EXPOSURE AGE AND OTHER INFORMATION ON LUNAR SURFACE MATERIAL AND METEORITES FROM $^{53}$Mn MEASUREMENTS

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Cosmogenic radionuclide production in the lunar surface and in meteorites can provide extremely useful and accurate information on exposure history, mixing rates of the lunar regolith, erosion rates of lunar rocks, recent exposure history, variations in solar or galactic flux, and on the size, shape and terrestrial age of meteorites.

The half life of $^{53}$Mn (3.7 million years), together with the measurement of $^{26}$Al (0.75 million years), permits the surface history of lunar rocks or the age of meteorites to be determined over a time scale of 10 million years. Measurements of this time period are not subject to memory effects which are inherent in rare gas age measurements such as those based on $^{81}$Kr-Kr.

In work reported here, we have measured $^{53}$Mn in several lunar rocks and in 4 meteorites. The lunar rock analyses confirm prior measurements based on either $^{53}$Mn or $^{81}$Kr-Kr ages, while measurements in meteorites provide a basis for real sample systematics which will permit accurate estimate of pre-atmospheric size and other events which may have occurred within the past 19 million years.

In Figure 1 we have plotted the $^{53}$Mn content of 3 lunar rock samples on a $^{53}$Mn growth curve. This growth curve is based on the predicted $^{53}$Mn production due to galactic protons only in the first 30 cm of the lunar regolith. These data indicate that 12002 (OP-6) and 14321 (RM-2) are saturated in $^{53}$Mn whereas 68815 is not. The two former samples were measured previously by one of the authors but have been analyzed again for cross-calibration purposes (1, 2). They have also been analyzed by the $^{81}$Kr-Kr age method and the ages determined from these measurements were used in plotting these points in the Figure (3). Sample 68815 is clearly undersaturated with respect to $^{53}$Mn. The $^{53}$Mn age date is 1.9 million years which compares to a reported $^{81}$Kr-Kr age date of 2.0 million years (3). These measurements are the first phase of a program which will estimate the lunar surface age of a large number of lunar rocks which were stated to have a relatively short lunar exposure age either on the basis of $^{26}$Al measurements or on the basis of $^{81}$Kr-Kr measurements. The number of rocks which appear to be undersaturated from the $^{26}$Al measurements greatly exceeds those which would be predicted from theoretical models of lunar regolith dynamics and manganese measurements should serve to confirm or refute the ages of these suspect samples (4, 5).

There have been relatively few measurements of $^{53}$Mn on meteorites, yet their analysis can provide important information...
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on the size, the exposure age and the time period since the last fracture of a meteorite. We have recently analyzed 2 samples of Allende, together with 1 sample each of the Peace River, Lost City, and Bruderheim Chondrites. These analyses, which will be discussed in detail at the Lunar Conference, permit one to place limits on the pre-atmospheric size of these chondritic meteorites. They will also provide a basis for the $^{53}\text{Mn}$ systematics of meteorites, which will extend the comparison of the galactic flux incident on the moon and meteorites further back in time.

REFERENCES


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