

Relation between concentrations of polycyclic aromatic hydrocarbons, grain size, and organic matter content in Lake Ketelmeer (The Netherlands)

A. A. Bakker
P. R. van der Linde
C. H. van der Weijden

Department of Geochemistry, Faculty of Earth Sciences, Utrecht University, Budapestlaan 4, P.O.-Box 80021, NL-3508 TA Utrecht, The Netherlands

The relation between concentrations of polycyclic aromatic hydrocarbons (PAH), organic carbon (C-org) content and grain size in a sediment sample from the Ketelmeer (the Netherlands) was investigated.

Before 1932 the area from where samples were taken was part of the inland sea called the Zuiderzee. Since the closure by a barrier dam (the Afsluitdijk), the Ketelmeer basin is a shallow fresh water lake which receives approximately 10 % of the total discharge of the river Rhine and thus forms an important sedimentation area for this river: heavy metals, pesticides, polychlorobiphenyls (PCB) and PAH are deposited in this area. Underneath the approximately 45 cm thick silty sediment layer deposited after 1932, there is a salt water clay deposit.

Two samples, one at a depth of 0–30 cm and one at 40–120 cm, were taken from a core that was collected in November 1996. The samples were separated into eight size fractions (<0.5, 0.5–1, 1–2, 2–10, 10–20, 20–38, 38–63, >63 μm) in the clay and silt range, using sieves and split-flow lateral transport thin separation cell fractionation (SPLITT). The top layer consists of 28 % (< 2 μm) and 63 % silt (2–63 μm); the fraction larger than 63 μm makes up only 9 % of the sediment, from which 95 % is in the range 63–200 μm .

In all fractions, C-org content and PAH concentrations were measured. Organic carbon contents vary from 6 % in the top layer to 10 % in the bottom layer. Determination of PAH was carried out by a Soxhlet extraction with an acetone-hexane mixture followed by analysis with High Pressure Liquid Chromatography (HPLC) with fluorescence detection. Eight of the 16 parental PAH identified by the World Health Organisation and the U.S.

Environmental Protection Agency were measured, i.e. phenanthrene, anthracene, fluoranthene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(ghi)perylene and Indeno(123cd)pyrene. Total PAH concentrations vary from 9.5 mg/kg in the top layer (0–30 cm) to 22.2 mg/kg in the bottom layer with a recovery of 80 to 100 % (reliability of the measured values was tested by measuring a blank and the reference material 1941 NIST).

PAH concentrations and C-org content, both expressed as the amount of substance per gram of a specific fraction, were found to be the highest in the coarsest fraction; this can be attributed to the presence of plant fragments. Among the various size fractions (except the coarsest fraction), no major differences in both C-org content and PAH concentrations exist. PAH concentrations and C-org content show a positive, approximately linear, correlation indicating that PAH behave like many other hydrophobic organic substances.

In terms of relative abundances (i.e. the amount of a substance relative to the total amount in the sample), PAH concentrations and C-org content were found to be the highest in the finest fraction (< 0.5 μm) because of the relatively large contribution of this fraction to the total sediment.

Concentration distributions of each of the eight PAH-compounds is essentially the same.

Normalisation of all concentrations to the total surface area, calculated on the basis of the assumption of spherical particles, indicates that specific surface area is not the major factor in controlling the PAH level in the sediment. Instead, texture (pore structure and size) seems to be more important.