ANALYSES OF MATERIALS FROM LUNAR HIGHLANDS, Philip A. Helmke, Larry A. Haskin, Jeffrey W. Jacobs, Douglas P. Blanchard, and Karen M. Telander, Department of Chemistry, University of Wisconsin-Madison, Madison, Wisconsin 53706.

We have analyzed 5 small fragments and a sample of <125 μm fines from the Luna-20 mission and 7, <1 mm fines samples (60601,9; 61221,12; 61241,14; 64501,11; 65701,18; 67601,15; 69941,25) and three rocks (67075,17; 65015,60; and 60335,35) from the Apollo 16 mission for REE and other trace elements. Concentrations of the REE in all 8 soils are lower than in soils from other missions. Negative Eu anomalies are present in all but 67075,17 and they are smaller than those found in previous missions. There is a general trend of mutual decrease of Sm concentrations, ratios of concentration of Sm to K_2O, and of Sm to Eu in these soils plus 7 others (1,2) which is strictly followed by all except 62281, 68501, and 61241.

Rock 65015,60 (monomict breccia produced from gabbroic anorthosite (3) has concentrations of REE and other trace elements that are characteristic of KREEP. Rock 67075,17 (anorthosite (3)) has low concentrations of REE (Sm = 0.12 ppm) and a positive Eu anomaly (Eu = 0.68 ppm). Rock 60335,35 (troctolite ?(3)) has intermediate REE concentrations and a negative Eu anomaly.

The presence of materials such as rock 65015,60 and 60315 and 62235 (4) suggests that a KREEP component may be responsible for the trends described above for the Apollo 16 soils.

The rock fragments from Luna 20 include two feldspar-rich pieces (22006,2 and 22008,1) with low REE concentrations and positive Eu anomalies (Sm = 0.68 and 0.93 ppm; Eu = 0.86 and 0.76 ppm), two breccias (22004,2; 22005,1) with concentrations similar to that of the soil (22001,7), and a breccia (22007,2) with concentrations intermediate between those of the soil and KREEP. The extent to which accurately measured concentrations for ~1 mg fragments represent larger rocks or rock formations is not known. The data correlate well, however, with those obtained on other small fragments from the Luna-20 core (2,5). Also, we have analyzed 4 small chips from rock 65015,60 and have found a spread of only ±10% from the value obtained for a portion of powder prepared from a 0.5 gm chip. The data for the feldspar-rich rocks are comparable to those obtained for anorthosite 15415 (6) and metamorphosed anorthositic gabbro 15418 (1). We tentatively conclude that analyses of small fragments provide representative data for at least certain types of highland rocks.

We have examined a number of mare materials and highland materials that are complementary in the sense that they can be combined to provide a REE distribution that has the same concentration ratio of Sm to Eu as do chondritic meteorites. Typical highland anorthositic rocks (Sm ~Eu ~ 0.77 ppm) as well as 15415 can be readily combined with the mare basalts to provide the chondritic concentration ratio of Sm to Eu. As observed previously (7), the concentrations of Sm and Eu in the resulting mixtures are constant and nearly 15 times those of chondrites for basalts of all Apollo missions. This constancy disappears when anorthosites with greater

concentrations of the REE such as those in 14313 and 14063 (7) are used.

One soil (67075,17) from North Ray crater has a small positive Eu anomaly. If the concentration ratio of Sm to Eu in the lunar crust equals that in chondrites, then soils with positive Eu anomalies are to be expected, if soils represent the presumed Eu-rich anorthositic crust. That all but one soil from the Apollo 16 and Luna 20 missions have negative Eu anomalies may be an artifact of their proximity to maria, so that soils nearest the surface in these highland areas are sufficiently "contaminated" with KREEP-like materials that they have, overall, negative Eu anomalies. It is interesting to note that the one soil (67075,17) with the positive Eu anomaly has the lowest REE concentrations of all of the highland soils yet examined, and was apparently excavated from approximately 200 m depth when North Ray crater was formed (8).

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