COMPOSITION, SPATIAL VARIABILITY AND SOURCES OF SEDIMENT PAHS IN TWO NEIGHBORING AQUATIC ENVIRONMENTS

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Abstract

The distribution, composition and sources of PAH mixtures in the sediments of the Gulf of Gemlik, sea of Marmara, and in a freshwater lake at its eastern extension, indicate characteristic spatial variability depending on various anthropogenic inputs. While atmospheric inputs are similar for both cases, other contributions are related to the spatial characteristics of riverine and terrestrial inputs and other activities such as shipping, fishing and agriculture. On the basis of several diagnostic criteria and principal component analysis -multiple regression models used to assess the type of process through which PAHs were generated, pyrogenic origin is dominant, even petrogenic PAHs also occur in combination with pyrogenic PAHs.

Keywords: Pah, Sediments, Pollution, Marmara Sea

Introduction:

Polycyclic aromatic hydrocarbons (PAHs), a group of particle-reactive hydrophobic organic chemicals, are deposited in aquatic sediments from a variety of sources. Their importance as an environmental hazard derives from their potential carcinogenic and mutagenic properties. Lower-molecular-weight PAHs, which may be acutely toxic, are less strongly adsorbed compared with the heavier species. PAHs migrate towards bottom sediments due to their extremely low solubility in water, so that sediments are the best media in evaluation of PAH impacts to aquatic environments.

Although it is not routinely applicable, PAH ratios, molecular indices and principal component analysis (PCA)-multiple regression models can be used in delineating the origin of sediment PAHs; natural or anthropogenic. Worldwide data may be helpful in understanding of their source apportionment. In the present study, evaluation of the sediment PAHs in the Gulf of Gemlik, SE part of the Sea of Marmara, and in Lake Iznik, a freshwater lake at its eastern extension, provides baseline information for hydrocarbon origin in the sediments of these two different aquatic environments.

Experimental details:

Before extraction, the surface samples (upper 5 cm) from the Gulf of Gemlik [1] and Lake Iznik [2] were thawed and homogenized until textural and color homogeneity was achieved. The concentrated extract was analyzed by gas chromatography/mass spectrometry (GC/MS), which is enable the identification of organic compounds presented at very low concentrations and in complex mixtures. The system was calibrated for the 12 priority pollutant PAHs using the internal standard calibration procedure described in US EPA method 8000. The method detection limits for Phe, Ant, Flu, Py, B[a]A, Ch were at the order of 1.0 ng/g dry sediment, while they were around 0.1 ng/g for other PAH compounds.

Results:

The sediment PAHs in both of the aquatic environments are closely related to the spatial variability of riverine and terrestrial inputs and other activities such as shipping, fishing and agriculture. Atmospheric inputs contributed for both cases, due to heating with coal, petroleum coke particles and biomass burning from various sources. The majority of sedimentary PAHs indicate pyrogenic origin, even though petrogenic PAHs do also occur in combination with pyrogenic PAHs. Eastern and southern shores of the Gulf of Gemlik were contaminated with higher-molecular-weight PAHs. The diagnostic ratios of Ph/Ant, B[a]P/(B[a]P+B[e]P) and IP/(IP+B[ghi]P) were found relatively more useful in source identification for the study areas. BaA/228 provides a useful tool for distinguishing pyrolytic PAHs, which are generated by incomplete combustion of petroleum, coal, and biomass as in the cases of industrial usage and household heating and cooking. The ratios of Phe/Ant, Ch/B[a]A, Ant/178 and IP/(IP+B[ghi]P) represent decisive differences between two basins while no diagnostic ratios are sensitive sufficiently to the sediment type, possibly due to rapid anthropogenic contamination.

Regarding the diagnostic power of PAH ratios and PCA-multiple regression models, three PAH origins were described; a) severe anthropogenic inputs with pyrolitic and petrogenic mixed pattern, b) pyrolytic and slightly petrogenic inputs, c) pyrolytic atmospheric inputs. The first factor is responsible for 52.5% of the total variance and attributed to composite sources of unburned petroleum and coal combustion. It is in agreement with the elevated-PAH concentrations mainly occurred due to sea port activities and river transportation. The second factor is responsible for 15.8% of the total variance and attributed to the inputs due to burned petroleum and liquid fossil fuel oil combustion (e.g. vehicular engine emission, gasoline and diesel). It is dominated along the southern half of the gulf where marine transportation is heavy. The last factor, weighted in B[a]P, B[ghi]P and IP, is responsible for 10.3% of the total variance. It can be considered as indicator for strongly pyrolytic and atmospheric inputs of petroleum combustion (heating with coal, petroleum coke particles) and biomass burning from various sources (wood, soot, grass and dried dung). It is dominant throughout the Lake Iznik as well as along the northern coastal water of the Gulf of Gemlik.

References

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