

Defining the Nature and Origin of the Grey Gabbro Unit in the Podolsky Cu-Ni-PGE Deposit, Sudbury, Ontario: A 2.6 Ga Gabbro Hosting 1.85 Ga Impact Related Mineralization

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Abstract

The 1850 Ma Sudbury impact event produced a melt sheet and both radial and concentric offset dykes, the latter of which commonly includes a homogeneous quartz diorite. The Podolsky Cu-Ni-PGE deposit, located within the radial Whistle-Parkin offset dyke in the North Range of the Sudbury Structure, is a hybrid-type Cu-Ni-PGE system that includes both sharp-walled, breccia-type veins, and low-sulphide disseminated mineralization. A unique phase in the offset structure is a large body of gabbroic rock informally named the “grey gabbro” (GG). Understanding the nature and origin of the GG is important, as it hosts sharp-walled chalcopyrite veins unique to offset deposits. In order to address the origin of the GG, part of a broader study of the Podolsky deposit, a petrological investigation was undertaken. The typically homogeneous, medium- to coarse-grained GG displays an ophitic texture with Cpx-Plg; it exhibits pervasive alteration (saussuritization, sericite) where sulphide veins are abundant in the unit. Importantly, primary plagioclase (An₅₀) of the GG is pseudomorphed by a granoblastic-textured plagioclase of An₂₀ composition. This texture is interpreted to be a feature of contact metamorphism related to the superheated melt sheet. Concordant magmatic (1850 Ma; TIMS) and metamorphic (2600 Ma; SHRIMP) zircons were found to reside within the same grain boundary and has been interpreted as metamorphic zircons recrystallized into magmatic zircons. Bulk-rock geochemistry for the GG indicates that it: (1) equates to an alkali basalt; (2) is in part of cumulate origin; and (3) is characterized by LREE enrichment, lacks any Eu anomaly, and is strongly fractionated. The chemistry of the GG contrasts with the crystallized products of the melt sheet (e.g., quartz diorite, norites), which are strongly depleted in LREE compared to the GG, and indicates derivation of the GG melt from a metasomatised mantle source region.