Structural and tectonic controls on Devonian intrusion related mineralisation on the Connaigre Peninsula, Newfoundland

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Abstract: The Canadian Appalachians represent an archetypal ancient, accretionary orogen the study of which has played a substantial role in developing modern geological concepts. From the initial simplistic models of a mountain belt deriving from the closure of the Iapetus Ocean, our understanding has evolved, recognising a richer, more complex geological history. Current models define multiple collisions between arcs and microcontinents due to the closures of interposed oceans and seaways. Delineating specific tectonic events provides context to the various periods and styles of mineralisation produced, which in turn can define new exploration models for the next generation of deposits.

One of the least understood deposit types in the Canadian Appalachians are the Devonian granitoid intrusion-related Sn-W-Mo mineralisation. The Connaigre Peninsula was selected to study such deposits as it contains a variety of supracrustal units plus (apparently) barren and mineralised intrusives within a relatively constrained and accessible area. The distributions of the main lithotectonic packages indicate three distinct tectonic blocks that were amalgamated by the Middle Devonian, and subsequently intruded by Upper Devonian granitoids concurrent with clastic sedimentation.

The ca. 376 Ma Old Woman Stock contains several known Mo occurrences. Molybdenite is disseminated and associated with vugs containing dog-tooth quartz, and intense alteration zones (up to 5 cm wide) are localised along north – south to north-west – south-east trending joints. The distribution of deposits demonstrates a potential linkage between regional structures and the localisation of mineralisation. At the large scale, the Connaigre Peninsula in the Upper Devonian is interpreted to be in extension associated with far removed non-orthogonal accretion of other peri-Gondwanan elements to composite Laurentia. It is notable however that the mineralisation does not occur at a major fault, but rather at the intersection of a prominent north- east to south-west lineament and well-developed north – south to north-west – south-east jointing. The implication is that the high-angle intersection of breaks that are contemporaneous with intrusion but have relatively little motion provide ideal pathways for mineralising fluids.

In contrast to the Old Woman Stock, the adjacent, approximately coeval to slightly younger Belleoram Granite is apparently barren. It remains unclear why the Belleoram Granite contains no known Sn-W-Mo mineralisation. Possible explanations include: i) its hybrid nature makes it compositionally unsuitable; ii) it formed at too shallow a crustal depth; or iii) it was too dry and did not develop fluid pathways.

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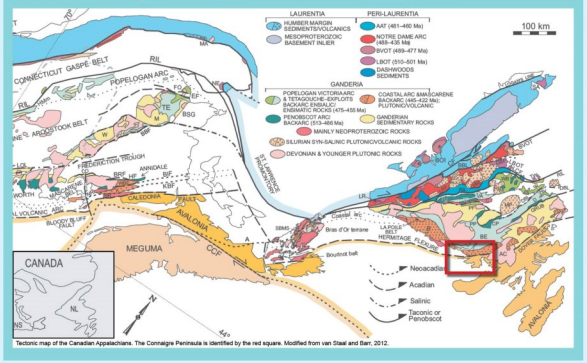
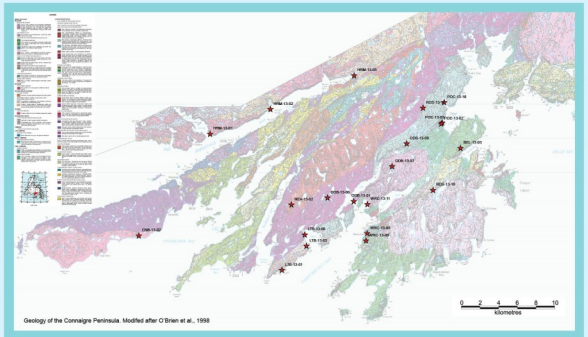
Intrusion related (e.g., porphyry) deposits are structurally-controlled, low- to medium-grade deposits that provide most of the Cu, Mo, W and Sn extracted worldwide along with significant quantities of Au, Ag, and PGEs. The mineralisation is associated with a variety of igneous rocks, ranging from diorite-granodiorite to high-silica granite, and is typically hosted within stockworks, veins and fractures. Porphyry deposits are associated with a variety of different tectonic settings that determines the metallogenic content.

The Connaigre Peninsula, located at the boundary between two different terranes (Ganderia and Avalonia) that collided during the Acadian orogeny in the Devonian, comprises a variety of collision-related intrusives closely related in space, some of which are barren, others host intrusion-related Sn – W – Mo mineralisations.

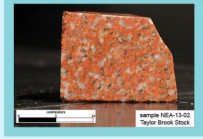
Because of these reasons, along with its relatively accessible area, the Connaigre Peninsula has been chosen to study the structural and tectonic controls on the genesis of this family of deposits.

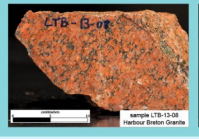


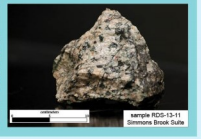
Tectonic map of the Canadian Appalachians. The Connaigre Peninsula is identified by the red square. Modified from van Staal and Barr, 2012.



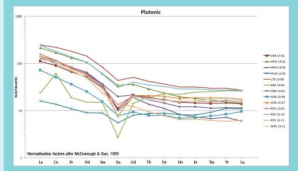
The project involves also the study of the foreland basin of the Acadian orogenic belt, represented in that area by three Devonian formations (Cinq Isles Fm., Pools Cove Fm. and Great Bay de l'Eau Fm.). Dating the sediments, assessing their provenance and deciphering their kinematics should lead to a comprehensive understanding on the collision between Ganderia and Avalonia in Newfoundland.

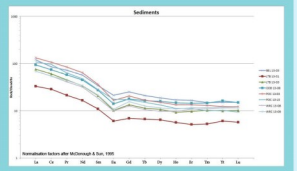


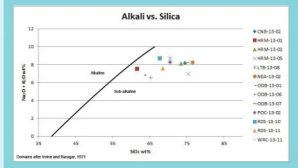


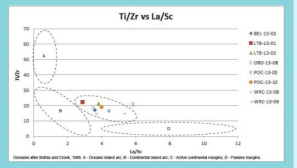


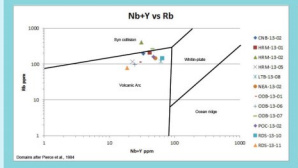
The samples collected so far have been analysed for whole-rock major and trace elements via x-ray fluorescence (XRF) and dilution-inductively coupled plasma mass spectrometry (ICP-MS). They are currently being examined for whole rock tracer isotopes and detrital zircon population via cathodoluminescence (CL) and laser ablation-inductively coupled plasma mass spectrometry (LA-ICP-MS).

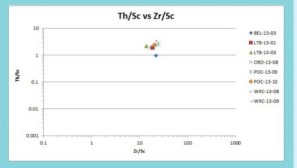












Most of the analysed granitoids show an enrichment in LREE, a generally flat HREE pattern and a variable but ubiquitous negative Eu anomaly.
The alkali vs. silica plot shows the undersaturate nature of the samples while the Nb+Y vs Rb plot highlights the tectonic domain is which they formed. The data are consistent with the tectonic model proposed in the literature (van Staal et al., 2009).

Sediments show a typical Upper Crust REE-chondrite normalized pattern with LREE enrichment, negative Eu anomaly and flat HREE.
The Ti/Zr vs La/Sc values fall in the Active Continental Margin field of Bathia and Crook (1986) and the Th/Sc vs Zr/Sc plot shows moderately high values for Zr/Sc and Th/Sc suggesting a minor component of recycled sediments.