Name: _____

Lab 7: Sedimentary Structures

Sedimentary rocks account for a negligibly small fraction of Earth's mass, yet they are commonly encountered because the processes that form them are ubiquitous in the near-surface environment. Thus, they preserve the history of that portion of the planet that is most familiar. Sedimentary rocks indicate paleoenvironment, i.e. ancient climates and ecology. Sometimes they provide the only remaining evidence of former mountain ranges or shallow seas. Sedimentary rocks are also essentially the only type of rock that contains fossils, which not only are indicative of previous environments, but also are crucial in dating and correlating rock units. Sedimentary rocks also provide a record of previous geologic hazards such as seismic events, volcanic eruptions (ash deposits), storms, and fluctuations in climate. Furthermore, key economic natural resources involve sedimentary rocks. Resources such as coal, oil, natural gas, gypsum, aggregate (sand and gravel), and salt are all found within sediments.

Sedimentary Structures
Sedimentary structures such as stratification (layering), ripple marks, cross-bedding, and mudcracks can be preserved in sedimentary rocks. These structures provide important information about depositional environments such as flow direction, climate (arid, semi-arid, or humid) and setting (e.g. fluvial, lacustrine, or marine). These structures also may indicate which direction was originally up within the rock. Tectonic forces can fold and overturn rocks, so establishing the original orientation is not always easy, but is often useful.

Bedding
Sedimentary rocks will often be deposited in discrete layers, which leads to a particularly important sedimentary structure called bedding. Bedding layers can range in thickness from millimeters to tens of meters. Typically, though not always, bedding is originally horizontal in orientation; tilted bedding indicates that the rock has been deformed in some way.

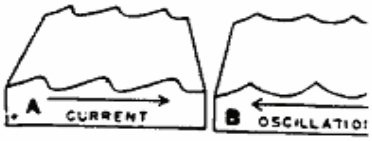
Lithification
Sedimentary rocks start out as loose sediment. To become a sedimentary rock, the sediments must be lithified, which involves compaction and cementation. Compaction occurs through pressure via deep burial. Water is removed and the grains are packed tightly together. During cementation, minerals such as quartz, calcite, or hematite precipitate out of water and fill the spaces between the clasts, locking them together. The term *friable* describes a poorly cemented rock that falls apart easily. Note: rocks can become friable either because they were never cemented thoroughly, or because the cement has been re-dissolved and removed.

Sorting
Sorting describes sediment in terms of the variability in the size of its particles. Sediment having a wide range of particle size, as in a jumble of gravel, sand, and finer particles deposited by a flood, is *poorly sorted*. If the size range is small, as in a uniform gravel, the sediment is *well*

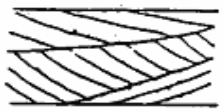
sorted. Changes in grain size typically result from fluctuations in the velocity of the transporting agent, such as water or wind.

Mud cracks: Occur in fine-grained layers when sediments dry out and shrink. Their presence indicates a very shallow water environment subject to periodic drying (eg. tidal flats or mud puddles)

Ripple marks: Occur where currents travel across sediments. The shape of a ripple mark indicates the direction and type of current involved. ASYMMETRICAL ripple marks (A) from when the current flows in one direction, as in a stream, SYMMETRICAL ripple marks (B) form when currents flow back and forth as on a beach.



Cross-Bedding: Occurs when shifting currents flowing in one general directions producing ripples cut off sedimentary layers and deposit new layers at different angles. Cross-bedded sediments are found in river channels and sand dunes.

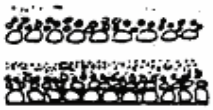


Parallel Bedding: There are two ways parallel bedding can form.

Laminar bedding: is the result of silt and clay deposition in quiet water environments such as lakes or protected bays Each individual bed is very thin.

Planar bedding: is the result of sand and gravel deposition at very high energies such as in fast flowing water. Individual beds are very thin.

Graded Bedding: forms where rapid sedimentation occur; in sediment-laden (Turbidity) currents flowing onto the deep-ocean floor, and in rapidly-flowing streams. In each case, the coarsest sediment settles first followed by progressively sediments. The next current repeats the sequence, creating a cycle of layers grading upward from coarse to fine.



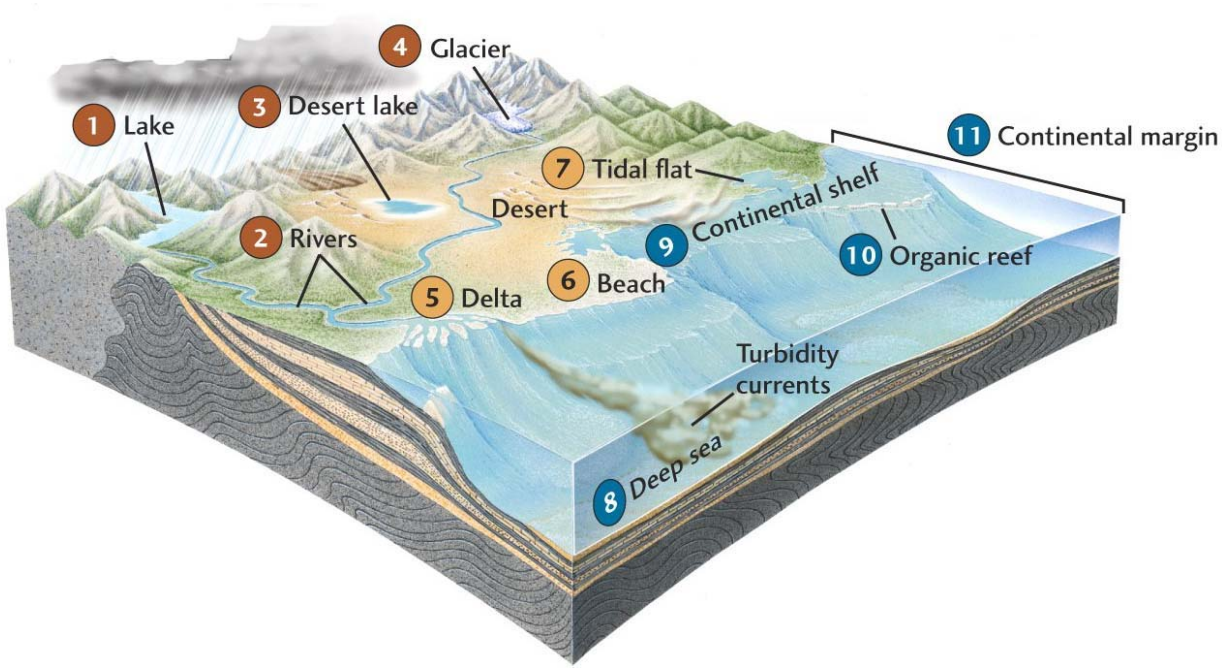
Load and flame structures: Occur when coarse sediment is RAPIDLY deposited on top of watery muds. As the coarse sediment settles the weight of the sediment caused it to sink into the mud which squirts up into the the coarse sediment forming flames. These structures are often associated with Turbidity currents.

Depositional Environments

A sedimentary environment is a geographic location characterized by a particular combination of geologic processes and environmental conditions. Geologic processes include the currents that transport and deposit sediments (water, wind, or ice) and the plate tectonic settings that affect sedimentation. For example, the geologic processes of a beach environment include the dynamics of waves crashing against the shore, shoreline currents, and the distribution of sediments on the beach. Environmental conditions include the kind and amount of water (ocean, lake, river, arid land), the landscape (lowland, mountain, coastal plain, shallow ocean, deep ocean), and biological activity.

Location	Depositional Environment	Characteristics	Rock Type(s) Formed
Continental Environments	Lakes (Lacustrine)	Lake deposits are generally low-energy environments where fine-grained sediments are deposited in thin layers. Lakes that freeze over seasonally may develop varves: alternating layers of light (coarser) and dark (finer) sediments. Large lakes can also have higher-energy, sandy beaches.	shale, siltstone
	Glacial	Glacial deposits form along the margins of and beneath glacial ice. Because ice can transport any size grain (unlike water or wind), deposits are typically very poorly-sorted	Conglomerate and sometimes breccia If glacial origin is known, the rock is called a "tillite"
	Alluvial Fan	Alluvial fans are fan-shaped wedges of sediment deposited along the margin of a steep slope. They often contain a lot of coarse-grained, moderately to poorly-sorted sediment.	Conglomerate, sandstone, and sometimes breccia
	Rivers and Streams (Fluvial)	Rivers and streams typically deposit medium- to coarse-grained (sand to cobble-sized) sediment in their channels. River sediment is often moderately- to well-sorted.	Sandstone, siltstone, some conglomerate
	Floodplains	Floodplains are relatively low-energy environments where finer (clay, silt, fine sand) sediments are deposited in well-defined layers. These plains are only periodically wet and when they dry out mudcracks often develop.	Siltstone, shale
	Swamps, Marshes, or Bogs	Swamps are typically rich in organic material that is buried and compressed to form coal	Coal
	Evaporite Basins	Shallow basins in arid regions and lagoons may become supersaturated and precipitate evaporite minerals.	Rock gypsum, Rock salt, crystalline limestone
	Desert (Eolian)	Eolian environments are arid and typically have winds that transport and sort medium- and fine-grained sediment (sand to silt). Eolian sediments are often well-sorted and show well-developed cross-bedding.	Sandstone, siltstone
Shoreline Environments	Deltas	Deltas form where rivers and streams enter larger bodies of water. They often contain fluvial-type deposits as well as swampy environments.	Sandstone, siltstone, shale
	Beaches	Beaches occur on the margins of large bodies of water. They generally contain deposits of well-sorted, medium-grained sediment with planar bedding.	Sandstone
Marine Environments	Shallow marine or continental shelf	Shallow marine environments are formed on the margins of continents, on the continental shelf. Associated deposits are typically medium- to fine-grained and well sorted. In warm (sub-tropical to tropical) environments these sediments may be calcite-rich.	Sandstone, siltstone, shale, diatomite, oolitic limestone, chalk (Depends on supply of clastic and chemical sediments)
	Deep marine	Deep marine areas receive relatively little clastic sediment. Common deep marine sediments are either very fine-grained or microcrystalline (from recrystallization of microscopic silica-producing organisms).	Chert, shale
	Reefs	Organic structures composed of calcium carbonate-secreting organisms (i.e. coral) built up on continental shelves or oceanic volcanic islands	Limestone (fossiliferous)

Figure 7.2 Depositional Environments



Continental Environments	1 Lake	2 Alluvial	3 Desert	4 Glacial
Transport agent	Lake currents, waves	River currents	Wind	Ice, meltwater
Sediments	Sand and mud, saline precipitates in arid climates	Sand, mud, and gravel	Sand and dust	Sand, mud, and gravel
Climate	Arid to humid	Arid to humid	Arid	Cold
Organic processes	Freshwater organisms and precipitates	Organic matter in muddy flood deposits	Little organic activity	Little organic activity

Shoreline Environments	5 Delta	6 Beach	7 Tidal flats
Transport agent	River currents, waves	Waves, tidal currents	Tidal currents
Sediments	Sand and mud	Sand and gravel	Sand and mud
Climate	Arid to humid	Arid to humid	Arid to humid
Organic processes	Burial of plant debris	Little organic activity	Organisms mix sediments

Marine Environments	8 Deep sea	9 Continental shelf	10 Organic reefs	11 Continental margin
Transport agent	Ocean currents Turbidity currents	Waves and tides	Waves and tides	Ocean currents and waves
Sediments	Mud and sand	Sand and mud	Calcified organisms	Mud and sand
Organic processes	Deposition of remains of organisms	Deposition of remains of organisms	Secretion of carbonates by corals and other organisms	Deposition of remains of organsims

Station 1

1. Describe samples 1a, 1b, and 1c.

	Structure	**Grain size**	**Sorting**	**Flow direction (e. g. R to L)**	**Depositional Environment**
1a					
1b					
1c					

2. Examine samples 1d and 1e.

    a. What is the flow direction in 1d? (R to L, L to R, or indeterminate?)

    b. Which side is the top of sample 1d (A or B)?

3. What sedimentary structure is common to all of these samples?

Station 2

4. What sedimentary structure is present in samples 2a, 2b, and 2c?

5. Which side is the top (A or B)?

   2a_____

   2b_____

6. Specimens 2a and 2d contain another sedimentary structure (easier to identify in 2d). What is this sedimentary structure and how did it form?

7. Describe the two different sediments in 2d.

	Grain size	**Sorting**	**Structures**	**Depositional environment**
A				
B				

Station 3

8. Describe samples 3a, 3b, and 3c.

	Grain size	**Sorting**	**Structures**
3a			
3b			
3c			

9. Samples 3a and 3b formed in a different type of environment than 3c. Was the environment for 3a and 3b much higher energy, much lower energy, or did the two environments have a similar energy? What indicates this?

Station 4

10. Describe samples 4a and 4b.

	Grain size	**Sorting**	**Structure**	**Depositional Environment**
4a				
4b				

11. Does sample 4a have a structure that you would expect to be commonly preserved? Why or why not?

Station 5

12. Examine samples 5a and 5b.

    a. What sedimentary structure is shared by these rocks?

    b. How did it form?

13. Identify samples 5c and 5d.

    5c_____

    5d_____

    a. What type of environment do samples 5c and 5d represent?

14. What depositional process is represented in different stages by these four rocks at this station?