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TITLE: The Samarco mine tailing disaster: A possible time-bomb for heavy metals contamination?

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ABSTRACT:

In November 2015, the largest socio-environmental disaster in the history of Brazil occurred when approximately 50 million m<sup>3</sup> of mine tailings were released into the Doce River (SE Brazil), during the greatest failure of a tailings dam worldwide. The mine tailings passed through the Doce River basin, reaching the ecologically important estuary 17 days later. On the arrival of the mine wastes to the coastal area, contamination levels in the estuarine soils were measured to determine the baseline level of contamination and to enable an environmental risk assessment. Soil and tailings samples were collected and analyzed to determine the redox potential (Eh), pH, grain size and mineralogical composition, total metal contents (Fe, Mn, Cr, Zn, Ni, Cu, Pb and Co) and organic matter content. The metals were fractionated to elucidate the mechanisms governing the trace metal dynamics. The mine tailings are mostly composed of Fe (mean values for Fe: 45,200 ± 2850; Mn: 433 ± 110; Cr: 63.9 ± 15.1; Zn: 62.4 ± 28.4; Ni: 24.7 ± 10.4; Cu: 21.3 ± 4.6; Pb: 20.2 ± 4.6 and Co: 10.7 ± 4.8 mg kg<sup>-1</sup>), consisting of Fe-oxyhydroxides (goethite, hematite); kaolinite and quartz. The metal contents of the estuarine soils, especially the surface layers, indicate trace metal enrichment caused by the tailings. However, the metal contents were below threshold levels reported in Brazilian environmental legislation. Despite the fact that only a small fraction (<2%) of the metals identified are readily bioavailable (i.e. soluble and exchangeable fraction), trace metals associated with Fe oxyhydroxides contributed between 69.8 and 87.6% of the total contents. Control of the trace metal dynamics by Fe oxyhydroxides can be ephemeral, especially in wetland soils in which the redox conditions oscillate widely. Indeed, the physicochemical conditions (Eh < 100 mV and circumneutral pH) of estuarine soils favor Fe reduction microbial pathways, which will probably increase the trace metal bioavailability and contamination risk.

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