



Lesson Title: Ice Cores: The Past is the Key to the Future!

NSF GK-12 Fellow: John Mischler (Boulder, CO)

Grade Level: 7th or 8th grade science

Type of Lesson: STEM or Earth Science

Objectives: The students will come to understand how an ice core forms and how they are useful in looking at past atmospheric concentrations of carbon dioxide. The students should come away with an understanding that (1) snow forms into ice on glaciers and ice sheets via compaction, and (2) air bubbles from the atmosphere that are present in the snow become trapped as the snow turns into ice and can be sampled 100,000's of years later.

Background: Climate scientists have used the gases trapped in ice cores over the last quarter of a century to understand how Earth's atmosphere has changed in the past. They use this information to then build models that try and predict how the climate system may change in the future. Ice cores are long cylinders of ice drilled from ice sheets in Greenland and Antarctica. Snow accumulating on the ice sheets does not melt, it just piles up. As the snow piles higher and higher, the weight of the snow above compresses the snow below until it turns into ice. When the snow below turns from snow to ice, the air that was in between the snow grains is trapped in that ice. Now, as more and more snow accumulates over 100,000's of years, that air stays in the ice and gets pushed farther and farther down into the ice sheet. Climate scientists can then drill down into the ice sheet to retrieve this ice with its associated air bubbles. The ice can then be melted or crushed to liberate the air from the ice, and this air can be sampled to see what the atmospheric concentrations of carbon dioxide (and other gases) were on Earth in the distant past.

References: http://tea.armadaproject.org/activity/tea_activity_shutey_permeabil.html

Lesson Vocabulary: Ice Core, Climate, Carbon Dioxide, Ice Sheet, Glacier

Materials:

Each group needs...

-a clear gallon-sized Ziploc bag

-fresh snow, snow cone material, or shavings of frost from the inside of a freezer

Preparation: Make sure the students are ready for the activity before the snow is

removed from the classroom freezer.

Safety Information: None.

Engagement: Show the students an image of ice core carbon dioxide data. These are found freely on the Internet, one example is at:

http://gcmd.nasa.gov/records/GCMD_CDIA_C02_VOSTOK_ICECORE.html

Make sure the students pay attention to the x axis (time). Ask the students how we could possibly know how much carbon dioxide was in the atmosphere 400,000 years ago, if we only started measuring carbon dioxide in the atmosphere a little over 50 years ago (Mauna Loa record).

Now introduce the students to the idea of ice cores. Explain to the students how ice sheets form, how air gets trapped inside the snow and that as that snow gets compacted it turns to ice and the air gets trapped. You will need to explain this again after the activity.

Exploration: Now divide the students into groups and give each group a Ziploc bag. Explain to the students that you will put snow into each bag. Inform the students that you want them to make observations about the snow...is it fluffy? Is there air in it? Is it light or heavy? Also tell them that after they have made a couple of observations you want them to place a stack of books on top of the bag with snow in it to compress it into ice just like how it happens in an ice sheet. You will want to make sure that they poke a couple of small holes in the bag so that air can escape as the snow is compressed. At this point you can fill each bag with snow and let each group follow your directions.

Explanation: Bring the class together and have a group discussion regarding their results. Ask the students what happened to the snow once it was compressed. If any students noticed that air escaped out of the bag through the holes discuss what would have happened to that air if this snow was in an ice sheet. Re-explain to the students how ice sheets form. Re-explain that in a real ice sheet the air that was in the snow would have been trapped in the ice and that that ice would then get buried with 100,000's of years' worth of more ice. Discuss that climate scientists drill this ice and get the air out of it to get the carbon dioxide records shown in the ice core data.

Elaboration/Extension: You can decide to go more in-depth into ice core drilling by going to <http://www.waisdivide.unh.edu/>. This is the website of the current American effort to drill an ice core in Antarctica. There is a wealth of information and pictures detailing how drilling an ice core is done and what the day to day life is like at camp.

Evaluation: When it comes time for a general science evaluation, show the students an image of an ice core record and ask them to explain how this record was obtained.

Wrap-up: Ask the students if they think ice cores could be good for measuring anything other than carbon dioxide. In the end they can be used for other atmospheric gases (CH₄, N₂O, VOC's, ash from fires, dust blowing off Southern Africa and Southern South

America, snow accumulation, wind direction, and MORE!).