PGE mineralization in the Archean Menarik Igneous Complex, James Bay, Québec, Canada

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Introduction

The Menarik Igneous Complex (MIC) was discovered in late 50's by Main Exploration. The MIC is located in the La Grande Subprovince, in the northeastern part of the Superior Province, the world's largest and best-preserved Archean Craton. The MIC is hosted by the 2732 +8/-6 Ma Yasinski mafic metavolcanic rocks and the 2716 ±3 Ma Duncan tonalite (Goutier et al., 1996). The MIC is one of the largest layered ultramafic-mafic intrusions found in the James Bay area and is exposed over 2 by 3 km^2 area with an approximate thickness of 500 m. Thus, the MIC is relatively small in comparison to major Proterozoic and Archean layered intrusions throughout the world, such as the Bushveld (2.05 Ga) and Stillwater Igneous Complexes (2.7 Ga). In this contribution, we present new geological, mineralogical and geochemical data to evaluate the metallogenic potential of the MIC.

Menarik Igneous Complex (MIC)

A major reverse fault divides the MIC in two blocks (southern and northern blocks). Igneous layering in the southern block exhibits a steep dip (~70°) towards the north. In the northern block the igneous layering is characterized by a shallower dip of 40° towards the north, which increases up to 70° in the vicinity of the reverse fault zone.

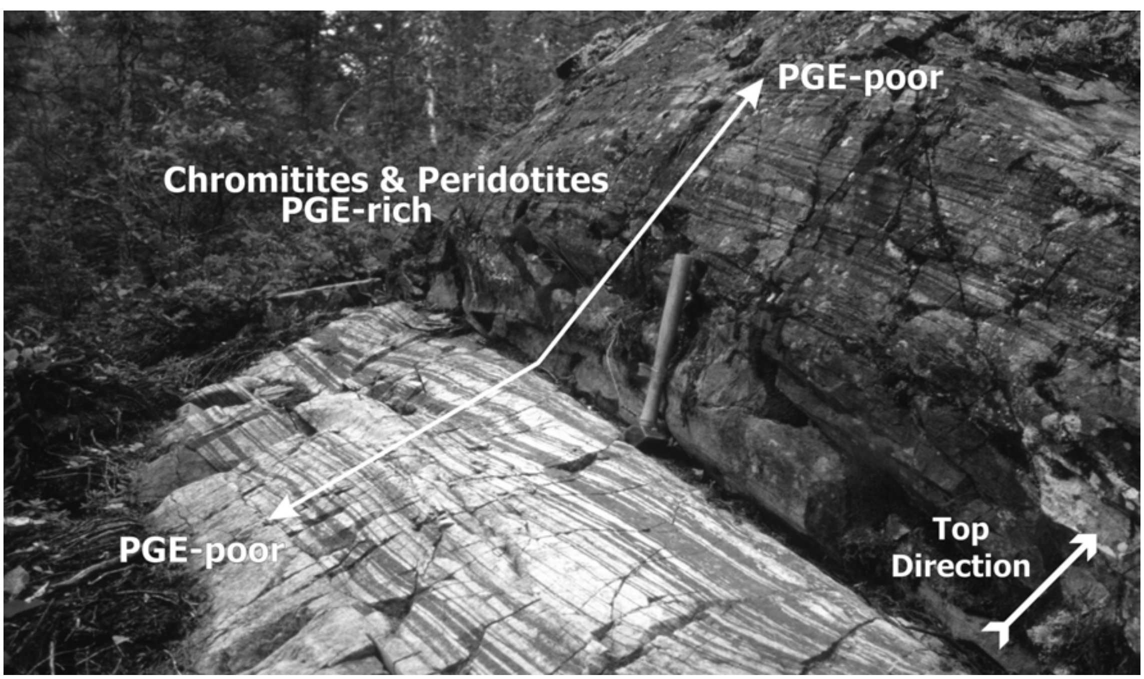

Figure 1. *Interlayered olivine-rich peridotite and chromitite seams reaching up to 2 meters in thickness from outcrop 97-MH-7371 (showing Cr-8 in the MIC). The peridotites stratigraphically below (0.12 g/t {~3.5 m below} to 0.47 g/t {~50 cm below}), and above (0.71 g/t {~ 30 cm above} to 0.20 g/t {~2.3 m above}) are depleted in PGE in comparison with the interlayered chromitite (1.8 to 2.1 g/t) and ad- to mesocumulate peridotite (1.2 g/t to 1.9 g/t) package.*

Recent work on the MIC has explored the Cr-PGE potential of this ultramafic-mafic intrusion (Houlé, 2000; Houlé et al., 1998; 2001). The MIC may be subdivided into a lower Ultramafic Zone (UZ) and an overlying Mafic Zone (MZ), with an outcrop (surface) area ratio of 4:1 for the respective zones. The UZ is dominantly composed of olivine-rich peridotites (harzburgite > dunite), peridotites (poikilitic lherzolites > lherzolite), pyroxenites (olivine websterite > websterite), chromite-bearing rocks, silicate chromitites and chromitite seams. The MZ is composed of medium-grained gabbro and locally coarse-grained gabbro. All mafic and ultramafic rocks have been metamorphosed to greenschist facies. Furthermore, pervasive serpentinization and localized carbonatization have obliterated all the primary silicate mineralogy. However, original igneous textures are frequently preserved. Conversely, chromite mineralogy has been less affected, with the preservation of primary igneous chromite cores surrounded by rims of secondary "ferritchromite" and chromian magnetite or magnetite-rich rims.

In the UZ, the crystallizing assemblage is olivine + chromite with lesser orthopyroxene. Clinopyroxene is present as a postcumulus phase. Olivine-rich peridotites and pyroxenites have textures ranging from ad- to mesocumulate and lesser orthocumulates. In contrast, peridotites have meso- to orthocumulate textures.

Over 30 silicate-chromitites and chromitite seams are found throughout the UZ. These chromite-rich horizons may be divided into 3 types: (1) chromitites and silicate chromitites in massive layers ranging from 30 cm to 1 meter thick (>50% of chromite), (2) homogeneous chromite-rich peridotite layers ranging from 5 to 30 cm (<50% of chromite), and (3) olivine-rich peridotite interlayered with chromitite seams or chromite-rich peridotites up to 2 meters thick (Fig. 1).

Two types of PGE mineralizations are present in the MIC: (1) PGE associated with silicate chromitites and chromitite seams; and (2) PGE associated with Ni-Cu sulfide veins. PGE in the chromitite layers are present as PGM alloys, arsenides and sulfoarsenide solid solutions and tellurides. All PGE in the Ni-Cu veins, located near topographic lineaments or faults, are present as PGM. The lower temperature Sb-Te-Bi-As assemblages are dominated by Pd compared to Pt species. Laurite, sperrylite, sudburyite, and testiopalladinite are the dominant PGM. The grain sizes of the PGM are relatively small (between 1 and 24 *u*m; average 8 ± 6 *u*m).

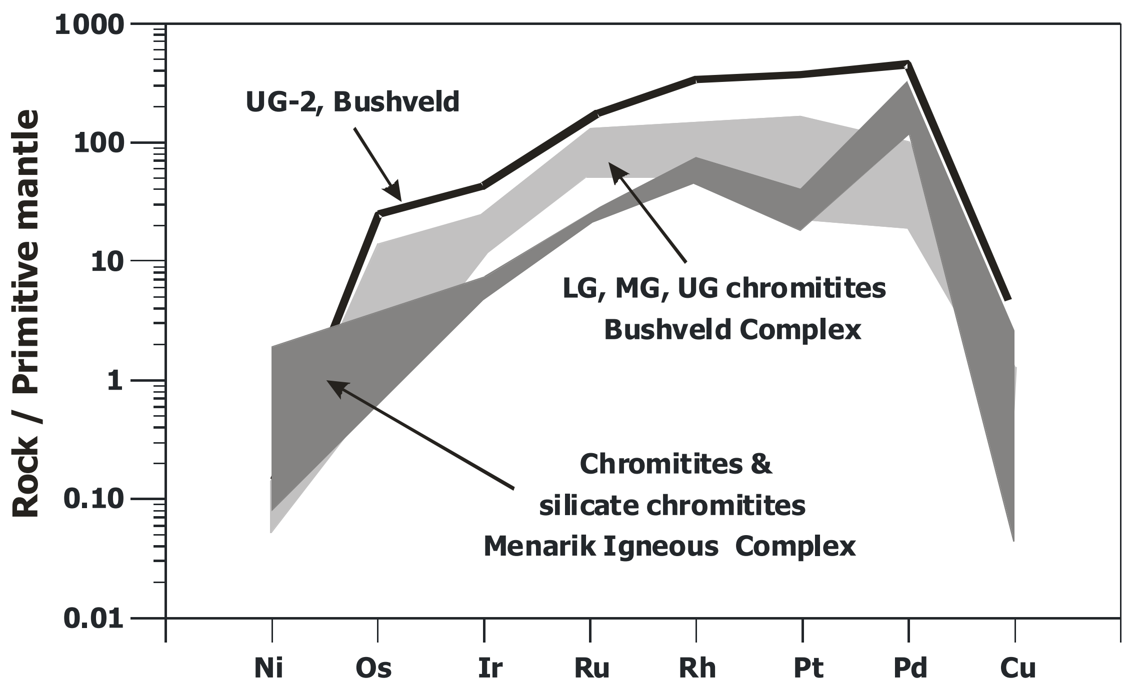

Figure 2. *Comparison of primitive mantle-normalized metal pattern for rocks from the Menarik Igneous Complex with rocks from the UG-2 and the Lower Group (LG), Middle Group (MG), and Upper Group from the Bushveld Complex of South Africa. Bushveld data from Barnes and Maier (1999).*

The chromitite seams contain up to 3.8 g/t ΣPGE (Pd/Pt range from 1.1 to 5.7; average 3.4 ± 1.1). The Ni-Cu veins contain up to 3.6 g/t PGE (Pd/Pt range from 4.7 to 9.7). Most of the PGE mineralization is chromitite-hosted, but several peridotites associated with chromitites have up to 1.2 g/t ΣPGE (see Fig. 2). Chromitites and silicate chromitites display arch-shaped primitive mantle-normalized PGE patterns (Fig. 2), with enrichment in PPGE (Rh, Pt and Pd) compared to the IPGE (Os, Is and Ru). Such PGE fractionation is similar to those reported from other high grade stratiform chromitite-hosted PGE horizons (e.g., UG-2, Bushveld Complex).

Discussion and Conclusion

The PGE mineralization in the Menarik Igneous Complex is of magmatic origin, similar to the UG-2 reef in the Bushveld Complex. This interpretation is supported by: 1) the presence of PGM inclusions within chromite, and 2) the presence of PGE sulfide solid solution species in the chromites. However, several additional features also suggest a late-stage remobilization of the primary PGE mineralization by hydrothermal fluids or during regional metamorphism including such as: 1) low temperature PGM Sb-Te-Bi-As assemblages; 2) the location of Pd-enriched arsenides and sulfoarsenides in fractured chromites; and 3) the similarity of PGM mineralogy in chromitite seams and later Ni-Cu-PGE veins.

Thus, the PGE-Cr potential of the MIC is high. Furthermore, this emphasizes the excellent potential for other PGE discoveries hosted in mafic-ultramafic intrusions in the under-explored James Bay region and other parts of the Superior craton.

Acknowledgements

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