PRESENTED BY: WGBH teachers'domain

Background Essay: Tropical Ice Cores Measure Climate

With only 150 years of instrumental weather records at their disposal, how do scientists know details about Earth's climate history? Scientists who interpret past climates are called paleoclimatologists. Paleoclimatologists use proxy data sources—preserved physical evidence from past climates—to do their work. A climate proxy is not a direct measure of climate, but instead a biological, geological, or chemical indicator that varies according to climatic conditions. As this video shows, cylinders of ice, called cores, taken from deep inside glaciers provide useful climate proxy information. Other proxy data can be found in sediment removed from the ocean floor or a lake bottom and can include microbial life, stable isotopes, dust, and pollen.

Falling snow captures wind-blown dust, volcanic ash, atmospheric gases, and stable isotopes around and within its crystals. In high mountain ranges and polar regions, where glaciers form, snow layers accumulate one on top of another. As more layers are added, snow is compressed into ice and the captured contents are locked inside. Scientists obtain ice cores by using hollow drill bits to bore deep into these layers. Each layer in a core corresponds to a single year or season, with the most recent layers near the top. Studying what gets trapped inside an ice layer gives scientists insights into the climate when the layer was formed. For example, scientists can determine past temperature by analyzing the ratio of oxygen isotopes present in the core, since this varies as average temperature changes. Tiny air bubbles may also help them determine the mix of gases in the atmosphere. By comparing layers and their contents, scientists can infer changes in past climate.

Paleoclimatologists also study core samples taken from ocean and lake bottoms. As with ice cores, each layer in a sediment core corresponds to a set of conditions that existed at the time the layer was deposited. The conditions that affected what is stored in each layer can be inferred based on the sediments that washed in from streams that fed the body of water, or that filtered down from the surface. For example, core sediments frequently contain pollen grains. Scientists analyze pollen to determine which plants were blooming at the time that the sediment was deposited. Knowing which plants were present can assist in reconstructing past precipitation and temperature. Nonliving proxy data sources include chemicals. For example, charcoal found in sediment cores may contain information about past volcanic eruptions or widespread fires.

Microorganisms called foraminifera (also known as forams) and diatoms are also used as climate proxies. Commonly found in aquatic and marine environments, they record in their shells information about past environmental conditions. Foram shells are made up of calcium carbonate ($CaCO_3$), while diatom shells are composed of silicon dioxide (SiO_2). When forams and diatoms die, their shells get buried and preserved in sediment. When sediment cores are brought up from lakes and oceans, the chemical makeup of these shells can reveal the water chemistry at the time the shells formed. By measuring oxygen isotope ratios contained in the shells, scientists can also infer past water temperatures. That's because the isotope ratio depends on two factors: the temperature and the isotopic composition of the water from which the organisms secreted their shells.