ORE PETROGRAPHY AND TRACE METALS OF THE PALEOPROTEROZOIC EISENBREY VMS DEPOSIT IN MIDWESTERN USA: IMPLICATIONS FOR HYDROTHERMAL FLUID COMPOSITIONS

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ABSTRACT: The Paleoproterozoic rocks of northern Wisconsin, USA, is famous for numerous polymetallic volcanogenic massive sulfide deposits (VMS) and occurrences. They are located within the Wisconsin Magmatic Terranes that consist of variably deformed and metamorphosed 1.86-1.83 Ga volcanic, intrusive, and sedimentary rock assemblages accreted onto the North American Craton during the Penokean Orogeny. These accreted oceanic and continental arc sequences preserve VMS in back-arc and caldera extensional geodynamic settings. The Eisenbrey Cu-Zn VMS deposit has an estimated resource of 1.6 million tons of 1.3% Cu, 0.06% Zn, 0.2 ppm Au and 5.7 ppm Ag. The deposit is hosted in primarily intermediate volcaniclastic rocks and are stratigraphically associated with chert-magnetite iron formation and chloritic mafic schists. These rocks are regionally metamorphosed to lower amphibolite facies and have been tightly folded. Hydrothermal alteration in the host rocks consists of orthoamphibole-corderite-magnetite mineral assemblages that were Mg-Fe chlorite protoliths. The ore of the Eisenbrey deposit consists of two different mineralization styles. The first, more common, style of mineralization is strata-bound massive to semi-massive sulfides. Less commonly there are semi-concordant sulfide stringers. The deposit has a quite simple composition, the common sulfide minerals are chalcopyrite, sphalerite, pyrrhotite and galena. Uncommon trace minerals are metal tellurides [hessite (Ag_2Te); tsumoite (BiTe); altaite (PbTe)], unidentified bismuth-tellurides, magnetite and electrum. Ore textures vary with stratigraphic depth. Banded pyritic ores with relatively common magnetite bands and prophyroblasts are more common at the top of the ore zone. Pyrrhotite-dominated massive ores with chalcopyrite and large porphyroblasts of pyrite are more common at the base of the ore zone. Microscopic textures include replacement (between chalcopyrite and pyrrhotite crystals), co-precipitation (between chalcopyrite and sphalerite as blebs and lamellae), and recrystallization (porphyroblastic textures and triple junction grain boundaries). The presence of tellurides in VMS deposits is relatively rare. They can provide constrains regarding fugacities of Te_2, S_2, O_2 in the ore-forming fluids and the temperature of formation. This research is focused on addressing the major and trace mineralogical and textural variations throughout the ore stratigraphy using petrographic (SEM-EDS, reflected light petrography) and trace element geochemistry. This data can answer important questions like the temporal variations of the physical and chemical characteristics of the ore-forming hydrothermal fluids as the Eisenbrey deposit was deposited. The use of telluride-bearing assemblages can provide narrower limits of fS_2 and fO_2. Preliminary results of stratigraphic analysis of the Eisenbrey ores are improving our understanding of the formation of base metal sulfide mineralization at or near the redox chemocline in a submarine basin.

KEYWORDS: PALEOPROTEROZOIC, PENOKEAN OROGENY, WISCONSIN, VMS