FORMATION INTERVAL OF THE LUNAR MANTLE FROM HIGH-PRECISION ND-ISOTOPE MEASUREMENTS OF SIX LUNAR BASALTS.

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Introduction: If the Moon has superchondritic $^{142}Nd/^{144}Nd$ identical to the Earth, as suggested by available data [1,2], then the giant impact must have occurred into an already differentiated Earth, predominantly sampling the LREE-depleted reservoir. In order to test this hypothesis, Nd-isotope ratios were obtained on a Thermo-Finnigan Triton TIMS for six lunar basalts that span the compositional range of lavas from the Moon: 15555, LAP 02205: low-Ti; 70017, 74275: high-Ti; 15386, SAU 169: KREEP basalts. The lunar samples have crystallization ages of 3.15 to 3.9 Ga and preserve a range of present-day $\varepsilon^{142}Nd$ from -0.30 ± 0.07 (2σ) to +0.07 ± 0.05 when corrected for the effects of neutron irradiation.

The evolution of the lunar mantle is modeled assuming formation from material with average chondritic composition with present day $\varepsilon^{143}Nd = 0$ and $\varepsilon^{142}Nd = -0.2$ [1]. The $\varepsilon^{143}Nd$ and $\varepsilon^{142}Nd$ of the evolving lunar mantle is calculated using a two-stage model [2]. Self-consistent values of $(^{147}Sm/^{144}Nd)_{t1}$ and t_1 are calculated for each sample by simultaneously solving the equations for the evolution of ^{142}Nd and ^{143}Nd. The best fit to the data yields a source formation age of all basalt samples of 215 +23,-21 m.y. (2σ) after solar system formation, and an intercept at the chondritic $^{147}Sm/^{144}Nd$ of = -0.19 ± 0.02 (MSWD= 0.99), consistent with contemporaneous formation of the source regions represented in this study from a LMO with a present day $\varepsilon^{142}Nd = -0.19$.

A model in which the Moon was formed from material that predominantly sampled the Nd-depleted reservoir of an already differentiated Earth and/or impactor, is not consistent with the data. Because both Earth and Moon likely formed in the same region of the solar nebula, the Earth should also have a chondritic bulk composition. In order to mass balance the Nd budget, these constraints require that a complementary reservoir with lower $^{142}Nd/^{144}Nd$ resides in the Earth's mantle.

References:

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