Greenland to Greenhouse

Mark Twickler cradles a slice of time in his arms. He stands inside a cold room bundled in a one-piece snowsuit, thermal hiking boots, a blue cap and thick gloves. In his hands, the University of Hampshire (UNH) glacial scientist holds a four-foot piece of ice formed 7,500 years ago in Greenland.

The ice is a sample from the Greenland Ice Sheet Project (GISP2). For the past two summers, over 100 American scientists from 20 universities, including Dartmouth and UNH, have burrowed through a 3,000-meter thick glacier in central Greenland. Dr. Paul Mayewski, director of the UNH Glacier Research Group, and his assistant directors, Michael Morrison and Mark Twickler, manage the scientific research for the $20 million Greenland Project, funded by the National Science Foundation. Mayewski expects to complete the drilling by 1993. A group of European scientists have conducted similar research 30 kilometers away.

The drill cuts through the ice sheet like a knife coring an apple, gently slicing and lifting a six-foot-long cylinder of ice—about a half-foot in diameter—from below the surface. The deeper the bit bites into the ice cover, the older the ice. When scientists reach bedrock next summer, they will have collected ice core samples more than 200,000 years old.

For the first 1,500 meters of the ice core, Dr. Deborah Meese, of the Army's Cold Region Research Environment Laboratory (CRREL) at Dartmouth, can visually determine the age

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Mark Twickler holds a piece of the ice core from the Greenland Ice Sheet Project

of the ice in the same way that geologists use sediment layers to date rock formations. Broad dark bands of ice alternate with narrow light bands and mark the passing of the seasons from winter to summer. The summer ice has a lighter color because its crystal structure permits more light to pass through.

At the surface, the bands equal the depth of the snowfall: three feet in the winter, less than a foot of snow in the summer. Only a few years comprise a core at the top of the ice sheet. As the seasons pass, older ice layers sink and compress and the bands meld together. Twickler's 7,500-year-old sample core was taken from a depth of 1,484 meters. That core's winter layers span a mere nine centimeters, the summer layers one centimeter. Twenty years of history are locked inside the sample core. Below 50,000 years, the seasons are indistinguishable and scientists focus on longer-term trends. Nonetheless, the Greenland Project provides the longest and most detailed seasonal climate history ever collected.

When snow falls on the Greenland ice sheet, it contains gases and debris from the atmosphere. The molecules and particles trapped inside the ice cores can provide scientists with important clues about past climates. UNH scientists have concentrated their research efforts on measuring the presence of nitrate, sodium, potassium, magnesium, calcium, ammonium, chloride, sulfate, hydrogen peroxide and volcanic ash in the ice samples. Each element has a story to tell.

For example, an abundance of ammonium in the core suggests that extensive forest fires have taken place. When scientists also find large traces of potassium and calcium, which originate from blowing dust, it is an indication that arid conditions probably contributed to the fires. A one or two-year spike in sulphur and chloride sets scientists in search of a written record to see if a volcanic eruption has occurred. Dr. Greg Zielinski of UNH found evidence of the 1883 explosion of Mount Krakatoa.

The ice core record provides a long view of the climate that extends beyond industrialization and recorded history. It contains traces of the Little Ice Age that occurred from 1400 to the early 1900s; the Medieval Warm Period, which spanned four centuries starting in 800 A.D.; an even warmer period called the Climactic Optimum approximately 5,000 to 7,000 years ago; and the last ice age. It stretches back far enough—through cold and warm periods, before and after industrialization—to help determine whether human activity has altered the climate over the past 100 years. The ice core record suggests that man has definitely had an impact.

Around 1900, the Little Ice Age ended and the planet's average temperature began to rise. Many scientists link the temperature increase to the production of greenhouse gases such as methane and carbon dioxide. However, the global temperature did not rise at the same rate as carbon dioxide levels. In fact, the northern hemisphere went through a cooling period between 1940 and 1970.

Published research by Mayewski and his colleagues in the UNH Glacier Research Group demonstrates that other pollutants, such as sulfuric acid—which cools the atmosphere by shielding incoming radiation and also causes acid rain—temporarily offset the warming effects of carbon dioxide emissions in the northern hemisphere. The Greenland ice cores show sulfuric acid and nitric acid levels steadily rising from the mid-1800s to 1970. These emissions are a direct by-product of industrialization. At no time in the past 1,000 years has the sulfuric count been as high.

Since 1970—the same year Congress passed the Clean Air Act—sulfuric acid emissions have leveled and temperatures in the northern hemisphere have again increased. Carbon dioxide and other greenhouse gas emissions continue to fill the atmosphere. Last month, British Meteorologist Bruce Callander speculated that temperatures would begin to rise in Europe when emission standards were frozen at 1993 levels.

The Greenland Ice Sheet Project has allowed scientists to peer inside Greenland's ice crystals and reconstruct the details of past climates as the Earth has passed through cold and warm periods. The ice record may also help us separate fact from fiction about our own impact on the climate. ■

John Ost/Durham