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Charleston Bump Expedition

It's OK to be a Clod

Focus
Principles of solubility and measurements of water currents

Grade Level
7-8 (Physical Science/Earth Science)

Focus Question
How can information on the solubility of a substance be used to measure water currents?

Learning Objectives
Students will be able to describe factors that affect the solubility of a chemical substance in seawater.

Students will be able to explain how information on the solubility of a substance can be used to measure water currents.

Materials
- ❒ Aquarium heater (optional)
- ❒ Plaster-of-paris, one pound or more, depending upon the number of factor combinations investigated
- ❒ Plastic ice trays or other molds
- ❒ Small plastic sheets, slightly larger than the size of the molds, approximately 3 mm thick
- ❒ Silicone adhesive
- ❒ Permanent markers
- ❒ Balance accurate to 0.1 gram
- ❒ 19-liter (5 gallon) glass or plastic containers, one or more for each student group
- ❒ Plastic or rubber tubing to construct a siphon, one or more for each student group
- ❒ Plastic trays or basins large enough so that a plaster block will be completely covered when the tray is filled, one or more for each student group
- ❒ Flow-control clamps, one for each siphon
- ❒ System for collecting or disposing of water flowing out of the trays
- ❒ 50 ml graduated cyclinder
- ❒ Sodium chloride (table salt), at least 3 kg (this is adequate to for the basic six-cell experimental matrix described in Learning Procedure

Audio/Visual Materials
- ❒ Chalkboard, marker board, or overhead projector with transparencies for group discussions

Teaching Time
One or two 45-minute class periods, plus time for group research

Seating Arrangement
Groups of 4-6 students

Maximum Number of Students
30

Key Words
Charleston Bump
Solubility
Clod card

Background Information
The Blake Ridge is a large sediment deposit located approximately 400 km east of Charleston, South Carolina on the continental slope and rise of the United States. The crest of the ridge extends in a direction that is roughly perpendicular to the continental rise for more than 500 km to the southwest

from water depths of 2,000 to 4,800 m. About 130 km east of the Georgia-South Carolina coast, a series of rocky scarps, mounds, overhangs, and flat pavements rise from the surface of the Blake Plateau to within 400 m of the sea surface. This hard-bottom feature is known as the Charleston Bump. While the Blake Ridge has been extensively studied over the past 30 years because of the large deposits of methane hydrate found in the area, benthic communities on the continental shelf of the United States are virtually unexplored (visit http://198.99.247.24/scng/hydrate/about-hydrates/about_hydrates.htm for more information about methane hydrates and why they are important). Although this area has been important to commercial fishing for many years, until recently it was generally assumed that benthic communities of the continental shelf were scattered and relatively unproductive,and that useful fisheries were the result of migrations from other areas and/or nutrients carried in from deeper or coastal waters. But once scientists actually began exploring the area more thoroughly, they found many diverse and thriving benthic communities.

The 2001 Islands in the Stream Expedition to the Charleston Bump found a series of very complex habitats, and numerous fishes and invertebrate species involved in communities that we are just beginning to understand. (Visit http://oceanexplorer.noaa.gov/explorations/islands01/log/sab_summary/sab_summary.html, and click on logs from September 27, 28, and 29 for more information). As the Gulf Stream flows around and over the Charleston Bump it is deflected, producing eddies, gyres, and upwellings. These kinds of water circulation patterns are associated with increased concentrations of nutrients and marine organisms in many other areas of the Earth's oceans, and studies have shown that water motion has a major influence on the distributions of numerous organisms in coral communities. Because deep-water corals are one of the most conspicuous organisms in benthic communities on the Charleston Bump, obtaining information on water movement in these communities is a high priority for the 2003 Charleston Bump Expedition.

Traditionally, recording current meters have been used to study water movement in aquatic environments. While these instruments can produce much useful data, their expense makes it difficult to conduct studies when many units are needed. Recently, many investigators have obtained information on water movement using "clod cards" made of plaster-of-paris blocks. Typically, these blocks are weighed, then placed at various stations under investigation. After 24 hours, the blocks are retrieved, dried, and re-weighed. Weight loss due to plaster dissolution provides a relative index of the degree of water movement between stations. This method is inexpensive and yields useful information, but to estimate actual current flow, investigators need information on the factors that affect the solubility of plaster-of-paris.

This activity is designed to introduce students to the use of clod cards for measuring water flow, as well as to acquaint students with some of the physical factors that affect solubility of many other chemical substances.

Learning Procedure

1. Lead an introductory discussion of the Charleston Bump and the 2001 and 2003 Ocean Exploration expeditions to the area. The website for the 2001 Islands in the Stream expedition is: http://oceanexplorer.noaa.gov/explorations/islands01/log/sab_summary/sab_summary.html; click on logs from September 27, 28, and 29. The website for the 2003 Charleston Bump expedition is: http://oceanexplorer.noaa.gov/explorations/explorations.html; click on "Charleston Bump." You may want to show students some images from the Ocean Explorer website and/or http://pubs.usgs.gov/of/of01-154/index.htm.

   Tell students that detailed surveys of the Charleston Bump are just beginning, but we can have a general idea of what to expect based on explorations in other deep-water, hard-bottom habitats. Explain that the

Charleston Bump alters the flow of the Gulf Stream, and scientists expect that water motion has a significant influence on biological communities in the area. Organisms such as corals and sponges can affect water flow as well, so current measurements are needed at many sites within a community to better understand the influence of water motion on living components of the community. Tell students that current meters could be used for these measurements, but they are very expensive.

Describe clod cards as an alternative approach. Be sure students understand that clod cards can provide a relative indication of water motion at different sites within a given benthic community (i.e. which sites have more water motion than others), but accurate comparisons of communities in different locations and/or at different times require more information on the factors that affect solubility of plaster-of-paris. Tell students that their assignment is to investigate some of these factors.

2. Explain that students are to investigate the effects of salinity and water flow on the dissolution rate of plaster-of-paris. The basic experimental matrix has six factor combinations to be investigated:

Salinity (‰)	Water Flow Rate (ml/min) 0	6	12
0			
35			

If you have a way to vary the temperature of water in your experimental system (such as an aquarium heater) you may want to add two or more temperature levels to the this matrix (for example, room temperature and room temperature + 20° C; this would result in a total of 12 factor combinations).

Assign one or more factor combinations to each student group, depending upon the availability of time and materials.

3. Have each student group mix plaster-of-paris with enough water to make a fairly stiff but pourable paste, and fill molds with the solution (plastic ice trays work well). The total number of blocks needed will depend upon how many factors each group investigates. A minimum of two blocks are needed for each combination of factors to be studied (so if a group is planning to investigate the six-cell experimental matrix above, a total of 12 blocks are needed). When the plaster has hardened, remove the blocks from the molds and mount them on small plastic sheets using silicone adhesive. Label each sheet with a unique number or letter, and weigh each block to the nearest tenth of a gram.

4. Have student groups prepare one experimental system for each factor combination to be studied. An experimental system consists of a 19-liter (5 gallon) container filled with plain water or salt (35‰) water, a siphon from the water container to a plastic tray or basin large enough so that a plaster block will be completely covered when the tray is filled, a flow-control clamp on the siphon, and some means for collecting or disposing of water flowing out of the tray (you may want to place several trays in a larger container with a drain leading to a sink). Before beginning an experiment, students should use the control clamp to adjust the flow rate through the siphon so that a graduated cylinder received the appropriate volume of water in one minute. For experimental systems using salt water, students should dissolve 665 grams of sodium chloride (table salt) in 19 liters of tap water. This provides a solution that approximates the total dissolved salt content of normal seawater.

5. Have students begin their experiments by placing a plaster-of-paris block in one of the experimental systems, and allowing water to flow through the system at the appropriate rate for 24 hours. To test zero-flow rates, omit the 19-liter (5 gallon) container from the experimental system; simply fill the tray with the plain water or salt water, and wait 24 hours. At the end of 24 hours, removed the plaster blocks, allow them to air dry, and re-weigh to the nearest tenth of a gram. Calculate dissolution rate in grams per hour by subtracting the final weight from the beginning weight and dividing the result by 24. Repeat this procedure for at least one more plaster-of-paris block so that there are at least two measurements for each factor combination. Average these results.

6. Have students pool their results on one or more matrices similar to the one in step 2. Lead a discussion of the results. How do salinity and water flow affect dissolution rate from the plaster blocks? Faster rates of water flow should result in faster dissolution rates. Dissolution rates should also be faster in plain water than in salt water. If students have not tested the effect of temperature on dissolution rate, you may want to explain that higher temperatures increase the dissolution rates of most substances. Ask students to predict which of these factors might have the greatest influence on water flow studies on the Charleston Bump, and what additional measurements scientists could make to compensate for these factors.

The BRIDGE Connection

www.vims.edu/BRIDGE/ – Enter "Currents" in the Search box for resources on ocean currents. Click on "Ocean Science" in the navigation menu to the left, then "Ecology," then "Deep Sea" for resources on deep sea communities.

The "Me" Connection

Have students write a short essay comparing the advantages and limitations of simple versus complicated techniques for making scientific measurements (sometimes simple is just as good or even better, if the simpler technique allows more measurements to be made; on the other hand, some measurements simply cannot be made without complicated equipment or techniques).

Connections to Other Subjects

English/Language Arts, Life Science, Earth Science

Evaluation

Written reports prepared in Step 5 provide opportunities for assessment. You may also want to have students prepare individual or group analyses of the pooled data in Step 6 prior to discussion with the class as a whole.

Extensions

Log on to http://oceanexplorer.noaa.gov to keep up to date with the latest Charleston Bump Expedition discoveries, and to find out what researchers are learning about deep-water hard-bottom communities.

Resources

http://oceanica.cofc.edu/activities.htm – Project Oceanica website, with a variety of resources on ocean exploration topics

http://pubs.usgs.gov/of/of01-154/index.htm – U.S. Geological Survey Open-File Report 01-154 "Sea-Floor Photography from the Continental Margin Program"

http://oceanexplorer.noaa.gov/explorations/islands01/log/sab_summary/sab_summary.html – Summary report of the 2001 Islands in the Stream Expedition

http://www.animalnetwork.com/fish2/aqfm/1998/aug/features/1/default.asp – Discussion of the clod card technique, and how it can be used to study turbulent flows in aquarium tanks

National Science Education Standards

Content Standard A: Science As Inquiry

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

Content Standard B: Physical Science

- Properties and changes of properties in matter

Content Standard C: Life Science

- Structure and function in living systems

For More Information

Paula Keener-Chavis, National Education Coordinator/Marine Biologist
NOAA Office of Exploration
2234 South Hobson Avenue
Charleston, SC 29405-2413
843.740.1338
843.740.1329 (fax)
paula.keener-chavis@noaa.gov

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