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ROLE OF ORGANIC MATTER AND FERRIC/FERROUS IRON IN CHROMIUM CONCENTRATION IN VOLKONSKOITES

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Heavy metals in sediments are bound in various components, the most important being clay minerals, Fe-Mn oxyhydroxides and organic substances.

Volkonskoite is a unique mineral from the smectite group, containing dominantly chromium in the octahedral position. This mineral is formed on different organic remains buried in productive sandstone from West Ural (Perm and Kirov regions). Besides veinlets, volkonskoite forms complete pseudomorphs of even large tree trunks ("volkonskoite tree").

Chemical analysis shows great variations in the chromium content of volkonskoites (Cr_2O_3 ~ 14–30 wt%). In volkonskoite-bearing rocks Cr accumulated in the clayey cement of sandstone (Cr_2O_3 ~ 2%). The silicified wood fragments retained well their original texture, which is often marked by finely disseminated inclusions of iron hydroxides, so the presence of ferric and ferrous iron can promote the concentration and fixation of chromium in clayey matter. Inner structure of such inclusions indicates their organic origin. The accumulation of chromium in silicified wood takes place firstly at the inner part of such ferric or ferrous inclusions.

The formation of "volkonskoite tree" can be explained as follows: in relics of silicified wood that keeps the original inner "biological" structure chromium accumulates firstly on clayey matter that has been formed on cell membranes, grain boundaries of quartz, small cracks and other parts where organic matter can endure and microorganisms can be present.

SEM investigations of volkonskoites show besides typical smectite structures (globular, acicular and curved-platy) the vermicular structure of bacterial cells unique for volkonskoite. So the reduction and fixation of chromium in clay minerals may be provided by microorganisms or by ferrous iron that is microbiologically reduced from ferric iron.

Laboratory experiments were carried out for modelling the chromium sorption and desorption on smectite at the combined or separate presence of humic acids, FeOOH and Fe^{2+}. Whole rock samples from Vychegda (Triassic montmorillonite) and Efimiata (Permian clay from volkonskoite-bearing rocks) were used as model materials.

These experiments show that chromium sorption is especially high on the montmorillonite clay at the presence of Fe^{2+} and goethite, and desorption of sorbed chromium after pH decrease is relatively low. Desorption of chromium from volkonskoite under oxic and anoxic conditions is also small. The influence of humic acids and ferrous iron increased the sorption capacity of clay minerals.