

DISTRIBUTION AND ORIGIN OF HYDROCARBONS AND CHLORINATED COMPOUNDS IN SEDIMENTS FROM STRYMONIKOS GULF IN NORTHERN AEGEAN SEA, GREECE

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Abstract

Hydrocarbons and chlorinated compounds were studied in surface sediments collected from the greater area of Strymon river estuary, in Northern Greece. Total hydrocarbon concentrations ranged from 19.2 to 95.9 $\mu\text{g/g}$, while total polycyclic aromatic hydrocarbon (PAH) values varied between 107.2 and 1019 ng/g . The application of different diagnostic criteria suggests a rather natural terrestrial origin for aliphatic hydrocarbons and pyrolytic origin for the PAHs. DDTs displayed the highest concentrations of all the organochlorines determined, varying between 0.6 and 48.1 ng/g . Polychlorinated biphenyl (PCBs) concentrations were lower and ranged between 0.09 and 3.0 ng/g .

Keywords: Aegean Sea, sediments, chlorinated compounds, petroleum, PAH

Introduction

It is known that estuaries can receive and retain large quantities of organic pollutants. The objectives of this work were: (1) to quantify the extent of hydrocarbon and organochlorine pollution in the area around the estuaries of Strymon river, one of the major rivers flowing into the Northern Aegean Sea; (2) to identify the nature and origin of these organic contaminants and associated types of pollution; and (3) to elucidate the importance of Strymon river in the fate and transport of these organic contaminants.

Materials and methods

Surface sediment samples (0-2 cm) were collected from 9 stations during December 1997 and May 1998 (Fig. 1). The aliphatic and polycyclic aromatic hydrocarbons were determined by gas chromatography/mass spectrometry after extraction, saponification, cleanup and fractionation [1]. The organochlorines were determined by gas chromatography/mass spectrometry in SIM mode after extraction and cleanup [2].

Figure 1. The sediment sampling locations

Results and discussion

Total hydrocarbon concentrations (THC) ranged between 19.2 and 95.5 $\mu\text{g/g}$ (Figure 2). These values are generally higher than those reported in open sea sediments of the northern Aegean Sea [3]. The lowest value was observed at station S13 in the middle of the gulf, while the highest values were measured at stations S9, S10, S8 close to the Strymon river mouth. This feature underscores the fact that riverine inputs are the major hydrocarbon supplier to the sediments of this area.

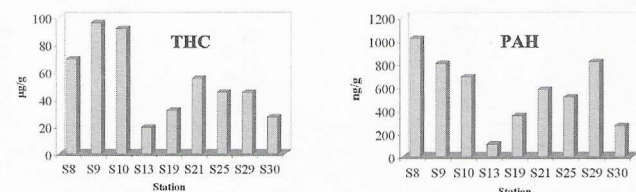


Figure 2. Total hydrocarbon (THC) and polycyclic aromatic hydrocarbon (PAH) concentrations in the sediments of Strymonikos gulf.

In all samples the gas chromatographic traces of the aliphatic fraction were characterized by two general features: resolved compounds and a unimodal hump corresponding to a mixture of unresolved compounds (UCM). The ratio unresolved/resolved compounds (U/R), which is widely used in order to identify the origin of the hydrocarbons, gives values indicative of petroleum contamination only at S9 (4.1), S10 (4.0) and S13 (3.7), while in the remaining stations they are below 3, suggesting the absence of important petroleum-related residues. N-alkanes presented a strong predominance of odd numbered carbon compounds in the range C₂₅-C₃₃, clearly indicating their terrestrial origin. Polycyclic aromatic compounds (PAHs) determined in this study include the parent compounds with two to six aromatic rings, dibenzothiophene, retene and the alkylated products of naphthalene, phenanthrene and dibenzothiophene. Their total values

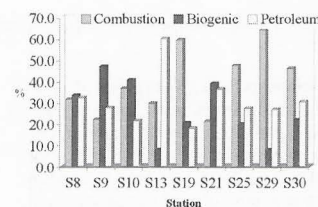


Figure 3. Distribution of combustion, biogenic and petroleum PAHs.

ranged between 107.2 and 1019 ng/g (Figure 1). Station S13 presented again the lowest value, similar to those measured in open sea sediments [3]. At the other stations the PAH concentrations are elevated but comparable to those found in other Mediterranean coastal or estuarine sediments [4]. In Figure 3 the percentages of pyrolytic, biogenic and petrogenic origin PAHs are presented. As can be seen, in most cases the pyrolytic PAHs predominate. Exceptions are the river-influenced stations S9, S10 and S21, where the terrestrial/biogenic retene and perylene are by far the dominant compounds, and S13, which seems to be affected by some petroleum residues.

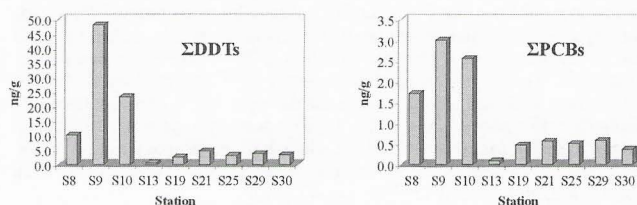


Figure 4. Total DDT and total PCB concentrations in the sediments of Strymonikos gulf.

p,p'-DDT and its metabolites p,p'-DDE and p,p'-DDD were present in the highest concentrations of all the organochlorine compounds. The sum of the concentrations of these compounds (Σ DDTs) ranged from 0.6 to 48.1 ng/g (Figure 4), but values higher than 10 ng/g were recorded only at stations S9, S10 indicating the importance of Strymon river in transporting these compounds. Similar DDTs values have been measured in other relatively non-polluted coastal Mediterranean areas [5].

Concentrations of PCBs (the sum of 15 congeners) were lower than those of DDTs, ranging between 0.09 and 3.0 ng/g . These concentrations are relatively low and indicate that no significant pollution from PCBs has occurred in the area. Hexachloro-substituted compounds (CBs 138, 153) dominated the congener distributions.

References

- 1 - UNEP/IOC/IAEA, 1992 Determination of petroleum hydrocarbons in sediments. Reference Methods for Marine Pollution Studies, No 20, UNEP
- 2 - Satsmadjis J, Georgakopoulou E. and Voutsinou-Taliadouri F., 1988. Separation of organochlorines in alumina. *J. Chromatogr.*, 437: 254-259
- 3 - Hatzianestis J, E. Sklivagou E. and Friligos N., 1998. Hydrocarbons in surface sediments from the Northern Aegean sea. *Rapp. Comm. int. Mer. Médit.*, 35:264-265
- 4 - Bouloubassi I. and Salot A., 1993. Investigation of anthropogenic and natural organic inputs in estuarine sediments using hydrocarbon markers (NAH, LAB, PAH). *Oceanologica Acta*, 16: 145-161
- 5 - Tolosa I., Bayona J. and Albaiges J., 1995. Spatial and temporal distribution, fluxes and budget of organochlorinated compounds in northwest Mediterranean sediments. *Environ. Sci. Technol.*, 29: 2519-2527