Clay Minerals Encyclopedia Article

Clay Minerals

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Clay Minerals

Clay minerals contribute to the physical and chemical properties of most soils and sediments. At high concentrations they cause soils to have a sticky consistency when wet. Individual particles of clay minerals are very small with diameters less than two micrometers. Because they are so finely divided, clay minerals have a very high surface area per unit weight, ranging form 5 to 800 square meters per gram. They are much more reactive than coarser materials in soils and sediments such as **silt** and sand and clay minerals account for much of the reactivity of soils and sediments with respect to **adsorption** and **ion exchange**.

Mineralogists restrict the definition of clay minerals to those aluminosilicates (minerals predominantly composed of **aluminum**, silicon, and oxygen) which in **nature** have particle sizes two micrometers or less in diameter. These minerals have platy structures made up of sheets of silica, composed of silicon and oxygen, and alumina, which is usually composed of aluminum and oxygen, but often has iron and magnesium replacing some or all of the aluminum.

Clay minerals can be classified by the stacking of these sheets. The one to one clay minerals have alternating silica and alumina sheets; these are the least reactive of the clay minerals, and kaolinite is the most common example. The two to one minerals have layers made up of an alumina sheet sandwiched between two silica sheets. These layers have structural defects that result in negative charges, and they are stacked upon each other with interlayer cations between the layers to neutralize the negative layer charges. Common two to one clays are illite and smectite.

In smectites, often called montmorillonite, the interlayer ions can undergo cation exchange. Smectites have the greatest **ion** exchange capacity of the clay minerals and are the most plastic. In illite, the layer charge is higher than for smectite, but the cation exchange capacity is lower because most of the interlayer ions are potassium ions that are trapped between the layers and are not exchangeable.

Some **iron minerals** also can be found in the clay-sized fraction of soils and sediments. These minerals have a low capacity for ion exchange but are very important in some adsorption reactions. Gibbsite, an aluminum hydroxide mineral, is also found in the clay-sized fraction of some soils and sediments. This mineral has a reactivity similar to the iron minerals.