THE CHEMISTRY OF ION ADSORPTION
BY SOIL COLLOIDS

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The following is a brief discussion of the results of a series of investigations carried out at the New Jersey Experiment Station. For tabulated details and full discussion the reader is referred to the following publications: The Laws of Soil Colloidal Behavior: III. Isoelectric Precipitates; Soil Sci. (1936). IV. Isoelectric Precipitates; Soil Sci. (1931). V. Ion Adsorption and Exchange, and VI. Amphoteric Behavior. The last two papers will shortly appear in Soil Science.

Adsorption in Relation to Composition.

It has been found that the adsorption of cations increases with the ratio of silica to sesquioxide, i.e. with an increase in the proportion of silica. The cation adsorption also increases with an increase in the proportion of the phosphate or humate content in the colloidal complex. The anion adsorption, on the other hand, increases with an increase in the proportion of sesquioxide in the complex.

Whereas the cation adsorption increases with an increase in the pH, the opposite is true of the anion adsorption. Among the common ions only the PO₄ ion is adsorbed from a neutral or alkaline solution. The SO₄, NO₃ and Cl ions, which (especially the last two) are highly dissociated by the complex, are easily displaced by the OH ions and are therefore adsorbed only from acid solutions.

The same relation between composition and adsorption is found in the case of (isoelectrically) precipitated "silicates", "phosphates" and "humates" of aluminum and iron. The sesquioxides themselves adsorb only anions except in alkaline solutions where they assume acidic properties and become electronegative. The sesquioxides are amphoteric colloids. Silica and humus are strictly electronegative and adsorb only cations at all pH values.

Nature of Compounds Formed

The sesquioxides are weak bases and silicic, phosphoric and humic acids are weak acids. Their combinations are therefore subject to extensive hydrolysis. The products of hydrolysis are however largely colloidal, except phosphoric acid, and remain therefore associated with the insoluble complex. But the hydrolysis of a compound consisting of bi- or polyvalent ions may be partial resulting in compounds which are at the same time acid and basic salts as for example: