

The distribution of heavy metals in bottom sediments in the vicinity of the Athens sewage outfall

by

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Abstract

The untreated domestic and industrial wastewater for the greater Athens area is discharged into shallow water at the upper end of the Saronikos Gulf, a semi-enclosed basin. Bottom sediments were collected and the concentrations of Hg, Cr, Zn, Sb, Au, As and Ag, were determined by non-destructive neutron activation analysis. A micropollutant index has been introduced which combines the concentration values for each element into a single parameter.

Résumé

L'eau provenant d'usage domestique et industriel, sans avoir subi aucun traitement, s'écoule dans les eaux très peu profondes du côté Nord du golfe Saronique, un bassin demi-clos. Les sédiments du fond ont été collectionnés et les concentrations des éléments Hg, Cr, Zn, Sb, Au, Ag déterminées, au moyen de l'analyse par radioactivation non-destructive. On a défini un indicateur de micropollution combinant les valeurs de concentration de chaque élément en un seul paramètre.

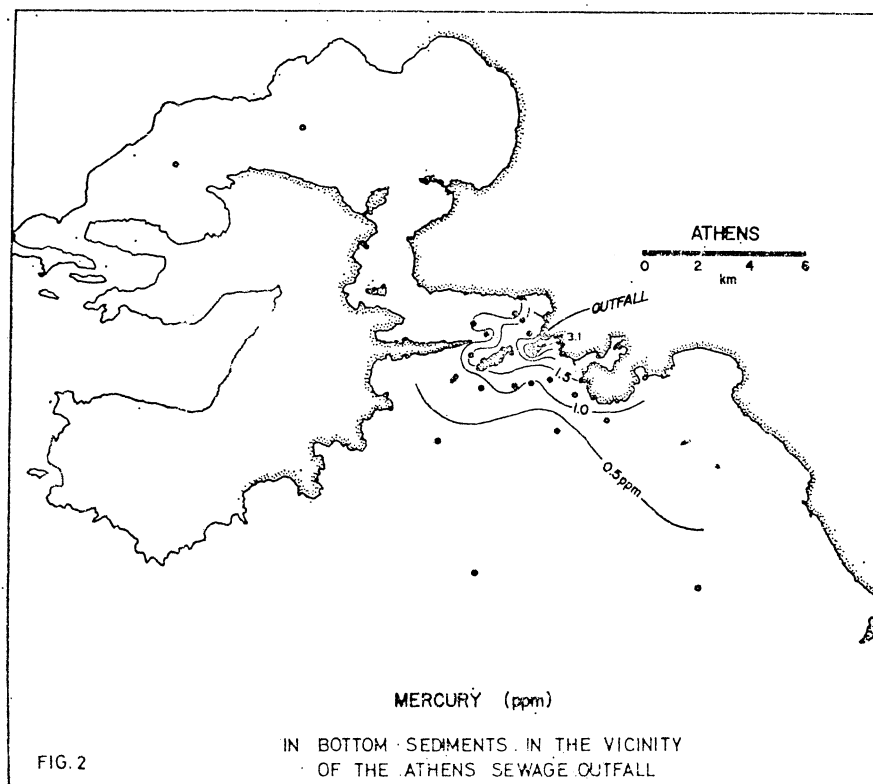
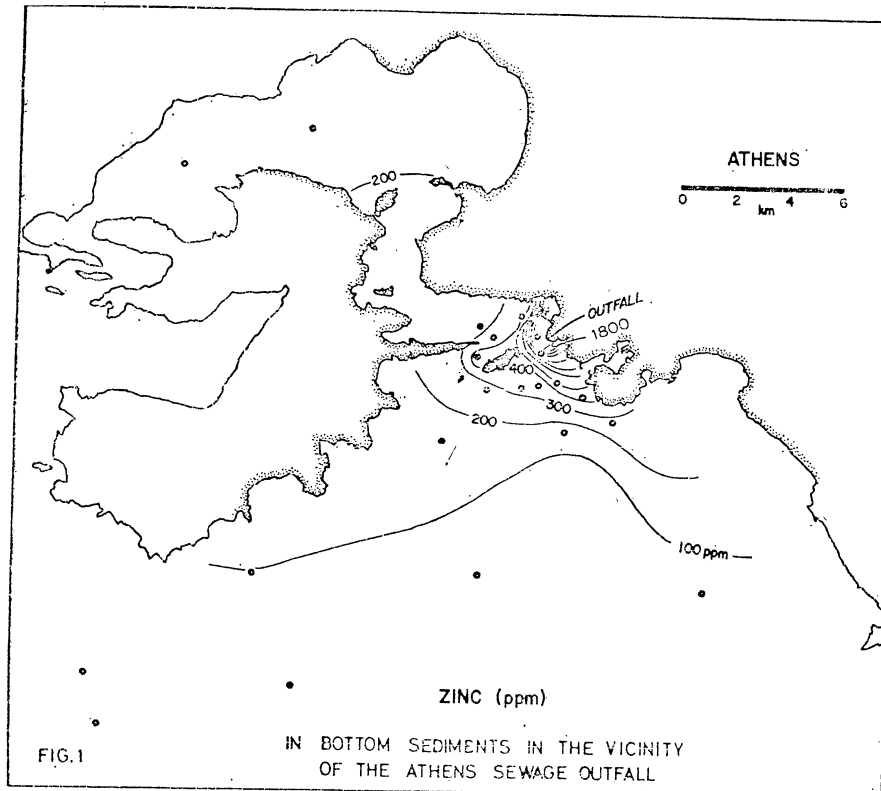
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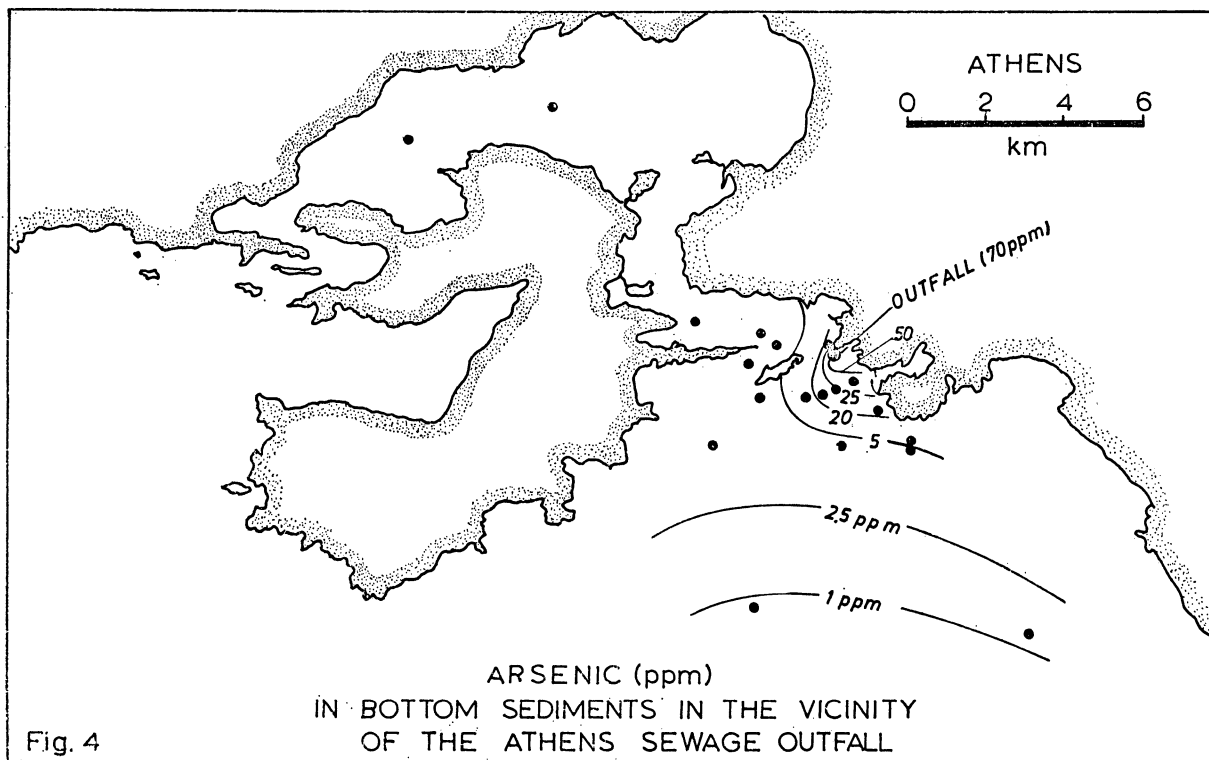
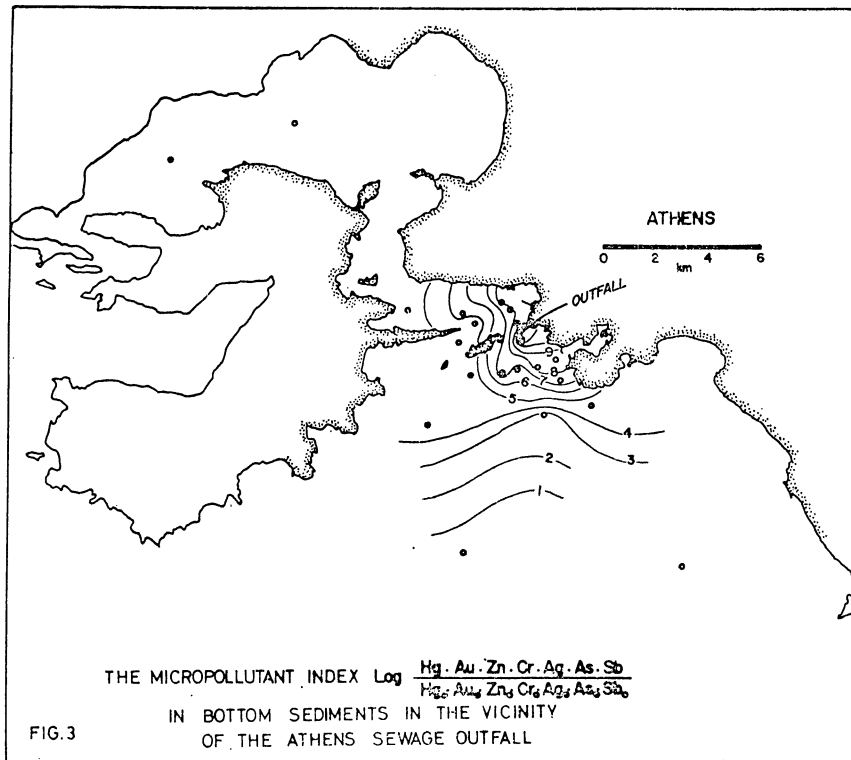
The untreated domestic and industrial wastewater for the greater Athens area is discharged into shallow water at the upper end of the Saronikos Gulf, a semi-enclosed basin. The discharges and contamination associated with shipping in the Pireaus port area are also concentrated here. The main outfall is approximately 100 m offshore at a depth of 30 m where circulation is restricted. Public health, tourism, fisheries and other marine related activities all stand to be affected by these discharges.

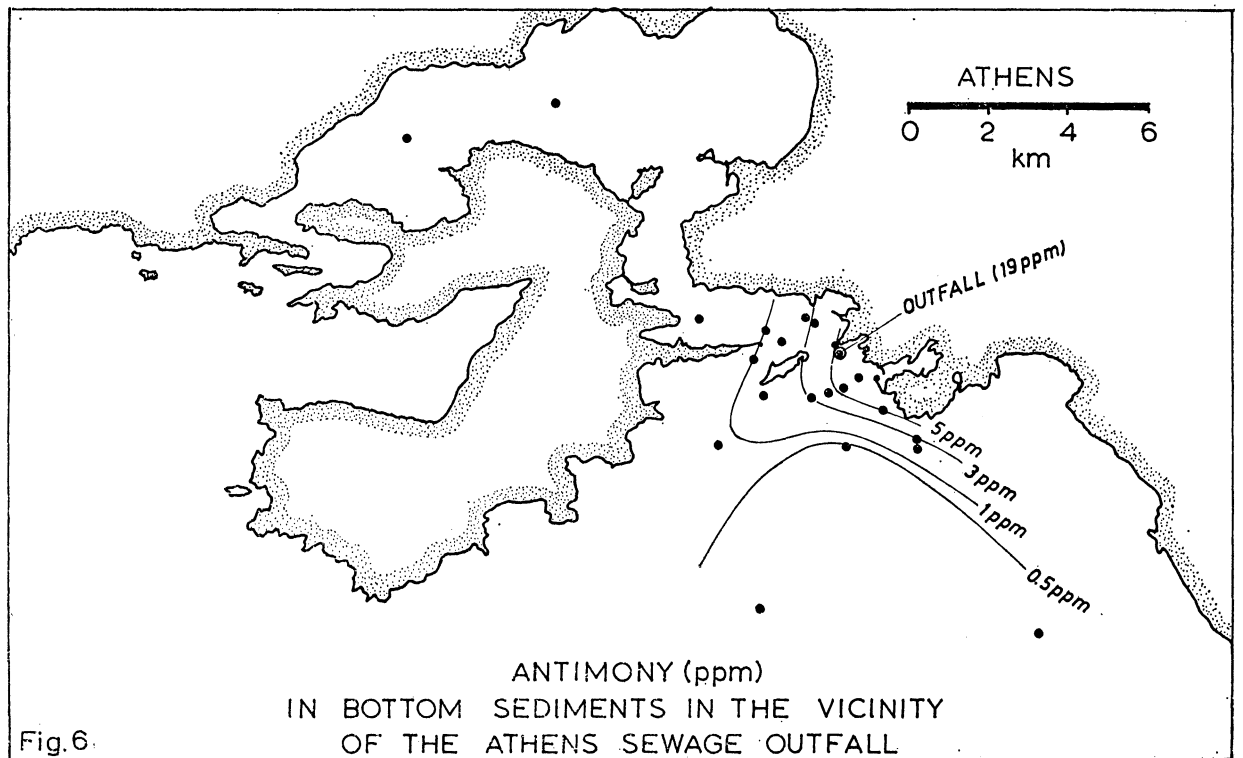
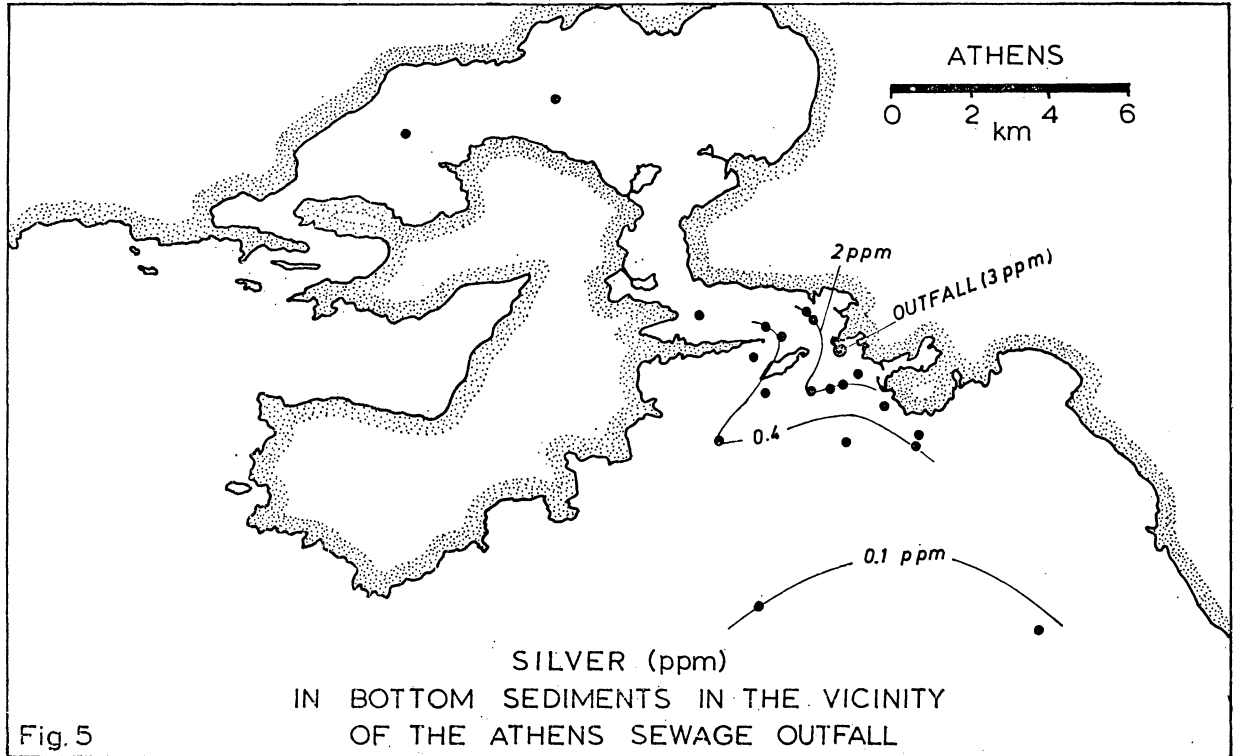
Heavy metals and other contaminants being added to coastal waters will be transported by the prevailing currents and removed by either physical, chemical, or biological processes. Although circulation patterns may change seasonally, and even over much shorter periods, the bottom sediments are continually accumulating on the seafloor, and are, therefore, a record of the long term dispersal and settling processes in the overlying waters.

Bottom sediments were collected during 1973 in the upper Saronikos Gulf in order to determine the nature of the pollutants being added to the system, and also the extent of the area being affected by these discharges. The abundances of selected heavy metals was determined through neutron activation analysis at the Demokritos Nuclear Research Center in Athens. Sample preparation, irradiation, and counting methods have been previously described by HOPKINS, GRIMANIS, PAPACOSTIDIS, & PAPADOPOULOS [1972]. The abundances of Hg, Cr, Zn, Sb, Au, As, Ag were all determined.

The concentrations of the various contaminants are highest in the immediate outfall area (within 1 km) and decline in nearly a radial manner outward. Maximum values near the outfall are many times greater than in the sediments from the apparently undisturbed areas further seaward. Concentration ranges for the various elements are as follows : Hg : 0.38-3.1 ppm, Cr : 35-1000 ppm, Zn : 45-1800 ppm, Sb : 0.16-18 ppm, As : 0.70-70 ppm, Au : 0.0003-2.8 ppm, Ag : 0.04-2.7 ppm. Increases above " natural " values for the area range from 7.5 × for Mercury to 140 × for gold.







Within a 3 km radius of the outfall, the concentrations decrease very quickly (Figures 1,2); Beyond this point the heavy metal values more slowly approach what appear to be "natural" levels. The total area affected by the marked increases in all trace metals is at least 13 sq km; the area affected by certain individual elements may be somewhat larger, however. A micropollutant index has been defined as the logarithm ratio of the concentration product of the elements under consideration at each station relative to a reference station. This index combines the concentration values for each element into a single parameter (Fig. 3). The distribution pattern appears to be bimodal towards the south-east and south-west, although more detailed sampling is needed to delineate this trend more precisely.

The concentrations of chromium and zinc are linearly related which would indicate that their behavioral patterns in the marine environment are very similar.

The most common sources for heavy metals are industrial wastes and agricultural chemicals, mainly pesticides and fungicides. The effluents from the industries of the Elefsis-Piraeus area which include plastic manufacture, fertilizers, textiles, tanneries, cement, steel works, oil refineries among others, all add unknown quantities of various pollutants to the water in the immediate area. It is difficult, however, to totally assess the impact of certain heavy metals on the marine environment. Knowledge of trace elements in marine systems is very limited and the effects of increased concentrations on marine organisms is just now being studied in depth. Metals are non-destructable, even when discharged in small quantities they can be accumulated to lethal levels by certain species. The uptake, retention, toxicity, and tolerance of metals by organisms are governed by many physiological and non-physiological factors [MERLINI, 1971]. More research is necessary on the cycling of various heavy metals in marine systems including the detrimental side effects on man so that the necessary preventative measures can be taken.

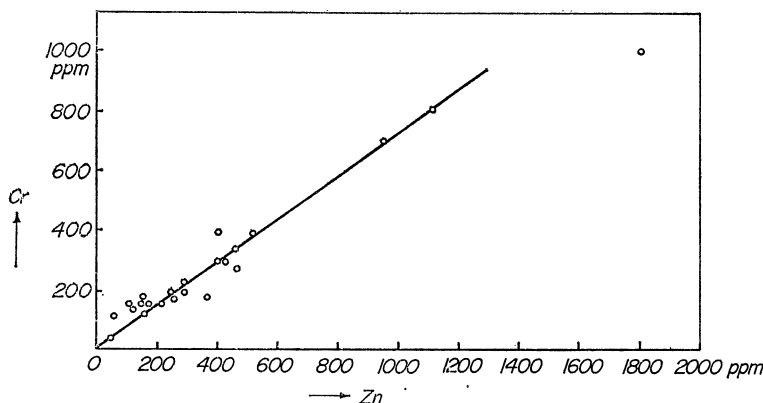


FIG. 7 Zinc-Chromium relationship in sediments

References

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