Determining sulphide mineral oxidation rates and trace metal release under seafloor conditions

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The mining of seafloor massive sulphide (SMS) deposits will result in the oxidation of sulphide minerals and the subsequent release of metals into the surrounding environment which may be lethal to some organisms. Batch reactor sulphide oxidation experiments have been undertaken in an attempt to determine oxidation rates and to predict metal release from SMS mining. This research may also have implications for the weathering of SMS deposits as they move away from ridge axes which may be vital for the exploration of inactive deposits.

Monomineralic samples of pyrite, chalcopyrite and sphalerite were reacted with synthetic seawater at temperatures of ~2ºC, under circum-neutral pH (~8.2) and anoxic conditions for eight hours. Monomineralic samples of pyrite, chalcopyrite and sphalerite as well as polymineralic mixtures of these three sulphide phases in all configurations were run under the same pH, temperature and time conditions as above, however, the synthetic seawater was equilibrated with atmosphere.

During these initial experiments, Fe-hydroxide phases precipitated from the synthetic seawater solution; a reaction known to occur at pH >5. These phases appear to sequester Fe and Zn from solution in different proportions, but not Cu. As a result, rates of sulphide mineral oxidation cannot be determined from the concentrations of Fe and Zn in solution as they are not representative of sulphide oxidation alone. Increased concentrations of dissolved oxygen likely increase the rate of sulphide mineral oxidation, but also increase the rate of Fe-hydroxide precipitation. This is reflected by observing higher concentrations of metals in solution in experiments run under nitrogen compared with those completed under atmosphere after eight hours.

Galvanic effects are evident in polymineralic experiments, predominantly the cathodic protection of pyrite by the preferential oxidation of chalcopyrite and sphalerite. The relationship between sphalerite and chalcopyrite remains unclear due to the removal of soluble Zn by Fe-hydroxides.

Experiments completed under atmosphere have been re-run for 73 hours in an attempt to produce enough data for predictive modelling. Results from this latest round of experiments and their implications for seafloor mining will be presented at the conference.