Study on physics and layers of ice cores containing information of climate change over the past 720 k-years, and study on the "oldest ice"

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Purpose and Background of the Research

Ice cores collected in inland of Antarctica is one of important information sources for histories of climatic changes that occurred over 1.5 M years. At ice core drilling sites, ice is older in deeper layers; such deep layers are subject to vertical compressions by ice flow. In addition, various time-dependent metamorphic processes undergoes by influences of the geothermal heat flux. If such very deep signals are once resolved with high time resolutions, we can uncover the history of rapid climate changes. Such ice-core-based knowledge will be crucial for building strategies to make sustainable society under global warming. However, current state of our knowledge is based on limited and discrete sampling from ice cores. High resolution continuous methods for analysis has just begun in recent years. In this study, we will use cutting-edge methods for high-resolution and continuous measurements for ice cores, based on crystal physics and continuous flow analysis (CFA); we will analyze layers of ice cores spanning ca. 200,000 years and ca. 720,000 years. Based on it, we will (i) produce valuable information of the climate in the past, (ii) clarify nature of the time-dependent metamorphic processes, (iii) synchronize multiple very deep ice cores, and (iv) predict quality of information from ice cores that cover 1.5 M years.

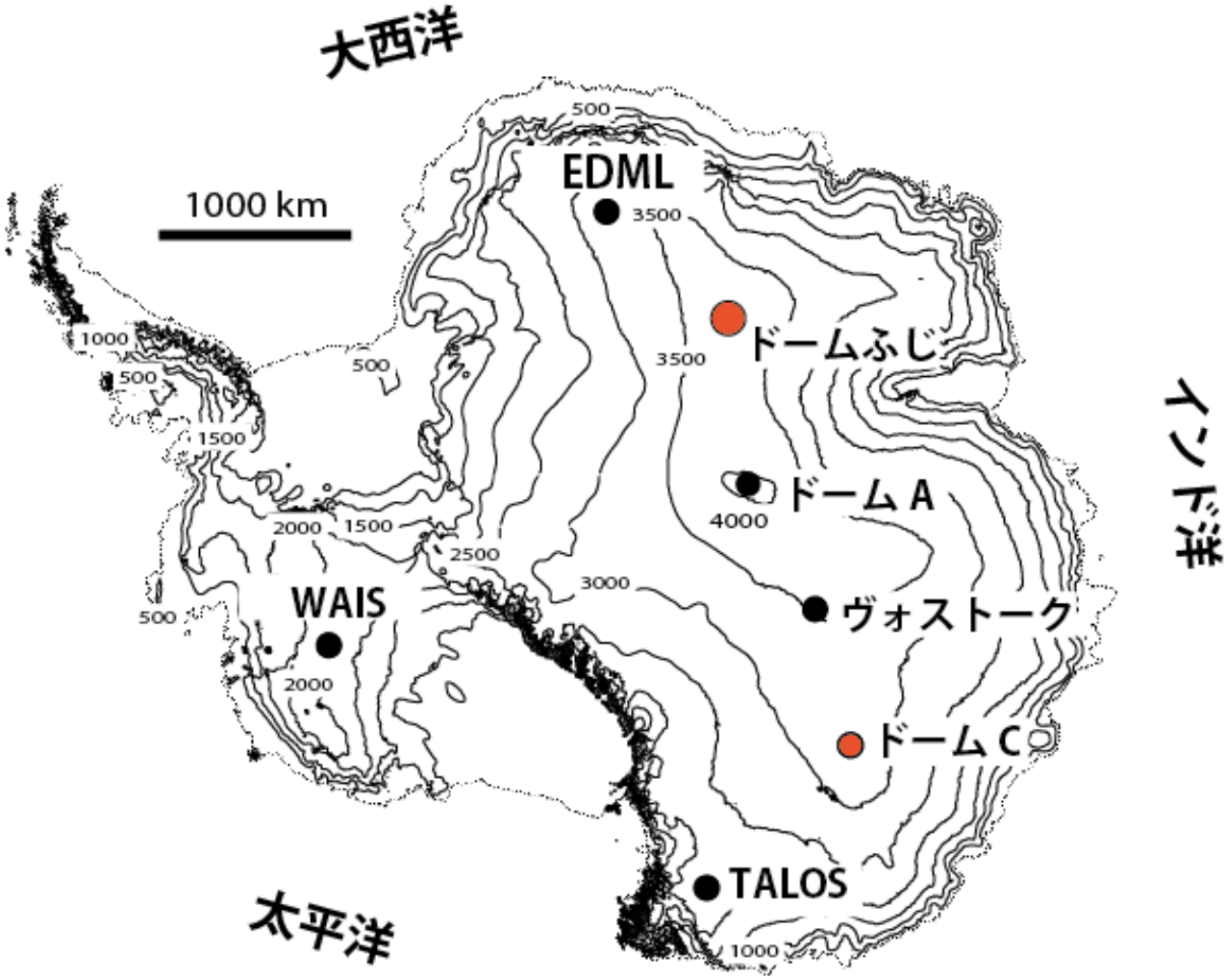
Research Methods

At an inland site called Dome Fuji in East Antarctica, ice core researchers organized by the National Institute of Polar Research, Japan, collected ice cores covering 720,000 years. We will analyze portions of the ice cores spanning ca. 200,000 years and ca. 720,000 years. Such very old portion constitute deepest ~1000 m span within the ~3000 m-thick ice sheet. Such layers are subject to vertical compressions. In this study, key questions are as follows:
(i) Can we synchronize these very old portions of ice between to major ice cores drilled at Dome Fuji and Dome C?
(ii) How old age of ice back in time, can we clarify detailed histories of rapid changes of climate?
As actions tackling the questions, we will use two major methods to read the layered strata. One of them is to read layers of crystal textures using a method to measure dielectric permittivity tensor with the millimeter wave resonators. Spatial resolutions of this method is ~20mm. Another method is "Continuous Flow Analysis" (CFA) method to read layers of Si, Na and Ca, with a resolutions of ~10 mm.

Expected Research Achievements and Scientific Significance

First, we will produce invaluable ice core data. The data will be used to tackle the key questions. Based on the data, we will synchronize two very old ice cores at Dome Fuji and Dome C, based on collaborations of the European deep ice study community. In addition, we will examine timing difference between the climatic change records between the two ice cores. We aim to accomplish the first reliable and detailed synchronization between very old ice cores up to 720,000 years back in time. we will study change of the climatic mode over the 720,000 years. Furthermore, we will study how very old ice older than 1 M years, can be preserved near the base of the ice sheet.

Keywords: Antarctica, ice sheet, ice core, climate change, dating, paleoclimate



図：南極氷床上の主要な深層アイスコア掘削点

