
A Synopsis of Archean and Proterozoic Platinum Group Element Mineralization in the Thunder Bay District, Ontario

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Platinum group element (PGE) occurrences and deposits are found in both Neoproterozoic and Mesoproterozoic, mafic to ultramafic intrusive rocks in the Thunder Bay District. Increases in platinum group metal prices and the development of the Lac des Iles Mine have prompted renewed interest in local PGE exploration, resulting in the discovery of hitherto unknown hosts and styles of mineralization. (Many of these PGE-mineralized intrusions are highlighted on a pre-meeting field trip associated with the 9th International Platinum Symposium.)

Archean

There are four broad, temporally diverse settings for Neoproterozoic PGE mineralization:

- (1) Pre-tectonic, mafic to ultramafic, subvolcanic(?) intrusions intimately associated and coeval with greenstone belts of various ages in the Wawa and Wabigoon subprovinces; (e.g. Haines Gabbro (Shebandowan belt / Wawa; 2722 Ma); Core Zone gabbro (Obonga Lake belt / Wabigoon; 2733 Ma);
- (2) Post-tectonic, mafic to ultramafic intrusions (ca. 2692 Ma), related to late plutonism in the Wabigoon Subprovince, hosted by gneissic tonalite-granodiorite (e.g. Lac des Iles and Tib Lake complexes; Buck Lake, Legris Lake, etc.);
- (3) Syn- to post-tectonic, mafic to ultramafic intrusions (a.k.a. "Quetico-type"; ca. 2680 to 2688 Ma) hosted by Quetico subprovince metasedimentary rocks (e.g. Samuels Lake, Kawene, Nym Lake, Chief Peter Lake, North Elbow Lake, etc.); and

- (4) Mafic intrusive rocks occurring within syn- to post-tectonic, diorite-monzodiorite-monzonite suites with sanukitoid affinity (ca. 2680 to 2685 Ma), within the Wabigoon, Quetico and Wawa subprovinces (cf. Stern et al. 1989) (e.g. Roaring River Complex; Entwine Lake).

Disseminated to locally net-textured chalcopyrite, Fe-sulphides, pentlandite and magnetite typically characterize PGE-mineralized zones, which are commonly associated with intrusive contacts, polyphase intrusive breccias, as well as sheared and hydrothermally altered zones.

Proterozoic

Mesoproterozoic intrusive rocks associated with the Midcontinent Rift locally range in age from ca. 1108 Ma (e.g. reversely polarized Coldwell alkaline complex; Logan diabase, etc.) to ages younger than the magnetic polarity reversal that occurred between 1105 and 1102 Ma (Davis and Green 1997). A tabulated synopsis is provided below (Table 1).

The development of tectono-magmatic models for these various suites of intrusions was the focus of research of part of the Ontario Geological Survey's Operation Treasure Hunt, as well as follow-up surveys in the Nipigon Basin. These new data will provide new insights into late Archean subprovince accretion in the Superior Province, as well as the development of the Mesoproterozoic Midcontinent Rift. They will help to elucidate possible links between the age, geochemistry and setting of these intrusive rocks and PGE mineralization processes in order to generate new exploration targets.

Table 1.

Intrusion / Lithology	Mineralization Style	Local Examples (Associated PGE-Mineralized Areas)
<i>Normal Magnetic Polarity < (1105-1102 Ma):</i>		
Layered gabbro-anorthositic intrusions: Crystal Lake Gabbro	Disseminated and blebby sulphides in medium- to coarse-grained, varied-textured (<i>a.k.a.</i> 'taxitic') gabbro	Crystal Lake Gabbro (Great Lakes Nickel deposit)
	Disseminated sulphides in Cr-spinel-bearing cumulate layers	(Cr-spinel-bearing, anorthositic gabbro above Cu-Ni deposit)
Pine Point - Mount Mollie Gabbro	Disseminated, intergranular sulphides, fracture fillings	(Mount Mollie; Pine River)
Pigeon River and Arrow River diabase dykes	Disseminated sulphides in medium- to coarse-grained gabbro and diabase	(Wallenius; Naomi Island; Jarvis Point)

*Reversed Magnetic Polarity
(ca. 1108 Ma):*

Logan diabase sills, cone sheets	Sparse, disseminated sulphides	(Numerous)	
Tholeiitic to alkaline complexes: Coldwell alkaline complex Killala Lake alkaline complex	Disseminated sulphides in medium- to coarse-grained, vari-textured (<i>a.k.a.</i> taxitic) gabbro	Coldwell	Killala Lake
	Disseminated sulphides in massive Fe-Ti-oxide cumulate layers	Two Duck Lake gabbro (Marathon deposit); Geordie Lake gabbro	Border gabbro (Sandspit - Killala)
Layered(?) picritic ultramafic intrusions	Disseminated sulphides and native metals in lherzolite, dunite, peridotite, etc.	Eastern Border gabbro (Skipper Lake zone)	(Unknown)
		Leckie Lake (Wolf Mountain); Hele Township; Eva-Kitto townships	

References

Davis, D.W. and Green, J.C. 1997. Geochronology of the North American Midcontinent rift in western Lake Superior and implications for its geodynamic evolution; Canadian Journal of Earth Sciences, v.34, p.476-488.

Stern, R.A., Hanson, G.N. and Shirey, S.B. 1989. Petrogenesis of mantle-derived, LILE-enriched Archean monzodiorites and trachyandesites (sanukitoids) in southwestern Superior Province; Canadian Journal of Earth Sciences, v.26, p.1688-1712.