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GEOCHEMISTRY OF SHORT CORE SEDIMENTS OFF ALEXANDRIA

GEOKEMIJA POVRŠINSKIH SEDIMENATA U VODAMA PODRUČJA ALEKSANDRIJE

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Short core samples were collected from the coastal waters of Alexandria region during July 1986. Man-made and natural impact on sediments was reflected on the enrichment of metals in the top layer of cores sampled off the Nile River estuary. Organo-metallic associations control enrichment of metals in core samples.

INTRODUCTION

Since the early of this century, the shelf sediments of the Egyptian coast, especially those of the Nile delta, have been the interest of several geological surveys. Texture, chemistry, minerology and microfauna were of primary importance for these investigations. Apart from the long core samples collected during the Swedich Deep-Sea Expedition (1947—48), R/V Albatross and R/V Vema in the late-fiftees along the Egyptian coast, attention was only focused to the characteristics of the surficial sediments.

Since most of metal input into rivers is retained into sediments, thus sediments could be regarded as a historical reflection to changes occurring in the overlying water system. In the present study we tried to follow up the concentrations of some metals in short core samples collected off the Nile River estuary to provide some insight into the retention of metals by sediments and record the increased loading of metal polution in the Nile River estuary.

MATERIAL AND METHODS

During July 1986, short core samples (18—30 cm) were collected from three diffferent locations west and east of Alexandria region (Fig. 1). Station I represents the bottom of a highly oligotrophic coastal water system (24 m depth west of Alexandria city, while station II represents the mouth of

Rosetta Nile branch (13 m depth). Station III was sampled at about 25 km (60 m depth) offshore from station II to represent the corresponding stratification at offcoast location.

Collection of samples was carried out using a Phleger core. After collection samples were kept freezed at -18°C. Organic carbon was determined according to El-Wakeel and Riley (1957) while the method described by Presely (1975) was used for determination of total carbonate content. Total concentrations of Al, Fe, Mn, Cu and Ni were determined using AAS according to the method described by Tessier *et al.* (1979). The accuracy of the analytical methods were tested against Standard River Sediments 1645 from NBS and were found satisfactory i. e. C. V. 2—5% from accepted values. The analytical precision of quadriplicate analysis were AL (5%), Fe (6%), Mn (4%) Cu (5%) and Ni (3%).

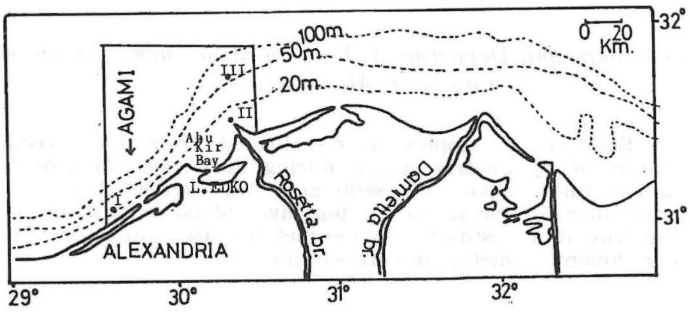

Fig. 1. Study area

RESULTS

Figure 2 represents the vertical profiles of organic carbon, total carbonate as well as the studied elements in sediments cores sampled from the three selected stations. Generally, considerable variations appear between the levels recorded for the inshore stations (El-Agami I and Rosetta II Comparatively higher carbonate levels i. e. 32—51% were observed at El-Agami station while the carbonate concentration in Rosetta II inshore station do not exceed 11%. The average ratio of carbonate for inshore to offshore samples in Rosetta region was 0.6 : 1 indicating the decrease of carbonate content of sediments seawards.

However, organic matter showed a reversed trend to that of carbonate with higher values for Nile sediments (average 1.37—1.74%) compared to 0.75% observed at station I (El-Agami) west of Alexandria region.

The enrichment of all studied elements was observed in the top layer of core samples (Figure 2) collected from stations II and III. Surface enrichment was followed by a sharp decrease in metals concentrations after which nearly constant profiles were observed to the core bottom. The gradient of metals decrease with depth was maximum between 3—6 cm for station II but

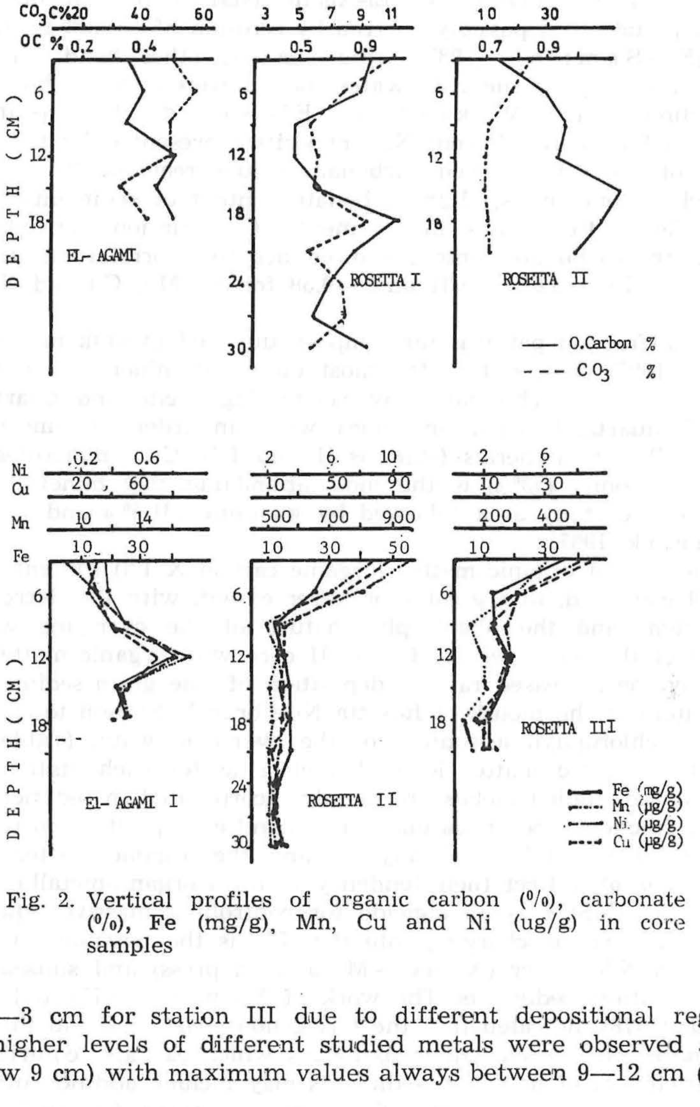

Fig. 2. Vertical profiles of organic carbon (%), carbonate (%), Fe (mg/g), Mn, Cu and Ni (ug/g) in core samples

between 0—3 cm for station III due to different depositional regimes. At station I, higher levels of different studied metals were observed at bottom levels (below 9 cm) with maximum values always between 9—12 cm (Figure 2).

DISCUSSION

The sediment type of different sampled stations is considerably variable. Sediments of station I (El-Agami) is mainly sand (>99%) while those of stations II and III are silt (83%) and sandy (30%) silt (64%). More information about sediments granulometry are given in Table 1. The mean size (Ø) for the sampled stations was linearly correlated with metals enrichment in sediments.

The carbonate formations of El-Agami (station I) west of Alexandria are mainly pseudo-oolit possibly derived by errosion of coastal formations and beaches (El-Sammak, 1987) while, on the other hand, the increased solubility of CaCO3 in the Nile water have lowered the carbonate content of Nile sediments (El-Wakkel and El-Sayed, 1978) as indicated in Rosetta II and III cores. Recent Nile deposits represented by the upper few cetimeters of the core showed carbonate values reaching 2—3 times those of mid and bottom layers. High carbonate content of sediments may act as a diluent factor for metals in sediments. Co-variation between different metals and the carbonate content showed negative correlations in Nile sediments (r = —0.75, —0.62, —0.31 and —0.39 for Fe, Mn, Cu and Ni, respectively).

X-Ray diffraction patterns for samples subjected to bulk mineralogy (El-Sammak, 1987) showed that the most dominant mineral at station I was aragonite followed in abundance by calcite, Mg-calcite and quartz. On the other hand, quartz, feldspar and mica were, in order, the most dominant minerals in Rosetta minerals (stations II and III). Clay minerology indicate that montmorillonite (53%) is the most abundante clay mineral in Rosetta sediments of the study area followed by kaolinite (31.5% and illite (15.5%) (El-Sammak, 1987).

The increase of organic matter (organic carbon X 1.8) content with depth at station I coincided, to a greater or lesser extent, with the decrease in carbonate content and the oligotrophic nature of the overlying waters. The enrichment of the top layer of Rosetta II core with organic matter could be explained by the increased rate of deposition of fine grain sediments rich in organic content at the mouth of Rosetta Nile branch. Station to station variations in the chlorophyll a content of the overlying water (Table 1) reflect arbitrary the organic matter load characteristic for each station and may indicate that the studied metals are mainly incorporated in sediments through the organic fraction. The appearence of a significant positive correlation between the studied metals, especially Cu and the organic matter content of sediments (= 0.66), reflect their tendency to form organo-metallic complexes.

The use of CuSO4 as an algicide for controlling massive aquatic plants in drains and canals discharging into the Nile is the possible source for Cu enrichment in Nile water (Abdel-Moati, in press) and subsequent accumulation in bottom sediments. The work of Moussa (1977) and Emelyanow *et al.* (1978) indicated that the terrigenous part of Cu in the Nile sediments is more pronounced. Other pathways which can also contribute to the relative enrichment of metals in sediments may include addition of weathered and fractioned material from the Nile banks or some diagenetic processing pumping mobile elements from sediments. Additional amounts of heavy metals are introduced into the river branch through domestic and industrial waste discharge derived from fertilizer, food canning and preservation industries.

The downcore profiles (Figure 3) for metals/Al ratio show the characteristic enrichment of pollutant metals in most recent sediments. Compared with the Cu/Al ratio for standard shale i. e. 56×10^{-4} (Turekian and Wedpohl, 1961) the Cu/Al ratio for Rosetta II (0—6 cm) and III (0—3 cm) sediments i. e. 2×10^{-3} — 14×10^{-3} and 11×10^{-3} reflect increasing Cu enrichment in the top core layer. The high retention of metals in surfacial sediments

Table 1. Sediment type and chlorophyll *a* data of overlying water for core samples off Alexandria region.

Location	SAND %	SILT %	CLAY %	TYPE	SORTING σI	SKWENESS SK_{I}	MEAN SIZE Ø	CHL. *a* mg/m³
AGAMI (I)	99	<1	—	sand	WSR	SFSK	2.70	0.21
ROSETTA (II)	10	83	7	silt	PSR	SCSK	6.22	6.00
ROSETTA (III)	30	64	6	sandy sailt	PSR	FSK	5.30	2.50

WSR = well sorted. PSR = poorly sorted. S = strong F = fine C = coarse SK = skewed.

Table 2. Mean and range of Fe, Mn and Cu concentrations in sediments off the Egyptian coast compared to those observed in the present study.

LOCATION	Fe mg/g	Mn μg/g	Cu μg/g	REFERENCE
Rosetta branch	16	104.2	64.1	Draz (1983)
Rosetta mouth	8.32	527—946	44.0	Toma *et al.* (1981)
Nile delta shelf	0.4—9.8	0.0—999	—	El-Sayed (1974)
Alexandria coast	23.6—34.0	—	—	El-Sokkary (1974)
Alexandria east coast	—	—	34.0	El-Sokkary (1978)
Abu-kir bay	1.08—29.4	12—408	N. D.—91.0	El-Nady (1981)
Mex-bay	0.5—3.5	41—308	4.1—69.8	El-Nady (1981)
Rosetta II	31	720	89.0	Present study
Rosetta III	33	510	44.0	Present study
Agami I	18	110	20.0	Present study

indicate the importance of using trace metals vertical profiles in sediments to asses continuous changes in pollutants dumped in the watershed.

The close correspondance of Fe and Mn concentrations as reflected on the significantly high correlation each with the other ($r = 0.95$, $p < 0.001$) indicate that the two metals are related in their mode of deposition. Sorption of Ni from the overlying water on sediments by iron and manganese hydroxides ($r = 0.63$ and $r = 0.752$, $p < 0.01$) may contribute to the significant portion of Ni in the Nile delta sediments.

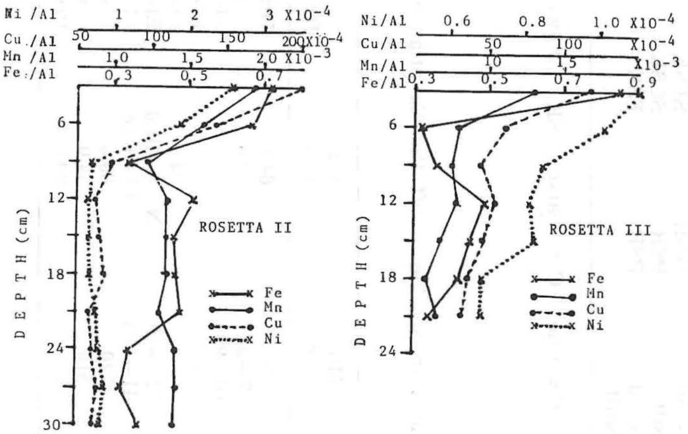

Fig. 3. Metal/aluminium ratio for core samples collected off the Nile delta region

A comparison between the levels of Fe, Mn and Cu observed in the present study and those recorded for the coastal sediments off Alexandria region including samples collected at the River mouth (Table 2) indicate the enrichment of studied metal especially at Rosetta II location. Data for Ni in the area are nearly lacking. The top core concentrations of Fe, Mn, Cu and Ni observed at El-Agami (station I) which lies apart from any land runoff could be considered as background levels for these metals in the nearshore area.

CONCLUSION

The increasing man-made impact on the Nile River estuary is reflected on the enrichment of Fe, Mn, Cu and Ni in the upper few centimenters of core samples. Organo-metallic interaction causes metals enrichment in the surfacial layer compared with the carbonate-rich sediments, the metal concentrations of which are considered as background levels for the area.

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KRATKI SADRŽAJ

Uzorci površinskih sedimenata sakupljeni su u obalnim vodama područja Aleksandrije u toku srpnja 1986. Djelovanje čovjeka i prirodnih činilaca na sedimente ogleda se u obogaćivanju gornjeg sloja površinskih sedimenata metalima u području ispred estuara rijeke Nil.