Vital Ice

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Vital Ice

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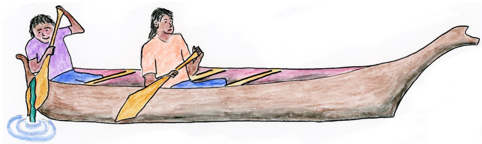


The Protracted Winter

THE following tale is from the Tlingit people of southeastern Alaska. The story teaches the importance of respect for the environment. Read it slowly and think about the meaning of every sentence.

> *At the beginning of summer near the Alaskan town of Wrangell, some boys pulled a piece of drifting seaweed out of the water from one side of their canoe and put it in again on the other. Because of this, winter came back and snow was piled high in front of the houses! It was so deep that food became hard to find. One day, a blue bird with elderberries in its beak perched on the edge of a smoke hole and cried, "KîlnA'xe." This was the name of a nearby town. So the people took all the cedar bark they had prepared to make houses out of and went to KîlnA'xe where they found that it was already summer and the berries were ripe. Only around their own town was it still winter.**

*Adapted from Swanton, J.R., 1909, *Tlingit Myths and Texts*, Bureau of American Ethnology, Bulletin 39, Smithsonian Institution, p. 43.

This story represents what the Tlingit people *believe* about the environment. Their beliefs came from generations of observations and experiences living in the extreme environment of Alaska. The belief described in this story is that small actions of an individual have major consequences for the community.

Science Notebook

Think of a small thing that you do everyday that might cause a big problem for your community later on. Write a few sentences.

Scientific knowledge is not based on beliefs. Scientists design research questions that they try to answer using data or models. If scientists only have a few pieces of data or a single model, they are not sure if the question has been answered correctly. The more data collected, the more confident the scientists become.

We are going to see how ice scientists build models and collect data.

Let's get started!

Permafrost

LIKE glaciers, permafrost occurs on nearly every continent on Earth. As the name suggests, permafrost is **perma**nently frozen ground. In Alaska, much of the ground is permafrost and in many places, there is no alternative to building roads and buildings directly on the permafrost. If precautions are not taken to insulate permafrost from hot black roads and warm buildings, serious damage may occur. Even trees have a difficult time growing on thawing permafrost.

Our research question is: W*hat happens when you build on top of permafrost?* ***(write this in your science notebook)***

Steps

1. Fill your beaker with 40 mL of water at the sink.
2. Use the small metal spoon to place a half scoop of the "polymer ice" in the tin pan and spread it around a bit.

3 Using the pipette, add a single drop of water to the polymer ice in the pan and carefully watch what happens.

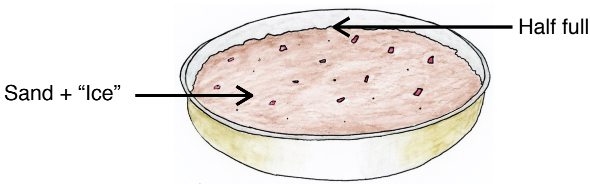
What did you notice? Draw two pictures: one before you added the water, and the second picture of what you saw happen.

4 Add a few more drops of water and continue to observe what is happening.

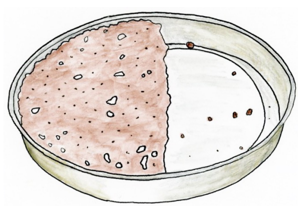
5 Continue adding drops of water until you have treated all of the polymer ice. It should be white, but not gray and sopping wet.

This is not real ice, but in what way is it like real ice?

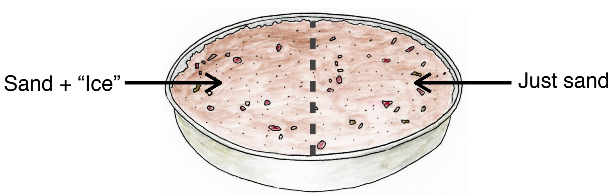
6 Add the natural brown sand labeled "soil" to the pan with the ice until the pan is half full. You should have 1/2 ice and 1/2 sand. Stir together until they are evenly mixed.



7 Use the spoon to shove the sand/ice mixture to one side of the pan like shown below. If you have too much, then discard the excess.



8 Fill the remaining half of the pan with just the natural brown soil. Use the back of the spoon to press down and smooth the surface.



9 Lightly place one metal "building" on the sand/ice mixture side of the model and place the second metal building on the sand only side. Make sure they are standing straight with the long edge vertical and do not press them into the "ground."

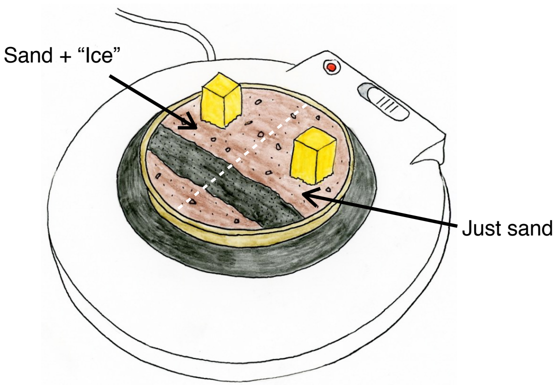
10 Add a centimeter wide black "road" across the two types of ground and pat it smooth with the back of the spoon (like a steam roller). Inspect your model with the magnifying glass to see what it looks like in fine detail.

11 Add some green "vegetation" to make your model look more natural.

Science Notebook

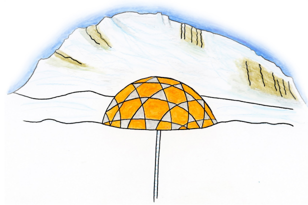
Draw and label a diagram of your model. Be sure to indicate which side of the model has the sand/ice mixture. What do you predict will happen when the permafrost thaws?

12 Place the hot plate in a safe location like in the middle of your table, away from elbows, and make sure the cord will not be tripped on. Carefully put your filled pan on the hot plate. It is okay if a little sand or ice spills on the hot plate.



13 Now, turn the hot plate on. Try not to bump or touch it as you work on the next section. Check on it every five minutes or so as you work on the next section. Put the lids back on your jars and clean up any spilled sand.

CAUTION: Do not touch the hot plate, pan, or metal buildings. They will get hot enough to burn you. Use the metal tweezers to move the pan if you must.



Glacial Ice

SCIENTISTS study the growth rings of trees to learn a lot about the past by identifying dry and wet years, dates of past forest fires, beetle kill, and even human activity. Similarly, glaciers have layers that record past climatic events in great detail.

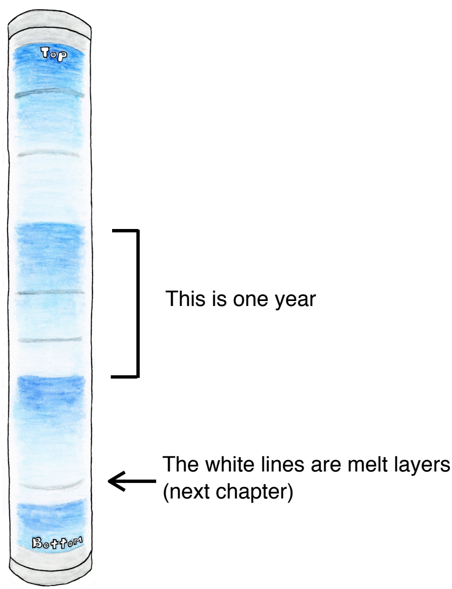
We are going to see what it is like to work with a team of glaciologists working in Denali National Park. The information encoded in your plastic "ice" core is the same information recorded in the real ice cores that the team collected. Each kit in the classroom set has a different section of the long core that was taken from a glacier on Mount Hunter in 2013. Denali and Mount Hunter are two of the highest mountains in North America and are called Deenaalee and Begguya in the Athabaskan language.

Our research question is: *What can we learn from glacial ice about the atmosphere in the recent past?* ***(write this in your science notebook)***

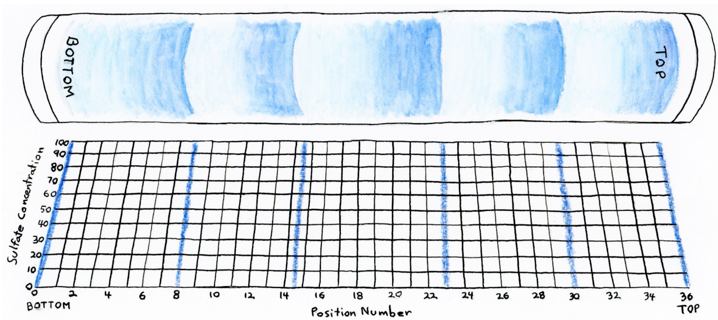
Steps

1 Find the "Top" and "Bottom" labels on your ice core.

2 Look for the different years that are represented in your section of the core using major changes in the blue color as shown below. Use the flashlight to backlight the ice core as needed in order to see better.



3 Lay the ice core on the graph paper. The bottom of the core should be lined up with the 0 mark and the top should be lined up with the 36 mark.



4 With a **blue** colored pencil, draw **thick** blue lines at the left and right sides of your graph (the 0 and 36 marks). Next, draw the divisions between each year of ice on your graph. Add the core number to the top of your graph.

How many years are represented in your core?

Melt Layers

NEXT we will inspect our cores to look for melt layers. As snow falls, it may remain as snow until it gets compacted into solid ice under the weight of new snow that accumulates on top. However, if the weather happens to warm up during the year, melting and refreezing can happen. This glacier is at an elevation of 3,962 meters (13,000 feet) where the highest summer temperatures rarely rises above freezing (0°C / 32°F).

Let's find out how often melting occurs!

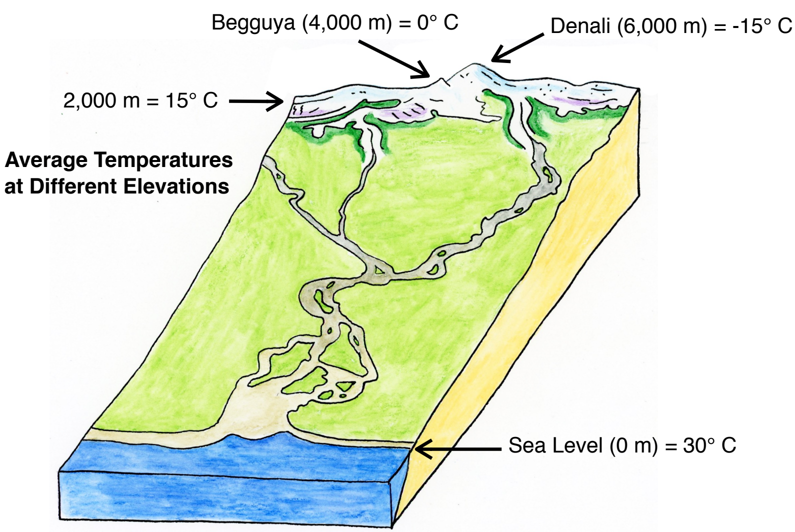
Steps

1 Using the flashlight and the magnifying glass, carefully inspect each year's layer of ice. Do you see any thin, white lines? These represent melt events. Add them to your slip of graph paper using a **green** colored pencil with **thin** vertical lines.

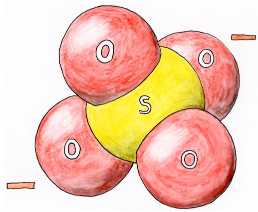
2 Count the number of melt events that happened during each year in your core.

Science Notebook

If there are melt events at nearly 4,000 meters above sea level during certain years, what is also happening to the depth of the permafrost at lower elevations during these years?



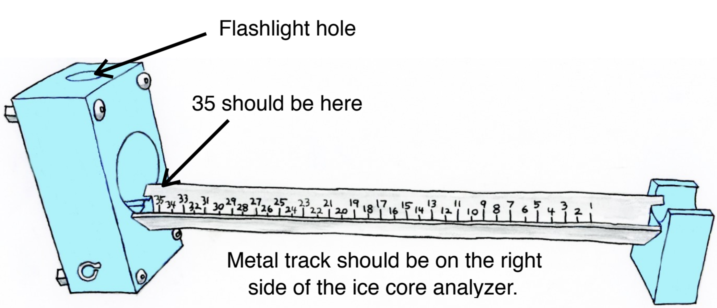
[50 minute classes can skip to page 20]



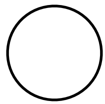
Chemical Record

THERE are several natural sources of an ion called sulfate (SO_4^{2-}) in nature: soil dust, sea salt, and volcanic ash. All of these things are carried by wind and get deposited over a large area that may include a glacier. It can be measured on a laboratory spectrometer that requires you to melt a small sample of ice for analysis. The simple device we are going to use is not a spectrometer, but it does give you an idea about how an ice scientist goes about studying a core.

1 Please be careful to not break the delicate plastic parts as you assemble your ice core analyzer as shown in the picture below.

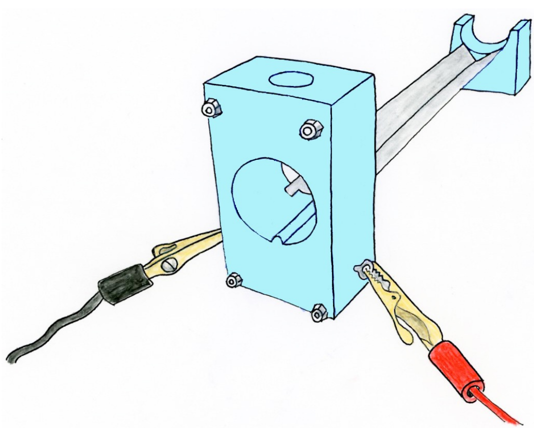


2 Turn on the flashlight by twisting the lens end. Shine the beam on the circle below and turn the lens until the center is the brightest white (not a dimmer gray circle):



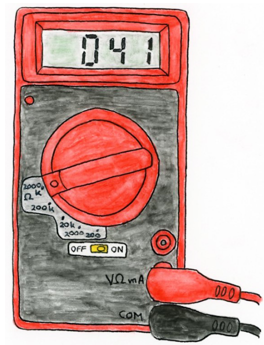
3 Place the flashlight in the hole on the top of the analyzer with the beam shining down.

4 Connect the alligator clips of the multimeter to the two metal screw eyes (loops) on either side of the analyzer. It does not matter which clip goes on which loop.



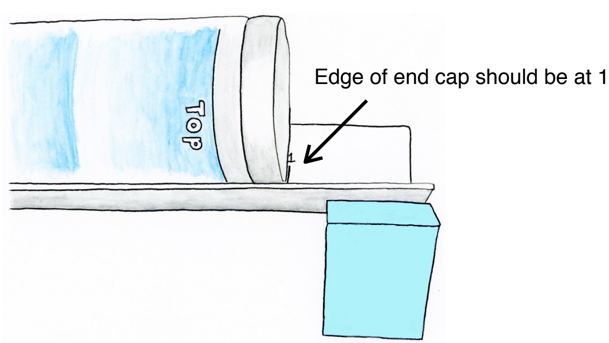
5 Set the big selector knob to 2000k in the Ohms (Ω) section and turn on the multimeter.

Multimeter



6 Place the ice core on the metal track with the same orientation: bottom of the core on your left, and make sure the groove of the core is down.

7 Ask your teacher to lower the room lights. Slide the core into the analyzer until the right edge of the core is at the "1" position on the scale.



Science Notebook

Copy this table format with 35 lines into your science notebook

Position	Sulfate Concentration
1	
2	
3	
4	
↓	
35	

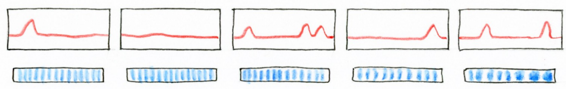
8 Using the scale on the metal track, slide the core through the analyzer stopping at each position and recording the reading from the multimeter on the table in your science notebook. You should end up with a total of 35 data points.

9 Using the **red** colored pencil, plot the points on your slip of graph paper, from left to right. Connect the dots with straight lines using your ruler.

Science Notebook

What do you notice about your data? Does the amount of sulfate change between seasons? What differences between summer and winter might explain this variation? If your core has big peaks in sulfate that came from volcanic eruptions, what other pieces of information do you need to figure out which volcano the sulfate came from?

Annual layers in real ice cores become more and more difficult to see as you go deeper into a glacier. Ice scientists use known volcanic eruptions and their sulfate peaks to help confirm that they counted the annual ice layers correctly.



Piecing it Together

THE core was drilled in early 2013. So the first year at the top of the core is 2012. To find the years for your segment of the core, you must count backwards from 2012. Each group in the class will tape their slip of graph paper on the white board in order from top (on the right) to bottom (on the left).

Steps

1 Take your **orange** colored pencil and slip of graph paper to the white board and tape your graph in its proper position. Core #1 (top) should be on the right and Core #15 (bottom) should be on the left.

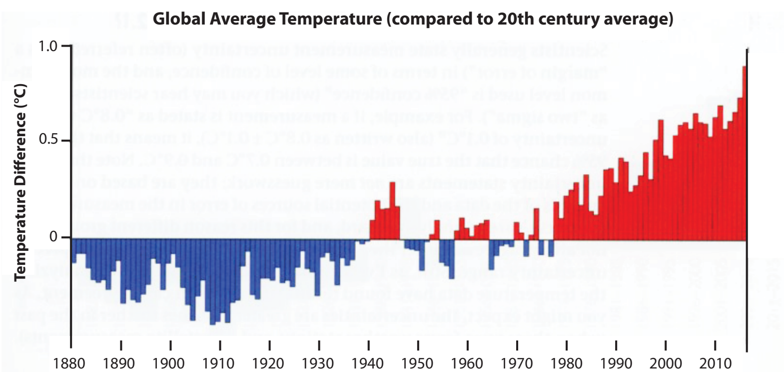
2 Wait until everyone gets their graph posted.

Check your permafrost experiment again if you have to wait.

3 Count the annual layers backwards from 2012 to figure out the years shown on your graph. Label each year on your graph using the orange colored pencil.

4 If you found a sulfate spike, use the laminated map in your kit to identify the source of the volcanic ash. Add that volcano's eruption to your graph.

5 Count the number of melt layers before and after 1950 and compare your results to this graph:



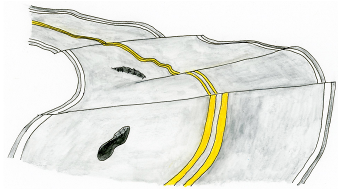
Source: National Centers for Environmental Information, NOAA

Science Notebook

What did you notice about the number of melt layers per year over the length of the entire core? How do the number of melt layers compare before and after 1950? Do the melt layer data make sense when compared to the global average temperatures?

6 If you have access to the Web, go to this link to explore the global average temperature data from the graph above but shown on a map of the world.

www.cns-eoc.colostate.edu/vital-ice-map.html



Thawing Effects

LET'S return to our permafrost experiment. We have seen that glaciers at very high elevations have recorded episodes of melting. Warmer temperatures at lower elevations are causing permafrost to thaw.

1 Carefully inspect the permafrost model with your magnifying glass. Look for small changes.

Science Notebook

Draw and label an "after" diagram showing what happened to your model when the permafrost thawed. In the real world, how does the changing of ice to water cause the results you observed in your model?

2 Refreeze some permafrost by using the pipette to add a drop of water to the edge of your black road on the permafrost side of the model. Do the same on the non-permafrost side. What happens to the road?

4 **Turn off your hot plate and let the model cool before touching.**

Science Notebook

How do the melt events you counted between 1950 and 2012 in the glacial ice core relate to people? What small things can you do to help protect your community from this warming trend?

Clean up

- Make sure your multimeter and flashlight are turned off.
- You may dispose of your sand/ice mixture in the trash; the polymer is non-toxic.
- Clean and dry off your tin pan, beaker, and metal buildings with a paper towel.

Materials Needed

Ice Core
Ice Core Scanner
LED Solitaire Maglite
Multimeter
Magnifying Glass
Ruler
Tin Pan
Metal Spoon
Metal Tweezers
60 mL of Brown Sand
30 mL of Black Sand
30 mL of Green Sand
30 mL of Polymer "Ice"
2 Metal "Buildings"
Pipette
50 mL Plastic Beaker
Map of Volcanic Eruptions
Hot Plate
Colored pencils
Science Notebook

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For more information, visit:
www.cns-eoc.colostate.edu/vital-ice.html

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