PARTICLE TRACKS AND MICROCRATERS IN LUNA 24 DRILL CORE SOIL SAMPLES. J.N. Goswami and D. Lal, Physical Research Laboratory, Ahmedabad 380009, India.

Six soil samples from various depths of mare Crisium, sampled by the Russian automatic space probe Luna 24, have been analysed for particle track and microcrater records. The track studies have been carried out in two grain size fractions: 40-90 micron and > 100 micron. The microcrater studies were carried out in selected grains > 100 micron in size. The details of the six samples analysed are given in Table 1.

Results of track studies in the > 100 micron size fraction have already been reported (Goswami, 1977). A summary of these results along with the preliminary data for the 40-90 micron grain size fractions is given in Table 1, in terms of the track parameters ρ_{min}, ρ_q and N_H/N. As discussed by Goswami (1977), the track data in the > 100 micron size fraction indicate varying degrees of maturity for the six samples analysed. All the three soil samples analysed from the upper zone (87-148 cm) of the drill core are submature to highly mature in nature, while two of the three samples analysed from the lower zone (162-208 cm) are extremely immature from particle track point of view. Such records are typical of mare materials (e.g. the Apollo 12 and 15 drill core samples). One can understand the observed track record of the Luna-24 drill core samples in terms of a two stage process: (i) a rapid deposition of the lower zone (163-210 cm) with little or no pre-depositional irradiation followed by (ii) either a deposition of pre-irradiated material or a very slow deposition of immature material over the entire length of the upper zone (87-148 cm) of this regolith column. A very unique situation that has been found in this drill core soil samples is the very low spallogenic Ne-21 concentration (27×10^{-8}cc STP/gm) for the sample 24163 which is also an immature soil from particle track point of view. The Ne data would place an upper limit of ~150 m.y. for the total duration of exposure of the regolith column upto 163 cm (Rao and Venkatesan, 1978). This short time scale would, therefore, imply that during the second stage of the above depositional scenario pre-irradiated material has been deposited over a short period of time.

The microcrater studies were carried out with two specific purposes: (i) to obtain the fraction of grains that have been exposed on the lunar surface with zero shielding condition and (ii) to study the probable variations in the flux of solar flare heavy nuclei and micro-meteorites in the past. Sub-micron to few micron size craters as well as accretionary discs have been observed

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in several grains taken from samples from various depths in the core. In Figure 1 are shown some examples of craters and accretionary discs. Areal sub-micron crater densities are as high as (3-4) x 10^7 cm^{-2} in some cases. The preliminary data on the fraction of grains having microcraters, N_C/N, in each sample are given in Table 1. These data suffer from limited statistics at present. However, one aspect that is clear from these data in that not all solar flare irradiated grains have been exposed with true zero-shielding condition on the lunar surface, as has already been emphasized by Poupeau et al. (1975). With additional statistics we shall be in a much better position to deal in greater detail the above mentioned two aspects at the time of the conference.

TABLE 1

Sample Number	Depth in core (cm)	Size fraction* (microns)	ρ_{min} (x $10^6 cm^{-2}$)	ρ_q (x $10^6 cm^{-2}$)	N_H/N	N_C/N (N)
24087, 11	87	40-90	22.0	100.0	0.91	-
		>100	1.5	100.0	0.95	0.5 (8)
24123, 14	123	40-90	24.0	100.0	0.98	-
		>100	1.6	30.0	0.69	0.5 (4)
24148, 12	148	40-90	2.8	100.0	0.88	-
		>100	1.0	30.0	0.60	0.33 (3)
24163, 12	163	40-90	2.6	22.0	0.62	-
		>100	0.28	5.0	0.36	0.16 (6)
24179, 12	179	40-90	45.0	100.0	0.98	-
		>100	6.0	60.0	0.76	0.5 (2)
24190, 11	190	40-90	1.4	8.0	0.37	-
		>100	0.1	0.5	0.41	<.1 (6)

* The > 100 micron fraction consists primarily of grains in the size range 100-250 micron.

The track analyses in the two grain size fractions were carried out to check on the evolutionary history of the soil samples in this drill core. Our earlier track data (Goswami, 1977) show that out of the six samples analysed by us only one sample (24190) is a mixed soil sample consisting of both an

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immature and a mature component. The observed track density frequency distributions and the values of the track parameters for the 40-90 micron fractions (Table 1) do not indicate any mixing between mature and immature soils for the other samples with the possible exception of soil 24163. The average values of track densities in the 40-90 micron size fractions are, however, somewhat higher than that for the >100 micron size fractions. Thus, quite clearly some of the soil samples (24087, 24123, 24148 and 24179) have no distinct immature component in either of the grain size fractions while mixing history can be postulated for the other samples (24163 and 24190). Our results therefore do not fully validate the conclusions drawn by McKay et al. (1977) and Blanchard et al. (1977) that the entire Luna-24 core materials represent a mixture of a mature and an immature component.

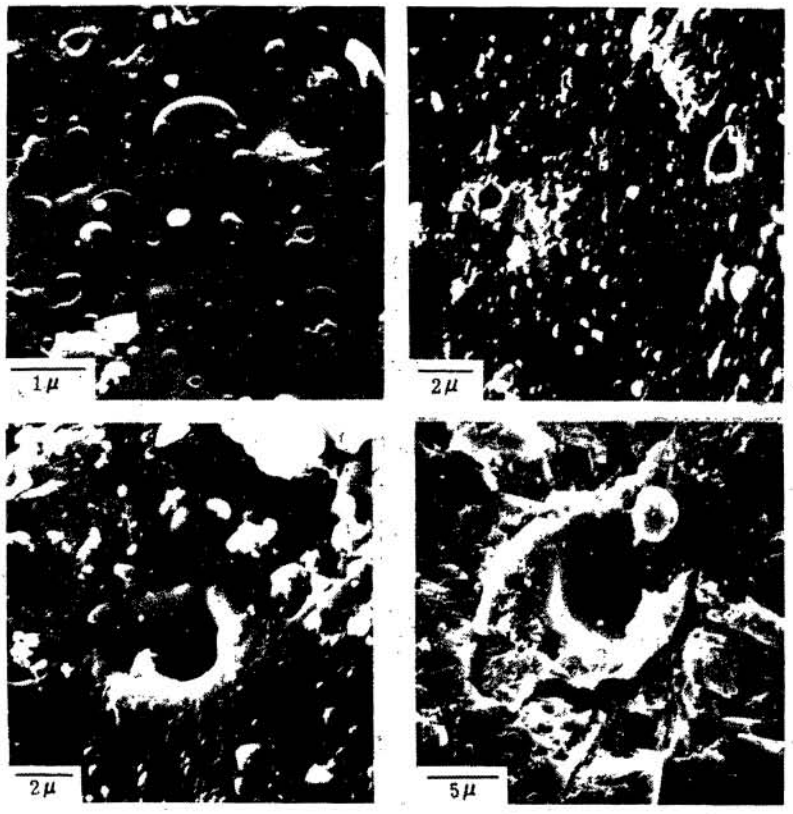

Fig. 1 Microcraters and accretionary discs observed on surfaces of individual grains taken from Luna-24 drill core soil column.

References: (1) Blanchard D.P. et al. (1977) In "Conference on Luna-24", 37-39. (2) Goswami J.N. (1977) Geophys. Res. Lett. (In press). (3) McKay D.S. et al. (1977) In "Conference on Luna-24", 115-117. (4) Popeau G. et al. (1975) Proc. Lunar Sci. Conf. 6th, 3433-3448. (5) Rao M.N. and Venkatesan T.R. (1978), This Volume.