COSMIC RAY IRRADIATION PATTERN AT THE APOLLO 17 SITE: IMPLICATION TO REGOLITH DYNAMICS, J. N. Goswami and D. Lal, Physical Research Laboratory, Navrangpura, Ahmedabad-380009, India.

Observations of cosmic ray induced fossil tracks provide important clues to lunar regolith dynamics (1, 2). We have now extended our fossil track observations to the several selenological units (3) sampled at the Apollo 17 site, using experimental techniques described earlier (1, 4). These results and some general features of the dynamical processes occurring in the lunar regolith, based on the observed fossil track record of 38 Apollo Scoop samples and 55 Apollo and Luna core samples, are summarised here.

During its existence on the lunar surface, the cosmic ray tracks are stored in the "fines" in a very depth sensitive manner. Based on theoretical and experimental studies of the stored tracks, Arrhenius et al (1) proposed two parameters which characterised the surface irradiation duration and pattern: the fraction of grains attaining high track densities due to exposure within 100 microns of surface, N_H/N and the quartile track density, ρ_q which is an index of the time for which a layer is exposed at the surface before being blanketted by another. The agglutinate content of a sample of fines is another indicator of the cumulative surface exposure age; agglutinates arise due to impacts of micrometeorites (5). We present here data on these 3 parameters for the Apollo 17 and other lunar sites studied.

(A) Cosmic ray fossil track date for the Apollo 17 soil samples.

Results of fossil track analyses of Apollo 17 samples are given in Table-1. The calculated (1) surface exposure ages of these samples vary over a wide span (2 to ~100 m.y.). The grey soil (74260) and the rock sample (74275) taken at Shorty Crater ejecta have surface exposure ages of ~2 and 2.8 m.y. respectively indicating Shorty to be a young impact crater. The soil sample (75081) from Camelot ejecta has a surface exposure age of 70 m.y. which agrees well with the age of (85 $\pm$ 10) m.y. obtained by Ar^{38} method (6). The observed "high maturity" of the soil (79511) from the Van-Serg ejecta is in agreement with the preliminary geologic observation that inspite of its being a fresh crater, the ejecta contains mostly breccia rather than sub-floor material. Another interesting aspect is the low ρ_q value for scoop sample 76501 which is a clear indication of present day regolith growth due to different geological processes.

(B) General features of the near surface regolith dynamics at Apollo sites

A correlation between the different track parameters and the agglutinate data is shown in figs. 1 and 2. The data for surface fines are from

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scoops with penetration depth >2 cm. (7). We have chosen ρ_q as against ρ_{av} (5) for the correlation plot as ρ_q is a better indicator of the cumulative surface exposure age (1). The general correlation observed between ρ_q and percentage agglutinate content (fig. 1) can be used to predict the surface exposure ages of scoops on the basis of agglutinate data alone: the production rate is found to be 1% agglutinates/m.y. (in the $<200\mu$ fraction).

The parameter N_H/N is a very sensitive indicator of the micrometeorite influx rate in the past (2). The scoop data in the N_H/N vs. ρ_q plot (fig. 2) has a smooth trend as expected which can be taken as an indicator of the micrometeorite influx rate averaged over the last ~100 m.y. On the other hand the stratified core samples provide an opportunity to study this aspect during different epochs of time in the past. We show the N_H/N, ρ_q correlation plot for the core samples in fig. 2; data from two successive core fines have been combined for the N_H/N and ρ_q values to permit a more meaningful comparison with the scoop data. It can be seen from fig. 2 that for the Apollo 11 and 12 cores, the samples having shielding depths between 4.5 to 9.0 cm and 44 to 56 cm lie outside the expected trend; in fig. 2, see envelopes marked 1 and 2 respectively. This should be taken to indicate a change (decrease) in the micrometeorite impact rate during these epochs as compared to the average value during the last few hundred million years. Assuming an average deposition rate of ≤ 0.4 gms/cm^2 the above depths refer to time spans between (~25-45 m.y.) and (~200-250 m.y.) before present, respectively. It will be important therefore to check on this result at corresponding depths in the well stratified Apollo 15 core samples. It is interesting to note that the first time span of low micrometeoritic influx i.e. between 25-45 m.y. before present coincides with the well known period of paucity of stone meteorites with cosmic-ray exposure ages > 30 m.y. (8).

References

(1) Arrhenius et al (1971), Geochim Cosmochim Acta, Suppl. 2, Vol. 3, pp. 2583-2598. (2) Bhandari et al (1972), Proc. of Fourth Lunar Sci. Conf. (In press). (3) Interagency Report: Astrogeology 71, NASA. (4) Bhandari et al (1972), Proc. Ind. Acad. Sci., Vol. LXXVI, No. 1, Sec. A, pp. 27-52. (5) McKay et al (1972), Geochim Cosmochim Acta, Suppl. 3, Vol. 1, pp. 983-994. (6) Kirsten et al (1973), Earth Planet Sci. Letters, Vol. 20, pp. 125-130. (7) The agglutinate data of Apollo 17 scoop samples are from G. Heiken (personal communication). (8) J. Zahringer, (1968). Geochim Cosmochim Acta, 32, pp. 209-237.

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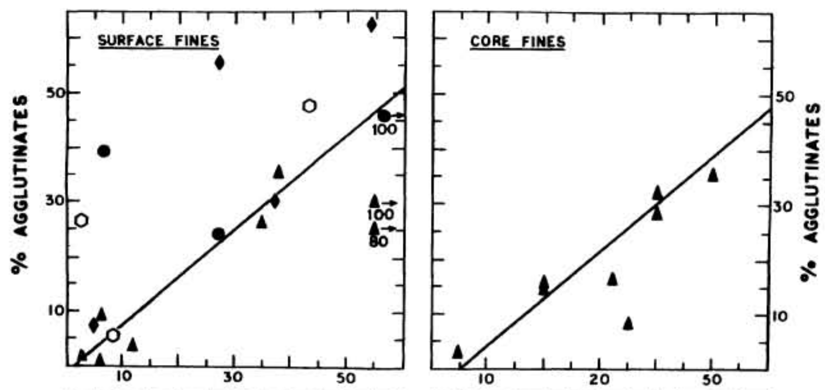

Figure 1

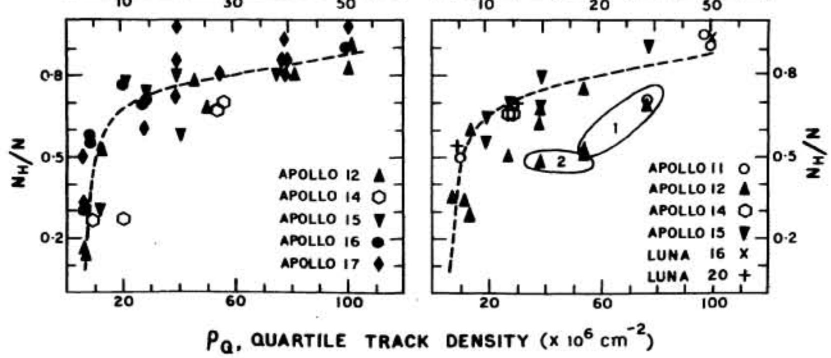

Figure 2

TABLE 1
Exposure ages of Apollo 17 Soil Samples

Sample	Location	ρ_q Quartile track density ($x10^6 cm^{-2}$)	Surface exposure age (m.y.)
70181,11	Near L.M. (5 cm scoop)	27	62
71501,24	At Station 1 (4 cm scoop)	38	70
72501,20	Base of South Massif (4 cm scoop)	76	~ 100
74261,8	Near Shorty Crater (~1cm scoop)	4.8	~ 2
75081	Camelot ejecta	38	70
76501,22	Rake soil at North Massif	3.3	6.0
78121,6	Ejecta of S.W.P. Crater	38	70
78421,60	Trench Sample at Station 8 (15-25 cm)	54	-
78441,13	-do-(5-15 cm)	76	-
78461,12	-do-(1-5 cm)	100	-
78481,28	-do-(Top~1cm)	76	-
79511,8	Van Serg ejecta	76	~ 100