EXPOSURE HISTORIES OF LUNAR METEORITES DHOFAR 025, 026, AND NORTHWEST AFRICA 482.

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Introduction: Most lunar meteorites have complex cosmic ray exposure histories, having been exposed both at some depth on the lunar surface (2π irradiation) before their ejection and as small bodies in space (4π irradiation) during transport from the Moon to the Earth. These exposures were then followed by residence on the Earth's surface, the terrestrial residence time. Unraveling the complex history of these objects requires the measurement of at least four cosmogenic nuclides. To investigate the complex exposure histories of lunar meteorites, we measured cosmogenic nuclides, ^{10}Be ($t_{1/2}$=1.5x10^6 yr), ^{26}Al (7.05x10^5 yr), and ^{36}Cl (3.01x10^5 yr) in Dhofar 025, 026, and Northwest Africa (NWA) 482. The measurements of ^{41}Ca (1.04x10^5 yr) are in progress.

Results and Discussion: The preliminary results are shown in Table 1 along with those of Dhofar 081 and NWA 032 lunar meteorites [1].

Dhofar 025: The ^{10}Be activity of Dhofar 025 indicates that it exposed to cosmic rays for more than 4 Myr in a 4π geometry. The cosmogenic radionuclides produced in this specimen were produced during the transition from Moon to Earth. The low ^{36}Cl and ^{26}Al activities can be accounted for given a relatively long terrestrial age, 0.5-0.6 Myr. The ^{10}Be concentration at the time of fall was 20-21 dpm/kg. This is the saturation activity and requires at least 5 Myr exposure in a 4π geometry. Even though this meteorite was located in Oman, the terrestrial age is surprisingly long. Extremely high Sr content (~2,000 ppm) and presence of terrestrial alternation products in Dhofar 025 suggest terrestrial weathering [2-4]. Measurements of ^{41}Ca and ^{81}Kr will further constrain the terrestrial age of Dhofar 025. If all cosmogenic ^{21}Ne [5] present in the sample was produced by 4π exposure, the total transition time is 13-20 Myr.

Dhofar 026: This sample is characterized by the lowest cosmogenic radionuclide and noble gas [5] concentrations among all lunar meteorites yet observed. If we assume the ejection depth from the moon was greater than 1,400 g/cm^2 the radionuclides indicate maximum transition times of 4±1 kyr (^{10}Be), 2±1 kyr (^{26}Al), and 3±1 kyr (^{36}Cl) respectively. The exposure ages based on the radionuclides are an order of magnitude shorter than the ^{21}Ne age [5]. Alternatively, ejection from a depth of ~1,100-1,300 g/cm^2 on the Moon and a negligible transition time marginally fit the measured radionuclide activities. In this scenario, the ^{21}Ne regolith exposure time is of the order of 10 Myr, much shorter than other lunar meteorites. Measurement of ^{41}Ca may further constrain the possibilities however the low ^{41}Ca activity makes this a difficult measurement.

NWA 482: The ^{26}Al activity in the exterior sample of NWA 482 is up to 40% higher than that of the interior sample. This excess ^{26}Al is produced by SCR during its 4π exposure to cosmic rays. The pre-atmospheric radius is estimated at 5.5-7 cm based on a recovered mass of 1,015 g and 1-1.5 cm of ablation. The ^{10}Be exposure age is 0.9±0.2 Myr. The saturation values of SCR produced ^{26}Al are 10-25 dpm for the interior sample (1 cm from fusion crust) and 20-40 dpm for the exterior sample, respectively. The latter value is similar to the SCR production rate for ^{26}Al at a depth of ~1.5-2 cm in an object having a radius of 6-7 cm [6]. The ^{36}Cl terrestrial age is 60-120 kyr.

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References: [1] Nishiizumi K. and Caffee M.W. (2001) *LPS 32*, #2101. [2] Cahill J. *et al.* (2001) *LPS. 32*, #1840. [3] Taylor L.A. *et al.* (2001) *LPS 32*, #1985. [4] Warren P.H. *et al.* (2001) *LPS 32*, #2197. [5] Shukolyukov Y.A. *et al.* (2001) *LPS 32*, #1502. [6] Reedy R.C. (1987) *LPS.18,* 822-823.

Table 1. Cosmogenic radionuclide concentration (dpm/kg meteorite) in new lunar meteorites.

	^{10}Be	^{26}Al	^{36}Cl
Dho 025 (exterior)	16.7±0.3	64.7±2.0	5.38±0.11
Dho 025 (interior)	17.4±0.3	61.9±2.0	5.47±0.10
Dho 026 (exterior	0.045±0.01	0.13±0.03	0.12±0.02
Dho 026 (interior)	0.035±0.01	0.17±0.04	-
Dho 081*(exterior)	5.38±0.09	31.2±0.8	7.16±0.11
Dho 081*(interior)	5.18±0.09	31.9±0.9	7.40±0.12
NWA 482 (0-1mm)	6.00±0.10	80.8±3.8	10.6±0.2
NWA 482 (1-2mm)	5.87±0.09	79.7±2.0	11.6±0.3
NWA 482 (7-9mm)	6.31±0.10	70.3±1.8	12.4±0.2
NWA 482 (0-2mm)	6.60±0.10	64.7±2.6	11.7±0.2
NWA 482 (interior)	6.36±0.10	58.7±1.5	12.6±0.3
NWA 032*(exterior)	0.40±0.11	4.4±0.3	1.39±0.05
NWA 032*(interior)	0.32±0.07	2.9±0.3	1.30±0.04

*[1]