Mineralogy Boot Camp Session #10

Silicate Minerals: Part 3

A common and abundant subgroup of silicate minerals are related by structure and given the name *phyllosilicates*. These minerals are composed of extensive layers of silica tetrahedra forming crystals found as thin sheets or stacks of sheets. In general, phyllosilicates are soft minerals, commonly in the range of 2 to 3 on Mohs scale of hardness. Talc, with a hardness of 1, is the softest phyllosilicate on Mohs scale. These minerals also have moderate to low specific gravities, typically in the range of 2.5 to 2.6. The two important phyllosilicate categories discussed in this session are the *micas* and the *clays*.

Micas

Mica minerals are characterized by having a tabular habit with one direction of perfect cleavage. This allows the minerals to be split into very thin sheets, regardless of their size. As loose grains, micas often appear quite flaky and flexible. They are relatively soft and readily disintegrate at the Earth's surface into small flat fragments in loose sediment. Mica is locally produced for industrial uses. The ability of mica minerals to remain stable when exposed to electricity, light, moisture and extreme temperatures allows them to function as an additive to numerous electrical insulators, plastics, rubber products, paints and adhesives. The physical properties of these minerals help provide resistance of the substance to cracking, and they can also enhance specific colors. Ground mica has also been added to well-drilling muds to help prevent loss of fluid circulation by plugging porous sections of the drill hole.

Biotite is an abundant mica mineral recognizable by being black to dark green (See Figures 1 and 2). It can form in a wide range of geologic environments, and thus is frequently observed in both igneous and metamorphic rocks. Biotite can also be found in sedimentary rocks, particularly sandstones where it occurs as small shiny flakes between the quartz grains.

Figure 1. Biotite flakes (black) in a piece of granite create a strong color contrast with the other minerals present, which include quartz (gray) and feldspar (white). Width of specimen is 2.2 inches. Rock is from Boise County, Idaho.

Figure 2. This is a typical specimen of granite. Visible mineral includes feldspar (white), quartz (gray), and biotite (black). The small patches of yellow to brown stain represent biotite flakes that are beginning to break down due to weathering, resulting in iron oxide staining. Width of this specimen is about 4 inches. Rock is from Boise County, Idaho.

Another common mica mineral is *muscovite*, which is colorless in very thin sheets or often a pale shade of golden-brown (See Figure 3). Like biotite, it is often found in a wide range of rocks, typically as an accessory mineral of low abundance. It's not unusual to have muscovite and biotite occurring together, particularly in granites. Large sheets of very thin muscovite were used as view ports on antique stoves and furnaces, allowing one to see into the unit while providing good thermal insulation.

Figure 3. This is a large piece of muscovite mica. Note the excellent cleavage and the reflection of the plastic peg on the surface of specimen, indicating the shiny reflective cleavage surfaces common in this mineral. Thinner flakes of muscovite become progressively lighter in color and eventually transparent. Specimen is approximately 5 inches long, and is from the Black Hills, South Dakota.

A relatively rare but important mica mineral is *lepidolite*, which is notable by its pink to lilac color (See Figure 4). This unusual color comes from the presence of lithium (Li) in the crystalline structure in place of aluminum. It has been historically mined for lithium recovery, much like spodumene as discussed in Session #9. Lepidolite often occurs with other lithium-bearing minerals such as spodumene and tourmaline.

Figure 4. The purple color of this mica indicates this mineral to be lepidolite. Physical properties of most micas are essentially the same, so color becomes very important in identifying which particular mica mineral is present. This specimen, from Brazil, is 4.4 inches wide.

Clays

Clay is actually a size term used for the smallest particles found in rock. Rock that consists primarily of these size particles is also often called clay or claystone. Clay minerals are numerous and often found together. They are the product of weathering of silicate minerals (particularly feldspars), and form the majority of soil. Because of their tiny size, x-ray diffraction is typically needed to determine specific clay species.

The most common of the clay minerals is *kaolinite*. It forms as a secondary mineral, during the breakdown of other silicates either during surface weathering or as a result of hydrothermal alteration of original minerals by circulating hot waters. Kaolinite is the dominant mineral in *fire clay*, used in refractory bricks and other industrial products for high-temperature environments. Kaolinite is also the main constituent of *kaolin*, used in paper coatings and ceramics.

The group of swelling clays, known as *smectites*, has the ability of absorb water to a great degree, resulting in a considerable increase in volume. When dried out, these clays will shrink their volume but usually not all the way back to the original volume. Soils containing abundant smectites are often apparent by the appearance of polygonal cracking (See Figure 5) which can be a major source of foundation problems due to swelling and shrinking. *Bentonite* is the name

given to a claystone largely formed of smectites. This material is used extensively in drilling muds (to thicken the mud and reduce lost circulation zones), pet waste absorbents ("kitty litter"), and various engineering applications (where an impermeable layer is required, such as landfill, pond, and canal liners).

Figure 5. The abundance of polygonal cracking in the surface of this soil indicates the presence of significant smectite clays. This swell-and-shrink property often results in cracking of concrete slabs and roadways. Note mechanical pencil for scale.