Researchers study glaciers on Earth's coldest desert

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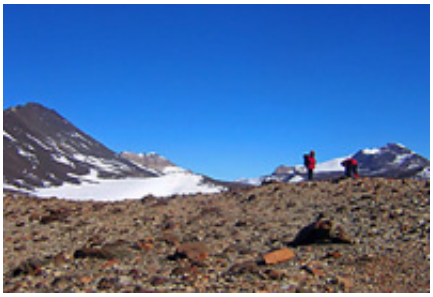

In the Nibelungen Valley, the Mukhopadhyay research team is graced with sunny weather as they conduct their research. Instead of precipitation, wind is the real weather hazard, as it tears across the barren desert landscape. Image courtesy of Jennifer Middleton and Allen Pope

(PhysOrg.com) -- It's December, and undergraduate Jenny Middleton bundles up to face the cold. While all across campus, students, and faculty don their winter gear, Middleton is not preparing for the New England winter; she is preparing for an expedition through the Earth's coldest desert: the McMurdo Dry Valleys in Antarctica.

"Occasionally, like when the wind is blowing so hard that you can hear the harmonics of a 50-gallon drum as if it were an empty Coke bottle and you can't see anything due to all the blowing snow, we wonder what we've gotten ourselves into," the Harvard junior jokes in a recent communication from the McMurdo Station, a research center on Antarctica's Ross Island.

Middleton, an Earth and Planetary Science concentrator, has come to McMurdo with two other Harvard researchers from Sujoy Mukhopadhyay's Noble Gas Laboratory in order to study the history of the East Antarctic Ice Sheet (EAIS) and its correlation to climate change. (Noble gases are odorless, colorless chemical elements with very low reactivity that act as unique geochemical tracers for studying a variety of processes in planetary science.) Allen Pope, a 2008 graduate of Harvard, who studied and wrote his thesis under Mukhopadhyay, an assistant professor in the Department of Earth and Planetary Sciences, is taking a few months from his graduate Polar Research Studies at Cambridge University to join the expedition. Robert Ackert, a glacial geologist and research associate in Mukhopadhyay's lab, will be supervising the field operations.

When it comes to monitoring the health of the Earth vis-à-vis climate change, ice sheets are like the planet's pulse. But, since glaciers effect both ocean circulation and the amount of radiation reflected from Earth back to space, the glaciers influence — as well as monitor — climate change. The dynamic feedback system is not yet completely understood. "Knowing whether or not the EAIS has been stable or has fluctuated in extent over the past 10 million years is a critical question for climate modeling," Mukhopadhyay explains in his National Science Foundation (NSF) proposal.

So, it is the Antarctic glaciers that bring Middleton, Pope, and Ackert to the bleak 10-million-year-old landscape of the McMurdo Dry Valleys, a journey that took almost two weeks — slowed as it was by the requisite stopovers and inevitable flight delays.

The extent of glaciation in Antarctica during the past 10 million years is still hotly debated. Did a several-kilometer thick sheet of ice completely cover the Transantarctic Mountains 10 to 14 million years ago? How did the Antarctic Ice Sheet behave between 3 and 5 million years ago, when

global temperatures and carbon dioxide concentrations were higher than they are today?

It's not the ice itself the research team will be studying, but rather the otherworldly tracks left by now-melted ice-sheets. The intriguing beauty and barren, desolate tranquility of the area have captured and enchanted Robert Acker for years. It is a topography, he explains, that is "eerily similar" to that of Mars. The mystery of this ancient terrain has drawn Ackert back to the icy continent for his 14th expedition. "It's kind of a detective story," he says, "Why does this landscape look like it does? And what's happened? What's the landscape trying to tell you?"

In trying to uncover the secrets of the Dry Valleys, the research team is examining one of the region's more intriguing landforms: massive "potholes," some more than 10 meters wide and twice as deep. The potholes are believed to have been carved by running water under a giant ice sheet 10 to 14 million years ago, and have been exposed to air since the ice sheet retreated around 10 million years ago. However, based on preliminary data obtained from samples collected during a previous field expedition, Mukhopadhyay thinks the story might be more complicated. Perhaps glacial floods associated with smaller valley glaciers or even erosion caused by wind and the freezing and thawing of ice formed the potholes. If either — or both — of these scenarios is accurate, it would have drastic implications for climate modeling.

To investigate the potholes and other topographical features, the team will be camping for one to two weeks each at three separate sites, which were chosen to provide the researchers with a variety of landscapes from which to collect samples. Members of the team will have to scale the massive holes, but the associated risks do not seem to worry them. Ackert jokes, "The most dangerous thing about going to Antarctica is crossing the street in Christchurch [New Zealand] because they drive on the wrong side of the road." Just in case, Mukhopadhyay and Ackert

enlisted a Kiwi mountaineer to help the fieldworkers complete their "extreme geology."

It is back in Mukhopadhyay's Noble Gas Laboratory that the mystery of the Antarctic Ice Sheets will be unraveled. In order to determine if these bizarre potholes are formed from ancient (10-million-year-old) sub-glacial floods or have been constantly eroding through other processes since the last deglaciation of the area, the age and erosion rate of the exposed sandstone must be figured. Mukhopadhyay's laboratory will measure concentrations of cosmogenic nuclides collected on this trip, which correlate to when the sandstone was exposed to air. Published results are expected in 2010 or 2011.

For Middleton, the opportunity to travel to this extreme locale is like a dream come true. She was not originally slated to join the expedition, but as an undergraduate research assistant in the Mukhopadhyay laboratory, word of the upcoming trip entranced her, and she began to wish she'd somehow get a chance to go. "I did spend a lot of time daydreaming," she says. "What if, at the last minute, they were like, 'You should go to Antarctica!'"

That is, in fact, precisely what transpired. After giving up his spot because of family constraints in mid-September, Mukhopadhyay invited Middleton to join the expedition. "I immediately had to sit down," she says, "because, otherwise, I probably would have fainted." Going to Antarctica has been a lifelong ambition. "I remember being like 6 and telling my grandma, 'I want to go to Antarctica.'"

Although young, Middleton and Pope already have polar experience. Both spent 10 weeks on the northern glaciers with the Juneau Icefield Research Program (JIRP). They received credit for the program through Harvard's Earth and Planetary Science Department. "[JIRP is] definitely what helped me decide that I wanted to go to grad school on this type of

thing," says Pope. Pope received the requisite training for this trip through his thesis research; Middleton has been doing an independent study with Mukhopadhyay this past semester. Neither student had much trouble convincing professors and advisers that the once-in-a-lifetime experience would be worth the missed school time.

Ackert, however, claims that it might not be once-in-a-lifetime. "They might get addicted," he jokes. Ackert, too, first visited the ice continent as an undergraduate; from then on, he was hooked. "I'm actually really excited about bringing Jennifer and Al down because, to a certain extent, it is a little bit old hat for me. And I think seeing other people being really excited is contagious. It's fun to be able to share your knowledge and excitement about things and expose them to the same things that I was exposed to and really excited me.... So, I feel like I'm kind of closing the loop after all these years."

Provided by Harvard University

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