Isotopic evidence for intensive activity of young Sun from REE isotopic compositions in CAIs

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Isotopic measurements of excess ^{10}B decayed from ^{10}Be in CAIs [1] and astronomical observations of intensive X-ray emissions from stellar analogues of the young Sun [2] suggest a possibility of intensive irradiation by the young Sun. However, the model for early solar irradiation from young Sun is somehow model-depending and still plausible. For further quantitative discussion about the early solar irradiation models, ^{138}La is one of adequate isotopic tracers as one of refractory and spallogenic products caused by solar irradiation [3,4]. The presence of excess ^{138}La as a spallogenic product may provide isotopic constraints on the early solar irradiation models. In this study, isotopic analyses mainly of La and other REE like Ce, Nd, and Sm in CAIs collected from the Allende CV3 meteorite were performed to understand the spallogenic reactions in the early solar system.

A Triton TIMS equipped with nine Faraday cup collectors was used for the isotopic analyses. La was measured as LaO^+ on double Re filaments. $^{138}La/^{139}La$ isotopic ratios were obtained from $^{138}La^{16}O^+/^{139}La^{16}O^+$ after correction for instrumental mass fractionation by $^{18}O/^{16}O$ ($^{139}La^{18}O/^{139}La^{16}O$) normalization [3,4]. Isotopic excesses of ^{138}La ($\varepsilon^{138}La$= +57.2 ± 4.3 and +90.9 ± 8.3) were obtained from the CAIs in this study. These values are consistent with the data in previous studies ($\varepsilon^{138}La$=0 to +60 ± 16 in [3,4]), but quite different from those in lunar surface soils ($\varepsilon^{138}La$=-27.8 ± 6.3 to +16.5 ± 7.7). The results suggest that spallation reactions were dominant in CAIs but not in lunar soils.

[1] McKeegan et al. (2000) *Science* **289,** 1334-1337. [2] Feigelson et al. (2002) *ApJ* **572,** 335-349. [3] Shen et al. (1994) *GCA* **58,** 1499-1506. [4] Shen and Lee (2003) *ApJL* **596,** L109-L112.