Sedimentary Rocks Lab

Although sedimentary rocks are estimated to make up only about 5% of the volume of the earth's crust, sediments and sedimentary rocks cover over 90% of the surface area of the earth. They provide us with evidence of ancient surface processes, they contain enormous mineral wealth, especially oil and gas, and they are our only record of ancient life. For these reasons, sedimentary rocks command our attention. In this lab you will carry out experiments to illustrate sedimentary processes and learn how to classify and interpret sedimentary rocks.

Materials and Preparation

Before coming to lab read through this hand−out and review Chapter 7 of Press and Siever. Bring pencils, and a calculator to lab with you.

An Introduction to the Study of Sedimentary Rocks

The principal characteristics to be described in a sedimentary rock are the following:

- color
- particle composition ("mineralogy")
- particle size (grain size) and sorting
- particle shape
- sedimentary structures (if present)
- fossils (if present)

The first three characteristics are important both for rock classification and for interpreting rock origin. The last three are used very little for classification, but are of great importance for understanding a sedimentary rock's origin.

Rock Color

Perhaps the most obvious feature of a sedimentary rock is its color. It is not within the scope of this laboratory to discuss in detail the origin of color in sedimentary rocks but we can note that it is largely controlled by the presence of minute amounts of iron−bearing compounds. For example, red, brown, or green sandstone owe their color to iron oxides and iron−bearing silicates minerals while black or dark gray shales contain iron sulfides or organic matter. Use of the rock color chart provided assures some reliability and consistency in the description of color.

Particle Composition (Mineralogy)

The primary subdivision of sedimentary rocks into categories is based on particle composition. Two groups are recognized: **clastic** and **chemical** sedimentary rocks. Clastic sedimentary rocks are made up of particles (grains) which have been transported from some distant source area to the site of deposition. Chemical sedimentary rocks are made up of particles (grains or crystals) formed at or near the site of deposition by chemical precipitation or by the activities of plants or animals.

Though a sedimentary rock may contain a variety of particles types, including mineral grains and bits of other rocks, we refer to the rock composition as the "mineralogy" for the sake of convenience. Those particles in sedimentary rocks, which have undergone transport, are referred to as grains. Most grains are either mineral fragments (quartz, feldspar and clay minerals are most common) or rock fragments (fragments of fine−grained igneous, metamorphic or sedimentary rocks). An ability to identify the visible minerals and rock grains is of fundamental importance for proper classification of sedimentary rocks and for interpreting their origin.

Other constituents in sedimentary rocks need only be mentioned here. Sedimentary rock particles are bound together by cement, masses of minute crystals which have grown from surfaces into the spaces between grains. These crystals include, for example, calcite, quartz, iron oxide or clay minerals. They make up a tiny percentage of any rock and are, as a result, not made note of in the rock name. Some other clastic sedimentary rocks contain fine particles of clay−rich or mica−rich rock fragments referred to as matrix. Matrix particles are usually squashed between grains (which are much larger), the effect being to "coat" the grains and make it difficult to distinguish grains outlined with the naked eye. Matrix may be a common constituent, even the dominate one, in some sandstones. Where this is so, the rock name "graywacke" is used.

Particle Size and Sorting

A glance at the samples of sedimentary rocks you will see in lab will show that they contain particles of various size. Grain size provides the basis for the second level of categorization in sedimentary rock classification. Differences in grain size are an important basis for interpreting the history of a rock.

We describe the grain size of a rock in terms of an average or dominant grain size using the size classes defined in Table 1.

TABLE 1: SEDIMENT and SEDIMENTARY ROCK GRAIN SIZE CLASSES

Dominant Grain Size	Sediment Name	Rock Name
>2 mm	Gravel	Conglomerate,Breccia
2 − 1/16 mm	Sand	Sandstone
1/16 − 1/256 mm	Silt, Mud	Siltstone, Mudstone
<1/256 mm	Clay	Claystone, Shale

Because most sedimentary rocks are made up of grains of many sizes mixed together, we also have an interest in the range of grain sizes, the sorting. Sorting is a reflection of the processes that transported and deposited the particles in the rock. Consider these two examples. A beach sand is made up of particles which are moved to and fro on the beach. During this repeated stirring and shifting, the fines are winnowed away. The beach sand, as a result, should exhibit good sorting. On the other hand, a sand mass deposited on a stream bar during a flood may be soon covered by more sediment and the fines may never be winnowed out. As a result, the river sand will be more poorly sorted than a beach sand.

Particle Shapes

Sedimentary particles that have been transported to the site of deposition from some distant source (clastic particles) include fragments of both minerals and rocks. They have been subjected to 1) weathering and erosion in the source area, 2) transportation by water, wind, or ice. The shape of the clastic grains reflects both their original shape and modifications caused by transport. Clastic particles formed at or near the site of deposition include fragments of shell, bone, and other organic material and fragments of partly lithified sediments. These are not likely to have traveled far and their shape in a rock usually reflects their original shape, modified little if at all by transport. Particles, which form as chemical precipitates, have no significance with respect to erosion and transportation.

Sedimentary Structures

Sedimentary structures are textural features that are artifacts of the processes that created a sedimentary rock. Stratification is the most common of sedimentary structures but there are many others (rain−drop impressions, mud cracks, cross bed, etc.). Taken together, they provide direct evidence of the processes which gave the sediment mass its final appearance. Those processes most often involve the passage of a current of water or air over some sediment covered surface and the structures result from the shaping of the sediment by the current.

Fossils

Any direct evidence of ancient life found in rocks is a fossil. All of us have seen fossils at some time or other, so the word provides a clear mental image. Most of the fossils we see are shells of creatures but many other kinds of fossils are likely to turn up in sedimentary rocks. Included are the prints of shells, plant debris and the tracks, trails or burrows of animals. Some limestones are made up entirely of fossils, but most sedimentary rocks contain only a few fossils or none at all. In dolostones we often find only remnants of fossils because most of the original material has been removed or altered by the process of lithification. Fossils can help to establish the relative age of a sedimentary rock, and they can also be useful clues to the type of environment in which a particular sediment was deposited.

PROCEDURE

This lab has three parts: (1) settling experiments, (2) classification of sedimentary rocks, and (3) description of sedimentary rocks and structures.

PART 1: Settling Experiments

Each lab table will have on it a water−filled cylinder, a stopwatch, and some size−sorted grains. Different tables have either different types of grains, or different sizes of the same type of grain. The participants at each table will measure the time required for grains to sink 30 cm through the cylinder. This settling time will be used to compute a settling velocity. We will compare the results from different tables by plotting all the class data on a plot of settling velocity versus grain size for each of the grain types. Our goal is to identify and understand the important controls of settling rates.

After the work with particles of a single, known size, you will see a demonstration of the settling of a sediment sample with mixed particle sizes. In this situation, the different settling rates (established above) manifest themselves as layers defined by differences in grain size .

PART 2: Sedimentary Rock Classification

Each lab table will have trays with a number of sedimentary rocks in them. Examine each of these samples, taking care to note the following characteristics (as much as it is possible to do so):

Rock Color:	use the rock color chart
Mineralogy:	name the minerals you can readily observe and estimate their abundance
Texture:	note grain size, sorting, and roundness
Sedimentary Structures	
Fossils	

Record your observations on the Sedimentary Rock Datasheet. Use your observations and the sedimentary rock classification chart in Table 2 to give each rock its proper name. Once you have finished describing and identifying the samples in your lab tray, we will ask you to demonstrate your ability to correctly classify sedimentary rocks by taking an in−class quiz.

PART 3: Interpreting Sedimentary Environments from Sedimentary Rocks and Structures

In the coming weeks we will look at several examples of sedimentary rocks in the field. To do well in these future field labs, you need to be able to describe sedimentary rocks and to recognize and interpret sedimentary structures. During lab we will look at several examples of sedimentary structures and explore their implications of the origins of the rocks which contain them.

For the final portion of this lab, your lab table will be given an example of a sedimentary rock. Working as a group, you are to carefully examine and describe this sample and discuss what information you can glean from it about its environment of deposition. Your group will orally present its findings to the rest of the lab.

ASSIGNMENT

Part of your grade on this lab will depend upon y your score on a sedimentary rock quiz to be taken out of class. This quiz will test your ability to classify sedimentary rocks.

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TABLE 2: Sedimentary Rock Classification

Sedimentary rocks are broken into two groups, the Clastic and the Chemical or Biochemical.
CLASTIC sedimentary rocks are made up of broken bits of rocks and minerals transported to the site of deposition by water, wind or ice.
CHEMICAL sedimentary rocks are made up of chemical or biological precipitates deposited in the basin of deposition. These materials may undergo subsequent reworking and so have clastic shapes and textures.

Clastic Sedimentary Rock Classification

Average Particle Size	Sediment	Rock Names	
>2mm	Gravel	CONGLOMERATE	(rounded particles)
		BRECCIA	(angular particles)
1/16th mm to 2 mm	Sand	SANDSTONE	Quartz Arenite (mainly quartz grains)
			Graywacke (abundant fine matrix) Arkose (abundant feldspar grains)
Too small to see, gritty	Silt	SILTSONE	
Too small to see, smooth	Clay	MUDSTONE	(breaks in blocks)
		SHALE	(breaks in layers)

Chemical and Biochemical Sedimentary Rock Classification

Minerals	Sediments	Rock Names
Calcite ($CaCO_3$)	Carbonate sand and mud	LIMESTONE
Dolomite ($CaMg(CO_3)_2$)	No primary sediment	DOLOSTONE
Hematite ($Fe2O_3$) Limonite (FeO(OH))	Iron oxide sediment	IRON FORMATION
Halite (NaCl) Gypsum ($CaSO_2(H2O)_2$) Anhydrite ($CaSO_4$)	Evaporite sediment, precipitates	EVAPORITE
Microcrystalline Quartz (SiO_2)	Siliceous sediment, ooze	CHERT
Not Applicable!	Organics, plant materials	COAL

SEDIMENTARY ROCK DATA SHEET

Sample, Rock Name	Color	Texture Clastic: grain size, roundness, sorting. Chemical: crystalline, microcrystalline.	Composition	Other Features