ANALYSIS OF INDIVIDUAL AGGLUTINATE PARTICLES FROM APOLLO SOIL 61181 AND IMPLICATIONS FOR AGGLUTINATE FORMATION; Douglas P. Blanchard and Richard V. Morris, Solar System Exploration Division, NASA Johnson Space Center, Houston, TX 77058.

Compositional variations among various components of lunar regolith samples has been the topic of active discussion. Evensen et. al.(1) found higher concentrations of KREEP related elements in the finer fractions of the regolith. Rhodes et al.(2) documented compositional variations among fractions of soils that had been separated by magnetic means. Korotev (3) investigated compositional dependence on grainsize using primarily Apollo 17 soils. Several investigators(e.g.4-7) have analysed a number of size fractions from various sites. The results of all this work demonstrate that the finest fractions of lunar soils have significantly different compositions than their bulk soil counterparts. Haskin and Korotev (8)did an experiment in which they comminuted an Apollo 17 mare basalt. The fines from that experiment were compositionally distinct from the bulk rock composition giving rise to the speculation that compositional differences among size fraction may be the result of differential comminution during the regolith formation process. At the Apollo 17 site, however, Korotev(3) attributed these differences to transport of fine material between mare to highland sources. At the Apollo 16 site, the differences have been attributed to mixing of soils with different composition, grainsize and maturity characteristics(7,9,10).

Papike et al.(11) have proposed a model in which the agglutinitic glass is formed from the finest fraction of the soil (the F^3 model). They cite as their evidence that the agglutinitic glass in many soils is more similar to the composition of the finest fraction than to that of the bulk. McKay et al.(12) by careful SEM analysis confirm this observation and also find that the agglutinitic glass is relatively homogeneous suggesting a homogeneous source such as the well mixed finest fines. Generally the composition of the finest fraction and the agglutinitic glass is more felsic than the bulk. At the Apollo 16 site, however, the finest fractions are generally more mafic and thus the Apollo 16 soil is a good test of the F^3 model; if the model is correct the agglutinates should also be more mafic than the bulk soil.

As a test of our hypothesis, we have analysed more than 30 individual agglutinates using ferromagnetic resonance and instrumental neutron activation analysis. The particles were hand picked from the 250-500 micron fraction of 61181. The mass of the analysed particles ranged from 20-250 micrograms. A histogram of the I_s/FeO results is given in Figure 1; the value of I_s/FeO for 61181 is 82 (12). The broad range is indicative of the heterogeneous mixtures of glass and clast that typify agglutinitic particles. We have used high values of I_s/FeO to identify particles that may be largely agglutinitic glass.

In Figure 2 it is evident that there is a distinct offset composition of the agglutinates compared to the bulk soil especially when the particles with I_s/FeO >60 are considered. Unfortunately, the composition of the finest fraction of 61181 is not yet available, but on the basis of analyses of other A16 soils it is reasonable to expect that it too will be more Fe and Sc rich than the bulk soil. On the basis of these preliminary results, the fusion of the finest fraction model seems to be valid in that the agglutinates seem to be offset toward the composition of the finest fraction even when the fractionation is toward fines of more mafic composition.

The remaining question is why the finest fraction has a different composition than the bulk soil. We question the importance assigned by Papike et al.(11)to comminution processes to account for the composition of the finest fractions of the regolith. Papike(11) notes that regolith at most sites shows enhancements in felsic and incompatible element concentrations in the finest fractions similar to the effects noted by Korotev(3) for comminution of a basalt. They suggest that comminution may also be responsible for the soil fractionation. They note that Apollo 16 soils do not show the same effect but suggest that the same comminution process results in the opposite effect at A16. There has been no experiment on a "typical" Apollo 16 rock analogous to Korotev's work on the mare basalt and thus there is no observed evidence to support their explanation.

We suggest that mixing of soils from various sources offers a more general explanation for these observations and requires no special case for the A16 soils. At sites with multiple geologic provinces, short range mixing seems to be the predominant influence (e.g.3). But even at the exclusively highland Apollo 16 site there is ample evidence (7,9,10) to suggest that the compositions of the bulk and fine fractions can be best explained as a mixture of a coarse-grained, immature, felsic soil with a fine-grained, mature, more mafic soil. The results of this study are consistent with that explanation. While some comminution effects are well documented and no doubt are active in the regolith evolution process, we find no convincing evidence that the effects of comminution processes are greater than or even equal to the effects attributable to simple mixing.

References:(1)Evensen N.M.et al.(1974) Proc. Lunar Sci. Conf 5th.1401-1407 (2)Rhodes J.M.et al.(1975) Proc. Lunar Sci. Conf 6th,2291-2307 (3)Korotev.R.L.(1976) Proc. Lunar Sci. Conf 7th,695-726 (4)Laul J.C. and Papike J.J.(1980a) Proc. Lunar Planet. Sci. Conf 11th, 1307-1340 (5)Laul J.C. and Papike J.J.(1980a) Proc. Lunar Planet. Sci. Conf 11th, 1395-1340 (6)Laul et al.(1978) Proc. Lunar Planet. Sci. Conf 10th,1269-1298 (7)Blanchard D.P. et al.(1974) Proc. Lunar Sci. Conf 7th,281-294 (8)Haskin L.A. and Korotev R.L.(1977) Geochim. Cosmochim Acta,41,921-939 (9)McKay D.S. et al.(1976) Proc. Lunar Sci. Conf 7th,295-313 (10)McKay D.S. et al.(1977) Proc. Lunar Sci. Conf 8th,2929-2952 (11)Papike J.J. et al.(1982) Rev. Geophys. Space Phys. 20,4;761-826 (12)Morris R.J.(1978) Proc. Lunar Planet.Sci. Conf 9th,2287-2297.