

ASSESSMENT OF COMPOSITION AND PROPERTIES OF URBAN DUST NEAR LARGE Cu SMELTER

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Introduction

The industrial development in the South Ural, Russia, has caused a tremendous damage to the environment. A large contaminated area has been formed around the copper smelter in Karabash (Chelyabinsk region). Emissions of sulphur dioxide, Pb, Zn, Cd, Cu, and other chalcophylic elements as finely dispersed aerosols result in the precipitation of "acid rains" (pH 3.5-4.0) characterized by anomalously high concentrations of metals in dissolved and solid phase forms. It is well known that the impact of metal/metalloid ions on the environment cannot be evaluated by measuring the total concentration of individual trace elements (TE), because mobility, bioaccessibility and toxicity of anthropogenic elements strongly depend on their chemical forms and type of binding. Studies on the properties and chemical composition of atmospherically deposited dust in the area of Karabash copper smelter is of great importance for risk assessment related to the migration of toxic elements and their inclusion in the biogeochemical cycle.

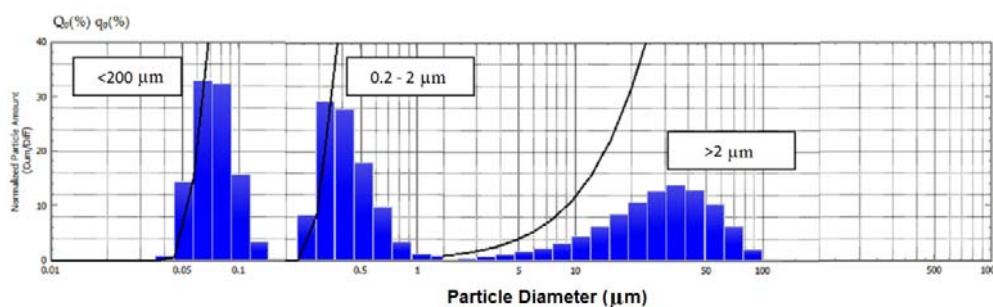
Materials and methods/ Atmospheric dust was sampled from the windowsills of the recessed balconies at the second floor of the building located at about 2.5 km from the copper. The samples were collected from two sides of the building. The east side faces the copper smelter, whereas the west side looks toward the street. The weight of "east" and "west" samples collected from nearly same surfaces (about 50 cm²) is 1.0 and 2.5 g, correspondingly. The elemental analysis of dust samples was performed by ICP-MS after acid digestion.

Results/ Our dust samples differ significantly from the road dust. The samples under study are integrated samples of dust deposited during several months. The concentrations of Cu, Pb, As, Cd, Zn, Hg and some other elements are higher in the "east" dust from the side of copper smelter. Moreover, the concentrations in both samples are dramatically elevated not only local background for soils of this area, but the maximum concentrations in soils of Karabash. The dramatically elevated concentrations of arsenic (up to 4.2 g/kg) and sulphur (up to 15.5 g/kg). These results confirm that the studied dust samples mainly consist of atmospheric solid-phase deposits from the copper smelter emissions.

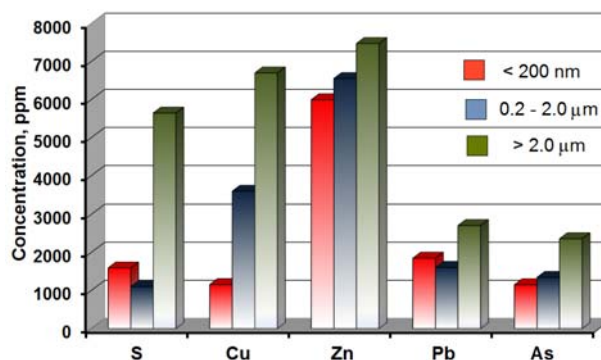
For the "west" dust up to 1.5, 4.1, 1.9, 11.1, and 46.1% of Pb, As, Cu, Zn, and S, correspondingly, can be easily mobilized by water. Necessary take into consideration the high total concentrations of these elements

in the samples. Such dust is also very dangerous for human health since it may penetrate into lungs during respiration.

It is known that particles smaller than 1 μm are the most dangerous to health because of high mobility and penetration. The main difficulty lies in separating nano- and submicron particles from dust. The fractionation of dust samples was performed on a planetary centrifuge with a vertical one-layer coiled column drum. Three different fractions were separated from initial dust samples. According to the data of static light scattering, these fractions contain particles <0.2 , $0.2-2$, >2 μm , respectively. This, size distributions was confirmed by scanning electron microscopy. The separated fractions were filtered, dried, weighed, digested, and analyzed by ICP-MS and ICP-AES.



ICP-MS analysis of fractions showed a different distribution of elements. Contents of rock-forming elements (Al, Ca, Mg and Fe) increases with the size of the particles, their contents into fractions 1 (>2 μm) in average 2-5 times higher than in the fraction 3 (<200 nm). Technogenic elements from smelter emissions also basically collected in the most rough fraction. Despite the large surface area of nanoparticles and, consequently, their higher sorption capacity, the content of these elements proved to be the lowest. In our case, the content of such elements as S, Cu, Zn, Pb, Cd, As increases with the size of the particles. This can be seen particularly well for sulphur and copper. The difference in the concentrations of Zn, Pb, As, Cr, Ni expressed significantly weaker, and to Cd is virtually non-existent. It is interesting, that concentration of technogenic elements (except Cu) in two fine fractions change slightly.



On the other hand, results of EDS microanalysis showed that a considerable part of dust microparticles are S, As, Cu, and Zn compounds, probably sulfides. These microparticles are of direct anthropogenic origin, emitted from copper smelter stack. Taking into account EDS data, higher concentrations of S, As, Cu, and Zn in rough fractions are quite logical.