Petrogenesis of Tin-Tungsten-Molybdenum Mineralized Intragrani

The Late Devonian Mount Douglas Granite, located in southwestern New Brunswick, is host to endogenic, granophile-element Sn-, W-, Mo-, Zn-, Bi-, and U-bearing greisen/sheeted veins. It forms the eastern part of the Late Silurian to Late Devonian Saint George batholith that was emplaced during the Acadian-Neoacadian orogeny.

Three units of the highly evolved post-orogenic peraluminous Mount Douglas Granite (Dmd1, Dmd2, and Dmd3), were formed by progressively higher degrees of fractional crystallization. Investigation of these three phases were carried out using a combination of geological field work (mapping), gamma-ray spectrometry, magnetic susceptibility, petrographic and geochemical investigations, EPMA, SEM-EDS imaging, Laser ablation ICP-MS measurements including U-Pb geochronological and radiogenic and stable isotope studies, supported by Raman spectroscopy on certain minerals.

The granite exhibits a hybrid S-type and A-type signature. Whole-rock δδδδO (6.0 to + 7.3‰), high initial δδδδSr/δδδδSr (mean = 0.70764), positive δδδδPb/δδδδPb (0.3 to +1.1), and Pb isotopic data indicate its derivation by partial melting of a predominately juvenile subducted Avalonian crustal source that was contaminated by supracrustal rocks. Magmatic biotite geochemistry combined with whole-rock zircon saturation temperature estimates suggest oxygen fugacity near Quartz-Magnetite-Fayalite (QFM) conditions for unit Dmd1, whereas units Dmd2 and Dmd3 have lower O2 and are more reduced.

Mineralized greisen/sheeted veins are associated with highly differentiated medium-grained to porphyritic units, Dmd2 and Dmd3, that are the most prospective units of the pluton in terms of metallic mineral deposits. The most fractionated character of Dmd3 is evident by its highest SiO2 content (avg. 76.4 wt.%), higher contents of LILE (e.g., Li, Rb, Cs), HFS (Ta, Th, U), Y (≤ 138 ppm) and REE, and the most pronounced negative Eu anomalies (avg. Eu/Eu* = 0.08). The degree of fractionation in Dmd3 is also manifested by its lowest K/Rb (70-127), Nb/Ta (average = 4.9), and Zr/HF (average = 23.5), and highest Rb/Sr ratios (average = 42), and also by geochemical composition of magmatic biotite, K-feldspar, and monazite. The most important indices of magmatic evolution are a decline in K/Rb, K/Cs, Rb/Cs, K/Li, and Nb/Ta ratios of co-existing biotite and K-feldspar with increasing degree of fractionation. The estimated κκκκ suggestive of a lower equilibrium temperature for Dmd3, consistent with whole-rock zircon and monazite saturation temperatures.

LA ICP-MS U-Pb geochronology of 157 in situ monazite grains along with 100 mounted zircon grains yielded a Late-Devonian crystallization age of 368 ± 3 Ma. With respect to the timing of the associated mineralization, there are at least two stages recognized in this system: (I) magmatic-related mineralization, which is recorded by new mineralization ages obtained on uraninite (366.4 ± 4.3 Ma; 2σ; n = 5) and cassiterite (363 ± 9 Ma; 2σ; n = 38), and (II) post-magmatic mineralization defined by hydrothermal monazite, and yielding a younger mineralization age ranging from 344 to 368 with an average of 357 ± 7 Ma. The post-magmatic hydrothermal activity can be associated with the High Heat Production (HHP) nature of this pluton, in which the pluton acts as a 'heat engine' producing heat by radioactive decay of U, Th, and K that prolong the hydrothermal fluid circulation (activity).
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October 23, 2018

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Forestry/Geology Bldg.

Room 203

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