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Quantitative Imaging for Trace-elements in Biochemical Samples using Laser Ablation-ICPMS coupled with Soft Ablation Tec

Takafumi Hirata[1*], Sho Mukoyama[1], Shu-hei Sakata[1], Atsuko Shinohara[2], Takehisa Matsukawa[2], Kazuhito Yokoyama[2]

[1]Division of Earth and Planetary Sciences, Graduate School of Science, Kyoto University, [2]Department of Epidemiology and Environmental Health, Faculty of Medicine, Juntendo University

In biological systems, many trace-elements play important roles to control numerous biochemical reactions. With the improvement of the analytical technique, nutritional status, distribution, metabolism and function of the trace-elements have been well investigated. To obtain further detailed information for elemental metabolism or function of the trace-elements, changes in concentration and distribution of the trace-elements at microscopic or histologic scales, such as tissue or cell, are highly desired. The combination of laser ablation sample introduction technique and ICP-mass spectrometry (LA-ICPMS) has now become a fast, accurate, versatile and user-friendly analytical tool for elemental and isotopic analysis of solid geochemical and biochemical samples [1]. One of the great advantage to use the LA-ICPMS technique is that sample is analyzed under the atmospheric pressure, and neither coating with conductive materials nor time-consuming evacuation procedures is required, and therefore the LA-ICPMS technique has a capability to accept the most biochemical samples including wet tissue or cell samples without any complicated sample preparation procedures.

For the conventional LA-ICPMS technique, abundance values for the trace-elements have been calibrated by means of comparison in the signal intensity data for analytes between the sample and standard. However, for the biochemical samples, availability of the homogeneous and well-calibrated matrix matched standard was very limited. Moreover, because of the heterogeneity in hardness or color within the sample piece, the amount of sample ablated can vary significantly even at the laser sampling under the identical ablation pit sizes and fluence, and the changes in ablation volume (weight) can become a major source of analytical error. In this study, we have developed a new quantification technique for the LA-ICPMS analysis. It is widely recognized that laser ablation can be achieved when the energy fluence exceeds the critical value (energy threshold). The ranges of energy fluence required to ablate the organic components is generally lower than those required for most glass, crystal or metallic samples, and therefore, only the organic components can be ablated when the fluence was carefully controlled (soft ablation [2]). With the soft ablation technique, the sliced sample (1um thickness) can be totally ablated or evaporated through the laser ablation without any damage or ablation of substrate (slide glass). This suggests that the resulting sampling depth (i.e., volume) for the samples can be kept constant despite the local heterogeneity in hardness or color of the samples, and therefore, reliable quantitative elemental analysis or mapping can be made. In this study, we will discuss the unique feature and the versatility of the present calibration protocol for the elemental determination using the LA-ICPMS technique based on imaging of Cu and Zn in the cross section of blood vein and also on the time-changes in element distribution of Ce and Eu in mices alveolus. With the high-sensitivity LA-ICP-MS technique with newly developed calibration technique, the LA-ICPMS technique has immediate potential as a reconnaissance method for reliable technique for quantitative imaging for trace-elements in biochemical samples.

References

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