Overview of the chemical composition and characteristics of Na^+ and Cl^- distributions in samples from Antarctic ice core DF01 (Dome Fuji) drilled in 2001

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Ice core samples contain information about the geological history of Earth, including past climate changes. Dome Fuji, situated at the highest point of land in central Antarctica, is considered one of the best drilling locations for procuring samples for reconstructing past climates and environments.

We present here fundamental data on the concentrations of dissolved ions in shallow samples, between depths of 7.7 m and 65.0 m, from the Dome Fuji ice core drilled in 2001. A total of 1435 samples were obtained for analysis. The measured anions were $HCOO^-$, CH_3COO^-, $CH_3SO_3^-$, F^-, Cl^-, NO_2^-, NO_3^-, SO_4^{2-}, $C_2O_4^{2-}$, and PO_4^{3-}, and the cations were Na^+, K^+, Mg^{2+}, Ca^{2+}, and NH_4^+. The measurements were carried out using ion chromatography. The temporal resolution of the depth profiles of the ion concentrations was less than one year. No significant correlations were observed among these ions except between Na^+ and Cl^-.

Figure 1 shows the ion balance in the core, based on the averaged ion concentrations of the samples. As shown in this figure, the ion balance in the ice core was far different from that of sea salt, a result consistent with a finding of previous studies[1),2)]. The previous studies and our data imply the probability that precipitation around Dome Fuji might reflect conditions in the stratosphere.

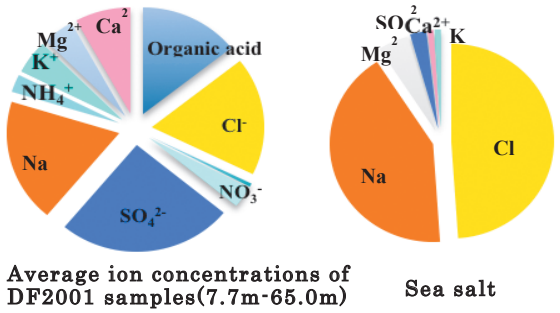

Fig. 1. Relative ion composition of the ice core (left) and sea salt (right).

In several samples, however, synchronous concentration peaks of Cl^- and Na^+ were identified, and the Cl^-/Na^+ ratios of the corresponding samples were close to the sea salt ratio. Figure 2 shows a plot of Cl^- vs. Na^+ concentrations and several samples exhibit Cl^-/Na^+ ratios close to that of the sea salt (dashed line). This observation indicates the possibility that climate conditions were such that precipitation containing sea salt occurred in the Dome Fuji area. The effect of sea salt can hardly be recognized around Dome Fuji thus far. This is a new finding by the analysis of high-resolution depth profiles of Na^+ and Cl^- concentrations. On the other hand, the Cl^-/Na^+ ratio of samples that did not exhibit Na^+ and Cl^- peaks in the depth profile differed from that previously reported for the covering snow[3), 4)]. This result implies that Cl^-, but not Na^+, was redistributed after the snow had fallen. According to Fujita et al., (in press)[5)], it is probable that high concentrations of sulphate made the Cl^- ion mobile in ice cores and the concentration of Cl^- was smoothed out. This might account for the alteration of Cl^-/Na^+ ratios and the distribution, exhibiting the dotted line in Fig. 2, has been achieved. To interpret these observations and elucidate the climatic conditions that might account for them, further studies to examine the transportation of water into Antarctica and the metamorphism of ice, such as isotopic analyses of δD and $\delta^{18}O$, will be required.

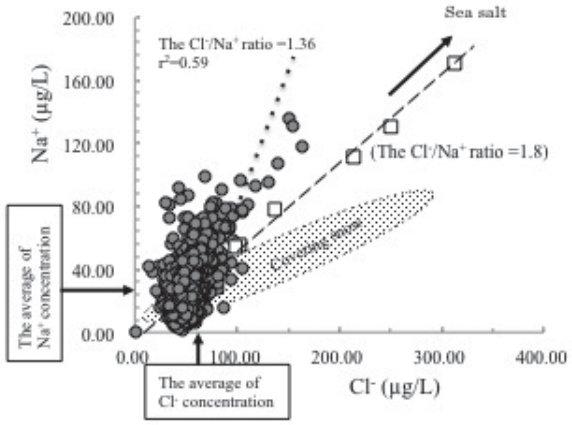

Fig. 2. Scatter plot of Na^+ vs. Cl^- concentrations in shallow samples, between 7.7 m and 65.0 m depth, from the Dome Fuji ice core drilled in 2001.

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