LASER MICROPROBE NOBLE GAS ANALYSIS OF CHONDRULES IN THE MOORABIE L3.8 CHONDRITE.

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Introduction: Trapped noble gases were discovered in chondrules by laser microprobe noble gas analysis [1-3]. The observed noble gases were explained by solar gas acquisition in dust grains before the chondrule formation [1-3]. These results show importance of trapped noble gases in chondrites to understand environment and formation processes of chondrules. We performed the laser microprobe noble gas analysis on chondrules of the Moorabie L3.8 chondrite, which characterized by solar free and short cosmic-ray exposure age [4].

Experimental method: A polished thick section (~350 μm thick) was made from the Moorabie chondrite, and then observed by scanning electron microscope (SEM). Noble gases in five chondrules and matrix of the section were extracted by melting small portions with a Nd-YAG laser (50 μm in diameter). Fused mass was approximately 12 μg for one measurement (5 - 6 fused spots) and the extracted noble gases were analyzed on a modified VG5400 (MS-II) at the University of Tokyo. We analyzed 4 – 13 sites for individual chondrules depending on their sizes.

Results and discussion: All the five chondrules show porphyritic texture and consist of Fe-rich olivine, Fe-rich pyroxene, and Ca-plagioclase. He and Ne in these chondrules are composed of cosmogenic component and radiogenic ^{4}He. Average concentrations of cosmogenic ^{3}He and ^{21}Ne are constant among the five chondrules and matrix (1.8 - 2.3 × 10^{-7} and 4.0 - 5.5 × 10^{-8} cm^3STP/g, respectively), indicating that the isotopes were produced in space by galactic cosmic-rays. On the other hand, concentrations of radiogenic ^{40}Ar show wide variation (4.2 - 39 × 10^{-6} cm^3STP/g), which would reflect variation in K contents among the chondrules. Moreover, excess of ^{129}Xe was detected in the chondrules with maximum ratio and concentration of ^{129}Xe/^{132}Xe = 21 ± 7 and ~1.5 × 10^{-9} cm^3STP/g, respectively.

Three chondrules among the five ones are free from the trapped noble gases, which would be attributed to complete degassing during the chondrule formation. Other two chondrules, however, contain Xe-rich trapped noble gases partially within their interior. The trapped ^{36}Ar/^{132}Xe and ^{84}Kr/^{132}Xe ratios are 30 ± 4 and 0.44 ± 0.06, respectively, which are lower than those for Q-gases (^{36}Ar/^{132}Xe = 76 ± 7, ^{84}Kr/^{132}Xe = 0.81 ± 0.05; [5]). Matrix materials neighboring to the chondrules also contain the trapped noble gases with similar ratios; ^{36}Ar/^{132}Xe = 35 ± 6 and ^{84}Kr/^{132}Xe = 0.65 ± 0.09. The noble gas elemental ratios extracted by our laser heating method are comparable to those of the bulk sample of Moorabie measured by conventional total melting method; ^{36}Ar/^{132}Xe = 28 ± 4 and ^{84}Kr/^{132}Xe = 0.62 ± 0.09 [4]. We should emphasize that the concentrations of trapped ^{36}Ar in the chondrules (~2.8 × 10^{-7} cm^3STP/g) are higher than those in matrix (1.1 ± 0.1 × 10^{-7} cm^3STP/g).

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