PETROLOGY OF APOLLO 17 DEEP DRILL CORE-III: STRATIGRAPHY AND DEPOSITIONAL HISTORY. G.J. Taylor, R.D. Warner, and K. Keil, Dept. of Geology and Inst. of Meteoritics, Univ. of New Mexico, Albuquerque, NM 87131.

We previously (1) developed a depositional model for the regolith sampled by the Apollo 17 drill core. The model was based on modal analyses of the upper three drill stems (70009-70007, corresponding to the upper ∿ 90 cm) and on inferences made from theories of cratering dynamics. We proposed that the coarse-grained layer, which resides between 24 and 56 cm below the lunar surface, originated as ejecta from Camelot Crater. We also suggested that ejecta from the Central Cluster of craters occurs beneath the coarse-grained layer and extends at least to the base of 70007 (∿ 90 cm).

We have now completed modal analyses on the remainder of the core, stems 70006-70002, extending the record to a depth of ∿ 285 cm. Our procedures were identical to those followed previously (1). In general, a modal analysis was done on each half of each section. The average number of points per analytical area was 1275; we counted a total of 218,790 points.

Stratigraphy. Lithologic abundances vary considerably with depth (Figs. 1-3). They also vary, however, because of random statistical and sampling errors, which obscure the genuine stratigraphy. To reduce the random scatter, we have smoothed the data in Figs. 1-3 by recalculating the values of a parameter at point i according to the following equation: $S(i)=[V(i-1)/4] + [V(i)/2] + [V(i+1)/4]$, in which $S(i)$ is the new, smoothed value at point i and $V(i)$, $V(i-1)$ and $V(i+1)$ are the values before smoothing at points i, i-1, and i+1, respectively.

Plots of abundances of agglutinates and the two main mare lithologies (Figs. 1-3) show clear-cut zones. We have tentatively divided the core into 8 zones (A-H), based mainly, though not exclusively, on agglutinate abundances. Other data, particularly tracks, may help define these zones more precisely. Zone A (0-19 cm) is what we previously (1) called the upper zone. It has a high agglutinate content, a low abundance of black glass (which is the crystallized equivalent of orange glass), and a high ratio of mare to nonmare lithic fragments. Zone B (24-56 cm) is the coarse-grained layer. It consists mainly of mare basalts and mineral fragments derived from them (1); the abundance of agglutinates is low. Zone C (56-80 cm) is characterized by increasing agglutinate content with increasing depth and a high, relatively constant abundance of black glass. Zone D (80-113 cm) displays distinctly lower agglutinate and black-glass abundances and a pronounced increase in the percentage of mare basalt lithic fragments. Zone E (113-163 cm) has a high and approximately uniform agglutinate content, with a cluster of black glass fragments in its center. Zone F (163-199 cm) is characterized by decreasing then increasing agglutinate abundances, variable black-glass contents, and an increase in the concentration of mare basalt fragments near its base. In Zone G (199-233 cm) the agglutinate content decreases gradually as mare basalt fragments increase. Finally, Zone H (233-285 cm) shows increasing, though variable, agglutinates contents and generally decreasing mare basalt abundances.

The positions of these zones are uncertain. Even more uncertain is their significance. We do not know the extent to which they represent specific events or periods in the regolith's history. An exception, however, is zone B, the coarse-grained layer. This layer was probably deposited as ejecta from Camelot Crater (1,2) and represents a significant and useful stratigraphic horizon. One can divide the core into three major, macro-zones: the coarse-grained layer and the materials above it and those below it. To facilitate comparisons among these three zones, we computed the average composition of each (Tables 1 and 2). (The average for the lower zone included zones D through H; zone C seems to be transitional from the coarse layer to the lower portions of the core).

The differences among the three macro-zones are striking. The upper and lower zones are considerably richer in agglutinates than the coarse-layer, which is characterized by a high content of mare basalt lithic fragments (Table 1). The ratio of mare to nonmare lithic fragments (Table 2) is significantly lower in the lower zone than in either the coarse-layer or the upper zone. The ratios of plagioclase and ilmenite to mafic silicates (Table 2) also indicate that the lower zone is enriched in nonmare materials compared to the regolith above it.

Depositional history and speculations. The Apollo 17 landing site is pockmarked by numerous craters; most notable are Camelot and the Central Cluster. These craters, thought to have formed when secondary projectiles from Tycho pummeled the Taurus-Littrow valley (3), have greatly affected the regolith (1,4). Since the coarse layer is probably Camelot ejecta, can we identify the materials excavated when the Central Cluster craters formed? We argued previously (1) that it probably underlies the coarse layer and calculations of the thicknesses of ejecta from Central Cluster suggested that it could extend 71 to 138 cm below the coarse layer. The calculations are only approximate, but suggest that Central Cluster ejecta may extend approximately to either the border with zones D and E or with F and G.

Zone D is the most pronounced and identifiable zone in the lower portion of the core. Perhaps we can determine that a specific crater formed this layer, as we did for the coarse layer. Zone D is ∿ 30 cm thick. Calculations (1) based on two different models for the distribution of ejecta surrounding craters indicate that the crater San Luis Rey, which is 300 meters in diameter and located 410 meters from the drill-core site, contributed 30 to 54 cm of ejecta to the core. It also contributed, according to calculations by (1), material consisting of ∿ 50% freshly excavated basalt and ∿ 50% regolith. Note that zone D has about half the abundance of agglutinates (Fig. 1) that zone A has, perhaps suggesting that it is composed of equal amounts of mature regolith and newly excavated basalt. Zone D also has a pronounced peak in mare basalt abundances (Fig. 2). We suggest, therefore, that zone D may represent ejecta from San Luis Rey Crater.

References: 1) Taylor, G.J. et al (1977) PLSC 8th, 3195. 2) Heiken, G. and McKay D. (1974) PLSC 5th, 843. 3) Arvidson, R. et al (1976) PLSC 7th, 2817. 4) Lucchitta, B.K. and Sanchez, A.G. (1979) PLSC 6th, 2427.

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Table 1. Average modal compositions (vol.%) of the major units of the Apollo 17 drill core

	Upper Zone	Coarse Layer	Lower Zone
Points counted	17,075	23,856	151,622
< 0.02 mm size range	55.6	47.2	62.0
0.02-0.2 mm size range	27.0	29.3	22.2
> 0.2 mm size range	17.4	23.5	15.8
% of 0.02-0.2 mm size range (normalized to 100)			
Agglutinates	30.7	6.5	25.4
Soil breccias	2.2	1.1	4.6
Mineral fragments	46.6	61.3	39.0
Mare basalt fragments	3.8	2.7	4.3
Nonmare lithic fragments	1.2	0.8	2.1
Glasses			
orange & yellow	2.6	4.9	3.1
"black"	8.5	19.9	14.7
colorless	1.3	0.5	2.3
other	0.9	0.4	1.5
Miscellaneous	2.0	1.9	3.0
% of > 0.2 mm size range (normalized to 100)			
Agglutinates	27.0	3.9	20.1
Soil breccias	14.1	7.9	24.4
Mineral fragments	16.7	23.4	6.9
Mare basalt fragments	29.2	52.8	21.8
Nonmare lithic fragments	5.2	3.2	12.4
Glasses	5.2	6.5	9.2
Miscellaneous	2.6	2.3	5.2

Table 2. Abundance ratios in major units of Apollo 17 drill core.

	Upper Zone	Coarse Layer	Lower Zone
Mare/(mare + nonmare)[1]	0.85	0.94	0.64
Plag/(px+ol)[2]	0.66	0.64	0.83
ilm/(px+ol)[3]	0.32	0.34	0.26

1) Lithic fragments, > 0.2 mm size range.
2) 0.02-0.2 mm size range
3) 0.02-0.2 mm size range

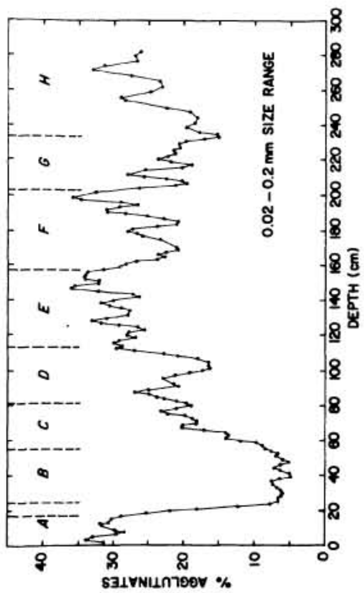

Figure 1

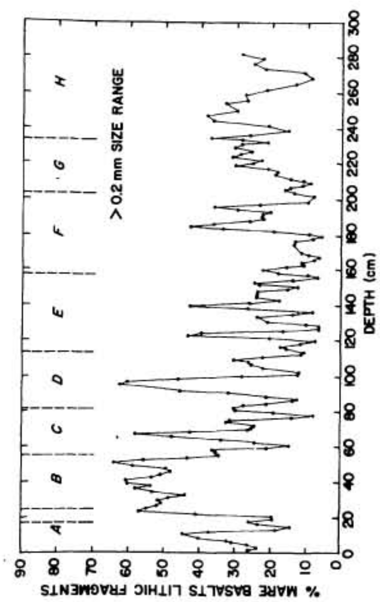

Figure 2

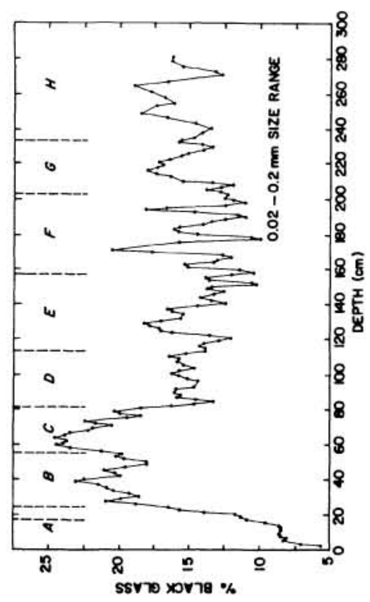

Figure 3