MULTI-PROXY CHARACTERIZATION OF THE SUBMERGED MINE TAILINGS DEPOSIT OF PORTMÁN BAY, SE SPAIN

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Abstract

The Portmán Bay represents one of the most extreme cases in Europe of the impact of mine tailings dumping on the marine ecosystem. During a period of 33 years, the mining activity in this region generated about 57 million tons of tailings that were disposed directly into the sea, infilling the bay and extending offshore along the continental shelf. In this work, we present a multi-proxy characterization of the mine tailings deposit carried out through fifty-eight sediment cores recovered from the submerged deposit, using high resolution micro X-ray computed tomography, elemental chemical composition X-ray fluorescence and laser diffraction particle size analysis. Bulk density and grain size along with the content of metals have allowed investigating the physical properties and composition of the deposit's upper layers.

Keywords: South-Western Mediterranean, Metals, Sediments, Coastal systems, Pollution

The Sierra de Cartagena mining district was exploited since the 3rd century B.C. due to its high density of Pb-Zn ore deposits. However, intensive exploitation occurred during 1957-1990 when started the open-pit mining activities. During this period, large volumes of ores were transported to the Lavadero Roberto plant where Pb and Zn minerals were selectively separated and concentrated. A large volume of tailings (57 million tones) were generated and pumped directly into the sea leaving behind hazardous (metal-rich) artificial soils and sands, moving the shoreline 500–600 m into the sea [1]. At present, sediments from the filled bay are enriched in Zn, Pb and As, but there is not any record that could confirm the metals concentration in the submerged deposit. The aim of the present study is to characterize the distribution of the submerged mine tailings deposit in the inner continental shelf in front of the Portmán Bay.

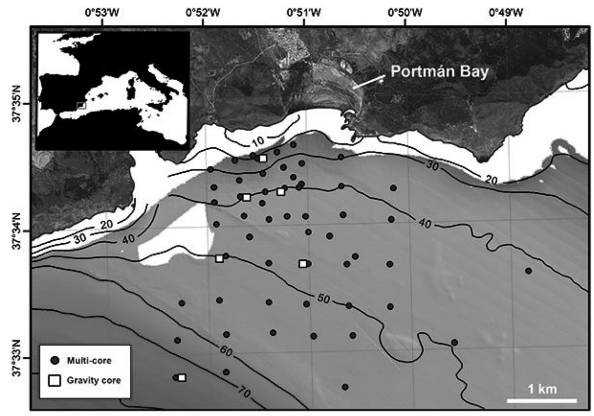

Fig. 1. General bathymetric map of the study area with contours every 10 m and location of multicore and gravity core stations.

Fifty-two short (up to 45 cm) sediment cores were collected with a multicorer system in August 2014, and six gravity cores (up to 300 cm) were collected in March 2015 within the framework of the MIDAS and NUREIEV projects (Fig. 1). All sediment cores were analyzed by two non-destructive techniques, the X-ray micro Computed Tomography (µCT MultiTom Core, X-Ray Engineering) for high-resolution analysis of 3D density changes and X-ray fluorescence core scanner (XRF, Avaatech) for determining the elemental chemical composition. Furthermore, grain size analyses were performed using a laser diffraction particle size analysis (Beckman Coulter LS230). Two depositional periods can be distinguished from the detailed sedimentary profiles of most of the sediment cores. Taking a reference core, the uppermost 20 cm layer shows quite homogeneous black sediments, with abundant bioturbation,

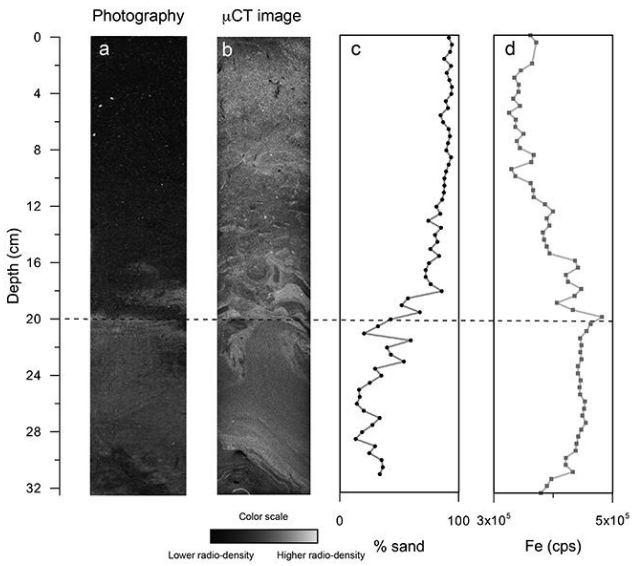

Fig. 2. Data from reference core MP-MC-05. (a) Photography; (b) µCT image; (c) Sand percentages; (d) XRF core scanner Fe content distribution (cps). Dashed line indicates the limit between the two depositional periods.

characterized by high percentages of sand, and relatively low, but highly variable, radio-density values (Fig. 2). The bottom layer, in our referece core from 20 - 32.5 cm, shows homogenous dark greenish grey sediments, with no bioturbation, reduced percentage of sands and much more constant radio-density values. Accordingly, these two units are characterized by different elemental composition. Of especial interest is the observed inverse correlation between the Fe content and sand percentages, which both show an abrupt change associated with the two layers limit around 20 cm core depth. Subsequently, and considering the preliminary dating information obtained by ^{210}Pb, our results suggest that the abrupt geochemical and physical changes observed in our sedimentary record could be related to the ceasing of the mining activity.

References

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