Lithogeochemistry and sulfur isotopic composition of hydrothermal mudstones associated with the Lemarchant volcanogenic massive sulfide (VMS) deposit, Tally Pond Belt, central Newfoundland

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The Cambrian precious metal-bearing, Zn-Pb-Cu, bimodal felsic volcanogenic massive sulfide (VMS) Lemarchant deposit is located within the Tally Pond Group, central Newfoundland. It contains abundant hydrothermal mudstones with both stratigraphic and spatial relationships to mineralization. Yet, the nature of this relationship of the mudstones to VMS genesis and their exploration significance is unresolved.

The Lemarchant mudstones occur either immediately on top of the massive sulfide mineralization and laterally along strike, or as interflow mudstones within the hanging wall basaltic rocks. The sulfide-rich hydrothermal sedimentary rocks comprise brown to black graphite-rich mudstones and shales, and can have intercalations of siliciclastic, volcaniclastic and/or amorphous chert layers, as well as fine laminae of organic matter. The main sulfide phases are pyrite (framboidal and euhedral) and pyrrhotite, with minor amounts of chalcopyrite, sphalerite, arsenopyrite and galena; barite is a common sulfate phase. Analyses of the mudstones show a range of Fe/Al and base-metal values from samples with hydrothermal signatures, indicated by high Fe/Al and base-metal values, to those with noticeable detrital input, indicated by lower Fe/Al and base-metal values.

The Lemarchant exhalites have positive shale- normalized Eu anomalies (Eu/Eu* ≥ 1) and negative Ce anomalies (Ce/Ce* ≤1), as well as an Y/Ho ratio of ~27. These values suggest precipitation from reduced, high- temperature hydrothermal vent fluids with a short residence time within the plume and thus, a vent-proximal setting under oxidizing conditions. In-situ analyses of sulfides (euhedral and framboidal pyrite, anhedral chalcopyrite and pyrrhotite, and euhedral arsenopyrite) were determined by secondary ion mass spectroscopy (SIMS). $\delta^{34}S$ values from -38 to +8‰ indicate the sulfides have a predominantly diagenetic-biogenic sulfur source and formed under open system conditions with abundant seawater sulfate present. The predominantly biogenic signatures in the sulfides suggest that most of the sulfides in the mudstones formed during diagenesis and are not primary, hydrothermal sulfides.

Atlantic Geology, 2014, Volume 50, Number 1
Geological Association of Canada Newfoundland Section Abstracts: 2014 Spring Technical Meeting
doi: 10.4138/atlgeol.2014005