Metal fluxes from a sea deposit site for mine tailings

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Introduction: Mining produce large amounts of waste material which needs to be stored in confined deposits on land or in the sea. Because of less exposure to O_2, leakage of metals from sulphide ore minerals has been used as an argument in favour of sea deposition. Mine tailings from a major ilmenite mine in SW Norway (Titania AS), has been placed both in sea (1960-94) and land deposits (1994-present). Run-off from the land deposit is regularly monitored and have been shown to contain toxic concentrations of Ni, Co and Cu [1]). The objective of this study was to quantify the leakage of metals from the sea deposits and compare with the discharge from the land deposit.

Methods: In November 2015, macrofauna was investigated in the deposit area in Jøssingfjorden and Dyngadjupet [2] and twelve box-core samples were transferred to a benthic mesocosm. In the mesocosm measurements of metals (Cd, Co, Cu, Ni, Pb, Zn, Mn and Fe) included concentrations in sediment and pore water, fluxes from sediments to overlying water and uptake in DGT probes and a sediment-dwelling organism (*Hinia reticulata*) after appropriate exposure times in the box-core sediments.

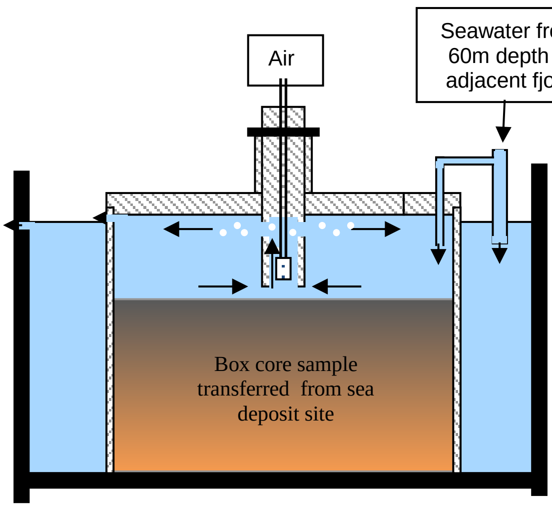

Fig. 1: One of twelve box-core samples maintained in benthic mesocosm.

Preliminary results: In the Jøssingfjorden deposit area pH at the sediment surface was ~7.3 compared to ~7.5 in the more seawards deposit area (Dyngadjupet) and at the reference location. Sediment Oxygen Consumption (SOC) was ~200 µmol m^{-2} h^{-1} and variations were small within the study area. The DGT-probes from the 0-12 cm depth interval showed similar profiles of Zn and Pb in all cores. However, the deposit sites showed generally higher concentrations of Ni, Cu and Co and increasing concentrations with increasing depth. The flux measurements corresponded well with the DGT-probes showing higher fluxes of Ni, Cu and Co from the deposit area. E.g. the release of Ni from the seabed was 0.53±0,07 µg m^{-2} h^{-1} at the reference station, 3.6±0.4 µg m^{-2} h^{-1} in the Dyngadjupet deposit area and 14.2±5.0 µg m^{-2} h^{-1} in the Jøssingfjord deposit site. Although the fauna showed some signs of disturbance, all stations obtained „good“ or „very good“ ecological status [2].

Discussion: The fluxes determined in the box-core samples corresponded to total fluxes of 260 g Ni day^{-1} from Jøssingfjorden and 140 g day^{-1} from Dyngadjupet, or in total 5.4% of the discharge from the land-deposit. The metals released from the sediments are quickly dissipated in the sea water and effects in pelagic species are not likely to occur via uptake from water. However, concentrations in sediment and pore water frequently exceeded European environmental quality standards (AA EQS) for sediments and coastal waters, respectively. In addition, fluxes via resuspension may be underestimated in the mesocosm set-up, and food web transfer has not been estimated. Both leakage from the sediment and uptake in sediment-living species are only marginally dependent on the thickness of the tailings deposit. Therefore, the total impact of a sea deposit is to a large extent proportional to the surface area of the deposit.

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References: 1) Tobiesen 2004. *NIVA-report 4685*, 34pp. 2) Trannum 2016. *NIVA-report 7010*, 23 pp + app.