

Evaluation of coupling LA-ICP-MS/MS and collision/reaction cell technique for in-situ zircon analysis

*Shuhei Sakata¹, Hiroki Saitoh², Takeshi Ohno²

1.Department of Earth Science and Astronomy, Graduate School of Arts and Sciences, The University of Tokyo, 2.Department of Chemistry, Gakushuin University

Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) is not only a relatively cheap, fast, low-costing method, but also has high sensitivity to obtain geochronological/geochemical information from micro region of solid samples. However, the highly-ionization capability of this method easily occurs multiple mass interference from isobaric, polyatomic and multi-charged ion. Hence, in the case of LA-ICP-MS, great care for these potential mass interference must be taken, compared to the traditional solution nebulization sampling in which chemical separation of target element is possible. To overcome these problems in LA-ICP-MS, the instrumental setting at high mass resolution power or low oxide formation rate is common, although the decrease of the sensitivity is unavoidable in many cases. Moreover, it should be noted that there has been no effective strategy for reducing the isobaric interference in LA-ICP-MS. In this presentation, we would like to demonstrate the effectiveness of coupling ICP-MS/MS and collision/reaction cell (CRC) technique for in-situ U-Th-Pb dating and quantitative analysis of rare earth elements (REEs) of zircons using laser ablation sample introduce technique.

In U-Th-Pb dating of zircon, the measurement of ²⁰⁴Pb is critically important because it is the only non-radiogenic nuclide among stable isotopes of lead. Unfortunately, in LA-ICP-MS, there is the isobaric interference on ²⁰⁴Pb from ²⁰⁴Hg which is derived from the impurity of the argon gas for ICP ion source. In this study, the reduction of this interference is tested by flowing a small amount of ammonia gas in the CRC. In this case, while the polyatomic ions made by collision of REEs in zircon and ammonia gas could be overlapped on mass peak of Pb isotopes, the first mass spectrometer (Q1) can effectively remove the REEs and ammonia gas collides with only isotopes of Hg, Pb, Th and U. In this operational settings, the accurate age from several standard zircons was obtained with reducing the isobaric interference from Hg lower than the level of 1/100.

In the quantitative analysis, the instrumental tuning at the low oxide formation rate is important because most of REEs tend to make oxide easily in ICP-MS and polyatomic interference on heavy REEs from the oxide of light REEs is not negligible. However, at the condition of the lower oxide formation rate (<1%), the instrumental sensitivity is greatly depressed as trade off. Therefore, we used mass shift method by flowing the oxygen gas in the CRC. In mass shift method, it is possible for operational settings to be tuned to maximize the sensitivity while removing the mass interference from polyatomic and multi-charged ions. We carried out the quantification of REEs in standard zircon sample at the condition of the high sensitivity (10 times higher than normal condition) and extremely high oxide formation rate (>100%) using mass shift method, and the resulting concentrations of REEs show good agreement with reported values.

In conclusion, the coupling ICP-MS/MS and CRC technique can be not only a great solution for the interference-related problems, but also brings out the potential capability of high sensitivity of LA-ICP-MS.

Keywords: LA-ICP-MS, Zircon geochronology, Trace element quantification, Collision/reaction cell