Development for in-situ radiogenic ^{4}He analysis in zircon

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Zircon is recently used for U-Th-He dating of various rocks because zircon contains high concentration of U and Th, and radiogenic ^{4}He which is produced by disintegration of U and Th (e.g., Reiners et al., 2004). The closure temperature of U-Th-He dating in zircon is low (~180°C). Recently, a low-temperature thermal history of their samples are revealed by using the U-Th-He dating of zircon, for example, the process of uplift and denudation of mountains (e.g., Sueoka et al., 2011).

There is a question about ^{4}He analysis in current U-Th-He dating. Since a typical range of an α-particle is ~20 μm, the conventional apparatuses for ^{4}He analysis cannot accurately evaluate an escape of radiogenic ^{4}He from minerals byα-decays due to a larger spatial resolution.

LIMAS (Laser Ionization Mass nanoScope) is an analytical system developed for analyzing noble gases in micro region, which shold be a key instrument to solve the issue. In this system, neutral particles sputtered by Ga focused-ion-beam from sample surface are ionized by femtosecond laser for tunneling ionization, and produced ions are separated by the multi-turn time of flight mass spectrometer 'MULTUM II' depending on their m/z. LIMAS has a potential to trace a track of the α-particle because a spatial resolution of LIMAS is less than 1 μm in case of analysis for trace amount of ^{4}He (Bajo et al., 2015). LIMAS can measure depth profile, and analyze distribution of the ^{4}He concentration at a given depth. Thus, the depth profiling may tell us the further details of ^{4}He diffusion profile in minerals.

If U-Th-He can be measured by LIMAS, the new U-Th-He dating which should be more reliable than previous measurements will be proposed. As the first step, we carried out quantitative analysis of radiogenic ^{4}He in a zircon standard (zircon91500), that have known data about U and Th concentrations and U-Pb age, by LIMAS.

We measured zircon91500 to detect radiogenic ^{4}He by using LIMAS. Concentrations of U and Th in zircon91500 are 80 and 30 ppm, respectively, of which U-Pb age is 1065 Ma (Wiedenbeck et al., 2004). The concentration of radiogenic ^{4}He was supposed to be 55 ppm based on the U and Th concentrations and U-Pb age.

We measured ^{28}Si ions and ^{4}He^{+} to estimate concentration of radiogenic ^{4}He. The radiogenic ^{4}He in zircon91500 was calculated to be 30 ±5 ppm after a blank correction. The blank level of this study was 7 ±3 ppm, which was derived from residual ^{4}He in the sample chamber of LIMAS.

Keywords: zircon, U-Th-He dating, 4-He, LIMAS

