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A FEASIBILITY STUDY ON HELIUM ISOTOPES IN ICE CORE (ABSTRACT)

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The isotope ratio of atmospheric helium, $^3He/^4He$ ratio, is believed to be constant on a global scale since the mixing time for the atmosphere is significantly shorter than the residence time for helium. Human activity such as fossil fuel exploitation may release significant amounts of crustal helium with low $^3He/^4He$ ratio. Recently a decrease in the atmospheric $^3He/^4He$ ratio from 1.362×10^{-6} in December 1977 to 1.339×10^{-6} in September 1988 was reported. These observations are compatible with an estimate of the anthropogenic release of crustal helium. For verification of the $^3He/^4He$ change with time, measurement of ancient air before the industrialization is highly desirable. Air bubbles in Antarctic ice cores may be the most suitable samples for the purpose.

The ice core samples, which were obtained at Mizuho Station in 1984, were carefully processed to extract the trapped air at the National Institute of Polar Research. A released air sample of about 0.3ccSTP from ice cores at 330-m depth, which was estimated to be about 3600 years old, was introduced into an evacuated stainless-steel canister equipped with a stainless-steel bellows valve. The $^3He/^4He$ and $^4He/^{20}Ne$ ratios of the samples were measured using the purification vacuum line and high precision mass spectrometer at the University of Tokyo. The observed $^3He/^4He$ ratio relative to the running standard was converted into the absolute $^3He/^4He$ ratio using a calibration line based on artificially mixed in-house standard gases. The observed $^4He/^{20}Ne$ ratio was calibrated against the present air standard. Experimental errors of $^3He/^4He$ and $^4He/^{20}Ne$ ratios are about 1 % and 10 %, respectively. Chemical compositions of the samples were determined using a quadrupole mass spectrometer.

The $^3He/^4He$ and $^4He/^{20}Ne$ ratios of air bubbles extracted from ice core samples before industrial activity vary significantly from 9.9×10^{-7} to 1.30×10^{-6} and from 0.31 to 0.47, respectively. Major chemical constituents of the samples are nitrogen, oxygen and argon, which agree well with present atmosphere. Ancient air might have had a higher $^3He/^4He$ ratio than that of the present air when considering that the atmospheric $^3He/^4He$ ratio has decreased with time. However, this is not the case with the Mizuho samples. There is a negative correlation between the $^3He/^4He$ and $^4He/^{20}Ne$ ratios, suggesting that the ice core samples were somewhat contaminated by helium with low $^3He/^4He$ ratio. It is said that the cryogenic experiment using liquid helium as a coolant was carried out in the ice core storage room at the National Institute of Polar Research. The $^3He/^4He$ of coolant helium is generally lower than that of air. Helium in the samples might be compromised by the contamination of

coolant helium if the helium content of the ambient atmosphere was significantly high in the storage room. Further studies are required to verify the results.

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