Mineralogy Boot Camp Session #7

Mineral Classification Scheme

As described in the previous session of Boot Camp, mineralogy classifies minerals using anions or anionic complexes. Anions are negatively charged ions, such as oxygen (O^{-2}) or sulfur (S^{-2}). Anionic complexes are formed when different ions join together into stable configurations, such as silicates [$(SiO_4)^{-4}$] or carbonates [$(CO_3)^{-2}$]. Because oxygen is the most abundant element in Earth's crust, most anionic complexes are built using oxygen combined with positively-charged cations.

Altogether, there are about a dozen classes of minerals recognized. The table below lists the more common of these classes, along with some representative examples of minerals that belong to that particular class. In many of the upcoming Mineralogy Boot Camp sessions, we will go into detail about the common classes, describing not only why this particular class is important but also giving more details on particular minerals within that class.

Mineral Classification Classes		
Class Name	**Anion Basis**	**Common Examples**
Silicates	$(SiO_4)^{-4}$	Quartz, Feldspars, Olivine, Garnets, Hornblende, Biotite, Tourmaline, Clays
Carbonates	$(CO_3)^{-2}$	Calcite, Dolomite, Malachite
Sulfates	$(SO_4)^{-2}$	Gypsum, Barite
Sulfides	S^{-2}	Pyrite, Chalcopyrite, Galena, Sphalerite, Cinnabar
Oxides	O^{-2}	Hematite, Magnetite, Rutile, Pyrolusite
Hydroxides	$(OH)^{-1}$	Goethite
Native Elements	N/A	Gold, Sulfur, Graphite, Diamond
Halides	Various	Halite, Fluorite
Phosphates	$(PO_4)^{-3}$	Apatite, Turquoise
Other miscellaneous classes		
Borates	Uses boron (B^{+1}) as $(BO_3)^{-3}$ or $(BO_4)^{-5}$	Borax
Tungstates	Uses tungsten (W^{+6}) as $(WO_4)^{-2}$	Scheelite, Wolframite
Sulfosalts	Like sulfides, but arsenic (As) or antimony (Sb) in place of sulfur	
Nitrates	Like carbonates, instead using nitrogen complex $(NO_3)^{-1}$	

Recall from Session #2 that the two elements oxygen and silicon make up nearly 75% of Earth's crust, so it's not surprising that the silicate class hosts almost 95% of the minerals that compose the crust. Silicate minerals are numerous and abundant. This collection is subdivided into six *subclasses* based upon structure. Because of the importance of silicate minerals, the next three sessions of Mineralogy Boot Camp will be devoted to describing some details of these important categories.

The majority of ore minerals, those minerals containing economically important metals, are sulfides. These metals include copper, lead, zinc, nickel and molybdenum, and are the targets of mining throughout the world. Because oxygen is so common in the crust, oxide minerals are frequently found at the Earth's surface. When water is abundant, oxygen may combine with hydrogen to form hydroxide minerals at the surface. Carbonate and sulfate compounds are also common in surface or near-surface environments whenever carbon or sulfur are present. The other mineral classes listed in the table are typically characterized by having only a few common minerals present in each class along with a group of related rarer species.