Acta Adriat., 29 (1/2) : 41—50 (1988)

YU ISSN: 0001—5113
AADRAY

UDK: 546.3 (262.2 : 282.263.1)
Original scientific paper

DISTRIBUTION OF SOME TRACE METALS IN THE MEDITERRANEAN WATERS OFF THE NILE DELTA

DISTRIBUCIJA TEŠKIH METALA U VODAMA DELTE NILA

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Thirtyseven water samples were collected from the Mediterranean waters off the Egyptian coast and analysed for dissolved (0.45 μm) and particulate trace metals, As, Cd, Co, Fe and Mn. On the whole the total concentrations of these metals in the study area were of comparable magnitude with their levels in other Mediterranean regions.

INTRODUCTION

The Mediterranean coastal waters off the Nile Delta (salinity 37.6—38.9‰) receive annually about 13×10^9 m^3 of brackish water from different sources of land drainage including agricultural drain water, industrial and sewage effluents. The role of these sources in enriching the coastal waters with nutrient salts and trace metals has become more important, since the construction of the Aswan High Dam and the subsequent curtailment of the flow of Nile water into the south-eastern Mediterranean (Fig. 1).

The present paper entails results on the levels and distribution patterns of dissolved and particulate As, Cd, Co, Fe and Mn in the Egyptian Mediterranean waters.

MATERIAL AND METHODS

A total of 37 stations covering both the neritic and offshore water between El-Agami (Long. 29°45' E) and El-Arish (Long. 33°40' E) were sampled during April and August 1982. At each station 10—20 l of sea water were collected at 3—5 m below the surface, using 10 l Nisken bottles previously washed with 0.2 N nitric acid. Samples were filtered on board through pre-weighed 0.45 μm nucleopore filters to separate dissolved particulate metals. After the determination of the total particulate matter (TPM), filters with particulate materials were digested in teflon vessels and heated over a thermostate controlled hot plate at 70°C (Tessler *et al.*, 1979). The filtrate collected in acid cleaned PVC stoppered bottles was allowed to pass through chelating resin column (chelex 100 in ammonia form), eluted by 2 N

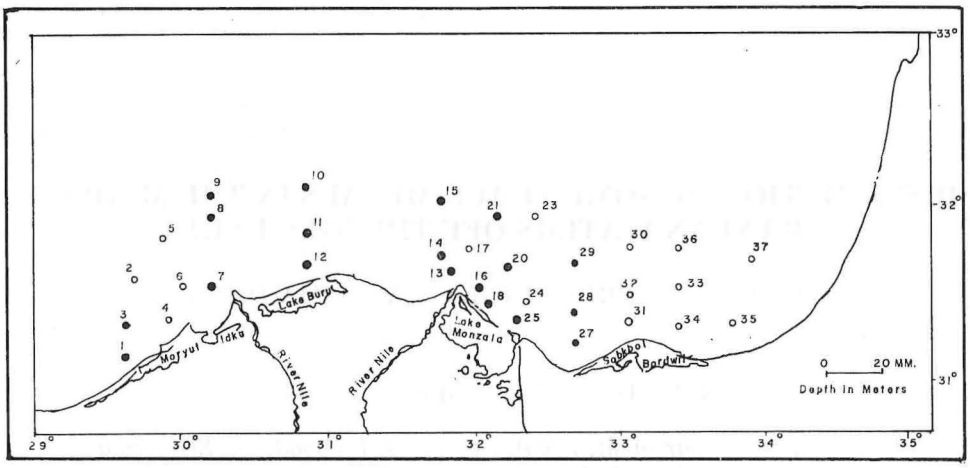

Fig. 1. The study area off the Egyptian coast and the stations sampled, ○ April stations and ● August stations (1982)

nitric acid and further concentrated by evaporation (A b d u l l a h and R o y l e, 1971). The concentrations of dissolved — and particulate As, Cd, Co, Fe and Mn were measured using Model 34000 Inductively Coupled Plasma Emission Spectrophotometer.

The precision and accuracy of the analytical techniques were checked and found satisfactory (percent of recovery ranged between 92—98%). Blanks were below detection limit of the instrument.

RESULTS AND DISCUSSION

The mean values of TPM were about 4 times higher in the inshore region than at offshore stations (Table 1). The input from the different sources of land drainage are responsible for enrichment of the coastal area particularly the eastern region with TPM and trace metals. As shown in Table 1, the total concentrations of nearly all of metals studied were significantly much higher in the inshore than in the offshore waters (figures 2—5).

The mean concentration of total As varied between 0.04 μg/l in the offshore water and 0.073 μ/l in the inshore region. Its concentration was higher in spring than in summer. About 67.5%—74.0% of the total concentration of As occurred in the dissolved form. A direct correlation ($r = 0.96$) was found between the dissolved and particulate forms of this metal (Fig. 6). In the study area the concentration of As was much lower than that reported from other Mediterranean regions. In Rhode Island and Saronikos Gulf the total As varied between 2.0 and 3.5 μg/l (P a p o d o p o u l o u, 1972).

Of the metals studied, the concentrations of Co and Cd were lowest, Both metals were dominantly present dissolved (Table 1).

Table 1. Mean TPM (mg/l), total metal concentration (μg/l), standard deviations and percent of dissolved metals (in parentheses) in the Mediterranean waters off the Nile Delta

	Inshore waters		
	Eastern region	Western region	Offshore waters
	I — April		
TPM	0.44 ± 0.39	0.24 ± 0.13	0.096 ± 0.064
As	0.067 ± 0.03 (71.6)	0.073 ± 0.005 (74.0)	0.044 ± 0.015 (72.7)
Cd	0.020 ± 0.019 (80.0)	0.018 ± 0.011 (77.8)	0.021 ± 0.022 (85.7)
Co	0.026 ± 0.019 (46.2)	0.019 ± 0.008 (73.7)	0.011 ± 0.004 (72.7)
Fe	17.91 ± 26.03 (8.7)	4.26 ± 1.169 (35.9)	3.99 ± 3.87 (35.0)
Mn	1.021 ± 1.60	0.203 ± 0.044 (36.4)	0.165 ± 0.079 (47.3)
	II — August		
TPM	0.317 ± 0,16	0.292 ± 0.19	0.087 ± 0.04
As	0.050 ± 0.11 (72.0)		0.087 ± (67.5)
Cd	0.014 ± 0.005 (72.0)		0.010 (70.0)
Co	0.010 ± 0.005 (78.6)		0.010 (70.0)
Fe	14.015 ± 14.25 (5.7)		0.010 (70.0)
Mn	0.335 ± 0.195 (17.0)		0.321 (21.8)

In the particulate form, the concentrations of both Cd and Co in μg/g were directly correlated with each other and with As according to the following equations:

$$Cd = 0.487 + 0.270\ As$$
$$Co = 26.64 + 0.188\ As$$
$$Co = 25.50 + 0.343\ Cd$$

The concentrations of Cd and Co in the study area were much lower than in other Mediterranean regions. In the western Mediterranean Fukai and Huynh-Ngoc (1976) reported concentrations of Cd varying between 0.05—0.51 μg/l. Roth and Hornung (1971) found Cd concentrations between 0.6—2.9 μg/l in the eastern Mediterranean.

Fe was the mainly dominant element among the metals studied, its total concentration varied between 17.91 μg/l in the inshore region and 3.99 μg/l in the offshore waters. Unlike the forementioned elements, Fe is mostly present in the particulate form, probably as a result of the formation of Fe (III) in the well oxygenated waters. The mean concentrations of dissolved kind varied between 8% and 35% of the total Fe. The lowest value was found in the turbid waters.

The iron concentrations reported in the present study are much higher than the mean values (i.e. 0.25 μg/l) recorded in the open Mediterranean waters (Kremling and Petersen, 1981). This is mostly due to enrichment from the Nile River and lake water inflow. The possibility for contamination by corroded hydrowires is however not excluded.

Manganese was the second abundant element after iron, its mean total concentration varied from 1.021 μg/l in coastal waters and 0.165 μg/l at offshore stations. Like Fe, Mn was mostly present in the particulate form. The ratio of dissolved to total Mn varied from 6.8% in the inshore waters of

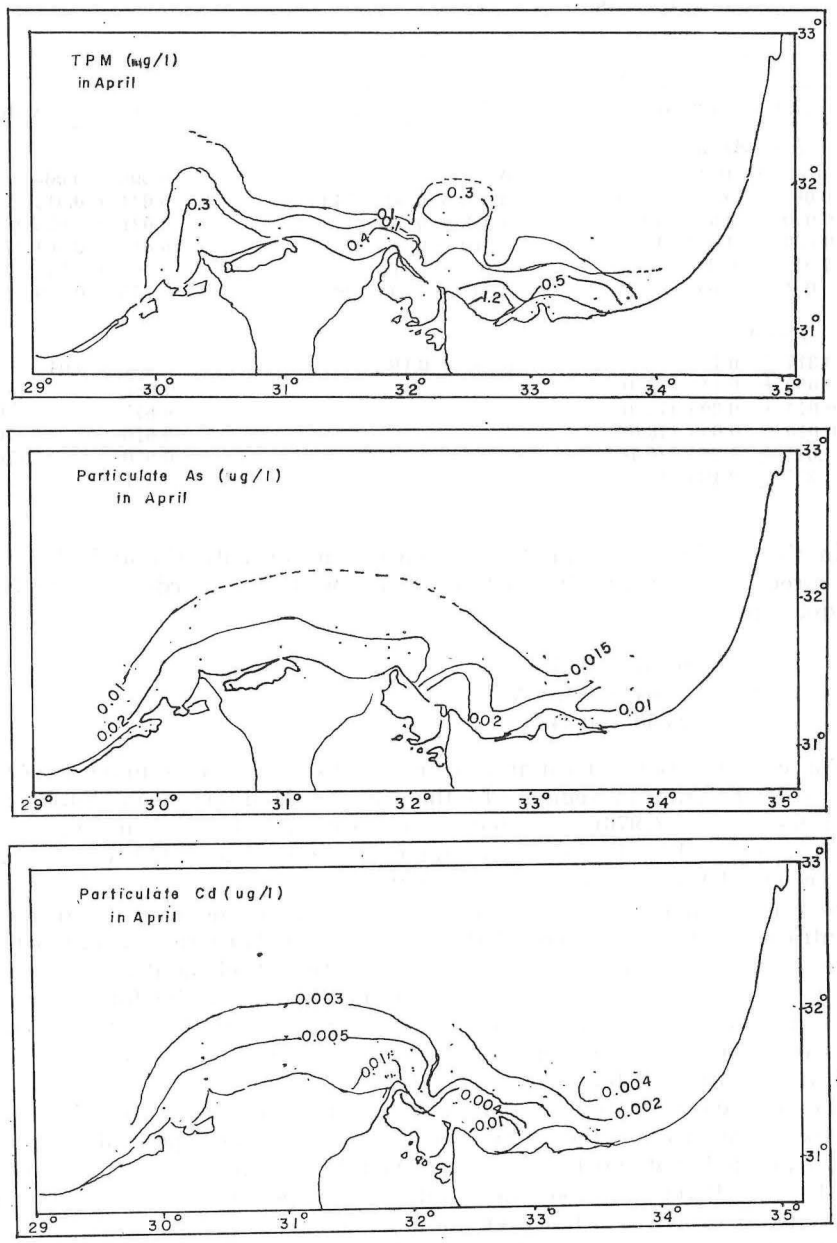

Fig. 2. Distribution of TPM (mg/l), As and Cd (μg/l) in the surface waters of the study area in April (1982)

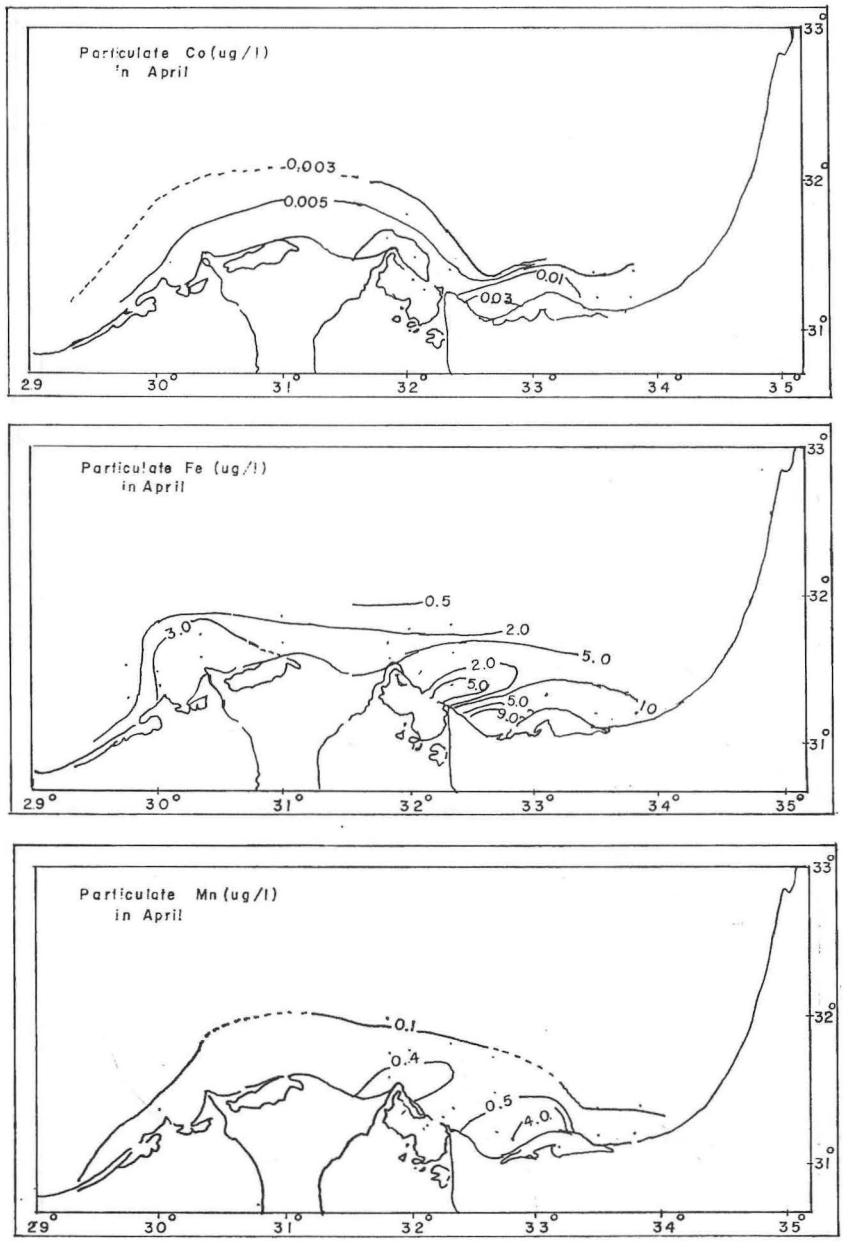

Fig. 3. Distribution of Co, Fe and Mn (μg/l) in the surface waters of the study area in April (1982)

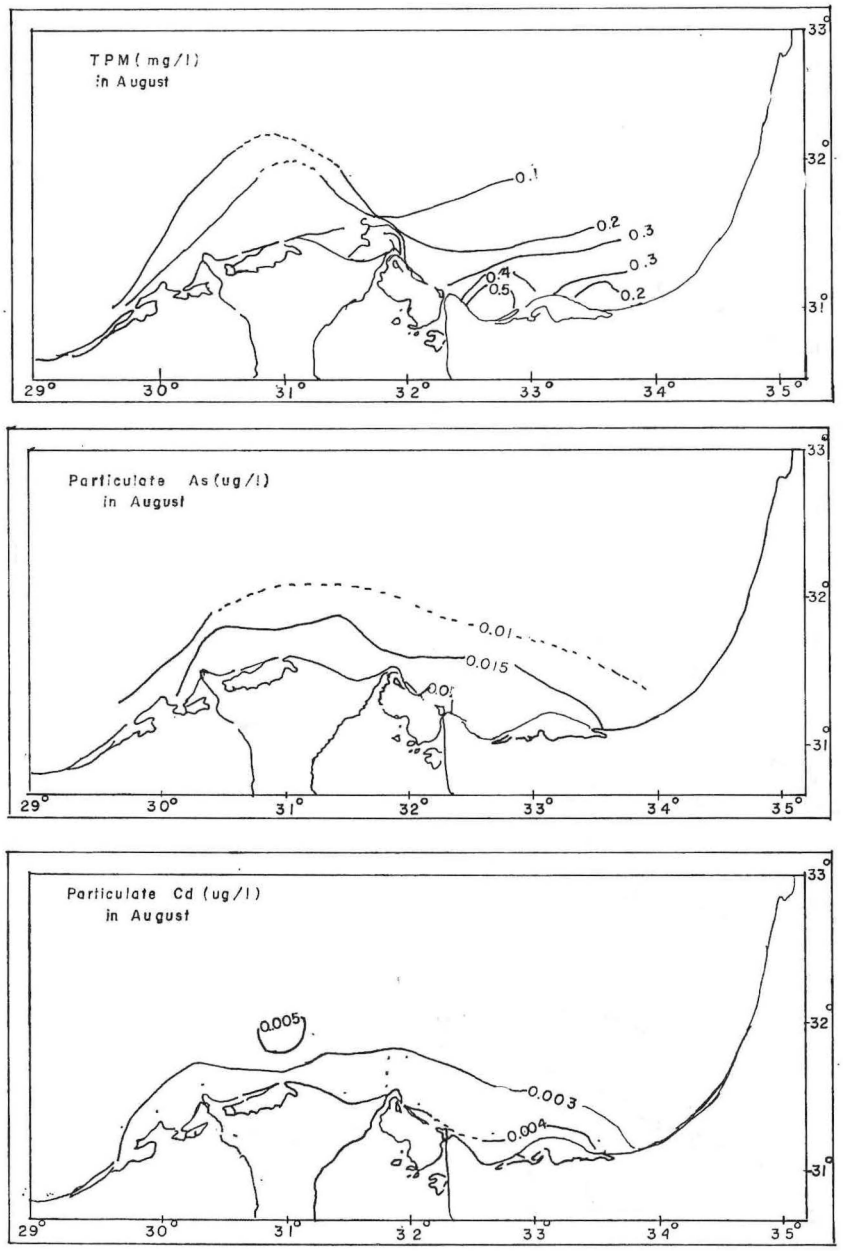

Fig. 4. Distriution of TPM (mg/l), As and Cd (μg/l) in the surface waters of the study area in August (1982)

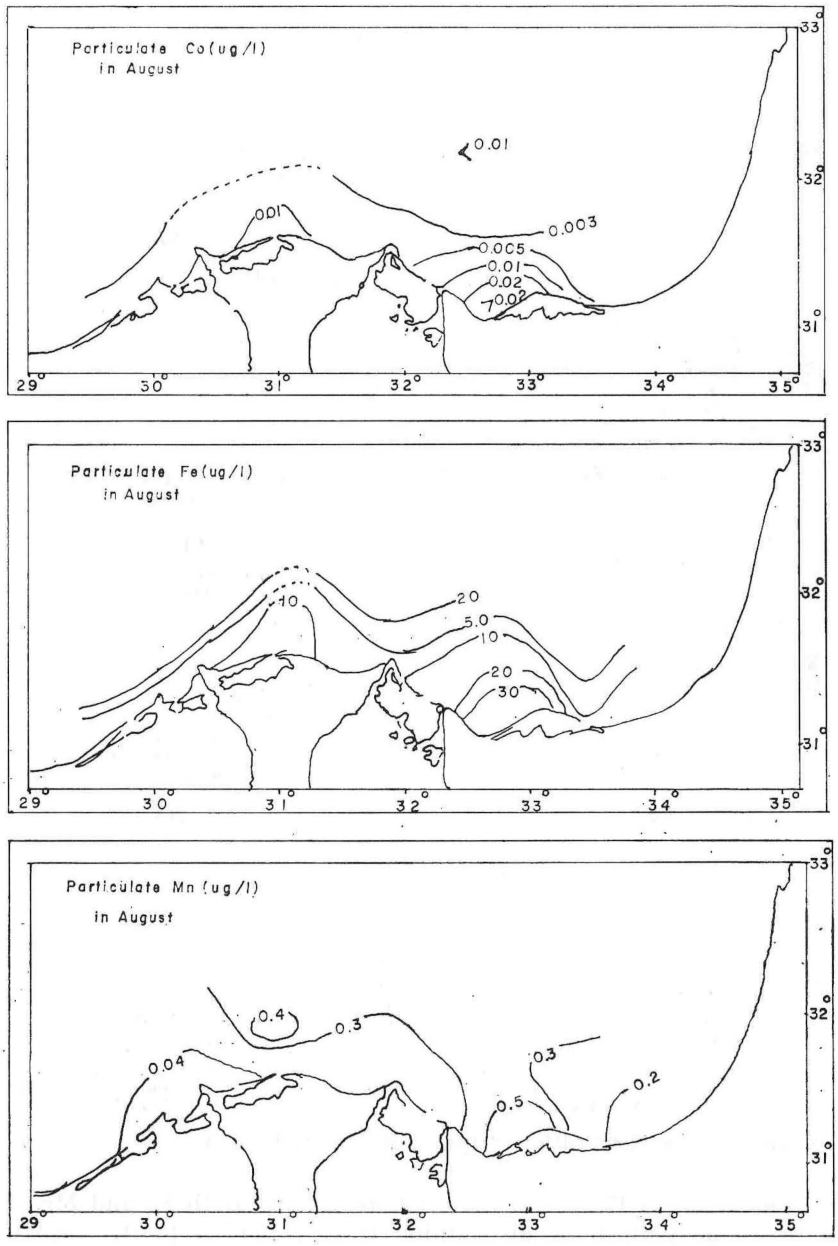

Fig. 5. Distribution of Co, Fe and Mn (μ/l) in the surface waters of the study area in August (1982)

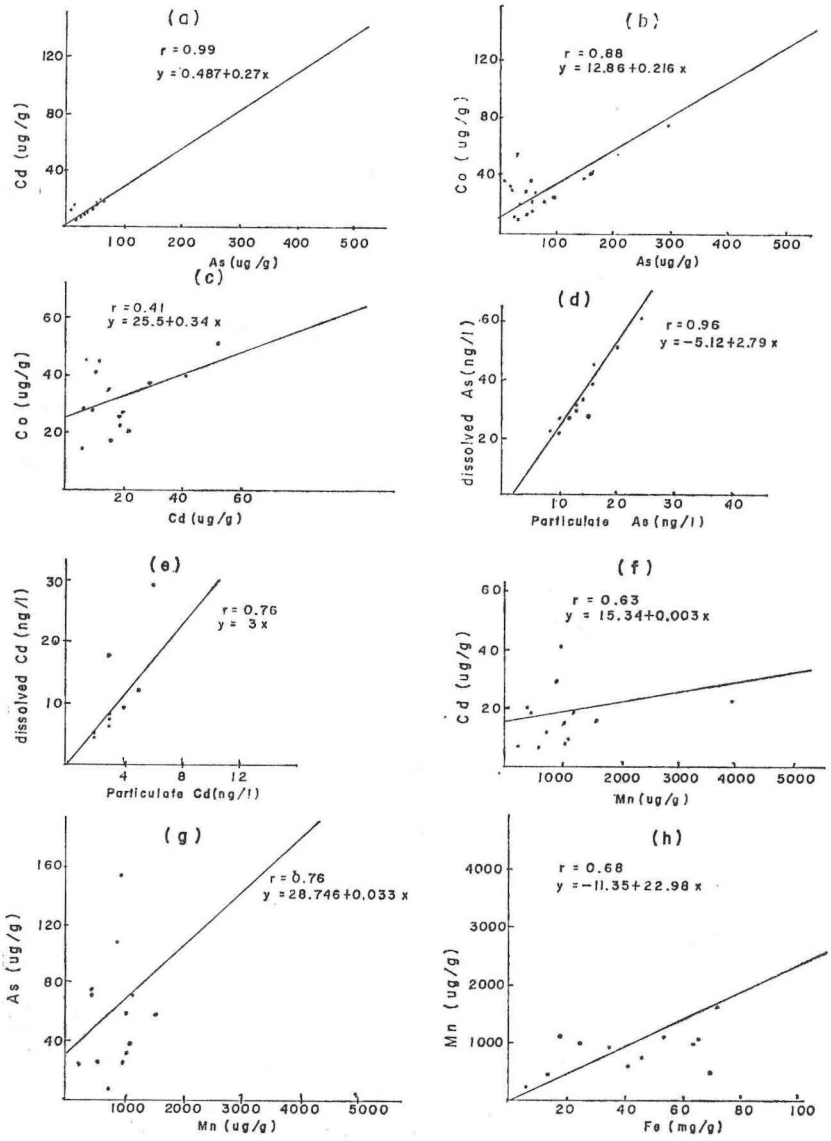

Fig. 6. Correlation between different metals in the study area

the eastern region to 47.30% in the offshore waters. Both Fe and Mn showed nearly the same pattern of distribution (Fig. 1) and a positive correlation ($r = 0.35$) was found between their particulate concentrations.

$$Mn = 939.9 + 0.0216\,Fe$$
$$As = 28.746 + 0.33\,Mn$$
$$Cd = 15.345 + 0.003\,Mn$$

It is to be noted that, the mean and the range of Mn concentrations found in the present study are in good agreement with the results given by Kremling and Petersen (1981) for the open Mediterranean waters off the Egyptian coast (0.48—1.22 μg/l). However, contrary to our results, Kremling and Petersen found that in the open Mediterranean waters most Mn is present in true solution.

In the present study the presence of dissolved Mn increased from inshore to offshore waters and the increase was directly correlated with the decrease in TPM. Kremling and Petersen (1981) believed that the high Mn concentration off the Egyptian coast is mostly due to its remobilisation from deposits of river — borne detritus. However, our results indicate that the high concentrations of most trace metals in the coastal area are mostly of allochthonus origin caused by the discharge of large quantities of brackish waters from the northern Delta lakes. The mean concentration of trace metals (in μg/l) at the lake sea outlet of Lake Manzalah were, Cd, 0.4; Co, 0.74; Mn, 21.0 and Fe, 950.0 μg/l (Dowidar and Abdel Moati, 1984, in press). These metals occur in the adjacent Mediterranean waters in exactly the same order of abundance but with much smaller concentrations. In comparison with other Mediterranean regions (Bernhard, 1978; Kremling and Petersen, 1981), it is obvious, that, except for the high Fe values, the levels of concentrations of trace metals in the study area are within the order of magnitude usually encountered in normal oceanic waters.

REFERENCES

Abdullah, M. I. and L. G. Royal. 1971. The determination of copper, lead, cadmium, nickel, zinc and cobalt in natural waters by pulse polarography. Anal. Chim. Acta, 58: 283—288.

Bernhard, M. 1978. Heavy metals and chlorinated hydrocarbons in the Mediterranean. Ocean Management, 3: 253—313.

Dowidar, N. M. and A. R. Abdel Moati. 1984. Trace metals in Lake Manzalah, VII workshop on Mar. poll. CIESM (in press).

Fukai, R. and L. O. Huynh-Ng. 1976. Trace metals in Mediterranean sea-water. In: Activities of the International laboratory of Marine Radioactivity, Monaco, 1976 Report. Tech. IAEA-187, IAEA Vienna, pp. 122—132.

Kremling, K. and H. Petersen. 1981. The distribution of zinc, cadmium, copper, manganese and iron in waters of the open Mediterranean sea. Meteor Forsch-Ergebnisse, 23: 5—14.

Papadopoulou, C. 1972. The elementary composition of marine invertebrates as a contribution to the sea pollution investigation. »Demokritos« Nuclear Research center, Aghia Parashevi Attikis, Athens. Int. Rep. 17 (mimeo).

Roth, I. and H. Hornung. 1977. Heavy metal concentration in sea water, sediments and fish from the Mediterranean coastal area, Israel. Environmental Science Technology, 2: p. 269.

Tessler, A., P. G. C. Campeil and M. Bisson. 1979. Sequential extraction procedure for the speciation of particulate trace metals. Anal. Chem. 51:

Accepted: June 9, 1988

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KRATKI SADRŽAJ

Uzorci mora iz rijeke Nil, sakupljeni su i analizirani na sadržaj nekih teških metala (As, Cd, Co, Fe i Mn).

Studirana je prostorna raspodjela spomenutih metala kako u vodi tako i partikularnoj tvari. Doiveni rezultati su reda veličine onih iz drugih dijelova Mediterana i svjetskih mora.