GS-11

Completion of geological mapping at Paint Lake, central Manitoba (parts of NTS 63P5, 12)

by C.G. Couëslan and T. Martins[1]

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Summary

Geological mapping of the Paint Lake area was completed in June 2010 with mapping at the north end of the lake. The area is largely underlain by multicomponent gneiss. Belts of metapsammite and metagreywacke with minor iron formation are continuous with metasedimentary rocks mapped the previous year. Trace-element and Sm-Nd isotope geochemistry suggests these metasedimentary rocks are not correlative with the Proterozoic Ospwagan Group. The Paint Lake metasedimentary rocks appear to be derived from an older, more mafic source than the Ospwagan Group.

A zone of previously recognized carbonatite magmatism and associated metasomatism was extended northward into the Grass River area. The total documented strike length of this system is now 23 km; however, the intensity of carbonatite magmatism and related metasomatism appears to be waning towards the north. Detailed mapping of two carbonatite outcrops suggests the carbonatite bodies intruded late in the tectonomagmatic history of the Paint Lake area. The dikes crosscut all phases but the latest pegmatite intrusions.

Although the Paint Lake metasedimentary rocks do not appear to be correlative with the Ospwagan Group, they could act as a potential source of sulphur for intruding ultramafic bodies. The extraordinary strike length of the carbonatite magmatism and metasomatism creates potential for rare earth element mineralization.

Introduction

A regional 1:20 000 scale geological mapping program of the Paint Lake area was initiated in the summer of 2008. The goal of the project was to obtain a better understanding of the Archean basement rocks to the Thompson Nickel Belt, and to look for occurrences of Ospwagan Group rocks. Work was completed in June 2010, with mapping being conducted along shoreline exposures at the north end of the lake (Figure GS-11-1). Mapping activities were based out of a field camp set up in the northwest arm of the lake for approximately 3 weeks. Low water levels on Paint Lake exposed outcrops that were drowned by high water levels during the summer of 2009. In addition to the completion of regional mapping, detailed mapping was conducted as part of a collaborative project with the University of Manitoba, investigating carbonatite intrusions in central Paint Lake.

Regional mapping

Regional mapping was extended north from the location of last year's activities (Couëslan, 2009a). The north end of the lake is largely underlain by multicomponent gneiss. Interpreted as dominantly orthogneiss, it consists of varying proportions of hornblende gneiss, biotite gneiss, plagioclase amphibolite, leucogranodiorite, granodiorite, aplite, pegmatite and assorted ultramafic blocks and boudins. The various rock types occur as intermixed, highly attenuated, centimetre- to metre-scale bands and discontinuous lenses. Hornblende or biotite gneiss generally forms the dominant phase, and is typically tonalitic to granodioritic in composition.

Belts of metasedimentary rocks continue through the central portion of the lake into the Grass River and along the eastern shore of the lake. They consist of metagreywacke and metapsammite, with subordinate silicate-facies meta–iron formation and metapelite. The metagreywacke forms medium-grained biotite gneiss with alternating, centimetre-thick layers of more siliceous and more aluminous compositions. In addition to biotite, it is characterized by variable amounts of garnet and orthopyroxene. Outcrops are characterized by light gossan staining and are commonly steep in zones of high strain. The metagreywacke is commonly interbedded with centimetre- to decimetre-thick layers of metapsammite and local meta–iron formation. The metagreywacke and metapsammite are locally gradational into each other. The metapsammite forms outcrops of siliceous gneiss, with minor biotite and variable amounts of garnet, orthopyroxene and magnetite. It is layered on a centimetre scale, and centimetre- to metre-scale interbeds of metagreywacke are not uncommon. Outcrops of metapsammite mapped the previous year were locally interbedded with centimetre-thick lenses of metapelite (Couëslan, 2009b). The meta–iron formation occurs as local bands within the metagreywacke. It contains variable amounts of garnet, magnetite, orthopyroxene, hornblende, biotite, pyrrhotite and quartz. Meta–iron formation is typically laminated to well layered but can occasionally be massive. The metasedimentary rocks of Paint Lake are described in greater detail in Couëslan (2008).

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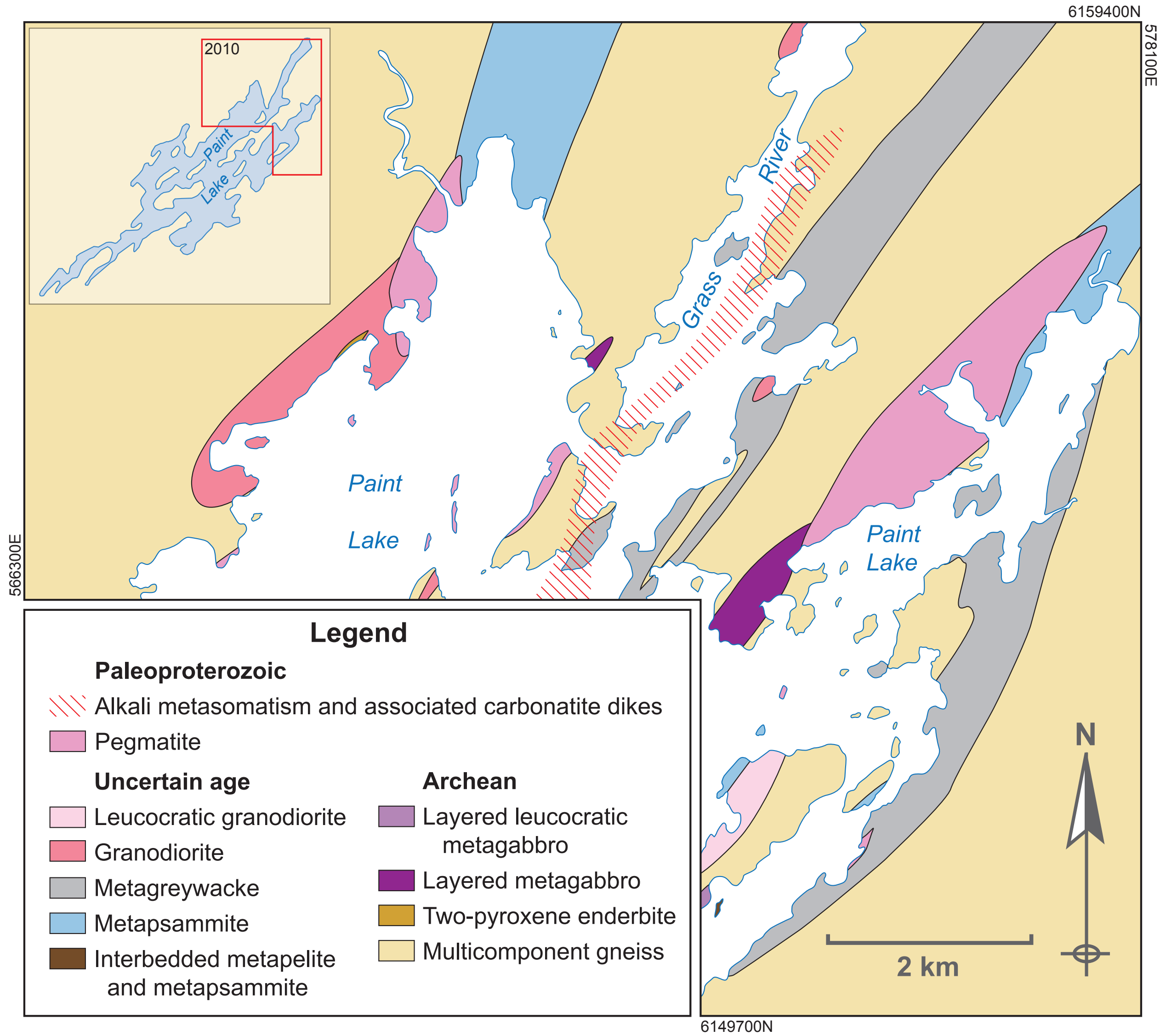


Figure GS-11-1: *Geology of the northern Paint Lake area; inset shows the location of 2010 mapping at Paint Lake.*

A zone of post-orogenic–type carbonatitic magmatism and related metasomatism outlined in 2009 (Chakhmouradian et al., 2009; Couëslan, 2009b) continues northward along strike and into the Grass River area (Figure GS-11-1), where it appears the intensity of the carbonatitic magmatism is waning. Three areas of significant metasomatism were recognized, and only one carbonatite dike, approximately 30 cm wide, was discovered. This dike is light grey on the fresh surface, with a chalky orange weathered surface (Figure GS-11-2). It consists of 5–7% apatite, 5–7% green amphibole, 7–10% biotite, and grey carbonate. The chalky orange weathering and mineralogy suggest it is related to the pink carbonatite suite (Chakhmouradian et al., 2009; Couëslan, 2009b). Recognition of these new areas of metasomatism, and the occurrence of the carbonatite dike, result in a total documented strike length of approximately 23 km for this zone of carbonatitic magmatism and metasomatism. The intrusive centre of carbonatitic magmatism, as indicated by the abundance of carbonatite dikes, appears to be in the islands and north peninsula of central Paint Lake.

Trace-element and Sm-Nd isotope geochemistry

Sulphidic horizons within the Ospwagan Group of the main Thompson Nickel Belt are believed to have been major sources of sulphur for the formation of ultramafic-hosted Ni-Cu deposits (Zwanzig et al., 2007; Burnham et al., 2009). Consequently, most of the Ni-deposit–hosting ultramafic bodies in the belt were emplaced within Ospwagan Group metasedimentary rocks. It is therefore advantageous to be able to recognize positively the Ospwagan Group rocks when exploring areas for Ni deposits. The relationship between the Ospwagan Group and the Paint Lake metasedimentary rocks is not certain.

Figure GS-11-2: *Carbonatite dike located approximately 3 km downstream of Paint Lake along the east shore of the Grass River.*

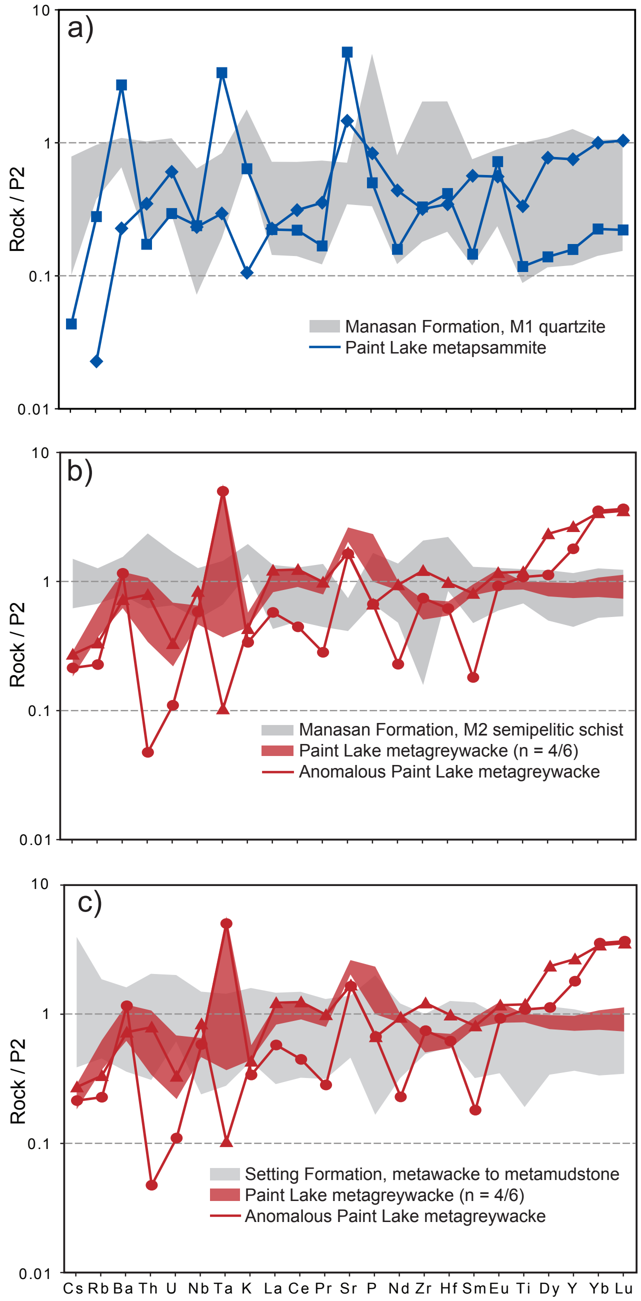
The latter rocks are tentatively interpreted to be older than the Ospwagan Group, possibly Archean; however, direct evidence is lacking. They do not directly match the Ospwagan Group sequence; however, similarities to portions of the sequence exist, as outlined by Couëslan (2009b). There is a possibility that the Paint Lake metasedimentary rocks could represent a lateral facies change, time correlative with the Ospwagan Group. To test for geochemical similarities, the metasedimentary rocks were examined using the method of Zwanzig et al. (2007), in which selected elements are normalized to the average P2 member metapelite of the Pipe Formation and plotted on extended-element diagrams.

The siliceous nature of the metapsammite on Paint Lake makes it similar to the Manasan Formation, M1 member quartzite of the Ospwagan Group. Although only two samples of metapsammite have been analyzed and there appears to be some scatter in the data, several anomalies stand out in the normalized data when compared to the M1 member (Figure GS-11-3a). The Paint Lake metapsammite is characterized by lower concentrations of Cs, Rb and K, and higher concentrations of Sr. The metagreywacke on Paint Lake is most similar to the M2 member semipelitic schist of the Manasan Formation and to metaquartzose wackes to metamudstones of the Setting Formation. When compared to the M2 member, the metagreywacke contains lower levels of Cs, Rb, Ba, Th, U, K and Hf, and higher levels of Ta, Sr and P (Figure GS-11-3b). Similarly, it contains lower levels of Cs, Rb, U and K, and higher levels of Ta, Sr, P and Eu, than do the Setting Formation rocks (Figure GS-11-3c). The metapelite on Paint Lake is mineralogically and chemically most similar to the P2 member metapelite of the Pipe Formation, although its mode of occurrence as centimetre- to decimetre-scale layers interbedded with metapsammite resembles the interbedded quartzite and metapelitic schist common to the Setting Formation. A single sample of the metapelite has very similar trace-element chemistry to the P2 member metapelite (Figure GS-11-3d), differing only in having a slight negative Sr anomaly. The trace-element pattern of the Paint Lake metapelite is also similar to that of Setting Formation rocks but with lower levels of Cs and slightly higher levels of Ti and medium and heavy rare earth elements (Figure GS-11-3e).

Lower levels of Cs, Rb, Ba and K, and higher levels of Sr ± Eu in the metapsammite and metagreywacke are likely the result of plagioclase being the dominant feldspar component, with little to no potassium feldspar. Conversely, the Ospwagan Group metasedimentary rocks typically contain a greater proportion of potassium feldspar or, in more pelitic rocks, muscovite (Bleeker, 1990). These differences, along with generally lower levels of U and Th, suggest a more mafic source for the Paint Lake metasedimentary rocks and a more evolved, likely granitic source for the Ospwagan Group rocks.

In addition to trace-element geochemistry, Sm-Nd isotopic analyses were carried out at the University of Alberta Radiogenic Isotope Facility on two samples of Paint Lake metagreywacke. The samples yielded model ages of 3.23 and 3.27 Ga. These model ages are slightly older than the range of ages obtained for Ospwagan Group metasedimentary rocks from the main Thompson Nickel Belt, 2.88 to 3.22 Ga (average of 3.00 Ga), but within the range of typical Archean basement gneiss, 3.14 to 3.52 Ga (average of 3.34 Ga; Böhm et al., 2007). These data suggest the Paint Lake metagreywacke is derived from slightly older detritus than the Ospwagan Group rocks.

It appears from both trace-element analyses and isotope geochemistry that neither the metapsammite nor the metagreywacke is correlative with the Ospwagan Group rocks of the Thompson Nickel Belt. They appear to be part of a sedimentary sequence sourced from older, more mafic, plagioclase-rich rocks, such as an Archean greenstone belt. The detritus that formed the Ospwagan Group rocks appears to include a more evolved component, possibly derived from the abundant granitoid rocks formed during the metamorphism of the adjacent Pikwitonei Granulite Domain. The Paint Lake metasedimentary rocks appear to be older than the Ospwagan Group (possibly Archean); however, this cannot be stated conclusively.



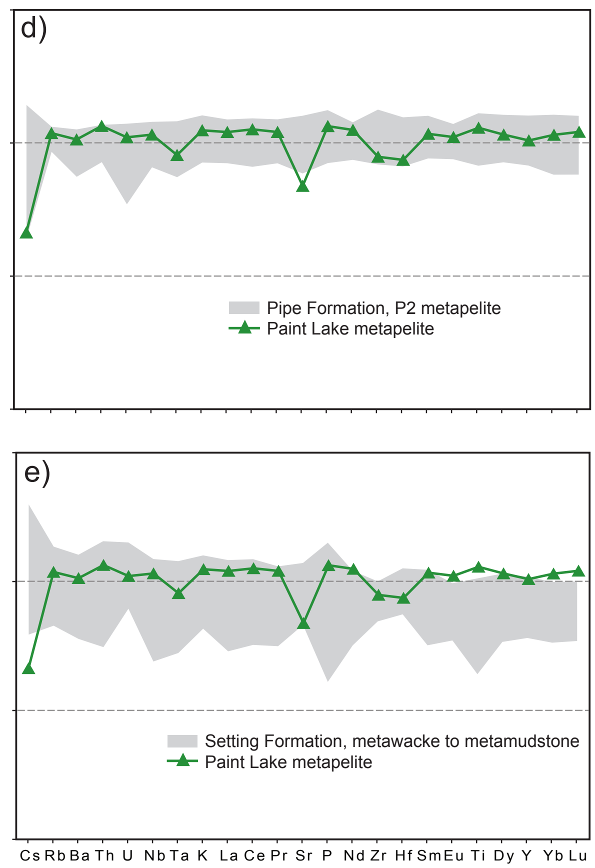


Figure GS-11-3: *Extended-element plots of Ospwagan Group metasedimentary rocks and those from Paint Lake, normalized to the average P2 metapelite member of the Pipe Formation. Data for M1 member quartzite, M2 member semipelitic schist, P2 member metapelite and Setting Formation metaquartzose wackes to metamudstones are from Zwanzig et al. (2007).*

An older source for the Paint Lake metasedimentary rocks does not necessarily mean they are not time correlative with deposition of the Ospwagan Group. The geochemical similarity between the Paint Lake metapelite and similar rocks from the Ospwagan Group does not allow for them to be discriminated based on a single analysis. The strong spatial association of metapelite with metapsammite and metagreywacke suggests it is part of the same metasedimentary sequence, and not an isolated sliver of Ospwagan Group metasediment. Additional samples of metagreywacke and metapelite were collected this summer for geochemistry and geochronology. The samples will be used to constrain metamorphic grade and potentially provide further insight into the timing of metamorphism and provenance of the detritus.

Detailed mapping

Two carbonatite outcrops were selected for detailed mapping based on excellent exposure along the strike length of the dikes. The aim of the detailed mapping was to document crosscutting relationships and relative timing of the carbonatite and other igneous phases present, and conduct detailed sampling for thin-section, geochemical and geochronological studies. The outcrops consist predominantly of multicomponent gneiss with centimetre- to decimetre-scale bands of plagioclase amphibolite, crosscut by up to four phases of pegmatitic granitoid dikes (Figures GS-11-4, -5). The carbonatite, which belongs to the pink carbonatite suite of Couëslan (2009b), forms centimetre- to decimetre-scale dikes that are locally anastomosing. The carbonatite crosscuts all rock types but the

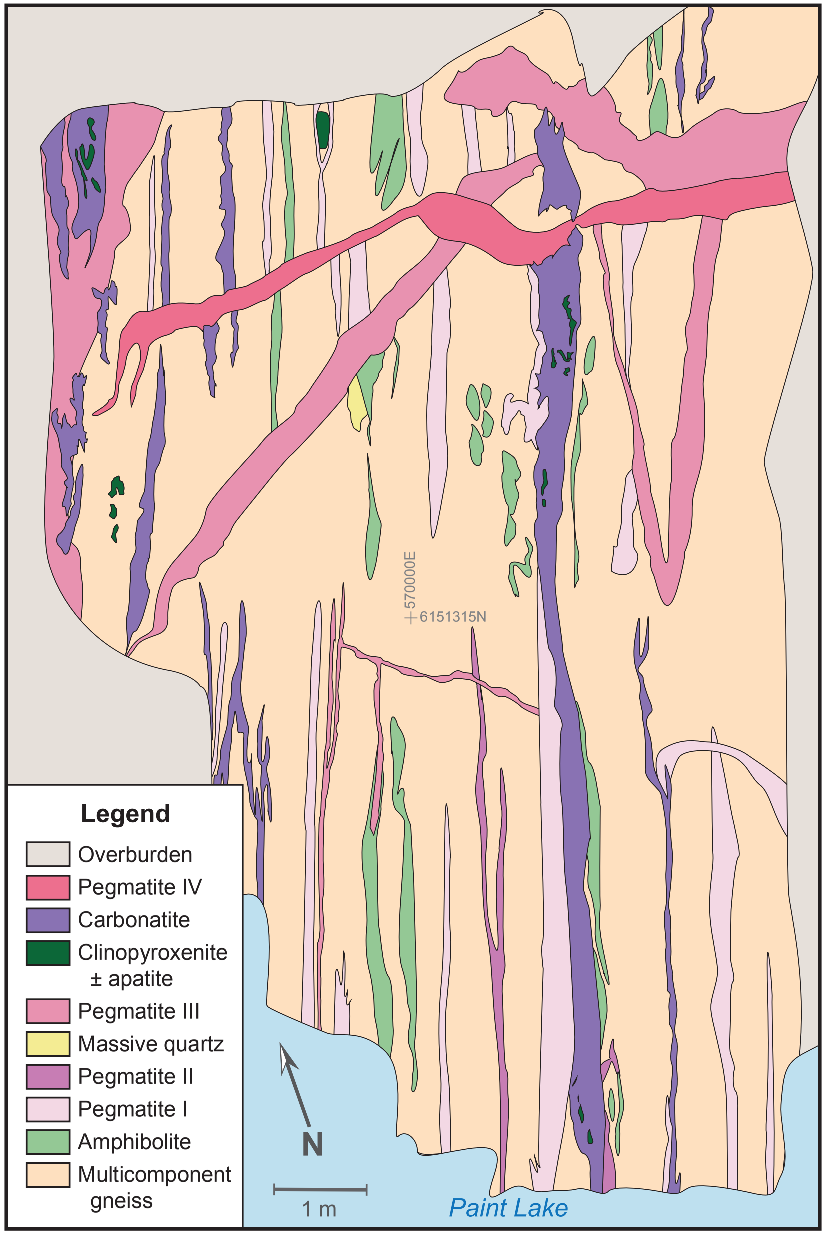


Figure GS-11-4: *Detailed geology of carbonatite outcrop 1.*

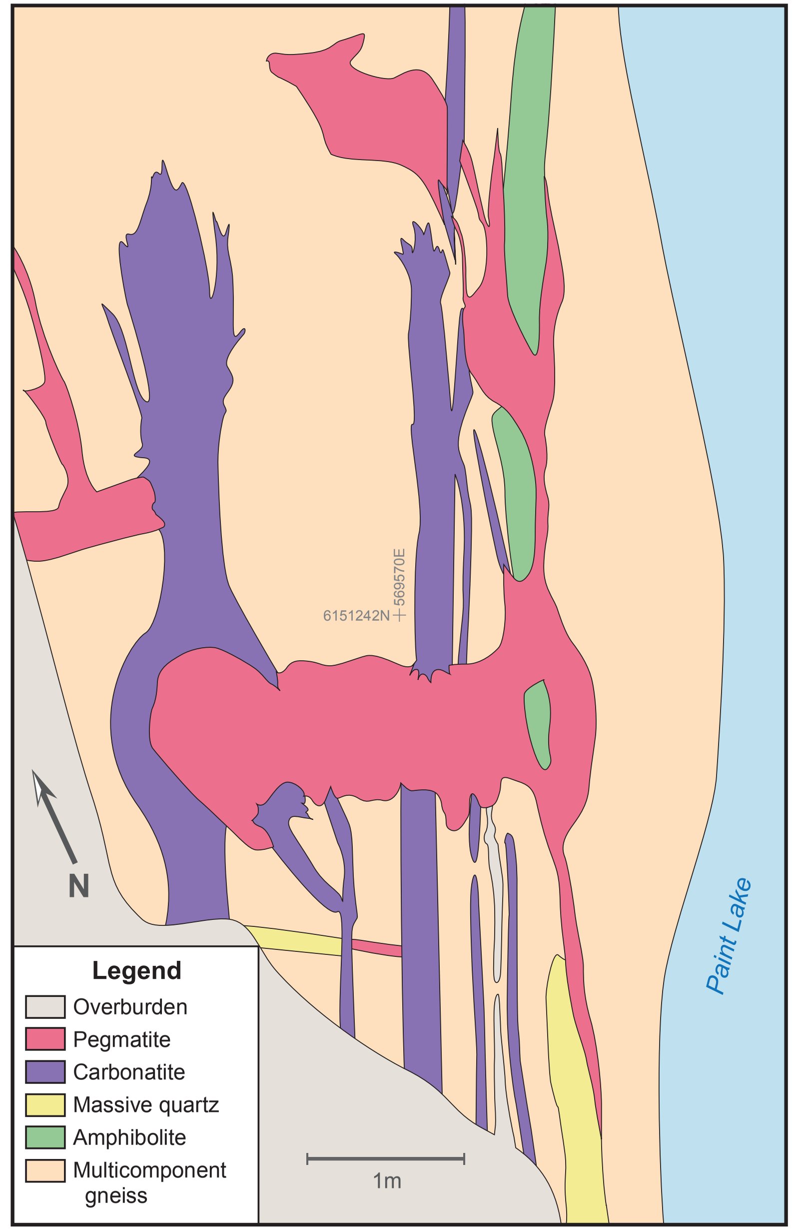


Figure GS-11-5: *Detailed geology of carbonatite outcrop 2.*

very latest generation of pegmatite dikes; however, this relationship can locally appear ambiguous. These late pegmatite bodies are massive, crosscut the regional structures and fabric of the host gneiss at a high angle, and are generally amphibole bearing. A bulk sample from the widest carbonatite in outcrop 2 was taken for geochronological studies. The sample was obtained from the core of the dike in an attempt to limit inheritance. A bulk sample for geochronology was also taken of the late pegmatite dike that crosscuts the carbonatite dike in outcrop 1 (pegmatite III, Figure GS-11-5).

Economic considerations

Ultramafic bodies in the Thompson Nickel Belt that intrude the Ospwagan Group metasedimentary rocks have a greater potential for forming magmatic Ni deposits than ultramafic bodies hosted by Archean gneiss (Zwanzig et al., 2007; Burnham et al., 2009). Sulphidic horizons towards the middle of the Ospwagan Group sequence are thought to have been a source of sulphur for the intruding ultramafic magmas, leading to sulphur saturation and the separation of a Ni-bearing sulphide melt. The Paint Lake metagreywacke and metapelite are characterized by a light gossan staining on almost all outcrops; samples of metagreywacke returned whole-rock values of 0.31 wt. % S, and the sample of metapelite contained 0.76 wt. % S. Additionally, the metagreywacke commonly contains lenses of silicate-facies meta–iron formation that can contain up to 7 modal % pyrrhotite. Although the Paint Lake metasedimentary rocks are not believed to be correlative with rocks of the Ospwagan Group, they may still have acted as a source of sulphur for intruding ultramafic bodies.

Post-orogenic–type carbonatite bodies similar to those at Paint Lake are associated with some of the largest rare earth element deposits in the world (Chakhmouradian et al., 2009). Another post-orogenic carbonatite complex at Eden Lake, Manitoba is currently being explored as a rare earth element prospect (Medallion Resources Ltd., 2010). Little is currently known about the rare earth element mineralogy of the Paint Lake carbonatite bodies, and no zones of rare earth element mineralization have been identified to date. However, given the huge strike length of the zone of carbonatite magmatism, the potential for rare earth element mineralization is significant.

Acknowledgments

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