Rare earth element measurements of melilite and fassaite in Allende CAI, 7R-19-1, by NanoSIMS.

伊藤 元雄[1*], メッセンジャー スコット[1]

Motoo Ito[1*], Scott Messenger[1]

[1]NASA JSC, ARES, [2]Lunar and Planetary Institute-USRA

[1]NASA JSC, ARES, [2]Lunar and Planetary Institute-USRA

The rare earth elements (REEs) are concentrated in CAIs by ~20 times the chondritic average (Grossman, 1980). The REEs in CAIs are important to understand processes of CAI formation including the role of volatilization, condensation, and fractional crystallization (Grossman, 1980; Boynton, 1984). REE measurements are a well-established application of ion microprobes (Crozaz and Zinner, 1985). However the spatial resolution of REE measurements by ion microprobe (~20 micrometer) is not adequate to resolve heterogeneous distributions of REEs among/within minerals. We have developed methods for measuring REE with the NanoSIMS 50L at smaller spatial scales. Here we present our initial measurements of REEs in melilite and fassaite in an Allende Type-A CAI with the JSC NanoSIMS 50L.

First we synthesized diopside glass standards doped with selected trace and REEs (100 and 500 ppm) optimized for simultaneous measurement of 7 masses by NanoSIMS. These standards were used to accurately determine relative sensitivity factors and oxide-to-element ratios, as well as finding target REE peaks. A focused O- ion beam was rastered over 5x5 to 10x10 micrometer regions. Secondary [REE+] ions were measured in multidetection mode with 7 electron multipliers at a mass resolving power of ~3000. An energy offset of -60V was applied to reduce interferences from complex molecular ions in the mass range of REEs following previously established techniques (Crozaz and Zinner, 1985). The integration time for each measurement was typically 2 hours. Data were corrected for EM dead time, and REE abundances were corrected for contributions from unresolved REEO+ peaks. We also have developed REEs mapping in CAI to look for 2-dimensional REE distributions within/among CAI minerals, spinel, melilite, fassaaite and perovskite, with spatial resolution of 1.6 micrometer and quantitative analysis (5-1500xCI).

We found that the key parameters for accurate REE abundance measurements differ between the NanoSIMS and conventional SIMS, in particular the oxide-to-element ratios, the relative sensitivity factors, the energy distributions, and requisite energy offset. Our REE abundance measurements of the 100 ppm REE diopside glass standards yielded good reproducibility and accuracy, 0.5-2.5 % and 5-25 %, respectively.

We determined abundances and spatial distributions of REEs in core and rim within single crystals of fassaite, and adjacent melilite with 5-10 micrometer spatial resolution. The REE abundances in fassaite core and rim are 20-100 times CI abundance but show a large negative Eu anomaly, exhibiting a well-defined Group III pattern. This is consistent with previous work (Yurimoto et al., 1998). On the other hand, adjacent melilite shows modified Group I pattern; Light REE enrichment and slightly positive anomalies of Eu and Yb. However, some melilites showed volatility or igneous

derived REE pattern. REE abundances (2-10 x CI) were lower than that of fassaite. These patterns suggest that fassaite crystallized first followed by a crystallization of melilite from the residual melt. REEs in the 7R19-1 were fractionated when the CAI crystallized from an original melt. The most volatile elements of Eu and Yb were lost by vaporization when the CAI melted. This suggests that melilite was melted and partially vaporized.