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Ecological response of benthic foraminifera to the acid drainage from mine areas. An example from the Gromolo torrent mouth (Eastern Ligurian Sea, Italy)

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Benthic foraminiferal assemblages react in short time to natural and anthropogenic environmental changes and, for this, they are considered as reliable indicators of environmental quality. An interesting application of these indicators is the study of their response to environmental changes in coastal marine areas, affected by dismissed mines and dump areas.
The Libiola Fe-Cu sulphide mine was intensively exploited in 19th and 20th centuries, and the activity ended in 1962. The sulphide mineral assemblages consist of pyrite and chalcopyrite, with minor sphalerite and pyrrhotite, in a gangue of quartz and chlorite. The sulphide ore occurs within the Jurassic ophiolites of the Northern Apennines which were subjected to metamorphic and tectonic processes during the subsequent Apennine orogenesis. Waters circulating in the Libiola mine area, and discharging in the adjacent streams and creeks, are strongly polluted due to the diffuse occurrence of Acid Mine Drainage processes. The Gromolo torrent collects these acidic waters enriched of heavy metals which flow into Ligurian Sea.
The study area is characterised by a shelf with a gentle slope, mainly constituted by sediment supplied by Entella torrent. The general circulation has trend from East to West and the coastal drift is generally eastwards.
A total of 15 marine sediment samples (upper 2 cm) were collected by means of Van Veen grab in the coastal zone close to the Gromolo mouth and analyzed for living (rose Bengal stained) and dead benthic foraminifera, together with grain size, metals and trace elements, and metal fractioning. Quantitative foraminiferal parameters, like as abundance, species diversity, heterogeneity and assemblage composition, were determined and evaluated for environmental purpose. Additionally, possible increase above the natural background level of deformed specimens was considered as indicative of metal contamination.
The grain-size analyses highlighted mainly sandy sediments, characterized by a small pelitic fraction, ranging from 0.5% to 28%. Sediments are greyish, usually very fine-grained, with infrequent organogenic fraction. The mineralogical composition is based on dark green grains of serpentine nature, sometimes fibrous, with spread inclusions of magnetite, associated with lithic sandstone, dark gray shales, gabbros, fragments of quartz, feldspar, serpentine and chlorite. Metal concentration shows, in the whole study area, high concentrations of As, Cr, and Ni while, in the samples close to the Gromolo mouth, high values also for Cu, Co, Zn, Pb, Hg, and Cd were recorded.
The foraminiferal study highlighted several samples with very low abundance, especially in the coastal belt between Gromolo and Entella torrents. Slightly higher abundance was recorded close to the Gromolo mouth, where sediments are strongly characterized by Ammonia. Both living and dead assemblages displayed low diversity and high dominance with Ammonia beccarii which accounts up to 66% of total abundance. Moreover, percentage of deformed specimens generally exceeded the natural background reaching 5%. All these aspects are clear evidence of an environmental stress.