

Assessment of Heavy Metal Pollution of Vistula River Sediments using Magnetic Method

Iga SZCZEPANIAK-WNUK^{1,✉} and Beata GÓRKA-KOSTRUBIEC¹

¹Institute of Geophysics, Polish Academy of Sciences, Warsaw, Poland

✉ igasz@igf.edu.pl

Abstract

The river sediments have high capacity to accumulate heavy metal pollutions originated a.o. from industrial wastewater, fossil fuel combustion and atmospheric deposition. The purpose of this research was to estimate the concentration of magnetic particles to assess the level of heavy metal pollution using magnetic methods.

The research was conducted on Vistula's sediments collected in the Warsaw's areas including the city center (area B, Fig. 1a) and out of the urbanized area (area A and C, Fig. 1a). For individual granulometric fractions of surface (0–2 cm) sediments several magnetic properties such as mass magnetic susceptibility (χ), changes of magnetic susceptibility in low and high temperature ranges and hysteresis loops were analyzed in order to determine the concentration and grain size of magnetic particles and their magnetic mineralogy. To characterize the morphology and chemical composition of magnetic particles the microscopic observations and chemical measurements were carried out.

The results of test study show that magnetic particles are mainly presented in the fine fractions of 100–71 μm and below 71 μm . Therefore, both fine fractions were taken account in the study of pollution level.

Distributions of χ along the Vistula river show the maximum in the very center of the city and relatively low values out of the urbanized area. The increase of χ in the city center and the decrease of χ outside the city center indicates that pollution level is mainly affected by local sources.

Significant correlations between the Pollution Load Index calculated for Pb, Zn, Al, Fe, Cr, Co, Cu, Ni and the magnetic susceptibility showed high heavy metal pollution level in very center. Outside the city heavy metal pollution level were relatively low and close to the background value.

The thermomagnetic analysis revealed magnetite as a primary magnetic phase in the city center (area B) and maghemite or cation deficient magnetite in areas outside of Warsaw (area A and C). The results show that in the area of Warsaw the magnetic extract is enriched in spherical-shaped particles (Fig. 1b). It was observed that fraction below 71 μm contained

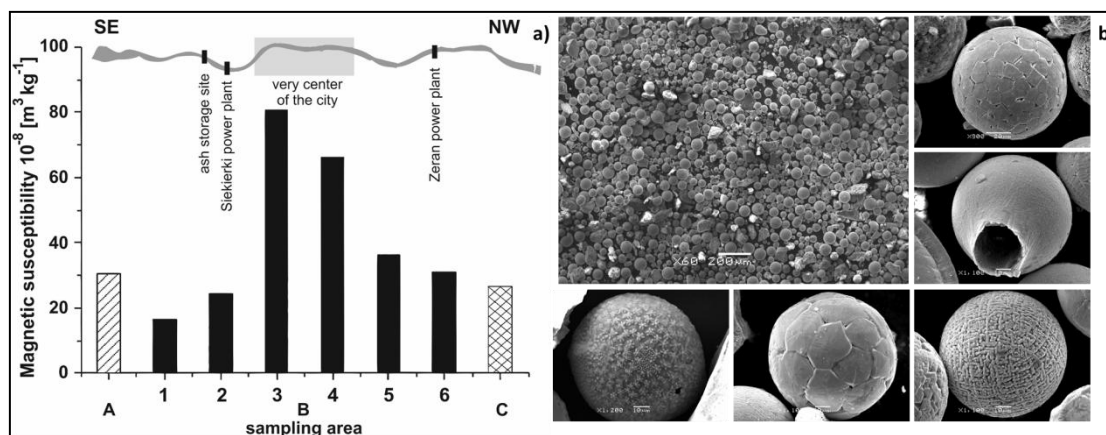


Fig. 1. Distribution of average magnetic susceptibility (χ_{av}) of surface Vistula River sediments for the Warsaw area (B) with corresponding subareas (from 1 to 6) and for two areas outside of Warsaw (A and C) (a). Scanning Electron Microscope images for fraction below 71 μm of surface sediments for area B (b).

more spherules than fraction of 71 μm . In both fractions a few types of surface morphology were observed such as particles with smooth, glossy, matt, orange-peel and druse-like surface.

Our research demonstrate that magnetic methods can be apply for detecting and mapping pollution in sediments around modern industrial cities.

Keywords: magnetic susceptibility, sediments, spherules, heavy metals.