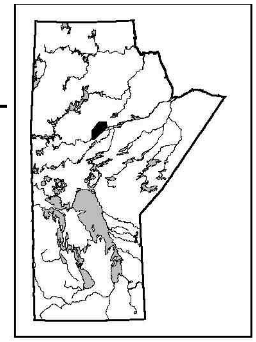
## GS-8 SUPERIOR BOUNDARY ZONE-REINDEER ZONE TRANSITION IN THE PEARSON LAKE-ODEI RIVER-MYSTERY LAKE REGION (PARTS OF NTS 63P AND 64O)

**by H.V. Zwanzig, Ch.O. Böhm[1] and J. Etcheverry[2]**



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### SUMMARY

A new project was started to document the geological relations and isotopic ages of rocks north of Thompson, along the complex boundary zone between the northwestern Superior craton and the Trans-Hudson Orogen. Work proceeded on a 60 km transect, northeast from Thompson to Pearson Lake along the eastern part of the project area, that will extend west to Leftrook Lake. This summer, the major unit mapped as paragneiss of the Sickle Group on Pearson Lake was reinterpreted to comprise granodioritic orthogneiss with sheets of amphibolite (dykes and xenoliths) and minor magnetite-bearing paragneiss of unknown affinity. The main unit south of Pearson Lake is greywacke-derived migmatite similar to the Paleoproterozoic Burntwood Group. Abundant large samples of fresh rock were collected in this poorly accessible area for a variety of laboratory studies, including Sm-Nd isotope work and U-Pb age determinations to be conduced by Ch.O. Böhm at the University of Alberta.

Relogging and sampling of company-owned drill core from an area northwest of Mystery Lake was carried out with the co-operation and assistance of Inco Technical Services Limited and Nuinsco Resources Limited. This work will provide vital information from the largely muskeg-covered northernmost part of the Thompson Nickel Belt to help to trace its full extent. Samples were taken for petrographic, geochemical and geochronological studies (Sm-Nd isotopes and U-Pb ages).

Detailed mapping and sampling of a small area north of Thompson will elucidate the contact relation between the Mystery Lake granodiorite and what is interpreted as part of the Ospwagan Group (P3 member, Pipe Formation). Uranium-lead geochronology may provide an age of intrusion and deformation.


### INTRODUCTION

A collaborative project of structural mapping, exploration drill-core re-examination, petrography, geochemistry and isotopic dating of a variety of gneissic rocks north of Thompson was started this summer by the Manitoba Geological Survey and the University of Alberta Radiogenic Isotope Facility in Edmonton, in co-operation with Inco Technical Services Limited and Nuinsco Resources Limited. This three-year project aims to help delineate:

- the northwestern extension of the Thompson Nickel Belt;
- the probable westward extension of early Archean gneiss;
- the apparent northeast termination of the juvenile Paleoproterozoic Kisseynew paragneiss; and
- the southeastern boundary of Paleoproterozoic orthogneiss.

The collection and analysis of surface samples and company-owned drill-core samples are important aspects of the project. During this summer, work on a northeast transect across the project area involved:

- structural mapping and sampling of the shoreline of Pearson Lake, 60 km northeast of Thompson;
- re-examination and sampling of exploration drill core from the area west of Mystery Lake; and
- detailed mapping and sampling of several critical outcrops on the Burntwood River near Thompson (work leading to an undergraduate thesis for J. Etcheverry at the University of Manitoba).

In subsequent years, the work will be extended further west to encompass the Thompson–Pearson Lake–Leftrook Lake area. We intend to document the petrography, stratigraphy, major- and trace-element geochemistry, Sm-Nd isotope geochemistry and U-Pb geochronology of the gneiss units. The interpretation of these data will help to establish the geological framework and mineral potential of the area by characterizing and mapping the extent of the tectonic domains.

### GENERAL GEOLOGY

The project area lies between Thompson and points 70 km to the northeast and 70 km to the northwest. It is largely covered by muskeg and clay, which overlie poorly understood Archean and Proterozoic bedrock along the northwestern boundary zone of the Superior craton and the southeastern boundary of the internal zone (Reindeer Zone) of the Trans-Hudson Orogen. The geology, compiled from shoreline exposures on the relatively small lakes and scattered inland outcrops in the area, features four or five tectonic domains of amphibolite facies gneiss (Fig. GS-8-1). A preliminary compilation, based on age and metamorphic history (Böhm et al., 2000; Corkery et al., 1999), indicates that the number, character, boundaries and

[1] Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta T6G 2E3
[2] Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2

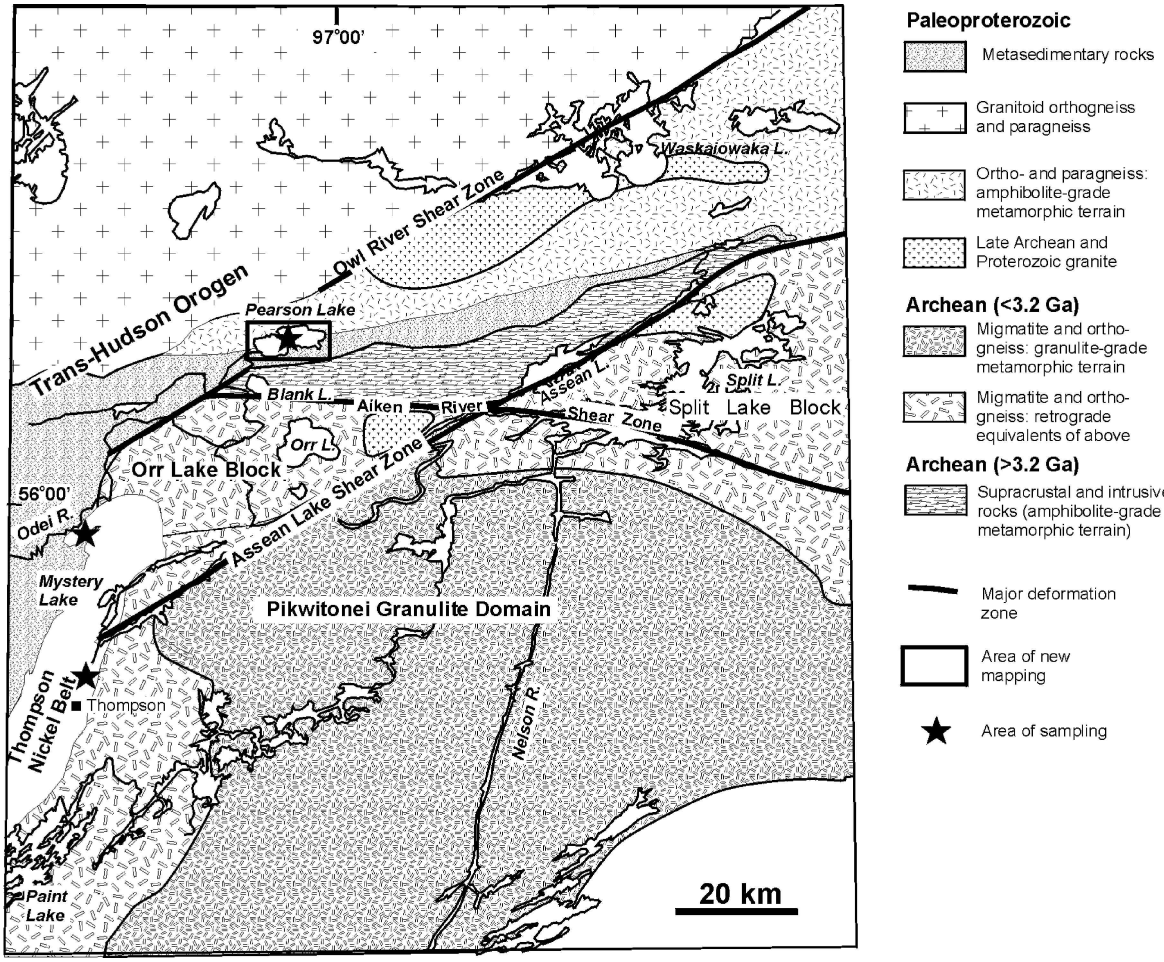


*Figure GS-8-1: Simplified geology of the northwestern Superior craton boundary zone and the southeastern boundary of the Trans-Hudson Orogen, showing new areas of mapping and sampling.*

tectonic origin of these domains are uncertain, but the tectonic architecture can be simplified to include, from south to north:

1) Thompson Nickel Belt (TNB), consisting of Archean basement rocks (partly retrograde from granulite facies gneiss) with infolds of early Paleoproterozoic supracrustal rocks (Ospwagan Group) and ultramafic to felsic intrusions;
2) Orr Lake Block, similar to TNB basement gneiss but in which the Ospwagan Group has not been confirmed by surface mapping;
3) Early Archean (≥3.2 Ga) orthogneiss and paragneiss (Clay River and Lindal Bay metagreywacke units; Böhm et al., 2000);
4) Kisseynew paragneiss (Burntwood Group metagreywacke and Sickle Group meta-arenite) and granitoid intrusive rocks of the largely juvenile Paleoproterozoic Reindeer Zone; and
5) Paleoproterozoic orthogneiss (foliated intrusive rocks of the Reindeer Zone) and local supracrustal enclaves.

The geology of the TNB, recently compiled on 1:50 000 and 1:100 000 scale maps (Thompson Nickel Belt Geology Working Group, 2001), indicates that the Ospwagan Group extends northwest of Mystery Lake, probably to the Odei River, but the limits of the belt are not defined (Fig. GS-8-2). Earlier mapping has indicated that the area northwest of Mystery Lake is underlain by Kisseynew gneiss, which extends northeast to Pearson Lake and northwest beyond Leftrook Lake (Lenton and Corkery, 1981; Manitoba Energy and Mines, 1991, 1995; Corkery et al., 1985). However, similar rocks farther east, at Assean Lake, include pre-3.2 Ga units in 3.1 to 3.2 Ga crust that extends west to Blank Lake, only 4 km south of Pearson Lake (Böhm et al., 2000; unpublished data). The full areal extent of the early Archean crustal block and the TNB are presently unknown. Surface mapping of these poorly exposed rocks has proven to be inadequate for distinguishing even the major crustal blocks. Samarium-neodymium isotope geochemistry model ages and high-precision U-Pb geochronological techniques are required to fully define exposed geological units north of Thompson. Additionally, samples are required from exploration drilling to characterize buried units. Other techniques, using geophysics, petrography, geochemistry and structure, will help in delineating the general geology in more detail.

## PEARSON LAKE AREA

Shoreline exposures were remapped on Pearson Lake. Based on field observations, the rocks on the north shore and on

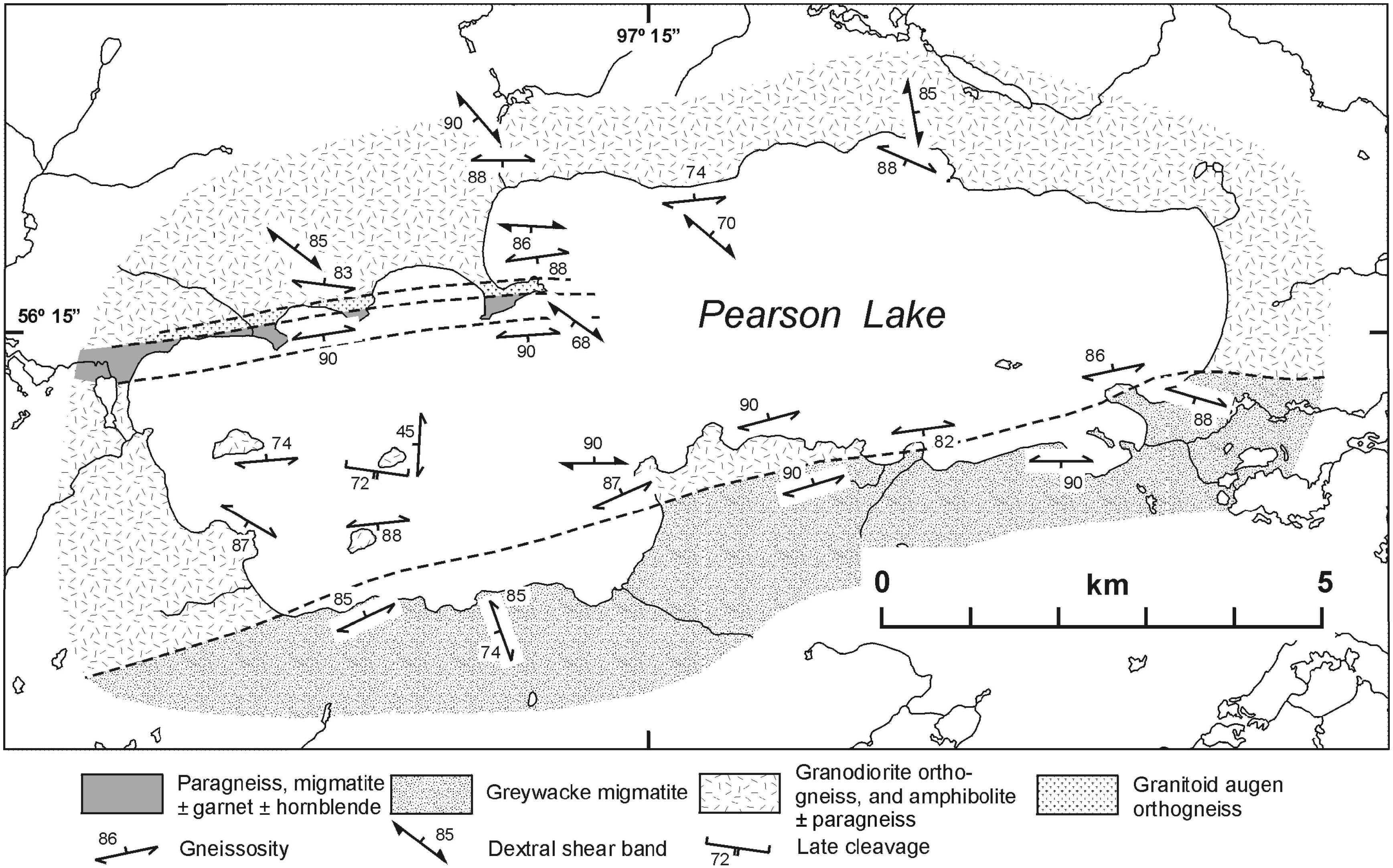


*Figure GS-8-2: Geology of the Pearson Lake area.*

several islands, previously mapped as paragneiss of the Sickle Group[3] (Lenton and Corkery, 1981), were reinterpreted as orthogneiss with only minor units of paragneiss. Migmatized greywacke encountered on the south shore of Pearson Lake had been mapped previously as Burntwood Group[3] (Lenton and Corkery, 1981). However, the age of the metagreywacke is uncertain because similar rock to the east, on Assean Lake, is early Archean (Böhm et al., 2000).

### Granodiorite Gneiss

Orthogneiss is best exposed on the western part of the north shore of Pearson Lake. Its most widespread composition is quartz-rich granodiorite or granite, comprising predominantly pale pink- and white-weathering feldspar and grey quartz (approx. 40%). The granodiorite gneiss has a fine- to medium-grained component with approximately 8% biotite±hornblende and a subequal component of medium-grained leucosome in 1 to 50 cm thick layers with less than 5% biotite; contacts are rarely sharp between these components. In many places, approximately 10% of the rock consists of more sharply defined pegmatite veins and dykes that cut the gneissic layering at a low angle. Narrow screens of magnetite±hornblende-bearing or garnet-bearing paragneiss occur locally, but much of the granodiorite gneiss contains magnetite+biotite–rich schlieren that may represent remnants of paragneiss after partial melting. A fourth component in the orthogneiss is mafic, grading from rare hornblende-rich amphibolite and common gabbroic or fine-grained amphibolite to schlieric hornblende granodiorite. Various field relationships indicate that there is more than one age of mafic component. Widespread sheet-like bodies of amphibolite, 1 m thick on average, constitute more than 10% of the orthogneiss on a few outcrops. These sheets have sharp contacts and may be dykes. They are cut by the pegmatite veins but only locally cut by the granodiorite leucosome. Smaller mafic lenses and boudins are migmatitic and some are altered to a much more felsic composition, suggesting infusion of granodiorite melt. Near some of these inclusions, the granodiorite gneiss contains amphibole, suggesting contamination. Light grey-weathering orthogneiss, which forms 10 to 20 cm margins on some mafic sheets and occurs as local screens, may represent an early tonalite phase that has escaped migmatization or has reacted with the mafic rock.

#### *Foliated granodiorite*

The orthogneiss locally consists of more uniform, medium-grained, foliated granodiorite. Biotite-rich schlieren are widely dispersed or absent, but thick, weakly defined layering is present. The unit is cut only by a young pegmatite phase. The granodiorite is interpreted to have formed from thick injections or accumulations of granodiorite melt that are also represented by veining in the main phase of granodiorite gneiss.

#### *Augen gneiss*

A second subunit of the orthogneiss contains 6 cm long quartzofeldspathic lenses or augen in a slightly more mafic matrix of granodiorite gneiss. The rock extends along much of the north shore of Pearson Lake, north of a narrow belt of paragneiss (*see* below), where it grades into more typical granodiorite gneiss to the north. It contains an estimated average of 10% biotite and 5% hornblende. Similar to the main phase orthogneiss, it is cut by pegmatite veins and dykes. Augen, which constitute 80% of the rock, locally contain a large feldspar crystal (<15 mm long) in their core. The rock is similar to porphyroclastic granite and quartz monzonite west of the Thompson Nickel Belt (Zwanzig, 1999) but contains no fully preserved phenocrysts.

### Paragneiss

A unit of intermediate to felsic paragneiss, heavily intruded by the various phases of the orthogneiss (*see* above), extends east-northeast along the northwest shore of Pearson Lake (Fig. GS-8-2). The intermediate rock contains quartz, feldspar, biotite and generally magnetite±garnet±hornblende. Migmatitic garnet-biotite gneiss, probably with graphite like the metagreywacke to the south of Pearson Lake, is also an important part of the paragneiss in the north. The intermediate compositions have an estimated average content of 15% biotite, 12% garnet, 12% hornblende and 1% magnetite, with the remainder being quartz and feldspar. The intermediate rock grades into magnetite-garnet amphibolite and more felsic garnet-biotite gneiss. The most mafic rock has the highest content of magnetite and is interpreted to be an Fe-rich sedimentary rock, although the local layering (<20 cm thick) cannot be clearly interpreted as bedding. The most felsic rock has about 50% granodiorite veins (<1.5 cm thick). Narrow inclusions and schlieren in the adjacent granodiorite gneiss contain hornblende-magnetite or garnet. The western part of the narrow paragneiss belt generally contains migmatitic garnet-biotite gneiss in the north and magnetite-biotite gneiss with rare garnet in the south. One exposure consists of well-preserved metagreywacke-derived migmatite with remnants of bedding.

### Greywacke Migmatite

Much of the south shore of Pearson Lake is underlain by highly migmatitic garnet-biotite gneiss (diatexite) with

[3] The terms 'Sickle Metamorphic Suite' and 'Burntwood River Metamorphic Suite' were used by Lenton and Corkery (1981) instead of the current terms 'Sickle Group' and 'Burntwood Group'.

porphyroblasts of cordierite and flattened quartz-sillimanite lenses (faserkiesel). South of the lake and in southern bays, layered (stromatic), greywacke-derived migmatite (metatexite) retains more primary characteristics (e.g., compositional grading), with increasing content of biotite interpreted to represent sedimentary grading from sandstone to mudstone, possibly from turbidite beds.

The greywacke metatexite typically weathers medium grey, with brown or red areas associated with traces of graphite±pyrrhotite, similar to metatexite units elsewhere in the Kisseynew Domain. The rock generally contains about 15% biotite and 10% garnet±sillimanite±cordierite. Leucosome occurs as early quartz- and feldspar-rich lenses (<10%) and leucogranodiorite to pegmatite veins (approx. 20%), 2 mm to 20 cm thick. Some veins contain partly chloritized porphyroblasts of cordierite or selvages with garnet, cordierite and small white lenses containing fibrolitic sillimanite. Thicker sills of granodiorite locally contain garnet±cordierite, suggesting contamination or partial melting of greywacke gneiss.

The greywacke diatexite weathers light grey and forms high outcrops. Granodiorite leucosome locally forms 80% of the rock, with only schlieren and local well-defined inclusions of metagreywacke. On the southeast shore of the lake, diatexite is rich in biotite and relatively homogeneous, with widespread quartz-rich lenses and feldspar, garnet and cordierite porphyroblasts (5–30 mm). It probably formed from Al-rich mudstone.

### Structure

Gneissic foliation and major geological contacts are subparallel and straight to undulose in the vicinity of Pearson Lake, suggesting high strain throughout the area. The strike is east-northeast and the dip is subvertical (Fig. GS-80-2). All rock types are foliated except the latest pegmatite veins. The foliation in granodiorite gneiss is defined by mineral and augen alignment, concentrations of mafic minerals (mainly biotite) and parallel granodiorite veins. Mafic sheets and boudins are subparallel to the foliation and show progressively increased flattening with relative age. Stretching lineations plunge steeply west and crenulations plunge gently east. Layering in greywacke migmatite is interpreted as structurally transposed bedding with parallel veins and lenses of leucosome. Where several relative ages of leucosome occur together, a progressive increase in the development of the foliation suggests synkinematic migmatization. Local north-northeast-trending foliation may represent domains with a relatively early gneissosity.

A set of northwest-trending, steeply dipping dextral shear bands is prominent in granodiorite gneiss, particularly along the north shore of Pearson Lake, where the mean trend of the main foliation is east (Fig. GS-8-2). Accordingly, a significant component of dextral shear was part of the regional deformation. Many of the shear bands contain granodiorite leucosome or pegmatite formed during intermediate to late stages of the deformation. Minor folds are predominantly Z shaped, plunge steeply and have axial surfaces that strike northeast, a style that is consistent with dextral transpression during the development of the east-northeast-trending regional plane of deformation.

### Sampling

Sampling was carried out after units had been identified and their relative ages and contact relations recorded. Where possible, each sample consists of a single rock type, intrusive phase or gneissic component with clearly defined contact relations. The collection includes samples of all units of paragneiss and all observed relative ages of orthogneiss and pegmatite.

Multiple samples were collected from all units and subunits for petrographic thin-section analysis and for modal analysis on slabs stained to distinguish quartz, K-feldspar and plagioclase. All major felsic units were also sampled for geochemistry, Sm-Nd isotope geochemistry and U-Pb zircon and/or monazite geochronology. The approximately 15 kg samples collected for these purposes comprise fresh broken pieces trimmed in the field on the sampled rock type, to remove weathered surfaces while avoiding possible contamination. About 1 kg was set aside for whole-rock and trace-element analysis.

## MYSTERY LAKE–ODEI RIVER AREA

Re-examination of drill core from the MEL Zone property between Mystery Lake and the Odei River (Fig. GS-8-1) was carried out in the Inco Technical Services Limited yard in Thompson. Units were identified and described for future comparison with better known units in the TNB and the Kisseynew Domain. Core was cut and sampled for thin-section and Sm-Nd isotope analysis; two 10 to 15 kg samples were collected for U-Pb zircon dating.

## BURNTWOOD RIVER–MYSTERY LAKE AREA

Low water conditions in the Burntwood River this summer provided a rare opportunity to study river shoreline outcrops, interpreted as part of the Ospwagan Group, and the intrusive contact of the Mystery Lake granodiorite (Thompson Nickel Belt Geology Working Group, 2001). A group of outcrops, mainly northeast of the Highway 391 bridge, were mapped in detail for comparison with part of the type section of the Ospwagan Group on the shoulder of the Pipe II open pit. Particular attention was given to the contact with granodiorite west of the Burntwood River. Samples were collected for petrographic description and chemical analysis of all units, and in an attempt to obtain a high-precision U-Pb zircon age of the granodiorite. The country rock east of the granodiorite was further examined on the west shore of Mystery Lake. If successful, this work may provide an age of crystallization for the granodiorite, a point in time during the development of the high-strain fabric and a minimum age of sedimentation for the Ospwagan Group.

### Preliminary Observations

The small detailed map area features eight lithological units interpreted to be from the P3 member of the Pipe Formation in the Ospwagan Group, as well as granodiorite of the Mystery Lake pluton. The main P3 marker unit is a layer of buff dolomitic marble that is in contact with, or surrounded by, iron-formation. The marble unit pinches and swells to a maximum thickness of 20 cm and is in direct contact with the granodiorite over much of the exposure. The iron-formation weathers brown or green, depending on its content of magnetite or diopside. It is interfingered with massive chert layers in the east and overlain by beige- and green-layered calc-silicate rock. The rocks of the Ospwagan Group are highly foliated to sheared; mylonite occurs several metres east of the contact with the granodiorite and as rafts in the granodiorite. However, despite the high strain, all of the layers closely resemble groups of beds in P3 and have been sampled to confirm this interpretation using petrography and geochemistry. Grey semipelite that lies east of the granodiorite on the west shore of Mystery Lake is tentatively interpreted as the P2 member of the Pipe Formation, suggesting that the granodiorite may cut across Ospwagan Group stratigraphy.

The Mystery Lake granodiorite weathers light grey to buff, is leucocratic (<5% biotite) and contains muscovite, which is typical of the main body of the intrusion. The following detailed field observations suggest that the sedimentary rocks are intruded by the granodiorite:

- Much of the margin is sheared or mylonitic, but moderately foliated granodiorite adjacent to the sedimentary rocks mapped in detail has a 10 cm band of dark material that may represent an original contaminated contact zone.
- The granodiorite is more pegmatitic near the contact with the sedimentary rocks than in areas closer to the centre of the pluton.
- Inclusions of the mylonitic metasedimentary rocks occur in the sheared granodiorite. Some of their terminations are angular, cut by the foliation and indicate that the inclusions are xenoliths.

The high strain is interpreted to predate and postdate the intrusion of granodiorite.

## ACKNOWLEGDMENTS

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