Variations in mineralogy of dust in snow and ice core obtained from Greenland Ice Sheet over the past 100 years

*Naoko Nagatsuka[1], Kumiko Goto-Azuma[1,2], Akane Tsushima[3], Hideaki Motoyama[1,2], Sumito Matoba[4], Koji Fujita[5], Tetsuhide Yamasaki[6], Yukihiko Onuma[7], Yuki Komuro[1], Masahiro Minowa[8], Teruo Aoki[1], Motohiro Hirabayashi[1], Fumio Nakazawa[1], Dorthe Dahl-Jensen[9]

1. National Institute of Polar Research, 2. SOKENDAI, 3. Meteorological Research Institute, 4. Institute of Low Temperature Science, Hokkaido University, 5. Graduate School of Environmental Studies, Nagoya University, 6. Avangnaq Arctic Project Corp., 7. Institute of Industrial Science, University of Tokyo, 8. Universidad Austral de Chile, 9. University of Copenhagen

Snow and ice on glaciers and the ice sheet in the Arctic contain windblown mineral dust derived from local sediments as well as distant deserts. Dust deposited on the ice sheet in the past can be obtained by ice core drilling, and the variations in its sources and transportation processes can be reconstructed by particle analysis of ice cores. In this study, we analyzed morphology and surface chemistry of mineral dust particles from an ice core drilled in Northwest Greenland with Scanning Electron Microscope (SEM, QUANTA FEG 450) and Energy Dispersive X-ray Spectrometer (EDS).

The ice core was drilled at the SIGMA-D site (N77°64’, W59°12’) of 2100 m a.s.l. in 2013. The ice core samples were collected every five years in plastic bottles and freeze dried on a polycarbonate filter to concentrate micro-particles. Here we report the temporal variations in size distributions and compositions of the minerals during the past 100 years (A.D 1920-2013).

The SEM observation revealed that the mean size of mineral dust in the SIGMA-D ice core ranged from 1-3 μm, which is similar to that of the other Greenland ice core dust that seems to be derived from distant areas. This suggests that the ice core contained mainly long–range transported wind-blown mineral dust. The EDS analysis revealed the ice core contained mainly silicate minerals, especially clay minerals that showed compositional variation among the samples. For example, the mineralogical composition varied in every 10-15 years and showed a negative correlation between minerals formed by chemical and physical weathering (kaolinite vs illite/micas and chlorite). This indicates that the minerals were derived from multiple geological sources and the source areas might have varied temporally. Furthermore, quartz and feldspar, which had larger particles than clay minerals and thus were generally used as a short-distant transport, were higher in 1920-1945 and 1990-2013 compared with the other periods. Based on the past temperature record in Greenland, the warming occurred from 1910 to 1945 and after 1990. This may suggest that the minerals were derived not only from distant areas but also from local sources, such as moraine around the ice sheet margin in warmer periods. This is likely due to exposure of ground surface without snow cover.

We have also applied this SEM-EDS method to mineral dusts collected from 4m-depth snow pit in East Greenland and tried to identify seasonal variations in their composition. Detailed results will be shown in our presentation.

