Sedimentary rocks are usually identified in the field by their stratification or layering, which originates by the successive deposition of physical and chemical products weathered from other rocks and organic remains. They can be classified into three genetic types: clastic, chemical, and organic. Clastic rocks contain the broken fragments of previously lithified rocks and minerals. Chemical sedimentary rocks are formed by the precipitation of minerals directly from water. In the Great Salt Lake of Utah, sodium (Na\(^+\)) weathered from a plagioclase in the nearby Uinta Mountains and carried downstream in solution by the Bear River might combine with a chlorine (Cl\(^-\)) weathered from chlorite in one of the ranges in western Utah, forming halite (NaCl) during periods of high evaporation. Organic sedimentary rocks are formed by the action of plants and animals. Incompletely decomposed plant matter forms coal, whereas coral and other sea organisms can build a calcium carbonate (CaCO\(_3\)-calcite) shells and skeletons that become the rock called limestone.

None of these is exclusive of the others: in fact it is common that a sedimentary rock will have characteristics of more than one of these genetic groups. For instance, a limestone may be composed of the broken pieces of shells (bio-clastic) mixed with sand-sized quartz sediment (clastic) in a matrix of pure calcite cement (chemical precipitate). Use the most formative attribute.

These three classes leave sedimentary rocks to be subdivided by texture as clastic or detrital (the individual fragments of rock, mineral and shell can be seen), and crystalline (where interlocking crystals have grown together, visible or microscopic, like both igneous and metamorphic rocks). Again there is a mixture of these textures. For hand samples, it is often not possible to determine whether a rock is composed of very fine clastic or crystalline grains.

The purpose of this lab is to introduce you to the different types of sedimentary rocks, the methods by which they are differentiated, and some of the diagnostic structures and textures common to sedimentary rocks. Refer to samples in drawer 3 (numbers 49-66, but not 67).

If you would like to see pictures of common sedimentary rocks, visit this web site with hundreds of images of sedimentary (and other) rocks.

http://skywalker.cochise.edu/wellerr/rocks/sdrocksL.htm

**Clastic Textures**

The texture of clastic sedimentary rocks is described first by the average & maximum size of detrital grains, and second by the range of grain sizes, known as the sorting. Sorting is shown below (from Tucker, The Field Description of Sedimentary Rocks).

![Texture diagrams](image)

Poorly sorted sediments contain a large range of sizes (use mm) and well sorted sediments are nearly all one size. Size and sorting are important indicators of the energy and constancy of the wind or water acting in the depositional environment. Beach sand is generally very well-sorted.

I. What is the sorting of sample numbers 60 __________, 61,__________ and 62 ________?

Answers on last page.
Texture also includes **grain shape**, which can be described by the roundness (or angularity) and sphericity. These attributes commonly reflect the distance of transport or the energy of the transporting mechanism. (from Tucker, *The Field Description of Sedimentary Rocks*)

Angularity distinguishes **conglomerates** and **breccias**. A breccia is a conglomerate with angular grains.

II. Apply the appropriate name to 59 _____________ and 60 ____________.

**Sandstones** are subdivided based on the mineralogy and texture of the constituent grains. Describe the mineralogy (and texture of any fine-grained matrix) of the following samples and then determine the type of sandstone using the following guidelines (and surely you can find outside sources of information about these differences, too).

- **Quartz arenite**: 90-95% quartz, generally yellow-white to clear, well rounded sand and fine gravel
- **Arkose**: feldspar 25% or more, generally angular grains, pink, and has same general mineralogy as granite
- **Greywacke**: >15% “matrix”, which is the fine-grained, commonly dark, mud (silt+clay) between sand grains, angular grains common, a “dirty” sandstone
- **Lithic sandstone**: >25% grain are rock fragments (no sample in drawer)

III. Name the following samples in drawer 3 based on their sand mineralogy (use your hand lens!).

52 __________, 53 __________, 61 __________, 62 __________, 65 __________

IV. How does one distinguish a sandstone (clastic) from a phaneritic igneous rock with sand-sized grains? (you need your hand lens!) The samples “X” and “Y” in the back of the room have many of the same minerals, but are different rock types. Classify them as clastic or igneous and give the reason.

X __________; __________ Y __________; __________

Fine-grained sedimentary rocks (<25% visible grains) are difficult to distinguish without the aid of a microscope. With a good hand lens, one can just barely see the largest silt grains. Therefore, we will call fine-grained clastic rocks by only two names. Mud is a mixture of silt and clay, so **mudstone** is cemented mud. The name **shale** is reserved for mudstones that are thinly laminated and friable, which we describe as “fissile.”

V. What sample in your drawer is gray, fissile shale (but cemented by CaCO₃)? _____________
**Bioclastic Rocks**

The grains of bioclastic rocks are composed partially of the remains of shells and can be mixed with other sediments. Most shells are formed from calcite. If the majority of the sediment is inorganic, it is a clastic rock and the term *fossiliferous* is added to the clastic name, such as “fossiliferous shale.”

- **Fossiliferous limestone** (or skeletal limestone) is composed of shells and shell fragments that are well-cemented by calcite into a dense, dark rock.
  - If shells and shell fragments make up the bulk of the rock and it is very porous, it is called *coquina*.
  - Rock composed of microscopic fragments of organisms is called *chalk*.
  - Ooliths (from Greek *oon*, for egg) are 0.25-2 mm, round accretionary bodies of calcium carbonate that grow around a shell fragment by inorganic precipitation in wave-agitated, carbonate-saturated water. **Oolitic limestone** (or oolite limestone) is formed from the cementation of ooliths or ooids.
- *Coal* is a dull to shiny, black, layered deposit of plant remains.

VI. Id the following samples from your drawer.

50 __________, 51 __________, 55 __________, 58 __________, 66 __________

**Crystalline Sedimentary Rocks**

Some carbonate rocks are formed by pure chemical precipitation, where crystals grow into an interlocking crystalline texture. From your mineral drawer, examine the gypsum and halite samples. These minerals form along with calcite in evaporating basins into rocks called evaporites. Others form in deep and shallow, open-marine environments. Those composed of calcite are simply called *limestone*. Limestones often include a high percentage of biogenic mud or they can be very dark colored.

- *Chert*, which is composed of microcrystalline quartz (chalcedony and opal), is frequently associated with carbonate rocks. It is very hard and can be broken to form sharp points (as in “flint” knapping).
- The calcium-magnesium carbonate mineral *dolomite* is also frequently associated with limestone and makes the rock “dolostone.” Dolomite is as hard as calcite, but reacts to dilute acid only when it is scratched or powdered. It is sometimes more porous than limestone. We may run into dolomite in the field, where we will break out the acid.

VII. Id the following samples from your drawer

49, __________, 56 __________, 57 __________, 64 __________

**PROBLEM** How does one tell the difference between a fine-grained, dark igneous rock (basalt), shale, a dark, crystalline limestone, and black chert (flint)?

- **hardness** - basalt and chert are harder than both shale and carbonates
- **reaction to acid** - carbonates effervesce with dilute HCl while the others do not. CAUTION! Any sedimentary rock can be cemented by calcite, so we won’t bother using the acid. Use hardness instead.
- **fracture** - only chert has the characteristic conchoidal fracture of quartz (it was used for arrowheads).
- **color on weathering** - limestone weathers to a characteristic buff color, basalt often weathers more toward red, and shale weathers to white/brown/red, depending on the level of calcite and iron.
Sedimentary Structures

The actions of the transport mechanism and post-depositional disturbances yield distinctive patterns and shapes called “structures.” Do some research on “sedimentary structures” and identify the name of the special structures found on the following samples and say what they indicate about the environment of deposition.

VIII. ID the structures on the 4 rocks labeled (A-D) at the back of the lab.

<table>
<thead>
<tr>
<th>Name?</th>
<th>Environment of Deposition Indication?</th>
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<tbody>
<tr>
<td>A.</td>
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IX. Finish identifying the rocks in your drawer

Fill out the sheet on the back page to assist the identification of the sample (most of which you have already done working through the above answers).
Answers to questions

I.  60 is moderately to poorly sorted,  
  61 is well sorted  
  62 is poorly sorted

II.  59 breccia (angular) (mineralogy is chert, therefore a “chert breccia”)  
  60 conglomerate (well rounded) (and by mineralogy, probably a “quartz arenite conglomerate” or a “greywacke conglomerate” depending on the amount of mud in each sample).

IV.  52 quartz arenite (some are conglomeratic),  
  53 greywacke (most grains are qtz, cement is hematite rich mud; some lithic grains, but not enough to be lithic sandstone),  
  61 quartz arenite,  
  62 greywacke,  
  65 arkose

IV.  Y - Clastic rock - grains are rounded or not in contact  
    X - Igneous rock - grains are intergrown or interlocked

V.  63 is shale, cemented with CaCO₃

VI.  50 Oolitic limestone,  
  51 Fossiliferous limestone,  
  55 Coal,  
  58 Coquina  
  66 chalk (would be called a "mudstone" by grain size and bedding, but is bioclastic)

VII.  49 limestone  
   56, limestone,  
   57 chert,  
   64 dolostone (micrite or mud-sized grains of dolomite)

VIII.  A: ripple marks, wave oscillation during deposition  
    B: cross bedding, current building bedforms (dunes) during deposition  
    C: mud cracks, subaerial exposure and sediment drying  
    D: bioturbation, presence of certain types of organisms that give ecological hints to the depositional environment
## Sedimentary Rock Identification

(not all samples will require information in all categories)

<table>
<thead>
<tr>
<th>clastic, organic, &amp;/or chemical</th>
<th>mineralogy or composition (including fossils)</th>
<th>grain size, sorting, &amp;/or crystalline texture</th>
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