Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MTT44-P01 Room:Convention Hall Time:May 26 18:15-19:30

Simultaneous determinations of 58 elements in volcanic glass shards using the femtosecond laser ablation ICP-MS

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Volcanic glass shards in the Quaternary widespread tephras have been chemically classified and identified on the basis of the contents of the major components (e.g. Al_2O_3, CaO, and MgO) determined using the electron beam microanalysis techniques. The abundances of the trace elements have been also measured using various analytical techniques including INAA, ICP-AES, and laser ablation ICP-mass spectrometry (LA-ICP-MS) techniques. However, the measurements of the trace elements have been generally restricted to the rare earth elements and some elements such as strontium, thorium and uranium. In this study, we carried out the quantitative analyses of the total of 58 elements from lithium to uranium simultaneously using the femtosecond LA-ICP-MS technique. Four volcanic glass samples on the International focus group on Tephrochronology And Volcanism (INTAV) sample mount described by Kuehn et al. (2011) were analyzed for comparison between the analytical values of the major components using the LA-ICP-MS technique and those obtained by the electron beam microanalysis techniques. The analytical values of the major oxide components of the INTAV volcanic glass samples deviate less than 10% from the preferred values shown in Kuehn et al. (2011). The analytical results suggests that the LA-ICP-MS technique can be reasonably available for quantitative analyses of the major elements in volcanic glass shards in addition to the trace elements, as an alternative of electron beam microanalysis techniques. We analyzed 22 tephra samples from Japan and surrounding region (e.g. Aira Tn tehphra and Aso-4 tephra) and 4 tuff samples of North America (e.g. Lava Creek Tuff and Bishop Tuff), and confirmed that the volcanic glass shards can be clearly distinguished from each other by the patterns of the wide-ranged element abundances. The abundances and the patterns of the wide-ranged elements of the volcanic glass shards are definitely helpful to more precise identification and correlation of tephra samples.

Keywords: volcanic glass, tephra, LA-ICP-MS, element abundance, element pattern, femtosecond laser

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Attempt to measure magnetization of single pollen in microgravity condition

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Precise analyses performed on microfossil pollen included in the soil have provided quantitative information to reconstruct the paleoclimate. In order to improve the precision of the chronical data, it is necessary to reduce the lower limit of detectable number of pollen included in the sample per unit volume. In analyzing an aggregate sample composed of heterogeneous grains, it is often difficult to conclude by visual observations whether or not the minor grains included in the sample are completely discovered and identified without omission. In such cases, it is desirable to separate the aggregate in to single grains and identify their material prior to various scientific researches. It was proposed that identification of solid grain is possible by comparing the grain's magnetization obtained by field-induced translation, with the compiled data of magnetization [1]. The proposed principle of identification has significance in investigating rare samples, such as primitive meteorites, because the method can analyze the small grains in a simple manner without consuming them.

In order to quantitatively evaluate the practicability of separating the microfossil pollen from the soil mineral grains, it is necessary to the precise value of magnetic susceptibility of pollens. Therefore, M-H curves were measured for two kinds of pollen, namely plum and hinokia cypress using a vibrating sample magnetometer VSM. The measurements were performed by sweeping static field between -0.5 and 0.5 T at room temperature. In addition to the diamagnetic relationship expected for the organic chemical composition of pollen, features that indicate saturated moments Ms were observed in the M-H curves of plum pollen, while no evidence of Ms was observed for hinokia cypress. The Ms values showed linear correlations with sample mass m for the two samples. The above-mentioned results magnetization results chemical analysis.

[1] K. Hisayoshi & C. Uyeda, J. Jpn. Soc. Microgravity Appl., (2012).

Keywords: pollen, fossil, identification, magnetic field gradient, microgravity

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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