Islands in the Stream 2002: Exploring Underwater Oases

At the Edge of the Continent

FOCUS

Bathymetry of the South Atlantic Bight continental shelf and upper shelf-edge

GRADE LEVEL

9-12 (Earth Science)

FOCUS QUESTION

What does the edge of the continent look like?

LEARNING OBJECTIVES

Students will learn how to interpret a bathymetric map.

Students will learn the main features of the continental margin.

Students will be able to plot and graph bathymetric data.

Students will think about and discuss the bathymetry of the edge of the continental shelf.

ADDITIONAL INFORMATION FOR TEACHERS OF DEAF STUDENTS

The words listed as key words are integral to the unit. There are no formal signs in American Sign Language for any of these words and many are difficult to lipread. Having the vocabulary list on the board as a reference during the lesson will be extremely helpful.

MATERIALS

Per group of 2 – 3 students
❑ Georgia Continental Margin Bathymetric Contour Map and South Carolina Continental Margin Bathymetric Contour Map (laminated, if possible)
❑ Student Graph Sheet
❑ Continental Margin Profile Data Tables Sheet
❑ South Atlantic Bight Profile Student Worksheet
❑ Straight Edge
❑ Pencil and Marker
❑ Calculator (if desired)

TEACHING TIME

45 minutes

SEATING ARRANGEMENT

Groups of 2 – 3 students

MAXIMUM NUMBER OF STUDENTS

40

KEY WORDS

Bathymetry
Bathymetric profile
Continental margin
South Atlantic Bight
Continental shelf
Continental slope
Continental rise
Submarine canyons
Isobath
Turbidity currents

BACKGROUND INFORMATION

This activity may be used on any contoured map that shows seafloor depth. These maps are usually referred to as bathymetric maps. Bathymetry is the

measurement of the changing depth of the seafloor. The world's ocean has tremendous variation in bathymetry, just as the world's continents have variability in topography (the changing elevation of the landscape). A bathymetric profile shows how the bottom depth changes over a distance, as though we were to take a slice into the seafloor and view it from the side in its cross-section.

Bathymetric contours are lines that connect points of equal bathymetry, or equal water depth. For example, the 100 m contour indicates where the seafloor has a depth of 100 m. If you could walk along the ocean floor along the path of this line, the water depth above you would never change. Navigation charts show water depths at individual points. Many navigational charts do not have contour lines and are not as useful for this activity.

The object of this activity is to familiarize students with the continental margin. The continental margin is the underwater portion of the edge of a continent. We will investigate some of the differences in continental margin bathymetry off the east coast of the U.S., in the region known as the South Atlantic Bight (SAB). The SAB extends from Cape Hatteras, North Carolina to Cape Canaveral, Florida.

Sea level changes may expose or submerge the upper portion of the margin, known as the continental shelf. Continental shelves of the world vary greatly in their width; however, most of them extend roughly to the offshore location where water depth is between 100 and 200 m. Just beyond the shelf region, the seafloor becomes much steeper. This portion of the continental margin is known as the continental slope. At the base of the slope is the continental rise, which is less steep and quite broad in places. The shelf, slope and rise together make up the entire continental margin. Many of the world's continental margins have steep-walled canyons cut into them, called submarine canyons. Some of these canyons may have formed when sea level was lower and rivers ran out onto the continental shelf. Today the submarine canyons continue

to serve as channels for turbidity currents, or water that flows along the seafloor.

In this activity, students will investigate the continental shelf and the upper portion of the continental slope. They will use a bathymetric map to create a cross-sectional bathymetric profile of the seafloor.

LEARNING PROCEDURE

1. Divide the class into groups of 2 – 3 students each. Each group will be given a bathymetric chart from the South Atlantic Bight. Half of the class should use the South Carolina Continental Margin Bathymetric Contour Map, and, for comparison the other half should use the Georgia Continental Margin Bathymetric Contour Map.

2. NOTE: Contours (= isobaths) indicate equal depths in meters (not fathoms!)

3. The graph paper is divided by centimeters, where 1 cm = 3 boxes on the graph paper. Each box on the graph will equal 20 m on the vertical scale (1 cm = 60 meters). The short edge of the graph paper will be the y-axis, or the vertical axis. The x-axis, or horizontal scale, will equal the scale of the map, which is 1 cm = 10 km.

4. The profile will extend from the westernmost edge of the profile line (i.e., on land, left edge of the map at Point A on the South Carolina Continental Margin Bathymetric Contour Map and Point B on the Georgia Continental Margin Bathymetric Contour Map), to the point offshore where a depth of 500 m is reached (A' on the South Carolina map and B' on the Georgia map). Make sure they write the PROFILE NAME and the names of the mappers in their group on the same sheet.

5. Students may now begin plotting their points, using the Continental Margin Profile Data Tables. Make sure they are using the table that corresponds to their Continental Margin Bathymetric Contour Map (either South Carolina or Georgia). They should only plot the depths indicated on the Data Table. In order to determine the distance of each point, they should use their straight edge

and the scale 1 cm = 10 km. Have them complete the appropriate table.

6. Next, students can connect the plotted points with the marker pen (freehand or with a straight edge). They have now constructed the cross-sectional bathymetric profile.

7. Make sure each profile includes the following:
   • Names of the students,
   • Profile name (South Carolina Continental Margin or Georgia Continental Margin), and
   • Profile from 0 to 500 meters.

8. Have students complete the SAB Profile Student Worksheet.

THE BRIDGE CONNECTION

www.ngdc.noaa.gov/mgg/global/global.html
www.bigelow.org/virtual/index_bath.html
http://gcmd.nasa.gov/Data/portals/gcmd/param_search/OCEANS.html

THE "ME" CONNECTION

Scientists often use sonar which shows them the depths of the seafloor (bathymetry) below their ships. This helps them locate certain types of fishes which prefer specific depths or underwater valleys. Research your favorite fish and find out what depth they prefer and if a bathymetric device might be helpful in locating them.

CONNECTIONS TO OTHER SUBJECTS

Mathematics, Geography

EVALUATION

Assess student work on the South Atlantic Bight Profile Student Worksheet.

EXTENSIONS

If you have access to a motion detector and a calculator-based laboratory with TI-83 graphing calculators, you can have the students graph the "bathymetry" of their classroom. They can stand, sit or crouch around the room as "seafloor features." Desks and other objects can also be part of the "seafloor."

RESOURCES

"Exploring the Depths: Making a Cross-Section View of the Seafloor" Dr. Leslie Sautter, Department of Geology, College of Charleston, http://oceanica.cofc.edu/

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

Continental Margin Profile Data Tables
Teacher Answer Key

South Carolina Continental Margin Profile Data Table

Distance on Map (cm)	Actual Distance (km)*	Depth (m)
0	0	0
4.0	40	20
6.6	66	40
8.0	80	60
8.5	85	80
8.8	88	100
9.3	93	140
9.5	95	180
9.6	96	220
9.8	98	260
9.9	99	300
10.0	100	340
10.1	101	380
12.0	120	420 (furthest line from shore)
13.4	134	460
13.6	136	500

Georgia Continental Margin Profile Data Table

Distance on Map (cm)	Actual Distance (km)*	Depth (m)
0	0	0
3.8	38	20
10.3	103	40
11.1	111	60
11.2	112	80
11.3	113	100
11.4	114	140
11.5	115	180
11.8	118	220
12.2	122	260
12.4	124	300
12.6	126	340
12.7	127	380
12.9	129	420
13.1	131	460
13.5	135	500

*Use map scale of 1 cm = 10 km

Continental Margin Profile Data Tables
Student Worksheet

South Carolina Continental Margin Profile Data Table

Distance on Map (cm)	Actual Distance (km)*	Depth (m)
		0
		20
		40
		60
		80
		100
		140
		180
		220
		260
		300
		340
		380
		420 (furthest line from shore)
		460
		500

Georgia Continental Margin Profile Data Table

Distance on Map (cm)	Actual Distance (km)*	Depth (m)
		0
		20
		40
		60
		80
		100
		140
		180
		220
		260
		300
		340
		380
		420
		460
		500

*Use map scale of 1 cm = 10 km

Teacher Answer Sheet
South Atlantic Bight Profile Worksheet

1. Which profile did you plot? _____

2. Convert the horizontal scale of your profiles using the scale on your map.
    HORIZONTAL SCALE: 1 cm =   10 km
                         1 cm =   10,000 m
                         1 cm =   1,000,000 cm

3. What is the vertical scale?
    VERTICAL SCALE: 1 cm = 60 m
                           1 cm = 6,000 cm

4. Calculate the vertical exaggeration (show your work):
    VERTICAL EXAGGERATION: 166.6
    (Note: the units cancel out, so the vertical exaggeration is described as "166.6")

    $\dfrac{\text{Horizontal scale (cm)}}{\text{Vertical scale (cm)}}$ = Vertical Exaggeration

    $\dfrac{1,000,000 \text{ cm}}{6,000 \text{ cm}}$ = $\dfrac{1000}{6}$ =   166.6

5. Describe the shape of your profile.
    Both profiles should show a relatively flat shelf turning into a slope (steeper on the Georgia map) to a more gradual slope at the very bottom.

6. Discuss any unusual features depicted on your map (not necessarily on your profile).
    On both maps (south on the Charleston Continental Margin Bathymetric Profile Map and northeast on the Savannah Continental Margin Bathymetric Profile Map) there is a large "mound" that starts about 120 km offshore. This mound is known as the Charleston Bump. On the Charleston Continental Margin Bathymetric Profile Map, there is a large area of sub marine slumping and canyons (northeast of the profile).

7.   Fill in the information in Table 1 for your profile. Get the information for the other profile from another group.

Table 1.	Distance to 60 m Water Depth	Distance to 220 m Water Depth	Distance to 500 m Water Depth
SC Continental Margin	*~80* km	*~96* km	*~136* km
GA Continental Margin	*~111* km	*~118* km	*~135* km

Teacher Answer Sheet - page 2
South Atlantic Bight Profile Worksheet

8. Based on the data in Table 1, describe the general bathymetry of the continental shelf and upper slope of the two locations of the South Atlantic Bight (compare distances between depths).
Although South Carolina's shelf edge is much closer to shore (80 km vs. 111 km), 500 km depth is reached at almost the same distance on both maps (136 km and 135 km). This indicates that the continental slope off the coast of Georgia is much steeper than that off South Carolina's coast.

9. (Optional)
To answer this question, go to http://oceanexplorer.noaa.gov, click on Gallery, then click on Maps, then click on the map labeled "Charleston Bump." (Note: the arrow pointing to the Florida-Hatteras Slope. This arrow also identifies the eastern edge of the continental shelf.)

Describe the north-to-south variations in width of the continental shelf within the SAB.
The shelf is narrow to the north and south and gradually becomes very wide in the middle, especially off the coast of Georgia.

Student Handout

South Atlantic Bight Profile Student Worksheet

NAMES _____

1. Which profile did you plot? _____

2. Convert the horizontal scale of your profiles using the scale on your map.
    HORIZONTAL SCALE: 1 cm = _____km
                           1 cm = _____m
                           1 cm = _____cm

3. What is the vertical scale?
    VERTICAL SCALE: 1 cm = _____m
                           1 cm = _____cm

4. Calculate the vertical exaggeration (show your work):
    VERTICAL EXAGGERATION: _____

$$\frac{\text{Horizontal scale (cm)}}{\text{Vertical scale (cm)}} = \text{Vertical Exaggeration}$$

5.   Describe the shape of your profile.

6.   Discuss any unusual features depicted on your map (not necessarily on your profile).

Student Handout

Table 1.	Distance to 60 m Water Depth	Distance to 220 m Water Depth	Distance to 500 m Water Depth
SC Continental Margin	km	km	km
GA Continental Margin	km	km	km

7. Fill in the information in Table 1 for your profile. Get the information for the other profile from another group.

8. Based on the data in Table 1., describe the general bathymetry of the continental shelf and upper slope of the two locations of the South Atlantic Bight (compare distances between depths).

9.(Optional)
To answer this question, go to http://oceanexplorer.noaa.gov click on gallery, then click on maps, then click on the map labeled "Charleston Bump". (Note: the arrow pointing to the Florida-Hatteras Slope. This arrow also identifies the eastern edge of the continental shelf.)

Describe the north-to-south variations in width of the continental shelf within the SAB.

Student Handout

Georgia Continental Margin Bathymetric Contour Map
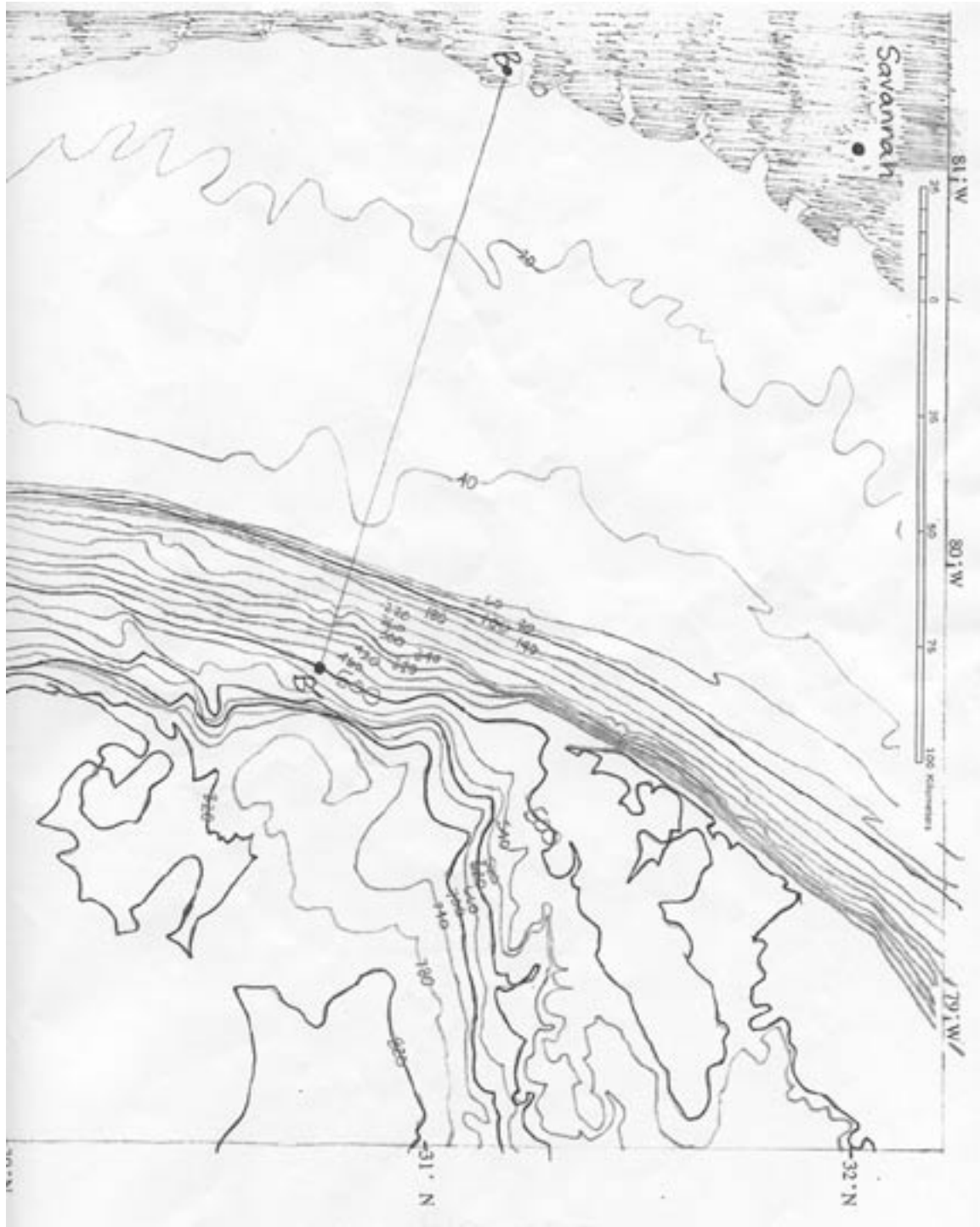
Student Handout

South Carolina Continental Margin Bathymetric Contour Map

Student Handout

Georgia Continental Margin Bathymetric Contour Map