Sedimentary Rocks - Laboratory 5

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(name)

BACKGROUND

Sedimentary rocks or their unconsolidated equivalents are composed of sediment, but what is sediment? Sediment is solid particles that originate from the (1) weathering, mass wasting, and erosion of previously existing Earth material, (2) minerals precipitated from a solution, or (3) the remains or traces of once living organisms (plant or animal) or material derived from their activities. If a sedimentary rock is dominated by component (1) above, then it is a **clastic** sedimentary rock. If instead it is dominated by component (2), then it is a **chemical** sedimentary rock**,** and if it is dominated by (3), then it is **organic**.

Clastic Sediments and Rocks

Sediment normally accumulates in layers of cohesion less particles. Such layers are termed **beds** (Figure 1)**.** With time beds are buried beneath younger beds as more and more sediment is deposited. Eventually, this process results in the cohesion less particles being cemented together to form rock as fluids migrating through the deposit become supersaturated with $CaCO_3$ or SiO_2, or pressures and temperatures due to burial are sufficient to cause minor recrystallization.

Figure 1. Beds in an ancient alluvial fan succession. Each bed resembles the pages in a book. In the photograph different colored layers represent individual beds (e.g., white versus brownish gray)

Clastic sedimentary rocks or their unlithified (uncemented) deposits are composed of minerals and fragments of previously existing Earth material. Such rocks or deposits are commonly classified on the basis of the size of the included minerals and fragments. Some common objects and their sizes are illustrated in Figure 2.

Figure 2. Some common objects and their sizes.

Gravel is a term used to refer to clastic particles that are greater than 2 mm in size (Figure 3).

Figure 3. Gravel. The smallest increment shown on the scale is 1 mm.

The term **sand** refers to particles between 0.0625 mm and 2.0 mm in size (Figure 4).

Figure 4. Sand. Smallest increment shown on scale is 1 mm.

Silt is smaller than sand and includes grains between 0.0035 mm and 0.0625 mm. **Clay** is the smallest and includes all particles less than 0.0035 mm. Some geologists do not subdivide the smaller grains into silt and clay categorizing all particles less than 0.0625 mm in size into **mud** (Figure 5).

Figure 5. Mud versus sand. The pile of sediment on the left includes mostly mud-sized particles while the pile on the right is composed of sand-sized material. The smallest increment shown on the scale is 1 mm.

If clastic material is cemented or lithified to form a rock, then the following names would apply to the various sizes of clastic grains illustrated or discussed above: gravel = **conglomerate** (or **breccia**) (Figure 6), sand = **sandstone** (Figure 7**)**, silt = **siltstone**, clay = **claystone**, silt + clay = **mudstone** (Figure 8). To apply the term conglomerate included gravel must be rounded (Figure 6). In contrast, if gravel is angular or blocky in form, then the term breccia is more applicable.

Figure 6. Conglomerate. Look closely and see if you can pick out the round pieces of gravel.

Figure 7. Sandstone. Note the much finer grain size when compared to Figure 6.

Figure 8. Mudstone. Compare this sample to Figure 7.

Sand and sandstones are ubiquitous features of the continents. For example, sand is common on the world's beaches, coastal areas, and rivers. As a result of its ubiquity geologists have further subdivided it into the grain size categories shown in Table 1.

Table 1. Classes of sand based on grain size

Size Range	**Name**
2.0 – 1.0 mm	very coarse
0.5 – 1.0 mm	coarse
0.25 – 0.5 mm	medium
0.125 - 0. 25 mm	fine
0.0625 – 0.25 mm	very fine

Exercise 1

It is important that you familiarize yourself with this grain scale classification. Hence, the first exercise in this lab is to make a grain-scale card that you can use to identify the various clastic sedimentary rock types based on the grain size.

Chemical and Organic Sedimentary Rocks and Deposits

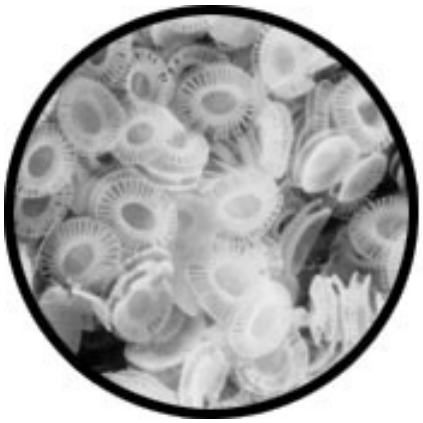
Chemical sedimentary rocks are composed of particles derived from organisms or their activities or are derived from particles precipitated from solution. This group of rocks includes the **carbonates**, **evaporites**, **cherts**, and **coals**.

The most common carbonate rock is **limestone**. It is composed of calcite mixed with varying proportions of organic debris, such as algae, coral, and/or shell fragments. If limestone contains abundant organic debris, then it is referred to as **bioclastic**. **Coquina** is a coarse grained variety (Figure 9).

Figure 9. Coquina composed of abundant broken shell fragments.

Chalk is composed of the calcareous remains of the coccolithophore (Figure 10).

(A)



(B)

Figure 10. (A) Chalk. (B) Coccolithophore are phytoplankton or one-celled marine plants. Coccolithophore surround themselves with circular plates composed of calcite (see photograph). Each plate is ~0.003 mm in diameter. Image is from *http://earthobservatory.nasa.gov/Library/Coccolithophores*

Cherts are hard dense rocks composed entirely of silica. They form as the result of replacement of limestones by silica rich ground waters and as deep marine deposits composed of the siliceous microfossil **radiolarian** (Figure 11). Radiolarian cherts are typically rhythmically bedded, each bed looking like the pages of a book (Figure 11), while replacement cherts form irregular shaped bodies.

(A)

(B)

Figure 11. (A) Radiolarians are unicellular protests that build external skeletons composed of silica (image is from *http://geology.er.usgs.gov/paleo/graphics/radio1a.gif)*. (B) Bedded chert near Avila Beach, California. Purple bag is about 5 cm long.

Evaporites are composed of minerals precipitated from solutions. Such minerals are found when lakes dry up. Common evaporates include **rock gypsum** and **rock salt** (Figure 12).

Figure 12. Halite (salt) crystals growing on a substrate of rock salt.

Coal is a rock composed of decayed and altered plant matter (Figure 13). In most cases the original plant matter originated in swamps. Composed of a complex mixture of organic C, H, and O with smaller amounts of N and S it is the most abundant fossil fuel in the United States. Information about coal and its uses in the United States can be found at

http://www.eia.doe.gov/fuelcoal.html,
http://www.bydesign.com/fossilfuels/links/html/coal.html, and
http://energyconcepts.tripod.com/energyconcepts/classification_of_us_coals.htm.

About 91% of the coal mined in the US is used in the generation of electricity. This amounts to about 51% of the total electricity generated in the US. The top coal producing states in 2003 were Texas, Wyoming, West Virginia, Kentucky, and Pennsylvania.

As pressure and temperature of burial increases accumulated and decaying plant matter is transformed into coal. During this transformation it passes through a variety of stages that produces differing ranks of coal. Lignite is the lowest rank coal. It is brown in color, contains considerable water (up to ~35%), and the remains of plant material are commonly evident. As rank increases from lignite to sub-bituminous to bituminous to anthracite, the amount of hydrogen and oxygen decreases as carbon content increases.

Sub-bituminous coals are black, soft, and lack the woody textures common to lignites. Bituminous coals are soft to hard, and dull to shiny black in appearance.

Anthracite, the hardest of all the ranks of coal, commonly has a lustrous or shiny appearance. It has the highest carbon content of any of the coals and burns with the cleanest flame.

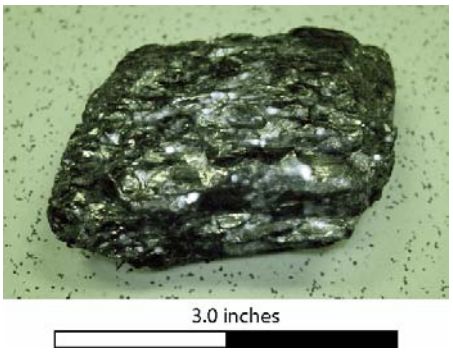


Figure 13. A sample of anthracite. Note that there are 2.54 cm in an inch.

THE LABORATORY

Your instructor will go over with you a variety of sedimentary rocks that display some of the above features. As each rock is discussed please fill in the key characteristics that distinguish it from other types of rocks in the attached table.

Table 2. Common sedimentary rock types

Rock Type	**Key Characteristics**
Conglomerate	
Breccia	
Sandstone	
Siltstone	
Claystone	
Shale	
Bioclastic limestone	
Coquina	
Chalk	
Chert	
Rock gypsum	
Coal	