PETROLOGY AND GEOCHEMISTRY OF LUNAR CRUSTAL ROCKS, M. J. Drake, Univ. of Arizona, Tucson, Az. 85721, G. J. Taylor, Washington Univ., St. Louis, Mo. 63130, and G. G. Goles, Univ. of Oregon, Eugene, Ore. 97403.

The geochemistry of petrologically-characterized lithic fragments from the Apollo 16 landing site is discussed. The data are used to investigate the provenance of the Cayley Formation and the initial REE concentrations in liquids in equilibrium with lunar anorthosites.

Few (if any) of the lithic fragments sampled exhibit primary textures. Most fragments are breccias which have experienced various degrees of recrystallization while a few have been completely remelted. The assumption implicit to the following discussion is that during brecciation and recrystallization or remelting, the bulk compositions of the particles have not been significantly altered. Hence, from a study of these particles, meaningful generalizations may be drawn concerning the composition and evolution of the lunar crust.

Lithic fragments in the size range 2-4mm from soil samples 60053, 61283 60503, 68823, and 68843 may be divided petrologically into four groups: the ANT suite; poikiloblastic rocks; (spinel)-troctolites; and K, SiO_2-rich mesostasis-bearing rocks. This fourth category is frequently indistinguishable petrologically from ANTrocks except for the presence of mesostasis. No light-matrix breccias were observed.

REE concentrations in ANT rocks are shown in Fig. 1. All samples display positive Eu anomalies. For Sm, enrichments relative to chondrites range from 0.2 to ~ 0.5 for essentially pure anorthosites (96-100% plagioclase) to ~ 10 for an anorthositic norite (68% plagioclase). REE concentrations in poikiloblastic rocks are shown in Fig. 2. All samples display negative Eu anomalies and enrichments of Sm relative to chondrites ranging from 50-160. None of the (spinel)-troctolites display a cumulate texture, but rather a variety of textures ranging from recrystallized breccias to diabasic is observed. All are characterized by the presence of plagioclase, olivine, usually (MgAl)-rich spinel, and SiO_2 - poor mesostasis. REE concentrations are shown in Fig. 3. Enrichments in Sm relative to chondrites range from 7 to 115. Most samples display negative Eu anomalies although one sample displays a positive Eu anomaly. REE concentrations in the K, SiO_2-rich mesostasis-bearing rocks are shown in Fig. 4. All samples except one show negative Eu anomalies and Sm enrichments relative to chondrites of 25-70. The exception displays a positive Eu anomaly and Sm is 10x chondrites. The REE concentrations in these samples, and also in the poikiloblastic rocks, are directly related to the amount of residual phases (K-rich mesostasis, phosphates etc.).

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Chao et al. have suggested that the Cayley Formation is Orientale ejecta. Our data, although not compelling, argue against such an origin. A census of 1 - 2mm lithic fragments in Apollo 16 soil samples (Taylor et al., 1973) suggests that ANT rocks are most abundant in our best sample of the Descartes Highlands (see also Aitken et al., 1973) while poikiloblastic rocks are most abundant in our best sample of the Cayley Plains (see also Bence et al., 1973). The data in Fig. 2 suggest intermediate to high LIL-element concentrations for the Cayley Plains materials. Yet the orbital γ -ray experiments (Metzger et al., 1973) indicate very low activity and hence low LIL-element concentrations in the Orientale basin. In view of this it is considered unlikely that the Cayley Plain material is Orientale ejecta and a more local source is implied. Oberdeck et al. (1973) reach the same conclusion by different reasoning.

ANT rocks 20, 8, 13, and 7 are essentially pure plagioclase anorthosites. Calculations of REE concentrations in model liquids in equilibrium with these anorthosites may be performed using the experimental Eu distribution coefficient data of Weill and Drake (1973). Assuming these liquids did not have an initial Eu anomaly, initial REE concentrations of 5-8x chondrites are indicated.

References: Aitken et al. (1973) EOS 54, 1130; Bence et al. (1973) Lunar Science IV, 60; Chao et al. (1973) Lunar Science IV, 127; Metzger et al. (1973) Science 179, 800; Oberdeck et al. (1973) NASA TM X-62, 302; Taylor et al. (1973) Proc. 4th Lunar Sci. Conf. (in press); Weill and Drake (1973) Science 180, 1059.

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Figure Captions:

REE/chondrites in different types of crustal rocks. Numbers refer to individual particles, those in parenthesis not plotted to avoid cluttering the diagram.

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Fig. 1

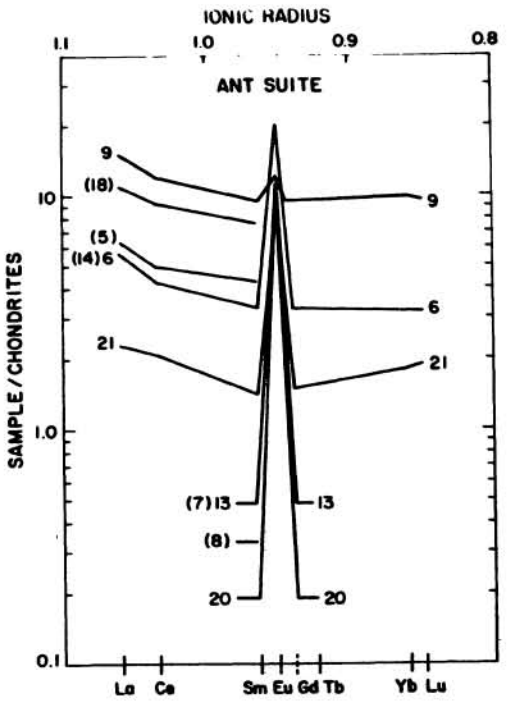

Fig. 2

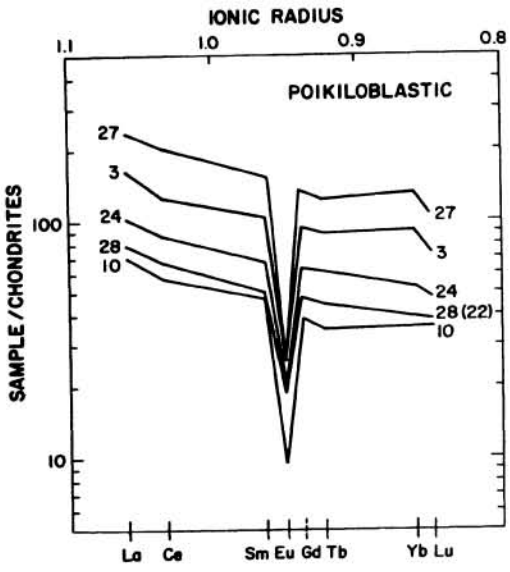

Fig. 3

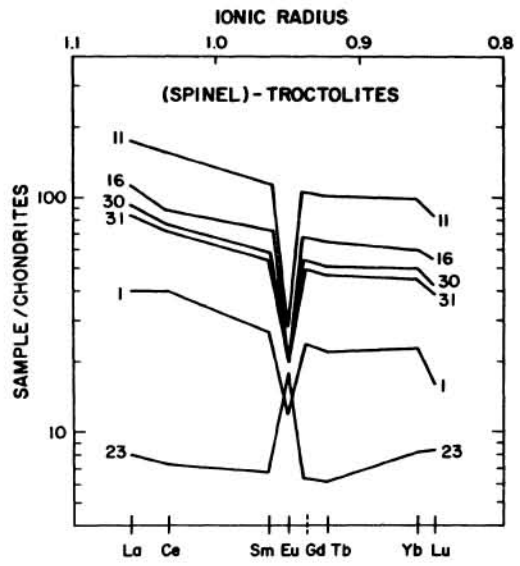

Fig. 4