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Long Lake Zinc Deposit in the Grenville Province, Canada: Evidence of Post-Metamorphic Mineralization and Magmatic-Input.

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The Long Lake zinc deposit occurs along the contact between Proterozoic Greenville Supergroup marbles and intrusive rocks within the Greenville Central Metasedimentary Belt. This belt also hosts other zinc mineralization for which the genetic model is poorly constrained. Understanding the processes related to the zinc mineralization is essential for developing exploration strategies for zinc in the Grenville Province and similar terranes. In this study, historical datasets are integrated with new field and drill core logging observations, lithogeochemical and petrological data into a 3D geological model to better constrain the geometry of the ore zones and the processes related to their formation. In the studied sections, zinc mineralization occurs as lenses up to 5 m thick in two main ore zones (A and B) with distinct mineralogy and geochemical signatures. Sphalerite is spatially and temporally associated with other sulfides (mainly pyrite, marcasite, and minor pyrrhotite, arsenopyrite, chalcopyrite, galena, molybdenite), silicates (amphibole, chlorite, epidote, phlogopite and talc) and carbonates, with distinct relative abundance in the two ore zones. These minerals fill embayments and fractures within garnet and pyroxene, indicating that the zinc mineralization formed after peak-metamorphic conditions. Outside the mineralized zones, garnet and pyroxene are well preserved. Pyrite-bearing zones form halos up to 3 m surrounding the zinc-rich lenses. Ore zones are consistently enriched in Cd, Hg, In, Mn, Se and S, showing high correlation with Zn. Silver, Bi, Ga, Ge, Pb, Sb, and Sn also reached elevated concentrations in ore zones and occur in halos extending up to 2 m beyond the ore zones. Notably, A Zone is characterized by higher absolute concentrations of Mn, Hg, Se, Cd, and S than B Zone, whereas the latter shows a relative enrichment in In, reflecting distinct conditions between both mineralized domains. The results of this study are not consistent with historical interpretations that the Long Lake zinc deposit represents a metamorphosed sediment-exhalative system and indicate that mineralization involved post-metamorphic processes within the Grenville Province, possibly with contributions from magmatic sources. This interpretation is also consistent with published sulfur isotopic data suggesting magmatic input to Long Lake mineralization.