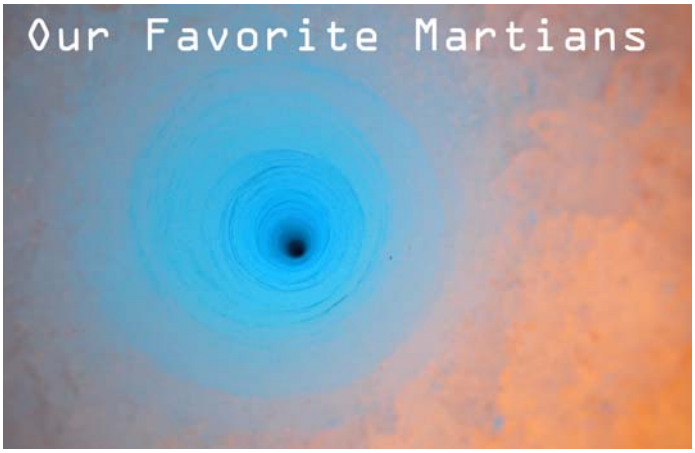
POLAR RESOURCES NEWSLETTER 7/26/06



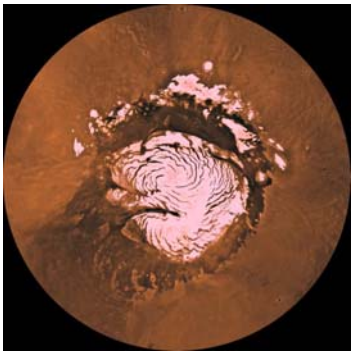
From a capsule, three silver legs unfold and stand in a waist-high tripod on the cold, white surface. Solar panels unfold like wings, upward looking, soaking up the sun for power. A copper-ended silver capsule, about three feet long and three inches in diameter, is lowered to the ice surface via a cable tether with the help of human-like arms affixed to the tripod's top.

Meet the autonomous robotic Thermal Drill, the ice drill affectionately called the cryobot. Two cryobot prototypes visit Greenland this summer as part of a NASA-funded collaborative testing project between the Jet Propulsion Lab (JPL) and the California Institute of Technology (Caltech). JPL and Caltech are currently teaming up in an effort to optimize cryobot technology and design. The cryobot will be included on a 90-day, unmanned mission, dubbed Chronos and proposed for 2011, to the Mars North Polar Ice Cap. Once the cryobot reaches the ice surface it will navigate to an appropriate location and drill into the ice, providing scientists with detailed information about Mars' climate history.

The NASA/JPL team arrives at Summit. From left, Kowalczyk, Smith, Behar, Cardell, Mogenson. Photo: Christina Reed

For JPL's Miles Smith, success in the field is a matter of perspective. "Ideally we would like to drill to 100 m depth, which takes us into solid ice at Summit and goes well beyond the proposed depth for Mars. A more modest depth would still be considered a success, since the objective of our field test is to learn the strengths and weaknesses of our system and to show that nothing is a showstopper for bringing this technology to Mars!"

Mars is similar to Earth as far as global systems are concerned. Both planets have an atmosphere and a cryosphere. Even so, significant differences between the two planets mean that the Martian Polar Ice Cap is no easy place to work, even for a cryobot. Earlier generations of cryogenic drills have been tested in some of Earth's most remote and climatically challenging locations such as Canada, Spitzbergen, and Antarctica, in an attempt to analogously approximate conditions on Mars. This year's test site at Summit Station is no exception. The Greenland field tests along with continued lab testing and a rigorous peer review process will ensure effective operation on the Red Planet.



The Martian North Polar Ice Cap. Image: NASA/JPL

"Of course, Greenland is not Mars," says Caltech's Hermann Engelhardt, who brings more than thirty years of Antarctic ice drilling experience to the project. "Greenland ice is much warmer than on Mars where it is -110° C. Also, the atmospheric pressure is much lower on Mars at 6 mbar as compared to 1000 mbar on Earth. These conditions we have to simulate in the lab."

Cryobots differ from traditional ice drills in that they do not extract the solid ice cores typically used for paleoclimate analysis. Solid ice cores require special handling, storage, and cold lab facilities, none of which are available on Mars. Cryobots are not only autonomous, but are cleaner and require less power. They also allow for on-site analyses both in the borehole and at the surface in the lander's microlab.

The JPL and Caltech drills operate on the same principle. The drill itself consists of a cylindrical stainless steel casing. The end pointing toward the ice is made of brass or copper, which heats up and melts the ice to form a borehole. Meltwater is subsequently taken in through a tiny hole in the nose cone and pumped to the surface through a heated tube that is part of an electronics and data communications umbilical. Engelhardt puts it simply, "What our cryobots do is melt the ice and pump the melt water to the surface where analysis in a microlab takes place."

Ultimately, the Chronos cryobot will have a side-looking camera which images ice layers while creating the borehole. As the drill descends, thermometers will monitor the drill nose cone temperature as well as the temperature of the surrounding ice. Meltwater pumped to the surface will flow

Top photo: the Caltech borehole, 32 meters deep, in the solid ice near Kangerlussuaq. Photo: Hermann Engelhardt

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The Air Logistics helo works hard for science. Photo: Cal Wachs

Toolik Field Station

In spite of "rain...every day, most of the day," VPR coordinator Bride Sweeney reports that the helicopter was busy this week getting researchers to and from their field sites:

The Douglas Kane (University of Alaska) hydrology and meteorology group set up instrument stations in the area.

Bill Fitzgerald (University of Connecticut) and his researchers finished lake-core sampling for his mercury studies. That's their Zodiac being sling-lifted [above].

Researchers on Fritz Nelson's (University of Delaware) CALM II network again took to the tundra for permafrost measurements. "Their research backs up the locally noted late arrival of spring," says Bride. "Permafrost is closer to the surface than last year."

Bride also reports that Toolik visitors had "a *Wild Kingdom* experience" last week with a near-miss between "Scruffy," Toolik's "yearling caribou camp mascot" and a lone wolf who's been hanging around the area, even popping in to visit folks in their tents (see last week's update). When Scruffy wandered too close to "Big Bad," he gave chase. But when the two-leggeds next spied the wolf, they were relieved to find him "catching his breath after not catching his meal," says Bride. She's "happy to report that Scruffy is back in camp" with no wolf in sight.

Big Bad huffs and puffs after losing Scruffy in the chase. Photo: Laura Belval

STEEP

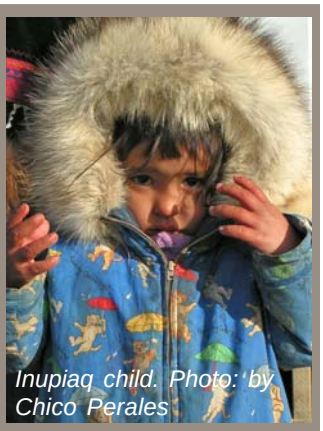
Researchers began to wrap up work on the north side of the study area last week, in preparation for moving the base of operations. For various reasons, mostly weather-related, the Terry Pavlis-led STEEP research team decided to move the helicopter directly to Cordova instead of trying to go first to Cape Yagataka for several days. With two seismic stations still to be installed and another needing a bit more attention, some teams still have work to do. But others are now positioned to finish their work and come out of the field this week.

As for the research itself, Terry checks in: "The paleoseismology group has found some really exciting things that demonstrate that there is a very actively deforming area in a part of the mountain belt that wasn't considered very active in the past. They can document 3 large earthquakes occurring on a fault beneath a range called Ragged Mountain, and they can demonstrate that many other ground ruptures in the area are the result of active faulting. This area may turn out to have more surface ruptures per unit area than anywhere I know of." These exciting initial findings now await further validation from remote sensing data when the researchers get back to their labs.

Working in Barrow, Alaska

It's the third week in July and the middle of the summer but you wouldn't know if you were from anywhere but Barrow, Alaska. The equinox has passed, and so have the hottest days—"hottest" meaning 60º F. For the Ukpeagvik Inupiat Corporation (UIC) workers installing and upgrading infrastructure supporting the large Walt Oechel-led biocomplexity research in Barrow, Alaska, the work stopped a week or so ago, just in time for seal hunting. VPR officially turned over stewardship of the 2006 infrastructure improvements to Barrow Arctic Science Consortium (BASC) on July 20.

Barrow has been a unique and fascinating place to live and work in. The life ways and traditions of the people here seem almost surreal, especially compared with some lifestyles in the Lower 48. People here hunt and fish as if their lives depended on it (they do). They don't drive large new trucks or have cookie cutter homes with beds of flowers and manicured lawns. In Barrow what was once important still is. Men hunt bearded seals and walruses and whales and caribou. And ducks and salmon and so on. They still make boots out of caribou and sealskins. Women still sew sealskins on boats and men still row with paddles to harpoon a whale. The Inupiat celebrate the successful spring whale-hunting season by sharing their catch with the rest of the community. It's amazing to see these tough-as-nails people go about their lives oblivious to cold water and colder winds.



Inupiaq child. Photo: by Chico Perales

You have to admire their culture and their passion for what they do and how they live. Boats get into the pack ice to look for seals and risk being crushed by its constant movement. Rescue calls are as common as near-death experiences. Being here means going to work at the BEO and seeing foxes and white snowy owls some days. Or watching exotically beautiful eider ducks flying overhead on others. Or looking at the sun shine dramatically on blossoming tundra and trying not to step on lemmings while going to work.

Sometimes you have to see it to believe it. Barrow is like that.—Chico Perales

Chico left Barrow last week for the season, tired but already planning how to improve the effort next year. Our thanks to him for doing an awesome job in Barrow—and for sharing his impressions of life in the great North!

GREENLAND News

Kangerlussuaq

VPR's Ben Toth returned to Kangerlussuaq last week, just ahead of the wheeled C-130 flight planned to arrive from New York on July 28. Ben will help colleagues Mark Begnaud and Ed Stockard sort out the people and cargo getting on and off the Twin Otters buzzing around Greenland this week.

Mark flew to Ilulissat last week. He met with Air Greenland personnel (who this year took over helicopter-based logistics work in Ilulissat), provided logistical support for the Das/Joughin science group, and inventoried and reorganized the storage space VPR rents there. "It was a very productive and educational trip in regards to how logistics work in Ilulissat," Mark reported.

A peat soil house in Ilulissat. Photo: Mark Begnaud

Around the Island

And speaking of the Das/Joughin supraglacial lakes research project, last week the team moved to their second research site. Measurements there are wrapping up, and the team will pull out their camp and return to Kangerlussuaq this week.

Up in Inglefield Land, the Darwent/LeMoine archaeological survey team has been waiting for a helicopter resupply flight since last week. Weather has caused an unplanned delay in their fieldwork diet. When the resupply helo does arrive, it will transport a field-team member onward to Thule, where she will use work space provided by The Peregrine Fund to sort, clean, and process some of the team's samples and artifacts.

Finally, we hear Liz Morris (who will be profiled in an upcoming issue of this newsletter) is making fine progress toward the ice edge as she traverses from Summit Station, taking borehole profiles for validation of CryoSat2. Liz says the work is going so well, the team may finish ahead of schedule. Onward, ho!

Summit Station

Folks were in a flurry at Summit last week as many prepared to leave on this week's Twin Otter flights. Among them, the Ice Core Drilling Services team worked tirelessly to break down the DISC drilling rig. It took 8 people just 7 days to pack 26 pallets of cargo; with the dog days of summer, loved ones and some deserved time off on the horizon, the team must have been motivated.

New at Summit last week: John Burkhart, who's currently playing a lot of parts. John is taking snow samples for PCB concentrations for the Joint Norwegian Institute for Air Research / GeoSummit organic pollutants project; as a member of the Science Coordination Office, he's working with the science technicians to establish (among other projects) a new snow accumulation line to replace the old ATM line for year-round sampling; and he assumed the Chief Scientist mantle when Jack Dibb departed.

Why are these people smiling? The DISC team celebrates the successful completion of work at Summit.

The Mike Bergin-led group studying particulate organic carbon in the air and snow at Summit is preparing to leave after a long, successful season. Researchers for this collaborative between Georgia Institute of Technology, University of New Hampshire, and The University of Wisconsin collected air samples as well as snow samples on the surface and in numerous snow pits near the station and up to 20 kilometers away. They're studying the deposition and post-depositional transformation of particulate organic compounds to better understand the effects of chemical processes in the air and snow and how these may affect the way researchers "read" past climate signals in ice cores. The research also will yield insights into the photochemical processes in snow, which influence atmospheric chemistry.

The project's ambient air monitoring site is located in the clean air sector of the station to avoid pollution from camp; the carbon particulates these researchers are studying come from industrialized North America, Europe, and elsewhere, transported thousands of kilometers in the lower troposphere to the Greenland ice sheet.

Atmo-Chemist/Rock Star Gene Smith grabs some air inside the Big House. Photo: Brian Bencivengo

The slightest human touch can spoil a sample, so the particulate carbon scientists suit up to prevent contamination. Photo: Gayle Hagler

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through an in-situ lab, new technology that will provide real-time analysis of the terrestrial polar ice. Housed in the micro-lab will be a laser spectrometer to analyze Oxygen isotope ratios and dust particles. Instrumentation for determining water chemistry, pH, and electrical conductivity will also be available. These data will yield detailed information related to Mars' climate history.

The Caltech team tested their cryobot in June near the coast about 35 km north of Kangerlussuaq on blue ice, solid ice left after the porous layer, called firn, and any new snow, melts away. Their cryobot, a relatively simple model built to test essential functions like the thermal properties of the nose cone and pump effectiveness, performed well, drilling to thirty-two meters. The camera successfully recorded video of the borehole wall and continuously recorded electrical conductivity. Meltwater samples will be analyzed in Caltech's lab in Pasadena, California.

The Caltech cryobot's nose cone. The brass section melts the ice. Photo: Hermann Engelhardt

"Our test was quite successful. We could demonstrate that the melting had produced a straight borehole and that the pumping of the water to the surface worked as well. We also tested the deployment mechanism of the tether that provided the electrical cables and the tubing between the downhole cryobot and the surface," says Engelhardt.

In July the JPL team will complete the second phase of testing at Summit Station where sub-ice temperatures may reach -32°C. The JPL cryobot has different nose geometry and is outfitted with more sensors similar to the instrument suite that will fly to Mars.

"We want to be sure that all the components of the drill work properly. For example, does the tube to the surface stay heated enough to keep the water from freezing in-line? Does the pump work to capacity? Does the tether remain flexible in the cold and will it become knotted? Does the camera look sideways? We can't anticipate many real-world situations, but field testing in Greenland can help us predict issues that may come up on Mars by expecting the unexpected," says Smith.

Oded Ahronson readies Caltech's cryobot. Photo: Hermann Engelhardt

Engelhardt explains further, "The field tests validate our theoretical models for the cryobot functions. What we learn in these tests always feeds back into improvements of our designs and helps us to optimize the instruments and gives us more confidence that we are on the right path."

Mars and Earth are alike in their global systems, and scientists predict that much can be learned by comparing their climate histories. Because snow accumulation rates on Mars are thought to be orders of magnitude lower than on Earth, ice of a particular thickness that accumulates there may represent a much longer period of time than on Earth. Therefore, the climate record in Martian subsurface ice can tell us much more about long-term climate evolution than similar records on Earth. The problem, until now, was in sampling this ice. Cryobots will solve this problem by providing a mechanism for observing and recording data essential to our understanding of Mars' climate history.—Marcy Davis

Marcy Davis is a freelance earth science writer and on technical staff at the University of Texas Institute for Geophysics.

For more information on this research:
http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=NASA-SIPR

SCIENCE & Other News

Japanese and American researchers climbed Alaska's Denali peak (the highest in North America) recently to repair the weather station near the mountain's summit.

Pictures from the Neumann/Catania field season in Greenland are posted on the UTIG website.

Give me a B! Barrow High School's football team!

Summering in the Arctic (life as a Buff-breasted Sandpiper).

Next up, the unicorn: A rare bowhead whale suddenly surfaced and played in the waters just off the pier in Longyearbyen, Svalbard, Norway, drawing crowds who'd never seen this kind of whale before.