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THE SCIENCE BEHIND THE COMIC: ICE-CORE RECORDS AS CLUES TO PAST CHANGES

Nathaelle Bouttes and Emilie Capron

Why do scientists go to Antarctica? Since the 1950s, scientists have been collecting ice from ice sheets*, because it provides clues of past climate changes. Let's see how.

When snow falls on the top of an ice sheet, it buries older snow that fell in the previous years, decades, and even centuries. Slowly but surely, the weight of the newer snow causes the snow deeper down to become more compact and transform into ice. Then the ice flows very slowly towards the bottom and the margins of the ice sheet (Fig. 1).

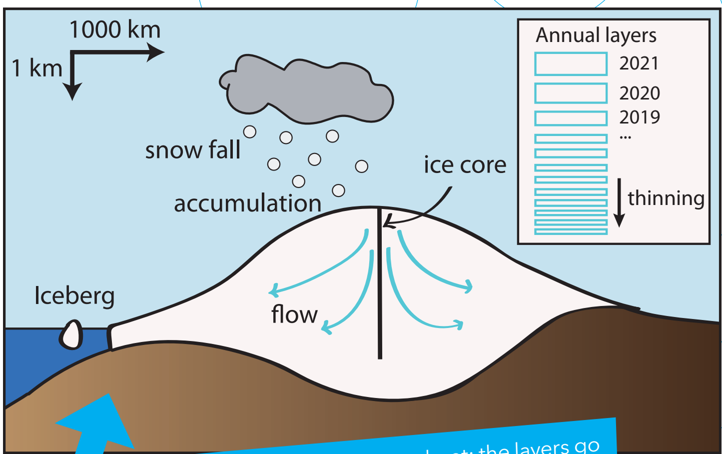

Figure 1. An ice core is drilled in an ice sheet: the layers go back in time from the newly formed snow at the top to the oldest (and thinner due to ice flowing) ice at the bottom.

Because of seasonal changes in the atmosphere and the amount of snowfall over the course of a year, scientists can detect different layers of ice in the ice sheet. While the deeper layers are being compacted and thinned, more snow deposits at the surface, leading to the formation of more layers of ice through time. Each layer of snow records information about the climate and the environment at the time it was deposited at the surface, and such information is preserved within the ice (see Christ and Bierman p. 56). This means that the ice becomes older and older the deeper you go into the ice sheet. By drilling ice cores into an ice sheet using a specialized drill, scientists are able to collect this ice and study those old ice layers. They can analyze many different chemicals, including gases, that are trapped in the ice, and also make physical measurements such as the temperature. These measurements allow them to reconstruct the climate of the past, including changes in local surface temperature (see Christ and Bierman p. 56).

Ice cores are full of surprises: not only are they made of ice, but they also contain air bubbles (Fig. 2)! As the surface snow is buried and compressed into ice, a small amount of air from the atmosphere is trapped in bubbles. By analyzing this gas, scientists can reconstruct the past composition of atmospheric gases. In particular, Antarctic ice cores provide a unique record of the past atmospheric concentrations of greenhouse gases* such as carbon dioxide (CO_2).

At the beginning of the 21st century, a large multinational European ice-core drilling project named EPICA (European Project for Ice Coring in Antarctica) measured the changes in Antarctic surface temperature and atmospheric CO_2 concentrations reaching as far back as 800,000 years (Fig. 1 in Capron and Bouttes p. 68). The records showed a very tight link between the changes of temperature and atmospheric CO_2 concentrations through time. During warm periods, the atmospheric CO_2 concentrations were high, and when it got colder (such as during the last ice age*), the atmospheric CO_2 concentrations were lower. Those records also show that the CO_2 concentration in the atmosphere today is higher than at any point during the past 800,000 years.

Figure 2. Emilie Capron is looking through a thin and polished piece of an ice core drilled in the Greenland ice sheet. Tiny air bubbles are visible; they enclose the composition of the atmosphere at the time the air was trapped in the ice (image credit: Sepp Kipfstuhl).

These analyses help climate scientists to better understand the links between climate and CO_2, and how to improve numerical models used to simulate future changes. In the context of current and future climate change, past climate data from ice sheets are essential to better understand how our climate system works.