Lesson 2. Antarctic Oceanography: Component I - Ice/Glaciers Component II - Marine Snow

Lesson Objectives:

- Introduces students to the different kinds of ice found in Antarctica,
- Students will become familiar with ice sheets, icebergs and glaciers.
- Marine snow is found in the oceans surround Antarctica. We will discuss what it is and what function it serves to our oceans.

Component I - Ice/Glaciers

Antarctica's cold, thick hard covering, called an **ice sheet,** began to form 25 million years ago. Approximately 98% of Antarctica is covered by ice. Antarctica actually changes size – during the summer months (October-March), the coastal ice melts and Antarctica "shrinks."

Although almost all of Antarctica's land mass is covered by ice, in a few places on the continent, mountain peaks poke through. The **Transantarctic Mountains** divide the areas of the continent known as West and East Antarctica.

A **glacier** is a huge mass of ice, formed from compacted snow, whose sides are often bounded by mountains or the walls of a valley. Ice sheets, or caps, which are also formed from compacted snow, are so massive that they cover entire landscapes, mountains as well as valleys. Glaciers and ice sheets flow slowly toward the sea where the temperature is slightly warmer. This causes chunks of ice to break off; since ice is lighter than water, it floats when it reaches the sea. Once these chunks of ice are free-floating, they are called **icebergs**. The process of "birthing" an iceberg is called **calving**. Only about one-tenth of the iceberg is visible above water. The largest iceberg ever recorded measured 200 miles by 60 miles.

Parts of the West Antarctic ice sheet rest on the sea floor and land. Scientists carefully monitor it to see whether it will be affected by global warming. If the temperature rises, large parts of the **ice sheet** will melt and float freely. As they float, these ice sheets will move are less stable than the ice on

toward a warmer climate and begin to melt, leading to a sharp increase in sea level which would cause severe flooding on a global scale.

Component II - Marine Snow

Marine snow is the debris or dust that falls through the oceans and settles on the sea floor, the same way as dust in the air settles on an object in your home. The difference is that this ocean dust is full of nutrients and life. Marine snow helps transport material from the surface ocean to the deeper layers of the sea. Scientists believe marine snow is a major food source for life in the abyssal deep, bringing important nutrients into the deep sea while carrying with it diverse populations of microorganisms. This marine snow consists of bits of dead animals and plants bound together by mucus, which is produced by the ocean dwellers. The mucus glues together scraps of crustacean shells, remnants of plants and excrement of animals. The particles are all different shapes and denser than the surrounding ocean, but have many cavities. While the particles have to be at least **one-half millimeter** in diameter to be considered snow, they can grow to be quite large, on the order of **feet**, but the are rare. Most marine snow in the ocean is 1-2mm in size.
Marine snow plays an important ecological role by moving atmospheric carbon from the surface of the oceans to the seafloor. This can affect the climate over thousands of years by removing carbon from the atmosphere and transporting it to the deep sea. Atmospheric carbon dioxide dissolves in the ocean water, and algae take up the gas as they photosynthesize, converting the atmospheric carbon into plant carbon as the algae grow. The algae contribute to the formation of the debris that

sinks through the ocean in marine snow. Some small percentage of the total carbon remains at the bottom of the ocean as marine snow and is largely consumed by benthic (bottom dwelling) organisms. This percentage can be as high as ten percent of the total carbon in coastal waters and less than one percent in the deep oceans.

Sinking marine snow in the Antarctic is primarily made up of algae and so it is an important source of organic carbon and silica to the deep Antarctic waters and the sediments. The silica is contained in the tiny algal cell skeletons that are of intricate shape and design. There is a very short season between approximately late November and February in the Antarctic (called the "**austral spring** and **summer**") when every year algae grow very rapidly due to the high amount of sunlight at this time and the supply of important nutrients from upwelling deeper waters. During this time of rapid algal growth, which we call a "bloom", large amounts of marine snow containing algae are formed and sink rapidly through the ocean. In addition, abundant krill feeding on the blooming algae produce lots and lots of fecal pellets that sink to the deep-sea. This process of marine snow and krill fecal pellets settling into the deep Antarctic over millions of years has transported huge amounts of algal materials to the Antarctic sediments. The result is that these sediments contain the world's largest amounts of algal skeletons made of silica.

Geological oceanographers who study ocean sediments, study the Antarctic sediments and the algal skeletons in sediment cores they obtain from the seafloor. The cores are often many, many feet long, and are collected with special equipment on oceanographic research vessels. Sediments and algae in the cores which have been deposited over millions and millions of years are used by scientists to look at how the algae populations have changed through time. Such changes are usually the result of changes in the ocean environment where the algae lived and are caused by climate variations affecting the water temperature, circulation patterns, and nutrient levels.

The Greenhouse Effect

The greenhouse effect is a condition that causes the average global temperature to rise over a period of time. Carbon dioxide and methane, two gases in the atmosphere, absorb heat as it radiates from the Earth's surface. They act like the glass in the greenhouse, not allowing the outgoing heat to radiate back out into space, thus the term "greenhouse effect". With modern industry, we have put new greenhouse gases into the atmosphere, nitrous oxide and chlorofluorocarbon. These gases come from sources such as car exhaust and aerosol sprays. As the amount of greenhouse gas increases, the Earth's temperature will rise. If that happens, some polar ice can melt and there will be a rise in sea level, flooding coastal areas and cities. Another effect is a change in weather patterns.

The increase in CFC's in the air also causes a thinning of the ozone layer in the air. This ultimately affects marine life in Antarctica. With less ozone in the atmosphere, more ultraviolet radiation reaches the Earth. Higher ultraviolet may have damaging effects on the ability of phytoplankton to grow in the Antarctic surface waters. If so, there may be less food (algea) for the krill to feed on. Less food for the krill means less krill; less krill means that the Antarctic animals that feed on and survive on krill will suffer. Because it is so cold in Antarctica, the ozone thins out even more than elsewhere on the globe.

Activity 2-1 Classroom Discussion

1. Describe the experience of Calving by imagining what you would see, hear and feel.
2. What effect would Polar melting have on other continents? (If the Antarctic ice were to melt, the sea would rise almost 200 feet.)
3. For what reasons would Amundsen leave his supplies at the South Pole for Scott?
4. Is Marine Snow really "snow"? (No. **Marine snow** is the debris or dust that falls through the oceans and settles on the sea floor. Marine snow helps transport material from the surface ocean to the deeper layers of the sea.)

Student Information Sheet 2.
Antarctica II:
Component I Ice/Glaciers
Component II Marine Snow

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