PRELIMINARY STRATIGRAPHY OF THE REGOLITH AT THE APOLLO 15 SITE. G. H. Heiken, U.S. Clanton, D. S. McKay, M. B. Duke, NASA Manned Spacecraft Ctr., Houston, TX, Roald Fryxell, Wash. St. Univ., Pullman, WA, G. A. Sellers, U.S. Geol. Survey, Washington, DC, Ron Scott, Cal. Inst. Tech., Pasadena, CA, and J. S. Nagle, N.S.I., Houston, TX.

The 242 cm long core collected by the Apollo 15 crew is the deepest sample yet studied from the lunar regolith. The core was collected from the regolith developed on Palus Putredinus, an embayment of mare lavas into the Apennine Mountains at the Apollo 15 landing site; located at Station 8, 3.75 km from the base of the Apennine Front.

A variable drilling rate during the collection of the core was the first indication that the regolith at this site consisted of a layered sequence (1). In the lab, the stratigraphy was first established on the basis of x-radiographs, then visually based on the texture, color, coherence, composition of coarser grains and soil structure when the core was dissected(2).

Each layer was considered a distinct soil zone and grain sizes ranged from silt to pebbly medium sand; a silty matrix was ubiquitous. Colors ranged from very dark gray to white, with the most common being gray. Coarser rock fragments were identified visually and included several breccia types, basalt and anorthosite. Green glass spheres were present in small amounts at all levels and were especially concentrated in the samples of 24.5 cm and -83.2 to 94.7 cm(2).

Boundaries between stratigraphic units were quite sharp; there appeared to be no distortion or mixing of the units by the coring process except in a 1 mm thick zone adjacent to the walls of the tube. The thickness of individual layers ranges from a few mm to 13 cm thick. A total of 42 major textural units were described; numerous subunits were apparent within several of these.

Nine of the layers exhibit normal and reverse graded bedding(2) and these beds range from 1 to 12 cm thick. Similar graded bedding occurs in base surge deposits on Earth; they probably represent deposition of ejecta from nearby craters on the Lunar surface. The other possible grading process involves reworking of the upper few cm of regolith by micrometeorite impact. Such a process is hypothesized by Bhandari et al.(3), who show that finer grain sizes correlate with higher track densities. They propose that finer particles are moved closer to the surface by impact gardening.

We have studied thin sections of 12 samples from 6 textural units in this core. The crystal, glass and lithic components exhibit a random, non-systematic variation with depth(4). On the basis of the fragment populations, each layer is unique and each appears to represent a discrete impact event; the same conclusion was reached in the preliminary description of the cores(2).

Lithic types characteristic of the Apennine Front include vitric or brown glass breccias, green glass, anorthosite, and metamorphosed breccia fragments(11). Based on our analysis of the <2 mm fraction, the generalization was made that most basalt fragments in the soil were derived from mare lavas(11) and we have a source or provenance indicator in the ratio between lithic fragments derived from the Apennine Front and from the mare lavas.

The 90-150μm and the 250-2000μm fractions were used to determine the Front/Mare Lithic Ratios; surface soils from the Apennine Front stations have ratios of

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between 8 and 24 and a Mare soil from Station 9A has a ratio of 0.65. The drill samples have ratios ranging from 0.65 to 2.1, with an average of about 1.00. The average lithic ratios indicate nearly equal portions of mare-derived and front-derived lithic components in the regolith section collected at Station 8. This agrees with the mixing model of Schnetzler and Philpotts(9) who found on the order of 50% mare basalt in the deep core samples, based on trace element analyses. Nearly all of the lithic components can be accounted for by the front and mare derived material. There is no evidence, positive or negative, from the soil studies to indicate that a ray from Aristillus or Autolycus crosses the landing site.

The heterogeneous, layered regolith model is supported by studies of fossil cosmic ray and solar flare tracks (3,5), by variations in mercury concentration(6), by the wide range of noble gas values(7), and by the wide range of Rb-Sr values(8). Trace element studies(9) indicate that the upper 1.6 m of soil has nearly the same composition, but that soils at -2.0 and -2.4 m are richer in KREEP and poorer in mare basalt and anorthosite.

The neutron fluence, or integrated neutron flux, in the deep core, determined by $^{158}Gd/^{157}Gd$ ratios indicates that one of two models may be possible(10). One model proposes the deposition of a blanket or slab of previously irradiated material about 450 million years ago which is allowed to remain undisturbed with a thin (35 gm/cm^2) 17 cm layer added at about 150 million years b.p. The other model requires a layer deposition over a period of 400 m.y., followed by an undisturbed period of about 500 m.y., except for the upper layer at 150 m.y. b.p.

Both of these models(10) require a long (450-500 m.y.) period of undisturbed residence for the bulk of the core except for the upper 17 cm. The presence of variable solar flare particle tracks throughout the core and the presence of many discrete layers argues against the first model (i.e., rapid deposition) and favors the accretion model.

CONCLUSIONS: 1. The 242 cm long core has been divided into 42 major textural units, on the basis of texture, color, structure, etc.

2. The regolith was accreted layer by layer. Each layer may have been reworked to a depth of a few cm by micrometeorite bombardment.

3. The graded bedding present may be due to base surge deposition or to reworking of the upper few cm of soil by micrometeorites.

4. The soils vary from layer to layer in content of lithic, crystal and glass fragments in a random fashion. The lithic fraction indicates that there are nearly equal portions of rock fragments derived from the Apennine Front and the mare surface. The presence of about 50% lithic material from the Apennine Front in the core samples, located 3.75 km from the base of the Front, is an indication of the efficiency of lateral transport by impact processes and mass wasting.

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