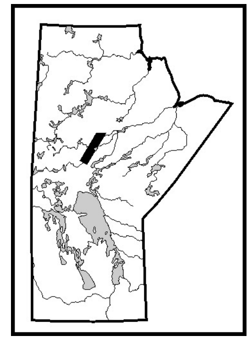
GS-12 Preliminary field observations of regional metamorphism in the Thompson Nickel Belt, Manitoba (parts of NTS 63J15, 63O1 and 2, 63O8 and 9, 63P12 and 13)

by C.G. Couëslan[1], D.R.M. Pattison[1] and J.J. Macek



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Summary

Field investigations have been carried out on the Hudsonian metamorphism of supracrustal rocks in the Thompson Nickel Belt (TNB). Outcrops were examined throughout the exposed portions of the belt for mineral assemblages useful for temperature-pressure determination. Orthopyroxene was identified in Ospwagan Group sedimentary rocks from Nichols and Phillips lakes and may also be present in garnet-bearing metagabbro at the Thompson mine, suggesting granulite-grade metamorphism (≥800°C, uncertain pressure). Potassium-feldspar-bearing metasedimentary rocks from the Hambone and Setting lakes areas contain sillimanite intergrown with biotite along the foliation and an absence of muscovite, suggesting grades of upper amphibolite facies. Sillimanite is common as discrete knots at Setting and Mid lakes. At Moak Lake, sillimanite knots contain possible andalusite cores, suggesting conditions near the andalusite-sillimanite phase transition and middle amphibolite facies grade. Metasedimentary rocks at Ospwagan Lake are also found to be andalusite bearing. Staurolite- and andalusite-bearing metapelite (middle amphibolite facies) and nonmigmatitic K-feldspar- and sillimanite-bearing metapelite (upper amphibolite facies) are present in proximity to one another at the Pipe mine. This makes interpretation of metamorphic conditions difficult, although both assemblages indicate pressures of 3.5 to 4 kbar. The distribution of higher grade and lower grade rocks suggests that grades may be higher along the eastern side and southern end of the belt, and lower along the western side and northern end of the belt.

The creation of a comprehensive tectonic model for the TNB has been hampered by a lack of metamorphic data. This is important both for a greater understanding of the Trans-Hudson Orogen in Manitoba and for exploration strategies within the TNB. The local grade of regional metamorphism may have an effect on the mobilization of orebodies through solid state, hydrothermal and anatectic processes. In addition, the character of Ospwagan Group metasedimentary rocks may vary greatly depending on metamorphic grade. These metasedimentary rocks are known to host the most significant nickel deposits in the belt, and documentation of this metasedimentary group at various grades will provide an additional tool for mineral exploration. This is a preliminary look into the Hudsonian metamorphism of the TNB as part of an ongoing Ph.D. study.

Introduction

The 400 km long by 10 to 35 km wide, northeast-trending Thompson Nickel Belt (TNB) occurs along the northwestern margin of the Superior craton (Bleeker, 1990a; Hulbert et al., 2005; Figure GS-12-1). As part of the Superior Boundary Zone, the TNB marks a segment of the collisional zone between the Superior craton and the juvenile terranes of the Trans-Hudson Orogen. The TNB begins 70 km northeast of Thompson (Zwanzig, 2005) and continues southwest, with half of its total length covered by Phanerozoic rocks. Its southeastern margin, in the northern exposed portion, is gradational with the Pikwitonei Granulite Domain. Its northwestern margin is bounded by the Kisseynew Domain of the Trans-Hudson Orogen internal zone.

The TNB is dominated by variably reworked Archean basement gneiss with minor Paleoproterozoic supracrustal and intrusive rocks (Bleeker 1990a, 1990b; Weber, 1990; Hulbert et al., 2005). The Archean basement consists largely of migmatitic gneiss that is believed to be derived from retrogressed Pikwitonei granulite (Russell, 1981; Bleeker, 1990b; Machado et al., 1990; Weber, 1990; Lettley, 2001). The Archean basement gneiss is unconformably overlain by metasedimentary and metavolcanic rocks of the Paleoproterozoic Ospwagan Group (Bleeker and Macek, 1988a; Bleeker, 1990a, 1990c). The supracrustal rocks occur in deeply dissected, regional-scale folds or fault slices (Bleeker, 1990a; Weber, 1990).

The Ospwagan Group supracrustal sequence consists, from base to top, of the Manasan Formation, Thompson Formation, Pipe Formation, Setting Formation and Bah Lake volcanogenic assemblage (Bleeker and Macek, 1988a; Bleeker, 1990a, 1990c; Zwanzig et al., work in progress, 2006). The Manasan Formation is a clastic sequence that consists of M1 member quartzite with local conglomerate, overlain by M2 member semipelite. The Manasan Formation clastic rocks grade into the overlying Thompson Formation, which consists dominantly of calcsilicate and siliceous dolomite. The Pipe

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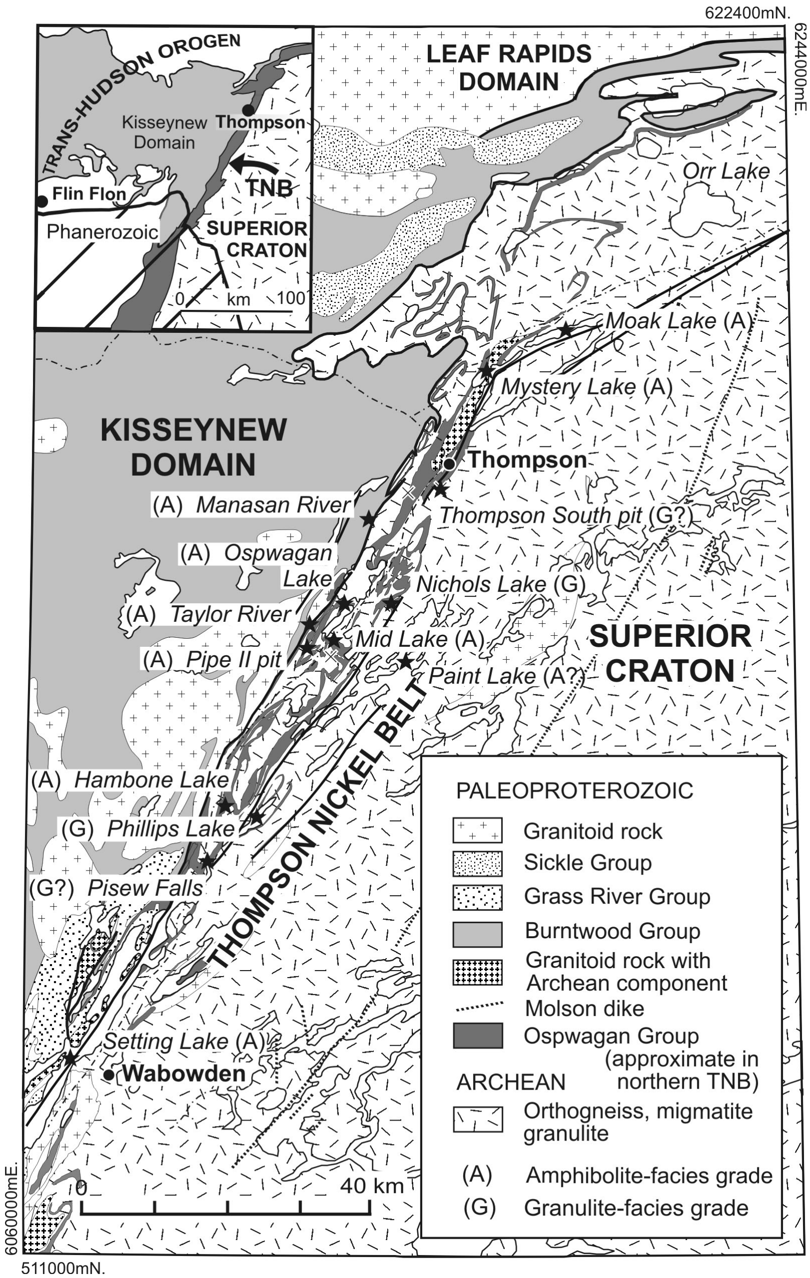

Figure GS-12-1: *Tectonic setting and regional geology of the exposed portion of the Thompson Nickel Belt (*after *Zwanzig, 2005), showing general locations of study areas.*

Formation consists of three members. The P1 member directly overlies Thompson Formation calcareous rocks and consists of sulphide- and silicate-facies iron formation, chert, and siliceous and ferruginous sedimentary rocks. The P2 member consists of a pelitic schist. It contains aluminous horizons that may contain garnet, staurolite and/or Al_2SiO_5. Above the P2 pelite are siliceous sedimentary rocks, ferruginous sedimentary rocks, iron formation, marble and calcsilicate of the P3 member. The Setting Formation consists of interlayered pelitic schist and quartzite with pink, garnet- and carbonate-bearing lenses. The Bah Lake assemblage consists of mafic to ultramafic volcanic flows with abundant dikes and sills (Zwanzig, 2005).

Quartzite and conglomerate of the Grass River Group unconformably overlie the Bah Lake assemblage (Zwanzig et al., work in progress, 2006). The basal polymictic conglomerate of the Grass River Group contains clasts that range in composition from ultramafic to felsic. Above the basal conglomerate is a lower, hornblende-bearing arkosic metasandstone, which grades into biotite- and magnetite-bearing arkosic metasandstone. The Grass River Group is interpreted to be the shallow-water facies of the Burntwood Group of the Kisseynew Domain (Zwanzig et al., work in progress, 2006). Burntwood Group rocks locally display rhythmic layering that is interpreted to be preserved, but metamorphically recrystallized, primary greywacke to mudstone turbidite beds (Zwanzig et al., work in progress, 2006). Ospwagan Group and Burntwood Group rocks are brought into contact only along major faults.

Few metamorphic studies have been undertaken in the TNB and they have generally been restricted to local investigations. A number of studies have been conducted at the Thompson mine. Paktunç (1984) determined a temperature of 700°C and a pressure of 4.8 kbar using spinel-olivine geothermometry and mineral assemblages present in an ultramafic body. Bleeker (1990a) found similar temperatures of 700 to 750°C using garnet-biotite geothermometry; however, pressures were found to be 6 to 7 kbar using garnet-sillimanite-quartz-plagioclase geobarometry. Bleeker (1990c) also investigated metamorphic conditions at the Birchtree mine and Ospwagan Lake. At the Birchtree mine, a temperature of 680°C was obtained with a pressure of 5 to 6 kbar, whereas the temperatures at Ospwagan Lake were considerably lower (530 to 575°C). Investigations by Russell (1981) at Paint Lake suggested peak Hudsonian metamorphic conditions of 650 ±50°C and 4 to 5 kbar using garnet-biotite geothermometry and garnet-sillimanite-quartz-plagioclase geobarometry. The peak metamorphic conditions at the Pipe mine were constrained using metamorphic assemblages by Fueten and Robin (1989) to be 575 to 625°C, and by Bleeker (1990a) to be 600 to 660°C and 5 to 6 kbar using garnet-biotite geothermometry and garnet-sillimanite-quartz-plagioclase geobarometry. Overall, metamorphic conditions in the areas observed in this study are interpreted to range from middle amphibolite facies to lower granulite facies of low to moderate pressures. This preliminary report is part of an ongoing Ph.D. study into the Hudsonian metamorphism of the TNB.

Methodology

Pre-existing geological maps were used to select outcrops of greatest potential for petrological studies. These outcrops, consisting largely of Ospwagan Group supracrustal rocks, include pelitic to semipelitic rocks, iron formation, amphibolite and calcsilicate rocks. Such rock types are most likely to yield favourable mineral assemblages for pressure and temperature determination using classical metamorphic petrology and thermodynamic modelling. Most of the outcrops were located along lakeshores and at two past-producing open-pit mines operated by Inco Limited.

Diamond-drill core, obtained from Inco Technical Services Limited, was examined from areas with poor accessibility and/or outcrop exposure. Drillholes were selected based on old core logs and current geological maps. The core had been previously condensed by sampling 6-inch lengths of core every 10 feet. Samples with mineral assemblages useful for petrological and thermodynamic studies were collected for thin sectioning.

Thompson mine South pit

The southwest shoulder of the Thompson mine South pit (Figure GS-12-1) was examined using the recent map of Macek et al. (2005). The textures and mineralogy of the various rock types were investigated in detail. Muscovite is abundant throughout the groundmass of the M2 semipelite; however, the presence of sillimanite and ubiquitous K-feldspar-bearing leucosome, which appear to be of in situ origin, suggests temperatures likely surpassed the stability field of muscovite and caused melting (Figure GS-12-2). The sillimanite knots, and occasionally feldspar within the leucosome, may be strongly overprinted by fine-grained muscovite (Couëslan, 2003), suggesting that much of the muscovite in the semipelite may be retrograde and likely related to the release of H_2O during crystallization of the melt

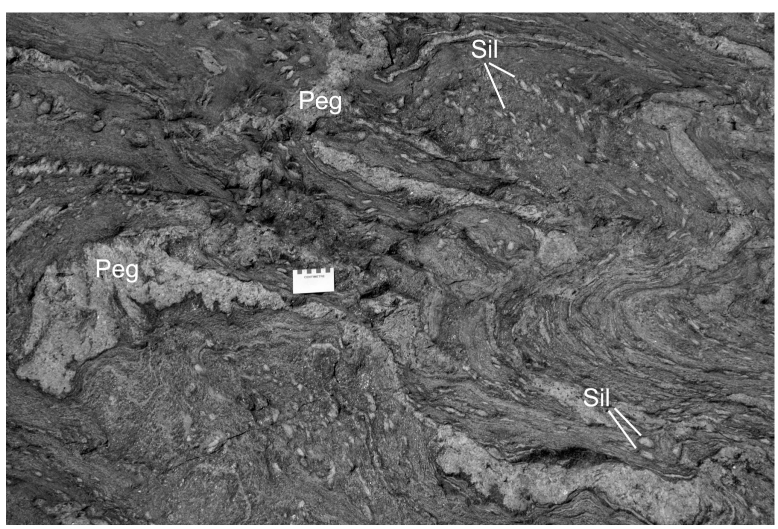

Figure GS-12-2: *Sillimanite knots and pegmatite sweats in Manasan Formation M2 semipelite at the Thompson mine South pit. The pegmatitic material appears to be in situ. The scale card is in centimetres. Abbreviations: Peg, pegmatite; Sil, sillimanite.*

(Spear et al., 1999). Field observations and detailed sampling revealed the garnet-bearing leucoamphibolite core of a metagabbro dike to be of greatest interest for metamorphic studies. Local pods of in situ leucosome within the amphibolite appear to originate from partial melting, possibly in the presence of an anhydrous fluid (Figure GS-12-3). In addition to quartz and feldspar, the leucosome is often characterized by very coarse grained anhedral garnet, blocky hornblende, diopside and what has tentatively been identified in the field as orthopyroxene. Bleeker (1990c) also reported orthopyroxene, which he interpreted to be metamorphic, in an ultramafic amphibolite at Thompson. If the orthopyroxene is, in fact, present, the metamorphic grade at the Thompson mine must have attained at least lower granulite grade.

Pipe mine open pit

Utilizing the detailed maps of Bleeker and Macek (1988b–e), lithological units at the Pipe mine (Figure GS-12-1) were examined in detail for mineral assemblages and textures. Detailed sampling of Ospwagan Group pelite and iron formation was conducted at outcrops to the east and north of the open pit.

Coarse-grained andalusite, wrapped by foliation, is present along with staurolite, muscovite, and biotite in the Pipe Formation P2 pelite exposure just north of the open pit (Figure GS-12-4). Whereas Bleeker (1990c) interpreted the andalusite at the Pipe mine as retrograde, the authors' observations suggest it occurs as primary porphyroblasts. Locally, staurolite porphyroblasts are rimmed with muscovite. Sillimanite occurs in pelitic horizons of the Setting Formation and in the easternmost exposures of the P2 pelite and M2 semipelite. In rocks of the Setting Formation, the sillimanite occurs as the discrete knots or rods recognized by Bleeker (1990c), which in some instances are characterized by blocky outlines. The occurrence of sillimanite in discrete, sometimes blocky, rod-like segregations, rather than intergrown with biotite within the foliation, suggests that sillimanite may be pseudomorphous after andalusite or possibly staurolite (Figure GS-12-5). This is supported by the observation of darkened cores in many of the sillimanite knots, suggestive of relict andalusite or possibly staurolite.

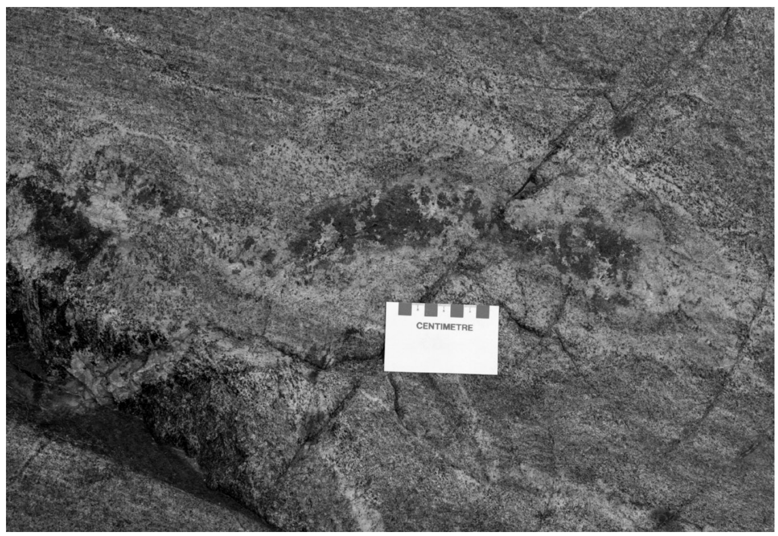

Figure GS-12-3: *Leucosome in garnet-bearing leucoamphibolite at the Thompson mine South pit. Coarse-grained mafic minerals found in the core of the leucosome consist dominantly of garnet, hornblende, diopside and a mineral that has been tentatively identified as orthopyroxene.*

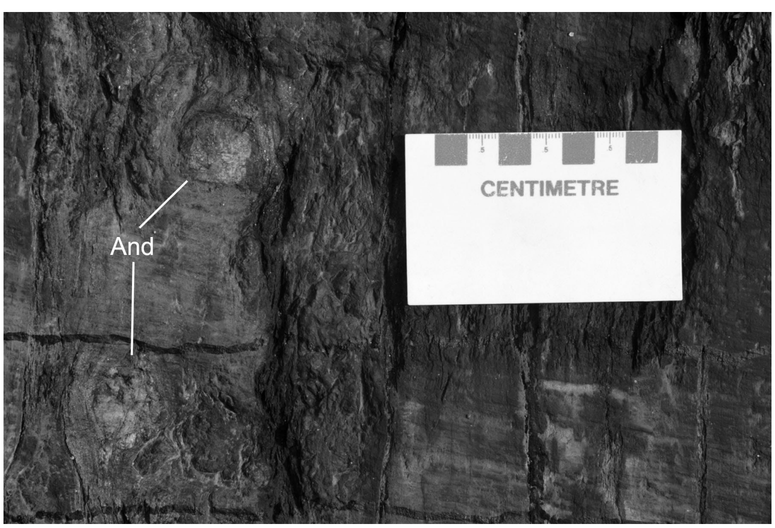

Figure GS-12-4: *Coarse-grained andalusite porphyroblasts in Pipe Formation P2 pelite at the Pipe mine open pit. The groundmass also contains staurolite. Abbreviation: And, andalusite.*

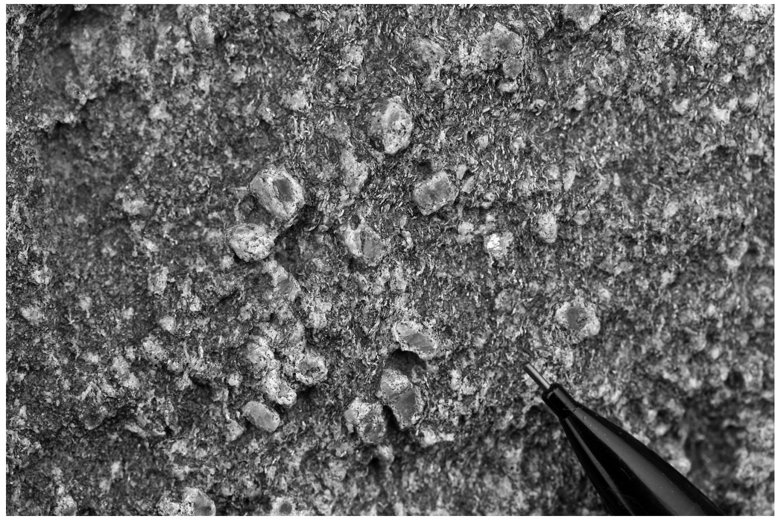

Figure GS-12-5: Sillimanite knots in Setting Formation sillimanite-biotite gneiss at the Pipe mine open pit. The sillimanite knots are characterized by darkened cores and frequently have a blocky habit, suggesting they may have pseudomorphically replaced andalusite or staurolite. Note the absence of leucosome development.

Prior to the 2006 summer field season, thin sections of Pipe Formation silicate-facies iron formation and Setting Formation sillimanite-biotite gneiss were examined in a preliminary study. The iron formation contains the prograde metamorphic assemblages fayalite-garnet-hornblende-grunerite-magnetite and fayalite-diopside-magnetite-grunerite-garnet. Ferrosilite is also commonly observed in the iron formation, and many grains show retrograde alteration to grunerite. The Setting Formation sillimanite-biotite gneiss contains abundant microcline, quartz and biotite, and is sillimanite and muscovite bearing. The microcline occurs as coarse-grained poikiloblasts with inclusions of biotite, tourmaline, muscovite and quartz (Figure GS-12-6). The sillimanite forms discrete fibrous knots, whereas the muscovite commonly forms discrete, coarse, tabular grains and is occasionally interleaved with biotite within the foliation. Outcrops of the gneiss display no signs of leucosome development (Figure GS-12-5). Although the presence of abundant microcline along with sillimanite suggests temperatures exceeded the stability field for muscovite, a lack of leucosome suggests that melting did not occur. This requires pressures low enough for the muscovite reaction to proceed under subsolidus conditions.

Mineral assemblages observed in the P2 pelite during field studies suggest middle amphibolite facies metamorphic conditions within the rather narrow stability field of co-existing andalusite and staurolite (~570–580°C and 3.8–4.2 kbar; Figure GS-12-7). Blocky sillimanite in rocks 200 m to the west suggests that this field may have been overstepped into the stability field of sillimanite. The relatively broad field defined by the mineral assemblages present in the iron formation is in agreement with a slight overstepping into the field of stable sillimanite.

The assemblage in the Setting Formation gneiss indicates pressure conditions similar to those in the andalusite- and staurolite-bearing P2 pelite (3.5–3.7 kbar); however, it suggests much greater (upper amphibolite facies) temperatures (640–650°C; Figure GS-12-7).

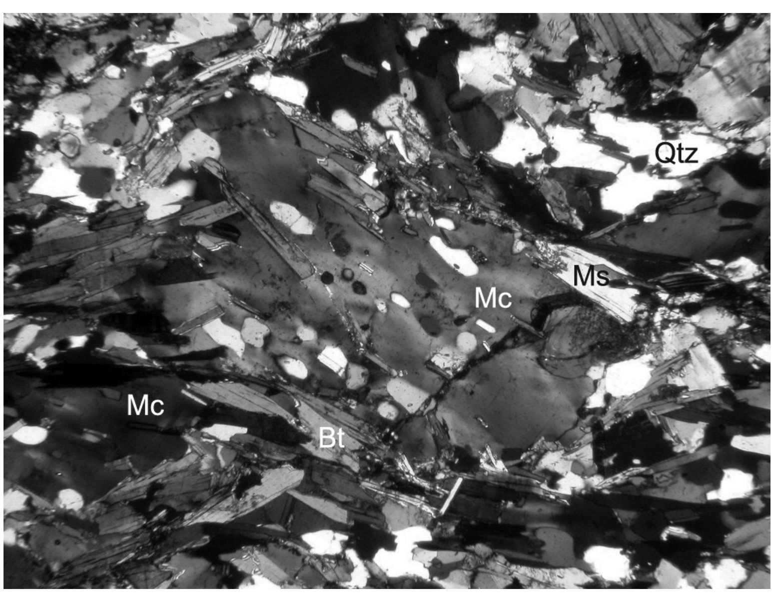

Figure GS-12-6: Photomicrograph in cross-polarized light of poikiloblastic microcline in Setting Formation sillimanite-biotite gneiss from the Pipe mine. The field of view is 2.6 mm. Abbreviations: Bt, biotite, Mc, microcline, Ms, muscovite, Qtz, quartz.

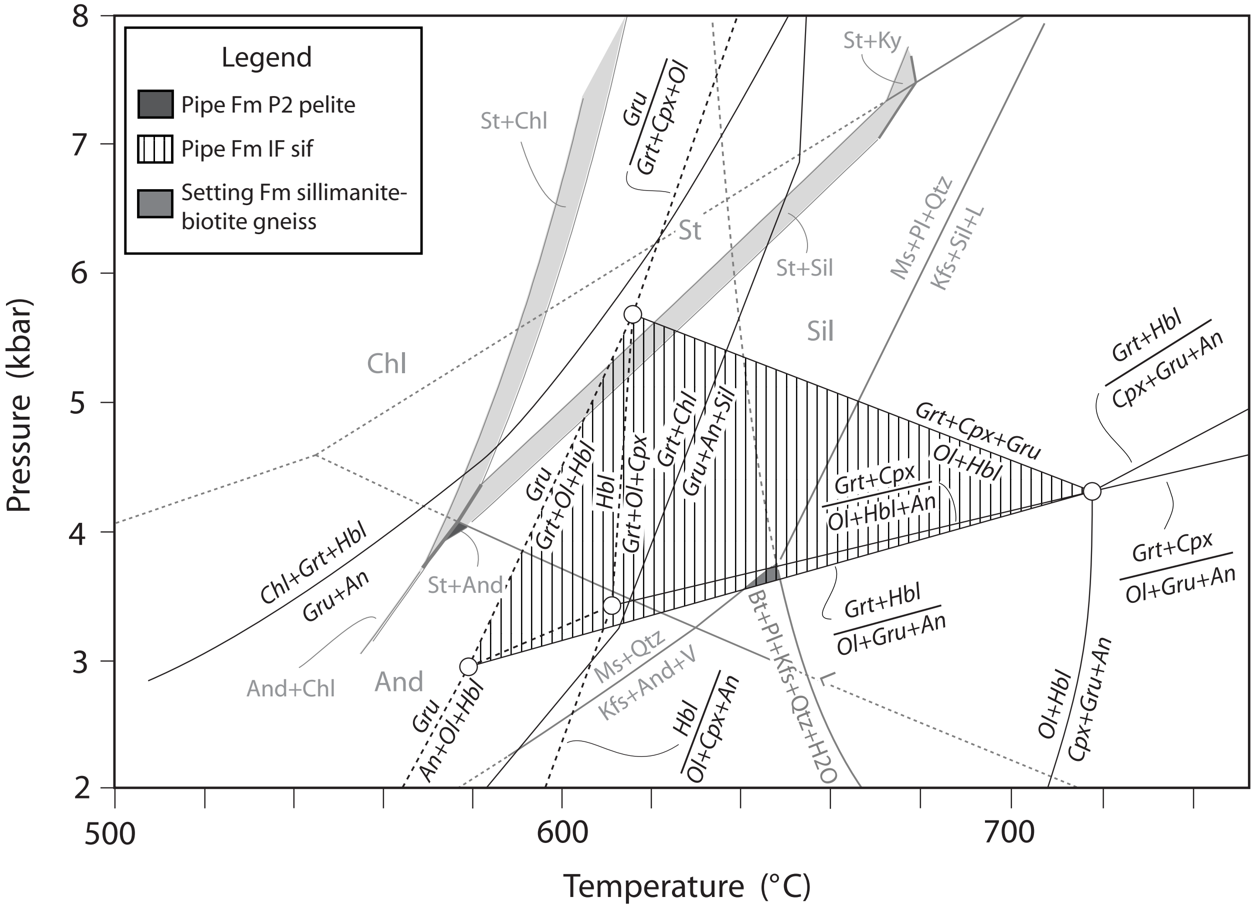

Figure GS-12-7: *Petrogenetic grid showing the metamorphic conditions for mineral assemblages found in pelite and iron formation at the Pipe mine. The phase relationships in black lines are in the systems CaO-FeO-MgO-Al_2O_3-SiO_2-H_2O (solid lines) and CaO-FeO-Al_2O_3-SiO_2-H_2O (broken lines) from Zeh et al. (2005) for iron formations, and the grey lines are for average pelite in the system K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O (Pattison and Vogl, 2005), Broken lines represent metastable assemblages. The reaction curves Ms + Pl + Qtz ↔ Kfs + Sil + L and Bt + Pl + Kfs + Qtz + H2O ↔ L come from Pattison et al. (2003). Abbreviations: An, anorthite; And, andalusite; Bt, biotite; Chl, chlorite; Cpx, clinopyroxene; Grt, garnet; Gru, grunerite; Hbl, hornblende; Kfs, K-feldspar; Ky, kyanite; L, liquid (melt); Ms, muscovite; Ol, olivine; Pl, plagioclase; Qtz, quartz; Sil, sillimanite; St, staurolite; V, vapour.*

The possibility of higher temperatures is also supported by the presence of Fe-Mg-amphibole and calcic amphibole pairs with exsolution lamellae. The occurrence of Fe-Mg-amphibole–calcic amphibole pairs displaying exsolution lamellae is characteristic of upper amphibolite to lower granulite facies (Deer et al., 1997).

The discrepancy in temperature indicated by the mineral assemblages at the Pipe mine is difficult to interpret. One possibility is the presence of a fault between the two locations; however, the continuity of units within the Ospwagan Group argues against great lateral displacement, and the similarities in pressures between the two mineral assemblages argue against significant vertical offset. Another possibility is the metastable persistence of andalusite and staurolite above the temperatures that define their stability range. Resolving this issue will be the subject of further research.

Natural outcrops

Outcrops were investigated along the shores of Mystery, Ospwagan, Paint and Setting lakes, as well as along the banks of the Manasan, Taylor and Grass rivers (Figure GS-12-1). Another outcrop locality was also visited near Mid Lake.

Mystery Lake

Outcrops of Burntwood Group garnet-biotite gneiss and Ospwagan Group M2 semipelite, P2 pelite and Setting Formation rocks were described and sampled at Mystery Lake. All rocks are intensely sheared and variably retrogressed, likely the result of proximity to the Mystery Lake Fault. The Burntwood Group gneiss is composed of alternating bands of metagreywacke and pelitic schist, and is migmatitic and highly sheared. Ribbon quartz and mylonitic textures are common, and veins of pseudotachylite are locally present. Quartz-rich segregations within the gneiss contain coarse-grained cordierite porphyroblasts. Staurolite is present locally within more aluminous horizons.

The Pipe Formation P2 pelite has been intruded by and infolded with a metadiabase dike, assumed to be of the Molson swarm. The pelite consists of highly sheared, fine-grained schist, and intensely folded ribbon quartz is common. The intensely infolded and sheared Molson dike is generally garnet rich along the contact with the pelite.

The Setting Formation rocks consist dominantly of quartzite with intercalations of pelitic schist. The rocks have been intensely folded and sheared, giving the quartzite the appearance of a siliceous mylonite. The pelite may be retrogressed, as it appears to be enriched in fine-grained chlorite.

Ospwagan Lake

A succession of Ospwagan Group supracrustal rocks from the Pipe Formation to the Bah Lake assemblage was studied at Niven Point on Lower Ospwagan Lake. Here, the P2 pelite is a muscovite schist that locally contains coarse-grained andalusite porphyroblasts in cherty horizons. A horizon of Bah Lake assemblage metabasalt with garnet- and plagioclase-bearing stringers occurs at the northeast corner of Upper Ospwagan Lake.

Taylor and Manasan rivers

Outcrops of Burntwood Group garnet-biotite gneiss were examined upstream and downstream from Lower Ospwagan Lake along the Taylor and Manasan rivers, respectively. The Burntwood Group gneiss is migmatitic and composed of metagreywacke with intercalations of metapelitic schist. Along the Taylor River, the Burntwood Group rocks are retrogressed with abundant pinitized cordierite. The cordierite in the Manasan River outcrops, although less common, appears to be relatively unaltered. Pelitic horizons in the Manasan River outcrops are locally sillimanite rich. The sillimanite occurs intergrown with the biotite within the foliation.

Paint Lake

The outcrops studied on Paint Lake consist of both Archean basement rocks and Proterozoic Ospwagan Group rocks. An outcrop of M2 semipelite, exposed in a roadcut at the marina on Paint Lake, is characterized by pods of mobilizate that appear to have been generated in situ. The leucosome occurs at all scales in the rock and is pooled between primary compositional layering (Figure GS-12-8), suggestive of temperatures above minimum melting.

Two samples of Archean metapelitic rocks were sampled and described from the northeastern and central parts of the lake. The pelite is characterized by very coarse grained garnet and discrete prismatic grains of aluminosilicate. The aluminosilicate appears to be sillimanite pseudomorphous after kyanite. The former presence of kyanite is attributed to higher pressures attained by the Archean rocks prior to the Trans-Hudson orogeny. A sample was also obtained of garnet-bearing enderbite from the southeastern portion of the lake.

Mid Lake

Outcrops of Bah Lake assemblage metabasalt and Setting Formation quartzite are present in an inactive clay quarry just south of the Mid Lake exit on Highway 6. At this location, metasedimentary rocks at the top of the Setting Formation are infolded with metavolcanic rocks at the base of the Bah Lake assemblage. The Setting Formation rocks consist dominantly of quartzite with intercalations of pelitic schist. The schist contains sillimanite as flattened knots within the foliation. The Bah Lake assemblage metabasalt consists of pillowed flows. At the contact between the Setting Formation and the Bah Lake assemblage, the bottom 30 cm of the metabasalt is garnet bearing.

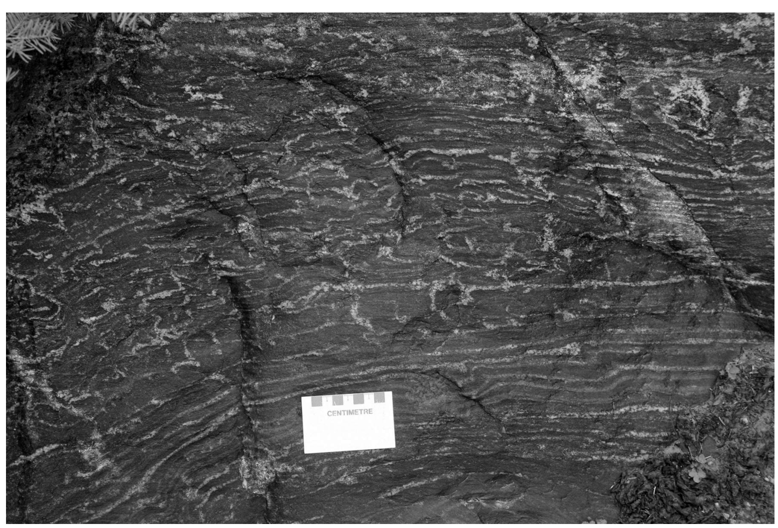

Figure GS-12-8: *Leucosome in Manasan Formation M2 semipelite at Paint Lake appears to be in situ. The pegmatitic material appears to be pooling between primary compositional layering in the rock and the primary bedding has begun to be disrupted by the melt. The scale card is in centimetres.*

Grass River

Metabasalt of the Bah Lake assemblage was investigated at two localities along the Grass River: west of Kwasitchewan Falls and above Pisew Falls. The metabasalt here is characterized by pods of sheared pillow selvages, interpillow material and/or mobilizate. The pods are generally rich in quartz and feldspar, and contain variable amounts of coarse-grained hornblende, diopside, garnet, carbonate and a blocky, brown-weathering mineral that is green on freshly exposed surfaces; although not positively identified, the mineral is likely either diopside or orthopyroxene. Further petrographic studies will be conducted.

Setting Lake

Metasedimentary rocks of the Grass River Group, Ospwagan Group and Burntwood Group were described and sampled from the northern, central and southern portions of Setting Lake. Rocks of the Grass River Group consist of a polymictic metaconglomerate and meta-arkose. Sillimanite-bearing meta-arkosic rocks occur in both central and northern portions of the lake, with the sillimanite occurring in discrete medium- to coarse-grained knots in the fine-grained arkosic groundmass.

Burntwood Group and Setting Formation rocks occur in the southern portion of the lake. The Setting Formation rocks consist dominantly of quartzite with intercalations of pelitic schist. The pelitic horizons are sillimanite rich. The entire unit has been intruded by pink pegmatite dikes that commonly contain rafts and schlieren derived from the Setting Formation rocks. The largest of these pegmatite dikes have an approximate north trend. The Burntwood Group rocks consist largely of garnet-biotite gneiss, interpreted to be metagreywacke, and contain semiconformable pods of quartzofeldspathic mobilizate.

Diamond-drill core

Drillcore was examined from areas near Moak, Mystery, Nichols, Liz, Hambone, Phillips, and Setting lakes (Figure GS-12-1). Pipe Formation P2 pelite in two separate drillholes from the Moak Lake area contains discrete, coarse-grained sillimanite knots with pinkish brown cores. The pinkish brown cores may be relict andalusite, suggesting metamorphic conditions near the andalusite-sillimanite phase transition. Muscovite is also abundant in the pelite, and porphyroblasts of staurolite were noted in several horizons.

Orthopyroxene was identified in Ospwagan Group metasedimentary rocks in core from Nichols and Phillips lakes. The orthopyroxene is found in biotite paragneiss and impure chert, and implies granulite-grade metamorphism.

Core from the Hambone Lake and Setting Lake areas contains sillimanite as discrete knots and intergrown with biotite within the foliation. No muscovite was noted.

Conclusions

Preliminary investigation suggests that metamorphic conditions in the Thompson Nickel Belt (TNB) during the Trans-Hudson orogeny may have reached higher grades, over greater areas, than previously recognized (Figure GS-12-1). Proterozoic rocks within the TNB have been subjected to metamorphic grades ranging from middle amphibolite to granulite facies, with no prograde greenschist-facies assemblages observed (Figure GS-12-9). Granulite-grade rocks (≥800°C, uncertain pressure) are recognized at Nichols and Phillips lakes, and may also be present at the Thompson mine and along the Grass River near Pisew and Kwasitchewan falls. Ospwagan Group rocks at Hambone Lake and Setting Lake have surpassed the limit of muscovite+quartz stability (upper amphibolite grade). Metamorphic conditions exceeded those required to produce melts at the Thompson mine and the Paint Lake marina (upper amphibolite grade). At Moak Lake, metamorphic conditions appear to be middle amphibolite grade, near the andalusite-sillimanite phase transition but within the stability field of muscovite+staurolite (~550–600°C, 3.5–4 kbar). At Ospwagan Lake, the presence of andalusite and muscovite suggests similar middle amphibolite facies conditions. Staurolite- and andalusite-bearing metapelite (middle amphibolite facies) and nonmigmatitic K-feldspar- and sillimanite-bearing metapelite (upper amphibolite facies) are present close to one another at the Pipe mine. This makes interpretation of metamorphic conditions difficult, although both assemblages indicate pressures of 3.5 to 4 kbar. The overall pattern for the TNB is that metamorphic grades are higher along the eastern side of the belt (Phillips and Nichols lakes) and lower along the western side of the belt (Ospwagan and Moak lakes), with some evidence for increasing grades to the south at Setting Lake.

Economic considerations

Better understanding of regional metamorphic data for the Thompson Nickel Belt will aid development of a regional tectonic framework for the belt. This is important for both a greater understanding of the Trans-Hudson Orogen in Manitoba and for exploration strategies within the TNB. The local grade of regional metamorphism may also be important, as it may have an effect on the mobilization of orebodies through solid-state, hydrothermal and anatectic processes. Finally, metamorphic grade affects the characteristics of Ospwagan Group supracrustal rocks (Zwanzig et al., work in progress, 2006). A thorough documentation of their characteristics at different metamorphic grades will greatly increase the ability to recognize Ospwagan Group rocks that have been metamorphosed. This is significant for exploration in the TNB, because the most significant nickel deposits in the belt occur within the P1 and P2 members of the Pipe Formation.

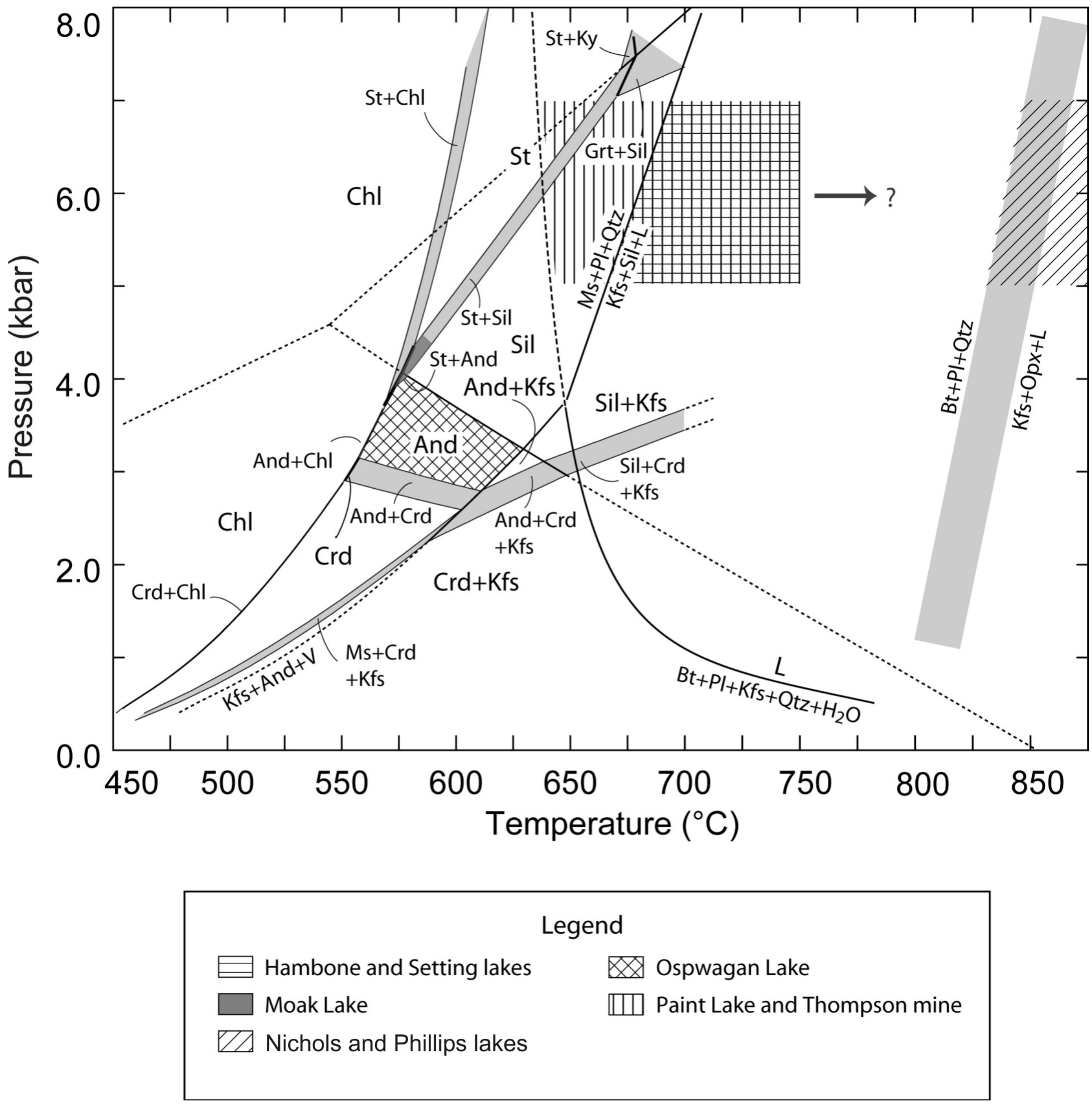

Figure GS-12-9: *Petrogenetic grid for pelite of average composition in the system K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O (Pattison and Vogl, 2005). The reaction curves Ms + Pl + Qtz ↔ Kfs + Sil + L; Bt + Pl + Kfs + Qtz + H_2O ↔ L; and Bt + Pl + Qtz ↔ Kfs + Opx + L come from (Pattison et al., 2003), with the Opx-producing reaction relevant to semipelitic rather than pelitic bulk compositions. Assemblages have been plotted for pelitic and semipelitic rocks observed at Hambone Lake, Moak Lake, Nichols Lake, Ospwagan Lake, Paint Lake, Phillips Lake, the Pipe mine, Setting Lake and the Thompson mine. The pressures depicted by the fields for Hambone and Setting lakes, Nichols and Phillips lakes, and Paint Lake and the Thompson mine are constrained by the geobarometric work of Bleeker (1990c), although it is probable that the pressures were lower. Abbreviations: And, andalusite, Bt, biotite, Chl, chlorite, Crd, cordierite, Grt, garnet; Kfs, K-feldspar, Ky, kyanite, L, liquid, Ms, muscovite, Opx, orthopyroxene; Pl, plagioclase, Qtz, quartz, Sil, sillimanite, St, staurolite, V, vapour.*

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