EVOLUTION OF LUNAR SOIL GRAIN-SIZE PARAMETERS. John F. Lindsay, Dept. of Geology, La Trobe Univ., Bundoora. Vic. Australia.

The stratigraphy of the few meters of soil exposed on the lunar surface provides a record of a large proportion of lunar history. However, before the geologic record preserved in the soil can be placed in a comprehensive framework an understanding of the processes involved in the accumulation and evolution of the soil itself is essential. With this in mind grain size analyses have been made of 52 soil samples from the Apollo 15 deep core and 9 soil samples from the Apollo 16 deep core.

In contrast to previous studies (1,2) the samples were wet sieved using Freon TF to determine the size distribution of particles larger than 4.5Ø (45μ). The particle size distribution finer than 4.5Ø was determined on the basis of the maximum projected chord using a Millipore πMC particle measurement computer system. The data were corrected to sieve size equivalents.

Despite an age difference of possibly as much as 0.4×10^9 yr between substrates at the Apollo 15 and 16 sites the bulk properties of the soils from the two sites are very similar (table 1). A comparison of the means of the parameters by means of a t-test at the 5 percent level of significance indicates that the soils from the two sites have essentially the same graphic mean, graphic standard deviation and graphic skewness (3). However, the graphic kurtosis of the Apollo 16 soils is slightly but significantly smaller than that of the Apollo 15 soils ($t_{.05} = 2.000 < 2.061$, d.f. 59).

The Apollo 15 samples come from the deepest three segments of the deep core (Fig. 1). From these samples it is possible to conclude that deeper soil samples are coarser grained, more poorly sorted and more negatively skewed. Kurtosis can not be interpreted simply in terms of depth below the lunar surface. It is difficult to say whether these trends can be interpreted directly as evidence of an evolutionary sequence without further samples from the upper three core segments. However, the trends are consistent with earlier models for an evolutionary sequence (1,2). The variations about the mean values for each parameter and the presence of apparently mature soils at depth in the core suggest that reworking and mixing of the soil is considerable. There is a general tendency for deviations about the grand mean grain size and the sorting to become less pronounced in core segment 15003. If the same trend continues upward to the

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surface it would be stronger evidence for an evolutionary sequence.

At the Apollo 16 site the trend is reversed and grain size and graphic standard deviation both decrease deeper in the soil layer (Fig. 2). Simple relationships are not apparent for skewness and kurtosis. The reason for the reversal in trend appears to be the presence of a very-fine-grained well-sorted layer sampled by core segment 60001. Vertical mixing of this soil has produced a sequence of layers which gradually change upward away from the source.

Three morphologic units of the Apollo 15 deep core were examined in detail for evidence of grading or other features which may indicate the effects of transport in a gaseous medium. In all three cases grain size at first increases downwards and then decreases again. The units are not regularly graded as in the case of turbidites but there are enough similarities among the three sets of curves to indicate that grain size was modified to a small extent during transport. On the other hand the soil from the bottom of core segment 60001 at the Apollo 16 site is much finer grain (4.969Ø) and better sorted (0.990Ø) than any sample previously examined. There is no way that these characteristics could be produced by either vitrification or comminution - the two major processes involved in the formation of the lunar soil. Both mature soils and freshly crushed bedrock materials are more poorly sorted and coarser in grain size. The light color of the soil plus its unusual grain size parameters suggest that sample 60001,10 is probably ray material which has been sorted during transport in a gaseous medium.

References

(1) Lindsay, J. F., Jour. Sed. Petrology, 41 (1971), 780-797.
(2) Lindsay, J. F., Jour. Sed. Petrology, 42 (1972), 876-888.
(3) Folk, R. L. and Ward, W. C., Jour. Sed. Petrology, 27 (1957), 3-26.

Table 1 - Statistical parameters for soils from Apollo 15 and 16 deep core samples.

	Apollo 15 N=52		Apollo 16 N=9	
	Mean	± δ	Mean	± δ
Graphic mean Ø	4.019	0.334	3.840	0.478
Graphic standard deviation Ø	1.780	0.213	1.747	0.359
Graphic skewness	-0.333	0.074	-0.310	0.110
Graphic kurtosis	0.954	0.099	0.879	0.079

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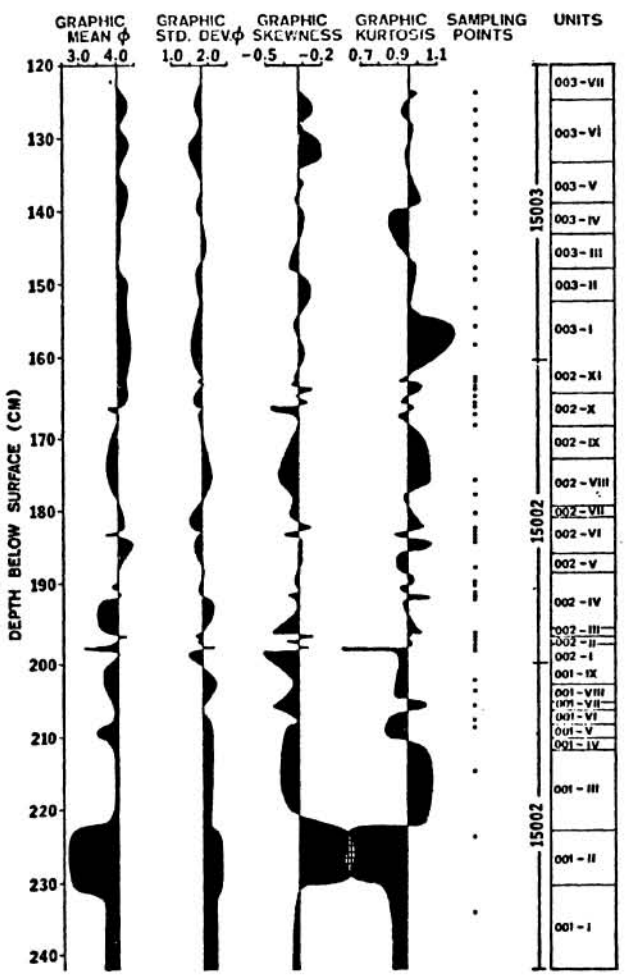

Figure 1.

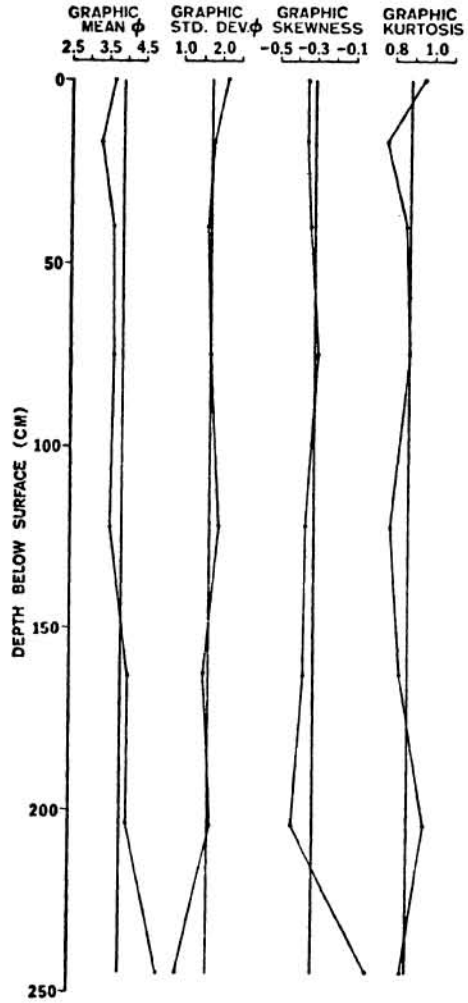

Figure 2.

Grain size parameters as a function of depth for Fig. 1 Apollo 15 deep core and Fig. 2 Apollo 16 deep core.