Europlanet TA Scientific Report

PROJECT LEADER

Project number: 22-EPN3-049
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TA Facility visited: Kangerlussuaq

Project Title: Retrieving multiple ice cores covering the last 100 years to study the link between the solar cycle and the cosmogenic tritium in precipitation

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database and published)

The objective of the mission was to retrieve multiple ice cores at the EGRIP site (75°37'N, 35°59'W, 2702 m a.s.l.) to study the natural as well as anthropogenic variation of tritium in the ice layers. We have studied the recent publications, which suggest lower snow accumulation rate than what we have previously thought. Therefore, we intended to drill more shallow cores. During five days at EGRIP (19-23 June 2023), we drilled five 24 m-long ice cores representing the last 100-110 years. The ice cores were cut into subsamples of 15 cm, and packed into plastic containers. One full core was collected. The bottom part (depth between 16.2 and 24.0 m) of the additional 4 cores was also collected to get more material for sensitive analysis of tritium by the ^{3}He-ingrowth method. Altogether 368 samples have been collected. Besides the cosmogenic tritium, stable isotopes of water, and Sr-Nd-Hf isotope signatures will be also analysed. To compare this latter to older ice (>10,000 years), we took ice samples at the ice margin in a location between the glaciers Isunnguata Sermia and Russell about 36 km from Kangerlussuaq, near Point 660. The ice there is supposed to be around 40,000 years old. We drilled a shallow core (~ 4 m), cut into 10 pieces, and stored in pre-cleaned plastic vessels. All of the ice samples have been already shipped to our laboratory in Hungary. The first analyses for stable isotopes, ^{137}Cs around the Chernobyl event, and tritium around the bomb-peak have been already started.

Full Scientific Report on the outcome of your TNA visit

The purpose of the visit to the planetary field analogue site in Kangerlussuaq was two-fold. Altogether, five people participated in the mission. Two of them have been sponsored by the EUROPLANET. We intended to perform shallow ice coring at the EGRIP location (75°37'N, 35°59'W, 2702 m a.s.l.), ~1100 km from Kangerlussuaq to study the isotope composition of the ice and the solid dust particles entrapped. To compare the strontium-neodymium-hafnium (Sr-Nd-Hf) isotope signature of recent ice retrieved from the EGRIP site, we planned to collect ice samples at the ice margin close to Kangerlussuaq.

The full duration of the TNA visit is described in the followings:

12 June 2023: we travelled to Copenhagen from our home town, Debrecen. We stayed in a hotel close the airport. Our sampling devices had been previously transported as a cargo to Kangerlussuaq.

13 June 2023: as the weather was good in Copenhagen as well as in Kangerlussuaq, we flew to Greenland. We occupied our rooms in Kangerlussuaq International Science Support (KISS), and then we checked the cargo in the warehouse of the EGRIP.

14 June 2023: we went to ice margin to a location between the glaciers Isunnguata Sermia and Russell about 36 km from Kangerlussuaq near Point 660. The ice there is supposed to be around 40,000 years old. We drilled a shallow core (~4 m), and cut into 10 pieces, and stored in pre-cleaned plastic vessels (Figure 1).

Figure 1. Drilling a shallow ice core at the ice margin close to Point 660 (top pictures and bottom left); and ice core entrapping some solid particles (bottom right).

15-18 June 2023: spending four days in Kangerlussuaq to get trained to the climate of Greenland. Additionally it is a kind of rule for EGRIP participants to be in a sort of quarantine before going to the ice cap. We were studying the geology and geomorphology of the area around Kangerlussuaq. In the meantime, we re-calculated how deep we would have to drill at EGRIP. We decided to drill multiple cores of 24 m. Five drillings were planned. According to the flight schedule, the departure from Kangerlussuaq was supposed to be on 17 June, however due to foggy weather at EGRIP, the flight was cancelled and postponed to the next day.
18 June 2023: we were flying to the EGRIP site with a Hercules aircraft. The drilling equipment was removed from the aircraft and then transported to a clean site 1 km away from the main dome.
19-24 June 2023: during these 5 days, we were manually drilling 5 ice cores of 24 m. The length of the cores represented the last 100-110 years. When drilling the parallel cores, the precise depth of each individual cores were noted. Here we want to retrieve ice cores to determine the variation of tritium as well as oxygen and hydrogen stable isotopes, and Sd-Nd-Hf isotope signatures. All these parameters will be compared to the ice samples taken from glaciers close to the Kangerlussuaq site. We expect that the tritium profile of the pre-nuclear era would confirm the relationship between the solar cycle and tritium, for the first time of this time period. On the other hand, the effect of climate change in Greenland during the last 100 years will be also recovered studying the stable isotope profile, provenance analysis and accumulation rate. For tritium, the detection limit is 0.002 TU using the ^{3}He-ingrowth method modified with a special ^{4}He isotope dilution technique. Stable isotopes as well as Sr, Nd and Hf isotope signatures of the polar dust extracted from 2-3 kg of ice samples will be performed on a Neptune Plus MC-ICPMS.

Figure 2. Drilling down to 24 m in the clean area of EGRIP (top left, bottom left); the main dome of EGRIP (top right); ice cores cut into subsamples of 15 cm.

24-25 June 2023: After completing the ice coring at EGRIP, we were flying back to Kangerlussuaq.

26-27 June: Travelling back to Copenhagen, and to Hungary.

The cores have been cut into subsamples on site, packed properly, and then shipped back to Hungary for further analysis. Altogether 368 subsamples (~200 kg) have been taken. During the preparation of this report, the samples have arrived at our laboratory, so we could start first the stable isotope analyses of all samples. To correlate the 5 parallel cores each subsamples have been analysed for oxygen isotopes to check how these cores are synchronised, since we want to merge the subsamples retrieved from the identical depth for sensitive tritium analyses (note that: the more water the more sensitive tritium measurement). Figure 3 shows the preliminary plot of $\delta^{18}O$ vs depth of the 5 cores.

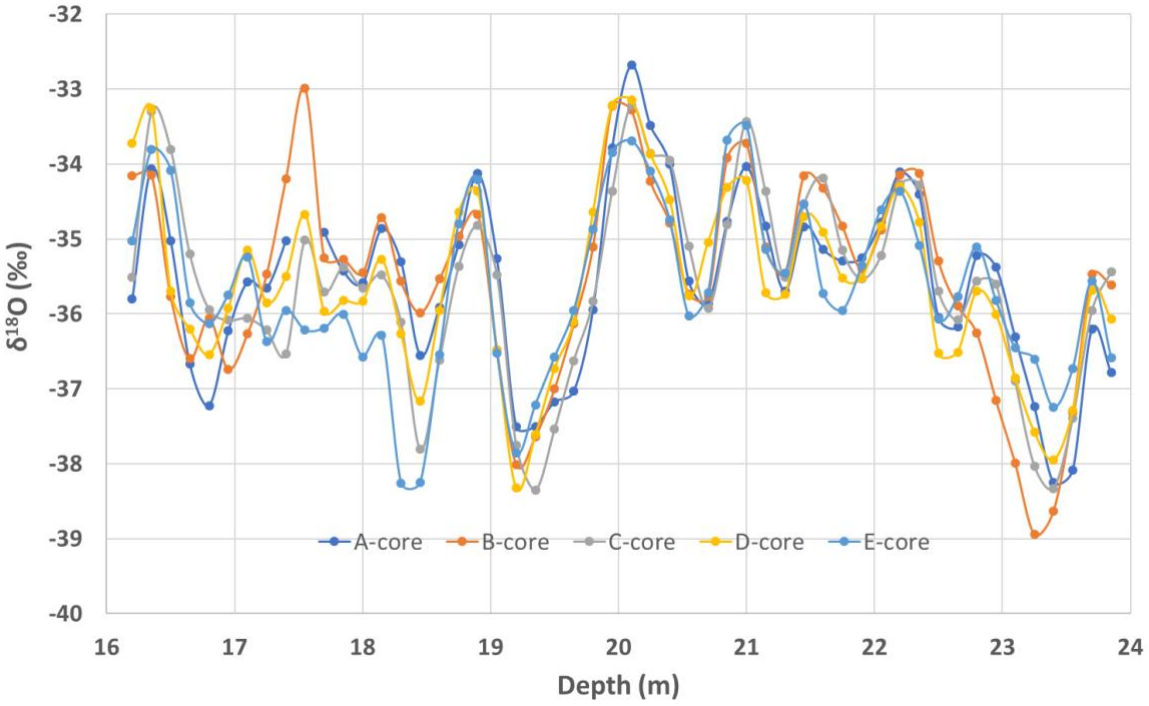

Figure 3. Stable oxygen isotope profile of the 5 parallel ice cores.

The expected results of the project are as follows:

1. Demonstration of the link between the Solar cycle and cosmogenic tritium in ice layers retrieved from the EGRIP site.
2. Moisture source distribution preserved in ^{17}O-excess in Greenland ice.
3. Examination of Sr-Nd-Hf isotope signatures from Greenland ice cores (EGRIP ice cap and Russell glacier.

- Give details of any publications arising/planned (include conference abstracts etc)

- Moisture source distribution preserved in ^{17}O-excess in Greenland ice: Target journal: Journal of Geophysical Research. Submitted in 2024.
- Comparison of Sr-Nd-Hf isotope signatures from recent and old ice cores in Greenland, and Tibetan ice cores. Target journal: Science of the Total Environment. Submitted in 2024.
- Evaluation of East-Greenland tritium profile and the Solar cycle. Target journal: Earth and Planetary Science Letters. Submitted in 2024.
- Comparative study of cosmogenic tritium profiles and the Solar cycle based on ice cores retrieved from the European Alps, Tibetan glaciers and Greenland. Target journal: Geochimica et Cosmochimica Acta. Submitted in 2025.

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:

Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 12-06-23 from Debrecen Arrived: 12-06-23 in Copenhagen	13-06-23 in Kangerlussuaq	0	5	0	18-06-23 (flying to EGRIP)	
Drilling at EGRIP						
Departed: 24-06-23 from EGRIP Arrived: 24-06-23 in Kangerlussuaq	13-06-23	0	2	0	26-06-23	Departed: 27-06-23 from Copenhagen Arrived: 27-06-23 in Debrecen

The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	Jon Merrison, Keld Rasmussen
Host Signature	Keld Rømer Rasmussen
Date	**10 August 2023**

- Project Leader confirmation

Do you give permission for the full version of this TA Scientific Report (in addition to the 250 word summary) to be published by Europlanet 2024 RI on its website and/or public reports? YES / NO

Project Leader Name	László Palcsu
Project Leader Signature	
Date	9 August 2023