Lateral Stratigraphic Variations in the Volcanic Lithofacies of the Eisenbrey Zn-Cu-Pb VMS Deposit, Rusk County WI

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Introduction

Figure 1: Precambrian geology of northern Wisconsin and Michigan showing the distribution of Cu-Zn-Au mineralization and major ore deposits. The primary objective of this project is to complete a property-scale assessment of the volcanic and hydrothermal stratigraphy hosting the poorly understood Zn-Pb-Cu mineralization of the Eisenbrey deposit. The deposit is hosted in the Paleoproterozoic volcanic assemblages of the Pembine-Wausau terrane in the Penokean Orogen (DeMatthews, 1994; Schulz & Cannon, 2007). Ongoing student-faculty collaborative research is improving our understanding of this region.

Figure 2: Discovery outcrop of the Eisenbrey ore horizon. The Eisenbrey was first discovered when mapping and prospecting discovered an iron formation with anomalous base metals exposed on the banks of Thomp nella River, Rusk County. Subsequent drilling discovered massive sulfide mineralization to the west of this outcrop.

Stratigraphy of the Eisenbrey Deposit

Figure 3: Drill cores from the Eisenbrey Deposit. With funding and logistical support from Wisconsin Geological and Natural History Survey (WGNHS), 21 holes were logged, totaling over 6400 feet of core, and we collected 84 samples from representative strata, mineralization styles, and alteration assemblages. These samples are crucial in improving our understanding the deposit because of the lack of surficial outcrop. The samples collected during this project will provide future student researchers with geologic materials.

Figure 4: Schematic of a modern hydrothermal vent and volcanogenic massive sulfides (VMS). The Eisenbrey, like many other sulfide deposits in the Penokean Orogen, are examples of ancient “black smoker” that formed on the seafloor and are associated with volcanism (e.g. Galley et al., 2007). They are caused by leaching of metals from volcanic rocks by interactions with superheated seawater in faults and pore spaces. Upwelling hot seawater will cool and precipitate metalliferous sulfide minerals and metasomatically alter surrounding host rocks. These deposits can be brought to the surface and onto the continent during orogenic events.

Figure 6: Cross-section of the Eisenbrey deposit. The geology interpreted from drilling has revealed complex hydrothermally altered and metamorphosed intermediate volcanic strata enveloping multiple lenses of massive sulfides. Previous work has focused on drill holes on this section (Jackson et al., 2016). For this study, drill holes away from this section were logged to improve our understanding of the geology and stratigraphy at the property-scale and critically assess previous structural models for the region.

Figure 7: Eastern Limit of Property. Hole T-1 tested mineralization at the iron formation discovered on the banks of the Thompella River. The uppermost units were pinkish, variably silicified intermediate tuffs. The iron formation has chert- and magnetite-rich layers (A) but has abundant chloritic and magnetite-rich layers as well (B). The iron formation is bracketed by strongly foliated, cherty calcic volcanic rocks that are likely amygdaloidal flows.

Figure 8: Southern Limit of Property. Hole T-15 tested magnetic anomalies south of the main ore body. Comprised of a strongly foliated and cherty iron formation. Locally, pink, garnetiferous layers associated with chlorite-epidote alteration. Primarily the metaliferous units are mostly magnetite bands within chert or matrix in chert breccia (B). Unit is in sharp contact with chlorite-altered intermediate tuffs. Heavily folded and quartz-veined rock may indicate some structural offset and/or repetition of units.

Figure 9: Central Section of the Property. Hole T-14 tested the eastern limit of the main ore horizon. The uppermost parts of the hole are pinkish silicified intermediate tuffs. The hole then intersects interlayered with quartz-sericite schists and anthophyllite-cordierite altered rock. These schists are variably mineralized with disseminated pyrite and pyrrhotite, but did not contain any massive sulfide.

Figure 10: Main Ore Horizon of Property. Hole T-16 tested mineralization at the thickest part of the ore horizon west of cross-section in Figure 6. This hole contained massive sulfide interlayered with altered stratigraphy. Massive sulfides (A) are variably banded to metamorphically recrystallized. The main ore mineralogy is mostly pyrrhotite and pyrite with minor amounts of chalcopyrite and sphalerite. Altered host rocks (B) are mainly medium to coarse grained magnetite-anthophyllite-cordierite with stringers and disseminated pyrrhotite and pyrite. Chalcopyrite and sphalerite are locally present in the altered rock as cm-scale stringers. Contacts between massive sulfide and altered host rock are usually sharp with some gradational lower contacts.

Figure 11: Western Limit of Property. Hole T-20 tested the eastern extent of the ore horizon. Massive sulfides are notably less abundant here and are mainly banded pyrite-pyrrhotite with minor chalcopyrite. Many of the rocks here are weakly silicified, with disseminated sulfides (A). The uppermost units pinkish, variably chloritized intermediate tuffs (B). These were in sharp contact with variably mineralized magnet-anthophyllite-cordierite altered rock. Mineralization generally is more abundant adjacent to ore zones. There is some minor heavy quartz veined and mylonitic fabric developed, suggesting some structural modification of stratigraphy.

Conclusions

Through the examination of drill core through the strata hosting the deposit, the intense folding originally interpreted by May (1996) is suggested and requires additional analyses to validate. Locations of fold axis existing maps yielded little to no exceptional deformation fabric in the rocks and there is no obvious repetition of volcanic or sulfide stratigraphy. In addition, the relationship between massive sulfide and underlying stringer mineralization suggests consistently upright stratigraphy. Instead of folded stratigraphy repeating ore horizons, it may be possible to explain repetition through a series of stacked ore lenses.

Perhaps most importantly, this project strengthened the collaborative relationship between UW-Eau Claire and the WGNHS. The mutually beneficial characterization of the Eisenbrey cores provided samples and data for future UW-Eau Claire research and also helped the WGNHS obtain digital meta data for their extensive collections at their Mount Horeb core repository.

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References


DeMatties, T.A., 1994, Early Proterozoic volcanogenic massive sulfide deposits in Wisconsin: An overview: Economic Geology, v. 89, p. 420-436. This model is included in the Geology of the Eisenbrey deposit.