GEOCHEMICAL ASPECTS OF THE S. AEGEAN SEA SURFACE SEDIMENTS

F. Voutsinou-Taliadouri*, H. Kaberi and N. Friligos
National Centre for Marine Research, Hellinikon, Athens, Greece - fvouts@ncmr.gr

Abstract

Surface sediment samples from the South Aegean Sea were analysed for organic carbon and calcium carbonate content and for total Fe, Al, Ti, Mn, Pb, Cu, Zn, Ni and Cr in the <63μm grain size fraction. Analysis of the data revealed that most of the elements analysed do not have terrigenous origin since they are not correlated with Ti; elements like Pb, Zn, Mn and Fe show relatively strong correlation with organic carbon whereas only Zn and Pb follow the finer fraction of the sediments. The concentration ranges of the elements analysed are found to be similar to those reported for other unaffected Greek marine regions.

Keywords: Geochemistry, trace elements, sediments, Aegean Sea, Eastern Mediterranean

Introduction

The present study is part of an on-going monitoring project that aims at providing an assessment of the state of pollution in the Aegean and the Ionian Sea. This part is going to add information on the geochemistry of the surface sediments of the South Aegean Sea. Sediments are important carriers of trace elements and also they are potential sources of contaminants in the hydrological cycle. The contaminants are not necessarily associated with permanently on the sediment, but they may be part of biogeochemical cycles [1]. Metals reach the seabed associated with allochthonous (terrigenous) or autochthonous (biogenic) particles. As a result, sediment analysis plays an important role in environmental investigations especially in those cases in which a short-term or past pollution event is not or only insufficiently traceable from water analysis since they are the final reservoir of metals in the marine environment. The study area comprises part of the Cyclades Plateau and the central and western part of the Cretan Sea. It is poorly investigated as far as its geochemistry is concerned. Hence, comparisons can be made with other nearby areas.

Methods and materials

Sediment samples were collected, during the July 2000 oceanographic cruise of the R/V *Aegaeon*. For the collection of the surface sediment samples (0-3cm) a Smith-McIntyre type grab sampler was used. Wet sieving was employed for the separation of the <63μm grain size fraction. The chemical analyses were conducted on the <63μm grain size fraction of the sediments since metals from anthropogenic sources are mostly concentrated on the fine sediment particles [1]. For the major and trace metal analysis, the X-ray Fluorescence technique was used. The <63μm dried sediment fraction was ground to a fine powder in a twin mill agate mortar (Retsch MM-200). Five grams of powder were well mixed with 0,5 g of wax (Hoechst Wax-C). The mixture was pressed in a 31mm aluminum cup (20 tn, 20 sec) inside a Herzog HTP-40 hydraulic press. The elements were measured in the powder pellets with a Wavelength Dispersive X-Ray Fluorescence system (Phillips PW-2400). The XR-F system was calibrated using reference samples from the U.S. Geological Survey and the National Research Council of Canada [2].

Results and discussion

The concentration ranges of the elements Fe, Al, Ti, Mn, Pb, Cu, Zn, Ni and Cr are reported in Table 1. For comparison purposes, metal concentration ranges from some other unaffected Greek areas are also included in the same table. The five stations sampled cover a rather wide marine area of the South Aegean Sea. The water depths ranged from 120 m to 1120 m, with the shallower stations within the Cyclades plateau and the deeper stations within the Cretan Sea. The difference between the station depths is directly reflected in the granulometric characteristics of the surface sediments. Thus, the shallower station is characterized by the lowest percentage of silt and clay (18,3%), whereas the percentage of the <63μm grain size fraction is increased with the water depth. Accordingly, the surface sediments of the shallow station in Cyclades plateau exhibited the lowest organic carbon content (0,38%) and the highest carbonate content (74%). The more or less similar distribution with the organic carbon is reflected by the heavy metal concentrations except for Cr. Iron, Al, Mn, Cu and Ni concentrations did not show any significant variation between the deeper stations, while they were significantly lower in the shallow station due probably to the elevated proportion of sand (>80%). According to the table Fe, Pb, Cu and Zn levels are of the same magnitude in the South and the North Aegean Sea. Chromium in this study presented a very narrow concentration range, while the maximum value is relatively low. However, great care should be exercised in making such comparisons because the extraction techniques used for the metal determinations are different.

Table 1: Heavy metal concentrations in sediments (ppm, except Fe in %) from the South Aegean Sea and other unaffected Greek marine areas.

Area	Fe	Pb	Cu	Zn	Ni	Cr	Mn	Method
South Aegean Sea (this work)	**1,92-2,81**	**20-43**	**11-43**	**50-81**	**53-106**	**68-78**	**442-1652**	**Total**
North Aegean Sea [3]	0,8-2,6	5-57	4-49	24-125	11-105	20-278	65-740	2N HCl
North Aegean Sea [4]	-	23-57	19-49	54-125	57-104	92-137	-	total
East Aegean Sea [3]	1,4-3,3	11-22	4-29	25-55	39-291	52-157	280-2640	c.HNO_3
Ionian Sea [3]	0,66-3,43	2-28	0-43	7-94	8-192	12-257	212-3820	2N HCl
South Evoikos Gulf[3]	0,60-1,50	12-27	3-15	25-44	25-144	37-97	165-555	2N HCl
Lakonikos Gulf [3]	0,67-1,66	6-45	7-30	22-52	14-40	26-58	121-2214	2N HCl
Pagassitikos Gulf [3]	1,3-2,7	19-30	9-25	38-72	32-228	50-186	290-2790	2N HCl
Elefsis Bay [3]	0,8-1,1	25-32	28-33	55-68	80-95	50-65	280-325	2N HCl

In the North Aegean Sea Ti concentrations in sediments varied between 3216 and 4640 ppm [4], while in the South Aegean area Ti ranged from 2520 to 2700 ppm. The elevated concentrations of Ti in the North Aegean sediments are attributed to the existence of some significant riverine sources that supply the marine environment with large amounts of terrigenous particles. In contrast, in the South Aegean Sea the main sources of suspended particle supply are atmospheric transport and biological processes within the water column. In order to determine the sources of the sediments in the area under investigation, the covariation of the elements with Ti (lithogenic sources), organic carbon (biogenic particles) and Al (aluminosilicates) was tested by plotting the metal concentrations against Ti, organic carbon and Al, respectively. According to the XY plots of the elements against Ti, only Al seems to have a relatively stronger linear correlation with lithogenic particles whereas all the other metals do not seem to be of lithogenic origin. Since terrestrial transport does not seem to be the main source of the sediments in the South Aegean Sea, the covariation of the metals with organic carbon, representing particles of biogenic origin, was tested. Elements like Pb, Zn, Mn and Fe showed a rather strong correlation with organic carbon, implying that heavy metals reach the bottom sediments possibly bound to particles produced by biological processes. Furthermore, from the XY plots of the elements against Al, only Pb, Zn, and to a lesser extent Mn and Ni seem to be partly associated with the finer sediment fraction where aluminosilicates are the prevailing sedimentary phase. From inter-element correlation plots, Cr distribution was not found to be correlated with any of the other metals, Cu was correlated only with Ni, and Zn was strongly correlated with Pb. Two representative plots are shown in the Figure 1.

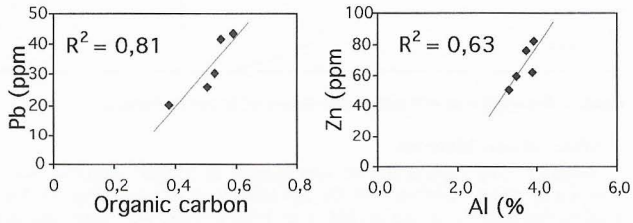

Fig. 1: Lead (ppm) *versus* org. C. (%) and Zn (ppm) *versus* Al (%) in South Aegean Sea

References

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