Particles in ice layers of SIGMA-A ice core, northwestern Greenland

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Arctic atmospheric warming accelerates surface melting on the Greenland ice sheet. In the accumulation areas of the Greenland ice sheet, ice layers are formed by snowmelt and refreezing processes during summer. In the snowmelt water, chemical substances originated from atmospheric soluble aerosols exist as dissolved anion and cation species. After refreezing process, the ions are preserved in the state of acid or salt in the refrozen ice layer. However, the behavior of inclusions in refreezing ice layers is still unclear. In this study, we observed salt inclusions in ice layers of a Greenlandic ice core to understand how and where inclusions were formed along the snowmelt and refreezing process.
During spring 2017, a 60m ice core (hereinafter referred to as SIGMA-A core) was drilled on the northwestern Greenland (78º 03′06″N, 67º 37′42″W, 1490 m a.s.l), which covers the past 100 years. The SIGMA-A core has 243 ice layers (longer than 1mm in thickness), whose mean thickness is 13.8mm.Both the number and the thickness of ice layers have increased in recent 30 years. In a -20℃ cold room of Institute of Low Temperature Science, Hokkaido University, ice layers formed in 2006 and 2014 were selected from the SIGMA-A ice core. The two ice layers were cut to three sections of 40*6.56*25 mm(the 2014 sample), 40*5.45*75 mm(the bottom part of 2006 sample), 40*6*80 mm(the top part of 2006 sample) in the -20℃ cold room. Then, the size and location of inclusions in the sections were observed by a measuring microscope (OLYMPUS, STM-UM) in the cold room. The chemical composition of inclusions were identified by Raman spectroscopy in a cold chamber at -30℃ with the same method described in Ohno et al.[1].
The location of inclusions tends to be the bottom part of the both ice layers. The mean particle size is 17.6μm, which is larger than that in other dry ice cores. For example, the mean size of particles in Greenland NEEM core is about 1-4μm[2], and that in Dome Fuji core is 1-3 μm[1]. Also, inclusions are identified as $Na_2SO_4 \cdot 10H_2O$ and $CaSO_4 \cdot 2H_2O$ by the Raman measurements. The snowmelt and refreezing processes may produce huge salt inclusions at the last stage of refreezing due to ion redistribution.

References

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