ATMOSPHERIC FLUXES OF HEAVY METAL CONTAMINANTS TO THE VENICE LAGOON

J. Kirk COCHRAN[1], Mauro FRIGNANI[2] and Marco SALAMANCA[1,3]

[1] Marine Sciences Research Center, State Univ. of Stony Brook, New York, USA
[2] Istituto per la Geologia Marina, CNR, Via Gobetti 101, 40129 Bologna, Italy
[3] Universidad de Concepcion, Concepcion, Chile

Salt marshes that are flooded only by extreme high tides are exposed to the atmosphere most of the time and thus record the atmospheric fluxes of contaminants to coastal areas (McCAFFREY and THOMSON, 1980). In order to obtain the atmospheric fluxes of some anthropogenic heavy metals to the Venice Lagoon, we collected a stalt marsh core in October 1992, from a site near S. Erasmo. The core was sectioned and analyzed for the naturally occurring radionuclide ^{210}Pb (half-life = 22.4 y) and trace metals (Fe, Mn, Ag, Cd, Ni, Pb, Zn). The chronology for the core was obtained using the constant flux method (APPLEBY and OLDFIELD, 1978; McCAFFREY and THOMSON, 1980). This method assumes a constant flux of ^{210}Pb from the atmosphere to the marsh surface. The inventory of unsupported ^{210}Pb in the core (25 dpm cm^{-2}) agrees well with prior analyses of ^{210}Pb inventories in marsh cores from the northern part of the lagoon (18-25 dpm cm^{-2}, BATTISTON *et al.*, 1988) as well as with predicted atmospheric fluxes to the site (TUREKIAN *et al.*, 1977).

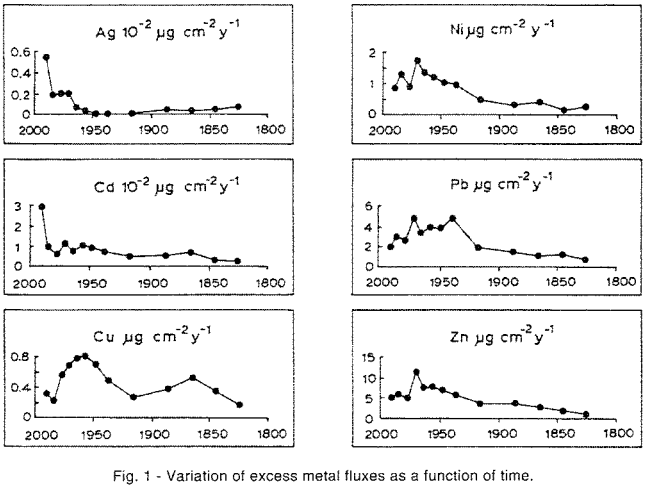

Fig. 1 - Variation of excess metal fluxes as a function of time.

The mass accretion rate of the marsh has varied over time, from 0.10 g cm^{-2} y-1 to 0.20 g cm^{-2} y^{-1}. At present the marsh is accreting at an accumulation rate equivalent to 0.17 cm y^{-1}, comparable to the eustatic rise in sea level. Fluxes of excess metals, defined as the fractions of metals above pre-industrial background levels observed at depth in the core, have varied significantly over time (Fig. 1). Several patterns are evident : fluxes of excess Ag and Cd show increases to the present, Ni and Zn show increases to about 1970 with decreases to the present, Cu displays a maximum flux at about 1960 followed by a decrease, and Pb shows increases to a period of relatively constant values (from 1940-1970) with recent decreases. These patterns reflect both regional trends in the atmospheric transport of trace metals and local inputs from the industrial development at Porto Marghera and Mestre.

Table 1. Comparison of ∑Excess Metal/∑Excess ^{210}Pb ratios in marsh and Venice Lagoon sediments.

	Pb	Zn	Cu	Ni
Marsh	18	32	3	5
Lagoon :				
S. Erasmo	14±8	49±23	13±7	37±46
Campalto	39±6	300±300	25±13	24±10
Cona	19	40	12	19

Comparison of inventories of excess ^{210}Pb in the marsh core and in subtidal sediments from the Venice Lagoon shows that, on average, ^{210}Pb input to the lagoon is dominated by the atmospheric flux (Table 1). Redistribution of sediments and associated ^{210}Pb and trace metals by physical and biological reworking of lagoonal sediments causes local variations in inventories, and ratios of excess metal inventories to excess ^{210}Pb inventories can better permit source variations in metal inputs to be resolved. Ratios of metal inventories to ^{210}Pb inventories demonstrate that point source inputs of metals are evident in lagoon sediments near the mainland, but that atmospheric inputs tend to dominate in the northern and eastern portions of the lagoon.

ACKNOWLEDGMENTS

The authors are endebted with R. Zonta, L. Zaggia and the technicians of the Istituto per lo Studio della Dinamica delle Grandi Masse (CNR, Venice) for the assistance during sampling operations. L. Zaggia determined marsh sediment densities. L. Bellucci and S. Lin carried out most sample preparations and many ^{210}Pb analyses. H. Muntau was responsible of metal determinations in sediment cores. The research is part of the Project "Sistema Lagunare Veneziano".

REFERENCES

APPLEBY P. G. and OLDFIELD F., 1978. The calculation of lead-210 dates assuming a constant rate of supply of unsupported ^{210}Pb to the sediment. *Catena*, 5 : 1-8.

BATTISTON G. A., DEGETTO S., GERBASI R., SBRIGNADELLO G. and TOSITTI L., 1988. The use of ^{210}Pb and ^{137}Cs in the study of sediment pollution in the lagoon of Venice. *Sci. Tot. Env.*, 77 : 15-23.

McCAFFREY R. J. and THOMSON J., 1980. A record of the accumulation of sediment and trace metals in a Connecticut salt marsh *In* : Estuarine Physics and Chemistry: Studies in Long Island Sound. Adv. in Geophys., vol. 22 (B. Saltzman, ed.), pp. 129-164.

TUREKIAN K. K., NOZAKI Y. and BENNINGER L., 1977. Geochemistry of atmospheric radon and radon products. *Annual Rev. Earth Planet. Sci.*, 5 : 227-255.