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Chalcophile Element Geochemistry and Metallogenesis of Komatiitic Rocks in the Abitibi Greenstone Belt, Canada

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ABSTRACT

Komatiitic rocks occur in four lithotectonic assemblages in the Abitibi greenstone belt of the Archean Superior province: the 2750 to 2735 Ma Pacaud assemblage, the 2723 to 2720 Ma Stoughton-Roquemaure assemblage, the 2719 to 2710 Ma Kidd-Munro assemblage, and the 2710 to 2703 Ma Tisdale assemblage. There are significant volcanological and geochemical differences between the komatiitic rocks in these assemblages. Those in the older (Pacaud and Stoughton-Roquemaure) assemblages are primarily Ti- and Al-depleted-Ti-enriched komatiites, respectively, that appear to be uncontaminated by upper continental crustal rocks, form unchannelized lava flow facies, and are not underlain by sulfur-rich metasedimentary rocks. In contrast, those in the younger (Kidd-Munro and Tisdale) assemblages are primarily Al-undepleted komatiites, locally contaminated by upper continental crustal rocks, locally form lava channels and channelized sheet flow facies, and locally overlie sulfur-rich metasedimentary rocks.

Sixty-four unmineralized samples from all four komatiite-bearing assemblages in the Abitibi greenstone belt have similar unfractionated platinum-group element (PGE) abundances at 0.5 to 5 times chondritic values. Minor variations in PGE abundances are attributable to variable (but uniformly high) degrees of partial melting, fractional crystallization and/or accumulation of olivine, chromite, or clinopyroxene and, rarely, loss of sulfide or Ir-bearing alloys. Almost all of the komatiitic magmas and lavas represented by the samples, regardless of komatiite type (including Al-undepleted, Al-

depleted–Ti-enriched, and Ti-depleted komatiites) and depth of melt extraction, appear to have been derived by high-degree partial melting of sources with essentially identical chalcophile element contents and to have remained undersaturated in sulfide during melt extraction, ascent, eruption, and emplacement. This is similar to most komatiites worldwide.

Type I (Kambalda-type) stratiform, basal massive-disseminated and type II (Mt. Keith-type), strata-bound, internally disseminated Ni-Cu-(PGE) deposits in the Abitibi greenstone belt are hosted mainly by Al-undepleted cumulate komatiites that are associated with sulfur-rich country rocks in the Kidd-Munro (e.g., Alexo-Dundonald, Marbridge, Dumont) and Tisdale (e.g., Langmuir-Redstone, Texmont, Sothman, Bannockburn) assemblages. Although many other deposits of this type are also hosted by Al-undepleted komatiites (e.g., Damba-Silwane-Shangani, Kambalda, Mt. Keith, Perseverance), some are not (e.g., Boa Vista, Forrestania, Ruth Well), confirming that the depth of melt extraction or the precise degree of partial melting do not appear to be important controls on the genesis of magmatic Ni-Cu-(PGE) deposits. However, virtually all deposits of this type are hosted by thick, cumulate komatiite units interpreted to represent lava channels or channelized sheet flows and most are associated with sulfur-rich country rocks, suggesting that high magma and/or lava flux, lava channelization, and sulfur-rich country rocks are the most critical features in determining the prospectivity of komatiites in the Abitibi greenstone belt and elsewhere.