Investigation of the physical effects such as diffusion, smoothing, deformation, and inclination, to ice core signals in the deep section (2400m to the deepest part) of the Antarctic Dome Fuji ice sheet

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1. Research Background and Objectives

Ice cores from the Antarctic inland plateau are important sources of information for understanding climate change history on the scale of approximately 1.5 million years. The deeper the ice containing climate change signals, the older the age becomes, and due to the flow of the ice sheet, it undergoes vertical compression and deformation. In addition, it experiences temporal changes due to geothermal influences on the signals. If we could read the climate change signals with high time resolution down to very old ice, it would be possible to understand the history of rapid climate changes. Until now, ice core analyses have primarily been based on discrete analyses (e.g., intermittent sampling or sampling every 0.1m depth). In this situation, the Continuous Flow Analysis (CFA) technique, which is a continuous high-resolution analysis method, has been put into practical use in the last several years. Additionally, the research group at the National Institute of Polar Research has developed the Dielectric Tensor Method (DTM), which enables rapid, large-scale, high-resolution measurements of crystal axis orientation distributions. The objective of this research is to clarify the processes of signal alteration in very old layers of ice cores collected from Antarctica's Dome Fuji, dating back approximately 200,000 to 720,000 years, using both DTM and CFA. In the Dome Fuji core, this contains the alteration processes from a depth of approximately 2000m to the deepest part. Based on this research, we are 1) clarifying the nature and characteristics of temporal changes, 2) investigating the possibilities for precise synchronization and comparative analyses between multiple cores, and 3) enabling predictions about the preservation of information in very old ice cores that will be drilled in the future.

2. Research Methods

We are conducting detailed analyses of particularly old sections of the Dome Fuji core, dating back approximately 200,000 to 720,000 years. Within the scope of this research's objectives, continuous analysis of all layers is not necessary. These chronological sections exist in a compressed state of annual layers within the deepest approximately 1000m of the ice core within a total length of about 3000m. First, this study uses the DTM method to obtain profiles of the accumulated strain in the Dome Fuji core. Next, we are attempting to clarify to what extent it is possible to recover the dynamics of rapid climate change within the Dome Fuji core as we go further back in time. We are reading the stratification of substances that are difficult to diffuse within the ice. Continuous analysis of silicon, sodium, calcium, and dust concentrations was carried out using the CFA method.

3. Results and Discussion

For the analysis of the ice cores, we conducted analyses on 7m-long ice core sections for each Marine Oxygen Isotope Stage (MIS) 9–17, totaling approximately 63m. At the stage of writing this abstract, data analysis and consideration are ongoing. At the conference, we will present findings that have become clear up to that point. From the high-resolution continuous analysis using DTM, we are advancing the work to read in detail how the deformation layers and recrystallization in the ice sheet are configured in the deep sections. Furthermore, from the high-resolution continuous analysis using CFA, we are considering how the layers that have been preserved for a long time in the deep sections are altering. We aim to clarify the information value, reliability, and limitations of the deep cores as old climate archives concerning rapid climate change.