PETROLOGY OF APOLLO 17 DEEP DRILL CORE. II. AGGLUTINATES AS RECORDERS OF FOSSIL SOIL COMPOSITIONS. G.J. Taylor, S. Wentworth, R.D. Warner, and K. Keil, Dept. of Geology and Inst. of Meteoritics, Univ. of New Mexico, Albuquerque, NM 87131

Last year (1), we showed that modal analyses readily divide the top three stems of the Apollo 17 drill core into three major layers which we termed the upper zone, the coarse layer, and the lower zone. We also devised a model that described the depositional history of the core. The model's essential ingredient is that the identifiable layers in the core are mixtures of mature regolith and mare basalt freshly excavated by the cratering events (Central Cluster and Camelot) that formed the layers. We also proposed, along with Delano (2), that the core contains fragments of the projectiles responsible for forming the Central Cluster craters and Camelot, and that these fragments came from Tycho; see also (3,4).

The brown, swirly glass in agglutinates has the composition of the soil in which it is formed (5-8). If, as we claim, the layers in the core contain varying proportions of excavated bedrock and mature regolith, the agglutinates ought to have the composition of the regolith that covered the Apollo 17 site in the vicinity of Central Cluster and Camelot before those craters were blasted out. What is the composition of this pre-Tycho soil likely to have been? It would clearly have been dominated by high-Ti mare basalt, but it would also have contained a significant percentage of a nonmare component derived from the local massifs. Since North and South Massifs contain (9,10) respectively 40% and 13% ANT (remainder noritic, or KREEPy, breccias), the agglutinates, which hopefully represent fossil soil compositions, should reflect greater proportions of noritic than ANT components.

Average agglutinate compositions in the three major layers and the top 5 cm of the core appear in Table 1. We also include in Table 1 the results of least-squares mixing calculations, involving computed abundances of the four major lithologies at the Apollo 17 site: Apollo 17 mare basalt, orange glass, ANT, and norite. Table 2 lists the compositions of these components. As expected, the nonmare component is quite abundant, ranging from 42 to 49%. More significantly, it generally contains less than 40% ANT, suggesting that the local highlands are the probable source. This contrasts sharply with the modal abundances among recognizable nonmare lithic fragments in the upper and lower zones of the core (1): the percentage of ANT ranges from 63% in the upper zone to 70% in the lower zone. This disparity with local highland composition constitutes the chief petrographic evidence that nonlocal material has been added to the Apollo 17 soil. In contrast to the agglutinates in the upper or lower zones, those in the coarse layer have unusual compositions. If the average agglutinate composition in this layer really reflects the make-up of a fossil soil, then that soil had more orange glass than mare basalt in it. Since the coarse layer was probably deposited by the Camelot event (1,11), the hypothetical soil presumably occupied the area where Camelot Crater now resides. Perhaps a small pre-Camelot crater (or craters) excavated large amounts of orange glass and deposited it on the surface, where impacts converted some of this soil into agglutinates.

Since the soil in the drill core represents a mixture of pre-Tycho regolith, more recently excavated basalt, and fragments of the projectiles that formed Central Cluster and Camelot, mixing calculations on bulk soil compositions are not necessarily meaningful. For example, mixing calculations (Table 3) on soil 70181 (the reference soil for the drill core, a scoop ∿5 cm deep) suggest that it is composed of subequal amounts of ANT and norite and that it contains 16% orange glass. The calculation is right, but it is incomplete. When the average agglutinate composition in the upper 5 cm (Table 1) of the drill core is added to the mix, the calculations (Table 3) indicate that soil 70181 is a mixture of 60% pre-Tycho regolith (whose composition is given by the agglutinates in the upper 5 cm), with 31% mare basalt and 9% ANT. (In Table 3, the proportion of agglutinates represents tha abundance of regolith that they were made in, not simply the abundance of agglutinates.) We note similar differences for soil 70008 (Table 3).

We conclude three things from this work: First, the soils that existed at the Apollo 17 site prior to the formation of Central Cluster, Camelot, and associated craters (and other events, such as the landslide at Station 2) were probably typical mature soils that were mixtures of underlying bedrock and local massifs. Second, our depositional model (1) is still valid. Third, mixing calculations on bulk soil compositions might be misleading. Bulk soil chemical analyses should always be accompanied by petrologic studies, including measurements of agglutinate compositions.

References. 1) Taylor, G.J. et al. (1977) PLSC 8, 3195, 2) Delano, J. (1977) LS VIII, 236, 3) Wolfe, E.W. et al. (1975) PLSC 6, 2463; 4) Arvidson, R., et al. (1976) PLSC 7, 2817; 5) Marvin, U.B. et al. (1971) PLSC 2, 679; 6) Taylor, G.J. et al. (1972) PLSC 3, 995; 7) Gibbons, R. et al. (1976) PLSC 7, 405; 8) Hu, H.-N. and Taylor, L.A. (1977) PLSC 8, 3645; 9) Taylor, G.J. et al. (1974) LS V, 777; 10) Bence, A.E. et al. (1974) PLSC 5, 785; 11) Heiken, G. and McKay, D. (1974) PLSC 5, 843; 12) Rhodes, J.M. et al. (1974) PLSC 5, 1106; 13) Taylor, S.R. (1975) The Moon: A Post Apollo View; 14) Laul, J.C. et al. (1974) PLSC 5, 1047.

AGGLUTINATES

Taylor, G. J. et al.

Table 1. Average Compositions (wt.%) of Agglutinates in the Apollo 17 deep drill core and calculated proportions of lithologic components. N is the number of analyses. Values in parentheses are standard deviations.

	Upper 5 Cm	Upper Zone	Coarse Layer	Lower Zone
N	36	182	45	62
SiO_2	41.2 (3.1)	41.9 (2.6)	42.4 (2.4)	42.1 (1.7)
TiO_2	7.5 (3.1)	6.9 (2.6)	5.4 (2.0)	6.0 (1.4)
Al_2O_3	11.9 (2.8)	13.2 (3.9)	14.0 (3.6)	14.1 (2.4)
Cr_2O_3	0.37(.16)	0.36(.18)	0.43(.12)	0.40(.06)
FeO	16.6 (3.0)	15.5 (3.3)	15.2 (3.8)	14.5 (1.9)
MnO	0.23(.08)	0.18(.07)	0.22(.09)	0.19(.06)
MgO	10.9 (0.9)	10.3 (1.7)	11.0 (1.9)	10.5 (0.9)
CaO	10.6 (0.6)	11.0 (1.4)	11.0 (1.6)	11.0 (0.8)
Na_2O	0.28(.09)	0.29(.10)	0.38(.10)	0.35(.11)
K_2O	0.09(.02)	0.09(.03)	0.08(.02)	0.12(.04)
P_2O_5	0.06(.03)	0.09(.05)	0.07(.03)	0.06(.02)
Total	99.73	99.81	100.18	99.32
A17 Mare Basalt	38.7	41.8	19.5	31.7
Orange Glass	28.1	16.6	32.9	19.7
ANT	10.2	12.9	21.2	17.5
Norite	22.9	28.7	26.4	31.1
% ANT in nonmare	30.8	31.0	44.5	36.1

Table 2. Compositions (wt.%) of Components used in mixing calc.'s.

	A	B	C	D
SiO_2	38.6	38.6	46.2	44.5
TiO_2	12.5	8.8	1.50	0.39
Al_2O_3	8.9	6.3	18.0	26.0
Cr_2O_3	0.45	0.75	0.20	0.06
FeO	19.2	22.0	9.2	5.8
MgO	8.6	14.4	12.3	8.0
CaO	10.5	7.7	11.2	14.9
Na_2O	0.38	0.36	0.65	0.25

A) Apollo 17 Mare Basalt; B) Orange Glass (11); C) Noritic Breccia (11); D) ANT (12).

Table 3. Proportions of components in two Apollo 17 soils. Calculation A does not include agglutinates as a component; calculation B does. Chemical data from (12) for 70181 and (14) for 70008.

	70181		70008	
	A	B	A	B
A17 Mare Basalt	54.5	30.7	59.3	51.8
Orange Glass	16.2	0.0	22.0	9.1
ANT	15.1	9.5	8.7	0.3
Norite	14.3	0.0	10.0	0.0
Agglutinates	-	59.8	-	38.8