MARE BASALT LAYERS IN THE LOWER HALF OF THE APOLLO 16, STATION 4 DOUBLE DRIVE TUBE (64001). Randy L. Korotev, Department of Earth and Planetary Sciences and the McDonnell Center for the Space Sciences, Washington University, St. Louis, Missouri 63130.

Core 64001/2 penetrated to a depth of 60 cm on the flank of Stone Mountain, Station 4, Apollo 16. The pre-mission intent was that this core might supply the best sample of Descartes material [6]. Although data on the upper half of the core (64002) are available [2,4,5,8] the only data on the lower section (64001) are the processor's report [7] and a preliminary petrographic report [1].

Sample description and experimental. A sample from each of the 68 half-centimeter intervals of 64001 was analyzed by INAA. The subsamples, 64001,300 (26.4-27.0 cm depth) through 64001,367 (60.0-60.5 cm depth), ranged in mass from 19 to 30 mg and are the same splits allocated to R.V. Morris for FMR analysis. Results for La, Sm, Fe, and Sc are plotted in Fig. 1.

Comparison to 64002 and station 4 surface soils. On the average, 64001 lies within the compositional range established by 64002 and the four station 4 surface soils. Concentrations of Fe, Sc, and Cr as well as LIL elements average on the high side of that range (e.g., Th ranges from 2.0-2.5 ppm). Concentrations of meteorite related elements (Co, Ni, Ir, Au) are typical of mature soils. None of the 68 subsamples from 64001 is as poor in Fe, Sc, and Cr as 64501 and the submature interval of 64002 (14-19 cm [4,5]). A corrolary (without benefit of Al data) is that no 64001 sample is as normatively anorthositic as these Fe-poor, station 4 soils. Except for the subsamples containing a mare basalt component, none of the 64001 samples is significantly more mafic than 64811 and some 64002 samples.

Internal variation of REE. Except for one subsample (325 at 39.25 cm) which is anomalously enriched in LIL elements, REE concentrations are, to a first approximation, uniform through the length of the section. The relative standard deviation for, e.g., La in the remaining 67 samples is only 4.9% (compared with <1% analytical precision). There is a very slight and apparently linear trend of decreasing REE concentration with depth. A least-squares line through the La points of Fig. 1 (except split 325) indicates a 4.2% decrease in La concentration from top to bottom of 64001. This is equivalent to a decrease in KREEP component from 12.0 to 11.5%. However, this trend does not continue to the surface because 4 of the 10 samples analyzed from 64002 have La concentrations lower than any of the sixty-eight 64001 samples [4].

At several intervals throughout the core regular increases and decreases in REE concentrations occur over 2-3 cm (e.g., decreases from 26-29 cm, 40-42 cm, 51-53 cm, and increases from 43-45 cm, 55-57 cm). Some of this fine structure is reflected in the data for other elements (e.g., Sc). These appear to be short-range mixing features between soils with similar but slightly different compositions. Some inflections correspond to lithographic boundaries observed by [7].

One sample (39.25 cm) is anomalously enriched in REE by about 60%. This corresponds to an 18% KREEP component instead of the typical 12%. This could be due to a single KREEP-rich particle in the 20 mg sample (i.e., a 1.2 mg particle of pure KREEP) and thus be a simple sampling problem. Fe, Sc, and Cr concentrations are also anomalously high in this interval (Fig. 1). However, REE concentrations are also somewhat enriched in the two adjacent intervals and decrease fairly regularly for 3 cm below the anomalous sample. Hence, this sample may represent a thin depositional layer of fine-grained, LIL-element rich material which has mixed with the underlying soil. Alternatively, it may contain a large component of comminution products of a small, nearby melt rock (the core was taken on a 10-15° slope). For the elements determined, the composition of the anomalous sample is more similar to VHA-type melt rocks than are other station 4 soils and is particularly similar to 64455.

Chemical correlation with depositional units. Nagle [7] observed four lithologic boundaries in 64001. No chemical changes are evident at the 35 cm boundary at which a "change in grain size, mineralogy, X-radiograph texture, and a concentration of unfragmented aggregates" was observed. Similar changes were observed at 50 and 58 cm. The only chemical changes correlating with these boundaries are a possible discontinuity in the locally decreasing trend in La concentration with depth and a distinct discontinuity in the concentrations of Sc (Fig. 1) and Cr (not shown) at 50 cm. Below 50 cm Sc concentrations average about 10% lower than typical values above this depth. This discontinuity is also slightly discernible in the Fe data. The decrease in Fe concentration below 50 cm is probably accompanied by a corresponding increase in Al concentration.

Mare basalts. At 42 cm Nagle [7] identified a lithologic boundary which had "...a number of unusual rock fragments. Most abundant are clods, rich in black droplets, with substantial orange glass" and speculated that this might represent a layer of mare material. This boundary corresponds to the most substantially irregular chemical feature in the lower half of the core. In sample 332 (42.75 cm) Sc, Cr, and Fe concentrations are 75, 22, and 22% enriched over mean values for the rest of the core. The two splits above 332 are also significantly, but less severely, enriched in Fe, Sc, and Cr. Split 332 also corresponds to a local minimum in La concentration. Significantly, relative REE abundances are slightly depleted in light REE for this split compared to values for the core average. These data are most consistent with a high-Ti mare basalt component with low absolute concentrations of REE. Among returned mare basalt types the Apollo 17 high-Ti basalts are the most likely candidates. A 10% component of Apollo 17 high-Ti basalt accounts well for the concentrations of Fe, Sc, Cr, and REE in split 332. This is a far greater component of mare basalt than in any other Apollo 16 mixed sample. The sample analyzed is fines material with no "black droplets" or other obvious mare material visible to the unaided eye. Presumably the coarser material described by Nagle [7] contains a greater proportion of mare material. Although it does not correspond to any feature reported by Nagle, split 309 (31.25 cm)

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MARE BASALT IN 64001

Korotev, R.L.

s also enriched in Fe, Sc, Al, Cr and has a slight relative depletion in light REE. So at least two layers of mare material occur in 64001.

Other anomalies. Concentrations of elements associated with meteorites (Ni, Co, Ir, Au) vary considerably but unsystematically in the core. The highest concentrations are found in splits 304, 317, 327, 352, 361, 362, and 366. These also have excess Fe with respect to Sc and Cr. Split 334 has an anomalously high Cr/Fe ratio. This is probably a result of stainless steel contamination and has been observed in other core samples [4]. Splits 336 and 341 may also be similarly but less extremely contaminated.

Cayley-Descartes. The 64001/2 drive tube did not sample Descartes material in the manner anticipated [e.g., 6]. Although the core undoubtedly contains some Descartes material (principally, the submature unit of 64002 [2,5]), material from most of the core is near the mafic-rich, anorthosite-poor, LIL-element rich extreme of the compositional range for Apollo 16 soils. The core is, consequently, more similar in composition to soils associated with the Cayley formation (LM area and stations 5 and 6 [3,4]) than to the North Ray Crater soils which presumably contain a significant component of Descartes material [6,9]. It is likely that the anorthositic unit from the bottom of the 60009 drive tube taken at the LM area is more nearly of Descartes origin than the 64001/2 material.

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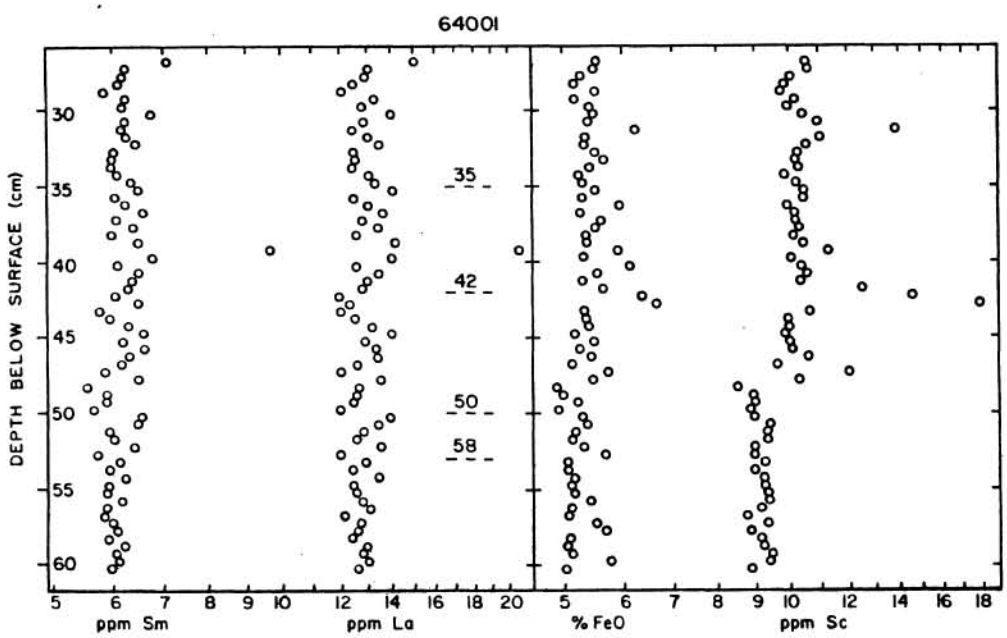
Fig. 1. Concentrations of La, Sm, Fe, and Sc as a function of depth in 64001 (logrithmic axis). Dashed lines are lithologic boundaries of [7].



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