Lithofacies, magnetic susceptibility and heavy-metal contents in regulated river-channel sediments of the River Morava, Danube catchment, Czech Republic

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ABSTRACT

Fluvial sediments deposited in floodplains, oxbow-lakes and dams represent the most important archives of anthropogenic contamination. Heavy metals (HM) and persistent organic pollutants (POP´s) are bounded mainly to fine-grained clay minerals and organic matter.

Much lower attention, however, is paid to deposits of river channels, which act as transport pathways for these archives and/or build archives of their own. In order to provide a better insight into the spatio-temporal distribution of pollutants in channel deposits, we investigated the relationships between sediment lithology (facies), grain-size, metal concentrations (Cu, Pb, Zn), magnetic susceptibility (MS) and chemistry of fly-ash particles in a series of sediment cores along the River Morava, a left-hand tributary of the Danube River, Czech Republic. We compared element chemistry and lithology of channel deposits with floodplain deposits in the same catchment.

We defined four river-channel facies, ranging from sandy-gravels to clayey silts, and confronted them with the floodplain sediments. Al/Si ratios were found to be useful proxies of grain size and Al was utilized as an excellent normalizing element for heavy metals, which filters out much of the grain size effects on contamination. The values of ^{137}Cs activity (11 Bq × kg^{-1}) and stratigraphic distribution of fly-ash "spherules" indicate local sedimentation rates in the river bed to vary between 1.6 and 2 cm per year. MS values do not show a simple dependence on grain size (paramagnetic clay- and silt-sized phyllosilicates vs. diamagnetic sand fraction comprising quartz and feldspar). The MS is partially controlled by grain size and partly by anthropogenic contamination in the form of "spherules." Vertical distribution of Pb/Al, Cu/Al and Zn/Al also showed a partial dependence on facies, especially in the upper parts of the borehole KV1 and OT4. Locally elevated enrichment factors (EFs) of Pb and Cu are accompanied by magnetic pollution, which is represented by elevated MS, MS/Fe and a high proportion of magnetic fly-ash spherules. The distribution of element concentrations and MS data suggest that significant part of the heavy-metal contamination can be carried by magnetic fly-ash spherules. A part of this contamination is bound to coarse-grained fluvial facies, indicating that the magnetic spherules can be transported as bed load sediments. Magnetic and heavy-metal pollution can therefore coincide in river bed deposits. It is suggested that most of this contamination can be related to local point sources of pollutants (fly-ash deposit spills). Ratios of Cu/Al, Zn/Al and Pb/Al in fine-grained floodplain sediments are significantly lower than in the river-bed sediments. The river-bed sediments of the Morava River show higher levels of anthropogenic pollution than its flood plain. This research was supported from the Czech Science Foundation Project GACR P210/12/0573.