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Chemical compositions of soluble particles around the Termination 1 in the Dome Fuji ice core

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Micro sized particles preserved in Antarctic ice cores are useful proxies for reconstructing past climate and environmental changes. The recent studies on chemical compounds of the particles by using the Dome Fuji ice core showed that sulfate salts were main soluble particles, and chemical compositions of primary sulfate salt were calcium sulfate during the glacial maximum and sodium sulfate during the Holocene #1. However, it is still unknown that how chemical compositions of sulfate particles have changed on millennial time scale. In this study, we focused on sulfate salts and sea salts (precursor of sulfate salts) and measured constituent element of non-volatile particles in the Dome Fuji ice core around the Termination 1(9-25 kyr BP).
A total of 48 samples were distributed from Dome Fuji ice core section from 298.900m to 582.590m (Holocene to Last Glacial Maximum: LGM, 9-25 kyr BP), with a time resolution of about 320 year. Non-volatile particles were extracted from the samples by sublimation system #2. Constituent elements and diameter of each non-volatile particle were measured by scanning electron micro scope (SEM) and energy dispersive X-ray spectroscopy (EDS). By using a method in our recent paper #3, we made a classification of non-volatile particles into insoluble dust, soluble sulfate salts and soluble chloride salts. Also we assumed that particles containing Ca and S are calcium sulfate, particles containing Na and S are sodium sulfate and particles containing Na and Cl are sodium chloride.
We found several fluctuations of calcium sulfate, sodium sulfate, and sodium chloride around the Termination 1, and these fluctuations are associated with changes in terrestrial as well as marine environments. Main sulfate salts changed from calcium sulfate to sodium sulfate after 16.5 kyr BP. A plausible explanation is that sulfuric acid in atmosphere became to react with sodium chloride instead of dusts (calcium carbonate) after 16.5 kyr BP, because atmospheric dust concentrations decreased to Holocene level around 16.5 kyr BP #4. Mass ratio of sodium sulfate+ sodium chloride (soluble sodium salt) to total particles showed 3 peaks at 16.5, 13 and 10 kyr BP. These peak ages were consistent with those of sea ice expansion in southern Atlantic Ocean which was reconstructed from the diatoms abundance of sea ice indicator in a marine sediment core #5. Therefore the mass fraction of the sodium salt probably reflects the sea ice expansion in southern Atlantic Ocean.

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