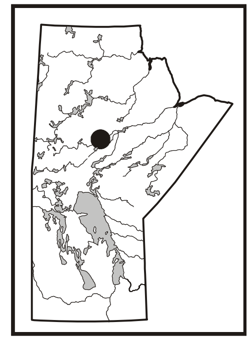
GEOLOGICAL INVESTIGATIONS IN THE MYSTERY LAKE AREA, THOMPSON NICKEL BELT (NTS 63P/13)

by P. Theyer, D.C. Peck and C. Freund[1]



Theyer, P., Peck, D.C., and Freund, C. 1999: Geological Investigations in the Mystery Lake area, Thompson Nickel belt (NTS 63P/13); *in* Report of Activities, 1999, Manitoba Industry, Trade and Mines, Geological Services, p. 24-26.

SUMMARY

Mystery Lake, located approximately 12 km northeast of the city of Thompson in the northern part of the Thompson Nickel Belt (TNB), is underlain by variably deformed members of the Ospwagan Group comprising siliciclastic and chemical metasedimentary rocks and mafic and ultramafic volcanic and plutonic rocks. The geology of the Mystery Lake area was investigated as a contribution to the multiyear, multidisciplinary CAMIRO investigation of the TNB (Peck, GS-3, this volume).

In Mystery Lake, the Ospwagan Group is bounded to the northwest by the Paleoproterozoic Mystery Lake granodioritic pluton (1.836 Ga, U-Pb monazite age; Syme et al., 1993) and to the southwest by Archean polymetamorphic ortho- and paragneisses that are interpreted as retrograded parts of the Pikwitonei granulite domain (Weber, 1990). At Mystery Lake, heterolithic gabbro intrudes and partially assimilates a sequence of Ospwagan Group felsic detrital metasedimentary rocks that include quartzite, arkose, and wacke, interpreted as parts of the Setting Lake formation. Pillowed, massive and brecciated basalt flows and interlayered, spinifex-textured ultramafic volcanic rocks are interpreted to be coeval and possibly cosanguineous.

Partially sulphidized oxide facies iron formation is associated with felsic and pelitic sediments and intruded by gabbro. The sulphidization of this iron formation may have resulted from metasomatism caused by the thermal aureole of the gabbroic intrusion.

INTRODUCTION

Ultramafic rocks in the Mystery Lake area were first reported in 1972 (Coats et al., 1972). Mapping of the Mystery Lake area by R.F.J. Scoates (Weber and Scoates, 1976) determined that the ultramafic rocks occur in conjunction with metasedimentary and mafic metavolcanic rocks. The stratigraphy of the Ospwagan Group in the Thompson Nickel Belt acquired a special significance subsequent to the discovery of the nickel deposits in the belt and the recognition that most of the mineralized ultramafic bodies occur in the Pipe Formation of the Ospwagan Group.

Mystery Lake is underlain by both the Ospwagan Group and a deformed occurrence of ultramafic intrusive rocks (Weber and Scoates, 1976) that contains nickel-copper sulphide deposits. A two-week field project was completed in 1999 that included detailed geological mapping and stratigraphic investigations combined with petrological, lithogeochemical and geochronological sampling. Field work concentrated on four islands in the southern and central parts of Mystery Lake (informally referred to as Islands 1, 2, 3 and 4; see Fig. GS-7-1).

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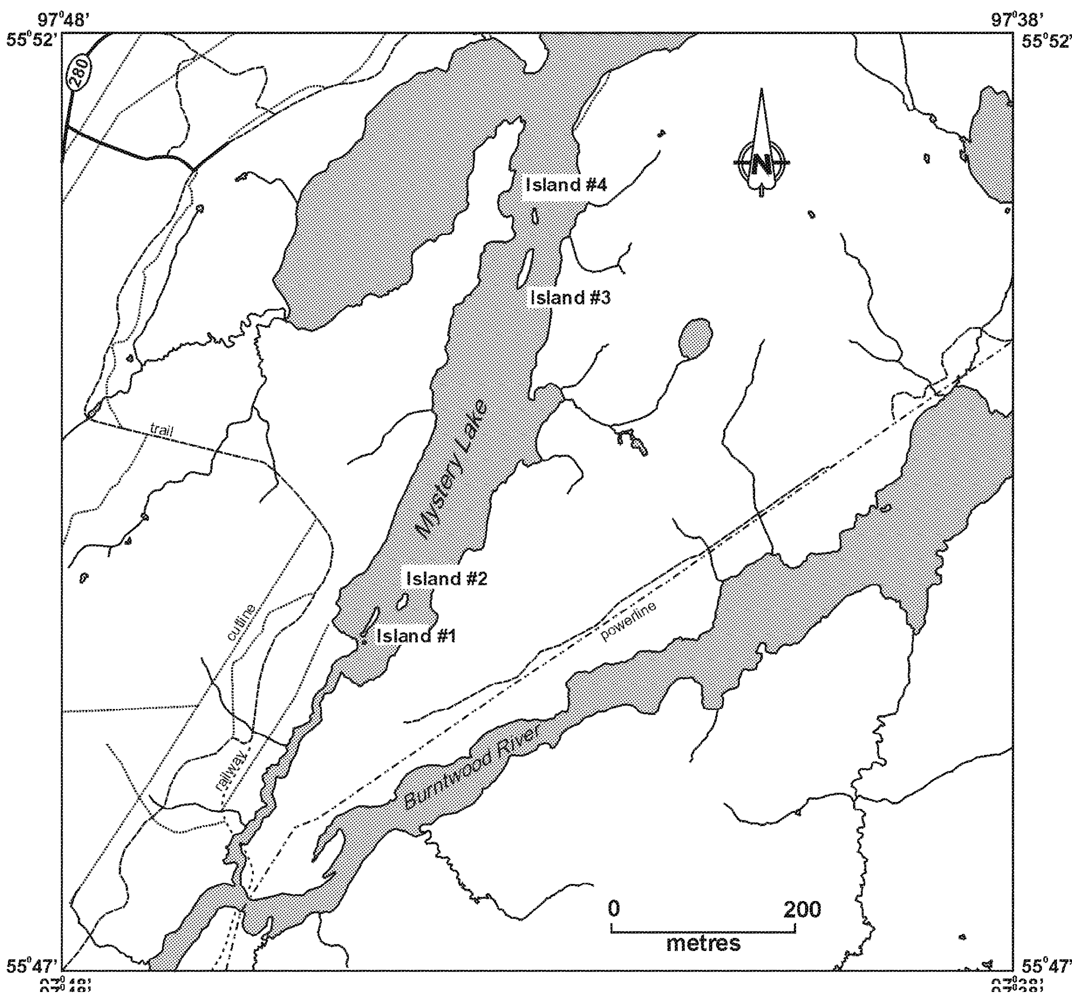

Figure GS-7-1: Location map of studied area

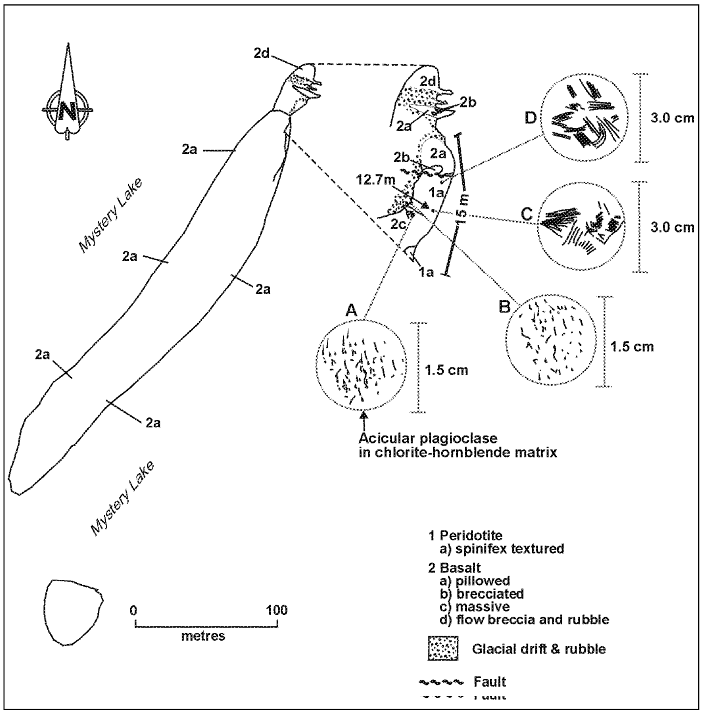

Figure GS-7-2: Geological map of Island #1

STRATIGRAPHY

Basalt

Narrow shoreline exposures on Island #1 (southernmost island) consist of pillowed basalt, subordinate, interlayered massive basalt and peridotite (Fig. GS-7-2). The pillows are flattened and display vertical extension. They range from approximately 20 cm to 1 metre thickness. The basalt is aphyric, fine-grained and grey to black in colour. Stratigraphic top indicators in these pillows are ambiguous.

Island #2 (Fig. GS-7-3) is underlain by two varieties of pillowed basalt distinguished by colour and weathering characteristics. The stratigraphically lower basalt is light green, has smooth weathered surfaces and contains virtually undeformed pillows that young to the west. The overlying, younger basalt is dark green and has rough weathered surfaces. Excellent exposures on the northern end of Island #2 (Fig. GS-7-3) contain massive grey to black basalt that contains subrounded amphibolitized zones that range from 10 to 50 cm diameters, characterized by 1 to 2 cm long, irregularly distributed lamellae bundles that could readily be confused with spinifex textures. However, the colour, habit and uniform distribution of these amphibole crystals (tremolite?) suggests that these textures formed during metamorphism.

Ultramafic Rocks

Spinifex-textured ultramafic rocks are exposed on the northeastern shore of Island #1 (Fig. GS-7-1). Spinifex textures are considered to be indicators of rapid cooling of the magma in volcanic rocks. The southernmost part of the exposure (see Fig. GS-7-2) displays sporadic millimetre- to centimetre-sized, radial to randomly oriented, spinifex lamellae in dark grey to black, fine-grained, aphyric pyroxenitic rock. The poor exposure at this locality, combined with the absence of stratigraphic indicators and clearly discernible contacts with the surrounding pillow basalts, preclude any speculation as to the stratigraphic significance of this occurrence of spinifex textures.

Acicular plagioclase lamellae occur in the southern part of the second, northern, approximately 10 m long exposure on Island #1. Spinifex textures formed by pseudomorphs after pyroxene and/or olivine are developed in the balance of the outcrop for a distance of approximately 8 m along the shoreline. They are characterized by systematic changes in grain size, shape and orientation, as illustrated in detailed sketches (Fig. GS-7-2). Textural variety A (Fig. GS-7-2) consists of submillimetre to millimetre-long acicular plagioclase developed in a chlorite-hornblende matrix. This texture, exposed over a distance of approximately 2 m, grades into textural variety B (Fig. GS-7-2), comprising stubby, millimetre-sized amphibole needles in a plagioclase-bearing chlorite-hornblende matrix. Textural variety C (Fig. GS-7-2) consists of a zone of randomly ordered stubby mineral needles that grade into textural variety D which are millimetre long, random, radial and plumose spinifex lamellae. The spinifex-textured ultramafic rocks are separated from brecciated basaltic flows and flow rubble to the north by a fault.

Quartzite, Arkose, Pelite

Metasedimentary rocks that include quartzite, arkose and oxide facies and sulphidized oxide facies iron formation are exposed on Islands # 3 and 4 (Fig. GS-7-4 and GS-7-5).

The quartzite is commonly well layered, impure, fine- to coarse-grained, and beige in colour. It contains millimetre-thick, regularly spaced, black cherty layers. Subordinate light grey-weathering quartzite contains pale beige, rounded to elongate siliceous inclusions that range from a few millimetres to several centimetres in length. Trace amounts of pyrrhotite and pyrite are locally present in the quartzites.

The arkose is well layered, grey- to pale beige-weathering, and commonly contains millimetre thick white bands. These rocks tend to be characterized by peculiarly pitted weathered surfaces.

Pelites are characterized by the occurrence of abundant micaceous minerals in a grey- to beige-weathering, generally homogeneous siliceous matrix.

Three measured stratigraphic sections (A, B and C) were completed across the quartzite and arkose exposed on Island #4 (see Fig. GS-7-5 for section locations).

Iron Formation

Oxide facies iron formation is exposed in two outcrops along the eastern shore of Island #3 (Fig. GS-7-4). The iron formation is locally intruded by gabbro. The southernmost of the two shoreline exposures consists of a 0.5 to 1 m wide sulphidized iron formation enclosed in oxide facies iron formation (detailed section sketch in Fig. GS-7-4).

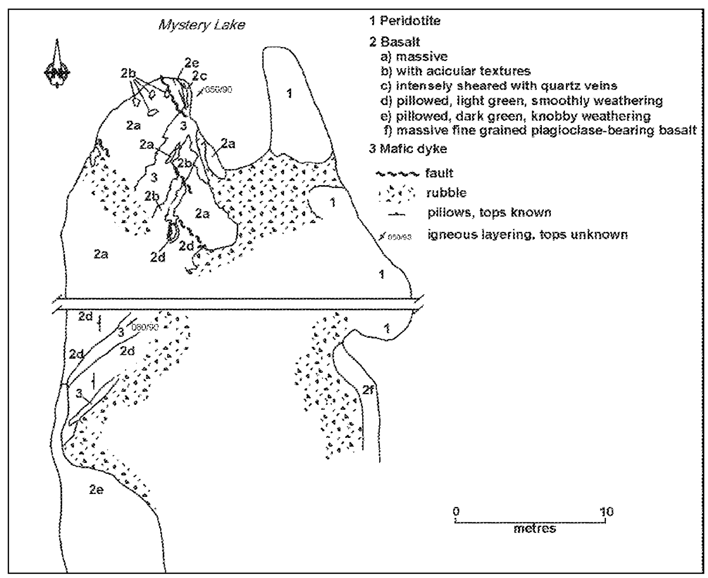

Figure GS-7-3: Geological map of Island #2

Gabbro

Modally variable gabbroic bodies comprising leucogabbro, gabbro, melagabbro and ferrogabbro are exposed on Islands #3 and #4 (Fig. GS-7-4 and GS-7-5). Medium-grained gabbro is the principal rock type. Melagabbro forms centimetre-thick veins and subrounded decimetre-sized discrete bodies; it appears to be the youngest intrusive phase. Coarse-grained to pegmatitic gabbro, characterized by centimetre-scale amphibolitized pyroxene and plagioclase crystal aggregates and metre-size, subrounded lenses of leucogabbro and melagabbro, form irregular shaped veins and pods within medium-grained gabbro. A ca. 1 m thick gabbro layer containing trace amounts of disseminated pyrite occurs on the eastern part of Island # 4.

The gabbroic bodies are, in most cases, conformable or semi-conformable with bedding in the metasedimentary host rocks. The largest bodies are a few tens of metres thick. They are interpreted as sills

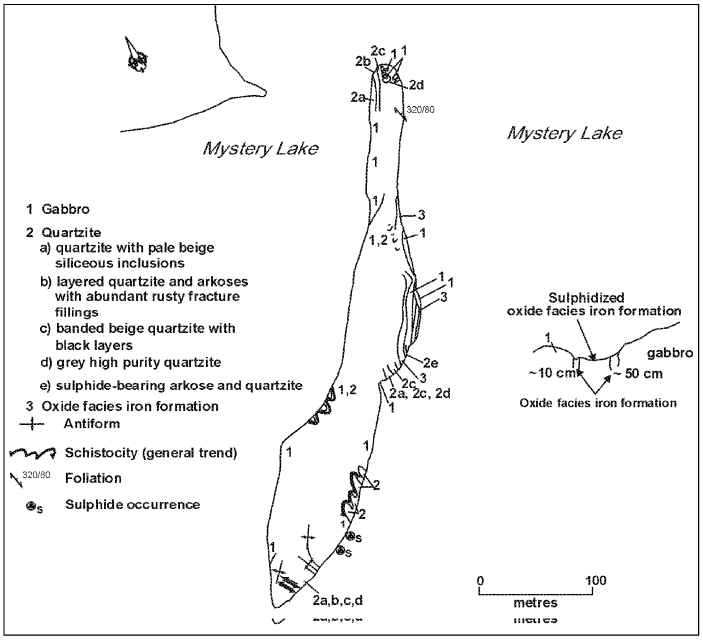

Figure GS-7-4: Geological map of Island #3

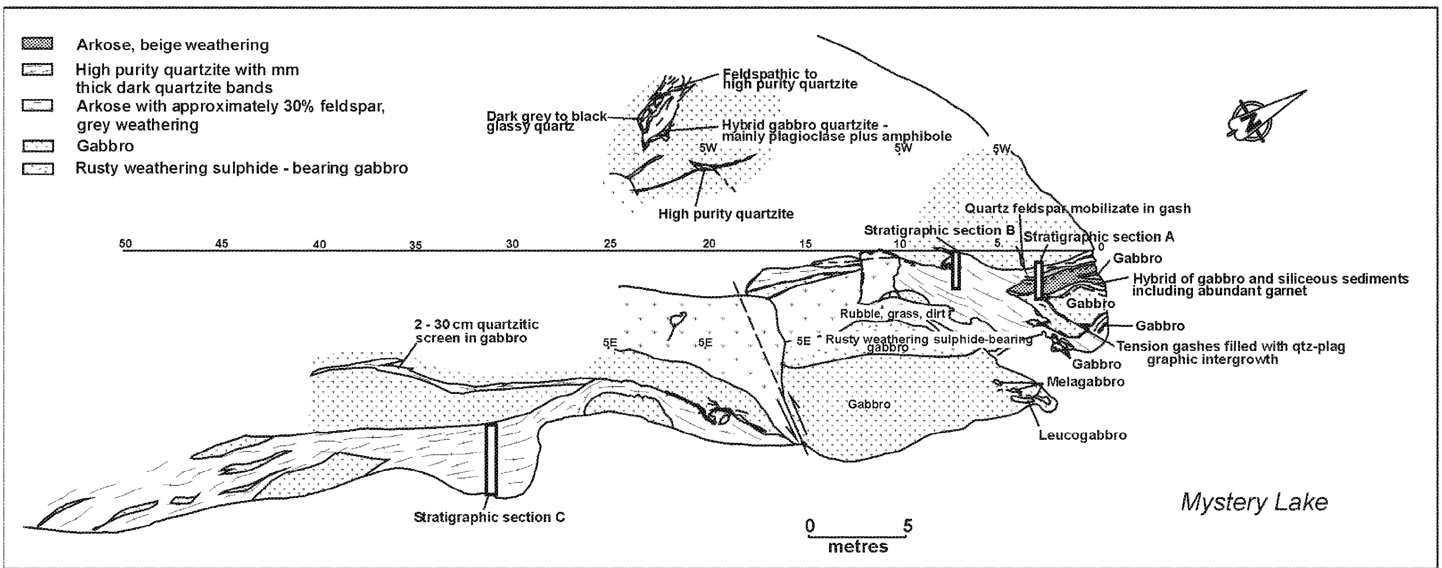

Figure GS-7-5: Geological map of Island #4

injected along bedding planes, and cause extensive delamination in the enclosing quartzite-arkose-pelite sequences. Modal variations observed in the largest gabbroic body (Island # 4) suggest that it may face west.

Decimetre-size blocks of recrystallized quartzite show evidence of partial melting and assimilation by the surrounding gabbro. Specifically, there appears to be a large amount of granodiorite mobilizate in the metasedimentary rocks immediately adjacent to the larger gabbroic bodies. Some of this mobilizate forms irregular veins that were back-injected into the chilled margins of stratigraphically overlying gabbro sill. Quartz and granophyre-bearing phases of the gabbroic bodies are locally developed above the contact with underlying, thermally metamorphosed sedimentary rocks. These rocks are interpreted to have crystallized from mixtures of uncontaminated gabbroic magma and country-rock derived felsic partial melts and/or hydrous fluids.

CONCLUSIONS

The study area, a series of islands in Mystery Lake, is underlain by variably deformed rocks of the Ospwagan Group, including mafic flows, ultramafic flows, mafic intrusions, quartzite, arkose, pelite and subordinate oxide-facies iron formation. The exposed ultramafic rocks are proposed here to be extrusive, based on their textures and spatial association with basalts. Gabbro is intrusive into the metasedimentary succesion; the metasedimentary rocks are likely part of the Setting Lake formation. Ongoing geochronological investigations (K. Toope and L. Heaman, Department of Earth and Atmospheric Sciences, University of Alberta) are intended to determine if the gabbro is cosanguineous with ultramafic rocks elsewhere in the TNB. If so, the Mystery Lake area represents a rare example in the TNB where it can be demonstrated that ultramafic and mafic magmatism was contemporaneous. If, as seems likely, the mafic and ultramafic magmatism in the study area post-dated the deposition of the Setting Lake Formation, it is possible that the conditions necessary to form magmatic Ni sulphide deposits may have existed at a higher stratigraphic position within the Ospwagan Group than is typically observed in the TNB. Accordingly, the timing of sulphur introduction into the oxide-facies iron formation observed on Island # 4 should be further investigated. If the sulphur was introduced before the emplacement of the mafic and ultramafic magmas, then the iron formation represents a significant, external sulphur source that could have triggered the development of immiscible sulphide liquids in these magmas.

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