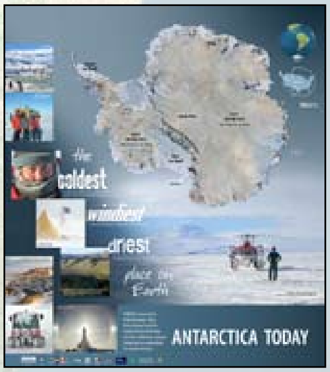

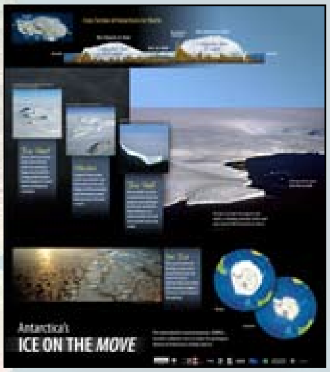

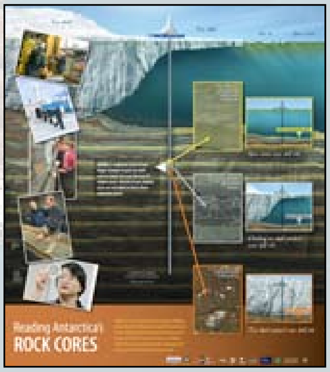

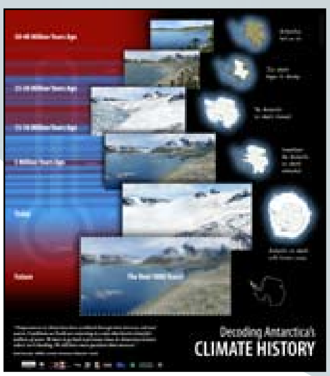

Antarctica's Climate Secrets

Hands-on Activities for Hosting a Showcase of Antarctic Climate Research

LuAnn Dahlman

Antarctica's Climate Secrets

Hands-on Activities for Hosting a Showcase of Antarctic Climate Research

LuAnn Dahlman
TERC

Antarctica's Climate Secrets

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Contents

Welcome to Antarctica's Climate Secrets

Activities

Leader Notes

Welcome to Antarctica's Climate Secrets

Antarctica is the last-discovered, least-visited, coldest, windiest, and driest continent on our planet. What kind of climate secrets does it have, and why do they matter?

About this book

Gentoo penguins and a scientific research vessel in Antarctica. Photo by Christine Hush, U.S. National Science Foundation.

This book presents background information and hands-on activities about Antarctica. It shows how geoscientists gather clues about Earth's past climates and use them to predict our planet's future.

The activities highlight a scientific project called ANDRILL, for (An)tarctic geology (drill)ing. ANDRILL scientists collect and study rocks from beneath the ice around Antarctica. They read clues in the rocks to learn how the amount of ice on Antarctica has changed over time in response to changes in climate. With an understanding of how climate has changed in the past, scientists are better able to predict how it will change in the future and how these changes affect the rest of the world.

During activity sessions, you'll build models and work with photographs and maps. You'll become an expert with the props, and then you'll use them to host a public science event. You'll share what you've learned in a flexible exhibit — a "Flexhibit" — that can be held at a museum, school, or other location. In addition to the exhibit props you build, your group can obtain professionally designed graphic banners and video Podcasts to display at your Flexhibit.

Everyone who does these activities or attends a Flexhibit is participating in an event called the International Polar Year, or IPY. The IPY is a worldwide effort to learn more about Earth's polar regions. An important goal of the IPY is to raise public awareness about these sensitive parts of our planet.

Join us for an exciting Antarctic adventure!

ANDRILL

Find out more about ANDRILL

Go to **http://www.andrill.org**

INTERNATIONAL POLAR YEAR 2007-2008

Find out more about the IPY

Go to **http://www.ipy.org**

About the Flexhibit package

This activity book is just one part of a package: the full package also includes five graphic banners and a set of video Podcasts that were filmed in Antarctica. The banners, activities, and Podcasts complement one another to build knowledge. Exploring illustrations on the banners, doing hands-on work with the activities, and discussing explanations in the video clips will help you tie the concepts together and build your confidence for teaching them to others.

About the five P's

Every activity has five parts. The five parts help you learn new information AND prepare you to teach it to others. Here's what to expect in each activity:

Preview — An introduction and background material to read and discuss

Prepare — Step-by-step instructions for building models or interacting with materials

Ponder — An opportunity to check your learning

Practice — Tips for getting ready to demonstrate or explain the activity

Present — Ideas and suggestions for how to help Flexhibit guests get the most out of their visit

About materials

The activities require materials that are commonly available in homes and from hardware, office supply, grocery, and pet supply stores. Comprehensive materials lists are included with each activity, and a complete materials list is provided at the end of the book. Materials for some of the activities require detailed preparation. For your convenience, a kit containing the prepared materials is available for purchase.

About SAFETY

Some of the preparation steps and activities call for using tools such as saws, knives, and sharp scissors. Adult supervision is necessary whenever youth or students use these tools. In some cases, adult intervention is better. Your leader or teacher will decide whether you should complete the steps that call for these tools or have them performed by an adult.

Flexhibit URLs

Banners

http://www.andrill.org/flexhibit/flexhibit/materials/index.html

Activity Book Documents

http://www.andrill.org/flexhibit/flexhibit/materials/activities/index.html

Podcasts

http://www.andrill.org/flexhibit/flexhibit/materials/podcasts/index.html

Video Journals

http://www.andrill.org/iceberg/videos/index.html

Materials Kit

Email AntarcticaFlexhibitKits@charter.net

Welcome to Antarctica's Climate Secrets

About ANDRILL

The ANDRILL project involves more than 200 scientists, technicians, and educators from around the world in the study of Antarctica's climate history. The group is drilling into rocks under the ice around the continent to recover and interpret sedimentary rock cores. Their purpose is to better understand the history, as well as the future, of Earth's climate.

The project's scientists are trying to learn the full story about how the amount of ice on Antarctica has changed over time. Specifically, they want to know how fast and how often ice sheets have advanced off the continent and retreated again. Sedimentary rocks deposited around the outer edge of Antarctica are a natural record of these changes, so project staff drill into these rocks and bring them up for study. As ANDRILL scientists learn how Antarctica's ice has responded to past changes in global temperatures, their results will help modelers make better predictions about how the ice will behave in the future, when global temperatures are projected to be several degrees warmer.

About the people

Individuals and groups from the United States, New Zealand, Italy, and Germany are all working together on the ANDRILL project. A wide variety of jobs contribute to making the project happen.

- **project managers** oversee the planning, obtain financial support for the project, and ensure that all tasks are completed
- **geophysicists** make explosions to send sound waves underground, then analyze the "echos" to predict what types of rock layers exist
- **drillers** design, build, and operate systems for collecting rock samples from below ground
- **core technicians** clean the core, make a log of its physical appearance, and cut it into 1-meter lengths
- **structural geologists** measure fractures and faults in rocks to deduce the direction and force of tectonic stresses in the region
- **physical properties scientists** look at patterns of density and other parameters in rock cores and correlate them to other rock features
- **curators** cut and prepare core samples for study and store the core for future research
- **sedimentologists** look at the shapes, sizes, and arrangements of rock fragments to deduce the type of environment where they were deposited

- **programmers** develop software to document and visualize information about the rock core and to manage information produced by the project
- **petrologists** figure out where sediments and clasts in the layers originated, then develop models to explain how those sediments were transported and deposited in the area where the core was drilled
- **paleontologists** look at fossils to infer environments and rock ages
- **paleomagnetists** measure the orientation of iron-containing grains and compare them to Earth's changing magnetic field to help establish when the grains were deposited
- **volcanologists** figure out when and where volcanoes erupted
- **down-hole loggers** measure characteristics of the rocks that surround the hole where a rock core was taken
- **educators and outreach staff** ensure that people learn about the project's accomplishments

Operations and logistics of the drilling process are managed by Antarctica New Zealand. The scientific research is administered and coordinated through the ANDRILL Science Management Office, located at the University of Nebraska-Lincoln in the United States.

For more information about ANDRILL, explore pages at **http://www.andrill.org**

About the International Polar Year

The International Polar Year (IPY) is a worldwide effort to learn about and raise awareness of our planet's polar regions. The March 2007 through March 2008 event is the fourth polar year. Previous polar years were held in 1882-3, 1932-3, and 1957-8. In order to have a full year of field seasons in both the Arctic and the Antarctic, IPY 2007-8 covers two full years.

Thousands of scientists from over 60 nations are participating in more than 200 IPY projects, researching a range of physical, biological, and social research topics. Thousands of students, teachers, and other citizens are also participating, becoming more aware of the changing conditions at Earth's poles. The IPY effort encourages international cooperation and data sharing, acknowledging that all nations depend on this single planet for their survival.

For more information about IPY, visit **http://www.ipy.org**

Books about Antarctica

The following titles for middle-school-age children can supplement the learning activities. Some books may be appropriate for display at a Flexhibit event.

How to Survive in Antarctica, Lucy Jane Bledsoe ISBN-10: 0823418901

Onward: A Photobiography of African-American Polar Explorer Matthew Henson, National Geographic Photographer Series, Dolores Johnson ISBN-10: 079227914X

The Shackleton Expedition, Jil Fine ISBN-10: 0516234897

Trial by Ice: A Photobiography of Sir Ernest Shackleton, K.M. Koystal ISBN-10: 0792273931

Antarctic Journal, Meredith Hooper ISBN-10: 0711216703

Shipwreck at the Bottom of the World: The Extraordinary True Story of Shackleton and the Endurance, Jennifer Armstrong ISBN-10: 0375810498

Antarctica, Charles Neider ISBN-10: 0815410239

Crossing Antarctica, Wil Steger ISBN-10: 0394587146

After the Last Dog Died: The True-Life, Hair-Raising Adventure of Douglas Mawson's 1912 Antarctic Expedition, Carmen Bredeson ISBN-10: 0792261402

Penguins!, Wayne Lynch ISBN-10: 1552094243

My Season With Penguins: An Antarctic Journal, Sophie Webb ISBN-10: 0395922917

Braving the Frozen Frontier: Women Working in Antarctica, Rebecca L. Johnson ISBN-10: 082252855X

Antarctica, Helen Cowcher ISBN-10: 1840590017

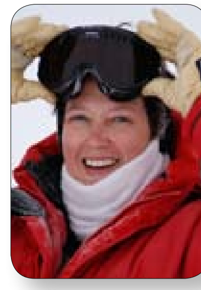
Antarctic Journal: Four Months at the Bottom of the World, Jennifer Owings Dewey ISBN-10: 0060285869

Antarctica: Journey to the Pole (Antarctica 1), Peter Lerengis ISBN-10: 0439163870 (Fiction)

Escape from Disaster (Antarctica 2), Peter Lerengis ISBN-10: 0439163889 (Fiction)

Surviving Antarctica: Reality TV 2083, Andrea White ISBN-10: 0060554568 (Fiction)

About the author



LuAnn Dahlman is an educator and curriculum developer for TERC in Cambridge, Massachusetts. She spent nine weeks in Antarctica, working as a member of the ANDRILL team during the 2006-7 Antarctic field season. She joined the team as a participant in ARISE — ANDRILL Research Immersion for Science Educators. You can read about her adventures as an ANDRILLian at **http://www.andrill.org/iceberg/blogs/luann/all.php**.

Antarctica Today

Foreigners in a foreign land

Antarctica is a remote and mysterious place. It was not discovered until 1820, and people are still learning about it. Compared with Earth's other continents, Antarctica is unusual. Instead of being covered by soil and plants, almost all of its land is covered with snow and ice. Also, huge areas of the ocean surface around Antarctica freeze each winter, then melt again in the summer. As a result, the ice surface that is considered part of the continent grows and shrinks throughout the year. Because Antarctica is centered on the South Pole, it experiences nearly six months of darkness every year, followed by almost six months of daylight.

Only a few thousand people visit Antarctica in any year. No matter how long they stay, visitors to this continent always rely on outside sources of food and energy, much like the astronauts who spend time living on the International Space Station.

Unit 1 Banner

Explore and discuss the *Antarctica Today* banner. Electronic versions of the banners are available at **http://www.andrill.org/flexhibit**.

Activities in this unit. . .

Read a set of postcards that show how animals and humans deal with the low temperatures of Antarctica.

Using a globe, locate your home and Antarctica and compare their surroundings. Look at maps of Antarctica and interpret them so you can describe the characteristics of the continent.

Sort picture cards in a Venn diagram to compare and contrast the Arctic and Antarctic regions.

Unit 1 Podcasts

The following short videos complement this unit. They can be viewed or downloaded from **http://www.andrill.org/flexhibit**.

- Tour of the Cryosphere
- ANDRILL
- Daily Life in Antarctica
- Antarctic Sounds
- Science Is.../Women in Science
- Antarctic Animals

Unit 1 - Antarctica Today

Postcards From Antarctica

Preview

Antarctica is the coldest, windiest, driest continent on Earth. How in the world can life survive in such a harsh place?

Animals that live in Antarctica have adapted to the conditions there. Over time, the animals that had the best features and strategies for dealing with the cold, wind, and dryness are the ones that were able to thrive and reproduce. Their bodies and behaviors are adapted to the harsh conditions.

On the other hand, humans have been coming to Antarctica for less than 200 years. Their adaptations to the cold are things they bring with them. From coats and gloves to specially designed buildings and vehicles, people use technology and outside resources to help them survive. In addition to the extreme cold, humans also have to cope with the isolation that comes with living in Antarctica.

In this activity, you'll view and discuss a set of postcards to learn what it's like for animals and humans to live in Antarctica.

Time

- 30 minutes

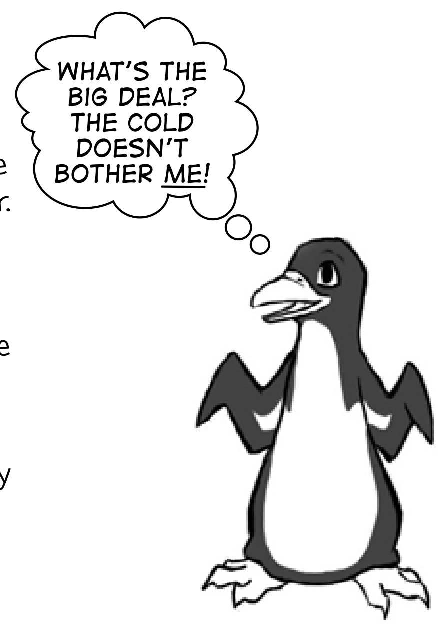
Tools & Materials

- Postcards From Antarctica (pages 11-28)
- Scissors
- Optional: Laminating equipment or clear plastic sheet protectors.

Items found in this book
Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
Additional items

Prepare

1. Cut out the postcards.
2. If you have access to laminating equipment, you may want to laminate the cards. If not, consider placing each one in a plastic sheet protector.
3. Spread the postcards out, picture side up, across a table.
4. Have group members each choose a postcard, one at a time, and describe what they see in the picture. Briefly discuss what the picture shows about living in Antarctica.
5. After discussing your ideas, read the message on the back. Don't worry if your ideas are different from what the card says – both may be correct!



Cut out cards along the dotted line…

Dear Warren-

Antarctica is waaaay remote! They don't have Wal-Marts or Home Depots here, so they have to deliver everything by boat or airplane.

At the South Pole, it's often too cold to land planes, so they have to drop supplies by parachute!

Yours, Leo

Warren Pease
1865 Tolstoy Ave.
St. Petersburg, FL 33701

Dear Alice,

We spent this week working at our field camp. Sure, it's remote, but the view is stunning and we are making good progress in our research. Members of our group found dinosaur bones and fossils of ancient plants this week!

Missing you, Kirk

P.S. We have to do our own cooking out here. The food isn't fancy, but it's hot and filling.

Alice Youn
1517 Shattuck Ave
Berkeley, CA 00U812

Cut out cards along the dotted line…

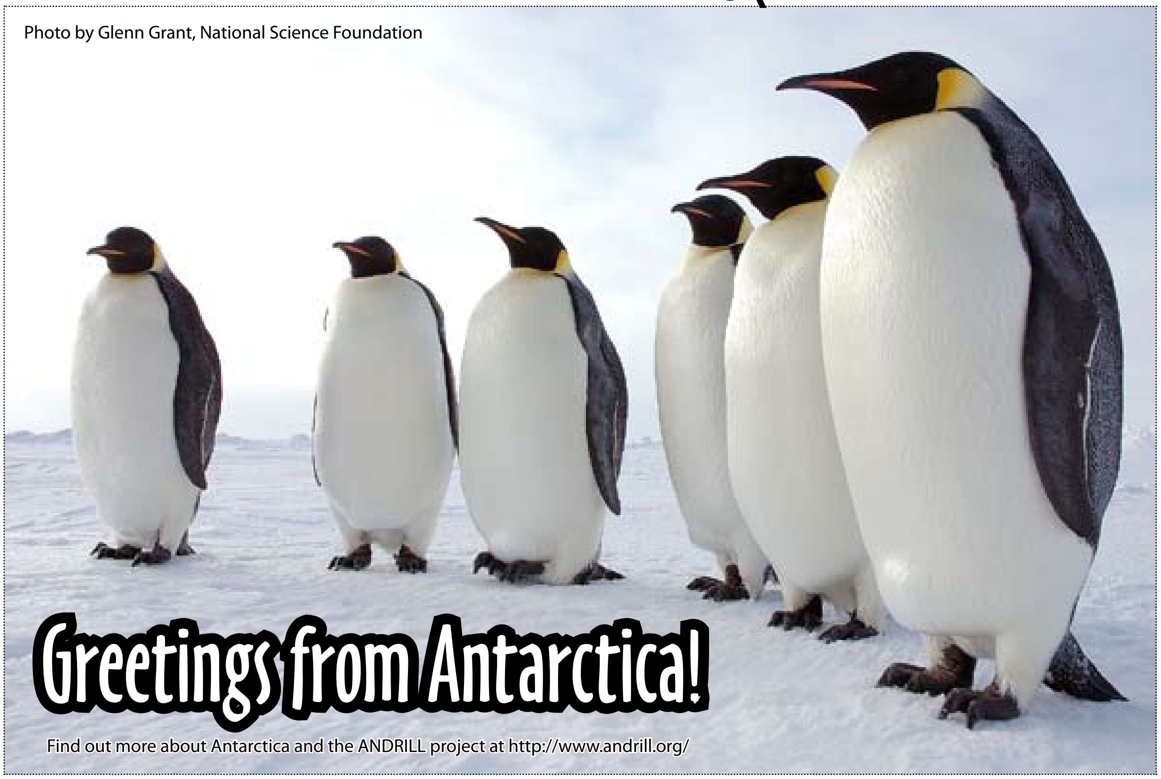


Photo by Glenn Grant, National Science Foundation

Photo by Micheal Claeys

Hi Mike -

The Emperor penguins here don't seem to mind the cold at all! They have layers of fat for insulation, short stiff feathers that trap air next to their bodies, and black backs that they point toward the sun to collect solar energy. This group was sociable and curious: they walked right into our camp and watched us work!

Yours, Milo

Mike Binkley
996 Melba Lane
Bloom County, TX 7627

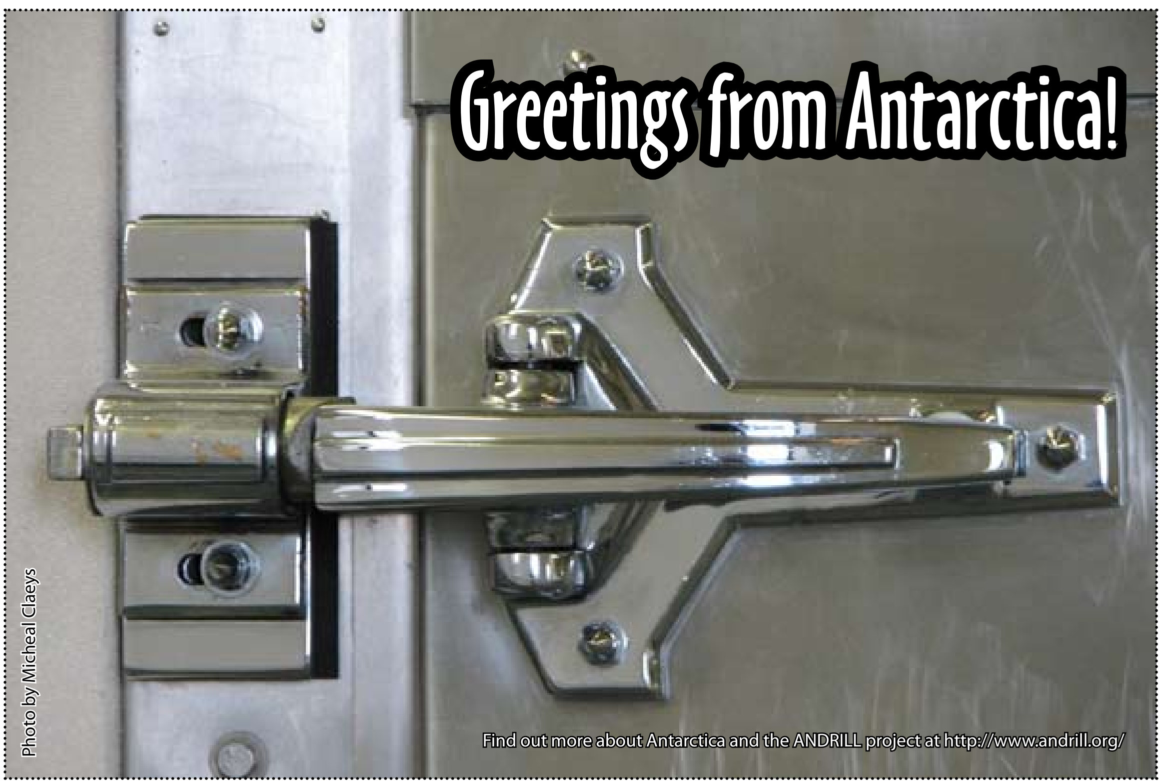
Dear Nancy,

McMurdo Station receives just one shipload of hard goods per year. All the building materials, preserved foods, and oil for generating heat and electricity have to be ordered and packed months ahead of time! Before the vessel can get to McMurdo, an ice breaker has to make a path through the sea ice.

Pete

N.E. Wan
421 Central Ave. Apt 4C
Boston, MA 02101

Cut out cards along the dotted line…



Dear Lanny --

The Recreation Department here helps keep people from getting bored. They loan out bikes and musical instruments, and organize different classes and movie nights. It would be hard to keep working without a little fun!

This shot shows what we mean by snow tires!

Love, Heather

Lanny Johnson
4321 Florence Blvd
Austin, TX 7330

Dear Andrea,

Remember the big heavy door that goes into the walk-in freezer at your brother's restaurant? Doors in Antarctica look like that, only they're designed to keep the cold OUTside instead of inside! Some doors even have special heat tape around their edges so they can't freeze shut!

LuAnn

Andrea Luchovits
4200 N Central Ave. Suite 200
Phoenix, AZ 85001

Cut out cards along the dotted line…

HI DESHAUN -

ONE OF THE FIRST THINGS WE DID IN ANTARCTICA WAS GO TO A SURVIVAL CLASS CALLED HAPPY CAMPER SCHOOL. WE PRACTICED THINGS THAT WOULD HELP US STAY ALIVE IF WE EVER GET STRANDED AWAY FROM THE BASE. WE BUILT A WINDBREAK OF SNOWBLOCKS AND SLEPT OUT IN A TENT!

LOVE, ANTONYA XOXOXO

DESHAUN WAVERLY
32254 SYCAMORE AVE.
BATON ROUGE, LA 70814

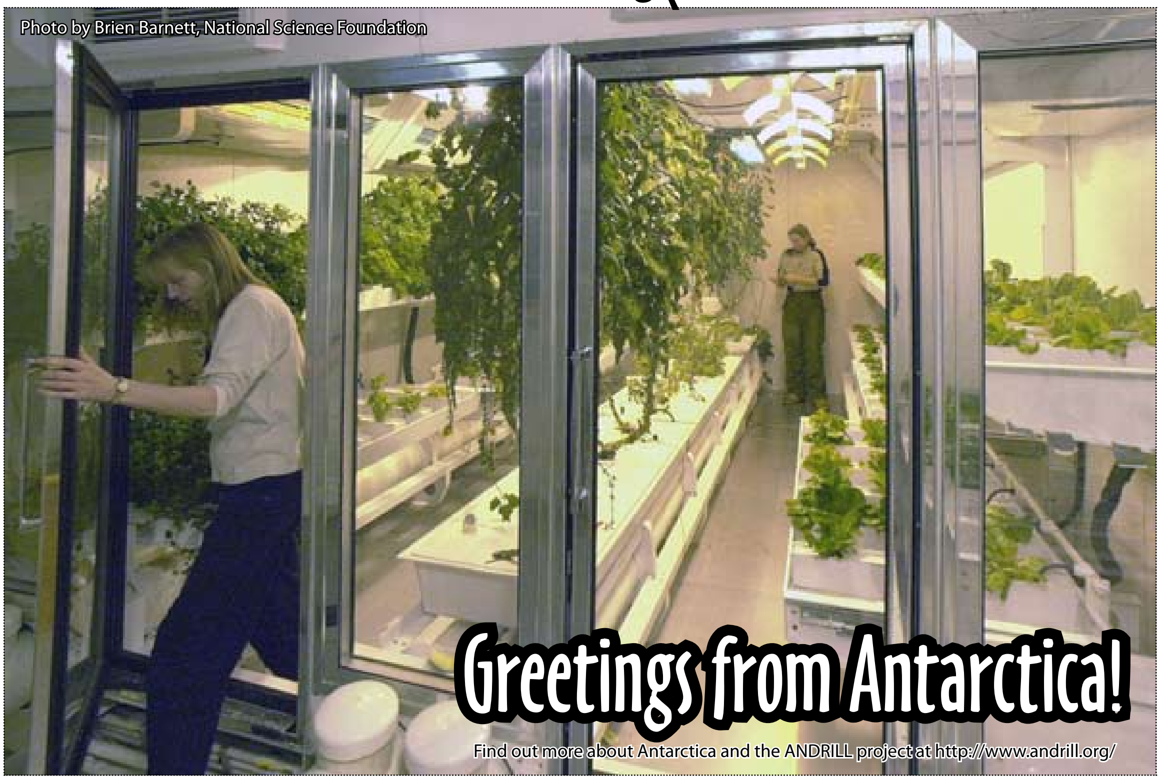
Hey, Bob!

Everyone who comes to work in Antarctica receives a set of ECW (Extreme Cold Weather) gear. We have to wear our special insulated boots and bring the long underwear, fleece jacket, extra gloves, socks, and hats with us in our orange bags whenever we leave the main base. I've become quite fond of my odd outfit, but I'll have to turn it all back in when I leave the ice.

T. Boggan

Bob Sled
3210 Downhill Run
Olympia, WA 98516

Cut out cards along the dotted line…



Hey, Filmore!

It's too cold to grow crops here, but they do have a greenhouse where they're experimenting with growing edible plants under artificial light. It's not a lot, but it's nice to get some fresh greens now and again. The greenhouse is also a soothing place to relax during a break: it's humid and green in there, like no place else on the continent!

Mario

Filmore East
105 Second Ave.
New York, NY 10001

Dear Sam,

You might think we use dogsleds to move people and equipment around here, just like they do in the Arctic. However, there are NO dogs at all in Antarctica!

People were worried that seals here might catch a deathly virus from sled dogs, so now we use snowmobiles.

Ann Tarktic

Sam Walker
421 Central Ave. Apt 4C
Boston, MA 02101

Cut out cards along the dotted line…

DEAR MICHEL -

REGULAR TIRES DON'T WORK SO WELL ON THE ICE HERE, SO LOTS OF THE PASSENGER VEHICLES HAVE HAD THEIR TIRES REPLACED BY THESE MATTRACKS GADGETS. THEY MAKE IT EASIER TO GET TRACTION ON THE SNOW AND TO CROSS CRACKS IN THE ICE.

WOULDN'T THESE LOOK AWESOME ON THE FAMILY CAR?

YOUR FRIEND, COOPER

MICHEL N. GOODYEAR
514 FIRESTONE AVE.
DETROIT, MI 4820

Hey Pam,

Would you care to join this Weddell Seal for an icy swim? He popped up through this hole in the sea ice to catch a breath of air.

You and I would freeze pretty quickly in this water—these seals have thick layers of blubber, though. The fat insulates their warm insides from the cold outside.

Always, Allen

P. N. Gwynn
4321 E. Cooper Apt. 4C
Tucson, AZ 85716

Cut out cards along the dotted line…

HI, JUAQUIN!

THE ICEBREAKER, POLAR STAR, SHOWED UP IN MCMURDO SOUND TODAY. IT'S JOB IS TO GET SEA ICE OUT OF THE WAY SO THE RESUPPLY SHIPS CAN MAKE THEIR DELIVERIES.

THAT'S MT. EREBUS, THE WORLD'S SOUTHERNMOST ACTIVE VOLCANO STEAMING IN THE BACKGROUND. WE RARELY SEE IT WITHOUT A PLUME OF STEAM!

YOUR FRIEND, ELODIE

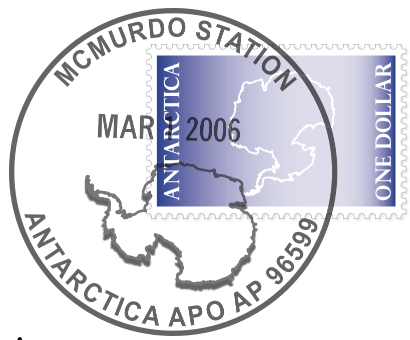
JUAQUIN VALLEJO
1077 S. ELEVENTH AVE.
EL PASO, TX 79906

Hi Zev!

I went on a training exercise with the Ocean Search and Rescue team last week. We don't expect anyone to get lost here, but we train for lots of situations so we'll be ready to help if something happens.

Lots of rules are in place here to keep people safe. For instance, whenever anyone travels away from the station, they need to radio in an estimate of their return time, and check back in when they're back. If they don't return on time and they can't be reached by radio, the Search and Rescue team goes into action to find them.

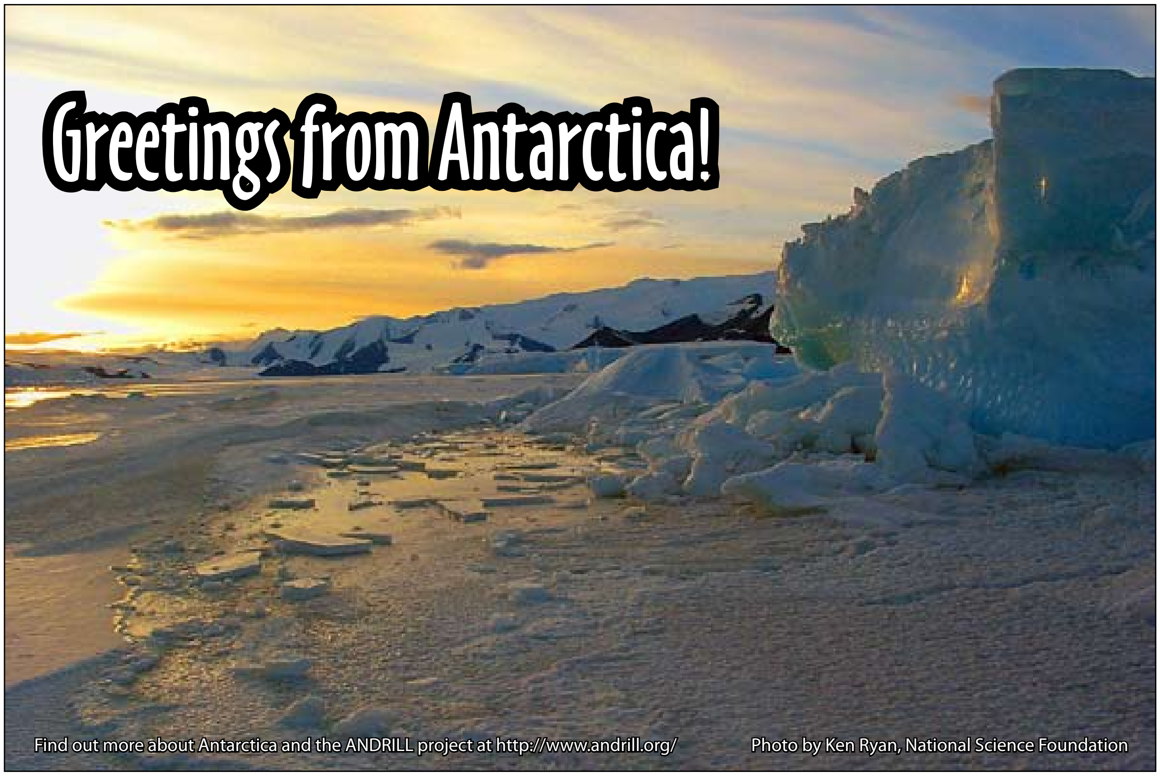
Your friend,
Catherine



Zevon Amari
2301 Jefferson Circle Dr.
Washington, DC 20392

Ponder. . .

What would you say on a postcard from Antarctica? Write a message on these and mail them if you like.



Place Postage Here

Place Postage Here

What would you say on a postcard from Antarctica? Write a message on these and mail them if you like.

Place Postage Here

Place Postage Here

Practice

Got the Big Idea?

Antarctica is an extraordinary place with extremely cold conditions. Wildlife there has adapted to the environment by living there over thousands of generations. Humans require special clothing, equipment, and buildings to help them survive the cold.

Get ready to present

Come up with an introductory comment or question that you can use to invite people to check out the postcards. You might choose a few of your favorites and point them out to people, or share a surprising fact from the postcards.

Present

Place the postcards out on a tabletop or in a stack as part of your display. Be ready to discuss what they show or answer questions to the best of your ability. Don't be afraid to tell your guests if you don't know the answer to one of their questions.

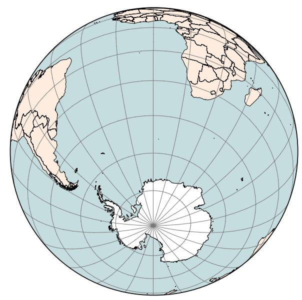
Antarctica in Maps

Preview

Most people know that Antarctica is at the "bottom of the world." In this activity, you'll check out Antarctica's place on the globe, then learn more about the continent by reading maps.

Prepare

Part 1 – The Globe



1. On the globe, find your own country and focus in on the place where you live. Think about the landscape around your community and how it changes through the year.
2. Next, find the continent of Antarctica. On it, look for the Ross Ice Shelf. McMurdo Station, the largest research base in Antarctica, is near the outer edge of the Ross Ice Shelf where it meets the Transantarctic Mountains (the station may not be labeled on your globe). What do you think the landscape looks like through the year in Antarctica?
3. From your home, what fraction of the globe (one-quarter? one-third?) would you need to travel across to get to Antarctica? Use a string and the distance scale on your globe to estimate the number of miles or kilometers from your home to the Ross Ice Shelf.
4. Look around the borders of your own country. Which countries are your neighbors? What kind of transportation would you need and how long would it take you to travel to one of them?
5. Look around the borders of Antarctica. Which countries are Antarctica's neighbors? What kind of transportation and how much time do you think it would take to travel to one of them from Antarctica?
6. If you were going to travel to Antarctica, what route would you follow? Trace a route from your home through major airport cities that would take you to Christchurch, New Zealand and then on to McMurdo Station, Antarctica.

Time

- 1 hour

Tools & Materials

- Maps (pages 33-58)
- Scissors
- 3-ring binder
- Plastic sheet protectors (12)
- Globe
- String
- Index cards
- Colored markers
- Large sheet of poster board or construction paper

> Items found in this book
> Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
> + Additional items

No distance scale on your globe?

If your globe does not have a distance scale, here's how you can make one.

- Wrap a string around Earth's equator. This distance represents Earth's circumference, approximately 25,000 miles or 40,000 kilometers.
- Fold the string in half and mark its length on a piece of paper and label the distance 12,500 miles or 20,000 kilometers.
- Fold the string in half two more times and mark and label the distance it represents on the paper each time.

You should be able to estimate distances on your globe using this scale.

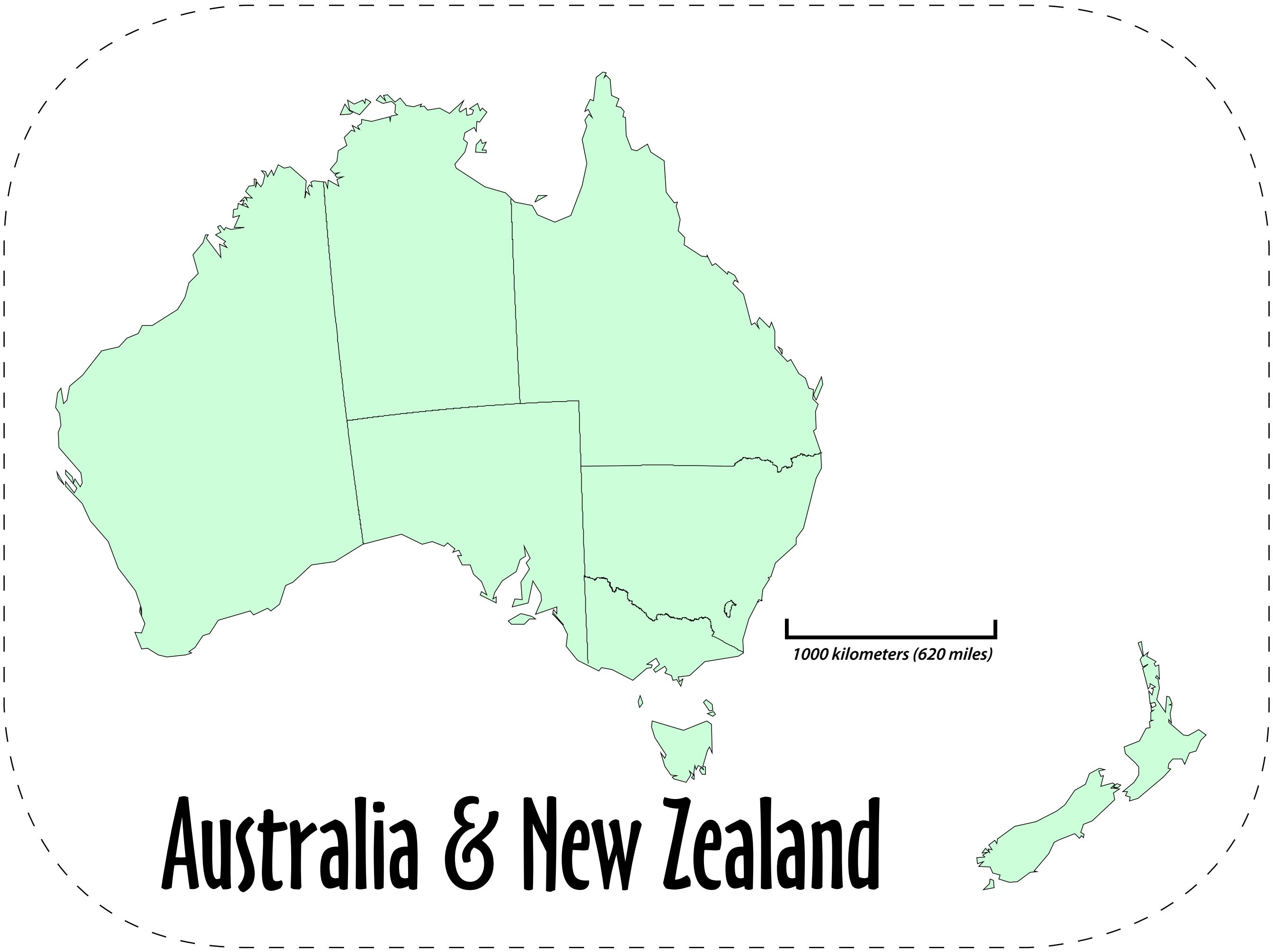
Part 2 – Maps

1. Laminate the maps or place them inside clear plastic sheet protectos to keep them clean and readable.
2. With a partner or in a small group, check out one map at a time. Consider the question and text on each sheet and read the map to come up with an answer that you can explain in your own words.
3. After you've discussed each map, check your ideas by reading the text on the back of the map.
4. For any map that you're not sure how to interpret, do some research in books or on the Internet.
5. You may want to make notes about individual maps on index cards. You can paper clip each index card to the back of the map it describes, or slip it into the back of the sheet protector.

How Large Is Antarctica?

Cutout of Europe to compare to Antarctica

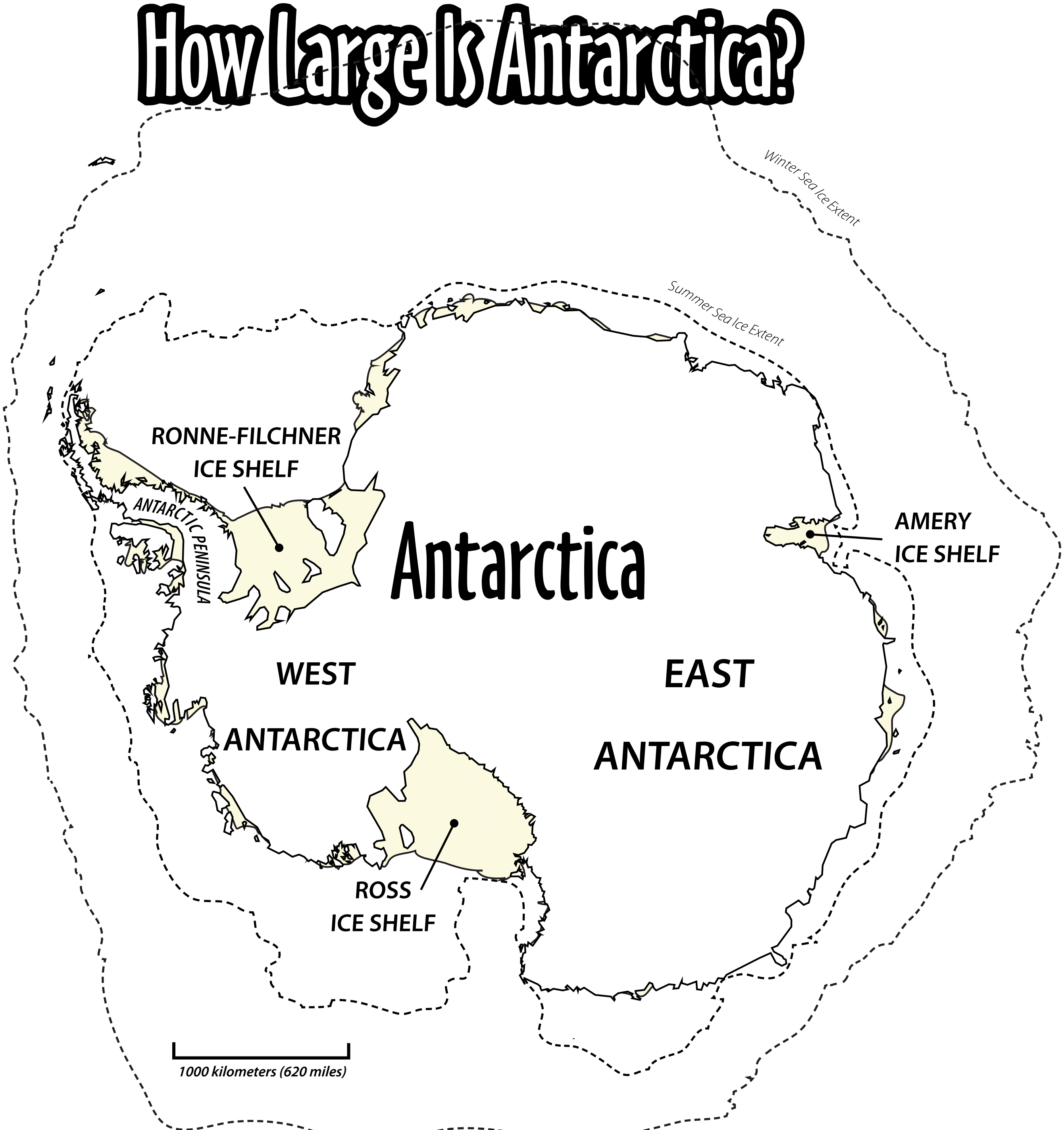
Cut out the maps of Europe, Australia & New Zealand, and North America so you can compare their size to the size of Antarctica on page 39. All four maps are shown at the same scale.



Australia & New Zealand


North America
1000 kilometers (620 miles)

How Large Is Antarctica?



Hold the cutouts of other continents up to this map to compare their size to the size of Antarctica. Look for some feature of the continent where you live that is about the same size as some part of Antarctica.

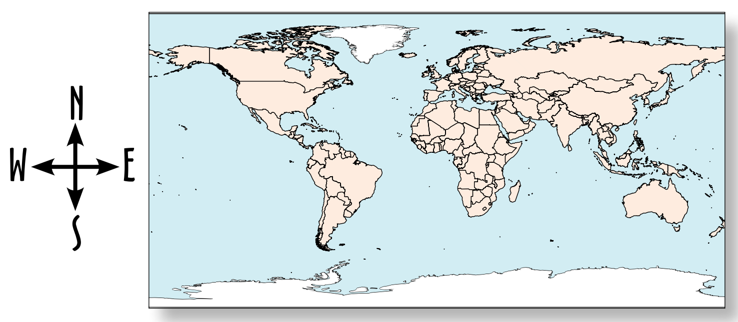
Antarctica is larger than most people realize. When the sea ice that surrounds the continent is included, Antarctica is even larger.

Which Way Is North in Antarctica?

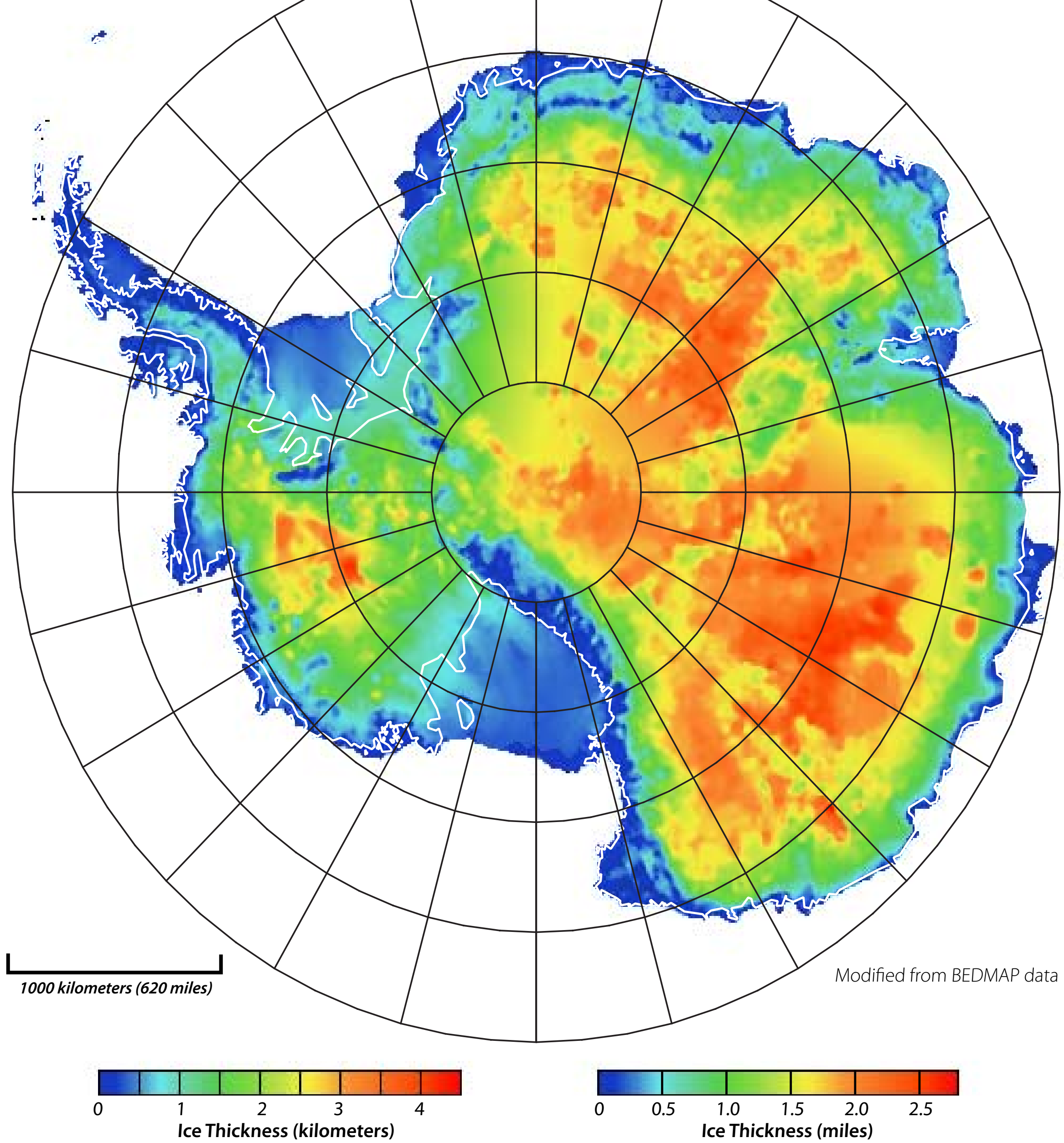
To travel from the South Pole to South America, in which direction would you go?
In which direction would you travel to go from the South Pole to Australia?
How do directions across this map differ from directions on a map of your continent?

From the South Pole, all directions are north.

Unlike the rest of the continents, Antarctica doesn't have an east coast and a west coast: every part of the coastline in Antarctica is its north coast.



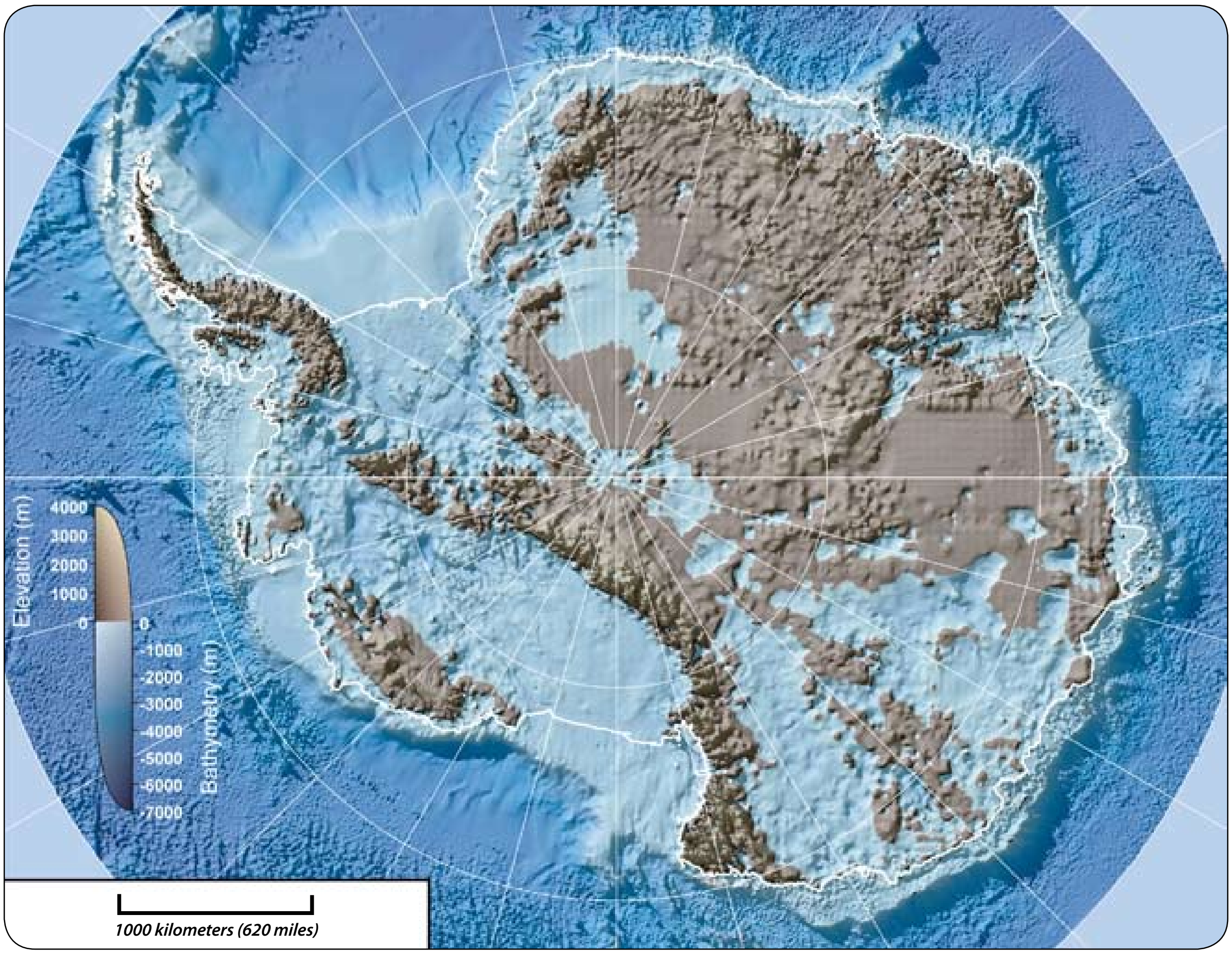
How Thick Is the Ice on Antarctica?



The color at each location shows the thickness of the ice at that spot.
About how thick is the thickest ice on Antarctica?
Think of a distance you know of that is similar to the thickness of the thickest ice.

The thickest ice on the continent of Antarctica is over 4 km (2.5 miles) thick. This is thicker than the Grand Canyon is deep and higher than the Rocky Mountains stand above the Great Plains of the United States. Horizontally, this depth would cover a distance that would take almost an hour to walk at a steady pace.

How Would Antarctica Look Without Its Ice?



Brian Welch, St. Olaf College, based on BEDMAP data

Using data collected over the past 50 years, scientists developed this model that shows the parts of Antarctica's rock surface that are above sea level. How would the map be different if the ice sheets melted and the water was added to Earth's oceans? If the weight of the ice sheets were removed from the land, scientists think that the land might spring back up. How would this "glacial rebound" change the map?

This map shows a visualization of areas where the rocky (land) surface of Antarctica is above (and below) sea level.

If all the ice on Antarctica melted and ran into the ocean, sea level would increase by tens of meters, so the lowest areas of the land shown in this map would be under water. The area above water would be smaller.

If glacial rebound were to occur, the land would be higher, so the area of land above water would be larger.

If both conditions were to occur, they could counteract one another and the map would not change.

Where Do Penguins Live in Antarctica?

Adelie
(Pygoscelis adeliae)
Population: ~ 4,900,000

Patrick Rowe

"I live along most of Antarctica's coast."

Chinstrap
(Pygoscelis antarctica)
Population: ~ 15,000,000

Zee Evans

"I live in the same places as Gentoo penguins, and also on another island."

Emperor
(Aptenodytes forsteri)
Population: ~ 400,000

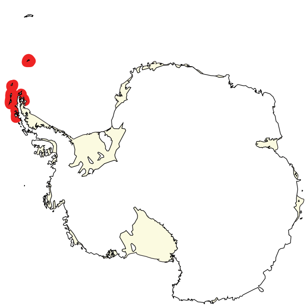
Kris Kuenning

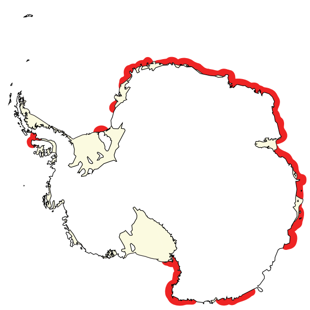
"I live mostly on the coasts of East Antarctica."

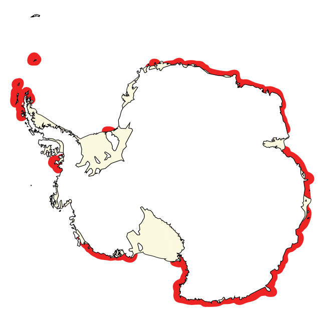
Gentoo
(Pygoscelis papua)
Population: ~300,000

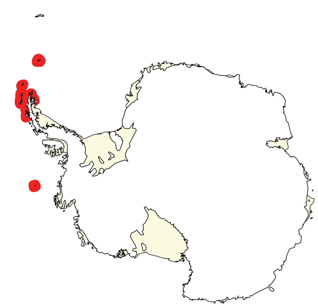
Melissa Rider

"I live only on the tip of the Antarctica peninsula."





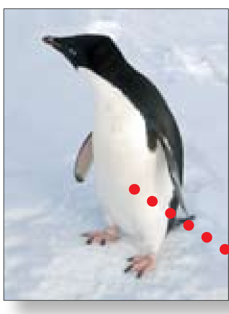




The red area on each map shows where one of these types of penguins lives. Read the clues under each penguin and look at the maps to match it to where it lives in Antarctica.

Source: http://www.seaworld.org/animal-info/info-books/penguin/appendix-species.htm

Adelie
(*Pygoscelis adeliae*)
Population: ~ 4,900,000



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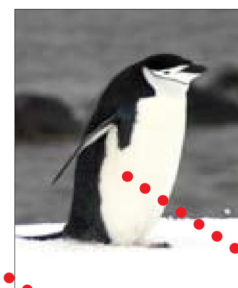

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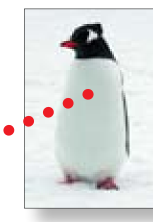
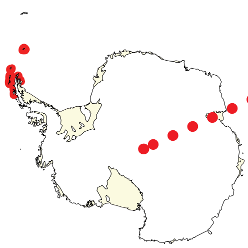
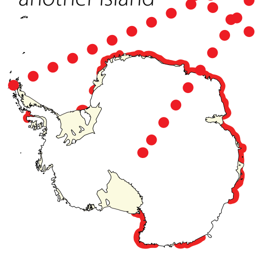
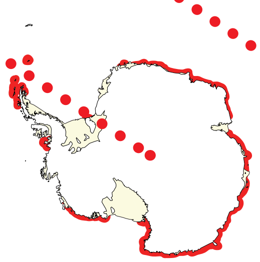


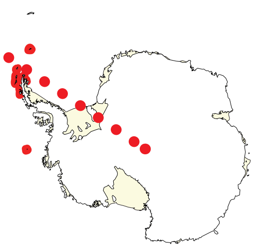
Melissa Rider

"I live only on the tip of the Antarctica peninsula."

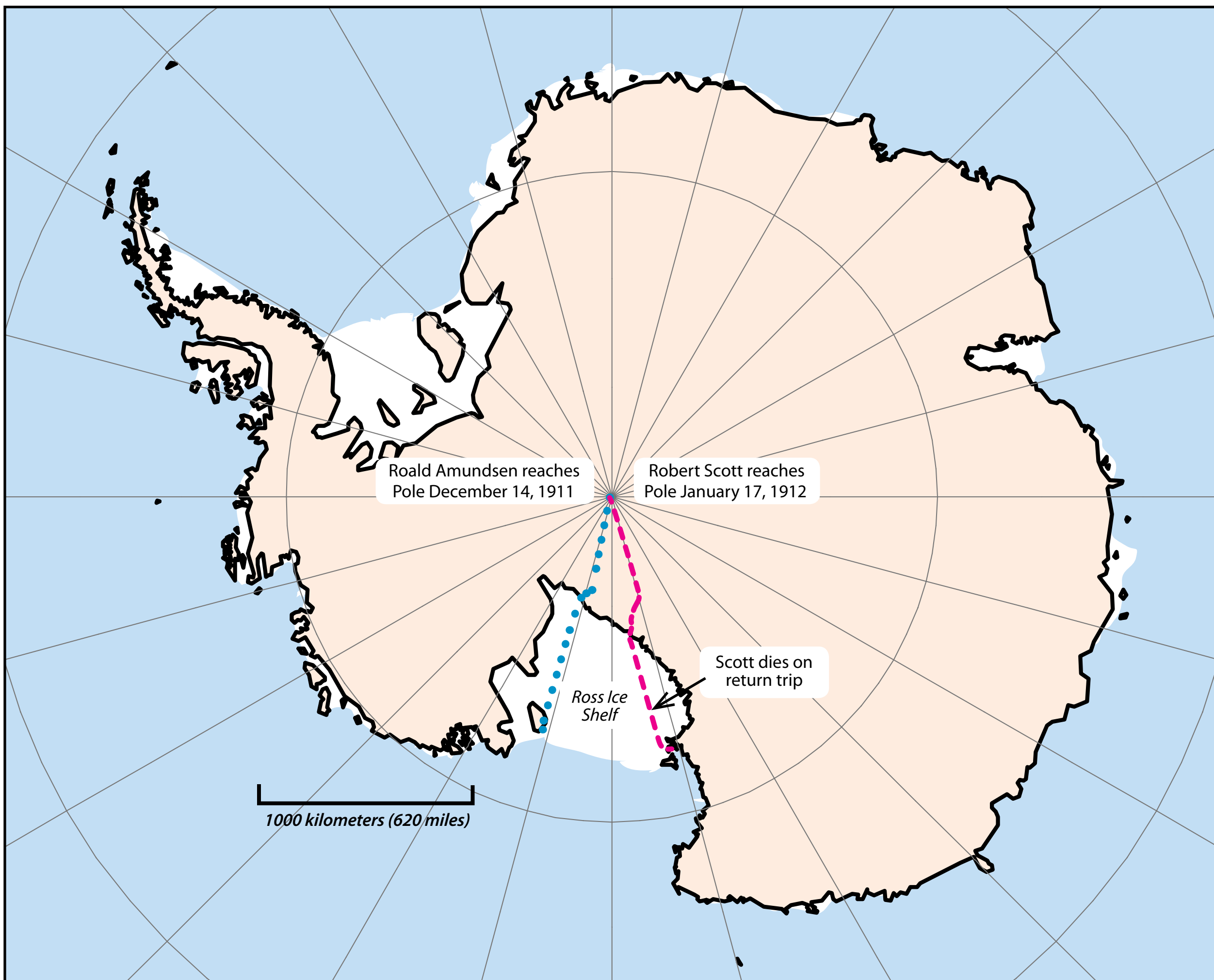








Would You Risk Your Life to Be the First Person to Reach the South Pole?



Roald Amundsen of Norway led one expedition: it took his group 57 days to make the 1400 km (900 mi) round trip. Another expedition, led by Robert Scott of Great Britain, encountered horrible weather. They reached the pole in 77 days, but Scott died on his return trip. Calculate the average distance each expedition traveled per day.

Amundsen's group traveled an average of 25 kilometers, or 16 miles, per day. Scott's group averaged around 18 kilometers, or 12 miles, per day.

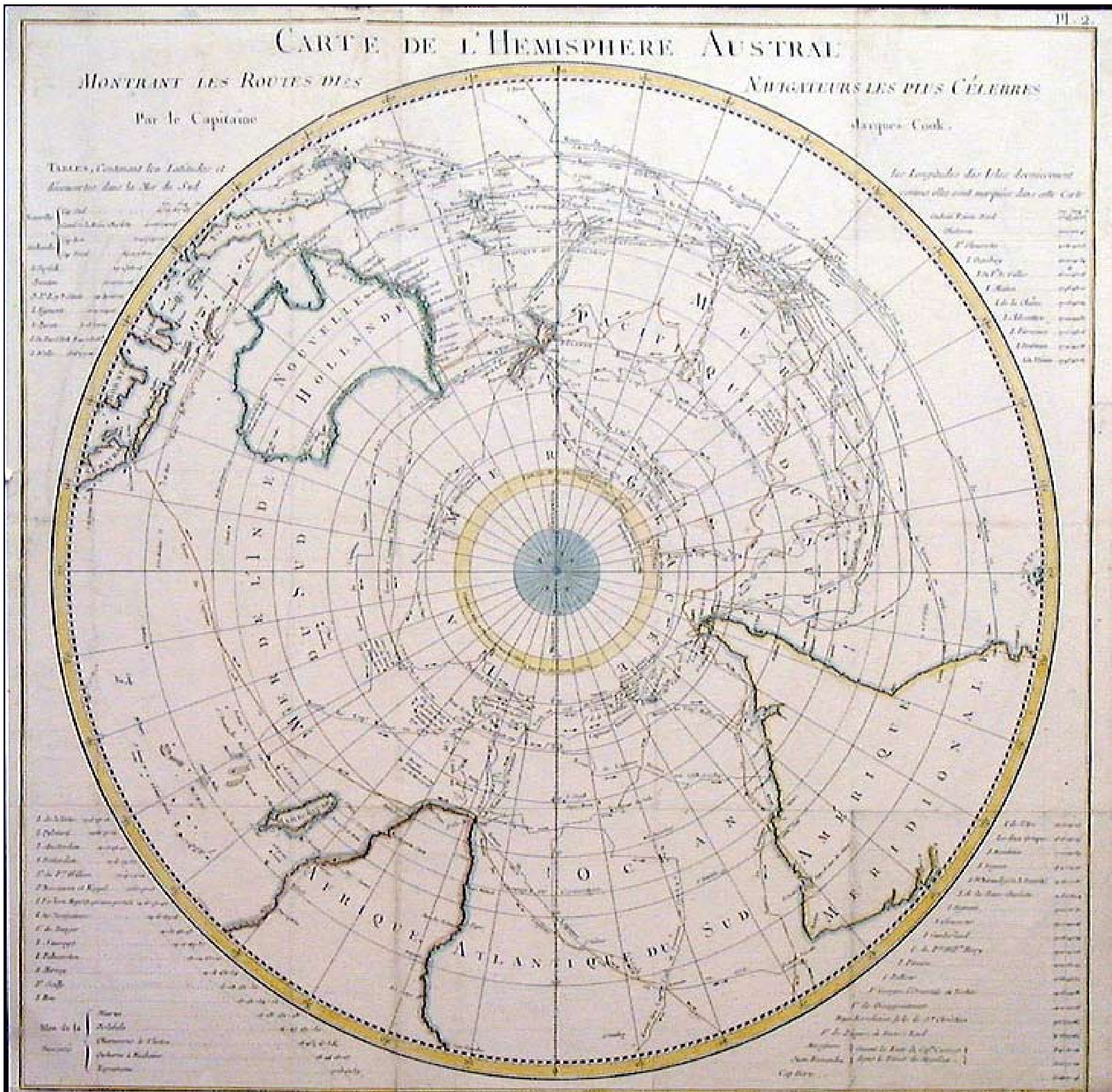
Calculations: 1400 km / 57 days = ~25 km/day

900 mi/ 57 days = ~16 mi/day

1400 km/ 77 days = ~18 km/day

900 mi/77 days= ~12 mi/day

Why Is Antarctica Missing On Old Maps?



Map image courtesy of Grace Galleries Inc. Harpswell, ME. www.gracegalleries.com

Compare this chart of the Southern Hemisphere with a globe. What differences do you notice? Drawn in France in 1785, this map shows the routes of early explorers. Why do you think they missed discovering Antarctica until 1820?

The maps shows fairly accurate outlines of Africa and South America, but it shows the southeastern tip of Australia (Tasmania) connected to the continent instead of as an island.

Early explorers may have missed discovering Antarctica because the sea ice that surrounds the continent kept them from getting close enough to the continent to see land.

Who Does Antarctica Belong To?

■ Research Station

Source: 2007 CIA World Factbook

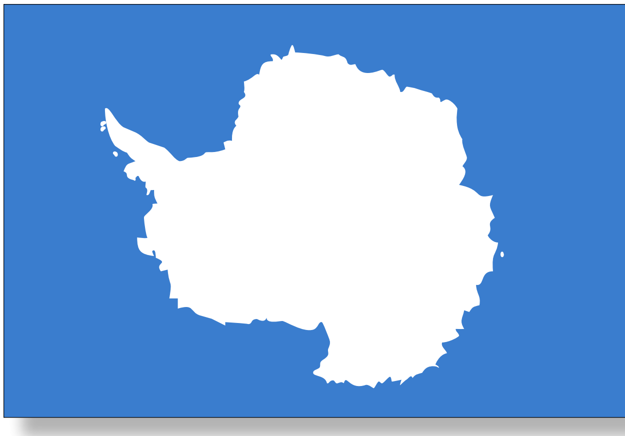
Seven countries once claimed parts of Antarctica, but all territorial claims were suspended by the Antarctic Treaty in 1961. Which countries had claimed some of the land? Many countries have research stations on the continent today. Can you find stations from at least ten different countries?

Countries that made claims to land in Antarctica were Australia, New Zealand, France, Norway, Britain (U.K), Argentina,and Chile.

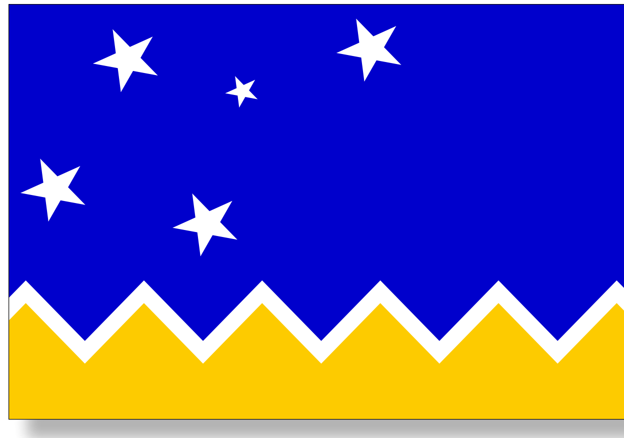
The map shows research stations established by 15 different nations: Argentina, Australia, China, France, Germany, India, Italy, Japan, New Zealand, Russia, South Africa, South Georgia, United Kingdom, United States, and Ukraine.

The primary purpose of the Antarctic Treaty is to ensure "in the interests of all mankind that Antarctica shall continue forever to be used exclusively for peaceful purposes and shall not become the scene or object of international discord."
To this end, the treaty prohibits military activity, except in support of science; prohibits nuclear explosions and the disposal of nuclear waste; promotes scientific research and the exchange of data; and suspends all territorial claims. The Treaty applies to the area south of 60° South Latitude, including all ice shelves and islands.

Does Antarctica Need a Flag?



This design by was inspired by the United Nations flag. The plain white continent on the blue background symbolizes the neutrality of Antarctica.



This flag, used by Chile's Magallanes Region, shows the Southern Cross, a prominent constellation in the Antarctic sky, over a mountain range.

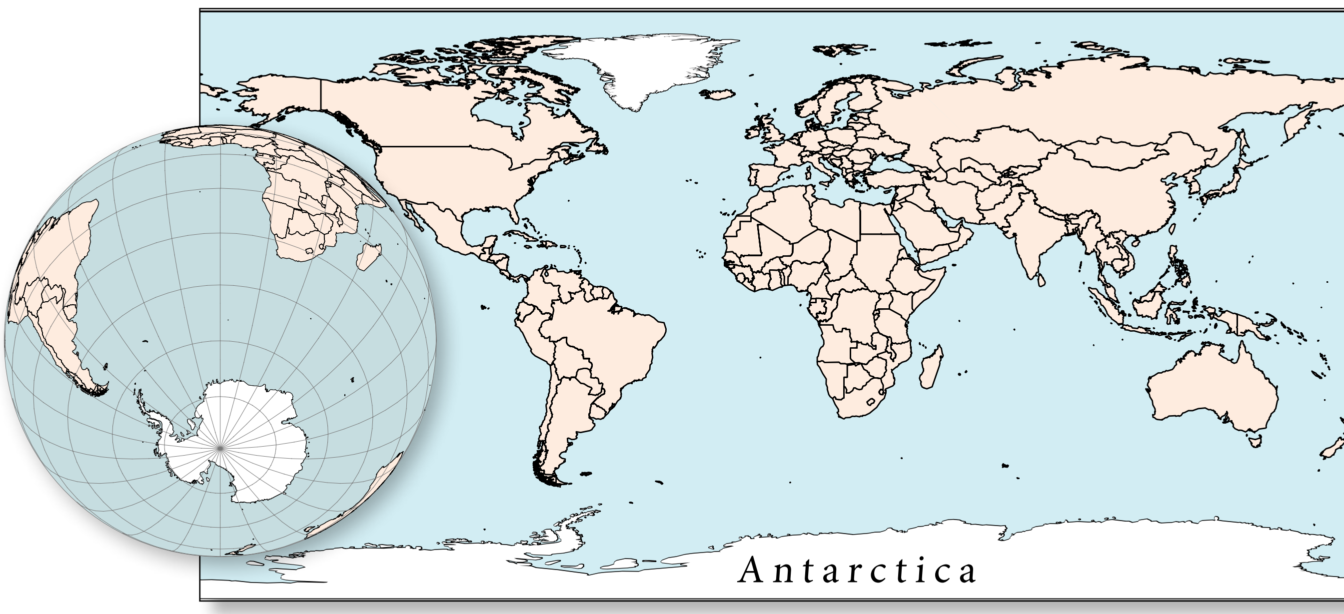
This flag, used by the Argentine province of Tierra del Fuego, shows an Antarctic bird and the Southern Cross.

This design uses "rescue" orange for the background, and the white represents snow and ice. A is for Antarctica, the "bowl" is Antarctica's position on Earth, and the hands represent peaceful cooperation.

These designs have been proposed as flags for Antarctica, or used for Antarctic Territories claimed by other countries. Use a blank piece of paper to make your own design for a flag for Antarctica.

There is no official flag for Antarctica.

Why Do Some Maps Show Antarctica As a Strip Across the Bottom?



Look at Antarctica on the picture of the globe and on the map. Where was the continent you see on the globe cut and how was it stretched to get the shape that you see along the bottom of the map? Why do you think people use this type of map, given that it distorts the shape of Antarctica so badly?

The bottom center of the continent pictured on the globe is the location of the "cut" into Antarctica. The point that represents the South Pole was stretched out into a line the same length as the Equator to produce the shape at the bottom of the map.

The flat map you see is called a Mercator projection. All flat maps of our round planet give inaccurate representations of either shapes or sizes. Though this type of map distorts and enlarges Antarctica (and the Arctic), it shows the mid-latitudes and equatorial regions (where human populations are concentrated) fairly accurately.

Ponder. . .

After looking at Antarctica on the globe and in the maps, make a list of 15 to 20 words and phrases that describe the continent.

Practice

Got the big idea?

Maps help us understand a place, especially a place that is so large and unfamiliar as Antarctica. Viewing a range of diffferent maps helps people build their understanding of the place by considering one thing about it at a time.

Get ready to present

Come up with an introductory question or comment you'll use to invite visitors to look at the globe or some of your favorite maps. Make sure that you can give a clear description of each map that explains your answer to the question.

You may want to prepare a large sheet of posterboard or construction paper with an outline of Antarctica on it. A whiteboard or chalkboard would work too. You can encourage visitors to record words and phrases that describe the continent.

Present

Display the open binder on a tabletop or post the maps on a bulletin board. Encourage visitors to find a map that interests them, then answer the question posed on the map. Be ready to answer questions or explain the message of each map. If you need help explaining what a map shows, read the description on the back of the map.

Polar Opposites?

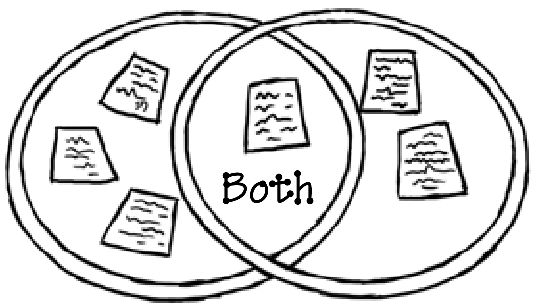
Preview

The "ends" of Earth are its **polar** regions. The region around the North Pole is called the **Arctic**. Its name comes from the fact that the stars above it form a constellation once known as **Arctos**.

The region surrounding the South Pole is directly opposite from the Arctic, so it is called the anti-Arctic, or **Antarctic**. Though their names are opposites of each other, the two regions have similarities as well as differences.

Take a look at both polar regions on a globe. Everything inside the Arctic Circle is part of the Arctic region; everything inside the Antarctic Circle is in the Antarctic region.

You may have learned about something called a **Venn diagram** in school. If so, you know that it's a graphical way of showing how two things are different and how they are the same. A Venn diagram is usually drawn as a pair of overlapping circles. The area where the circles overlap represents what the two things have in common. Things in the separate parts of the circles only apply to one of the groups.



In this activity, you'll get a stack of pictures and descriptions of polar features. You'll sort them into a Venn diagram to show if they represent the Arctic, Antarctic, or Both polar regions.

Time

- 30 minutes

Tools & Materials

- Polar Picture Cards (pages 11-28)
- Globe
- Scissors (or paper cutter)
- Two overlapping circles, each about 1 meter in diameter (hula hoops, chalk, white board, tape, etc.
- Optional: Double-stick tape, velcro, or stick-on magnetic strips.

- Items found in this book
- Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
- Additional items

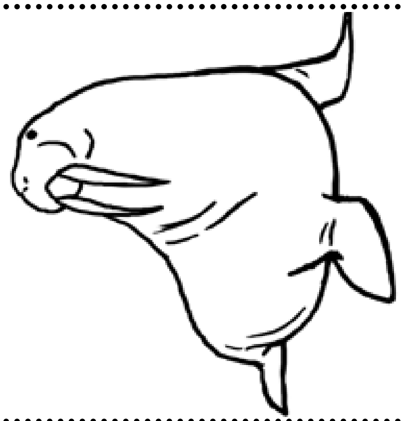
Prepare

1. Cut out the Polar Picture Cards along the dotted lines.
2. Decide on a place to make your Venn Diagram. You'll want circles that are about 1 meter (1 yard) in diameter. You might draw them on a chalk board or a white board, or outline them with chalk or string on a table or the floor. Set up your two circles so that about one-third of their areas overlap.
3. One circle will contain things found in the **Arctic** and the other will contain things found in the **Antarctic**. The area of overlap represents things that are found in **Both** polar regions. Make these three labels and place them in appropriate areas of the diagram.
4. Distribute the Polar Picture Cards among your group members. Participants should consider where their pictures belong in the Venn diagram, then check themselves by reading the information on the back.
5. One at a time, show/describe your card to your group and ask them for ideas about where it belongs in the diagram. After a brief discussion, share the information from the back of the card and place it in the appropriate area on the diagram. Use a rolled piece of masking tape on the back of the card if you need to stick it to a board.

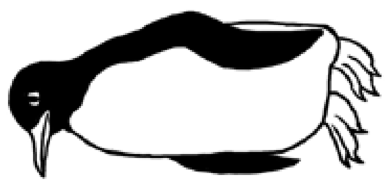
White Board Trick

Most white boards have a metal backing that magnets will stick to. If you use a white board for your circles, you can stick a small adhesive magnet (available separately or in rolls, from most hardware and craft stores) to the back of each card, to hold the cards to the white board.

Cut out cards along the dotted line…



Walruses

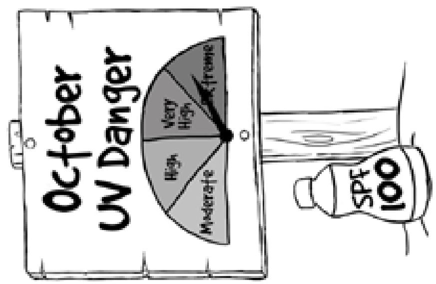


Penguins

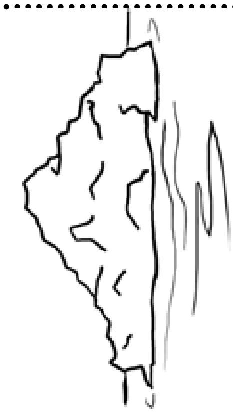
Polar bears

Seals

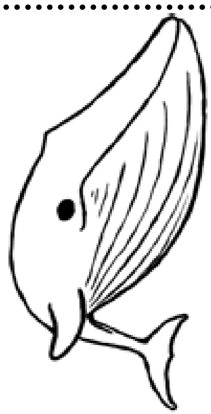
Volcanoes



Regularly experiences an ozone hole



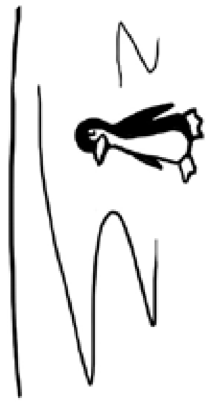
Icebergs



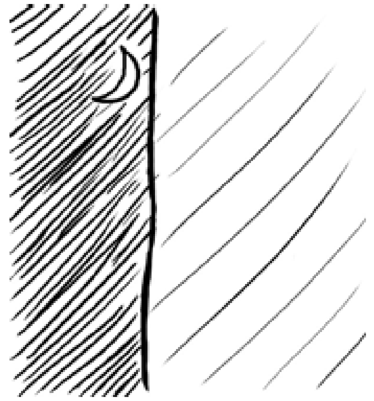
Whales

Arctic	Antarctic	Arctic	Both
Walruses, with their long white tusks, live only in northern waters	Penguins live around the coasts of Antarctica and other southern continents and islands	Polar Bears live only in the Arctic	Seals live in both the Arctic and the Antarctic
Antarctic	Antarctic	Both	Both
Mt. Erebus in Antarctica is the world's southernmost active volcano	Every October since 1985, instruments have detected a reduction in the ozone concentration over Antarctica	Icebergs form in both polar regions—they are chunks of ice that originally formed from fresh water snow on land	Whales live in waters of both the Arctic and Antarctic

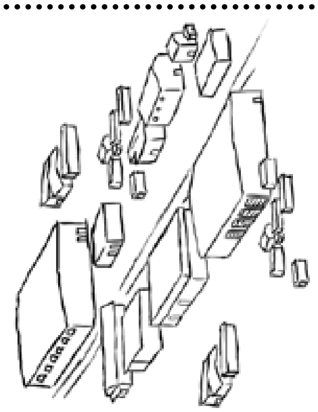
Cut out cards along the dotted line…



Permanent home to zero humans

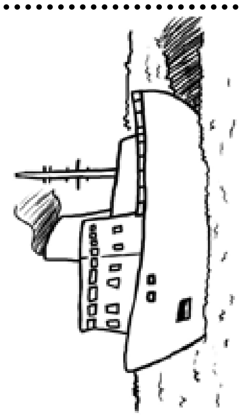


6 months of darkness

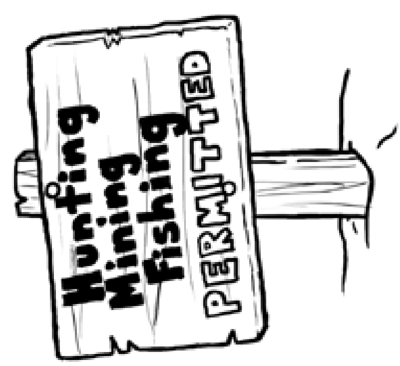


Permanent home to over 3 million humans

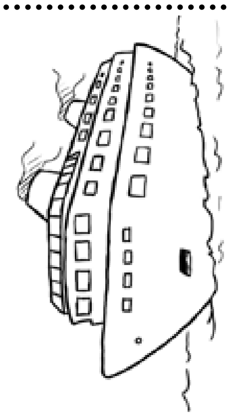
6 months of daylight



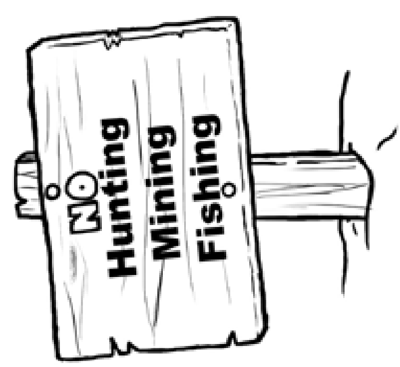
Ice breaker



Not Protected



Cruise Ship

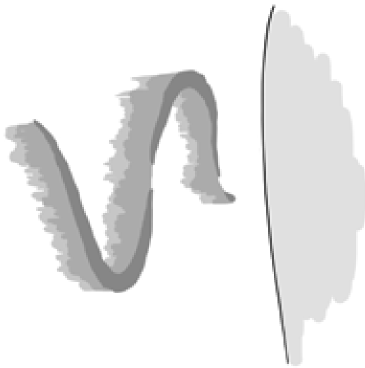


Protected

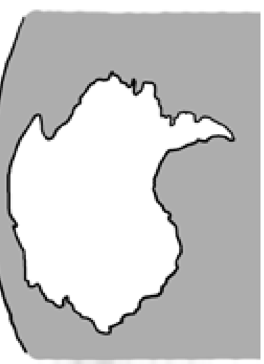
Antarctica	Arctic	Both	Both
There are no permanent residents in Antarctica, only temporary visitors	Cities inside the Arctic Circle have a total population over 3 million	Icebreakers are used in both polar regions to carve through sea ice.	Cruise ships regularly take passengers to see the beauty of both polar regions.
Both	Both	Arctic	Antarctic
The Arctic and the Antarctic both experience approximately 6 months of darkness in the winter	Both the Arctic and the Antarctic experience approximately 6 months of daylight in the summer	Except in specially set-aside areas, hunting, fishing, and mining are permitted in the Arctic	Hunting, fishing, and mining are prohibited in the Antarctic

Cut out cards along the dotted line…

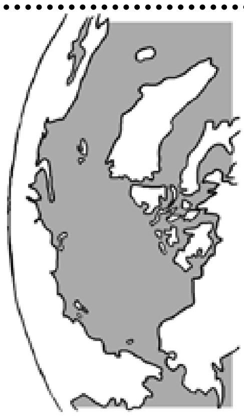
Dogs Pulling Sleds



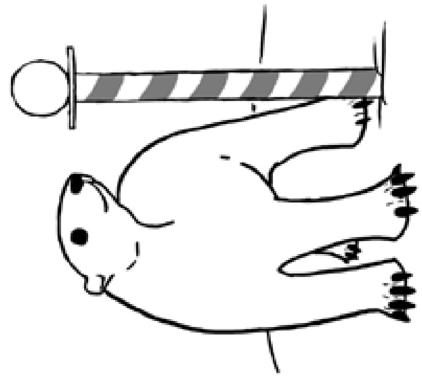
Auroras



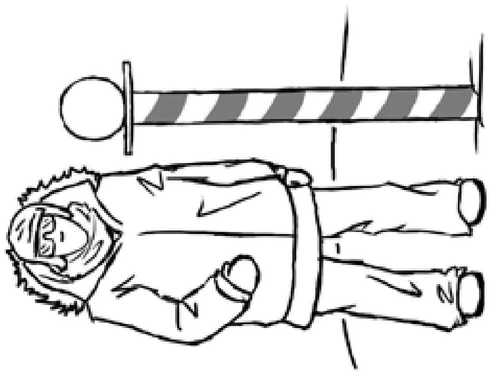
Land surrounded by Ocean



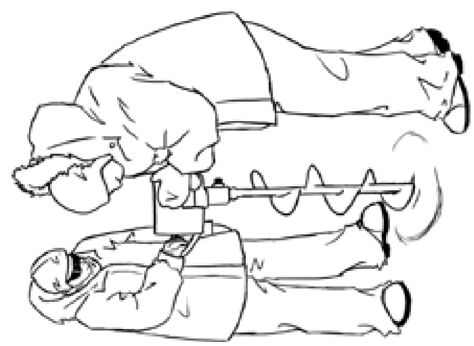
Ocean surrounded by Land



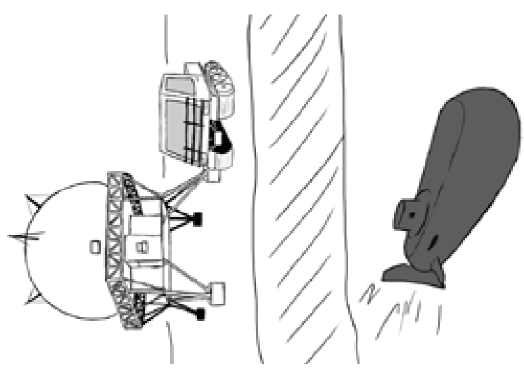
The North Pole



The South Pole



Scientists



Military Presence

Arctic

Since 1993, sled dogs have been banned in Antarctica because the canine disease distemper can spread to Antarctica's seals.

Both

Auroras - bright, shimmering sheets of light caused by interactions between particles from the sun and Earth's magnetic field - are seen in both hemispheres.

Antarctic

Antarctica is land surrounded by ocean.

Arctic

The Arctic is ocean surrounded by land.

Arctic

The North Pole is located in the Arctic. (There are no polar bears in Antarctica.)

Antarctica

The South Pole is located in Antarctica. (A permanent scientific research station is located at the South Pole.)

Both

Scientists actively study both of Earth's polar regions.

Arctic

Military bases and operations are common in the Arctic, but are prohibited in Antarctica.

Ponder

Movies, television shows, and commercials occasionally show unlikely pairings of animals from the Arctic and Antarctic together. Think of some of the pairs of animals that you would never expect to see together, and list them.

Make up a fun sentence that will help you remember that the continent of Antarctica is at the South Pole where penguins live. Include some of the other Antarctica-only details in your sentence.

Practice

Polar Animals

Find out more about the animals in the Polar Picture Cards at **http://animals.nationalgeographic.com/animals/**.

Got the big idea?

Both of Earth's polar regions are cold and icy. Each region experiences several months of darkness followed by months of sunlight each year. The Arctic includes the North Pole: it is an ocean surrounded by land. The Antarctic includes the South Pole; it is land surrounded by an ocean. Each location has a unique set of wildlife.

Get ready to present

Think of a question or comment you can use with visitors that will invite them to interact with the Polar Picture Cards and the Venn Diagram. You may want to cover the answer on the back side of each card with a sticky note.

Present

Set up or draw the two circles of your Venn Diagram and label the three areas of your diagram. Place a few of the cards into the correct locations as examples and spread the remaining cards face up on a table. If necessary, provide tape or magnets to keep the cards in place.

Encourage Flexhibit visitors to choose a card and decide where to place it. Don't tell them to look at the back until after they have given it some thought.

Animal Insulation

Preview

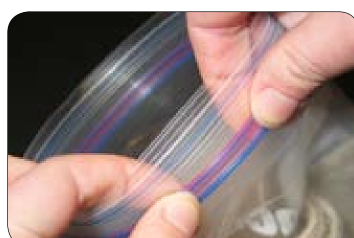
Photo by Opher Ganel, University of Maryland and National Science Foundation

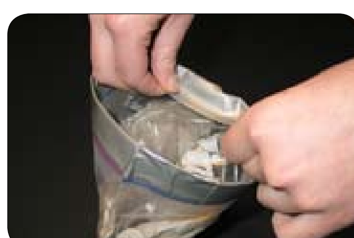
Whales, Weddell seals, and penguins swim in the icy waters of Antarctica. These animals all have thick layers of fat, called **blubber**, under their skin. Some also have fur or feathers on the outside. This activity will give you a first-hand feel for how blubber and fur insulate animals from the cold.

Prepare

Part 1 - Blubber

1. Spoon about two cups of blubber (shortening) into one of the plastic zipper lock bags.
2. Turn a second bag inside out and put it into the first. Push it in and turn it so the zipper halves of the inner bag line up with the zipper halves of the outer bag.
3. Squeeze out any extra air between the bags, then zip them together.
4. Knead the shortening around between the two bags to make an even layer of blubber between the walls of the bags.
5. To prevent leaks, wrap a piece of duct tape around the opening and fold it inward to seal the two bags together.
6. Prepare a second pair of plastic bags as your "control" glove. Leave them empty so you'll be able to compare the blubber glove to one with no insulation.





Time

⌛ 30 minutes

Tools & Materials

- Large, waterproof container: bowl, plastic bin, bucket, aquarium, etc.
- 1-quart plastic zipper lock bags (10) - *see note below.
- Duct tape
- Washcloth or other cloth of similar size
- Other insulating materials (cotton balls & fiberfill)
- Colored markers
- + 2 cups solid vegetable shortening or lard
- + Medium size cooler of ice
- + Water
- + Large sheet of poster board or construction paper
- + Towels for cleanup
- + Optional: Additional insulating materials (feathers, down, etc.)

📖 Items found in this book
- Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
- + Additional items

* Plastic Bag Tip

Heavy-duty freezer bags work best, but don't use the kind with plastic sliders. Use the kind that seal by pressing the two strips together.

The finished blubber glove.

7. Fill a large container with ice cubes. Add water until the water level is about halfway up the sides of the container.
8. Put one hand into the blubber glove and the other into the control glove.
9. Place both gloved hands into the icy water at the same time and compare how they feel.

Comparing the blubber glove and the control glove.

10. **IMPORTANT! Remove the gloves from the ice water and let them return to room temperature before the next person uses them!**

Part 2 - Insulated Clothing

It's not practical — or healthy — for us to put on a thick layer of blubber to protect us from the cold, so we need to do something different to stay warm. People visiting or living in areas with cold climates wear thick layers of insulated clothing. The air spaces trapped within the clothing keep our warmth inside and the cold outside.

1. Fold the washcloth or piece of cloth in half and in half again.
2. Turn one plastic bag inside out on your hand and place it within the fold of the washcloth.
3. Insert the cloth and plastic bag into a second plastic bag and seal the openings using the plastic seal and duct tape.
4. Test this glove in the ice water bath — compare it to the control glove and to the blubber glove.
5. Can you think of a way to improve the insulation level of the cloth glove? What other materials might you test? If you have time and materials, make additional gloves containing other insulating material.

Ponder. . .

Photo by Henry Kaiser, National Science Foundation

Some researchers in Antarctica SCUBA dive under sea ice to observe animals or gather specimens. In order to survive in the water, humans wear insulated dry suits that trap heat in and keep water out. Once they are out of the water, they need to remove their suits, to avoid overheating.

Since animals can't take off their blubber, what can they do to keep from overheating? Describe your ideas about how Antarctic animals might cool off.

Would YOU go SCUBA diving under Antarctica's ice? Describe what it would take to get you to go into the water.

Practice

Acknowledgment

This activity was adapted from "Blubber Glove," originally produced by the Gulf of Maine Aquarium.

Got the Big Idea?

Blubber and fur insulate animals from the cold in Antarctica. Humans bring insulated coats with them to keep warm.

Get ready to present

Come up with a question or statement to invite visitors to test your gloves to feel for themselves one way that animals stay warm in Antarctica. Prepare one or more sets of blubber gloves, control gloves, and gloves with other insulating materials. Store your blubber glove in a refrigerator. Get it out of the refrigerator a day ahead of time so that it can warm up to room temperature before your Flexhibit.

Special preparations for this station

You'll need to have a supply of extra ice available to add to the container of ice water as it melts.

Present

Set up your container of ice water and place your gloves in front of it. Invite visitors to put their hands in the gloves and then into the ice water. Be ready to explain what the gloves represent and demonstrate how to do the test.

After a visitor tests the gloves, remove them from the ice water right away. Let the blubber warm up to room temperature between trials—if it remains in the container too long, it will be as cold as the ice water.

As the ice begins melting, add additional ice to the container. Use a cup to take some of the melted water out whenever you add extra ice. Keep the water level in the container low enough that water won't leak into the top of the gloves as visitors test them. Keep a towel handy and use it to wipe up drips and spills.

Antarctica's Ice On the Move

Slow-moving water

There's no doubt about it — Antarctica is an icy place. About 70% of Earth's fresh water is trapped as solid ice on this large southern continent. The ice there has been accumulating for over 30 million years, piling up one snowstorm at a time.

Just as liquid water flows downhill, solid water does as well, but at a much slower rate. Over time, ice behaves something like gooey toothpaste: its shape can change, though it remains solid.

Three names for one kind of ice

Ice that covers the continent of Antarctica is part of an **ice sheet**. Some parts of the ice sheet are over 2 miles (3 km) thick! At its base, an ice sheet moves over land, grinding over mountains and valleys and carrying rocks downhill.

Around the edges of the continent, ice sheets flow off the land and extend out over the ocean. The floating outer edges of the ice are called **ice shelves**. Ice shelves cover large areas of ocean around Antarctica, especially in bays and inlets along the coastline. Ice shelves are about as thick as the length of a football field, around 100 meters.

NASA Scientific Visualization Studio, modified by Angie Fox

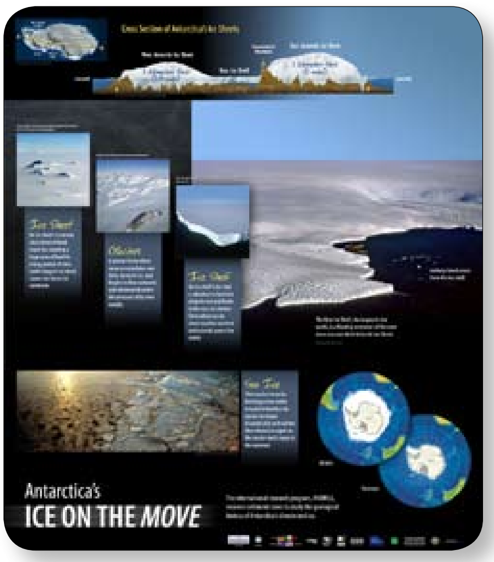
At the outer edges of ice shelves, tidal motions and other forces break large pieces of ice from the shelves. The parts that break off—called **icebergs**—float on their own, no longer attached to land.

Ice sheets, ice shelves, and icebergs are all made of freshwater ice: they started as snow that fell from the sky. The three different names tell the current condition or location of the ice.

One more kind of ice

Sea ice is another kind of ice: it forms when the surface of the ocean gets so cold that it freezes. It's similar to ice that forms on the surfaces of ponds and lakes. As sea ice is frozen ocean water, it is salty rather than fresh. Compared to ice shelves and icebergs, sea ice is thin. First-year sea ice is around a meter thick; multi-year sea ice can be up to around 10 meters thick.

Unit 2 Banner



Explore and discuss the *Antarctica's Ice On the Move* banner. Electronic versions of the banners are available at **http://www.andrill.org/flexhibit**.

Unit 2 Podcasts

The following video clips show information that goes along with this unit. They can be viewed or downloaded from **http://www.andrill.org/flexhibit**.

- The Larsen B Ice Shelf
- Antarctic Ice: Sea Level Change

Activities in this unit. . .

Make your own model glacier. Add annual layers of snow that alternate with summer melting. Keep the glaciers growing to show how an ice sheet forms.

Make a model of Antarctica's ice sheets right in your freezer. Demonstrate how ice sheets become ice shelves and icebergs, and observe how they deposit sediments on the seafloor.

Build a Model Glacier

Preview

Imagine what would happen if more snow fell every winter than could melt away in the summer. During the first storm of each winter, fresh new snow would land on top of the previous year's dirty old snow. More new snow would be added to the top of the pile with each storm. During summers, the surface would get darker from dust and experience some melting. After a century or more of adding such layers, the pile of snow would grow quite thick. The darker summer surfaces would form layers on the top of each winter's snow.

Layers of snow near the bottom of the pile would eventually get compressed by the weight above them. Individual snowflakes would be squeezed together so tightly that they'd merge together into solid ice. When the snow-turned-to-ice begins to flow downhill under the force of gravity, a **glacier** has formed.

Glacier-filled valleys in Antarctica. Photo by Michael Rynbrandt, National Science Foundation

At the bottom of the glacier

Even when a pile of snow gets larger every year, some of the snow melts during the warmer months. Liquid water trickles down to the land below the snow. When this water refreezes, it expands, and rocks from the land's surface get frozen into the bottom of the glacier. As the glacier moves downhill, it carries these rocks with it, and the rocks and ice grind over the land.

Time

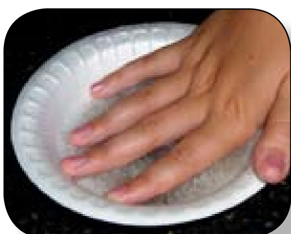
- 45 minutes

Tools & Materials

- Disposable paper or styrofoam bowls
- Mixture of gravel, sand, and silt-sized sediments (2-3 cups)
- Pepper
- Clear plastic wrap
- Corrugated cardboard (3-4 pieces, each 18" x 10")
- Clear packaging tape
- Scissors
- + Snow, shaved ice, or crushed ice.
- + Ice chest or cooler for storing ice
- + Freezer
- + Large sheets of poster board or construction paper
- + Towels (for cleanup)

Items found in this book
Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
+ Additional items

Prepare

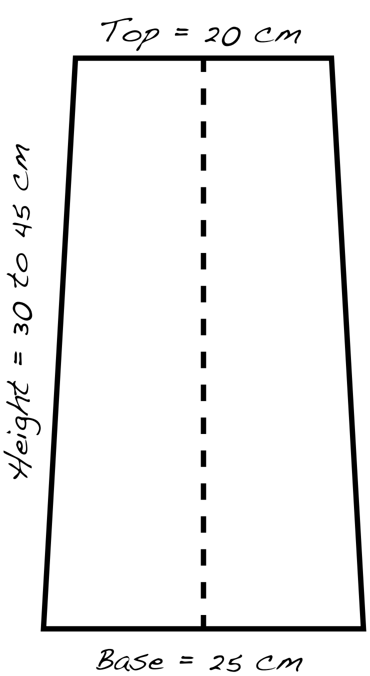


The Preview section tells how real glaciers form. While you're building your model glacier, refer to that description and discuss which part of a real glacier you are modeling in each step.

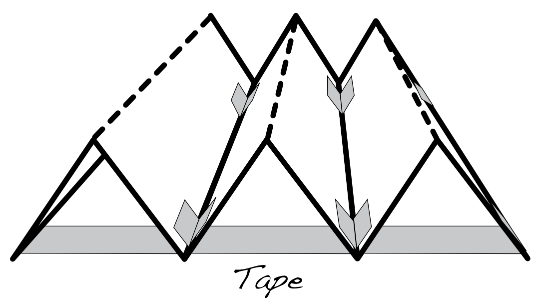
1. Pour a spoonful of mixed sediments into the bowl. Add three spoonfuls of snow, shaved ice, or crushed ice plus a tablespoon of water. Stir the mixture and flatten it into the bottom of the bowl.
2. Add 2-3 spoons of ice on top of your first layer and flatten it again. Press the surface for a while so the warmth of your hand causes a little melting. Add a very light dusting of pepper.
3. Repeat step 2, adding thin layers of ice until your glacier fills the bowl.

An Optional Extension: Make some mountains and grow an ice sheet

If snow continues to accumulate, a glacier can get so thick that it fills its entire valley. Individual glaciers can grow so large that they overflow their valleys and cover the mountains between them. When glaciers merge with other glaciers to form a blanket of ice over a huge area of land, an **ice sheet** has formed.



1. Use the dimensions at left to cut three trapezoids of cardboard. Fold along the center line and use tape across the open side to hold the cardboard in ta triangular prism. These are your model mountains.
2. Wrap the individual mountains in plastic wrap, then line them up parallel to one another. Use tape across the bottom to connect them, forming a model landscape of three mountain ranges with two long valleys.



3. Place two or three model glaciers in a line in each of your valleys.
4. Use your imagination to consider how the valley glaciers could continue growing to form an ice sheet.
5. When you are ready to demonstrate how an ice sheet forms, you'll pack crushed ice around the model glaciers and add more layers of ice over your model landscape. You'll keep adding "snow" until the valleys fill up and cover the mountains.
6. Cover all the model glaciers with plastic wrap and store them in a freezer so they are ready to use at your Flexhibit.

Ponder. . .

Tree rings offer one way of studying past climates. From spring through fall, a ring of light-colored wood grows around the outside of a tree trunk, just under the bark. When winter comes, a layer of darker wood grows. During years when trees have plenty of water for growing, they produce more of the light wood than they do during dry years.

Photo © Henri D. Grissino-Mayer, The University of Tennessee

Consider how annual layers of snow are similar to and different from tree rings. What do you think you could find out by studying snow layers and tree rings?

Practice

Got the Big Idea?

In places where more snow falls than can melt each year, layers of snow build up and glaciers form. Glaciers show annual layers that are similar to tree rings. If glaciers keep growing, they can merge together to form an ice sheet.

Plan your presentation

Consider how you can set up this station so that your visitors will have a chance to interact with ice. You can invite visitors to add a layer of snow or ice on the top of model glaciers, or they can add ice to show the formation of an ice sheet in your model landscape. Explain that the model shows how Antarctica became the icy continent it is today, one snowstorm at a time.

Special preparations for this station

At your Flexhibit, this station needs to be set up in a way that you can keep the water produced by melting ice from getting everywhere. You might place the downhill edge of your model landscape on a tray, or place the whole model inside a shallow plastic bin. Plan to have several sponges or towels on hand to soak up melting ice.

This station also requires a considerable supply of crushed ice. Athletic departments at high schools or school cafeterias may be places where you can fill a large cooler full of ice for your Flexhibit event. Consider how long your Flexhibit will last and how fast the ice will melt to figure out how much ice you'll need for the whole event.

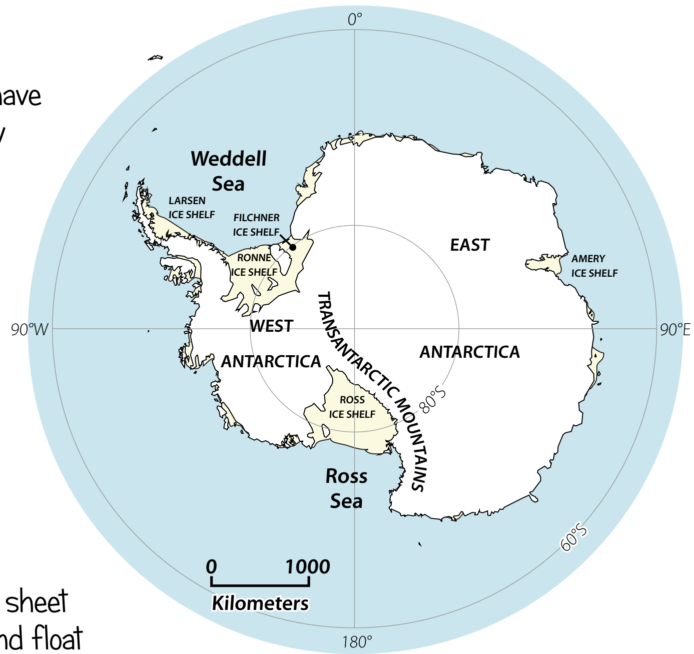
Present

As visitors add ice to your models, ask them to imagine that it is winter and lots of snow is falling. Afterwards, encourage them to "make summer happen" by warming the ice surface with their hands. Be ready to explain that solid glaciers move downhill without melting, though your model does have solid ice turning to liquid. Share the fact that the same process that builds glaciers (accumulating snow) on a local scale results in formation of an ice sheet on a larger scale.

When Ice Meets the Sea

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.



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.

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.

Time

⌛ 1 hour

Tools & Materials

- Mixture of pebbles, gravel, & sand (2 tablespoons)
- Rectangular baking pan (glass or metal)
- Paint roller tray
- Paint roller tray liner
- Water pitcher
- Blue food coloring
- Salt (2 tablespoons)
- ✚ Water
- ✚ Freezer

📖 Items found in this book
Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
✚ Additional items

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

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 tablespoons of pebbles, gravel, and sand across the bottom of the pan, then place it in the freezer.
3. Leave the pan in the freezer until it is frozen solid (several hours).

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.

Ice terms

ice sheets — enormous masses of glacial ice and snow that cover huge areas of land

ice shelf — portions of an ice sheet that extend off a continent and float on sea water

iceberg—A chunk of ice that breaks off an ice shelf

sea ice — frozen ocean water

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

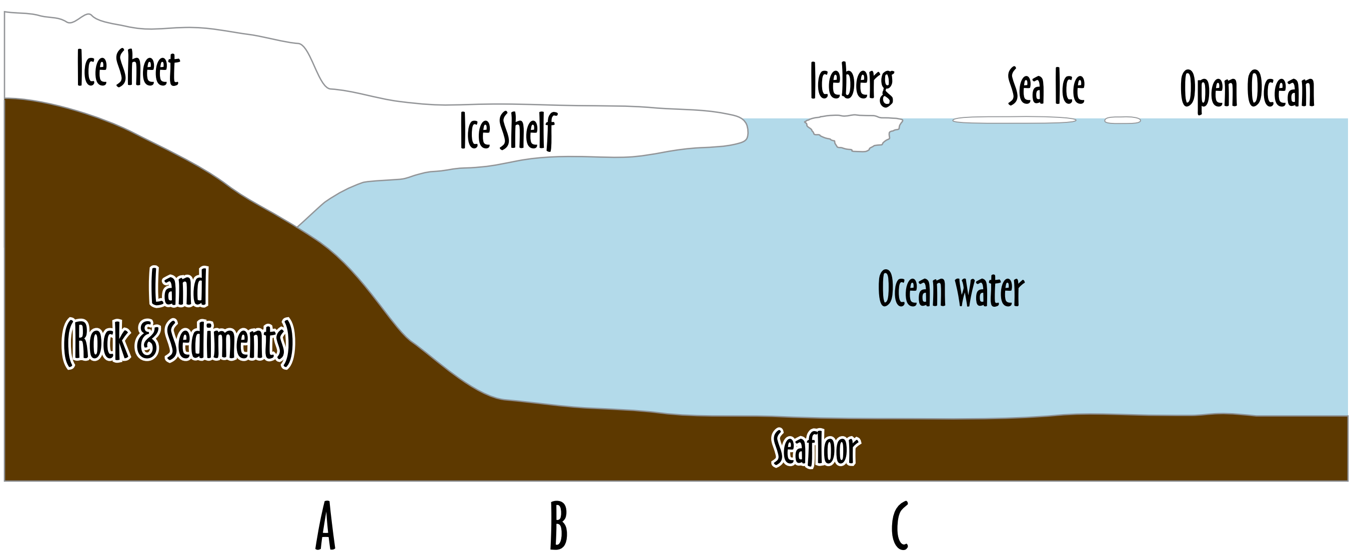
1. Get your model ice sheet out of the freezer. Dip the bottom of the pan into warm water for 30 seconds or so to make it easier to remove the ice sheet from the pan.
2. Set the ice, sediment side down, on the land part of the paint pan. It's okay if some of the ice extends beyond the pan. In this position, 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.

Dominick Dirksen, National Science Foundation

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.

Ponder. . .

Compare your model to the diagram below. Based 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.



How is ice on Antarctica similar to rivers on other continents?

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.

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.

Reading Antarctica's Rock Cores

Sedimentary rocks tell stories

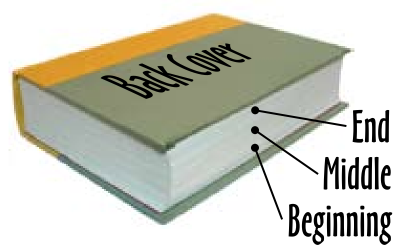
Oceans, rivers, swamps, and glaciers all produce different types of sediments. Sediments are rock grains and other debris that settle in low spots under water or on the ground. Over thousands of years, sediments can turn into rock, and the rocks preserve clues about the environment that produced them. Some of the clues in sedimentary rocks are easy to read. For instance, if a place has rocks made of sand and seashells, it suggests that a sea once covered the area. Interpreting the stories of other clues takes more practice. By matching the sediments in rocks to places where those types of sediments are found today, we can tell what environments existed in a place in the past.

The Grand Canyon. (National Park Service photo)

In some parts of the world, erosion has cut through layers of sedimentary rocks. Cliffs and canyon walls such as these at the Grand Canyon show sediments that tell of past oceans, plains, and sand dunes. Starting at the bottom of the canyon, we can read the story of the site's environmental history as we hike to the top.

The stories go in order

Sediments pile up in flat layers, one layer at a time. This simple fact helps us read rock stories in the order they happened. The bottom layer of any undisturbed sediments is the oldest—it had to form first, before the next layer could settle on top of it. Moving up from the bottom, we see that each layer formed sometime after the layer below it, so the age of the rocks is progressively younger. The top layer is the last one formed, so it is the youngest.



Reading rocks from the bottom up is the same as reading a book from the front to the back. By starting at the bottom layer of rocks, you find out what happened first. Moving upward, you "read" what happened next. Finally, at the top, you discover what happened last.

Drilling into the past

Sedimentary layers have recorded environmental stories all around the world. In many of those places, though, the layers have not been exposed by erosion. In order to explore the history of those places, we need to dig down through the layers to read their stories.

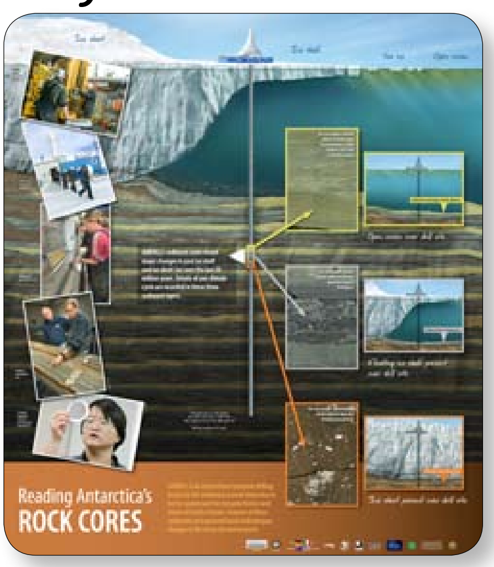
Photo by Davide Persico

To get to the rocks, geologists drill down into the rock layers with a hollow pipe. They bring up a long cylinder of rock called a **core**. Drilling for rock cores is something like sticking a straw down into a layered dessert, then pulling it out—the straw contains a thin sample of all the dessert's layers. After geologists bring up a section of rock core, they cut it in half, lengthwise, as shown in the picture on the left.

Getting to the rocks

Sounds easy, doesn't it? Just drill down into the rocks and then bring them up to read their stories. In Antarctica, however, two major issues have to be addressed. The most complete records of sedimentary rocks there are located just off the edges of the continent, under hundreds of meters of ocean water. In Antarctica, that water is covered with ice! So, in order to obtain Antarctic rock cores, drillers and scientists had to design a way to get through the ice *and* the water to reach the seafloor and begin drilling.

Unit 3 Banner



Explore and discuss the *Reading Antarctica's Rock Cores* banner. Electronic versions of the banners are available at **http://www.andrill.org/flexhibit.**

Activities in this unit. . .

Unit 3 Podcasts

The following short videos complement this unit. They can be viewed or downloaded from **http://www.andrill.org/flexhibit.**

- Core Flow
- Meet the Drillers
- Selecting Where to Drill

Build a Model ANDRILL Site

Preview

To understand and demonstrate how scientists drill and retrieve rock cores from beneath ice and seawater around Antarctica, you'll build a model drill site. Parts of your model will represent ice, seawater, and rock layers. You'll rotate a long pipe to simulate how they drill through the rock. When your model is complete, you'll lower a string and core catcher down through the pipe and pull up model rock cores from below the seafloor.

Prepare

Construct the rock, water, and ice model

1. Look at the pictures and diagrams in this activity to get an idea of how your model will look when it's complete.
2. Paint all sides of the four yardsticks and set them aside to dry.
3. Use markers to draw lines that represent sedimentary rock layers across the large piece of paper.
4. Set the cardboard box on one end so it is tall. The box represents a three-dimensional block of rock below the seafloor. The open side of the box will be the back of your model. The top surface of the box represents the seafloor: cover it with black construction paper.
5. Cut the PVC pipe so you have a 40" length of it. Use sandpaper to smooth the cut surface.
6. Make a mark at the center of the seafloor side of your cardboard box. Use scissors or a sharp knife to make a hole through the box that is just large enough for the PVC pipe.

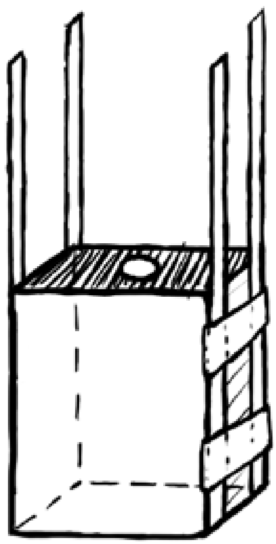
Time

⌛ 1 hour

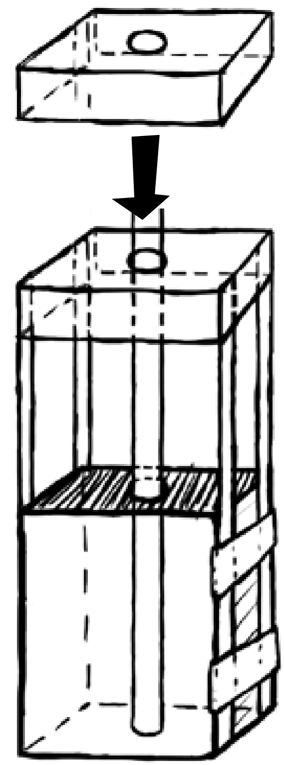
Tools & Materials

- 📖 Rock core photos (page 93)
- Yardsticks (4)
- Blue paint & paint brush
- Cardboard box (~ 18"x12"x9")
- White cardboard gift box (~ 12"x9"x2")
- Sheet of black construction paper
- Large sheet of brown or white paper (18"x52")
- Blue cellophane or plastic wrap (18"x30")
- Clear packaging tape
- Scissors or sharp knife
- ½" PVC pipe (40 inches long)
- ½" diameter wooden dowel (18" long)
- Medium sandpaper
- Steel thumbtacks (3)
- Small screw eye, (¼" or smaller)
- Round magnet, ½" diameter
- String (4 feet)
- + Optional: Saw for cutting dowel and PVC pipe (not needed if you get the kit)

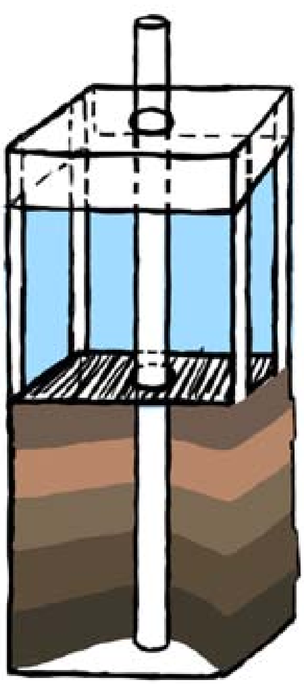
> 📖 Items found in this book
> Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit**.
> + Additional items you may need



7. Nest the top of the shirt box into its bottom. Center the combined halves of the shirt box over your model seafloor and mark the location where the PVC pipe will go through them. Cut round holes through both halves of the shirt box. Make the holes just large enough for the PVC pipe.
8. Line up the 4 yardsticks along the edges of the sides of the large box so they extend upward above the model seafloor. Align them so they are as straight and parallel as possible, then tape them securely into place with packaging tape.



9. Insert the PVC pipe through the hole in the seafloor, then push the shirt box bottom onto the top of the pipe. Work the pipe through the holes gently. The holes need to hold the pipe upright yet allow it to rotate to simulate drilling.
10. Mark where the yardsticks touch the bottom of the shirt box. Cut slits through the box and press it onto the tops of the yardsticks. Line the top edge of the box's bottom with the tops of the yardsticks and tape to hold them in place.
11. Put the top of the shirt box back on. If you can find a can of aerosol spray "snow," you might spray the top to give it a snowy look.

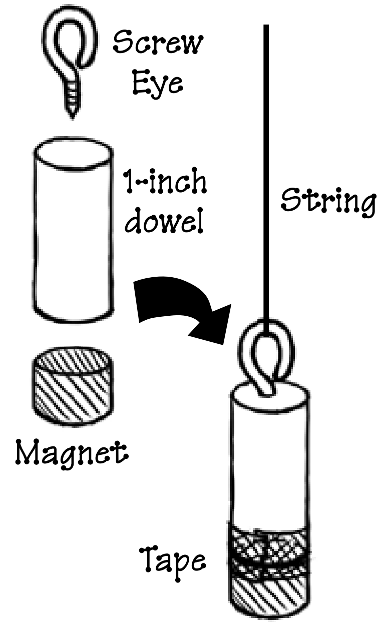


Put the finishing touches on the ice, seawater, and rock

1. Use your best gift-wrapping skills to cover the outside of the cardboard box with your "rock" paper. Keep the lines horizontal so they look like sedimentary rock layers. Put the paper behind the PVC pipe on the open side to give a cut-away look to the model.
2. Tape a sheet of blue or clear cellophane or plastic wrap around three sides of the space that represents the seawater. Leave the back side open as part of the cut-away view.
3. Optional: Place cutouts of sea-bottom creatures on the seafloor to help people visualize what the model represents.

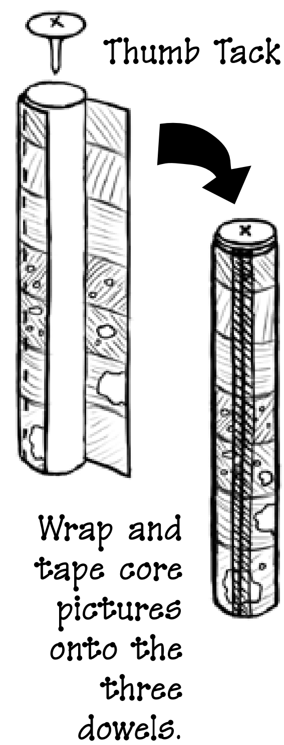
Prepare your core catcher and wire line

1. Cut a 1-inch length of ½-inch dowel.
2. Tape the ½-inch round magnet to the bottom end of the dowel. Tape around the edges of the magnet and dowel to keep the bottom surface of the magnet exposed.
3. Create a starter hole for the screw eye by pushing a thumb tack part way into the center of the top end of the dowel, then pulling it out. Twist the screw eye into this hole until the eye is flush with the top end of the dowel.
4. Tie a 4- to 5-foot length of string to the screw eye. Tie a bead onto the other end of the string to give you something to hold on to.



Make your model rock cores

1. Cut three 4-inch lengths of the ½-inch dowel.
2. Push a steel thumb tack solidly into the center of the top end of each of the dowels.
3. Cut out the three core photos and tape one around each of the dowels.



Pull up some rock cores

1. Drop the model rock cores, thumb tack end up, into the PVC pipe.
2. Simulate drilling down through the rock by rotating the PVC pipe as it moves down through the rock layers.
3. Lower the core catcher down the PVC pipe on its string. When it hits bottom, pull up a model rock core.

Ponder. . .

Make a sketch of the model. Label each part with what it represents in the real world.

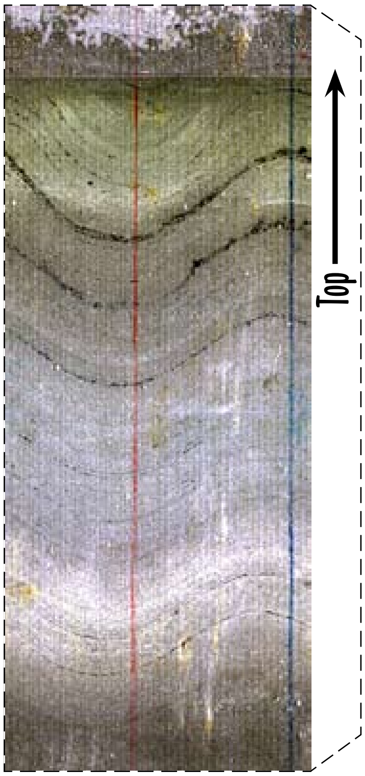
In what ways is your model realistic? Which parts of the model are not very realistic?

What ideas do you have for improving the model?

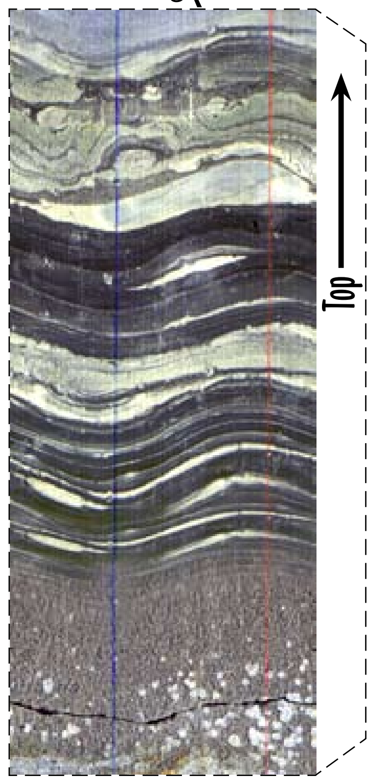
Rock Cores

Cut out these rock core images to wrap around the dowels.

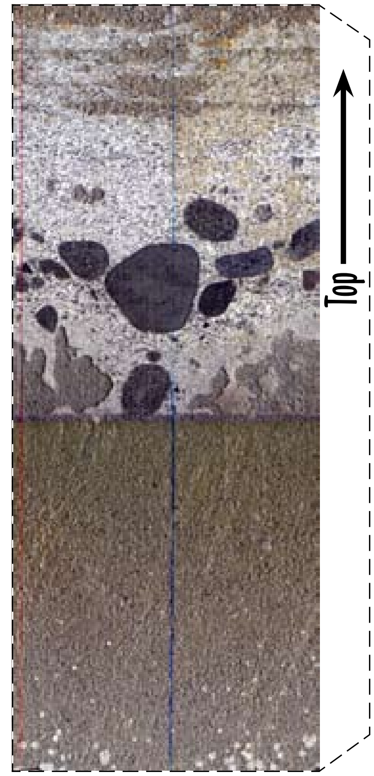
Cut carefully along the dashed lines…



These layered sediments were probably deposited under an ice shelf. Some tectonic motion or local faulting tilted the originally horizontal layers. After the tilting, the seafloor surface was eroded flat and more deposition occurred.



The light bands are layers of microscopic diatoms that settled on the seafloor after they died. The dark layers are volcanic ash from a volcano. The wavy pattern shows that the layers were squeezed or jostled before they became hard rock, perhaps due to tremors from the volcanic eruptions or from the weight of overlying rocks.



This core shows a change from seafloor sedimentation to a colder time when an ice sheet expanded off the land. The ice sheet eroded the seafloor to a flat surface and then deposited a set of poorly sorted sediment.

Practice

Got the BIG Idea?

Building, using, or viewing a physical model helps people understand the unique challenges of drilling for rock cores through an ice shelf or sea ice in Antarctica.

Getting Ready to Present

Come up with a short statement or question to invite people to interact with the drill model. Practice explaining what the different parts of the model represent.

You may want to prepare a chart that shows the description and interpretation of the particular model core your visitors pull up.

Optional Extension

You may have heard of scientists who study ice cores: they analyze air bubbles trapped in the ice to find out how Earth's atmosphere has changed over the past half-million years. ANDRILL is different: its scientists study **rock cores**. The sedimentary rocks they study provide information about the environment over the last 40 million years. To help your visitors understand this difference, you may wish to create a large table like the one below, comparing ANDRILL's rock cores with ice cores that are drilled in Antarctica and Greenland

Characteristic	Rock Core	Ice Core
Material drilled for samples	Sediments	Ice
Length of time represented by core	Millions of years	Hundreds of thousands of years
Precision of age model	Ages accurate within 100,000 years	Ages accurate within 100 years
Range of Environments represented	Ice sheets, ice shelves, & open marine conditions	Polar conditions

Present

Help guests figure out what the different parts of the model represent. Encourage them to simulate drilling and pull up the rock cores themselves. If you need to demonstrate what to do, you might make a grinding noise as you rotate the PVC pipe to simulate drilling down into the rock. Make a different noise to simulate the sound of the engine that pulls the cores to the surface.

Photo Sort: Core Flow

Preview

Does the name "ANDRILLians" sound like it might refer to beings from another planet? It's actually a nickname for the scientists and technicians who work on the ANDRILL project in Antarctica.

The photos in this activity show ANDRILLians performing some of the steps involved in drilling, retrieving, preparing, and studying Antarctic rock cores. Your task is to examine the photos and place them in a logical order to show the sequence of work with the core.

Prepare

1. Cut out the pictures of ANDRILLians doing their jobs and spread them across a table.
2. Examine the pictures. Look for clues that will help you interpret what's going on in each scene. Discuss what you see with your team members to develop your ideas about what's happening in each step.
3. Sort the photos into a timeline to show the order of the processes. Put the photo that shows the first step of drilling for rock cores in Antarctica on one end and the photo that represents the last step at the other end.
4. Finding clues in the photos will help you decide the order. Place each photo somewhere along the timeline, even if you're not yet sure where it belongs.
5. Watch one or more of the video clips at the URLs shown at right. They provide information that can help you complete the timeline. Move any of the photos that you think you misplaced.
6. Read the caption on the back of each photo. Use the information to confirm that you know the sequence and purpose of each step.

Time

⌛ 20 minutes

Tools & Materials

- 🕮 Drilling Process Photo Cards (Pages 99-116)
- Scissors (or a paper cutter)
- ✚ Optional: Laminating equipment or clear plastic sheet protectors.

> 🕮 Items found in this book
> Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
> ✚ Additional items

Podcasts & Video Journals

The general sequence of shown in the **Core Flow** Podcast at **http://www.andrill.org/flexhibit.**

Detailed information on the core flow process is shown in videos 6 through 12 at **http://www.andrill.org/iceberg/videos/2006/index.html**.

Cut out cards along the dashed line…

Photo by LuAnn Dahlman

Photo by Peter Rejcek, National Science Foundation

Petrologist examining core image

ANDRILL scientists can zoom in to examine enlarged views of the core images that are made after the core is cut lengthwise.

Specialized software and large monitors offer clear views of the photographic images. Scientists correlate what they can see in the images with other data about the core.

Hand-guided saw cutting core

Once a 3- to 6-meter length of core has been cleaned and described, core technicians cut them into 1-meter lengths.

Core technicians label a pair of plastic core splits (half-cylinders of PVC pipe) with depth information and place them around every meter of core. The core splits are also labeled with arrows indicating which way is up.

Cut out cards along the dashed line…

Photo by Peter Rejcek, National Science Foundation

Photo by Peter Rejcek, National Science Foundation

Pipes ready for drilling

Bundles of pipe sit outside near the newly constructed drill rig and drill site core laboratory.

The drill cuts rock cores by pushing a rotating drill bit at the end of a hollow metal pipe through the rocks. The drill "string"—the long hollow pipe that goes into the rocks—is lengthened by adding one new pipe at a time. As single pipes are added at the top of the drill string, it grinds down deeper into the rocks below the seafloor.

Whole-core scanning

Once the core is cut into 1-meter lengths, structural geologists place each meter on rollers to make a digital photograph of the whole (cylindrical) core.

The direction and angles of fractures and faults in the core reveal clues about the regional tectonic stresses in this part of Antarctica. Data gathered by downhole instruments (after drilling is over) help geologists figure out the direction in which the core was oriented in the ground.

Cut out cards along the dashed line…


Photo by Megan Berg


Photo by LuAnn Dahlman

Transporting the cores to McMurdo Station

Once the whole cores have been scanned and their physical properties recorded at the drill site laboratory, they are stored in padded boxes and transported to the Crary Laboratory in McMurdo Station. The trip takes about an hour in a Mattracks truck, or 15 minutes by helicopter.

Boxes of core halves packed for shipping

The archive halves and the unsampled portions of the working halves of each meter of core are wrapped and boxed. They are eventually loaded onto the supply ship to be transported to the core storage facility at the University of Florida.

Cut out cards along the dashed line…

Photo by Peter West, National Science Foundation

Photo by Megan Berg

Washing the core

Once a length of core is delivered into the drill site core lab, core technicians wash it to remove drilling residue.

Core technicians make an initial description of the major physical characteristics of each length of core. They work with the drillers' depth measurements to label each part of the core with accurate depth information.

Examining core material

Core samples are distributed to scientists who perform various tests and examine the material for different studies. One analysis procedure involves doing a series of chemical analyses on water that is squeezed out of the core.

Cut out cards along the dashed line…

Photo by Peter Rejcek, Nationa Science Foundation

Photos by Micheal Claeys

Photo by Megan Berg

Photo by Megan Berg

Photo by Gary Hochman

Core curator splitting the core

In McMurdo Station, core curators briefly examine the whole core and make a series of labels to keep track of the depth from which that section of core was retrieved. They tape the plastic core splits tightlly around the core, then place the whole core on a rock saw. The saw grinds through the rock, cutting it lengthwise down the center.

One of the core halves is the working half. It will be imaged before being cut apart to provide samples to scientists. Some nondestructive tests will be performed on the archive half, and it will be stored for future research.

Drilling montage

Drillers connect a pipe to a hoist line. They lift each length of pipe straight up the drill mast (inside the white wind screen) to add them to the top of the drill string.

Once a 3- to 6-meter length of rock core has been cut, drillers drop a connector on a wire line down the hole and pull up the core by winding up the wire.

Cut out cards along the dashed line…

Photo by LuAnn Dahlman

Photo by Elizabeth Trummel

Cutting the working half apart for samples

Once scientists have claimed portions of the core, core curators prepare carefully labeled bags for each sample. They cut sections from the cores, place them in sample bags, and distribute them to the scientists who requested them.

Hand drawing of clasts

Petrologists make records of all the clasts (larger rock grains) in the core, noting the type of rock they represent. By matching the clasts with locations where that type of rock is exposed, they can tell where it came from. This helps the petrologists figure out which direction ice was moving in order to deposit that rock type.

Cut out cards along the dashed line…

Photo by Gary Hochman

Photo by Peter Rejcek, National Science Foundation

Photo by Peter West, National Science Foundation

Delivering core from the drill rig

Drillers carry a 6-meter length of core from the drill rig to the drill site core lab. Cores are delivered into the drill site core lab through a special window in the container.

Scientist pointing at core

Once the working half has been imaged, sedimentologists examine and describe the physical characteristics of every centimeter of the core.

They note the types and sizes of rock grains and their arrangement to infer the depositional environments. The sedimentology team shares this information with the rest of the team in a daily core tour. The tour helps the other scientists decide which sections are most important for their particular studies.

Cut out cards along the dashed line…

Photo by Peter Rejcek, National Science Foundation

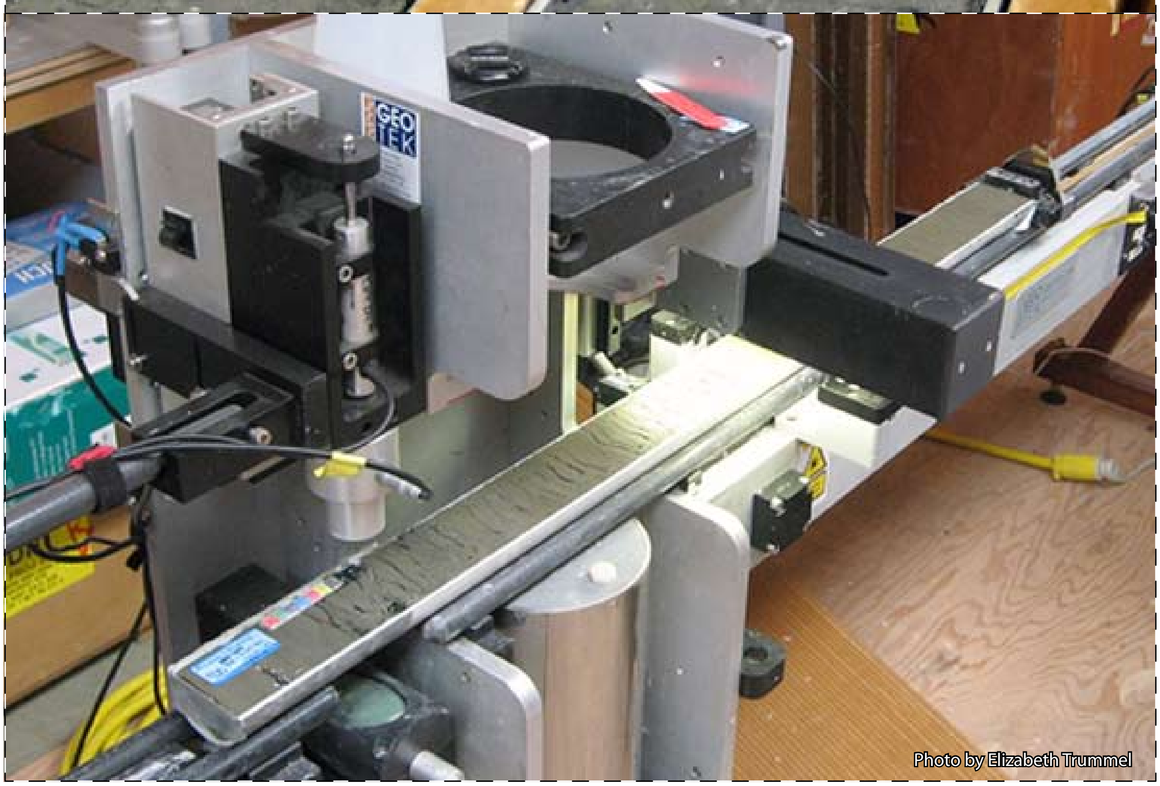


Photo by Elizabeth Trummel

Flags along core

After the daily core tour, scientists place small flags along the cores to "claim" the samples they want to study.

Slabbed core under imager

After each meter of core is cut lengthwise, detailed photographic images are made of the slabbed (cut) surface of the working half. A color bar and label with information about the depth are placed on the surface and the core is pushed slowly along a track under a bright light and camera.

Cut out cards along the dashed line…

Photo by Peter Cleary

Photo by Stacie Blair

Photo by Kari Bassett

Tractor pulling containers

A tractor tows equipment across the ice shelf on the way to set up the drill site.

The equipment containers will serve as offices, lab space, and housing quarters at the drill site. All the equipment needed to drill through ice, water, and rock had to be prepared, tested, and packed months ahead of time. The equipment arrived in Antarctica the previous fall, on the supply vessel that comes to McMurdo Station once per year.

Micropaleontology studies

Micropaleontologists collect their samples by scratching a toothpick across the surface of the core. Material on the toothpick is placed on a microscope slide for analysis.

Micropaleontologists keep detailed records of the numbers, types, and conditions of the microfossils they find at different levels in the core. The records help define the depositional environment of the rocks in the core as well as how long ago the sediments were deposited.

Ponder. . .

Imagine that you are a rock below the seafloor in Antarctica. Tell a story to describe the adventure you'd have when ANDRILLians drill around you and pull you to the surface to study you.

Practice

Got the Big Idea?

Obtaining, preparing, and studying rock cores in Antarctica is a complex process. By examining and sorting photographs of the steps, people can build their understanding of the process as a logical sequence.

Get ready to present

Decide how you want to interact with visitors at this station. Consider that without some background information, visitors will probably not be able to sort all the photos as you did. You can choose from a variety of tasks that can help them understand. For instance, you may want to display all the pictures in order and describe the process orally. Another option is to put many of the photos in the proper sequence, holding back just a few for visitors to place in the line.

Present

At the Flexhibit, lay out the photos in the way you decided would work for your audience. Be ready to help guests understand how the rock cores are obtained and studied. Point out clues such as whole versus half cores that will help them understand the photo order.

Mix Up a Model Rock Core

Preview

After scientists examine the cores in Antarctica, they ship them to a special core storage facility in Tallahassee, Florida in the United States. Scientists from around the world can request small samples from the cores for further study. The cores are too valuable to ship around for public viewing. In order to have a model of a rock core to display at your Flexhibit, follow these three sedimentary-rock recipes to mix up a model rock core.

Prepare

Layer 1: Sediments Under an Ice Sheet

The bottom surface of an ice sheet isn't nearly as white as its top: as layers of snow pile up on the surface, rocks are frozen into its base. Over time, rocks of all sizes and shapes are embedded in the bottom of the ice. As the ice moves downhill, rocks in its base scratch the ground.

When the ice melts, the rocks it was carrying form a layer of sediments with all sizes and shapes of rocks mixed together. If these sediments are later buried by other rock layers and turn into solid rock, the rock is known as **diamictite**. Wherever geologists find diamictite, they know that an ice sheet once existed in that place.

Mix a batch of icy sediments

1. Put about ¾ cup each of stones, gravel, sand, and fine silt into a large mixing bowl, Mix in about 5 cups of crushed ice or snow.

2. Discuss how your mixture is the same and how it's different from the bottom of a glacier.
3. Put one of the PVC slip caps on the bottom of the plastic tube.
4. Using your hands, fill the plastic tube all the way to the top with this mixture. Put the PVC slip cap on and set the tube where it won't be disturbed while the ice melts. Melting may take several hours.

Time

- ⌛ Layer 1: 20 minutes, followed by at least one hour of melting
- ⌛ Layers 2 & 3: 30 minutes

Tools & Materials

- Large mixing bowl
- Large spoon
- 2 cups each of:
  Stones (larger than ½" diameter)
  Gravel (about ¼" diameter)
  Sand
  Fine silt or dirt
- Clear plastic protective tube for fluorescent light bulb (24")
- 1¼" PVC slip caps (2)
- Clean plastic jars with water-tight lids (3)
- Adhesive labels for jars (3)
- Green sand (2 cups)
- White sand (2 cups)
- String (4 feet)
- ✚ Crushed ice or snow (5 cups)
- ✚ Water
- ✚ Freezer
- ✚ Optional: Plastic containers (8) for holding sediments
- ✚ Optional: Laundry bleach

📖 Items found in this book
Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
✚ Additional items

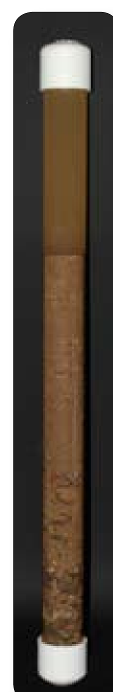
5. Put the rest of the mixture into a jar and seal it. Make a label for it that reads **Sediments in the bottom of an ice sheet**. Store it in a freezer.
6. After the ice has melted in the tube, examine and discuss the layer of sediments. Leave the water in the tube.
7. Optional: Have an adult carefully add a few drops of bleach to the tube. This will discourage algae from growing in your sediments.

Layer 2: Sediments Under an Ice Shelf

When an ice sheet enters the ocean, it becomes a floating ice shelf. Where the ice enters the water, rocks that were frozen into it drop out and pile up on the seafloor. When the pile of sediments grows too steep, underwater landslides occur. These landslides carry smaller sediments long distances from the coast, out under the ice shelf. As the sediments move through the water, the larger rocks drop to the seafloor first and smaller particles settle out later, after the water calms down. The result of each landslide is a layer of sediments that has slightly larger grains at the bottom and smaller grains at the top. Occasionally these layers have a larger rock dropped on top of them. This happens when rocks that were still embedded in the bottom of the ice shelf melt out and fall to the seafloor.

Deposit some under-an-ice-shelf sediments

1. Mix together 1/4 cup of gravel plus 1 cup of sand and 1 cup of silt.
2. One at a time, pour large spoonfuls of this mixture through the standing water in the plastic tube, on top of Layer 1. Let each spoonful settle for a minute or two before you add the next one.
3. Once every 2 or 3 spoonfuls, drop a single stone into the tube. These represent "dropstones" from the ice shelf.
4. Discuss how your layers are similar to and different from sedimentary processes under an ice shelf.
5. Fill a jar about 3/4 full of water. Put ¼ cup each of gravel, sand, and silt into the jar and close the lid tightly.
6. Label the jar: **Shake to simulate an underwater landslide**.
7. Shake the jar vigorously. This simulates the high-energy environment of an underwater landslide.
8. Set the jar down and let the sediments settle out. Examine how the sediments are arranged: look for a pattern of smaller grains on top of larger ones.



Layer 3: Sediments in Open Ocean

Microscopic algae called **diatoms** are abundant in water. Wherever water receives sunlight, these single-celled organisms flourish. Diatoms use the sun's energy for **photosynthesis**. While they are alive, diatoms float near the surface, where they can get sunlight. When they die, their skeletons sink to the seafloor. Zillions of diatom skeletons pile up into thick layers on the seafloor. Occasionally, an iceberg might float across the area and drop stones that are still melting out of the base of the ice onto the accumulating diatoms.

If layers of diatom skeletons get buried by more sediments and turn to solid rock, the result is known as **diatomite**. When geologists find diatomite, they can tell that an open marine environment once existed in that place.

Deposit some dead diatoms

1. In a plastic container, mix ½ cup of green sand with ½ cup of white sand.
2. Randomly alternate pouring spoonfuls of pure green sand, pure white sand, and mixed green and white sand through the water into the tube. The different colors represent slightly different types of diatoms.
3. Within the bottom third of Layer 3, add a few rocks to the tube to represent stones that may have dropped out of icebergs.
4. Fill a jar about 3/4 full of water. Add two spoonfuls of green sand and close the lid tightly.
5. Label the jar: **Shake to simulate live floating diatoms.**
6. Set the jar where it won't be disturbed to let the sediments settle.
7. Put the PVC slip cap on top of the tube. Store your model rock core upright, in a cool, dark place.

The Finished Core

Ponder. . .

Sketch and label a diagram of the three main layers of your model rock core.

Consider the environments that all three of the sedimentary rock layers you made represent, from the oldest to the youngest. What kind of climate change does the sequence of layers represent?

Which layer do you think is the best model for the rock type it represents?

Practice

Got the Big Idea?

The model rock core made with three different rock "recipes" provides examples of sediments produced in three different environments. The sequence of rock types tells the story of a warming climate. The environment changed from a cold climate (ice sheet) to a more moderate climate (ice shelf) to a warmer climate (open ocean) while the rocks were forming.

Get ready to present

Come up with a statement to tell visitors about the three rock recipes and your model rock core. Show your prepared jars and the sediments that match the environment represented by each jar. If possible, plan to set this station up near the *Reading Antarctica's Rock Cores* banner so you can point out the similarities between rock layers in your core and the ones on the banner.

Present

Encourage visitors to examine the sediment layers and compare them to the rocks on the *Reading Antarctica's Rock Cores* banner. Consider the environment represented by each layer and the climate story told by the overall sequence of the three layers.

Mess-free Model Rock Cores

Preview

Photographs of the cores

Every meter of rock core drilled from Antarctica gets its picture taken two times. First, the core goes on a whole-core scanner. Rollers turn the core and a scanner records the view of the entire outer surface of the cylinder of rock.

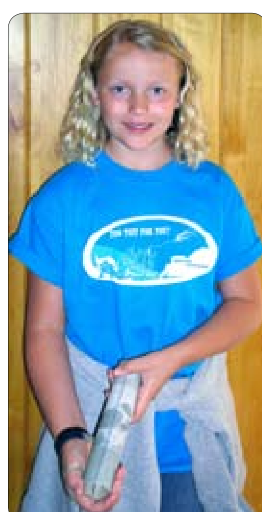
The core is photographed again after it is cut in half lengthwise. The flat surface of the cut core is scanned by a camera to record a very detailed image. Digital photographs of the cores are much easier to work with than the actual rock cores—ANDRILL scientists can download the core images over the Internet at any time.

Two sides to every core

Cutting each meter of core in half lengthwise results in two sets of core. One set of the core is known as the **working half**. Scientists examine this half and mark the sections they are interested in studying. Core curators, technicians who take care of the core, literally cut the working half into pieces. They label and distribute the samples to the scientists who have requested them. The unsampled (leftover) parts of the working half remain available for other scientists to study.

The other half of every meter of core is known as the **archive half**. It serves as a permanent record of the entire length of the core. The archive halves are packed in boxes and shipped to Florida, where they are stored for verification and later studies.

You'll use the two types of core images to make some mess-free model cores. You'll wrap the whole-core photos around a cardboard mailing tube to make a realistic-looking model of an Antarctic rock core. You'll also make some cores that can be split into working and archive halves.



Time

⌛ 30 minutes

Tools & Materials

- 📖 Whole Core and Composite Core photos (pages 127-144)
- 2-inch diameter cardboard mailing tubes (2" x 24" long)
- Scissors
- Clear packaging tape
- ✚ Optional: Saw and metal snips for cutting poster tube.

📖 Items found in this book
Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
✚ Additional items

Prepare

The red and blue lines on the whole-core photographs are intentional. Core technicians draw these lines along opposite sides of the whole core right after it is cleaned. The lines are used to document the angles of fractures and faults in the core.

Part A: Make a model of a whole core

1. Cut out and trim the three sections of the whole-core photographs carefully.
2. Starting with the bottom section, line up the right edge of the photo (the side with the label and arrow) along the length of the 2-inch cardboard mailing tube. Use two small pieces of tape to adjust the photo so it as straight as possible, then attach it securely with tape or glue along the entire edge.
3. Wrap and tape or glue the photo tightly around the tube. To keep it tight, have one person hold the paper in place while another person tapes or glues the edge.
4. Add the middle and top sections to the tube to produce a model core. Be sure to locate and line up the red and blue lines on each section with the lines on the section below it.
5. Use what you've learned in this unit to interpret the types of rocks in the model core. Make a diagram of the core, and label different sections according to the types of rock and the environments they indicate.

Part B: Make model rock cores of working and archive halves

1. Mark straight lines down opposite sides of a 2-inch cardboard mailing tube. Use angled scissors or tin snips to cut along the lines.
2. Measure and cut each of the mailing tube halves to a length of 8 inches.
3. Cut out and trim the photos of the archive and working halves of the core. Fold along the two lines indicated.
4. The portion with the red or blue lines goes on the round part of the tube. The part next to the white edge is the flat "slab" of each split core. Neatly glue or tape the core photos to the tube halves, working with another person to get the paper reasonably tight.
5. Once you have constructed the two halves, use a rubber band to keep them together. You can remove the rubber band to show how the cores are split in half.

Cut out along the dashed line…

Top section of whole-core photograph

Cut out along the dashed line…

Middle section of whole-core photograph

OVERLAP & GLUE OR TAPE HERE

Cut out along the dashed line…

Bottom section of whole-core photograph

OVERLAP & TAPE HERE • BOTTOM SECTION OF WHOLE CORE PHOTOGRAPH • THIS END UP

Split-core photo 1, archive half

fold ↓ here

fold ↓ here

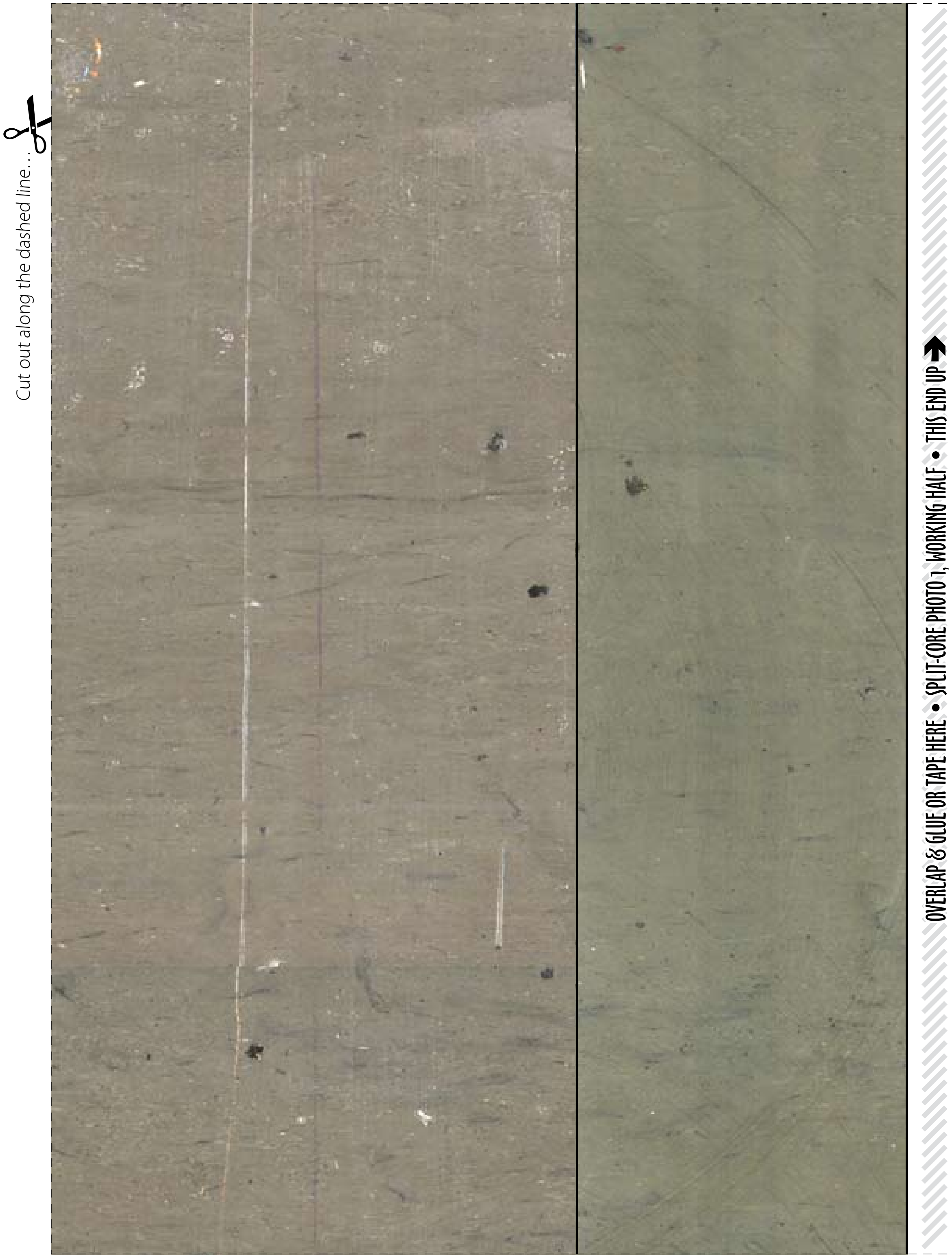
Cut out along the dashed line...

THIS END UP • SPLIT-CORE PHOTO 1, ARCHIVE HALF • OVERLAP & GLUE OR TAPE HERE

Split-core photo 1, working half

fold ↓ here

fold ↓ here



Split-core photo 2, archive half

fold ↓ here fold ↓ here

Cut out along the dashed line...

THIS END UP • SPLIT-CORE PHOTO 2, ARCHIVE HALF • OVERLAP & GLUE OR TAPE HERE

Split-core photo 2, working half

fold ↓ here

fold ↓ here

Cut out along the dashed line...

OVERLAP & GLUE OR TAPE HERE • SPLIT-CORE PHOTO 2, WORKING HALF • THIS END UP ➜

Split-core photo 3, archive half

fold ↓ here
fold ↓ here

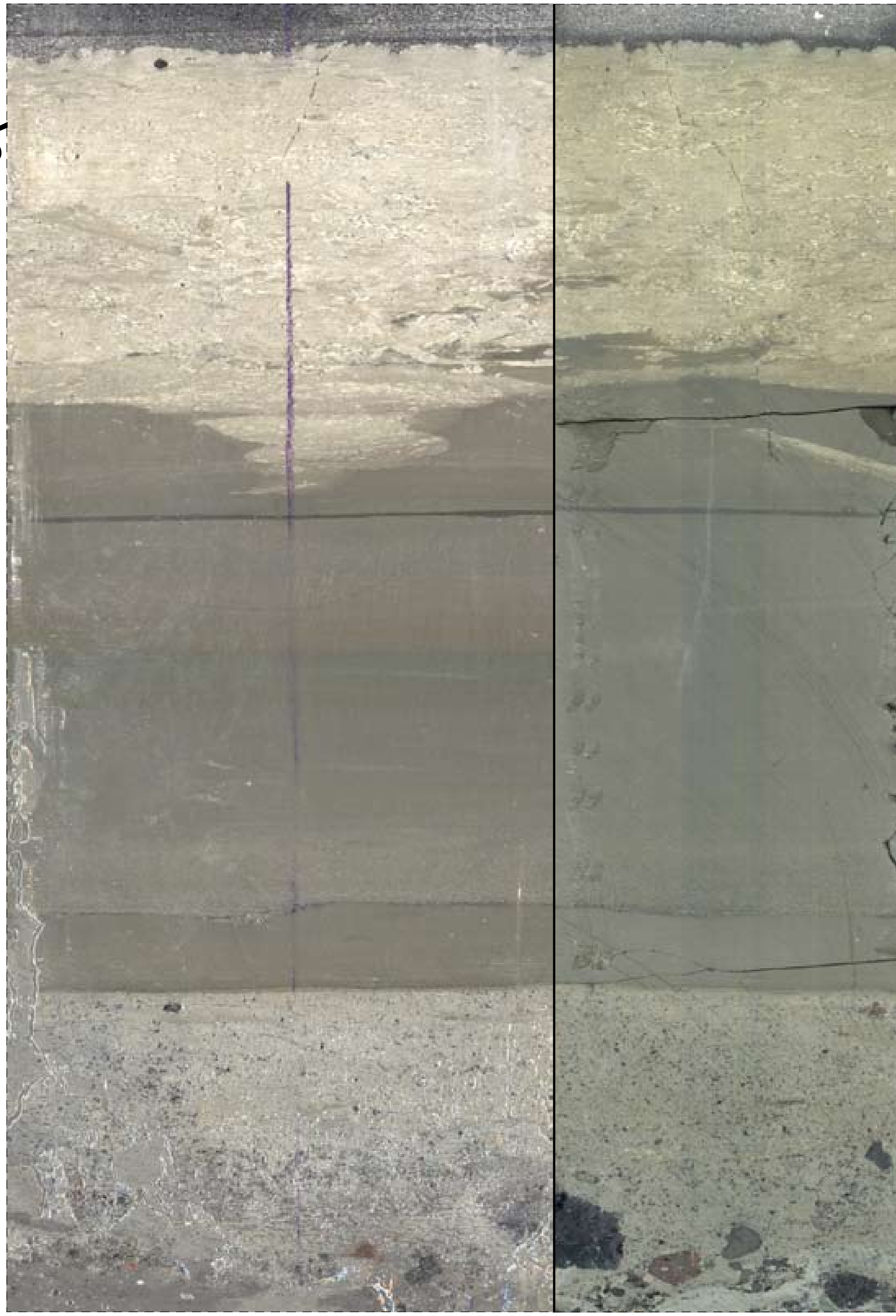
Cut out along the dashed line...

🡅 THIS END UP • SPLIT-CORE PHOTO 3, ARCHIVE HALF • OVERLAP & GLUE OR TAPE HERE

Split-core photo 3, working half

fold ↓ here   fold ↓ here

Cut out along the dashed line...



OVERLAP & GLUE OR TAPE HERE • SPLIT-CORE PHOTO 3, WORKING HALF • THIS END UP ➜

Ponder. . .

Why are two half-cores better than one whole core?

What are the advantages and disadvantages of using digital images of the cores?

Practice

Got the Big Idea?

Models of rock cores help people understand ANDRILL's research. By examining changes along the length of the model core, people build their understanding of how scientists read past environments from rocks.

Get ready to present

Come up with a statement or question that will invite people to check out the model cores. Practice giving a description of the rock types present and the environments that likely produced them.

Present

Show your visitors the model cores. Point out the different types of sedimentary rocks, and give an explanation of the environments where each type formed.

Tiny Clues to Antarctica's Past

Life at the bottom of the marine food chain

Diatoms are one of the most abundant organisms in the world: these single-celled algae live wherever they have access to both moisture and sunlight. Individual diatoms are too small to be seen except under powerful microscopes. However, the number of diatoms in one area of the ocean sometimes gets so large that cameras on Earth-orbiting satellites can see them. Diatoms are one group of a larger set of organisms called **phytoplankton**.

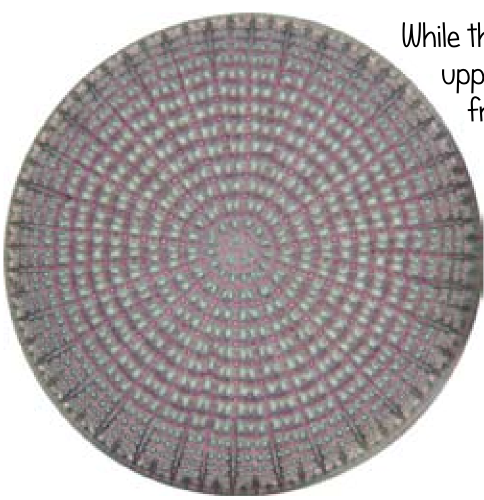
Diatoms are extremely important for wildlife in Antarctica because they form the base of the food chain. Small shrimp-like animals called **krill** eat diatoms, and just about everything else in the Southern Ocean eats krill!

Krill eat diatoms. As the diatoms pass through a krill's digestive system, large numbers of them get "packaged" into fecal pellets that settle to the ocean floor. Diatoms' cell walls are made of glass, so they aren't damaged by passing through a krill.

Diatoms' glassy skeletons

Like any type of organism that gets its energy from the sun, diatoms have cell walls to protect their insides. Diatoms extract silica – the material you know as glass – from the water around them and use it to build their cell walls. These rigid cell walls can be thought of as glass "skeletons." Each species of diatom has a unique structure for its skeleton. Many of the patterns are complex and beautiful. These unique patterns make it possible for scientists who study them to identify diatom species from small fragments of their cell walls.

While they are alive, marine diatoms float in the uppermost layers of the ocean, using energy from sunlight for photosynthesis. After diatoms die or pass through the digestive system of a krill, their skeletons sink to the seafloor. There, they might remain whole, they might be crushed by other sediments, or they might be ground into bits by the friction from an ice sheet moving over them.



George Swann

Unit 4 Banner

Explore and discuss the *Tiny Clues to Antarctica's Past* banner. Electronic versions of the banners are available at **http://www.andrill.org/flexhibit.**

Unit 4 Podcasts

The following short videos complement this unit. They can be viewed or downloaded from **http://www.andrill.org/flexhibit**.

- Diatom Tour
- Microorganism Tour

Activities in this unit. . .

Prepare four artificial rock cores using glass seed beads as model diatoms. Sample the cores and decipher the diatoms' stories to infer the rock's history.

Use buttons to represent forms of diatoms that grow in chains. Sample a core and count the different forms to illustrate how they indicate the presence or absence of sea ice.

Dead Diatoms Do Tell Tales!

You probably already know that scientists who study fossils are called **paleontologists**. Though some paleontologists study large fossils such as dinosaur bones or ancient seashells, many examine tiny fossils that can only be seen under a microscope. These scientists are called **micropaleontologists**, and diatom skeletons are one of the kinds of fossils they study.

Scientists who study past environments are pleased when they discover fossil diatoms in their sedimentary rock samples. The types, numbers, and conditions of diatom skeletons tell something about the environment that existed when they were deposited. Diatom species that lived for relatively short time spans can also provide important clues about the age of sediments.

Preview

In this activity, you'll use glass seed beads to represent fossil diatom skeletons. Like diatoms, seed beads are small, and both items are made of glass. You'll prepare four artificial rock cores with sediments and seed beads. Once the cores are prepared, you and others will take samples of the sediments and use a magnifying glass to find and identify the model diatoms. Just as micropaleontologists do, you'll separate the "diatoms" from the rocks, check to see if they've been broken or crushed, and identify the species they represent. You'll read the dead diatoms' tales to infer what type of environment existed when they died.

Three Environments that Preserve Fossil Diatoms

After diatoms die, their skeletons sink and accumulate on the ocean floor. If this happens in an ice-free **open ocean**, most of the skeletons remain whole and unbroken, even after they are buried by other layers and compressed into rock. During times that Earth's climate is cooler, **ice sheets** expand off the continent over the former seafloor. The motion of ice and rocks grinding over diatoms crushes them into small fragments. Under an **ice shelf**, broken diatoms from the base of the ice sheet are deposited in layers with other sediments.

Different colors of glass seed beads represent different diatom species.

Time

- 2–3 hours

Tools & Materials

- Core Log Sheet (page 155)
- Clear plastic fluorescent bulb guard (two 10-inch pieces split in half lengthwise)
- Duct tape
- Coarse sand (3 cups)
- Dark sand (¼ cup)
- White sand (¼ cup)
- Orange or red sand (¼ cup)
- Gravel (15-20 pieces)
- Four different colors of glass seed beads (1½ teaspoons each)
- Heavy-duty plastic zipper-style bags (4)
- Paper plates (6)
- Magnifying glasses (2-3)
- Craft sticks (4)
- Fine-tipped paintbrushes (2-3)
- Clear-drying white glue
- Permanent marker
- Scissors
- Hammer
- Safety glasses or goggles
- Colored markers
- Large sheet of construction paper or poster board

Items found in this book
Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
\+ Additional items

Prepare

Part 1 – Break some beads!

Diatom skeletons can be broken apart in nature. Glass beads can also be broken — with a hammer!

1. Assign each of your four colors of beads to one of the four diatom names below. Read the pronunciations aloud to learn how to say their names. Write the color of bead you'll use to represent each type of diatom on this chart.

Diatom Name	Pronunciation	Bead Color
Thalassiosira	thuh-**lass**-ee-oh-seer-uh	
Chaetoceros	ka-**tah**-seer-us	
Fragilariopsis curta	frah-jill-airy-**op**-sis **ker**-tuh	
Fragilariopsis species	frah-jill-airy-**op**-sis	

2. Put your *Thalassiosira* beads in a heavy zipper-type plastic bag.
3. Lay the bag on a hard surface such as a concrete floor or sidewalk. Shake it gently to spread the beads into a single layer.
4. Put on safety glasses or goggles to protect your eyes.

5. Tap the hammer on about two-thirds of the beads, so that many (but not all) of them are broken.
6. Pour the contents of the bag onto a paper plate. Shake the plate gently to help separate the bead fragments by size.
7. View the beads with a magnifying glass. Use a fine-tipped paintbrush to sort the pieces into three piles: whole beads, large pieces, and small fragments. Your sorting doesn't need to be perfect, just good. You should end up with about the same amount of each of the three sizes. If necessary, return some of the whole beads to the plastic bag to break more of them.

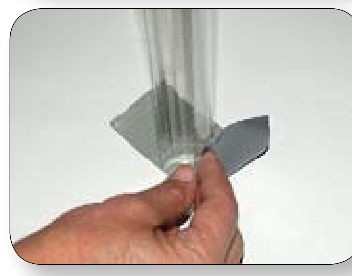
8. Repeat this breaking and sorting process two more times, once each for your *Chaetoceros* and *Fragilariopsis curta* beads.
9. For your *Fragilariopsis* species beads, only tap the hammer on about one-quarter of the beads so you keep most of them whole. Use gentle shaking and the paintbrush to separate them on their paper plate into the three sizes.

Part 2 – Prepare a key to your model diatoms

1. Prepare a page-sized piece of poster board or construction paper with a chart like this.

Example of Beads	Diatom Name	Pronunciation	Environment where they lived
	Thalassiosira	thuh-**lass**-ee-oh-seer-uh	Open ocean
	Chaetoceros	ka-**tah**-seer-us	Open open
	Fragilaropsis curta	frah-jill-airy-**op**-sis **ker**-tuh	Sea ice
	Fragilariopsis species	frah-jill-airy-**op**-sis **spee**-sees	Open ocean

2. Glue two or three of the beads that represent each type of diatom into the **Example of Beads** column and set the chart aside to dry
3. Prepare another page-sized chart like this.



Condition of Beads	Relative Number of Beads	Depositional Environment
Whole	Many	Open Ocean
Broken	Some	Under an Ice Shelf
Crushed	Few	Under an Ice Sheet

Part 3 – Prepare holders for four artificial rock cores

1. Cut two 10-inch lengths of the clear plastic tube.
2. Use a ruler to mark two straight lines, on opposite sides, along the length of each tube.
3. Cut each tube in half lengthwise. You will end up with four half-cylinders.

4. Use eight 4-inch pieces of duct tape to close both ends of the half-cylinders as shown in the photos.
5. Using a permanent marker, label the duct tape at one end of the holder as the TOP of the core and the other end as the BOTTOM.
6. Add an additional piece of duct tape to the side of each core holder to label them as Core 1, Core 2, Core 3, and Core 4.

Which way is "UP"?

When working with rock cores, the standard practice is to always keep the TOP of the core to the left. That way, everyone knows that the older rock is at the right end (BOTTOM) of the core and the rock gets younger as you move to the left.

Part 4 – Make some model cores

Preparing the sand

1. Add just enough water to your sand so it sticks together — you want a consistency like what you'd use for building sand castles.
2. Add moist sand along the length of all four core holders so each trough is about ½ to ⅔ full. Press the sand gently to make a flat surface.

Making Core 1

1. Take about one-quarter of each color of the **Crushed** bead fragments and sprinkle them along the surface of the sand.
2. Smooth the surface gently so that most of the bead fragments are covered but are still within the top several grains of the surface.
3. Put 8-10 pieces of gravel on the core's surface. Press them flat into the sand so the surface looks like a cut core.

Making Core 2

1. Use a spoon to move some of the sand in the core holder out of the way. (Anywhere along the length of the core is fine.) Add a spoonful or two of another color of sand to make a new layer that crosses the core from side to side. Repeat this process two or three times to give this core a layered appearance.
2. Sprinkle about half of the **Broken** bead fragments of the four species in separate horizontal layers across the surface of this core. Add about half of the remaining **Crushed** bead fragments to this core as well.
3. Smooth the surface gently so that the bead fragments are covered by sand but are still within the top several grains of the surface.

4. Add 2-3 small pieces of gravel along the bottom of the layers you made and press them flat into the sand. These represent the larger rocks that settled first after an underwater landslide.

Making Core 3

1. Make a thick horizontal layer of the **Whole** *Fragilariopsis species* beads crossing the surface of Core 3. Use about ¾ of your supply.

2. Sprinkle about ¾ of the **Whole** *Thalassiosira*, *Chaetoceros*, and *Fragilariopsis curta* beads in separate horizontal layers across the surface of the core.

3. Add about half of the remaining **Broken** beads and **Crushed** beads to the surface. This core surface should be almost covered with beads.

Making Core 4

1. Sprinkle your remaining **Crushed** bead fragments along the surface of Core 4. Smooth the surface lightly and add 4-5 pieces of gravel to the bottom third of the core. Press them flat into the sand.

2. Add a thin layer or two of another color of sand across the middle third of the core. Sprinkle your remaining **Broken** bead pieces in separate horizontal layers across this section. Smooth the surface lightly and add two or three small pieces of gravel along the bottom of the sand layers.

3. Sprinkle your remaining **Whole** beads in separate layers across the top third of the core.

Part 5 – Sample the cores

1. Place your prepared cores next to metric rulers. Line up the bottom of each core with the bottom of the ruler.

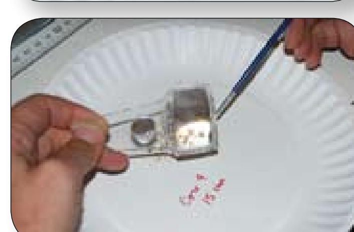
2. Choose a place in one of the four cores where you'll take a sample. Write the core number and the distance from the bottom of the core on a paper plate.

3. Use a craft stick to gather a small sample of sediments from the surface of the core. Gather enough to cover the bottom half-inch (1 cm) of the craft stick. Put the sediments on your paper plate.

4. Gently shake the plate or use a small paintbrush to spread the sample out. Use a magnifying glass to examine any diatoms you find.

Studying diatoms

Micropaleontologists who study diatoms learn how to recognize different diatom species by the shape and patterns preserved in small fragments of their skeletons. You'll use color to help you recognize the model diatoms in the artificial cores you make.



5. Compare the diatoms you find in your sample to your two charts. Write the answers to the following questions directly onto your paper plate.
    - What types of diatoms did you find? What environment did those diatoms live in?
    - On the whole, how would you describe the number of diatoms in your sample – Many? Some? or Few?
    - In general, what condition are the diatoms in – Whole? Broken? or Crushed?
    - What environment would you infer was there when they were deposited – an ice sheet? an ice shelf? open ocean?
6. For samples from Core 4, transfer your data to the appropriate spot on the Core Log Sheet.

Core Log Sheet

Initials of Sampler	Distance from Bottom of core (cm)	Relative number of diatoms in sample (Many, Some, Few)	Condition of diatoms (Whole, Broken, or Crushed)	Environment in which diatoms were deposited
	25			
	24			
	23			
	22			
	21			
	20			
	19			
	18			
	17			
	16			
	15			
	14			
	13			
	12			
	11			
	10			
	9			
	8			
	7			
	6			
	5			
	4			
	3			
	2			
	1			
	0			

Ponder. . .

Once you've gathered the Core Log information for Core 4, use it to tell the tale of the changing depositional environment. Start your story at the time rocks at the bottom of the core were deposited. Describe the environments that existed through time to produce the sediments and diatoms you found in the core.

Practice

Got the Big Idea?

The types, numbers, and conditions of fossil diatoms found in rock cores are indicators of past environments.

Check your core interpretations

Core 1 – Samples of this core show very few diatoms among the sand grains. Of the diatoms that are present, most have been crushed into small fragments. Along with the mixed sizes of sediments, this indicates that this portion of the core was deposited beneath an ice sheet.

The presence of none or a few diatom fragments tells that rocks were deposited under an ice sheet.

Core 2 – Samples from this layered core show a noticeable number of diatoms among the sand grains. Most of the diatoms are broken, indicating that an ice sheet moved over them at some point. Later, they were arranged in layers by underwater landslides that occur under an ice shelf.

The presence of some diatoms that have been broken and deposited in layers tells that rocks were deposited under an ice shelf.

Core 3 – Samples of Core 3 contain many diatoms, and most of them are whole. The diatoms weren't exposed to grinding and friction, indicating that they were deposited in the open ocean.

The presence of many diatoms that are whole tells that rocks were deposited in the open ocean.

Core 4 – This core represents rocks from unknown environments. Depending on the section you chose, these samples may represent any one of the environments described above.

Get ready to present

Come up with an introductory comment or a question to invite people to look for model diatoms in the cores. Read over the unit introduction and the activity Preview to be sure you can give a simple explanation of what diatoms are. Consider which pictures or text on the "Tiny Clues" banner might help you explain your topic.

You may want to set up your station with samples from Cores 1, 2, and 3 already on paper plates. This will allow you to demonstrate the use of a magnifying glass to look for diatoms in the samples.

Present

Tell visitors what diatoms are. Let visitors know that they can take a sample of the cores to look for model diatoms. When they find model diatoms in their sample, have them match what they found to the diatom key, then figure out what the condition of the diatoms tells. Some people may enjoy trying out the pronunciations of the different diatoms.

For visitors who are interested and engaged, you can tell the environmental history represented by diatoms in Core 4. Start at the bottom section of the core and tell its story, then move up to the next section, and so on. Point out that scientists (and you!) are anxious to learn how the rock record of Antarctica fits into global climate history.

Evidence of Ice-Free Seas

Preview

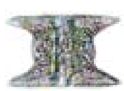
Paleontologists have some ingenious ways of finding out what the climate was like long ago. For instance, they've developed a way to learn how much sea ice was present in the past, simply by counting different forms of a certain kind of fossil diatom.

A living Eucampia chain of two individual diatoms. (Courtesy of the Japan National Institute of Polar Research)

In this activity, you'll make a model core using two types of buttons to represent fossil diatoms. By comparing numbers of the two forms, you'll figure out whether the seas were free of ice while the diatoms were alive.

Eucampia antarctica

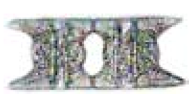
Eucampia antarctica (yoo-**kamp**-ee-a ant-**ark**-tik-a) is the name for a kind of diatom that grows in a chain — a group of individual diatoms connected together in a line. Microbiologists who study living diatoms have observed how *Eucampia* diatoms live today: the chains can survive under sea ice, but they need sunlight in order to grow new cells that make the chain longer.



Here's how a Eucampia cell looks after it first develops as a result of sexual reproduction. The individual diatom is made of two similar halves.

When sea ice is thin or the ocean is ice-free, diatoms receive sunlight, and new cells grow in the center of the chain, making the chain longer. The opposite case is important too: when sea ice is thick, diatoms below it don't get much light, and they stay short because they don't add new cells.

Here's how two different chains might look at the end of a growing season.



Eucampia from a time when climate was cold and sea ice was relatively thick.

Eucampia from a warmer time, when sea ice was thin or absent

Time

30 minutes

Tools & Materials

- 📖 *Eucampia* Index chart (Pages 165-168)
- 3-inch-diameter corrugated plastic drain pipe (30 inches long, split in half lengthwise)
- Duct tape
- Polished aquarium gravel (2 cups)
- Shank buttons (86)
- Flat buttons (50)
- Assorted plastic beads (½ cup)
- Pebbles (15-20 pieces)
- Sturdy paper plates (6)
- Toothpicks (60)
- Blank mailing labels (60)
- Needle & thread
- Scissors
- Measuring cups
- Colored markers
- + Large sheet of construction paper or poster board

📖 Items found in this book
Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
+ Additional items

Eucampia chains grow in a unique way: they only add new cells in the middle of the chain, in between the two end cells. Look carefully at the diagrams—the diatoms at the ends of the chains are visibly different from those in the middle.

After a chain of *Eucampia* dies, it breaks apart and the diatom halves settle to the ocean floor. The ends and middles can still be recognized and counted. Knowing that every chain has only two ends, counting the number of pointed end forms versus flat middle forms gives information about how long the chains were.

Look at the tips of the two diatom halves. The one with the sharp points is an end form. The one with flattened extensions is a middle form. (Photo by Diane Winter)

See for Yourself

Look at these examples. They show sets of *Eucampia* diatoms from different depths in a rock core. Which set represents a time with longer chains?

Working with a partner, discuss and describe how you can figure out which sample was deposited at a time when there was less sea ice.

Here's another example: A micropaleontologist takes a sample from a rock core and finds 8 end forms and 20 middle forms of *Eucampia* diatoms. Does this represent a time with *more* sea ice or with *less* sea ice than the samples pictured above?

Statistically speaking

It's unlikely that a single sample from a rock core would contain all the diatoms from a single *Eucampia* chain. The numbers of ends and middles for a whole population of *Eucampia* chains still show, on the average, how short or long the chains were.

The *Eucampia* Index

You can probably tell that the example described above is from a period with less ice: it has a larger number of middle forms compared to the number of end forms than the samples pictured above have. For any sample, dividing the number of end forms by the number of middle forms results in a number called the ***Eucampia* Index**. Two ways to show this calculation are:

$$\frac{\text{Number of End Forms}}{\text{Number of Middle Forms}} = \textit{Eucampia}\ \text{Index}$$

$$\text{Number of Middle Forms}\ \overline{\smash{)}\ \text{Number of End Forms}}\ \ \rightarrow\ \textit{Eucampia}\ \text{Index}$$

The smaller the value of the *Eucampia* Index, the more ice-free the ocean was when they grew.

Dividing by zero (no middle forms)

If there are no middle forms in a sample, you would need to divide by zero. Mathematically, dividing by zero is "undefined" - in other words, you can't do it. In this investigation, if there are no middle forms, you will record the sample's *Eucampia* Index as "≥1.0," which suggests a very cold climate.

On the other hand, if there are no end forms in your sample, suggesting a warm climate, the *Eucampia* Index is zero (0), because dividing zero by any number gives zero.

Prepare

Make a core holder

Add duct tape to the ends of a 30-inch length of 3-inch-diameter drain pipe that has been cut in half lengthwise. You'll fill the trough with model sediments and a variety of "microfossils."

Get out your button box!

You'll use buttons to represent the two forms of *Eucampia* diatoms.

- **Shank buttons** have loops or tabs on the back with holes for the thread. These will represent the end forms of *Eucampia* diatoms.
- **Flat buttons** have two or more holes through them. They will represent the middle forms of *Eucampia* diatoms.

If buttons were to form chains like Eucampia does, they might look something like this. The shank buttons represent the end forms because new buttons can only be added to the chain on one side of them. Flat buttons represent the middle forms because they can be added to the middle of the chain.

Environmental conditions and *Eucampia* chain length

The average lengths of *Eucampia* chains provide evidence of the local climate:

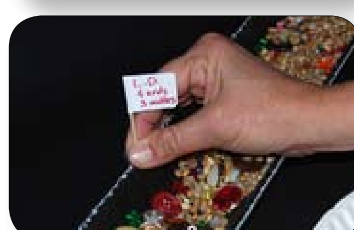
- Shorter chains = fewer middle forms = colder climate = more sea ice.
- Longer chains = more middle forms = warmer climate = less sea ice

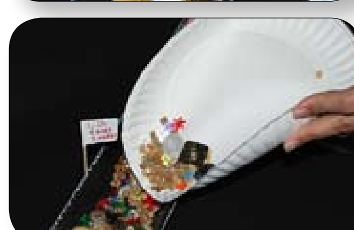
Recipe for a button core

1. Spread 1 cup of polished aquarium gravel along the length of the core holder.
2. Add about 80 shank buttons, spreading them fairly equally along the length of the core.
3. Sprinkle about 20 of the flat buttons along the entire length of the core, then drop groups of several flat buttons at 3 or 4 different levels in the core.
4. Sprinkle the beads and other plastic doodads along the length of the core. These will represent diatoms of other species besides *Eucampia*.
5. Add 1 more cup of aquarium gravel along the core.
6. Prepare your *Eucampia* Index chart and place it next to the core.

Sample the buttons and calculate the *Eucampia* Index

1. Scoop a sample of the core onto a paper plate. Sort and count the shank and flat buttons to come up with a ratio. You can ignore everything that is not a shank or flat button.
2. Prepare a small flag by sticking a label to itself around a toothpick. Put your initials on the flag and record the number of shank (end) and flat (middle) buttons on it. Stick your flag in the edge of the drain pipe at the location where you took your sample. Be careful to return your entire sample to the same location where you took it from along the core.





3. Divide the number of shank buttons in your sample by the number of flat buttons. This value is the *Eucampia* Index. Mark the value by putting an X in the appropriate column on the chart next to your flag.
4. Take samples from several locations along the core. For each sample, count the buttons, post the data flags, and mark the *Eucampia* Index on the chart.

5. Once the chart has several data points, interpret it to tell how climate changed over the time represented by the core.

Cut carefully along the dashed lines...

Eucampia Index Chart

Put an "X" in the column that shows the *Eucampia* Index for sample locations along the core. If there are no middle forms (flat buttons) in your sample, put an "X" in the ≥1.0 box.

Longer Chains ⟷ Shorter Chains

Warmer Climate ⟷ Colder Climate

Less Sea Ice ⟷ More Sea Ice

Distance from bottom of core (cm)

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	≥1.0
76											
75											
74											
73											
72											
71											
70											
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68											
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62											
61											

Overlap and tape or glue next section here

Distance from bottom of core (cm)

60											
59											
58											
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54											
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Overlap and tape or glue next section here

Distance from bottom of core (cm)

40											
39											
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Distance from bottom of core (cm)

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Ponder. . .

Draw several frames of a cartoon or storyboard. Show some *Eucampia* chains growing in different climate conditions, the diatoms dying and breaking apart, and a paleontologist finding and counting the middle and end forms to understand what the environment was like when the diatoms grew.

Practice

Got the Big Idea?

Eucampia diatoms record climate conditions by growing longer chains during warm periods when the sea is ice-free and shorter chains during cold periods when sea ice is present. The numbers of end and middle forms of these diatoms reveal the lengths of the chains and the relative amounts of sea ice that were present when they lived.

Get ready to present

Come up with an introductory comment or a question to invite people to interact with you and the button core. Take a look at the banner for this unit, and consider which pictures or text might help you explain your topic.

For demonstrations, you may want to make and display some sample chains of *Eucampia* models from shank and flat buttons, similar to those in the photographs for this activity. You can point to the short and long chains and explain how length indicates how much sea ice was present when they grew.

You might also draw some diagrams of *Eucampia* cells on a poster board, or keep the pages of the activity available to show diagrams and photographs to visitors.

Present

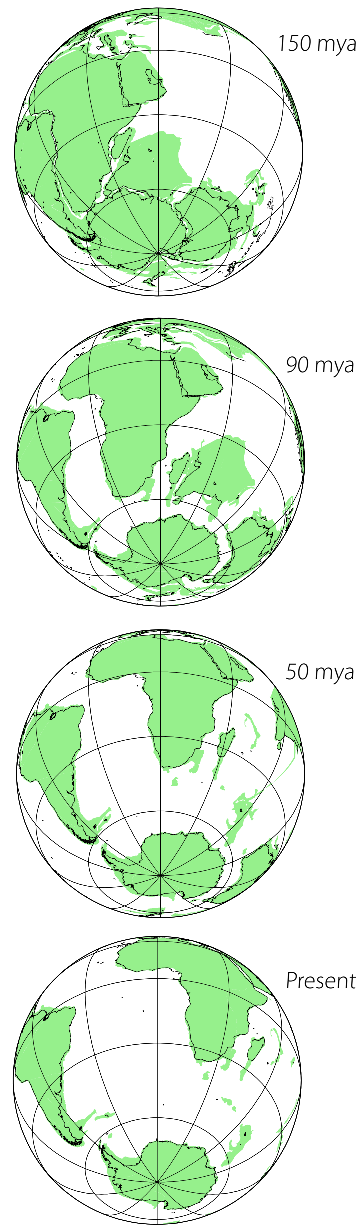
Set up the core, paper plates, sampling spoon, and flags. Place a copy of the *Eucampia* Index chart next to the core. Encourage visitors to scoop a sample of the core and count the shank and flat buttons. Post a flag with their data along the core and mark their *Eucampia* Index on the chart. Tell them how their sample compares to others from the core—did their sample indicate a time of relative warmth or cold?

Try to return the samples to the same location in the core that they came from, or the data may change through the event. Knowing the locations of the concentrations of flat buttons can help you keep them in that general spot.

Safety Note: Watch that young children don't walk off with your buttons. Toddlers may find them very attractive, yet they represent a choking hazard.

Decoding Antarctica's Climate History

Scientists are working to uncover and decode Antarctica's climate secrets. In order to piece together a complete story, they study tiny things such as the different types of oxygen molecules in the shells of marine fossils, and large things such as changes in global sea level. ANDRILL's rock cores contain pieces of evidence that are key to answering questions about Antarctica's past climates.



The breakup of Gondwana, from 150 million years ago to the present. Courtesy of the Ocean Drilling Stratigraphic Network, University of Bremen.

The Role of Plate Tectonics

Over time, movements of Earth's tectonic plates have changed the face of our planet. Many continents have changed shapes and locations. Continents have moved together to form large supercontinents, then moved apart again.

The continent of Antarctica has stayed near the South Pole for the past 120 million years. It was once part of a huge southern continent called Gondwana. By around 40 million years ago, Africa, India, Australia, and South America were all moving away from Antarctica, leaving it behind.

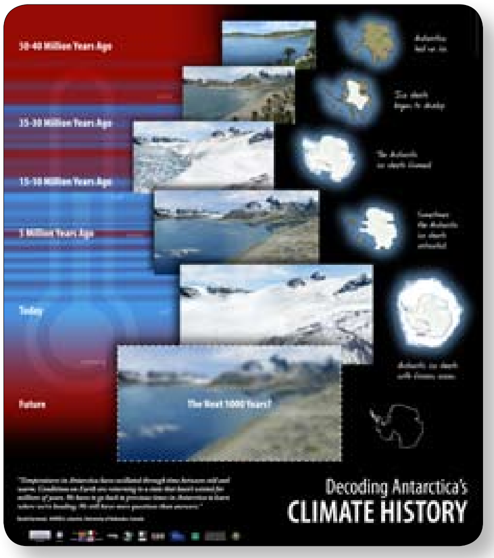
The Antarctic Circumpolar Current (ACC) flows around Antarctica, blocking warm waters from other oceans from reaching Antarctica.

This rearrangement of continents resulted in a new ocean around Antarctica. That ocean developed a strong current that flows in a circle around the continent. The fast-moving cold water blocked warmer water from the Pacific, Atlantic, and Indian Oceans from reaching Antarctica's shores. By about 35 million years ago, the entire continent was isolated from the rest of the planet's warmth. Temperatures on Antarctica plunged, and they remained low enough that snow began to accumulate and ice sheets began to grow.

In this final unit, you'll build an interactive graph and decode rock cores to show how temperature has changed over time. You'll also make a model to explore how Antarctica might look in the future. You'll end by comparing the potential for rising sea level in two models.

Unit 5 - Decoding Antarctica's Climate History

Unit 5 Banner



Examine and discuss the *Decoding Antarctica's Climate History* banner. Electronic versions of the banners are available at **http://www.andrill.org/flexhibit**.

Unit 5 Podcasts

The following podcasts show information that goes along with this unit. They can be viewed or downloaded from **http://www.andrill.org/flexhibit**.

- CO_2 and Climate Change
- Antarctic Environments Through Time
- The Larsen B Ice Shelf

Activities in this unit. . .

Build a display to show how Antarctica's climate has changed over time. Read climate clues from rocks and show your interpretation on the display.

Make a model of Antarctica and its ice sheets. Watch what happens to the ice sheets when you remove the major ice shelves.

Compare what happens when ice melts on land with what happens when floating ice melts.

Charting Temperature Changes

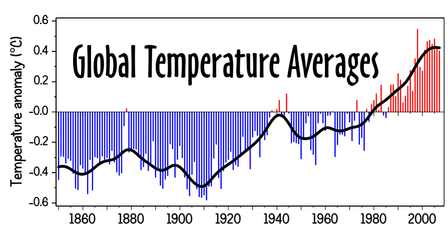
Preview

Climate Change

Compared to 40 million years ago, Earth's overall temperature is now cooler by about 5°C. Evidence from rocks, including fossils of plants and animals, shows that global climate has changed over time. Detailed studies reveal that the average temperature didn't decrease steadily; instead, every 5 or 10 million years, the temperature dropped by a degree or more. Other times, the temperature remained steady or got warmer for a while. The causes and timing of these types of temperature changes are what climate scientists want to learn about as they attempt to predict how Earth's climate will change in the future.

Some of the causes of climate change are known. For instance, a regular pattern in Earth's orbit causes our planet to receive more or less energy from the sun for thousands of years at a time. In addition, the sun's output of energy changes slightly over time. Changes in Earth's atmosphere are another factor: the mixture of gases and the number of small particles in the atmosphere control how much energy the planet absorbs and how much it reflects.

In the past 50 years, Earth's average temperature has warmed by 0.6°C. Projecting current conditions into the future, we can expect another 1°C of warming over the next 50 years. Though we know that natural variations have caused changes in climate throughout Earth's history, the rate of climate change is now much faster than usual. A growing body of evidence indicates that human activity is affecting Earth's climate.



Global surface temperature data from 1850 to 2007. Blue represents temperatures below average and red represents temperatures above average. Source: Phil Jones, Climate Research Unit, University of East Anglia, UK.

People are wondering what impact higher global temperatures will have on Antarctica's ice. ANDRILL scientists are gathering evidence that will help answer that question: they are reading the rock record from around Antarctica to find out how ice on Antarctica reacted during times in the past when temperatures were warmer.

Time

- 1 hour

Tools & Materials

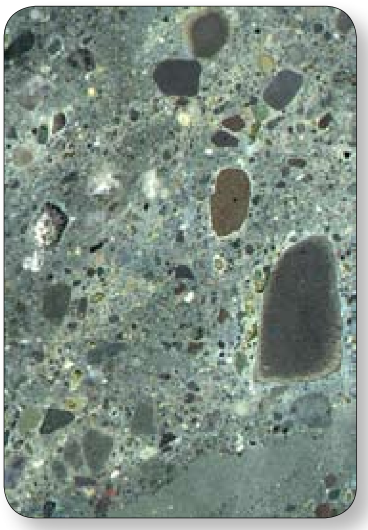
- Preprinted signs and labels (Pages 179–190)
- ½-inch PVC pipe (10 feet)
- ½-inch PVC slip elbows (2)
- ½-inch PVC slip tees (4)
- ½-inch PVC slip caps (4)
- Red construction paper
- White poster board (22" x 28" sheet)
- Red 1½"-wide grosgrain (ribbed) fabric ribbon (3 yds)
- White 1½"-wide grosgrain (ribbed) fabric ribbon (3 yds)
- White, 1"-wide sticky back hook and loop fastener (15" long)
- Scissors
- Clear packaging tape
- Sandpaper
- Colored markers
- + Saw or PVC cutter
- + Tape measure

- Items found in this book
- Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
- + Additional items you may need

Reading Climate Clues from the Rock Record

Layers of rock from the seafloor around Antarctica show how the Antarctic climate has changed. ANDRILL cores reveal that many cold-to-warm climate cycles have occurred over the last 10 million years. Though the details are more complex than what is presented here, the descriptions will help you connect different rocks to the climates that produced them.

Cold climates



Diamictite

Ice sheets on Antarctica grow during times when its climate is cold. Snow that falls never melts, so the frozen ice sheets get larger, moving out onto the seafloor around the continent. The growing ice sheets grind over the former seafloor, carrying rocks of all sizes and shapes off the continent. These rocks are deposited below the ice as a layer of mixed sediments. As additional layers are deposited, these sediments are pressed together and turn into solid rock. This type of rock is called **diamictite**; it forms when the climate is relatively cold.

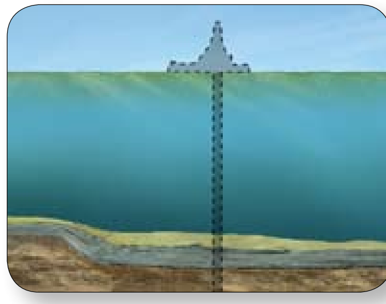
Warming climates

As the climate begins to warm, the area covered by ice sheets starts shrinking. Solid ice on land begins to melt, raising sea levels, and ocean water moves in below the edges of the ice sheet. Ice at the bottom of the ice sheet melts first because it is in contact with ocean water. Ice at the surface remains solid longer. This part of the ice sheet is still attached to land, but it is floating on ocean water as an ice shelf.

Sediments that were trapped in the bottom of the ice sheet continue to melt out and pile up under the ice shelf. When the piles get too steep, underwater landslides occur, spreading the sediments across the seafloor. Larger grains in the fast-moving landslides come to rest first, then progressively smaller sediments settle on top of them. The **layered rocks** that form from these sediments go by a variety of names. Around Antarctica, they indicate a time when an ice shelf existed over the seafloor—a time when the climate was somewhere between cold and warm.

Transitional Layered Rocks

Warm climates and open ocean



When Antarctica's climate warms even more, ice shelves melt and the open ocean surrounds the continent. Diatoms live and die in these waters—their cell walls fall to the seafloor where they form a layer of sediments. During these relatively warm periods, sea ice can still form. Comparing the numbers of open-ocean and sea-ice diatoms offers more detailed evidence of past climates. Layers of diatoms form a light-green rock called **diatomite**; it forms during times when Antarctica has a relatively warm climate.

Diatomite

When Did It Happen?

With undisturbed sedimentary rock layers, the deeper the rocks are, the older they are. The older rocks had to be there first before the younger rocks could be deposited on top of them. This simple fact makes it easy to understand the ORDER of environments that produced the rocks, but figuring out WHEN the environments existed takes more information.

Clocks in the rocks

Igneous rocks, those that form from melted rock, contain certain elements that change into other elements over time. From the time hot liquid rock cools into solid rock — when it erupts from a volcano, for instance — these elements change into other elements at a predictable rate. Scientists called **geochronologists** (*geo* = Earth; *chron* = time; *ologists* = people who study) have figured out how to measure the amounts of unchanged and changed elements. They use those amounts to calculate how long ago the rock solidified.

Volcanic ash forms when lava cools quickly as it is blown apart by escaping volcanic gases. When Antarctic volcanoes erupt, this volcanic ash is lofted into the air and settles out over the landscape. Ash particles fall on areas of open ocean and settle onto the seafloor in a new layer.

Where ANDRILL scientists find suitable layers of volcanic ash in the core, they can get an age date. The date tells the number of years ago that the layer was deposited. Layers beneath the ash were deposited before that date and layers above it were deposited after that date. Using this information along with data from fossils, geochronologists figure out when different climates existed and how quickly they changed.

Prepare

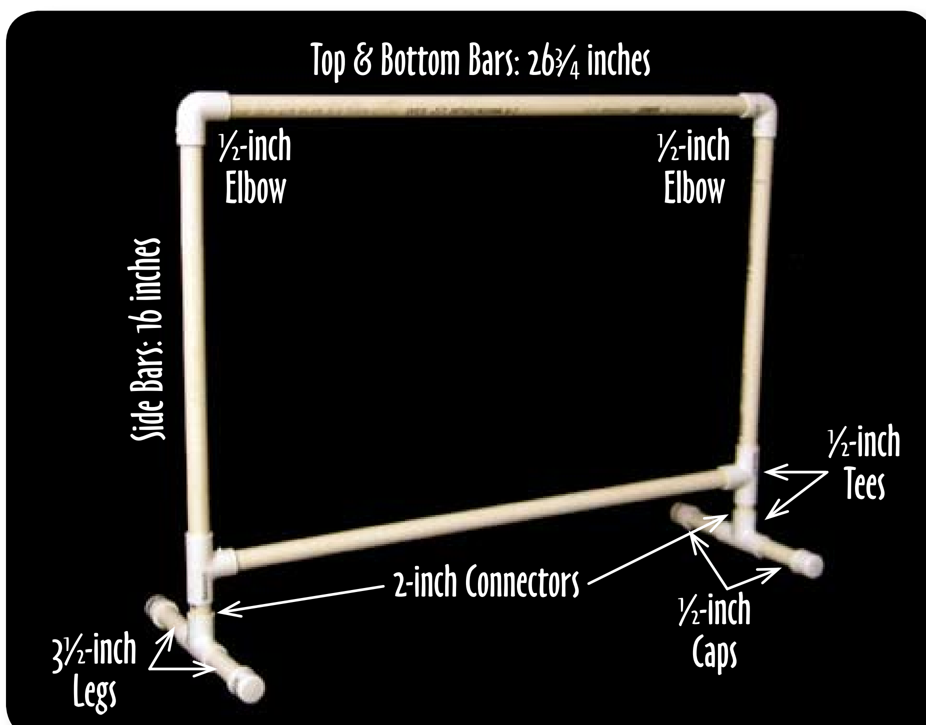
In this activity, you'll build an interactive display to illustrate how Antarctica's climate timeline can be interpreted from ANDRILL's rock cores. The picture at right shows an example of the finished product: the adjustable thermometers indicate relative temperatures on Antarctica through time.

Assemble the frame

Measure and mark the following lengths of ½-inch PVC pipe. Double-check your measurements, then use a PVC cutter or a small saw to cut the pipe.

- 2 Connectors, each 2 inches long
- 4 Legs, each 3½ inches long
- 2 Side Bars, each 16 inches long
- 2 Top & Bottom Bars, each 26¾ inches long

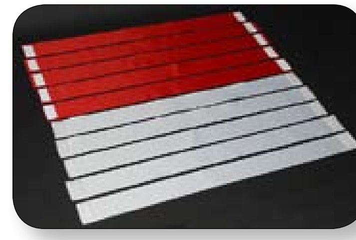
Assemble the pieces as shown:



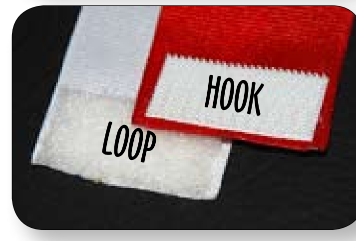
PVC frame assembly tips

- When assembling the PVC pipe and fittings, insert the pipe into the fitting and twist while pushing them together.
- For a snug fit, you can lightly sand the ends of the pipe with fine sandpaper before assembly.
- You don't need to glue the pieces—this allows you to disassemble the frame for transporting and storing it.

Prepare the "thermometer" ribbons



1. Measure and cut five 20-inch-long red ribbons and five 20-inch-long white ribbons.
2. Have an adult use a candle flame or butane lighter to carefully and quickly pass the ends of each ribbon through the flame to fuse the threads. This will keep the ribbon from fraying. Lay all the ribbons out flat to keep them organized.
3. Cut ten 1½-inch-long pieces of VELCRO®. "Rip" the two sides apart so you have 10 hook pieces and 10 loop pieces.
4. Peel the backing off one hook piece of VELCRO® at a time and stick it close to one end of a red ribbon. Add another hook piece at the other end of the same side of the ribbon. Repeat for all 5 red ribbons.
5. Attach loop pieces of VELCRO® to each end of the five white ribbons. All VELCRO® pieces go on the same side of the ribbons.
6. Connect each red ribbon to a white ribbon by pressing the VELCRO® pieces together.

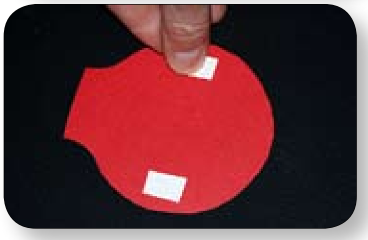


Prepare additional pieces

1. Cut out the Template for Thermometer Bulbs and use it to make 5 "bulbs" out of red construction paper.
2. Measure and cut a 28×17½-inch piece of white poster board.
3. Attach the Relative Temperature label vertically along the left edge of the poster.
4. Cut out and fold the six Antarctic landscape picture cards and the age-date markers on the dashed lines. (NOTE: The age-date markers do NOT go with their adjacent landscape picture cards.)
5. Cut and fold the Antarctica's Climate Timeline tent card. It will serve as the graph's title.
6. Cut out the Core Cards.

Final assembly

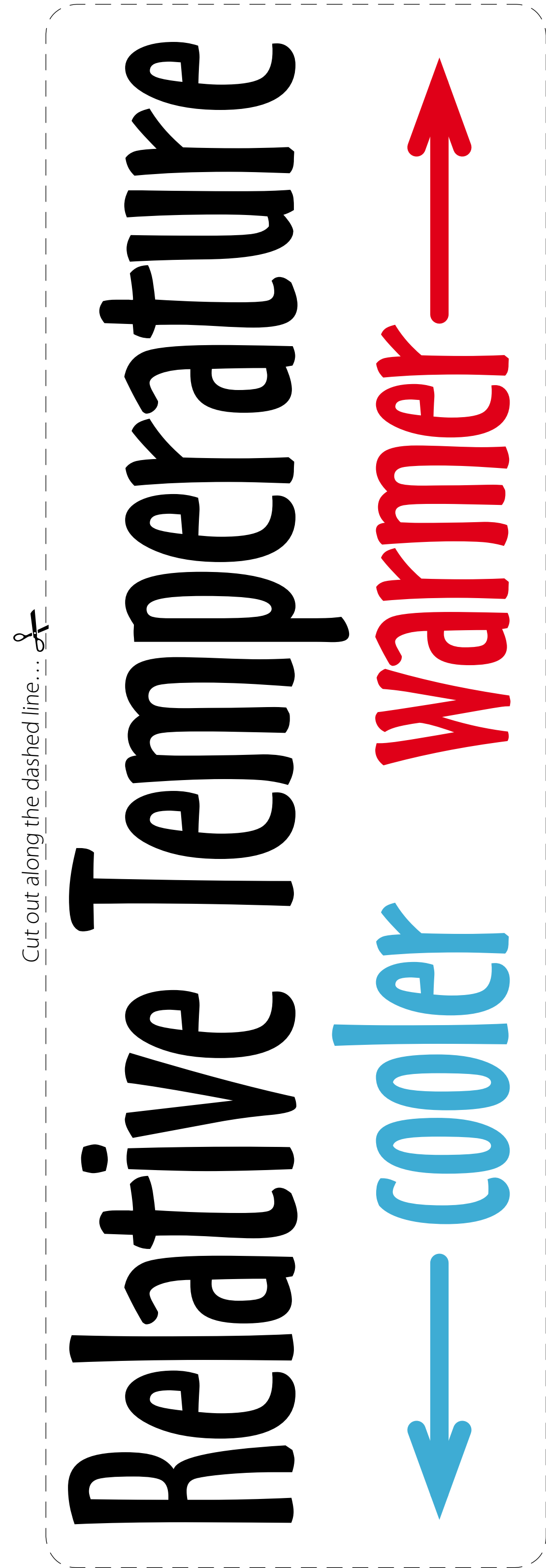
1. Tape the poster board to the sides of the PVC frame with clear packaging tape. This is the background of your temperature graph.
2. Lay the ribbons over the PVC frame with the white part going over the top bar and the red part going under the bottom bar.

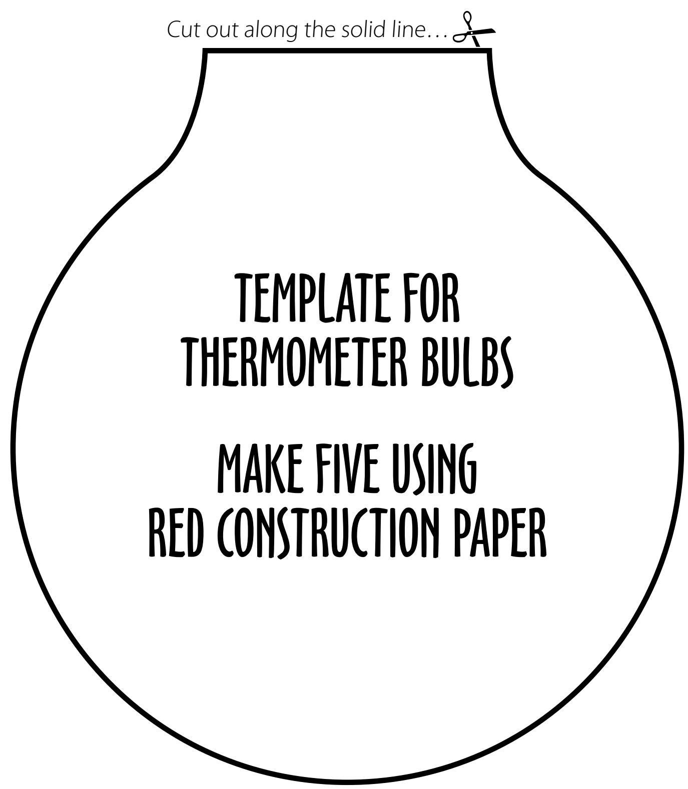


3. Pull the ends together and connect them by pressing the VELCRO® pieces together. Make the ribbons snug enough to stay taut, but not too tight for them to slide around the top and bottom of the PVC frame. If necessary, release and adjust the VELCRO® connection to tighten the ribbons. Space the ribbons evenly across the frame.
4. Place a small rolled piece of tape on each side of the five thermometer bulbs. Stick each bulb to the bottom bar of the PVC frame over one of the ribbons. Make sure the ribbons can move freely behind each bulb.

Decode a rock core to show a climate timeline

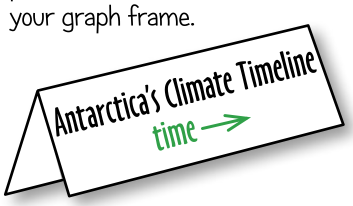
1. Take one of the Core Cards at a time. Your task is to read the rock layers and set the timeline graph to show how climate changed over the time the rocks were deposited in that core.
2. Decide what climate the oldest rock layer on the card indicates. Select the Antarctic landscape picture card that illustrates this climate and place it at the top of the first thermometer on the left. Adjust the thermometer ribbon to show the relative temperature of the climate you decided on.
3. Repeat the process for the next four thermometers.
4. Add the age-date markers indicated by your core along the top of the frame.
5. Describe the climate history that your timeline shows. Discuss how certain or uncertain you are about different parts of your interpretation.
6. Repeat this process with each of the other two Core Cards.


Cut out along the dashed line…
Relative Temperature
warmer
cooler


Cut out along the solid line…
TEMPLATE FOR
THERMOMETER BULBS
MAKE FIVE USING
RED CONSTRUCTION PAPER

Graph Title Tent Card

This sign is the title for your temperature graph. Cut it out and fold it along the dotted line to form a "tent" shape, and place it on the table in front of your graph frame.



Cut out cards along the solid line and fold on the dashed line...

Antarctica's Climate Timeline

time →

Cut out cards along the solid lines and fold on the dashed lines…

6.9 Million Years

Note: This age date marker ↑ does not go with this landscape scene ↓.

Cut out cards along the solid lines and fold on the dashed lines…

1.1 Million Years

Note: This age date marker ↑ does not go with this landscape scene ↓.

Cut out cards along the solid lines and fold on the dashed lines…

5.4 Million Years

Note: This age date marker ↑ does not go with this landscape scene ↓.

Cut out cards along the solid lines and fold on the dashed lines…

2.2 Million Years

Note: This age date marker ↑ does not go with this landscape scene ↓.

Cut out cards along the solid lines and fold on the dashed lines…

6.4 Million Years

Note: This age date marker ↑ does not go with this landscape scene ↓.

Cut out cards along the solid lines and fold on the dashed lines…

4.3 Million Years

Note: This age date marker ↑ does not go with this landscape scene ↓.

Core Cards

Cut out cards along the dashed lines…

Core 1

Core 2

Core 3


Core 3
Volcanic Ash
4.3 Million Years Old
Diatoms
Layered Sediments
Mixed Sediments
Diatoms
Volcanic Ash
5.4 Million Years Old
Diatoms
Core 2
Mixed Sediments
Mixed Sediments
Mixed Sediments
Volcanic Ash
6.4 Million Years Old
Diatoms
Volcanic Ash
6.9 Million Years Old
Layered Sediments
Core 1
Volcanic Ash
1.1 Million Years Old
Diatoms
Layered Sediments
Mixed Sediments
Volcanic Ash
2.2 Million Years Old
Diatoms
Mixed Sediments

Ponder. . .

The red and blue pattern on the Decoding Antarctica's Climate History banner represents a scientific interpretation of climate changes in Antarctica. Use the colors, times, and landscapes on the banner to write a description of Antarctica's climate over the past 50 million years.

Practice

Got the Big Idea?

Rock layers are records of the climates that produced them. By "reading" rocks in order, we can figure out how the climate of the place where they formed changed over time. Age dates from volcanic rocks are used to determine when different climates existed and how quickly the climate changed.

Get ready to present

Read the introductory text for Unit 5 and activity 5A carefully. Read one paragraph at a time, then discuss the idea with your team members to make sure that everyone understands. For each section, practice describing the most important point in your own words. This will prepare you to explain the ideas to visitors at the Flexhibit.

Decide what information visitors will need to be able to set the climate timeline from the Core Cards. You may want to make a chart that connects the different rock types to the climates that produced them. For instance, you might show the three types of rocks in one column with the landscape pictures that match them in another column.

Come up with an introductory comment or question you can use to invite people to interact with you at the graph. Be ready to explain how the rocks indicate different climates and how the order of the layers tells the sequence of climates. Make sure you can explain how the volcanic ash layers give age dates.

You may want to show visitors one of the Core Cards and challenge them to set the climate timeline themselves. If the task seems too difficult at first, consider setting the thermometers for the first two or three ribbons, then inviting visitors to set the remaining ones.

Present

Set up the frame and tent card with the graph title. Place the landscape pictures and age-date markers where visitors can choose the ones they need.

Encourage visitors to set the thermometer ribbons themselves, even if you need to place the landscape pictures along the top of the frame for them according to the Core Card. This will help you communicate the idea that we can read rocks to tell how climate has changed over time.

In some cases, if visitors are reluctant to interact with the graph, you might demonstrate how you interpret a rock layer's climate and set the thermometer yourself.

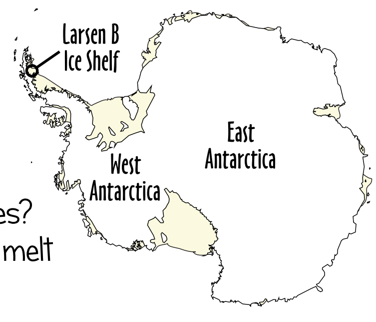
For visitors who are interested and engaged with the climate timeline, describe how the red and blue pattern on the Decoding Antarctica's Climate History banner shows a scientific interpretation of climate changes in Antarctica.

When a group of visitors leaves your station, "reset" the graph so that the next group can start fresh, interacting with the graph and making the climate timeline.

What If the Ice Shelves Melted?

Preview

In February of 2002, a huge section of the Larsen B Ice Shelf collapsed. You can take a look at the **Larsen B Ice Shelf** podcast to learn more about this startling event.



How permanent are Antarctica's other ice shelves? What might happen if they were to break up or melt away?

In this activity, you'll make a model of Antarctica and mix up a white "slime" material to represent the continent's ice. You'll create a demonstration to show how the ice on Antarctica might respond if the continent's major ice shelves were to melt away.

Prepare

Similar to the way rivers flow downhill off the other continents, Antarctica's ice sheets also move downhill toward the ocean. Along the bottom of the ice sheet, right at the boundary between rocks and ice, tremendous pressure builds up. This friction tends to hold the base of the ice on the continent. To model this friction, you'll make an Antarctica-shaped tray with a slight wall around the edge of the land. The wall represents the friction that keeps the ice on the continent.

Antarctic ice flow patterns, NASA Scientific Visualization Studio, modified by Angie Fox.

Time

- 1–2 hours

Tools & Materials

- 📖 Outline map of Antarctica and major ice shelves (Page 201)
- Aluminum foil
- Wax paper
- Non-hardening modeling clay (1 tablespoon)
- Multi-purpose white glue (Elmer's Glue All, 4 oz)
- Borax powder (20 Mule Team laundry booster, 1 tablespoon)
- Small plastic mixing container
- Stirring stick (craft stick)
- Scissors
- Measuring cups & spoons
- Clear packaging tape
- Colored markers
- + Large sheet of construction paper or poster board
- + Small plastic container, such as a butter tub
- + 1¼ cup water

📖 Items found in this book
Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
+ Additional items you may need

Make an Antarctica-shaped tray

1. Remove or copy page 201 from this book and place strips of clear packaging tape across the page to give it a water-repellent surface.
2. Cut out the continent along the heavy dark line. Cut out the three additional shapes and set them aside.
3. Set the cut-out continent on a piece of aluminum foil. Trim the foil so it extends about 2 inches beyond the edge of the continent.
4. Make a "T" cut in the foil at the Ronne-Filchner Ice Shelf. Cut in from the edge of the foil and across the front of the ice shelf.
5. Starting with the Antarctic peninsula, roll and pinch the outer edge of the foil upward to make a foil wall ¼ to ½ inch high along both sides of the peninsula.
6. When you get to the Ross Ice Shelf, make another T-shaped cut in the foil. Cut in from the edge of the foil and across the front of the ice shelf.
7. Start building the foil wall again along the end of the Transantarctic Mountains. Keep building the wall around East Antarctica to the Amery Ice Shelf.
8. Make a small T cut for the Amery Ice Shelf. Complete the wall around the outer edge.

Ice Streams in a Traffic Jam

Ice at and near the surface of Antarctica's ice sheets can flow downhill in ice streams. Arrows in this visualization show the general direction of ice movement off the continent. Notice that much of the ice is funneled toward the major ice shelves. With large volumes of ice moving into limited areas, a sort of "traffic jam" occurs. Ice that was moving downhill has to slow down when it becomes part of the ice shelf. In turn, the slower ice holds up ice that is behind it, keeping it from flowing freely off the continent. You'll build foil walls on the INSIDE edge of each of the major ice shelves to model their tendency to hold back the flow of ice.

1. Use foil to build the same type of wall you made around the continent along the boundaries of each of the three ice shelf pieces you cut out.
2. Place the ice shelves where they belong on the continent, holding them in place by pinching the ends of their foil walls together with the wall that surrounds the continent.
3. Roll the clay to add a line of mountains across the continent, along the label and mountain symbols. Make the roll a little higher than your foil walls. Pinch the clay to form a few valleys in the long mountain chain.

Prepare a saturated solution of borax

1. Put 1 tablespoon of borax powder into a plastic cup.
2. Add ¾ cup water and stir for about 1 minute with a craft stick.
3. Allow the undissolved powder to settle to the bottom of the cup. The liquid in the cup is a saturated solution of borax.

Mix up some white slime!

1. Wash your hands and cover your work area with wax paper. Put about 4 ounces of white glue and ½ cup water into a plastic tub or bowl and mix them thoroughly. Be careful not to splash.
2. While stirring the glue mixture with a craft stick, slowly drip about a tablespoon of the borax solution into it. Keep stirring and a ball of slime will form around your stirring stick!
3. Use your hands to collect the ball of slime from the stick. Put the slime aside in another plastic container.
4. Stir the glue and water mixture again and drip another tablespoon of the borax solution into it. Continue stirring and collecting the slime that forms on your stirring stick. Repeat this step until most of the glue and water mixture has been transformed into slime.

5. Work with it! Pick up the slime and squish it through your hands. You'll be amazed at the non-sticky feel of this polymer material you made.

Add the slime to your continent

1. Place "blobs" of your slime onto your continent. Start with East Antarctica, adding enough slime to cover the continent to a thickness that is a bit higher than your foil wall.
2. Add slime to West Antarctica and the Antarctic Peninsula as well.
3. Within about 5 minutes, the blobs of slime will relax, leaving a smooth cover of model ice over the whole continent. If any slime flows over the foil walls, put it back into the plastic container.

Melt away the ice shelves

The average temperatures of Earth's atmosphere and oceans have increased in the past 50 years. Evidence suggests that temperatures will continue to increase for at least 50 more years. Because Antarctica's ice shelves are floating on ocean water, they are at risk of melting.

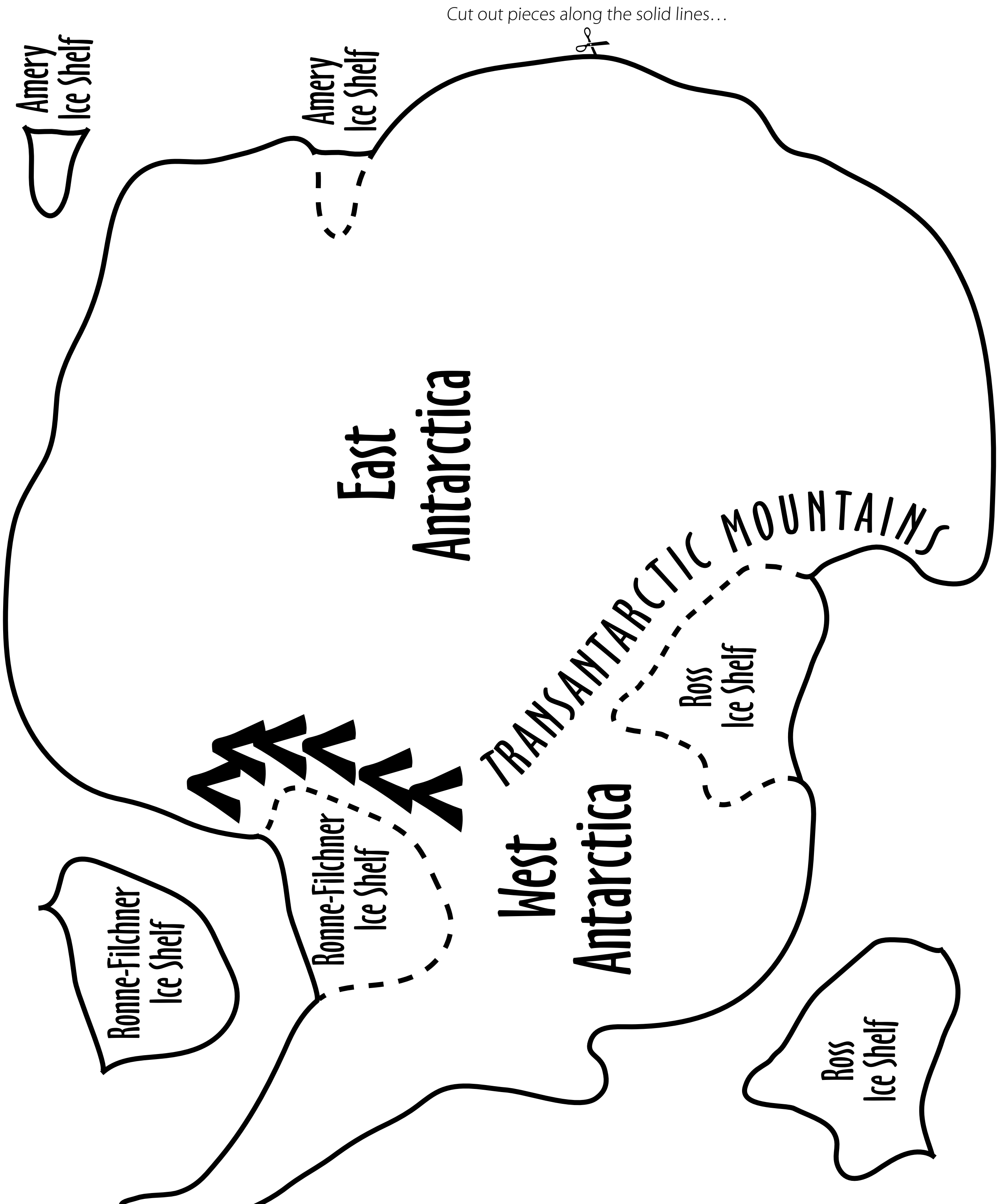
1. Remove the ice shelves and their walls from your continent to model the melting of floating ice.
2. Note what happens to the "ice" on Antarctica over the next 10 to 15 minutes.

Revisiting the Larsen B Ice Shelf

Though the model you built for this activity is simple, it illustrates a process that is happening in the real world. After the collapse of the Larsen B Ice Shelf, scientists measured the speed of glaciers that flow down to the site where the ice shelf was. In 2004, they found that the glaciers were moving up to eight times faster than they did before the collapse of the ice shelf in 2002.

Clean up your slimy mess!

1. After you've seen the results, collect as much of the slime as possible and put it in an airtight plastic bag. Store it in a refrigerator.
2. Use a damp paper towel to clean the continent. It's okay if some of the slime remains stuck in the foil walls; it will make them stronger for the next time you use it.


Cut out pieces along the solid lines…
Amery Ice Shelf
Amery Ice Shelf
East Antarctica
TRANSANTARCTIC MOUNTAINS
Ross Ice Shelf
West Antarctica
Ronne-Filchner Ice Shelf
Ronne-Filchner Ice Shelf
Ross Ice Shelf

Ponder. . .

Sketch two pictures of your model, one from before you removed the ice shelves and one showing how it looked 10 or 15 minutes after you removed them.

Write about your experience with the model: How realistic do you think it is? What differences did you see between East and West Antarctica?

Practice

Got the Big Idea?

Ice shelves tend to keep ice on Antarctica. If the major ice shelves were to melt or collapse, ice may move off the continent more freely than it does now. West Antarctica is much more vulnerable to melting than East Antarctica.

Get ready to present

Come up with an introductory comment or question you can use to invite people to check out your slimy model. You may want to keep a sample of slime available for visitors to touch. Another idea is to use the Podcast of the Larsen B Ice Shelf collapse as an introduction to this activity.

It may be helpful for you to make a chart with drawings or photographs of the model both before and after the ice shelves are removed. Another option would be to prepare two or three of the Antarctica-shaped trays and additional slime so that Flexhibit attendees can see the model in different phases.

Read over the introductory sections of this activity and discuss it with your team members. Be sure you can explain what the wall of foil represents, including why the wall is on the outside of the continent but on the inside of the ice shelves.

Present

Get the slime out of the refrigerator at least two hours before you need it so it can warm up to room temperature. Have the materials on hand to mix up some additional slime if you'll need it to fill the tray or for a sample that visitors can touch.

For visitors who are interested and engaged with the activity, you can discuss your ideas about how realistic the model is.

How Does Melting Ice Affect Sea Level?

Preview

Arctic Ice Loss

The area covered by sea ice in the Arctic Ocean has been shrinking. For many decades, more sea ice has melted away during summers than has reformed during winters. Projections show that the ocean around the North Pole could be ice-free during summers as early as the year 2030! How might the melting of this sea ice — an area larger than the country of India — affect the rest of the world?

The ice sheet on Greenland is also shrinking. Over the past 30 years, the total area of the Greenland ice sheet affected by summer melting has grown. What effect might the melting of Greenland's ice sheet have on the rest of the world?

Antarctic Ice Loss

Antarctica has ice sheets on land, floating ice shelves, and sea ice surrounding it. How would the melting of these three different kinds of ice affect the rest of the world?

In this activity, you'll make two models that are identical except for one factor: one will have ice on "land" and the other will have ice in the "sea." You'll compare how melting ice affects each model.

Time

⌛ 1 hour

Tools & M-aterials

- Transparent plastic food container, about 8" x 6" x 2" (2)
- Plastic food container, about 4" x 4" (2)
- Aquarium gravel (2 cups)
- Overhead transparency marker
- Measuring cup
- Labels (2)
- Colored markers
- ✚ Large sheet of construction paper or poster board
- ✚ Water

📖 Items found in this book
- Items included in the Flexhibit Kit, available from **http://www.andrill.org/flexhibit.**
✚ Additional items

Prepare

Make two identical pieces of ice

1. Put water into one of your small plastic containers so it is approximately ½ inch deep.
2. Pour the water into a measuring cup so you know exactly how much you have.
3. Pour that same volume of water into each of the two small plastic containers and put them in the freezer.

Make two models of land and sea

1. Put a label on the outside of each of the two rectangular containers. Write "Ice on Land" on one container and "Ice in Water" on the other.
2. Pour 1 cup of gravel into each container. Tilt and shake each container gently so the gravel is piled in one end to form the "land."
3. Gently pour 1½ cups of water into each container. Make sure that the water doesn't cover the surface of the gravel.
4. In the Ice on Land container, place one of the pieces of ice on top of the gravel. No part of the ice should be in the water.
5. In the Ice in Water container, put the piece of ice in the water, so no part of it is supported by the gravel.
6. On the outside of each container, mark the water level, using an overhead-transparency marker.
7. Have a discussion with your team members: What do the different parts of the model represent in the real world? In the model, what is the significance of the water level?

What about a beach resort?

On the "land" area of your model, use small objects to represent buildings, roads, and parking lots right along your "beach." What might happen to your resort as the ice melts in each model?

Wait for the ice to melt

1. Put both containers in a place where they won't be disturbed while the ice melts. If it's necessary to leave them for more than a few hours, put lids on the containers to keep water from evaporating.
2. After both pieces of ice have melted, check and mark the water levels again.

Ponder. . .

Imagine a flat beach area with roads, houses, and shops just beyond the sand. Now imagine how rising sea levels would affect your mental picture. Describe what might happen in your scene year after year as sea levels rise and water covers more of the land.

Go back to the Preview section of this activity. Based on your results, answer the questions about sea ice, Greenland's ice sheet, and the three types of ice in Antarctica.

Practice

Got the Big Idea?

When ice that is floating in the ocean melts, sea level does not change. This applies to all floating ice, including sea ice and ice shelves. When ice that is on land melts and runs into the sea, additional water is being added to the ocean, so sea level rises.

Get ready to present

Think of an introductory comment or question you can use to explain what the two models show.

As the ice will likely melt during the Flexhibit, you may want to make a chart with drawings or photographs showing how the two models look before and after the ice melts. Emphasize the observed change in water levels so you can draw a connection to changes in sea level. Another option would be to prepare an extra set of the models so that Flexhibit attendees can see what they look like before and after melting.

Present

When you set up your station, be sure that visitors will be able to see the difference in water levels for the container with ice on land. Be ready to explain that the water level represents sea level for the whole world.

For visitors who are interested and engaged with the concept, you might share some of the estimates (below) of the amount of sea-level rise that would result from the melting of ice in different places.

Ice Sheet	Estimated Sea-Level Rise
Greenland	7 meters
West Antarctica	7 meters
East Antarctica	70 meters

Planning & Logistics

What is a Flexhibit?

The name Flexhibit comes from two words — it's a "flexible exhibit" package. The package include hands-on activities, attractive banners, and video Podcasts; it gives kids the means to do some fun learning activities and then use their knowledge to do some teaching. The activities culminate with the kids hosting a public science event or installing an exhibit for a science museum or other venue.

While doing the activities, kids build and interact with models and learn to give cool science demonstrations. The kids become the experts—they do the teaching at their event, or they prepare interpretive signs for the props at their exhibit. The package has been tested in a range of situations and places. It has been used successfully in 4-H clubs, classrooms, and after-school science clubs.

Planning the activity sessions

Flexhibit activities are designed so you can adapt them to the size of your group and the amount of time you have available. For relatively small groups (10 or fewer), all the kids can participate in all the activities. With a larger group, it makes sense to split them into two or more subgroups and have different subgroups work on different activities. If you use this strategy, kids will get some initial practice giving demonstrations and explanations to the other kids.

The sequence of activities is designed to build kids' understanding about Antarctica from concrete and visible concepts to more abstract, global-scale ideas. Within each unit, activities complement one another; kids will develop the most complete understanding if they have some exposure to all the activities, either by participating in the activity session or by having their peers explain the content. Realistically, however, groups may not have the time or resources to cover every activity. To design the most complete learning experience possible, peruse the activities in each unit and decide which ones your group will complete. Check the "Got the Big Idea?" section of the activities for the learning outcomes.

Plan to examine and discuss the banner, read over the unit introduction in the activity book, and watch the video Podcasts before you begin the activities. These introductory materials provide context and background to help kids make sense of the models. Within the activities, the Preview sections are also designed to provide context. If kids are anxious to get started doing the activities, you may choose to summarize the Preview information for them ahead of time, then read and discuss that section more thoroughly after the activity as a way of solidifying their understanding and preparing them to present the material.

Flexhibits Are Flexible!

You don't need to use all the activities for your Flexhibit event. Decide which activities will be most attractive to and understandable by your kids and your target audience.

Scheduling the activities

This chart shows one suggestion for a group of 15 kids completing the activities in ten one-hour sessions.

Session	Whole Group Intro	Team-based Activities (Split group into # of teams indicated)
1	Examine and discuss the **Antarctica Today** banner and the Unit 1 Introduction in the activity book. Watch Unit 1 Podcasts: Tour of the Cryosphere and ANDRILL Activity 1A: Postcards from Antarctica	Activity 1B: Antarctica in Maps Break group into pairs and begin examining maps.
2	Have pairs of kids practice giving a brief explanations of the maps they examined to the rest of the group.	Team 1: Activity 1C, Polar Opposites? Team 2: Activity 1D, Animal Insulation Prep for next session: Prepare ice for Activity 2A and ice sheet for 2B.
3	Teams 1 & 2 practice presenting Activities 1C and 1D to each other. Examine and discuss the **Antarctica's Ice on the Move** banner and the Unit 2 Introduction in the activity book. Watch Unit 2 Podcasts	Team 1: Do Preview and Prepare of Activity 2A. Team 2: Read 2A Preview and prepare model landscape for optional extension. When Team 1 has completed the individual glaciers, they pass them over to Team 2 to become part of the ice sheet.
4	Activity 2B as a demonstration	In small groups, do Ponder and Practice for Unit 2 activities. Reconvene the whole group to read the introduction for Unit 3 and examine and discuss the **Reading Antarctica's Rock Cores** banner.
5	Activty 3A: Build a Model ANDRILL Site	Break into subgroups to complete separate sections of the activity. One subgroup makes layer 1 of Activity 3C.
6	Watch ANDRILL 2006 Video Journals #7, #8, and #9 Activity 3B: Photo Sort: Core Flow	Team 1: Complete Activity 3C Team 2: Activity 3D
7	Examine and discuss the **Tiny Clues to Antarctica's Past** banner and the Unit 4 Introduction in the activity book. Watch the **Diatom Tour** Podcast.	Team 1: Activity 4A (subgroups complete Parts 1, 2, and 3) Team 2: Activity 4B
8	Practice sharing Activities 4A and 4B Read and discuss Unit 5 Introduction and examine and discuss the **Decoding Antarctica's Climate History** banner.	Team 1: Activity 5A Team 2: Activity 5B Team 3: Activity 5C
9	Complete work on Unit 5 activities. Split the group into 5 sub-groups corresponding to the 5 units.	Each group reads through the Practice and Present sections in their unit and prepares their presentations.
10	Flexhibit Setup and Rehearsal	Practice setting up the teaching stations and sharing information with other groups.

Planning your Flexhibit

Reserve your venue well in advance. If you are using a school building outside of school hours or on a weekend, consider whether you'll need to have a custodian or security person available to unlock doors during your setup time or your event. Plan ahead to have access to water and a place to store ice. Secure a couple of waterproof trash cans so that you'll have a place to throw wet paper towels or other messy trash.

As a practical minimum, you'll need at least one table for each of the five themes. If you have additional space and tables, you can expand. One option is to set the tables around the edges of the room with space for an aisle behind them: this arrangement allows youth presenters to stand behind the tables and visitors to move from one table to another without backtracking. As possible, set up so that it is convenient for visitors to start at Unit 1 and move through the sequence, ending at Unit 5. Visitors may not choose to follow this pattern, but make it available if possible. As each group decides how they'll present the activities from their unit, you may need to make slight spacing adjustments to ensure that all the stations are accessible.

Use whatever resources you have to display the banners at eye level for your intended audience. Ideally, use large tacks or nails to hang the banners by their grommets flat on the wall. If you can't attach the banners to the wall, consider hanging them over frames on easels, across tri-fold cardboard displays, or from the ceiling, using strong string or fishing line.

During your setup time, check to see that banners and props are well spaced rather than clustered in a few locations. Check that there is enough room for people to move between the exhibits. Double check for possible safety issues, considering that young children may handle things in ways you don't expect.

Materials List

This list details the items needed to complete the activities and produce a single set of Flexhibit props. Flexhibit Kits containing all these items can be purchased. For current pricing or to place an order, send an email to AntarcticaFlexhibitKits@charter.net

		Unit 1				Unit 2		Unit 3				Unit 4		Unit 5		
Description	Quantity	A	B	C	D	A	B	A	B	C	D	A	B	A	B	C
duct tape	1 roll				•						•	•				
measuring cups & spoons	1 set															
scissors	2 pair	•	•	•	•			•	•					•	•	
saw (for cutting PVC & wood)	1							•						•		
clear packaging tape	1 roll					•										
colored markers	1 set	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
physical globe (Earth)	1		•	•												
string	4 ft		•													
3-ring binder	1		•													
plastic sheet protectors	1 doz		•													
index cards	1 doz		•													
plastic basin or bowl	1				•											
zipper-lock bags, 1 quart	10				•											
vegetable shortening or lard	2 cups				•											
washcloth	1				•											
insulating materials	misc				•											
cotton balls	30				•											
styrofoam bowls	12					•										
black pepper	2 Tbsp					•										
plastic wrap	1 roll					•										
cardboard 12"x18"	3					•										
9-inch square baking pan	1						•									
paint tray	1						•									
paint tray liner	1						•									
plastic pitcher	1						•									

		Unit 1				Unit 2		Unit 3				Unit 4		Unit 5		
Description	**Quantity**	A	B	C	D	A	B	A	B	C	D	A	B	A	B	C
blue food coloring	1 bottle						•									
salt	2 Tbsp						•									
yardsticks	4							•								
blue acrylic paint	2 oz							•								
foam paintbrush	2							•								
cardboard box 18"x12"x9"	1							•								
black construction paper	1 sh							•								
cardboard box 12"x9"x2"	1							•								
½" PVC pipe	20 ft							•						•		
sandpaper, medium	1 sh							•						•		
kraft paper, brown, 30"x52"	6 ft							•								
½" diameter wooden dowel	18 in							•								
steel thumb tacks	3							•								
½" diameter round magnet	1							•								
small screw eye	1							•								
nylon cord or string	4 ft							•								
blue cellophane, 30" wide	18 in							•								
plastic mixing bowl	1									•						
large spoons	3									•						
plastic containers, 16 oz	8									•						
pebbles (>½" diameter)	2 cups									•						
gravel (about ¼" diameter)	2 cups									•						
coarse sand	5 cups									•		•				
fine sand & silt	2 cups									•						
clear fluorescent bulb cover	1									•						
1¼" PVC caps	2									•						
plastic funnel	1									•						
plastic jars w/lids, 12 oz	3									•						
green hermit crab sand	2 cups									•						
white sand	2¼ cups									•		•				
cardboard tube, 2"x24"	2										•					

Description	Quantity	Unit 1				Unit 2		Unit 3				Unit 4		Unit 5		
		A	B	C	D	A	B	A	B	C	D	A	B	A	B	C
black sand	¼ cup											•				
orange sand	¼ cup											•				
gravel & pebbles	20 pcs											•				
glass seed beads, 4 colors	1¼ tsp ea											•				
paper plates	12											•				
plastic spoons	3											•				
hammer	1											•				
safety glasses or goggles	1											•				
thick plastic zipper bags	4											•				
magnifying glass	2-3											•				
fine-tipped paintbrush	2-3											•				
30-cm rulers	4											•				
black permanent marker	1											•				
shank buttons	86												•			
flat buttons	50												•			
assorted plastic beads	½ cup												•			
polished aquarium gravel	5 cups												•			
3" corrugated plastic drain pipe	30 in												•			
toothpicks	60												•			
adhesive mailing labels	60												•			
sewing needles	3												•			
thread	1 spool												•			
½" PVC slip elbows	2													•		
½" PVC slip tees	4													•		
½" PVC slip caps	4													•		
poster board, 22"x28"	1 sheet													•		
red construction paper	1 sheet													•		
1½" red grosgrain ribbon	3 yd													•		
1½" white grosgrain ribbon	3 yd													•		
1" wide sticky Velcro®, white	18 in													•		
aluminum foil	1 roll														•	

		Unit 1				Unit 2		Unit 3				Unit 4		Unit 5		
Description	**Quantity**	A	B	C	D	A	B	A	B	C	D	A	B	A	B	C
waxed paper	1 roll														•	
non-hardening clay, brown	1 oz														•	
craft sticks	12											•			•	
white glue	8 oz											•			•	
borax laundry booster	3 Tbsp														•	
8 oz plastic container, w/ lid	1															•
clear plastic container, 8"x5"	2															•
clear plastic container, 4"x4"	2															•
adhesive labels	3															•
overhead transparency marker	1															•

Activity Notes

Unit 1 - Antarctica Today

This unit serves as an introduction to the continent of Antarctica. Kids learn that Antarctica is a cold, remote, and unique place where humans are only visitors.

Activity 1A Postcards from Antarctica

Preparation for the Activity Session

If your activity sessions are particularly short, or your group of kids is not especially skillful or safe with scissors or paper cutters, consider using volunteer resources to cut out the postcards before the session.

The postcards are not actually from or to real people. Rather, the messages were written to share interesting facts about living in Antarctica. The stamps shown on the postcards are only replicas: they were designed to look realistic, while avoiding any infringement on postal rules. Because mail to and from McMurdo Station is handled by the U.S military postal system, the actual cost for sending mail to or from Antarctica is the same as sending mail anywhere within the United States.

Flexhibit Station Setup

The postcards can be a stand-alone station. Display the postcards on a tabletop or in a binder of plastic photo sleeves. Lay some of them out with the writing side up so visitors realize that they can learn something from both sides of the postcards.

Ponder Answer

There are no wrong answers for the blank postcards. Kids may write about

- the beauty of the icy landscape
- daylight and night lasting for several months per year
- adventurous work such as rappelling on ice cliffs for science research
- the clothing necessary for working outdoors in Antarctica

Activity 1B Antarctica in Maps

Preparation for the Activity Session

Before you ask kids to do this activity, work through it yourself. Read through the questions and answers for each of the map pages so that you can assist kids in understanding the concepts. Note which maps or questions may be challenging for your kids and be ready to help them. Work to build kids' confidence in their ability to read maps.

Flexhibit Station Setup

Display the globe and maps where visitors can handle them. Place the open binder of maps on a tabletop, or post the maps on a bulletin board.

Ponder Answer

Examples of words and phrases that describe Antarctica:

Freezing, Cold	Remote, Isolated
Surrounded by Ocean	Large
White	Snowy, Icy
Windy	Dry
South of every place else on Earth	Covered with ice
Partly below sea level	Has penguins around its coast
Dangerous	Discovered after all other continents
Place for Adventure and Discovery	Governed by the Antarctic Treaty
No military presence	No official flag
Distorted on maps	No one owns it

Activity 1C Polar Opposites?

Preparation for the Activity Session

Come up with at least one practical method for making a large Venn diagram. If your kids don't come up with a way to make the two circles themselves, you'll be able to suggest it.

If you don't think your kids will be able to resist looking at the answers before they sort the cards, you may want to cover the answers with sticky notes.

In order to help kids distinguish between the two polar regions, plan to wrap up the activity with a focus on Antarctica. Gather and put away all the Arctic-only cards. Display the cards that show features of Antarctica and ask for volunteers to share ways of helping everyone remember which items are Antarctic.

Flexhibit Station Setup

The Venn diagram circles can be arranged horizontally or vertically, depending on the facilities and the space available. If feasible, consider placing the circle that represents the Arctic to the north of the circle that represents the Antarctic. This can reinforce the physical locations of each polar region.

Ponder Answer

Examples of unlikely pairings of polar animals include penguins and polar bears, sled dogs and penguins, and penguins and walruses.

Sentences about Antarctica should emphasize that Antarctica is a continent located near Earth's South Pole.

Activity 1D Animal Insulation

Preparation for the Activity Session

You may want to provide additional insulating materials for testing, such as down, feathers, fake fur, or pieces of old jackets or other clothing.

Ponder Answer

Kids' descriptions will vary. They may suggest that animals go into the water, lie on the ice, or pant to cool down. Similarly, kids will have different reactions to the idea of SCUBA diving under Antarctica's ice.

Flexhibit Station Setup

This station requires a supply of extra ice to add to the container of ice water as it melts. One point is crucial to this station's success: be sure kids remove the gloves from the ice water when they are not being used. If the blubber becomes chilled, there will be no difference in the temperatures of the blubber and control gloves.

Unit 2 - Antarctica's Ice on the Move

This unit gives kids a chance to chill out with ice. They learn that solid ice flows downhill, carrying rocks with it. Antarctica has four major types of ice. These are **ice sheets** on land, **ice shelves** over ocean water, and floating **icebergs**—chunks of ice that broke free from ice shelves; **sea ice** is frozen ocean water.

Activity 2A Build a Model Glacier

Preparation for the Activity Session

Building a model glacier requires snow, shaved ice, or crushed ice. If you plan to use shaved ice, be sure to freeze water in the appropriate molds ahead of time. If you have a local shaved-ice retailer, consider asking them to donate ice for your activity or event.

Flexhibit Station Setup

Decide ahead of time if you will use the optional mountain landscape to demonstrate how glaciers can coalesce to form an ice sheet. If so, be sure that you have a way to contain the considerable amount of water the melting ice will produce.

Ponder Answer

Annual snow layers and tree rings are very similar. Each layer marks a single year. The thickness of the light-colored wood and the white portion of each layer of snow indicate something about the conditions during the year it was formed. In tree rings, the thicker layers indicate good conditions for growing, with plenty of access to water. In layers of snow, thicker layers indicate years with abundant snowfall. Annual snow layers also trap bubbles of air that serve as tiny samples of the atmosphere from the time that the snow fell.

Activity 2B When Ice Meets the Sea

Preparation for the Activity Session

Freezing the ice sheet with sediments in the bottom of it well in advance is necessary for this activity. Also, when you are ready to remove the ice sheet from the pan, it's important to dip the bottom of the pan in warm water just long enough to loosen the ice, but not so long that the sediments begin melting out.

Flexhibit Station Setup

Prepare several ice sheets ahead of time and keep them in a freezer or cooler for use at the Flexhibit. Making the ice sheets slightly thicker than the 1 cm suggested for the activity is one way to make the demonstration last longer.

Ponder Answer

Sediments at point A would be of all sizes and shapes. This is where they would initially melt out of the bottom of the ice sheet.

At point B, there would be fewer sediments because most of them melted out and dropped to the seafloor at point A. Some of the sediments that had piled up at point A may move downhill to form layers at point B.

Point C would have the fewest rocky sediments from the ice sheet. Plants or animals that live in the open ocean may die and accumulate on the seafloor at point C.

Unit 3 - Reading Antarctica's Rock Cores

Kids get to the core of the matter in this unit: they learn that scientists drill into the seafloor around Antarctica to retrieve rock cores. The scientists study the rocks to understand how Antarctica's climate and environment have changed over time.

Activity 3A Build a Model ANDRILL Site

Preparation for the Activity Session

Consider whether the kids you are working with can safely handle sawing through PVC and making holes through cardboard with scissors. If not, complete those steps yourself.

Flexhibit Station Setup

Set the drill model on the floor so people can reach it.

Ponder Answer

The scale of the model is inaccurate. Though the ice shelf and ocean water are proportional to their real-world thicknesses for drilling through an ice shelf, the diameter of the PVC pipe and the length of the rock cores are exaggerated.

Activity 3B Photo Sort: Core Flow

Preparation for the Activity Session

If you think your kids won't be able to resist looking at the descriptions before they sort the photos, you may want to cover the answers with sticky notes.

Flexhibit Station Setup

Lay the photos out on a table or countertop. Let kids decide if all, some, or none of the photos should be laid out in the proper sequence for visitors.

Ponder Answer

Though some of the photos show processes that overlap, the general sequence is listed below. Kids should tell their stories from the point of view of a rock core, generally following a sequence similar to the photos, beginning with step 3 or 4.

1. Tractor pulling containers
2. Pipes ready for drilling
3. Drilling montage
4. Delivering core from the drill rig
5. Washing the core
6. Hand-guided saw cutting core
7. Whole core scanning
8. Transporting the cores to McMurdo Station
9. Core curator splitting the core
10. Slabbed core under imager
11. Scientist pointing at core
12. Flags along core
13. Micropaleontology studies
14. Cutting the working half apart for samples
15. Petrologist examining core image
16. Hand drawing of clasts in core
17. Examining core material
18. Boxes of core halves packed for shipping

Activity 3C Mix Up a Model Rock Core

Preparation for the Activity Session

Plan to do this activity outdoors if possible, or in an area where spilled gravel, sand, and ice can be cleaned up without permanent damage. Part 1 takes about 20 minutes to mix the rocks and fill the tube, plus an hour or more of melting time. If possible, schedule your activities to do Part 1 during one activity session and finish Parts 2 and 3 during the following session.

Flexhibit Station Setup

If you have access to a ring stand (available in chemistry classrooms), you can use it to hold the core in a vertical position.

Ponder Answer

Student sketches should show the bottom layer of mixed sediments indicating an ice sheet, the layered rocks that indicate presence of an ice shelf, and the green diatomite, which indicates open marine conditions.

Taken together as one continuous story, the rock layers signify that an ice sheet existed and then shrank, ending with open ocean covering the area. Essentially, this is a story of a warming climate.

Any one of the three layers might be mentioned as the best model for the rock type it represents. The sediments mixed with the ice is a model for the bottom of an ice sheet, the spoonfuls of rocks settling through water represent material that flows downhill in underwater landslides, and the green sand grains suspended in water represent diatoms.

Activity 3D Mess-free Model Rock Cores

Preparation for the Activity Session

Cutting across and along poster tubes can be quite difficult. Consider completing this step in advance, giving yourself plenty of time to achieve good results.

Flexhibit Station Setup

These cores can lie on a table top. Presenters may want to lay them next to a diagram that describes the layers. Take the rubber band off at least one of the split cores so visitors can take the halves apart and fit them back together.

Ponder Answer

Splitting each meter of core into two pieces means that one half can be cut apart for samples and the other half will remain intact. If a scientist discovers something odd in the working half of the core, other scientists can examine the archived half of the core to confirm or deny those findings.

Using digital images of rock cores is more convenient than traveling to the archive facility to look at the actual cores. The digital images can also be enlarged to show details of the sediments that make up the rock layers. One disadvantage of examining images instead of the actual core is that scientists can't feel the texture of the rock or get a sample of it for testing.

Unit 4 - Tiny Clues to Antarctica's Past

In this unit, kids use beads and buttons to represent diatoms. Diatoms are microscopic algae that produce unique "skeletons" of their cell walls. Fossil diatoms found in rock cores provide clues about past environments.

Activity 4A Dead Diatoms Do Tell Tales!

Preparation for the Activity Session

Cutting the clear plastic tubes is not particularly difficult, but kids may not have the control to make the cuts straight. Consider whether your participants will be able to handle this task or if you should complete it for them.

Flexhibit Station Setup

Display the model cores, along with craft sticks for sampling and magnifying lenses or examining the samples. Include the chart for finding the names and environments indicated by the beads. Be ready to sweep up spilled sand and beads between visitors' turns with the materials. As possible, encourage your presenters to return samples taken by visitors to the same location where they came from along the core.

An Alternative Exhibit Idea

The sampling portion of this activity is designed as a realistic simulation of what micropaleontologists do. By conducting this activity in a controlled environment, kids can model the scientific process by finding and categorizing the model microfossils, including interpreting the environments indicated by their color and condition.

In the festive and faster-paced atmosphere of a Flexhbit, you may want to offer visitors the opportunity to search for larger, unbroken plastic beads of different colors and match them to a chart to find their names. Younger children are generally more interested in searching for and finding beads buried in sand than in focusing on the condition of the bead and what it says about the depositional environment. To offer this option at your Flexhibit, prepare a set of 6 to 10 core holders by cutting paper towel or bathroom tissue rolls in half and then covering them with foil. Use 4 different colors or shapes of plastic beads to represent the diatoms mentioned in the activity. Bury 4 or 5 of the beads in moist sand in each core holder, and prepare a chart of their names. After visitors have found the beads and moved on to the next station, put the beads and sand back into the core holder and pat the surface smooth so another visitor will be able to search for the beads.

Ponder Answer

Beginning at the bottom of the Core Log for Core 4, kids should describe the environments indicated by the sediments and model diatoms found in the core. The sequence will vary, but each of the three environments described for Cores 1, 2, and 3 in the "Check your core interpretation" section should be included.

Activity 4B Evidence of Ice-Free Seas

Preparation for the Activity Session

In order for the assortment of buttons used in this activity to be meaningful at all, be sure that your kids understand two things. First, that *Eucampia* diatoms grow longer chains when they receive sunlight, and second, that the ends of the chains are different from the middle forms. Plan to spend sufficient time on the Preview section; check that your participants can see the difference in the two sets of diatoms on page 160 and the similarities between the images at the bottoms of page 159 and page 161.

Flexhibit Station Setup

Set up the core and the *Eucampia* Index Chart beside it. Prepare a set of the toothpick flags for people to record the number of each type of diatom.

Ponder Answer

Storyboards or cartoon strips should show short *Eucampia* chains under sea ice and longer *Eucampia* chains in ice-free conditions. Kids might include diagrams like the ones in the middle of page 160. Sets of *Eucampia* diatoms with many more middle forms than end forms indicate relatively warm climates, when the sea was free of ice.

Unit 5 - Decoding Antarctica's Climate History

The BIG Idea for Unit 5

Antarctica's environmental changes are related to changes in its climate. Removal of ice shelves and melting of ice sheets in Antarctica would affect the entire globe by raising sea levels.

Activity 5A Charting Temperature Changes

Preparation for the Activity Session

Give sufficient time for reading and discussing the information in the Unit 5 Introduction. This section establishes that changes in Antarctica's climate are not the result of continental motion.

Flexhibit Station Setup

Place the PVC frame on a table where people can see and move the thermometer ribbons.

Ponder Answer

Descriptions should include mention of warmer and colder periods of different durations over the last 50 million years. The amount of ice on Antarctica would be lower during warm periods and higher during colder periods.

Activity 5B What If the Ice Shelves Melted?

Preparation for the Activity Session

Encourage kids to read the directions carefully and look at the pictures to understand that the foil wall goes around the **outer** edge of the continent, but on the **inner** edges of the ice shelves.

Flexhibit Station Setup

Kids may want to make photographs or diagrams showing the model before, during, and after the placement of the slime. This would allow visitors to visualize the various stages of the model without waiting for the slime to flow.

Ponder Answer

Sketches should show the slime piled on the continent before removal of the ice shelves, and flowing off the continent after the ice shelves are removed.

Activity 5C How Does Melting Ice Affect Sea Level?

Preparation for the Activity Session

Freeze several of the shallow blocks of ice ahead of time and store them in a plastic bag in a freezer. It is important to make sure that the ice blocks are all the same size. Adding a few small houses, such as the plastic hotels from a Monopoly® game, to the simulated land can help kids understand the effects of rising sea level.

Flexhibit Station Setup

Kids may want to make **Before** and **After** photos or drawings to share at the Flexhibit. The ice can melt very slowly, so if you have an extra set of containers, you could set up the station with one pair of containers with the ice and another pair showing the ice completely melted.

Ponder Answer

Rising sea level would gradually cover some of the beach and may eventually submerge the lower-lying buildings and roads. In some areas, seawalls or levees might be built to protect the property from the rising sea level.

As demonstrated in the activity, melting of sea ice would not affect sea level around the world, but it might have other effects on climate or wildlife.

The activity shows that the melting of large ice sheets would add water to the world's oceans, causing sea level to rise. Low-lying coastal areas would be most affected, with large areas of land being covered by the rising water.

National Standards

Activity Name	Standards Category	Standards Covered
1A Postcards from Antarctica	National Science Education Life Science Content Standards for Grades 5-8	Regulation of an organism's internal environment involves sensing the internal environment and changing physiologic activities to keep conditions within the range required to survive.
		An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species' evolutionary history.
		Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.
1B Antarctica in Maps	National Science Education Earth Science Content Standards for Grades 5-8	Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.
		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." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.
	National Geography Standards	THE WORLD IN SPATIAL TERMS: STANDARD 1: How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information.
1C Polar Opposites?	National Geography Standards	THE WORLD IN SPATIAL TERMS: STANDARD 2: How to use mental maps to organize information about people, places, and environments.
		PLACES AND REGIONS: STANDARD 5: That people create regions to interpret Earth's complexity.
		PHYSICAL SYSTEMS: STANDARD 8: The characteristics and spatial distribution of ecosystems on Earth's surface.

Activity Name	Standards Category	Standards Covered
1D Animal Insulation	National Science Education Life Science Content Standards for Grades 5-8	Regulation of an organism's internal environment involves sensing the internal environment and changing physiologic activities to keep conditions within the range required to survive. Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.
2A Build a Model Glacier	National Science Education Earth Science Content Standards for Grades 5-8	Water, which covers the majority of Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.
2B When Ice Meets the Sea	National Science Education Earth Science Content Standards for Grades 5-8	Water, which covers the majority of Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.
		Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.
		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. Earth history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.

Activity Name	Standards Category	Standards Covered
3A Build a Model ANDRILL Site	National Science Education Standards: Science as Inquiry	Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models.
	National Science Education Standards: Science and Technology	Evaluate completed technological designs or products. Students should use criteria relevant to the original purpose or need, consider a variety of factors that might affect acceptability and suitability for intended users or beneficiaries, and develop measures of quality with respect to such criteria and factors; they should also suggest improvements and, for their own products, try proposed modifications.
		Communicate the process of technological design. Students should review and describe any completed piece of work and identify the stages of problem identification, solution design, implementation and evaluation.
		Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as quantity, distance, location, size and speed. Technology also provides tools for investigations, inquiry, and analysis.
	National Science Education Earth Science Content Standards for Grades 5-8	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. Earth history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.
3B Photo Sort: Core Flow	National Science Education Standards: History and Nature of Science	Women and men of various social and ethnic backgrounds — and with diverse interests, talents, qualities, and motivations — engage in the activities of science, engineering, and related fields such as the health professions. Some scientists work in teams, and some work alone, but all communicate extensively with others.
	National Science Education Standards: Science and Technology in Society	Scientists and engineers work in many different settings, including colleges and universities, businesses and industries, specific research institutes, and government agencies.

Activity Name	Standards Category	Standards Covered
3C Mix Up a Model Rock Core	National Science Education Earth Science Content Standards for Grades 5-8	Living organisms have played many roles in the earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.
		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. Earth history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.
3D Mess-free Model Rock Cores	National Science Education Earth Science Content Standards for Grades 5-8	Living organisms have played many roles in the Earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.
4A Dead Diatoms Do Tell Tales!	National Science Education Earth Science Content Standards for Grades 5-8	Fossils provide important evidence of how life and environmental conditions have changed.
		Living organisms have played many roles in the earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.
4B Evidence of Ice-Free Seas	National Science Education Earth Science Content Standards for Grades 5-8	Fossils provide important evidence of how life and environmental conditions have changed.
5A Charting Temperature Changes	National Science Education Standards: Science as Inquiry	Develop descriptions, explanations, predictions, and models using evidence. Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description — providing causes for effects and establishing relationships based on evidence and logical argument.
5B What If the Ice Shelves Melted?	National Science Education Earth Science Content Standards for Grades 5-8	Water, which covers the majority of Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.
5C How Does Melting Ice Affect Sea Level?	National Science Education Earth Science Content Standards for Grades 5-8	Water, which covers the majority of Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.

Activity Name	Standards Category	Standards Covered
Presenting at any Flexhibit station or event	National Science Education Standards: Science as Inquiry	Communicate scientific procedures and explanations. With practice, students should become competent at communicating experimental methods, following instructions, describing observations, summarizing the results of other groups, and telling other students about investigations and explanations.

Glossary of Terms

ANDRILL
Antarctic geology drilling project. An international scientific research project to recover sedimentary rock cores from the margins of Antarctica

ANDRILLian
A scientist, driller, technician, or educator who works on the ANDRILL project

annual
Once every year

Antarctic
The region from 66.6 degrees south to the South Pole

Antarctic Circumpolar Current
Ocean current of water moving in a clockwise direction around Antarctica

archive
Collection of records

archive half
Half-cylinder of rock core stored away for future use

Arctic
The region from 66.6 degrees north to the North Pole

Arctos
A constellation of stars located above the North Pole

atmosphere
Gases that surround Earth

aurora
Displays of light in the night sky, often seen in polar regions. Auroras are generated by interactions of charged particles from the sun with Earth's magnetic field.

carbon dioxide
Gaseous molecule in Earth's atmosphere consisting of one carbon and two oxygen atoms. Carbon dioxide is largely responsible for Earth's greenhouse effect. Measurements that began in 1960 show that the amount of carbon dioxide in Earth's atmosphere has been increasing over time.

Chaetoceros
A kind of diatom that lives in open marine conditions around Antarctica

circumpolar
Around Earth's polar regions

climate
Long-term conditions of temperature and precipitation

CO_2
Carbon dioxide

contour
An outline showing the points of equal elevation of land or ice

core
Cylinder-shaped material produced by a hollow drill

cryosphere
Earth's ice

decode
Analyze and interpret; make sense of

diamictite
Rock type with mixed grain sizes. Usually deposited by ice sheets

diatom
Single-celled microscopic algae that produce intricately patterned cell walls of silica

diatomite
Rock type that contains a high percentage of diatoms

ECW gear
Extreme Cold Weather clothing including parka, wind pants, boots, long underwear, hats, and gloves. Issued on loan to everyone who works in Antarctica.

elevation
Height above sea level

environment
Main conditions of an area, including climate and landcover

Eucampia antarctica
A species of diatom in which individuals grow in a chain. These diatoms live in ocean water and under sea ice around Antarctica.

Eucampia index
A unitless measurement comparing the number of middle forms of *Eucampia antarctica* diatoms to the number of end forms.

evidence
Facts or information used to support a theory

Flexhibit
A flexible exhibit event in which presenters share demonstrations and information with visitors

fossil
A sign or trace of ancient life

Fragilariopsis curta
A kind of diatom that lives in sea ice around Antarctica

Fragilariopsis species
A kind of diatom that lives in open marine conditions around Antarctica

friction
Force of resistance to moving one surface over another

geochronologists
Scientists who gather evidence to learn the timing of geologic events

geology
Study of Earth, especially its solid structure

geosphere
Solid structure of Earth including the core, mantle, and crust

glacier
Snow that has accumulated to the point that individual snowflakes are compressed into solid ice. The weight of overlying snow results in the ice moving downhill under the force of gravity

Gondwana
Southern super-continent that existed from 180 to 120 million years ago. Africa, South America, Australia, India, and Antarctica were all connected at a location near the South Pole.

happy camper school
Snowcraft 1; a two-day course to prepare Antarctic workers for survival in extremely cold conditions

hydrosphere
Earth's waters

ice sheet
A mass of glacial ice that covers an area greater than 50,000 km^2

ice shelf
Platform of glacial ice that forms where an ice sheet flows off a continent and floats on the ocean surface

iceberg
Floating chunk of ice that breaks off an ice shelf

igneous
Rocks that formed by cooling and solidifying from hot melted rock

krill
Small shrimp-like animals that live in the ocean around Antarctica

layered rocks
Rocks that show a series of flat or tilted beds, often distinguished by the gradual change from larger to smaller grains

lengthwise
Along the long axis

marine
Having to do with the ocean

mattracks
Tank-like treads that bolt on to vehicles in place of ordinary wheels

metamorphic
Rocks that have been changed by heat and pressure

micropaleontologist
Scientist who studies microscopic fossils

model
A physical or conceptual representation of an object or process

ozone
Gaseous molecule in Earth's atmosphere consisting of three oxygen atoms. Ozone in Earth's upper atmosphere blocks ultraviolet wavelengths of light from reaching Earth's surface.

ozone hole
Area where the concentration of ozone in Earth's upper atmosphere is less than 300 Dobson units

paleontologist
Scientist who studies fossils

photosynthesis
Process by which plants make food using energy from sunlight plus water and carbon dioxide

plate tectonics
Theory that Earth's surface is composed of rigid pieces that move relative to one another

polar
Directly opposite in character or location

pressure ridge
In map view, a line of sea ice that is pushed upward as an ice shelf presses against it horizontally

relative
Compared to

sea ice
Ice that forms on the surface of the ocean

sea level
Global average height of the sea

sedimentary
Rocks formed from pieces of other rocks

sediments
Pieces of rock material produced by weathering and erosion

simulate
Imitate the appearance or character of something

technician
Person who takes care of technical equipment or performs practical work in a laboratory

Thalassiosira
A kind of diatom that lived in open marine conditions around Antarctica

Transantarctic Mountains
Linear chain of mountains that crosses most of the continent of Antarctica, separating it into East and West Antarctica

variation
A change in condition

Venn diagram
A diagram with two or more overlapping circles to show sets of objects based on their differences and similarities

volcanic ash
Molten lava that solidifies into very small pieces of rock during eruption of a volcano

West Antarctic Ice Sheet (W.A.I.S)
Ice sheet that covers West Antarctica. The WAIS is a marine-based ice sheet whose base is below sea level; its edges flow into floating ice shelves

working half
Half-cylinder of rock core that is sampled by scientists