Volcanic Setting of the 1.8-1.9 Ga. Eisenbrey Cu-Zn Deposit, Rusk County, Wisconsin

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Introduction

The objective of this research is to complete a petrographic and geochemical characterization of the least-altered volcanic rocks hosting the Eisenbrey Cu-Zn deposit in Rusk County, WI. This study builds on previous UWEC student research on the Eisenbrey deposit (Jackson et al, 2016). Major and trace element geochemical data was used to assess the magmatic characteristics of the volcanic system that formed the Eisenbrey ore body. In addition, the geochemical data will be used to characterize the stratigraphy and hydrothermal alteration hosting the Eisenbry ore body and will ultimately allow for the reconstruction of the physical volcanology and tectonic setting that created this deposit. Reconstructing the Eisenbrey volcanic system will lead to a better understanding of the tectonic history of the 1.8-1.9 Ga Penokean orogen in northern Wisconsin. The analyses will also aid to give a better understanding on the petrogenesis and metallogeny of the volcanogenic massive sulfide deposits in the region.

Eisenbrey Map and Cross Section

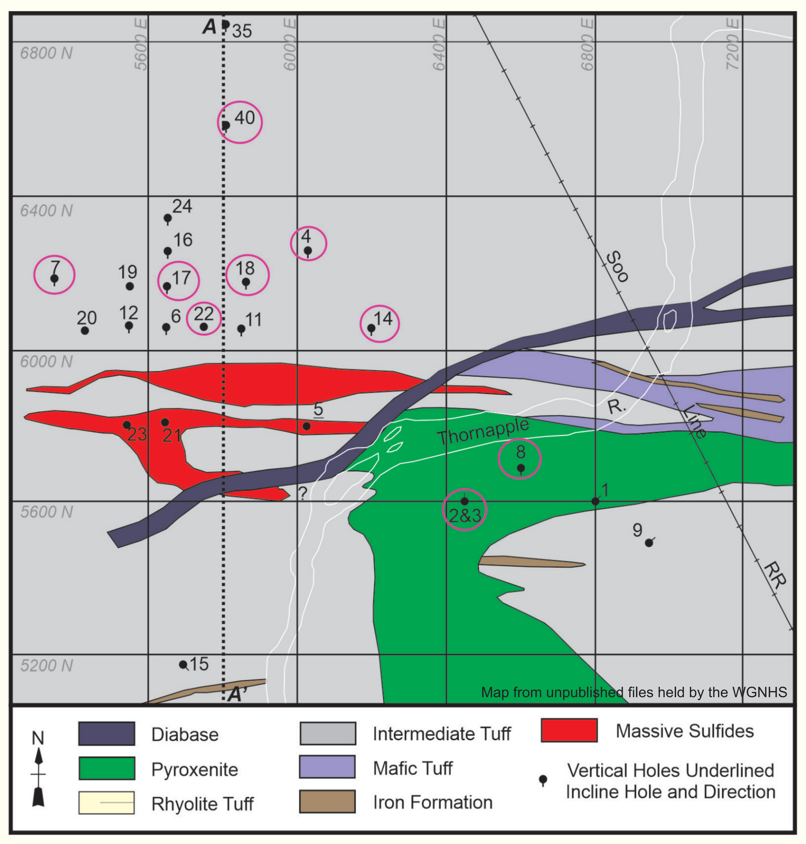

Figure 1: Geologic map of the exploratory Drilling done at Eisenbrey. The rock samples used for the geochemical models were obtained from the drill holes surrounded by pink circles.

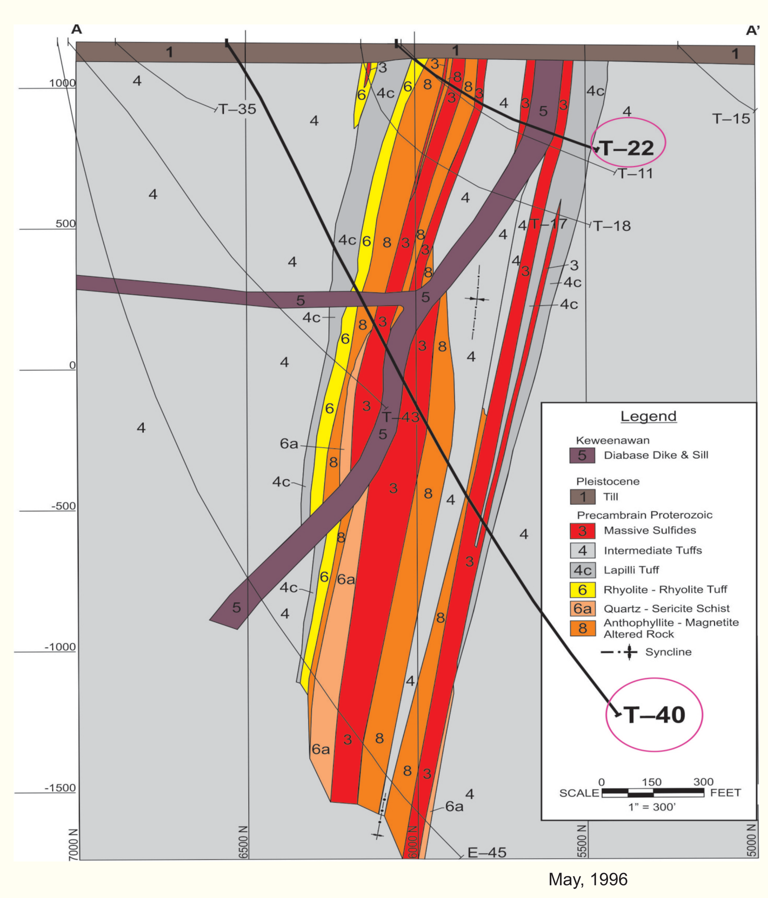

Figure 2: Cross Section of the Eisenbrey deposit from drill site from A to A' from figure 1. Drilling has revealed a hydrothermally altered and metamorphosed bimodal volcanic suite, iron formation, and low-grade massive sulfides.

Eisenbrey Rocks

Drill Hole T-14: The drill core from T-14 revealed a moderately foliated siliceous pink tuff with some pyrite dissemination. Following this tuff is a strongly folliated garnet quartz sericite

Drill Hole T-22: The drill core from T-22 revealed a Mg-An-Co altered Qrtz-Sericite Schist. The alteration increases down-hole with increasing beds of massive Py & Po. The rock has porphyritic rock texture. Biotite mineralization, sphalerite mineralization, and sericite mineralization is present

Drill Hole T-40: The drill core from T-40 revealed an altered dark metamorphic rock. Some diseminated pyrite to massive py-po-dominated sulfide present. Zones of weakly altered and sparsely mineralized intermediate tuff and lapilli-tuff.

Hand Samples

Figure 3: 17TH-T14-243. Ga-Qrtz-Ser schist. Strongly foliated, disseminated Py+Po

Figure 4: T-22-406. Massive sulfide

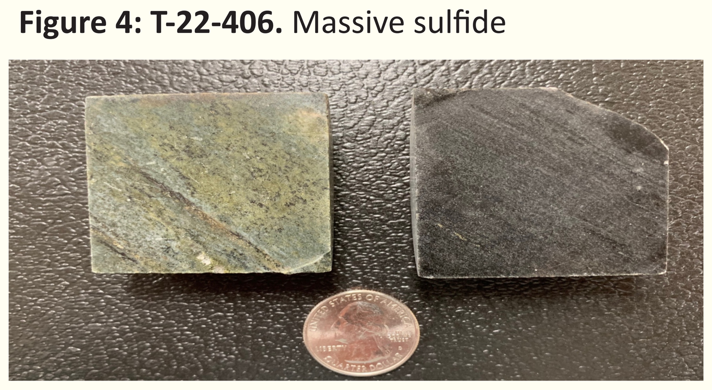

Figure 5: T-40-1955 (left) & T40-1742 (right). (left): Weakly altered and sparsely mineralized intermediate tuff and lapilli-tuff (right): Weakly ant+mg+chl altered fesp-phyric int-felsic volcanic rock

Thin Sections. Left - Normal Light. Right - Polarized

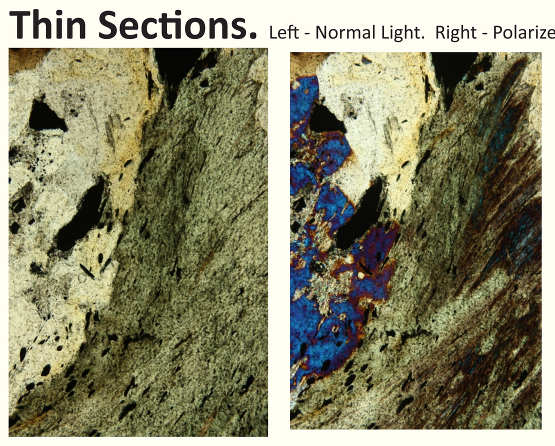

Figure 6: 16th-[T-40]-1578. 75% Chlorite, 10% Magnetite, 5% Cordierite, 5% Anthophyllite. Lots of foliation. Low grade metamorphism

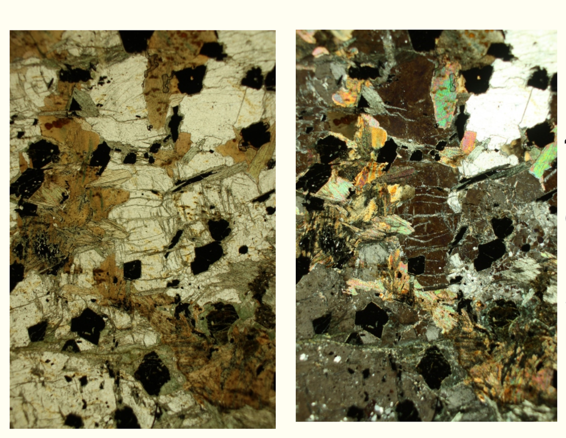

Figure 7: 16TH-[T-40]-1505. 40% Cordierite, 30% Biotite, 15% Chlorite, 10% Quarts & Feldspar, 5% Magnetite. Some foliation. Low grade metamorphism

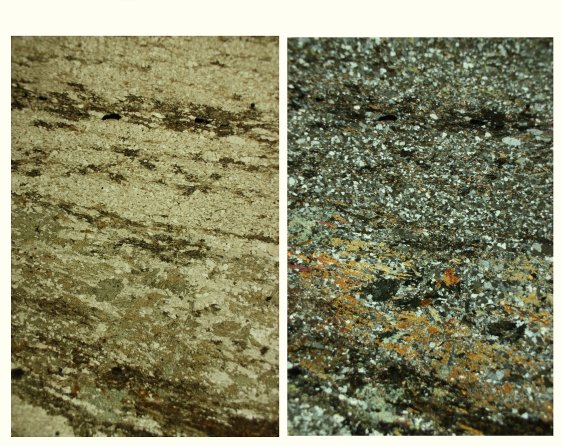

Figure 8: 16th-[T-40]-1758. 45% Quartz and Feldspar, 45% Chlorite, 10% Biotite, traces of Magnetite. Foliation. Low grade metamorphism

Geochemical Results

40 rock samples were used to generate the geochemical plots.

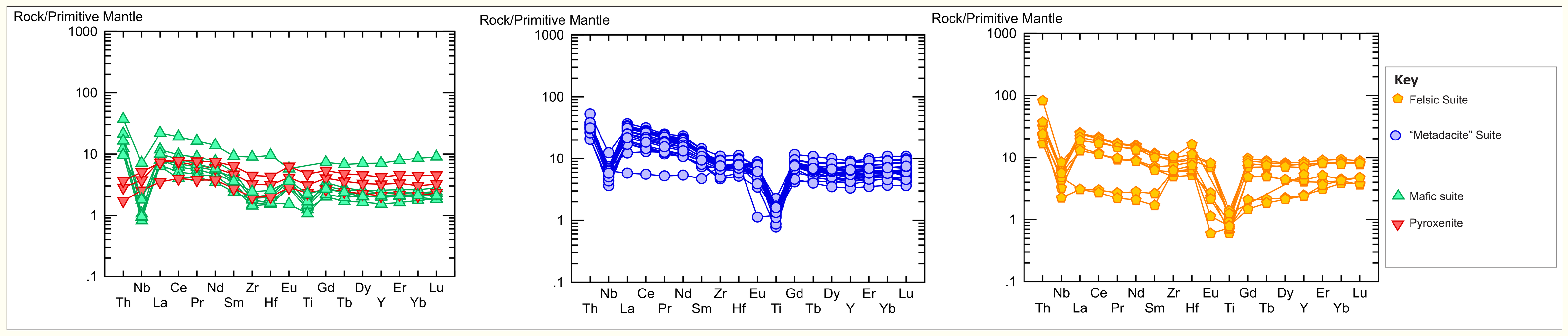

Figure 9: Primitive mantle normalized plot diagrams of the sampled units. Normalizing values from Sun & McDonough (1989).

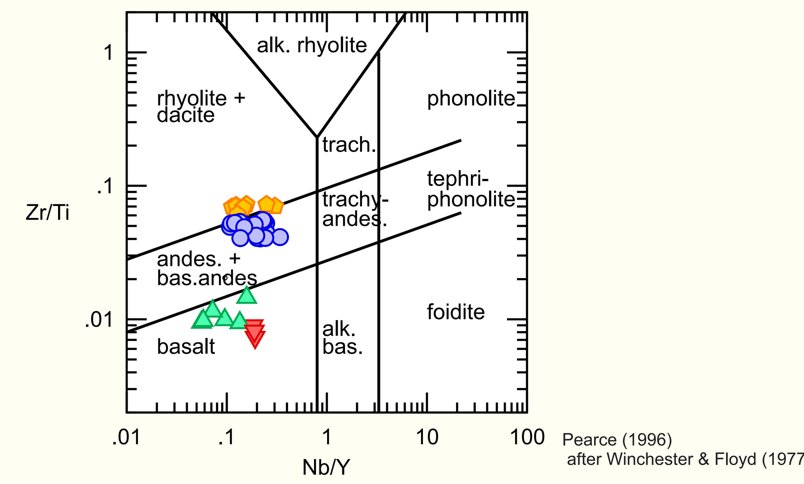

Figure 10: Nb/Y vs Zr/Ti classification diagram illustrating the compositions of the sampled Eisenbrey volcanic rocks.

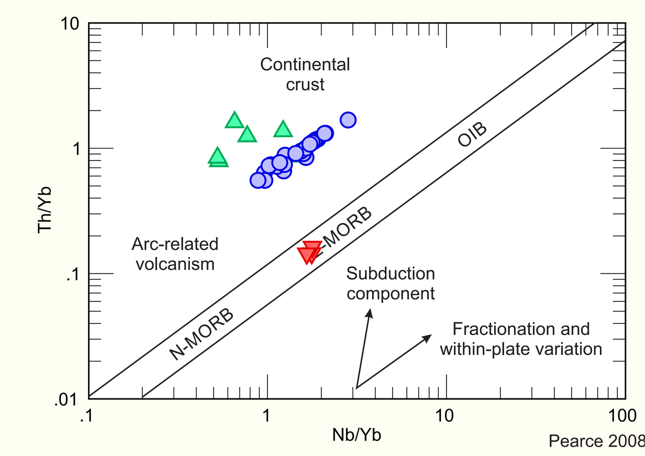

Figure 11: Nb/Yb vs Th/Yb diagram indicating a petrogensis in a subduction setting.

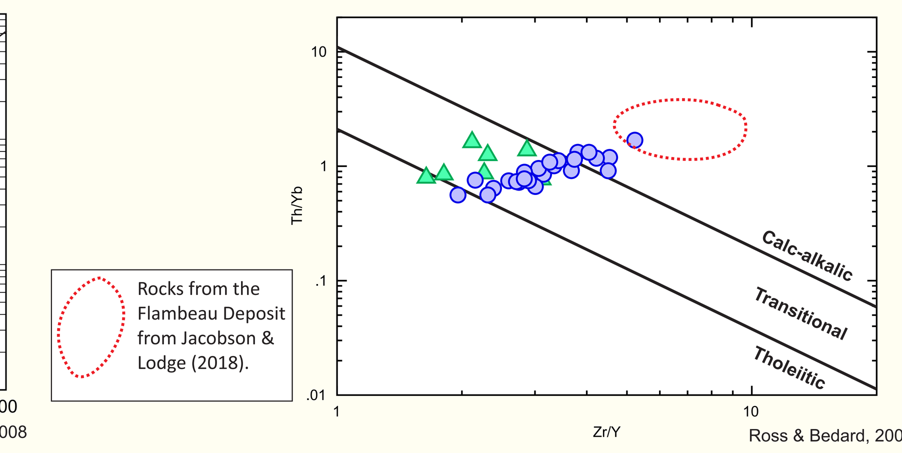

Figure 12: Zr/Y vs Th/Yb discrimination diagram revealing a transitional calc-alkalic-tholeiitic magmatic affinity.

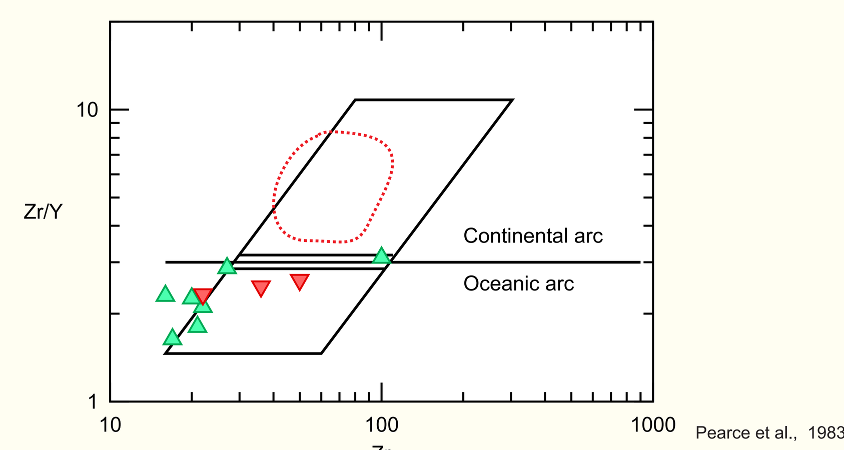

Figure 13: Zr vs Zr/Y diagram. Zr/Y ratios of the Eisenbrey mafic rocks have an oceanic arc signature, while the Flambeau mafic rocks have continental arc signatures.

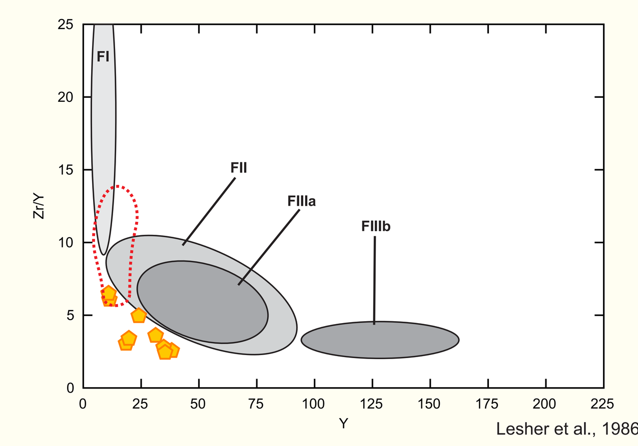

Figure 14: Y vs Zr/Y diagram for the felsic suite illustrating FII to FIII suggesting formation in shallow crust.

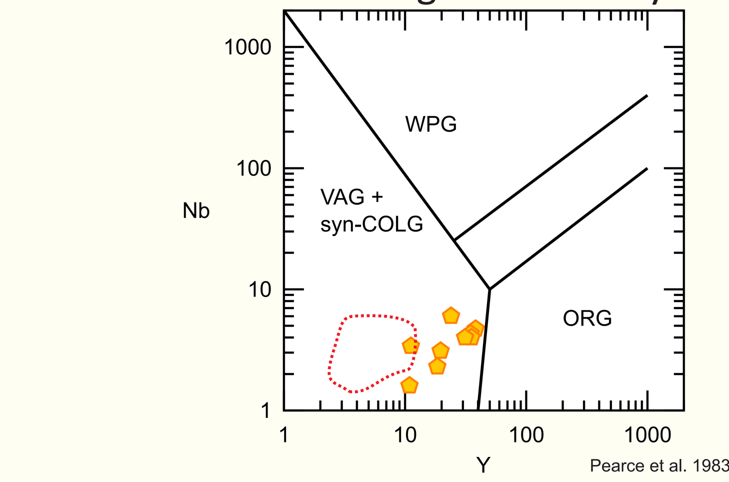

Figure 15: Y vs Nb discrimination diagram of the felsic suite showing the felsic rocks are Volcanic Arc Granites (VAG).

Tectonic History of the Eisenbrey Deposit

During the Paleoproterozoic Penokean orogeny, the Pembine-Wausau Terrane collided and accreted onto the Superior Province ca. 1890 Ma. The subduction that followed (B) lead to autochthonous formation of VMS deposits, like the Flambeau, during a period of continental back-arc extension forming bimodal volcanism. By 1850 Ma the Marshfield terrane collided with the Pembine-Wausau terrane and subduction stopped (Schulz and Cannon, 2007).

Despite being only 4 miles from the Flambeau deposit, the volcanic rocks hosting the Eisenbrey deposit are geochemically distinct, suggesting a different volcanic and tectonic setting is responsible for the formation of the VMS deposit.

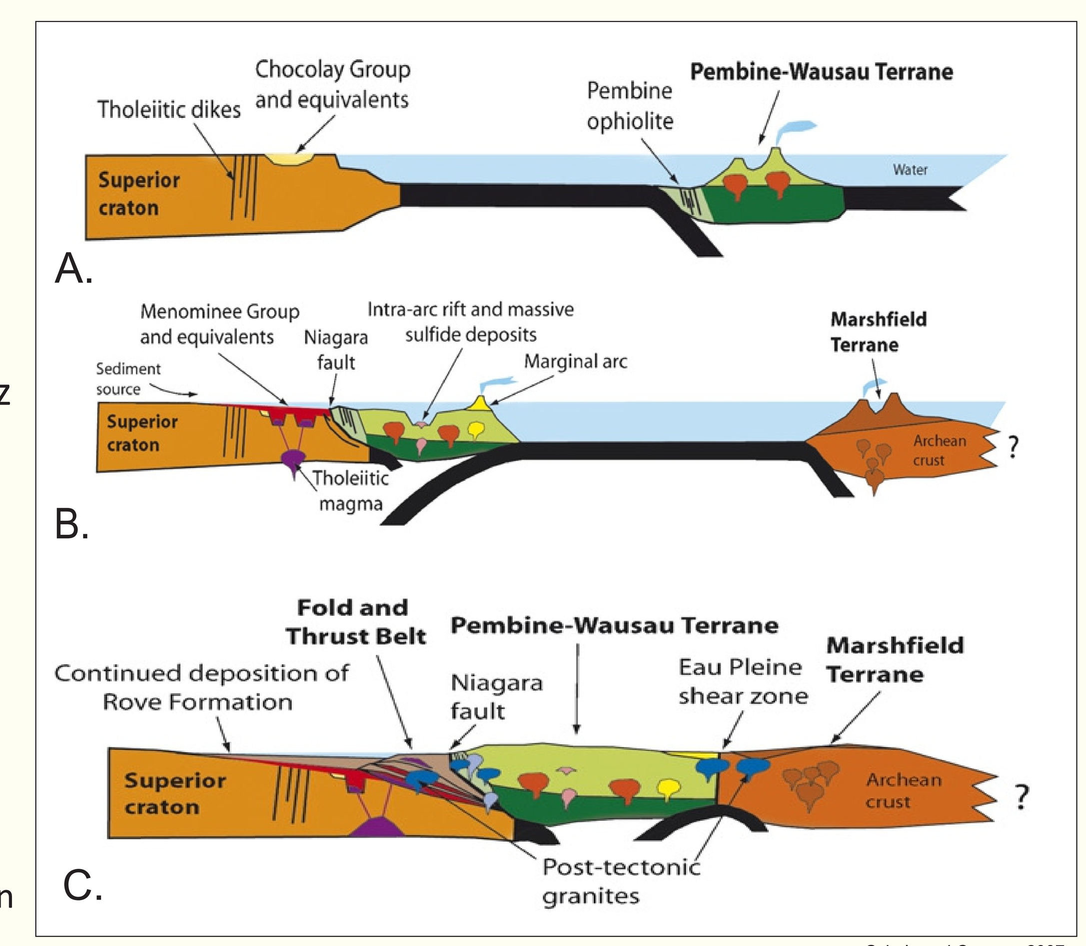

Figure 16: A.~1890 Ma: Ocean Closure and Arc Formation. B. ~1875 Ma: Accretion of Pembine-Wausau Terrane, Subduction flip and back arc Basin development. C. ~1830 Ma: Accretion of Marshfield Terrane.

Schulz and Cannon. 2007

Conclusions

The petrographic and geochemical characterization of the least-altered volcanic rocks hosting the Eisenbrey Cu-Zn deposit confirmed previous interpretations that they were formed in a subduction setting. However, this ends the similarity. Based on distinct geochemical differences with other volcanic assemblages hosting VMS deposits in northern Wisconsin, it is apparent that the Eisenbrey deposit has a unique petrogenetic history that reflects a more juvenile, ocean arc setting.

The Flambeau deposit, and most others in the Penokean, formed autochthonously formed in continental back arc extension after the accretion of the Pembine-Wausau terrane. **However, the Eisenbrey deposit is <u>allochthonous</u>, forming within the Pembine-Wausau Terrane but prior to accretion onto the Superior Province.**

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