DEPOSITIONAL PROCESSES ON THE LUNAR SURFACE, J.F. Lindsay, La Trobe Univ., Melbourne, Australia.

Introduction: Surface and shallow core samples returned by the Apollo missions suggest that the lunar soil is not a static deposit but is a continually evolving sedimentary body (1,2,3). In the following paper a series of samples from the Apollo 15 deep drill is examined in an attempt to understand the transporting mechanism and its effect on the nature of the lunar soil. Grain size data from Apollo 17 samples are also compared with data from earlier missions in order to determine the nature of erosional processes on the moon's surface.

Stratigraphic Layers: The thickness-frequency distribution of the 42 stratigraphic layers in the Apollo 15 deep core is bimodal with the strongest mode at 1.0 to 1.5 cm and a second weaker mode at 4.5 to 5.0 cm. This implies that: first the impact events which constantly rework the lunar soil are, for the most part, small. Second, the major mode at 1.0 to 1.5 cm suggests that thinner morphologic units are destroyed by continuous micrometeorite reworking of the surface layers. Finally, unless there are observational errors, the meteorite energy frequency distribution may be bimodal.

Grain Size: Both normal and reverse grading were observed in some stratigraphic layers during dissection (4). The layers studied here are not regularly graded but there are enough similarities in the grain size data to suggest that the grain size distribution is being modified in a regular manner by a process or processes (Fig. 1). For example, Units 002-VI and 002-X are similar in thickness and in both cases a major inflection is present in the curves of their grain size parameters at between 2 and 3 cm below their upper boundaries. Likewise weaker inflections appear in the curves for unit 002-IVE.

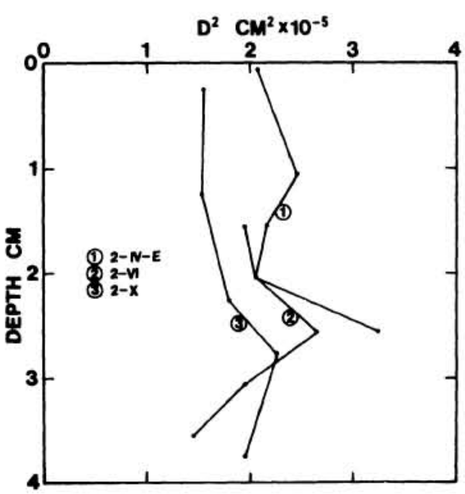

Fig. 1

Evidence of base surges is abundant in the textures of the soil breccias and some Apollo 16 soils (2,3,5,6,7,8,9). Particles transported in a base surge are fluidized by the upward flow of escaping gases. The settling velocity (under Stokes Law) of the particles is determined by their size or more precisely their radii squared and to some extent their shape. Thus larger more spherical particles tend to move towards the base of the flowing mass of debris and produce normally graded deposits. The supply of fluidizing gases is not necessarily in any direct propor-

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tion to the momentum of the base surge with the result that one of two things may occur. If the gas supply is abundant fluidization will continue until the base surge comes to rest and a normally graded depositional unit will result. If, on the other hand, the gas supply is limited the base surge may collapse rapidly before the flow has completely come to rest. In this situation fluidization will cease and inertial grain flow will dominate. Bagnold (10) has shows that at a given shear stress the dispersive pressure in inertial grain flow is a direct function of the square of the diameter of the particles and that larger particles will tend to migrate to regions of least shear strain. That is, they will tend to migrate towards the top of the flow and produce reverse graded depositional units. The three units studied appear to have undergone some inertial grain flow just prior to coming to rest with the result that concentrations of larger particles occur in the middle of the unit.

Uniformity of Sedimentary Processes: Grain size data have been gathered using standard methods for Apollo 15, 16 and 17 soil samples (3). This allows the soils from three sites to be compared directly (Table 1). A Students t-test (5% level of significance) indicates that there is no significant difference between pairs of sites for the mean, standard deviation and skewness. The soils are all poorly sorted and coarse skewed. Kurtosis values for the Apollo 15 and 17 missions are from the same populations, however, the Apollo 16 soils have kurtosis values which are significantly smaller than for the other two sites.

A strong linear relationship exists between the mean and standard deviation of soils from both the Apollo 15 and 16 sites (Fig. 2). The two regression lines parallel each other but the intercept of the Apollo 16 regression line is somewhat smaller. The displacement of the regression lines may be connected with the fact that the Apollo 16 soils are generally from older surfaces. The constant slope of the regression lines suggest that uniform depositional processes were active at the sites. Apollo 17 data are not complete enough to establish a regression line, however, the points fall close to the Apollo 15 and 16 regression lines indicating that a similar relationship exists. Overall the data from the three widely spaced sites are consistent with there being a very uniform set of erosional processes active on the lunar surface. This suggests that if vulcanism ever played a significant role in soil formation the randomness of its effects has since been obliterated by the long term homogenizing effects of meteorite impact.

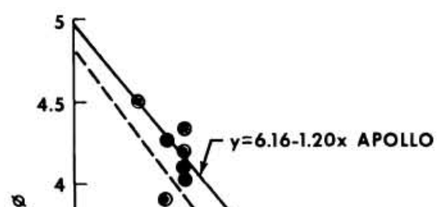

Fig. 2

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Figure Captions

Fig. 1. Mean grain size squared (cm) as a function of depth for three stratigraphic units from the Apollo 15 core.

Fig. 2. Mean grain size versus standard deviation for Apollo 15, 16 and 17 soils.

Table 1

Mission	Graphic Mean	Graphic Standard Deviation	Graphic Skewness	Graphic Kurtosis
Apollo 15	4.019 ± 0.334	1.780 ± 0.213	-0.333 ± 0.074	0.954 ± 0.099
Apollo 16	3.840 ± 0.478	1.747 ± 0.359	-0.310 ± 0.110	0.879 ± 0.079
Apollo 17	3.974 ± 0.345	1.635 ± 0.173	-0.251 ± 0.082	0.946 ± 0.064