

If I am an oceanographer...
I study past, present, and future oceans.

Experiment 8

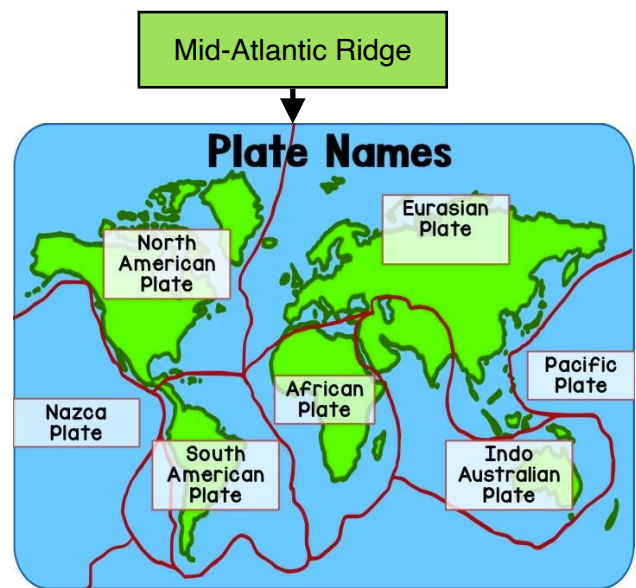
Ocean Puzzles

You will need the plate puzzle, the cross-sectional graph of the ocean, nonporous rock from rock collection (A), measuring tape (G), 2 beakers (H), colored pencils, scissors, ice, water, and a washable marker.

Past Puzzle - Things To Know:

The Mid-Atlantic Ridge is the Earth's longest mountain range. The height of the underwater mountains increase when underwater volcanos erupt. The molten material then spreads out, pushing older rock to both sides of the ridge. This process, called sea-floor spreading, continually adds new material to the ocean floor. As the ocean's floor spreads, the continents along its edges also move or drift apart.

From the deepest ocean trench to the tallest mountain, plate tectonics explains the features and movement of Earth's surface in the past, present and future. The theory of plate tectonics was proposed by Alfred Wegener and states that Earth's outer layer is made up of large, moving plates. The Mid-Atlantic Ridge separates the North American Plate from the Eurasian Plate and the South American Plate from the African Plate.



Evidence for Wegener's theory of continental drift and plate tectonics is seen as the outlines of many coastlines (like South America and Africa) look like they fit together like a puzzle. In addition, fossils of similar types of plants and animals in rocks of a similar age have been found on the shores of different continents, suggesting that the continents were once joined. Today plate motion is tracked with satellite positioning instruments embedded into the ground.

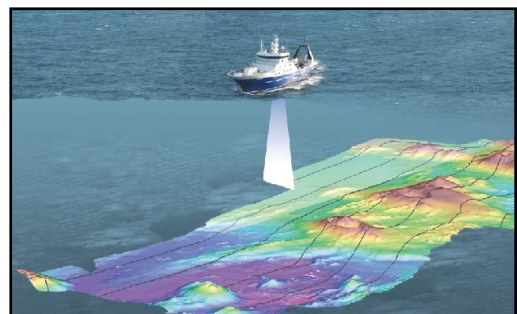
The U.S. Geological Society published "This Dynamic Planet: A Teaching Companion, Wegener's Puzzling Continental Drift Evidence, 2008. A copy of this puzzle is found on the student sheet.

What To Do:

1. Create a color legend.
2. Color the fossils and mountains according to the legend.
3. Cut out the pieces.
4. Match up the fossil and mountain evidence to recreate Pangaea and the surrounding ancient ocean, Panthalassa.

Present Puzzle - Things To Know:

Oceanographers have been able to map the ocean floor using SONAR (**SO**und **NA**avigation and **R**anging). Sonar systems send sound waves from the bottom of a ship to the bottom of the ocean. These sound waves bounce off the ocean floor and back up to the ship. Oceanographers use the length of time it takes for the sound to travel from the boat to the floor and back as an echo to determine the depth of the ocean. They can also tell what materials are on the ocean floor. Hard areas of the floor like rocks reflect more sound and have a stronger or louder echo than softer areas like sand.



What To Do:

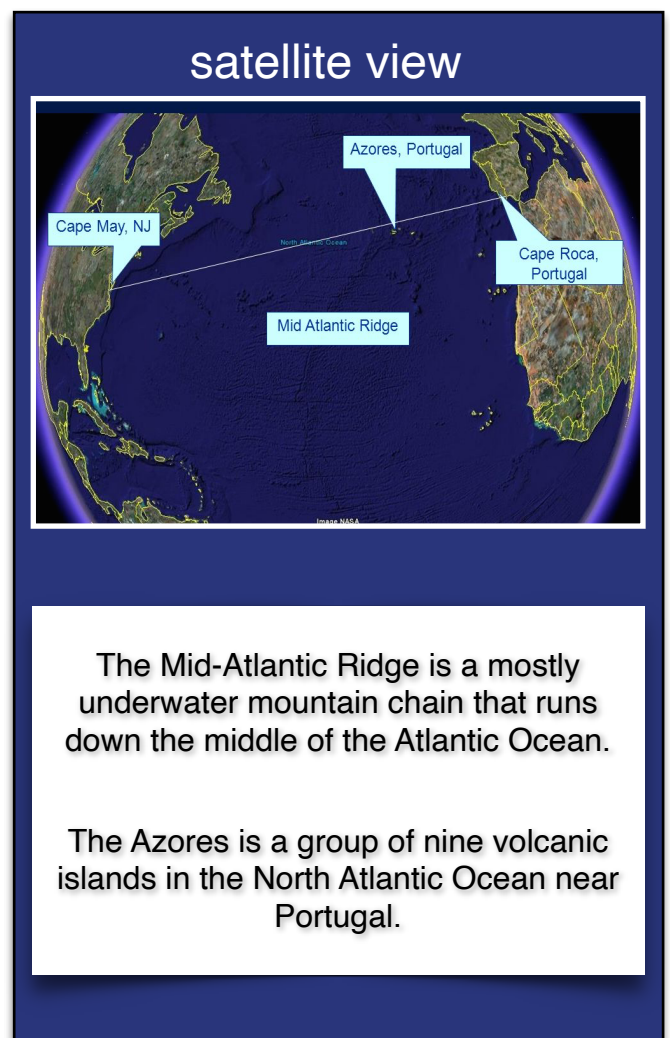
In this activity, you will use SONAR data to make a map of the ocean floor and identify geologic features.

1. The Atlantic Ocean's depths from Cape May, New Jersey, USA to Cape Roca, Portugal are listed in the table on the student sheet. The satellite view shows the length of ocean floor to be graphed. The North Atlantic Ridge and the Azores are geographical structures found along the path. Answer questions #1-5 on the student sheet.

2. The graph, Mapping the Ocean Floor, has the distance from Cape May (0 km) to Cape Roca (5600 km) along the bottom. The depths in fathoms are on the left of the graph. One fathom equals 6 feet or about 1.8 meters.

3. Use the data listed in the table on the student sheet to map the ocean floor between Cape May and Cape Roca. To plot the points listed in the table, find the distance along the bottom of the graph. At that location, go to the depth and place a point on the graph. Connect the points to see the ocean floor.

4. Label the structure at 3900 km the Mid-Atlantic Ridge and the structure at 3950 km the Azores.



Future Puzzle - Things to Know:

Global warming is the increase in the average temperature of Earth's air and oceans. Global warming is thought to be caused mainly by things that people do, like burning gas to drive cars, burning coal to make electricity, burning oil or natural gas to heat homes, and burning forests to make room for growing crops. The burning of all these things creates gases that trap heat from the Sun. One concern with global warming is that as the average temperature increases, this will cause ice to melt, which could cause the level of the ocean to rise. Many people around the world enjoy living near coasts, but even a small rise in sea levels will cause flooding of areas that are at a low elevation along the beach.

The ice in the north is in the form of a floating polar ice cap, while the ice in the south is mainly in the form of an ice sheet on top of the continent of Antarctica. If the floating ice near the North Pole were to melt, would that make the sea levels rise? What about the ice sheet on top of Antarctica at the South Pole? Solve the puzzle by making a model of the ice at each pole to find out!

What To Do:

Model of the **North Pole** floating polar ice cap

5. Place an ice cube in the beaker. The ice cube represents the polar ice cap.
6. Add cold tap water to the beaker until the water level is at the 50 mL mark on the beaker. If the ice cube is sitting on the bottom of the beaker, add a little more water to the cup. Make sure the ice cube is floating. The water represents the Arctic ocean.
7. Immediately get down at eye level and use the marker to mark on the outside of the beaker the water level.

Model of the **South Pole** ice sheet on top of Antarctica

4. Place a non-porous rock (such as marble or obsidian) in the beaker. The rock represents the continent of Antarctica.

5. Add cold tap water to the beaker until the water level is about 10 mL below the top of the rock. The water represents the Southern Ocean.
6. Place an ice cube on top of the rock. The ice cube represents the ice sheet on top of Antarctica.
7. Immediately get down at eye level and use the marker to mark on the outside of the beaker the water level.
8. Allow the ice in your models to melt in a place where they will not be disturbed. Keep an eye on the ice cube in the South Pole model to make sure it stays balanced on top of the rock, and that the water from the melted ice cube is able to run off of the rock.
9. Once the ice has completely melted in your models, get down at eye level with the water and see if the water level has risen in either of the beakers. If the water level has risen, measure and record the amount of rise with the measuring tape, in millimeters (mm), and record it in the data table on the student sheet.
10. Repeat steps 1-9 for a second trial.
11. Calculate the average for the two trials for the North Pole model by adding the rise for the two trials and dividing by 2. Record the average time in millimeters in the data table.
12. Repeat step 11 to calculate the average for the two trials for the South Pole model.
13. Make a bar graph to compare the rise of the water level in the North Pole and the South Pole models on the student sheet.

Discussion Topics

Discuss how the distribution of fossils and rocks, continental shapes, and seafloor structures provide evidence of past plate motions.

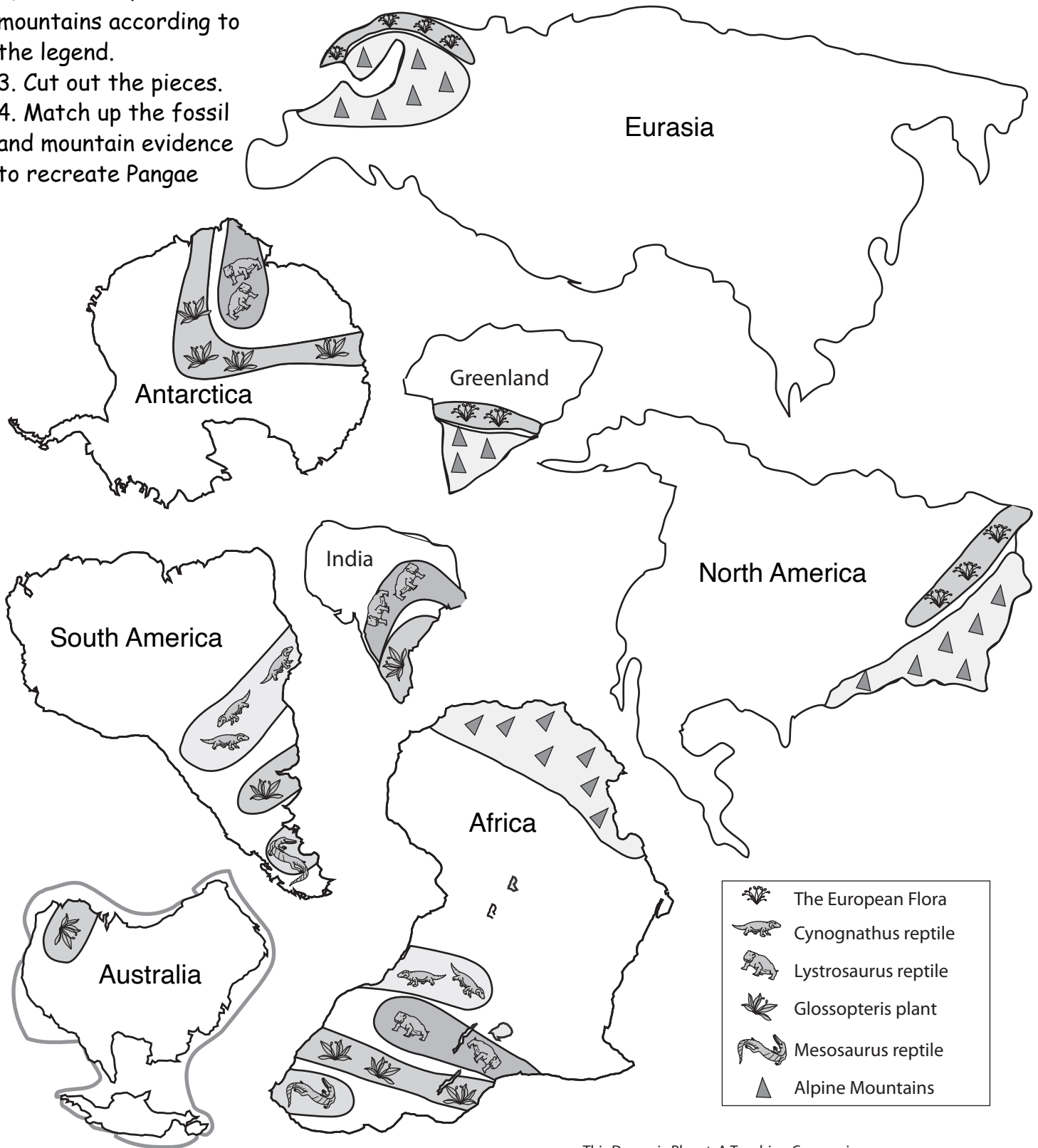
Discuss how geoscience processes are changing the ocean floor.

Discuss the effects of global warming and how the effects might be reduced.

Experiment 8: Ocean Puzzles

Past Puzzle: Pangae and the Ancient Ocean, Panthalassa

1. Create a color legend.
2. Color the fossils and mountains according to the legend.
3. Cut out the pieces.
4. Match up the fossil and mountain evidence to recreate Pangae



Modified From:
U.S. Department of the Interior
U.S. Geological Survey

This Dynamic Planet; A Teaching Companion
Wegener's Puzzling Continental Drift Evidence
U.S. Geological Survey, 2008
For updates see <<http://volcanoes.usgs.gov/about/edu/dynamicplanet>>

Name _____

Date _____

Experiment 8: Ocean Puzzles

Present Puzzle: Mapping the Atlantic Ocean Floor

1. What is SONAR?

2. What is the name of the state and country where Cape May is located?

3. What is the name of the country where Cape Roca is located?

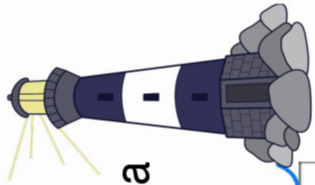
4. What is the name of the ocean that is between Cape May and Cape Roca?

5. What is the name of the nine volcanic islands near Cape Roca?

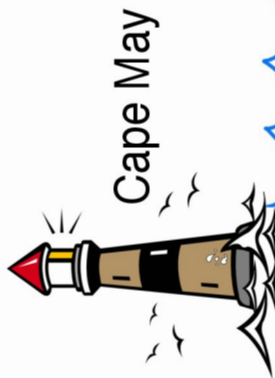
Ocean Depths from Cape May to Cape Roca			
Distance (km)	Depth (fathom)	Distance (km)	Depth (fathom)
0	0	3500	1200
100	100	3600	800
200	1000	3700	700
500	2000	3900	600
800	2500	3950	0
1000	3000	4000	1000
1400	2800	4300	2000
1800	2900	4500	2800
2100	3100	5000	2700
2400	3000	5300	2300
2600	1600	5400	1000
3000	2500	5500	500
3200	3100	5550	100
3400	1800	5600	0



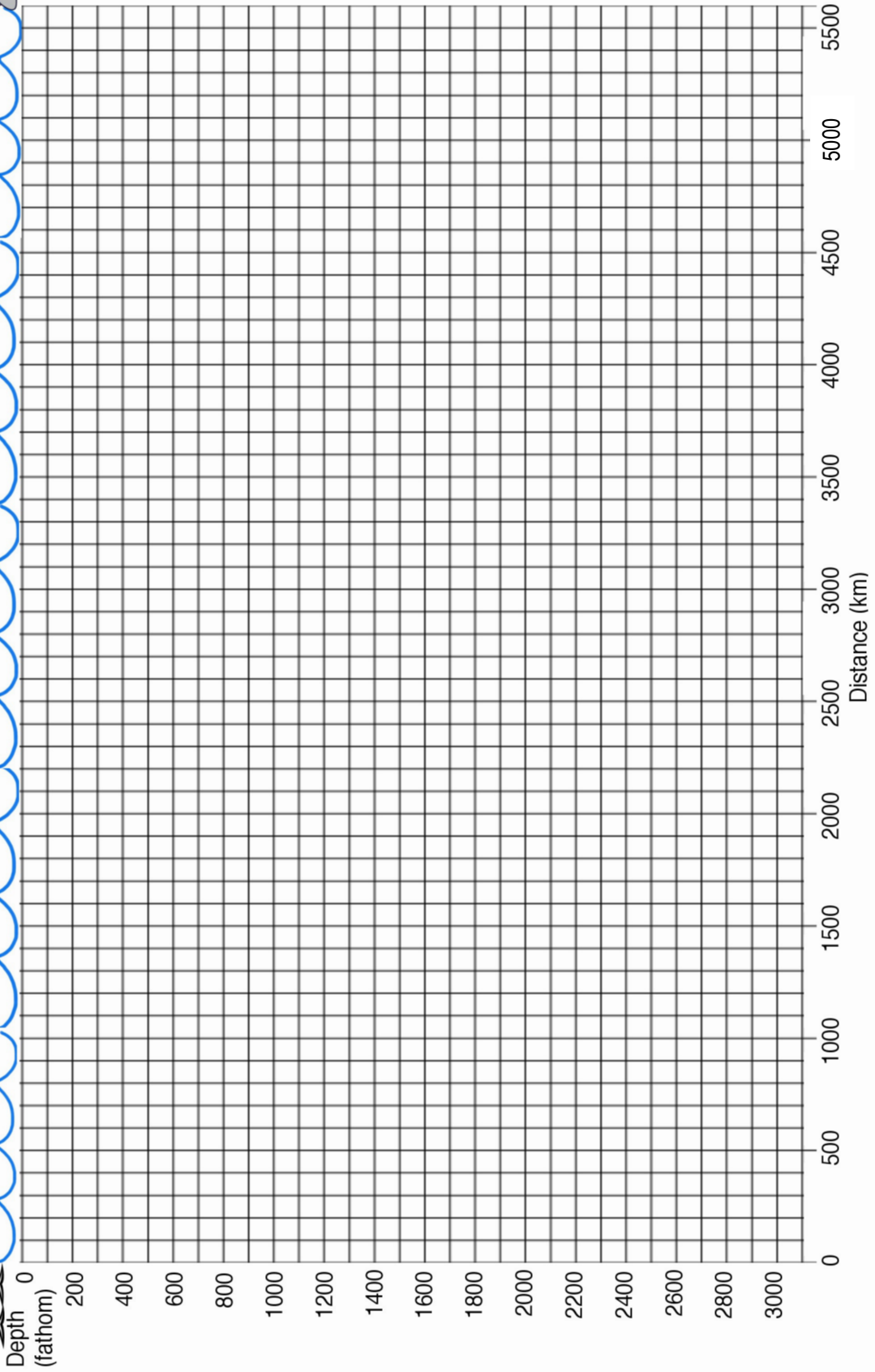
Mapping the Ocean Floor



Cape Roca



Cape May



Name _____

Name _____

Date _____

Experiment 8: Ocean Puzzles

Future Puzzle: Predicting Changes in the Polar Ice Caps

	North Pole Rise in Water Level (mm)	South Pole Rise in Water Level (mm)
Trial 1		
Trial 2		
Average		

Bar Graph of Rise in Water Level vs Polar Cap

