Exploring Ocean Acidificaiton

Overview:
This activity demonstrates the effect of increased acidity on the calcium carbonate skeletons of corals and allows students to investigate the effect of various levels of acidity on calcium carbonate.

Grade level:
7th – 12th

Materials:
- Chalk
- Vinegar
- Beaker or cup

Time required:
Demonstration: 5 minutes.
Extension Activity: two 45 minute class periods

National Park Service
www.nps.gov/index.htm

Pacific Island Network Inventory & Monitoring Program
National Park Service
www.science.nature.nps.gov/im/units/pacn/

Integration & Application Network (IAN)
University of Maryland Center for Environmental Science
www.ian.umces.edu

Objectives
- Students will understand that coral skeletons are made of calcium carbonate.
- Students will understand that calcium carbonate dissolve under acidic conditions.
- Students will understand that increased carbon dioxide in the atmosphere from burning fossil fuels dissolves in the ocean and increases ocean acidity.
- Students will build/enhance inquiry and investigation skills.

National Science Education Standards
9-12 Standard D: Earth and Space Science
- Energy in the Earth System

9-12 Standard F: Science in Personal and Social Perspectives
- Natural Resources
- Environmental Quality
- Natural and Human Induced Hazards
- Science and Technology in Local, National, and Global Challenges

Procedure
Introduction
Review the following information about pH with students. pH refers to the acidity or base of a solution. An acid has a low pH (0-6), which indicates a high concentration of hydronium ions. A base has a high pH (8-14), which indicates a low concentration hydronium ions.

Neutral pH is 7. Ocean water has a pH of around 8. As humans burn fossil fuels they create carbon dioxide gas. When this gas dissolves in water, it makes the water more acidic and the pH of the ocean water may decrease from 8 to 7.5. When ocean water becomes acidic, the calcium carbonate that makes up the coral skeletons and snail shells can dissolve.

In this activity the chalk represents coral. Chalk and coral are both made of calcium carbonate. We don't want to use coral for this demonstration because we do not want to contribute to the destruction of reefs or beach resources. The vinegar represents acidic sea water. Vinegar is much more acidic (2.4) than sea water is predicted to become due to climate change (7.4). This creates a much faster and more vigorous reaction. In the extension activity the students can investigate the rate of dissolution of a piece of chalk in liquids with a range of pH measurements.

Demonstration
1. Show students the piece of chalk and explains that it is composed of the same chemicals that make up coral skeleton.
2. Show the students a beaker containing vinegar and explain that vinegar is acidic. Also explain that burning fossil fuels creates carbon dioxide (CO_2).

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CO2 can dissolve in water, causing the ocean to become more acidic.

3. Place the chalk in the vinegar; it will bubble and dissolve.

Discussion Questions

- What happened when the chalk was placed into the vinegar?
- What would happen to corals if the ocean water became as acidic as vinegar?

Extension Activity

1. After watching the demonstration, students are encouraged to come up with a related experiment. They can investigate questions such as: How does the time required for the chalk to dissolve change if the concentration of vinegar is changed? How does the time required for the chalk to dissolve change if it is placed in liquids of varying pH?
2. After developing a question the students should identify their independent variable, their controlled variable, and their dependant variable.
3. Have students develop their materials and methods, including how much liquid they will use, how big the piece of chalk will be, and how they will determine when the chalk has completely dissolved. The students should create a data table to record their data.
4. After the teacher has checked each group/student's question, variables, materials and methods, they can begin their experiment.
5. Students should follow their methods and perform their experiment.

Conclusion questions

- What were your independent variables?
- What variable led to the fastest reaction? What was the pH of this variable?
- What variable led to the slowest reaction? What was the pH of this variable?
- Based on your data what can you conclude about the effects of decreasing pH of ocean water on coral skeletons? Write 3 -5 sentences. Use specific examples from your data.

Additional Resources

- Global warming and ocean acidification information from NOAA:
  http://www.ncdc.noaa.gov/oa/climate/globalwarming.html
  http://coastalmanagement.noaa.gov/climate.html
  http://oceanservice.noaa.gov/education/kits/estuaries/media/supp_estuar10f_ph.html
- Ocean acidification information from NRDC: http://www.nrdc.org/oceans/acidification/
- Diagram of the pH of various chemicals: http://staff.jccc.net/PDECELL/chemistry/phscale.html
- Graphic of the effect of increasing ocean acidity on corals: http://www.barrierreef.org/WhyResearch/TheReefandclimatechange/Whatisoceanacidification.aspx
- C-MORE Science Ocean Acidification Kit (Only available in Hawaii, Oregon, California, and Massachusetts.) http://cmore.soest.hawaii.edu/education/teachers/science_kits/ocean_acid_kit.htm