

Age-cytometry : new approach for meteorite anatomy

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The chronology for meteorite samples has played an important role to decode the early sequence of the solar system. Among the chronometers based on the radio-active decay of long-lived nuclides, because of the high time resolution of the resulting age data, the U-Pb chronometry has been widely used to define the timing of formation of refractory inclusions or to understand the formation sequence of the chondrite parental body. The high time resolution on the U-Pb chronometers was achieved by the small contribution of the analytical uncertainties in the isotope ratio measurements onto the resulting age data, and also because of the well-defined decay constants for ²³⁸U, ²³⁵U and ²³²Th nuclides. Moreover, the U-Pb isotope systematics has further advantages of evaluating of system closure since the sample formation or crystallization of minerals, and therefore, reliability of the resulting age data can be rigorously tested. Using the U-Pb chronometer, the resulting time-resolution can become as small as 0.2 ? 1 Ma range for chondritic materials, but this could not be high enough to understand the planetary formation during the runaway growth or to understand the timing of the core formation. To overcome this, we are trying to measure in-situ ²³⁸U/²³⁵U ratio from individual minerals by means of combination of two ion collectors. Details of the instrumentation and operational conditions would be demonstrated in this talk.

Cytometry is the quantitative analysis of cells and cell systems. Cytometry measures optical properties of cells, and most often uses fluorescence to measure specific antigen molecules, intracellular ions and DNA/RNA using antibodies, indicator dyes, or nucleic acid-specific probes. Cells may be live or fixed, depending on the application, and individual cells can often be physically sorted. ? Advantage of the cytometry are the analysis speed, detection sensitivity, the ability to measure many parameters simultaneously, and the ability to sort individual cells, and therefore, mechanism or process of elemental metabolism could be precisely evaluated based on the extensive number of cells (e.g., Benfall et al., Science, 2011; Bodenmiller et al., Nature Biotechnology, 2012). This approach can also be applied to understand the solar system evolution based on the numerous number of age data. In recent ten years, we have demonstrated the unique study approach using the distribution pattern of sample ages based on the series of precise age data collected from large number of samples (i.e., age-cytometry) [e.g., Rino et al., PEPI, 2008; Iizuka et al., Geology, 2008; Iizuka et al., Iizuka et al., Chem. Geol., 2009; Iizuka et al., GCA, 2010]. With the high-time resolution age data obtained by present analytical technique using the LA-ICPMS, further precise and quantitative discussion could be made on the solar system evolution through the age-cytometry. The newly developed high-resolution and high-throughput age determination system using a laser ablation-ICP mass spectrometry has a potential to become a significant tool to promote an age-cytometry.

Keywords: meteorite anatomy, cytometry, solar system evolution, multiple collector mass spectrometry, laser ablation-ICPMS, ICP-mass spectrometry