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Geochemical forms and mobility of heavy metals in alluvial sediments of Arakawa lowlands, Japan

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This study examined depthwise changes in chemical compositions of alluvial sediments, as well as Geochemical forms and leachability of copper (Cu), zinc (Zn), chromium (Cr), lead (Pb), and arsenic (As) of the same sediments sampled from Arakawa lowland, central Japan. Three investigation sites along the Arakawa river, ie., upstream (terrestrial), middle (terrestrial and marine) and downstream (marine) areas, were selected to set boring core samplers. The core samples from 0 m to 20 m depth of each site were collected. They were characterized thick silt and sand layers. Gravel deposits were collected from below 12 m depth of the upstream site. A peat layer with a thickness of 80 cm was sandwiched between two silt layers in the upstream site. Two peat layers in the middle sites with thicknesses of 150 cm and 20 cm were observed between silt and sand layers at the 8 m depth and between terrestrial silt and brackish silt layers at 13 m depth, respectively. Chemical compositions of the specimens were determined using X-ray fluorescence spectrometry (XRF) while the solution water chemistry was analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP/MS). The sequential extraction procedure was followed to identify the fractions of each heavy metal associated with different geochemical forms in sediments.

The observed Pb, Cu, Cr and Zn contents of all sediments were within the average values of natural sediments, hence presumably have natural origins. The As contents of the sediments in the upstream and downstream areas were also below the environmental standards. However, the As contents of the two peat layers in the middle areas exceeded the rough standards of natural sediments. Leaching test results further revealed that the water eatractable As concentration exceeded the standard for drinking water and a greater portion of the extractable fraction is colloid-bound. Results of the sequential extraction test revealed that the order of potential metal mobility in the examined sediment profile was Zn > Cu > As > Cr > Pb.

The geochemical analysis results on the sediment samples lead to presume the dissolution and/or desorption of Fe oxides in anoxic environments as the most likely mechanism of As release from sediments to groundwater. The results on geochemisty of groundwater and porewater of the concerned area is, however, limited and need to be examined to arrive at a firm conclusion on As releasing mechanism(s). I conclude that the presence of As and other heavy metals will not likely pose an immediate threat to the environment, although peat sediments will be required closer observation and monitoring.

Keywords: Heavy metals, Geochemical forms, Mobility, Seqential extraction, Leaching