

## SUMMARY

Metallurgical activities are one of the important sources of environmental pollution, especially due to inappropriate treatment of waste materials containing potentially harmful elements. Soils in the vicinity of smelting operations are the main target reservoirs for these emitted contaminants. The aim of this study was to depict reactivity of copper smelter flue dusts and slags in aqueous and soil environments using laboratory and field experiments.

Slags exhibited high concentrations of As (up to 0.95 wt.%), Cu (up to 2.4 wt.%), Pb (up to 1.02 wt.%), Sb (up to 0.37 wt.%), and Zn (up to 2.45 wt.%). Copper and other metal(loid)s were predominantly bound in sulphides, especially bornite, digenite, chalcocite, and galena. Flue dusts were mainly composed of  $As_2O_3$  phase (arsenolite and claudetite), with minor amounts of gypsum, galena, quartz and covellite. The main contaminants in the dust were As (53.3 wt.%), Pb (3.41 wt.%), Sb (1.26 wt.%), Zn (1.41 wt.%), Cu (1.07 wt.%) and Bi (0.80 wt.%).

The leaching tests performed in the pH range of 3–12 indicated that the release of metal(loid)s from both types of metallurgical wastes was highly pH-dependent. During the leaching in deionised water, up to 42 mg/kg As was released from slags and up to 52.6 g/kg was leached from the flue dust; the latter highly exceeding EU limit values for hazardous wastes.

Short-term reactivity of the flue dust was investigated *via* laboratory pot experiments in eight different soil types in the time frame of 504 hours and, in some cases, of 1008 hours. Average mass losses of the dust at the end of the experiment were in the range 18–44 % with the maximum values obtained after weathering in acidic soils. Soils after dust incubation exhibited up to 2570 mg/kg As and pore water up to 1820 mg/l.

Field experiment indicated that mass losses were rather low for slags and no significant soil contamination has been observed after long-term (3-year) incubation. In contrast, flue dust transformation was rather fast (35 % dissolved after first 6 months of incubation) and further increased with time (mass loss up to 60 %). Despite high solubility of arsenolite, this primary phase was persistent in the material even after the long-term incubation; newly formed arsenates, especially mimetite, partly controlled the mobility of the released As. The dynamics of metal(loid)s release was not only dependent on soil pH, but also on water regime and soil saturation affected by the vegetation cover and clay content. The highest dust solubility was observed in acidic Dystric Cambisol developed under the beech cover: up to 980 mg/kg As was observed in soil and up to 13.1 mg/l As was found in pore water.

The results indicate that, in the long-term perspective, slags were relatively stable in soils, but flue dust was highly reactive under all the studied conditions. This study highlights the usefulness of long-term field experiments for understanding reactivity of metallurgical wastes in real systems and underlines the crucial role of the flue gas cleaning in smelting industries for preventing large-scale environmental contaminations.