EFFECT OF SOIL CLAY MINERALS ALTERATION AND VERMICULITE FORMATION ON THE ADSORPTION OF COPPER IN A FOREST SOIL B HORIZON: A TEM-AEM AND XRD STUDY

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Clay minerals are very important natural metal-ion adsorbents in soils. As the adsorption capacity depends on the crystal structural features, clay mineral transformation processes may affect the adsorption properties of the soil itself. Relationship between mineral alteration of soil clay in a Luvisol B horizon and copper adsorption, as well as the effect of adsorbed metal-ion on the clay mineral properties was studied by TEM-AEM and XRD. The predominating clay mineral phases in the studied soil profile is chlorite/vermiculite mixed layer mineral (Chl/V) and vermiculite (AlV), probably with partial hydroxy-interlayering. Chl/V is the weathering product of the primary chlorite dominating the siltstone parent rock. Based on TEM-AEM and XRD this phase shows different stages of vermiculitization, which is reflected in the partial swelling and in the gradual substitution of Mg by Al. AlV is considered as a pedogenic Al-rich vermiculite, with the presence of some hydroxy-interlayers. The adsorption capacity for copper of the bulk soil clay sample was found very high (13.4 g Cu/kg). To reveal the distribution of copper among the different clay mineral phases we used TEM-AEM. Both major clay mineral phases adsorbed large amount of copper, while the uptake of illite was found no significant. The copper uptake increased with the decrease of Mg within the Chl/V series, or the increase of octahedral occupancy decreased the Cu adsorption within the series. It clearly indicates that vermiculitization of chlorite increased the copper adsorption (figure 1). On the contrary, fixed potassium commonly found in pedogenic Al-vermiculite, i.e. illitization, as well as initial Al-hydroxy-interlayering of pedogenic Al-vermiculite slightly reduced the copper uptake.

Contrary to potassium, iron apparently enhanced the copper adsorption in the case of a part of both major clay mineral group, but was not found a regular trend. It suggests the presence of iron coating on the clay particles being also an important factor, which increases copper adsorption on clay minerals.

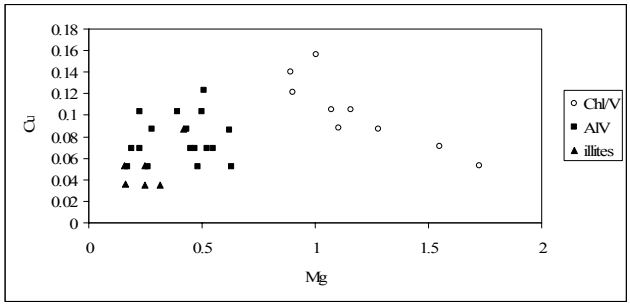

Figure 1: Plot of Mg content vs. Cu content of different individual clay particles after the adsorption experiment (AEM data).

XRD revealed that Cu adsorption take place in the interlayer space of vermiculite components with 14.1 Å basal spacing in the highest Cu concentration range. The initial expansion upon ethylene-glycol solvation to 15.5 Å reduced with the increase of adsorbed Cu to 14.5 Å, indicating that Cu adsorption can cause the loss of intracrystalline expansion of vermiculite.

In our work, TEM-AEM analysis was found a very useful tool to study the effect of clay mineral transformation on the metal adsorption in soils.

ACKNOWLEDGEMENTS

We thank M.M. Abad (C.I.C., Univ. Granada) for her help with the HRTEM work. Financial supports of Research Group RNM-325 of the Junta de Andalucía and Hungarian National Scientific Research Found (OTKA No. F-62760) are acknowledged.