Anatexis and uranium protore in the Wollaston Domain, Saskatchewan

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The Fraser Lakes Zone B U-Th-REE-bearing granitic pegmatites are located within the Wollaston Domain of northern Saskatchewan, Canada. The mineralized zone lies circa 25 km from the southeastern edge of the highly prolific Athabasca Basin; home to some of the world's highest grade uranium deposits.

The granitic pegmatites intruded into a NNE-plunging regional fold structure at/near the highly deformed contact between Archean orthogneisses and overlying Paleoproterozoic metasedimentary rocks of the Wollaston Group.[1,2,3] Their intrusive contacts suggest the pegmatites formed during the later stages of the ca. 1.8 Ga Trans-Hudson Orogeny.[1,2,3] This agrees with CHIME dating of uraninite in the uranium-rich pegmatites (a cluster of ages between 1.85 and 1.80 Ga). A primary magmatic age has yet to be determined for the Th-LREE-rich pegmatites, which have contact relationships similar to the strongly U-rich pegmatites. High-grade metamorphism and migmatization occurred concurrently with pegmatite intrusion, at peak temperatures of up to T ca. 850°C at P ca. 9 kbar (i.e. lower granulite facies) followed by retrograde amphibolite-facies metamorphism.

A combination of partial melting of a metasedimentary-dominated source at depth, accessory mineral entrainment, and assimilation-fractional crystallization processes during ascent and emplacement is thought to be responsible for U, Th, and REE enrichment of the granitic pegmatites.

These pegmatites show similarities to the alaskite-hosted uranium deposits at Rossing (Namibia) and to uraniferous pegmatites in the Grenville Province (Canada).[1] Similar pegmatites have also been found in the proximity of some of the Athabasca Basin basement-hosted unconformity-type uranium deposits, including Moore Lakes, Eagle Point, and Millennium. Hence, it has been proposed [4,5,6,7] that such pegmatites are protore for the formation of these uranium deposits in the Athabasca Basin. Hydrothermal alteration (i.e. chlorite, hematite, and clay minerals) similar to that in the alteration halos around some of the Athabasca deposits is also found at Fraser Lakes Zone B [1,2,3,7], indicating that fluids of similar composition may have passed through the pegmatites.[7] The presence of younger, secondary, hydrothermal U mineralization within fractures cutting the pegmatites also supports this hypothesis.

[1] Austman *et. al.* (2010) *SEG 2010 Conference Abstr.* **Ext. Abstr. F-1**. [2] Annesley *et. al.* (2010) *GeoCanada 2010 Abstr. No.* **815**. [3] Annesley *et. al.* (2010) *SGS Open House Abstr. Vol.* **2010**, 8. [4] Annesley *et al.* (2000) *Sask. Geol. Survey Sum. of Invest.2000 Vol.* **2**, 201-211. [5] Hecht & Cuney (2000) *Miner. Deposita* **35**, 791-795. [6] Mercadier *et. al.* (2010) *Lithos* **115**, 121-136. [7] Mercadier *et.al.* (submit.) *Econ. Geol.*

Mineral and element vectoring in the Pilley's Island VMS district, Newfoundland Appalachians, Canada

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A major challenge in ancient volcanogenic massive sulfide (VMS) districts is that many have been strongly affected by metamorphism and deformation, resulting in mineralization being hosted within imbricated, thrust-faulted terranes, with abundant stratigraphic offset and juxtaposition. In such environments, barren volcanic units are often juxtaposed next to those that may be VMS-bearing, causing difficulty in stratigraphic reconstruction and in the discrimination of prospective from less prospective stratigraphy. These stratigraphic and structural uncertainties result in the requirement for the integration of lithogeochemistry and detailed mineralogy with traditional mapping, to vector towards mineralization at the prospect and regional scale. Pilley's Island, Newfoundland is an ideal location to demonstrate this vectoring because it hosts several VMS deposits in a small area (10 km^2), it is heavily faulted with barren mafic volcanics thrust between VMS-bearing felsic volcanic panels, and has excellent surface exposure and archived drill core for detailed geological and geochemical visualization.

Results from mapping, lithogeochemistry, and shortwave infrared-near infrared (SWIR-NIR) spectroscopy have identified alteration haloes around the VMS deposits of Pilley's Island. The distribution of AlOH, FeOH, and MgOH hull absorption values from SWIR-NIR spectra defines, from proximal to distal to mineralization, haloes of illitic phengite, phengite, illitic muscovite, muscovite, and Fe- to Fe-Mg- to Mg-chlorite. Surface and 3D gridding of lithogeochemical data have also identified prospective zones for mineralization. In particular, useful vectors include Na, K, and alteration indices. For example, zones with highest Na depletion, with K addition and associated with illitic phengite alteration are most prospective for sulfide mineralization.

Despite this VMS district being intensely imbricated, the integration of mapping, drill core reconstructions, lithogeochemistry, and SWIR-NIR spectroscopy readily distinguishes the mineralization-related thrust faulted panels from those that are barren of mineralization. The integration of both geochemical and mineralogical vectoring methods exemplified at Pilley's Island, can be useful in the exploration and delineation of VMS and other hydrothermal deposits elsewhere in the Appalachians and in other heavily faulted collision zones worldwide.