Frozen in Time: Ice Cores

Hook: Why do scientists care about the big blobs of ice in the polar regions? How do they study it, and what can they learn from it? What can the ice tell us about the earth's history?

Contact

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Overview/objectives

In this lesson, students observe and measure ice cores to simulate the study of ice cores by glaciologists. They will count the number of years of snow accumulation represented by their cores and graph their data to discover trends of annual snowfall.

Grade level
Grades 3-6

Standards

Content Standard B: Science As Inquiry
Content Standard C: Physical Science
Content Standard E: Earth and Space Science
Content Standard G: History and Nature of Science

T**eacher Preparation**

Make 3 sets of ice cores for each group of 3 students: Pour a 3 cm column of water into the orange juice can and place can in freezer. Mix food coloring with water to make a grayish color. Remove can from freezer when the water is frozen and pour a 1cm column of the gray water on top of the original 3-cm column of water. Place in freezer until the second layer is frozen. Continue pouring and freezing alternating clear and gray water into the can until the can is full in the following order: 2 cm clear water, up to1 cm gray water, 4 cm clear, up to 1 cm gray, 5cm clear, and one cm gray. Label the can "Core 1" and label the

bottom and top of the can. Repeat this procedure for the other two ice cores using varying amounts of clear water, and 1 cm of gray water. Label the cans "Core 2" and "Core 3," and label each bottom and top.

Materials

Block of wood
Drill
Hollow core bit
Per group of 3 students:
- 3 empty 16-oz orange juice cans
- water
- food coloring
- white paper
- colored pencils
- metric rulers
- bowl of hot water
- scotch tape
- graph paper

Time

Engagement

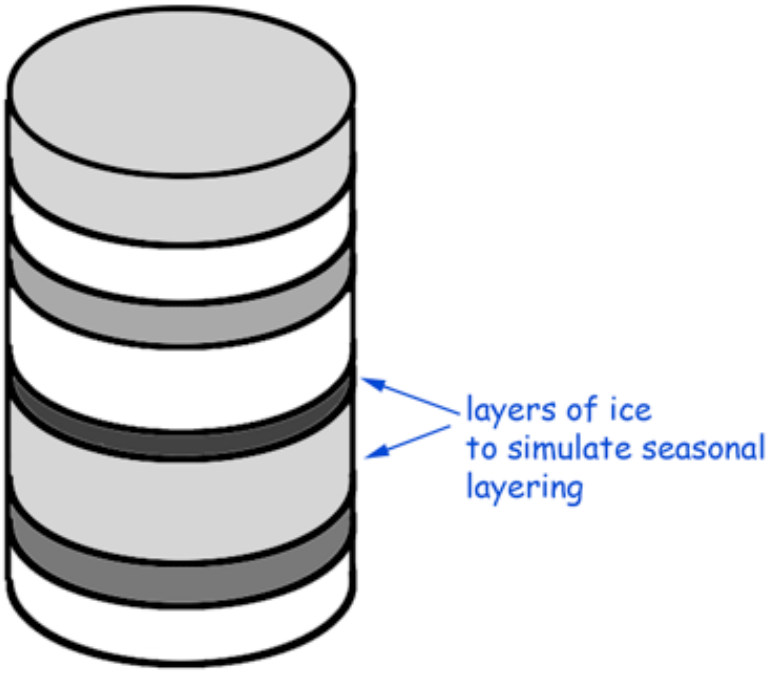
1. Explain to the class that one way scientists study glaciers is by drilling down into the ice to extract a column of ice that they can visually inspect. Demonstrate how an ice core is drilled by drilling a core of wood using a hollow core bit. Pass the core around the class and direct the students to notice the layers in the wood. Ask the class what they think these layers are.

2. Explain that glaciologists use a similar method to extract ice from glaciers except on a much larger scale. Show pictures to the class of scientists drilling cores (http://www.secretsoftheice.org/icecore/cores.html). Hollow drill pipe is used extract the core in segments. The driller may drill a total of 2 miles, but bring out the ice one meter at a time. Once they extract the cores, they use them to study the climate history of the core's location. One way they do this is to figure out the annual snowfall for that location and compare it to other core locations. This allows them to see what the ice looks like very deep below the surface. Show a picture of an ice core (http://www.pbs.org/wgbh/nova/warnings/stories/ ; click on "Ice Core Timeline", and then click on "Dating"). Tell the class that they will be studying their own simulated ice cores in a manner similar to the glaciologists.

3. Give each group of 3 students a set of three cores. Explain that these frozen cans of water simulate the ice cores collected by glaciologists. Each group will stack their cores on top of each other in order to visualize the core before it was

drilled: core 3 will be on the bottom, then core 2 on top of core 3, and core 1 on the very top. Explain that the cores are numbered in the order that they were drilled, from top to bottom, and that the orange juice can represents the drill pipe.

4. Each student takes one core and peels the cardboard off the ice. This can be helped along by dipping the can in the bowl of hot water to melt the outer layer of ice away from the can. Caution them to remember which ends are the top and bottom because the ice itself is not labeled. Place the bottom of the core on the desk so that it stands vertically.



5. The class will share their initially observations. Direct them to notice the layers if they don't mention them. Ask what they think these layers are.

6. Give each student a piece of paper. They will label the paper at the top with their core number. Students will draw their core to scale, including the layers, by using the colored pencils and rulers. Each group will then tape their core depictions together so that they are in order from bottom to top.

7. Students may dispose of their cores in the sink once they are finished examining and drawing the cores.

Explanation

8. Elicit from the class their ideas about the layers of ice: How did they form? Why are there layers? Explain that the layers are similar to tree rings in that each layer represents a different period of snowfall and subsequent freezing. The light-colored layers are snow that accumulated in the winter and the darker

layers are those that accumulated in the summer. Ask: which layers are thinner, darker or lighter layers? Why? (Darker layers are thinner. They accumulated during the summer, which has less snowfall). Challenge the class to think of a reason that the summer layers are darker than the winter layers (during the summer, there is periodic melting and refreezing, causing the ice to become more dense and thus, slightly darker).

Elaboration

9. Explain that since each couplet of light and dark layers represents a summer and winter, then each couplet represents a year of snowfall. The couplets can be counted like tree rings to determine how many years of ice the core contains. Direct the students to count their couplets and record the number years of ice their core contains. They will then determine how much snow fell each year.

10. Explain to the class that once cores are brought back to the lab, scientists do a series of chemical tests on the ice to determine atmospheric and climatic conditions at the time of snowfall. One such test is an analysis of the strontium-90 and cesium-137 content. These radioactive elements were part of the nuclear fallout during the 1950's nuclear bomb testing in the Pacific Ocean. Once they entered the atmosphere, they drifted with prevailing winds and eventually fell with the snowfall in Antarctica. They were subsequently trapped in the ice and became part of the ice core record. By pinpointing the depth in the ice of high levels of strontium-90 and cesium-137, scientists can in turn date the ice at that point as being the year of the nuclear testing (1955).

Exchange

11. Tell the class that in the case of their cores, the peak of strontium content occurs at 10 cm above from the bottom of the core. Therefore, the 10-cm mark represents the 1955 snowfall. Ask: did it happen in the summer or winter? Have them make a tick mark on their drawing at the 10-cm mark and label it 1955. Then have them make tick marks and label each year at the beginning of the winter layer along their core drawing.

12. Direct students to draw a line graph showing the amount of snow accumulation for each year. The vertical axis will be the amount of ice (in cm), and the horizontal axis will be the year. They should study their graph to determine which year had the most snowfall, which year had the least, and if there is an overall trend in snow accumulation (an overall increase/ decrease, or no real trend, multiple trends of gradual increase then gradual decrease or vice versa).

13. Direct students to make a bar graph showing the amount of snow accumulation for each winter and summer of their core. Use one pencil color for winter accumulation and a different color for summer accumulation. The vertical

axis will be the amount of accumulation in cm, and the horizontal axis will be the respective years represented by the ice core. They will answer the following questions on the graph: which winter had the most accumulation? Which summer?

(Student Master on following page.)

Name_____ Frozen in Time: Ice Cores

Directions: using your ice core depiction and both of your graphs, answer the following questions:

1. What is an ice core?

2. Why do scientists drill ice cores?

3. How do scientists drill ice cores?

4. Why does the ice have layers?

5. How long (in cm) was your group's ice core? _____

6. How many years of ice did your core contain?_____

7. Which year had the most snow accumulation in your core? _____

8. How can you tell the winter snow from the summer snow?

9. In which season does more snow fall, summer or winter? Why?

10. What trend did you see in the accumulation of snow through time?

11. What year had the most accumulation of snow in the winter? _____

12. What year had the least accumulation of snow in the winter? _____

13. What year had the most accumulation of snow in the summer?_____

14. What year had the least accumulation of snow in the summer?_____

Evaluation may be based on:

1. the accuracy and completion of the ice core drawing
2. the accuracy and completion of both graphs
3. level of understanding of the basic concepts as demonstrated on the student master

Background

Glaciologists, scientists who study glaciers, go to the polar regions to learn about the earth's past and present climate in order to predict future climatic change. One method of studying climatic history is to drill ice cores up to 70 meters deep. The ice that is extracted from the core is formed by successive accumulations of snow that compact and freeze due to the weight of the overlying snow layers. Distinct layers of ice in the cores represent annual snow accumulations, much like tree rings represent the annual growth in trees. One year of snow accumulation can be seen in the core as a couplet of a light-colored ice layer and a thinner, darker colored layer. The light-color is snow that fell in the winter months, and the darker layer is snow that fell in the summer months. By counting the layers, glaciologists can determine the number of years represented by the ice core. This in turn leads to an understanding of how snowfall and climate have changed over time.

In addition to the snow, thin radioactive layers and volcanic ash may also be present in the cores. Glaciologists use these to help date the various layers of ice. Nuclear-bomb tests in the Pacific lead to the distribution and fallout of radioactive material around the globe. The fallout has been trapped in the ice and can help pinpoint the date of a particular layer of snowfall. By knowing the date of the nuclear tests and testing the snow layers for the presence of strontium-90 and cesium-137 (only formed during nuclear bomb explosions), glaciologists can date the layers of snow that contain high levels of these isotopes (personal communication; Gordon Hamilton, University of Maine, US International Trans Antarctic Scientific Expedition).

Resources

Ice Core Contributions to Global Change Research: Past Successes and Future Directions
http://www.nicl-smo.sr.unh.edu/icwghtml.html

NOVA: Stories in the Ice
http://www.pbs.org/wgbh/nova/warnings/stories

Scecrets of the Ice; an Antarctic Expedition
http://www.secretsoftheice.org

International Trans-Antarctic Scientific Expedition
http://www.ume.maine.edu/USITASE/index.html