EXPOSURE HISTORIES OF LUNAR AND MARTIAN METEORITES.

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Introduction: Cosmogenic nuclide studies of lunar and Martian meteorites have contributed significantly to our understanding of these objects. The specific goals of these measurements are to constrain or set limits on the following shielding or exposure parameters: (1) the depth of the sample at the time of ejection from the Moon or Mars; (2) the transition time from ejection off the lunar or Martian surface until capture by the earth; (3) and the terrestrial residence time. The sum of the transition time and residence time yield an ejection age. The ejection age in conjunction with the sample depth on the Moon or Mars can then be used to model impact and ejection mechanisms. We have measured cosmogenic nuclides in 21 (28 individual) lunar and 24 (29) Martian meteorites. Measurements of 9 additional meteorites are in progress. In this study, I summarize exposure and terrestrial histories of lunar and Martian meteorites.

Discussion: (1) More than half of the lunar meteorites have complex cosmic ray exposure histories, having been exposed both at some depth on the lunar surface before their ejection and as small bodies in space during transport from the Moon to the earth. On the other hand, we have not yet observed evidence of complex exposure histories for Martian meteorites. (2) Transition times of meteorites from the Moon and from asteroids to the earth have previously been predicted by Monte Carlo simulations [1, 2] and recent numerical simulations modeling the dynamical evolution of lunar and Martian impact ejecta have also been performed and can be used to explain the distribution of transition times for these meteorites [3, 4]. In general, the model predictions agree with our measurements that indicate that the intervals between ejection and capture by the earth are less than 1 Myr for lunar meteorites and much longer for Martian meteorites. As we increase the number of meteorites measured we obtain better statistics to help constrain or modify theoretical predictions. It seems that launch velocities of lunar meteorites are higher than those originally predicted. All lunar meteorites having exposure ages greater than 0.5 Myr were ejected from large depths within the lunar surface. These meteorites may in general have higher launch velocities than those lunar meteorites ejected from shallower depths. The distribution of transition times of Martian meteorites supports a ~2 Myr collisional lifetime of ejecta from Mars. (3) To date, at least 6 lunar meteorites and 4 Martian meteorites show clear SCR produced ^{26}Al at their near surface regions. Presence of SCR effects indicates minimal ablation during atmospheric entry, presumably the result of either low entry velocity or low entry angle. (4) Terrestrial ages (up to 0.5 Myr) of lunar and Martian meteorites, especially those recovered from hot desert regions, are longer than ordinary chondrites recovered from the same regions. Lack of metal in these meteorites slows the effect of weathering. (5) So far recovery rates of lunar and Martian meteorites are ~1:1. Since both meteorites may have similar resistance against terrestrial weathering, one possible explanation is that most lunar meteorites are ejected into heliocentric orbit rather than staying inside the Earth-Moon system so that capture rates of lunar meteorites are lower than predicted.

References: [1] Arnold J. R. 1965 *Astrophys. J.,* 141: 1536-1547. [2] Wetherill G. W. 1968 *Science,* 159: 79-82. [3] Gladman B. J., et al. 1995 *Icarus,* 118: 302-321. [4] Gladman B. J. and Burns J. A. 1996 *Science,* 274: 161-165.