

Noble gas isotopes of micrometeorites collected from Antarctic snow

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As a comprehensive study [e.g., 1], we have been investigating micrometeorites (MMs) collected from Antarctic snow in 2003 and 2010 by JARE. MMs used in this study were recovered by filtering melted snow water at 20 °C in a clear room at Ibaragi Univ. Each MM was investigated by several analytical methods: identification using SED-EDS, followed by characterization by SR-XRD, TEM, micro-Raman, SEM, and EPMA analyses, and additionally by INAA, and/or noble gas mass spectroscopy. We classified the MMs investigated into five types based on their mineralogical features: 1) refractory, 2) chondrule-like, 3) fine-grained polycrystalline, 4) coarse-grained crystalline, and 5) phyllosilicate-rich MMs. Here, we report results of noble gas analyses for the MMs and show the relation between their noble-gas and mineralogical features.

Each of the samples mounted on Mo sheets was removed using acetone, and packed into an Al cup. The Al cups were set in a sample holder of a small furnace (designed for submicrogram to milligram samples) equipped with a purification line of the noble gas mass spectrometer at Kyushu Univ. The samples were heated *in vacuo* at 150 °C for 1 day to reduce adsorbed atmospheric gas contamination. Each sample was heated stepwise at 400, 650, and 1800 °C to extract noble gases. Absolute abundances and ratios of noble gas isotopes were calibrated by measuring known amounts of atmospheric gas and a He standard gas with ³He/⁴He of 1.71E-4. Blank levels of He and Ne at every extraction temperatures are reasonably low but those of the other elements are comparable to those released from MMs: e.g., ⁴He = 5E-12, ²⁰Ne = 5E-13, ³⁶Ar = 1E-12, ⁸⁴Kr = 1E-14, ¹³²Xe = 3E-15 cm³ STP for the 1800 °C blank run.

Samples studied are two chondrule-like MMs, one fine-grained MM, and three coarse-grained MMs, and are 30-60 micrometers in diameter. Isotopic ratios of He and Ne are indicative of solar wind (SW) origin, while elemental ratios of ⁴He/²⁰Ne are <90, lower than SW value (~650 [2]). Release profiles of SW noble gases are different among MMs: two out of seven begin to release noble gases at 400 °C, three at 650 °C, and two at 1800 °C. This indicates that they were heated to varying degrees during atmospheric entry. Plotting ⁴He concentrations against ⁴He/²⁰Ne ratios, a positive correlation is observed in the MMs, as is the case with Itokawa particles [3], IDPs [4], unmelted MMs [5, 6], and cosmic spherules [7]. The largest amounts of He and Ne among the MMs studied were obtained from a fine-grained MM (D03IB67), which consists mainly of sub-micron olivine and low-Ca pyroxene grains. This MM releases noble gases at 400-1800 °C, indicating that this MM was not heated above 400 °C during atmosphere entry. The TEM observation revealed that this MM contains abundant solar flare track with ~5E10 /cm² density, which corresponds to >1E4-years exposure [8] to solar wind and flare. The presence of the flare track is consistent with the noble gas release temperature, since the track can be erased by flash heating above ~600 °C [9].

A chondrule-like MM (D03IB057) and a single olivine MM (D10IB170) contain only small amounts of He and Ne with the lowest ⁴He/²⁰Ne ratios (1.4 and 0.4, respectively). They release detectable amounts of noble gases only at 1800 °C. Both of the MMs show signs of higher degrees of heating: the uppermost surface layer of D03IB057 is partly melted, while that of D10IB170 is decomposed into magnetite and glass.

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Keywords: micrometeorites, noble gas, solar wind