Arsenic mobility in coal-combustion ashes mixed with agricultural soil

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In this study, we focus on the influence of coal combustion residues (ashes) on soils. Ashes with elevated As content were buried in soils when a dam of an ash impoundment of the Nováky power plant (Slovakia) failed in 1965; subsequently, the ashes were covered by agricultural soil. In order to assess the arsenic mobility, we performed leaching studies with distilled water, ammonium nitrate, and acid ammonium oxalate solutions on ash-soil samples collected in three various depths intervals (0-30, 20-60 and 40-100 cm) at various locations in the 1965 ash spill.

Mild extractions with H_2O and 1 M NH_4NO_3 show that there is a potential to contaminate the surrounding environment with As due to relatively high concentrations of As measured in the leachates. However, in both extractions, the released As concentrations represent only a small percentage of the As_{TOT} (5.3% and 0.3%, respectively).

Oxalate-extractable As fraction (73% of the As_{TOT}) should be associated with the poorly crystalline Fe, Al, and Mn oxide phases, which represent 17%, 14%, and 63% of the total element concentrations in the samples, respectively. It could be assumed that released amounts of Si_{OX} (484- 21, 319 mg/kg) and Al_{OX} (10.04-22, 984 mg/kg) support a possibility of silicate leaching from amorphous glasses in this extraction step.

Single extractions were complemented with magnetic separation of heavy fraction, X-ray diffraction and electron microprobe analyses of ash-soil mixture. These studies show, that the magnetic fraction of the soils contains an average value of 0.15 wt% As and 0.08 wt% As in the non-magnetic fraction. In depths of > 40 cm, there were significant positive correlations between As and total Fe (r=0.71), as well as As and total Al (r=0.78). Positive correlation of r=0.94 was also found for As-Ca, indicating that Fe, Al, and Ca-rich minerals control the distribution of As and retain this element in the soils.

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From compositional to P-T-deformation-t(relative age)-redox maps at the thin section scale

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Linking deformation with metamorphic conditions requires spatially continuous estimates of pressure (P) and temperature (T) conditions at least in two dimensions (P–T maps) that can be superposed to the observed structures of deformation at different scales.

We have developed an approach and a package of matlab scripts to produce EMP quantitative X-ray maps of composition at the thin section scale. These maps of mineral composition can be combined with a multi-equilibrium approach involving phyllosilicates to calculate P–T-deformation-t (relative age)-Fe^{2+}/Fe^{3+} maps, even for samples free of low variance parageneses. Various application examples show that in metapelites metamorphosed at < 550 °C, the composition of phyllosilicates does not change significantly by lattice diffusion with varying P and T. Different compositions of phyllosilicate grains coexisting metastably in the same thin section are therefore indicative of different P-T conditions of crystallization that were achieved at different times. The nucleation of new phyllosilicate grains with different compositions during P–T variation is activated by deformation, so that the location of the different phyllosilicate generations characteristic of different P–T conditions is correlated to the microstructures. In addition to historical information about the P–T and deformation history, the P–T-deformation-t-Fe^{2+}/Fe^{3+} maps highlight the evolution of redox condition and the heterogeneity of rheology at the thin section scale.