

Zinc in Deep Time: Paleoproterozoic Mvt Mineralization in Neoarchean Stromatolitic Limestone (Pering-Bushy Park, South Africa)

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Mississippi Valley-type deposits (MVTs) are epigenetic, sedimentary rock-hosted zinc-lead mineralization that result from the mixing of oxidizing, metal- and usually sulfate-bearing basinal brines with a reducing agent. The latter either supplies hydrogen sulfide [H₂S] (e.g., bacterially reduced sulfate or petroleum-borne H₂S) for Zn-Pb mineralization or contributes to the reduction of sulfate through thermochemical sulfate reduction.

Understanding the timing of MVT mineralization prior to the Phanerozoic can provide an indirect proxy for the presence of dissolved sulfate and oxygenation of seawater in deep time. Here, we build on earlier work showing that MVT mineralization did occur in reactive carbonate in platform setting in the Paleoproterozoic (e.g., Black Angel deposit, Greenland). We address the timing and geodynamic context for MVT mineralization at the Pering and Bushy Park MVTs that are hosted in Neoarchean stromatolitic limestone in the Campbellrand Subgroup, South Africa. We hypothesize that these MVTs formed by storage of early Paleoproterozoic seawater sulfate within the Neoarchean sediment pore spaces until sulfate was reduced to H₂S for Zn-Pb mineralization. This suggests that the original geochemical trigger for mineralization could have been the contemporaneous contraction of seawater sulfate during the Lomagundi event and a decrease in oxidation of the atmosphere-ocean system. Given the current (yet imprecise) estimate for the timing of MVT mineralization at Pering and Bushy Park ca. 2.05 Ga, we test this hypothesis by (1) establishing the relative chronology of epigenetic pyrite, galena, sphalerite and ore-stage calcite along carbon seams or dissolved open space in stromatolitic limestone; (2) obtaining ore-stage calcite bulk $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ analyses together with in situ uranium-lead LA-ICP-MS geochronology to provide new time stamps for mineralization, (3) and documenting the source of sulfur for mineralization through pyrite in situ SIMS sulfur stable isotope work ($\delta^{34}\text{S}$, $\delta^{33}\text{S}$, $\delta^{36}\text{S}$).