CARBON-14 TERRESTRIAL AGE OF THE MAC88105 LUNAR METEORITE;

A. J. T. Jull and D. J. Donahue, NSF Accelerator Facility for Radioisotope Analysis, University of Arizona, Tucson, AZ 85721.

Two meteorites of apparently lunar compostion, MAC 88104 and 88105 were recovered in Antarctica in 1988. The cosmogenic-radionuclide composition of lunar meteorites provides useful constraints on the terrestrial age, exposure time and possible depth of ejection of the material from the moon. Usually, several radionuclides are needed to constrain the various possible scenarios. We have measured cosmogenic ^{14}C in a powdered sample of MAC88105,41. The results are summarized in table 1. Based on the oxygen composition (1) of 45.3%, a saturated ^{14}C activity of about 61 dpm/kg is estimated for this sample. The sample was found to have practically no cosmogenic ^{14}C, the levels detected are close to the blank, and to that expected for in-situ production of ^{14}C by high-energy neutrons at the latitude and altitude of the MacAlpine Hills. The terrestrial age is calculated to be in excess of 43,000 years.

Combined with the low ^{26}Al measurements on this meteorite of about 16-20 dpm/kg (1,2), the data on these 2 radioisotopes put some limits on the possible scenarios for the transit time and terrestrial age of this meteorite. The low ^{26}Al content can be explained either by a short exposure time in space, of roughly 100 to 150 thousand years. This time would be long enough to saturate ^{14}C in space. Thus, the low ^{14}C content of MAC88105 would be due to a terrestrial age of >43Kyr as calculated above, but not more than about 100 Kyr. A much longer terrestrial age would necessitate a longer exposure in space.

A less-likely scenario is that the low ^{26}Al content is due to heavy shielding at a depth of over 300g/cm^2 on the moon. At this depth on the moon, the production rate of ^{14}C is estimated to be about 6-8 dpm/kg for a 2-π irradiation. The material would then have to be ejected, and have a short enough transit time not to produce a significant amount of ^{14}C, less than a few hundred years, and the meteorite would still have to have resided on the earth's surface for about 30 kyr. Both of these scenarios will be further constrained by exposure-age measurements using ^{10}Be and other cosmogenic nuclides.

These conclusions can be compared with the limiting 2-π and 4-π exposure ages and terrestrial ages for other lunar meteorites. These ages have been discussed by Nishiizumi et al. (3), who have discussed the measurements of 4 different radionuclides in four anorthositic meteorites. Eugster et al. (4,5) have also estimated ^{81}Kr terrestrial ages.

The three Yamato meteorites Y-82192, 82193 and 86032 appear to have up to 10 million years exposure in space, the terrestrial age was estimated (4) to be about 80$\pm$30 Kyr. The meteorite Y-791197 appears to have been irradiated on the surface of a large body, and have a <0.2 million-year exposure in space, on the basis of four radionuclides (2,3). The Allan Hills lunar meteorite appears to have a quite different radiation history from these two groups, with a longer terrestrial age of >140 Kyr, and an irradiation at depth on the moon.

The MacAlpine Hills meteorites would appear to form another discrete fall of an anorthositic meteorite. Thus, there are at lease four different lunar meteorite falls in the Antarctic collection to date. This seems to be a rather high rate of occurrence of what ought to be a rare event.

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In conclusion, radiocarbon measurement of MAC88105 produces a limiting terrestrial age. ^{14}C measurements of some Yamato lunar meteorites would considerably improve the estimates of terrestrial age range, given the uncertainties in the current estimates. This work was supported by NASA and NSF.

References: (1.) Antarctic Meteorite Newsletter, Sept. 1989; (2.) Nishiizumi, K., et al., Lunar Planet. Sci. XXI, this volume; (3.) Nishiizumi, et al., Meteoritics, 23, 294 (1988); (4.) Eugster, et al., Meteoritics, 23, 268 (1988); (5.) Eugster et al., Earth Planet. Sci. Lett., 78, 139 (1986).

Table 1: ^{14}C content of MAC88105,41

Sample	^{14}C atoms (10^5)	^{14}C atoms/g[1] (10^5)	dpm/kg	Terr. age, yr.
MAC 88105,41 0.32g	7.7±0.6	11±3	0.25±0.07	>43,000*
Quartz powder 0.11g	4.2±0.6	<1		

[1]Blank subtracted

*minimum age. If the 0.25±0.07 dpm/kg is assumed to be from cosmic-ray effects in space, an age range of 43-48Kyr would be quoted.