

Survey of Heavy Metal Distribution in Greek Sediments

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Several oceanographic investigations have been carried out within the last 15 years in order to study heavy metal distribution in Greek surface sediments. Samples were collected from various polluted or partly polluted Greek areas, as well as from some unaffected regions. Collection of the samples was made using a 0.1m² van Veen grab. For the determination of the metals, 5g of the dry material was shaken with 2N HCl for 16 hours at room temperature. The leachates were processed on a Perkin-Elmer 305 B A.A.S. (SATSMADJIS, J. & VOITSINO-TALIADOURI, F. 1981). The study of each of the above mentioned areas lasted from one to five years.

Table I: Metal concentrations of Greek unpolluted regions.

	Fe (%-%)	Cr (-)	Ni (-)	Mn (ppm)	Zn (-)	Co (-)	Cu (-)	Pb (-)	σ of \bar{q}	v of \bar{q}	Q	Ref.
Kavala	0.8-2.6 (mean) 1.4	20-278 105	11- 47 22	65- 417 273	24-90 67	0-10 5	4-24 16	5-36 30				4
Thermaik.	0.82 1.2-2.2 (mean) 1.8	1.03 66-120 75	0.24 55-105 81	0.45 215-740 465	1.37 32-74 48	0.42 14-18 17	0.89 8-28 18	1.50 11-27	0.45	54.07	0.84	4
Pagassit.	1.3-2.7 (mean) 1.8	50-186 105	32-228 90	290-2790 980	38-72 58	8-22 15	9-25 17	19-30 24	0.17	17.37	0.97	7
N.Euboek.	0.3-3.0 (mean) 1.9	40-250 157	50-300 207	120-1000 557	9-46 31	3-30 20	-	-	0.58	42.73	1.35	4
S.Euboek.	0.6-1.5 (mean) 1.2	37-97 79	25-144 91	165-555 370	25-44 7	4-15 9	3-15 20	12-27	0.15	21.20	0.73	4
Elefsis	0.8-1.1 (mean) 1.0	50- 65 60	80- 95 90	280- 325 320	55-68 60	7-10 8	28-33 30	25-32 30	0.45	46.71	0.96	9
Navarino	0.3-1.0 (mean) 2.3	12-251 180	8-123 91	243- 600 460	7-81 62	4-15 12	0-32 23	2-28 19				5
Patraik.	1.6-3.2 (mean) 2.2	55-119 100	60-132 110	750-2610 1420	43-88 72	11-23 19	16-43 35	11-20	0.50	33.63	1.49	4
Messolon.	1.0-2.8 (mean) 1.9	56-112 73	40-112 80	470-1380 764	30-80 11	6-16 11	8-34 23	6-17 12	0.26	25.95	1.00	6
Amvrakik.	0.5-3.0 (mean) 2.2	27-177 125	33-188 131	323-3820 870	12-80 62	4-30 18	2-31 24	7-21	0.28	22.32	1.25	4
Lesbos	0.3-2.1 (mean) 1.2	40-247 155	20-315 89	172-1126 447	18-43 52	0-19 8	3-12 8	10-39 28	0.38	42.22	0.89	8
Milos	0.3-0.6 (mean) 0.4	10-19 14	6- 21 12	113- 251 170	15-18 17	2- 4 3	2- 4 3	2- 7 5	0.07	33.26	0.22	4
East Aege.	1.4-5.3 (mean) 2.2	52-157 131	39-291 84	280-2640 84	25-55 17	8-24 15	4-29 11	11-22	0.27	24.77	1.09	4
	q	1.29	0.84	1.41	1.41	0.77	1.25	0.94	0.85	0.27	24.77	1.09

Analysis of the data indicates that polluted subregions can be identified in some of the studied areas. In Kavala Bay, the oil-platforms and the fertilizer factory raise the amounts of Pb (322-908ppm), Zn (110-510ppm) and Cu (45-226ppm), while in Thermaikos Gulf, the industrial effluents, as well as, the domestic wastes raise more or less the concentrations of all metals Fe (2.2-5.3%), Cr (140-390ppm), Ni (105-270ppm), Mn (275-1340ppm), Zn (74-2600ppm), Co (19-37ppm), Cu (28-200ppm) and Pb (28-330ppm). The industries and the city of Volos cause a slight enrichment of the values of Cr (66-70ppm), Ni (46-53ppm), Zn (72-94ppm), Cu (27-39ppm) and Pb (30-53ppm) in surface sediments of Pagassitikos Gulf. In the adjacent N. Euboikos Gulf, a Fe-Ni alloy smelting plant causes heavily enriched values of Fe (3.0-25.4%), Cr (250-1200ppm), Ni (300-3550ppm), Mn (1140-4560ppm), Zn (46-320ppm) and Co (30-212ppm). Surface sediments in Elefsis Bay, show heavy metal pollution [Cr (70-390ppm), Zn (100-1680ppm), Cu (20-230ppm), Pb (40-400ppm) and Cd (0.2-2.5ppm)] due to the influence of industrial effluents and domestic wastes from three and a half million people of the greater Athens area. Finally, in Navarino Bay, a tanker shipwreck caused an enhanced Pb-value (53ppm). Our values are comparable with those reported by other investigators (VARNAVAS *et al.*, 1984, ANGELIDIS *et al.*, 1984, etc). However, a close comparison is not attempted herein because of the different extraction methods used.

Table I shows metal concentrations of unaffected sections from the polluted regions, as well as metal concentrations from other unpolluted Greek areas. Comparison of metal concentrations in the various unpolluted areas may be made with the use of an enrichment ratio \bar{q} = mean concentration of a metal for each area/mean concentration of a metal for all areas. From Table I is evident that the coefficient of variation of \bar{q} does not vary considerably between regions (17.37-54.07). Factor Q (the mean value of all \bar{q} ratios for each area) gives an idea about the concentration level of the metals in each area comparing with the mean values of all unpolluted Greek regions. In the classification that follows regions characterized with coeff. of variation > 50.00 (arbitrary selected) are excluded. Hence, the unpolluted areas (according to their metal concentrations) may be arranged as follows: Patraikos Gulf (Q=1.49); N.Euboikos G. (Q=1.35); Amvrakikos G. (Q=1.25); Navarino B. (Q=1.17); Pagassitikos G. (Q=1.15); East Aegean Sea (Q=1.09); Messolonghi L. (Q=1.00); Thermaikos G. (Q=0.97); Elefsis B. (Q=0.96); Lesbos Isl. (Q=0.89); S.Euboikos G. (Q=0.73); Milos Isl. (Q=0.22).

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