Distribution of U, Th and Pb in Ryugu rocks – preliminary results of a SIMS study

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Uranium and thorium are radioactive parent elements of U-Pb and Th-Pb isotope chronometers. Knowing the location of these elements in the rock is required for correct interpretation of Pb-isotopic ages obtained with high precision ID-TIMS analyses. Furthermore, concentration mapping allows identification of minerals with elevated Th and U concentrations that may be suitable for in-situ dating.

We have measured concentration of U, Th a Pb, as well as the isotope composition of Pb, in Ryugu specimens A0063 and C0046 on KBSI SHRIMP IIe, using procedures of [1,2]. These specimens were prepared for previous petrologic studies as ca. 5 mm epoxy mounts of 2-3 mm rock fragments. The mounts were imaged at KOPRI for element distribution of Na, Si, K, Fe, Cr, Mg, Al, Ca, Mn, P, S, Ti and Cl using WDS, and F, Sc, V, Co, Ni, Cu, Zn, Y and Zr using EDS. These element distribution maps were used for mineral identification and interpretation of SIMS isotope analyses. For SIMS analyses, the mounts were placed inside brass adaptors for standard 25mm SHRIMP mounts that were designed and made at KBSI. In order to minimise sample loss, the mounts were analysed without repolishing. It was found that even small changes of the primary beam location within the sample area resulted in significant changes of the secondary beam focusing conditions. This problem is probably caused mount obliquity and proximity of the sample spots to the metal frame, which can be efficiently avoided in analyses of samples in regular 25mm SIMS mounts. We are currently looking for a method of data normalisation that would allow obtaining accurate element concentrations despite these problems.

U, Th and Pb concentrations have been measured in 40 spots in the specimen A0063, and 49 spots in the specimen C0046. The concentrations of Th, U and total Pb are 7.3±5.3 ppb, 2.5±1.5 ppb, and 467±241 ppb, respectively (uncertainties are 1SD). Because of the secondary focusing variations mentioned above, these concentrations should be considered preliminary semi-quantitative. Concentrations of all three elements in dolomite, sulfides and magnetite are similar or lower than in the phyllosilicate-rich matrix, and the latter dominates the budget of these elements. Three analyses of apatite grains showed slightly elevated concentrations of U and Th, but these grains are too rare to significantly affect the overall distribution of these elements.

The elemental and isotopic ratios are unaffected by the abovementioned problem. The matrix has average Th/U ratio of 2.9±1.1, and $^{238}U/^{204}Pb$ ratio of 0.14±0.11. The weighted mean $^{206}Pb/^{204}Pb$ and $^{207}Pb/^{204}Pb$ analyses (with 95% confidence intervals) are 9.88 ± 0.17 (MSWD=1.3), and 10.87 ± 0.19 (MSWD=1.5), respectively, which is close to the TIMS data of [3], and are only slightly more radiogenic than the primordial Pb of the Solar System. One apatite grain yielded elevated U concentration of 35 ppb, and $^{206}Pb/^{204}Pb$ of 19.5. This result shows that searching other mounts for apatite can potentially yield some grains suitable for in-situ U-Pb dating.

References

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