Fallon, E. K., Brooker, R. A., & Scott, T. B. (2017). Designing an experimental approach to simulate the mining process of seafloor sulphide ore deposits. *Applied Earth Science*, *126*(2), 56-57. https://doi.org/10.1080/03717453.2017.1306248

Designing an experimental approach to simulate the mining process of seafloor sulphide ore deposits

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Acid rock drainage is a natural weathering process that is often exacerbated by mining activities, and this type of pollution is common in terrestrial sulphide ore deposit mines. A similar weathering process also occurs on seafloor massive sulphide (SMS) ore deposits, and the prospect of seafloor mining in the future raises similar concerns. Unlike terrestrial deposits, it is assumed the seafloor sulphides are converted to oxides with negligible metal release and minimal net acid generation due to the buffering capacity of seawater and low solubility of iron at near neutral pH[[1],[2]. Whilst dissolution studies of specific sulphide minerals in seawater have been undertaken[3], the majority are within the context of acid mine drainage arising from terrestrial mines[4],[5]. The only study that exists that emulates a true composition of sulphide sediments dissolving in seawater was undertaken by Nautilus Minerals Ltd as a regulatory need to provide an environmental impact statement for future mining in Papua New Guinea. No other dissolution studies exist that emulate the true composition of sulphide ore deposits that are actively mined in a colder, higher pressure, saline context. It is of particular importance that SMS deposits include a variety of minerals, and along with the seawater, these minerals have potential to form galvanic cells that have the ability to substantially increase the dissolution of metals into the water column[6].

Nautilus Minerals Ltd provide the only current concept for the mining of hydrothermal vents. During this process, there is the potential to agitate and expose a high surface area of fresh sulphide minerals to seawater and exacerbate any natural weathering. Material released during the mining process and waste water return from dewatering the slurries at the surface, will be suspended in the water column as a sediment plume to be either dispersed into wider ocean and ultimately to settle out some distance away. During sediment agitation, this fine suspended sulphide particulate has the ability to dissolve, releasing heavy metals and toxins into the water column and thereby have a detrimental impact on the local ecosystems[7],[8]. For accumulation or dispersion throughout the wider ocean, the impact is presumed to be limited as a result of the large dilution factor. If however, any heavy metal release is not balanced by subsequent oxidation and precipitation, there is the potential for toxicity to the local environment and associated ecosystems.

Based on the mining procedures outlined by Nautilus Minerals Ltd, an experimental approach has been designed to simulate this process to provide an understanding of any heavy metal release and toxicity. Presented here is the design of the experimental set up, variables to be investigated as well as the challenges encountered including method and analysis and how they were overcome. Trial experiments to test the set up and analytical techniques indicate large variability in metal release between SMS samples with varying mineralogy as well as significant release of Cu and Zn.

References

[1] Schoonen, M., Elsetinow, A., Borda, M. & Strongin, D. Effect of temperature and illumination on pyrite oxidation between pH 2 and 6. *Geochem. Trans.* **1,** 23 (2000).

[2] Edwards, K. J. Formation and degradation of seafloor hydrothermal sulphide deposits. *Geol. Soc. Am.* (2004).

[3] Feely, R. A. *et al.* Composition and dissolution of black smoker particulates from active vents on the Juan de Fuca Ridge. *J. Geophys. Res.* **92,** 11347 (1987).

[4] Acero, P., Cama, J. & Ayora, C. Sphalerite dissolution kinetics in acidic environment. *Appl. Geochemistry* **22,** 1872–1883 (2007).

[5] Constantin, C. A. & Chiriţă, P. Oxidative dissolution of pyrite in acidic media. *J. Appl. Electrochem.* **43,** 659–666 (2013).

[6] Abraitis, P., Pattrick, R. A. D., Kelsall, G. H. & Vaughan, D. J. Acid leaching and dissolution of major sulphide ore minerals: processes and galvanic effects in complex systems. *Mineral. Mag.* **68,** 343–351 (2004).

[7] Van Dover, C. L. Impacts of anthropogenic disturbances at deep-sea hydrothermal vent ecosystems: a review. *Mar. Environ. Res.* **102,** 59–72 (2014).

[8] Boschen, R., Rowden, A., Clark, M., Pallentin, A. & Gardner, J. A. Seafloor massive sulfide deposits support unique megafaunal assemblages: implications for seabed mining and conservation. *Mar. Environ. Res.* **115,** 78–88 (2016).