ARM

CLIMATE RESEARCH FACILITY

Education and Outreach Lesson Plan

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Grade levels 3–5

When Land Ice Melts

When Land Ice Melts

Approximate Time

One hour

Objective

The objective of this activity is to demonstrate what happens when land ice melts and how it is different from the effect of melting icebergs.

Background Information

- Like great rivers of ice, glaciers have sculpted mountains and carved out valleys. They continue to flow and shape the landscape in many places today.
- The Arctic and Antarctica are covered with large, heavy sheets of ice. Other islands like New Zealand have ice masses in the form of glaciers on them.
- When land-based ice melts, more water flows into the sea and sea level rises.
- However, the land on which the ice previously rested rises too when the load is removed.
- Icebergs in the ocean are broken off bits of land ice. The process of land ice breaking off as a new iceberg is called “calving”. Antarctic ice shelves may calve icebergs that are over 80 kilometers (50 miles) long.
- Presently, 10% of land area on Earth is covered with glacial ice, including glaciers, ice caps, and the ice sheets of Greenland and Antarctica.
- Glaciers store about 75% of the world's freshwater.
- Glacierized areas cover over 15 million square kilometers (5.8 million square miles).
- Antarctic ice is over 4.2 kilometers (2.6 miles) thick in some areas.
- In the United States, glaciers cover over 75,000 square kilometers (30,000 square miles), with most of the glaciers located in Alaska.
- During the last ice age, glaciers covered 32% of the total land area.
- If all land ice melted, sea level would rise approximately 70 meters (230 feet) worldwide.
- Glacier ice crystals can grow to be as large as baseballs.
- The land underneath parts of the West Antarctic Ice Sheet may be up to 2.5 kilometers (1.6 miles) below sea level, because of the weight of the ice.
- North America's longest glacier is the Bering Glacier in Alaska, measuring 204 kilometers (127 miles) long.
- Glacial ice often appears blue when it has become very dense. Years of compression gradually make the ice denser over time, forcing out the tiny air pockets between crystals. When glacier ice becomes

extremely dense, the ice absorbs all other colors in the spectrum and reflects primarily blue, which is what we see. When glacier ice is white, that usually means that there are many tiny air bubbles still in the ice.

- The Kutiah Glacier in Pakistan holds the record for the fastest glacial surge. In 1953, it raced more than 12 kilometers (7.5 miles) in three months, averaging about 112 meters (367 feet) per day.
- In Washington State alone, glaciers provide 1.8 trillion liters (470 billion gallons) of water each summer.
- Almost 90% of an iceberg is below water—only about 10% shows above water.
- The Antarctic continent has been at least partially covered by an ice sheet for the past 40 million years.
- From the 17th century to the late 19th century, the world experienced a "Little Ice Age," when temperatures were consistently cool enough for significant glacier advances.
- This illustration shows the many aspects of land ice (definition of terms found under Key Vocabulary).

Key Vocabulary

- **Bergschrund**: Crevasse between the firn and the rock face; it appears when the glacier breaks away from the rock face.
- **Crevasse**: Deep narrow fissure that forms on the surface of the glacier.
- **End moraine**: Deposit of rock debris scraped from the ground and pushed to the front of the glacier.
- **Firn**: Accumulation of snow inside a cirque; compressed by its own weight, it is converted into ice and feeds the glacier.

- **Glaciers**: A huge mass of ice slowly flowing over a land mass, formed from compacted snow in an area where snow accumulation exceeds melting and sublimation.
- **Glacial cirque**: Semicircular cavity with steep sides, carved out by ice.
- **Glacier tongue**: River of ice formed by the flow of the firn.
- **Ground moraine**: Deposit of rock debris (till) that is dragged along and deposited under the advancing glacier.
- **Hanging glacier**: Glacier with no tongue that remains in its cirque.
- **Isostatic response**: Also called post-glacial rebound, continental rebound, glacial isostasy, or glacial isostatic adjustment; is the rise of land masses that were depressed by the huge weight of ice sheets during the last glacial period, through a process known as isostasy. It affects northern Europe (especially Scotland, Estonia, Fennoscandia, and northern Denmark), Siberia, Canada, the Great Lakes of Canada and the United States, the coastal region of the US state of Maine, parts of Patagonia, and Antarctica. Post-glacial rebound (or glacial isostatic adjustment) produces measurable effects on vertical crustal motion, global sea levels, horizontal crustal motion, gravity field, Earth's rotational motion and state of stress and earthquakes.
- **Lateral moraine**: Deposit of rock debris scraped from the sides of raised land by ice.
- **Medial moraine**: Forms where the lateral moraines of two parallel glacier tongues come together.
- **Meltwater**: Water that runs beneath the glacier tongue, forming rivers and occasionally lakes at the foot of a glacier**.**
- **Outwash plain**: Relatively even, gently sloping tract of land, formed by the action of a glacier's meltwater.
- **Riegel**: A rocky ridge set crosswise to the glacier tongue.
- **Rock basin**: Basin dug out of soft rock by a glacier**.**
- **Serac**: Chaotic mass of unstable ice bordered by crevasses.
- **Terminal moraine**: Frontal moraine marking the glacier's most advanced position before it recedes.

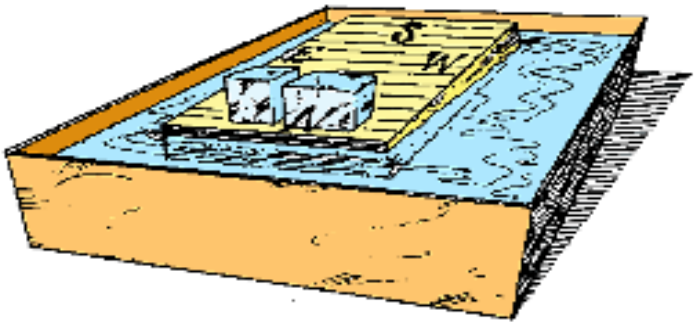
Materials

- A big plastic rectangular container or aluminum cake pan
- Piece of wood (approximately 5 centimeters deep x 15 centimeters long x 5 centimeters wide)
- Several ice cubes
- Water to fill the cake pan 3-4 centimeters

Preparation

Explain what happens to the continents (land) that are floating on the earth's molten core when they are relieved of their heavy burden of ice load.

An increase in **elevation** of the land is an **isostatic response** to the removal of the ice load that had depressed the land. Explain that as the ice melts on the piece of wood, the water level will rise, but the level of the wood will too as the weight of the ice is relieved.



Procedure

On the surface of the wood, mark the points of the compass: North, South, East, and West.

1. From North to South across the surface draw lines east to west at 1-centimeter intervals.
2. Along the north and south edge, mark lines at 2-millimeter intervals.
3. Fill the container with water, leaving about 4 centimeters.
4. Place the wood in the water.
5. Put one or two ice cubes on the N edge of the floating wood.
6. Watch and note the level of water in the container and on the N and S edges.

Closure and Evaluation Questions

Students can either respond to these in a class discussion, in small learning groups of 2, 3 or 4, or in written form.

1. What happened to the water level in the container?
2. What happened to the north and south edges of the block of wood as the ice melted?
3. Do you think melting glaciers and other land-based ice masses will make the sea level rise? Explain your reasoning with what you observed during the demonstration.
4. Will the melted glacial ice water submerge the continents on which the ice used to be?
5. Most of the world's tide gauges are on the edge of continents that in the recent geologic past had massive ice sheets on them. Can we get a good measure of trends in the world's sea levels from such gauges if we do not properly consider the vertical land movements?

Suggested Follow-Up Activities

- Go to the site http://nsidc.org/cryosphere/glaciers/ to research the different types of glaciers.
- Make two types of ice at home: a tray of fresh water ice cubes and one of salt water. Investigate which one freezes first and which type melts the slowest. Before you start, make a prediction regarding which one you think will freeze first and melt more slowly. P.S: ask Mom or Dad first!

Sources

www.visualdictionaryonline.com

http://visual.merriam-webster.com/earth/geology/glacier.php

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