Hess's Method

Overview:

During the teacher demonstration, students will map the topography (or bathymetry, the submarine equivalent of topography) of a shoebox model of the ocean floor using a method similar to the one Harry Hammond Hess used to map the floor of the Pacific Ocean when he was developing the theory of ocean floor spreading. During the student activity, students will use echo location information to construct a map of the sea floor.

Objectives:

The student will:
- understand how to use a ruler to measure the bathymetry of a hidden model;
- graph data gathered;
- understand that Harry Hammond Hess used a similar method to map the floor of the Pacific Ocean, where he found mid ocean ridges and deep ocean trenches;
- construct a map of the sea floor using echo location information; and
- identify the point on the map that represents an ocean trench.

Materials:

- Shoebox with lid
- Plastic bag
- Newspaper
- Plaster of Paris
- Knife
- Ruler
- Transparency: "Hess's Method Graph"
- Student Worksheet: "Hess's Method"

Cultural Tie

ʻŌpeʻapeʻa, the Hawaiian bat, is the only terrestrial mammal native to Hawaiʻi. Bats, as well as dolphins and whales, use echo location to navigate and find food. They send out high-pitched sounds that bounce off objects, creating an echo that returns to the bat. Bats can detect the shape, size and location of objects with great accuracy.

Activity Procedure:

1. The procedure for the optional teacher demonstration can be found at the end of this lesson.
2. Explain to students that they will create their own maps of the ocean floor, using measurements similar to those Hess gathered. Distribute the Student Worksheet: "Hess's Method." Read and discuss the Background Information. Share the Cultural Tie found above.
3. Ask students to look at the map on the second page of their worksheets. Explain that the deepest point in the ocean is located near Guam. This depth, known as the Challenger Deep, lies at the southern end of the Mariana Trench. Ask students to hypothesize the distance between the Challenger Deep and Guam, then ask students to follow the directions to complete the worksheets.
4. After students finish their worksheets, ask them to share their conclusions.

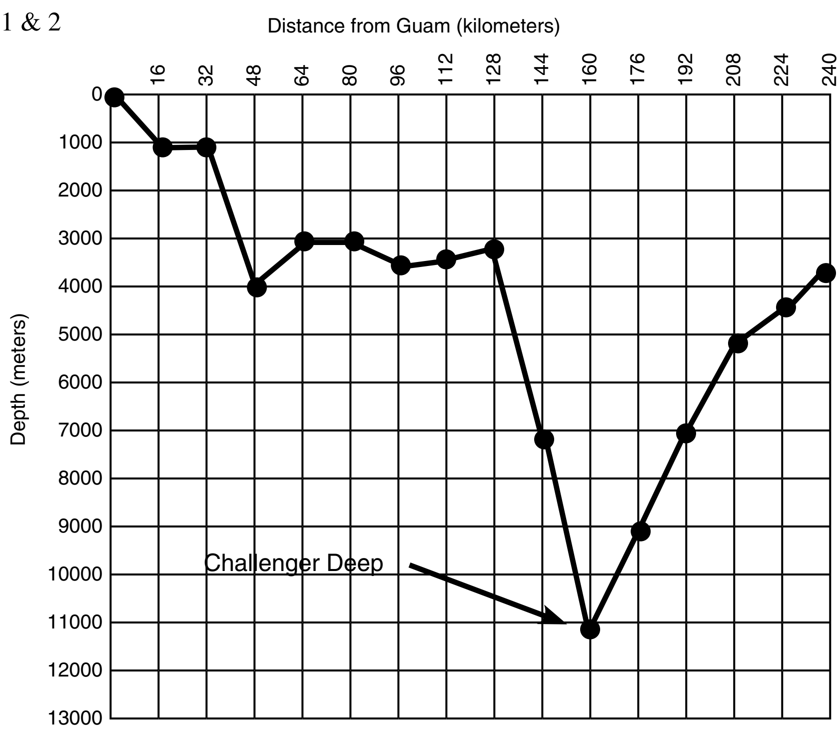
Hess's Method

Sonar Data Table:

Distance from Guam (km)	Total time for echo to return to ship	Time it took for sound to reach bottom	Speed of sound in ocean water	Distance to bottom in meters (Depth)
	Total time in seconds	(Total time ÷ 2)	1500 m/s	(Total time ÷ 2) x 1500 m/s = Distance
0	0	0	1500	0
16	1.34	.67	1500	1005
32	1.34	.67	1500	1005
48	5.22	2.61	1500	3915
64	4.00	2.00	1500	3000
80	4.00	2.00	1500	3000
96	4.88	2.44	1500	3660
112	4.27	2.14	1500	3210
128	4.13	2.07	1500	3105
144	9.47	4.74	1500	7110
160	14.70	7.35	1500	11025
176	12.00	6.00	1500	9000
192	9.33	4.67	1500	7005
208	6.80	3.40	1500	5100
224	5.60	2.80	1500	4200
240	5.07	2.54	1500	3810

Analysis of Data:

1 & 2



Conclusion: If the sonar data collected is accurate, then the distance from Guam to the Challenger Deep is 160 km.

Answers to Further Questions:

1. c) Harry Hammond Hess

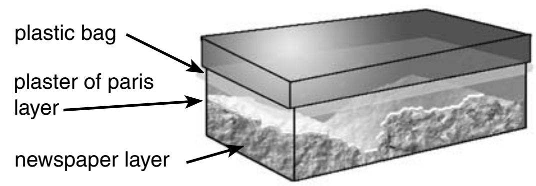
Answers to Critical Thinking:

1. Answers will vary
2. Answers will vary

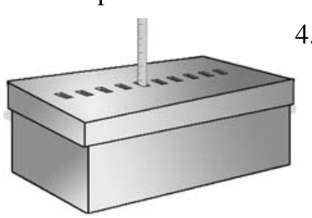
Hess's Method

Teacher Demonstration Procedure:

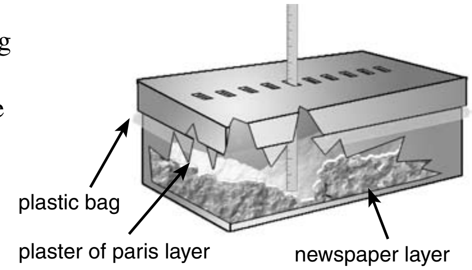
1. Before World War II, not much was known about the ocean floor. The development of sonar during the war made more detailed maps of the ocean floor possible. Harry Hammond Hess, a geologist from Princeton University, was the captain of the assault transport vessel Cape Johnson. While stationed in the Pacific Ocean during World War II, Hess used the echo location (sonar) capabilities of his ship to collect data about the ocean floor. He later used this data to construct a map of the ocean floor that led him to develop the hypothesis of sea floor spreading.



2. In preparation for this activity, make a shoebox model of an ocean trench. Wad up newspaper and place it in the bottom of a shoebox. Over the newspaper, line the box with a plastic bag. Mix plaster of paris and pour it into the plastic-lined shoebox. The plaster of paris should mold over the newspaper, creating a model landscape. Make sure the model includes a noticeable trench. Allow the plaster to dry and the model to harden. While your model is drying, push a knife through the lid of the shoebox, making slits at 2 cm increments wide enough for a ruler to fit through. When the model is dry, place the lid on the shoebox. Do not allow students to look in the box.
3. Explain that students will map the bathymetry of a model of the sea floor in the shoebox. They will create a map similar to the one Hess created when he mapped the topography of the ocean floor. During this activity, the lid of the box will represent the sea surface and the model inside will represent the sea floor. Hess used instruments that measured the distance to the ocean floor from sea level (his boat). These instruments send sound waves through water to take their measurements. Many people use instruments on boats to measure the depth of the water or to find fish. Tell students they will use rulers to take their measurements.



4. Explain that students will measure the distance from the sea surface to the sea floor from each hole in the lid of the shoe box. Demonstrate by inserting a ruler into the first hole. Read the measurement (in centimeters) on the ruler at the level of the lid. Explain that this measurement represents how far below sea level the ocean floor is located. In this activity, 1 cm equals 1,000 m. Ask a student to make a measurement every 2 cm (2,000 m) through the lid. Ask another student to record the data as it is collected.
5. Place Transparency #1: "Hess' Method Graph" on the overhead projector. Ask a student to use a marker to plot the distances measured from the shoe box model onto the transparency, with the depth on the "y" axis and the horizontal measurement on the "x" axis.
6. When plotting measurements, be sure to count down from the top the specified number of centimeters (1,000s of meters) that were measured for each depth, and make a dot for each horizontal location. The top of the graph indicates sea level, and the graph is plotted to demonstrate how far below "sea level" the ocean floor is located. Ask the student to connect the dots on the graph.
7. Discuss student results and unveil the model ocean floor by removing the lid from the box. The model should have the same shape as the dark profile on the transparency. Ask students if they can identify the shallowest point on the graph. If this were a map of the ocean floor, that point might indicate a mid ocean ridge. Ask students to identify the deepest point on the graph. If this were a map of the ocean floor, that point might indicate an ocean trench.



Name:___________________________________ **Student Worksheet**

Hess's Method

Testable Question:

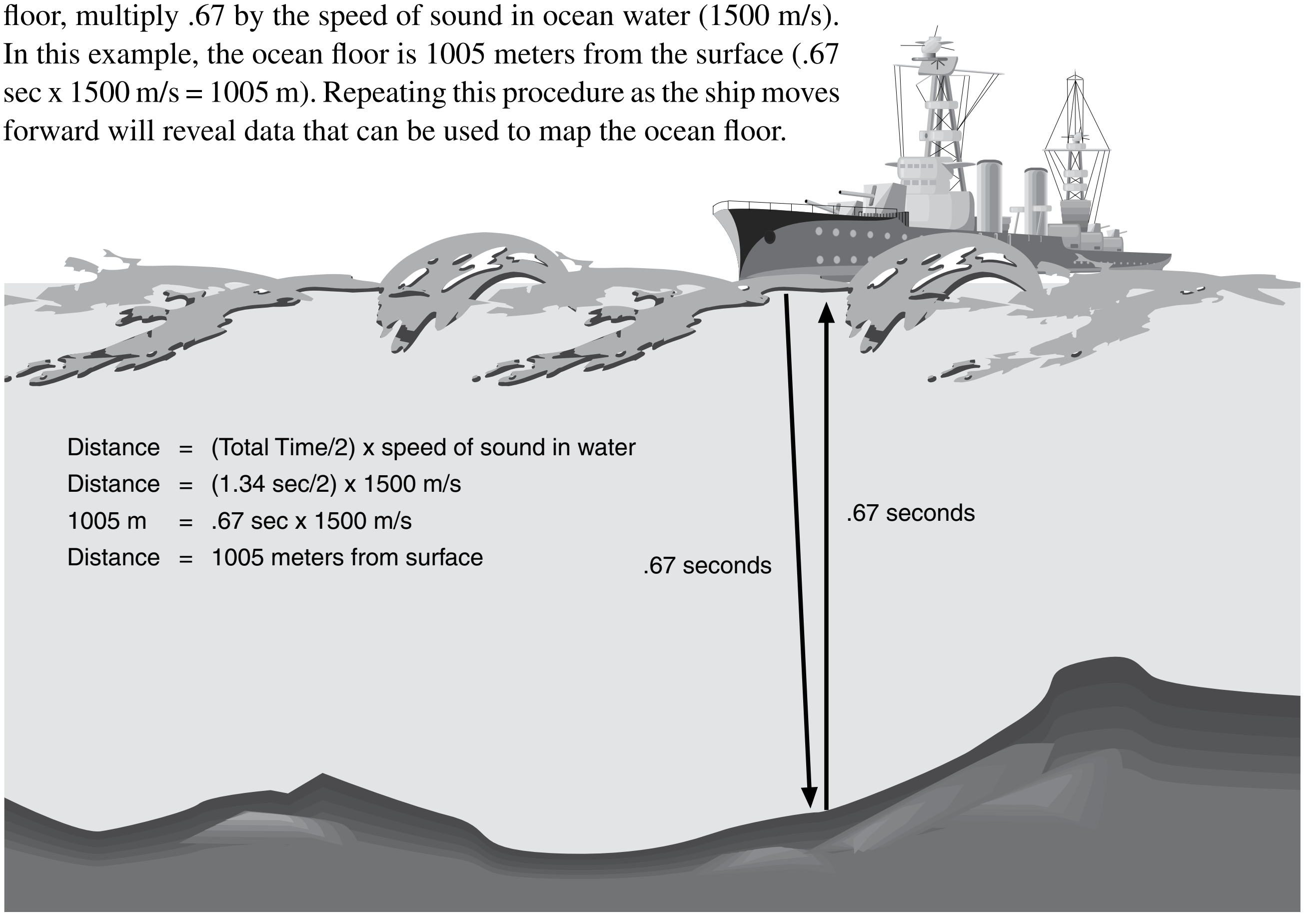
How far from Guam is the Challenger Deep (the deepest point in the ocean)?

Background Information:

Before World War II, not much was known about the ocean floor. With the development of sonar during the war more detailed maps of the ocean floor could be made. Harry Hammond Hess, a geologist from Princeton University, was the captain of the assault transport vessel Cape Johnson. While stationed in the Pacific Ocean, Hess used the echo location (sonar) capabilities of his ship to collect data about the ocean floor. He later used this information to construct a map of the ocean floor that led him to develop the hypothesis of sea floor spreading.

Echo location works by sending out a signal, called a ping, from a ship. That sound bounces off the ocean floor and is reflected back to the ship. By timing how long it takes to hear the echo of the sound, scientists can determine how far it is to the bottom. To determine the distance to the ocean floor, the time of the echo and the speed of the sound in ocean water (1500 meters per second) must be determined.

For example, if a ship sends out a ping that is reflected back in 1.34 seconds, the ping took .67 seconds to go down and .67 to reflect back (1.34 sec ÷ 2 = .67 sec). To find the distance from the ship to the ocean floor, multiply .67 by the speed of sound in ocean water (1500 m/s). In this example, the ocean floor is 1005 meters from the surface (.67 sec x 1500 m/s = 1005 m). Repeating this procedure as the ship moves forward will reveal data that can be used to map the ocean floor.



Name:______________________________________ **Student Worksheet**

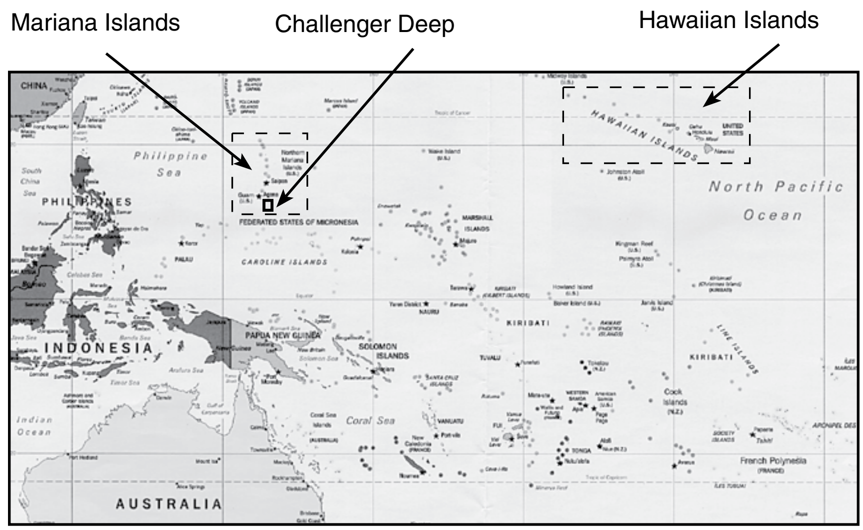
Hess's Method

Hypothesis:

If the sonar data collected is accurate, then the distance from Guam to the Challenger Deep is ________km.

Data:

Below are sonar data recordings from the sea floor near Guam, where the Challenger Deep is located. The sonar data will help you create a map of the bottom of the ocean for this area. Start by completing the Sonar Data Table. The first calculations are done. Be sure to round decimals to the nearest hundredth.



Sonar Data Table

Distance from Guam (km)	Total time for echo to return to ship	Time it took for sound to reach bottom	Speed of sound in ocean water	Distance to bottom in meters (Depth)
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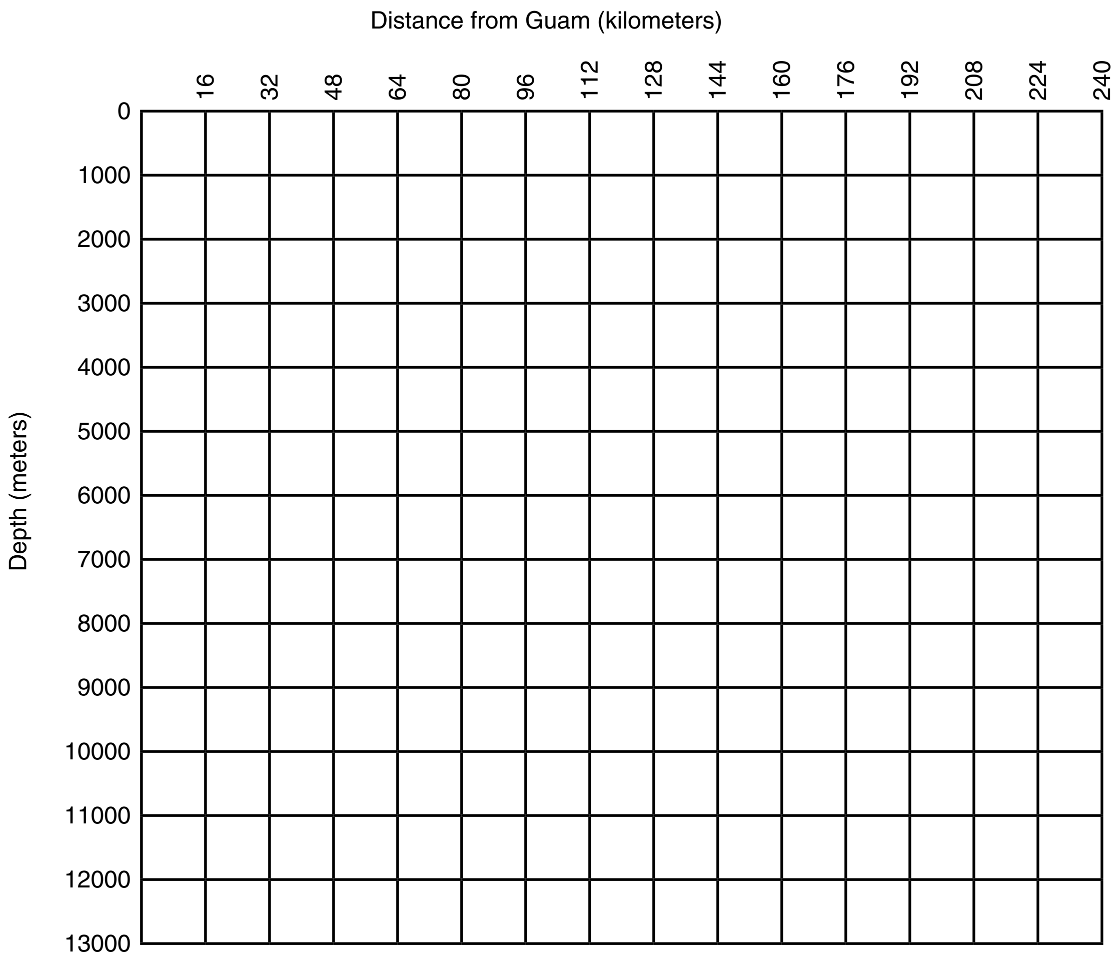
112	4.27		1500	
128	4.13		1500	
144	9.47		1500	
160	14.70		1500	
176	12.00		1500	
192	9.33		1500	
208	6.80		1500	
224	5.60		1500	
240	5.07		1500	

Name:_______________________________________ **Student Worksheet**

Hess's Method

Analysis of Data:

1. Plot the data from the Sonar Data Table on the graph below.



2. On the graph, write "Challenger Deep" on the point that represents the deepest part of the ocean trench.

Conclusion:

If the sonar data collected is accurate, then the distance from Guam to the Challenger Deep is ________km.

Was your hypothesis proved or disproved? Explain your answer.

____

____

Name:____________________________________ **Student Worksheet**

Hess's Method

Further Questions:

1. Who developed the theory of ocean floor spreading?
   a) J. Tuzo Wilson
   b) Pierre Laplace
   c) Harry Hammond Hess
   d) Florence Bascon

Critical Thinking:

1. What is the relationship between the time it takes for a sonar ping to return to the ship and the depth of the ocean?

   ____

   ____

   ____

   ____

2. How is the ruler and shoebox model of ocean floor mapping similar to and different from Hess's method of mapping the ocean floor? Complete the diagram below.