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He-isotope evidences in the basal layer of EPICA drill sites

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Helium enters the ice sheet not only at the firn/ice transition, but also at the ice-bedrock interface. In contrast to other gases, He is highly soluble in ice and may undergo diffusional transport within the ice sheet. Thus, we expect a significant basal layer enhancement of crustal He, which, similar to the temperature profile, is controlled by the competing transport processes of upward He-diffusion versus downward ice advection. Knowing the profile of this mostly radiogenic He fraction would basically allow to place experimental constraints on the vertical ice velocity distribution in the near bedrock section. Vice versa, if the velocity profile is pre-described the (not well known) continental flux of crustal He may be inferred. The high diffusivity of He causes diffusional He-losses between core break off and final sealing of the ice sample that have to be accounted for. A 3D He-degassing model allowed to overcome these problems by estimating the initial He concentrations as well as the respective diffusion constants for ^{4}He and ^{3}He.

Our first He ice sheet profile obtained at the Greenland summit (GRIP) mainly revealed a general ^{4}He-level around $50 \cdot 10^{-8}$ Nml/g consistent with modelled atmospheric inputs and a clear crustal ^{3}He/^{4}He signature showing up near bedrock, but surprisingly extending much higher up as could be explained by reliable scenarios of vertical ice velocity, crustal input and He-diffusivity. Results from EPICA cores show no substantial difference in the mean ^{4}He levels compared to GRIP. Similar to GRIP, also both EPICA cores show remnants of the crustal (radiogenic) He-signal far above bedrock, with EDML basal layer revealing the by far highest crustal He-signal. The basal EDC He-profiles stand out by unexplained, systematic variations, though respective simple age calculations are consistent with the current chronology.