

## C-III7

### Vertical Distribution of Heavy Metals in Sediments from Rivers in Northern Greece

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Data obtained by vertical distribution studies may, generally, cover the last two hundred years or greater time span of industrial development.

The vertical distribution of Cu, Cd, Cr, Mn, Zn, Fe, and Pb was studied in sediment cores from two rivers in Northern Greece, Axios and Aliakmon, which had been previously (SAMANIDOU et al 1987) examined for the metal partitioning into selective fractions in surface (0-10 cm) sediments. Both rivers flow into the Thermaikos Gulf.

Axios is affected by domestic effluents and industrial wastes mainly from the Yugoslavian region, since in the Greek area only domestic and agricultural effluents are discharged into its waters. Aliakmon is affected by domestic effluents and wastes of textile and food industries (FYTIANOS et al, 1986).

Four samplings were performed in three month intervals during a period of one year. A plexiglass corer of 1 m length and 8.0 cm diameter with a latex stopper for the upper side, was manually driven into the sediment. Samples were subsequently subdivided in 10 cm fractions. Due to technical difficulties the subdivision of the core in shorter sections, in order to obtain more detailed information, was not possible. Only at one sampling was it possible to take a core of a length greater than 30 cm, due to the sandy texture of the sediments beneath this depth. All sediment samples were wet sieved using nylon sieve, and the fraction <0.063 mm, was selected for study. The sieved material was then dried at 105°C. Metal analysis was performed by wet acid digestion under pressure using a mixture of HNO<sub>3</sub>-HClO<sub>4</sub> 4:1 v/v, at 150°C (AGEMIAN et al, 1976). The acid extracts were analysed for the above mentioned metal ions, by flame AAS (Pye-Unicam SP 192) or flameless AAS (Perkin-Elmer HGA 400) when needed. The standard addition method was followed for each metal separately. The precision of sediment metal analysis was checked by five replicate samples of SD-N-1/2 IAEA reference river sediment material and coefficients of variation ranged between 1 and 8 %.

Table 1 presents the metal core correlation coefficients for the examined metals at the four sampling stations ( AX1, AX2, AL1, AL2 ), obtained from one sampling, for core depth >30 cm. As shown, a negative correlation (significant though only for Pb, Zn and Cu in AX1 station), is observed, between metal concentration in sediments and depth in the core. Except for Cd, all other metals exhibit a peak concentration at 10-20 cm depth in core, probably due to resuspension of surface sediments. The fact that most of the metals show the peak concentration at the same depth implies, that these metals have a common origin. Cadmium which has its maximum concentration at the surface layer has probably a different origin. The enrichment of Cd at the top

Table 1. Correlation coefficients between metal concentrations and depth in core.

	AX1	AX2	AL1	AL2
Pb	<u>-0.786*</u>	-0.823	-0.576	-0.772
Zn	<u>-0.883</u>	-0.636	-0.401	-0.439
Cu	<u>-0.855</u>	-0.368	-0.517	-0.764
Mn	-0.735	-0.620	-0.754	-0.876
Fe	-0.410	-0.727	-0.162	0.493
Cr	-0.641	-0.525	-0.941	-0.642
Cd	-0.641	-0.705	-0.771	-0.659
d.f. (n-2)	5	3	2	4

\*The underlined values are significant at the 5% level.

of the core is due to the high anthropogenic flux during the last decades ( ETCHEBER et al, 1977).

Surface layers (0-10 cm) are directly affected by human activities. Suspended materials after a certain period of transportation are deposited on the river bottom, enriching consequently the upper layers of sediments with heavy metals. On the other hand, surface layers are mostly exposed to the pH-Eh changes in aquatic environment, which lead to a heavy metal release ( HILTON et al, 1985). As acid mine effluents are discharged into Axios river, a decrease of pH value can lead to a release of heavy metals bound to carbonates and hydroxides. A change of redox conditions can cause the reduction of hydrous Fe-Mn oxides yielding the scavenged or sorbed heavy metals ( SALOMONS et al, 1984).

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