FeO AND SURFACE EXPOSURE (MATURITY) DEPTH PROFILES FOR THE APOLLO 11 CORES 10004 and 10005 AND THE APOLLO 14 CORES 14211 AND 14230. Richard V. Morris[1] and H.V. Lauer, Jr.[2] ([1]NASA-JSC, Houston, TX; [2]LEC, Houston, TX.)

INTRODUCTION

We have determined values of FeO and the surface exposure (maturity) index I_s/FeO (1,2) for virtually every dissection interval (usually 0.5 cm) of the Apollo 11 cores 10004 and 10005 and the Apollo 14 cores 14211 and 14230. The depth profiles of FeO and I_s/FeO provide high depth resolution characterization of the vertical variations of composition (as indicated by the major element FeO) and relative duration of surface exposure of soil in the cores. Aside from this basic characterization, the depth profiles serve as a data base for the development and the constraint of models of lunar regolith dynamics, such as in situ reworking (gardening) of the lunar regolith (3).

The experimental procedures are described by (1,4). In addition, we now further process the FeO and I_s/FeO data by performing a three point sliding average on each of them as a function of depth. That is, each final value of FeO and I_s/FeO for a given depth is the average value of the primary values of FeO and I_s/FeO at that depth and the corresponding ones from the contiguous deeper and shallower depths. This procedure was adopted primarily to minimize artificial variations due to our small sample size (~25 mg), but it also serves to reduce random errors in the experimental determinations.

APOLLO 11 CORES 10004 AND 10005

Sampling Site and Core Dissections

These two Apollo 11 cores were hammered into the lunar regolith ~4 m apart ~4 m NNW of the LM (5). Our samples came from the 1977 dissection of the cores, and that dissection and the one in 1969 are described by (6). (6) documents that there has been movement of soil in both cores since their collection on the lunar surface, and that this problem is especially severe for 10004 since the soil was loose inside the core tube. Thus, the lunar stratigraphy is probably not accurately represented by our suite of samples.

Discussion

The depth profiles of FeO and I_s/FeO for the 10004 and 10005 cores are shown in Figure 1. For comparison, FeO and I_s/FeO histograms for Apollo 11 surface/trench soils are also shown (data from (2)). The FeO concentrations in both cores are essentially constant, equal to each other, and comparable to other Apollo 11 surface/trench soils. The values of I_s/FeO indicate that the soil in both cores is submature to mature. A systematic decrease from about 80 to 40 units of I_s/FeO from the top to the bottom is observed in 10004. Using fewer samples, the same general trend was also observed by other indicators of surface exposure (e.g., 7). The systematic decrease in maturity is most likely the reason for the dark to light color gradient observed in the core during dissection (6). The soil at the bottom of 10004 has the least surface exposure (maturity) of Apollo 11 soils studied to date. The maturity of 10005 is relatively constant and ranges between ~58 and 70 units of I_s/FeO.

These cores are too short to infer in situ reworking depths as previously done for longer cores by (3); in any event, such an exercise is questionable considering the extra-lunar mixing these cores (especially 10004) have experienced. However, the systematic trend in maturity for 10004 does demonstrate

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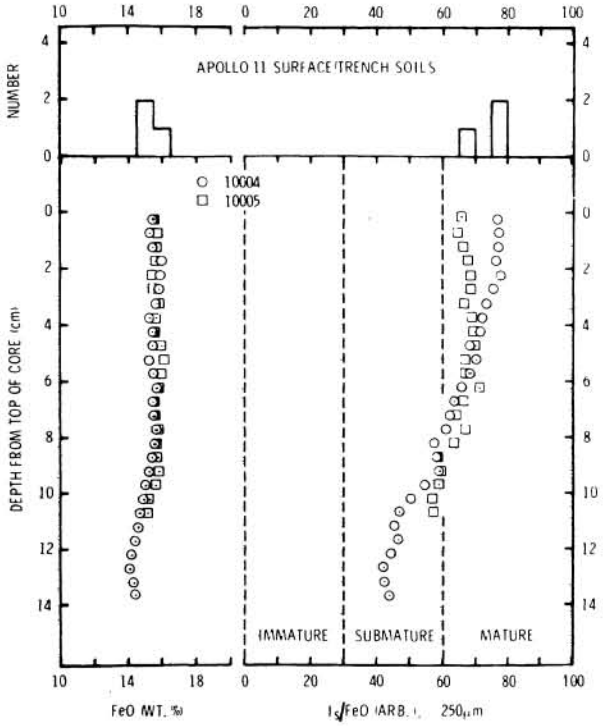

Fig. 1. FeO and I_S/FeO depth profiles for the Apollo 11 cores 10004 and 10005.

that even multiple inversions of a core tube with loose soil in it did not thoroughly homogenize the soil.

APOLLO 14 CORES 14211 AND 14230

Sampling Site and Core Dissections

The double drive tube core 14210/11 (14211 is the upper section) was pushed into the regolith at Station A. The core could not be completely inserted into the regolith so that only the lower 8 cm of 14211 was filled with soil (9). However, the soil was immobilized by the core plugs so that there was probably not much disturbance of soil in 14211 after sampling (9). Our 14211 samples came from the dissection described by (9); samples from 14210 are not yet available to us. The single drive tube core 14230 was pushed into the regolith at Station G (8). The soil was loose in the core tube (so there is extra-lunar mixing) and the core probably does not contain lunar-surface soil (10). Our samples came from the dissection described by (10).

Discussion

The depth profiles of FeO and I_S/FeO for 14211 and 14230 are shown in Figure 2. For comparison, FeO and I_S/FeO histograms for Apollo 14 surface/trench samples are also shown. The FeO concentration in both cores is very constant and typical of that for other Apollo 14 soils. The soil in 14211 is

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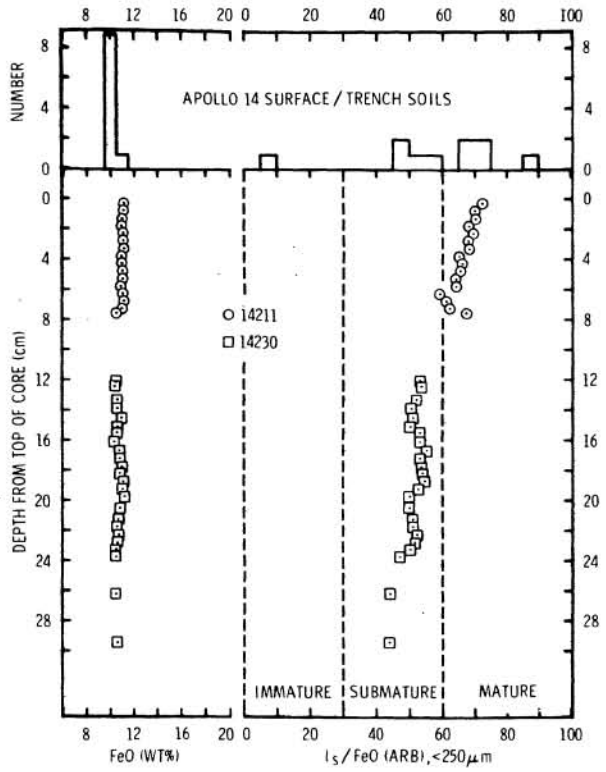

Fig. 2. FeO and I_s/FeO depth profiles for the Apollo 14 cores 14211 and 14230.

mature; the soil in 14230 is submature. We will defer further discussion of 14211 until we have collected data from the lower section 14210. The extent to which the depth profiles for 14230 reflect the extra-lunar mixing is indeterminate. The nearly-constant FeO and I_s/FeO depth profiles are necessary but not unique criteria for extra-lunar homogenization because lunar processes alone could have homogenized the soil.

References: (1) Morris (1976) PLSC7, p. 315; (2) Morris (1978) PLSC9, p. 2287; (3) Morris (1978) PLSC9, p. 1801; (4) Morris et al. (1978) PLSC9, p. 2033; (5) LSPET (1969) A11 PSR, p. 52; (6) Allton (1978) Core Cat. Suppl.; (7) Crozaz et al. (1970) PLSC1, p. 2051; (8) LSPET (1971) A14 PSR, p. 62; (9) Nagle (1979) Core Cat. Suppl.; (10) Duke and Nagle (1974) Lunar Core Cat.; JSC 09252.

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