
Effect of Selective Dissolution on Charge and Surface Properties of an Acid Soil Clay

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Abstract: To evaluate the importance of oxides to the surface chemistry of acid mineral soils, clay fractions were separated from a surface and subsurface horizon of an Inceptisol representative of many of the acid soils of the Southern Tier of New York state. Portions of the clays were treated to remove selectively noncrystalline and microcrystalline Fe and Al oxides (acid ammonium oxalate extraction), total free iron oxides (dithionite reduction in buffered citrate solution), and organic matter (hypochlorite oxidation). Charge and ion-adsorption characteristics of the treated and untreated clays were investigated by means of Ca^{2+} - and Cl^- -exchange capacities, potentiometric titrations, and electrophoretic mobility (zeta potential) measurements of the CaCl_2 -treated clays.

Based upon surface area and anion- and cation-exchange measurements, the Fe and Al oxides or oxide-organic matter complexes were found to contribute a large part of the surface area and pH-dependent charge of these clays. Oxide removal increased the cation-exchange capacity (CEC) and virtually eliminated the anion-exchange capacity (AEC) at pH 3 and 5.5 while shifting the positive zeta potential (ZPC) of the B-horizon clay toward negative values. Organic matter oxidation increased the AEC at pH 3 and the CEC at pH 5.5 and markedly shifted the ZPCs of both A- and B-horizon clays toward more positive values, probably by the removal of adsorbed organics from oxide surfaces. Estimates of the ZPCs of the clays varied among the three methods used, Ca^{2+} - and Cl^- -exchange capacities giving the lowest, and electrophoresis giving the highest values.

Key Words: Anion exchange • Cation exchange • Electrophoresis • Inceptisol • Soil clay • Surface charge • Zeta potential

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