

年代サイトメトリー推進のための ICP 質量分析計の開発 Development of new ion collector for U-Pb Age cytometry

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Age distribution (age cytometry) is one of the most principal and versatile information to decode the geological events underlying the Earth evolution. To take full advantage of the age cytometry, both the high analytical throughput and the better precision in the age determination is severely desired. Combination of laser ablation sampling technique and the high-sensitivity ICP-mass spectrometer (LA-ICPMS) enables us to measure precise U-Pb ages directly from the small area in the solid samples. Recently, both the precision and reliability of the U-Pb age data was dramatically improved by both the newly developed ion counting technique using the attenuator device and the correction technique for the initial disequilibrium for the U-Th-Pb decay series (Sakata et al., 2014). Moreover, magnetic sector-based mass spectrometry equipped with the multiple-ion counting system results in much higher analytical precision in the Pb/U and Pb/Th isotope ratio measurements. With the multiple-ion counting system, the analysis time for the U-Pb age determination could be dramatically shortened down to 1 - 5 sec, which was almost 1/4 - 1/10 levels over the conventional U-Pb age determinations using the single collector ICPMS instruments. This suggests that both the higher analytical throughput and the better precision in the Pb/U ratio measurements could be achieved. The problem associated with the multi-ion counting technique would be a time-dependent changes in the gain and the background (dark noise) of the multipliers. This is one of the large sources of analytical error in the U-Th-Pb age determinations. To overcome this, multiple-ion counting system using Daly ion collectors was employed in our MC-ICPMS system.

Several unique features could be achieved by the Daly ion counter, such as (a) wider dynamic range of the ion counting up to <10 Mcps, (b) smaller time-changes in gain and background level of the collector, and (c) better peak parallelism (peak flatness) over the conventional multipliers. Only the problem associated with the Daly counter is that the width of the Daly collector would be significantly larger than the mass dispersion for the heavier elements. In this study, two pairs of ion deflectors were used to obtain wider mass dispersion for the ion beams. With the multiple ion counting using the Daly ion counters, better precision and smaller contribution of the time-dependent changes in the gain and background counts could be achieved.

In this presentation, new ion collector system was applied to the MC-ICPMS system, and the preliminary results on the Pb/U and Pb/Th isotope ratio measurements and age determinations on zircon samples will be described.

Keywords: Age Cytometry, Multiple Ion Counting, Laser Ablation, U-Pb Dating, Zircon Chronology