Progress of the activities of the Beyond EPICA Oldest Ice project

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**Information Paper submitted by Italy, France, Germany, Netherlands, Norway, Sweden, United Kingdom**

***Summary***

This Information Paper reports a synthesis of the activities performed by the ongoing Beyond EPICA Oldest Ice project, which represents the European effort to obtain a 1.5 Myr Greenhouse Gas – Climate Feedback Record from an Ice Core in East Antarctica. In the introductory section an overview of the project with its key features, objectives and expected impacts, is provided. The following sections briefly report firstly, the status of the project with the field activities carried out so far and secondly, the plans for future field activities.

1. ***Introduction***

The project “Beyond EPICA Oldest Ice Core: 1,5 Myr of greenhouse gas – climate feedbacks” has been funded by the European Union’s Horizon 2020 - Research and Innovation Action (RIA) programme under the Grant Agreement No. 815384, with a budget of €10 999 942.00 and significant financial contributions from participating nations.

It started on 1st June 2019 and will last until 31st May 2026: 7 years of activities in total (six initially, extended to seven due to the cancellation of one field season due to the COVID19 pandemic). In 2020 an Initial Environmental Evaluation was prepared, indicating that the activity was estimated to have a minor or transitory impact and therefore the activity could proceed.

The project is led by the Institute of Polar Sciences of the National Research Council of Italy, who is driving a consortium of 12 European and non-European international research institutes.

The list of partners and third parties with their contacts persons can be found at the following link <https://www.beyondepica.eu/en/about/participants/>

The **main scientific objective** of the project is to retrieve a continuous ice core to bedrock in Antarctica, in order to obtain quantitative, high-resolution ice core information on climate and environmental changes over the last 1.5 Myr in Antarctica. This will allow to understand the role of forcing factors and especially greenhouse gases during the Mid-Pleistocene transition (MPT), which occurred between 800,000 and 1.2 million years ago. During this period, the climatic periodicity transitioned from 41,000 to the current 100,000 years between ice ages.

Once the ice cores are collected, the aim is to fully document and prepare them to delivery to European laboratories and partial archiving in Antarctica. The analysis of the ice cores aims to establish a first robust age scale for the core and to derive first high-resolution climate records over the time interval older than seven hundred thousand years (700kr).

The new climate records will be used to constraint the cause of the MPT and long-term carbon cycle-climate feedbacks.

During the previous EPICA (European Project for Ice Coring in Antarctica) project, which ended in 2008, an 800,000-year-old ice core has been extracted and analysed.

Beyond EPICA project wants to travel back further in time and go beyond this result, by improving and extending the understanding of the linkages between GHGs and climate that began with EPICA. In addition, Beyond EPICA builds on the team and institutions that successfully completed the EPICA project and now includes a new generation of ice core science leaders.

Ice cores contain direct and quantitative information about past climate forcing and atmospheric responses, thus contributing to the knowledge of global changes on the climate system and to understanding the cause-and-effect relationship that led to the enigmatic MPT change.

The expected impacts of Beyond EPICA project are:

* support the major international scientific assessments such as the Intergovernmental Panel on Climate Change (IPCC) by improving estimates of Earth System sensitivity to GHG changes and of climate and carbon cycle feedbacks;
* increase confidence in climate change projections by contributing to design solutions to mitigate future climate changes;
* providing an evidence base to support and validate climate model thus providing added value to decision and policy makers;
* sustain European leadership in climate science by increasing the expertise of the joint European science area.

1. ***State of the Art of the Beyond EPICA project***

The drill site is located at Little Dome C (Figure 1 and 2), an area of about 10 km2, 35 km away from Concordia Station, the Italian-French research station on the Dome C zone, in the high Antarctic Plateau. Dome C is 1000 km from the coast, at an altitude of 3233 m above sea level, and is run by the French Polar Institute (IPEV) and the Italian Research Program in Antarctica (PNRA), the French and Italian polar agencies.

Imagen que contiene nieve, esquiando, tabla, cubierto

Descripción generada automáticamente

Figure 1: Beyond EPICA drill site at Little Dome C

Immagine che contiene grafico

Descrizione generata automaticamente

Figure 2- Little Dome C camp layout

The project is currently in its fourth year of activity, with three field campaigns successfully completed.

During the first field season (November 2019 – January 2020), ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) and IPEV built the drill camp at the site previously identified by an EU funded geophysical survey project, including more than 4,000 km of airborne and ground-based Radar Echo Sounding (RES) survey and basal temperature assessment based on vertical velocity and temperature measurements.

Una persona con una tabla de nieve

Descripción generada automáticamente con confianza baja

Figure 3: Drilling tent at Little Dome C

During the second field season (November 2021 – January 2022), ENEA and IPEV completed the field camp installation and set up the drilling area, the international team started drilling, reaching a depth of 130 m, the temporary storage cave was completed, and a complex drilling system was installed, which was necessary to continue drilling activities during the following seasons.

During the third field season (November 2022 – January 2023), the international team completed the installation of the deep ice drilling system and fine-tuned it to continue the drilling operations started in the previous campaign. Drilling activities reached a depth of 808.47 metres. At this depth the ice preserves information about the climate and the atmosphere of the last 49,300 years.

This year, the first 217 metres from the Beyond EPICA ice core were also processed at the “Cold Lab” at Concordia Station, making observations on the cores and measuring its conductivity parameters, as well as performing the first cuts. A part of these ice cores is being transferred to Europe for analysis in European laboratories.

Immagine che contiene diagramma

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Figure 4. Drilling Depth.

### Since the beginning of the Beyond EPICA project, Scientific Consortia, have been working on ice core science. These are represented by groups of researchers, who work together to carry out analyses and to progress in the study of the ice core analysis. Fourteen consortia, including overall 200 researchers, have so far been identified and formed. The list is reported at the link <https://www.beyondepica.eu/en/about/science-consortia-sc/>. These groups are platforms to exchange ideas, share expertise, research tools, ice samples, data and facilities, and to define key science goals for the future.

1. ***Future Plans***

The Beyond EPICA project has three more field seasons ahead to conclude drilling activities and to close the Little Dome C camp.

The specific objectives and actions for the coming seasons are:

* Continuing deep drilling to a depth of about 2000 m. Transport by traverse to Little Dome C of 20 m3 of fuel, and 20 m3 of drilling fluid. Transport by Basler/*l’Astrolabe[[1]](#footnote-1)*/cargo of the ice samples to the EU (Field season 2023-24).
* Drilling to the bedrock - replicate cores (the last 2/300 m, older than 700 kyr) and retrograding the traverse module and camp at Concordia. Transport by traverse to Little Dome C 20 m3 of fuel. Transport by Basler/*l’Astrolabe*/cargo of the ice samples to the EU (Field season 2024-25).
* Borehole logging. Retrograde the traverse module and camp at Concordia. Clean the camp (Field season 2025-26). Once drilling activities will be completed the borehole will be monitored, from an environmental assessment point of view, as it will remain of scientific relevance. New methods will allow the fluid to be recovered if scientific activity will not continue.

1. The French ice-breaker which connects Hobart, Australia to the French research station Dumont d’Urville on the coast of Terre Adélie. Dumont d’Urville and Concordia are subsequently linked by a terrestrial convoy of caravans (the “traverse”). [↑](#footnote-ref-1)