Deep Impact; Environmental toxicity of mining black smokers

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Nautilus Minerals Inc have developed the only current concept for the mining of hydrothermal vents. During this process, the associated agitation has the potential to expose a high surface area of fresh sulphide minerals to seawater. Material released during the mining process and waste water return from dewatering of slurries at the surface, will be suspended in the water column as a sediment plume to be dispersed into the wider ocean. These finely suspended sulphide particules may dissolve, releasing heavy metals and toxins into the water column. Although impact on the wider ocean is assumed to be limited based on the large dilution factor, locally there is potential for toxicity to the local environment and associated ecosystems especially if any heavy metal release is not balanced by subsequent oxidation and precipitation.

Following the mining process outlined by Nautlis Minerals Inc, an experimental approach has been designed to simulate this activity and provide an understanding of heavy metal release. Experiments were undertaken in a cold seal pressure vessel of original 'Tuttle' design that has been adapted with a peltier plate cooling system and motor operated oscillation. Dissolution experiments have been undertaken with a variety of natural sulphide samples from various settings (high temperature vent, ultra-mafic hosted, back-arc rift, hot spot). The majority of experiments were controlled at 150 bar, 4°C, with 2.5-50 μm grain size and 100 g/L rock-fluid ratio using synthetic seawater. As well as mineralogy and geochemistry, other variables were also investigated including pressure, temperature and fluid-rock ratio. Results provide an understanding of the way metals are released and their concentrations over time, as well as which deposits (variable mineralogy and geochemistry) may pose the greatest environmental risk in terms of toxicity. Results also have implications for the efficiency of the mining process itself and how variables like grain size and fluid-rock ratio (total dissolved solids in any return water) can be adapted, how dilution can be controlled to reduce release of heavy metals and which minerals (and/or deposits) should perhaps be avoided.