SILICATES AND SILICA

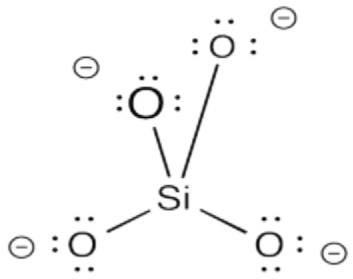
About 90% of the earth's crust is composed of silicate minerals. Silicates are compounds composed of silicon and oxygen; these compounds have negative charges on them. That means there are positive counterions found together with these anions. The variety of possible cations, ranging from sodium and potassium to copper and iron, is one of the factors that leads to a dazzling array of silicate minerals.

In addition to having a wide range of possible cations, silicate anions themselves have a breadth of available structures. These structures range from individual silicate anions (SiO_4^{4-}) to three dimensional networks of tetrahedra.

Silicates are not necessarily network solids, but we will see that their structures range from straightforward ionic solids at one extreme to something that looks more and more like an extended network at the other. By looking at these materials we can learn a little bit more about the related network solids.

Nesosilicates

Nesosilicates (meaning "island" silicates) are individual silicate anions arranged in crystalline ionic solids with their counterions. Those individual ions mean that nesosilicates are not network solids at all. They represent the extreme, other end of the silicate spectrum of structures.



The nesosilicate anion forms a tetrahedral shape. The silicon atom is at the centre and the oxygen atoms are at the four corners. That tetrahedral shape is often illustrated in structural drawings rather than drawing the atoms explicitly. Instead of showing the SiO_4^{4-} anion with labelled atoms on the left, the tetrahedron on the right is shown to represent it.

Silicates can have lots of different cations. Frequently, several different cations may be found in one material. For example, olivine is a pretty common nesosilicate with magnesium and iron cations (Mg^{2+} and Fe^{2+}). If the olivine is of very high quality, it can be a gemstone, called peridot.

There are two limiting forms of olivine, called "endmembers". At one end is forsterite, Mg_2SiO_4. At the other end is fayalite, Fe_2SiO_4. In between is every possible combination of magnesium and iron. There could be equal amounts of magnesium and iron, or there could be just a few magnesium ions and many, many iron ions in a sample.

- Minerals frequently occur in families, in which one, similar ion can be substituted for another.
- Frequently, both ions can be present in varying amounts, but the properties of the material (such as colour) change with changing ratios of these ions.
- The minerals that have just one of the possible ions but not the other are called the endmembers of the family.

Another common nesosilicate is garnet. Garnets are used as gems as well as abrasives -- they are sometimes used in sandpaper. There are many kinds of garnet, but a common one is almandine, the red-brown colour of which we usually think of as "garnet". Garnets always contain two different cations. One of them is a M^{2+} ion and the other is a M^{3+} ion (M here just stands for "metal"). These two counterions are always present in a 3:2 ratio in garnet.

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