The lithogeochemistry and metallogeny of the southern Tobique Zone, New Brunswick

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Massive-, disseminated- and stringer-type base metal sulphide deposits in the Tobique Zone are hosted by Lower Devonian felsic domes and associated hyaloclastic flows. The deposits of economic interest occur close to the contact between the felsic volcanic rocks and units composed of intercalated mafic volcanic rocks, greywackes and slates. Major, minor and REE lithogeochemistry was carried out to characterize the volcanic sequences that host the various sulphide deposits.

Plots of FeO(tot)/MgO vs SiO_2 indicate that the volcanic sequences hosting the deposits are characterized by bimodal tholeiitic to mildly calc-alkalic compositions. Zr/TiO_2 vs Nb/Y plots indicate that the mafic volcanic rocks range in composition from sub-alkalic basalts to andesites, whereas the felsic volcanic rocks range from rhyolites to rhyodacites. TiO_2 vs Zr and Zr/Y vs Zr plots for the mafic volcanic rocks are consistent with within-plate basalts, but most of the samples plot close to the island-arc tholeiite field due to relatively low TiO_2 values. Zr vs Ce (highly incompatible elements) plots for all the investigated volcanic rocks show that most of the felsic volcanic rocks have distinctly different Ce/Zr ratios than the associated basalts. This indicates that crustal contamination was involved in their formation.

Rock/chondrite variation diagrams for the REE show the following patterns: (1) light rare earth elements (LREE) are enriched relative to heavy ones (HREE), but the degree of enrichment is greater in the felsic than in the mafic volcanic rocks; (2) the relative enrichment of LREE vs HREE is greater in the Gravel Hill (La/Yb - 6.0), Taffy Lake (La/Yb - 6.4) and Bear Lake (La/Yb - 5.3) prospects than in the Riley Brook area (La/Yb - 4.7), but the overall REE content in the latter is greater; and (3) all the felsic volcanic rocks show pronounced negative Eu anomalies that reflect plagioclase fractionation. The flatter REE pattern and more pronounced negative Eu anomalies in the felsic volcanic rocks of the Riley Brook area, as compared to the Gravel Hill, Taffy Lake and Bear Lake areas, are consistent with a higher degree of partial melting and more intense plagioclase fractionation in higher level magma chambers. This probably favoured the formation of base metal sulphide deposits in the Riley Brook area. This implies that REE along with major and minor element lithogeochemistry and detailed stratigraphic mapping can be used to distinguish volcanic units with potential for prolific base metal sulphide deposits.