Ice Core Drilling Project
Wrangell-Saint Elias National Park and Preserve

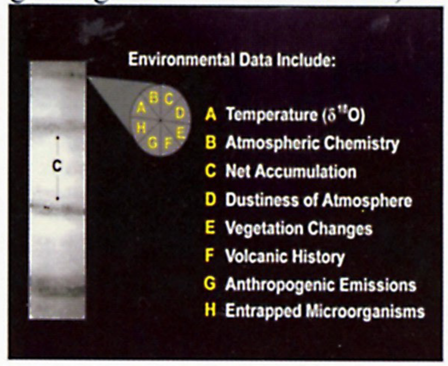
April-June, 2002

The Project

This spring (2002) Dr. Lonnie Thompson will lead an international team of scientists to drill two deep ice cores in the col between Mt. Bona and Mt. Churchill (61° 24'N, 141° 42'W, 4420 m asl; see map on the back of brochure) in Wrangell-St. Elias National Park and Preserve. They plan to retrieve a high temporal resolution paleoclimate history for the area, possibly extending back to the Last Glacial Maximum (~18,000 years ago).

The team plans to drill two cores to bedrock (~500-m) and five 10- to 20-m cores along north-south and east-west transects. The second deep core will verify the record of the first, and shallow cores will reveal the spatial variability of ice properties. Three key factors determine the length of history recorded in an ice core: (1) the annual accumulation rate, (2) the thickness of the glacier, and (3) the temperature at the ice-bedrock contact (which must remain below 0°C to preserve basal ice).

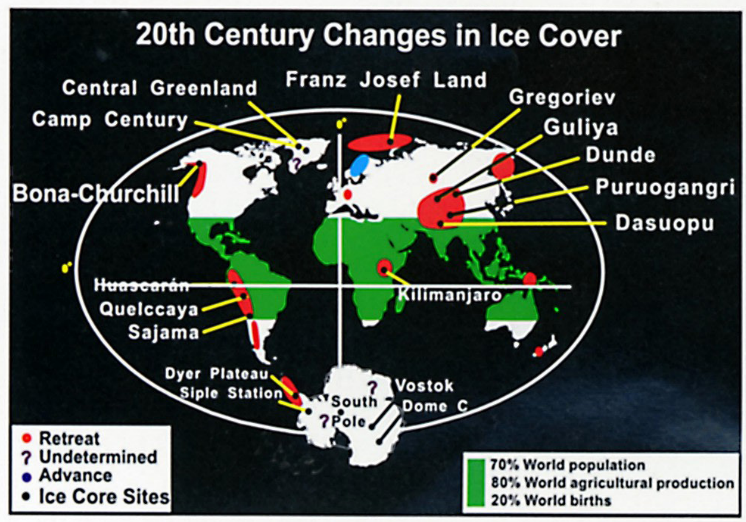
Ice cores record an abundance of environmental data such as temperature, precipitation, the chemical composition of air, changes in biomass and vegetation, volcanic history, geomagnetic field variations, and solar activity (see figure). The Bona-Churchill ice cores will likely provide more information about the two most recent eruptions of Mt. Churchill, dated to approximately 1890 and 1250 ^{14}C years before present (Richter *et al.* *Canadian J. of Earth Sciences 32:6*, 1995).



The ice coring team will be complemented by a glacial geologic team who will map the terrain to reconstruct past fluctuations of glaciers in the area and correlate their growth and decay with the ice core climate record and other existing regional paleoclimate records.

The Warming Earth and Melting Ice

Meteorological data from across the world suggest that the Earth's globally averaged temperature has increased 0.6°C since 1950. Globally averaged temperatures were the warmest on record in 1998 (an El Niño year) while 2001 (a La Niña year) was the second warmest. The longer histories of temperature and precipitation from the Bona-Churchill ice cores will allow assessment of the uniqueness of the very strong 20th century warming in this region.



The figure above highlights the regions on the Earth where glaciers and ice caps are shrinking. Clearly, most non-polar ice fields are losing mass. The Inter-governmental Panel on Climate Change (IPCC, 2001) concluded that "the balance of evidence suggests that there is a discernable human influence on global climate." This human influence takes many forms but the most pervasive is the emission of radiatively active 'greenhouse' gases that selectively absorb longwave radiation emitted by the Earth and its lower atmosphere. This enhanced absorption (or trapping) reduces the Earth's ability to lose heat, thus causing a rise in surface temperatures. These gases, primarily carbon dioxide and methane, result from the burning of fossil fuels and large-scale changes in land use including deforestation.

The Field Logistics

Transportation of drilling equipment and personnel to and from the col (4,420 m asl) will be by helicopter and twin otter. A base camp for acclimatization will be set up at 3,200 m on the Klutlan Glacier that terminates in Kluane National Park in the Yukon, Canada. Once the ice cores are recovered and cut into meter-long pieces, they will be placed in plastic sleeves and then into cardboard tubes that will be placed in thermally insulated boxes. Frozen blue packs (Kryo-Pac), much like those used in coolers, will be placed inside these boxes to keep the cores frozen while they are airlifted to a freezer truck at the Chitna airport. When the project is completed the truck will return the cores to The Ohio State University's freezers (photo on back). At OSU, various chemical and physical analyses will be made in the Class 100 Clean Room facility (photo on back). The drilling team will be flown off the col, but before leaving the site they will take special care to remove all waste and equipment, thus leaving the col as they found it.

The Drill System

An array of 60 photovoltaic cells used on the col of Huascaran in 1993 produced four kilowatts of power.

Ice cores are recovered using a variety of drills. The most portable and convenient is the hand-auger, with a depth range of 30 to 40 m. For deeper cores, a power source is necessary and the down-hole portion that extracts cores is of two types. The electro-mechanical (EM) drill is very efficient for retrieving cores to about 200 meters depth on cold glaciers (temperatures well below freezing). EM drills have been used to reach Several kilometers through the ice sheets of Antarctica and Greenland. For extracting cores in 'warmer' ice caps and glaciers where temperatures may be only slightly below freezing, the light-weight, portable thermal-electric drill may be the best tool. The two most common power sources for ice core drills are fuel-powered generators and solar panels (see photo above). Solar panels provide a reliable, pollution-free, and light-weight source of power. The OSU Paleoclimatology Group pioneered the use of solar powered drills for ice core recovery in 1983 when they retrieved two cores to bedrock on the Quelccaya Ice Cap in Peru. Since then, several ice cores have been obtained from glaciers at high elevation (>5,000 m asl) using special, portable drills powered with solar panels. The drill system to be used for the Wrangell-St. Elias project includes a 700-m cable (photo below) and a controller unit weighing about 150 kg. The system may be switched quickly from a dry hole EM drill to an antifreeze thermal electric drill as needed. A light-weight, highly fuel efficient diesel engine generator that minimizes environmental impacts on the col will power the system. Both drills (EM and thermal) produce 100-mm diameter core sections up to 1.4 meters long. A newly developed quick assembly, geodesic dome (see photo below) designed and built by a mechanical engineering student at OSU houses all drilling and core processing activities.

Quick assembly geodesic dome (left) and drill system (right).

Sponsors include NSF, NPS, BPRC, and OSU
Logistic Support was provided by VECO

The Project gratefully acknowledges the cooperation and generous assistance provided by local Park Service personnel and members of the McCarthy and Wrangell-St. Elias Community.

BPRC Website

Additional information and photos can be found at
http://www-bprc.mps.ohio-state.edu/

View of Mt. Bona from the col (photo by Henry Brecher).

Research Team Members
Lonnie G. Thompson
Ellen Mosley-Thompson
Garry McKenzie
Henry Brecher
Amanda Cavin
Mary E. Davis
Patrick Ginot
Ping-Nan Lin
Michael Loso
Tracy Mashiotta
Vladimir Mikhalenko
Keith Mountain
Victor Zagorodnov

Byrd Polar Research Center

Named for Richard E. Byrd, the polar explorer, the Byrd Polar Research Center (BPRC) at OSU maintains an internationally recognized program in climate and glaciological studies. Research programs have been conducted in more than 20 countries and focus on the role of cold regions in the global climate system. Some of the research topics explored by the members of BPRC in addition to climate reconstruction from ice cores and sediments include: ice dynamics, ice-atmosphere interactions, high latitude landform evolution, soils and hydrology, Antarctic geology, polar meteorology, and history of polar exploration.

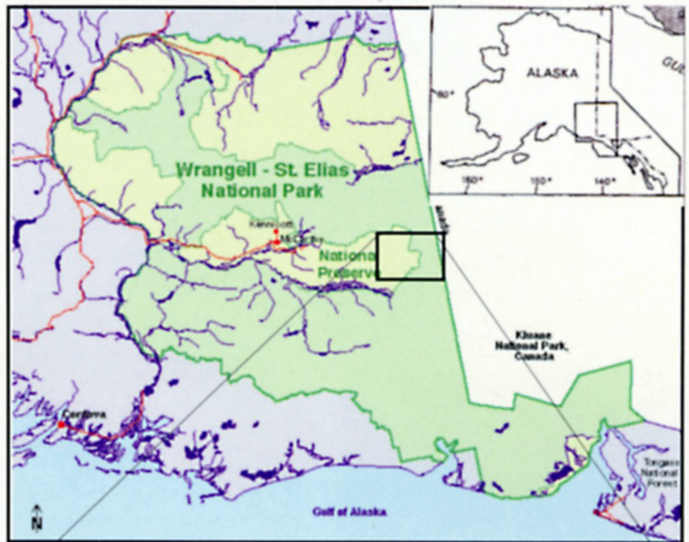
Facilities

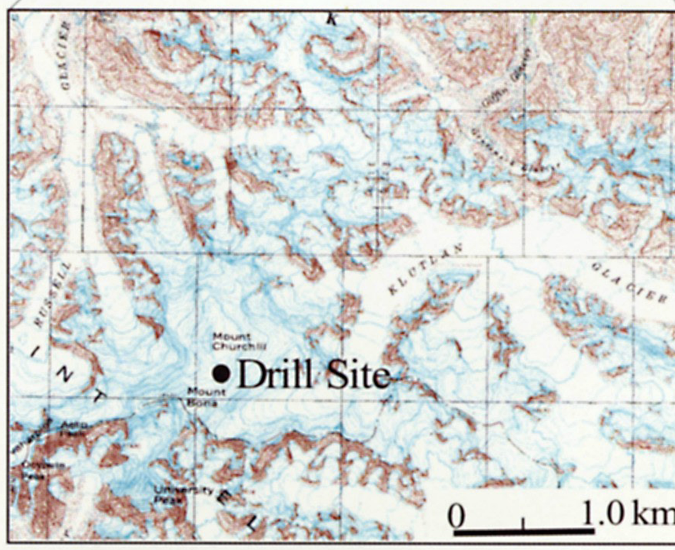
The Ice Core Paleoclimatology Group's facilities include cold storage and analytical facilities. The cold storage building contains two 30' by 35' freezer compartments with rack-type storage units maintained at -30° to -40°C.

These can hold about 3,000 meters of ice core. Ice core processing, including cutting samples for lab analyses and various analytical measurements on solid ice (such as visible stratigraphy and structural studies), are conducted in two cold work rooms (-10°C) attached to the deep freezers. State-of-the-art instruments are used that perform multi-parameter analyses on melted ice samples. Stable isotopic ratios of oxygen and hydrogen are determined with a Finnigan-MAT mass spectrometer. The radioactivity of particulates filtered from meltwater samples is measured on a Tennelec Alpha/Beta counting system. The remaining analyses are performed in the large Class 100 Clean Room facility (photo to the right). Inside the clean room, pre-cut ice samples are cleaned (using filtered deionized water from Millipore systems) for dust and chemical analyses.

Microparticle concentrations in melted samples are measured in 16 size ranges using Model TAII Coulter Counters and in 256 size ranges using Coulter Multisizers. Inorganic chemical species in melted samples are measured using Dionex ion chromatographs.

Bona-Churchill Study Area





The Program

The OSU Ice Core Paleoclimatology Group has pioneered many aspects of ice core retrieval and analysis. They recovered the first tropical cores containing ice deposited during the last glacial-stage (older than 12,000 years). The team has also drilled cores from the highest elevations, performed the first solar-powered drilling, and obtained the first radiocarbon dates from an ice core.

Common Conversions

1 km = 0.621 mi	°F = (°C * 1.8°F/°C) + 32 °F
1 m = 3.28 ft	1 kg = 2.205 lbs
1 cubic kilometer = 0.24 cubic miles	