NEW BEDFORD OCEANARIUM

WOW Mobile Curriculum

Charting the Contours of the Coastline and Ocean Floor

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Introduction

Over two-thirds of the surface of the Earth lies beneath the ocean. Throughout history, people have believed that the ocean floor is flat and fairly unremarkable. However, during the 19^{th} century, researchers began to systematically study the ocean. Among the earliest findings was the discovery of the Mid-Ocean Ridge, underwater mountains in the center of the Atlantic Ocean. This discovery led to more explorations that continue to this day. The study of the ocean's depth and "topography" is called bathymetry.

It is conceivable that many students hold the misconception that the ocean floor is flat and featureless and composed of sand. Fishermen, sailors, scientists, and navigators know that this is not the case and further understand that the shape and composition of the ocean floor are related to the commerce, culture, and social systems of various regions. As educators, we can give students this information and hope that they will remember it. However, if they investigate the tools that are used to gather this information, they will begin to understand the complexity of the earth and ocean's "topography" and composition, and appreciate its importance. In this module, students will be introduced to these tools and the science of contour mapping and bathymetry.

Why do we study bathymetry? The ocean, like all aspects of our environment, undergoes constant changes that have the potential to impact our social, cultural, and economic systems. If we are to protect the ocean's resources we need to understand it. Bathymetry meets that need. The development and use of research devices has led to our increasingly sophisticated understanding of the mysteries of the ocean. In this curriculum, we will explore some of these mysteries and will also learn how scientists are developing and using complex technologies that allow them to understand:

- What the ocean floor looks like;
- The depths of the ocean at various locales; and
- How ongoing technological developments support the exploration of the ocean.

This module begins with a concrete experience on land in which students explore a technique for creating a landscape model. Next, they use a simulated experience to investigate the topography of the ocean floor. They then learn how to create a three-dimensional model from a two dimensional contour chart. Finally, they explore new technologies that allow them to read, interpret, and analyze a combination of ground-based observations, satellite data, and computer models to demonstrate Earth systems and their interconnections.

Learning Experiences

The development of the unit and learning experiences in this curriculum unit was guided by the following *Understanding by Design* (UbD) principles:

- **W The** students know **where** they are going and **why**. They also know **what** is expected and required and how they will be evaluated.
- **H Students** are **hooked** or engaged in working with the enduring understandings and essential questions.
- **E Students** have opportunities to **explore** enduring understandings and essential questions and receive instruction they need for the required assessments.
- **R Students** have opportunities to **rethink**, **revise**, and **refine** their work based on feedback.
- **E Students** have opportunities to **evaluate** their own work and set learning goals.
- **T Instruction** is **tailored** to the needs of individual students using**:**
  - Differentiated instruction
  - Content area literacy strategies
  - Cooperative learning
  - Opportunities for oral language
- **O Organized** and sequenced

Sequence of Learning Experiences (LE's)

- LE One: Creating a profile of the beach
- LE Two: Using a bathymetric box to probe unseen contours
- LE Three: Creating a three-dimensional contour map
- LE Four: Using technology to explore the ocean floor

Assessment and Evaluation

Each learning experience has been planned to give students the knowledge and skills necessary to meet the final assessment requirements. The teacher should allow time, throughout the unit, for students to form groups, plan, and research information for the final performances. The teacher should also work with students, throughout the unit, to develop criteria and rubrics for successful completion of the performances. Models and directions for creating rubrics can be found at:

http://school.discovery.com/schrockguide/assess.html#rubrics

Stage 1 – Desired Results

Established Goals – Standards
Massachusetts State Curriculum Frameworks

Recognize, interpret, and be able to create models of the Earth's common physical features in various mapping representations, including contour maps.

Describe and give examples of ways in which the earth's surface is built up and torn down by natural processes, including deposition of sediments, rock formation, erosion, and weathering.

Read, interpret, and analyze a combination of ground-based observations, satellite data, and computer models to demonstrate Earth's systems and their interconnections.

Enduring Understandings

- The natural environment–particularly the ocean–plays a central role in shaping people, their cultures, and commerce.
- Ongoing technological development shapes and is shaped by natural resources.
- A reciprocal relationship exists between humans and Earth's natural systems.

Essential Questions

- How do researchers collect data from the sea floor, observe the sea floor and analyze the information?
- Why is it important to know and understand the ocean floor's composition and its depth below sea surface?
- How do researchers make maps of the ocean floor?
- How are these maps read and used?

Students will know and be able to:

- Identify and explain different methods for viewing and sampling the sea floor;
- Describe various types of sampling equipment and explain how they are used; and
- Provide an explanation of bathymetry.

Students will be able to:

- Read a 3 – D contour map;
- Construct a 3 – D contour map;
- Measure the vertical profile of a beach; and
- Construct a graph of the vertical profile of a beach.

Stage 2 – Assessment Evidence

Performance Task

* Students will develop and deliver a presentation that demonstrates their understanding of the ocean and how it is studied (power point, poster session, and the like.) Their presentations should include a discussion of the technologies that are used to explore the various features of the ocean floor.

* The teacher and/or students should develop a rubric for the presentation:

http://school.discovery.com/schrockguide/assess.html#rubrics

Other Evidence

- Class discussion and journal writing
- Quizzes and exam

Student Self-Assessment: How will students reflect upon and assess their own learning?

- Journal Writing
- Discussion

Learning Experience One

Creating a Profile of the Beach

Overview

Students will measure the vertical profile of a beach, graph their profile and construct a three-dimensional model of the beach sampled. It is best to conduct this activity during low tide. Also, choose a beach with interesting contours. This activity will take 2 to 3 hours to complete. If you do not have access to a beach, use any locale that has a changing elevation.

Evaluation

- The three-dimensional model students create will demonstrate their understanding of the various information required to create a vertical profile.

Materials for each group

Part one

- o Handout One (a chart for recording data)
- o Meter stick
- o Levels
- o String or rope
- o Clip boards and a writing utensil

Part two

- o Handout Two (a graph)
- o Scissors
- o Glue
- o Cardboard

Activity One: **The Beach Component**

- Assessing Prior Knowledge: Ask students to look at the beach (or landscape) and draw a sketch of what they see. The teacher should circulate to check for understanding and use this as a starting point for teaching.
- Tell students that there is a way to use scientific measurement to accurately record what they see (i.e. change in elevation).
- Place students in groups of four. Distribute materials to each group.
- Remind groups that the starting point will be along the high tide line. Place groups two meters apart along the high tide line.
- The groups need to determine the shortest distance from the starting point (this will eventually be called the zero elevation line) to the water's edge. Students will then lay out a string or make a line in the sand with a stick from the starting point at the top of the beach down to the water's edge. All measurements that follow will be taken along this line from the top of the beach to the water's edge. Viewed from above, this line will be at a right angle to the water's edge and go directly up the beach in the shortest distance to the starting point at the high tide line.

- To begin, one member of the group will secure a one-meter long string or rope (the line) to the ground at the high tide line (starting point) at the top of the beach.
- A second member must pull the line tight and extend it one meter toward the water. Using the level provided, a third member of the group will make certain that the line is always level.
- Record the change in elevation in centimeters at the one meter point on the data table (Handout Two).
- Holding the lower end of the line in place one meter from the starting point, release the upper end and rotate one meter further down the beach in a leapfrog fashion past the one-meter point You will now be two meters away from the starting point heading directly down the beach towards the water's edge.
- Move down the beach by rotating the line again in turns one meter closer to the water each time. Record each change in elevation, then rotate the line again and move down the beach. Remember to keep the line level for each elevation.
- Continue this process until the water line is reached.

Activity Two: Back in the Classroom and the Graphing Component

- Provide each student with materials listed under part two.
- Tell students that they will be graphing the inverse or negative depths of their measurements because they are going down the hill.
- Model this for students at the board or on chart paper. Check for understanding. Do they understand that their measurements were becoming greater in depth, not in elevation?
- Ask students to graph the inverse or negative depths for each of their group's measurements on Handout Two.

Activity Three: Three-Dimensional Profile Construction

- Create new groups of three or four students. Each new group should include one student from each of the original groups.
- Show students a sample model of a three-dimensional Profile you are asking them to construct. You will have to prepare this ahead of time. This visual image will help them know what the completed assignment will look like.
- Ask students to cut out their graphed profiles along the line they graphed.
- Ask students to fold their profiles on the zero elevation line and glue these profiles in consecutive order to a piece of cardboard.
- When the original groups were at the beach, they placed themselves two meters apart. When the new groups put their data on the cardboard, their profiles will reflect their different locations. The result should be a standing three dimensional profile of the entire beach sampled using the data from the entire class.
- Students should return to their sketch of the beach or landscape. How has their thinking changed?

Handout One

Name:_________________________ Group #:___________ Date:_______________________

Beach Profile Activity

Directions:
Materials
- Meter stick
- Clip board
- Level
- Rope
- Writing utensil

1. Each group must be two meters apart and perpendicular to the beach along the high tide line.
2. In each group, one member must secure the line to the ground at the high tide line.
3. A second member must pull the line tight one meter toward the water, while a third member makes sure the line is level using the level provided.
4. Record the elevation in centimeters one meter out and record your results in the data table below.
5. Take the elevation measurements every meter until the water line is reached.

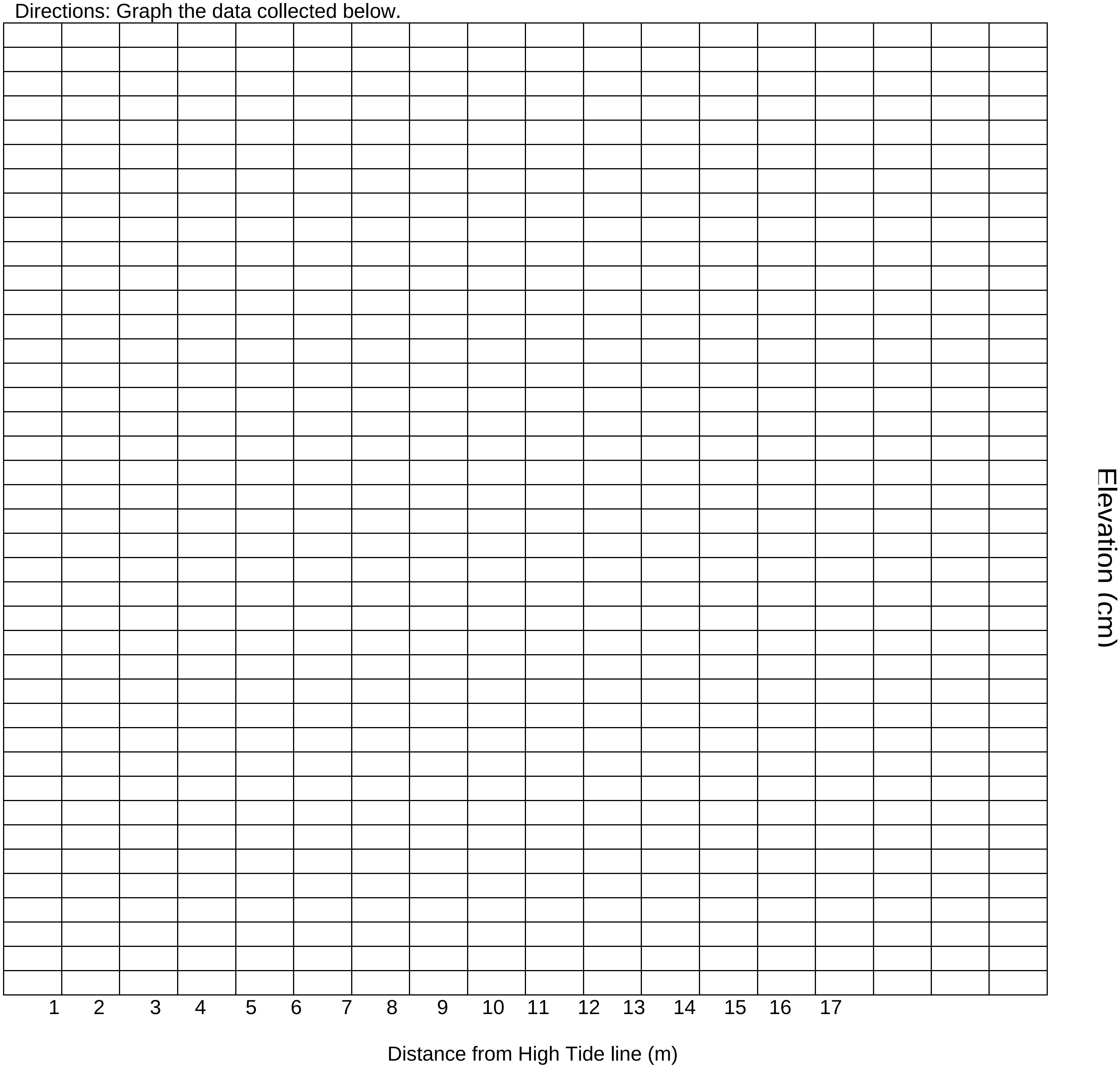
Distance from the high tide line, in meters	+/- Change in Centimeters
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Handout Two

Name:____Date:______________________

Beach Profile Activity

Directions: Graph the data collected below.



Learning Experience Two

Using a Bathymetry Box to Probe Unseen Contours

Overview

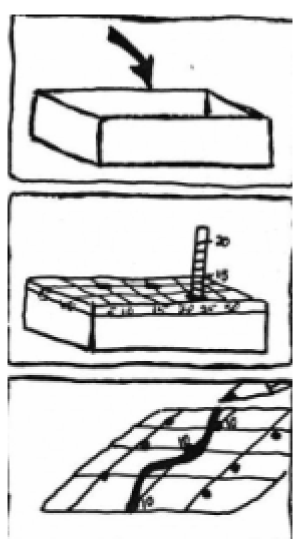
From the start of human existence, people around the globe conducted experiments to measure the depths of ponds, lakes, or oceans. They used sticks, oars, rocks, or ropes with rocks or weights to probe the depths of various bodies of water. Until advanced sonar technology with acoustic sounding beams became available, the use of probes was the only available method for learning about the topography of the ocean floor. In this activity, students will simulate this older method, using bathymetry boxes, wooden dowels, pins, and other simple tools. They will measure the depth of a bathymetry box and begin developing an understanding for contour mapping.

Evaluation

Class discussion

Materials

- Bathymetry Boxes: Construction of boxes is simple.
    - Use a dark colored, opaque plastic or cardboard box with a lid. Drill or punch holes in the lid, in a grid measuring one or two centimeters apart. Make several rows to cover the lid of the box and label or number rows so students can transfer results to a data table and then onto a map representing the bottom of the box. The variations in the contours can be simple or complex. A simple contour can be created from plastic cups, rocks, wood scraps, and other items duct-taped to the bottom of the box. A more advanced contour can be created from wood cutouts or other solid material modeled to represent actual ocean bottom features and coastal areas you want students to observe in this new way. (Note: The WOW Mobile has six bathymetry boxes ready for classroom use.)
    - The image below will help you construct bathymetry boxes.



- Measuring stick such as wooden dowels or skewers
- Data table entry sheet (graphing paper) that represents the grid on the box top. Students will use this to record the data they gather when they conduct the experiment.
- Handout One

Activity

- In the previous Learning Experience, we plotted changes in elevation that were visible on the beach. In this Learning Experience we attempt to plot unseen changes in elevation.
- Prepare the bathmetry boxes ahead of time.
- Place students in small groups. Give each group a bathymetry box, probes, and Handout One. Ask students to imagine that they are on the ocean and they need to create a map of the sea floor. Students must measure the depth of each station (hole) and record it on their data sheet. Tell students that they should not open the boxes.
- Ask each group to select a recorder who will enter the data on the grid on Handout One.
- Students will place the probe into each hole in the box top grid and note where and how deep the probe went until it touched the bottom.
- Students will take careful measurements of the depth at each spot on the grid and transfer results to a data table.
- Students will then discuss and plan how they will generate maps from their data and make graphic displays and maps of their data to show their study results.
- When they have completed their map projections they will open the box to compare their maps to the actual objects in the boxes. You may wish to repeat this activity a few times with different contour models inside the boxes. You can vary the contents in the boxes from very simple objects to more advanced models of actual areas of an ocean floor.
- Process: Writing to learn: In an earlier activity, students were asked to guess what the ocean floor might look like. Now, ask students to answer the following prompt in their journals:
    - How has your thinking changed about the ocean floor?
- Show students a contour map of the ocean floor: (http://serc.carleton.edu/images/eet/rodes_3/GeoMapApp_Contour_Atlantic_500.jpg)
- Discuss the contour map with students. Record their observations on the board or chart paper. In the next Learning Experience, students will create their own contour maps. They will return to these observations to compare and contrast how their thinking has changed.
- Process and discuss: What are some of the problems you had in making a beach profile in LE One? What are some of the problems you had in making a map from the bathymetry box data? What would be some potential problems in using bathymetric charts on the ocean or another body of water? Why?

Handout One

Name:____Date:_____________________

Bathymetry Box Activity

Directions:

1. You will be given a bathymetry box. DO NOT OPEN until the activity is complete.

2. Imagine the top of the box is the ocean surface and you are in a ship mapping the sea floor.

3. Using a wooden dowel, measure the depth of every hole (station) and record the measurement on the graphing paper.

4. Of the measurements you have recorded, select the most common deep measurement, the most common middle depth measurement, and the most common shallow measurement. On your graph, highlight those numbers in three different colors. Next, draw a line connecting the deepest measurements. Lightly shade that deep area. Do the same for the middle depth numbers and lightly shade the middle depth area. Finally, draw a line connecting the most shallow numbers. Lightly shade the shallow depth area.

5. Describe in words the image that you see and predict what you think the remainder of the “ocean floor” will look like.

6. Now that your bathymetry map and verbal description are complete, you may open the box. Is your drawing and description similar or very different? Explain why or why not.

Learning Experience Three

Creating a Three Dimensional Contour Chart

Overview
This lesson continues to develop student understanding of contour maps. Students turn a two dimensional sea floor chart into a three-dimensional contour chart.

Evaluation
- Class discussion
- Construction of a three dimensional contour chart

Materials
- Bathymetric map in three or four colors (white, green, blue and yellow)
- Scissors
- Glue
- Cardboard (or foam core)

Activity
- In the first two Learning Experiences, we created two-dimensional images from numbers in the real environment (the three-dimensional world). In this Learning Experience, we will go from a two-dimensional chart or map and use the numbers and other data on the chart to create a three-dimensional model.
- Explicit Instruction: Before students can do this activity, you will have to provide specific information. Show students a three-dimensional chart. Explain the following information:
    - This is called a chart because that's the term that is used for images of the sea floor. Maps are images of the land.
    - On three dimensional ocean charts, the ocean is usually white.
    - Contour lines: Tell students that a contour line shows elevation. It will be helpful if you read and discuss information about contour charts with students, paying particular attention to gradient and slope. (See suggested web pages in Learning Experience 4, Activity 2).

Construction of Contour Maps
- Students will construct a contour map from a nautical chart.
- Download nautical charts or a contour map of your local area from the Internet. If you are in the Greater New Bedford area, you can contact the New Bedford Oceanarium, which has several different charts available for various age groups.
- If you want to add extra height to your map, you can glue it to cardboard or foam core. This will make the contours more dramatic and easier for students to comprehend.

Directions for constructing a contour map are on the following three pages:

Contour Mapping with Optional 3-D Mapping

Materials Needed:
- 4 Photocopies of the Map (one each in white, blue, green and yellow)
- Color Markers (if color paper is unavailable)
- Rubber Cement/Glue Stick
- Scissors
- Tape/Thumbtacks

Optional Materials:
- Foam Core/Cardboard
- Cutting Tool (utility knife)

Grade Level: Grades 5 - 12

Time Required: 1 - 2 hours

Disciplines: Geography and Marine Science

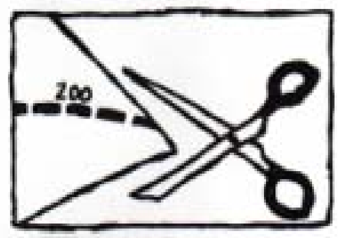
Objectives:
- To be able to define a gulf as a semi-enclosed body of water and recognize such features on a map or globe.
- To be able to locate the Gulf of Maine and the three states and two Canadian provinces that border it.
- To be able to read and use contour maps.
- To be able to explain how coastal and underwater geologic features affect water circulation in the Gulf of Maine, including the enclosing properties of the shallow Georges and Brown Banks and the deep Atlantic Ocean water flow through the Northeast channel.

Special Note:

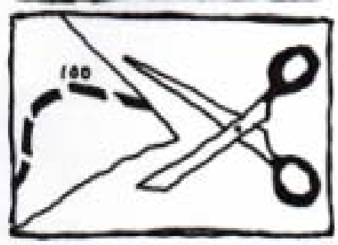
To study how coastal and underwater features affect water circulation patterns, make overhead transparencies of both the contour map and the surface current map on pages 6 and 8 *(the maps have been printed in the same scale)*. Overlay the maps using an overhead projector.

Procedure:

1. Study the white copy. This is your base map.



2. Use the blue copy to cut along all the 200 meter contour lines. Throw away the sections representing areas deeper than 200 meters. Glue the blue pieces onto the white base map.



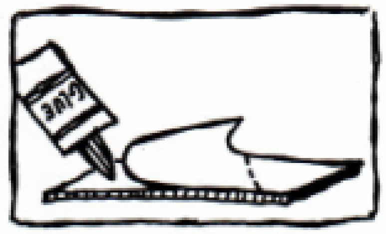
3. Repeat the procedure using the green paper and a 100 meter contour. Throw away areas deeper than 100 meters. Glue the green pieces on top of the blue map.

4. Repeat a final time with the yellow paper. Cut along the edge of the land and glue this section, along with any islands such as Nantucket and Martha's Vineyard, onto the green section. You now have a contour map of the Gulf of Maine.

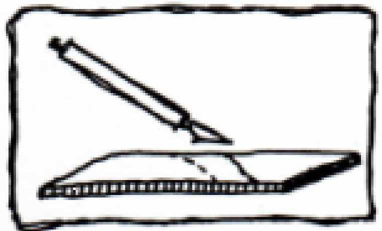
   Q. How does deep Atlantic Ocean water enter the Gulf of Maine?
   Q. If sea level were to drop 150 meters, what would the Gulf of Maine look like?

5. If you would like to further extend the project, you can use additional colors and continue contouring deeper into the ocean *(e.g., 1,000 meter and 2,000 meter contours)* or along shallower contours *(e.g., 10 meter and 30 meter contours to reveal Nantucket Shoals and Stellwagen Bank)*.

Optional 3-D Mapping Extension Activity:

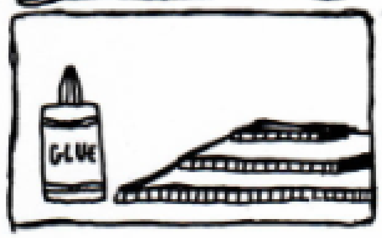


Glue the maps onto the mounting material and then proceed as you would with the previous activity. Glue each successive contour onto the previous one. When you are finished you should have a "wedding cake" effect with the land on the top layer. If possible, treat the model with water repellent, place in a tray and fill with water to serve as a three-dimensional wave tank.



Special Note:

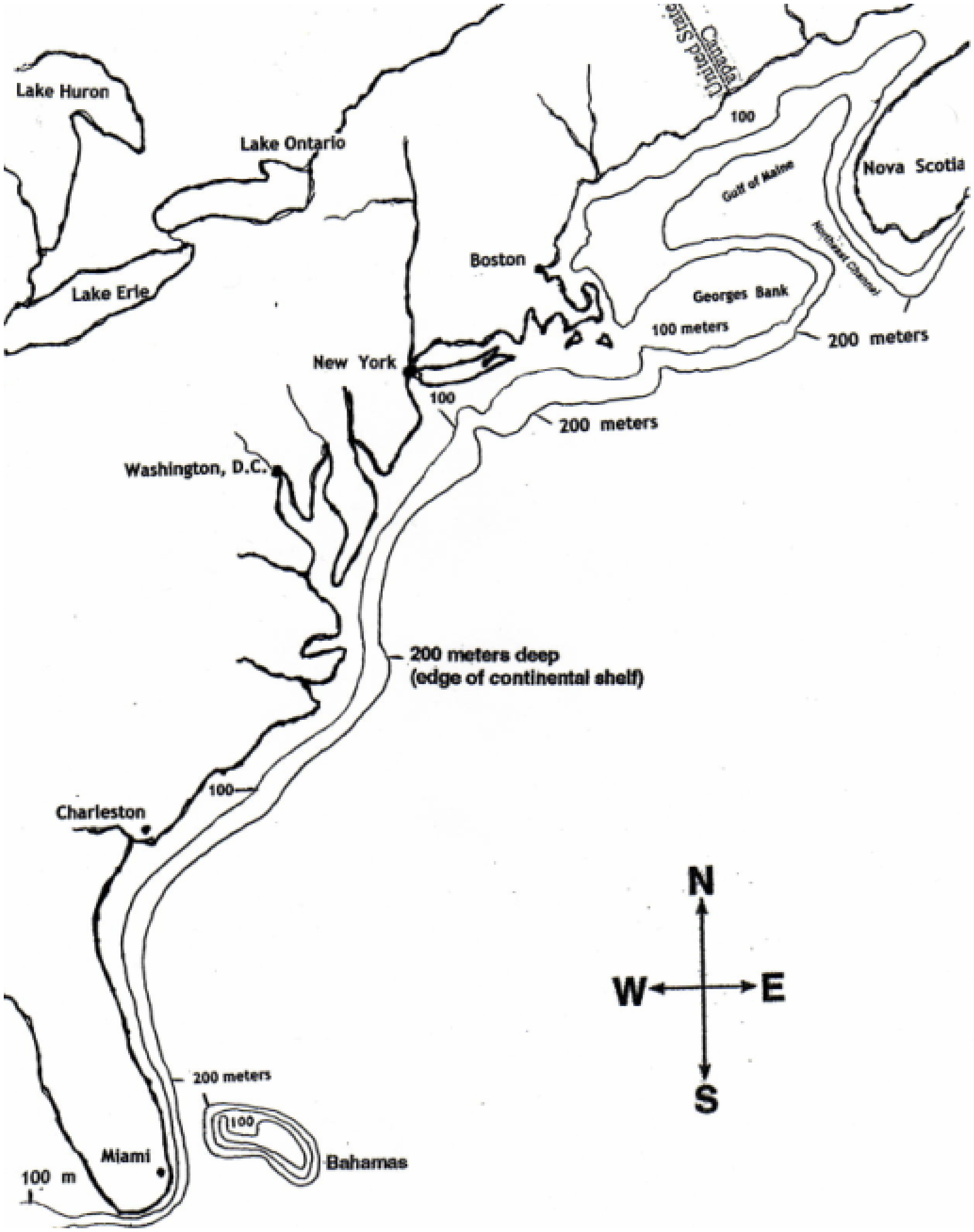
This experiment uses the Gulf of Maine map included in this book. You may wish to use another map, perhaps of your local coastline or Boston Harbor. Navigational charts are ideal for this use. If you use a coastal area, you may have to select different *(shallower)* contours *(perhaps 6, 12 feet and 30 feet)*.



Further Investigations:

1. Use references to study various features in the Gulf — Stellwagen Bank, Georges Bank, Bay of Fundy. Have students write reports on the resources and value of these areas.
2. Find tide tables for different areas in the Gulf. How does the physical configuration of the Gulf affect tidal range?
3. Chart a course from Point A to Point B on a nautical map that gives safe passage for an imaginary boat of 30-foot draft.
4. Create your own coastline with clay. Include examples of deep channels, safe harbors, sand bars, etc.
5. Make a 3-D model of your local coastline. Mark shipping lanes, channels, intertidal zones, rocky outcroppings.

   A. Make a 3-D map that extends from deep water through mountains on land.
6. Collect pictures and postcards from various places along the Gulf of Maine. Have students select a picture and write about it — either a descriptive passage or a story inspired by the art.


Lake Huron
Lake Ontario
Lake Erie
Canada
100
Nova Scotia
Boston
Georges Bank
100 meters
200 meters
New York
100
200 meters
Washington, D.C.
200 meters deep
(edge of continental shelf)
100
Charleston
N
W
E
S
200 meters
100
Bahamas
Miami
100 m

Learning Experience Four

Exploring the Still Mysterious Ocean Floor through Advanced Technologies

Overview

It is conceivable that before working on this module, many students held the misconception that the ocean floor was flat, featureless and composed of sand. Fishermen, sailors, scientists, and navigators know that this is not the case and further understand that the shape and composition of the ocean floor are related to the commerce, culture, and social systems of various regions. As educators, we can give students this information and hope that they will remember it. However, if they investigate the sophisticated tools that are now used to gather this information, they will begin to understand the complexity of the Earth and ocean's "topography" and composition, and appreciate their importance. In this learning experience, students will be introduced to advanced technologies that give us new images of the still mysterious ocean floor.

Evaluation

- Students' ability to correctly match the picture with the description and a class discussion answering the questions the students may have written down.

Activity One: Activating and Assessing Students' Understanding

- Begin the class by assessing students' knowledge.
- Ask students to generate questions about the ocean that scientists and researchers might investigate.
- Write students' questions on the board or chart paper. Add your own questions to ensure that students know where they are headed and what they are going to learn.
- Ask students to draw and/or write responses to the following questions in their journals:
    - What do you think the bottom of the ocean looks like?
    - How deep do you think the ocean is? Why?
    - How might you determine if your answers are accurate?
    - Describe what you think the bottom of the ocean might be composed of.
    - What do you think researchers do to determine what the composition of the bottom of the ocean is? Why is this information important?
- Place students in groups of three or four. Allow them about ten minutes to discuss their responses.
- Process with the class. This will provide you with baseline data indicating students' current levels of knowledge about the questions.

Activity Two: The Hunt for Answers

- Place students in heterogeneous groups of four or five, depending on the size of the class. Assign roles to each student:
    - The **Director** keeps the group on track in their search for answers.
    - The **Vocabulary Discoverer** identifies four or five vocabulary words and works with the group to create clear definitions for each of the words. Vocabulary words and definitions should include the following:

- Sonar
- Acoustic
- Bathymetry
- Sediment
- Calibrate

The teacher can circulate from group to group to ensure that students are discussing these and other words.

  - The **Image Maker** studies the pictures and diagrams on the websites and works with the group to select those that best explain the concept.
  - The **Recorder** takes notes and works with the group to outline and pull together the information that will be presented to the class.
  - The **Presenter** reports on the findings to the class.
- Assign one of the following questions to each group. Students will read and research each of the questions. At the end of "the hunt for answers" each group will present the information they have learned to the other groups. Remind students to download images that will help with their presentations. This unit is designed for grades 6-8 and grades 9-10. You should set expectations and develop a rubric with students in advance as to what a "good explanation" would include. The expectations in the rubric should reflect the information you've gathered about students' prior knowledge in Activity One.
- The questions:
  - What is *side scan sonar* and how does it work? www.punaridge.org/doc/factoids/DigitalData/Default.htm
  - Describe *multibeam sonar*. What information is available with "multibeam sonar?"
  - www.divediscover.whoi.edu/tools/sonar-multibeam.htmlchartmaker.ncd.noaa.gov
  - What is an *Autonomous Benthic Explorer* and what does it do? www.divesiscover.whoi.edu **and** www.visions05.washington.edu/mapping
  - What is a *benthic grab sampler*, how does it work, and what information is obtained? www.csc.noaa.gov/benthic/mapping/techniques/sensors/grab.htm
  - What is *core sampling*? How is it used and what information does it provide about the ocean? www.seddb.org and www.jamstec.go.jp/jamstec-e/30th/part3/page5.html

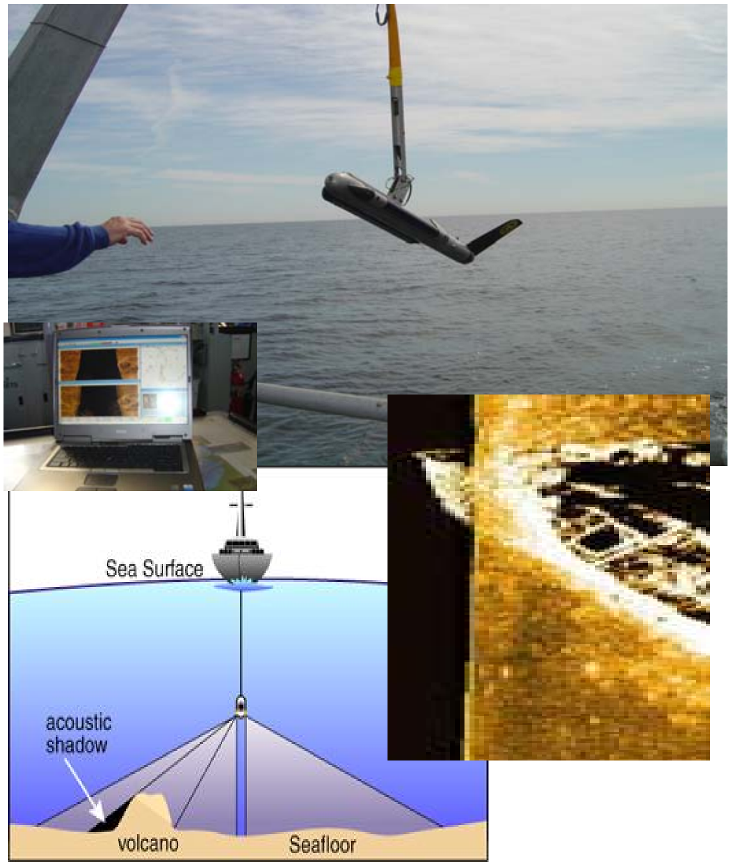
Activity Three: The Presentations

- Each group will present its findings and related images to the class.
- Remind students that you will be checking for understanding and, at the end of the presentation, will clarify misconceptions, and provide additional information.
- Use the rubric you developed to assess students' presentations.

Activity Four: Review and Process

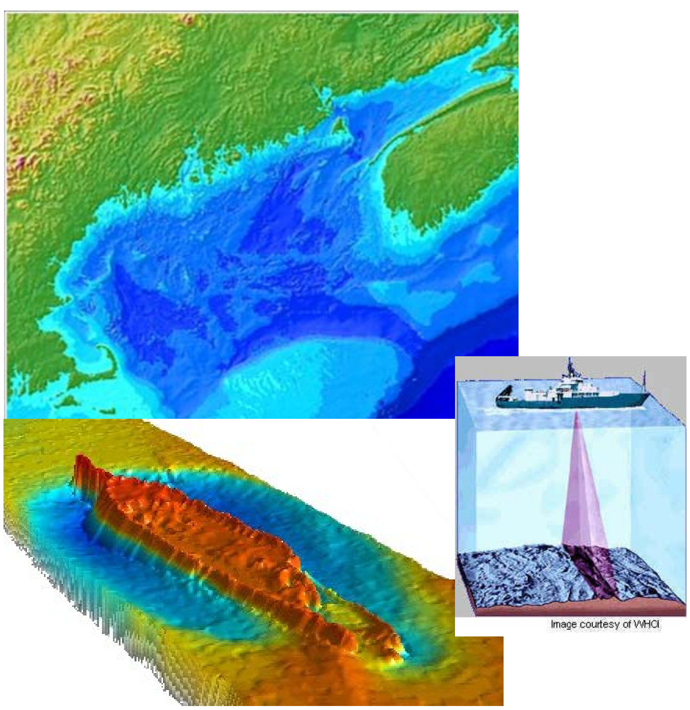
- Create new groups of three or four students. Each group should choose a Recorder and a Reader.
- Provide each group with a shuffled deck of bathymetry cards (below).
- The Reader in each group will read the first card to the rest of the group. For each card, the group will answer the following questions. The Recorder will write the responses for the group.

    - What does the information on this card mean?
    - What questions do we have about the information?
    - What makes sense?
    - What is unclear?
- Each group will report out. The teacher will lead a discussion that clarifies and provides additional information.



Side Scan Sonar is a sonar system that uses sound echoes to create an image of the seafloor bottom. The instrument can be attached to the hull of a vessel or towed as a “towfish.” It sends out sound pulses from each side of the instrument and receives return echoes. The echoes create an image that can be displayed instantly on a computer screen. The two shipwrecks are the Palmer (top) and the Crary (bottom).

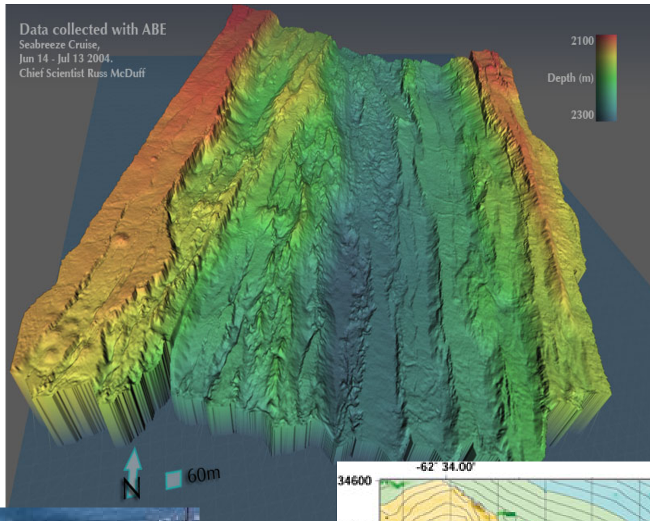
www.punaridge.org/doc/factoids/Digital Data/Default.htm
oceanexplorer.noaa.gov

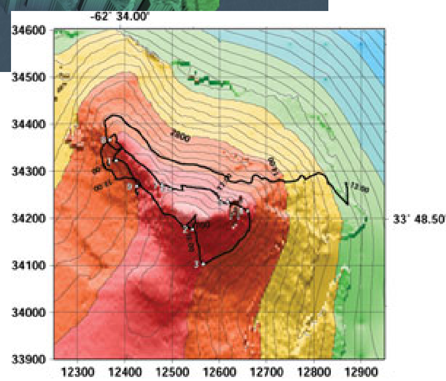


Multibeam sonar sends out several beams of sound simultaneously. The acoustic signals reflected back to a vessel are timed and a depth is determined. A 3-Dimentional graph can be made of the seafloor with the multiple depth readings taken from below the moving vessel. Color is often used to enhance the visual effects of the seafloor. The bottom image is of a shipwreck.

www.divediscover.whoi.edu/tools/sonar-multibeam.html

www.chartmaker.ncd.noaa.gov

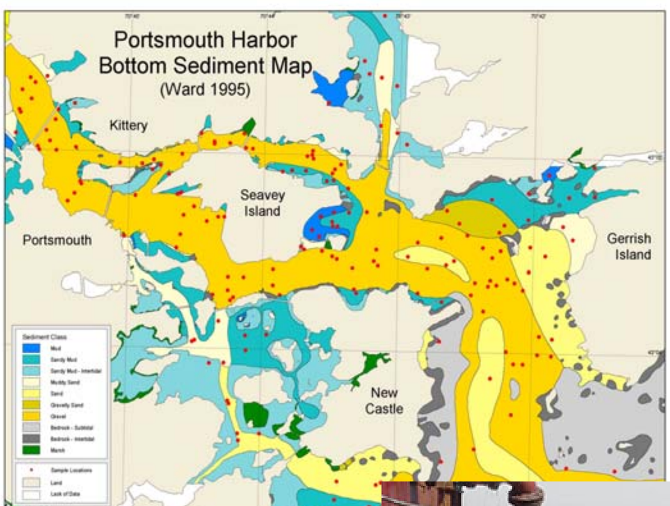




Autonomous Benthic Explorer otherwise known as ABE is an ROV and one of a kind. It can operate on its own without a pilot or connect to a ship. ABE can cover lots of area taking pictures, samples, and recording valuable data, such as bathymetry. It has sonar capabilities resulting in high resolution maps of the seafloor.

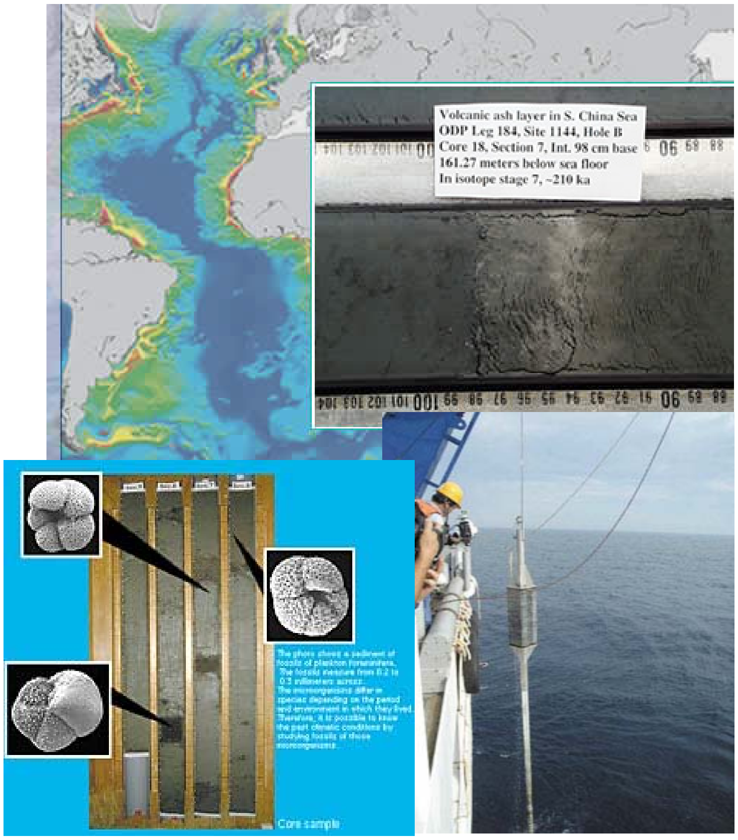
www.divediscover.whoi.edu

http://www.visions05.washington.edu/mapping/



Benthic grab sampling is used in conjunction with sediment profile imaging. There are several variations of a grab sampler, but they are all lowered to the seafloor and scoop up a layer of sediment. The samples are analyzed for their chemical and physical composition. This method is necessary to calibrate surveys and mapping done by sonar and satellite. Sediment knowledge is important not only to scientists but fisherman as well.

http://www.csc.noaa.gov/benthic/mapping/techniques/sensors/grab.htm



Core Sampling is a mean of sampling the sediment. Samples are taken by driving a hollow tube into the seafloor sediment. Rings are created as a result of variations in the types of particles settling from year to year. They provide historical data and they are used to identify possible sources and direction from which sediment can travel. Core samples are also a means for calibrating sonar data.

http://www.seddb.org/
http://www.jamstec.go.jp/jamstec-e/30th/part3/page5.html