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Role of smectites and smectite-iron oxide associations in metal sorption by soils

Péter Sipos (1), Viktória Kovács Kis (2), Réka Balázs (1), and Tibor Németh (1)

(1) Institute for Geological and Geochemical Research, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences (sipos.peter@csfk.mta.hu), (2) Institute for Technical Physics and Materials Science, Centre for Energy Research, Hungarian Academy of Sciences

Smectites and iron oxides are the most important mineral phases affecting sorption of metals in soils. Their exact role in this process, however, cannot be evaluated using data from sorption experiments carried out on bulk soil samples. To overcome this limitation, we studied the sorption capacity of individual particles of smectites and iron oxides, as well as their associations by transmission electron microscopy (TEM-EDS). Before that, single element batch Cd, Cu, Pb and Zn sorption experiments were carried out on six soil samples characterized by contrasting characteristics but by smectitic clay mineralogy.

Relating Langmuir maximum sorption capacities (Qmax values) of the studied soil samples to their major physico-chemical properties (pH, TOC, surface area, CEC, dithionite extractable Fe content, clay content) showed that Qmax values cannot be related to a single soil parameter for metals showing higher sorption in all studied samples (Cu and Pb). This can be due to the complex nature of soils where large number of parameter affects the sorption of certain metal in varying degree. In contrast, Qmax values for metals exhibiting lower (or higly varying) sorption (Cd and Zn) could be related to certain parameters (to pH, TOC and to Fed subordinately). These results, however, provide strongly insufficient information about the role of soil mineral phases in sorption of the studied metals.

The TEM-EDS analyses carried out on selected samples showed that both smectites and iron oxides may immobilize varying amount of these metals with significantly higher sorption capacities for the latter phases. They generally appear in close associations in the soils: submicron sized smectite particles were found to be associated to tiny ferryhidrite and goethite patches in the acidic soil samples, whereas the alkaline soils could be characterized by goethite and smectite particles attached to large carbonate grains. We found that the higher the Fe content of the smectite the higher its sorption capacity. This is the most conspicuous in the alkaline samples and applies to each studied metals there, whereas this phenomenon was characteristic only for Cu and Pb in the acidic soils.

Our results demonstrated the significant role of smectites, iron oxides and their associations in the sorption of metals in soils directly. Although this phenomenon remains often hidden due to the complexity of sorption processes in soils, its direct observation supports a deeper insight into soil-metal interaction.

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