Investigation of Climate, Ice Dynamics and Biology using a Deep Ice Core from the West Antarctic Ice Sheet Ice Divide (I-477)
NSF-OPP supported
PI: Ken Taylor (Desert Research Institute)

Field Team:

Maria Banks	John Fegyveresi	Heidi Roop
Ryan Banta	Bess Koffman	Kendrick Taylor
Thomas Bauska	Peter Neff	Bruce Vaughn
Tommy Cox	Anais Orsi	Bo Vinther

Field Season Summary:
Core recovery for the 2009/2010 drilling season ended as scheduled at a bottom depth of 2560 m (driller's depth), just a day's drilling short of our goal of 2,600 m. This season's core quality was stunningly excellent with only a few mid-run breaks.

RPSC opened the camp on November 1 and provided the logistics that were the base of the operation. A set of storms reminded the put-in crew where they were and kept the IDDO drilling and NICL and SCO science crews away until November 28, which was 10 days later than planned. RPSC worked through some Sundays and postponed some work allowing us to make up some of the lost time. The SCO and NICL crew opened the arch and packed up the kilometer of brittle (and some ductile) ice that was stored in the basement. Drilling operations started on December 11 and routinely produced 30+ m per day of perfect 3+ meter long cores. At these depths the gas bubbles have been forced into the ice lattice, making the ice almost glass clear. The cores occasionally had bands of volcanic ash, some razor sharp, others diffuse, that served as welcome treats. By working many Sundays and reducing the time required to take down the camp, we were able to make up for the lost time and meet our depth goal for the season.

The camp had a monotonous rhythm set by the 2.5-hour cycle it takes to recover each 3 m segment of ice core. But there was always something interesting going on, a new friend to share a meal with, a talk/slide show to attend, a ski with a friend or a solo off into the big white, the Winter Olympics, coffee house entertainment, a charity raffle, dazzling light shows in the sky. It never slowed down and everyone pulled together as a single team.

It takes a team to pull this off, most of who are in the attached photo. At home, Mark Twickler, Joe Souney, Alex Shturmakov and Tony Wendricks laid the groundwork for the operation. Matthew Kippenhan worked the logistics system to make sure we got the 40 cargo plane loads of stuff we needed. Tbird (Theresa Tran) ran a smooth, friendly, no drama camp. John Wight, Camille Frost and Erika Neal served up another season of great food from marginal ingredients. Eric Brown led our construction crew as helpfully as he has for the last 5 years. Jay Johnson and Krissy Dahnert led the drill crew in a professional and friendly way. Nicolai Mortensen kept the drill running with quick and effective problem solving. Lou Albershardt was working the drill controls as smoothly as she did for me on the GISP2, Taylor Dome, and Siple Dome deep core projects. Charlie Bentley stopped in to check on the drill operation. The first time he passed through here was in 1957. He was my master's advisor and still has a lot to teach me. Geoff Hargreaves and Brian Bencivengo organized the core handling and took responsibility for keeping the irreplaceable core safe for a very, very, long time in a very cold place. Bruce Vaughn herded the operation through McMurdo at the beginning of the season and got all the parts working as one team at WAIS Divide. For a third season Anais Orsi appropriately fretted over every small detail of the whole operation and kept everyone focused at the end of the

season. The early career scientists that made up the core handling crew, and who will be working with this ice a second time at NICL, and then a third time in their labs, kept everyone motivated to do a quality job. They also provided lots of social energy despite working in a snowy and windy building with four noisy refrigeration units, from which they would go outside to the middle of Antarctica to warm up. This was Bess Koffman's and John Fegyveresi's second full season in that nasty place. Bo Vinther taught us a few core logging tricks; and following the tradition of Danish ice corers, provided good company. Almost a hundred others passed through camp spending months to days, and many hundred more in McMurdo backed us up.

Acknowledgements:
Many, many thanks to all those involved in the WAIS Divide activities this year especially, Matthew Kippenhan's planning management, Theresa Tran's camp management, Brian Johnson's and Cara Ferrier's science support, Jane Marquard cargo support, Julie Grundberg's and fixed wing support, and Eric Brown's construction management. Special thanks to the WAIS Divide camp staff for all of their help and support this season. This project would not be possible without the dedication and continual support of Julie Palais, Brian Stone and George Blaisdell, our sincere thanks to them.

2009/2010 Science Technicians and NICL Staff
Back row (L to R): John Fegyveresi, Tommy Cox, Heid Roop, Maria Banks, Bo Vinther
Front row (L to R): Brian Bencivengo, Thomas Bauska, Bess Koffman, Ryan Banta, Peter Neff, Bruce Vaughn, Anais Orsi, Geoff Hargreaves

Physical Properties of the WAIS Divide Deep Core (I-168-M)
NSF-OPP Supported
PIs: Richard Alley (Pennsylvania State University) and Kurt Cuffey (University of California-Berkeley)

Field Team:
John Fegyveresi (Penn State University, University Park, PA)

Season Objectives:
To obtain samples from 20-meter depth intervals from the WDC06A ice core, prepare and characterize various physical properties of those samples, and gain additional useful information from observing snow pits and surface evolution.

Season Note:
John Fegyveresi deployed two weeks earlier than required for physical properties studies, in order to assist members of project I-477 prepping, packing, and shipping ice cores that were stored on-site during the 08-09 season.

Season Overview:
The 09-10 season went exactly as planned. John Fegyveresi deployed to Antarctica on schedule, and first prepared cargo in McMurdo for projects both I-168 and I-477. Following a few weeks of weather delays, he arrived at WAIS Divide on November 22nd. For the first two weeks at WAIS Divide, John assisted I-477 project members with the packing and shipping of the ice cores that were stored on-site. Once new drilling began, physical properties samples were received at intervals of 2 sets per day. These sample sets included both horizontal and vertical sections taken at 20-meter intervals. During a normal daily shift, John cleaned, prepped, mounted, and glued each sample appropriately before packaging them up for shipment in individual storage bags. By the end of the season, every sample had be mounted and packaged from depths of 1500 meters up to and including 2560 meters. All samples were included in the ice shipment that was sent back to the NICL for processing and analysis. During his time in the field, John also dug two snow pits from which he took various density and isotope samples. In addition, John documented various surface and crusting observations and also assisted the science technicians with various core handling duties.

Fig. 1: John Fegyveresi digging a snow pit at WAIS Divide for studies of the physical properties of the snow and ice. Photo: John Fegyveresi.

Fig. 2: The finished snow pit after it has been converted to a back lit snow pit and sampled for density and isotopes. Photo: John Fegyveresi.

Ice Drilling Design and Operations (IDDO) group activities at WAIS Divide 2009-2010 (T-350)
NSF-OPP supported
PI: Charles Bentley (University of Wisconsin-Madison)

Field Team:

Jay Johnson	Dave Ferris	Nicolai Mortensen
Kristina Dahnert	Ben Gross	Elizabeth Morton
Lou Albershardt	Josh Goetz	Steve Polishinski
Patrick Cassidy	Robb Kulin	

Field Season Overview:
IDDO operations at WAIS Divide this season began on November 26 with the arrival of Lead Drillers Jay Johnson, Kristina Dahnert and Lead Systems Engineer Nicolai Mortensen. Drillers Lou Albershardt, Patrick Cassidy, Dave Ferris, Elizabeth Morton and Steve Polishinski arrived on December 3, and the remaining three crewmembers, Ben Gross, Josh Goetz and Robb Kulin, arrived on December 7. Jay Johnson left WAIS Divide on December 19, at which time Kristina Dahnert took over as lead driller.

The initial drill crew worked to re-assemble drill equipment that had not wintered over as well as to install upgrades to both the computer control software and the level wind tracking device. These activities coincided with both the Arch excavation and the science construction crew's work on the drill slot walls, which was needed as a slight bowing of the walls had left inadequate clearance for drill tower travel. Another primary task of season startup was spooling a new 3800m drill cable onto the winch drum. This cable replaced the previous 2800m cable and will now allow for completion of the main borehole.

The first core was drilled on December 11 from a depth of 1514m. Several equipment modifications had been made in the off-season with the hope of producing longer cores per run. The most successful modification implemented proved to be the new thin kerf core barrel. While the core sample size remains at 122mm, the new core barrel produces a 163mm borehole as opposed to the previous 170mm core barrel setup. Fewer chips produced per run allowed the drill to retrieve approximately 3.30m of core per run, a 0.6m/run improvement over previous drill seasons. Another highlight of the season was the large number of ash layers found in the cores. Due to excellent cooperation between the WAIS Divide camp staff, core-processing staff, drill staff, and the camp closeout crew, drilling was able to continue until January 25, two days later than originally planned. The final borehole depth was 2564.370m. The DISC drill produced high quality core throughout the season.

Packing and winterizing of the drill system was completed over the next three days. To facilitate camp closeout, drill staff was reduced in stages. Ferris, Gross, Kulin and Polishinski left WAIS Divide on January 25, Albershardt, Cassidy and Morton on January 28, and Dahnert, Goetz and Mortensen on January 29, after packing and cargo preparations had been completed.

Raytheon Polar Services Company (RPSC) Activities at WAIS Divide 2009-2010

RPSC WAIS Divide Project Manager: Matthew Kippenhan

Field Season Overview:

After numerous weather delays with opening the camp, the WAIS Divide (WSD) project safely concluded their fifth field season on 05 February, 2010. Weather was poor this season, especially for aircraft operations; however, snow accumulation and drifting was much less than previous seasons. This drastically reduced the need to recover from heavy storm periods and certainly kept the camp looking well groomed and tidy.

During the summer season, the camp supported 10 science groups, two media groups, and three RPSC field support groups (Byrd Camp, two CReSIS groom teams) with a camp population maxing at 55 persons. To keep the camp and science running, the New York Air National Guard (NYANG) flew 43 LC-130 missions frequently bringing in valuable cargo, personnel, and fuel while flying out 1,428 meters of packed ice cores to McMurdo Station. Inbound LC-130 missions delivered a total of 840,000 lbs. of everything.

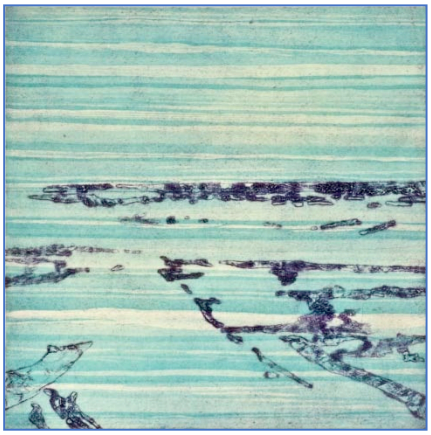
The Ken Borek team (KBA) flew 21 days supporting a variety of science activities using Twin Otter and Basler aircraft. Their aircrafts are vital for science teams to reach deeper into the region.

Overall, the season was very successful in terms of operations, safety, and supporting science. The camp crew and construction teams did another excellent job despite typical field challenges and resource constraints. We all look forward to next season's "to near bed" drilling operations and preparing for the next round of science activities at WSD.

Ice Cores: Translucent Truths from the West Antarctic Ice Sheet (W-217-M)

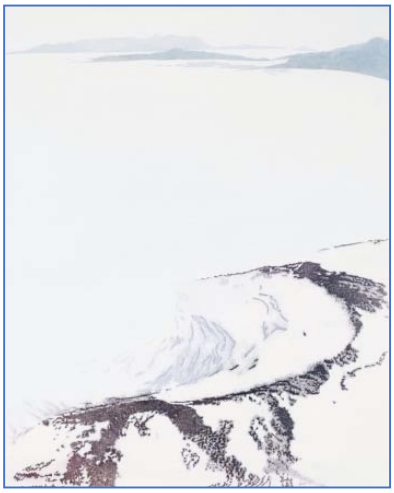
NSF-OPP Supported

PI: Anna McKee, Independent Artist, Seattle, Washington



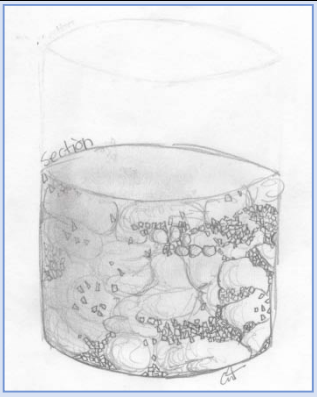
I traveled to the WAIS Divide field camp as a participant with the 2009-10 NSF Artists and Writers Program. This visit was part of an ongoing inquiry into ice cores and the glaciated environments of the West Antarctic Ice Sheet and the Pacific Northwest. My primary goals are to create artwork that both documents this research and articulates a visual response to these landscapes, the ice specimens and the environmental changes that this research is tracking.
Prior to the trip, I visited NICL and the University of Washington's Isolab to draw ice cores, spoke with several scientists to gain insight into current research, and hiked to Northwest glaciers for sketching sessions. During this time, I created a series of etchings and drawings that explored the micro scale of ice cores and the macro scale of glaciers.

While in Antarctica, I spent time sketching, writing, taking pictures, watching the ice coring operations and talking with a rich array of scientists and staff. I returned with a flood of impressions. Some of the more striking impressions are: the peculiar effects of undifferentiated space on my perception, observing cutting edge science first hand, and the curious experience of being in a remote extreme place with very high tech and resource intensive support. In the studio, I am sorting these impressions into themes: the story of the camp, the character of "the white", and the concurrent trapping and obliteration of substances on the plateau (i.e. the gradual burial of the arch, the constant shifting of the snow surface, etc.).



I am now creating artwork in several groupings; *The Camp Stories*, *Antarctic Space and Light*, *Ice Cores*, and *Temperate Glaciers.* It is a process of sifting through a large collection of images, (ranging from my own photographs and sketches, to scientific and historic sources) to convey the beauty and magnificence of these frozen landscapes in the face of environmental degradation. I began by creating drawings of my first impressions of the place and am now adding narrative elements to current drawings that allude to the changing environment and human history. The goal is for the viewer to consider their surroundings to reconnect to natural processes and our intertwined relationship with these processes.

In June, I was a "Visiting Artist" to art and science classes at two middle schools in Seattle. In addition to a slide and video presentation about my work and the WAIS Divide Ice Core Project, Heidi Roop and I developed an activity in which the students build "Mallow" ice cores using marshmallows as the snow crystals and small candies to represent various particles that get trapped in the snow column. Students then wrote about or sketched their core columns.



The West Antarctic Ice Sheet is a remote and unique place that few people are able to experience, though because of global climate change, the public is being asked to consider its fate. Mass media attention, though important, may not always be effective in connecting people to the frailties of Earth's systems in an emotional way. Through the use of metaphors and symbols that communicate both consciously and subconsciously, art is an alternate and potent vehicle of communication.

Schedule of Exhibitions and Outreach Events:

2010

- "Phinney Resident Captures Antarctica in Art", Phinney Ridge Review, Spring 2010
- *Critical Messages: Contemporary Northwest Artists in the Environment*; curated by Sarah Clark-Langager, Director, Western Gallery and John Olbrantz, Director, Halle Ford Museum, Willamette University – Traveling group exhibition with catalog.
- Visit to the Mt Waddington Ice Core Project, British Columbia
- Visit to Girls on Ice, Easton Glacier, Mt Baker, Washington
- November 12-December 12, *Deep Ice, Deep Time*, Exhibition of Prints and Drawings, Francine Seders Gallery, Seattle
- November 19-January 8, 2011, Artist Talk and Exhibition of Mt Waddington drawings at Gage Academy of Art, Seattle
- Community talk at the Seattle Public Library, Greenwood Branch

2011

- January-April, American Meteorological Society & EcoArts *Communicating Weather and Climate* Group Exhibition at the Washington State Convention Center.
- November-December, *Ice Stories,* Three Woman Exhibition, including *The Camp Stories* prints at the Washington State Convention Center, Seattle
- Release of a catalog of artwork and journal entries.

List of Illustrations: *Strata-Plateau*, etching, collography, 18"x18", photo credit-Nancy Heins; *The Arch I*, etching, 12"x8"; *Ice Shelf*, multimedia on panel, 30"x24", photo credit-Nancy Heins; photo of Mercer Middle School science classroom; Eckstein Middle School art student sketch.