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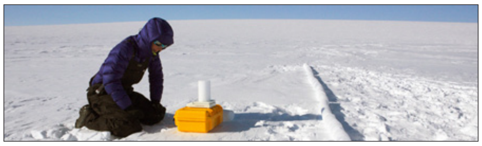

Betty Adrian, NICL Technical Director, Retires

By Betty Adrian, Technical Director, NICL (retired)

ON APRIL 10, 1978 BETTY ADRIAN BEGAN HER USGS CAREER. She was hired as a geologic field assistant to assist in the collection of samples that would help determine the mineral resource potential for metallic minerals in the Wallace 1° x 2° quadrangle, Montana and Idaho. She was a member of a branch that was organizationally located in the Geology Division, Office of Mineral Resources. What was supposed to be a summer appointment turned into a 38-year career! After the first summer of field work Betty prepped samples and then learned the science (and art) of optical emission spectroscopy. She also learned how to drive "the dually" and began pulling a fifth wheel trailer that contained her spec instrument at the age of 23.

Betty became a "Jane of all trades" while working in the "spec lab" fifth wheel. She was the plumber and electrician when she took the fifth wheel trailer to the field. Locations of this fieldwork were Lone Pine, California; Mt. Shasta, California; and Lake Havasu City, Arizona. In 1988 Betty's team moved to Building 20 at the Denver Federal Center. She continued to work in the chemistry lab but by 1989, she realized she preferred working with people rather than rocks and chemicals. It was at that time that she enrolled in Regis College's new Master of Science in Management Program. Her thesis, "*Development and Implementation Plan of a New Organizational Design in a Government Chemistry Lab*," was the framework that was used to make changes at the Branch of Geochemistry labs. One of her proposed options was to go from two lab chief positions to one. One of those lab chief positions was hers!

Betty found herself back working in the lab as a bench chemist but it wasn't too long

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Betty Adrian, NICL Technical Director, Retires

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and she was soon working with people (not chemicals!) as the Associate Branch Chief for the Branch of Geochemistry. The mid-1990s was a rough time for those who were in the Geologic Division (GD). Due to substantially reduced funding GD went through a reduction-in-force (RIF) and reorganization. Under the new post-RIF organization Betty went back to perform analyses on rocks. This only lasted for a while as she preferred working with people and not chemicals. Soon she was the Associate Team Chief Scientist of Operations for the Central Region Minerals Team. She oversaw the facilities (which included many labs), the computer group, and moved a lot of people in/out of the space. She helped renovate many offices and labs in Bldg. 20 in an effort to help scientists perform their jobs much better.

With opportunities comes challenges, soon this large team was too large and was divided into two smaller teams. Betty stayed on as Associate Team Chief Scientist for both of these teams. At that time she was the only person in GD who held the same positions in two different teams at the same time. In 2007 a new opportunity knocked on Betty's door. This time it was as the Core Research Center Director. This opportunity was seized and she moved up to Bldg. 810.

While she was in Bldg. 810 several other opportunities were placed in front of her. She seized these opportunities and eventually became the National Ice Core Laboratory Director and the National Geological and Geophysical Data Preservation Program Coordinator along with the Core Research Center Director. Betty has also become very active in the USGS collections-related efforts. In 2008 she chaired the Geologic Materials Repository Working Group that investigated and, ultimately, published the "*The U.S. Geological Survey Geologic Collections Management System (GCMS): A Master Catalog and Collections Management Plan for U.S. Geological Survey Geologic Samples and Sample Collections*". In light of all the federal mandates to appropriately preserve and make federal collections available to the public, Betty helped establish the USGS Collections Steering Committee. She was one of the first co-chairs of this very important committee. As a bench chemist for many years Betty analyzed and generated millions of analytical records. Now she was helping preserve samples and ensure the public could gain access to the data and samples.

Betty has thoroughly enjoyed the opportunities to work with so many people from very diverse backgrounds. She will take into retirement many things she learned during her 38-year career. She learned that it was far more important to work smart and hard, not just hard. She learned that if she didn't ask for something, she had already assumed the answer was "no". She learned to accept challenges as they can turn into great opportunities. She learned the importance of paying it forward. She will smile every time she and her husband, Ken, travel with their fifth wheel as she also learned how to back up fifth-wheel trailers as one of her tasks early in her 38-year USGS career! Never underestimate skills learned on the job. Many of those skills are transferable – in your work or pleasure!

Betty officially retired from the USGS on April 30, 2016. The USGS has advertised the vacancy for her position and will be interviewing potential candidates in the near future. There are several iterations of the interview process, which will take several months. In the interim Betty has returned on an intermittent basis to assist with several of her previous roles. She will continue to work with NSF and NICL staff to ensure a continuity of effort until her replacement has been identified and is comfortable in his/her new role.

■

The U.S. National Ice Core Laboratory (NICL) is a facility for storing, curating, and studying meteoric ice cores recovered from the glaciated regions of the world. It provides scientists with the capability to conduct examinations and measurements on ice cores, and it preserves the integrity of these ice cores in a long-term repository for current and future investigations. NICL is funded by the National Science Foundation Division of Polar Programs and operated by the U.S. Geological Survey. Scientific management is provided by the University of New Hampshire.

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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Princeton researchers go to the end of the Earth for the world's oldest ice

By Morgan Kelly, courtesy of Princeton University Office of Communications

The researchers' base camp at Allan Hills, Antarctica. –Credit: Sean Mackay, Department of Geosciences [Princeton University]

WHEN ONE IS ALREADY IN POSSESSION of the world's oldest chunk of ice, perhaps it's only natural to want to go older.

John Higgins, a Princeton University assistant professor of geosciences, led a team of researchers who reported in 2015 the recovery of a 1-million-year-old ice core from the remote Allan Hills of Antarctica, the oldest ice ever recorded by scientists. Analysis of the ice showed that the concentration of carbon dioxide in the Earth's atmosphere was higher than in the oldest ice core previously, which was 800,000 years old. It also confirmed that atmospheric carbon dioxide and Antarctic temperatures have been directly proportional – as one increased so did the other. The ice is stored in Princeton's Guyot Hall in a freezer kept at -30 degrees Celsius.

But Higgins wants to go further back in time. He and four other researchers returned to the Allan Hills for seven weeks from mid-November to mid-January hoping to come away with even older ice, preferably 1.5 million to 2 million years old. The work is supported by a $700,000 grant from the National Science Foundation.

"We're currently in possession of some of the oldest ice that's been dated and we want to push that further," Higgins said in November, days before he and his team took off for the Allan Hills via New Zealand. Gases such as carbon dioxide and methane trapped in the ancient ice could provide clues about conditions on Earth in the distant past – and what they could be in the future if greenhouse gas emissions continue to rise.

Higgins traveled with research specialist Preston Kemeny, graduate student Yuzhen Yan and postdoctoral researcher Sean Mackay, all in the Department of Geosciences, and drill operator Mike Waszkiewicz of the U.S. Ice Drilling Program. The five men endured the harsh open ice shelf, camping an hour flight by prop plane from McMurdo Station, the research center on the Ross Ice Shelf operated by the National Science Foundation.

Temperatures hovered around -15 degrees Celsius, despite it being the height of the Antarctic summer. Winds sustained a speed of 25-30 miles per hour, slightly less than a tropical storm. Storms lasted five days straight and left behind drifts 12 feet tall.

The photo and video essay below captures the researchers' experience in one of the world's most unforgiving places, and explains the techniques and significance of their work.

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Princeton researchers go to the end of the Earth for the world's oldest ice

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Researchers led by John Higgins (above, holding ice core), a Princeton University assistant professor of geosciences, spent seven weeks in Antarctica drilling for ice cores over 1 million years old, which would be the oldest collected. The ice could provide a snapshot of how Earth's climate was – and what it may become. –Photo by Preston Cosslett Kemeny, Department of Geosciences [Princeton University]

The researchers' camp was in the Allan Hills, about 130 miles northwest of the National Science Foundation's McMurdo Station research center. The team spent two weeks at McMurdo safe-checking their equipment and gathering supplies. The initial journey to the camp was done in four one-hour trips by plane, moving a total of four tons of goods and gear, Higgins said. The drill and associated equipment alone weigh about one ton. – Illustration by Maggie Westergaard, [Princeton University] Office of Communications

Preston Kemeny (pictured), a research specialist in the Department of Geosciences who was in Antarctica for the first time, carries an ice auger and marker flags. The invaluable research experience of being in the field in Antarctica comes at the cost of spartan living in a harsh, isolated environment. "It's stunningly beautiful and there's a tremendous amount of science to be done," said Kemeny, who received his bachelor's degree in geosciences from Princeton in 2015. "But it needs a lot of logistical support." A plane from McMurdo Station delivered supplies to the camp each week, weather permitting. –Photo by Sean Mackay, Department of Geosciences [Princeton University]

The Princeton team camped for seven weeks on the barren blue ice of the Allan Hills. Strong winds here scour away ice at the surface, bringing up ancient ice from the depths like a giant conveyer belt. "We're letting the glacier do the work for us by bringing the old ice to the surface," Higgins said. For the same reason, blue-ice areas such as the Allan Hills have long been studied for their extraordinary accumulation of meteorites. –Photo by Preston Cosslett Kemeny, Department of Geosciences [Princeton University]

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Princeton researchers go to the end of the Earth for the world's oldest ice

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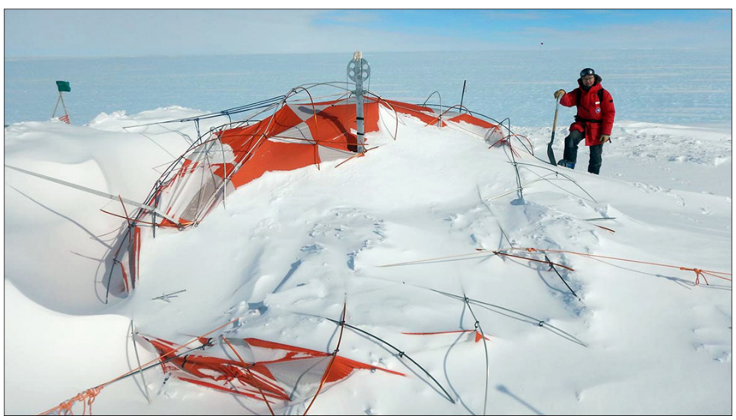
The work Higgins published in 2015 showed that when deployed in the right location drilling shallow cores 100-200 meters long could retrieve the old ice scientists need to understand Earth's past climate without drilling several kilometers into the ice sheet. Higgins and his colleagues came away with the million-year-old ice after drilling 128 meters. The researchers particularly want to go further back in time now to understand a period more than 1 million years ago when ice ages occurred every 40,000 years as opposed to the 100,000-year cycle of the past 800,000 years. "That's a massive change in Earth's climate system," Kemeny said. – Photo by Yuzhen Yan, Department of Geosciences [Princeton University]

The team had three drill sites that they would travel to by snowmobile, hauling the drilling equipment and tent between sites. The team spent all day at the drill site, monitoring the stop-and-start process while trying to stay warm. Only two or three other research groups undertake this kind of fieldwork, said Higgins, shown above carrying a drill bit filled with an ice core. "It's a minority who have deep-field camps and a smaller minority doing their own drilling out there," he said.. –Photo by Yuzhen Yan, Department of Geosciences [Princeton University]



The researchers finally returned to one of the drill sites after the days-long storm to find that their work tent had been destroyed. In the photo above, geosciences graduate student Yuzhen Yan stands ready to dig out the drilling equipment. The researchers ultimately obtained three ice cores: two that are 98 and 205 meters long, respectively, and a 20-meter core from the same drill hole as the million-year-old core. Altogether, the cores weigh 4.5 tons, Higgins said. Packed in individual freezer chests, the ice samples will arrive in the United States from Antarctica in April via Los Angeles then be shipped to the National Science Foundation's National Ice Core Laboratory in Denver. Higgins and his team will begin determining the age of the ice cores in early summer, examining 500 grams of ice per day – or 14 to 15 centimeters of ice core at a time. "If things go well, by next winter we'll have a good idea of how old the ice is," Higgins said. Once the age of the ice is determined, the researchers will work with collaborators to measure the composition of chemicals such as carbon dioxide and methane. – Photo by Preston Cosslett Kemeny, Department of Geosciences [Princeton University]

Base camp is a "small-family situation" of people confined to small tents striving to stay busy, keep warm and get along, Higgins said. "Everyone got along really well," Higgins said. "It's Antarctica, so it's never going to be especially pleasant." The isolation can be perilous in an emergency. In 2010, Higgins developed a severe toothache. He hopped an hour-long resupply flight back to McMurdo Station where he had a root canal performed. He returned to camp on the next supply flight a week later. – Photo by Sean Mackay, Department of Geosciences [Princeton University]

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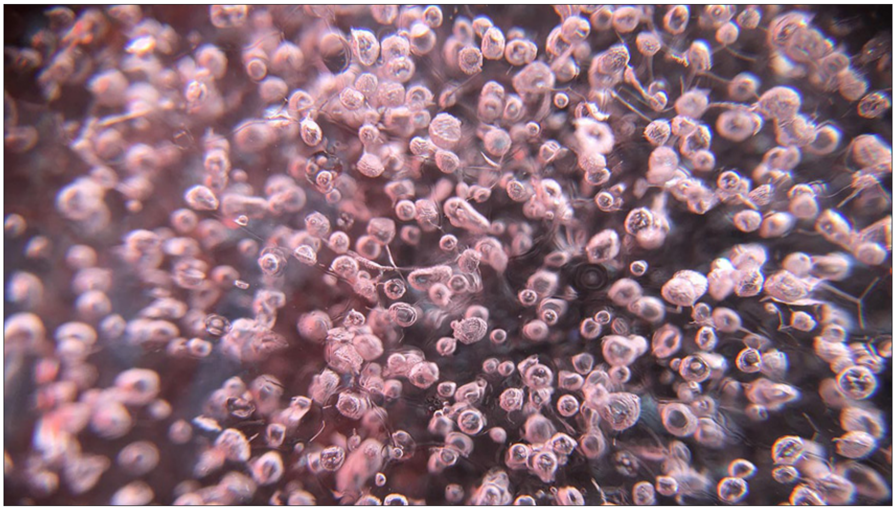
Yan, on his first trip to the southern continent, packs a shipping container with snow to insulate the ice cores and prevent them from melting in transit. The white box weighs nearly 200 pounds and contains nine core segments measuring approximately 30 feet altogether. Despite the all-day sun of the Antarctic summer behind Yan, exposed skin can become frostbitten or, to a lesser extent, frost "nipped" in a matter of minutes. "To do deep fieldwork in Antarctica, you have to be pretty scientifically motivated," said Higgins, for whom it was his third trip to Antarctica. "It involves long time commitments in less than ideal conditions." – Photo by Preston Cosslett Kemeny, Department of Geosciences [Princeton University]



The researchers will date the ice using a technique developed by Michael Bender, Princeton professor of geosciences, emeritus, and Higgins' former postdoctoral adviser. The bubbles in the ice contain trapped ancient air, approximately 1 percent of which is the noble gas argon. The researchers compare the abundance of the three stable isotopes of argon (Ar) – 36Ar, 38Ar and 40Ar – in the trapped air relative to the modern atmosphere. Because 40Ar (but not 36Ar or 38Ar) is continually added to the atmosphere through volcanic emanations from Earth's interior, samples of ancient air from ice cores will contain less 40Ar – but the same 38Ar and 36Ar – than the modern atmosphere. The greater the deficit of 40Ar in the sample, the older the air, and, thus, the older the ice. – Photo by Yuzhen Yan, Department of Geosciences [Princeton University]

This article originally appeared at https://www.princeton.edu/main/news/archive/S45/77/22G94/index.xml ■

Upcoming Meetings

XVI Glaciological Symposium
24-29 May 2016
St. Petersburg, Russia
http://glac2016.igras.ru/publ/

Fourth International Summer School in Glaciology
7-17 June 2016
McCarthy, Alaska, USA
http://glaciers.gi.alaska.edu/courses/summer-school/2016

SCAR 2016 Open Science Conference
20-30 August 2016
Kuala Lumpur, Malaysia
http://scar2016.com/index.php

South Pole Ice Core Science Meeting
19-20 September 2016
La Jolla, California, USA
http://spicecore.org

2016 West Antarctic Ice Sheet Workshop
4-6 October 2016
Algonkian Regional Park, Sterling, VA

2016 AGU Fall Meeting
12-16 December 2016
San Francisco, California, USA
http://fallmeeting.agu.org/2016/

International Symposium on the Cryosphere in a Changing Climate
12-17 February 2017
Wellington, New Zealand
http://www.igsoc.org/symposia/2017/newzealand/

Getting to the bottom of SPICECORE

Researchers drill deep into the ice beneath the South Pole to sample Earth's ancient atmosphere

By Mike Lucibella, Antarctic Sun Editor
Courtesy: *The Antarctic Sun*, U.S. Antarctic Program

Ice that fell as snow ages ago sees the light of day for the first time in thousands of years –Credit: Mike Lucibella

AS THE WINCH EXTRACTED a two-meter-long cylinder of ancient ice in late December, Murat Aydin looked on.

"If we can keep this pace up we should be able to hit 1,600 meters," he said. "This is going to be the deepest ice core drilled at the South Pole by quite a margin."

By the end of the project a month later, researchers with the South Pole Ice Core project, known more succinctly as SPICECORE, had exceeded even their most ambitious goals.

Aydin is an atmospheric chemist at the University of California, Irvine and the lead scientist on SPICECORE. The project wrapped up its two-year drilling effort at the South Pole in late January, having collected ice samples from 1,751 meters (5,744 feet) below the surface, more than 200 meters (656 feet) deeper than the original goal.

"There is no better feeling for a field scientist than coming back home, having surpassed all expectations," Aydin said.

SPICECORE is supported by the National Science Foundation, which manages the U.S. Antarctic Program.

These ancient ice samples are important to climate scientists because sealed inside each ice core are numerous tiny air bubbles, which are essentially samples of atmosphere from before the ice was completely buried. Scientists analyze these trapped bubbles to learn what the Earth's atmosphere was like thousands of years ago. These measurements have become a key tool for climate researchers investigating ancient carbon dioxide levels to better understand the planet's present warming trends.

Though much ice core trace gas research focuses on gleaning insight into ancient carbon dioxide and methane levels, the SPICECORE research will also focus on a different class of gases found at much lower levels in the atmosphere. Measurements of rare gasses like carbonyl sulfide, methyl chloride and methyl bromide offer further details about how the trace gas composition of the atmosphere changed over thousands of years and what impacts the changes in global biogeochemical cycles may have had on it.

The ice started out as accumulated snow at the surface. Each year a new layer of snow builds up on top of the layer laid down the previous year. The weight of all this extra snow compresses the frozen snowflakes together until they fuse and become solid ice. The farther down into the ice sheet the team drills, the older the ice gets. The samples nearest to the bottom could be as many as 50,000 years old.

Setting up shop next to the South Pole station is ideal for the team in part because the station can provide logistical support that would otherwise have to be established for an isolated field camp. Drilling at the South Pole also helps fill in some of the gaps in the scientific record around the continent.

"If you look at all the other ice cores drilled in East Antarctica, they're kind of far away, so there isn't a lot from this region of East Antarctica, climate record wise," Aydin said.

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In addition, the station's location atop the frigid polar plateau is a boon for collecting atmospheric samples.

"We wanted an East Antarctic ice core because of the temperatures," Aydin said. "The ice is a lot colder here, because the annual mean temperature is about minus 50 [Celsius]. For some of the gas measurements we make, colder ice is better."

But on the flip side, the temperatures that help with the science can wreak havoc on the equipment.

"The ice here, because it's colder, it's also harder," said Jay Johnson, a mechanical engineer at the University of Wisconsin, Madison's Ice Drilling Design and Operations (IDDO). "Last season we had a lot of problems with [drill] bits chipping and cracking corners off and things like that, so we had to go to a different process of heat treating the metal this year and that's working much better."

Johnson is one of the chief designers of the drill boring through the ice. The Intermediate Depth Drill (IDD) the IDDO developed is based on an existing Danish drill design called the Hans-Tausen drill but with some modifications. The idea was to develop a design with standardized parts that could be shared between both programs.

"This might be one of the first times that has happened internationally," Johnson said. "That was one of the goals of that too, so we could have some interchangeability between the two countries' systems."

One of the main changes the IDDO made to the original Danish design is that they used fiberglass to make their outer core barrel, the part of the drill bit that's lowered into the hole and sheathes the ice sample while it's brought back to the surface.

"We were able to make these tubes for about ten times cheaper than you can make them out of metal," Johnson said. "They're straighter, more round and run more true. They're probably a little more disposable, probably a little shorter life span maybe than stainless [steel], but the benefit is that they're extremely cost effective."

This South Pole ice coring operation is the first run of the new IDD. It was designed to fill a gap in drilling capabilities between small ice coring drills that can only penetrate about 300 meters (about 980 feet) into the ice, and much larger operations like WAIS Divide that can bore down several thousand meters.

"This is one that had been in the works for a number of years," Johnson

Shawntel Stapleton operates the drill that's boring into the ice under the South Pole. –Credit: Mike Lucibella

The SPICECORE drill hauls up an ice core from hundreds of feet below the surface. –Credit: Mike Lucibella

Murat Aydin cleans cutting fluid off of a recent ice core as he prepares it for storage. –Credit: Mike Lucibella

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Getting to the Bottom of SPICECORE

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said. "The U.S. science community wanted this intermediate depth drill for lighter logistics and easier transportability."

By reducing the amount of support that the drill needs, the system can be deployed more quickly and cheaply than other, larger drills.

"We designed this project to be quick, efficient and get the biggest impact for the buck," Aydin said. "Let's get the most valuable science out of it with the smallest footprint possible."

Because of its smaller size, the IDD can't reach all the way to bedrock nearly three kilometers (1.8 miles) below the surface of the ice. However the lowest layers under the Pole are not ideal ice samples, because the ice that the South Pole rests on is constantly flowing at a rate of about 10 meters (30 feet) a year.

"The ice that we find at South Pole didn't originate here... the deeper you go, the farther away it's coming from," Aydin said. "It complicates the interpretation of the isotope record, especially the deeper sections."

Aydin will return to the South Pole next season to close out the project. The drilling is finished, but the camp still needs to be disassembled. There are also samples that remained behind that need to be packed up and shipped to the National Ice Core Laboratory (NICL) in Denver where cores from previous years are already stored.

"It's a great feeling but I don't feel like it is all over," Aydin said. "It is just starting in a way because we have all this beautiful ice to analyze now. Making good measurements and publishing interesting papers are the next targets now."

In the lab, Aydin works to identify and characterize the rare trace gasses trapped in the ice.

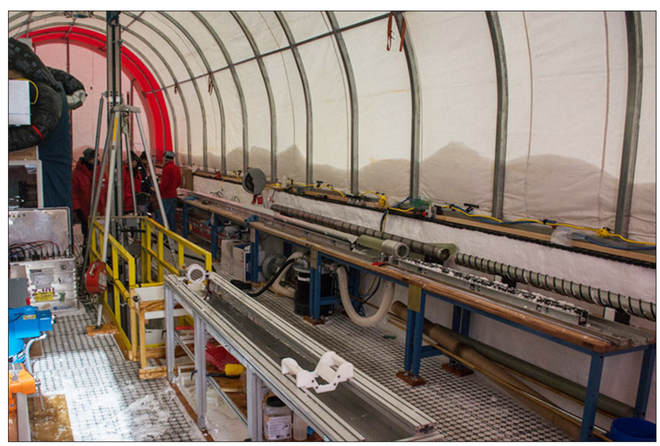
In addition, scientists from around the world will be able to process and analyze the core samples stored at the lab for their own projects.

"There are many measurements that are going to be made and there are different institutions that are going to be involved," Aydin said. "When all is said and done, there's going to be plenty of South Pole ice there for years to come at NICL."

NSF-funded research in this story: Murat Aydin, University of California-Irvine, Award No. 1142517

Shawntel Stapleton cleans and prepares the ice drill for another run. The team was drilling 24 hours a day. –Credit: Mike Lucibella

Murat Aydin jots down information about the last ice core he processed. –Credit: Mike Lucibella



SPICECORE's Intermediate Depth Drill was designed to have a smaller footprint than larger ice drilling projects like WAIS Divide. –Credit: Mike Lucibella

This article originally appeared at http://antarcticsun.usap.gov/science/contenthandler.cfm?id=4214

$2.3M grant moves ice cores a step closer to UAlberta

Funding will provide for storage, research on Canada's ice core collection

By Jennifer Pascoe, courtesy of the University of Alberta

Ice core driller Ali Criscitiello examines a core sample. – Credit: Anja Rutihauser

THE GOAL OF HOUSING CANADA'S ICE CORE COLLECTION at the University of Alberta and turning it into an accessible scientific resource is a big step closer to reality, thanks to a $2.3-million grant from the Canada Foundation for Innovation.

Glaciologist Martin Sharp, Professor in the Department of Earth and Atmospheric Sciences, has been working tirelessly for nearly two years to turn this vision into a reality, since the announcement that the former federal government wanted to find another home for the collection.

"By their nature, the ice cores are a diminishing resource–they are used up as they are analyzed, and the ice caps from which they were retrieved are now changing and shrinking rapidly," says Sharp. "The evidence of climate change is abundantly clear, and there isn't going to be a way to replace some of these cores." He notes one of the most dramatic examples of melting ice caps in the Canadian North, on Meighen Island, where 50 years of ice accumulation disappeared in less than three years. "This is about the most graphic example imaginable of how things have changed in the last decade."

Provided through the Exceptional Opportunities Fund, the grant (including operating funds) will facilitate the construction of a new facility for the ice cores–two walk-in freezers to house the thousand-plus metres of core and allow it to be characterized and sampled for analysis, plus an analytical laboratory that is expected to be completed in late 2016. Following that, the ice cores can begin the cross-country trek from their current home in Ottawa. Sharp is hopeful that the cores can be made available to researchers worldwide sometime in 2017.

Some of the surviving cores were drilled in the 1970s, with the most recent collected in the mid-2000s. In total, there is more than 1.7 kilometres of core, representing at least 10,000 years of ice accumulation and, in some cases, including remnants of ice from the last ice age.

Using the cores for research will require a delicate balance. "Ultimately, we want to see people using these materials, as a lot of analyses are possible now that were not possible when the cores were collected. The challenge is that if we use it all, there will be nothing left."

In addition to the challenges presented by climate change and rapidly melting ice, collecting new ice core samples is also extremely expensive. Sharp notes that it will be challenging to find resources to collect new cores, especially from the oldest ice found at the bottom of glaciers and ice caps, but he says there is an opportunity to partner with other coring groups in the world to collect cores and analyze samples in areas where the U of A has particular expertise.

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$2.3M grant moves ice cores a step closer to UAlberta

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And with increasingly sophisticated scientific instruments and analytical techniques, researchers are now able to do more with less. "If you look at the range of ice core analyses that people are doing now versus what they were doing in the 1970s, it is night and day in terms of the number of things you can do. The amount of sample you need has decreased enormously."

Whereas some analyses might once have required up to 300 millilitres of water from the core, researchers can now obtain the data they need from as little as a millilitre.

Helping answer critical climate change questions

Sharp notes that there are upwards of 10 world-class analytical labs on the U of A campus alone with interest in working on the ice cores, as well as researchers around the world who want to work on topics like the history of the atmospheric nitrogen cycle, organic contaminant and black carbon deposition in the Arctic, and reconstructing past variations of Arctic sea ice.

"Our goal is to create a national ice core facility that is open to all interested researchers, nationally and internationally," says Sharp. "We want people to come here to work with the material. We want them to generate and publish new results and then deposit the data in our archive for the benefit of all."

The timing couldn't be better as the U of A works to maintain its reputation for excellence in research on the Canadian North. Canada's cold regions are increasingly recognized for their valuable water, mineral and energy resources, and researchers from the university have spent decades getting to the bottom of what is happening at the top of the Earth. There is a renewed sense of focus with the recent launch of UAlberta North and the announcement that the U of A will lead the push for a new mountains-focused Network of Centres of Excellence.

"The University of Alberta is proud and honoured to be chosen as the new custodian of Canada's ice-core archive," says Lorne Babiuk, vice-president (research). "The cores are an invaluable research resource not only for Canada, but also for the world because of the information they contain–vital data to help advance knowledge in crucial areas such as climate change, the environment and even health via ancient microbes."

"The facility will play a key role alongside our existing laboratories focused on the physical, chemical and microbiological analysis of snow, ice and permafrost, and provide access and vital data to the national and international research community. On behalf of the university, I thank CFI for this important research investment."

This article originally appeared at https://uofa.ualberta.ca/science/science-news/2016/february/ice-core-collection

Report from the 2nd International Partnerships in Ice Core Sciences open science conference

By Eric Wolff, IPICS co-chair and co-chair of SCAR's IPICS Expert Group
Courtesy: The Scientific Committee on Antarctic Research (SCAR)

ICE CORES PROVIDE UNIQUE quantitative knowledge about past climate change, and have become one of the most persuasive symbols of the importance of polar science. 24 nations have active ice core programmes, and are represented in International Partnerships in Ice Core Sciences (IPICS). This past March the ice core community met in Hobart (Australia) at the second IPICS open science conference (OSC). About 220 researchers attended the conference, which followed a very successful 1st OSC in France in 2012. The meeting was preceded by a 1 day workshop of Ice Core Young Scientists (ICYS). [See related article on page 12 – *Ice Core Young Scientists workshop report*]

That so many early career scientists could attend the OSC and ICYS workshop was due to the excellent work of the local organizers, led by Tas van Ommen, and the generosity of a range of sponsors including SCAR, Past Global Changes (PAGES) and Australian sponsors, as well as travel support from the U.S. National Science Foundation and the European Project for Ice Coring in Antarctica (EPICA) Descartes Prize Fund, for whom IPICS acts as an expert group. The oral and poster sessions, running over 4.5 days, covered the whole range of topics amenable to study with ice cores, from compilations of records over a few centuries (from both polar and non-polar sites) to the

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Report from 2nd IPICS open science conference

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use of ice cores to understand ice dynamics and biogeochemical cycles. Technical aspects such as improvements in age models and new proxies were explored. Two topics that were especially prominent concerned the Antarctic in particular. The first is that of understanding the history of the West Antarctic Ice Sheet, with a new emphasis on learning how much of it survived the last interglacial. There was also a lot of anticipation about attempts to find the so-called "oldest ice": extending the ice core record back towards 1.5 million years. Much exploratory geophysics and modelling is underway to find the right site and a number of consortia have ambitions to obtain this old ice within the next decade. The last formal presentation of the meeting was given by the Martha T. Muse 2015 Prize recipient, Valérie Masson-Delmotte, who outlined how ice core findings have contributed to policy debates through the IPCC.

The OSC allowed delegates plenty of time for social interaction, and included a special showing of the new movie, "*Ice and Sky*" which features the career of French Antarctic ice core scientist Claude Lorius.

The IPICS SSC met during the meeting to confirm and renew the community's scientific priorities. A survey carried out at the end of the meeting confirmed the enthusiasm of participants for the style and content of the OSC, with the vast majority agreeing that it was better or much better than other meetings they had been to recently. The SSC therefore agreed to continue the series with a 3rd OCS in 2020.

Group photo of the IPICS 2016 delegates. – Photo courtesy of the second IPICS open science conference (OSC).

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Ice Core Young Scientists workshop report

By Pascal Bohleber[1], Marie Cavitte[2], Bess Koffman[3], Bradley Markle[4], Pavlina Pavlova[5], Mai Winstrup[4], Holly Winton[6]

Ice Core Young Scientists (ICYS) held a highly successful one-day workshop for early career researchers on 6 March 2016. The workshop was held in conjunction with the International Partnerships in Ice Core Sciences (IPICS) 2016 second open science conference in Hobart, Australia. [See related article on page 11 – *Report from the second International Partnerships in Ice Core Sciences open science conference]* This was the first event of its kind for ICYS. Over 85 early career researchers attended the event, equivalent to about 40% of the IPICS conference delegation. In addition to providing professional development, the workshop offered a chance for early career researchers to get to know each other before the weeklong conference began.

The workshop kicked off with a plenary lecture by Nerilie Abram of Australia National University, asking the question "Why do we need more paleoclimate records from Antarctica?" Dr. Abram presented new research, currently in preparation by the PAGES Antarctica 2K group, showing that climate models currently do not accurately represent the climate in the Southern Hemisphere. She argued for additional ice core records from Antarctica and for improved integration of ice core and other paleoclimate proxy data.

The plenary was followed by a lively panel discussion on the future of ice core science. Eight panelists shared their views on what and where the next big ice core project should be, and what major questions the community can try to address using ice cores in the future. Major themes coming out of the discussion

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included: a) integrating data from multiple ice cores, such as the work by the PAGES Antarctic 2K array; b) filling in the latitudinal gap of paleoclimate records between the poles and taking advantage of other types of climate proxy records, such as those from corals and speleothems; c) enhancing the interaction with climate modelers, oceanographers, biologists, and others using ice cores to answer non-climate questions related to biology and ice dynamics; d) advancing technologies, such as rapid access drilling and in situ analysis down boreholes; and e) engaging the broader community in our science. Major questions centered on improving predictions for future climate, especially in regard to sea level rise, and understanding the role of Antarctica in the climate system.

The ICYS workshop included two rounds of breakout discussions focused on topics of great importance to early career researchers, but which are rarely taught in formal settings. Session topics included, "how to get your research funded as an early career researcher," "leadership techniques and being a principal investigator," "science, family and equality: negotiating the early career researcher career path," "initiating international collaborations," and "evaluating funding proposals." Each breakout group was facilitated by a mid-career scientist who shared their expertise and experience in these areas and led discussion. We were also lucky to have Michael White, an editor at Nature, discuss issues around authorship. Many thanks to all our invited speakers!

Our final plenary session was facilitated by Dr. Heidi Roop, of the Science and Society research group at Victoria University of Wellington. Dr. Roop studies the science of science communication, and shared insights on how to communicate more effectively with the public. We learned that "knowledge building" efforts, such as having community meetings and developing citizen science initiatives, are most effective in getting the public to understand, appreciate, support, and critically become involved with the science we do. We were able to fold these ideas into short outreach videos that we produced at the end of the workshop. These videos, called *FrostBytes*, highlight different aspects of ice core research. They will serve as a valuable resource for outreach and engagement, and will be made publicly available on the Climate and Cryosphere (CLiC) and Association of Polar Early Career Science (APECS) websites.

Group photo from the Ice Core Young Scientists workshop. – Photo courtesy of the second IPICS open science conference (OSC).

Finally, ICYS was given the opportunity to summarize the workshop during the IPICS conference closing session. We provided the broader ice core community with an early-career perspective on the future of ice core science.

PAGES generously supported six travel packages for early career researchers from developing countries to attend the workshop. Travel support for early career attendees was also provided by the US National Science Foundation, the IPICS 2016 conference sponsors, the EPICA Descartes Prize, and the West Antarctic Ice Sheet Divide ice core program. Lunch was kindly supported by Climate and Cryosphere (CLiC).

The first of its kind, the 2016 ICYS Workshop was successful in both building a more cohesive international community of early career researchers in ice core sciences, as well as providing those researchers with information and skills useful to their developing careers, the primary goals of ICYS. Many attendees remarked that simply meeting fellow early career scientists the day before the main meeting improved their conference experience and sense of involvement in the community. Participants were asked to provide feedback on the workshop and we received many positive responses, such as:

"Thank you very much for establishing this great event! The science communication part was most useful, we have very few opportunities to learn about it while it becomes a more and more important part of science."

"I enjoyed the panel discussion on the future of ice core sciences. As young scientists we are lacking knowledge of the big picture in research trends. It is really helpful to get some ideas from experienced scientists."

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"The communication part was most useful. Scientists tend to forget how simple they have to keep a message for the average population of our planet."

"Heidi was great! Very useful, and I appreciate the participative aspects of it."

"You guys rock. Thanks for the hard work, thanks for pumping energy into the community!!!"

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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
Climate History and Flow Processes from Physical Analyses of the SPICECORE South Pole Ice Core	Alley, Richard	1542778
Collaborative Research: A High-sensitivity Beryllium-10 Record from an Ice Core at South Pole	Steig, Eric Schaefer, Joerg	1443144 1443448
Collaborative Research: Kr-86 as a Proxy for Barometric Pressure Variability and Movement of the SH Westerlies during the last Deglaciation	Brook, Ed Severinghaus, Jeff	1543267 1543229
Collaborative Research: Tephrochronology of a South Pole Ice Core	Dunbar, Nelia Kurbatov, Andrei	1543454 1543361
Laser Dust Logging of a South Pole Ice Core	Bay, Ryan	1443566
Measuring an Ice-core Proxy for Relative Oxidant Abundances over Glacial-interglacial and Rapid Climate changes in a West Antarctic Ice Core	Alexander, Becky	1542723
Operations and Maintenance of the National Ice Core Laboratory	Adrian, Betty	1615556
P2C2: Geophysical Reconnaissance to Expand Ice Core Hydroclimate Reconstructions in the Northeast Pacific	Kreutz, Karl	1502783
RAPID: Characterizing the Chemical and Physical Signature of the 2015-16 El Nino in the Quelccaya Ice Cap Snow and Ice to Calibrate Past ENSO Reconstructions	Thompson, Lonnie	1603377
Revealing Late Holocence Climate Variability in Antarctica from Borehole Paleothermometry	Muto, Atsuhiro	1619793

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Masthead photos courtesy of Lonnie Thompson and Michael Morrison