

Variation of helium isotope compositions at Lake Mashu

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Helium-3 is one of the most sensitive geochemical tracers which reflects addition of mantle components to gas and fluids in volcanic hydrothermal systems, and ${}^3\text{He}/{}^4\text{He}$ ratios may be useful to assess temporal change of hydrothermal activity at volcanic lakes. Lake Mashu is a caldera lake which formed around 7000 years ago in Hokkaido. Igarashi et al. (1992) measured He and Ne isotopes in water of Lake Mashu, and concluded that the depth profile of isotopic compositions reflect injection of mantle-derived He due to hot spring activity at the lake bottom. After that, there is no subsequent study reporting He isotope data. The lack of observational data may be due to difficulty of water sampling at caldera lakes. Igarashi et al. (1992) collected water samples into copper tubes. However, this method requires heavy and large sampling tools, and people who can transfer water and seal the tubes properly. In May and September 2017, we investigated Lake Mashu in order to check volcanic activity and practical sampling methods for caldera lakes. We collected water using a Niskin bottle at several depths (surface to 210 m) around the deepest point (211 m). Collected water was immediately transferred into lead-glass containers with vacuum valves at both ends. In Atmosphere and Ocean Research Institute, dissolved gases were extracted by the head space method, and introduced into a purification vacuum line. In the line, He and Ne were purified for isotope analyses. ${}^3\text{He}/{}^4\text{He}$ and ${}^4\text{He}/{}^{20}\text{Ne}$ ratios were measured using Helix-SFT and QMS, respectively. The highest ${}^3\text{He}/{}^4\text{He}$ ratios were observed at 205-210 m depth, indicating that injection of fluids with the high ${}^3\text{He}/{}^4\text{He}$ ratio at the bottom. The linear correlation between ${}^4\text{He}/{}^{20}\text{Ne}$ and ${}^3\text{He}/{}^{20}\text{Ne}$ ratios in water samples indicated mixing of two components: injected fluids and the atmosphere. The estimated ${}^3\text{He}/{}^4\text{He}$ ratio of the fluid end member was indistinguishable from the value reported by Igarashi et al. (1992), implying a possibility that there was no significant change in volcanic activity at Lake Mashu in the past 30 years.

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