博士論文の要約

論文題目　　Investigation for the cosmic ray event around 5480 BCE by measuring ^{10}Be and ^{36}Cl concentrations from the Dome Fuji ice core
（ドームふじアイスコアの ^{10}Be 及び ^{36}Cl の測定による 5480BCE 宇宙線イベントの原因調査）

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Galactic cosmic rays are constantly incoming to the earth, and their intensity varies with solar activities in several time scales. In addition to the continuous input of galactic cosmic rays, a sudden input of energetic particles can be expected by eruptive events, such as solar proton events (SPEs), supernova explosions, or gamma-ray bursts. Since these particles produce cosmogenic nuclides (e.g., ^{10}Be, ^{14}C, and ^{36}Cl) in the atmosphere, past solar activity variation and the eruptive event occurrence can be reconstructed from the cosmogenic nuclides stored in terrestrial archive samples.

An abnormal ^{14}C enhancement has been discovered around 5480 BCE (hereafter 5480 BCE event), wherein ^{14}C concentration increased to the same extent as the grand solar minimum (~20‰) in just ~10 years. As the cause of the rapid and large ^{14}C concentration increase around 5480 BCE, an unusual grand solar minimum, occurrence of multiple extreme SPEs, or gamma-ray events has been expected; however, its cause has not yet been determined. To investigate the origin of the abnormal ^{14}C variation around 5480 BCE, multiple nuclide analysis is effective because the cosmogenic nuclide production ratio depends on the source of incoming cosmic rays.

In order to investigate the origin of the 5480 BCE event, we measured ^{10}Be and ^{36}Cl concentrations in the Antarctic Dome Fuji ice core for ~100 years, covering the time period of the 5480 BCE event. The ^{10}Be and ^{36}Cl measurements were performed in quasi-annual and 4–5-year resolutions, respectively.

We found a rapid increase in the ^{10}Be concentration around 5469 BCE (+11y/–16y), however, ^{36}Cl concentration did not significantly increase in the entire measurement period. The ^{10}Be enhancement around 5469 BCE was not due to SPE since the ^{36}Cl concentration did not increase synchronously. In addition, the gamma-ray event is probably not the cause of the 5480 BCE event since there was no synchronous increase in ^{14}C and ^{36}Cl during the period of stable ^{10}Be. The total ^{10}Be concentration increase in the 5480 BCE event was similar to that of recent grand solar minima obtained from Dome Fuji. Moreover, the ^{10}Be concentration increase completed in ∼10 years in the 5480 BCE event was shorter than other minima, which is consistent with the ^{14}C data. Further, the ^{10}Be concentration showed an 8–12-year periodicity during the 5480 BCE event, which might reflect the Schwabe cycle. The results suggest that the most probable origin of the 5480 BCE event is the unusual grand solar minimum that solar activity decreased in ∼10 years.

In addition, we developed a system to calcinate $Be(OH)_2$ to BeO for the ^{10}Be measurement using AMS. Since ^{10}B (isobar of ^{10}Be) becomes a background in the ^{10}Be measurement, we investigated the calcination condition to prepare BeO samples with less ^{10}B contamination. We confirmed that the ^{10}B background did not differ between the calcination under air, vacuum, and oxygen conditions. Also, the results suggest that the sufficient BeO^- beam current for the ^{10}Be data analysis can be obtained from the blank samples calcinated at a temperature lower than ~400°C.