EGU24-4497, updated on 19 May 2024
https://doi.org/10.5194/egusphere-egu24-4497
EGU General Assembly 2024

Plio-Pleistocene ice cores from the Allan Hills Blue Ice Area, Antarctica: recent results and prospects for future work

Ed Brook[1] and the Center for Oldest Ice Exploration Allan Hills Research Team[*]
[1]Oregon State University, College of Earth, Ocean, and Atmospheric Sciences, Corvallis, United States of America (brooke@geo.oregonstate.edu)
[*]A full list of authors appears at the end of the abstract

The Center for Oldest Ice Exploration (COLDEX) is a US initiative to search for climate records covering the last 5 million years, including cores from blue ice regions where very old ice has been identified. Ice cores from the Allan Hills, Antarctica contain discontinuous ice sections that date to as old as 4.6 Ma, and numerous samples with ages between 1 and 3 Ma, all dated with the $^{40}Ar_{atm}$ technique. These samples provide constraints on a variety of past environmental variables, including greenhouse gases (Marks Peterson et al., this meeting) and mean ocean and Antarctic surface temperature (Shackleton et al., this meeting), and create opportunities to explore other properties of climate and the environment beyond the 800 ka limit of the existing ice core record (for example, Hudak et al., this meeting).

The Allan Hills cores and glaciological setting are unusual. Ice flow, likely from a relatively local depositional area, traps old ice at shallow depths near the ice margin, albeit in a poorly understood manner. In most locations drilled so far, ice younger than 1 Ma is underlain by a relatively thin layer (20-40 m) of older material. In the “Cul-de-sac” region, ice older than 1 Ma is found within 15 m of the surface

Dating Allan Hills cores clearly shows age reversals indicative of folding. Deformation of dust and tephra bands at the surface, and deformation of bubbles at depth, also indicate complex ice flow. Dust mass concentrations are lower than expected for glacial periods, with anomalously high values at greater depth indicating incorporation of basal sediment. $\delta^{15}N$ of N_2 measurements indicate a relatively shallow firn column in the original deposition site. Three-dimensional mapping of electrical conductivity and isotopic measurements in large, 24-cm diameter cores clearly shows inclined layers and folding. Phase-sensitive radar is being used to measure spatial variations in vertical velocity (with some repeat measurements completed), and polarimetry profiles. Temperature measurements in Allan Hills boreholes suggest heating related to shear between the old ice and shallower layers.

Results from sections that date to 500-800 ka reproduce the long-term mean values of various parameters (CO_2, CH_4, $\delta^{18}O_{atm}$, MOT, $\delta^{18}O_{ice}$) but not the entire glacial-interglacial range. Small-scale folding, diffusion and hiatuses are all possible explanations for the muted variability. Detailed studies of large diameter cores are currently investigating these possibilities.

So far, five cores (ALHIC1502, 1503, 1901, 1902 and 2201) sample ice older than 1 million years. ALHIC1902 contains the oldest ice dated, at 4.6 Ma. Drilling in the 23/24 field season partly completed a 24-cm diameter core (2302) at the 1902 site, intended to provide large volumes of very old ice, A 90 m core in the Cul de Sac, (2301), at the location where old ice was found near the surface, was also completed.

COLDEX drilling will continue in the Allan Hills in 2024-25 and possibly in later seasons. Future work may also include an ~1250 m ice core in a region where modelling predicts continuous stratigraphy for ~1 Ma.

Center for Oldest Ice Exploration Allan Hills Research Team: Ed Brook, John Higgins, Sarah Shackleton, Yuzhen Yan, Howard Conway, Julia Marks Peterson, Austin Carter, John-Morgan Manos, Margot Shaya, Annika Horlings, Lindsey Davidge, Peter Neff, Valens Hishamunda, Liam Kirkpatrick, Alissa Choi, Michael Bender, Christo Buizert, Abby Hudak, Asmita Banerjee, Jeff Severinghaus, Eric Steig, TJ Fudge, Maciej Sliwinski, Douglas Introne, Andrei Kurbatov, Michelle Koutnik, Sarah Aarons