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Dynamics of deposited fly-ash and fine grained magnetite in sandy material of different porosity (column experiments)

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Several studies confirm that soil magnetometry can serve as proxy of industrial immisions as well as heavy-metal contamination. The important assumption for magnetic mapping of contaminated soils is that atmospherically deposited particulate matter, including the ferrimagnetic phase, accumulates in the top soil horizons and remains there over long period. Only if this is true, large areas can be reliably mapped using soil magnetometry, and, moreover, this method can be used also for long-term monitoring. However, in soil types such as sandy soils with different porosity or soils with substantial variability of water regime, translocation of the deposited anthropogenic particles may result in biased (underestimated) values of the measured topsoil magnetic susceptibility. From the physical point of view, this process may be considered as colloid transport through porous medium.

In our column experiments in laboratory we used three technical sands with different particle sizes (0,63 – 1.25mm, 0,315-0,80mm, 0,10-0,63mm). Sands in cylinders were contaminated on the surface by fly-ashes from coal-burning power plant (mean grain size 10μm) and fine grained Fe3O4 (grain size < 20 μm). Soil moisture sensors were used to monitor water regime within the sand columns after controlled rain simulation and temperature distribution in sand column was measured as well. Vertical migration of ferrimagnetic particles-tracers presented in the fly-ash was measured by SM 400 Kappameter.

By means of magnetic susceptibility distribution we studied two parameters: gradual shift of peak concentration of contaminants (relative to surface layer) and maximum penetration depth. Results indicated that after rain simulation (pulls infiltration of defined water volume) the positions of peak values moved downwards compared to the initial state and gradual decrease of susceptibility peak values were detected in all studied sand formations. Fly-ash migrated more or less freely in coarse sand material. In medium and fine sand the contaminants moved only to the depths of several cm due to the pore-space blocking and water flow decrease. Fine-grained magnetite shows different behavior. Position of peaks value is more or less stable and maximum depth of penetration is only a few cm in all cases.

Higher grain size value is probably reason for higher stability of magnetite. Moreover, magnetic interaction between grains increase “effective” grain size value and restricts transport in material with given porosity.

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