Mobilization of heavy metals in submarine mine tailings

I. Okland[1]*, j.K. Gravdal[1] Håkon dahle[2] A.K.S Kvassnes[3] and i.H. Thorseth[1]

[1] *Centre for Geobiology/Department of Earth Sciences University of Bergen, Alle gaten 41, N-5007 Bergen (*correspondence: Ingeborg.Okland@uib.no)*

[2] *Centre for Geobiology/Department of Biology Thormøhlensgate 53, N-5006 Bergen*

[3] *IRIS, Prof. Olav Hansensvei 15, N-4021 Stavanger*

Submarine mine-tailing disposal (STD) is considered as an alternative for land based tailings disposal for near-coast mining operations in Norway, and is also used in some other countries. However, also STDs have some environmental issues, such as smothering of benthic fauna and, potentially, leaking of heavy metals and chemicals used in the beneficiation processes from the tailings. The ongoing biogeochemical processes in STD, and which role they play in mobilization and/or immobilization of heavy metals are not well understood.

The Ballangsfjord, northern Norway, has two STDs. The sulphide-quartz dominated Ballangsleira deposit contains tailings from a Cu, Zn and S mine, while the olivine rich Fornesodden deposit has tailings from a Ni mine. In this study we investigate the sediment and porewater geochemistry and the microbial communities of sediment cores collected from the two different tailing deposits and from the background sediment in the fjord.

Both porewater geochemistry and microbial community profiles differ between the two tailing deposits, and between the tailings and the background sediment. In the background sediment, SO_4 decreased from 28 to 19 mM from the top of the core to 140 cm depth. Moreover, the abundance of Deltaproteobacteria was positively correlated with sulphate concentration and decreased from 18% – 6% of the microbial community in the same depth interval. Sulphate reduction was not apparent from the porewater chemistry in the mine tailings. However, the coexistence of putative sulphide oxidizers and sulphate reducers suggests that sulphate reduction might be ongoing, but masked by sulphide oxidation. Ni, and to a lesser degree Co, was present in the porewater from both tailings. The porewater from the sulphide-rich tailings also contained Zn and lesser amounts of Cu and Pb. Sequential extraction of the mine tailings revealed the presence of heavy metals both in the fraction representing loosely-bound and carbonate-bound metals and in the fraction representing Fe and Mn oxide–bound metals. The porewater geochemistry and sequential extraction data suggest that heavy metal are mobilized and redistributed in the tailing deposits. To what degree the heavy metals are leached to the seawater is, however, not clear.