OIMB GK12 CURRICULUM

5th Grade **60 minutes**

HYDROTHERMAL VENT FORMATION

Adapted from For Sea

Oregon Science Content Standards:

5.2 Interaction and Change: Force, energy, matter, and organisms interact within living and non-living systems.

5.2L.1 Explain the interdependence of plants, animals, and environment, and how adaptation influences survival.

5.3 Scientific Inquiry: Scientific inquiry is a process of investigation based on science principles and questioning, collecting, describing, and examining evidence to explain natural phenomena and artifacts.

5.3S.1 Based on observations and science principles, identify questions that can be tested, design an experiment or investigation, and identify appropriate tools. Collect and record multiple observations while conducting investigations or experiments to test a scientific question or hypothesis.

5.3S.2 Identify patterns in data that support a reasonable explanation for the results of an investigation or experiment and communicate findings using graphs, charts, maps, models, and oral and written reports.

5.3S.3 Explain the reasons why similar investigations may have different results.

Ocean Literacy Principle:

1. The Earth has one big ocean with many features.
5. The ocean supports a great diversity of life and ecosystems.
7. The ocean is largely unexplored.

Goals: To introduce students to hydrothermal vents through an experiment on supersaturation and precipitation.

Concepts:

- Hydrothermal vents, plumes of hot, mineral rich water, are found along spreading centers on the ocean floor.
- More salts can be dissolved in warm than cool water.
- When a liquid can hold no more solute (in this case salts), it is supersaturated.
- When a supersaturated solution is cooled, some of the solute (salt) will precipitate out.

Materials:

- PowerPoint of Hydrothermal Vents.
- Videos at http://www.ocean.udel.edu/deepsea/level-1/creature/creature.html
- Experiment Worksheet, one per student

- 1 liter measuring cup
- Heat resistant cup, one per group
- Thermometers, one per group
- Spoons, one per group
- Hot pot, or way of heating water
- Large box of salt
- sandwich baggies that zip shut, one per group
- Ice, a few cubes per group
- sink

Background:

Hydrothermal vents were discovered quite recently. In 1972 along the Galapagos Rift, temperature and chemical samples revealed that seawater was circulating through newly formed oceanic crust. In 1974, dives with submersibles showed new crust forming in a 1 km wide zone in the rift, as well as outside the rift. In 1977, the submersible Alvin made 24 dives to the 2500m deep rift. The pilot and 2 scientists were able to see the vents! The mineral rich water near the vents was much, much hotter than the surrounding seawater; rocks were coated with chemical deposits precipitating out of the vent water; and AMAZINGLY, communities of never-before-seen animals were living in a world of darkness and far away from surface food sources. The vent water is rich in hydrogen sulfide gas. Hydrogen sulfide is poisonous to most animals, but in the vent community, it is the basic source of energy supporting life. Chemosynthesis, rather than photosynthesis, fuels the vent community.

Since the late 1970s, other hydrothermal vents have been found, such as near the tip of Baja California. What is happening? Along spreading centers, sea water seeps into cracks in the crust and down 10-12 km to the mantle where it is superheated (as high as 1000 degrees C). As the water heats, it dissolves particles in the crust, mostly sulfides. Eventually the sulfide-rich water returns to the ocean floor through a restricted area called a vent. The salinity of water escaping through vents has been measured at over 7 times the normal salinity of seawater (253 parts per thousand, compared to 35 ppt). The temperature of the water exiting the vents can be 350 degrees C (when the Alvin first attempted to take temperature readings, the PVC housing of the recording instrument melted). A few centimeters away, temperatures are 2-4 degrees C, normal for these depths. When the supersaturated water escapes, the water quickly mixes with the surrounding water, cooling it rapidly. The dissolved particles precipitate out, collecting on the sides of the vent, eventually forming chimneys as high as 20-30 meters (the largest is even taller, 50 meters, and is 270 miles off the coast of Washington at the northern end of the Juan de Fuca spreading center). Precipitates that remain suspended in the rising vent water look like smoke. This is why these vents are sometimes called smokers.

Lesson Plan:

1. Ask the students what they know about hydrothermal vents and the animals that live there.

2. Show the PowerPoint and videos and introduce the points covered in the background section.
3. Tell the students that they will conduct an experiment to learn about supersaturation and precipitation.
4. Divide the students into groups.
5. Go over the experiment (refer to worksheet) and assign roles (teacher should be the one to pour warm, not too hot, water)
6. Students work through the experiment and record their data.
7. Discuss whether cold or warm water held more dissolved salt.
8. Discuss why there might be differences in the student results (different rates of stirring, different amounts in each spoonful, different water temperatures, etc.)
9. Compare what the students did with what happens at hydrothermal vents.

Assessment: Experiment worksheet

Source: Adapted by GK12 Fellow Myndee McNeill from Kolb, James, A. 2001. Marine Science Explorations, Instructional Materials, Lessons, Activities and Resources for Teaching Marine Science. For Sea Institute of Marine Science, Indianola, WA. (Disc)

Name:_____

Hydrothermal Vent Formation (adapted from For Sea)

We are going to replicate the process of precipitation that leads to the formation of deep sea hydrothermal vent chimneys.

Procedure/Data Collection:

1. Measure 500 mL of tap water (from the sink) into your cup.

Record the temperature of the water: _____

2. Add one small spoonful of salt to your cup. Stir until completely dissolved.

3. Continue adding and stirring the salt, one spoonful at a time, until no more salt can dissolve. Stop.

How many spoonfuls of salt did you put into the cup?_____

4. The water is now **saturated** with salt.

What does saturated mean?_____

5. Wash out your cup, and measure 500 mL of HOT water into your cup.

Record the temperature of the water: _____

6. Add one small spoonful of salt to your cup. Stir until completely dissolved.

7. Continue adding and stirring the salt, one spoonful at a time, until no more salt can dissolve. Stop.

How many spoonfuls of salt did you put into the cup?_____

8. Put a baggie of ice into your cup of hot water. Observe and record your observations.

What are your observations?

What do you think was happening in the cup when the ice was added to it?

What do you think is forming in the cup?

CONCLUSION:

Does HOT water hold more or less salt than COLD water?

At hydrothermal vents, salts come out of the water after the water comes out of the vent and starts to cool, forming a chimney around the vent. Why do you think this happens?