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Islands in the Stream 2002: Exploring Underwater Oases

Mud is Mud…or is it?

Focus
Comparing and analyzing the difference in deep-sea sediments

Grade Level
9-12 (Earth Science)

Focus Question
Why is the sediment all over the seafloor not exactly the same?

Learning Objectives
Students will learn to compare and contrast similar items.

Students will learn to use the computer as a learning tool.

Students will be able to identify different variables that affect deep-sea habitats and organisms.

Additional Information for Teachers of Deaf Students
In addition to the words listed as Key Words, the following words should be part of the vocabulary list.

Authigenic
Volcanogenic
Cosmogenic
Resuspended
Classify
Composition
Diverted
Fauna
Calcium carbonate sediment
Oolitic sands
Scarp

Although the key words are integral to the unit, they will be very difficult to introduce prior to the activity. They are really the material of the lesson. There are no formal signs in American Sign Language for any of these words and many are difficult to lipread. If some of these topics have not already been covered in your class, you may need to add an additional class period to teach vocabulary and teach some of the Background Information to the students prior to the activity. It might be helpful to copy the Background Information and hand it out to the students to read at the beginning of the activity. Then you may lead the students in a discussion of what they have read. This will be a good introduction to the activity and would allow for review of unfamiliar vocabulary.

Materials
- ❐ Internet access
- ❐ Sediment Comparison Worksheet – one per student

Materials
- ❐ Overhead projector

Teaching Time
45 minutes

Seating Arrangement
Groups of 2 to 3 students

Maximum Number of Students
40

Key Words

Sediment
Lithogenic
Biogenic
Eddie
Continental shelf
Plateau
Upwelling
Gulf Stream
Scarp

Background Information

Sediment can be classified either by grain size or on basis of mode of formation. In the first case, the classification depends on grain size. In the second case one must interpret the origin of the deposit. From smallest to largest, particle sizes are clay, silt, sand, and gravel. As for origin, sediments can be classified as lithogenic (coming from land by erosion of rocks), biogenic (derived from hard parts of organisms, usually calcium carbonate and silica), authigenic (precipitated by chemical or biochemical reactions in the water), volcanogenic (particles ejected from volcanoes), and cosmogenic (grains that originate in outer space) (Pined, 1998).

Composition of sediments depends on several factors. Under high energy conditions, such as strong currents, fine grains stay in suspension and more fine grains, which may have temporarily settled, are resuspended. Coarse grains are able to settle out in these conditions. Low energy sites do not contain as many coarse grains because there is not enough energy to transport them to these areas. The shape of the grains also tells us something. Generally, the more rounded the grains, the older the sediment. This means they have been tumbled and rolled around for a long time. Younger grains may also be rounded if they have been in a high energy area for a period of time.

Proximity to land also helps determine the composition of seafloor sediment. The continental shelf is relatively shallow and close to land and thus receives much more lithogenic sediment from rivers and wind-blown dust. The deep sea receives some of the lithogenic sediment carried by strong currents but the majority of the sediment here is the hard parts of surface-water organisms that settle to the bottom (Pinet, 1998).

The sediment used for this activity came from the Savannah Scarp and the Charleston Bump. The Savannah Scarp consists of a series of rocky ridges and outcrops, where Gulf Stream currents have diverted sediments away from the underlying rock. The shelf-edge reef here occurs at about 55 m (180 ft), and the bottom drops steeply to 70 m (250 ft) or more. Along this edge is a spectacular reef habitat, consisting of large rocks, ridges, ledges, caves, and overhangs that provide habitat for an abundant and diverse fauna. Off the coast of Savannah, Georgia, however, the shelf-edge reef is very well-developed into a series of two or more parallel ridges in depths from 55 m (180 ft) to 90 m (295 ft) (Sedberry, 2001). The site includes a variety of habitats between depths of 46 m (150 ft) to nearly 91 m (300 ft), and rocky ridges that extend more than 6 m (20 ft) above the bottom.

The Savannah Scarp sediment sample was taken about 60 miles offshore at a depth of approximately 61 m (200 ft.) Henry and Barans' (1984) studies of the Savannah Scarp showed that the limestone rock in this area probably originated as loose grains of calcium carbonate sediment (oolitic sands, to be more precise) that were cemented together when the sea level was much lower, approximately 18,000 yrs ago (Sautter, 2001).

The Charleston Bump (Bump) is a deepwater seafloor feature 80 to 100 miles southeast of Charleston, South Carolina. The Bump rises from the relatively flat Blake Plateau that lies beyond the edge of the continental shelf in the South Atlantic Bight. From depths of over 700 m (2300 ft), the bottom ramps up to a shallow scarp at 375 m (1230 ft). From there, the bottom plunges 125 m (410 ft) in a series of steep scarps with rocky cliffs, overhangs and caves. The Charleston Bump also deflects the flow of the

Gulf Stream. As the warm water of the Stream flows northward out of the Florida Straits, it encounters the Bump and is deflected offshore, producing eddies and other current features that are important fish habitats. This mixing and upwelling brings nutrient-rich, deepwater to the surface, enhancing plankton production and producing food for fishes (Sedberry, 2001). The Charleston Bump sediment was taken about 100 mi. offshore at a depth of about 46 m (1600 ft).

Learning Procedure

1. If your class has access to computers, they may access the necessary figures at http://oceanica.cofc.edu/samplematerial/images.htm.
2. They should open the page twice so that they can have Bump sediment on one window and Scarp sediment on the other for easy comparison.
3. Once at the page, they can choose Bump or Scarp sediment by clicking the appropriate button. They can then enlarge the image they want to look at by clicking on it.
4. The Sediment Comparison Worksheet refers to Figures 1-6. These figure numbers are just for this activity and DO NOT match the image numbers on the web page. Below is the key which is also included on the Sediment Comparison Worksheet.
   Figure 1 = Bump Image #4
   Figure 2 = Scarp Image #7
   Figure 3 = Bump Image #1
   Figure 4 = Scarp Image #5
   Figure 5 = Bump Image #15
   Figure 6 = Scarp Image #3
5. They should now be able to complete the worksheet.
6. If you prefer to use an overhead, you will need to make overheads of the figures for each question on the Sediment Comparison Worksheet (included) and use them to take the students through the Worksheet.

   For example: Question 1 refers to Figures 1 and 2. Put them both on one overhead so they are next to each other and easily compared.

The BRIDGE Connection

www.chariho.k12.ri.us/curriculum/MISmart/ocean/sands.htm

The "Me" Connection

(See Extension #2) Have the students describe what organisms can best survive in the soil in their backyard versus the organisms that may live in the other habitat from which they gathered soil.

Connections to Other Subjects

Oceanography, Geology

Evaluation

Have your students complete the Sediment Comparison Worksheet.

Extensions

Go to http://oceanica.cofc.edu/samplematerial/samples.htm and request samples of the sediment from the Charleston Bump and the Savannah Scarp (They are FREE!!). Once you have received your samples, go back to the same web page and have your students go through the activity available on the web page.

Have students gather soil samples from two very different habitats (e.g., a beach and their backyard). After analyzing the samples using the Sediment Comparison Worksheet (you may modify and use many of the same questions included on the original Sediment Comparison Worksheet included in this activity), have the students discuss the variables that may cause the two samples to be different.

By Spring of 2003, sediment samples from the current expedition will be available for FREE distribution from Project Oceanica. When you request your samples at http://oceanica.cofc.edu/samplematerial/samples.htm, you will also receive appropriate answers to the Sediment Comparison Worksheet unique to the requested sediment samples.

Resources

http://oceanexplorer.noaa.gov/explorations/islands01/background

http://oceanexplorer.noaa.gov/explorations/islands01/log

Pinet, Paul R., 1998. *Invitation to Oceanography*, Jones and Bartlett Publishers, Inc. London, England

"A Profile of Savannah Scarp", NOAA Ocean Exploration Website (2001) George R. Sedberry, Senior Marine Scientist, Marine Resources Research Institute, South Carolina Department of Natural Resources

"A Profile of the Charleston Bump", from NOAA Ocean Exploration Website (2001) George R. Sedberry, Senior Marine Scientist, Marine Resources Research Institute, South Carolina Department of Natural Resources

"Getting to the Bottom of a Rocky Rubble Reef", from NOAA Ocean Exploration Website (2001) Dr. Leslie R. Sautter, Dept. of Geology and Environmental Sciences, College of Charleston, Charleston, SC

National Science Education Standards

Content Standard A – Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard D – Earth and Space Science

- The origin and evolution of the Earth system

For More Information

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http://oceanexplorer.noaa.gov

All figures courtesy of Project Oceanica

Sediment Comparison Worksheet
(Teacher Answer Key)

If you are doing this activity on the web refer to the following key for the proper images:

Figure 1 = Bump Image #4
Figure 2 = Scarp Image #7
Figure 3 = Bump Image #1
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1. What are the two main ways to classify sediment?

    By particle size and basis of formation.

2. What is the difference between biogenic and lithogenic sediment?

    Biogenic sediment is composed of the skeletal remains of microscopic organisms and fragments of coral. Lithogenic sediment is derived from the weathering and erosion of rocks on land and is composed of mostly rock fragments.

3. Figure 1 was taken from the Charleston Bump. Figure 2 was taken from the Savannah Scarp. How would you classify each of them in terms of their basis of origin (i.e., what is the primary composition of each?)

    The Bump sediment is primarily biogenic and the scarp sediment is primarily lithogenic

4. Give two reasons why the samples might be so different in composition.

    The Scarp is much closer to land than the Bump (60 mi offshore vs. 100 mi.) and, therefore, receives more eroded rock from rivers and wind-blown debris.

    The Scarp is much shallower than the Bump.

    The Gulf Stream runs past the Bump making it a very high energy area, thus preventing fine particles from settling out.

5. Figure 3 is from the Bump. Figure 4 is from the Scarp. Using the 3-mm scale bar in each figure, determine which of these samples has the larger grain size. What do you think is the main reason for this?.

    The Bump has larger grains due to the high energy environment of the Gulf Stream.

6. Low-energy conditions tend to have what size sediment grains? _____fine_____________.

7. Using Figures 5 (Bump) and 6 (Scarp) as well as all the previous figures, are there any similarities in the two sediments?

    They should be able to find many of the same organisms or "grains" in each of the two samples. Grain shape in both is mixed. There are rounded coral and rock pieces and angular shell fragments in both.

8. What can grain shape tell us about sediment?

    It can tell us about the age (young or old, not specific years) of the sediment

    It can tell us about the energy conditions where the sediment was collected.

9. Again using all of the figures, what are some other differences you notice?

    The color of the two sediments is different. The Scarp sediment is a very dark, almost a greenish color, whereas the Bump sediment is a light to medium brown.

Student Handout

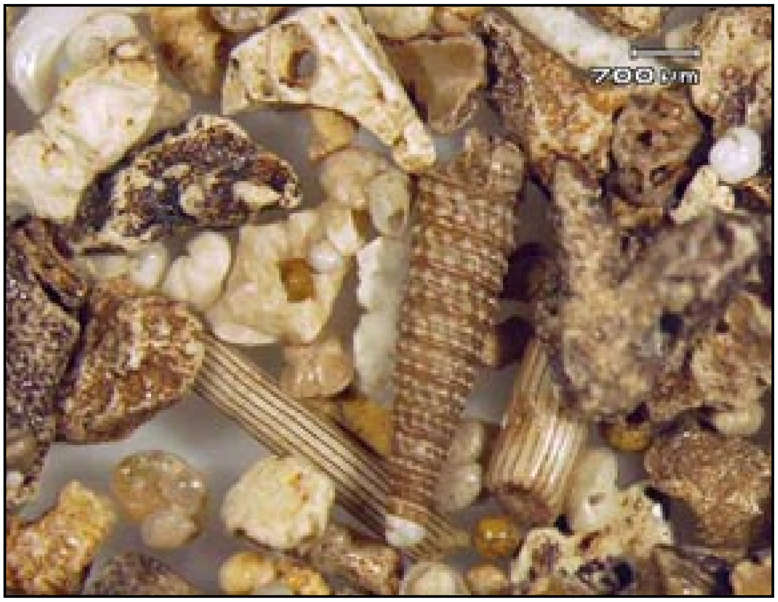

Figure 1

Figure 2

Figure 3

Student Handout

Figure 4

Figure 5

Figure 6

Student Handout

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