PARTICLE TRACK CORRELATION STUDIES IN LUNAR SOILS: LONG TERM FLUCTUATIONS IN ANCIENT METEORIC FLUX IN LUNAR SPACE, J.N. Goswami and D. Lal, Physical Research Laboratory, Navrangpura, Ahmedabad 380009, India.

Particle track records have been analyzed in more than 50 surface scoop samples from different Apollo sites and 43 soil samples from the Apollo 15 deep drill core. Correlation studies of track and agglutinate data have been carried out to distinguish cases where the track densities have been acquired as a result of maturation along a normal evolution path, from soil samples which are a mixture of samples having different irradiation histories. Studies of samples for which albedo measurements have already been reported is under progress.

The track records in Apollo 15 deep drill core samples indicate systematic trends which should probably be attributed to a change in the meteorite flux in the past; the results indicate some periodic trends.

(1) Correlation studies of lunar soil: We show in Fig. 1 the plot of "quartile" track density as a function of agglutinate content for surface and drill core samples from various Apollo missions. The agglutinate data are for the 90-150 μm size fractions except for the Apollo 12 surface soil samples, where they are based on analysis of > 250 μm size fractions. About

![Fig. 1 Percentage agglutinate content for Apollo 12, 14, 16 and 17 soil samples plotted as a function of quartile track densities. Agglutinate data are from McKay et al., (1971, 1972, 1974) and Heiken et al., 1973.](image-url)
PARTICLE TRACK STUDIES AND ANCIENT METEORIC FLUX

Goswami, J.N. et al.

manner (Arnold, 1975; Borg et al., 1976). During increased meteorite flux in the size range $>>1$ cm which is expected to contribute to blanketing, one would expect low track densities because of low duration of exposure of each soil layer.

![Graph showing variations in $\rho_q$ and $\rho_{\text{min}}$ values for soil samples as a function of their positions in the Apollo 15 deep drill core.]

Fig. 2 Variations in $\rho_q$ and $\rho_{\text{min}}$ values for soil samples as a function of their positions in the Apollo 15 deep drill core.

80% of the soils follow a distinctive evolution path; agglutinate content increases monotonously up to $\rho_q$ values of $\sim 40 \times 10^6$ cm$^{-2}$ beyond which saturation sets in for the agglutinate content. We shall designate such soil samples as "normal". In the remaining 20% of the cases the agglutinate content is too high considering their low quartile track density values. The agglutinate-rich soils must arise due to mixing of a mature soil with an immature soil; the agglutinate content in such cases will be a weighted average of the two soils, whereas, the $\rho_q$ value will primarily be determined by the immature component.

(ii) Track record in Apollo 15 deep drill core: Variations in the ancient micrometeorite flux: The observed values of the quartile and minimum track densities, ($\rho_q$ and $\rho_{min}$) for different soil samples from the Apollo 15 deep drill core are shown in Fig. 2 where we have also included data due to Fleischer et al., (1973, 1974) for several depth intervals for which we do not have any samples; it is gratifying to note that for overlapping depth intervals, our data agree well with those of Fleischer et al., (1973, 1974).

The marked decrease in the values of both $\rho_q$ and $\rho_{min}$ in the depth intervals ($\sim 40-80$ cms), ($\sim 140-160$ cms) and ($\sim 220-240$ cms) with in between highs are clearly observable; visual inspection reveals a long term periodic variation superimposed on small scale fluctuations. An analytical treatment to delineate harmonics and their amplitudes is in progress. We may briefly consider here the principal reasons for the observed marked periodicity.

The long term changes in track parameters may be due to a slow periodic variation in cosmic ray intensity or in the meteorite flux. The track parameters ($\rho_q$ and $\rho_{min}$) considered are primarily governed by galactic cosmic ray irradiation and if the variations are exclusively attributed to changes in cosmic ray intensity, more than an order of magnitude variations would be required. This seems very unlikely considering the smooth gadolinium and spallogenic isotopic profiles obtained for this drill core (Russ et al., 1972; Pepin et al., 1974). It seems more plausible that the observed variations are due to changes in meteorite flux. The evolution of the lunar regolith is controlled by meteoritic bombardment in a complex