Ice Core Shows Speedy Climate Change

Scientists drilling deep into Greenland's glacial blanket have pulled up evidence from the last ice age showing that the island's climate underwent extreme shifts in just a year or two. This unexpected finding suggests the globe has the potential to warm and cool much faster than ever anticipated.

"What this shows us is that there are big thresholds or instabilities and we don't know what those are yet. So maybe there are some surprises out there," says Kendrick Taylor of the University of Nevada at Reno.

Taylor and his colleagues reported their unexpected findings this week to a standing-room-only crowd at a meeting of the American Geophysical Union in San Francisco.

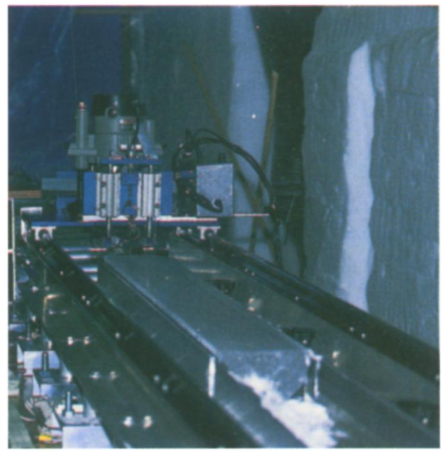
The scientists are part of an effort called the Greenland Ice Sheet Project 2 (GISP 2), which seeks to remove a 3-kilometer-long cylinder of ice from the thickest part of the ice sheet covering Greenland (SN: 9/14/91, p.168). That huge glacier formed as snow accumulated layer upon layer over the millennia, gradually compacting into ice. By counting the layers backward, the researchers have traced how temperature, snowfall, and other factors changed year by year back into the last ice age, when glaciers covered much of North America, Europe, and Asia.

The ice began melting about 15,000 years ago, signaling the end of that glacial age. But after several thousand years of warming, the climate plunged back into ice-age conditions during a time known as the Younger Dryas period, which lasted between 13,000 years ago and 11,500 years ago.

Studies of less detailed ice cores previously had shown that the cold conditions of the Younger Dryas ended when temperatures in southern Greenland warmed by 7°C over a half-century — a span then considered short (SN: 6/17/89, p.374). But analysis of ice drilled at GISP 2 this summer shows that modern conditions replaced the glacial ones of the Younger Dryas even faster.

Taylor and his colleagues first uncovered the evidence while measuring the electrical conductivity of the ice core — which reveals the relative amounts of acids and bases in the ice. A drop in conductivity indicates the presence of neutralizing bases, which are carried by windblown dust. During cold periods in the GISP 2 record, the ice conductivity drops, reflecting the dry, windy, and dusty conditions in the northern hemisphere at that time.

The conductivity data reveal that the climate often shifted in a year or two between dusty, glacial conditions and warmer weather. These rapid changes took place at the end of the Younger Dryas and several times between 20,000 and 40,000 years ago.


Monastersky

Machine measuring conductivity of Greenland ice.

Another GISP 2 scientist, Richard B. Alley of Pennsylvania State University in University Park, reported that the annual amount of snow accumulation also changed abruptly at these times. As the climate went from cold to warm, the amount of snowfall jumped by as much as 100 percent in just a few years. More snow falls during warmer intervals because the atmosphere holds more water then, explains Alley.

While the findings show that the climate of central Greenland often switched rapidly from glacial to interglacial conditions, they cannot reveal how much of the globe experienced such changes. The GISP 2 scientists think the same shifts affected broad regions, but researchers will have to collect more data at other places to resolve the question.

Climate experts must also strive to explain the causes of such abrupt climate changes. Many suggest there was something about the ice-age Earth that allowed the climate to jump between two different states by redirecting atmospheric and perhaps oceanic circulation patterns. The new finding raises questions about whether global warming from greenhouse gas pollution could soon knock the climate into a new pattern.

"The lesson to me would be that the atmospheric system clearly has inherent instabilities, and it can clearly change in extremely short times. It ought to add just one more note of caution to proceed slowly," says Gifford Miller, a geologist with the University of Colorado at Boulder.

GISP 2 researcher James White of the University of Colorado says, "I used to tell my students climate could change in their lifetime. Well, now I can tell them that it can change in less time than it takes them to graduate." *— R. Monastersky*

Chili hot chemistry

In recent years, David E. and Susan K. Henderson have developed an appetite for spicy cuisines. Indeed, Susan says, "We're chili heads."

Last year, this husband-wife team of Connecticut-based analytical chemists cooked up a sabbatical project to marry their culinary and professional interests. And that study of how capsaicin — the primary pungent chemical in hot chilies — breaks down under the heat of frying has proven a recipe for surprise, Susan notes. Chief among their observations: evidence that hot chilies may contain a previously unrecognized antioxidant.

If confirmed, this finding would expand the repertoire of natural agents known to retard the potentially harmful oxidation of dietary fats.

The Hendersons cooked up batch after batch of capsaicin at about 400°F for two hours — with and without oleic acid, the primary monounsaturate in both olive and canola oils. They analyzed the resulting heat-fostered breakdown products with gas chromatography and mass spectrometry.

Hot chili aficionados have reported that heating brings out a pepper's flavor. And in the just-released November JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY, the Hendersons report a number of thermal decomposition products that might contribute to flavor — especially vanillin, a methyl ether responsible for vanilla's sweet smell.

Moreover, they note, though oleic acid usually oxidizes readily when heated, this oxidation "appears to be inhibited by the presence of capsaicin." Although they used rich mixes of capsaicin to oil (10 to 50 percent by weight), they also heated the oil for a long time. Still, in batches containing capsaicin, they detected less than 10 percent of oleic's normal oxidation products — usually 1 to 2 percent of those seen when the fatty acid was heated alone.

The Hendersons teach at small local colleges — he at Trinity in Hartford, she at Quinnipiac in Hamden. Susan says they hope to give their undergraduates a taste of this food chemistry through involvement in follow-up studies. □