CLIMATE

A High Glacier Opens a View Of the Ice Age Tropics

The secrets of tropical climate aren't easy to ferret out, as Lonnie Thompson and his colleagues know well. To get a good look at climate history near the equator, the Ohio State University glacial geologist and his colleagues had to set up camp on a glacier 6000 meters high in the Peruvian Andes. And, as if that weren't challenge enough, they had to endure tent-shredding gales, subzero temperatures, and blistering sunburns. But their less adventurous colleagues are hailing the effort. The group came down from the mountain with ice from a pair of cores, 160 and 166 meters long—the first to give a picture of climate in the tropics back into the last ice age.

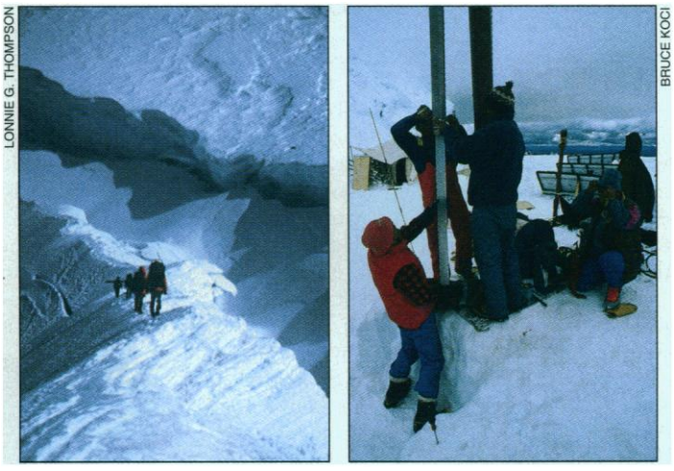
The researchers, from Ohio State and Louisiana State universities, are still analyzing the chemical markers in the ice. But already, as they describe on page 46, the 20,000-year climate history depicted in the cores is providing detailed support for a new understanding of the ice age tropics. Until recently, most researchers thought that as ice sheets grew and retreated in the northern and southern hemispheres, the tropics remained relatively balmy. Lately, though, researchers have found hints that the tropics did share in the cooling during the last ice age, which ended about 14,000 years ago.

The new ice cores, from a Peruvian site called Huascarán, offer detailed confirmation—and show that climate in the tropics experienced sharp oscillations at the end of the ice age, just as it did in more northerly regions. "That's the most remarkable thing," says University of Colorado geologist and paleoclimatologist Jim White. "Here's a core from the tropics that shows the same sort of rapid climate oscillations that are most prominently seen in the North Atlantic region."

The picture of the tropics as insulated from the chills wracking the rest of the planet stems from an influential study in the 1970s called CLIMAP. Based on microfossils of plankton that lived near the surface of the tropical oceans during the ice age, CLIMAP suggested the tropics cooled by no more than 1° to 2°C below today's average during the depths of the last global glaciation. But lately, evidence on land, ranging from the altitudes of ancient snow lines in the tropics to chemical tracers in ground water, has indicated a larger cooling on land than at sea, an unreconciled discrepancy (*Science*, 17 February, p. 961).

Thompson and co-workers didn't set out to address this puzzle, however. Instead, they wanted to explore the long-term history of the periodic warming episodes in the tropical Pacific known as El Niños. El Niños, which cause widespread disruptions including flooding, affect annual snow accumulation in the high mountains. Their signature would be visible in an ice core as variations in the thickness of its annual layers.

To read that signature, the researchers had to find a tropical glacier high enough and thick enough to have remained intact over thousands of summers. Their chosen site in the Andes was far from roads, accessible only to climbers, so the usual motorized drilling equipment was out of the question. Instead the team built a system, light enough to pack in to the site, that runs off solar power. Even so, it took the help of 44 burros and 30 Peruvian porters to shuttle the 60 photovoltaic panels, winch, drill, and other supplies from a tropical valley town up over three vertical kilometers to the site.



High adventure. Researchers trek to a site 6000 meters high in the Andes, where they use a solar-powered drill to bore 160-meter ice cores.

As they drilled, the researchers began to suspect that the thin layers of ice from the deepest parts of the core, right above bedrock, were much older than a few thousand years. They sliced up the cores with a solar-powered band saw for transport down the mountain and back to Ohio State, one as lengths of ice and one as bottles of meltwater. There, preliminary chemical analyses confirmed their suspicion: The deepest ice bore the same hallmarks as ice age layers in northern cores. Their reaction was, in a word, "Fantastic!" recalls Thompson.

The researchers used three main tracers to see how the ice age and its aftermath were felt at the site. One tracer was the ratio of the isotopes oxygen-18 to oxygen-16, which indicates air temperature during the snowfall that formed the ice. The ratio declines at colder temperatures, and it was lowest in the bottom 3 meters of the core, which date from about 20,000 to 14,500 years ago. It then increased substantially, indicating a warming of 8° to 12°C at the site.

That's consistent with the 5 to 6 degrees of warming at lower elevations that Northern Hemisphere records show for the end of the ice age. And it's in line with the temperature change estimated from other evidence, including ancient snow lines, which lay at lower elevations on tropical mountains during the last ice age. "Getting an ice core that shows [isotopic oxygen] values which support snow line drops is a major breakthrough," says White. So, he adds, is detecting the signature of an abrupt return to ice age conditions known as the Younger Dryas, which peaked about 12,000 years ago. Many researchers had thought the Younger Dryas was largely a northern phenomenon, perhaps driven by changes in North Atlantic currents. There had been a few signs of it in the tropics, says White, but the new cores show it "in a very dramatic fashion."

The other two markers fill out the picture of the ice age tropics. In the layers that were depleted in oxygen-18, the researchers found a 200-fold increase in dust, signaling the same kinds of drier conditions in South America that other ice cores have indicated for northern continents. Their analysis also revealed a decrease in nitrate levels—which can be a marker for plants—perhaps because forest cover in the nearby Amazon Basin was patchier than it is today.

But the Huascarán ice cores are of more than just historical interest, Thompson emphasizes. He and his colleagues are now deciphering their record of El Niños, and the cores also offer a view of how the tropics respond to worldwide climate changes such as recent warming. "Fifty percent of the land mass on the planet and 75% of the population are in the tropics," says Thompson. "It's very important to understand the climate and climate variability in these tropical regions." And, as he's recently shown, he's willing to go to extremes to do it.

–Christine Mlot

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