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Micro CT characterization of a coastal mine tailings deposit, Portmán Bay, SE Spain

Jaime Frigola (1), Marc Cerdà-Domènech (1), Eduardo Barriuso (1), Anna Sanchez-Vidal (1), David Amblas (1,2), and Miquel Canals (1)

(1) CRG Marine Geosciences, Dept. of Earth and Ocean Dynamics, Faculty of Earth Sciences, University of Barcelona, Barcelona, Spain (jfrigola@ub.edu), (2) Scott Polar Research Institute, University of Cambridge, CB21ER Cambridge, UK

Scanning of sediment cores by means of high-resolution non-destructive techniques provides researchers with huge amounts of highly valuable data allowing fast and detailed characterization of the materials. In the last decades several devoted instruments have been developed and applied to the study of sedimentary sequences, mainly multi-sensor core loggers (MSCL) for the physical properties and XRF core scanners for the chemical elemental composition. The geoscientific community started using computed tomography (CT) systems about two decades ago. These were mainly medical systems as dedicated instruments were essentially lacking by that time. The resolution of those medical systems was limited to several hundreds of micrometres voxel size. Micro computed tomography (micro-CT) systems have also spread into geoscientific research, although their limited workspace dimensions prevents their use for large objects, such as long sediment cores. Recently, a new micro-CT system, the MultiTom Core X-ray CT, conceived by University of Barcelona (UB) researchers and developed by X-ray Engineering, became operational. It is able of scanning sediment cores up to 1.5 m long, and allows adjustable resolutions from 300 microns down to 3-4 microns. The system is now installed at UB's CORELAB Laboratory for non-destructive analyses of geological materials.

Here we present, as an example, the results of MultiTom scans of a set of sediment cores recovered offshore Portmán Bay, SE Spain, in order to characterize at very high-resolution the metal-enriched deposit generated after 33 years of direct discharge into the sea of mine tailings resulting from the exploitation of Pb and Zn ores. In total 52 short cores and 6 long gravity cores from the mine tailings infilled bay were scanned with the MultiTom system at a mean voxel resolution of 125 microns. The integrated study of micro-CT data allowed differentiating the main tailings units from deposits formed after disposal cessation. Tailings units show higher radio-density values, which correspond to metal enrichments. A lower unit consists of highly laminated interbedded low radio-density and very high radio-density layers, while an upper mine tailings unit is more homogeneous and shows intermediate radio-density values. The limit between the tailings and the post-mining deposits is defined by a sharp surface associated with an abrupt decrease in the radio-densities. Post-mining deposits are also characterized by an increment in bioturbation marks, which are practically absent in the tailings units, and an increase in carbonate particles and organic matter patches. Micro CT scans allow observation of very small structures, which are indicative of the complexity of the sedimentation processes involved in the transport and final deposition of the mine tailings.

Integration of micro CT scans together with XRF core scanner and MSCL data allows a better characterization of the metal concentrations and their distribution within the deposit, directly demonstrating the great value of non-destructive techniques for actually high-resolution sedimentological studies.