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Elemental Analysis of Individual Small Particles Collected from Primitive Chondrites using ICP-TOF-MS Coupled with Laser Ablation in Liquid Technique

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Small particles in matrices of chondrites record fingerprints on cosmochemical events either before or during the formation of the solar system.[1] To obtain inherent cosmochemical features of the individual small particles in chondrite matrices, techniques for both sampling of particles from meteorites and chemical analysis of individual particles with high throughput is highly desired. To achieve this, we have developed a new analytical technique using inductively coupled plasma time-of-flight mass spectrometry combined with laser ablation in liquid sampling (LAL-ICP-TOF-MS).

In our previous research based on LAL-ICP-TOF-MS, the elemental compositions from individual particles sampled from a meteorite with weakly thermal metamorphism (Allende CV3) were successfully derived.[2] Despite this, in our preliminary experiments employing water as the LAL solvent, when aqueously altered or nearly unaltered meteorites were investigated, dissolved ions of some elements such as Na, Mg, S, and Ca in sample solutions significantly increased signal intensities underlying transient particle signals of interest. The high ion fluxes emanating from the dissolved elements retarded the detection of small particles (e.g., <100 nm) mainly due to both the lowering of signal-to-background ratios and saturation of a detector. Faced with this, LAL sampling using organic solvents with less polarity than water was developed to reduce the dissolution of elements from meteorites into sample solutions. Series of experiments revealed that isopropanol would be especially effective for the LAL sampling without the significant dissolution of elements.

By using the analytical technique developed so far, elemental analysis of matrix particles collected from an aqueously altered meteorite (Murchison CM2) was carried out. Differences in mineral species between Allende and Murchison was observed, reflecting their histories of alterations. In this presentation, in addition to the data from Allende and Murchison, we will show elemental data of individual particles collected from three other meteorites with low alteration grades (Mukundpura CM2, Tarda C2-ung, and Chwichiya C3.00-ung). Elemental compositions of refractory siderophile elements will also be focused, which provide information on condensation of materials in the early solar system.

References: [1] Buseck and Hua (1993), *Annu. Rev. Earth Planet Sci.* 21, 255–305. [2] Kurihara et al. (2023), *Geochem. J.*