In-Depth

NEWSLETTER OF THE NATIONAL ICE CORE LABORATORY — SCIENCE MANAGEMENT OFFICE

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In this issue . . .

Message from the Director

As autumn rolls in, investigators from this year's Arctic program have completed their fieldwork and are busy analyzing samples and data. It was a successful field season at Summit Station and two projects recovered ice cores. Read about one of these projects to the right. As the austral summer starts to arrive in Antarctica several major projects are underway. The U.S.-Norway traverse is getting ready to start their way to South Pole (http://traverse.npolar.no/) and the WAIS Divide put-in crew has arrived at camp (see story on page 3). NSF has funded an outreach project to visit these projects in the field this season (and were in Greenland this past summer). Learn more about Polar-Palooza on page 5. We hope all those in the Antarctic have a safe and successful season.

-MST ■

Volcanic Events in Greenland Ice Cores

A team of scientists and engineers spent six weeks, from June to mid-July of 2007, at Summit Station, Greenland to drill ice cores for an atmospheric chemistry research project. The main objective of the collaborative project between South Dakota State University and the University of California-San Diego is to understand the oxidation chemistry of the atmosphere by studying the isotopic composition of sulfuric acid in ice that is formed in the atmosphere when sulfur compounds are emitted by volcanic eruptions.

The six members of the team were: Bella Bergeron and Terry Gacke from Ice Coring and Drilling Services (ICDS, University of Wisconsin), Alyson Lanciki and Jihong Cole-Dai from South Dakota State University (SDSU), Joël Savarino from Laboratoire de Glaciologie et Géophysique de l'Environnement (LGGE; Grenoble, France) and Mark Thiemens from University of California, San Diego (UCSD). When the team arrived at Summit in early June, an ice coring site located approximately 5 kilometers from the camp had been selected and set up by the camp staff. Researchers from another project had used the site in May and had dug a 3-meter deep snow pit for snow property studies.

Pictured from left to right: Terry Gacke (ICDS), Bella Bergeron (ICDS), Mark Thiemens (UCSD), Jihong Cole-Dai (SDSU), Joel Savarino (LGGE). Photo: Alyson Lanciki (SDSU).

Drilling activities began soon after the team's arrival and continued through early July. A total of approximately 500 meters of ice core was collected from four boreholes, with bottom depths ranging from 80 to 215 meters. These ice core samples are expected to contain sulfuric acid from several large explosive volcanic eruptions that occurred during the last 800 years. The team also collected snow samples from a shallow (2 meter) snow pit dug near the boreholes. The snow and ice core samples filled nearly 100 large insulated shipping boxes. The team worked

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We welcome your comments, suggestions and submissions.

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Masthead photos courtesy of
Lonnie Thompson and Michael Morrison.

Upcoming Meetings

10 December 2007
U.S. International Partnerships in Ice Core Sciences, San Francisco, CA
nicl.smo@unh.edu

10-14 December 2007
AGU - Fall Meeting, San Francisco, CA
www.agu.org/meetings/fm07/

15-20 April 2008
EGU General Assembly, Vienna, Austria
http://meetings.copernicus.org/egu2007/

26-30 May 2008
AGU Joint Assembly, Fort Lauderdale, FL
www.agu.org/meetings/ja08/

8-11 July 2008
SCAR-IASC Open Science Conference, St Petersburg, Russia
www.scar.org/events/#2008

29 July-1 Aug 2008
AGU Western Pacific Meeting, Cairns, Australia
www.agu.org/meetings/wp08/

Volcanic Events in Greenland Ice Cores *(continued from page 1)*

with Summit Station staff and the 109th Air National Guard to load and ship the boxes, weighing about 14,000 pounds, to Kangerlussuaq. Once in Kangerlussuaq, the boxes were stored in a large freezer at -15C until they were flown to Scotia, NY via C-130, and then sent via refrigerated truck to the National Ice Core Laboratory in Denver, CO.

Alyson Lanciki (SDSU) logs a 1-meter long section of ice core. A total of approximately 500 meters of ice core was collected from four boreholes, with bottom depths ranging from 80 to 215 meters.
Photo: Mike Pasternik

During drilling, several groups of visitors to Summit Station, as well as members of other Summit research projects, visited the drill site. One large group of Danish and Greenland science teachers on an education and outreach project toured the drill site on June 20. They observed a demonstration of ice coring by the drilling team and learned how ice cores are used to study the global atmospheric environment and climate change. Several enthusiastic visitors tried their hands at handling ice cores and left with demonstration ice cores to use as teaching tools in their classrooms. In addition to learning about ice coring, the visiting teachers jumped into the 3-meter snow pit in which they observed, through a double-sided snow wall back-lit by the sun, the visible horizontal layers in snow that are often used to study snow stratigraphy and to determine the amount of annual snow fall.

Noted glaciologist Charlie Bentley, Principal Investigator of ICDS, visited with the drill team on June 20 and 21 and inspected the four-inch ICDS mechanical drill while in operation.

Over the next year, the ice core samples will be analyzed at the Ice Core and Environmental Chemistry Lab at South Dakota State University to determine the chronology and to locate the prominent volcanic events. The volcanic sulfuric acid will be extracted and later analyzed for isotopic composition at the University of California, San Diego.

-- Jihong Cole-Dai and Alyson Lanciki,
South Dakota State Univeristy

Collaborative Research: An Isotope MIF Study of Volcanic Events in Greenland Ice Cores
NSF Award Number 0612461
Principal Investigator: Jihong Cole-Dai, South Dakota State University

NSF Award Number 0612422
Principal Investigator: Mark Thiemens, University of California-San Diego

WAIS Divide Ice Core Update

The West Antarctic Ice Sheet (WAIS) Divide Ice Core project is progressing very well. In June we processed the top 110 meters of the main ice core drilled during the 2006/2007 field season at the National Ice Core Laboratory (NICL) in Denver, CO. On October 4-5 the first annual science meeting was held at Lake Tahoe. Sixty-eight people attended the meeting and twenty-one science talks were presented. In addition to the science meeting, a gas group meeting and a borehole logging planning meeting were also convened.

The 2007/2008 field season at WAIS Divide is rapidly approaching and everyone is excited to start drilling with the new DISC drill. Ice Coring and Drilling Services (ICDS) finished all of the post-Greenland Field Test modifications to the DISC drill with plenty of time to spare and the drill is now on its way to Antarctica.

2007 WAIS Divide core processing line (CPL) at NICL. Shown left to right is: Eric Cravens (NICL), Trevor Poenisch (So. Dakota St. U), Andrei Kurbatov (U. Maine), Matthew Spencer (Lake Superior State U.), Katie Hess (RPS), David Ferris (So. Dakota St. U), Brian Bencivengo (NICL), Terry Topping (NICL), Sylvia Englund (U. Colorado), and Trevor Popp (DRI). Not shown: Geoff Hargreaves (NICL). Photo: Eric Cravens (NICL).

Preparations for the 2007/2008 field season at WAIS Divide are complete thanks to the Herculean efforts of Matthew Kippenhan (Raytheon Polar Services – camp logistics), Joan Fitzpatrick and Geoff Hargreaves (NICL – core processing equipment), and Alex Shturmakov and Jay Johnson (ICDS – drilling).

It is going to be a very busy season at WAIS Divide this year. This will be the first winter-over with all of the field camp stored outside on cargo lines, rather than stored inside the arch facility as during the 2006 winter. It is expected to take several weeks to get the camp up and running to the point where it can support larger populations. On October 24, six camp staff safely arrived to WAIS Divide via a Basler airplane and started the long process of digging the camp out.

The anticipated field schedule is as follows:

- 01-December: key ICDS personnel arrive at camp. Move DISC cargo into arch and start drill installation
- 07-December: NICL, SCO, and some science technicians arrive at camp. Move core processing equipment into arch and begin CPL installation
- 3rd week of December: start drilling operations
- 23-January: start ICDS/SCO redeployment back to McMurdo Station and start arch shutdown
- ~ 28-January: all remaining ICDS, NICL, and SCO personnel leave camp
- 7-8 February: all camp staff back at McMurdo Station and WAIS Divide is closed for the season

If all goes according to schedule we'll be drilling by late-December. After a little warm-up time operating the DISC drill and handling the core the plan is to switch into a 6 days/week, 24 hours/day drilling operation. The goal is to drill at least 800 meters this season. All non-brittle ice will be retroed to NICL. All brittle ice will winter-over at WAIS Divide.

For the latest news, updates and photos visit the WAIS Divide project website at: http://www.waisdivide.unh.edu

-- Joe Souney, Operations Manager
WAIS Divide Science Coordination Office (SCO)

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Stable Isotopes

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TBD

In 1986, the National Academy of Sciences recommended developing an Ice Core Working Group of representatives from institutions prominent in ice coring activities. The ICWG now provides guidance to NSF on the future directions for ice core research, on topics related to sample access, distribution, inventory, policy issues, and operation and maintenance of the NICL facility. Administered by the NICL-SMO, ICWG is organized around scientific disciplines, rather than institutions. Members are elected to a three year term, with the committee chair serving two years.

Borehole Optical Stratigraphy at the WAIS Divide Ice Core Site

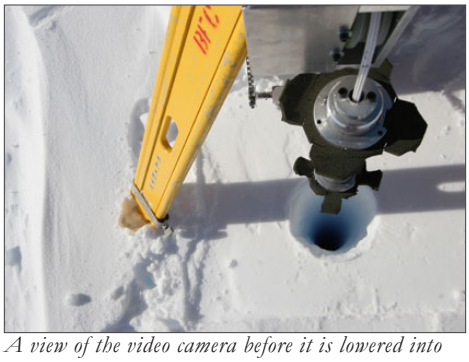
In late 2006, a team from the University of Washington visited the WAIS Divide field camp in West Antarctica to investigate the distribution of annual-scale layers upstream of the WAIS Divide ice coring site. This upstream area is of considerable importance for the WAIS Divide ice core because this is where all of the ice found in the ice core originally fell as snow. For example, an ice sample from a depth of 900 m started approximately 5 km upstream of the present ice coring location and traveled downstream over the next three thousand years. If there are large variations in the rate of snowfall in the upstream area, or if the snowfall rate varies in time with a spatially coherent pattern, the climate signal from the ice core will show climate-like signals that may not be caused by global climate variations.

Ben Smith (U. Washington) lowers a video camera into a borehole at the WAIS Divide field camp in West Antarctica. Photo: Steven Profaizer (Antarctic Sun/NSF)

The field party used a combination of ground-penetrating radar and a borehole camera to look at variations in accumulation patterns in the 6 km immediately upstream of the ice-core site. The radar measures the depths to a few layers in the top 50 to 100 meters of the firn. These depths can be converted into an estimate of accumulation rates over the past 200 years, although, because only a few different layers are present in the records, these data can show only changes in accumulation over a few decades. In the same area, the field team drilled an array of fourteen boreholes to a depth of 15 meters. In each of these boreholes, they lowered a camera with a light source, and recorded video as the camera traveled up and down the borehole. These videos give a record of the reflectance of the borehole wall as a function of depth. Melt layers, hoar-frost layers, and wind crusts all leave signatures in the firn that show up as fluctuations in the brightness of the borehole wall, allowing us to use these records as "virtual ice cores." By identifying patterns of layers that appear in different cores, we can calculate how accumulation varied on a 1 year to 2 year time-scale over the last 20 to 30 years.

Preliminary analysis shows that, in the undisturbed upstream region of the WAIS Divide ice coring site, the accumulation rate varies by around 3% to 5%, with a wavelength greater than the extent of our grid. The strongest variations occur in the upwind direction; across-wind variations are on the order of half as large. The layering patterns appear to reflect spatially fixed accumulation variations, presumably driven by subtle undulations in the snow surface. Interestingly enough, in the 500 meters upwind of the eight-meter-high arch-shaped building now housing the WAIS Divide ice-core drill, the near-surface layers are strongly disturbed due to the arch structure: There is an area of wind scour within a few hundred meters of the arch where the accumulation rate is cut in half, and an area of high accumulation directly at the arch where the accumulation increases by a factor of around three. The impact of the building shows that deposition and erosion of blowing snow is very sensitive to variations in surface height.

The borehole data show a variety of small features that we can identify between boreholes up to 3 km apart, but overall, the background layering pattern is substantially different from borehole to borehole. This suggests that, while storms impact the whole region, most spatial variability in firn characteristics is driven by local processes such as random snow drifting shortly after deposition. The depths of features that correlate between boreholes vary by 10 to 20 cm from hole to hole, which is approximately the scale of surface drifts and sastrugi at the WAIS Divide site today. In most of the boreholes, there does not appear to be a strong annual-layering signal as has been seen with the downhole camera at Summit, Greenland and at Siple Dome, West Antarctica. However, in the four deeper boreholes, the annual signal becomes cleaner as the firn becomes denser, and those holes show brightness variations that match the expected annual signal at WAIS Divide.



A view of the video camera before it is lowered into the borehole. Photo: Steven Profaizer (Antarctic Sun/NSF)

Further analysis of the borehole and radar data will result in a map of accumulation in the upstream area, and a precise estimate of the annual spatial variability in accumulation on a 1 to 2 km scale. Our data do not suggest that the accumulation pattern varies through time, but further analysis is needed to rule out this possibility. These results will be relayed to the WAIS Divide science community so that they can assist in the interpretation of the upper part of the WAIS Divide ice core.

-- Ben Smith, University of Washington

Spatial Variability in Firn Properties from Borehole Optical Stratigraphy at the Inland WAIS Core Site
NSF-OPP Award Number 0538639
Principal Investigator: Edwin Waddington, University of Washington

POLAR-*PALOOZA* and Ice Core Science

POLAR-PALOOZA, an innovative public education and outreach initiative supported by both NSF and NASA, successfully presented a special "sneak preview" of its national tour: "Stories from a Changing Planet", on Saturday October 13th at ASTC 2007--the annual conference of the Association of Science-Technology Centers. In a massive space at the Los Angeles Convention Center, the presentation used three screens, HD video and a movie-style projector loaned by Sony to show more than 700 leaders of the informal science education community some of the unique aspects of POLAR-PALOOZA. The public tour premieres in San Diego October 19th, and then continues to Albuquerque, San Francisco, Tampa, Atlanta and Baton Rouge, with 20 more communities to come in 2008.

"Along with leading polar researchers - such as glaciologists Sridhar Anandakrishnan and Charlie Bentley - we're delighted to be traveling with an authentic part of Earth's climate history," said project director Geoff Haines-Stiles. "Courtesy of NICL, Todd Hinkley and Mark Twickler, we've got a 20cm piece of the Newall Glacier flying with us from town to town. Getting ready to make the ancient ice part of public presentations meant our production team coming up to speed on the basics of the care and feeding of ice cores, acquiring an insulated shipper, and briefing our science center partners on being sure to have deep freezes ready and waiting!"

Delivering the ice core during the public presentations is going to be given a certain theatricality by enlisting local celebrities to carry the core onstage to deliver it to researchers, like Bentley and Anandakrishnan, who will explain what has been learned from deep ice cores like GISP2.

Along with the public presentations, POLAR-PALOOZA also features a growing library of video podcasts, which can be accessed at: http://passporttoknowledge.com/polar-palooza/pp06.php

Two recently added videos (which can be downloaded in QT, .wmv and .MP4 formats for iPods and MP3 players) also feature ICDS drillers, and show how researchers Mary Albert and Jeff Severinghaus rely on ice cores for their studies. Shot on location at Summit, Greenland, the videos - ICE DRILLERS ARE HARD CORE and READING ICE CORES - are meant to show the research process as well as the core (sic) science.

"We've just learned that NSF will also support 'iPPZA' - International POLAR-PALOOZA - so we hope to take the core on the road to China, South Africa, Australia and Norway in 2009" says Haines-Stiles. "And next month, November 2007, we will be sending one of our videographers off on the first weeks of Mary Albert's US-Norwegian traverse from Troll Station to South Pole. If all goes well, the same cameraman will capture scenes at Amundsen-Scott South Pole station in January 2008 as the traverse party and their ice cores from the heart of East Antarctica reach the end of their journey. So, as you can see, ice cores appear in all our various efforts and we really appreciate the support of researchers, NICL staff and especially Mark Twickler, as we try to increase the public understanding of Earth's past climate - and what the future may bring."

POLAR-PALOOZA is made possible by support from the National Science Foundation and NASA's Science Mission Directorate and is an official International Polar Year activity. POLAR-PALOOZA is produced by PASSPORT TO KNOWLEDGE, which is solely responsible for its content.

-- Geoffrey Haines-Stiles, Project Director
PASSPORT TO KNOWLEDGE & the LIVE FROM specials
http://passporttoknowledge.com

Editor's Note:

The National Science Foundation (NSF) news release regarding the Polar-Palooza "Stories from a Changing Planet" traveling museum can be viewed at:
http://www.nsf.gov/publications/pub_summ.jsp?ods_key=ma07030

The NSF and the National Aeronautics and Space Administration (NASA) are funding Polar-Palooza as part of the International Polar Year (IPY), which began in March 2007 and ends in March 2009.

The tour will stop in cities across the country in 2007 and 2008.

Upcoming 2007 tour dates include:

Nov. 8-10:
Tampa, Fla. - Museum of Science and Industry

Nov. 11-13:
Atlanta - Fernbank Science Center

Nov. 15-17:
Baton Rouge - Louisiana State University Museum of Natural Science

The "Stories from a Changing Planet" tour will continue in 2008, with events planned in Chicago, St. Louis, Denver, Philadelphia, New York, Houston and several other cities.

For more information about Polar-Palooza and links to the 2007 tour schedule, visit:
http://passporttoknowledge.com/polar-palooza/

-JMS ■

International POLAR-PALOOZA - Emphasizing the "I" in IPY & Enabling Global Conversations on the Antarctic Treaty
NSF-OPP Award Number 0732879
Principal Investigator: Geoffrey Haines-Stiles, Geoff Haines-Stiles Productions

POLAR-PALOOZA
NSF-OPP Award Number 0632262
Principal Investigator: Geoffrey Haines-Stiles, Geoff Haines-Stiles Productions

National Science Foundation Projects Related to Ice Cores or Ice Core Data

The table below shows projects related to ice core research that have been funded by the National Science Foundation (NSF) since the last issue of *In-Depth* was published. To learn more about any of the projects listed below, go to the NSF Award Search page (http://www.nsf.gov/awardsearch/) and type in the NSF Award Number. If you have a newly-funded NSF project that was omitted from this listing, please let us know and we will add it to the next issue of *In-Depth*.

Title of the Funded Project	Investigator	Award Number
Atmospheric, Snow and Firn Chemistry Studies for Interpretation of WAIS-Divide Cores	Frey, Markus	0636929
Collaborative Proposal: 2000+ Year Detailed, Calibrated Climate Reconstruction from a South Pole Ice Core Set in an Antarctic - Global Scale Context	Aizen, Vladimir Dunbar, Nelia Mayewski, Paul	0636475 0636515 0636506
Collaborative Research in IPY: Abrupt Environmental Change in the Larsen Ice Shelf System, a Multidisciplinary Approach -- Cryosphere and Oceans	Gordon, Arnold Mosley-Thompson, Ellen Pettit, Erin Scambos, Ted Truffer, Martin	0732651 0732655 0732738 0732921 0732602
Collaborative Research: Anisotropy, Abrupt Climate Change, and the Deep Ice in West Antarctica	Waddington, Edwin Pettit, Erin	0636996 0636795
Collaborative Research: Biogeochemistry and Geomicrobiology of Taylor Glacier Basal Ice	Christner, Brent Skidmore, Mark	0636828 0636770
Collaborative Research: Cosmogenic Radionuclides in the WAIS Divide Ice Core	Caffee, Marc Welten, Kees	0636815 0636964
Collaborative Research: Drillsite Reconaissance and Snow Chemisty Survey in Denali National Park	Kreutz, Karl Wake, Cameron	0713974 0714004
Collaborative Research: Microparticle/tephra analysis of the WAIS Divide ice core	Dunbar, Nelia Kreutz, Karl	0636767 0636740
Ice Stories: A Public Educational Resource for IPY	Miller, Mary	0733048
International Research Fellowship Program: Carbonaceous Particle Concentrations Since the Pre-Industrial Era from Asian Ice Cores	Kaspari, Susan	0653933
IPY: Collaborative Proposal: Constraining the Mass-Balance Deficit of the Amundsen Coast's Glaciers	Das, Sarah Gogineni, S. Prasad Joughin, Ian	0632031 0631994 0631973
IPY: Collaborative Research: A Metagenomic Investigation of Adaptation to Prolonged Cold and Dark Conditions of the Lake Vostok Microbial Community	Carey, Stephen Lanoil, Brian	0632250 0632359
IPY: Collaborative Research: The NEEM Deep Ice Core	White, James Laird, Claude	0632222 0632105
Methyl Chloride, Methyl Bromide, and Carbonyl Sulfide in Deep Antarctic Ice Cores	Saltzman, Eric	0636953
Photochemical Formation and Destruction of Hydrogen Peroxide on Antarctic Snow Gains	Anastasio, Cort	0636985
Pollen Deposition on a Tropical Andean Ice Cap: Testing a New Automated Tauber Trap	Reese, Carl	0724181
Self-consistent Ice Dynamics, Accumulation, Delta-age, and Interpolation of Sparse Age Data using an Inverse Approach	Waddington, Edwin	0636997
Tracing Glacial-interglacial Changes in the Dust Source to Antarctica using Helium Isotopes	Winckler, Gisela	0636898

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