HEAVY METAL DISTRIBUTION IN THE SUPERFICIAL BOTTOM SEDIMENTS OF THE NORTHERN CONTINENTAL SHELF OF CRETE

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Abstract

This study examines the dispersion of heavy metals (Cu and Ld), as pollutant indicators, in the surface sediment of the inner shelf of the north coast of Crete (Gulfs of Heraklion and Malia) on the basis of their source points, in land, and the general circulation of surface shelf waters. Increased values of Cu and Ld have found at the western part of the Heraklion Gulf, close to their terrestrial source, whilst increased values in the Gulf of Malia have been attributed to the presence of an anticyclonic circulation.

Keywords : Cretan Sea, Lead, Metals, Sediments.

Introduction

The major contribution of anthropogenic metals in a marine coastal area is of terrestrial origin, (mining, industrial, and urban developments) and other human practices near rivers and estuaries [1]. The scope of this work is to investigate the dispersion of trace metals in the sea floor sediments and to correlate their spatial abundance to offshore water circulation patterns and the location of their sources.

Study area and sampling procedure

The study area is located in the northern coast of the Island of Crete (South Aegean) including the Gulfs of Heraklion (to the west) and Malia (to the east). Sediment samples for all analyses were collected on a seasonal basis along 93 stations, which were located from the continental shelf and in depths from 30 m to 100 m (Fig. 1).

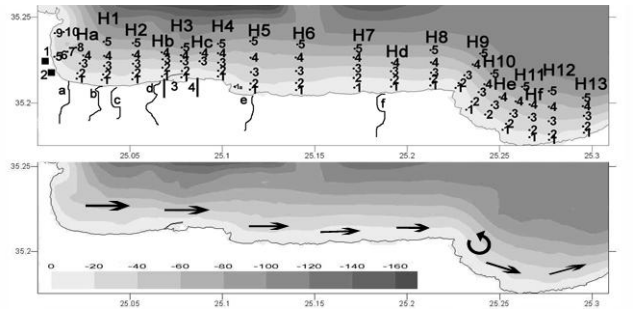

Fig. 1. Study area, sampling stations, bathymetry, schematic circulation, pollutant sources (1:Fuel and cement silos, 2:Power plant, 3,4:Biological waste treatment plant), major torrents (a:Almiros, b:Gazanos, c:Xiropotamos, d:Giofiros, e:Karteros, f:Aposelemis).

The local coastal circulation depends weakly upon the prevailing wind conditions and is mainly dictated by the bottom topography and the general circulation of the Cretan Sea. From re-analysis of existing current meter records in the region, we conclude that local currents appear to be relatively weak ($\sim$10 cm/s). The main direction of variability is along isobaths. Although during spring and summer flow exists in both directions, during the rest of the seasons currents propagate towards east. Moreover this is the sense of flow of the residual circulation. Finally, within the gulf of Malia, an anti-cyclon is present and influences the local circulation.

The area under investigation receives urban sewages and industrial wastes from the nearby coastal zone, including the influxes of 6 torrents, and in particular from the harbor and airport of the city of Heraklion. Besides, in the western section there are petrol, oil and cement storage silos, whilst at its central and eastern part has gathered the majority of the tourist industry in Crete Island.

Methodology

For the quantitative analysis of the trace metals, the sediment from each station was separated with a plastic sieve in two fractions: sand (>63μm) and the silk-clay (<63μm) to achieve satisfactory degree of normalization of the results; this is for the comparison between concentrations of different stations with non-homogeneous sedimentological characteristics [2].

The trace metals analysis was made by humid digestion with dense HNO_3 and H_2O_2 and the engagement of the metals with nitric ions. The concentrations of the metals (copper, zinc) were determined with the method of atomic absorption (AAS, PE4100ZL) and correction at Zeeman. Subsequently, the total stockings of metals were determined and the seasonal average of their concentration has been calculated.

Results

The measured concentrations of Copper and Lead show that there are high values for both metals (Cu: 40-117ppm and Pd: 20-60ppm) in the eastern part of the study area and in depths 30-40m. For the Lead there are even higher values in the area seawards of the Heraklion harbor. Their values then reduce eastwards until the Malia gulf where there are some stations with relatively higher values H9.3 (29.50ppm), H9.4 (17.02ppm), H10.3 (19.32ppm)-H10.4 (16.09ppm), He.3 (16.91ppm), He4 (13.42ppm), H12.2 (11.18ppm) and H12.5 (25.32ppm) for Cu and H9.3 (25.79ppm) H9.4 (23.10ppm), H9.5 (19.73ppm), H10.3 (12.13ppm), H10.4 (15.08ppm), He.2 (15.48ppm), He4 (16.98ppm) and H12.5 (17.42ppm) for Pd (fig2).

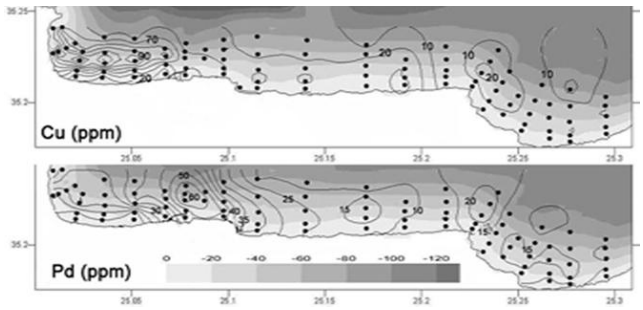

Fig. 2. Copper and Lead concentrations in ppm.

This distribution pattern is explained by the offshore circulation that incorporates an eastward water movement that transport trace metals eastwards away of their sources, reducing their concentrations. On the other hand, the presence of an anticlockwise gyre in the Malia gulf entraps the trace metals and increases, therefore, their concentrations are increased.

References

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