# Particle alignments observed in a Greenland ice core, retrieved by North Eemian Ice Drilling (NEEM)

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Variations of concentrations and chemical composition of impurities in polar ice cores have been studied to reconstruct the past climate and environment. Size distribution of insoluble microparticles (particles, hereafter) provide us with the information on sources, wind speed in source regions, and transport and deposition processes. Compared to many of soluble impurities such as acidic species, particles have been thought to undergo less post-depositional changes. Distribution of particles in ice and their size distribution, however, could change in ice sheets. In deepest parts of deep ice cores, particles form large aggregates and alignments (e. g. Sakurai, 2010; Ohno et al., 2016). This could be due to physical processes occurring in ice sheets, such as deformation and recrystallization. Detailed mechanisms, however, are still unclear. It has not been known if post-depositional changes in particles occur at shallower depths in ice sheets. To reconstruct the past climate and environment using particles, we should better understand the mechanisms. Using an optical microscope and a scanning electron microsope, we have observed particles in an ice core retrieved by North Eemian Ice Drilling (NEEM), and investigated their distribution in ice.

We found that the particles formed alignments in the ice at 1548 m depth in the NEEM ice core (ca. 19.2 kyr before present, which is in the last glacial period). Most particles existed as aggregates of smaller particles. At this depth, alignments and aggregates were found to be more pronounced in sub-layers with higher particle concentrations. In ice samples cut along the vertical direction, particles aligned horizontally. Ice crystal grains are elongated horizontally, and crystal basal planes oriented horizontally. These facts indicate that particle alignments and ice microstructure are related. In the interglacial samples (Holocene at 124 and 426 m depth, Eemian at 2406 m depth), only a few alignments were observed. We discuss the mechanisms of formation of alignment and aggregate of particles, in relation with shapes and orientation of ice crystal grains along the NEEM ice core.

**References**

Ohno, Hiroshi, Yoshinori Iizuka, Akira Hori, Atsushi Miyamoto, Motohiro Hirabayashi, Takayuki Miyake, Takayuki Kuramoto, Shuji Fujita, Takahiro Segawa, Ryu Uemura, Toshimitsu Sakurai, Toshitaka Suzuki, and Hideaki Motoyama (2016) Physicochemical properties of bottom ice from Dome Fuji, inland East Antarctica, *J. Geophys. Res. Earth Surf.*, 121, 1230–1250, doi: 10.1002/2015JF003777.

Sakurai, Toshimitsu (2010) Studies on phase equilibrium states and spatial distributions of water-soluble microparticles preserved in polar ice sheets, Ph.D thesis, Graduate School of Environmental Science, Hokkaido University