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Development of high-precision La isotope analysis by MC-ICP-MS

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The long-lived radionuclide ^{138}La is of exclusive supernova origin and therefore can be used as a tracer of supernova-derived material in the early Solar System. However, the very low isotope abundance of ^{138}La (0.09%) makes its precise measurement difficult. Shen and Lee (2003) [1] successfully detected La isotope variation among CAIs using TIMS. Yet, the analytical precision in the pioneering work (2σ = 8–16ε) is not high enough for investigating potential isotope variations among whole-rock meteorites. In this study, we have developed a method for precise La isotope analysis using MC-ICP-MS. This has been achieved by (1) using 10^{13} and 10^{10} Ω amplifiers on 138 and 139 amu, (2) correcting for instrumental mass bias by the Nd external calibration technique, and (3) developing a novel chemical separation scheme for effective removal of isobaric elements, Ba and Ce.

The precision of La isotope measurements was tested by analyzing a La standard solution NIST 3127a. The use of 10^{13} and 10^{10} Ω amplifiers improved the precision by a factor of two compared with using 10^{11} Ω amplifier. The external calibration technique improved the precision by an order of magnitude compared with the standard bracketing method. As a result of these improvements, an internal precision of ±1.4ε (2SE) was achieved. We also found that ^{138}Ba and ^{138}Ce isobaric interferences can be accurately corrected when Ba/La and Ce/La are as low as 2×10^{-3} and 2×10^{-4}, respectively.

Our La chemical separation technique consists of 3-step column chromatographic procedures. In the first step, matrix elements and Ba were separated from rare earth elements (REEs) by using AG 50W-X8 (100–200 mesh) cation exchange resin with elution using HCl and HNO_3 successively. In the second step, REEs were further purified from Ba with TODGA resin (50–100 μm) by direct loading from the former column. In the last step, La was separated from other REEs using Ln resin (25–50 μm) by eluting with 0.15 M HCl. For 100 mg JB-1b basaltic reference material, the total recovery of La was >97% while Ba/La, Ce/La, Nd/La were $<3\times10^{-4}$, $<5\times10^{-5}$ and $<2\times10^{-4}$, respectively.

[1] Shen and Lee (2003), *ApJL* **596**, L109–L112.