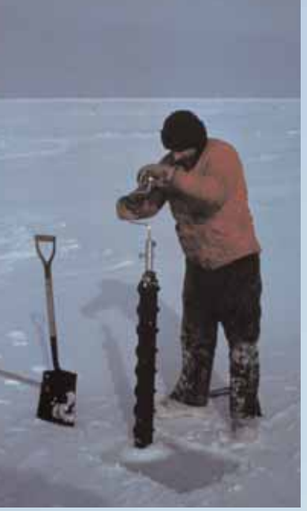

On Ice

BY JAMES SCHULTZ

Vast, deep currents move immense volumes of water through the open oceans, intermingling the planet's seas. These massive "gyres," or conveyor belts, of seawater have a profound effect on global weather patterns, warming continents with crops-sustaining rain or chilling them to the bedrock with a massive buildup of ice and snow.

Should the warm-water-bearing Gulf Stream alter direction, for instance, the relatively mild maritime climate of Great Britain could grow as cold as that of modern-day Scandinavia. Coastal Atlantic waters could quickly cool to temperatures more characteristic of those found off the coasts of Washington state and Oregon, while vacationers to North Carolina's Outer Banks could find the seawater as bracing as that of Cape Cod in Massachusetts on an overcast day. Some regions would experience drought, others an abundance of precipitation.

For decades, climatologists assumed that such changes would be gradual, unfolding over several human generations, if not over centuries or millennia. Old Dominion University professor of oceanography Dennis Darby says the latest findings contradict such suppositions. In geologic terms, stupendous change can occur in a relative blink of an eye.

"In the late 1980s and early 1990s, geologists and glaciologists started to collect ice cores from Greenland that showed us what happened decade by decade, century by century," Darby explains. "Change can be really rapid—in less than a few decades, from warm to frozen. It's startling."

(Above left) Coring sea ice near Resolute Bay, NT, Canada. (Above) Navy Board Inlet between Bylot Island and Baffin Island. Photos courtesy of Glenn Cota.

(Right) Using an ETEC Electron Microprobe, oceanography professor Dennis Darby is able to "fingerprint" individual grains of sand which calculates the chemical composition of various mineralized iron oxides. This method in turn assesses how the Arctic may help set global temperatures by tracing ice-borne sediments.

Ice Chronicles

In a career spanning nearly 30 years, Darby has studied the way the ocean moves and carries with it such natural debris as pebbles and sands. In recent years, he has begun to investigate how ice floes exit the gelid waters of the Arctic Ocean.

"We know the Arctic is a major ice exporter," Darby says. "One of the age-old questions is whether the Arctic is a passive player in climate change or whether it takes an active role. It's probably a mixture of the two. Nothing is ever clear cut where Nature is concerned."

Darby has identified a little understood ocean current, with origins in the Greenland Sea, christening it the North Atlantic Deep Water, or NADW. NADW may play a major role in the climates of North America and Europe, moderating cold weather and preventing an abrupt return to a more frigid climate.

To determine how the Arctic may help set the global thermostat, Darby invented a new way of tracing ice-borne sediments. His method involves a kind of fingerprinting of individual sand grains by means of an electron microprobe, which determines the chemical composition of different varieties of mineralized iron oxides. With the help of Old Dominion colleague Jens Bischof, who has compiled data on the mineral composition of coarse sediments, Darby has managed to track ice-rafted debris back to precise points of origin throughout Arctic coastal regions. Since 1992, Darby and Bischof have determined the pedigree of nearly 50,000 sand grains and hundreds of the coarser samples.

The picture that emerges is one in which the normal NADW conveyor belt can grind to a literal halt when excess sea ice or icebergs exit the Arctic Ocean into the Greenland Sea. As the ice begins to melt, fresh water diffuses through the upper layers of the Sea, diluting its salt content. Because fresh water is not as dense as saltwater, it doesn't sink to form NADW. And with less NADW flowing south, little warm water moves north to replace it. The net effect is a noticeable northern hemispheric cooling. The cycle intensifies: air temperatures begin a downward spiral, causing the formation of massive ice sheets that begin to crawl southward, further lowering temperatures and spurring the aggregation of additional ice.

"Once ice starts building up ..." Darby pauses before finishing. "I don't know how to stop an ice sheet that covers thousands of square miles."

Cold Times, Hot Planet

Ice ages dominate Earth's climatic history within the last million years. At the height of the last major glaciation some 18,000 years ago, sea levels dropped, extending North America's east coast an additional 200 miles toward Europe and Africa. Warm "interglacials," such as the one in which most scientists believe the planet currently basks, occur briefly every 100,000 years. Ironically, Darby says, human-induced global warming — popularly known as the greenhouse effect — could trigger the next cold snap.

In recent years, a number of Northern Hemisphere mountain glaciers have retreated to higher, colder altitudes. Portions of others near coastal areas have melted outright. An increase in melting could lubricate the base of the coastal glaciers enough to prompt a surge into river mouths and bays. A large volume of glacial meltwater would alter typical ocean circulation patterns, precipitating widespread alterations in global climate.

As befits the subject matter, Darby says his research has been global in scope. Teams of investigators in the United States, Canada, Europe and Russia have contributed sediment samples and expertise to help Darby puzzle out the Arctic's past and future roles in climate change. In turn, Darby has passed on what he calls "ground truth," or findings based on observation and analysis, to climate modelers in order to improve the precision of computerized forecasts.

"The more I get into climate change, the more I realize what a difficult and complex thing it is to tackle," Darby confesses. "It's the most difficult thing I've done in my 28 years as a scientist. There's a lot we just don't understand. What excites me is finding out more about the whole story."

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