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Trace element imaging and semi-quantitative analysis of meteorites by Laser ablation ICP-MS

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Introduction

So far, electron microprobe has been used to study two dimensional distributions of elements in earth and planetary samples. However, the sensitivity of the method is insufficient for trace elements analysis. Furthermore, though synchrotron radiation X-ray fluorescence imaging has high sensitivity, micro-XRF imaging of trace heavy elements is still difficult to perform. In this study, LA-ICP-MS method was adopted to analyze two dimensional distributions of trace heavy elements in meteorites. This method is highly sensitive and is suitable for the analysis of meteorites, because it allows the analysis of two dimensional distribution of trace elements up to 72 elements. In this study, LA-ICP-MS was applied to obtain semi quantitative information of the trace elements and to reveal correlation of the elemental distribution in the sample.

Experiment

Analyzed samples were stony meteorite (NWA2086), iron meteorites (Sikhote-Alin, Gibeon, Odessa, Henbury, Nantan) and stony-iron meteorite (Fukang Pallasite). The LA instrument used in this study was a UP-213 Universal Platform (New Wave Research, USA), coupled to an Agilent 7500s ICP-MS instrument (Agilent Technologies, USA). Semi-quantitative analysis was performed based on the external standard glass sample NIST 612. The imaging was obtained by combination of the line scans on fixed area.

Results and Discussion

Our LA-ICP-MS imaging of the stony meteorite successfully revealed the distribution of the platinum Group elements (Os, Ir, Pt), rare earth elements (La, Ce, Sm, Eu) and other heavy elements accumulated in CAI (Calcium-Alminium rich Inclusion). A correlation of siderophile elements (Ni, Co and also) are observed in a matrix part of the meteorite. On the other hand, in iron meteorites and stony-iron meteorite, a local correlations of elements in Fe-rich regions was observed though uniform distributions were observed for other elements. Semi-quantitative analysis of rare earth elements were successfully carried out and revealed a distribution pattern of the rare-earth elements in the sample, demonstrating a potential ability of quantitative two dimensional imaging of trace elements in the samples. In conclusion, the LA-ICP-MS imaging can provide elemental distribution of light and heavy elements in ppm level, which could not be obtained by using any other analytical methods. We believe that the LA-ICP-MS imaging will become a powerful analytical tool in earth and planetary sciences.

Keywords: ICP-MS, imaging, semi-quantitative analysis