Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16464

New insights on Greenland ice sheet basal processes: modelling the evolution of a biological signature and diffusion processes

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In contrast to the traditional ice sheet layers, the gases trapped in the bottom ice from Greenland ice sheet do not display direct indications of the past atmosphere [1, 2, 3]. The basal layers are distinguished by their proximity to the bedrock, which can result in the incorporation of sediments and debris from a minimum of 6 meters at GRIP to as much as 25 meters above the bedrock in DYE-3 [4]. Additionally, the basal ice is characterized by its low total gas content, ranging from 46 to 2 $mL.kg^{-1}$ [as opposed to 90-100 $ml.kg^{-1}$ in meteoric ice, 2,5], and its specific gas composition, which suggests that an accumulation of gases such as CO_2, CH_4, and N_2O (up to 9 %, 2 % and 9.4 ppmv, respectively) together with a consumption of O_2 down to anoxic level. This gas content can be attributed to a combination of melting and refreezing, diffusion, shearing, and biological processes that occurred either in the sediments below the ice or within the ice itself [1, 2, 3]. In this study, we measured the basal ice total gas content and composition (N_2, O_2, Ar, CO_2, CH_4, N_2O) from three localities in Greenland (Camp Century, GRIP, NEEM). Our study involves 1D-modelling of the changes in gas concentration within the ice, considering advection, diffusion, and internal consumption/production. We aim at constraining these processes by using the vertical gas profiles to place observation constraints on biogeochemical processes at the base of the ice and potentially on the age of the basal ice itself.

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