Pressure-Temperature-Time Constraints on Synvolcanic Intrusive Activity in the Gold-Rich Doyon-Bousquet-LaRonde Mining District, Abitibi Greenstone Belt, Québec

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The Mooshla Intrusive Complex (MIC) is an Archean low-Al polyphase tonalite-trondhjemite-quartz diorite-gabbroic magmatic body located in the Doyon-Bousquet-LaRonde (DBL) mining camp of the Abitibi greenstone belt, Québec, Canada. The MIC is spatially and temporally associated with numerous Au-rich VMS, epizonal intrusion-related Au ± Cu, and shear zone-hosted orogenic Au and/or remobilized VMS mineralization deposit types. The MIC is grouped into two distinct stages, the tholeiitic to transitional Mouska-stage and the transitional to calc-alkaline Doyon stage. Through a combination of petrography, high-precision U-Pb geochronology, accessory mineral thermobarometry, and zircon trace element chemistry from the different phases that make up the MIC, this study provides new constraints on the P-T-time evolution of this potentially gold-causative magmatic system. The results demonstrate that individual phases crystallized relatively synchronously and likely in distinct magma chambers at deep levels within the crust (T=~700° to 800°C; P=~5 to 11 kbar, 18.5 to 40 km), consistent with conditions expected for TTG magma generation and evolution. The entire intrusive complex formed over a maximum of ~1.44 Ma, and the relatively synchronous formation of the tholeiitic-dominant Mouska stage and the calc-alkaline-dominant Doyon stage implies a rapid change in tectonic setting from a rift- to arc-dominated environment early in the magmatic evolution of the MIC magmas. Based on distinct zircon trace element ratios in each lithology, this supports the change in tectonic setting and that each magma phase of the Mouska stage evolved separately. The duration and depth of crystallization of the early magma stages of the MIC are comparable to magmatism in major Cu-Au porphyry systems. Thus, the role of deep-seated magmatic processes (and not exclusively shallow degassing) should be considered for supplying gold and other metals to VMS and other hydrothermal systems in the Archean sub-seafloor environment.