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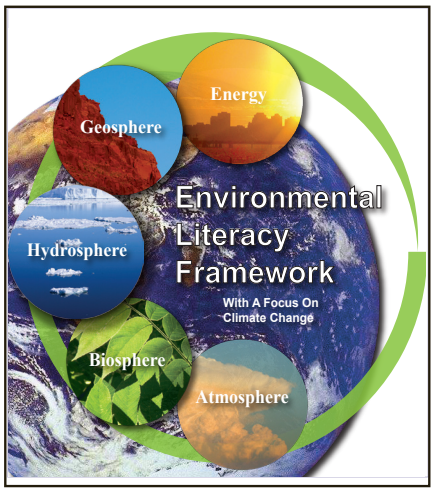

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When Ice Meets the Sea

Focus Questions:

If floating ice (ice shelves and sea ice) melts, will sea levels around the world rise?

If land-based ice (glaciers and ice sheets) melts, will sea levels rise?

Time

- 1 hour

Materials

- Mixture of gravel, sand, & silt (2-3 tablespoons)
- Square or rectangular baking pan (glass or metal)
- Paint roller tray
- Paint roller tray liner
- Water pitcher
- Blue food coloring
- Salt (2 tablespoons)
- Water
- Freezer

Vocabulary (Terms)

Ice sheet
Ice shelf
Sea ice

Preview

On Antarctica, glaciers have grown so large that they have merged to cover large areas of land. These thick masses of glacial ice on East and West Antarctica are called ice sheets. In the northern hemisphere, an ice sheet also covers Greenland.

Over time, ice flows downhill. Parts of an ice sheet flow off the continent and float on ocean water. Floating ice that is still connected to land is called an ice shelf.

At the leading edge of ice shelves, sections of the ice occasionally break off: free-floating chunks of this glacial ice are called icebergs.

Frozen seawater on the ocean surface is called sea ice. Each winter, the area covered by sea ice around Antarctica expands. By summer, much of it melts away again, leaving open ocean in its place.

In this activity, you'll make a model to show all five of these environments, and check out what happens on the seafloor when ice meets the sea.

Ice sheets cover both East and West Antarctica. The Ross Ice Shelf is Antarctica's largest ice shelf; it is about the same size as France. The Ronne-Filchner Ice Shelf is the second largest.

Prepare

Make a model ice sheet

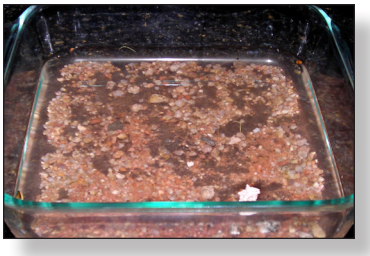
1. Add water to your baking pan until it is about ½ inch (1 cm) deep.
2. Sprinkle two or three tablespoons of pebbles, sand, and clay across the bottom of the pan, then place it in the freezer.
3. Leave the pan in the freezer until it is frozen solid (at least one hour).

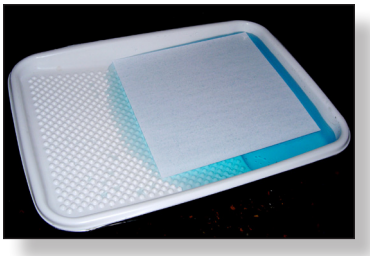
Prepare your Antarctic coastline

1. The paint roller pan represents a section of the coastline of Antarctica. Set the pan on a sturdy surface and put the liner in the pan. Keep a towel nearby for wiping up spills.
2. Mix up a pitcher of model seawater by adding 2 tablespoons of salt to 2 quarts of warm tap water. Add a few drops of blue food coloring to help you tell the difference between the water and the ice.
3. Pour the blue water into the paint pan until the water level is about 1 inch (2 cm) from the top edge of the pan.
4. Cut a piece of white printer or copier paper that will fit on your ocean. Float it on top of the blue water to represent sea ice.

Color code

white = ice sheet
yellow = ice shelf
gray = sea ice
blue = open ocean

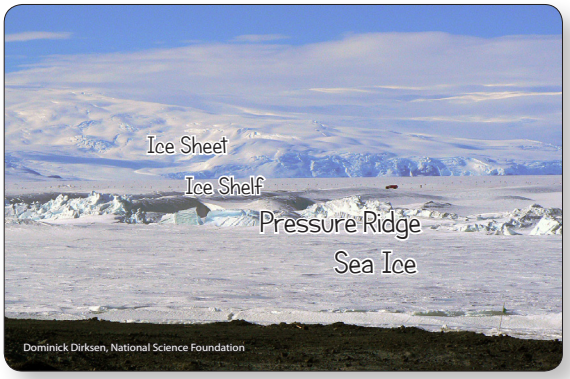


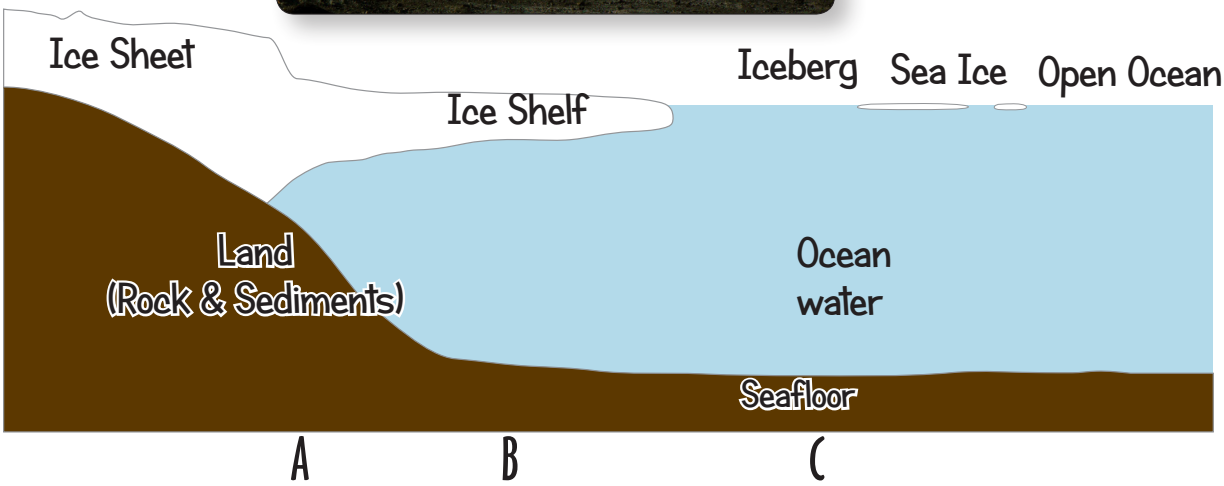


The thickness of the model sea ice (paper-thin) is about right compared to the thickness of your model ice shelf.

Move your ice sheet into the ocean

1. Get your model ice sheet out of the freezer. Dip the bottom of the pan into warm water for 30 seconds or so to make it easier to remove the ice sheet from the pan.
2. Set the ice, sediment side down, on the land part of the paint pan. It's okay if some of the ice extends beyond the pan. In this position, the ice represents an ice sheet.
3. Model the slow downhill motion of the ice sheet by pushing your ice down the slope about ½ inch (1 cm) every minute. Carefully apply some gentle downward pressure on the ice as you move it forward—this will model the grinding action of sediments in the bottom of the ice scraping over the land.
4. After about 10 minutes, lift one side of your ice sheet to check what's happening right at the leading edge of the ice.
5. As your ice sheet moves into your model ocean and becomes an ice shelf, the sea ice (paper) will likely buckle and fold, forming a pressure ridge, just as real sea ice does. Once you've compared the ice shelf with the sea ice, remove the sea ice to avoid a mess.
6. Stop moving your ice sheet when part of it is still on land but much of it is floating in your model ocean.
7. After the leading edge of the ice shelf has been thinned by melting, you may be able to break off some chunks of ice to show how icebergs form.
8. Once most of the "ice shelf" has melted, examine the bottom of your paint tray. What does the result tell you about what happens underneath a real ice shelf? Discuss your ideas with your team.





Practice

Got the Big Idea?

Ice sheets move downhill over land, taking rocks with them. Where the ice sheet meets the sea, rocks frozen into the bottom of the ice melt out and are deposited on the seafloor. Parts of an ice sheet that extend out over the ocean are known as ice shelves. Chunks of ice that break off the leading edge of an ice shelf are called icebergs. Sea ice forms when the surface of the ocean freezes.

Ponder

Compare your model to the diagramBased on what you saw in your model, describe the type of sediments you would expect to find on the seafloor at letters A, B, and C on the diagram.

Get ready to present

Come up with a short statement you can use to tell visitors what your model shows. Make sure you can tell which parts of the model represent land and the ocean, and which parts of the ice represent an ice sheet versus an ice shelf. Compare the model to the pictures on the Antarctica's Ice on the Move banner. You may also want to make a poster that shows one or more diagrams from this activity.

Special preparations for this station

The ice sheet/ice shelf will melt during the Flexhibit, so you may want to prepare two or three model ice sheets in advance. Plan ahead so you have an ice chest or freezer to keep your supply of ice sheets frozen until you use them.

Present

Show visitors your model and explain what it represents. You may want to point to pictures on the Antarctica's Ice on the Move banner to help explain the differences among the four types of ice. Also, draw visitors' attention to what happens on the bottom of the ice in your model. You may want to lift one edge of the ice to show them where the sediments accumulate.

Keep a towel or cloth available to wipe up spills. Be especially careful not to spill the water with the food coloring onto surfaces that might stain.

Background Information for the Teacher

Ice Shelves are floating extensions of land glaciers that move toward the coasts under the weight of accumulating snow and ice in the interior of the continent. Approximately 44% percent of the coast of Antarctica has an ice shelf. As the ice shelf advances over the ocean, pieces break off forming icebergs. Advance and retreat of ice shelves is a natural cycle, however in 2002 the Larsen B Ice Shelf in the Antarctic Peninsula indicated that the glacier flow was accelerating. For more on the story go to this website.

http://earthobservatory.nasa.gov/Features/WorldOfChange/larsenb.php

The two largest ice shelves in Antarctica are the Ross Ice Shelf (487,000 sq mi/148,437.6 m, 2600 ft/792.48 m thick) and the Ronne Ice Shelf (430,000 sq miles/131,064 m, 3000 ft/914.4 m thick). The Ross Ice Shelf moves toward the ocean at a rate of approximately 3000 ft/914.4 m per year.

When glaciers move onto the oceans they add volume and increase sea level. However, once floating on the water, melting or break up of the shelf does not increase sea level rise.

Sea ice forms when ocean water freezes forming a thick solid sheet of ice that extends away from the shore. During the Arctic winter, 9.32 million sq m/15 million sq km cover the Arctic Ocean region which shrinks to 4.34 million sq m/7 million sq km in summer. For Antarctica, the sea ice extent ranges from 11.8 million sq m/19 million sq km in the winter to 2.17 sq m/3.5 million sq km in the summer. These large ice shelves work to control the heat exchange between the polar oceans and the atmosphere, limit the access of the water underneath to receive sunlight and increases the albedo of the oceans. The sea ice reflects solar radiation which helps keep the planet cool. Many scientists are concerned about shrinking ice because of its effect on climate as water absorbs solar radiation and adds to the Earth's heat budget. Pack ice are large rafts (floes) of ice which extend away from the shore. About 90% of the frozen ocean is pack ice. The other 10% is called fast ice and is attached to the land. Both these sea ice formations support a wide array of life from diatoms to seal and whales.

Fluctuations in floating ice (pack ice, fast ice, ice shelves and the North Pole ice cap) does not affect sea level. For more information on sea ice formation go to the website:

http://earthobservatory.nasa.gov/Features/WorldOfChange/sea_ice_south.php

Glaciers are large amounts of land ice that build up with the accumulation of snow falling over thousands to millions of years. Under the weight of the ice and the influence of gravity, glaciers move toward the coast. As the glaciers move over the surface of the land, they carve landscapes, erode and break up rocks, and carry away the resulting sediments. As the Earth's climate changes over geologic time, glaciers advance and retreat. In the last few decades most of the world's glaciers are retreating.

During cooler times in the Earth's history, glaciers covered large parts of continents and the sea level was lower than it is now. As the glaciers retreated and the ice melted, sea levels rose. When glaciers melt, water is returned to the oceans and sea levels rise.

For more information on glaciers, go to the website: http://climate.noaa.gov/warmingworld/glaciers.html

Arrigo, K. 1998. Antarctic Sea Ice Biological Processes, Interantionc, ad variability, Antarctic Research Series, Vol 73, p 23-43

When Ice Meets the Sea		
Learners simulate the moving of a glacier from the land, to floating over the ocean creating an ice shelf and pressure ridges.		
NSES gr 5-8	CLEP	ELF
EARTH Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Oceans have a major effect on climate, because water in the oceans holds a large amount of heat. The earth processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past.	2B Changes in ocean circulation caused by tectonic movements or large influxes of fresh water from melting polar ice can lead to significant and even abrupt changes in climate, both locally and on global scales. 4 D. Scientific observations indicate that global climate has changed in the past, is changing now, and will change in the future. The magnitude and direction of this change is not the same at all locations on Earth. 7 A. Melting of ice sheets and glaciers, combined with the thermal expansion of seawater as the oceans warm, is causing sea level to rise. Seawater is beginning to move onto low-lying land and to contaminate coastal fresh water sources and beginning to submerge coastal facilities and barrier islands.	

Glossary

Unit	Activity	Vocabulary Word	Definition
Geosphere	When Ice Meets The Sea	Icesheet	A large glacier covering a significant area of a land mass.
Geosphere	When Ice Meets The Sea	Iceshelf	A floating sheet of ice permanently attached to a landmass.
Geosphere	When Ice Meets The Sea	Sea Ice	Seawater that freezes. Because of the salt content in the oceans, the freezing point is 0° C.