Unit 3. Antarctic Oceanography

Lesson 1. – Overview and Research Stations

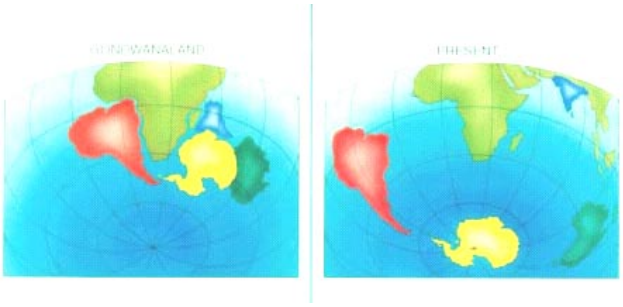
Lesson Objectives:

- Introduces the continent of Antarctica and the oceans that surround it
- The student will learn about the geography, history and climate.
- The second section of this chapter discusses research stations and the scientists who live on the frozen continent.

Antarctica is a continent located at the southern-most point of the globe. Millions of years ago, this landmass was attached to a giant landmass that consisted of modern-day South America, India and Africa. Powerful underground forces ripped a large piece of land from this giant landmass, which then drifted to its current position at the bottom of the globe. It is surrounded on all sides by the Indian, Pacific and Atlantic Oceans.

Antarctica's cold, thick hard

covering, called an **ice sheet,** began to decrease as one moves from the coastal form 25 million years ago. The ice in Antarctica locks up more than two-thirds of the planet's fresh water. If the Antarctic ice were to melt, the sea would rise almost 200 feet. It is the only



continent that man had left

untouched for millions of years.

Antarctica is considered the coldest and driest continent on earth. Temperatures regions inland. Temperatures during the long, dark winters

range from –4° F to –22° F on the coast, -40° F to –90° F inland. During the summers, coastal temperatures average 32° F (occasionally climbing to 50° F), while the inland summer temperatures range from –4° F to –31° F. The lowest temperature recorded in Antarctic history was in 1983, a chilling -129° F. This is colder than the surface of Mars. When water was thrown into the air, it froze before it hit the ground.

Antarctica receives less snow than you may think. Actually, it only snows an average of 10" per year on the coast, and less than 2" inland. Because it is so cold, the snow never melts.

Blizzards are produced not by falling snow, but when high winds (100- 200mph) blow ground snow around, creating blinding conditions and snowdrifts that can cover local research stations in an hour.

The snowfall has accumulated over several million years to make Antarctica's average elevation 2.5 miles above sea level, making it the highest continent. But in a sense, it is also the lowest continent: the landmass itself, because of the weight of all that snow, has been pushed down so heavily that some parts of the continent are actually under sea level.

History

Aristotle, an ancient Greek philosopher, believed that if the world was round, then there *must* be a continent at the bottom of the globe holding all the other continents in place. He named the continent *Antarktikos,* meaning "anti-Arctic". Most believe that the first man to sight Antarctica (in 1820) was Fabian von Bellingshausen, a Russian explorer. Others believe it to be a British seaman named Edward Bransfield. Captain John Davis, a US sealer, was the first to set foot on the continent. James Weddell, an English sealer, had both a seal and a sea named after him because of his discovery of an unknown seal.

In 1911-1912, the first men to reach the South Pole were two teams led by Ronald Amundsen from Norway and Robert F. Scott from Great Britain. Scott made it to the South Pole 10 days after

Amundsen, who had left his country's flag at 0^{o} to let Scott know he had made it first. Amundsen left supplies behind for Scott, but because of poor preparation on their part, Scott and his team perished from cold and starvation on the way back to their camp.

Research Stations

Having been isolated for so long, Antarctica provides numerous opportunities for scientists to conduct research. By the mid 1950s, seven countries had claimed territories of Antarctica as their own, establishing year-round research stations there. Soon five more nations were expressing an interest in the continent for research purposes. An 18-month period from 1956-57 was declared the **International Geophysical Year (IGY).** These twelve countries came together in the interests of science and discussed how they could help each other in terms of locating and building research bases, setting up communication systems, launching rescue

operations and sharing weather reports. They, and eventually 45 more nations, spent the IGY cooperating with each other on various scientific and research projects. This period of harmony led to the signing of the **Antarctic Treaty** in 1959, declaring Antarctica as a research preserve. This treaty took effect in 1961, and since then, many other countries have agreed to it. The preamble to the Antarctic Treaty clearly sets forth its purpose:

*Recognizing that it is in the interest 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; …the establishment of a firm foundation for the continuation and development of such cooperation on the basis of freedom, of scientific investigation in Antarctica as applied during the **IGY** accords with the interest of science and the progress of all mankind…."*

The treaty states that Antarctica will remain open for research for any scientists from nations who agree to the treaty. It also calls for a ban on military and weapons (including nuclear) testing; international cooperation and freedom of scientific investigation; and free exchange of science program plans, results and personnel. This treaty guarantees that no country's claim on any territory will ever be acknowledged by the other parties. Any disputes are to be settled by the International Court of Justice. The Treaty was re-examined in 1991, 30 years after signing, and re-affirmed.

Some of the modern research stations, especially the larger ones, are like small towns. McMurdo Station, the principal U.S. facility, on Ross Island, coast of Antarctica (peak summer population capacity 1,258; 1996 winter, 232**)** is Antarctica's largest station, it has airports and a seaport, research laboratories and support facilities.

McMurdo is built on the bare volcanic rock of Hut Point Peninsula on Ross Island, the most southerly solid ground that is accessible by ship. It is located just 20 miles south of Mt. Erebus, an active volcano that steams continually and erupts frequently though not violently.

Heat and lighting is provided by small power plants. The buildings must be designed to withstand blizzards, and due to the dry conditions, fire remains a major threat. The base is run by an administrative director, who is not necessarily a scientist. The base requires personnel to perform a myriad of tasks: cooks, bulldozer

operators, pilots, mechanics, communication specialists. Some bases even have chaplains to help those on the base deal with the isolation and the cramped living conditions.

Although nations build their own bases, it is not unusual to have scientists from many nations working together on research projects at one base. There are 40-50 research stations in Antarctica, and more than 50,000 people from many different countries work on these bases.

One of the problems created by the research stations is the accumulation of trash. Garbage does not break down or biodegrade in the frigid climate. Piles of trash that accumulated over the decades of research, including thousands of oil barrels and broken or abandoned machinery, littered the landscape. Recently, the US and other nations have started cleanup procedures and now transport trash from the continent back to their countries.

The Oceans that Surround Antarctica

Antarctica is surrounded on all sides by water; the Atlantic, Pacific and Indian Oceans all meet at Antarctica. The three oceans are collectively called the Southern Ocean. This is the area located south of 50° latitude.

The Antarctic Divergence

The East Wind Drift drives the waters closest to Antarctica**,** which move in a westerly direction around the continent. Further out from the continent the waters are driven by westerly winds called the **West Wind Drift***.* These westerly winds remain strong through out most of the year.

In the Southern Hemisphere, the Coriolis Effect deflects moving masses to the left. The inner **East Wind Drift** moves toward the continent while the outer **West Wind Drift** moves away from the continent. This creates an area of divergence called the **Antarctic Divergence**.

The Antarctic Convergence

The **Antarctic Convergence** is the irregular ocean zone that surrounds Antarctica. It is where warm deep water from the northern oceans collide with colder surface water from the Southern Ocean and the colder bottom water. Because the colder water is saltier, and therefore more dense, it flows beneath the warmer water. This convergence brings the rich nutrients from the warmer waters into the cold water of the Southern Ocean.

These nutrients are necessary for **photosynthesis** and create the perfect environment for **zooplankton** and **phytoplankton** to thrive. Because plankton is so abundant, they form the foundation of the food web. A small shrimp-like creature called **krill** feeds on the plankton.

Krill

Krill is a general term used to describe about 85 species of crustaceans found in open oceans. They belong to the group of crustaceans called *euphausiids* and look like smaller versions of familiar crustaceans such as prawns or lobsters. They range in size from small tropical species of less than a centimeter in length to little known deep-sea giants that can reach 14 centimeters. Krill usually feed on the surface of the water at night and often sink deeper in the water column in the daytime.

The primary food of krill is phytoplankton, which are microscopic ocean plants suspended in the upper water column where light is sufficient to allow for growth. Most of the Antarctic creatures, everything from penguins to whales, feed on krill. Without it, the ecosystem would collapse.

Activity 1-1. Classroom Discussion Questions

1. Would you consider Antarctica a dry or moist continent? (Antarctica is considered the coldest and driest continent on earth. Antarctica receives less snow than you may think. Actually, it only snows an average of 10" per year on the coast, and less than 2" inland. Because it is so cold, the snow never melts.)
2. What types of changes would Global Warming have on the food chain?
3. If you were to follow the Scott or Amundsen path to the South Pole what type of personnel would you want to accompany you through Antarctica? (Ex. Doctor, trained climber)
4. What is the Antarctic Convergence? (The **Antarctic Convergence** is the irregular ocean zone that surrounds Antarctica. It is where warm deep water from the northern oceans collide with colder surface water from the Southern Ocean and the colder bottom water.)
5. If you were to follow Scott or Amundsen path to the South Pole what type of personnel would you want to accompany you through Antarctica? (Ex. Doctor, who else)

Activities 1-2. Interaction of Sea Ice and Water

1. Start with a bowl of water, put several ice cubes in the water.
2. You will notice that most of the ice is under the surface of the water.
3. Icebergs float the same way, with only a small part of the ice showing.

Activity 1-3. Sea Ice and Its Effects on Water Temperature

1. Mix water with blue food coloring.
2. Pour it into an ice cube tray and freeze.
3. Fill a glass bowl full of cold tap water.
4. Place an indoor/outdoor thermometer under water on the bottom of the container wait five minutes.
5. Write down the temperature.
6. Once the cubes are frozen put them in the water.
7. Take the temperature of the water.

- What evidence do you see that the ice is interacting with the water?
- Has the temperature of the water changed since the ice cubes have been added?
- What is the difference between the first and the second temperature readings?

Activity 1-4. Join Admunsen and his Team on a South Pole Expedition

Write a short essay on one of the following:

- Imagine you were part of the expedition to the South Pole with Robert F. Scott. What would you have done differently?

- Imagine you are part of a modern day expedition to the South Pole following the same route as Amundsen (on skis). What supplies would you take with you? Write a list of things that you would want to carry in your backpack. Where do you suppose you will get fresh water to drink? What types of people would you want to be with you on your expedition? (example: medical doctor, survivalist)

Activity 1-5. Help Eliminate Dangerous Icebergs

Source: ©Markle, Sandra. *Pioneering Frozen Worlds.* Atheneum Books for Young Readers: New York, 1996.

Student Question: Is there something that could be done to eliminate dangerous icebergs?

Before you tackle this problem it will help you to know more about what effects how quickly an iceberg breaks down, these activities will let you find out.

1. First collect two identical glasses.
2. Fill one with hot tap water and one with cold tap water.
3. Place an ice cube in each glass.
4. Use a watch with a second hand to time how long it takes ice to melt in hot water and in cold water.
5. Repeat the test two more times and compute the average of the results.

- Based on this test do you think that water temperature affects how quickly icebergs break down?

6. Next collect two sandwich size self sealing plastic bags.
7. Fill each bags half full of cold tap water.
8. Put three ice cubes in each bags and seal.
9. Set one bag in the sink.
10. Hold the other bag and shake for 30 seconds.
11. Then, compare the size of the ice cubes in each bag.

- The ones in the bag you shook should look noticeably smaller. If not shake for 30 seconds more.
- Based on the activity how do you think wave action affects how quickly icebergs break down?

- Now use what you have discovered while you were investigating to come up with a plan that might help the International Ice Patrol deal with potentially dangerous icebergs.

- Brainstorm for 10 minutes listing all the ideas you can think of, Evaluate your ideas considering what if anything will keep you plan from working.
- Write a description of your plan, list any special equipment that would be needed. If the equipment does not yet exist draw a diagram of it and briefly tell how it would work.

Activity 1-6. Classroom Discussion Part II.

Compare a map of Antarctica and the Arctic Circle. Make a list of the differences and similarities of these two areas.

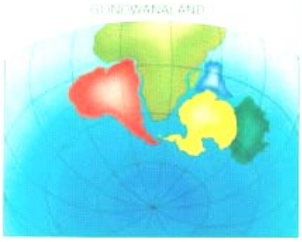
Why are the polar lands sometimes called the high latitude lands?

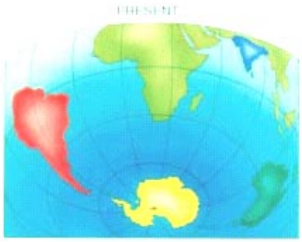
Use an atlas to find out the latitude of the Antarctic Circle. What is the latitude of the South Pole?

If the nations of the world decided to allow no more developments (mining, industrial etc.) in one of the Polar Regions, which one should it be and why? What would be the benefits of that decision?

Student Information Sheet: Antarctica Oceanography I: Overview and Research Stations

Antarctica is a continent located at the southern-most point of the globe. Millions of years ago, this landmass was attached to a giant landmass that consisted of modern-day South America, India and Africa. Powerful underground forces ripped a large piece of land from this giant landmass, which then drifted to its current position at the bottom of the globe. The Indian, Pacific and Atlantic Oceans surround it on all sides. Antarctica is surrounded on all sides by water; the Atlantic, Pacific and Indian Oceans all meet at Antarctica. The three oceans are collectively called the Southern Ocean. This is the area located south of 50° latitude.





Antarctica's cold, thick hard

covering, called an **ice sheet,** began to form 25 million years ago. The ice in Antarctica locks up more than two-thirds of the planet's fresh water. It is the only continent that man had left untouched for millions of years.

Antarctica is considered the coldest and driest continent on earth. Temperatures decrease as one moves from the coastal regions inland. Temperatures during the long, dark winters

range from –4° F to –22° F on the coast, -40° F to –90° F inland. During the summers, coastal temperatures average 32° F (occasionally climbing to 50° F), while the inland summer temperatures range from –4° F to –31° F.

History

History: Aristotle, an ancient Greek philosopher, believed that if the world was round, then there *must* be a continent at the bottom of the globe holding all the other continents in place. He named the continent *Antarktikos,* meaning "anti-Arctic".

Captain John Davis, a US sealer, was the first to set foot on the continent. James Weddell, an English sealer, had both a seal and a sea named after him because of his discovery of an unknown seal.

In 1911-12, the first men to reach the South Pole were two teams led by Ronald Amundsen from Norway and Robert F. Scott from Great Britain. Scott made it to the South Pole 10 days after Amundsen. But because of poor preparation on their part, Scott and his team perished from cold and starvation on the way back to their camp.

Research Stations

McMurdo Station, the principal U.S. facility, on Ross Island, coast of Antarctica (peak summer population capacity 1,258; 1996 winter, 232**)** is Antarctica's largest station, it has airports and a seaport, research laboratories and support facilities

.

The Antarctic Divergence

The waters closest to Antarctica are driven by the **East Wind Drift,** which move in a westerly direction around the continent. Further out from the continent the waters are driven by westerly winds called the **West Wind Drift**. These westerly winds remain strong through out most of the year.

In the Southern Hemisphere, the Coriolis Effect deflects moving masses to the left. The inner **East Wind Drift** moves toward the continent while the outer **West Wind Drift** moves away from the continent. This creates an area of divergence called the **Antarctic Divergence**.

The Antarctic Convergence

The **Antarctic Convergence** is the irregular ocean zone that surrounds Antarctica. It is where warm deep water from the northern oceans collide with colder surface water from the Southern Ocean and the colder bottom water. Because the colder water is saltier, and therefore more dense, it flows beneath the warmer water. This convergence brings the rich nutrients from the warmer waters into the cold water of the Southern Ocean.

Krill

Krill is a general term used to describe about 85 species of crustaceans found in open oceans. They belong to the group of crustaceans called *euphausiids* and look like smaller versions of familiar crustaceans such as prawns or lobsters.