Low-temperature carbonate replacement and intrusion-related Pb-Zn-Ag deposits of Nicholas-Denys, Bathurst mining camp, Canada: Genetic implications*

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The Nicholas-Denys property of Puma Exploration Inc. offers a variety of potential mineral exploration targets for intrusion-related deposits. Skarn mineralization appears on the edge of the Nicholas-Denys intrusion, a Middle Devonian (ca. 381 Ma) granodioritic pluton known to contain Mo, Cu, and Au. The skarn system holds two major types of mineralization: (1) a proximal type, forming Fe-Cu skarn deposits due to the conduction of magmatic fluids, and (2) a distal type, forming Pb-Zn-Ag deposits by the process of convection.

Pb-Zn-Ag hydrothermal-skarn deposits occur in the Nicholas-Denys property, which is located between the Rocky Brook Millstream Fault and the Main Fault, two major EW-striking strike-slip faults of the Bathurst Mining Camp in northern New Brunswick. The Nicholas-Denys intrusion lies just a few hundred meters to the north of the RBMF. Regional geological structures belong to the Nigadoo River synclinorium, which is part of the Chaleur Bay synclinorium. The polymetallic veins are: (1) transverse tension structures, they crosscut limestone and siliciclastic rocks of the La Vieille and Simpsons Field formation, a sedimentary rock sequence that was deformed during the Middle Devonian Acadian orogeny, and (2) longitudinal structures along the RBMF.

Two areas of study with distinctive geological features have been interpreted to be part of the same system. Zone 1 (Hachey), closer to source input and pyrrhotite dominant, has a fine-grained mineralization and shows evidences of repeated pulses of mineralization along longitudinal structures. Zone 2 (Dante-Raya), further out from the intrusion, has a coarse-grained mineralization with some euhedral galena and sphalerite visible in transverse structures. Massive sulfide ore bodies, with sphalerite-galena-pyrrhotite-pyrite-arsenopyrite-chalcopyrite, are associated with low-temperature calc-silicates such as actinolite and ferropumpellyite. The gangue is predominantly controlled by calcite, chlorite, and quartz.

This study presents maps of scoured outcrops along with the analysis of drillcore logs, the description of polished thin section accompanied with scanning electron microscopy analysis, Pb-Pb dating of galena minerals in vein and ore bodies, as well as the results of sulfur ($\delta^{34}$S), carbon ($\delta^{13}$C) and oxygen ($\delta^{18}$O) isotope analysis. A summary of regional geological events and a regional-scale compilation and analysis of Pb-Zn occurrences is also shown.

The determination of relationships between faults, contact metamorphism, metasomatism and structures related to hydrothermal activity have been used to constraint the timing of the Pb-Zn mineralization. Mineralized hydraulic breccias affect the limestone/skarn and gabbro transversally, and along sedimentary contacts. Sulfur isotope signatures of galena and sphalerite
suggests that they are genetically related to the Nicholas-Denys granodioritic intrusion and the deposit is therefore considered to be a Pb-Zn hydrothermal intrusion-related deposit, most specifically, a Pb-Zn manto – chimney.

The mineralizing process is a fluid convection between the intrusion and the country rock. The help of structures carries fluids away. Trapping mechanisms are essentially low-pressure zones where the mineralizing fluids are most likely to have focused. Such low-pressure zones can be either some lithologies with high permeability and porosity, but also areas where faults intersect. Their location can be predicted by the analysis of magnetic and gravimetric geophysical maps.