Reductive dissolution of magnetite from iron mine tailings: potential impacts on coastal environments

J. PALAU[1,2]*, R. BENAIGES[1,2], F. OFFEDDU[1], J. URMENETA[2,3], J.M. SOLER[1], J. CAMA[1] AND B. DOLD[4]

[1]Institute of Environmental Assessment and Water Research (IDAEA), CSIC, Barcelona 08034, Catalonia, Spain
[2]University of Barcelona, Barcelona 08028, Catalonia, Spain
[3]Biodiversity Research Institute (IRBio), University of Barcelona, Barcelona 08028, Catalonia, Spain
[4]Luleå University of Technology, Luleå 97187, Sweden
* Correspondence: jordi.palau@ub.edu

Adverse impacts of mine tailings on sediments and water quality are major worldwide environmental problems. Due to the environmental contamination associated with the deposition of mine tailings on land, an alternative option is submarine disposal, which is already performed in some countries. However, toxic effects on coastal sediments may result from the release of different metals (e.g. Cr, V, Cu, Zn, Ni) and metalloids (e.g. As) contained in the iron oxides (e.g. magnetite) in the tailings. At the moment, we have little knowledge on the microbial reductive dissolution of iron oxides under marine conditions and the related potential release of trace elements.

In this study, batch experiments were performed using a number of iron ore samples from Chilean and Swedish mines and a mine tailings sample. The goal was to study the extent and kinetics of magnetite bioreduction under marine conditions and the potetial release of trace elements. The determined elemental composition of the magnetite in the tailings showed relatively high amounts of trace elements (e.g. Mn, Zn, Co) compared with those of the iron ore samples (LA-ICP-MS and EMPA analyses). This enrichment of trace elements in the tailings' magnetite might occur during the separation process at the iron ore processing plant.

The batch experiments, which were prepared using sinthetic seawater (pH 8.2), a marine microbial strain (*Shewanella loihica*) and lactate as electron donor and carbon source, were conducted at 10º C in the dark for up to 113 days. Samples were collected at different times to measure lactate, acetate, Fe(II) and trace element concentrations in solution. Based on the consumption of lactate and production of acetate and aqueous Fe(II), the magnitude of microbial reduction of Fe(III) was calculated using a geochemical model including Monod kinetics. Furthermore, the model was used to simulate and evaluate the release of the trace elements detected in solution (e.g. Mn, V, Ga, Cu and As).