Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.21974

# Controls on volcanogenic massive sulphide mineralization in the Kamiskotia area: insights from lithogeochemical analysis and mineral prospectivity modelling

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The Cu-Zn ± Au ± Ag volcanogenic massive sulphide (VMS) deposits in the Kamiskotia area occur within a restricted, east-facing stratigraphic interval in the Kamiskotia Volcanic Complex (KVC) of the Blake River Assemblage west of Timmins, Ontario, Canada. The host volcanic units in the area may possess geochemical signatures which, when combined with geologic and structural data, can be useful in delineating potential fertility for VMS mineralization. This study, therefore, analyzed 10,338 lithogeochemical data points in a large dataset obtained from the Kidd-Munro, Deloro and Tisdale assemblages, and the KVC to identify key geochemical signatures of fertile VMS-host lithologies and to produce evidence layers for generating mineral prospectivity map for the area using a machine learning approach.

Mafic to intermediate volcanic units are predominantly tholeiitic to transitional basalts and basaltic andesites with favorable Fe-Ti signatures (i.e., $P_2O_5$ > 0.3 wt %, $TiO_2$ > 2.2 wt %) and MORB-like magma affinities relating to an extensional environment at high crustal levels. Th/Nb ratio suggests an interaction of these mafic magmas with existing hydrated crust, resulting in crustal contamination. Felsic units in the area are mainly of tholeiitic to transitional rhyolite-dacite composition, with more fractionated rare earth element patterns and positive Y anomaly. The rhyolites are predominantly of high-silica, FII-FIII type. These favorable geochemical signatures are similar for all sampled assemblages and indicate a fertile setting for VMS mineralization.

Continuous and binary evidence layers (surface maps) generated for the favorable geochemical signatures, principal components, trace elements (Cu, Zn, and pathfinders), and alteration indices show good spatial relationships with past producing mines and known base metal occurrences, synvolcanic faults, Archean synvolcanic intrusions, and mafic and felsic host lithologies. Similarly, 3D numerical Leapfrog models for alteration indices show that hydrothermal alteration zones correspond with sites highest in Cu and Zn. These zones are in 3D space proximal to samples identified as high-silica, high-Zr, and FIII rhyolites, Fe-Ti mafics, and tholeiitic. Utilizing these evidence layers (vectors to mineralization) in a machine-learning approach will generate mineral prospectivity maps useful for highlighting potentially new areas of exploration interest.