In-Depth

NEWSLETTER OF THE NATIONAL ICE CORE LABORATORY — SCIENCE MANAGEMENT OFFICE

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PolarTREC Teacher Joins Hunt for Old Ice in Antarctica

By Jacquelyn (Jackie) Hams, PolarTREC Teacher
Courtesy: *PolarTREC*

Dave Marchant and Jackie Hams
Photo: PolarTREC

WHEN I APPLIED to the PolarTREC program (http://www.polartrec.com/), I was asked where I would prefer to go given the options of the Arctic, Antarctica, or either. I checked the Antarctica box only, despite the fact that I may have decreased my chances of being selected. Antarctica was my preference for many reasons. As a teacher I felt that Antarctica represented the last frontier to study the geologic history of the planet because the continent is uninhabited, not polluted, and restricted to pure research. Over the last few years I have noticed that my students were very concerned with global climate change and based their opinions primarily on media information and misinformation, and not on science. I thought following me on this trip would open their eyes to the process of the scientific method and what it takes to acquire reliable data. On a personal level, I wanted to visit a unique environment that very few people in the world will ever see.

My experience as a PolarTREC teacher was unique, and took a few twists and turns before I actually left for Antarctica. I was originally selected by the CReSIS (Center for Remote Sensing of Ice Sheets) project, which has headquarters at the University of Kansas. I met and spent a few days visiting the team at the University of Kansas and had dinner at the Principal Investigator's home with other team members. We were all pleased with the match and looked forward to working together.

In the late summer of 2008, I was informed that the project was cancelled and that I would be assigned to another research team. Although I was philosophical regarding the change and rationalized that it was meant to be, I was totally stressed. I like to be well prepared and organized, almost to a fault, and I didn't know how the experience of camping in a remote location with people whom I have never met would turn out. PolarTREC teachers have an active network, and I had already heard some horror stories. What if they didn't like me or if the Principal Investigator did not want to be bothered?

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In-Depth

In-Depth is published semi-annually by the **National Ice Core Laboratory - Science Management Office (NICL-SMO)**.

We are interested in project stories and news from the ice coring community. Please contact us if you are interested in submitting a story or news item to *In-Depth*.

In-Depth **Newsletter**
Mark Twickler (MST), Director
Joe Souney (JMS), Production/Editing

nicl.smo@unh.edu
(603) 862-1991
http://nicl-smo.unh.edu

University of New Hampshire
Institute for the Study of Earth, Oceans, and Space
Durham, New Hampshire 03824

Masthead photos courtesy of Lonnie Thompson and Michael Morrison.

Message from the Director

The news coming out of the North Eemian Ice Drilling (NEEM) project in Greenland regarding reaching the Eemian is extraordinarily exciting. The Eemian ice core record has been sought after in the Northern Hemisphere ever since the days of deep core drilling at Camp Century in the early 1960s. While other paleoclimate proxies record the Eemian, the unprecedented resolution provided by the ice core will shed new light on the climate of our world. We wish our colleagues great success as they drill further back through time.

Looking now to the Southern Hemisphere, the U.S. ice coring community is in final preparations to complete the WAIS Divide ice core project. After over a decade of planning, site selection, camp construction and drilling, the community plans to reach their goal of drilling to 3,330 meters. This record will undoubtedly provide keen insights into our Earth's climate history.

-MST ■

Eric Cravens: Farewell & Thanks!

By Betty Adrian, National Ice Core Laboratory

ERIC CRAVENS' LAST DAY as Assistant National Ice Core Laboratory (NICL) Curator was April 23, 2010. Eric received his BA from the University of Colorado, Boulder in 1995. He majored in Chemistry, Biochemistry, and Molecular Cellular and Developmental Biology. When Eric started his undergraduate studies, ice was not a career option for him.

During the summer of 1991 Eric participated in the field operations for the GISP2 project in Greenland and his interest and, ultimately, passion for working with ice began. Eric had the opportunity to not only work that summer but unexpectedly he became the core processing line (CPL) manager when the Field CPL manager left suddenly. Eric's interaction with Deb Meese led to Eric's return to Greenland in the summer of 1992 to perform physical properties measurements at the remote GISP2 site in central Greenland. During the summers of 1993 and 1994, Eric worked at the NICL in an Assistant Curator role. From May 1997 – January 2000 Eric worked as a research associate at Eltron Research, Inc. in Boulder, CO. During this time he performed prototype development, fabrication and research on total organic carbon analyzers for ultrahigh purity water systems in silicon chip manufacturing.

In January 2000 Eric became a member of the NICL staff and has been an integral member since his arrival at the USGS. He has been instrumental in the development of the current NICL database to track the current inventory of over 16,000 tubes of ice core (almost 50,000 samples!), provided the necessary day-to-day coverage at the NICL when the other two NICL staff members were deployed, an advocate for the ice core collection, and an active participant in the past CPLs.

Eric's Greenland field experience and industrial research background support responsibilities proved to be a great asset in his NICL role. His passion and understanding of the ice and the valuable research it provides

Photo: National Ice Core Laboratory, NICL/USGS

the ice community scientists were evident in the manner in which he worked with the NICL clients. He customized and machined equipment for use on the CPLs to fit the various needs as they developed.

Over the time that Eric has been at the NICL, due in large part to Eric's efforts, great advancements have been made in knowing what exists in the NICL ice core collection and in one's ability to access this information. Eric's philosophy was that the ice core collection needs to stand on its own and be understood by any interested party. Should any tube in the collection be opened and examined, Eric made sure that the labels were clear, the notations helpful, and the history be as complete as possible. While the entire detailed inventory was not completed prior to Eric's departure from the NICL, the NICL is well on its way to completing and fulfilling Eric's vision.

Eric had the opportunity to expand his horizons and work at something else he is passionate about. We wish him well in his newest adventure!

■

WAIS Divide Ice Core Images Now Available from AGDC

THE ANTARCTIC GLACIOLOGICAL DATA CENTER (AGDC) at the National Snow and Ice Data Center is pleased to announce the release of a new data set, WAIS Divide Ice Core Images, Antarctica. This data set is comprised of optical images of ice core sections, acquired with a digital line-scan camera in the cold room facility at the U.S. National Ice Core Laboratory (NICL). WDC06A ice core sections are archival cuts, which have rough-out rounds of ice with a single plane cut along one side. Ice sections were illuminated with fiber optic light guides connected to a 1000 watt (W) xenon light source. Original scan resolution varies from about 0.05 mm to 0.1 mm, and is documented in the metadata for each image. Images are in uncompressed Tagged Image File (.tif) form, with resolutions of 1.0 mm and 0.1 mm. Depth of image in the ice core is documented in the metadata files for each image.

Data are available via FTP as .tif image files. Supporting information is available as ASCII text files (.txt), and other file formats readable with a freely available image processing program, IceImageJ.

Please see the documentation page at http://nsidc.org/data/docs/agdc/nsidc0375_mcgwire/index.html for more detailed information.

Additional ice core data sets are available at the AGDC (http://nsidc.org/agdc/data/paleoclimate.html) or through the Ice Core Gateway (http://www.ncdc.noaa.gov/paleo/icgate.html).

Rob Bauer
Antarctic Glaciological Data Center
http://nsidc.org/agdc/

WAIS Divide Ice Core Update

2009/2010 Field Season Review

CORE RECOVERY for the 2009/2010 drilling season ended as scheduled on January 25 at a bottom depth of 2560 meters. A total of 1049 meters of ice were drilled and the season's core quality was excellent with only a few mid-run breaks. In addition, the brittle ice drilled during the previous season had relaxed and was packaged and shipped to McMurdo Station prior to the start of the drilling season.

Drilling operations started on December 11 and routinely produced 30+ meters per day of perfect 3+ meter long cores. At these depths the gas bubbles have been forced into the ice lattice, making the ice almost glass clear and ductile. The cores occasionally had bands of volcanic ash, some razor sharp, others diffuse, which were a welcome treat.

After the ice was flown from WAIS Divide to McMurdo Station it was transferred into three new "SafeCore" freezer containers. The SafeCore containers were then transported from McMurdo Station to NICL. The SafeCore containers have backup cooling units in the event of a cooling unit failure. They also have generators on board in case of a power outage. We believe this

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Upcoming Meetings

22-23 July 2010
6th Antarctic Peninsula Climate Change Workshop, University of Leeds, UK
www.see.leeds.ac.uk/misc/apcc/

3-6 August 2010
SCAR 2010 Open Science Conference, Buenos Aires, Argentina
www.scar.org/events/#31scarbuenosaires

5-10 September 2010
12th International Conference on the Physics and Chemistry of Ice, Sapporo, Japan
www.lowtem.hokudai.ac.jp/PCI-2010/

15-20 September 2010
International Symposium on Earth's Disappearing Ice, Byrd Polar Research Center, OH
www.igsoc.org/symposia/2010/ohio/

22-25 September 2010
Seventeenth Annual WAIS Workshop, Lake Raystown Resort in Raystown, PA
www.eesi.psu.edu/WAISWorkshop.shtml

30 September - 1 October 2010
2010 WAIS Divide Ice Core Science Meeting, La Jolla, CA
www.waisdivide.unh.edu/meetings/

8-10 October 2010
Northwest Glaciologists' Meeting, University of Alaska, Fairbanks
http://glaciers.gi.alaska.edu/events/northwest/

13-17 December 2010
AGU Fall Science Meeting, San Francisco, CA
www.agu.org/meetings/

3-6 April 2011
European Geosciences Union, Vienna, Austria
http://meetings.copernicus.org/egu2011/

Ice Core Working Group

Karl Kreutz, Chair
University of Maine

Murat Aydin
University of California-Irvine
Gases

Ian Baker
Dartmouth College
Physical Properties

Ryan Bay
University of California-Berkeley
Borehole Logging

Brent Christner
Louisiana State University
Biology

Todd Dupont
University of California-Irvine
Ice Sheet Modeling

Ross Edwards
Desert Research Institute
Ice Chemistry

Tom Neumann
University of Vermont
Surface Glaciology

Erin Pettit
University of Alaska-Fairbanks
Ice Flow Dynamics

Mark Skidmore
Montana State University
Biogeochemistry

Eric Steig
University of Washington
Isotopes

Stefan Vogel
Northern Illinois University
Sub-glacial Environments

Kendrick Taylor
Desert Research Institute
At Large

In 1986, the National Academy of Sciences recommended developing an Ice Core Working Group of representatives from institutions prominent in ice coring activities. 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.

WAIS Divide Ice Core Update

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was the safest transport of a deep ice core ever. The WAIS Divide community is sincerely grateful to Raytheon Polar Services Company and to the National Science Foundation for the procurement and funding, respectively, of the SafeCore freezer containers.

With only 34 days of drilling, and drilling 24 hours/day, the 2009/2010 Field Team was able to recover more than 1000 meters of ice. Photo: Kristina Dahnert, IDDO.

NICL Core Processing Line (CPL)

The NICL CPL began on June 2 this year. Start-up was slow, as to be expected, with new equipment going on-line and new workers on the line. NICL recruited excellent interns and Bruce Vaughn did a great job recruiting students to help out from UColorado. Geoff Hargreaves, as always, keeps things working and moving smoothly. Richard Nunn, brought over from the USGS Core Research Center, has come quickly up to speed on the database and is a pleasure to work with. The entire CPL crew is excellent and extremely capable.

So far we have processed **625** meters of ice. The current depth is **1202** meters, which means we're almost through the brittle ice zone and nearing the ductile ice. The netting applied in the field does an excellent job of keeping the ice intact. There are lots of breaks and spalls in the brittle ice, but for the most part the ice cores are holding together and don't just fall apart as the horizontal cuts are made. Last week we averaged ~**30** tubes (~31 meters) per day.

Our goal is to reach 1300 meters by July 23 and we are on track to complete this milestone. On July 26 we plan to start the ductile ice processing where we hope to increase the production rate to 35 meters per day. Our hope is to process down to about 2030 meters by the end of this summer's CPL.

2010 Science Meeting

The 2010 WAIS Divide Ice Core science meeting will be held on September 30 and October 1 at the Scripps Seaside Forum in La Jolla, California. The meeting will have activities for all of both days and the evening of the 30th. Everyone associated with the project is encouraged to attend (PIs, technicians, students, field support staff, drillers, NICL, and Artist and Writers program participants).

We also currently have four "pre-meeting" meetings scheduled for Wednesday, September 29:
1-2 PM – WAIS Divide Borehole Logging (led by Gary Clow)
2-3 PM – WAIS Divide Replicate Coring (led by Jeff Severinghaus)
3-4 PM – WAIS Divide Executive Committee (led by Ken Taylor)
4-5 PM – Ice Drilling Program Office Planning Meeting (led by Mary Albert)

Full details about the meeting, including deadlines and the online registration form, can be found at:
www.waisdivide.unh.edu/meetings/

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PolarTREC Teacher Joins Hunt for Old Ice

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Fortunately I was "adopted" by Dave Marchant of Boston University who has been conducting research in Antarctica for over twenty years. The goals and details regarding his science research are well documented in my journal (Buried Antarctica Ice Sheets), so I would like to focus on how the research experience affected me.

We worked in a remote field camp in Beacon Valley, Antarctica. Access to the camp was by helicopter only and any water used in the camp was collected from nearby snow banks. I summoned my "inner child" geology student from many years ago to deal with the challenges of primitive camping.

There were many surprises in my research experience. It may sound ridiculous to say that the weather was a surprise because after all, I knew I was going to Antarctica where it would be very cold. That reality hit me during the "Happy Camper" snow school training when I suffered from frostnip. I was further surprised by the winds in Beacon Valley, which literally knocked me to the ground on my third day in the field. As I look back, with the exception of one or two days at camp, I was always cold. The big surprise was that I was able to endure the cold and still function.

Dave Marchant's team was the most pleasant surprise. Dave runs a happy camp and the team members are upbeat and laughing all the time, despite the harsh weather. Dave was very accessible and always eager to answer questions and explain the geology of Beacon Valley. He made me feel like a valued, respected, and competent member of the team, which contributed to my positive experience. I admire his dedication to research and his team's ability to do such hard work in extreme conditions. He was an excellent role model for leadership. It was not difficult to decide how to translate this research experience back to the classroom given the unique geology of the area. The process of debris glacier formation is fascinating and believed to be analogous to what is happening on Mars. The katabatic winds of Beacon Valley provide a great meteorology lesson - especially when students calculate the wind speeds. The Dry Valleys of Antarctica present interesting geography and geomorphology lessons.

> *"We worked in a remote field camp in Beacon Valley, Antarctica. Access to the camp was by helicopter only and any water used in the camp was collected from nearby snow banks."*

Was I changed by the experience? I feel that I gained confidence during my research experience. I assumed the duties of Department Chair at my college when I returned from Antarctica. I was initially intimidated by the administrative politics and the prospect of taking on this leadership role, but now that I am here, I feel well suited to the position and confident that I can do a good job.

Three important transformative life lessons apply to my research experience in Antarctica that may be helpful to students. (1) Go for what you want in life. You may not get it, but if you don't try, you are certain not to get it. (2) Allow yourself to be open to the "accidents" and chance encounters in life. In this case the unexpected afforded me an opportunity to take an incredible adventure and meet and work with extraordinary people. (3) Challenging situations can be opportunities for personal growth. The people closest to me see deeper, more profound changes that extend beyond newly gained confidence, so my research experience clearly changed me in dramatic and subtle ways. ■

To read all of the PolarTREC journal entries from this project visit:
http://www.polartrec.com/expeditions/ancient-buried-ice-in-antarctica/journals

Drilling for Old Ice

JACKIE HAMS' essay (see cover story) on her visit to Antarctica is part of a project that studies ancient ice buried in the Dry Valleys (Antarctica). David Marchant of Boston University and Michael Bender of Princeton University are collaborators on the project that is collecting this old ice. The ice is covered by rock debris, which protects it from sublimating. The investigators use argon and uranium radioisotope techniques to date the ice. Analysis has shown that the ice is over a million years old, making it the oldest ice found on the planet. The researchers are working on how the ice was formed in hopes of providing climatic evidence of past atmospheric conditions more than a million years ago.

The Ice Drilling Design and Operations group at the University of Wisconsin designed and built a special drill called the Koci Drill, named after the late drilling engineer Bruce Koci, that is basically a thin-kerf hand auger powered by a shop drill. It is designed to core ice that contains silt and rocks. The system includes cutters with interchangeable edges: carbide for silty ice and steel for cleaner ice. A small drill press provides pressure on the drill bit when cutting through rock. The drill produces 76-mm (3-inch) diameter cores up to 1 meter long. ■

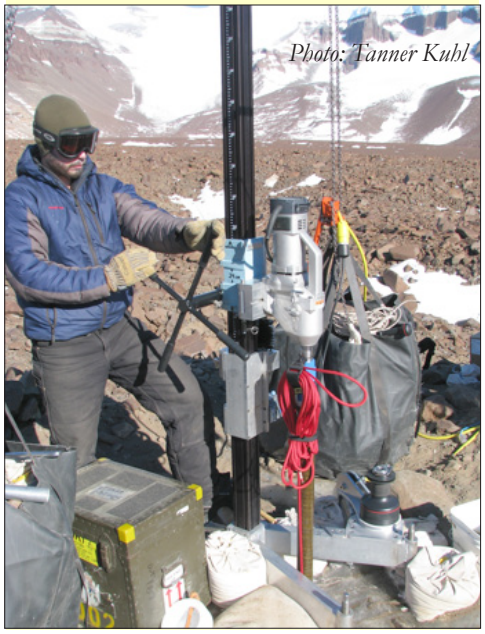

Photo: Tanner Kuhl

WAIS Divide Ice Core Update

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2010-2011 Field Season

The 2010-2011 field season will be the fourth season of deep drilling with the DISC Drill. As usual, we will drill 24 hours per day, six days per week (Sundays off). We will resume drilling at 2560 meters depth and the goal for this season is to get to within ~70 meters of the bed at 3,330 meters. However, this is an ambitious goal that may require more time than is available due to the fact that we will be drilling in 'warm' (due to the geothermal heat flux that heats the ice sheet from below) basal ice.

Drilling in basal ice is challenging and a high risk. The heat from the drilling process is expected to melt some of the ice, which will refreeze on the drill and cause complications. Other warm ice drilling operations have temporary or permanently stuck drills, and produced core at rates of only a few meters per week. We are preparing for these complications by planning on using antifreeze compounds and having engineers experienced in warm ice drilling on site.

In addition to the new ice that will be drilled during the season, there are 530 meters of ice drilled during the 2009-2010 field season wintering over at WAIS Divide that will also be shipped back with the newly drilled ice cores.

- WAIS Divide Science Coordination Office

www.waisdivide.unh.edu

NEEM Reaches Eemian and Approaches Bedrock

EXCITING NEWS from the North Eemian Ice Drilling (NEEM) project!

According to reports from the NEEM field camp, they are now (as of July 18, 2010) at 2,491 meters depth, which means they are a mere ~70 meters from bedrock. More importantly, it is very likely that the NEEM project has reached ice from the Eemian period. This is based on high oxygen isotope values, large ice crystals and high ECM values in the ice that they have been drilling.

A 3.2 m long ice core from almost 2450 m depth is ready to be logged. Photo: NEEM ice core drilling project (www.neem.ku.dk)

According to the June 29, 2010 NEEM field diary, "The freshly drilled cores gives a hint about in which climate the snow was deposited. In cold climates, such as a glacial period, the ice contains high concentrations of dust and other impurities which are often seen in the ice as 'cloudy bands'. The freshly drilled ice is completely transparent, indicating that we are now drilling the Eemian interglacial ice. Another climate proxy is the ice crystal size, which is related to both the impurity content and the temperature history of the ice. In the ice drilled over the last days we've occasionally seen ice crystals that are several cm across, which is also indicating that we are drilling in warm low-impurity ice. The next climate indicator we get [is] from the DEP and ECM measurements, which are measures of the dielectric properties and the conductivity of the ice, respectively. Comparison of those profiles to the corresponding profiles from the NGRIP ice core shows that we are now in the Eemian. Probably the most robust climate indicator we get [is] from the water isotopic composition of the ice which is measured in camp some days after the core is drilled."

NEEM is an international research effort involving 14 nations and led by the University of Copenhagen in Denmark. The University of Colorado at Boulder is the lead U.S. institution. The goal of the project is to retrieve ice from the last interglacial period, called the Eemian, that ended about 120,000 years ago. In Greenland, the Eemian was several degrees Celsius warmer than today, and is our best analog for a potentially warmer future climate. For more information about NEEM, read the NSF press release (International Greenland Ice Coring Effort Sets New Drilling Record in 2009) featured in the Fall 2009 issue of *In-Depth* (http://nicl-smo.sr.unh.edu/indepth/).

For the latest information on how the NEEM field season is going, be sure to read the field diaries at:
http://neem.nbi.ku.dk/field_diaries/

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
Applications of Advanced Laser Spectroscopy to the Ice Core Record of Changes in Climate and Methane Biogeochemistry	Brook, Ed	0944552
Atmospheric CO2 and Abrupt Climate Change	Ahn, Jinho	0944764
Collaborative Research: Establishing the Chronology and Histories of Accumulation and Ice Dynamics for the WAIS Divide Core	Taylor, Kendrick Waddington, Ed	0944191 0944197
Collaborative research: Quantifying the Sensitivity of Antarctic Snowpack Nitrate to Primary NOx Sources and Photodenitrification: Implications for the Ice Core Record	Alexander, Becky Henze, Daven	0944537 0944309
EAGER: A Test for the Younger Dryas Impact Hypothesis	Jacobsen, Stein	1007367
Firn Metamorphism: Microstructure and Physical Properties	Albert, Mary	0944078
Methane Isotope Variations Covering the Holocene from the WAIS Divide Core	Sowers, Todd	0944584
MRI-R2: Acquisition of a Single Particle Soot Photometer (SP2) for Analyses of Black Carbon in the Environment	Kaspari, Susan	0957935
Noble Gases in the WAIS Divide Ice Core as Indicators of Local and Mean-ocean Temperature	Severinghaus, Jeffrey	0944343
The Antarctic Glaciological Data Center: Continued Data Collection, Archiving, and Distribution of Results of NSF-OPP Funded Research in Antarctic Glaciology	Scambos, Ted	0944763
Understanding Atmospheric Sulfur Cycle using Triple Isotopes of Oxygen and Sulfur (ASCTIOS)	Thiemens, Mark	0960594

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