



Heavy-minerals: an Italian recipe for source to sink analyses

Sergio Andò, Eduardo Garzanti, Mara Limonta, Alberto Resentini, Chiara Ileana Paleari, and Guido Pastore
Milano-Bicocca, Earth and Environmental Sciences, Milano, Italy (sergio.ando@unimib.it)

Heavy-mineral analysis represents a quantitative and valuable tool in high-resolution provenance study of modern and ancient sediments. New ideas in the preparation and analysis of silt and sand mineralogy open up a new frontier in the exploration of sedimentary sequences in the deep ocean. After the analysis of sediments cored during IODP Expedition 355 in the Laxmi Basin deposits, mineralogical analyses were carried out to investigate and quantify the different compositional signatures of sand and silt fractions. Heavy minerals were recognized with a single grain approach, coupling classical polarizing microscope with innovative Raman spectroscopy methods, to better identify species commonly found in sediments and their source rocks and related source area. Such single grain protocol is crucial in provenance studies and source to sink reconstruction of complex systems, like the Indus Fan, where the sediment cored is generated thousands of kilometers away from the sampling area. Reliable quantitative results, even in the medium to fine silt classes, which represent the dominant sediment sizes encountered in the recovered cores, are a priority and can be obtained by point-counting of single grains under the microscope assisted by a micro-Raman spectrometer. Raman spectroscopy allows us to identify silt-sized grains down to the size of a few microns with the same precision required in quantitative provenance analysis of sand-sized sediments.

First data from the studied turbidites document not only a rich and diverse heavy-mineral assemblage in both sand and silt fractions and open up a new age in varietal studies of amphibole, epidote, and garnet. A wide, unexplored, field of Raman spectroscopy applied to provenance studies is discussed, pointing to the potential information stored in sediments and not yet truly explored. We can routinely apply a protocol to distinguish within the isomorphous series of garnet, and diverse pyralspites and ugrandites are distinguished by the position of characteristic peaks (873–880 cm^{-1} in ugrandites, 907–926 cm^{-1} in pyralspites). Raman discrimination of amphibole and epidote-group varieties is also possible and the diagnostic position and shape of the most intense OH group stretching bands (frequencies between 3600 and 3700 cm^{-1}) are particularly helpful. Metamictic state of zircon population encountered both in silt and sand fractions can be identified and coupled with their absolute age. The creation of an appropriate data base of Raman spectra of detrital minerals is essential to apply routinely this method in future provenance studies of deep-sea sediments. Such a new methodological approach plays a key role in the unveiling of dissimilarities among diverse sources of detritus and opens up a new frontier for future studies of the largely unexplored marine sedimentary record unravelling the differences and similarities with sediments eroded in the source area.