$^{26}Al/^{53}Mn$ DEPTH PROFILE AND ITS IMPLICATIONS TO LUNAR SURFACE PROCESSES. N. Bhandari and P.N.Shukla, Physical Research Laboratory, Ahmedabad 380 009, India

The depth profile of spallogenic isotopes e.g. $^{26}Al$ or $^{53}Mn$ in lunar samples depends upon the flux and shape of the energy spectra of solar and galactic cosmic rays but the depth profile of isotopic ratio ($^{26}Al/^{53}Mn$) is nearly independent of these parameters. The ratio,however,is very sensitive to change in shielding depth and time of irradiation. Consequently it is more diagnostic of dynamic processes such as erosion of rocks [1] and surface transport and accumulation of soils.

The depth profile of $^{26}Al$ and $^{53}Mn$ in several rocks and soil columns have been studied earlier [2] . Based on differences in absolute activities in rocks (taken to be due to solar flare protons with flux $J_S$ and rigidity $R_o$ = (70, 100) derived from rock 68815 [3] ) and in soils (which is much higher ), Langevin et al [2] have proposed a sedimentation model for accumulation of soils. We discuss here the $^{26}Al/^{53}Mn$ profile which can be used to classify different processes responsible for growth of the regolith and provides additional constraints on models of accumulation.

The depth profiles in some soil columns are shown in fig. 1. The following observations can be made: 1) At depths $<2g/cm^2$ the profile is nearly flat and falls near or below values for (70,100). 2) At depths $>2g/cm^2$ the profiles in soils e.g. 12025 and 15011 are close to the profile calculated with (125,125).

In their sedimentation model [2] it is assumed that a thin veneer of lunar soil is irradiated on the very surface of the moon, which deposits in craters,due dominantly to downslope movement on the lunar surface, at a rate of about 1-3 cm/Myr. This type of sedimentation process only slightly modifies the isotope profile; its net effect is to flatten the profile near the surface and to increase the concentration with depth, depending on the rate of sedimentation (fig.1). Isotope ratio, however, changes significantly due to sedimentation and it is possible to distinguish different sedimentation models based on $^{26}Al/^{53}Mn$ ratio alone. The observed activities for both the isotopes shown in fig.1 do not match profiles for any sedimentation rate. A comparison of $^{26}Al/^{53}Mn$ depth profiles (fig.2) also shows that neither the absolute values nor the shape of the profile measured in various cores match the calculated sedimentation profile. Because of these difficulties, particularly the low activities in surface grains, which must be the material sedimenting, we consider other possible processes for soil accumulation. It must be noted that the observed ratio profiles for various cores could be categorized into two types: cores 12025,15011 and 60007 showing nearly a flat profile at $>5g/cm^2$ and rising slowly towards the surface. The other cores (60010,70009 and 76001) showing a flat pattern at surface and possibly higher depths with a trough in the intermediate depth regions. Some of these features, atleast in cores 12025 and 15011 can be explained if ($J_S$,$R_o$) is taken as (125,125), consistent with that observed in 61016 [4], and if deep seated grains (not recently irradiated to solar flare particles) are continuously ejected by meteorite impacts and mixed in upper $1\text{-}2g/cm^2$ region of the soil. For these two cores it is then not necessary to invoke sedimentation to explain either isotope or ratio profiles. In such a case the top layer of the lunar soil will not have enough exposure on the surface to attain saturation in the radioisotopes and will give lower value of the isotope activity and higher value of isotope ratio as observed. This observation is consistent with low track density and low $N_H/N$ in 12025 [5]. In other cores i.e. 60010,70009 and 76001 variable sedimentation rates between

0.3-4.0 cm/Myr are required to explain the ratio profiles. However, it appears difficult to choose a unique sedimentation rate which can explain the observed activities as well as the ratio profiles.

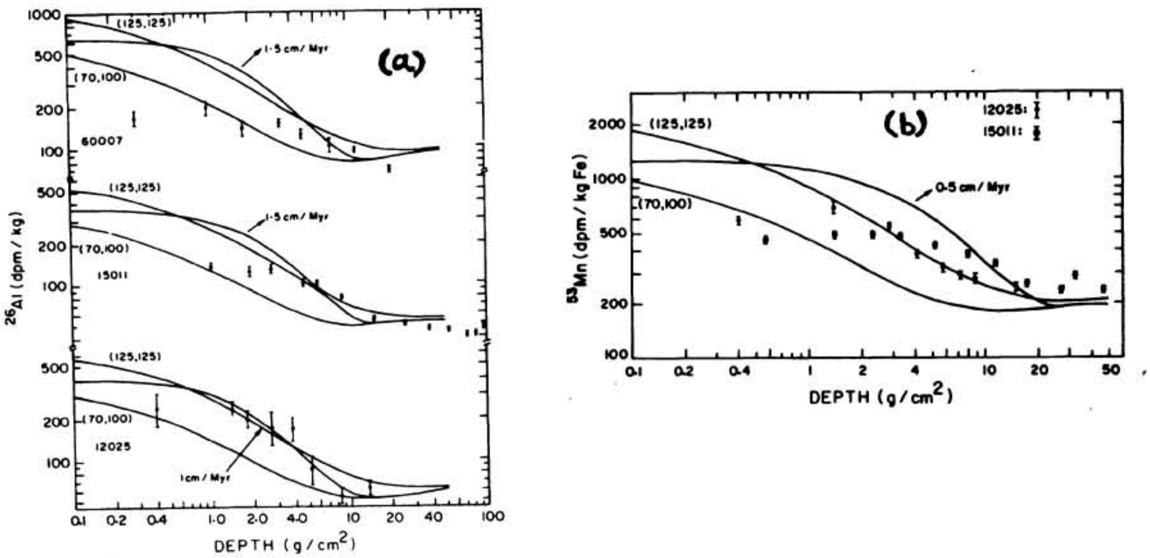


Fig.1 $^{26}$Al (a) and $^{53}$Mn (b) depth profiles. Calculated profiles for (70,100), (125,125)and for various sedimentation rates (cm/Myr) on (70,100)are shown.

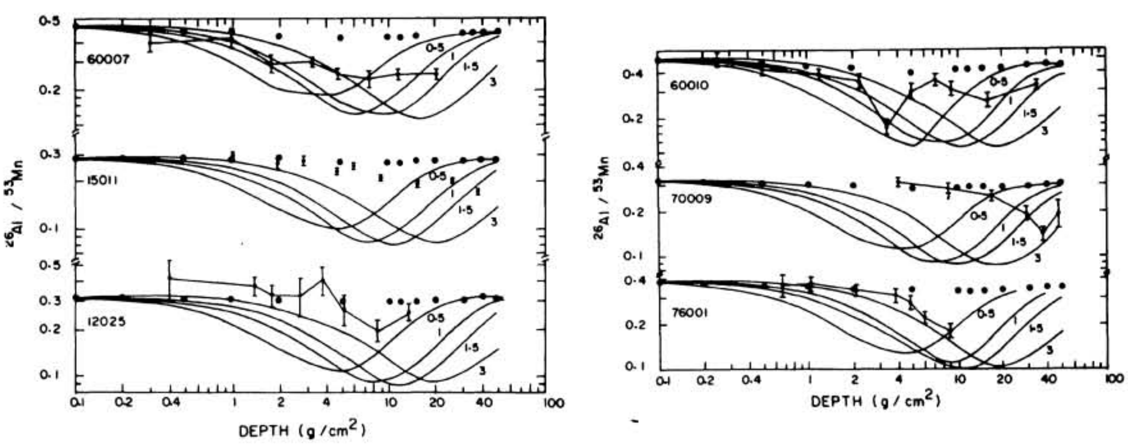


Fig.2 Observed (Ī)and calculated $^{26}$Al/$^{53}$Mn depth profiles in various cores for sedimentation rates of 0.5,1,1.5 and 3cm/Myr. Profiles for zero sedimentation rate are shown by solid circles.

References

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