Deep in sediments off Antarctica, Stanford scientists find insight into past -- and possible future -- climates

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Looking up through the rig at the nighttime Antarctic sky.

(PhysOrg.com) -- From the Antarctic Ocean, Earth scientist Rob Dunbar blogs about the challenges of drilling ancient deep-sea sediments -- and what he's found in them.

If cabin fever is gnawing at you this winter, consider taking a vicarious voyage with Stanford Earth scientist Rob Dunbar, who is drilling in - and blogging from - the deep sea off the East Antarctic Ice Sheet. He's in search of clues to Earth's past climate, and his blog, full of video clips,

photos and written entries, gives a lively account of an expedition to Wilkes Land, an area due south of Australia that has never been drilled before.

Dunbar and his fellow researchers are extracting cores of sediment from deposits under the ocean that were laid down over the last 50 million years or so, stretching back to a time when a balmier Antarctica was largely ice free and covered with forests. The team particularly wants to analyze sediments deposited about 34 million years ago, during the transition from that warm climate to a cooler one that produced the first growth of polar ice caps.

Dunbar said the transition is thought to have been triggered by changes in the levels of carbon dioxide and other greenhouse gases in the atmosphere. "Learning more about abrupt climate transitions in the past will help us better understand what lies ahead in our greenhouse future," he said.

Dunbar, a professor of environmental Earth system science, is on board the research vessel JOIDES Resolution, along with more than 30 other scientists including paleontologist Christina Riesselman, a graduate student in geological and environmental sciences. The ship set out from Wellington, New Zealand, in January and is scheduled to be out for a little over two months. Dunbar is blogging about the voyage for the Exploratorium as part of its Ice Stories project, which began covering Arctic and Antarctic scientific explorations during the International Polar Year (2007-2008).

Wilkes Land is covered by the East Antarctic Ice Sheet, the oldest and largest polar ice field on the planet over at least the past 180 million years. Though most of the East Antarctic sheet sits on land that is above sea level, the portion on the margin of Wilkes Land lies more than 1,000 meters below sea level, which means it is partly supported by the ocean.

If sea level rises a little, this causes the ice sheet to lift off of its bed, allowing it to flow faster to the sea.

Why drill here?

"One reason we are drilling here is to see if this part of the Antarctic ice has been unstable during past intervals of warming. No one has drilled here before to ask this question," Dunbar said. "If we can learn the answer, we will learn something important about sea level rise in the centuries ahead."

Now roughly halfway through their voyage, the team has extracted several cores - one of them over a kilometer long - but the drilling hasn't always been easy. Simply reaching the ocean floor in some spots can require 4 kilometers (2.5 miles) or more of drill pipe, all of it lowered from a derrick mounted amidships.

In their first attempt at drilling, they discovered that the seafloor under them was so rocky and hard that the end of the drill pipe broke when it hit bottom, forcing them to pull 3,800 meters of pipe back up to replace the damaged pieces. Even adding a diamond drill bit wasn't enough, as it turned out they were drilling into a massive pile of large rocks, gravel and sand that Dunbar said was produced by the scouring action of the ice sheet as it progressed out to the continental shelf.

"Think of a bulldozer with unlimited horsepower and a blade 2000 km wide," Dunbar wrote in his blog. "The power of ice to erode the hardest rock and move it great distances is unmatched by any other natural process on Earth." The researchers suspect they chanced onto a giant submarine fan, similar to what is found at the seaward end of the immense Monterey submarine canyon. Such canyons act as conduits for masses of debris eroded from the continent. After penetrating only 40 feet into the fan, the team had to give up.

Dunbar said the canyon was unexpected from the survey work they had done of the area prior to drilling. Finding it, he wrote, was "to be honest, very unlucky on our part - there aren't that many channels of this type out here in the deep sea."

Sediment cores by the kilometer

But the rest of the expedition has gone much better, and the researchers have hauled up over 2 kilometers of sediment cores for analysis. Dunbar, a sedimentologist, scrutinizes the cores for evidence of past climate, which he can discern from data such as variations in the grain size of the sediments and their mineralogy. Shells of microorganisms that fell to the seafloor long ago also provide clues.

In addition to their climate work, the researchers use the sediments to view Antarctica's tectonic history. Dunbar has seen sediments that may have been eroded from Tasmania or other parts of Australia millions of years ago when the two continents were separated by only a few hundred kilometers.

Riesselman specializes in studying microscopic single-celled algae called diatoms. Fossil diatoms are common in the sediments, and because they evolved rapidly over time, the shape of their skeletons can be used to determine the age of the sediments.

Shipboard summer sunbathing

Along with the scientific doings, Dunbar's videos and photos show the gamut of shipboard activity, from the complex process of assembling the drill pipe to the amazing abundance of birds constantly circling the ship to some incredibly colorful Antarctic sunrises and sunsets.

And to further distract you from the blahs of being housebound by cold and snow, you can read about the joys of summer weather in the far southern hemisphere. The days are long, with sunshine for over 20 hours a day, and the temperature … well, Dunbar said the temperature has been mostly hovering around freezing. But at times it has rocketed all the way up to 39 degrees Fahrenheit. Perhaps not much compared to American summertime temperatures, but it's still toastier than a lot of the United States has been so far this winter and it was enough to bring the researchers out on deck to sunbathe.

One cautionary note, though. To achieve the maximum "mental margarita" benefit from reading Dunbar's blog, you should probably try to ignore his mentions of the winds that can gust over 60 knots and the 25-foot waves.

Provided by Stanford University