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Monitoring contamination using biogenic materials & LA-ICP-MS – Examples from Black Angel Pb-Zn mine, West Greenland

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Metal pollution from mining activities is a well-known environmental concern, and detailed environmental monitoring before, during, and after mining is essential to evaluate the pollution status of a mining area. Traditionally, monitoring entails sampling of a selection of key monitoring organisms (e.g. lichens, sea weed, bivalve mollusks and sedentary fish species) and the estimated contamination status of the area is based on assessment of metal analyses (e.g. Q/HR-ICP-MS) in soft-tissues and organs from the key monitoring organism. Although metal concentrations in soft tissues is a valid proxy for metal exposure and recent metal pollution, such analysis provide no temporal information on metal exposure, uptake and accumulation over time. However, recent advances in analytical techniques such as laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) have opened new opportunities for analyzing low concentrations of metals in biogenic materials (e.g. otoliths and shells) with a very fine spatial resolution[1]. Such mineralized biogenic materials are considered metabolically stable, grow continuously during the lifetime of the organism, and have the ability to incorporate metals. Consequently, biogenic materials may provide a complete time-resolved chemical record of organism's exposure history. A preliminary study[2] indicates that LA-ICP-MS analyses of sculpin otoliths, collected along a distance gradient near the Pb-Zn Black Angel-mine (West Greenland), have the potential to become a valuable method for assessing time-resolved metal loading near mine sites. The study showed that sculpin otoliths incorporated Pb, which is the most important pollutant in the area, but also that the annual variations in the otolith Pb concentrations was controlled by a complex interaction between Pb exposure in the environment and physiological processes in the fish. Consequently, further studies are required to investigate the links between metal sources, pathways, and the geochemical and physiological processes controlling otolith metal concentrations. Here, we continue the analysis of chemical compositions of fish otoliths collected near the Black Angel-mine (e.g. *Myoxocephalus scorpius* and *Gadus ogac*) and combine it with data on metal accumulation in blood and organs of the fish as well as other environmental proxies for metal contamination. In addition, we also investigate the potential of LA-ICP-MS analyses on a range of other solid biogenic samples including shells of blue mussels and sea snails (*Mytilus edulis/Mytilus trossulus, Littorina saxitilis*) as well as rotula bones from sea urchins (*Strongylocentrotus droebachiensis*). If successful, the potential application of solid biogenic material as archives of metal pollution can become an important new tool for environmental monitoring of contaminated areas, especially at remote sites where the location logistically inhibits frequent monitoring on an annual scale.

[1]Halden, N. & Friedrich, L. 2008. Trace-element distributions in fish otoliths: natural markers of life histories, environmental conditions and exposure to tailings effluence. Mineralogical Magazine **72**(2): 593-605.

[2]Sondergaard J., Halden N., Bach L., Gustavson K., Sonne C., Mosbech A. 2015. Otolith Chemistry of Common Sculpins (Myoxocephalus scorpius) in a Mining Polluted Greenlandic Fiord (Black Angel Lead-Zinc Mine, West Greenland). Water Air and Soil Pollution 226(10):12Please fill in your abstract text.