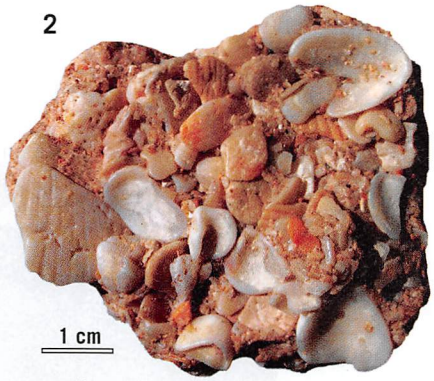
Name: _____ Course/Section: _____ Date: _____

A Analyze the sedimentary rocks in Fig. A6.1.1, or actual rock samples of them if available. Below each photograph, describe briefly the rock's **composition** (what it is made of) and **texture** (the size, shape, and arrangement of its parts). Use your current knowledge, and complete the worksheet with your current level of ability.

1

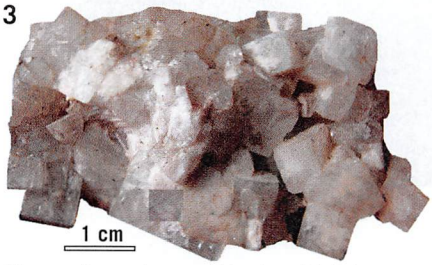
Observation: does not fizz in acid

2



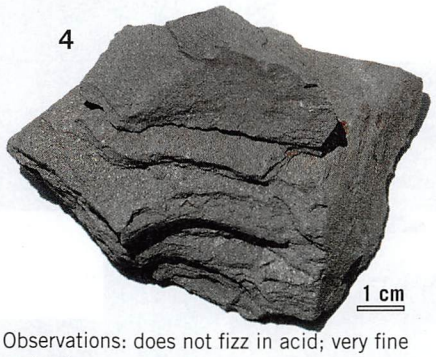
Observations: fizzes in acid; mostly shells

3



Observations: does not fizz in acid; intergrown crystals; salty

4

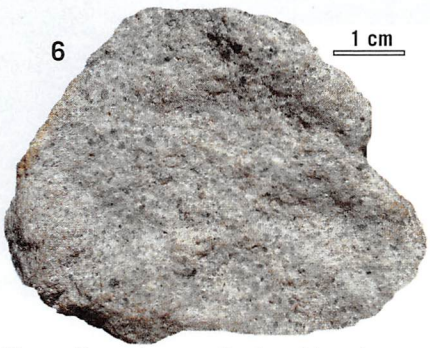


Observations: does not fizz in acid; very fine grained

5

Observation: fizzes in acid

6



Observations: does not fizz in acid; grains average ~0.5 mm diameter

Figure A6.1.1

B **REFLECT & DISCUSS** Reflect on your observations and descriptions of sedimentary rocks in part **A**. Then describe how you would classify the rocks into groups. Be prepared to discuss your classification with your classmates and teacher.

Activity 6.2 Sediment from Source to Sink

Name: _____ **Course/Section:** _____ **Date:** _____

A Look at **Fig. A6.2.1**. A rockfall from one of the steep granitic walls of Yosemite Valley (**A**) caused boulders as large as 2 meters in diameter to crash down into the forested slope below (**B**). Eventually, these sediments might end up in the steep channel of a local stream (**C**) on their way to the Merced River (**D**), which flows through the main part of Yosemite Valley.

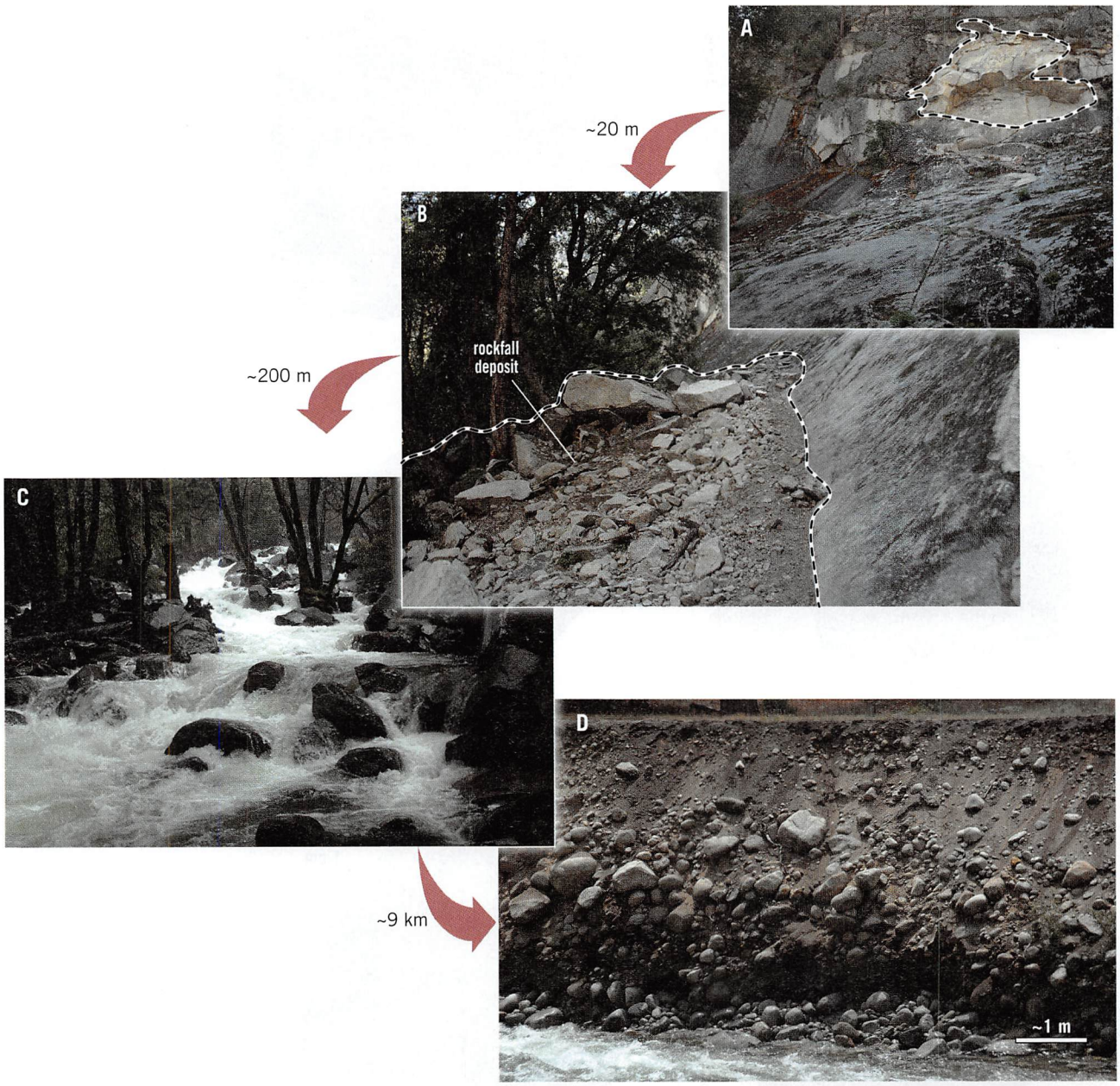


Figure A6.2.1

1. **Rockfall deposit close to the source area** (Photo B).

   (a) List all of the grain sizes that you see or that are likely to be present in the rockfall deposit shown in photo **B** (also refer to **Fig. 6.2**). The largest sediment grain in **B** is approximately 2 meters long. Use the grain-size class names listed in **Fig. 6.15**.

(b) How would you describe the *sorting* of sedimentary grains in the rockfall deposit? Use the terms in **Fig. 6.16A**.

(c) How would you describe the *shape* of sedimentary grains you can see in the rockfall deposit? Use the terms in **Fig. 6.16B**.

(d) If the sediments in the rockfall deposit were lithified together as they currently rest without any further movement downslope, what kind of sedimentary rock would they form?

2. **Tributary stream just downslope from rockfall deposit** (Photo C).

(a) The large sedimentary grains that can be seen in the stream channel are generally less than ~1.5 meters in diameter. Judging from the turbulence of the mountain stream, what grain sizes do you expect to be carried (suspended) in the water?

(b) What grain sizes do you expect to be rolling, sliding, or resting on the bottom of the channel, including those that you can see?

(c) How would you describe the *shape* of the sedimentary grains you can see in or near this stream channel (**Fig. 6.16B**)?

3. **River deposits exposed in the eroded bank of the Merced River** (Photo D).

(a) List all of the grain sizes that you see or that are likely to be present in the Merced River bank shown in photo **D**.

(b) How would you describe the *sorting* of sedimentary grains in the stream bank?

(c) How would you describe the *shape* of sedimentary grains you can see in the stream bank?

(d) If the sediments in the stream bank were lithified, what kind of sedimentary rock would they form?

(e) How would you describe the change or evolution of sediments between the tributary streams and the main Merced River?

4. **Use your observations to make predictions.** The Merced River flows from Yosemite Valley at an elevation of ~1,200 meters above sea level in central Yosemite Valley to an elevation of ~250 m where the river enters Lake McClure: a reservoir in the San Joaquin Valley west of Yosemite Valley. The actual distance the river travels along its channel from Yosemite to the upper end of Lake McClure is more than 65 km. You can examine the Merced River course between latitude 37.72°N, longitude 119.63°W (central Yosemite Valley) and 37.602°N, 120.100°W (inlet to Lake McClure on the Merced River) using Google Earth.

   (a) What sedimentary grain sizes are likely to be deposited in Lake McClure from the erosion of Yosemite Valley?

   (b) What do you think will be the composition of most of the sedimentary grains deposited in Lake McClure from Yosemite Valley?

B REFLECT & DISCUSS Based on your work, write a brief description of how the clastic sediment from Yosemite Valley might change as it travels downstream to Lake McClure. Then describe how you could use these insights to interpret clastic rocks in general.

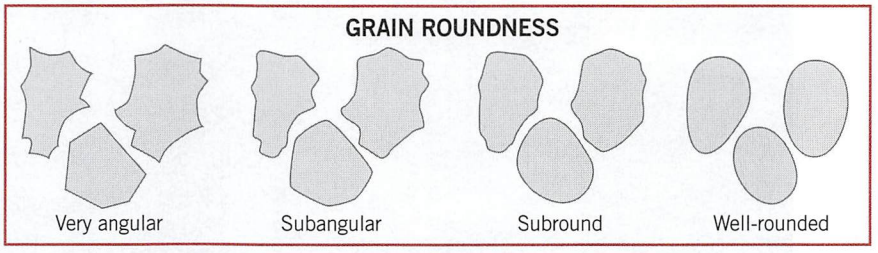
Name: _____ Course/Section: _____ Date: _____

A Obtain two pieces of granite or diorite. Hold one in each hand and tap them together over a piece of paper. As you do this, you should notice that you are breaking tiny sedimentary grains from the larger rock samples. These broken pieces of rocks and minerals are called **clasts** (from the Greek *klastós*, meaning "broken in pieces").

1. Using a hand lens or microscope, observe the tiny clasts that you just broke from the larger rock samples. Describe what minerals make up the clasts and whether or not the clasts are fragments of mineral crystals, rock fragments, or a mixture of both.

2. Geologists commonly refer to several different kinds of clastic sediment. Circle the one that you just made.
   - **pyroclastic sediment** or **tephra**—volcanic bombs, lapilli, and ash blasted into the atmosphere by volcanic eruption
   - **bioclastic sediment**—broken pieces of shells, plants, and/or other parts of organisms
   - **siliciclastic sediment**—broken pieces of silicate mineral crystals and/or rocks containing them

3. **Roundness** is a general description of how completely the rough edges and points of a clast have been smoothed by banging into other particles during transport (see chart in Fig. A6.3.1). Re-examine your clasts from part **A1** and sketch the outline of several of them. Compared to the chart, what is the roundness of the clasts that you sketched?

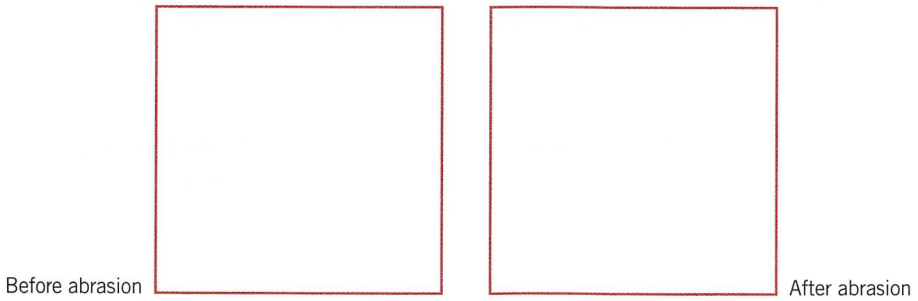


A6.3.1

4. Using **Fig. 6.15** or a grain-size scale (from GeoTools 1 or 2 at the back of your manual), circle the Wentworth size classes of the clastic sediment that you made above.

   clay silt sand gravel

5. Obtain a piece of quartz or garnet sandpaper and lay it flat on the table. Find a sharp corner on one of the granite/diorite samples that you used above and sketch its outline in the "before abrasion" box in Fig. A6.3.2. Next, rub that corner against the quartz sandpaper for about 10 seconds. Sketch its profile in the "after abrasion" box. What did this abrasion process do to the sharp corner?



A6.3.2

6. The sediment that you just made by wearing down the corner of a rock clast is called **clastic sediment**. The Mississippi River carries clastic sediment that has been weathered and eroded from the landscape of much of the central United States. The river discharges its load of water and sediment through the Mississippi Delta into the Gulf of Mexico. As shown in the satellite images in Fig. A6.3.3, the Mississippi River passes by Lake Pontchartrain (LP) and the city of New Orleans (NO) on its way to the great "bird's foot" delta that extends into the gulf of Mexico. The detailed view of the bird's foot delta is a true-color image acquired using NASA's Landsat 7 satellite and shows the broad main channel of the Mississippi River discharging water and sediment to more than half a dozen smaller channels that extend in many different directions. The center of the larger image is around latitude 29.16°N, longitude 89.16W.

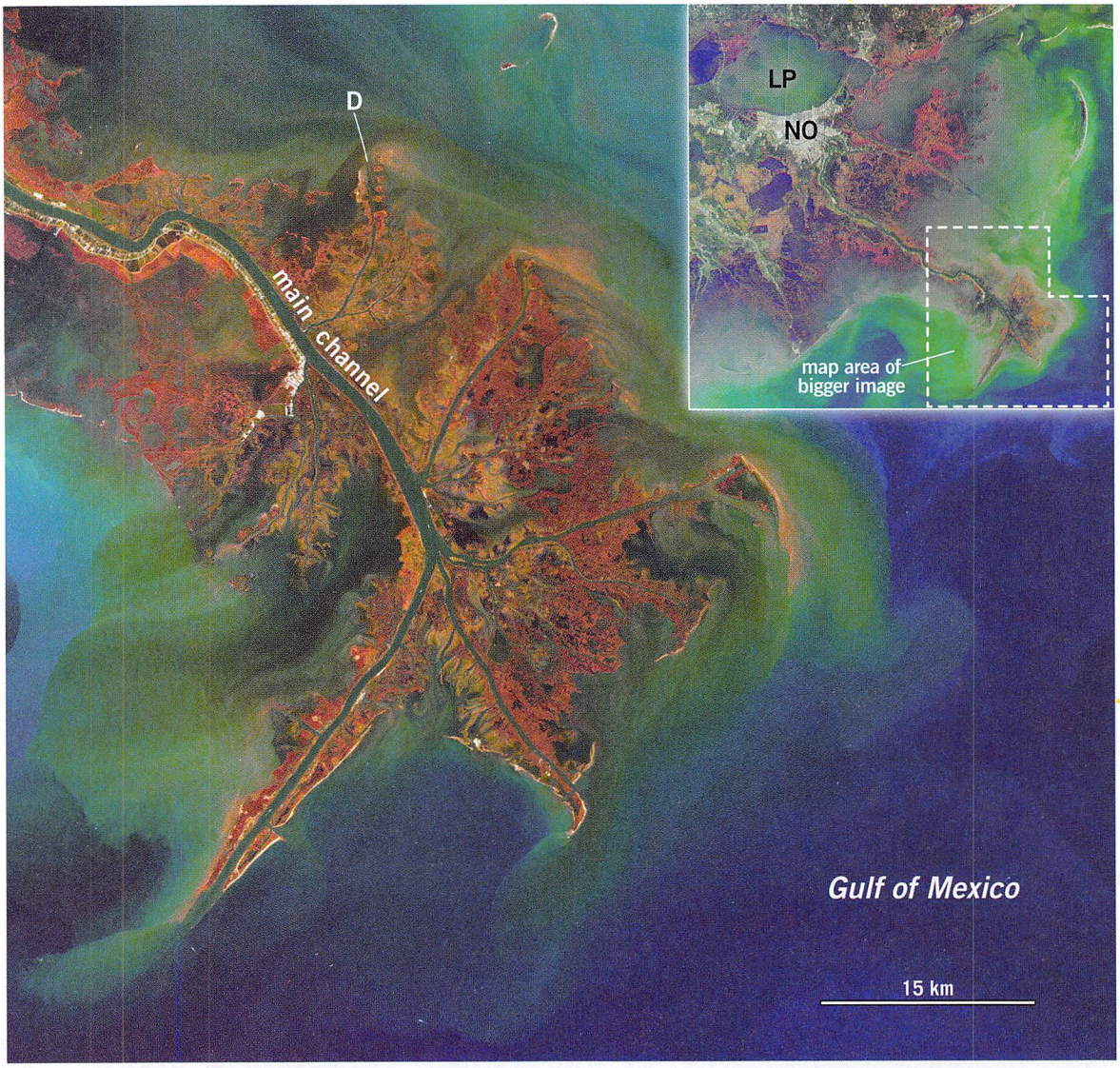


Figure A6.3.3

On the image in **Fig. A6.3.3**, write "D" to indicate all of the places where one of these smaller channels is discharging water and sediment out into the Gulf of Mexico. One example is done for you, marked with a white D near the top of the image.

B REFLECT & DISCUSS How do you think the roundness of sediment in the river in **Fig. A6.3.3** changes from near the source areas throughout the continent to the locations where you placed the "D"s on the image?

Bioclastic Sediment and Coal

Activity 6.4

Name: _____ Course/Section: _____ Date: _____

A Seashells are formed through the biochemical processes of organisms, and eventually become sedimentary grains. When you find a rock with a fossil of a marine organism, you have found evidence that the rock contains sediment deposited in a marine environment. Some limestone is entirely made of shells or broken pieces of shells.

1. Obtain a seashell (e.g., a hard clam shell) and draw it below this paragraph. It may be easiest to trace it and then fill in the outline with details of what the shell looks like inside or out.

2. Next, place the shell into a plastic sandwich bag. Lightly tap the bag with a hammer to break the shell into pieces, taking care not to damage the surface that the bagged shell is on. Examine the broken pieces of shell with a hand lens. The shell fragments that you just made are called **clasts** (from the Greek *klastós*, meaning "broken"). Geologists commonly refer to several different kinds of clastic sediment. Circle the one that you just made.

   - **pyroclastic sediment** or **tephra**—volcanic bombs, lapilli, and ash blasted into the atmosphere by volcanic eruption
   - **bioclastic sediment**—broken pieces of shells, plants, and/or other parts of organisms
   - **siliciclastic sediment**—broken pieces of silicate mineral crystals and/or rocks containing them

3. Compared to **Fig. 6.16B**, what is the roundness of your clasts? _____

4. What is the roundness of the clasts in Fig. A6.4.1? _____

   Explain how and in what environment the shell clasts could have attained their roundness.

Figure A6.4.1

5. Some limestone is made of shells that are calcareous (calcite or aragonite), but they are microscopic. Chalk is such a limestone. Some "chalk" used to mark sidewalks or blackboards is actually made of clay or plaster of paris rather than real chalk. Obtain a piece of chalk from your lab room or instructor. Explain how dilute hydrochloric acid can be used to help you test your chalk and find out if it is real chalk or not. Then conduct your test and report its results.

B Place a charcoal briquette into a plastic sandwich bag. Lightly hammer the bag enough to break apart the briquette, taking care not to damage the surface that the bagged briquette is on.

1. Examine the broken pieces of charcoal with a hand lens. Describe what kinds of grains you see and their texture.

2. Charcoal is made by allowing wood to smolder just enough that an impure mass of carbon remains. In the presence of oxygen, the charcoal briquette will naturally combine with oxygen to make carbon dioxide. Over a period of many years, it will all react with oxygen and chemically weather to carbon dioxide. When you burn charcoal in your grill, you are simply speeding up the process. However, if plant fragments (peat) are buried beneath layers of sediment that keep oxygen away from them, then they can slowly convert to a charcoal-like material called coal, which is stable for millions of years. Obtain a piece of coal and compare it to your charcoal. How is it different? Why?

C **REFLECT & DISCUSS** Shells and the skeletons of microscopic organisms like plankton are made of precipitated mineral material that they secrete. Coal is made of altered plant material: leaves, grasses, wood, and so on. Lignite alters to sub-bituminous, bituminous, or anthracite coal due to increasing pressure and temperature. Do you think coal is a rock? If you do, which of the three main types of rock would you classify it as?

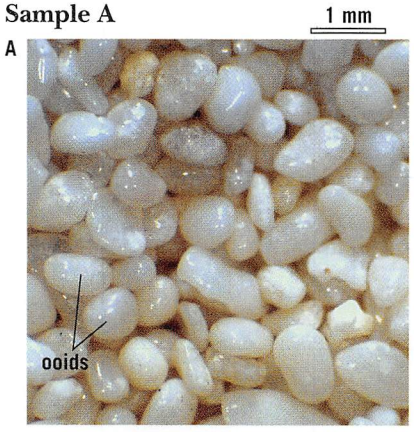
Sediment Analysis, Classification, and Interpretation

Activity 6.5

Name: _____ **Course/Section:** _____ **Date:** _____

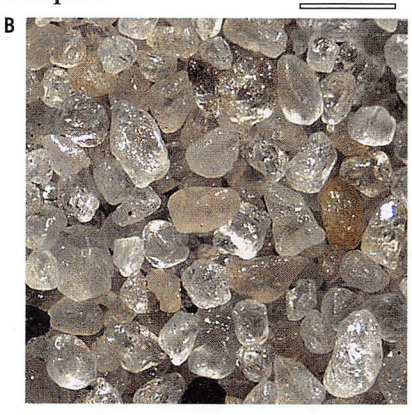
A Complete parts **1** through **6** for each sample in Fig. A6.5.1. Refer to **Figs. 6.15**, **6.16**, and **6.27** as needed.

Sample A



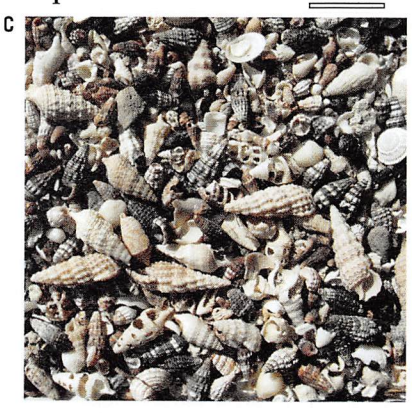
1. Grain size range in mm: _____
2. Percent of each Wentworth size class:
   clay _____ silt _____ sand _____ gravel _____
3. Grain sorting (circle):
   poor moderate well
4. Grain roundness (circle):
   angular subround well rounded
5. Sediment composition (circle):
   precipitated siliciclastic bioclastic pyroclastic
6. Describe how and in what environment this sediment might have formed.

Sample B



1. Grain size range in mm: _____
2. Percent of each Wentworth size class:
   clay _____ silt _____ sand _____ gravel _____
3. Grain sorting (circle):
   poor moderate well
4. Grain roundness (circle):
   angular subround well rounded
5. Sediment composition (circle):
   precipitated siliciclastic bioclastic pyroclastic
6. Describe how and in what environment this sediment might have formed.

Sample C



1. Grain size range in mm: _____
2. Percent of each Wentworth size class:
   clay _____ silt _____ sand _____ gravel _____
3. Grain sorting (circle):
   poor moderate well
4. Grain roundness (circle):
   angular subround well rounded
5. Sediment composition (circle):
   precipitated siliciclastic bioclastic pyroclastic
6. Describe how and in what environment this sediment might have formed.

Figure A6.5.1

B **REFLECT & DISCUSS** Imagine that these sediments are rocks. Which of the samples do you think would be the least diagnostic of a specific ancient environment? Why?

Activity 6.6 Hand Sample Analysis and Interpretation

Name: _____ Course/Section: _____ Date: _____

SEDIMENTARY ROCKS WORKSHEET

Sample number or letter	Does matrix fizz in acid?	Is matrix made of microscopic grains?	Is matrix a mass of intergrown crystals, or is it clastic?	What is the grain size class of most particles (See Fig. 6.15)	What are the grains composed of? (e.g., calcite, quartz, clay, feldspar, rock fragments, fossils, ooids, evaporites, pyroclasts)	Assign a provisional rock name.	Where might this sediment have been deposited/precipitated? (See Fig. 6.27)
6.4	yes	no	clastic (bioclastic)	sand: many of the fossils are small-gravel sized	matrix (sand) is probably bioclastic calcite, abundant marine fossils made of carbonate	fossiliferous limestone	it might have been deposited on the seafloor

Figure A6.6.1

Name: _____ Course/Section: _____ Date: _____

SEDIMENTARY ROCKS WORKSHEET

Sample number or letter	Does matrix fizz in acid?	Is matrix made of microscopic grains?	Is matrix a mass of intergrown crystals, or is it clastic?	What is the grain size class of most particles (See Fig. 6.15)	What are the grains composed of? (e.g., calcite, quartz, clay, feldspar, rock fragments, fossils, ooids, evaporites, pyroclasts)	Assign a provisional rock name.	Where might this sediment have been deposited/precipitated? (See Fig. 6.27)

Figure A6.6.1 *(continued)*

Name: _____ Course/Section: _____ Date: _____

SEDIMENTARY ROCKS WORKSHEET

Sample number or letter	Does matrix fizz in acid?	Is matrix made of microscopic grains?	Is matrix a mass of intergrown crystals, or is it clastic?	What is the grain size class of most particles (See Fig. 6.15)	What are the grains composed of? (e.g., calcite, quartz, clay, feldspar, rock fragments, fossils, ooids, evaporites, pyroclasts)	Assign a provisional rock name.	Where might this sediment have been deposited/precipitated? (See Fig. 6.27)

Figure A6.6.1 *(continued)*

Name: _____ Course/Section: _____ Date: _____

SEDIMENTARY ROCKS WORKSHEET

Sample number or letter	Does matrix fizz in acid?	Is matrix made of microscopic grains?	Is matrix a mass of intergrown crystals, or is it clastic?	What is the grain size class of most particles (See Fig. 6.15)	What are the grains composed of? (e.g., calcite, quartz, clay, feldspar, rock fragments, fossils, ooids, evaporites, pyroclasts)	Assign a provisional rock name.	Where might this sediment have been deposited/precipitated? (See Fig. 6.27)

Figure A6.6.1 *(continued)*

Activity 6.7 Grand Canyon Outcrop Analysis and Interpretation

Name: _____ Course/Section: _____ Date: _____

A Analyze the images in **Fig. A6.7.1**, from the South Rim of the Grand Canyon near Grand Canyon Village. The edge of the canyon here is formed by a fossiliferous limestone composed of sand-sized clastic grains, called the Kaibab Limestone, deposited about 270 million years ago during the Permian Period.

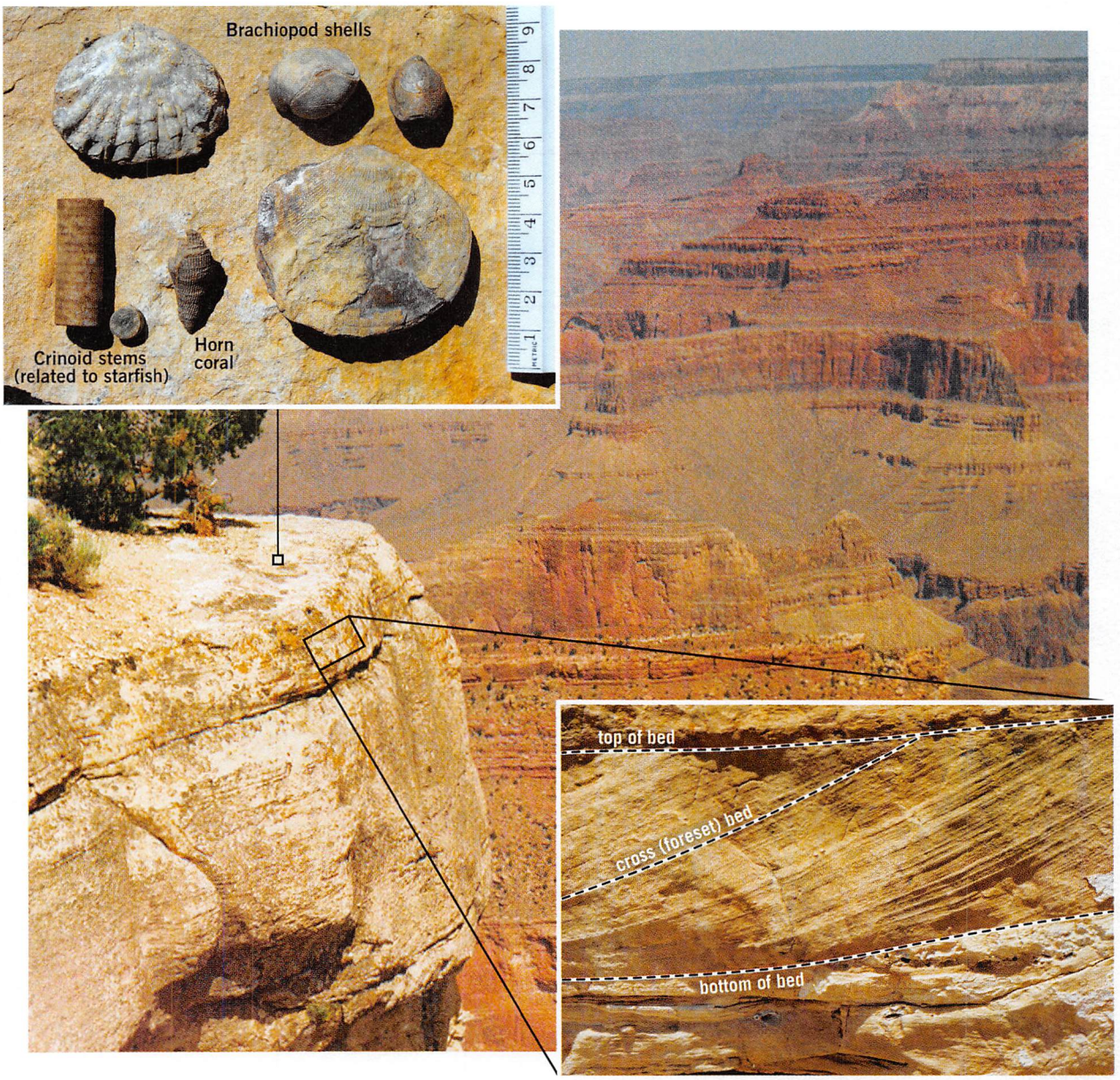


Figure A6.7.1

1. Notice that some of the beds in the outcrop are cross-bedded. Draw an arrow on the picture to show the direction that the water moved here to make this cross bedding. Refer to **Fig. 6.25** as needed.

2. Does this cross bedding indicate a steady flow of air or water, or does it indicate an oscillating (back and forth) flow? (**Fig. 6.25**) _____

B **REFLECT & DISCUSS** Describe your ideas about what the environment might have been like here about 270 million years ago (e.g., **Figs. 6.26** and **6.27**) and the evidence and logic that you used to reach your conclusion.

Using the Present to Imagine the Past—Dogs and Dinosaurs

Activity 6.8

Name: _____ Course/Section: _____ Date: _____

A Analyze photographs X and Y in Fig. A6.8.1.

X. Modern dog tracks in mud with mudcracks on a tidal flat, St Catherines Island, Georgia

Y. Triassic rock (about 215 m.y. old) from southeast Pennsylvania with the track of a three-toed *Coelophysis* dinosaur

Figure A6.8.1

1. How are the modern environment (Photograph X) and Triassic rock (Photograph Y) the same?

2. How are the modern environment (Photograph X) and Triassic rock (Photograph Y) different?

3. Describe the environment in which *Coelophysis* lived about 215 million years ago in what is now Pennsylvania.

B **REFLECT & DISCUSS** Use what you learned about sediment and sedimentary rocks. Develop a hypothesis about how the dinosaur footprint in Photograph Y was preserved.

Activity 6.9 Using the Present to Imagine the Past—Cape Cod to Kansas

Name: _____ Course/Section: _____ Date: _____

A Analyze photographs X and Y in Fig. A6.9.1 of a Kansas rock and the modern-day seafloor near Cape Cod, respectively.

X. Pennsylvanian-age rock from Kansas (290 Myr old)

Sand-sized fragments of fossil shells comprise the rock

10X close-up of thin section

Y. Modern seafloor environment, 40 m deep, ~16 km north of Cape Cod, Massachusetts.

Photo includes clastic sediment from the continent, bioclastics, and living organisms.

- 1% gravel
- 90% sand
- 9% mud

Figure A6.9.1

1. How are the modern environment (Photograph Y) and Kansas rock (Photograph X) the same?

2. How are the modern environment (Photograph Y) and Kansas rock (Photograph X) different?

3. Today, this part of Kansas is rolling hills and farm fields. Describe the environment in which the sediment in this rock sample (Photograph X) was deposited there about 290 million years ago.

B **REFLECT & DISCUSS** What would have to happen to the sediment in Photograph X to turn it into sedimentary rock?