Microbial reductive dissolution of iron oxides and subsequent heavy metal release in submarine tailings disposal

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Submarine tailings disposal (STD) is an accepted method of mine waste management. However, the potential reactivity of such tailings deposited into seawater can generate unexpected contaminants. For instance, dissolution of tailings may increase the mobility of toxic metal ions such as Cr, As, Zn, and Co.

We present an experimental approach to identify the chemical and physical conditions for STDs that may result in harmful levels of contaminant release into the overlying water column – specifically as a result of microbial reductive dissolution in iron-bearing sediment. Mine tailings from Portman Bay, ES were used because they contain considerable amounts of Fe(III) oxides in the form of Magnetite (~15% by mass), a widespread source of Fe^{+++} for reductive dissolution. The biogeochemical reactions and diagenetic alteration in the experimental sediment column were modelled to characterize the rate-controlling reaction mechanisms and further describe the *in-situ* mineralogical changes.

Results suggest that a competition between deposition rate, the quality and quantity of organic carbon, and the Fe^{++} sorption capacity of the sediment strongly influence the mobility of solubilized toxic metal ions. Further, the relatively simple 1D model calibrated here may be applied to real systems to make reasonable predictions about the extent of both dissolution product release, microbial activity, and further diagenetic alteration in STDs. The implications of this work may help to inform decisions for current and future mining operations, such that any potential environmental impact of STDs may be minimized.