GEOLOGY 640: Geology through Global Arts and Artifacts

LAB 5: SEDIMENTARY ROCKS

CLASTIC SEDIMENTARY ROCKS

Clastic sedimentary rocks are composed of grains that have been weathered from pre-existing rocks. The chemical weathering processes of hydrolysis, oxidation, and dissolution act on sediments, destroying those minerals that are most reactive, and forming new minerals that are stable at surface conditions: most halides and sulfates will dissolve; pyrite will form hydroxy-oxides such as limonite; unstable silicates will form clays. Minerals that are susceptible to physical weathering (i.e., minerals that are soft or cleavable) will be reduced in size during transport, and so may only be identified under the microscope.

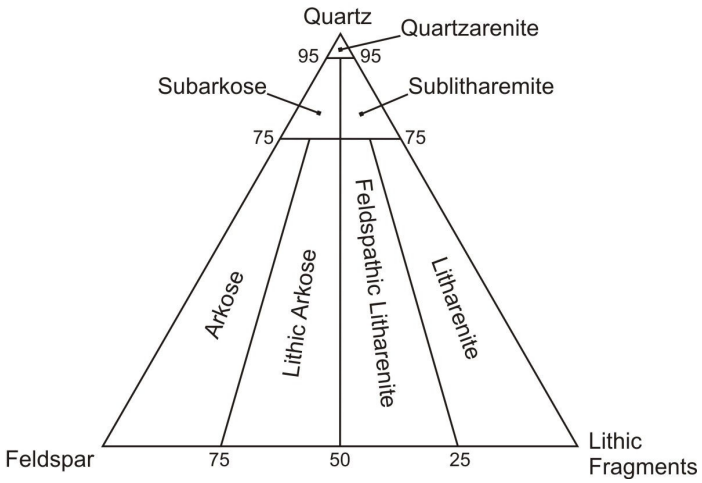
Quartz is a common rock-forming mineral, and resistant to both chemical and physical weathering. Accordingly, it is a common constituent of clastic sedimentary rocks. **Feldspars** are relatively stable in the surface environment, with potassium feldspars being more resistant to chemical weathering than plagioclase. Mafic minerals (olivine, pyroxene, hornblende) readily weather to form **clays** and **iron hydroxy-oxides**, and so are uncommon in sedimentary rocks. Thus the most important minerals in clastic sedimentary rocks are *quartz, potassium feldspar (microcline and orthoclase), plagioclase, clays, and oxides/hydroxy-oxides (hematite, limonite, goethite).*

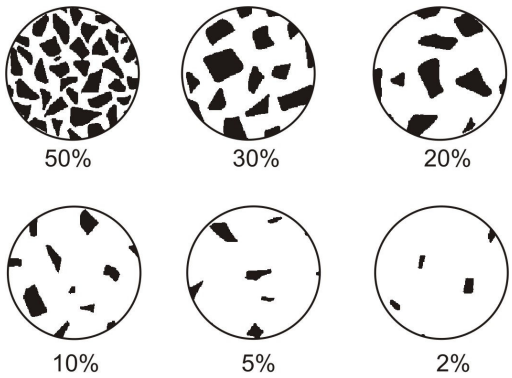
Percentages of quartz, feldspar, and clay are used to classify most clastic sedimentary rocks (sandstones, siltstones, claystones). The **Folk classification scheme for sandstones** is used commonly and is based upon the relative proportion of three components: quartz, feldspar (both plagioclase and alkali feldspars) and rock fragments. In hand sample, quartz will appear grey-white, feldspars will appear pink or milky white, and rock fragments will appear grey, brown or black.

Rocks fragments (including mafic minerals) weather more quickly than feldspar, which in turn weathers far more easily than quartz. Accordingly, the Folk classification scheme for sandstones not only provides information about composition, but also tells us about how much weathering the sand experienced before it was deposited (referred to as **maturity** of the sediment). **Quartz arenites** are the most mature, and typically form on *beaches or in desserts*, where sand grains are worked and reworked by waves or wind. Arkose typically forms in *river channels* that are a moderate distance from the source of the sand. **Litharenites** are immature sandstones whose grains have not had time to weather; these rocks commonly occur in stream deposits at the base of cliffs or mountains. Such accumulations in high relief terrains are called **alluvial fans**.

Quickly re-examine and review the samples of plagioclase (albite and labradorite), microcline, and quartz. Pay attention to color. Note that while many colors of quartz can exist, white and clear varieties are overwhelmingly common, and so it is there varieties that will be found in sandstones.

Folk Classification of Sandstones





Examine the following hand samples of sandstone. Identify quartz, feldspar, and lithic fragments in these rocks in order to identify the rock and determine a likely environment of deposition.

Sample 119:

Folk Classification: _____

Environment of Deposition: *Beach* *River* *Alluvial Fan*

Sample 124:

Folk Classification: _____

Environment of Deposition: *Beach* *River* *Alluvial Fan*

Sample 126:

Folk Classification: _____

Environment of Deposition: *Beach* *River* *Alluvial Fan*

Sample 141:

Folk Classification: _____

Environment of Deposition: *Beach* *River* *Alluvial Fan*

To turn an accumulation of sand into sandstone, the grains must be cemented together by the precipitation of minerals from ground water (a diagenetic process). The most common cement minerals are calcite, quartz, and hematite. Cement is too fine grained to identify crystals in hand sample, however, you can make some inferences. If the sandstone fizzes when dilute HCl is applied, then it probably contains calcite cement. If the sandstone has an overall reddish-brown color, then it probably is cemented by hematite. Sandstone cemented by hematite are indicative of sandstones deposited in a terrestrial environment because oxidized iron is insoluble; when iron is liberated from mafic minerals during chemical weathering it will immediately form an insoluble iron oxide (hematite) or iron hydroxyl-oxide (limonite) and be incorporated into the nearby sediments. The rock used to build Brooklyn's brownstones are cemented, in part, by hematite.

Re-examine the following hand samples of sandstone. What is the likely cement in these rocks?

Sample 119:

Likely cement: *calcite* *hematite* *quartz*

Sample 124:

Likely cement: *calcite* *hematite* *quartz*

Sample 126:

Likely cement: *calcite* *hematite* *quartz*

Sample 141:

Likely cement: *calcite* *hematite* *quartz*

CHEMICAL SEDIMENTARY ROCKS

The carbonate mineral calcite ($CaCO_3$) precipitates commonly from seawater in shallow, tropical environments to form **limestone**. Organisms commonly precipitate calcite to form their shells since it is at, or near, its solubility limits in shallow marine water and so requires little metabolic energy to create a protective skeleton. Skeletal debris (e.g. coral fragments, clam shells, etc.) is a common component of limestones, and all limestones will react with dilute hydrochloric acid. Limestone may also form from precipitation of calcite from groundwater in caves. Such limestones are called **travertine** (a common decorative building stone), and tend to be finely laminated and contain many small holes

Limestone commonly reacts with warm, salty groundwater to form dolomite. A rock composed of dolomite is called a **dolostone**. This rock will only react with dilute HCl if the rock is scratched (powdered) first.

The sulfate **gypsum** ($CaSO_4 \cdot 2H_2O$) and the halides (e.g. halite NaCl) precipitate from seawater that has become hypersaline due to extreme evaporation in hot arid climates. Accordingly, this group of rocks is called the **evaporites**. Massive, fine-grained gypsum is called **alabaster**, and is commonly used as a carving medium because of its extreme softness (can be scratched with a fingernail).

Re-examine and the samples of calcite, dolomite, and gypsum. Review what physical properties allow you to distinguish these three minerals that are common in chemical sedimentary rocks.

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Examine the following hand samples of chemical sedimentary rocks. Identify the rocks based on their mineral composition. Determine a likely environment of deposition.

Sample 9:

Rock type: _____

Environment of Deposition: *Open Marine* *Hypersaline* *Cave*

Sample 120:

Rock type: _____

Environment of Deposition: *Open Marine* *Hypersaline* *Cave*

Sample 143:

Rock type: _____

Environment of Deposition: *Open Marine* *Hypersaline* *Cave*

SEDIMENTARY ROCKS AND POROSITY

If a sedimentary rock is not fully cemented (usually the case), then the rock may contain many small holes (**pores**). Economically these pores are important because they hold commodities such as oil, gas, and groundwater.

Drop a little water on granite from last week's lab and a sandstone from this week's lab. Describe what happens to the water. What does this tell you about the porosity of each rock? Which rock would be most easily weathered by the physical processes of frost wedging and salt crystallization? Explain.

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