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On risk element fates in fluvial system and dam reservoirs: case study on dam reservoirs in Chrudimka River, Czech Republic

Michal Hošek (1,2), Ondřej Bábek (3), Jan Sedláček (3), Karel Hron (3), Martin Faměra (2), Tomáš Matys Grygar (1,2)

(1) Faculty of Environment, J. E. Purkyne University in Usti nad Labem, Czech Republic, (2) Institute of Inorganic Chemistry AS CR, vvi, LEGA, Řež, Czech Republic , (3) Department of Geology, Faculty of Science, Palacky University, Olomouc, Czech Republic

Recognition and quantification of pollution by risk elements in river and dam reservoir sediments require at least four pre-requisites: (1) identification of grain-size effects on geochemical composition, (2) knowledge on partitioning of the risk elements in the fluvial system and the dam reservoir, (3) knowledge on the actual natural geochemistry of the sediments resulting from specific catchment geology and geography, and (4) at least rough knowledge on pollution history/sources in the catchment. Item (1) is of crucial importance, because the grain size of river channel, floodplain, and reservoir sediments ranges from boulders to mud with substantially variable sorting in the deposits in individual fluvial-reservoir compartments. The risk element partitioning, item (2), is something to be intuitively expected but not really implemented in current studies, however, segregation of risk elements according to the grain size of their carriers will definitely play role in dam reservoirs. The items (1) and (2) are neglected in studies where the entire catchment history is inferred from a single sediment core. Items (3) and (4) may seem trivial, but they are often ignored in studies of sedimentary archives.

The grain-size control of sediment geochemistry was inferred from element concentrations and particle size distribution functions (PSD). This, together with sampling unpolluted fluvial sediments in the river floodplain, allowed for selecting reference element for geochemical normalization in broad scale of sediment grain sizes. This in turn allowed to process sediments with bulk fine sediments (<2 mm) and distinguish anthropogenic pollution by Pb, Zn, Cu, and Ni (ordered from more ancient to more modern). The best performing reference element was Fe, which limits processing floodplain sediments depleted in Fe by reduction and dissolution (below water table). On the other hand, Rb was mainly bound to coarser particles and Ti to medium-sized particles, while the above listed risk elements, were mostly bound to the finest particles. The risk element concentrations reflected catchment geochemistry (granitic rocks): Pb was naturally enriched and Cu depleted compared to the mean upper continental crust. We found, that Fe and Mn oxides and other finest sediment components, otherwise depleted in floodplain sediments, are specifically accumulated in the deepest parts of the reservoir (near the dam) thus changing element fluxes through the river system due to river damming.

We finally obtained grain-size independent pollution chemistratigraphic scheme for the Chrudimka River sediments, mostly based on the Sec dam reservoir sediments. The dam retained a substantial part of risk elements due to deposition of its carriers, including finest particles of Fe oxides.