




# Sedimentary Rocks: Our Clues to the Past

-Sean Tvelia-

## Clastic Sedimentary Rocks

**Clastic sedimentary rocks** are those rocks formed from the lithification of sediment derived from the weathering and erosion of other rocks and material. Since the movement and final deposition of this sediment is dependant on the environmental and climatic aspects of a geographic region, understanding how these factors influence the composition of sediment and therefore the resulting rock gives us great insight into the climate and environmental condition of the past.

When studying sedimentary rocks, the one of the most obvious aspects will be the particle or **clast** size. Determining whether a sedimentary rock is composed of sand-sized, silt or clay, or gravel is the first step in identifying clastic sedimentary rocks. The following table defines these terms based on average particle diameter.

Sediment Type	Gravel	Sand	Silt	Clay
	≥ 2mm	0.0625mm to 2mm	0.0039mm to 0.0625mm	<0.0039mm
Grain Size				

For general purposes of identification, it is not usually necessary to measure individual sediment grains since the texture of the rock and visual observation will help identify the grain size.

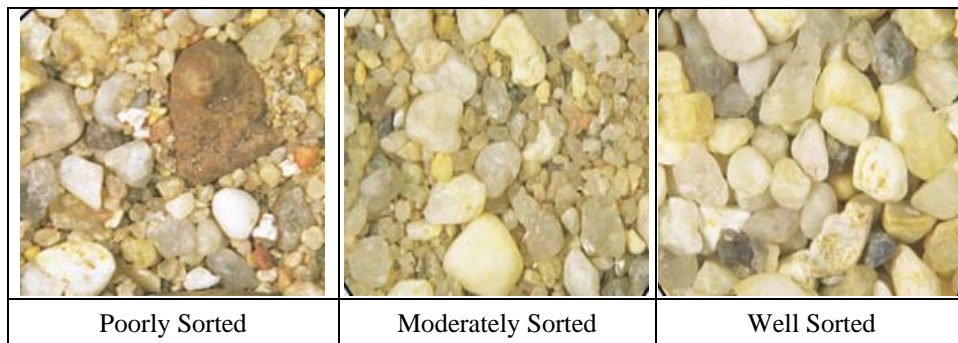
Another sediment property that can be detected by the texture of the rock is the grain shape. Grain shape stores a tremendous amount of information about the geologic history of the sediment. Whether particles in the sediment are rounded or angular is determined by the amount of abrasion the particles have undergone. Abrasion occurs as sediment is moved throughout the environment and it bounces or rubs against other material. This abrasion slightly wears down the edges of the sediment. Therefore, the further a material travels from its point of origin, the more abrasion occurs and thus the more rounded the material should be.

Transport of sediment is determined by both the particle size and the process by which it is being transported. The most common forms of transport are wind and water; the velocity of either force will determine the greatest particle size able to be transported. In other words, the faster the water, the bigger the particle that can be transported.

When studying deposition by rivers and streams it is important to note that the velocity of the water is directly related to the slope or **gradient** of the river or stream channel. In mountainous

areas, where streams are relatively steep, water travels much faster and is therefore capable of carrying much larger particles. However, as the slope decreases the velocity of the water also decreases and the size of material able to be carried by the water decreases. This natural separation of sediment based on size or density is known as **sorting**. Sediment that is well sorted will be composed of material that is all similar in size (or density). Poorly sorted sediment, however, will be composed of sediment of all different sizes.

Well sorted sediments are typically deposited by moving water; therefore, the particles have been transported for relatively long distances and rounded by abrasion. On the other hand, poorly sorted sediment has been transported relatively short distances and is therefore angular.



Identifying the mineral components of a sediment can also give clues about the history of a sediment. If transport causes particles to be abraded and worn down, the net effect of transport would be the reduction of particle size. Since some minerals are softer than others, it should be expected that some mineral particles will be abraded more easily than others. If this is the case, then the particle size of softer minerals should be reduced much more rapidly than particles of harder minerals. Over time these softer minerals will be carried away from the harder minerals through erosional processes. Sedimentary rocks that contain mostly hard minerals (quartz) are then considered **mature**. Rocks that are made of sediments composed of more softer minerals (feldspars and micas) are considered **immature**.

### Formation of Sedimentary Rocks

Sedimentary rocks can be formed by **compaction** or **cementation**. Compaction occurs when pressure, caused by the weight of overlying sediment, causes sediment grains to become more closely packed and reduces pore spaces between the sediment. Finer material that may have resulted from pulverizing original sediments then fills these pore spaces and binds the rock. This finer material is called the **matrix**.

Cementation occurs when minerals that have been dissolved in water begin precipitating within the pore spaces of sediments. Common cements include: quartz ( $\text{SiO}_2$ ), calcium carbonate ( $\text{CaCO}_3$ ), and hematite ( $\text{Fe}_2\text{O}_3$ ). The acid test can be used to determine whether or not a rock has been cemented by calcium carbonate. Hematite cement will typically result in a rust-colored sedimentary rock.

## Chemical Sedimentary Rocks

Another type of sedimentary rock is the **chemical sedimentary rock**. This type of rock is formed when minerals, dissolved in water, begin to precipitate out of solution and deposit at the base of the water body. This can occur in hot springs, such as those in Yellowstone, where changes in water chemistry initiate precipitation of calcium carbonate in the form of travertine, or in areas where sea water evaporates, depositing rock salt or gypsum.

Due to the manner in which they are formed, these types of rocks exhibit a crystalline texture. This texture can also occur in rocks that have undergone some form of recrystallization during the lithification process. This most often occurs in rocks produced by the accumulation of siliceous or calcareous tests (or shells) of microorganisms. During the burial process, water may react within the small pores and recrystallize into fine-grained texture. Because most chemical sedimentary rocks are formed in marine environments, it is not unlikely to find fossils within chemically precipitated rocks.

In shallow marine environments a specific type of precipitation, called **oid**, can occur. In these environments material is often under constant motion due to tidal or wave action. As these materials roll back and on the sea floor, precipitates will crystallize on only the exposed surface. Eventually, thin spherical layers of precipitate will develop on original particle (or nucleus). Sedimentary rocks composed of ooids described by the precipitated mineral, for example, oolitic limestone oolitic hematite.



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## Questions

1. How can the presence or absence of certain minerals in a sedimentary rock be used to determine the environment in which the sediment was deposited?
2. Based on size, shapes, and components, describe the sediment that would be deposited by water from the head of a mountain stream to the flat lowlands of the mouth.
3. How and why would the sediment deposited by a Glacier differ from that in question #2?
4. How would you expect sand derived directly from the weathering of igneous rocks in a mountainous region differ in composition from sand derived from the weathering of sedimentary rocks?

## Identification of Selected Sedimentary Rocks

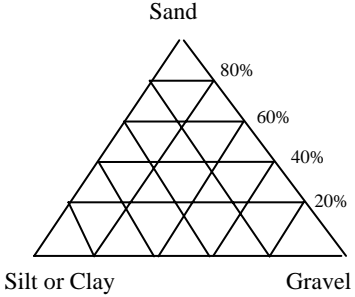
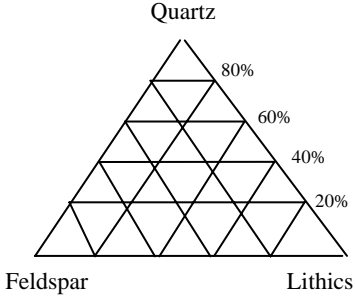
Using the diagram on the last page of this assignment, along with previous knowledge and the information contained in this lab, fill in the following table and identify the rocks supplied by your instructor.

### Clastic Data Sheet

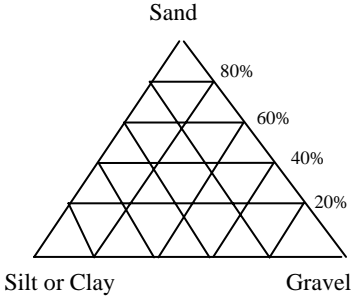
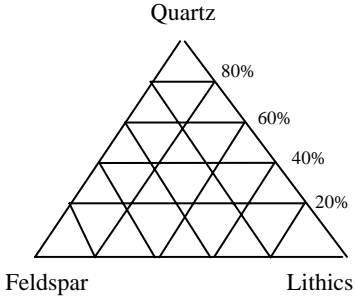
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		<b>Grain Sorting</b>	
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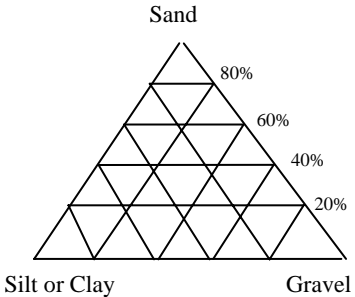
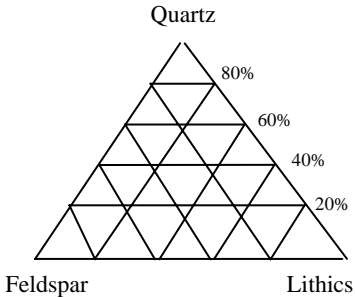
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## Chemical Data Sheet

<b>Sample #</b>	
<b>Color</b>	<b>Composition:</b> Describe the look and relative percentage of each that apply <input type="checkbox"/> Shell material <input type="checkbox"/> Oolites <input type="checkbox"/> Plant material <input type="checkbox"/> Crystalline CaCO <sub>3</sub>
<b>Acid Reaction</b>	
<b>Other</b>	
<b>Name</b>	

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Describe the composition		Describe the Texture and other distinctive properties			Rock Name	
Detrital (Clastic)	Mainly fragments from other rocks or mineral grains	Mostly gravel-mixed pebbles and smaller	Rounded grains	Mostly Feldspar & Quartz	<b>Arkose Conglomerate</b>	
				Mostly Lithics	<b>Lithic Conglomerate</b>	
				Mostly Quartz in Silt/Clay Matrix	<b>Wacke Quartz Conglomerate</b>	
			Angular Grains	Mostly Feldspar & Quartz	<b>Arkose Breccia</b>	
				Mostly Lithics	<b>Lithic Breccia</b>	
			Mostly sand-sized particles	Mostly quartz		<b>Quartz Sandstone</b>
		Quartz and Feldspar		<b>Arkose</b>		
		Sand mixed with silt and clay		<b>Greywacke</b>		
		Fine grain	Silt	Breaks into blocks		<b>Siltstone</b>
			Clay	Splits easily		<b>Shale</b>
Biochemical	Plant fragments or dark charcoal	Visible plant fragments		Breaks easily	<b>Lignite</b>	
		Black		Brittle and sooty	<b>Bituminous coal</b>	
	Effervesces in dilute HCl Visible fossils or shell fragments	Porous, poorly cemented mass of fragmented shells			<b>Coquina</b>	
		Mostly fine grained, earthy, chalky			<b>Chalk</b>	
		Mostly very fine grained mass of calcite and microfossils			<b>Micrite</b>	
Visible shells and or shell fragments cemented into dense mass			<b>Calcidurite</b>	Limestone		
Mainly crystals of calcite or aragonite	Crystalline bands of calcite crystals				<b>Travertine</b>	
	Spherical grains with concentric laminations				<b>Oolitic Limestone</b>	
Chemical	Mainly varieties of quartz (chalcedony, flint, chert, jasper)	Microcrystalline	Scratches glass		<b>Chert</b>	
		Mainly Calcium Sulfate	Can be scratched with fingernail		<b>Rock Gypsum</b>	