LIGHT AND DARK SOILS AT THE APOLLO 16 LANDING SITE. D. Heymann, J. R. Walton, J. L. Jordan, Department of Geology, Rice University, Houston, Texas, 77001.

The near-surface soils from Apollo 16 can be divided into three major groups on the basis of inert gas systematics alone; however, 61220 is truly "unique". The geochemistry (K, Fe, Ti, Zn, Tl/Cs: see Figure) and maturity (mean grain size, agglutinates) broadly support the following groups:

I. North Ray Crater Soils. Light, immature to submature with He-4/Ne-20 < 42, Ar-40/Ar-36 < 1.6, relatively low Fe, K, Ti, Zn, and Tl/Cs. This is the least uniform group; K increases from W to E at Sta. 11 and from Sta. 11 to Sta. 13. We find no evidence for substantial amounts of group I soils elsewhere in the landing site. Light soils at Stas. 1 + 2 are definitely not group I soils. In our thinking, the N. Ray ejecta blanket is a "transient feature", albeit large in volume. We do not know what lies beneath the continuous blanket. Judging from the whole landing area we suggest: principally group III soils with patches of group II soils. The increased K, etc. at Sta. 13 could be due to mixing of ejecta with pre-existing regolith by N. Ray secondaries. Soils: 332, 334, 350, 746, 748, 760, 770, 794, 796 (332 stands for 63320, etc.)

II. Light Soils. Light, mostly mature; 4/20 < 42, 40/36 > 2.0; intermediate or relatively high K, Fe, Ti, Zn, Tl/Cs. These are not "fresh" N. Ray or S. Ray ejecta. The association of 61240 with 61220 in the trench of Sta. 1 leads us to conclude that these soils are principally derived from sources rich in 61220-like material (volatile-rich, intermediate K, Fe, Ti). This material is also seen at the base of the deep drill (section 60001), overlain by about 2 meters of group III soils. We suspect that horizons or lenses of material, rich in light matrix breccia debris occur at variable depth in the regolith in the area, and that these have been "tapped" from time-to-time by moderately large craters such as Flag. Soils: 114, 116, 118, 124, 128, 150, 224, 228, 450, 550, 551 (underlined: tentative, no inert gas data available)

III. Dark Soils. Dark; mature; 4/20 > 42; 40/36 > 1.8; K, Fe, Ti, Zn high; Tl/Cs intermediate (?). Occur everywhere, unless masked by "transient features". "Country fines" of the landing area. Contain substantial proportions of a relatively Fe, Ti-rich material, presumably derived from the dark unit. Ubiquitous on Stone Mountain, especially at Stas. 8 + 9. Soils: 005, 050, 060, 442, 480, 570, 590, 604, 608, 882, 884, 994, 996. Note: Soil 992 falls in group I on the basis of inert gases, but in II in the basis of geochemistry. We suspect that this "skim" soil from Sta. 9 is the "purest representative of fresh S. Ray ejecta.

The soils at the surface of the Apollo 11 site exhibit a remarkable degree of non-uniformity on a coarse grid of at least several meters, perhaps tens to hundreds of meters. If group II soils are related to the light matrix breccia unit and if the Fe-rich material in group III soils is related to the dark unit, then most of the soils are principally made up of local materials derived from distant or extra-lunar sources. We suspect that the surface expression implies that the regolith is grossly non-uniform in three
dimensions on a relatively coarse grid with horizons, or lenses, or pockets of relatively unmixed material, such as 61220, or its parent, present everywhere. "Transient features" have been produced by large, medium, and small-sized craters, with the probability of survival of the features in the depositional record roughly proportional to their size. Hence, the regolith has always been grossly non-uniform at the surface as well as at depth.

The depositional record in cores from Apollo 16 must still be investigated in detail. Because the grid is much finer in cores (in principle as fine as one wants to make it) our considerations do not apply directly to cores, i.e. we do not expect every core to contain group I, II, and III soils. Certain cores, e.g. 69001, may well be entirely made up of group III soils with a thin veneer of 69920-type material at the top. On the other hand, localized near-surface deposits, such as group II soils at Stas. 1 + 2 become redistributed; hence, older now-defunct deposits may be present in layers of the three cores at Sta. 10. One such layer seems to occur at about 2 meters in the deep drill.

The number of publications on which this abstract is based is approximately 50; they include papers from our own laboratory. We concluded that it was a hopeless task to single out a few "most important" papers; hence, we cite none, with apologies to our colleagues in the lunar program.

FIGURE LEGEND

Plot of $^{36}Ar/^{36}Ar$ vs. trapped $^{38}Ar/^{36}Ar$. Data from our laboratory and literature. The distinction of three major soil groups is based on the inert-gas systematics as well as on the geochemistry of the soils. $^{32}Ne/^{20}Ne$ is correlated with FeO, i.e. soils richer in FeO have larger values than soils poorer in FeO, with the exception of 61221, which shows an unusually small ratio. We think that large $^{40}Ar/^{36}Ar$ ratios reflect primarily the presence of particles in the soil with surfaces that were exposed at the top of the regolith in the far distant past. More recent exposure leads to values of $\approx 1.0$ or less, both in fresh particles as well as in old particles that become re-exposed. Group II soils can be interpreted as mixtures of 61220-like material with group III soils; however, the former may also be a more mature version of 61220. Group I and II soils cannot become group III soils unless they are mixed with relatively FeO-rich material. All soils from the deep drill at Sta. 10 fall in group III, except for material at the base of the drill, 60001. Numbers in parentheses refer to the station where the sample was collected.
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