Did You Know ?

1. Adélie Penguins have lived in the northern part of the Antarctic Peninsula for only the last several hundred years.
2. Adélie Penguins lived at Beaufort Island both before and after the last Ice Age (34 000 to 12 000 years ago).
3. There were more Adélie Penguin colonies in the Ross Sea region 3 000 to 4 000 years ago than there are now.

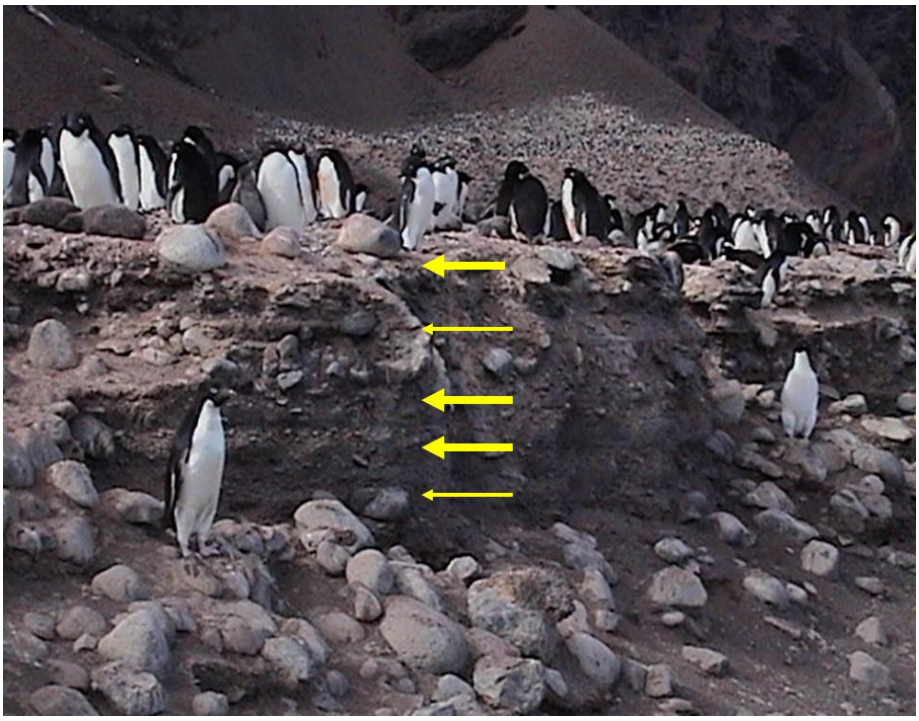
The History of Penguin Colonies

Adélie Penguins have not always lived in the colonies where they live now. Some colonies have had penguins for thousands of years, others for only 100's and some are only just beginning. Some colonies that used to have penguins don't anymore. Scientists look for reasons why Adélie Penguins would leave a nesting colony to find another to live in. Is there a pattern? What factors are involved? Adélie Penguins require snow- and ice-free land but a certain amount of sea ice in their marine habitat (similar to song birds needing trees). Researchers looked at the changing climate of Earth to see if that would give them a clue. Warmer climate means less or no sea ice, cooler climate means more sea ice. Do Adélie nesting colonies follow sea ice patterns?

A penguin mummy, perhaps several hundred years old, AT LEAST! It has lost the skin on its exposed side due to being sandblasted by countless wind storms.

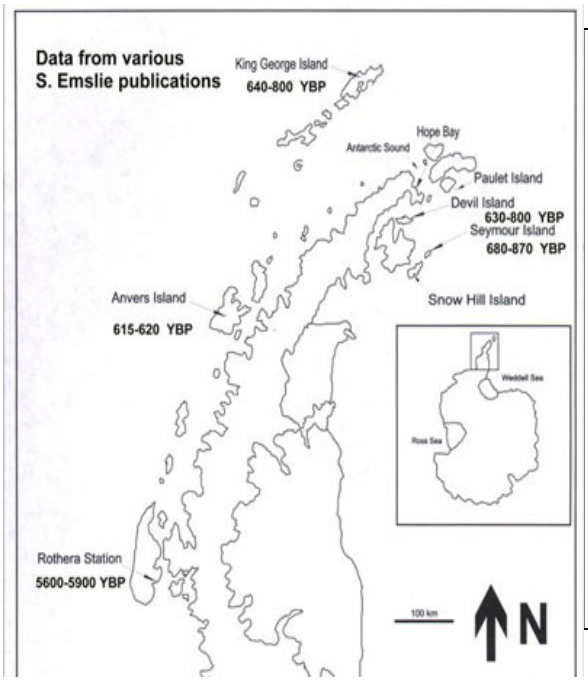
There are many penguin mummies and old bones in the Antarctic because it is so very cold and dry. Any dead thing becomes freeze-dried. Penguin eggs, chicks and adults that die do not disappear as they would in warmer parts of Earth. These mummies remain in place for many centuries.

Where ever penguins nest, they leave a deposit of guano. The guano gets mixed with eggshells and the remains of dead chicks and adults, and over the years, this layer gets thicker and thicker. If the penguins leave a breeding site for a century or more, their guano deposit will be covered by rocks brought by gravity and streams from higher elevations. This forms layers of rock debris in between layers of penguin debris. How long ago the penguins were actively nesting at each layer can be determined if eggs or bones are found through a process called carbon-dating.

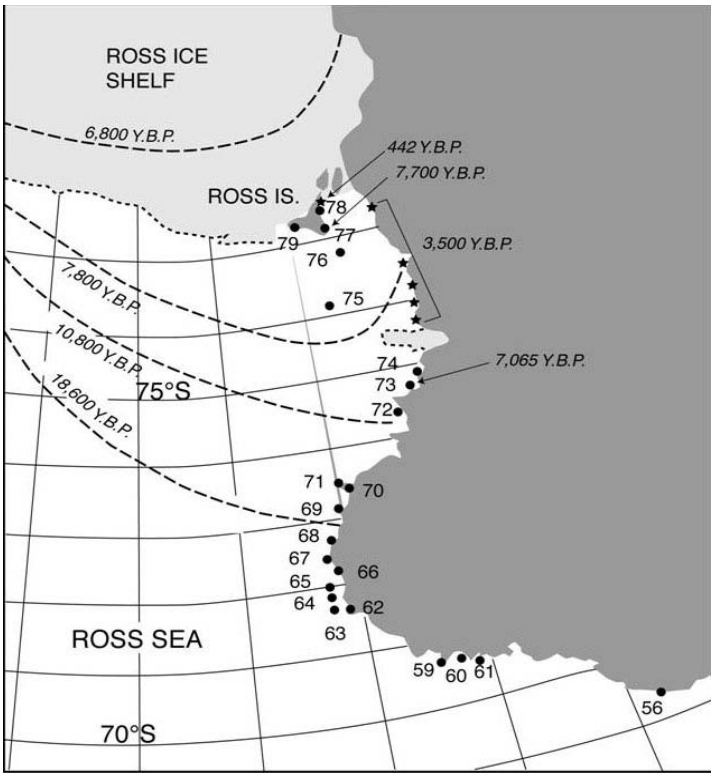


This section of the ground beneath a penguin colony at Beaufort Island has been cut away by ocean wave action. The arrows point to layers of guano and small (nest-stone sized) rocks separated by layers of larger, rounded (eroded by water) boulders. If bones are found in the guano layers, they can be used to determine the date when the penguins were present. In this case, at Beaufort Island, the lowest layers could well have been deposited before the last Ice Age, more than 34 000 years ago. The layers at the bottom are the oldest.

Carbon (C) is the main ingredient of all organic matter on Earth, and is also common in the atmosphere (as carbon dioxide). It comes in several forms depending on the composition of its nucleus. One form of carbon, carbon-14, decomposes to another form of carbon, C-12, over time. We know the rate of this change. For example, if we have 10 atoms of C-14, we know how long it will take before we have 8 atoms of C-14 and 2 atoms of C-12. When ocean phytoplankton (microscopic plants) used those 10 C-14 atoms centuries ago to make more phytoplankton, the krill ate the phytoplankton, and then the penguins ate the krill. In the process, those 10 C-14 atoms became incorporated into the penguins' tissues. Then the penguin died, no more C was incorporated, and the C-14 began to slowly change (no new C-14 was added). When we find the penguins' bones 2000 years later, we count the ratio of C-12 to C-14 atoms (using a fancy machine, a mass-spectrometer), and estimate how long it has been since the penguin was living. We use this information to know the date when the penguin lived and the guano layer was deposited. By dating bones in layers of rock/guano debris at ancient penguin colonies, as well as seashells left on ancient beaches, scientists have learned how long it has taken the West Antarctic Ice Sheet (continental glacier) to retreat since the last Ice Age.

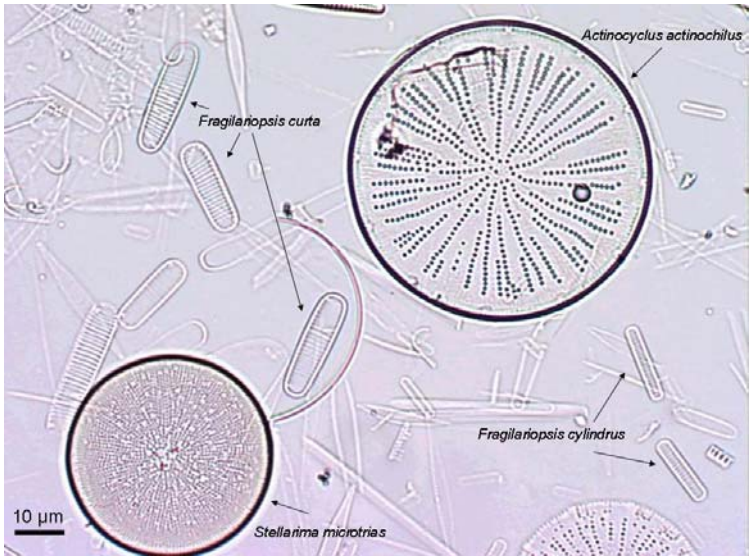


Map of Antarctic Peninsula showing the dates (years before present, YBP) when Adelie Penguins founded currently existing colonies: the bones at the lowest layers of guano underneath the penguins now present were deposited at the dates shown.



Here you see a map of part of Antarctica, with penguin colonies numbered (number 76 is Beaufort Island). The dotted lines show where the edge of the glacier was at various times since the middle of the last Ice Age. The Ice Sheet was at its maximum 18 600 years ago. There were no penguins at sites 69-79 during that time. The penguins colonized sites along the coast as the Ice Sheet retreated southward to its present position reached about 6 800 years ago. The youngest colonies are numbered 78 and 79.

The Adélie Penguin colonies in the northern part of the Antarctic Peninsula are relatively young as penguin colonies go. The colony at Rothera Station has been there for 5900 years because the land became ice free then and the sea ice had been present there for at least that long. But at Anvers Island and north, Adelie Penguins did not create a nesting colony until the 1300's (only 600 years ago). This was a period of cooler climate (called the Little Ice Age) and sea ice started to become far more persistent, which made that place suitable for the Adelies. We know when the sea is covered with ice and when it is not because of the skeletons of diatoms left in the mud of the ocean floor.

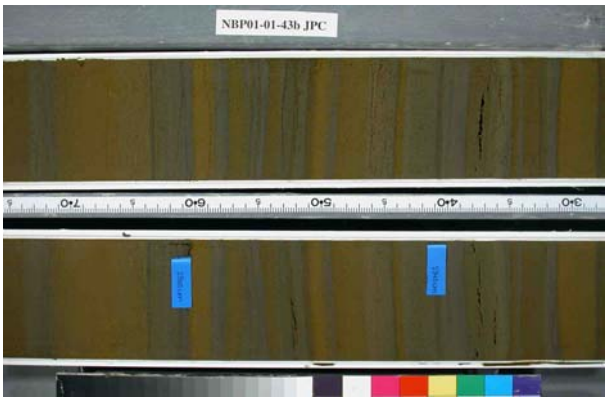


A picture taken through a powerful microscope showing different species of diatoms. These are diatoms that can not grow where the ocean is covered by sea ice.

The species of diatoms that live at the ocean surface where there is sea ice are different from those that live where there is no sea ice. This has to do with the ability of these organisms to tolerate freezing. When these single-celled ‘plants’ die, their skeletons (made of silica) fall to the ocean floor. Over many centuries their skeletons accumulate forming what is called ‘ooze’. The ooze forms in layers. What's in the layers depends on the climate above and what organisms live in that climate. We can tell what the climate was when that layer was formed based on the skeletons of the organisms we find in that layer. The types of organisms have changed over time, so we know the climate has changed as well.

To determine when sea ice covered the ocean off the west coast of the Antarctic Peninsula, scientists had to visit those waters in ships and extract cores of sediment from the ocean floor. The scientists then ‘read’ these layers, determining the identity of the skeletons and the age of the layers.

Here is a weighted pipe that falls quickly to stick deeply into the ocean floor (a ‘coring device’). When pulled back onto the ship, it will have sediment inside. The pipe contains a perfectly fitting plastic liner. When slid out of the pipe, the plastic liner contains a cylinder of sediment. This is taken to the laboratory for study. Photo courtesy Pat Manley.



Here the plastic cylinder containing the sediment has been cut in half right down the entire length of the pipe. You can see layers. The scientists then determine the dates when each layer was deposited, and also the species composition of the diatoms contained in each. Photo Amy Leventer.

Combining all these techniques — fossil hunting, carbon-dating, sediment coring — scientists have determined the advance and retreat of sea ice over past centuries and the response of Adélie Penguins to those changes. As the sea ice advances, the penguins follow founding new colonies, but as the ice retreats, the penguins abandon existing ones. With that information we now have a pretty good idea of how penguins will respond as our Earth continues to warm and sea ice disappears. As the sea ice retreats, the Adelie colonies will continue to disappear with it.