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Temporal changes of environmental impact in the coastal marine area in front of a former mining zone, detected by means of benthic foraminifera

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Benthic foraminifera are increasingly used to assess environmental quality of present and past marine environments. They are suitable for the study of ancient environments because their hard and small shells are preserved and abundant in sediment and an adequate number of them can be collected by small samples of sediment cores, supplying reliable data for a statistical approach. The study of foraminiferal assemblages, associated to sediment abiotic parameters, allows to define the anthropogenic impact along the time; reference conditions may be recognized in deep uncontaminated levels.
The Sulcis Iglesiente Guspinese area (SW Sardinia, Italy) was affected in past times by intensive mining, which started in mid 19th century and ceased in 1990s. The marine area of Cala Domestica is located few kilometers from the mining district, where mainly galena and sphalerite were exploited. The area houses buildings for storage of minerals receives drainage material from mineral dumps determining a strong enrichment for several metals in the coastal sediments.
Sediment core SI/69 was collected by means of vibrocorer in front of Cala Domestica beach, during a vast sampling survey aimed to environmental characterization of marine sediments. The core was subsampled in the laboratory, and a total of 28 levels were collected. Microfaunal, grain size and chemical (As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Zn) analyses were carried out on different aliquots of the same level. The quantitative analysis on benthic foraminifera was based on the count of at least 300 specimens per sample. Faunal parameters such as Foraminiferal Number (FN i.e. number of specimens / 1 g dry sediment) and species diversity ([U+F061] - index and H-index) were considered as potential indicators of environmental status.
Principal Component Analysis (PCA) showed a group of strongly correlated metals (Ba, Cd, Cu, Hg, Mn, Pb and Zn), associated to the superficial samples. These elements displayed a typical profile along core depth, characterized by low steady concentration in the lower part of the core, and increased values in the upper 20 cm. This pattern, which displays for most elements the highest concentrations in the top level, may be considered as influenced by anthropogenic enrichment. Quantitative faunal data were compared with concentrations by means of Canonical Correspondence Analysis (CCA) to highlight the effects of contamination on biota. It highlighted the pollution-tolerant character of some foraminiferal species, which are nearly exclusively present in the upper 20 cm core interval. Moreover, CCA demonstrated that FN was negatively affected by the anthropogenically enriched metals.
Foraminiferal assemblages do not show major changes along core depth and high species diversity would suggest, in general, a good environmental status through time. Nevertheless, the comparison of assemblages from the contaminated upper core interval with reference conditions of the pre impacted interval, reveals that heavy metal pollution determined the increase of the pollution-tolerant taxa and a great decrease of foraminiferal abundance. Consequently, a comprehensive degradation of the ecological status referable to mining activity and dumping was recognized in this study.