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Galapagos Rift Expedition

AdVENTurous Findings on the Deep Sea Floor

Focus:
Vent development along the Galapagos Rift

Grade Level
5-6

Focus Question
What causes hydrothermal vents to form?

Learning Objectives
The students will conduct investigations to observe formation of precipitates.

The students will create a model of a developing hydrothermal vent.

The students will generate comparisons between the created hydrothermal vent model and the actual hydrothermal vents developing along the Galapagos Rift.

Additional Infromation for Teachers of Deaf Students
The words listed as key words should be introduced prior to the activity. There are no formal signs in American Sign Language for any of these words and many are difficult to lip-read. If some of this information has not already been covered in your class, you may need to add an additional class period to teach vocabulary and teach some of the background information to the students prior to the activity.

The steps of activities for both days can be written on the board and covered with paper. As each step is done then they can be revealed. This is a very visual activity and represents the concept well to the students.

Materials
Part 1—For each group of 3 to 4 students:
- ❒ 2 to 3 pictures of hydrothermal vents downloaded from the NeMo Explorer website at http://www.pmel.noaa.gov/vents/nemo/explorer.html and www.divediscover.whoi.edu
- ❒ One copy of the activity entitled "Make Your Own Deep-sea Vent!"
- ❒ 1 large glass container, gallon capacity
- ❒ 1 small bottle, 8 oz capacity (or less)
- ❒ 5 drops of red food coloring
- ❒ A piece of cotton string, I meter in length, cut so it hangs over the edge of the large container but does not touch outside surface.
- ❒ Cold water (approx. 15 degrees C), enough to fill each gallon capacity container for each group of students
- ❒ Hot water (approx. 80 degrees C), enough to fill the small 8 oz. bottle for each group of students

Part 2—For each group of 3 to 4 students:
- ❒ 50 ml water
- ❒ 5 ml calcium chloride (Damp Rid, used to remove moisture from closets and other damp areas, can be found easily in stores or you can use road salt used to clear roads in the winter)
- ❒ 5 ml baking soda
- ❒ 8 oz clear plastic cup

Teaching Time

Two periods of 60 minutes each

Seating Arrangement

Groups of 3 or 4 students

Maximum Number of Students

30 students

Key Words

Hydrothermal vent
Magma
Geysers
Rift
Mantle
Molten
Precipitate
Chemical reaction
Continental plates

Background Information

Rifts and hydrothermal vents offer a real life example of how transfer of energy affects solids and liquids. Rifts occur on the ocean floor where drifting continental plates are separating. The rift, the area in the crust where the plates separate, creates an opening in the crust where the cold water of the deep ocean is exposed to the Earth's mantle. The mantle, with an average temperature of 1000°C, consists primarily of molten rock and minerals. When the continental plates separate, the magma of the mantle rises to fill the gap in the crust. When this molten rock comes in contact with the cold ocean water (near 2°C), the energy of the magma is transferred to the water, the magma lowers in temperature, and the minerals in the magma form bonds that create new solid rock sea floor crust.

Deep hydrothermal vents are underwater hot springs, yet they are different from the geysers that often burst out of volcanic areas on land. The great pressures on the bottom of the sea cause the difference. This pressure keeps water from boiling. Great pressure also speeds up many chemical reactions, so deep hydrothermal vents often erupt into the ocean as superheated plumes of water that are laced with the minerals of the volcanic rocks below. These minerals are what give the hot water plumes their color.

Hydrothermal vents, etiher shallow of deep, often form on the newly-minted hot, volcanic oceanic crust, which is created during the process of sea floor spreading. The thin, new ocean crust has cracks in it through which ocean water can seep down to the hotter mantle below. As the ocean water comes in contact with the magma of the mantle, the energy of the magma is transferred to the water, which becomes superheated. The heated water molecules are less dense than the cool ocean water, and will begin to rise. The underground water also dissolves minerals from the surrounding magma and rock. As the water rises, it carries the minerals from the magma with it. When the heated minerals come in contact with cooler water again, the energy from them is transferred out and the minerals precipitate and settle to the ocean floor. As the minerals settle they form structures that resemble chimneys with the hydrothermal vent in the middle. Thus, the transfer of energy between magma and water creates new ocean floor structures.

Learning Procedure Part 1 (Day 1):

1. Using the Background Information, discuss with the students what hydrothermal vents are and where they are found. Distribute pictures of hydrothermal vents downloaded from the NeMo Explorer website: http://www.pmel.noaa.gov/vents/nemo/explorer.html and www.divediscover.whoi.edu
2. Explain to the students that explorers from the National Oceanic and Atmospheric Administration, Woods Hole Oceanographic Institution, and other university scientists on the Galapagos Rift Expedition are looking for hydrothermal vents on the bottom of the deep sea floor. Discuss with the students that hydrothermal vents release extremely hot water, minerals, and gases from the Earth's crust to the surrounding cold water of the deep sea.

3. Distribute one copy of the activity entitled "Make Your Own Deep-sea Vent!," to each group of students. Ask the students the following question: "How can you model the action of the heated water rising from the cracks of hydrothermal vents as it mixes with the surrounding cold water?"
4. Provide each group of students with a piece of string and red food coloring. Tell the students that each group will be getting cold water to put in a large glass container and hot water to put in a small container.
5. Ask one student from each student group to come up to the front of the room to collect their samples of hot and cold water.
6. Ask the children to follow the directions on their Activity Sheet. The students will record their results and draw their conclusion.
7. Allow each student group to report their results and conclusions to the class as a whole.
8. Guide the students to recognize that underwater hot springs that are found on the new oceanic crust are formed by the rifts in the ocean floor. The thin, new ocean crust has cracks in it through which ocean water can seep down to the hotter mantle below. As the ocean water comes in contact with the magma of the mantle, the energy of the magma is transferred to the water, which becomes superheated. The heated water molecules are less dense than the cool ocean water, and will begin to rise.

Learning Procedure Part 2 (Day 2)

1. Have one student from each group come to the front of the room to collect the necessary materials for their group to conduct the investigation (See Materials, Part 2).
2. Ask the children observe the calcium chloride and baking soda separately. Ask them to identify one person in their group to record their observations. Provide time for each group to share observations with the other groups.
3. Ask the children to identify one person in their group to put the calcium chloride and baking soda into the 8 oz. cup.
4. Ask the children to continue to make observations and record these observations.
5. Ask the class the following question, "Do you observe any changes now that the solids are combined?" Allow the children the opportunity to record their observations and group share with the entire class.
6. Ask the children to identify someone in their group to add the water to the two solids.
7. Ask them to discuss what is happening within their group and to record their observations. Let the students group share with the class as a whole. Explain that what they are seeing is a chemical reaction. The bubbles are carbon dioxide gas, which is given off during this reaction.
8. Ask the students the following question, "What do you see developing in the bottom of the cup?" Allow time for them to discuss as a group, record their observations, and group share with the class as a whole. The children should describe seeing a white substance. Explain that the white substance is calcium carbonate, and is called a precipitate.
9. Explain to the children that what they have observed is similar to the process that causes hydrothermal vent chimneys to form on certain regions of the deep sea floor. When the heated minerals dissolved in hot water coming from beneath the seafloor come in contact with cooler water again, the energy from them is transferred out and the minerals precipitate and settle to the ocean floor. As the minerals settle, they form structures that resemble chimneys with the hydrothermal vent geyser in the middle. Thus, the transfer of energy between magma and water creates new ocean floor structures.

The BRIDGE Connection:

http://www.vims.edu/BRIDGE/vents.html

Go to this site for a BRIDGE Ocean AdVENTure on hydrothermal vents.

The "Me" Connection

Have the children explore possible uses by humans for the precipitates found around a hydrothermal vent site. What creative invention could the children make using these newly- found precipitates and what would they name their new invention?

Connection to Other Subjects

English/Language Arts

Evaluation

Observe the children during Part 2 of the activity to ensure they are using all the components of a scientific investigation. Written responses in a science notebook may be evaluated for understanding how precipitates are formed, if students record these findings individually.

Extensions

Have your students visit http://oceanexplorer@noaa.gov and www.divediscover.whoi.edu with a member of their family each day to keep up to date with the latest Galapagos Rift Expedition discoveries.

Resources

http://oceanexplorer@noaa.gov and www.divediscover.whoi.edu - Follow the Galapagos Rift Expedition daily as documentaries and discoveries are posted each day for your classroom use. A wealth of resource information can also be found at both of these sites.

http://www.pmel.noaa.gov/vents/nemo/explorer.html - A wealth of information on hydrothermal vents.

http://pubs.usgs.gov/publications/text/exploring.html "Exploring the deep ocean floor: Hot springs and strange creatures"

http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/ps_vents. html "Creatures of the Thermal Vents"

National Science Education Standards

Content Standard A: Science as Inquiry

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

Content Standard B: Physical Science

- Properties and changes of properties in matter

Content Standard D: Earth and Space Science

- Structures of the earth system
- Earth's history

For More Information

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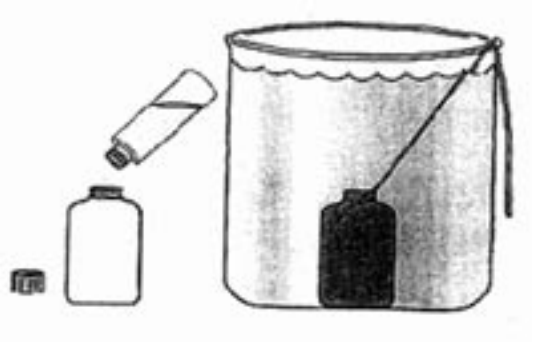
Student Handout

Make Your Own Deep-Sea Vent!

Materials:
1 large glass container
1 small bottle
Food coloring
A piece of string
Hot and cold water

Directions:
1. Fill the large glass container with very cold water.
2. Tie one end of the piece of string around the neck of the small bottle.
3. Fill the small bottle with hot water and add a few drops of food coloring.
4. Keeping the small bottle upright, carefully lower it into the glass container until it rests on the bottom.
5. Watch what happens!



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