Geophysical Research Abstracts
Vol. 21, EGU2019-11032-2, 2019
EGU General Assembly 2019

Considerations for drilling site of an oldest ice core around Dome Fuji, Antarctica, based on radar sounding, shallow coring and ice-flow modeling

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The recovery of a new Antarctic ice core to cover one million years will advance our understandings of the Quaternary climate. Previous studies have indicated that such old ice may exist in inland areas of the Antarctic continent, where the ice is thick enough (but not too thick), accumulation rate is low, basal temperature is well below the pressure melting point, and horizontal ice flow is slow (Pattyn 2010; Fischer et al. 2013; Van Liefferinge and Pattyn 2013; Sun et al. 2014; Parrenin et al. 2017). In the efforts to select the drilling site in the Dome Fuji area, the 59th Japanese Antarctic Research Expedition (JARE 59, 2017-2018 Antarctic summer) conducted intense glaciological field surveys. In particular, a densely arranged ground-based radar survey improved the mapping of bedrock topography as well as internal layers of the ice sheet around Dome Fuji. Three shallow ice cores (40 - 152 m depth) were also drilled for better constraining the spatial differences of accumulation rate in the area. We have been analyzing the new and existing field data, and conducting ice flow modelings constrained by the data, to estimate the flow and age of ice near the bed of the ice sheet, as the essential parts of the site selection activities.

As the first step of modelings to aid interpretation of the field data, we use an one-dimensional ice flow model to simulate the vertical profile of temperature and age of ice. The modeled age and temperature profiles at the previous Dome Fuji drilling site are first compared with the depth-age relationship of the Dome Fuji deep ice core (3034 m, 720 kyr) and borehole temperature to optimize model parameters such as geothermal heat flux and vertical-strain-rate parameterization. The model is then applied to the vicinity of Dome Fuji along the transect of JARE 59 surveys, and simulated age profiles are compared with internal layers of the ice sheet, to estimate the areas where very old ice may exist or where the ice bed is melting. We also investigate the influence of various glaciological parameters such as ice thickness, accumulation rate, geothermal heat flux, and thinning rate, on the age estimation of ice especially in the lowest few hundred meters.

In the presentation, we will discuss potential sites around Dome Fuji and the relative importance of uncertain glaciological parameters on the age estimation of the deepest layers in the ice sheet. Our results were also partly used for the planning of survey areas of the Japan-Norway-US international survey with JARE 60 using higher-performance ice radars (see presentation by Shuji Fujita et al. in the same session).