation.

15.1-44.85 m **Gneissic mafic metavolcanic unit**

This is a texturally variable unit that has a well developed foliation at 45° to the core axis. In places, there is a gneissosity that varies from vague lenses to well defined layers that range in width from 1 mm to several centimetres; lenses and layers are defined by variations in the ratio of felsic to mafic minerals. Mafic minerals, which are dominantly hornblende but also include biotite, range in abundance from 50 to 60%; there is also as much as 5% garnet. The ratio of hornblende to biotite is variable among the gneissic layers. Grain size ranges from 0.5 to 1 mm, and is locally as much as 1.5 mm, with slight variations from place to place. Some of the grain size variations along the core, which include intervals several metres long that have a relict grain size of 1.5 mm, may represent primary grain size variations in lava flows. In places, there are also possible amygdules represented by rounded, spherical to ovoid aggregates of quartz + calcite that are as much as 3 mm wide. These occur in 5- to 30-cm-long intervals where there is as much as 10% aggregates.

The upper contact is a 2-cm-wide, sugary quartz vein that parallels foliation.

21.2-21.5 m **Quartz vein**

This is a concordant vein that lacks visible sulphide minerals. This vein was sampled for assay during the original logging of the core; assay results are not available.

24.4 m **Quartz vein**

This is a 5-cm-wide, concordant vein.

33.2-34.0 m **Granitoid dike**

This is a white dike that is 40° to core axis and 90° discordant to foliation. No chilling was observed at contacts. Grain size is 1 to 2 mm, and the dike contains 5% biotite and more than 20% quartz.

Similar granitoid sills occur locally elsewhere; these are generally finer grained, concordant, and <3 cm wide.

**Mineralization**
In most of the unit, there is only rare pyrite, but in the uppermost 45 cm there is as much as 10% pyrite and pyrrhotite that is both disseminated and in concordant veins; sugary quartz is, in places, associated with massive sulphide minerals. Sulphide-mineral abundance is variable within this interval, and, in the upper 10 cm, there is about 30% sulphide minerals. Adjacent to the upper-contact, quartz vein, there is a 1.5-cm-wide interval that contains 50 to 60% pyrrhotite and pyrite with pyrrhotite more abundant than pyrite. In the uppermost 10 cm, there are numerous, discontinuous, concordant, sulphide-mineral lenses that are as much as 5 mm wide; these decrease in abundance downward changing from massive lenses to disseminations and concordant aggregates. No sphalerite or chalcopyrite were observed in the tarnished core of the sampled interval (see below). In the lower part of the unit, there is locally as much as 1% pyrite and minor chalcopyrite.

15.1 to 17.5 m: samples for assay were collected during the original logging of the core; results are not available.

**NOTE:** Two boxes of core, from 44.85 to 53.55 m, were not found. During the original core logging, samples for assay were taken from 48.27 to 49.16 m, 49.28 to 50.30 m, 50.30 to 50.69 m, 50.69 to 51.43 m, 51.43 to 51.52 m, 51.52 to 51.83 m, and 52.15 to 52.51 m. These intervals were not available for examination and assay results are not available. According to the original drill logs, the sampled intervals contained 3 to 17% pyrite plus some pyrrhotite and locally chalcopyrite.

53.55-54.3 m **Metasandstone (?)**
This is a grey, fine-grained unit that contains 10 to 15% biotite; variations in biotite abundance define 2- to 20-mm-wide layers that may be beds. Well foliated to gneissic.

53.7-54.0 m **Granitoid dike**
This is a grey unit that has a grain size of 1 to 1.5 mm and contains 5% biotite. Contacts are 45° to core axis and 20 to 30° discordant to foliation.

**Mineralization**
Most of the unit contains only minor pyrite, but locally, there is 1 to 2% pyrite within discrete, 1- to 2-cm-wide layers.

54.3-54.8$^+$ m **Core missing**; includes lower contact of previous unit.

54.9-79.4 m **Gneissic mafic metavolcanic unit**
This is a pale-grey to green unit with well developed foliation and gneissosity. Gneissic layers are sharply to gradationally bounded and range in thickness from 1 mm to 2 cm, and locally as much as 10 cm. Layers are defined by variations in the ratio of felsic to mafic minerals, and the ratio of biotite to hornblende. Mafic mineral abundance ranges from 10 to 60%, and is locally as much as 90%. There is a variable abundance of 1- to 5-mm garnet; abundance ranges from 0 to 10%. There are local intervals, 10 to 20 cm wide, where amphibole appears to be absent and biotite is the only mafic mineral; biotite content in these intervals is <10%. These intervals could be sandstone interbeds.

White to grey, massive to foliated, granitoid intrusions that have a grain size of 1 to 1.5 mm and contain 5% biotite occur at

55.7 to 56.0⁻ m: concordant upper contact; core missing at lower contact.

57.3 to 58.2 m: slightly discordant intrusion.

58.7 to 60.3 m: upper contact is relatively concordant, but lower contact is 90° discordant.

62.3 to 63.3 m: discordant unit.

69.2 to 69.8 m: discordant unit.

70.3 m: a 3-cm-wide, discordant unit with a grain size of 0.5 to 1 mm.

77.6 m: a 1.5-cm-wide, concordant sill.

There are local, <1-cm-wide dikes and sills elsewhere in this unit.

**Mineralization**
There is only rare pyrite in this unit.

**NOTE:** Box 16, with core from 79.4 to 83.8 m, was not found.

83.8-90.1 m **Gneissic mafic metavolcanic unit**
This is a continuation of the unit between 54.9 and 79.4 m.

86.5-87.0 m **Granitoid intrusion**
This is a grey unit.

90.1-92.4 m **Porphyritic felsic dike complex**
This is a pale-grey unit that contains as much as 15%, 2- to 4-mm, recrystallized phenocrysts; the composition of the phenocrysts is uncertain, but they are either quartz or plagioclase. The unit is foliated and contains 5% biotite. Within this unit, there is a 3- to 4-cm-wide, more biotite-rich septum that contains 20 to 30% biotite. This interval was intruded by several, 1- to 10-cm-wide, grey granitoid sills.

**Mineralization**
This unit contains only rare pyrite.

92.4 m End of hole.

Drill Hole: **PW04-97** Relogged by: L. D. Ayres Date: September 28, 2006

**Location: 60 m east and 550 m north of post number 3, former claim 1178387.**

Initial Inclination: -50° Initial Bearing: 090°

**Purpose: To undercut the sulphide mineralization intersected in the uppermost part of drill hole PW03-97.**

0-19.42 m Overburden.

**NOTE:** The first box of core, 19.42 to 23.7 m, was not found. The second box of core, 23.7 to 28.2 m, was found, but 20 to 30% of the core is missing, and the remainder is jumbled. The core in box 2 was examined, although not logged, because the box contains sampled mineralization. In the final 4 boxes of core, 28.2 to 44.5 m, the core appears to be complete and in order.

**Mineralization**
According to the original log, the mineralized interval is 24.7 to 25.1 m, but sulphide-mineral-bearing, sawn core halves are now scattered through the core box, and not all of the sawn core represents the sampled interval. Complicating recognition of the sampled interval, some of the core in the box was sawn but not sampled. Because the mineralized core is scattered through the core box, the host lithology to the mineralization could not be determined.

Part of the material in the box, which was sawn but not sampled and may be close to the mineralized interval, is a grey, well foliated unit that has a grain size of 0.3 to 1 mm, and, in spite of amphibolite facies metamorphism, this unit appears to be recognizable pebbly sandstone. This core contains 10 to 15%, lenticular, fine-grained aggregates that are as much as 3 mm wide and 2 cm long; the aggregates vary in colour from grey to pink and appear to be flattened, felsic, lithic clasts. There are sparse mafic lenses that are probably flattened mafic clasts. There are also sparse, less flattened (2:1), 4- to 6-mm-long aggregates that appear to be recrystallized crystals. The unit contains rare garnet. Foliation is 45° to core axis. Other pieces of core in the box are finer and could be coarse sandstone or possibly metamorphosed, porphyritic felsic intrusions.

The pieces of mineralized core still present in the box have a combined length of about 28 cm, which is less than the 40-cm length of the sampled interval. The sulphide minerals, which include both pyrite and pyrrhotite, occur in a brecciated, siliceous unit. Some fragments contain 0.1- to 0.5-mm-wide magnetite layers, and the host rock is probably brecciated ferruginous chert. No chalcopyrite was recognized in the badly tarnished, broken pieces of core.

28.2-32.2 m **Gneissic mafic metavolcanic unit**
This is a well foliated unit that, in places, is also gneissic. Grain size ranges from 0.3 to 2 mm, with the coarser grain sizes being a relict texture preserved by aggregates of metamorphic minerals. Foliation is 40° to core axis. Grain size fines toward the lower contact over a distance of 1 m.

There are sparse, concordant and discordant, pink and locally grey granitoid dikes and sills that are as much as 3 cm wide.

**Mineralization**
The unit contains rare pyrite.

32.2-38.3 m **Metasandstone (?)**

This is a grey, well foliated unit that has a grain size of 0.5 mm and contains 5% biotite and 1 to 3%, 2- to 5-mm, rounded, equant to ovoid, recrystallized quartz crystals. The unit has a variably developed streakiness with 0.5- to 2-mm-wide lenses that are more leucocratic than other parts of the unit. These lenses are most obvious when viewed from a distance of about 50 cm. Closer examination reveals that the lenses lack well defined boundaries, and the lenses merge with the rest of the rock. The lenses could be flattened lithic clasts in a sandstone or a metamorphic effect in either a sandstone or an intrusion; if an intrusion, then the quartz crystals are phenocrysts. At the amphibolite-facies metamorphic grade of this unit, genesis cannot be properly determined.

**Mineralization**

The unit contains rare pyrite that, where present, is along foliation planes.

38.3-38.4 m **Granitoid unit**

This is a grey sill that has a grain size of 1 mm and contains 5 to 10% biotite. Both contacts are concordant although the lower contact appears to be a fault.

38.4-43.5 m **Gneissic mafic metavolcanic unit**

This is a well foliated unit that has poorly developed gneissosity. Grain size is <1 mm and the abundance of mafic minerals ranges from 25 to >60%. From 38.4 to 40.1 m, the unit contains as much as 15%, irregular, partly chloritized garnets that are as much as 1 cm in diameter. Locally, there are lenses and layers that are as much as 1 cm wide and contain 80% garnet. Garnet is largest and most abundant in the central part of this interval. Foliation is best developed in the upper 60 cm of the unit, adjacent to the upper fault contact. Near 41.0 m, there is a 30-cm-long, spotted interval that contains as much as 10%, 1- to 3-mm-long, pale-grey ovoids. In detail, the shape of the ovoids is irregular and the ovoids have slightly gradational contacts. The ovoids are probably recrystallized plagioclase phenocrysts.

Near the bottom of the unit, there are 2, pale-grey, granitoid dikes that are as much as 3 cm wide and are subparallel to the core axis. The dikes have a grain size of 2 to 3 mm, and they contain 5% biotite. In places, the dikes appear to grade into quartz veins. There are rare patches of cream-coloured alteration in the dikes.

**Mineralization**

In the upper 13 cm of the unit, there is about 20% sulphide minerals. These are dominantly pyrrhotite with lesser amounts of pyrite. No sphalerite was positively identified. Most of the sulphide minerals are in 2 concordant layers that are 5 to 10 mm wide. In these layers, there is 70 to 80% sulphide minerals forming interconnected networks. There are also other, <1-mm-wide, sulphide-mineral-rich layers. In the remainder of the garnetiferous interval, there is trace to 1%, and locally, in intervals several centimetres wide, 2 to 3% pyrite and more rarely pyrrhotite. There is rare pyrite in the lower part of the unit.

38.41 to 38.53 m: Sample for assay collected during the original logging; results not available.

43.7-44.5 m **Quartz- and plagioclase-phyric, felsic dike**

Upper contact is missing.

This is a pale-grey, leucocratic, fine-grained, weakly foliated, felsic unit that contains 1 to 3%, 2- to 4-mm, rounded quartz phenocrysts. In local, more altered intervals, there appears to be 5 to 10% plagioclase phenocrysts of similar size.

The unit is intruded by an irregular, pink, fine- to medium-grained, granitoid unit that contains 30%, 2- to 3-mm, altered feldspar phenocrysts. The granitoid unit is pod-like and the width of the unit changes from 2 to 12 cm across the width of the core.

**Mineralization**
The unit contains trace to 3%, disseminated pyrite.

44.5 m End of hole.

# APPENDIX 4

# PROPERTY DISCRIPTION AND CLAIM MAP

MARCH, 2006

## PROPERTY DESCRIPTION

### LOCATION AND ACCESS

The Off Lake properties occur as two separate blocks located about fifty kilometres northwest of Fort Frances, Ontario, within the Kenora Mining Division (Figure 1). The properties lie within the Ministry of Natural Resources Administrative District of Fort Frances, and are situated within N.T.S. Map Area 52 C/13. The geographic centre of the Off lake claim block is located at approximately 438300mE and 5419600mN. The 3 claim Pinewood block is located 4 south of the Off Lake block centered about 436350mE and 5409200mN. The figure below shows the boundaries of the property in relation to township boundary lines and significant bodies of water.

Access to both properties is obtained via the Off Lake Road, provincial Highway 615, which departs from Highway71 about 18.5 km north of provincial Highway 11. The Off Lake Road crosses nearly the entire property in a north-south direction, and all portions of the property are readily accessible from it or boat access from Off Lake .

Access onto the Pinewood Lake claim block is obtained via a gravel access road to a gravel pit going west from Off lake Road 1.6 kilometres north of the Potts/Mather township boundary. A disused forestry haul road leads south from the pit into the middle of the Pinewood Lake block.

### PROPRTY DESCRIPTION

The Off Lake property is composed of two claim blocks totaling 670 unit covering 10 704 hectares over portions of Flemimg, Menary, Potts and Senn townships. The Off Lake block consists of 50 claims surrounding three additional claims optioned from Clinton Barr of Stares Contract of Thunder Bay. The four year option involves payments totaling $65 000 and 50 000 common shares of Rainy River Resources Ltd. Upon completion of these payments Rainy River Resources will have purchased 100% of the property less a 3% NSR.

The Pinewood Lake block consists of 3 claims covering 384 hectares straddling the Potts-Mather township boundary. The claims are 100% owned by Rainy River Resources.

(Off Lake Block as of March 21, 2007)

| Township/ Area | Claim Number | Recording Date | Claim Due Date | Status | Percent Option | Work Required | Total Applied | Total Reserve | Claim Bank |
|---|---|---|---|---|---|---|---|---|---|
| FLEMING | 4208907 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $6,400 | $6,400 | $0 | $0 |
| FLEMING | 4208908 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $3,200 | $3,200 | $0 | $0 |
| FLEMING | 4211671 | 2006-Jun-26 | 2008-Jun-26 | A | 100% | $400 | $0 | $0 | $0 |
| MATHER | 4215472 | 2006-Oct-27 | 2008-Oct-27 | A | 100% | $3,200 | $0 | $0 | $0 |
| MENARY | 4208866 | 2005-Oct-26 | 2007-Oct-26 | A | 100% | $6,400 | $0 | $3,777 | $0 |
| MENARY | 4208867 | 2005-Oct-26 | 2007-Oct-26 | A | 100% | $4,800 | $0 | $2,583 | $0 |
| MENARY | 4208868 | 2005-Oct-26 | 2007-Oct-26 | A | 100% | $6,400 | $0 | $3,711 | $0 |
| MENARY | 4208869 | 2005-Oct-26 | 2007-Oct-26 | A | 100% | $6,400 | $0 | $2,777 | $0 |
| MENARY | 4208870 | 2005-Oct-26 | 2007-Oct-26 | A | 100% | $6,400 | $0 | $2,777 | $0 |
| MENARY | 4208871 | 2005-Oct-26 | 2007-Oct-26 | A | 100% | $6,000 | $0 | $2,479 | $0 |
| MENARY | 4208872 | 2005-Oct-26 | 2007-Oct-26 | A | 100% | $6,400 | $0 | $2,777 | $0 |
| MENARY | 4208873 | 2005-Oct-26 | 2007-Oct-26 | A | 100% | $6,400 | $0 | $2,777 | $0 |
| MENARY | 4208874 | 2005-Oct-26 | 2007-Oct-26 | A | 100% | $6,400 | $0 | $2,777 | $0 |
| MENARY | 4208875 | 2005-Oct-26 | 2007-Oct-26 | A | 100% | $6,400 | $0 | $2,777 | $0 |
| MENARY | 4208876 | 2005-Oct-26 | 2007-Oct-26 | A | 100% | $5,600 | $0 | $2,180 | $0 |
| MENARY | 4208910 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $6,400 | $6,400 | $0 | $0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MENARY | 4208911 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $6,400 | $6,400 | $0 | $0 |
| MENARY | 4208912 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $4,800 | $4,800 | $0 | $0 |
| MENARY | 4208914 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $4,800 | $4,800 | $0 | $0 |
| POTTS | 1161279 | 1992-Apr-10 | 2008-Apr-10 | A | 100 % Y | $1,600 | $22,400 | $0 | $0 |
| POTTS | 1161280 | 1992-Apr-10 | 2008-Apr-10 | A | 100 % Y | $6,400 | $89,600 | $0 | $0 |
| POTTS | 1161304 | 1992-Apr-10 | 2008-Apr-10 | A | 100 % Y | $800 | $11,200 | $0 | $0 |
| POTTS | 1161328 | 1992-Apr-10 | 2008-Apr-10 | A | 100 % Y | $3,200 | $44,800 | $0 | $0 |
| POTTS | 4207826 | 2006-Feb-20 | 2008-Feb-20 | A | 100% | $1,600 | $0 | $1,194 | $0 |
| POTTS | 4207827 | 2006-Feb-20 | 2008-Feb-20 | A | 100% | $1,600 | $0 | $1,193 | $0 |
| POTTS | 4208900 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $3,200 | $3,200 | $0 | $0 |
| POTTS | 4208901 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $1,600 | $1,600 | $0 | $0 |
| POTTS | 4208902 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $3,200 | $3,200 | $0 | $0 |
| POTTS | 4208903 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $2,400 | $2,400 | $0 | $0 |
| POTTS | 4208904 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $3,600 | $3,600 | $0 | $0 |
| POTTS | 4208905 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $3,600 | $3,600 | $0 | $0 |
| POTTS | 4208906 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $2,400 | $2,400 | $0 | $0 |
| POTTS | 4211670 | 2006-Jun-26 | 2008-Jun-26 | A | 100% | $1,600 | $0 | $0 | $0 |
| POTTS | 4211672 | 2006-Jun-26 | 2008-Jun-26 | A | 100% | $2,000 | $0 | $0 | $0 |
| POTTS | 4215470 | 2006-Oct-27 | 2008-Oct-27 | A | 100% | $1,600 | $0 | $0 | $0 |
| POTTS | 4215471 | 2006-Oct-27 | 2008-Oct-27 | A | 100% | $4,800 | $0 | $0 | $0 |
| SENN | 3012521 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3012522 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3012523 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3012524 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3012525 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3012526 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3012527 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3012528 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3012529 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3012530 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3016066 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3016067 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3016068 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3016069 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 3016070 | 2006-Feb-13 | 2008-Feb-13 | A | 100% | $6,400 | $0 | $0 | $0 |
| SENN | 4208909 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $6,400 | $6,400 | $0 | $0 |
| SENN | 4208915 | 2005-Aug-17 | 2008-Aug-17 | A | 100% | $4,800 | $4,800 | $0 | $0 |
| **FLEMING*** | 3019809 | **2004-May-17** | **2007-May-17** | **A** | **100%** | **$4,800** | **$4,800** | **$0** | **$0** |
| **SENN*** | 3008455 | **2004-Jun-21** | **2007-Jun-21** | **A** | **100%** | **$5,600** | **$5,600** | **$0** | **$0** |
| **SENN*** | 3008456 | **2004-Jun-21** | **2007-Jun-21** | **A** | **100%** | **$1,600** | **$1,600** | **$0** | **$0** |

* Stares Option

(Pinewood Lake Block as of March 21, 2007)

| Township/ Area | Claim Number | Recording Date | Claim Due Date | Status | Percent Option | Work Required | Total Applied | Total Reserve | Claim Bank |
|---|---|---|---|---|---|---|---|---|---|
| POTTS | 4215470 | 2006-Oct-27 | 2008-Oct-27 | A | 100% | $1,600 | $0 | $0 | $0 |
| POTTS | 4215471 | 2006-Oct-27 | 2008-Oct-27 | A | 100% | $4,800 | $0 | $0 | $0 |
| MATHER | 4215472 | 2006-Oct-27 | 2008-Oct-27 | A | 100% | $3,200 | $0 | $0 | $0 |

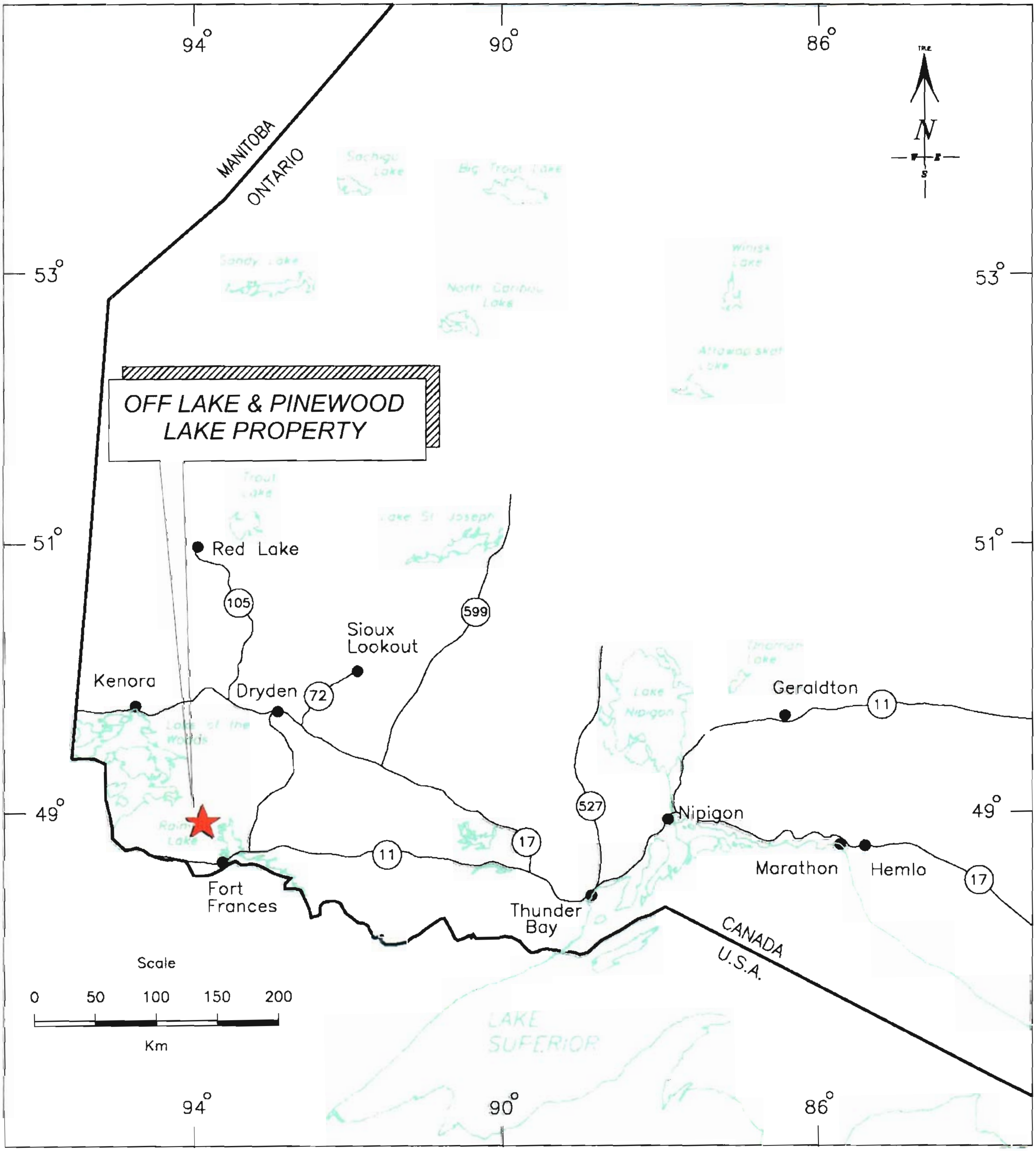



FIGURE 1 Regional-Scale Location Map

**PHYSIOGRAPHY**

The Rainy River region is located within the Severn Upland of the Canadian Shield. Generally the Precambrian surface and the overlying Paleozoic and Mesozoic strata to the west, dip at a very low angle to the southwest into the Williston Basin. Physiographically the Rainy River claim groups are situated in typical Precambrian highland and are only sparsely covered by glacial drift. The Pinewood Lake claim block is 5 km to the south of Off Lake in the vicinity of the northwest-southeast trending Rainy Lake -Lake of the Woods Moraine and has subsequently less outcrop. Overall this area has been subjected to only one of the most recent glacial advances (the Whiteshell - from the northeast) because of the elevated topography which prevented the advance of other glacial lobes from the west. Glacial drift attains significant thickness only in very local areas. It displays few signs of intense weathering. Relief is controlled by bedrock geology with the supracrustal sequences displaying positive relief relative to the batholithic complexes; relief can attain 90 meter. The area has been subdivided by Bajc (1991b) into two regions. Region 2a contains 10-40% outcrop by area, and may attain significant relief which is related to bedrock topography; areas separating outcrops are sites of extensive drift accumulation. In region 2b southwest of the Rainy Lake -Lake of the Woods Moraine outcrop density is less than 5% of the surface area, topography is low and undulating, drainage is poor, and peatland is common.

**EXPLORATION HISTORY**

Although exploration activity in the area by individual prospectors dates back to the 1930's, the documented exploration in the Ministry of Natural Resources assessment files commences in 1967. Additional exploration programs are known to have taken place on private land, however a record of assessment has not been filed for this work.

*Off Lake Block*

In 1967 copper was recorded from a water well hole on the western shore of Off Lake. Consequently Noranda Exploration Company registered claims around the original discovery and performed mapping, geophysics, and diamond drilling. This activity met with limited success and the claims were allowed to lapse. In 1971 International Nickel Company of Canada Limited conducted airborne and follow-up ground geophysics in the region as a whole.

In the mid 1980's exploration programs were mounted in Menary Township and the Off Lake area by several companies. Agassiz Resources examined the potential for both base metal and gold in both area's with a program of mapping, stripping, sampling, and geophysics over two field seasons. In the process they discovered numerous showings of both gold and copper-zinc and discovered what came to be termed the Agassiz Showing in Menary Township. In 1984 Lacana Mining Corporation undertook a single field season of mapping and sampling over an extensive area adjacent to Off Lake and Burditt Lake. No significant areas of mineralization were reported.

Spartan Resources conducted an I.P. survey over a grid adjacent to the eastern shore of Off Lake in 1988. Anomalous responses were obtained from the survey but no further assessment is recorded, although unreported trenching, stripping and sampling was conducted at the site of the survey.

In 1989 Western Troy Capital Resources began a mapping and sampling program on claims staked in Menary Township which partly encompass the lapsed properties of Agassiz and HBED. Both gold and base metal occurrences were discovered during these programs. Following initial exploration for base metals Western Troy discovered "several" native gold bearing, quartz veins late in 1991. The veins are at present interpreted to be the folded and boudinaged fragments of a single original vein. When sampled, this zone returned an average of 1.4 oz/ton gold.

Subsequently, additional showings were discovered later in 1991 and during the 1992 season. Interestingly most of these veins are situated in the lowermost unit of the mafic stratigraphic succession of the area in close proximity to the contact of the Sabaskong Batholith. A 250 ton bulk sample of the veins discovered in 1991 was taken during the 1992 program. Sampling was later expanded to a reported 500 tons and was completed in September of 1993. An additional more ambitious extraction was conducted throughout the 1994 field season (to December, 1994).

Nuinsco Resources began to assemble a land position in the region in 1991, initially centered on the Richardson Township -Menary Township area. Nuinsco completed two drill holes in 1994 on base metal showings along the Ontario Hydro power on either side of highway 615.

Rainy River Resources re-established the Off Lake property and completed a VTEM survey over the central portion of the block in February 2006. A geological mapping project was carried out during the summer of 2006 by Lorne Ayers for Rainy River Resources.

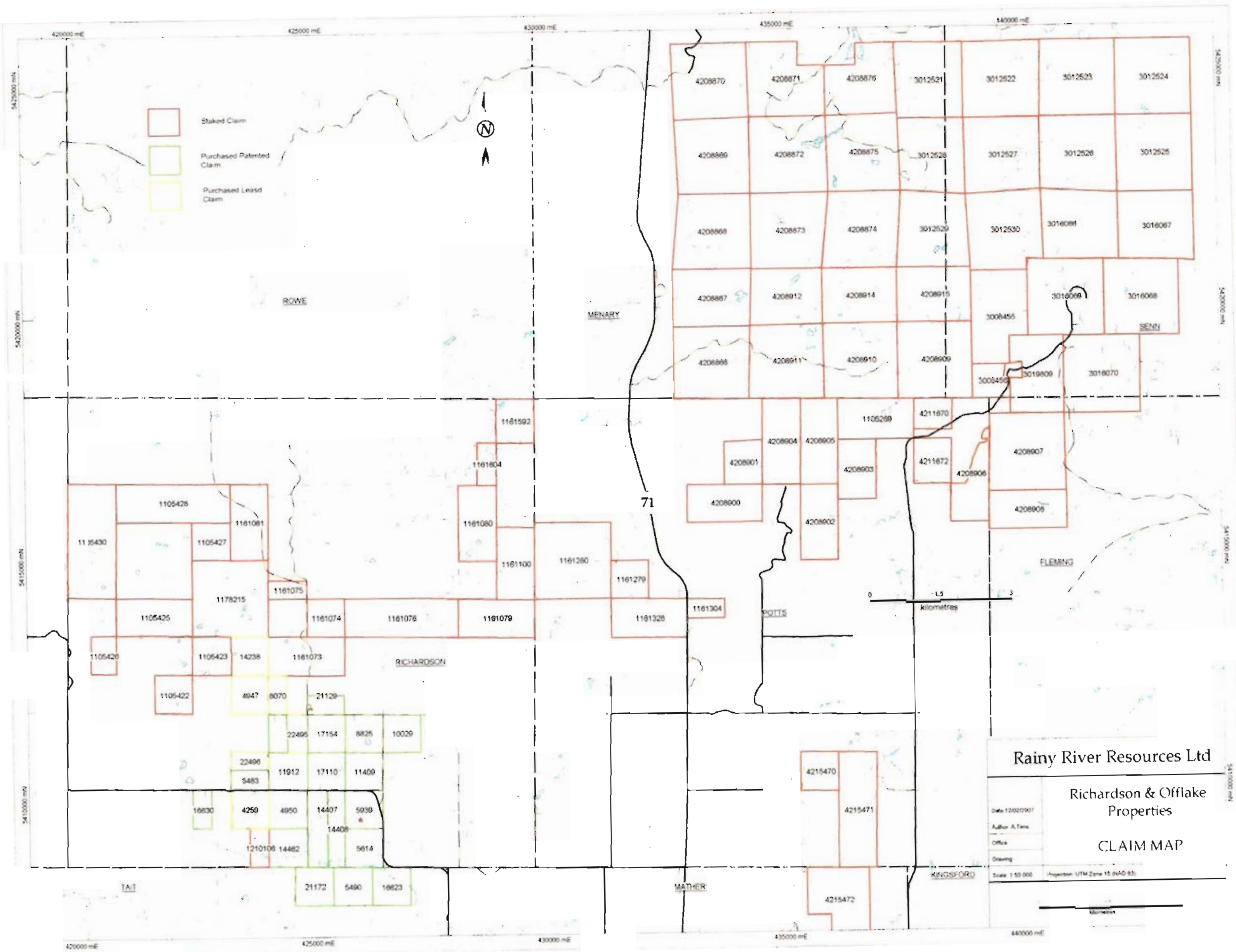
*Pinewood Lake Block*

Noranda staked the central portion of the Pinewood Lake property in 1968 and completed a grid with a baseline at 45°N. The subsequent magnetic and ground electromagnetic surveys failed to identify any drill targets. Inco completed restaked the property and completed magnetic and electromagnetic surveys in 1972 to ground proof airborne conductors. Inco completed two drill holes in 1972 and returned in 1973 to complete a third follow-up hole.

Walter Cummings staked the area of the Inco conductors in 1988 undertaking prospecting, biogeochemical sampling [plus magnetic and self potential surveys. During 1989 a grid was cut and magnetic and electromagnetic survey completed over the majority of the property.

Noranda restaked the Pinewood property in 1993 and established four separate grids. A total of 23.5 km of magnetic and 13.2 km of Max-Min surveys were completed. The Noranda claims were allowed to lapse and were subsequently restaked by Glenn Allen who drill four BW thin wall diamond drill holes totaling 310 m.

The Pinewood Lake block was staked and a grid established in 2006. A Max-Min survey was completed in January of 2007 to locate the airborne conductors.


Staked Claim
Purchased Patented Claim
Purchased Leasd Claim
ROWE
MENARY
SENN
FLEMING
POTTS
RICHARDSON
TAIT
MATHER
KINGSFORD
71
kilometres
Rainy River Resources Ltd
Richardson & Offlake Properties
CLAIM MAP