

Setting of Volcanogenic Massive Sulfides Deposits in the Paleoproterozoic Penokean Volcanic Belt, Lake Superior Region, USA

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The Penokean volcanic belt, located in north-central Wisconsin and the south portion of the upper peninsula of Michigan, is one of the world's most prolific base metal provinces. It is host to a large number of volcanogenic massive sulfide (VMS) deposits and prospects, including the world-class Crandon deposit that comprises an estimated 65.8 million metric tons of polymetallic massive sulfide ore. Despite the high exploration potential, the Penokean volcanic belt has received little attention from exploration companies for the past two decades because of public opposition to exploration and mining in Wisconsin. Due to the lack of exploration, only limited academic research has been conducted and little is known about the setting of the massive sulfide deposits within the Penokean volcanic belt. Many key aspects of the regional geology and tectonic evolution of the belt remain poorly understood compared to similar Paleoproterozoic belts such as the Flin Flon district in Manitoba or the Skellefte and Bergsladen districts in Sweden.

This new research project aims to create a comprehensive geological framework for the Penokean volcanic belt. Existing geological maps across the belt and historic U-Pb age dates of volcanic and intrusive rocks have been compiled into a common GIS environment. Publically available aeromagnetic and gravimetric data were enhanced and used to map bedrock geology in areas covered by extensive glacial deposits. Field magnetic susceptibility readings helped to ground-truth the aeromagnetic data. New ID-TIMS age dating is being performed on felsic volcanic rocks hosting some of the massive sulfide deposits in the belt, including the Back Forty, Bend, Lynne, Pelican River, and Horseshoe deposits. In addition, least-altered volcanic rocks will be analyzed to determine the magmatic affinity of volcanic rocks in key areas across the belt.

Preliminary interpretation of the airborne geophysical data reveals the existence of a linear, east-west trending package of volcanic rocks defined by magnetic lows within the Penokean volcanic belt. Based on drill hole data, this volcanic package is interpreted to be bimodal in composition. Virtually all of the VMS deposits and prospects known in the belt are hosted by this package of bimodal volcanic rocks. The tilt derivative shows major lineaments within the bimodal volcanic rocks, which are thought to represent mafic volcanic flows. The analytic signal transformation highlights magnetic anomalies within this unit, which are thought to represent synvolcanic mafic plutons. Large felsic intrusions occur throughout the Penokean volcanic belt, many of which are outcropping. Previous age dating of these felsic intrusions, combined with their geophysical signatures, help to identify the spatial distribution of synvolcanic and syntectonic intrusions. Felsic, synvolcanic intrusions are generally located in the core of the belt while most orogenic intrusions tend to be located in the southern portion of the belt. A distinct line of felsic intrusions with an age between 1800-1760 Ma occurs just south of and trending parallel to the Niagara fault, which defines the northern margin of the Penokean volcanic belt.