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The Pedosphere of Floodplains in a historic Lead Mining Area: Sink or Source for Heavy Metals at the Ground-Water/Surface-Water Interface?

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In North-east Bavaria (Germany) alluvial sediments of the Vils River are extensively contaminated with heavy metals. A potential source of heavy metals is the historic mining area at Vilseck/Freihung with former mine slag and ore dumps at the upper reaches of the Vils River. This study focusses on particulate and mobile fractions of the heavy metals lead and zinc and the metalloid arsenic in alluvial soils by balancing total and elutable contents. One major aim is the assessment of the potential danger of further soil and water contamination deriving from these element accumulations at the ground-water/surface-water interface of the Vils River floodplain.

To assess the heavy metal charge, alluvial sediments of a ten kilometre fluvial section between Vilseck and Freihung were analysed. After percussion drilling of 120 profiles up to five metres depth, samples of each drilling metre were dissoluted by aqua regia and eluted with de-ionised water (n = 572 each). Selected samples were prepared for a sequential extraction procedure (n = 13) to characterise binding forms and mobility of lead. Measurements of Pb, Zn and As were carried out by ICP-MS. In addition total element contents of samples taken from each soil horizon (n = 1915) were detected by field-portable X-ray fluorescence (FPXRF).

The total heavy metal contents vary specific to each element and show high ranges

over the depth of five metres. Pb, As and Zn are enriched in the first metre of the profiles. They show a negative gradient according to depth within the cores, which is best shaped for lead. Elution measurements document an increasing mobility of elements in the order of Pb $<$ As $<$ Zn. Determinations of all samples show relative low solubility in de-ionised water with means of 2.6 % for Zn, 0.7 % for As and 0.2 % for Pb (ratio H_20 elution : aqua regia dissolution). Highest total contents of lead are found in the topsoil horizons and in hydromorphic horizons of the alluvial soils, especially about 33 % solely within oxidised aGo-horizons and 17 % within reduced gleyic horizons (aGr). On average, soil horizons staying recently under ground-water influence have an enrichment factor for lead of more than thirty. Results from the sequential extraction procedure reveal highest contents of Pb (28.6 %) in the organically bound fraction. In the fluvial gravels, proportions of up to 50 % Pb in the mobile fractions are noticeable. Obviously, under current pH conditions ranging from 3.6 to 4.2 and under presence of minor salt contents even a potential mobility of lead is given. The investigations show that soil horizons at the ground-water/surface-water interface of the Vils River floodplain play a major role both as a sink and a source for elements derived from historic mining.