ALUMINOSILICATES

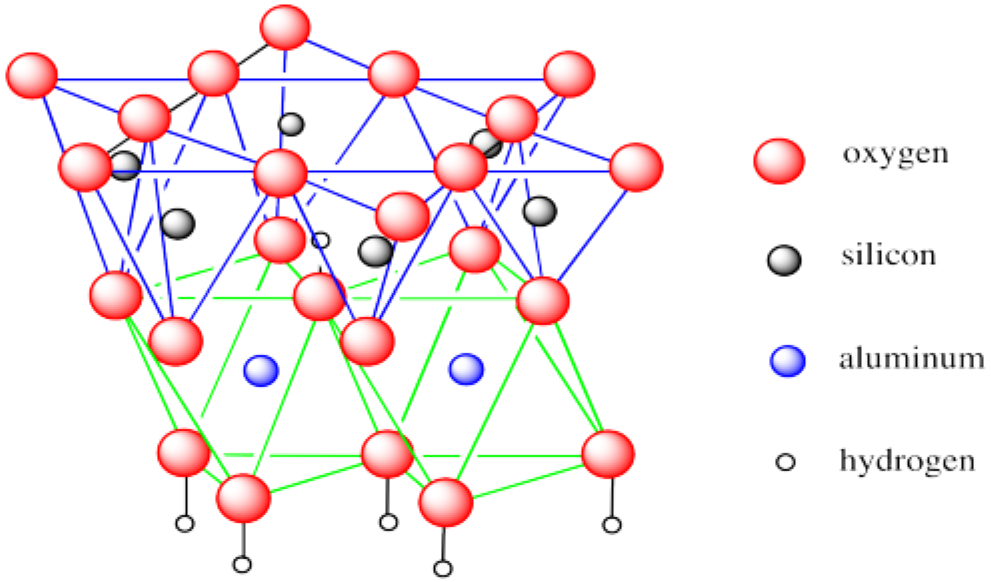
Aluminosilicates are compounds containing oxides of both silicon and aluminum. These compounds are quite common in the earth's crust, so it is worth taking a look at a few examples. Two of the most prevalent types are phyllosilicates, with extended layered structures, and tectosilicates, with structures that extend through a three dimensional network of covalent bonds.

Phyllosilicates

The clay minerals are a class of layered aluminosilicates formed by weathering of other silicate minerals. You are probably familiar with clay in some form or other. It is much finer-grained than sand, which is another product of weathering that is commonly found in the soil or exposed at beaches. Unlike sand,clay can sometimes be formed into shapes. We will take a look at two important examples.

The first example, kaolinite, is the major component of kaolin, a clay that is heavily used in making "china" and other ceramics. It is usually white but small amounts of iron can make it pink, yellow or orange. Kaolin contains hexagonally arrayed layers of silicate tetrahedra, as we have seen in other phyllosilicates. The difference is that this layer sits on top of a layer of aluminate octahedra, with some of the oxygens shared between the two layers.

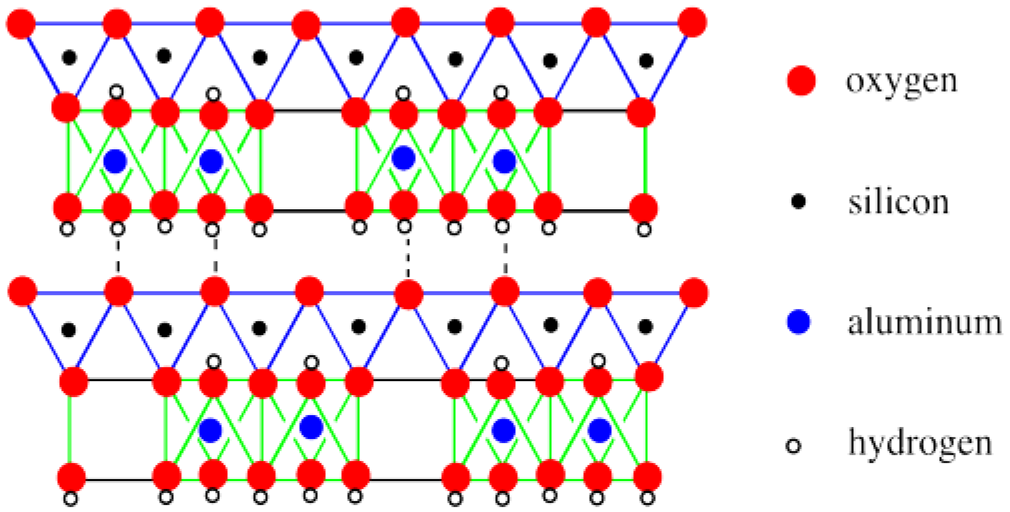
In the picture below, the lines are meant to reinforce the idea of the geometries involved: tetrahedra are outlined in blue and octahedra are outlined in green. The bonds between silicon and oxygen are not shown, nor are the bonds between aluminum and oxygen. We have shown the tetrahedra on top and the octahedra below but there really is no top or bottom to the layer, so it can just as easily be drawn the other way around.



Kaolinite is an example of what is sometimes called a 1:1 clay mineral or a T-O clay mineral. These designations convey the idea that there is one tetrahedral layer and one octahedral layer bonded together by shared oxygen atoms.

If you take a look at the structure, you will see that some of the oxygen atoms are bonded to hydrogens; they are hydroxides. These hydroxides play an important role in the long-range structure of kaolin.

In the picture below, we have simplified the structural drawing to a cartoon. We have also expanded the view to see cross sections of two phyllosilicate sheets and to see a little bit further down each sheet.



In the drawing, the basal layer of hydroxides (that's the layer of OH groups on the bottom face of a sheet) interacts with the basal layer of oxides on the next sheet (that's the layer of oxides on the top of the sheet). These sheets are held together via hydrogen bonding. Of course, there are more sheets than that. You could easily picture a third layer above the ones that are shown, with its basal hydroxides hydrogen bonding with the oxygens of the tetrahedral layer on top of the drawing.

The other feature that is apparent in this drawing is that the long-range structure of the layer varies a little bit. Some of the octahedra are missing. Only 2/3 of the possible sites in the octahedral are actually occupied, although they are not necessarily spaced out evenly like in the drawing. There are other clay minerals that don't have these absences, although we aren't going to look at any here.

One of the unique features in kaolinite is an electrically neutral layer. If we were to consider all of the oxygens to be O^{2-}, with the cations Si^{4+}, Al^{3+} or H^{+} based on the positions of these atoms in the perioidc table, then the positive and negative charges would exactly balance each other. That contrasts with what we will see in the other cases that we will look at.

Source : http://employees.csbsju.edu/cschaller/Principles%20Chem/network/NWalumina.htm