Name: **Miramar College** **Grade:**

GEOL 101 - Physical Geology Laboratory

SEDIMENTARY ROCK CLASSIFICATION AND IDENTIFICATION

PRELAB SECTION – To be completed before labs starts:

I. Introduction & Purpose:

The purpose of this laboratory exercise is to become familiar with identifying common sedimentary rocks and understanding their depositional origin. In this lab you will learn to identify sedimentary rocks in hand samples from their physical properties. You will also learn the nature and origin of sedimentary rocks, the major types of sedimentary rocks, and their structures, and the connection between plate tectonics and sedimentary rocks in the rock cycle will be explored.

II. General Overview and Classification of Sedimentary Rocks

A. The classification of sedimentary rocks is based upon two major criteria (see page 110 in text)

1. Texture = grain size and rock "fabric"

2. Composition = mineralogy

Sedimentary rocks are divided into **three major groups,** based on composition and/or texture:

1) Silico-clastic

2) Biochemical clastic/crystalline

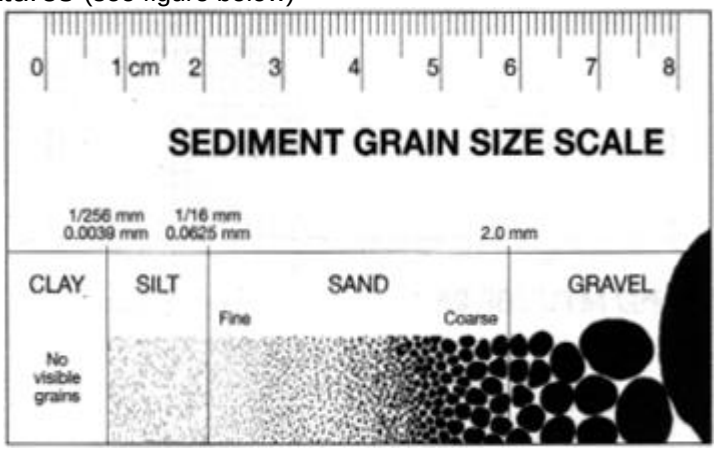
3) Chemical crystalline

Silico-clastic sedimentary rocks consist of sediment grains (called clasts) of silicate minerals that are cemented together; these rocks have a "**clastic**" sedimentary texture. The sediment grains consist of one or more silicate mineral crystals that come from the weathering and erosion of preexisting source rock, such as granite or volcanic rock; any source rock type is possible. Detrital silicoclastic sedimentary rocks are classified primarily upon grain size, e.g. sand(-sized)stone versus silt(-sized)stone.

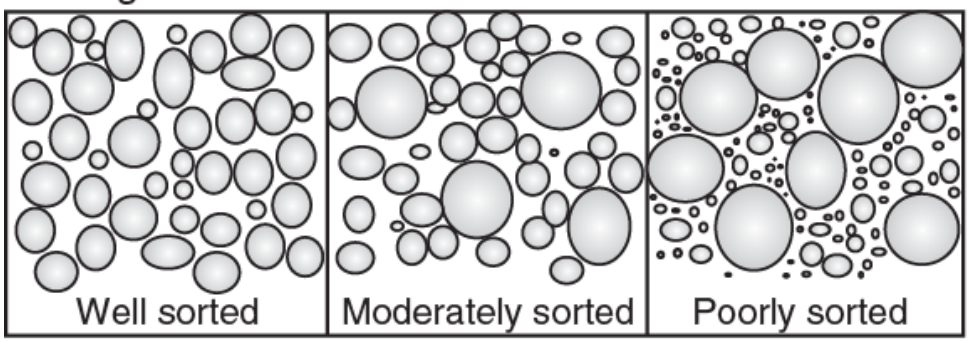
In contrast, **biochemical** and **chemical** sedimentary rocks consist mainly of mineral crystals that have crystallized directly out of aqueous solutions (water), either secreted by living organisms (biochemical), or by inorganic precipitation (chemical), respectively. Most of these chemically derived sedimentary rocks have a "**crystalline**" sedimentary texture, much like that of igneous rocks. Biochemical and chemical sedimentary rocks are classified primarily upon mineral composition, e.g. limestone ($CaCO_3$) versus chert (SiO_2).

The 6 types of sedimentary grain sizes and the textures (see figure below)

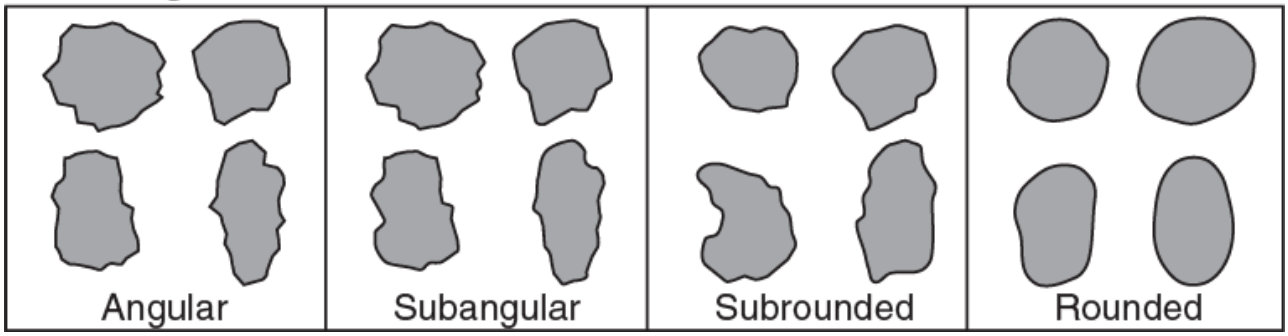
Grain Size Name	**Grain Size** (range)
1. Gravel-size	_____mm to _____ mm
2. Sand-size	_____mm to _____ mm
3. Silt-size	_____mm to _____ mm
4. Clay-size	smaller than _____ mm
5. Macrocrystalline	Visible to naked eye
6. Mirocrystalline	Need microscope to see



Sorting:



Rounding:



B. Grain Shape: Detrital grains are typically rock fragments that have been weathered and eroded from pre-existing rock and transported, over time, a certain amount of distance from its source. As a general rule of thumb, the farther and longer the grains have been transported form their source, the more rounded they become. Thus, the detrital grain shape gives an indication of its "**maturity**" in the sedimentary cycle.

1. List the four types of sediment grain ***shapes*** exhibited in detrital rocks (See above figure)

Detrital Grain Shapes

a. _____ b. _____ c. _____ d. _____

2. Question: Which grain shape type would you expect to be the *least* "mature"? Why?

3. Question: Which grain shape type would you expect to be the *most* "mature"? Why?

C. Grain Arrangements: Transported sediment grains become sorted (according to size), over time, as the fluid mediums that transport them, such as running water and wind, selectively deposit some grains while continuing to carry the smaller grains ever greater distances from the source region. The causes for sorting include systematic variation in flow rate and turbulence of the transporting medium over distance and time. As a general rule of thumb, greatest sorting occurs within consistently medium to high energy transport mediums over long periods of time (effective winnowing of sediment), whereas the conditions of poorest sorting occurs where either, flow rate changes drastically or is very inconsistent (effective dumping of sediment). Additionally, non-fluid transport mediums such as glaciers do not have the capability to sort sediment by size, and therefore sediments directly deposited by glaciers are virtually unsorted.

1. **List** the three types of sediment grain ***arrangement****s* found in detrital rocks (See above figure)

Detrital Grain Arrangements

1. _____ 2. _____ 3. _____

2. **Question:** Why would a river be good at sorting sediment and a glacier not?

3. Question: Would you expect there to be a direct relationship to exist between grain *shape*, i.e. roundness, and grain *arrangement*, i.e. sorting? Explain your answer.

D. Composition of Sedimentary Rocks: The mineral composition of a sedimentary rock is a reflection of 1) **source material** and 2) **sedimentary processes**. Sources include virtually all types of geologic, biologic, hydrologic, and cosmologic materials such as: 1) land-derived materials such as weathered and eroded igneous, metamorphic and sedimentary rocks; 2) hard-part remains (shells) of marine organisms; and 3) seawater chemical precipitates. Sedimentary lithification processes, termed "diagenesis" can both, alter and add chemicals and minerals to the rock, such as rock cement. A review of the composition of all the major sedimentary rock types shows a surprising conclusion: *that there are only a small number of major sedimentary rock-forming minerals and rock fragment detrital types*. The vast bulk of sedimentary rocks have one or more of the following mineral constituents: quartz/ silica, feldspar, mica, clay, iron oxide, amphibole, calcium carbonate, and various minor amounts of sulfate, phosphate, and halide minerals. The primary reason for this compositional simplicity, compared to those of igneous and metamorphic rocks, is the fact that most of the sedimentary rock-forming minerals are stable or meta-stable at Earth surface conditions; many of the igneous and metamorphic rock-forming minerals are unstable at the surface and with sufficient time will alter to minerals such as the clays, silica, and carbonates.

The major source materials for each of the three sedimentary rock types (see Figure 6.2 page 114)

Detrital-Silicic (Clastic-origin)

1. Rock fragments 2. **Quartz** 3. Feldspar 4. **Clay** 5) Dark silicates and oxides

Biochemical (Organic-origin)

1. Shells and Shell and coral fragments (calcite and quartz) 2. Carbon and Charcoal

Chemical (Inorganic-origin)

1. Calcite 2. Dolomite 3. Quartz 4. Gypsum 5. Halite 6. Iron-bearing minerals

1. Question: Clay is the most common sedimentary mineral. How is it derived? Why so much?

2. Question: Calcium carbonate is another major sedimentary constituent. How is it derived?

F. Detrital Silico-clastic Rocks: Detrital silico-clastic rocks are named primarily upon their grain size, while their composition, which is a reflection of the source rocks and subsequent weathering erosion history, is secondary to naming a detrital rock, e.g. arkose and wacke. The five major **detrital** (silicioclastic) rock types that are based on grain size and shape.
Note: siltstone and shale are lumped together as "mudstones". (See top of Figure 6.8, page 118).

Rock Name	***Notes***
1. Breccia	
2. Conglomerate	
3. Sandstone	
4. Siltstone	
5. Shale	

1. Question: What is the basic difference between a breccia and conglomerate?

2. List four different mineral cements that bond sediment grains together in detrital rocks.

a. _____ b. _____ c. _____ d. _____

3. Question: How might you easily test whether calcite is the cementing agent in sandstone?

G. Naming of Biochemical Rocks: Biochemical rocks are named based primarily upon their composition, e.g. calcium carbonate fossil shell or plant material, and secondarily upon their texture, e.g. sandy, shelly, crystalline, microcrystalline, etc. Limestone is a sedimentary rock named primarily for being rich in calcium carbonate. The types of limestone are named by the type and texture of the calcium carbonate. As an example, coquina is a poorly cemented mass of large-sized shell fragments, whereas, chalk is a super fine-grained mass of microfossils.

Five major **biochemical rock** types are based primarily on mineral composition.

Rock Name	***Notes***
1. Coal	
2. Coquina Limestone	
3. Fossiliferous Limestone	
4. Chalk Limestone	

1. Question: How might you easily test for whether your sedimentary rock is a limestone?

H. Nomenclature of Chemical Rocks: Chemical sedimentary rocks are also named based primarily on composition. However, **all** chemical sedimentary rocks have **crystalline** textures that reflect their direct precipitation of ions from an aqueous fluid such as seawater.

Rock Name	***Notes***
1. Oolitic Limestone	
2. Travertine Limestone	
3. Dolostone	
4. Rock salt	
5. Rock Gypsum	
6. Chert	

1. Question: What is the primary difference between a chemical and biochemical limestone?

2. Question: How might you easily test whether or not you have a limestone versus a chert?

3. Question: How might you test whether or not you have rock salt versus rock gypsum?

III. Depositional Settings of Sedimentary Rocks

A. Sedimentary rocks retain a memory of the conditions in which they formed in, and that information is recorded by the rock's texture, composition, fossils, and structure. By observing and studying today's depositional environments and the type and structure of the sediments that collect there, we can infer the depositional setting and history of sedimentary rock assemblages by comparing their sedimentary characteristics to that of modern day depositional systems.

B. Examine **the figure with depositional environments** in your lab manual. This illustration shows most of the major types of modern sedimentary environments where sediments are depositing and sedimentary rocks are forming. **Directions:** List the depositional environments where each type of sedimentary rock forms as shown in the figure in your lab manual.

Sedimentary Rock	**List the Most Common Depositional Environments**
1. Breccias and Conglomerates	_____
2. Sandstones	_____
3. Mudstones	_____
4. Limestones	_____
5. Cherts	_____
6. Rock Salt and Gypsum	_____

IN-LAB SECTION -- SEDIMENTARY ROCKS IDENTIFICATION

I. Preliminary Examination of the Sedimentary Rock Types:

A. Introduction: A **reference collection** ("S" collection box) of sedimentary rocks are found on your lab table. The reference set includes the three major types of sedimentary rocks: Siliciclastic samples S1 through S5; Bio-clastic/chem samples S6 – S10; and chemical samples S11 – S16.

Directions: Carefully observe, analyze, and note each rock's **1) *composition*** *(mineralogy)*, **2) texture** (grain size/shape/sorting), and **3)** inferred **origin** (depositional environment.)

B. The Silici-clastic Sedimentary Rocks:

Sample	**Rock Name**	**Composition**	**Texture**	**Origin**
S1	**Conglomerate**	_____	_____	_____
S2	**Breccia**	_____	_____	_____
S3a	**Sandstone**	_____	_____	_____
S3b	**Sandstone**	_____	_____	_____
S3c	**Sandstone**	_____	_____	_____
S4	**Siltstone**	_____	_____	_____
S5a	**Shale**	_____	_____	_____
S5b	**Shale**	_____	_____	_____

1 .Question: What is the primary difference between the set's breccia and a conglomerate?

Answer: _____

2 .Question: What is the principle mineral in the sandstone? Answer: _____

3 .Question: What is the principle mineral in the shale? Answer: _____

4 .Question: What is the primary difference between the set's siltstone and shale?

Answer: _____

C. The Bio-Clastic/chemical Sedimentary Rocks

Sample	Rock Name	Composition	Texture	Origin
S6	Coal	_____	_____	_____
S7a	Fossil L.S.	_____	_____	_____
S7b	Fossil L.S.	_____	_____	_____
S8	Chalk	_____	_____	_____
S9	Coquina	_____	_____	_____
S10	Mud L.S.	_____	_____	_____

1. Question: Which of the samples contain fossils that you can see?

2. Question: How can you tell the limestone from the coal sample?

D. The Inorganic Chemical Sedimentary Rocks

Sample	Rock Name	Composition	Texture	Origin
S11	Oolitic L.S.	_____	_____	_____
S12	Rock Salt	_____	_____	_____
S13	Rock Gypsum	_____	_____	_____
S14	Chert	_____	_____	_____
S15	Ironstone	_____	_____	_____
S16	Travertine	_____	_____	_____

1. Questions: Which of the chemical sed rocks fizzed in acid? _____

2. Questions: Which of the chemical sed rocks is very hard? _____

3. Question: Which of the above samples can be scratched by a fingernail? _____.

II. Classification of Unknown Sedimentary Rock Samples:

Introduction: Sedimentary rock classification is done in a systematic manner, utilizing a step-by-step procedure. Sedimentary rocks are identified based upon **1)** compositional make-up and **2)** textural and structural qualities. A sedimentary rock analysis and classification chart is shown in **lab manual.**

The 3-step procedure for identifying sedimentary rock samples is as follows:

Step 1: Identify and record the rock's composition (rock fragments? minerals?, fossils?)
Step 2: Identify and record the rock's texture and other distinctive properties.
Step 3: Name the rock, including its most likely depositional setting

III. Analysis and Identification of 11 Unknown Sedimentary Rock Samples:

Directions: Identify eleven unknown sedimentary rock samples found in **sample Collection "UN"**. Be sure to check the following information about the rock: **a)** Composition (circle one or more); **b)** Texture (grain type and size – circle one each) **c)** Other distinguishing characteristics (fossils, layering, fizz in acid, etc); **d)** List rock name; **e)**List the mostl likely depositional environment that the rock originated in? Depositional environments are shown in Figure in lab manual

Sample# SU1

a) Composition: Rock fragments; quartz; feldspar; clay; calcite; gypsum; salt; carbon; fossils

b) Texture: Rock type: Siliciclastic; Bioclast/chem; Chemical Grain size: Very fine; Fine; Medium; Coarse

c) Other distinctive features _____

d) Rock name _____

e) Which depositional setting(s) did the rock form? _____

Sample# SU2

a) Composition: Rock fragments; quartz; feldspar; clay; calcite; gypsum; salt; carbon; fossils

b) Texture: Rock type: Siliciclastic; Bioclast/chem; Chemical Grain size: Very fine; Fine; Medium; Coarse

c) Other distinctive features _____

d) Rock name _____

e) Which depositional setting(s) did the rock form? _____

Sample# SU3

a) Composition: Rock fragments; quartz; feldspar; clay; calcite; gypsum; salt; carbon; fossils

b) Texture: Rock type: Siliciclastic; Bioclast/chem; Chemical Grain size: Very fine; Fine; Medium; Coarse

c) Other distinctive features _____

d) Rock name _____

e) Which depositional setting(s) did the rock form? _____

Sample# SU4

a) Composition: Rock fragments; quartz; feldspar; clay; calcite; gypsum; salt; carbon; fossils

b) Texture: Rock type: Siliciclastic; Bioclast/chem; Chemical Grain size: Very fine; Fine; Medium; Coarse

c) Other distinctive features _____

d) Rock name _____

e) Which depositional setting(s) did the rock form? _____

Sample# SU5

a) Composition: Rock fragments; quartz; feldspar; clay; calcite; gypsum; salt; carbon; fossils

b) Texture: Rock type: Siliciclastic; Bioclast/chem; Chemical Grain size: Very fine; Fine; Medium; Coarse

c) Other distinctive features _____

d) Rock name _____

e) Which depositional setting(s) did the rock form? _____

Sample# SU6

a) Composition: Rock fragments; quartz; feldspar; clay; calcite; gypsum; salt; carbon; fossils

b) Texture: Rock type: Siliciclastic; Bioclast/chem; Chemical Grain size: Very fine; Fine; Medium; Coarse

c) Other distinctive features _____

d) Rock name _____

e) Which depositional setting(s) did the rock form? _____

Sample# UN7

a) Composition: Rock fragments; quartz; feldspar; clay; calcite; gypsum; salt; carbon; fossils

b) Texture: Rock type: Siliciclastic; Bioclast/chem; Chemical Grain size: Very fine; Fine; Medium; Coarse

c) Other distinctive features _____

d) Rock name _____

e) Which depositional setting(s) did the rock form? _____

Sample# SU8

a) Composition: Rock fragments; quartz; feldspar; clay; calcite; gypsum; salt; carbon; fossils

b) Texture: Rock type: Siliciclastic; Bioclast/chem; Chemical Grain size: Very fine; Fine; Medium; Coarse

c) Other distinctive features _____

d) Rock name _____

e) Which depositional setting(s) did the rock form? _____

Sample# SU9

a) Composition: Rock fragments; quartz; feldspar; clay; calcite; gypsum; salt; carbon; fossils

b) Texture: Rock type: Siliciclastic; Bioclast/chem; Chemical Grain size: Very fine; Fine; Medium; Coarse

c) Other distinctive features _____

d) Rock name _____

e) Which depositional setting(s) did the rock form? _____

Sample# UN10

a) Composition: Rock fragments; quartz; feldspar; clay; calcite; gypsum; salt; carbon; fossils

b) Texture: Rock type: Siliciclastic; Bioclast/chem; Chemical Grain size: Very fine; Fine; Medium; Coarse

c) Other distinctive features _____

d) Rock name _____

e) Which depositional setting(s) did the rock form? _____

Sample# UN11

a) Composition: Rock fragments; quartz; feldspar; clay; calcite; gypsum; salt; carbon; fossils

b) Texture: Rock type: Siliciclastic; Bioclast/chem; Chemical Grain size: Very fine; Fine; Medium; Coarse

c) Other distinctive features _____

d) Rock name _____

e) Which depositional setting(s) did the rock form? _____

IV. SEDIMENTARY ROCK LABORATORY REFLECTION

Directions: Write a 120 word minimum reflection of the lab activity, explaining its purpose, the methods used, the results obtained, and a brief personal reflection of what you enjoyed and learned about doing this lab (*3 points possible*). Answer the following 3-point question reflection set on a separate sheet of paper:

1) *What was the purpose of this lab? What did you actually discover and learn during this lab?*

2) *What did you enjoy most about this lab? Also, what was challenging or thought-provoking?*

3) *What are your constructive comments about the design and execution of this lab? What's good? What's bad? Offer suggestions for making the lab better.*