Recent Pb soil pools and comparison of long-term Pb mass balances in headwater catchments with different pollution loads

Bohdálková, Leona [a,b], leona.bohdalkova@geology.cz , Chrastný, Vladislav [c], chrastny@fzp.czu.cz, Pacherová, Petra [a], petra.pacherova@geology.cz, Oulehle, Filip [a,b], filip.oulehle@geology.cz, Hruška, Jakub [a,b], jakub.hruska@geology.cz, Krám, Pavel [a,b], pavel.kram@geology.cz, Chuman, Tomáš [a,b], tomas.chuman@geology.cz, Šípková, Adéla [c], sipkovaa@fzp.czu.cz, Novák, Martin[a], martin.novak@geology.cz, Lamačová, Anna [a,b], anna.lamacova@geology.cz

[a] Czech Geological Survey, Geologická 6, 152 00, Prague 5, Czech Republic
[b] Global Change Research Institute of the Czech Academy of Sciences, Bělidla 986/4a, 603 00 Brno, Czech Republic
[c] Faculty of Environmental Sciences, Czech University of Life Sciences, Kamýcká 129, 165 00 Prague-Suchdol, Czech Republic

Lead is toxic for the environment and human health. Its natural geochemical cycle has been substantially changed by human activities. In Central Europe, Pb emissions reached a maximum during the 1980s, due to coal burning, use of leaded gasoline, base-metal smelting and chemical industry. Pb is removed from the atmosphere via dry and wet deposition to the hydrosphere and pedosphere. In Central Europe, forested headwater catchments are an important source of drinking water.

Twelve small forested catchments of the GEOMON monitoring network are situated along a north-south pollution gradient and include different bedrock types. At each site, three soil pits were sampled at the depths of 0–10, 10–20, 20–40 and 40–80 cm, and analyzed for water-soluble, bioavailable, and total Pb concentrations (H_2O extracts, EDTA, and HF digestions, respectively). Across the sites, the overall mean water-soluble Pb pool was 0.17 kg/ha (with a minimum of 0.04 and a maximum of 0.32 kg/ha), the mean bioavailable Pb pool varied from 22 to 84 kg/ha, with the mean of 42 kg/ha, and the total Pb storage ranged from 65 to 481 kg/ha, with the mean of 210 kg/ha. On average, almost half of the water-soluble Pb storage and more than 40% of bioavailable Pb pool were located in the uppermost layer of the mineral soil (0-10 cm). On the other hand, more than 40 % of the total Pb pool were in the deepest sampled layer (40-80 cm).

Pb mass balances (atmospheric Pb input minus Pb output) based on long-term hydrochemical monitoring of open-area precipitation, throughfall and runoff water were evaluated for 24 consecutive years (1996-2019). Sites exhibited a wide range of mean annual atmospheric Pb input (4.3–49.5 g ha^{-1}) with the mean of 14.8 g ha^{-1} across the sites, as well as output (0.6–30.4 g ha^{-1}) with the mean of 6.2 g ha^{-1}. Moreover, the mean annual output/input ratios varied substantially among the sites (7–180%). All the sites showed decreasing trend in Pb atmospheric input, however only at half of the sites significant decrease in Pb output was detected during the monitoring period. Analysis of hydrochemical and soil parameters controlling Pb retention/release is under way.