

Metal mobility in river and sea sediments affected by mine drainage (Sestri Levante, Italy)

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The Gromolo Torrent is a metal-polluted Apennine streamflow located near Sestri Levante (Liguria, Italy). It springs from the Monte Rocca Grande (850 m a.s.l.), and flows for 11.5 km through the Gromolo Valley before flowing into the Ligurian Sea. Inside the Gromolo basin is located the abandoned Fe-Cu mine of Libiola, which was the most important sulfide deposit of the Ligurian Apennines. In this mining site, extensive Acid Mine Drainage (AMD) processes are active, both inside the mine tunnels and in the sulfide rich waste-rock dumps; the solutions generated are characterised by low pH values and high amounts of dissolved SO₄²⁻, Fe, and other chemical elements such as Cu, Zn, Pb, Al, Co, and Ni. Moreover, extensively precipitation of Fe and Cu-rich secondary minerals occurs both as soft crusts inside the mine adits and as loose suspensions associated with overland flow of mine drainage. AMD waters flowed into the uncontaminated Gromolo Torrent where abundant precipitation of amorphous Fe(III)-oxy-hydroxides occurred.

The marine study area is characterised by the presence of the headland of Sestri Levante with two bays, the western one named "Baia delle Favole". The dynamics of the area is dominated by a permanent north-westward off-shore current flowing approximately along isobath, and an eastward counter-current along the north coast with a resulting drift of the coastal materials from the West to Est towards "Baia delle Favole". The bottom sediment are principally characterised by coarse materials, mostly consisting of fine sand, with a percentage of the fine sediment increasing inside the bay, where the dynamics is low.

The aims of this work are to 1) evaluate the metal mobility of colloidal river precipitates for about 7 km up to its mouth in the Ligurian Sea; 2) verify the contamination state of the marine bottom sediments off the mouth of the Gromolo Torrent ("Baia delle Favole" of Sestri Levante), and 3) identify the main sources and diffusion ways of contaminants based on the dynamics of the area, the mineralogy, and the sedimentary characteristics of the bottom sediments.

The results evidenced that amorphous, metal-rich colloidal precipitates are present along the entire course of the Gromolo Torrent until its mouth and control the dispersion of metals in the stream bed sediments. In particular, the observed concentrations of Cu, Zn, and Cd are at least ten times higher than the background values. Other elements, such as Pb, As, and Sb, were linked with human activities, as their concentrations increased as the Gromolo Torrent flowed across the town of Sestri Levante. In the marine bottom sediments, the results showed the existence of a high contamination in Cd, Cu, Ni, and Zn inside the bay deriving directly from the input of the Gromolo Torrent, and strongly influenced by the dynamics of the area.