

C-II9

Fate of Trace Elements (Co, Sb, Zn) Entering Saronikos Gulf, Greece

N. KALOGEROPOULOS*, M. VASSILAKI-GRIMANI** and A.-P. GRIMANIS**

*National Centre for Marine Research, Athens (Greece)

**Radioanalytical Laboratory, NCRPS "Demokritos", Athens (Greece)

INTRODUCTION

Saronikos Gulf receiving the industrial and domestic wastes of the greater Athens area is among the most polluted gulfs of Greece. In order to study the fates and pathways of trace elements in Saronikos Gulf, several sampling cruises were organised and a big number of seawater and sediment core samples were collected from several stations (See Fig. 1). The trace element content of the samples was determined by Instrumental Neutron Activation Analysis. The results obtained for three selected trace metals namely cobalt, antimony and zinc, are presented and discussed.

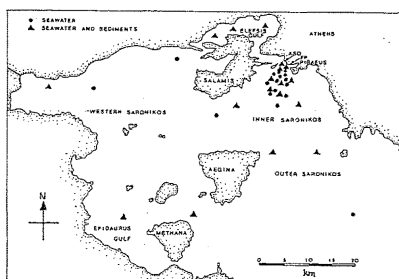


Figure 1. Sampling Stations

DISCUSSION

-The main pollution sources of the trace elements studied are the Athens Sewage Outfall (ASO) and a big Fertiliser Plant (FP) at the entrance of Piraeus Harbour where the highest concentrations of Co, Sb and Zn in seawater and sediments were observed (See Tab. 1 and 2).

-The settling of particles and flocs in the area of the outfall is very effective in removing the bulk of these trace elements from the water column, since their concentrations decrease with distance from the sources to reach those of unpolluted coastal regions at a distance of 5-7 Km. The rapid sedimentation was confirmed by the analysis of particulate matter which revealed that with the exception of the area close to the point sources where 15-25% of total Co, Sb and Zn were found to be associated with particulate matter, the bulk of the elements in seawater were in dissolved forms which constituted 95-99% of their total concentrations in the rest of the stations.

-The concentrations of Co and Sb in seawater and sediments of Inner Saronikos were almost equal to those of the Open Saronikos, while the respective Zn levels were higher in the Inner Gulf. In the water column the higher concentrations were observed in summer samples. The following can be considered as typical concentrations for the waters of open Saronikos: Co: $0.090 \pm 0.014 \mu\text{g/l}$, Sb: $0.23 \pm 0.11 \mu\text{g/l}$ and Zn: $4.8 \pm 3.0 \mu\text{g/l}$. For the open Saronikos sediments the respective values are: Co: $9.2 \pm 0.41 \mu\text{g/g}$, Sb: $0.43 \pm 0.13 \mu\text{g/g}$ and Zn: $83 \pm 5.8 \mu\text{g/g}$.

-A distinction among the point sources was possible by means of sediment treatment with 0.5N HCl, which extracts the "anthropogenic" fraction of trace elements (Agemian and Chau, 1976). It was found that 40-60% of total Zn and Co were in extractable form in the sewage outfall cores, while in sediments affected by the fertiliser plant solid wastes (gypsum, pyrites, phosphorites etc) this fraction was much lower, ranging from 6-18%.

-A correlation study among several trace elements and organic carbon in the "anthropogenic" fraction of the sediments revealed that the easily dissolved iron forms and the organic matter on recent particle coatings affect the distribution of Co, Sb and Zn in the Saronikos sediments. Furthermore, concerning the distribution patterns of trace elements in polluted and not polluted samples, it was documented that Zn and Co in Saronikos Gulf behave in a similar manner with other trace elements of anthropogenic origin like Ag, Cr, V (Kalogeropoulou et al., 1989), while Sb together with As consist a distinct group mainly as a result of their distribution in the polluted samples (Grimanis et al., 1984; 1988).

TABLE 1. Cobalt, antimony and zinc in seawater ($\mu\text{g/l}$). Average values are given in parentheses

AREA	COBALT	ANTIMONY	ZINC
ASO, FP	0.12-0.60 (0.22)	0.60-1.40 (1.0)	9.0-41 (19)
Inner Saronikos	0.03-0.18 (0.10)	0.16-0.55 (0.29)	0.5-19 (10)
Outer Saronikos	0.03-0.16 (0.09)	0.11-0.31 (0.23)	0.5-14 (4.8)

TABLE 2. Cobalt, antimony and zinc in silt-clay fraction of sediments ($\mu\text{g/g}$). Average values are given in parentheses.

AREA	COBALT	ANTIMONY	ZINC
Fertiliser Plant	35-87 (54)	14-100 (60)	840-2100 (1520)
Sewage Outfall	13-24 (18)	6.6-32 (16)	220-620 (430)
Inner Saronikos	8.6-9.6 (8.0)	0.48-0.72 (0.57)	81-110 (91)
Outer Saronikos	7.8-10 (9.2)	0.31-0.60 (0.43)	68-100 (83)

ACKNOWLEDGMENTS The partial financial support of this work by the IAEA (R. Contract E/4544) is gratefully acknowledged.

REFERENCES

- AGEMIAN, F. and A.S.Y. CHAU, 1976. *Analyst*, **101**, 761-767.
 GRIMANIS A.P., D. ZAFIROPOULOS, N. KALOGEROPOULOS and M. VASSILAKI GRIMANI, 1984. *Viles Journ. Etud. Pollution, Lucerne, CIEM*, 391-397.
 GRIMANIS A.P., N. KALOGEROPOULOS and M. VASSILAKI-GRIMANI, 1988. *Rapp. Comm. Int. Mer. Médit.*, **31**, 2, p. 160.
 KALOGEROPOULOS N., M. SCULLOS, M. VASSILAKI-GRIMANI and A.P. GRIMANIS, 1989. *Sci. Total Environ.*, **79**, 241-252.