Name: _____ Period: _____

Analyzing Ice Cores

Students will:
• Understand climate is a fluctuating system.
• Demonstrate how scientists estimate historical climate data using ice cores.
• Analyze the results of their scientific investigation.

Throughout much of its 4.5-billion year history, Earth's climate has been in a state of fluctuation. Some eras were dominated by coldness while others were characterized by warmth. Some of these periods included drastic fluctuations while others remained fairly stable for millions of years. Many times during the last 1.8 million years, glaciers ground slowly across Illinois, reshaping the landscape. Snow accumulated in what we now call Canada, became ice, and flowed under its own weight South over what is now the northern United States. Glaciers covered most of the state (Fig. 10), bypassing only the northwestern corner (the Galena area), the extreme south (the Shawnee Hills) and a small area in western Illinois. The cliffs and rocky ridges of these areas were never touched or covered up by the glaciers. Glaciers filled in river valleys (Fig. 11) with outwash and buried them under till. The Mahomet River and others ceased to exist.

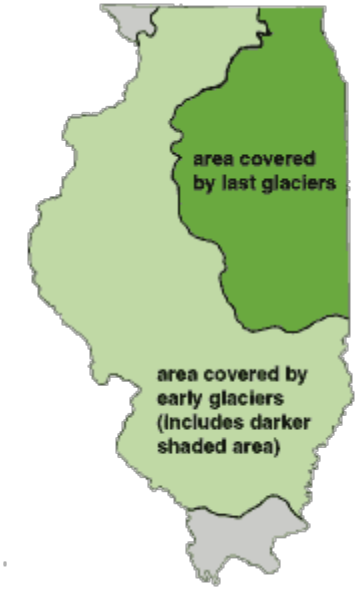


Figure 10 *Glaciers in Illinois*

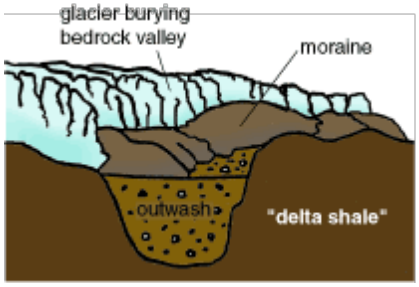
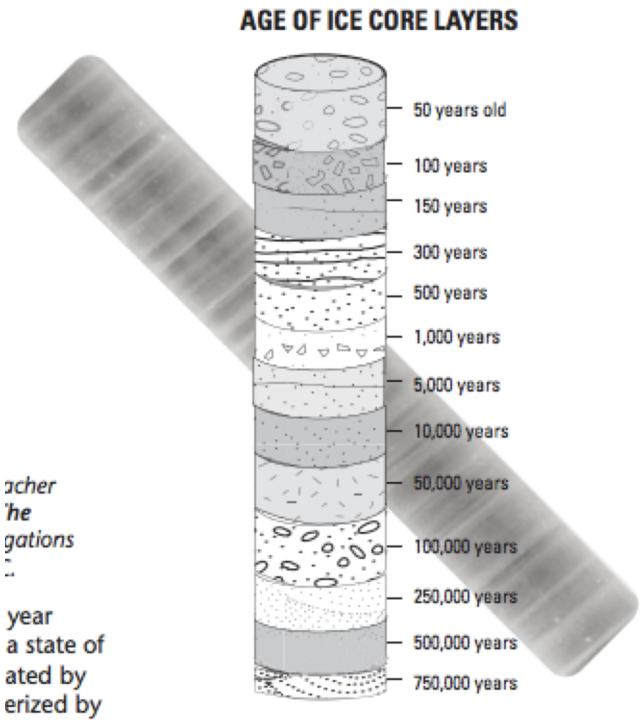


Figure 10 *A glacier buries a bedrock valley*

The last glaciers entered Illinois about 25,000 years ago (the Wisconsin Glacial Episode) and covered just the northeastern quarter of the state. As these glaciers moved across northeastern Illinois, they again modified the landscape, leveling hills, filling valleys, and building new moraines.

Before people had thermometers, indeed before any temperatures were recorded, the Earth itself recorded clues about temperature, precipitation, atmospheric gases, and other aspects of the environment in the thick layers of ice that have accumulated in places like Greenland and Antarctica. To reveal these clues to the past, researchers drill into glaciers and ice sheets and remove cylinder-shaped samples of ice called ice cores.

Back in the laboratory, scientists can use chemical sampling techniques to determine the age of each layer of ice and the concentrations of different gases trapped in tiny air bubbles within the ice, which reveals the composition of the atmosphere in the past. Small bubbles in the ice hold trapped atmospheric gases from hundreds of thousands of years ago. When scientists analyze the composition of those trapped gases they are measuring the concentrations of gases in Earth's atmosphere when each layer was formed, including the concentration of carbon dioxide (CO_2), a greenhouse gas. In addition, the water in each layer of the ice holds oxygen and hydrogen isotopes. The relative concentrations of these isotopes will vary depending on the temperature when the layer was created. Thus, the scientists are able to determine the historical record of the temperature as well.



They can also examine the water molecules in the ice itself to get information about historical temperatures. Trapped pollen and dust provide additional clues about the climate. Ice core records can go back hundreds of thousands of years, and they help scientists find out whether the rapid increase in CO_2 levels and temperature we are currently observing fits a natural pattern or not.

Perhaps the most famous study of this type is the Vostok ice cores from Antarctica. This data is often cited in climate change articles. By showing a correlation between global temperatures and atmospheric CO_2 levels, scientists find evidence that changing the concentration of CO_2 in the atmosphere can change the global temperature and climate.

Pre-lab questions:

1. What was Illinois like during the last Ice Age?

2. What is an ice core?

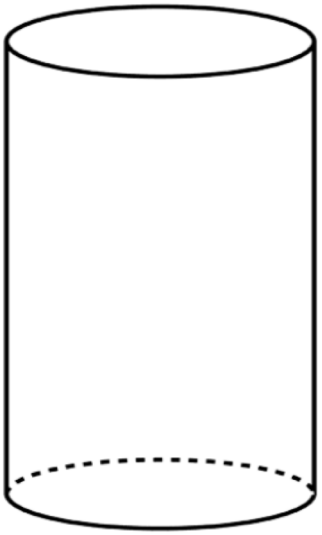
3. How do scientists estimate temperature and carbon dioxide levels from thousands of years ago, using their ice core analyses?

4. Besides the CO_2 trapped in the ice core layers, what else we can learn by studying past climatic conditions in ice cores?

Directions: Write the letter of your ice core on the line below. Carefully observe the ice core. Use a ruler to measure the layers. Use the colored pencils to accurately represent the layers and create a scale drawing (a drawing that shows a real object with accurate sizes reduced or enlarged by a certain amount). Be sure to include things like gas bubbles and other substances you see in the ice. Label the oldest and youngest layers. Note your observations on the lines below.

Ice core data for Sample # _____

Layer number	Layer color	Height (mm)	Other observations	Inference



Analysis & Conclusion

1. How many years does your ice core sample represent (1 layer = approximately 1 year)?

   _____

2. Describe any significant ecological events recorded in your sample. **What evidence led you to this conclusion?**

Chemicals in the ice are the actual clues to the past. Oher major chemicals that can be found in ice include:

Sulfate:
• Scientists have found that a high amount of sulfate and chloride in the ice indicates a major volcanic eruption on the earth that year.
• When the sulfate level is high but not the chloride level, scientists have found it means that year had a lot of healthy marine life in the ocean (sulfate comes from phytoplankton—microscopic marine plants, which increases with healthy marine life)

Dust particles
•Scientists have found when there were a lot of dust particles in an ice core layer, that told them that year was very dry and windy on Earth.

Sodium
•Sodium is found in sea salt. When there are many storms in one year, the Antarctic wind strength increases and whips the ocean into foam and transports more sea salt to the land, increasing the amount of sodium other land.

Oxygen (*also Carbon Dioxide)
• This can be measured in the amount of oxygen in the air bubbles in the layer
• Scientists have found that the more oxygen in the air bubbles in the layer, the warmer the temperature was that year.

Chloride
• Scientists have found that if the chloride level is high when the sulfate level is high, it indicates a major volcanic eruption on earth that year.

Answer the following questions according to the chemicals found in the ice cores and the graph on the following page. If the ice layer 1 was in the year 1980(layer 2 is 1979, layer 3 is 1978…), fill in the following chart:

Event	In what year(d) did this occur?	How do you know?
Healthy marine life		
Dry, windy year		
High storms		
Low temperatures		
High temperatures		
Volcanic activity		