TRACE METAL CHARACTERIZATION OF AIRBORNE PARTICLES FROM THE NORTHEASTERN MEDITERRANEAN

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SUMMARY: Data from 24 airborne dust samples collected on a land-based atmospheric collection tower at the southeastern coast of Turkey and analyzed for Al, Fe, Mn, Cr, Ni, V, Co, Na, Ca, Mg, Zn, Pb and Cd are presented.

KEY WORDS: trace metals, airborne particles, northeastern Mediterranean.

INTRODUCTION

In recent years it has become increasingly apparent that transport via the atmosphere is an important route by which materials, natural and anthropogenic, are delivered to the sea surface. Many of the studies indicated that large quantities of material could enter the seas through the atmosphere both from the coasts and even from distant sources. This is especially true for such semi-enclosed regional seas as the Mediterranean. Saharan dust has frequently been noted by scientist working in the area. Thus, some investigators claimed to have observed the long range transport of dust both from the Saharan and Arabian deserts (1,2).

The Mediterranean Sea is also one of the largest bodies of oligotrophic water in the world. Despite the limited data base existing for the region, it is possible to conclude that levels of atmospheric pollution over the Mediterranean Sea are comparable to those over other European regional seas and the atmospheric deposition of some contaminants are comparable in magnitude to their riverine inputs to the Mediterranean (3,4).

MATERIALS AND METHODS

Aerosol samples were collected during October 1991 from the top of 21 m high tower on the southeast coast of Turkey at 34°15'18" E, 36°33'54" N. They were collected on Whatman 41 (8x10 inches) filters, using a standard General Metal Works, hi-vol sampler equipped with a continuos flow recorder. One fourth of the filters were placed in PTFE beakers and digested with HF/HNO_3 acid mixture at 120 °C and solutions were made up to 25 mL with 0.1 N HNO_3. Digested samples were analyzed for their trace metal contents by a GBC-906 model automatic atomic absorption spectro-photometer (AAS) equipped with a deuterium lamp. Both flame and flameless modes of AAS were utilized. The accuracy of the analytical technique was tested by analyzing BCR (Community Bureau of Reference) standard light sandy soil (CRM 142) and the data quality assurance was recorded. The analytical precision obtained in our laboratory during this work was approximately 9% for Al, 8% for V, 7% for Co and Mg, 6% for Fe, Ca, Cr and Ni, 5% for Pb and Na, 2% for Mn and 3% for Zn.

RESULTS AND DISCUSSION

The geometric means of the concentrations, enrichment factor (EF) values and ranges of each element are given in Table 1.

Enrichment factors (EFs) can be used to indicate the sources of trace metals in atmospheric particulates. For the crustal source Al is used as the source indicator element, and EF_{crust} values are calculated according to the equation,

$$EF_{crust}=(X/Al)_{air}/(X/Al)_{crust}$$

in which the numerator on the right hand side shows the ratio of the concentrations of the element X and Al in atmospheric particulates whereas the denominator shows the same ratio in average crustal material. EF values <10 indicate that elements have mainly crustal source and can be termed non enriched elements (NEEs). EF values in the range >10 - $<10^2$ are known as moderately enriched elements (MEEs) and EF values $>10^2$ define anomalously enriched elements (AEEs). On the basis of EF values the trace metals can be divided into three groups.

Table 1. Trace metal data of atmospheric particulates collected during October 1991 (concentration in ngm^{-3}).

	Metal Concentration			EF crust	
	Geometric Mean	Range	3-4 Oct.	Geometric Mean	Range
Al	1031	229-3216	22568	1	
Fe	711	49-2488	20047	1.03	0.14-4.94
Mn	13	1.1-51	306	1.02	0.17-5.51
Ni	6.4	2.2-11	56	6.76	2.56-21
Cr	11.2	3.4-15	66	8.8	2.37-32
V	6.39	1.5-18.3	123	4.56	1.91-15
Co	0.37	0.01-0.93	11.2	1.3	0.16-5.9
Ca	3118	299-7535	37600	5.97	1.16-23
Na	1021	184-3308	1746	3.34	0.26-41
Mg	844	189-2801	14296	2.88	1.07-10
Zn	19.2	5-55.6	53.7	21	3-72
Pb	23.1	3.9-87	46.5	146	131-602
Cd	0.18	0.04-0.4	1.39	173	62-595

The first group contains NEE which are Al, Fe, Mn, Co, Ni, Cr, V, Na and Ca. The second group contains MEE and only geometric mean of EF for Zn satisfies the required value for this group. The last group contains AEEs which are Pb and Cd. The NEEs like Na, Ca, V, Cr and Ni show the characteristics of the MEEs depending on the prevailing meteorological conditions.

There are geographical variations in the levels of Pb, Cd and Zn which may be related to anthropogenic sources throughout the basin. The highest average concentrations of these trace metals are found for the samples collected around the north-western Mediterranean coast (Pb=58, Zn=41, Cd=0.36 ngm^{-3}) (5). Concentration values of these metals found in this study (see Table 1.) are comparable with the results obtained from the samples collected on-board in Central Mediterranean (Pb=12.5, Zn=18.4 Cd=0.101 ngm^{-3})(6).

The atmospheric concentrations of the trace metals exhibit relatively large daily variations and ranged over one or two orders of magnitude during one month collection period. The controlling factors for these variations in this short time span are the input of Saharan dust and the precipitation scavenging which reduces aerosol concentrations. The

impact of these two processes on the concentrations of trace metals are illustrated for Al and Pb respectively in Figure 1.

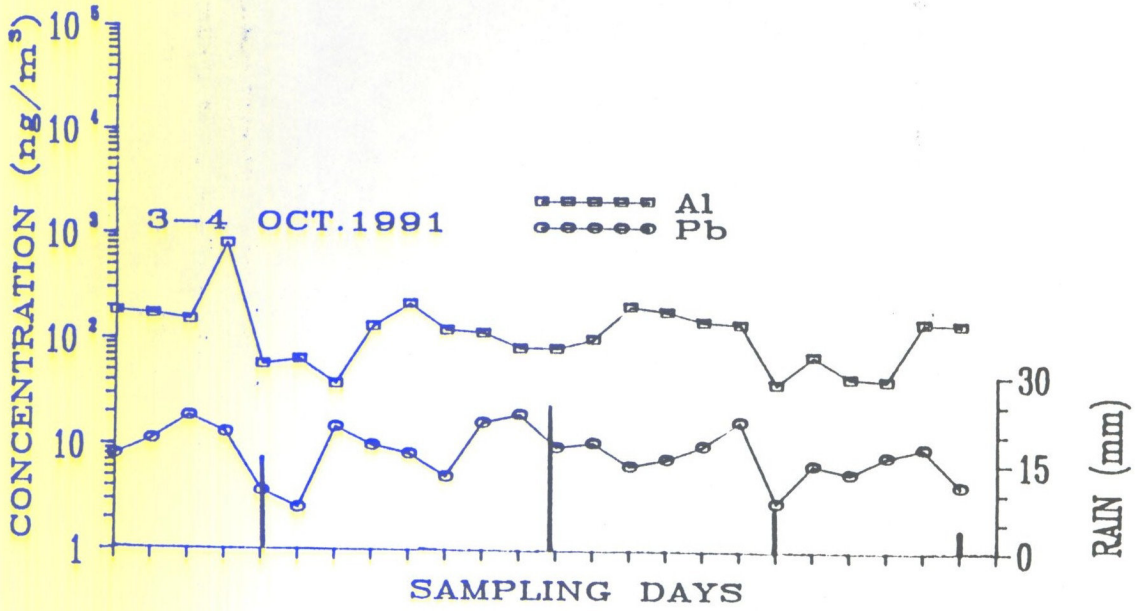

Figure 1. Daily variations of Al and Pb in atmospheric particulates during October, 1991.

As seen in Figure 1 the concentrations decrease dramatically following a rain event. The peak concentration of Al for the sampling day of 3-4 October, 1991 represents a Saharan dust incursion event. The color of the dust on the filter paper for the corresponding date was reddish-yellow. Concentrations of the metals for the corresponding date are shown in Table 1. as a separate column. As seen the values are much higher than the geometric mean concentrations during the sampling period. In order to trace back the transport of atmospheric particles from the source region, air mass trajectory have been collected by the Center des Faibles Radioactivities, France (7). Figure 2. displays the 5-days back trajectory at 700 mb, finishing at the sampling point and at the midtime of the sampling date. The air mass trajectory indicates that dust have been transported from Tunisia-Lybia at high altitude.
Thus, the combination of the colour and chemistry of the dust and the meteorology allows us to show the long range transport of soil particles does occur from Saharan to the northeastern Mediterranean.

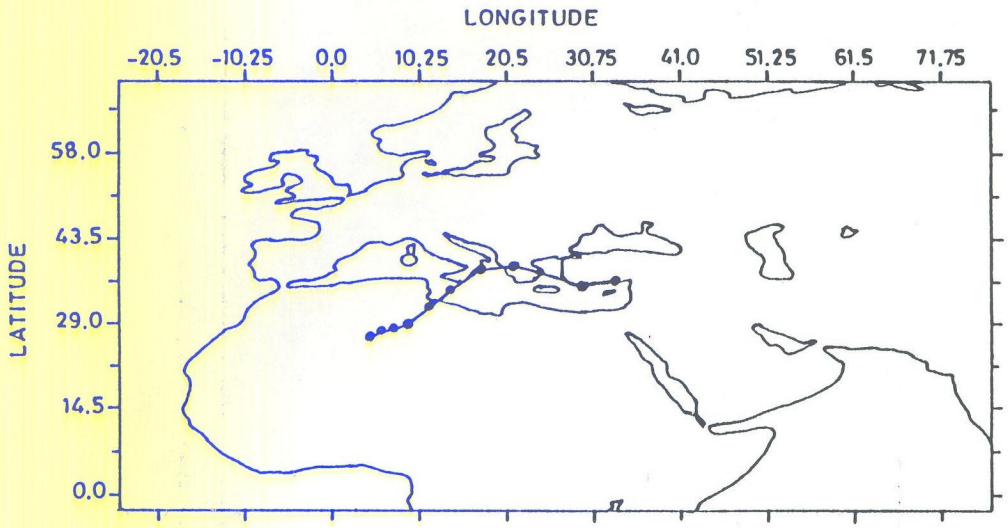

Figure 2. Air mass trajectory associated with sample 3-4 October 1991.

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