Part I – Sedimentary Rock Characteristics

**Source Rock** – Location and composition of the rock from which the sediment was derived.

- **Composition** – feldspar, that easily weathers, is an indication of a nearby igneous source. Abundant rock fragments and poor sorting usually indicates a nearby source. Abundant quartz may mean a recycled sandstone source and/or distant source.

**Transport** – the process and mechanism of moving sediment

- **Rounding** – rounding of grains is related to length of transport.
- **Sorting** – grains get sorted by grain size. More sorting indicates longer transport.
- **Composition** – the presence of feldspar and easily weathered rock fragments indicates short transport. A rock consisting of only quartz grains indicates longer transport.

**Depositional Environment** – all of the environmental factors under which sediment is deposited. This includes geographic setting (continental, marine, etc) and energy of the setting (low energy lake, high energy river or beach)

- **Grain Size** – grain size is related to the energy of the depositional environments. Larger grains are deposited in higher energy environments (river channel, beach). Smaller grains (shale, mud) are deposited in low energy environments (lake, bay, offshore).
- **Composition** – the composition of sediments may indicate the depositional environment. Limestone indicates an established shallow ocean environment (commonly a reef). Evaporites (salt, gypsum) indicate an arid environment with high rates of evaporation.
- **Sedimentary Structures** – structures such as cross beds, ripples and mud cracks each indicate specific environments (dunes/delta, shallow water, arid environments)
- **Fossils or trace fossils** – this evidence of specific organisms provides evidence of an environment. For example, fossil marine clams indicate shallow marine environment.
- **Color** – coloration may indicate post-depositional processes such as oxidation. Red colors usually indicate oxidation in a terrestrial environment. Dark colors may indicate a low oxygen environment (marine) and/or the presence of organic material.

**Facies**: A distinctive type of sedimentary rock that can be used to determine the depositional environment. For example, a limestone facies indicates a marine environment.

**Rock Stratigraphic Units** (Lithostratigraphy)

- **Formation** – A distinctive rock unit with distinct contacts with other rocks units (above and below) and can be traced laterally for a large enough distance to be mapped. There may be variation within the formation (e.g., sandstone, shale, conglomerate). The age may vary across a formation.
- **Group** – Two or more formations
- **Member** – Subdivisions of a formation, such as a mudstone member of a formation.
Written Responses for Part I

1. Provide a short definition of what is meant by Depositional Environment and provide two examples (p. 83 text):

2. Explain how grain size is related to the energy of the depositional environment. What are the relations between grain size and energy?

3. Explain how sorting and rounding are related to the transport of grains. What is the relations between sorting and rounding to length (and type) of transport?

4. Explain how color (such as redness) may relate to the sedimentary environment (p. 89 of text)?
5. Describe what is meant by a Formation. Provide an example.

6. Explain how a formation may not be the same age everywhere encountered.

7. What is the collective name for several formations? What is the name for a subdivision of a formation?

8. What is facies? Provide an example.
GEO 2: Historical Geology with Lab
Lab 4: Sedimentary History

Part II – Lab Specimens

A. Examine the numbered lab specimens provided and answer the following for each specimen

1. Provide information about the source rock (if possible)
2. Discuss the length (and mode) of sedimentary transport involved
3. List a probable energy level (low, medium, high) for the depositional environment
4. Provide a plausible sedimentary environment
5. Is there evidence of post-depositional changes to the rock
Sedimentary Structures

The following is from: http://geology.csupomona.edu/drjessey/class/Gsc101/Weathering.html

Structures formed during deposition

- **Bedding** - Layering of sedimentary rocks. Each bed represents a homogeneous set of conditions of sedimentation. New beds indicate new conditions. Most layering is parallel, but occasionally it is inclined. These inclined layers are cross beds. Examples of sedimentary environments in which cross beds form are dunes and deltas.

- **Graded beds** occur when a mass of sediment is deposited rapidly. The bedding has the coarsest sediment at the bottom and finest at the top. Often found forming in submarine canyons. A collection of graded beds is termed a turbidite deposit.

- **Ripple Marks** - Waves of sand often seen on a beach or bay at low tide and in stream beds.

- **Mud Cracks** - Polygonal-shaped cracks which develop in fine grained sediments as they dry out. Common in arid environments, such as a desert.

Structures formed after deposition (note that concretions and nodules are combined)

**Nodule/Concretion** - Irregular, ovoid concentration of mineral matter that differs in composition from the surrounding sedimentary rock. Often consist of calcite, iron oxide or silica. Can exceed 1 meter in diameter.

**Fossils or trace fossils** (worm tubes, foot prints, etc)

**B. Examine the numbered Lab Specimens and for each:**

- a. state if you identified any sedimentary structures
- b. describe what the structure or features tells about the depositional environment.
Stratigraphic Relations and Correlation

- **Transgression (Onlap)** – A distinctive sequence of sedimentary rock results when sea level rises (or the land falls) and a series of sedimentary facies moves landward. The transitions shown in the first figure below indicate this change. The limestone (the bricks) indicates deeper water, the shale (the dashed lines) indicates near shore marine environment, and the sand (dots) indicates a shore/beach environment.

- **Regression (Offlap)** – The opposite sequence occurs as sea level drops (or land rises). The time sequence changes from limestone to shale to sandstone (marine to continental).

- **Stratigraphic Column** – The Column (X) shown in both diagrams is called a stratigraphic column and it represents the strata deposited at a location over time.

Note that the sequence shown in Column X (both diagrams) is also the lateral sequence change. This relationship of the vertical succession of facies (limestone to shale to sandstone) corresponding to lateral facies changes is named Walther’s Law.

1. Indicate if the columns above represent a transgression, regression, or both. If the column represents more than one, indicate the portions that are regressive and the portions that are transgressive.
Facies Maps – these maps define the distribution of similar rock types (facies). They can be constructed of modern environment such as coastal regions. They can also be used to reconstruct the past depositional patterns during specific time interval. The following diagram shows how a facies map is constructed. The rock types of a particular age are located on the map (a). The difference rock types, representing different environments, are separated using the dashed line in map (b). Rock symbols are used to construct the final facies map (c).

2. Indicate on the map above the location of the ancient shoreline when these rocks were deposited?

3. Examine the map and legend below, which shows the generalized distribution of Late Cretaceous sedimentary rocks in the western U.S. This area is bounded by the “zero lines”. Late Cretaceous rocks are not preserved in the unshaded areas. The absence of Late Cretaceous rocks in these areas may be due to erosion or limits of the basin where rocks were deposited

a. **Draw a line** showing the approximate western edge of the sea that covered the area during Late Cretaceous time (separating terrestrial from marine facies)

b. **What inference** can be made about the probable topography of western Idaho, Nevada and western Arizona during Late Cretaceous time? How does this compare to today’s topography?
Facies map of Silurian Rocks of the eastern U.S. The numbers represent the thickness of sediment in each area (in feet). This information comes from both outcrops and drill cores, as much of the area is covered by younger sediment.

4. Where is the most likely source rock for the clastic rocks shown in the figure?

**Correlation** – When the rock record is incomplete due to limited surface exposures and limited drilling data, correlation of stratigraphic columns can be used to show lateral changes across an area. The example below shows correlation of two outcrops. Note that some rock units are thicker or thinner in one location. The limestone in B has a symbol indicating algal mats, which implies it was closer to the shore.

**Correlation Examples:**
5. Use lines to correlate the stratigraphic sections below, similar to what was done above.

a. State Walther’s Law and describe a portion of Section C that corresponds to the Walther’s Law concept as seen across the three sections.
b. What happens to the conglomerate shown in section C? Why is it not present in A and B?

c. Which section has the most low-energy sediments present?

d. In which direction does the sandstone thin?

e. Where would you predict the source rock and continent are located (toward the West or East)? Explain your answer.

6. Correlate the three columns in Figure 3.28 (below), and answer the following questions.

(a) Explain what is happening to the limestone unit at time 3 in the column sequence A-B-C. Can you suggest a reason for your observation?

(b) If all the rocks were deposited in a marine environment, which column is the one most likely to have been deposited farthest from land?

(c) Which one was deposited closest to land?

(d) In which direction did the land lie? Explain.

(e) What was happening to sea level from time interval 1 to time interval 3?

(f) What was happening to sea level from time interval 3 to time interval 7?
7. Use lines to correlate the rock units shown in the two columns above.

   a. Which section (A or B) contains an unconformity? Label the unconformity on the column.

   b. What rock units are missing in the column with the unconformity?

   c. Is the sequence above the unconformity transgressive or regressive? State your evidence.