Role of mudstones and shales in the localization, genesis, and palaeo-environment of volcanogenic massive sulfide (VMS) deposits of the Tally Pond volcanic belt, central Newfoundland, Canada

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The Cambrian Tally Pond VMS belt in central Newfoundland contains numerous VMS deposits and prospects associated with metalliferous mudstones. Deposits in the belt are bimodal felsic VMS deposits that are both, base metal- (e.g., Duck Pond, Boundary) and precious metal-enriched (Lemarchant). At the Lemarchant deposit, hydrothermal mudstones are stratigraphically and spatially associated with mineralization: they cap the mineralization, are interlayered with exhalative barite, and underlain by rhyolite domes and/ore breccias, as well as interlayered with post-mineralization pillow lavas. The Duck Pond and Boundary deposits are also associated with black shales, but their relationships are spatial and less obvious, and may not be genetically related to mineralization. Metalliferous mudstones at Boundary West and Old Camp predominantly occur at or adjacent to the contact of the footwall felsic and the hanging wall mafic volcanic rocks and represent a distal equivalent to the mineralized horizon at Boundary. Other sampled Tally Pond belt prospects include Keats Pond, South Moose Pond, North Moose Pond, Duck West, Cooks Town, Higher Levels, and Beaver Lake, which also have occurrences of metalliferous mudstones and shales associated with felsic and/or mafic volcanic units. In some cases, there is also an immediate association of sulfide mineralization with mudstones.

The sulfide-rich mudstones of the Tally Pond belt represent a hiatus in the volcanic activity, where the deposition of hydrothermal matter dominated over the abiogenic background pelagic sedimentation. Lithogeochemical signatures distinguish between whether the mudstones are predominantly hydrothermal or detrital (i.e., non-hydrothermal). Upper Cambrian to Lower Ordovician black shales from Bell Island in eastern Newfoundland were utilized as an example for detrital sediments. Hydrothermal mudstones, like those at Lemarchant, have hydrothermal signatures with elevated Fe/Al and base-metal values, have shale- normalized negative Ce- and positive Eu anomalies, and Y/Ho ~27, indicative of deposition from high temperature (>250°C) hydrothermal fluids within an oxygenated water column. The presence of barite in the mudstones and massive sulfides suggests free SO_4^{2-} in the water column and supports precipitation under oxygenated conditions. Mudstones and shales sampled from other Tally Pond prospects have more variable signatures ranging from hydrothermal (signatures as above) to non-hydrothermal black shales (no positive Eu anomalies) with detrital constituents that were deposited under partially anoxic conditions (flat REE-patterns), and to those that have mixed lithogeochemical values. Accordingly, mudstones from those areas with a Lemarchant-like hydrothermal and vent-proximal character might be better exploration targets than those mudstones and black shales that seem to have predominantly detrital and less hydrothermal contributions.

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