COMPOSITIONAL SURVEY OF PARTICLES FROM THE LUNA 16 REGOLITH

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Five 0.9-3.2 mg particles from Luna 16 sample 21036,7 (parent: ,2), which are described as "coarser-grained crystalline rocks" [1], and a 3.2 mg sample of bulk soil (21036,10; <0.5 mm grain size) have been analyzed by instrumental neutron activation analysis. Three of the particles have compositions of mare basalts and the other two appear to be of highlands origin. Chondrite-normalized concentrations of the rare-earth elements (REE) of the six samples are shown in Fig. 1.

Particles B and C have similar concentrations of elements associated with major mineral phases, but their concentrations of incompatible trace elements differ by a factor of three. The relatively low concentrations of FeO (5.6 and 4.9%) and Sc (9.7 and 8.3 ppm) and the enrichment in light REE (Fig. 1) suggest that the particles are of highlands origin or, if they are breccias, have a major component of nonmare material. These are the only two of the five particles for which Ni was detected (120 and 240 ppm, compared with 240 ppm in the soil). Particle C is similar in composition to Luna 16 sample 21013,49b, which has 27% Al_2O_3 and is similar in composition to lunar meteorite ALHA81005 [2].

Particle A is the largest particle (3.15 mg) and appears both macroscopically and compositionally to be a mare basalt. It is coarser-grained than the other two basalt fragments. The FeO concentration is 19.4% and Sc and Cr concentrations are 63 and 3000 ppm. The REE pattern is relatively flat with a moderate negative Eu anomaly (Fig. 1). Compositionally, this particle is similar to Apollo 12 pigeonite basalts; however precise comparisons cannot be made at present because data have not yet been obtained for some key elements.

Particles D and E are very similar in composition, particularly the concentrations of incompatible trace elements. Visually, they are very dark and are finer grained than particle A. Compositionally, they are similar to samples of Luna 16 basalts previously reported, e.g., sample G-27 of [3], sample C-29 of [4], the three samples of [5], and probably the large sample B-1 of [6]. Concentrations of FeO (18.3 and 19.9%), Sc (70 and 62 ppm), Cr (2000 and 1600 ppm), and Co (17 and 20 ppm) are typical of mare basalts from other sites. As noted by [5], the heavy REE are relatively depleted compared to other mare basalts. Na_2O concentrations (0.56 and 0.61%) are at the high end of the range observed for mare basalts and, as has been noted for other samples of Luna 16 basalt [3,6], concentrations of Sr (~500 ppm) and Eu (3.5 and 3.9 ppm) are exceptionally high. The Eu concentration in these basalts, approximately 50 times the chondritic concentration (Fig. 1), is at the high end of the range observed even for samples with KREEP compositions. Among lunar rock types, only alkali anorthosites have greater Eu concentrations.

Na, Sr, and Eu each concentrate in plagioclase. Luna 16 basalts are aluminous (13-20% Al_2O_3 [5,6,7,8]) and generally contain more plagioclase than other mare basalt types, suggesting that the enrichment in these elements relates to the modal mineralogy [e.g., 3]. However, Albee et al. [6] show that the Sr enrichment results principally from plagioclase rich in Sr, not from an excess of plagioclase; this probably also accounts for the enrichment in Eu and possibly Na. The composition of plagioclase in Luna 16 basalts ranges to more albitic (An_{76}) than that from most other types of mare basalt [8 & 9 (fig. 1.2.9.21)]. These observations suggest that Luna 16 basalts derive from a plagioclase-bearing source and that the amount of melting was not so extensive as to dilute the enrichment of the early melt in Na, Sr, and Eu.

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Figure 1. Chondrite-normalized REE concentrations in subsamples of 21036.