EJECTION (LAUNCH) DEPTHS OF LUNAR METEORITES

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More than 130 lunar meteorites have been found in Antarctica and other arid regions throughout the world. Even though nearly half of all lunar meteorites are paired falls and the location from which they were launched is unknown, they sample a more extensive area of lunar crust than manned sample returns, thereby providing a vital record of lunar crust materials. To use lunar meteorites to explore the Moon's surface however, it is critical that we both identify pairs and determine the ejection depth of each object.

Using a combination of cosmogenic stable- and radionuclides it is possible to determine a number of important properties of lunar meteorites. Most lunar meteorites have complex cosmic ray exposure histories, having been exposed both at some depth on the lunar surface (2π irradiation) and after their ejection as small bodies in space during transport from the Moon to Earth (4π irradiation). Following these exposures is a period of residence on Earth's surface, a time commonly referred to as the terrestrial age. Unraveling the complex history of these objects requires the measurement of at least four cosmogenic radionuclides. The specific goals of these measurements are to constrain the following shielding or exposure parameters: (1) the time a sample had spent near the lunar surface; (2) the depth of the sample at the time of ejection from the Moon; (3) the transit time from ejection off the lunar surface until capture by Earth; and (4) the terrestrial age. The sum of the transit time and terrestrial age yields the ejection age that is critical to recognize launch pairing of lunar meteorites. The ejection age, in conjunction with the sample depth on the Moon, can then be used to model impact and ejection mechanisms.

We have measured cosmogenic nuclides in 81 (59 individual) lunar meteorites, 28 new lunar meteorites since our last report [1]. These data are still preliminary but we can obtain significant information using this dataset. To calculate each exposure condition, cosmogenic nuclide results were compared to that of observed Apollo 15 depth profiles (2π) and 4π model calculations for small meteorites. Among the 24 NWA (Northwest Africa) lunar meteorites studied, we found 19 individual falls. Although theoretical calculations indicate that the minimum source crater size is 450 m in diameter for launching lunar meteorites [2], only 24 out of 52 individual lunar meteorites were launched from deeper than 1,000 g/cm^2 on the Moon. The other 28 meteorites were launched from depths between a few g/cm^2 and 850 g/cm^2. Those meteorites that were launched from shallow depth had short transition times from the Moon to Earth, <0.1 Myr, with only one exception. On the other hand, lunar meteorites that had a transition time longer than 0.3 Myr were all launched from deeper than 1,000 g/cm^2. The observed relationship between lunar ejection depth and Moon-Earth transition time has not been explained/explored yet by model calculations.

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References: [1] Nishiizumi K. and Caffee M. W. 2006. *Meteoritics & Planetary Science* 41:A133. [2] Head J. N. 2001. Abstract #1766. 32nd Lunar & Planetary Science Conference.