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Antarctica: Historic Drilling Campaign Reaches more than 1.2-Million-Year-Old Ice

The fourth Antarctic campaign of the "Beyond EPICA - Oldest Ice" project, funded by the European Commission, has achieved a historic milestone for climate science. An international team of scientists with participation of the University of Bern successfully drilled a 2,800-meter-long and over 1.2 million years old ice core, reaching the bedrock beneath the Antarctic ice sheet.

The ice samples are expected to unveil, for the first time, critical details about Earth's climate and atmospheric history, extending beyond 800,000 years ago and showing a continuous record of the history of our climate as far back as 1.2 million years, and probably beyond. Coordinated by the Institute of Polar Sciences of the National Research Council of Italy (Cnr-Isp), the project aims to resolve one of climate science's most complex mysteries.

At the remote Little Dome C site in Antarctica, a research team representing twelve scientific institutions from ten European nations has just achieved a historic milestone for climate science. As part of the European funded Beyond EPICA - Oldest Ice project, the team successfully concluded a decisive drilling campaign, reaching the depth of 2,800 meters – where the Antarctic ice sheet meets the bedrock.

The extracted ice preserves an unprecedented record of Earth's climate history, continuous information on atmospheric temperatures and pristine samples of old air with greenhouse gases spanning over 1.2-million-year-old ice and probably beyond.

Longest continuous record of past climate from an ice core

"We have marked an historic moment for climate and environmental science" comments Carlo Barbante, professor at Ca' Foscari University of Venice, senior associate member of the Institute of Polar Sciences of the National Research Council of Italy (Cnr-Isp) and coordinator of Beyond EPICA. "This is the longest continuous record of our past climate from an ice core, and it can reveal the interlink between the carbon cycle and temperature of our planet. This achievement was made possible through the extraordinary collaboration of various European research institutions and the dedicated work of scientists and logistical personnel in the field over the last ten years." The project also benefits from the synergy with the EU-funded ITN DEEPICE project, which contributed three PhD candidates to this field campaign.

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Hochschulstrasse 6
3012 Bern
medien@unibe.ch

“From preliminary analyses recorded at Little Dome C, we have a strong indication that the uppermost 2,480 meters contain a climate record that goes back to 1.2 million years in a high-resolution record where up to 13,000 years are compressed into one meter of ice”, reports Julien Westhoff, chief scientist in the field and postdoc at Copenhagen University.

Cutting-edge technology and modeling

The principal investigator in the field, Frank Wilhelms, joint professor at Göttingen University and the Alfred Wegener Institute adds: “The identification of the right location implied strong efforts with the application of cutting-edge radio echo sounding technologies and ice flow modeling. Impressively, we found the record that goes from 0.8 to 1.2 million years ago, exactly where it was predicted to be, in the depth range between 2426 and 2490 meters, extending our previous twenty-year-old EPICA ice core record.”

Below the ice harboring the climate record of more than 1.2 Myr, the lowest 210 meters of the ice core above the bedrock consist of old ice that is heavily deformed, possibly mixed or refrozen and of unknown origin. Advanced analysis could help test previous theories about the behavior of refrozen ice under the Antarctic ice sheet and reveal East Antarctica's glaciation history.

Unravelling the mystery of glacial cycles slow down

The European teams in the field have accomplished an impressive achievement: a total of more than 200 days of successful drilling and ice core processing operations across four field seasons in the harsh environment of the central Antarctic plateau at an altitude of 3,200 meters above sea level and with an average summer temperature of -35°C.

The ice core from Beyond EPICA will offer unprecedented insights into the Mid-Pleistocene Transition, a remarkable period between 900,000 and 1.2 million years ago when glacial cycles slowed down from 41,000-year to 100,000-year intervals. The reasons behind this shift remain one of climate science's enduring mysteries, which this project aims to unravel.

Specialized transport to Europe for analysis

“The precious ice cores extracted during this campaign will be transported back to Europe on board of the icebreaker Laura Bassi, maintaining the -50°C cold chain, a significant challenge for the logistics of the project”, says Gianluca Bianchi Fasani, senior researcher at ENEA-UTA (National Agency for New Technologies, Energy, and Sustainable Economic Development - Antarctica Technical Unit) and head of ENEA logistics for Beyond EPICA. “In order to reach this goal, a strategy was developed involving the design of specialized cold containers and precise scheduling of the National Antarctic Research Program (PNRA) air and naval assets”.

As soon as these ice cores are in Europe, the project will focus on analyzing the ice samples to uncover the Earth's climate and atmospheric history over the past 1.2 million years and probably beyond. In the most basal sections of the core, even older pre-Quaternary ice might be present. Dating of the underlying rocks will be undertaken to unravel when this region of Antarctica was ice free for the last time.

The Little Dome C camp was deployed and sustained thanks to the highly effective logistics provided by the French Polar Institute and the ENEA, utilizing both their expertise and the various means of

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transport at their disposal. These included aircraft for transporting personnel to Mario Zucchelli Station and onwards to Concordia Station, and the traverse between Dumont d'Urville and Concordia Stations for heavy cargo, as well as the provision of the French and Italian ships L'Astrolabe and Laura Bassi, respectively.

Bernese precision for gas analysis

The Division for Climate and Environmental Physics (CEP) at the University of Bern is one the 12 European member Institutions of the Beyond EPICA - Oldest Ice project and has comprehensive experience in ice core sciences since its first days in the 1960s. Prof. Hubertus Fischer is the Swiss Principal Investigator of the EU Project Beyond EPICA - Oldest Ice and co-chair of the Science working group of BE-OIC. Prof. Thomas Stocker and Prof. Hubertus Fischer are PIs of the Swiss National Science Foundation Project "Beyond EPICA - The Swiss contribution" which provided additional 3 MCHF to the logistics costs of the project complementing the EU funding of 11 MEuro.

Specialized in the analysis of atmospheric species in the ice (greenhouse gases and their isotopes, noble gases and their isotopes, particulate and dissolved aerosol compounds in the ice), the analyses of CEP will be essential for several of the central objectives of the BE-OIC project, such as the reconstruction of the greenhouse gas, the mean ocean temperature, the weathering and the aerosol records over the last 1.2 Myr and beyond. In preparation of the BE-OIC ice core, CEP has developed completely new analytical techniques in recent years (for example within the ERC Advanced Grant deepSlice by Prof. Hubertus Fischer), which allow to measure these records with unprecedented precision and minimal consumption of this extraordinarily old and precious ice. Fischer was also the leading author of an initial paper defining the goals of BE-OIC and the strategy to find such old ice.

"It is absolutely stunning and rewarding to see the work of more than 10 years to find an ice core drill site and subsequently drilling a deep ice core to bedrock to finally provide exactly the ice we envisaged", says Fischer. "This is a huge success and was only possible thanks to dedicated work of all the logistics, drilling and science staff in the field. Now the exciting BE-OIC story really picks up speed, as the real work on the ice core records only starts and will keep us very busy in the coming years."

Thomas Stocker, who was also Principal Investigator of the Swiss contribution to the parent project EPICA from 1995 to 2005, and which produced the so far longest greenhouse gas records of CO2 and CH4 covering the past 800,000 years, is excited: "A dream has come true that the European ice core science community once more takes the lead, pushes the boundaries and sets a new record. For the first time, we bring to the surface ice core samples that contain continuous greenhouse gas information during the great slow-down of the ice age clock."

At CEP, Thomas Stocker also led the development of physical-biogeochemical climate models of intermediate complexity. "These models are the key to understand the new ice core record, greenhouse gas variations and ultimately the Earth's global energy balance." And he adds, "With these same models, we assess how our climate system responds in the coming decades to centuries to emissions of greenhouse gases caused by the burning of fossil fuels."

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3012 Bern
medien@unibe.ch

Participants in the 2024/2025 campaign: Université Libre de Bruxelles (BE): Lisa Ardoin; University of Bern (CH): Barbara Seth and Lison Soussaintjean; AWI (DE): Matthias Hüther, Manuela Krebs, Gunther Lawer, Johannes Lemburg, Martin Leonhardt, and Frank Wilhelms; University of Copenhagen (DK): Julien Westhoff; CNRS (FR): Marie Bouchet and Ailsa Chung; IPEV (FR): Inès Gay; ENEA (IT): Danilo Collino and Michele Scalet; Cnr-Isp (IT): Federico Scoto.

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To learn more about Beyond EPICA Oldest Ice project: https://www.beyondepica.eu/en/

Photos and Videos of the Field Campaigns:

Download latest photos:
https://drive.google.com/drive/folders/1YHkb2L5MmKQ9Me8kISWvIaBwTNBrjqIA?usp=sharing

Beyond EPICA Field Seasons Gallery: https://www.beyondepica.eu/en/gallery/field-seasons/

Contact:

Prof. Dr. Hubertus Fischer
Climate and Environmental Physics (CEP) and Oeschger Center for Climate Change Research (OCCR), University of Bern
Phone: +41 31 684 85 03
E-Mail: hubertus.fischer@unibe.ch

Division for Climate and Environmental Physics (CEP)

Climate and Environmental Physics is a division of the Physics Institute at the University of Bern with over 60 employees. It is part of the Oeschger Centre for Climate Change Research and investigates processes in the Earth system on time scales ranging from seasons to millions of years. Climate and environmental changes are reconstructed using environmental archives such as ice cores, tree rings and stalagmites. Physical-biogeochemical climate models are used to investigate the causes of past climate changes and simulate future scenarios.
Further information: https://www.climate.unibe.ch/index_eng.html

Oeschger Center for Climate Change Research (OCCR)

The Oeschger Center for Climate Change Research (OCCR) is one of the strategic centers of the University of Bern. It brings together researchers from 14 institutes and four faculties. The OCCR conducts interdisciplinary research at the forefront of climate science. The Oeschger Center was founded in 2007 and bears the name of Hans Oeschger (1927-1998), a pioneer of modern climate and ice core research who worked in Bern.
Further information: www.oeschger.unibe.ch

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3012 Bern
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