COMPOSITION AND MATURITY OF THE 60013/14 CORE; RANDY L. KOROTEV, Dept. of Earth & Planetary Sciences, Washington Univ., St. Louis, MO, RICHARD V. MORRIS, NASA Johnson Space Center, Houston, TX, and HOWARD V. LAUER, JR., Lockheed Engineering & Sciences Co., Houston, TX.

The 60013/14 double drive tube (62 cm deep) is one of three regolith cores taken 35-40 m apart in a triangular array on the Cayley plains at station 10' (LM/ALSEP), Apollo 16 (Fig. 1). This trio, which includes double drive tube 60009/10 (59 cm deep) and deep drill core 60001-7 (220 cm), is the only such array of cores returned from the Moon [1,2]. The top 45 cm of 60013/14 is mature (Fig. 2a), as is surface reference soil 60601 taken nearby. Maturity generally decreases with depth, with soil below 45 cm being submature. The zone of lowest maturity (34 ≤ L/FeO < 50) extends from 46 to 58 cm depth, and corresponds to the distinct region of light-colored soil observed during core processing [3]. In the other two cores, most of the compositional variation results from mixing between fine-grained, mature soil with 10-11 μg/g Sc and coarse-grained ferroan anorthosite consisting of >99% plagioclase with <0.5 μg/g Sc [1]. This is most evident in 60009/10 which contains a high abundance of plagioclase at about 54 cm depth (minimum Sc: 3-4 μg/g; Fig. 3); a similar zone occurs in 60001-7 at 17-22 cm (MPU-C [1]), although it is not as rich in plagioclase (minimum Sc: 6-7 μg/g). Compositional variations are less in 60013/14 than in the other two cores (range: 7.9-10.0 μg/g Sc; Figs. 4,5a), but are generally consistent with the "plagioclase dilution" effect seen in 60009/10, i.e., most 60013/14 samples plot along the mixing line of 60009/10 (Fig. 4). However, a plagioclase component is not the cause of the lower maturity and lighter color of the unit at 46-58 cm depth in 60013/14. Many of the samples in this zone (hollow symbols in figures) have distinctly lower Sm/Sc ratios than typical LM-area soils and plot off the mixing trend defined by 60009/10 (Figs. 4,5c). This requires a component with moderately high Sc, but low-Sm/Sc, such as feldspathic fragmental breccia (FFB) or granulitic breccia [4]. A component of Descartes regolith, such as occurs at North Ray crater (NRC) and which is rich in FFB, could account for the composition of these soils (i.e., a 3:1 mixture of 60601 and NRC soil; Fig. 3). It seems unlikely that NRC ejecta would occur half a meter deep at the LM station [5], thus this low-Sm/Sc component may result from an older, local crater that penetrated the Cayley surface layer and excavated underlying Descartes material, as did North Ray crater. There is no evidence for such a unit or component in the other two cores. Soil below the light-colored unit (58-62 cm) has 'typical' Sm/Sc ratios, but the lowest absolute Sc concentrations (Figs. 4,5), i.e., it is compositionally equivalent to a mixture of surface soil and plagioclase such as that in ferroan anorthosite. This is the only soil that might be related to the plagioclase-rich units in the other two cores. Except for the mature soil at the top of each core and, perhaps, the plagioclase-rich layers, there is little compositional evidence for any common unit among the three cores. Soil corresponding to the mare-glass-bearing unit (MPU-B) and regolith-breccia-bearing unit (MPU-A) of 60001-7 do not occur in 60013/14 or 60009/10 [1].

Metal nuggets. Concentrations of metallic iron (Fe⁰) are highly correlated with those of Ni (R² = 0.983) because Fe-Ni metal containing about 6% Ni is the major carrier of both constituents in samples with high metal concentration (Fig. 2) [1]. Some samples (50-60 mg each) contain 'nuggets' of metal grains, leading to anomalously high concentrations of Fe⁰, Ni, and FeO (total Fe as FeO). With 6.4% Fe⁰ and 4740 μg/g Ni, the sample at 35 cm depth has the greatest concentration of metal we have observed in more than 1000 lunar soil samples (i.e., a 4-mg nugget). In Apollo 16 soils, Ni, Ir, and Au are carried subequally by a chondritic micrometeorite component and by the Fe-Ni metal, which derives from ancient impact-melt breccias that are a major constituent of the soil. The Ir/Ni ratio of the metal is low compared to chondritic meteorites [6]. Thus, most soil samples have Ir/Ni ratios intermediate to those of the metal and chondrites, and samples with high Fe⁰ and Ni concentrations (Figs. 2c,d) typically have anomalously low Ir/Ni ratios (Fig. 5d). The Ni-rich sample at 4 cm depth has approximately chondritic Ir/Ni (Fig. 5d) and Co/Ni (not shown) ratios, thus this sample probably contains a fragment of metal from an ordinary chondrite.

Iron micrometeorite. The sample at 2.0-2.5 cm depth (split of 60014,19) is highly unusual in having 427 ng/g Ir, but normal concentrations of Fe, Ni, Co, and Au. This leads to an exceedingly high chondrite-normalized Ir/Ni ratio of 17 (Fig. 5d). The cause of this anomaly is an iron micrometeorite containing 148 μg/g Ir which is discussed more fully in a companion abstract [7].

Fig. 3

L$_x$/FeO
FeO (%)
Fe$^0$ (%)
Ni (µg/g)

Sc (µg/g)
Sm (µg/g)
Sm/Sc
Ir/Ni (CI-normalized)

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