GEOCHEMISTRY OF TRACE ELEMENTS IN SEDIMENTS OFF THE SOUTHERN MEDITERRANEAN COASTAL ZONE: AN ASSESSMENT OF POTENTIAL RISKS

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Abstract
The present study provides an initial assessment of nine heavy metals (Cd, Cr, Co, Cu, Fe, Mn, Ni, Pb and Zn) distribution in 34 sampling sites from Egypt and Libya representing special Mediterranean seaside areas that cover contrasting topography, geology, sediments and human impacts. The ecological risks were assessed, and the pollution sources were identified to provide valuable information for environmental impact assessment and pollution control. Both the ecotoxicological index method and the potential ecological risk index (RI) suggested that the combined ecological risk of the studied metals may be low in the Egyptian Mediterranean coast, while the Libyan Mediterranean coast was at medium ecological risks. Multivariate analysis (Principal component analysis, cluster analysis) and correlation matrix were used in this study.

Keywords: South-Eastern Mediterranean, Geochemistry, Trace elements, Sediments

Introduction
Rapid industrialisation and uncontrolled urbanisation around many cities and coastal areas have brought alarming levels of pollution to aquatic environments because of their anthropogenic inputs. Trace metals are considered as serious inorganic pollutants because of their toxic effects on life in aquatic system, having a high enrichment factor and slow removal rate [1]. To date, many methodologies have been developed to assess ecological risks of trace elements. However, most of them are suitable only for ecological assessment of a single contaminant (e.g. Geoaccumulation index method and Enrichment factor). In reality, trace elements usually accumulate simultaneously and cause combined pollution. To address this, Hakanson (1980) [2] developed the potential ecological risk index, which introduced a toxic-response factor for a given substance and thus can be used to evaluate the combined pollution risk to an ecological system [2]. On the other hand, mean Sediment Quality Guidelines quotient (mSQGQs) has been developed for assessing the potential effects of contaminant mixtures in sediments. The aim of the present study was to: (1) characterize the concentration and distribution of some trace elemnts in the Southern Mediterranean Sea sediments. (2) provide a better understanding of the potential ecological risk levels of some heavy metals by applying the Potential Risk Index Method. (3) investigate the biological effects of some heavy metals concentrations using available Sediment Quality Guidelines (SQGs); and (4) identify the sources of the heavy metals using multivariate statistical analyses.

Study area
Thirty four surfacial sediment samples (0–5 cm depth) were collected from different selected stations along the Southern Mediterranean Sea from Egypt and Libya using Peterson grab sampler (Figure 1). Sampling sites were selected to cover the expected polluted area due to industrial and other activities.

Fig. 1. Study area

Materials and Methods
A concentrated acid digestion protocol according to Oregioni and Aston [4] was followed and the digested solution was diluted accordingly and measured for Cd, Cr, Co, Cu, Mn, Fe, Pb, Cd, and Zn using an atomic absorption spectrophotometer. Reagent blanks, parallel replicates, and a standard reference material (IAEA-405: estuarine sediment, International Atomic Energy Agency, Vienna, Austria) were incorporated in each digestion batch for quality control and quality assurance. Recovery rates of the selected metals ranged from 90.3 to 104%.

Results and Discussion
Risk assessment showed that Cd had the highest ecological risk (Er=21.52) and (Er=835), followed by Pb (Er=3.01) and (Er=9.09) for Egyptian and Libyan Mediterranean coastal sediments, respectively. While Zn and Mn had the lowest ecological risk (Er=0.23) and (Er=0.03). Both the ecotoxicological index method and the potential ecological risk index (RI) suggested that the combined ecological risk of the studied metals may be low in the Egyptian Mediterranean coast, while the Libyan Mediterranean coast was at medium ecological risks. Multivariate analysis (Principal component analysis, cluster analysis) and correlation matrix were used in this study. Highly significant correlations were found between the concentrations of Cd, Co, Cu, Mn, Ni and Zn in the sediments of the Libyan Mediterranean coast suggesting similar sources and/or similar geochemical processes controlling the occurrence of these metals in the sediments. On the other hand, highly significant correlations were found between Fe, Mn, Co, Cr, and Ni in the Egyptian Mediterranean coastal sediments. This study supports metal pollution monitoring and control for the Egyptian and Libyan Mediterranean coastal environment. It will be a useful tool to authorities in charge of sustainable marine management.

References
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