Name of research institute or organization:

Labor für Radio- und Umweltchemie der Universität Bern und des Paul Scherrer Instituts

Title of project:

A thermal drill for ice coring on high-elevation glaciers, NCCR Climate VIVALDI (Variability in Ice, Vegetation, and Lake Deposits – Integrated)

Project leader and team:

PD Dr. Margit Schwikowski
Dr. Anja Eichler
Dr. Susan Kaspari
Manuel Schläppi
Leonhard Tobler
Michael Sigl
Anita Ciric
Beat Rufibach
Dieter Stampfli
Felix Stampfli

Project description:

Non-polar ice cores have now been obtained from all continents except Australia, almost exclusively by small teams from one or two institutions, and with a modest amount of funding compared to polar ice coring projects. However, many areas remain from which no ice cores have been retrieved yet. This is especially true for temperate glaciers, where the ice reaches the melting point during summer. Such glaciers exist in high precipitation regions of the Canadian and Chilean west coasts, the Himalayas/Tibetan Plateau, as well as in New Zealand, Scandinavia, and elsewhere. It is commonly believed that temperate glaciers are of limited use as paleo climate archives because meltwater formed during summer percolates through the summer snow and erases or homogenizes the chemical or stable isotope information contained therein. Yet useful information may be preserved because the formation of impermeable ice layers at the end of the summer prevents infiltration. Due to global warming many of the cold glaciers will turn into temperate glaciers in the future.

Due to the remoteness and high altitude of most mid- and low-latitude glaciers, the drilling equipment must be custom designed to meet narrow specifications. Particularly for glaciers located above 5500 m, i.e. above the range of helicopter operation, a lightweight and modular drill design is required to allow for transportation by either porters or pack animals. The drill must be easy and fast to assemble and operate under extreme conditions, in order to limit the exposure of scientists to dangerous high altitude environments. Most of the drilling devices used under these conditions are electromechanical (EM) drill systems designed primarily for dry hole drilling. However, EM drilling is constrained to glaciers with temperatures well below the ice melting point, since pressure induced melting during drilling can cause refreezing of meltwater on the drill which then easily gets stuck in the borehole. Another disadvantage of EM drilling is its susceptibility to ice core fracture. Especially in the deepest part just above bedrock, which is under highest shear stress, small pieces (“chips”) of ice are often produced instead of good quality

ice cores. Fractured ice cores cannot be used for the analysis of most trace species, since the standard decontamination techniques cannot be applied.

Thermal drills (TD) using ethanol/water mixtures as antifreeze drilling fluid provide good ice core quality, where shear stress is high or where the ice is warmer. Because ice conditions at mid- and low-latitude glaciers vary from "warm" ice (just below freezing point), to "cold" ice, a multi-faceted drilling technology is ideal for retrieving the best possible core quality. However, only one system has been designed so far that can quickly be switched from electro-mechanical drilling to a thermal-alcohol drilling, and still be transported by porters (Zagorodnov et al., 2000).

The mail goal of this project was the development of a TD for ice core drilling on high-elevation glaciers which can be used in combination with the existing electromechanical drill FELICS (Ginot et al., 2002). This required a modification of the control unit and the power supply, since thermal drilling consumes more power. The TD itself consists of two barrels. The upper barrel contains two pumps and two containers, for ethanol and for the ethanol/meltwater mix, respectively. The lower one is the core barrel bearing the melting ring and the core catchers (Fig. 1). The new TD was tested on the Jungfraujoch in June 2008. Good quality ice cores with a diameter of 75 mm and a length of 70 cm could be drilled with a speed of 2 m/h. After this successful test the TD will be used for ice core drilling on Lomonosovfonna in Svalbard in April 2009.

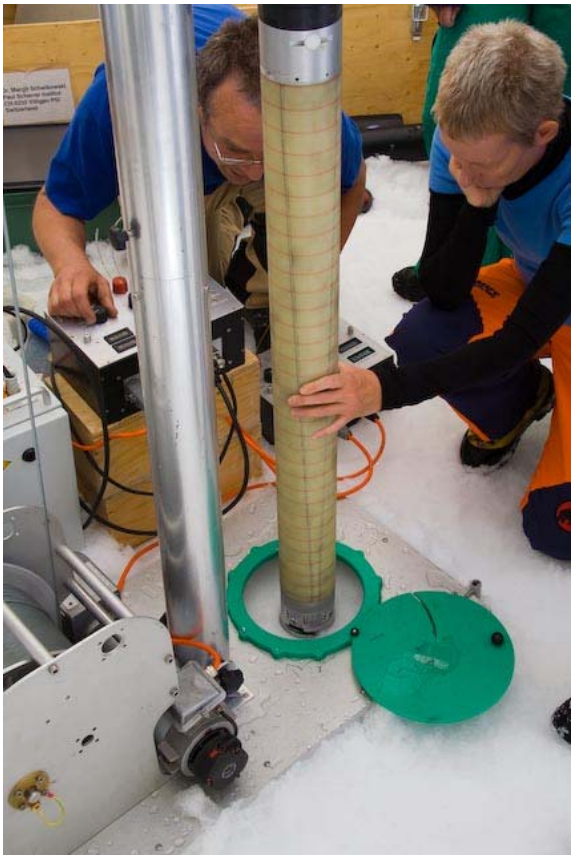

Fig. 1: The core barrel of the new TD during test on the Jungfraujoch (photo J. Cunningham).

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Internet data bases:

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Collaborating partners/networks:

Markus Leuenberger, KUP, University of Bern.
Martin Grosjean, Heinz Wanner, Geographical Institute, University of Bern.

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Address:

Paul Scherrer Institut
Labor für Radio- und Umweltchemie
CH-5232 Villigen
Switzerland

Contacts:

Margit Schwikowski
Tel.: +41 56 310 4110
Fax: + 41 56 310 4435
e-mail: margit.schwikowski@psi.ch
URL: http://lch.web.psi.ch/