NEWSLETTER OF THE NATIONAL ICE CORE LABORATORY — SCIENCE MANAGEMENT OFFICE

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An Update on International Partnerships in Ice Core Sciences

By Ed Brook, Oregon State University, IPICS co-Chair

International Partnerships in Ice Core Sciences (IPICS) has been an active organization since 2002, with a mission of defining and promoting priorities for international ice core science. Membership in IPICS is open to all countries conducting ice-coring activities, with 22 nations currently involved. Two co-Chairs manage IPICS, Eric Wolff (University of Cambridge) and Ed Brook (Oregon State University). The co-Chairs work with a steering committee, which has representatives from all IPICS nations as well as additional representatives for specific scientific issues.

One of the primary activities of IPICS is to create broad frameworks for ice coring activities in support of major international science goals. Originally, IPICS was organized around four scientific themes: 1) Creating an array of 2,000 year long ice core records to aid understanding of modern climate, 2) Creating an array of 40,000 year records to aid understanding of glacial-interglacial environmental change, 3) recovery of an Eemian climate record from Greenland, 4) The search for the “oldest ice core” – a 1.5 million year record from Antarctica, and 5) development of new technology for ice core drilling.

Over the last 5 years the IPICS themes have evolved somewhat, although the underlying scientific motivations remain very compelling. The 2,000 and 40,000-year array projects are well underway, with many new records and new efforts at synthesis of the data. The NEEM ice core in Greenland has recovered an Eemian record, albeit not in stratigraphic order, and a new, broader initiative on ice coring to study interglacials in general is emerging. The search for 1.5 million year old ice remains a cornerstone of IPICS efforts, and a new initiative on drilling to study ice dynamics is also developing.

IPICS has also been active in supporting and organizing conferences related to ice coring. Most

Attendees at the IPICS 2012 Open Science Meeting on the Giens Peninsula, southern France. –Credit: Jerome Chappellaz, LGGE

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notable among these was the 2012 IPICS Open Science Conference in Presqu'île de Giens, France, which brought together over 200 ice core scientists for a week of presentations and discussions. Smaller meetings organized by IPICS have focused on more specific topics, for example the 2012 Oldest Ice Meeting in La Londe les Maures. These focused meetings are intended to help move IPICS priority projects forward. In the case of the oldest ice project the La Londe les Maures meeting resulted in an influential paper in *Climate of the Past* (Fischer et al., 2013) which outlined our current understanding of the challenges of searching for oldest ice, and outlined remote sensing and modeling work needed to move the effort forward. Other IPICS-related synthesis efforts of note include contributions to the PAGES 2K networks and the recent PAGES 2K synthesis (Pages 2k Consortium, 2013), as well as independent synthesis of longer Antarctic records by Pedro et al. (2011) and Parrenin et al. (2013).

The first IPICS OSC stimulated the creation of a new organization, the Ice Core Young Scientists (ICYS) [see related article on page 9 – Young Ice Core Scientists' Network]. ICYS now holds its own activities and more information can be found on their web site: http://www.pages-igbp.org/workinggroups/endorsed-and-affiliated/icys.

IPICS is currently planning a second open science conference, for 2016. The host location has not been chosen yet, but should be known soon. The first OSC was extremely successful, and we fully expect the second to be similarly stimulating.

IPICS is an independent organization, but receives operating support from PAGES, SCAR, and IACS. Past IPICS meetings have been supported by those organizations and also by the US NSF, ESF, the EPICA Descartes Prize, and numerous other organizations. IPICS Web pages are maintained by PAGES at http://www.pages-igbp.org/workinggroups/endorsed-and-affiliated/ipics.

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Upcoming Meetings

International Workshop on Ice Caves
17-22 August 2014
Idaho Falls, ID, USA
http://www.iwic-vi.org/

International Symposium on the Changing Arctic Cryosphere
18-23 August 2014
Edmonton, Alberta, Canada
http://www.igsoc.org/symposia/2014/alberta/

XXXIII SCAR Biennial Meetings and Open Science Conference
August 22 - September 3, 2014
Auckland, NZ
http://www.scar2014.com/

PIRE/ICEICS Workshop
27-29 August 2014
Helsingor, Denmark
http://iceics.science.oregonstate.edu/content/events

WAIS Divide Ice Core Science Meeting
22-24 September 2014
La Jolla, CA, USA
http://waisdivide.unh.edu/meetings/

WAIS Workshop
25-25 September 2014
Julian, CA, USA

Past as Prologue: Holocene Climate as Context for Future Climate Change
13-16 October 2014
Portland, Oregon, USA
http://people.oregonstate.edu/~marcotts/Holocene_Workshop.html

Getting Dusty in the Name of Science

By Bess Koffman, Lamont-Doherty Earth Observatory

Bess Koffman samples fresh silt, called glacial flour, produced by the Tasman Glacier in New Zealand. –Credit: Noah Pollock

Bess Koffman enjoys getting dusty in the name of science. Currently a postdoctoral scientist at Columbia University's Lamont-Doherty Earth Observatory, Koffman recently returned from New Zealand's South Island, where she collected fine-grained sediments produced during the last Ice Age, around 18,000-30,000 years ago. These sediments will help Koffman and others pinpoint the sources of dust around the Southern Hemisphere, including Antarctica and the Southern Ocean. Why would we want to know where dust comes from? Because dust carries iron to the ocean, and iron is a critical nutrient for the single-celled algae (called phytoplankton) that form the base of the marine food web. When dust delivers extra iron to the surface of the Southern Ocean, these algae can grow rapidly, incorporating carbon into their bodies and potentially changing the global distribution of carbon between the atmosphere and ocean.

But, not all dust is created equal. Knowing where dust in the Southern Ocean came from during the last Ice Age is important to help us understand how the global carbon cycle—the balance and movement of carbon between the land, air, and ocean—functioned in the past compared to today.

For several decades, scientists have known that Earth's Ice Ages, or glacial periods, were very dusty times. In fact, on a global scale, dust deposition increased by about 2.5 times during glacial periods. The increase in dust was even more pronounced in the polar regions, where it reached 25-35 times the level seen during warmer interglacial climates (the periods between the Ice Ages). These changes in dust supply have been credited with adding more iron to the ocean, leading to increased growth of phytoplankton, and in turn driving about 25% of the change in atmospheric carbon dioxide concentrations between glacial and interglacial periods.

So why was Ice Age Earth so dusty? It is likely that several factors were at play. First, colder climates are drier. Less precipitation allows dust to linger longer in the atmosphere, giving it more chance to get transported and deposited. Second, the Ice Age spawned changes in vegetation cover, glacier activity, and other factors that led to more dust being generated. And finally, changes in the strength, location, and gustiness of winds helped to mobilize more dust.

We know that dust is important as a source of iron to the ocean, but some dusts carry far more iron than others. Rock freshly ground to

A silty stream flows from Mueller Glacier in the New Zealand Southern Alps. Glacier outwash such as this may have been an important source of dust during the last Ice Age. –Credit: Bess Koffman

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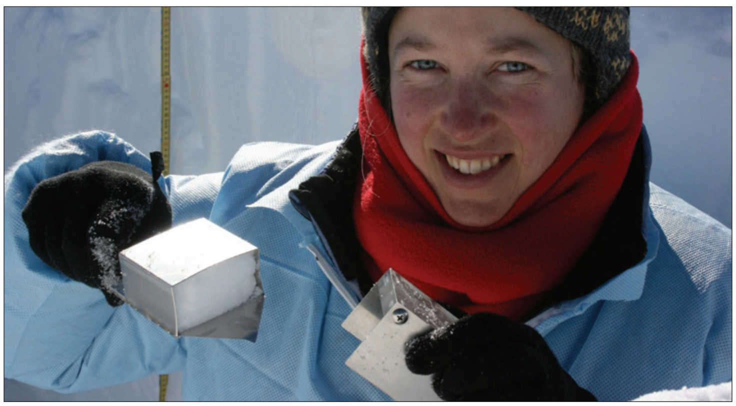
dust by glaciers can contain iron that is 100 times more soluble in ocean water than iron found in old, weathered dust, such as that which might blow from Australia into the ocean. This difference in solubility likely translates directly to its use by algae — the more soluble the iron, the more it boosts phytoplankton growth, and the bigger the impact on the carbon cycle. During the last Ice Age, dust coming to the ocean from New Zealand was primarily glacier-derived, and likely richer in soluble iron than the older, weathered dust from Australia.

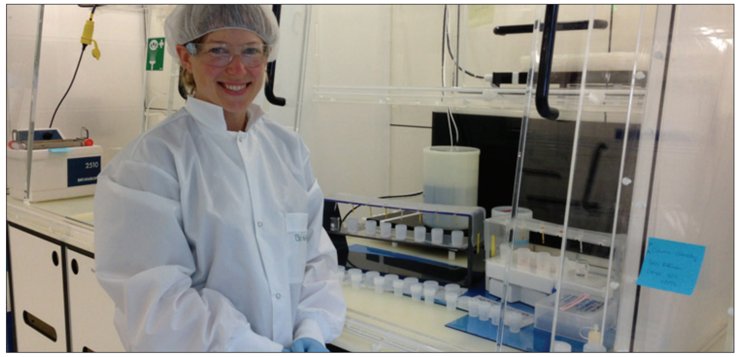
Koffman has set out to test the idea that New Zealand glacier-derived, iron-rich sediments were a significant source of dust to the ocean during glacial periods, challenging the view that Australian dust dominated in the southern Pacific.

So how does one take something as small as a speck of dust and determine where it came from? In a word, isotopes. For most



Collecting surface snow samples near WAIS Divide, Antarctica, during the 2009-10 field season. –Credit: Thomas Bauska

elements on the periodic table (like iron), there are multiple forms, or isotopes, of the element that exist in nature, each with a different mass. As an element moves from deep within Earth's mantle up to the surface, forming rock, natural radioactive decay causes the ratio of one isotope to another to change, giving the resulting bedrock its own special flavor. The particular mix of chemicals and isotopes that make up a rock is like a fingerprint, a unique pattern that makes it possible to distinguish rock from one region from another. Fortunately for scientists like Koffman, the composition of mineral dust reflects these different geographic regions. And in the same way that a colored dye can be used to track the movement of water, the geochemical 'fingerprinting' of far-traveled dust can be used to trace its source, or provenance. It turns out that the most useful elements to study for this type of provenance work are strontium (Sr), neodymium (Nd), and lead (Pb). Though present in tiny (or trace) quantities and often obscure, these isotopes have proven to be useful



The New Zealand and Antarctic dust samples are dissolved and purified for isotope analysis at Columbia University's Lamont-Doherty Earth Observatory. –Credit: Yue Cai

tools in understanding important processes such as dust transport. For example, they have shown us that Patagonia, the arid region spanning southern Chile and Argentina, is the dominant source of dust to East Antarctica, and therefore to the southern Atlantic and Indian Oceans, during Ice Ages.

But scientists have yet to determine the source of dust to West Antarctica and the Pacific part of the Southern Ocean.

Koffman is trying to fill this gap. As part of her postdoctoral work at Columbia, she is analyzing samples from several West Antarctic ice cores, looking at both modern and Ice Age dusts. She will compare the isotopic 'fingerprints' of these samples to those measured on New Zealand glacier-derived sediments, and to other potential source regions such as Australia and Patagonia. In this way, she hopes to trace the sources of dust to West Antarctica, and to see if New Zealand—though outsized by its cousin to the west—may have been an important player in sending fresh, iron-rich dust to the ocean during the last Ice Age.

Koffman's work is part of a larger collaborative project that includes Columbia University graduate student Alejandra Borunda, who is also working in Antarctica, and postdoctoral researcher Cristina Recasens, who studies dust provenance in Patagonia and the South Atlantic. The three are mentored by Columbia professors Michael Kaplan, Steven Goldstein and Gisela Winckler, and by Natalie Mahowald of Cornell University. By looking at many different parts of the Southern Hemisphere, the team hopes to improve scientific understanding of the role of dust in climate change.

This work is supported by the National Science Foundation PostDoctoral Research Fellowship #1204050.

NSF Press Release 14-057

Frozen in time: Three-million-year-old landscape still exists beneath the Greenland Ice Sheet

NSF-funded researchers say the massive ice sheet has fixed the landscape in place, rather than scouring it away

A camp at the edge of the Greenland ice sheet. –Credit: Paul Bierman, University of Vermont

April 17, 2014

Some of the landscape underlying the massive Greenland ice sheet may have been undisturbed for almost 3 million years, ever since the island became completely ice-covered, according to researchers funded by the National Science Foundation (NSF).

Basing their discovery on an analysis of the chemical composition of silts recovered from the bottom of an ice core more than 3,000 meters long, the researchers argue that the find suggests "pre-glacial landscapes can remain preserved for long periods under continental ice sheets."

In the time since the ice sheet formed "the soil has been preserved and only slowly eroded, implying that an ancient landscape underlies 3,000 meters of ice at Summit, Greenland," they conclude.

They add that "these new data are most consistent with [the concept of] a continuous cover of Summit... by ice... with at most brief exposure and minimal surface erosion during the warmest or longest interglacial [periods]."

They also note that fossils found in northern Greenland indicated there was a green and forested landscape prior to the time that the ice sheet began to form. The new discovery indicates that even during the warmest periods since the ice sheet formed, the center of Greenland remained stable, allowing the landscape to be locked away, unmodified, under ice through millions of years of cyclical warming and cooling.

"Rather than scraping and sculpting the landscape, the ice sheet has been frozen to the ground, like a giant freezer that's preserved an antique landscape", said Paul R. Bierman, of the Department of Geology and Rubenstein School of the Environment and Natural Resources at the University of Vermont and lead author of the paper.

Bierman's work was supported by two NSF grants made by its Division of Polar Programs, 1023191 and 0713956. Thomas A. Neumann, also of the University of Vermont, but now at NASA's Goddard Space Flight Center, a co-author on the paper, also was a co-principal investigator on the latter grant.

Researchers from Idaho State University, the University of California, Santa Barbara, and the Scottish Universities Environmental Research Centre at the University of Glasgow also contributed to the paper.

The research also included contributions from two graduate students, both supported by NSF, one of whom was supported by the NSF Graduate Research Fellowships Program.

The team's analysis was published on line on April 17 and will appear in *Science* magazine the following week.

Understanding how Greenland's ice sheet behaved in the past, and in particular, how much of the ice sheet melted during previous warm periods as well as how it re-grew is important to developing a scientific understanding of how the ice sheet might behave in the future.

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Frozen in time: Three-million-year-old landscape still exists beneath the Greenland Ice Sheet

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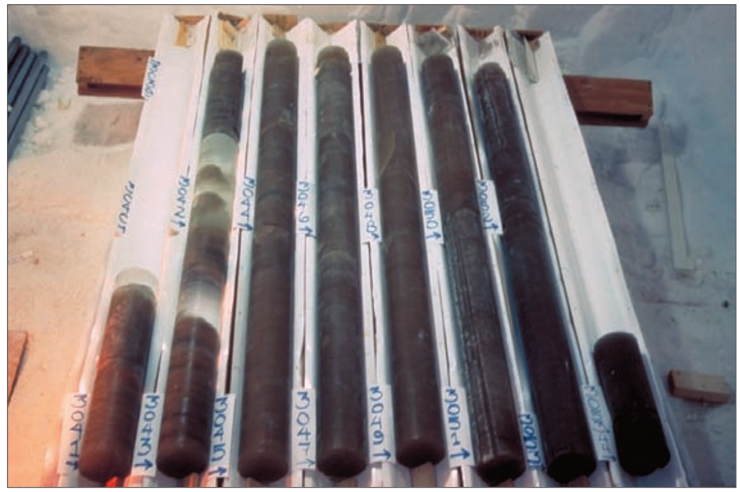
The ice edge meets the landscape in modern Greenland. –Credit: Paul Bierman, University of Vermont



Photograph of GISP2 ice core silty ice zone. –Credit: J. S. Putscher, GISP2 SMO, University of New Hampshire

As global average temperatures rise, scientists are concerned about how the ice sheets in Greenland and Antarctica will respond. Vast amounts of freshwater are stored in the ice and may be released by melting, which would raise sea levels, perhaps by many meters.

The magnitude and rate of sea level rise are unknown factors in climate models.

The team based its analysis on material taken from the bottom of an ice core retrieved by the NSF-funded Greenland Ice Sheet Project Two (GISP2), which drilled down into the ice sheet near NSF's Summit Station. An ice core is a cylinder of ice in which individual layers of ice, compacted from snowfall, going back over millennia can be observed and sampled.

Summit is situated at an elevation of 3,216 meters (10,551 feet) above sea level.

In the case of GISP2, the core itself, taken from the center of the present-day Greenland ice sheet, was 3,054 meters (10,000 feet) deep. It provides a history of the balance of gases that made up the atmosphere at time the snow fell as well as movements in the ice sheet stretching back more than 100,000 years. It also contains a mix of silts and sediments at its base where ice and rock come together.

The scientists looked at the proportions of the elements carbon, nitrogen and Beryllium-10, the source of which is cosmic rays, in sediments taken from the bottom 13 meters (42 feet) of the GISP2 ice core.

They also compared levels of the various elements with soil samples taken in Alaska, leading them to the conclusion that the landscape under the ice sheet was indeed an ancient one that predates the advent of the ice sheet. The soil comparisons were supported by two NSF grants: 0806394 and 0806399.
-NSF-

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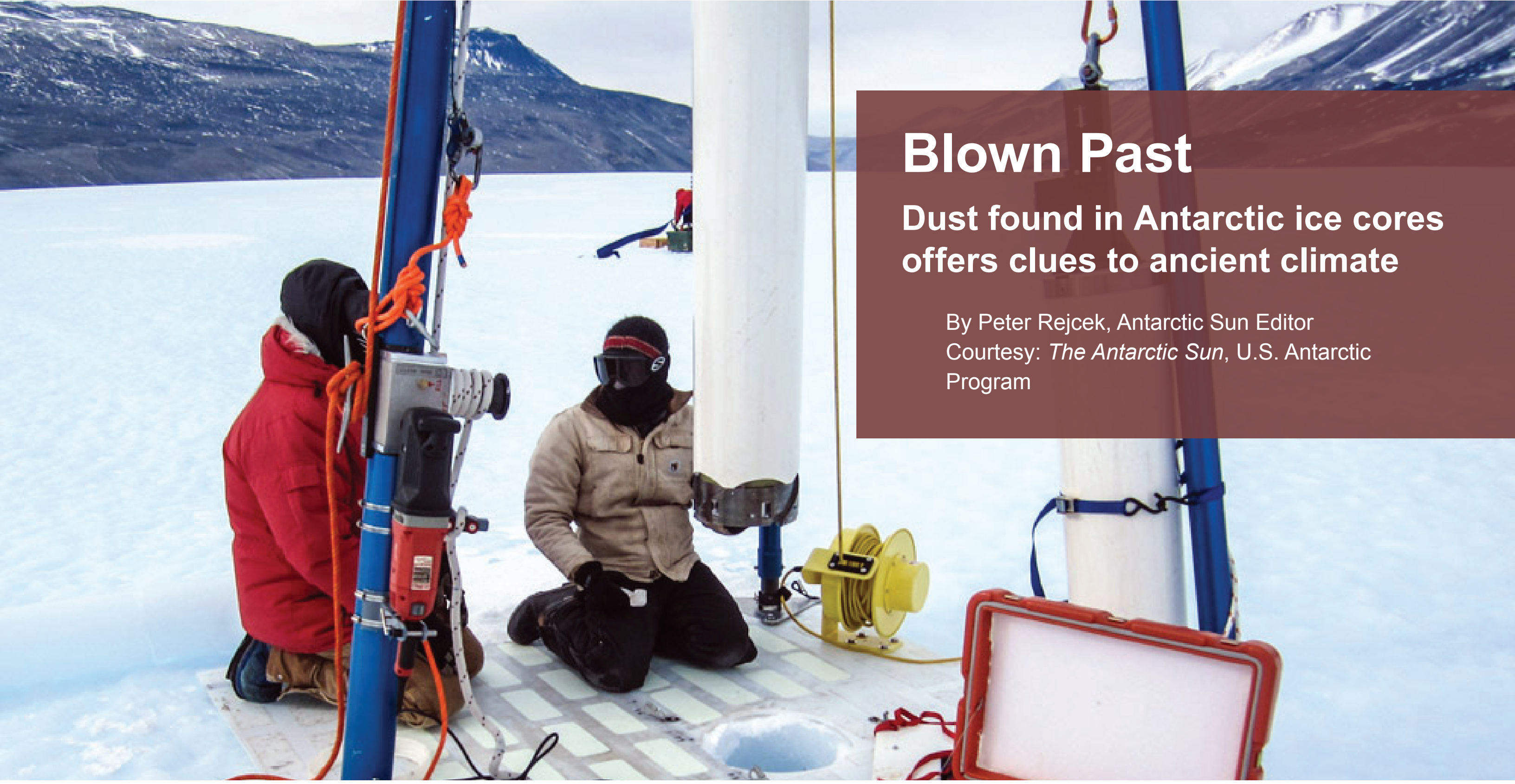
Blown Past

Dust found in Antarctic ice cores offers clues to ancient climate

By Peter Rejcek, Antarctic Sun Editor
Courtesy: *The Antarctic Sun*, U.S. Antarctic Program



A special drill is used to extract ice cores from Taylor Glacier for a study using microscopic grains of dust to understand past atmospheric and climate conditions on Earth. –Credit: Sarah Aciego/NSF

Antarctica conjures many different images depending on the imagination. Ice. Cold. Penguins.

For Sarah Aciego, it's dust.

Those who have visited McMurdo Station during the height of summer in January and February are familiar with the dust devils that swirl through the research town after the snow has melted and the muddy rivers of snowmelt have dried up. However, Ross Island isn't like most of the rest of the continent, more than 99 percent of which is perpetually covered in ice.

But it's exactly that ice where Aciego, an assistant professor in the Department of Earth and Environmental Sciences at the University of Michigan, hunts for microscopic bits of dust that may have landed in Antarctica thousands of years ago from half a world away.

"Dust is really important because it can inform planet dynamics," Aciego said during a presentation about her National Science Foundation-funded project at McMurdo Station.

Dust in the atmosphere can actually alter atmospheric chemistry, as well as change the radiative balance by absorbing or reflecting incoming solar radiation. Dust carrying micronutrients such as iron that falls into the ocean can influence biological activity. A layer of dust on ice or snow can affect albedo, causing the surface to absorb more sunlight.

Today, scientists can use satellites to pinpoint major dust storms and employ computer models to determine where atmospheric winds will deposit material.

"In the past, we can't look and see where it came from. We need some other mechanism for determining where the dust came from and what its pathway was," Aciego explained.

That's where Antarctic ice comes in – a lot of Antarctic ice, from a glacier not far from McMurdo Station in the nearby McMurdo Dry Valleys.

Taylor Glacier is a river of ice that flows from a high point on the East Antarctic Ice Sheet called Taylor Dome. It terminates in Taylor Valley at the shore of the ice-covered Lake Bonney. On the surface of the glacier, about 15 kilometers from its terminus, scientists have discovered a gold mine of ice.

Make that a mine of blue ice thanks to its location in an ablation zone, where there is negative accumulation of snow and ice. In combination with how the ice flows through the valley, researchers have found and mapped ice stratigraphy at the surface that is up to 150,000 years old.

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A trench is cut in the top of Taylor Glacier as part of the project looking for ice of a certain age containing dust grains. –Credit: Sarah Aciego/NSF

Taylor Glacier. –Credit: Sarah Aciego/NSF

Scientists already know that dust concentrations are much higher during the 100,000-year-long glacial periods that have dominated climate for at least the last million years than compared to the warmer interglacial periods. However, in recent centuries, with industrialization, intensive agricultural practices and climate change, dust production is up by 500 percent, according to Aciego.

"It's huge," she said, though still far less than what occurred during the cold, dry glacial periods. What's not huge is the amount of ancient dust available to Aciego and her team for the isotopic techniques they use to date the dust and determine its composition, which they can use to determine its provenance or source.

In a traditional ice core drilled vertically through an ice sheet, there is about 1 milligram of dust per half-meter of ice from a glacial period, according to Aciego. That's roughly the equivalent of one grain of salt. During warmer interglacial periods, that number drops to 0.01 milligrams per meter-long ice core.

Scientists use ice cores for various studies aside from dust measurements, such as a way to learn about the composition of the Earth's past atmosphere from bubbles of gas trapped in the ice, meaning there is a lot of competition for very limited samples.

"We need more ice," Aciego said.

On Taylor Glacier, near the surface, is a nearly inexhaustible supply of such ice.

"If you want to look at high-resolution changes in dust records, you have to have bigger samples in the horizontal direction," Aciego said.

That's what she and her team did during the 2013-14 summer season, joining another research group on the glacier that was mining ice for paleoclimate studies involving methane. [See related article – Cooking with gas: Scientists extract big ice cores from Taylor Glacier for methane measurements.] Both groups used a specialized drill developed and built by the Ice Drilling Design and Operations (IDDO) group at the University of Wisconsin-Madison to extract large ice cores from just below the surface.

The cores collected by Aciego and her team will eventually be melted to extract micro grains of dust to conduct radiogenic isotope geochemistry analyses on the samples. Radiogenic isotope

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A helicopter carries away a load of ice cores from the field camp on Taylor Glacier to McMurdo Station. –Credit: Sarah Aciego/NSF

geochemistry uses techniques to measure radioactive isotopes resulting from the natural decay of elements.

The two principal methods – rubidium-strontium and samarium-neodymium – should help date and identify the provenance of the dust over a time period of 6,000 to 55,000 years ago. That's when researchers believe storm trajectories in the region reversed due to the retreat of the Ross Ice Shelf. The climate system was once dominated by storms from the north rather than from the south as they are today, according to Aciego.

The change in wind trajectories should be reflected in the radiogenic isotopes, concentration, and size distribution of dust particles within the Taylor Glacier ice, she said. In addition, the project may differentiate regional versus global dust sources to the Taylor Glacier and provide a continuous record of southern hemisphere dust during abrupt climate change events.

"This research has potential implications for predicting the climate shifts in circumpolar coastal regions that have been experiencing or will experience a decrease in ice shelf extent," Aciego said.

NSF-funded research in this article: Sarah Aciego, University of Michigan Ann Arbor, Award No. 1246702 Paolo Gabrielli, The Ohio State University, Award No. 1242799.

Young Ice Core Scientists' Network

Ice Core Young Scientists (ICYS) is an informal, international network of early career scientists dedicated to the study of polar and alpine ice cores and ice core related science.

Following the International Partnerships in Ice Core Sciences (IPICS) [see related article on page 1 – An Update on International Partnerships in Ice Core Sciences] conference in Giens, France in 2012, a small group of passionate early career ice core researchers, from Australia, Europe and the United States, joined together to form ICYS.

ICYS' purpose is to foster personal connections among young scientists from around the world, in order to build a supportive ice core science community and to inspire future collaborations. It is a self-organized group, which has been meeting on a regular basis since Giens. They are now ready to start welcoming new members and to extend the network. Progress to date includes the construction of a LinkedIn page where members can connect and exchange scientific ideas or advertise upcoming meetings, and the creation of an informational website under the Past Global Changes (PAGES) umbrella.

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Young Ice Core Scientists' Network

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To get involved, join the LinkedIn page, check out the newly developed website hosted by PAGES (http://www.pages-igbp.org/workinggroups/endorsed-and-affiliated/icys) or contact icecoreys@gmail.com

Also, keep a look out for a poster advertising ICYS at ice core and polar science conferences!

Organizing committee (in alphabetical order):

- Pascal Bohleber, Heidelberg University, Germany
- Marie Cavitte, University of Texas at Austin, USA
- Bess Koffman, Columbia University, USA
- Bradley Markle, University of Washington, USA
- Pavlina Pavlova, University of Bern, Switzerland
- Mai Winstrup, University of Copenhagen, Denmark
- Holly Winton, University of Tasmania, Australia

Brian Bencivengo: Farewell & Thanks!

By Richard Nunn, National Ice Core Laboratory

Brian Bencivengo concluded his time as Assistant Curator of the National Ice Core Laboratory (NICL) on February 7, 2014. Brian received his BS in geology from CU Boulder in 2005. Shortly after graduating, he became a member of the NICL staff in September of 2005. Within his first year as an Assistant Curator for the NICL Brian was deployed to the field, spending the summer of 2006 at Summit Greenland during the DISC Drill tests, testing the core handling equipment and procedures that were to be used at WAIS Divide in Antarctica later that year.

Quickly taking to the fieldwork, Brian became an important member of the WAIS Divide project, deploying to Antarctica for four field seasons from 2007 to 2010. During his time working both in the field and at the NICL, Brian became known for his hard work, amiable personality, and a wide variety of playful outfits including some of the most unique hats the ice core community has ever seen. He was an integral part of the collection and shipping of the WAIS Divide core, one of the largest and most successful ice cores ever drilled by the United States. Working tirelessly in the field as well as at the NICL, Brian had the unique opportunity to be involved with both ends of the project. Between four seasons of drilling in the field and six core processing lines at the NICL, Brian likely had more hands on time with the WAIS Divide core than anybody else involved in the project.

Throughout his eight years working at the NICL, Brian was dedicated to the preservation of the ice core collection and the research that came from the cores. His passion for the science was evident in his interactions with scientists from the ice core community and his deep involvement with the WAIS Divide Project. Along with all of his other duties and contributions to the NICL, Brian was also the Collateral Duty Safety Officer for the lab and was awarded the 2013 USGS Safety and Occupational Health Award of Excellence. With all of his responsibilities, Brian never failed to put all of his effort into everything he did, and he was a vital part of keeping the operations at the NICL running smoothly.

During his time at the NICL, Brian was also actively pursuing his Masters in Hydrology from CU Denver, balancing his studies and his work with unfailing tenacity. Brian finished his Masters program in 2013, offering him new opportunities to pursue his passions. In February 2014 Brian accepted a position with the Office of Natural Resources Revenue (ONRR), Department of the Interior Office of the Secretary. He will be missed at the NICL, and we wish him all the best in his new endeavor.

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

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
Characterization of Brine Network Microstructure in First Year Arctic Sea Ice	Obbard, Rachel	1304134
Climate Warming in West Antarctica	Bromwich, David	1341695
Collaborative Research: Bipolar Coupling of late Quaternary Ice Sheet Variability	Pollard, David Timmermann, Axel	1341394 1341311
Collaborative Research: Characterizing Arctic Climate Extremes from the Pliocene to the Present: the view from Lake El'gygytgyn, western Beringia	Brigham-Grette, Julie Snyder, Jeffrey	1204087 1204049
Collaborative Research: P2C2--Reconstructing Tropical Pacific Climate Variability and Monsoon Systems, and Abrupt Changes from Ice Cores on Irian Jaya, Indonesia and Hualcan, Peru	Susanto, Raden Dwi Thompson, Lonnie	1342395 0823586
Collaborative Research: P2C2: Contributions of northern cold-climate peatlands and lakes to abrupt changes in atmospheric methane during the last deglaciation	Walter, Katey Sowers, Todd	1304823 1304408
Heterogeneous and Photochemical Transformations on Aerosol Surfaces: Understanding the Link between Hydrogen Peroxide and Carbonates Using Carbon and Oxygen Triple Isotopes	Thiemens, Mark	1259305
Ice Drilling Program Office	Albert, Mary	1327315
Impact of Atmospheric Trace Elements on the "Third Pole" Glaciers	Gabrielli, Paolo	1149239
PostDoctoral Research Fellowship	Koffman, Bess	1204050
Quantifying nitrite and peroxynitrite formation from the photolysis of nitrate in/on ice	Anastasio, Cort	1204169

This material is based upon work supported by the National Science Foundation through an Interagency Agreement (PLR-1306660) to the U.S. Geological Survey. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation or the U.S. Geological Survey.