Lab 3: Minerals and Earth's Layers

Geology 202: Earth's Interior

Introduction: Minerals and Rocks

Imagine that you were to pick up a stone on the beach. How could you tell if it was a mineral or a rock? In order for something to be classified as a *mineral*, it must:

- Be naturally occurring
- Be inorganic (not contain living or once-living matter)
- Possess a definite crystalline structure
- Have a characteristic chemical composition
- Have characteristic physical properties (such as hardness, color and crystal form).

On the other hand, a *rock* is an aggregate of one or more minerals. For example, most people are probably familiar with the mineral quartz. Some sand can be 100% pure quartz crystals. These sands are made by natural processes, and have no organic material. The grains are clearly crystals, with a composition of SiO_2, and a common hardness, specific gravity, and breaking strength. Overtime, the grains of quartz-sand could be compacted together to form the rock sandstone.

There are many useful things that we can learn by identifying minerals and rocks. By looking at the minerals in a rock and how they are structured, we can learn more about its history. We also can interpolate the conditions endured by the rock as it formed (e.g. magma type, source rock, pressure and temperature).

Some Common Mineral Properties:

There are thousands of different minerals, but most are very rare. Here we will discuss how to recognize some of the most common ones. Using classifications based on composition and structure some of the most common properties used to identify minerals are:

Color- Color is a property which is surprisingly not always very useful. Many minerals can have similar colors - and some mineral may have many different colors! Colors vary because of minute amount of impurities in the mineral. Examples: Rose quartz, smoky quartz, amethyst, clear quartz.

Luster- Luster is the appearance of the mineral in reflected light. The two basic types of luster are: *metallic* (pyrite, galena) and *non-metallic*. Other types are: *vitreous* (quartz), *waxy* (chalcedony), *brilliant*, *greasy*, and *earthy* (hematite).

Streak- A mineral's streak is determined by rubbing it along an unglazed porcelain plate, where bits of the mineral can rub off and leave a mark on the plate. The color of the streak is closer to the true color of the mineral. Example: Hematite.

Crystal form- Minerals possess an atomic structure that yields a definite crystal form if growth occurs under ideal conditions. In most cases, crystals may not be apparent, but are best observed with a hand lens. There are many different crystal forms, but the most important are *cubical* (pyrite), *hexagonal* (six-sided, quartz), and *rhomboidal* (slanted cube, calcite).

Cleavage and Fracture- Cleavage is demonstrated by a tendency for a mineral to break smoothly along a flat surface (which is determined by the strength of the bonds within the mineral crystal). Some minerals will cleave on only one or two planes, and some won't cleave at all. Examples of minerals with good cleavage: mica, calcite, gypsum, feldspar. Sometimes, the mineral breaks along an irregular surface, called fracture. A common type is *conchoidal* fracture (e.g. quartz), which has the pattern of broken glass.

Hardness- Hardness is a measure of how difficult it is to scratch a mineral. In 1872, Friedrich Mohs created a relative hardness scale that is still in use today. Since harder minerals (and other common objects) will scratch softer ones, he arranged his scale so that the hardest minerals have the highest number. His scale is as follows:

Mohs Scale of Hardness

Hardness	Mineral	Hardness	Common Object
10	Diamond		
9	Corundum		
8	Topaz		
7	Quartz		
6	Orthoclase		
		5.5	Glass, steel knife, masonry nail
5	Apatite		
		4.5	Wire nail
4	Fluorite		
		3.5	Copper penny
3	Calcite		
		2.5	Fingernail
2	Gypsum		
1	Talc		

Specific Gravity- This term dates back to the Middle Ages and it is used to measure the density of a particular substance. A good example of a mineral with a high specific gravity is galena. Specific gravity is the ratio of the density of a particular substance compared to the density of an equal volume of water (and since it is a ratio, specific gravity is a dimensionless number). Since the two volumes, V are the same, the density of the substance, $\rho_{substance}$, is directly related to the mass of the substance, $M_{substance}$:

$$\rho_{water} = M_{water} / V \quad , \quad \rho_{substance} = M_{substance} / V \quad , \quad \frac{\rho_{substance}}{\rho_{water}} = \frac{M_{substance}}{M_{water}} \quad .$$

There are also more advanced techniques used to identify minerals. With Optical Mineralogy, petrographic microscopes are used to examine the optical properties of mineral crystals. Thin sections (very thin slices of the sample) are used to recognize properties, such as refractive indices and anisotropy. Other methods such as X-ray diffraction (XRD) and electro-microscopy (one such instrument called, the **S**canning **E**lectron **M**icroscope) are used to identify minerals, where inter-atomic spacing and precise crystal structure are determined.

Experiment

1. Using the characteristics given in the following table, match each sample number with its respective Mineral name.

Examples of Earth's most Common Minerals

#	Hardness	Streak	Luster	Distinctive Properties	Mineral name
1					
2					
3					
4					
5					
6					
7					
8					
9					

Chart

Examples of Earth's most Common Minerals

Mineral name	Hardness	Streak	Luster	Distinctive Properties
Plagioclase Feldspar	H=6	white	non-metallic	White or gray, Cleavage good or excellent, 2 Cleavages at nearly 90° with striations
Potassium Feldspar	H=6	white	non-metallic	Orange, brown, white, gray, green or pink Cleavage good or excellent, cleavages at nearly 90°, sub-parallel ex-solution lamallae
Quartz	H=7	white	vitreous or greasy	colorless, white, gray, or other colors massive or hexagonal prisms and pyramids, conchoidal fracture, no cleavage
Garnet	H=7	white	non-metallic	red, black or brown, forms dodecahedrons (12-sided crystals), cleavage absent, translucent to opaque
Olivine	H=7	white	non-metallic	pale olive green to yellow, conchoidal fracture, cleavage absent, forms short stout prisms
Muscovite mica	H=2-2.5	white	non-metallic	colorless, yellow, brown, or red-brown splits along 1 excellent cleavage into thin transparent sheets
Hornblende (Amphibole)	H=5.5	grey, green or white	non-metallic	cleavage excellent or good, opaque, dark green -black color, 2 cleavages at about 60° and 120°
Augite (Pyroxene)	H=5.5-6	white-pale gray	non-metallic	cleavage excellent or good, green-black color, 2 cleavages at nearly 90°
Biotite mica	H=2.5-3	grey-brown	non-metallic	Black-green-brown color, splits easily along 1 excellent cleavage plane into thin sheets