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Digging for Ancient Air at South Pole

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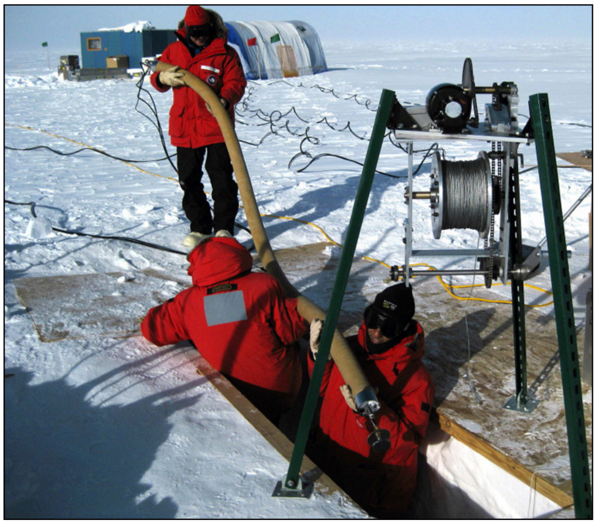
DURING THE AUSTRAL SUMMER of 1911-12, Roald Amundsen and Robert Falcon Scott led the first overland expeditions to reach the geographic South Pole. Imagine for a moment, what it must have been like to stand at the most southerly point on the globe for the first time. Nothing but sun, snow, wind and the satisfaction of being the first people to stand at this historic site. A far cry from the state-of-the-art-facility that now sits at the pole with daily flights, Internet connectivity, and a Frosty Boy that delivers soft serve ice cream 24/7. The snow that these heroic travelers strolled upon is currently buried some 15 meters below the surface. The air they breathed has long since vanished. Or has it?



Murat Aydin and Todd Sowers prepare to sample firn air at South Pole.

Photo courtesy Murat Aydin, UC-Irvine

Today there is a clean air facility at South Pole (operated by NOAA/ ESRL) that has continuously monitored the composition of the atmosphere in this pristine setting since 1975. The instrumentation housed in the clean air facility has evolved considerably since its inception providing more accurate measurements of an ever-expanding suite of atmospheric constituents that are critical for assessing the degree to which man has altered the global atmosphere. One factor that limits the science of assessing the anthropogenic impact on the composition of the atmosphere is the lack of long-term records. For example, atmospheric carbon dioxide (CO_2) measurements were initiated in 1956-7 as part of the International Geophysical Year (IGY). To reconstruct an atmospheric CO_2 record prior to 1956 we've utilized measurements of trapped gases in ice cores, which are somewhat less accurate than direct atmospheric measurements. A composite CO_2 record from the mid-18th century to present is illustrated in Figure 1a. It shows that CO_2 levels have increased from ~280ppm to present day values of 384ppm (a 37% increase).

> *"The CO_2 data provide the chronometer we need to determine the age of the air at each sampling depth..."*

Anyone who has visited the top of an ice sheet knows that the surface is covered with snow, not ice. In the absence of surface melting, progressive snow accumulation increases the load on buried snow causing the density of the snow (more commonly referred to as firn) to

— continued on page 3

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**
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Masthead photos courtesy of Lonnie Thompson and Michael Morrison.

Message from the Director

EVERY FEW YEARS we like to remind the community about the policies for the use of the National Ice Core Laboratory and acquisition of samples from the archive. You can read about these policies, which have been in place for more than 10 years, on page 8 of this issue and visit the link to read the complete policy. Scientific interest in ice cores has been increasing over the years and because of this, NICL has become a very busy place for sectioning newly collected ice cores along with sampling of the archive. To properly plan for allocation of NICL resources we need to know what is being proposed for the use of NICL. This is to allow us to meet your needs and serve you better. We thank you in advance for reviewing the policies.

-MST ■

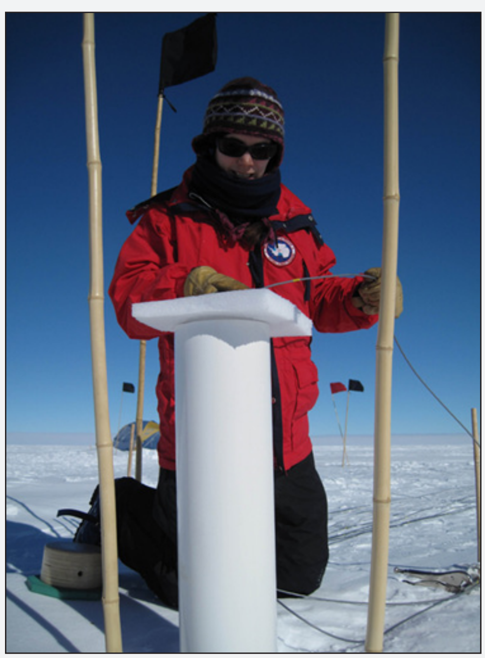
"How Was Antarctica?"

Anais Orsi, Scripps Institution of Oceanography

WHEN PEOPLE ASK ME "How was Antarctica?", I inevitably respond, "It was white!" WAIS Divide resembles most deep ice coring field camps: the white ice sheet extends to the horizon like a frozen sea. On a cloudy day, when the light is flat and the horizon indistinguishable, it really feels like being nowhere.

Our camp is actually almost like a small town: we have a post office ("COMMS"), a restaurant (the galley, also called the "oWAISis"), a theater ("REC"), a medic, a mechanic, a carpenter, and even two gas stations - one for the planes, and one for the snowmobiles. We have our suburbs, which we call "Tent City". Most of us choose to live in Tent City, which consists of individual non-heated tents, but we do enjoy the comforts of modern life, like liquid water and heated common areas. WAIS Divide town is a bit like a busy ant colony. Once the camp is fully set-up, drillers and ice core handlers work around the clock to produce as much ice core as possible in our ~2.5 month-long summer field season (~mid-November through January).

This year, we drilled through the sensitive "brittle ice" with a new technique, allowing us to cut the core down hole, and bring to the surface two and a half meters already cut. As the name implies, brittle ice can fracture on its own, making a popping sound, without any stress applied to it. It is impossible to cut it at the surface: merely touching it with the saw causes it to break into many pieces! To minimize the chances of breaking the cores, we left them in a storage trench at WAIS Divide (which stays below -25 degrees Celsius), where they will have a year to slowly adjust to surface pressure and temperature before they are sent back to the US.



Anais Orsi adjusting the depth of the borehole thermometer at WAIS Divide, Antarctica. Photo courtesy Dave Ferris, SDSU.

> *"...what really attracted me to climate research is the fact that it is interdisciplinary."*

The large-scale fieldwork at WAIS Divide provides an opportunity for students in glaciology to get a taste of Antarctica. Each year, approximately ten students working on the WAIS Divide ice core or other similar projects are chosen as core handlers. As part of my graduate work at Scripps Institution of Oceanography in La Jolla, CA with Dr. Jeff Severinghaus, this is how I became involved with Antarctic research. Like many other students in my field I have a passion for the outdoors, but what really attracted me to climate research is the fact that it is interdisciplinary. The problems I study are a mix of physical oceanography, atmospheric science, glaciology, numerical modeling, basic physics, and chemistry, all of which suit my diverse interests.

I am working on the top portion of the WAIS Divide ice core, which corresponds to the recent past. I am reconstructing the temperature history at WAIS Divide during the "Little Ice Age", a cool period between approximately 1350AD and 1900AD. This was a time when glaciers advanced all over Europe, and the Dutch could ice skate on canals in the winter. Although there is much evidence of the Little Ice Age around the

— continued on page 5

Digging for Ancient Air at South Pole

— continued from page 1

increase with depth below the surface. Air in the upper few meters of firn directly below the surface is readily mixed throughout the open channels around the firn grains. As the density increases with depth, the open porosity decreases thereby limiting the ability of air to mix (via diffusion) with the overlying atmosphere. As a result, firn air ages with depth until it is locked into bubbles. The bubble close-off region is some 120 meters below the surface at South Pole. It turns out that the air right above the bubble close-off region at South Pole dates to the early part of the 20th century when Amundsen and Scott arrived at the South Pole for the first time. The air in the firn at South Pole retains a record of atmospheric compositional changes spanning the last century.

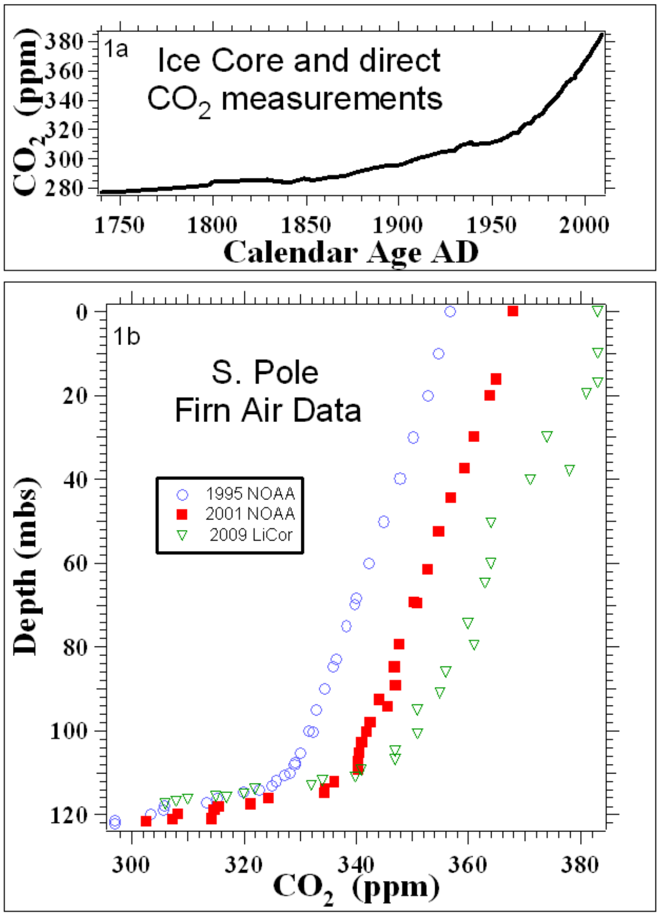


Figure 1: *CO_2 records covering the last two centuries. Ice core CO_2 record between 1750 and 1979 (Etheridge et al., 1996) combined with direct atmospheric measurements from the clean air facility at South Pole beginning in 1957 are plotted in 1a (ppm stands for parts per million). In 1b, we plot the firn air CO_2 results from three expeditions as a function of depth (meters below surface, mbs). CO_2 data from the '95 and '01 flasks were generated at NOAA/ESRL. The 2009 data are from our LiCor measurements in the field and will be replaced with more accurate NOAA/ESRL data when they become available. All NOAA/ESRL data were kindly provided by P. Tans and T. Conway and can be found at http://www.esrl.noaa.gov/gmd/ccgg/.*

There have now been three summer expeditions to South Pole to sample firn air (1994-95, 2000-01 and 2008-09). During each sampling, electromechanical drills were used to incrementally drill holes to specified depths. A rubber bladder with air sampling lines was then lowered to the bottom of the hole and inflated to isolate the firn air at the bottom of the hole. Pristine firn air was then pumped from below the bladder to the surface and into glass/metal flasks that were subsequently analyzed for as many constituents as possible. The CO_2 data from the three expeditions is plotted in Figure 1b (note the 2009 data from NOAA/ESRL are not available yet. The data plotted for 2009 are less accurate values from our on-site monitoring). In each case, the surface CO_2 value agreed with the contemporaneous values measured by NOAA/ESRL from the clean air facility supporting the integrity of our sampling protocol. The CO_2 data show a gradual decrease from surface to ~115m. Below 115 meters, CO_2 values drop very quickly because the air in

— continued on page 4

Upcoming Meetings

15-19 June 2009
AGU Chapman Conference on Abrupt Climate Change, Ohio State University, Columbus, OH
www.agu.org/meetings/chapman/2009/ccall/

6-7 July 2009
IPICS Science Meeting, Oregon State Universiity, Corvallis, OR
www.pages.unibe.ch/ipics/meetings.html

8-11 July 2009
PAGES Open Science Meeting, Oregon State University, Corvallis, OR
www.pages-osm.org/

19-29 July 2009
Joint Assembly of IAMAS, IAPSO, and IACS (MOCA-09): J08 - Ice Cores in Paleoclimate, Montreal, Quebec, Canada
www.moca-09.org/e/J08.shtml

27-31 July 2009
International Symposium on Glaciology in the IPY, Northumbria University, Newcastle, UK
www.scar.org/events/IGS_IPY_Symp_Jun09-2ndCirc.pdf

7-11 September 2009
First Antarctic Climate Evolution (ACE) Symposium, Granada, Spain
www.acegranada2009.com/

27-29 September 2009
WAIS/FRISP 2009 Workshop, Pack Forest Conference Center, Eatonville, WA
http://neptune.gsfc.nasa.gov/wais/index.html

1-2 October 2009
WAIS Divide Ice Core Project Annual Science Meeting, La Jolla, CA
www.waisdivide.unh.edu/meetings/index.html

14-18 December 2009
AGU Fall Meeting, San Francisco, CA
www.agu.org/meetings/

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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.

Digging for Ancient Air at South Pole

— continued from page 3

the few open pores remaining can no longer communicate with the overlying atmosphere. Here, firn air ages with depth based on the annual accumulation rate at South Pole (~6-8cm per year.) The CO_2 values at the bottom of the South Pole firn holes range from 290 to 306ppm (Figure 1b) and correlate well with CO_2 values from the Law Dome ice core dated between 1880 and 1920AD (Figure 1a).

> *"These isotope records provide independent means of assessing historical CH_4 emission scenarios that involved a multitude of both natural and anthropogenic CH_4 sources."*

The CO_2 data provide the chronometer we need to determine the age of the air at each sampling depth and allow us to tune a firn air diffusivity model. The model is then used to reconstruct the composition of other atmospheric constituents that we measure in the flasks spanning the last century. For our most recent expedition (2008-09) we will measure the isotopic composition ($^{13}C/^{12}C$ and D/H) of methane (CH_4) in the returned flasks to reconstruct the atmospheric isotope variations over the last century. These isotope records provide independent means of assessing historical CH_4 emission scenarios that involve a multitude of both natural and anthropogenic CH_4 sources. Non-methane hydrocarbons (e.g. ethane, propane and butane) will provide clues to changes in the oxidative capacity of the atmosphere and can be useful in understanding the causes of variability in methane. Measurements of changes in the O_2/N_2 ratio of the air provide important information for constraining terrestrial (including anthropogenic) and marine sources and sinks of O_2 and CO_2 to the global atmosphere. These measurements are crucial for an improved understanding of the CO_2 sources that have contributed to the CO_2 buildup illustrated in Figure 1a. Measurements of several halogenated species will help us evaluate halogen transport to the stratosphere where they catalyze the destruction of ozone. We will also analyze for carbonyl sulfide (COS), which is the most abundant sulfur containing gas in the troposphere and contributes to formation of sulfate aerosols in the stratosphere.

It is very clear that Amundsen and Scott had plenty to think about as they stood at the geographic South Pole nearly a century ago. Nonetheless, one thing we can be sure they were not thinking about was the composition of the air that they were breathing. Efforts to recover and measure the composition of firn air from South Pole allow us to reconstruct the atmosphere during their arduous expeditions and identify important changes that have occurred since then.

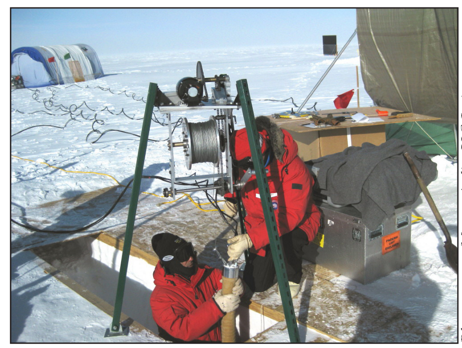

Photo courtesy Murat Aydin, UC-Irvine

Sampling firn air at South Pole.

Acknowledgments:
Firn air data would not be available without the help of the drillers. On the 2009 South Pole drilling team, we'd like to thank Mike Waszkiewicz and Bella Bergeron for their expert drilling services as part of Ice Coring and Drilling Services (ICDS). All the staff/support at South Pole along with the 109th ANG were essential for success during all three expeditions. Science support comes from the National Science Foundation, Office of Polar Programs.

Reference:
Etheridge, D. M., Steele, L. P., Langenfields, R. L., Francey, R. J., Barnola, J.-M., and Morgan, V. I. (1996). Natural and anthropogenic changes in atmospheric CO2 over the last 1,000 years from air in Antarctic ice and firn. Journal of Geophysical Research 101, 4115-4128.

“How Was Antarctica?”

— continued from page 2

An ice core sample melts under vacuum to release the air bubbles. Photo courtesy of Anais Orsi, Scripps Institution of Oceanography.

world, the cause of this cold spell is not fully understood. In particular, its manifestation in the Antarctic remains to be explored. Did penguins feel the Little Ice Age? Did they feel it at the same time as Vikings did in Greenland? Or was it delayed? Understanding those things will help us pinpoint potential causes of this climate anomaly. Looking at the timing also helps us understand internal dynamics of the climate system, and this, in turn, enables us to build better climate models and allows us to make more accurate predictions regarding future climate changes.

To reconstruct temperature history I use two complementary methods. The first one, called borehole temperature logging, consists of taking a precise thermometer with a very long cable and lowering it down a hole left over by a previous ice core (the “borehole”). The ice sheet is actually a good insulator, and changes in the temperature of the ice do not get smoothed out very quickly. Long-timescale temperature changes, such as ice age cycles, are clearly recorded in the borehole but rapid seasonal or decadal changes are erased. To measure faster changes, I use the bubbles of ancient air trapped inside the actual ice core. The isotopes of nitrogen and noble gases like argon and krypton inside those bubbles record a temperature signal: the temperature difference between the surface of the snow and the depth at which snow turns into ice and locks in the air bubbles (about 76 meters at WAIS Divide, Antarctica). Abrupt changes in climate will create such a temperature gradient, and affect gas isotopic composition. By combining noble gas isotopic measurements with borehole temperature, I can get an accurate temperature record.

> *“Did penguins feel the Little Ice Age? Did they feel it at the same time as Vikings did in Greenland? Or was it delayed?”*

The first part of my work consisted of building the thermometer and calibrating it in the lab. In the field, it takes just a few days to conduct the borehole temperature measurements. The ice analysis, however, is much more time consuming. Once we finish drilling at the end of January, the ice is shipped by vessel back to the United States, and reaches the National Ice Core Laboratory (NICL) in Denver, CO sometime in April. Once the ice reaches NICL, we cut and distribute the samples to all the labs participating in the ice-coring project, and it finally reaches my own lab in the middle of the summer. The proper analysis takes me about a year to complete, but this is only the beginning. Once I get all the data, I need to undo step-by-step what nature has done and go back in time with an inverse model. Finally, after all this, I get my surface temperature record of WAIS Divide. Only then can I start answering the science questions I mentioned above and put it all in the context of global climate. Other students, post-docs, and researchers are working at the same time to reconstruct other climate records. A lot of effort goes into dating the core, and my own results depend upon it. Through different studies we learn not only about temperature but also about storminess, how much it snowed in the past, how the concentration of greenhouse gases have changed in the atmosphere, how many fires there were at lower latitudes, and much more. We even learn about volcanic eruptions and all sorts of other things! All of these data sets complement one another, and we get much more out of looking at them in concert than we do looking at one individual record.

It takes a lot of effort to drill an ice core - more than 40 people go down to Antarctica for the ~2.5 month-long field season, and 20 laboratories work year round analyzing the ice core - but in the end it is the only way to understand how certain parts of the climate system interact and to provide accurate benchmarks to climate models so that we can more accurately predict the consequences of climate change in the future. This is what the WAIS Divide expedition is all about: obtain the best possible data to better understand how the Earth’s climate works.

New Ice Drilling Agreements for NSF-Funded Research

THE ICE DRILLING PROGRAM OFFICE (IDPO) and the Ice Drilling Design and Operations group (IDDO) were established by the National Science Foundation (NSF) effective October 2008 to coordinate long-term and short-term planning in collaboration with the greater U.S. ice science community, and to be the principle supplier of ice drilling and ice coring support and expertise for NSF-funded research.

The IDPO consists of Mary Albert (Executive Director) at Dartmouth College, Charles Bentley (Director of Drilling Technology) at the University of Wisconsin (UW), and Mark Twickler (Director of Communications) at the University of New Hampshire. The IDPO provides scientific leadership and oversight of ice coring and drilling activities funded by NSF and also oversees the IDDO.

Photo by Stephen Profaizer, NSF

A drill used to extract ice cores in Antarctica. Ice drilling is vital to a wide range of scientific research. The IDPO/IDDO will work with the U.S. ice science and drilling communities to facilitate planning efforts and be proactive in the planning and coordination that is necessary to form and execute continuously evolving ice drilling and science programs.

The IDDO, led by Charles Bentley at UW, provides engineering design support for new ice drilling systems as well as the operation and maintenance of existing drill systems. The IDDO cooperative agreement from NSF replaces the previous NSF contract to University of Wisconsin-Madison's Space Science and Engineering Center (UW-SSEC) for the Ice Coring and Drilling Services (ICDS) activity. Under the new NSF agreement, personnel from the ICDS group will provide IDDO operations and drilling services under IDPO oversight. The equipment purchased and developed by ICDS is now under the purview of the IDDO. The UW-SSEC group known as ICDS may provide drilling services for funding sources outside of NSF, under the name ICDS.

If you are preparing a NSF proposal that includes use of drills or requires any kind of coring or drilling support from the IDPO as part of your proposed project, you should notify the relevant NSF program director and also contact IDPO via an email to IceDrill@Dartmouth.edu at least four weeks before you submit your proposal. This email will be received by the IDPO collaborators and by IDDO. Personnel from IDDO will contact you to discuss your needs, coordinate a letter of support with IDPO, and provide a letter with a cost estimate. This letter must be included as Supplemental Information with your proposal.

If you have any questions, please contact the IDPO at IceDrill@Dartmouth.edu. For more information about IDPO/IDDO, please visit the project website at www.icedrill.org.

Ice Drilling Program Office
Mary Albert, Executive Director
Charles Bentley, Director of Drilling Technology
Mark Twickler, Director of Communications

WAIS Divide Season Two A Success

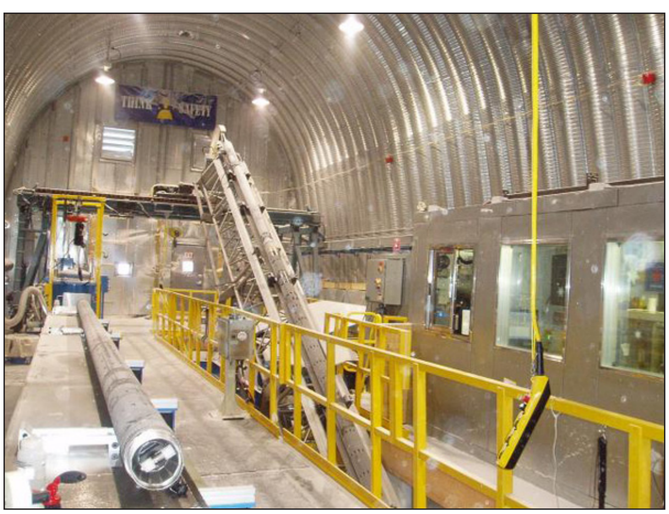

Photo by Jay Johnson, ICDS

The DISC Drill tilts back into vertical position to resume drilling.

DEPSITE A TWO-WEEK DELAY due to budget cuts and heavy equipment problems at camp, the second field season of the West Antarctic Ice Sheet (WAIS) Divide Ice Core Project was extremely successful. The first core of the season was drilled on December 16 from a depth of 580 meters. Around-the-clock drilling operations began on December 22 and 31 days later, with only four rest days, we met our drilling goal for the season. Drilling ended on January 22, one day ahead of schedule, with the arch facility's core storage basement filled to capacity with ice cores. The final borehole depth was 1510 meters in ice that is about 7,700 years old.

Most of the season was spent drilling brittle ice, in which the gas pressure in the ice is sufficient to spontaneously fracture the core when it is brought to the surface. Several new methods were used to maximize the core quality of the brittle ice. The resulting core quality is the best we have ever seen

— continued on page 7

WAIS Divide Season Two A Success

— continued from page 6

Photo by Logan Mitchell, Oregon State University

The DISC Drill sonde with the last ice core of the season.

for brittle ice. By 1310 meters depth, the pressure was sufficient to push the air bubbles into clathrates and the ice was no longer brittle. Below this depth we pulled up clear, unfractured 2.5-meter pieces of ice. For a description of the new methods used, please read the February 2009 WAIS Divide Quarterly Update located at www.waisdivide.unh.edu/news/quarterlyupdates.html.

In addition to drilling and collecting core, we measured the electrical properties of the ice cores. The electrical measurements were made in the field where the core quality is best. The electrical measurements show strong well-resolved annual layers that will be used to determine the age of the ice. In addition, John Fegyveresi (Penn State) made vertical and horizontal thin sections of the ice below the brittle ice zone, Anais Orsi (Scripps Institution of Oceanography) made borehole temperature measurements (see story page 2) in a different 300-meter borehole that will be used to help interpret the gas records, and Bess Koffman (University of Maine) collected snow pit samples that will be used as part of the trace chemistry work.

We currently have 932 meters of brittle ice (drilled this past season) stored in the arch basement at WAIS Divide. We are allowing the ice to relax over the Antarctic winter so that it will be less susceptible to damage during shipment back to the U.S. in February 2010. This leaves us with the task of recovering the remaining ~2,040 meters of ice and shipping ~3,000 m of ice back to the U.S. If Raytheon Polar Services can increase the time available for drilling by a few weeks per season, and if ICDS can recover more core per drill trip down the borehole, we should finish the main drilling in January 2011. The current plan is to stop drilling before we have a hydraulic connection with the basal environment. This is an NSF requirement. That means stopping 50 to 30 meters above the bed of the ice sheet, depending on how accurately we can determine the depth to the bed. It is unlikely we will have a significant amount of time for borehole logging in January 2011, but we will try to do temperature logging in January 2011. We will have about four weeks for logging in November and December 2011. This will be the main logging period. In January 2012 we will start replicate coring, which will continue through the following season (2012-13). Due to anticipated structural issues with the arch facility at WAIS Divide, we anticipate that the 2012-13 season will be the last season of working inside the arch. The borehole will be left in a condition suitable for logging after 2012-13, which will likely consist of just the borehole casing on the ice sheet surface.

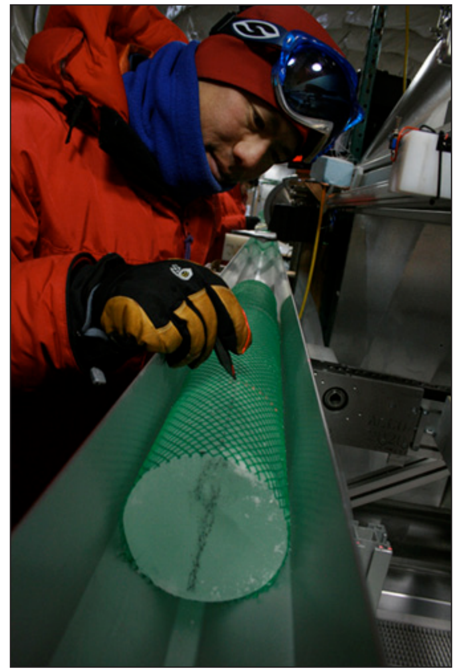

Photo by Anais Orsi, Scripps Institution of Oceanography

Gifford Wong examines an ice core.

Photo by Jay Johnson, ICDS

The ice core storage basement, which currectly has ~950 meters of brittle ice in it wintering over at WAIS Divide.

As a reminder, investigators from the U.S. need to submit a proposal to NSF to obtain samples from the WAIS Divide ice core or to access the borehole for logging. If you are planning on submitting a proposal you must contact the WAIS Divide Science Coordination Office (SCO) (kendrick@dri.edu) and obtain a letter from the SCO stating that your proposal is consistent with the WAIS Divide operation plan. This letter needs to be submitted with your NSF proposal.

WAIS Divide Science Coordination Office
www.waisdivide.unh.edu

NICL Use and Accessing Ice Cores

THE U.S. NATIONAL ICE CORE LABORATORY (NICL) is a government-owned facility on the grounds of the Denver Federal Center. NICL provides approximately 50,600 cubic feet of safeguarded freezer space, which is maintained at a temperature of -35 degrees C for the storage of ice cores collected from the polar ice sheets and glaciers from around the world. NICL currently contains approximately 17,000 meters of ice cores collected mostly by scientists funded by the National Science Foundation (NSF) that are available for study. NICL also includes a series of cold examination rooms, staging and changing areas, as well as instruments and equipment for routine examination and processing of ice cores. The NSF supports the majority of the costs of operating NICL, in partnership with the U.S. Geological Survey-Geological Division. Requests for samples from NICL are coordinated through the NICL-Science Management Office (NICL-SMO). Samples are available to any qualified investigator, but NSF funded investigators may be given priority to certain ice core sections. Decisions on sample allocation are coordinated by the NICL-SMO and made by the Sample Allocation Committee, appointed by the Ice Core Working Group, with final approval from NSF-OPP. The Scientific Coordinator of NICL-SMO, Mark Twickler, is the central point of contact for requests for ice core samples.

Investigators interested in obtaining samples from NICL or using the NICL facility are required to familiarize themselves with the NICL Use and Ice Core Sample Allocation Policy, located on the NICL-SMO website at http://nicl-smo.unh.edu/access/policy.html . The following is an overview of the guidelines for accessing NICL ice cores, storing ice cores at NICL, and using the NICL facility.

Questions should be addressed to the NICL-SMO Scientific Coordinator (Mark Twickler; 603.862.1991; nicl.smo@unh.edu).

Accessing Ice Cores

Two steps must be followed before scientists are granted access to the ice cores at NICL.

Step 1:

Scientists interested in obtaining ice from NICL must contact the NICL-SMO located at the University of New Hampshire and obtain a core grant. NICL is not authorized to release any ice core, nor to cut any archived ice core, without prior approval by the NICL-SMO. Investigators must contact the NICL-SMO Scientific Coordinator at least three weeks before submitting a proposal to a funding agency and must include details of expected usage of the NICL facility in the proposal. In order to initiate the core grant process, contact Mark Twickler at 603-862-1991 or nicl.smo@unh.edu. Before contacting NICL-SMO, scientists should first read and become familiar with the NICL Use and Ice Core Sample Allocation Policy (see website address above). Non-U.S. scientists and non-NSF funded scientists may be

Photo courtesy of the National Ice Core Laboratory, NICL/USGS

NICL currently stores over 17,000 meters of ice core collected from various locations in Antarctica, Greenland, and North America

required to have an NSF funded collaborator before they can be given access to certain ice cores.

Step 2:

Once access has been granted by the NICL-SMO, the scientist can call 303-202-4830 or email nicl@usgs.gov to schedule a sample visit at NICL.

Storage of Ice Cores at NICL

Ice cores from glaciers and ice sheets obtained through NSF and USGS-funded programs will be accepted for storage at NICL. Investigators must contact the NICL-SMO during the planning stages of a project when the proposal is being submitted to obtain permission to ship their cores to NICL if the proposal is funded. Only ice cores made of meteoric ice are authorized for storage at NICL. No sea ice cores or permafrost cores are permitted in the NICL facility.

Conditions of the Principal Investigator's proprietary rights to the core must be established when an investigator first contacts NICL to ask permission to store ice cores there. NICL expects that investigators, either individually or in groups, may want exclusive access to a core obtained by them for a limited but defined period of time following acquisition of the core. The conditions of these exclusive rights (including the duration of the period of exclusive access) should be established at the stage of proposal funding, so that the conditions may be considered as part of the peer-review process. For cores from NSF-funded programs, the program supporting the work, with the concurrence of the Scientific Coordinator, should establish these conditions. NICL will accept cores with proprietary rights attached under these circumstances.

— *continued on page 9*

NICL Use and Accessing Ice Cores

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Scientists cut samples from an ice core during a core processing line at NICL.

Use of NICL

The NSF and USGS support NICL. Investigators funded by these agencies may access the facility's resources. Investigators must contact the Scientific Coordinator at least three weeks prior to submitting a proposal to the funding agency, and must include details of expected usage of the NICL facility in the proposal. Multi-investigator projects should designate a single point of contact who will work with the Scientific Coordinator and NICL.

Investigators funded by agencies other than NSF and USGS wishing to use NICL must contact the Scientific Coordinator prior to proposal submission to obtain permission to use the facility and work out details with NSF and USGS. Use includes but is not limited to storage of ice cores or samples, use of NICL workspace, use of staff time or other resources. The Scientific Coordinator will work with the investigator and NICL staff to determine the scope of work and provide a cost estimate. These costs will be born by the agency funding the work and must be negotiated in advance of access to the facility.

Please note: These are not new policies, just a reminder about existing policies.

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
CAREER: The Atmospheric Chemistry of Ice and Snow	McNeill, V. Faye	0845043
Collaborative Project: Ice Drilling Program Office (IDPO)	Albert, Mary Bentley, Charles Twickler, Mark	0841308 0841225 0841166
Collaborative Research: Combined Physical Property Measurements at Siple Dome	Spencer, Matthew	0917509
IPICS Workshop on Science and Technology for the Next Generation of International Ice Coring, Corvallis, OR July 6-7, 2009	Brook, Edward	0930059
Provision of Ice Drilling Design and Operation Group (IDDOG)	Bentley, Charles	0841135

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