Introduction

Volcanogenic Massive Sulfide (VMS) deposits constitute one of the world's greatest sources of copper, zinc, lead, silver, gold, and a wide range of by-products including tin, cadmium, antimony, and bismuth (Kearnsy, 2003). The metals we mine on earth from ore bodies such as VMS deposits, are vital to everyday life from the vehicles we drive to the homes we build. The first step involved in unlocking the value of metal on earth begins with geologic exploration to locate these deposits within the earth. This begins with field work conducted by geologists involving mapping, rock sampling and analysis.

VMS deposits form in oceans, where convective circulation of seawater is driven through the seafloor by local or regional magmatic heat sources. This super-heated ocean waters leaches components out of the footwall volcanic rocks, carrying metals and sulfur. When these fluids interact with cold, ambient seawater, decreasing temperature and increasing pH causes precipitation of base and precious metals as sulfide minerals at venting zones of within the seafloor. Deposits are classified based on host rock compositions: felsic, bi-modal-mafic, mafic-siliciclastic, bi-modal-felsic, and bimodal-siliciclastic (Barrie and Hannington, 1999). It is important to classify VMS deposits based on these types, allowing for comparison between similar deposits based on tectonic settings, geographic occurrence, and metal content.

Objectives

- Geochronologically classify host rocks based on minor, major, and trace element geochemistry (Fig. 2).
- Establish a relationship between sulfide ore mineral occurrence and the textural characteristics within the host rock (Fig. 3).
- Establish the occurrence and textural characteristics of sulfide minerals within the host rock to provide a relative timeline of volcanism and mineralization/hydrothermal infiltration events.
- Acquire sulfur isotope values from sulfide minerals in each of the five major zones of the Back Forty deposit containing massive sulfide mineralization, and use these values to model the source of the sulfur.
- Integrate all the available data to generate a model for formation of the Back Forty VMS deposit (Fig. 4).

Sulfur Isotope Analysis

Sulfur isotope values characterize the distribution of sulfide minerals in the Back Forty deposit and model the origin of sources. Magmatic or mantle derived sulfur has δ34S values of 0 to 2‰ VCDT (Ribak and LL 2002). Biologically derived sulfur would produce depleted or negative δ34S values, resulting locally from microbial reduction of seawater sulfates (Taylor et al., 1990). Sulfur derived from heavy, contemporaneous seawater sulfates would produce enriched or positive δ34S values (Strauss and Schieber, 1990). Sulfur isotope values obtained from 25 sulfide ore minerals from the five major zones of sulfide mineralization within the Back Forty indicate a primarily mantle-derived source of sulfur. δ34S values range from 2.53 to 3.92‰ VCDT with an average value of 0.04‰ and a standard deviation of ± 1.42‰. In contrast to Paleoproterozoic deposits, such as deposits formed during the Paleoproterozoic, the bulk of the sulfur was derived by leaching rocks (i.e. primitive mantle-derived volcanic rock) underlying the deposits with little contribution from seawater sulfates which results in uniform and near zero per mil values of δ34S (Huston et al., 2010). Sulfur isotope analysis has never been used on the Back Forty deposit, and so few other deposits around the world. The basis of this research is to explore the possibility of utilizing this method as tool in exploration for new, undiscovered metal deposits that can someday be mined.