

**GEOLOGY 17.01: Mineralogy**

**LAB 4: COMMON MINERALS IN SEDIMENTARY ROCKS**

**Part 2**

**Learning Objectives:**

- Students will be able to classify sandstones based on their mineral content
- Students will be able to identify hand samples of carbonate, sulfate, oxide and clay minerals that are common in sedimentary rocks
- Students will be able to identify glauconite, calcite, dolomite, and gypsum in thin-section

**New Minerals:** Kaolinite, Bentonite, Glauconite\*, Calcite\*, Dolomite\*, Gypsum\*, Anhydrite, Halite, Sylvite, Hematite, Limonite, Bauxite

**Review Minerals:** Quartz, Plagioclase, Microcline

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**CLASSIFYING SANDSTONES**

The Folk classification scheme for sandstones is used commonly and is based upon the relative proportion of three components: quartz, feldspar (both plagioclase and alkali feldspars) and rock fragments (multi-grain clasts, including chert).

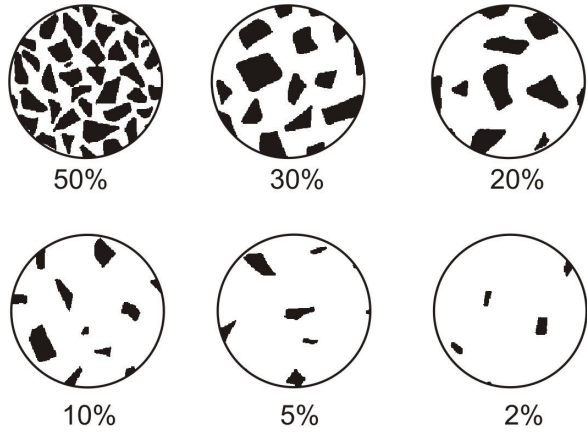
Re-examine the hand-samples for quartz, plagioclase, and microcline. Then examine hand-samples SANDSTONE A, SANDSTONE B, and SANDSTONE C.

Which sandstone sample has the most quartz? \_\_\_\_\_

Which sandstone sample has the most feldspar? \_\_\_\_\_

How did you distinguish quartz from feldspar in these sandstone samples?  
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Re-examine the thin-sections of quartz, plagioclase, and microcline. Then examine thin-sections SANDSTONE 1, SANDSTONE 2, and SANDSTONE 3. Estimate the percentage of quartz, feldspar in each rock. Use the figure to the right to help you to estimate the percentage of these two key minerals. Use this information to classify the sandstone using the Folk Classification diagram.



SANDSTONE 1:            % Quartz    \_\_\_\_\_            % Feldspar    \_\_\_\_\_

SANDSTONE 2:            % Quartz    \_\_\_\_\_            % Feldspar    \_\_\_\_\_

SANDSTONE 3:            % Quartz    \_\_\_\_\_            % Feldspar    \_\_\_\_\_

SANDSTONE 1 Classification:

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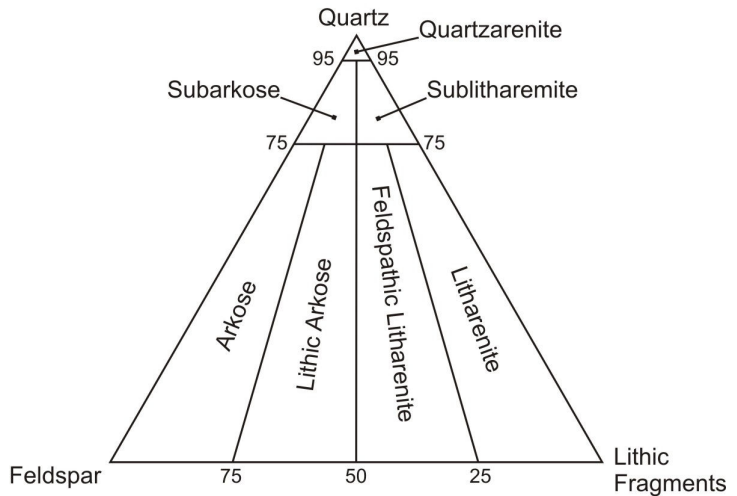
SANDSTONE 2 Classification:

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SANDSTONE 3 Classification:

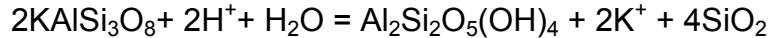
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**Folk Classification of Sandstones**



## CLAYS

Clays are a group of hydrous sheet silicates that minerals that are fine-grained (usually microscopic). Most clay is produced from chemical weathering of rocks. For example, **kaolinite** is formed from the hydrolysis of potassium feldspar:



Shales are composed predominantly of clays such as kaolinite. Clays may also occur as cement in sandstones. Because of their microscopic size, analytical methods such as x-ray diffraction are required to accurately identify most clay minerals.

**Bentonite**  $[(\text{Na},\text{Ca})_{0.33}(\text{Al},\text{Mg})_2\text{Si}_4\text{O}_{10}(\text{OH})_2 \cdot (\text{H}_2\text{O})_n]$  absorbs water and expands when wet, and so is often referred to as a swelling clay. It is derived from the weathering of volcanic ash.

**Glaucanite**  $([\text{K},\text{Na}][\text{Fe}^{3+},\text{Al},\text{Mg}]_2[\text{Si},\text{Al}]_4\text{O}_{10}[\text{OH}]_2)$  is a green clay that is found as rounded aggregates of very fine grained scaly particles. It is generally indicative of deposition on a continental shelf with slow rates of sediment accumulation.

Examine the hand-samples of KAOLINITE, BENTONITE, and GLAUCONITE. Be sure to soak subsamples of these clays in water. What physical properties to these clays share? What physical allow you to distinguish each of these clays?

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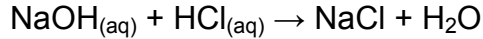
Examine the thin-section GLAUCONITE, determine the optical properties of glauconite and complete a sample description form. Which optical properties cannot be determined for clays, due to their extremely fine-grained nature?

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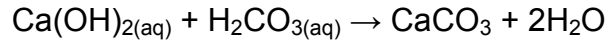
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## SALTS: CARBONATES, SULFATES and HALIDES

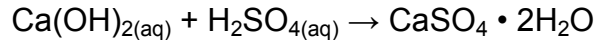
A salt is a substance formed from the anion of an acid (a proton donor) and the cation of a base (proton acceptor). Examples of reactions that form mineral salts that are relatively common in sedimentary rocks are:



Sodium Hydroxide + Hydrochloric Acid → **Halite** + Water



Calcium Hydroxide + Carbonic Acid → **Calcite** + Water



Calcium Hydroxide + Sulfuric Acid → **Gypsum**

A salt will precipitate if a solution becomes saturated with respect to that mineral. The carbonate mineral **calcite** ( $\text{CaCO}_3$ ) precipitates commonly from seawater in shallow, tropical environments. Aragonite is a polymorph of calcite that may form cement in sedimentary rocks. The sulfate **gypsum** ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) and the halides **halite** ( $\text{NaCl}$ ) and **sylvite** ( $\text{KCl}$ ), precipitate from seawater that has become hypersaline due to extreme evaporation. **Dolomite** ( $\text{CaMg}[\text{CO}_3]_2$ ) and **anhydrite** ( $\text{CaSO}_4$ ) are minerals that commonly replace calcite and gypsum, respectively. Carbonates, sulfates and halides are ionic compounds. Accordingly, these minerals are relatively soft and soluble.

Examine the four hand-samples of CALCITE (Calcite, Dogtooth Calcite, Chalk, Calcite var. Onyx), ARAGONITE and DOLOMITE and document their physical properties. What physical properties do these carbonate minerals share? What physical properties allow you to distinguish calcite from dolomite?

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Examine thin-sections CALCITE and DOLOMITE. Determine the optical properties of each, and complete a sample description form for each sample. What properties may allow you to distinguish calcite from dolomite?

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Examine the five hand samples of gypsum in its varied forms (SELENITE, BLADED, DESERT ROSE, SATIN SPAR, and ALABASTER) and document their physical properties. What physical properties are common to all forms of gypsum? What physical characteristics distinguish these forms from each other?

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Compare the hand sample of massive ANHYDRITE with GYPSUM: ALABASTER. Which physical properties allow you to distinguish anhydrite and gypsum?

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Examine thin-section GYPSUM and document its optical properties on a sample description form.

Examine the hand-samples HALITE and SYLVITE and document their physical properties. What physical properties do these halides share? What properties allow you to distinguish halite and sylvite?

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What physical characteristics most readily allow you to distinguish calcite, gypsum, and halite from each other?

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## **OXIDES and HYDROXYOXIDES**

When iron-bearing minerals (e.g., olivine, hornblende, pyrite) weather, they produce a variety of insoluble iron oxides (e.g., hematite  $\text{Fe}_2\text{O}_3$ ) and iron hydroxyoxides (e.g., limonite,  $\text{FeO}[\text{OH}] \cdot n\text{H}_2\text{O}$ ). Limonite is not a true mineral, but is composed by a mixture of similar hydrated iron oxide minerals. Limonite may coat clasts or occur as the cementing material in iron rich sandstones. Hematite and limonite are opaque minerals and so are dark under the PLM. A very thin coating of these iron oxide minerals on translucent minerals such as quartz can result in a deep red stain that is visible under the microscope.

Like limonite, the aluminum ore bauxite is a mixture of very fine-grained minerals (gibbsite  $\text{Al}[\text{OH}]_3$ , and diaspore  $\text{AlOOH}$ ). It is produced by intense chemical weathering of silicate rocks (typically in tropical climates) during which all of the more mobile elements are removed in solution, leaving behind only aluminum compounds. Bauxites commonly contain iron oxides; such examples will have a rusty-red color.

Examine the three hand samples of HEMATITE (Hematite, Specular, Oolitic) and document their physical properties. What properties are common to all forms of hematite?

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Examine the hand samples of LIMONITE and BAUXITE and document their physical properties