Using Ore Petrography and Geochemical Mass Balance to Constrain the Hydrothermal Environment at the Paleoproterozoic Flambeau Cu-Zn-Au Deposit, Wisconsin, USA

Robert W. Lodge, Tara C. Lemke, Kaelyn E. Blotz
University of Wisconsin-Eau Claire, Eau Claire, WI, USA

Volcanogenic massive sulfide (VMS) deposits can form in a variety of tectonic environments that ultimately influence the composition of ores and style of hydrothermal alteration. Traditional models for VMS formation factor in the influence of host rock and hydrothermal fluid composition on ore types and alteration products. These subtle differences in ore minerals and hydrothermal products are important for understanding the genesis of VMS deposits in various environments and has served as a first-order exploration model. The Paleoproterozoic Flambeau Cu-Zn-Au deposit in northern Wisconsin produced 1.9 Mt of supergene-enriched ore but the deposit geology and ore genesis has not been fully characterized because of poor exposure and a lack of mineral investment. However, the deposit has unique alteration assemblages (biotite-andalusite-chlorite schists) and is one of the most Cu- and Au-enriched deposits in the Penokean Orogen. Therefore, improving our understanding of the hydrothermal features of this deposit will help improve our knowledge of the fluid conditions that from Cu- and Au-rich VMS deposits.

This study sampled representative metamorphosed hydrothermally-altered rocks and ore zones of the Flambeau deposit from drill core stored at the Wisconsin Geologic and Natural History Survey. Whole rock lithogeochemistry from altered rocks reveal characteristic major element mobility found in most VMS deposits. However, mass balance calculations reveal an enrichment of potassium and silica that are characteristic of argillic alteration and have little evidence for a significant component of Mg-metasomatism that is common in many other VMS deposits in similar tectonic environments. Additionally, SEM-EDS of polished ore sections have identified various tellurides (hessite, altaite, tsumoite, bismuth), electrum, arsenopyrite, acanthite, bismuthinite, cassiterite, monazite, and an unnamed tungsten mineral. This suite of trace minerals suggests a magmatic fluid component to the hydrothermal system. Based on these observations, the Flambeau deposit is possibly an example of a metamorphosed hybrid VMS-epithermal system.