

GEOCHEMICAL CHARACTERISTICS OF THE SURFICIAL SEDIMENTS OF THE AEGEAN SEA

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Abstract

Surface sediment samples were collected during an oceanographic cruise in October 1996 and analyzed in order to estimate grain size distribution and carbonate content, metal concentrations, organic carbon and organic nitrogen. The grain size parameters vary widely, while the carbonate content ranges between 18-81%. The results show an almost uniform distribution regarding concentrations of Pb, Cu and Cd, while Cr, Ni, Zn, Fe and Mn present maximum values which correlate well with each other. Total carbon ranges between 3-10%, organic carbon between 0.2-0.77% and nitrogen content between 0.008 and 0.056%. Both carbon and nitrogen are found in the natural concentration ranges. However, the C:N ratio in a few stations in the Northern Aegean varies from the value suggested in the literature.

Key-words: trace elements, sediments, Aegean Sea

Introduction

Trace element concentrations in marine sediments is a result of both natural and anthropogenic processes. Monitoring of trace metals can therefore contribute not only to the understanding of the geochemical history of a certain area, but in the identification of anthropogenic enrichment as well. However, most of the studies on heavy metal pollution in the eastern Mediterranean sediments have been conducted in coastal areas and embayments [1-3], whereas only a single study has been performed around the Cyclades islands [4]. Our study aims at identifying the sediment type, organic carbon and nitrogen content and metal distribution in surface sediments of the open Aegean Sea, which will serve as baseline information for future studies in the region.

Methodology

Surface sediment samples (0-3 cm) were collected with a Smith-McIntyre type grab sampler from 15 stations in the Aegean Sea at depths ranging from 45 to 814 m. The cruise took place in October 1996 and the sampling locations are shown in Figure 1.

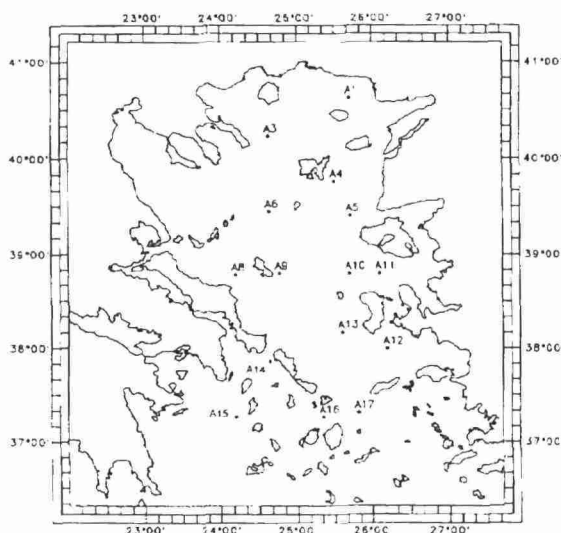


Fig. 1. Map with the 15 sampling locations in the Aegean Sea.

For trace metal analysis, about 20 g of undisturbed sediment was collected from the central part of the grab sample with a plastic tool and stored in a polyethylene bag. Grain size analysis was carried out by wet-seiving. The samples were dried at 60°C, the < 63 µm fraction was estimated, ground in an agate mortar and a portion was analyzed for silt-clay content by X-ray analysis with Sedigraph (Micromeritics 5100). Heavy metal analysis was performed after a complete digestion of the ground sample with subsequent addition of HNO₃, HF, aqua regia (HCl:HNO₃) and HClO₄ [5, 6]. The final sample was analyzed for Pb, Cu, Zn, Ni, Cr, Mn and Fe by flame atomic absorption spectrometry on a Varian SpectrAA 20 Plus. Cd determinations were performed on a Perkin-Elmer 4100 spectrophotometer with a HGA 100 Graphite Furnace. A reference material (SD-M-2/TM IAEA Monaco, N° 182) of known concentrations was treated like the samples and analyzed in order to check the accuracy of the analyses.

Organic carbon, total carbon and nitrogen and carbonate content were determined in the bulk sample after oven drying the samples at

60°C and grinding in an agate mortar. The method is a modification of Nieuwenhuize *et al.* [7]. Splits of 10-15 mg of powdered homogenized samples were accurately weighed into silver cups. Organic carbon was determined after the removal of inorganic carbon by in situ acidification of samples with hydrochloric acid 1:1 and drying the samples at 60°C. Silver cups were pinched closed, compacted and formed into a ball. The balls were transferred to the autosampler of the Fisons Instruments CHN elemental analyzer type EA-1108. For total carbon analysis, carbon splits of 5-50 mg of dried samples were weighed into tin cups, sealed and analyzed without any pretreatment.

Results and discussion

Sampling locations, maximum water depth, geographical coordinates, carbonate content and sediment distribution are shown in Table 1. The grain size parameters fall among a wide range of values. Carbonate content follows the sand and total carbon distribution and presents the higher values at stations A8, A14, A16, A17 and A1.

Table 2 shows the concentrations of heavy metals in the surface sediments of the 15 stations. Pb and Cu were low among the stations and were similar to natural background values for the Mediterranean [8]. Zn concentrations were 72 mg/kg at station A7 and 140 mg/kg (the highest value) at station A1. The highest value of Ni was observed at

Table 1. Sampling locations, maximum depth, geographical coordinates and grain size parameters of sediments.

Station	Depth(m)	Longitude	Latitude	CaCO ₃ %	Sand. %	Silt. %	Clay. %
A1	45	25 42.00	40 38.00	65.46	70.56	12.71	16.73
A3	814	24 38.00	40 14.00	18.56	3.53	36.80	59.67
A4	93	25 30.00	39 46.00	22.00	85.00	10.52	4.48
A5	300	25 42.60	39 24.50	28.37	10.55	51.69	37.76
A6	358	24 38.30	39 26.90	35.84	23.23	39.00	37.80
A8	365	24 11.90	38 47.20	80.67	92.00	3.88	4.12
A9	254	24 46.00	38 48.00	53.55	45.36	32.90	21.74
A10	375	25 42.00	38 48.00	41.66	29.53	37.51	32.96
A11	284	26 06.00	38 48.00	36.78	15.85	51.31	32.84
A12	770	26 12.00	38 00.00	30.13	4.64	47.68	47.68
A13	427	25 36.00	38 10.50	71.35	70.22	16.85	12.93
A14	168	24 38.60	37 51.80	79.09	97.81	1.51	0.68
A15	476	24 12.00	37 16.00	57.59	18.38	47.34	34.28
A16	106	25 21.00	37 16.00	75.89	87.93	8.81	3.26
A17	325	25 48.80	37 19.00	68.53	68.23	19.32	12.45

Table 2. Heavy metal concentrations in the < 63 µm fraction of surface sediments from the Aegean Sea. Results are expressed in mg/kg, except for Fe in %.

Stations	Pb	Cu	Zn	Ni	Cr	Cd	Mn	Fe%
A1	30.11	33.68	140.34	76.29	85.91	0.17	419.00	3.94
A3	30.36	47.06	123.72	108.71	89.95	0.16	2205.00	3.96
A4	24.34	23.40	96.71	75.02	70.50	0.14	618.00	3.19
A5	27.65	34.45	103.84	106.66	71.41	0.15	2164.00	3.51
A6	26.02	33.66	93.94	100.27	68.32	0.16	2031.00	3.19
A8	29.34	41.87	105.48	151.02	100.02	0.22	1899.00	3.31
A9	23.86	28.92	81.40	127.91	118.60	0.15	1196.00	2.78
A10	24.26	33.60	90.38	133.80	92.71	0.13	2050.00	3.36
A11	26.42	30.95	94.55	130.09	92.05	0.15	1884.00	3.35
A12	25.38	38.72	99.63	216.51	129.58	0.16	1427.00	3.69
A13	26.21	37.47	86.63	153.98	83.13	0.18	1420.00	2.96
A14	23.75	24.63	82.53	84.80	78.46	0.20	579.00	2.47
A15	28.61	32.15	86.14	93.53	62.48	0.17	1190.00	2.27
A16	22.72	15.25	68.76	70.18	55.43	0.14	406.00	1.98
A17	25.02	28.62	71.90	125.58	63.14	0.16	1170.00	2.31