PROBLEMS INHERENT IN THE STUDY OF LUNAR HIGHLAND SAMPLES: THE "TYPICAL CASE" AT
APOLLO 14

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The lunar highland areas are considered to be plagioclase floatation cumulates from a "magma ocean" which formed early in lunar history (e.g., [1,2]). These highlands contain the oldest rocks found on the Moon (e.g., [3]). Three broad suites of these highland rocks have been defined: 1) Ferroan Anorthosites (FANs); 2) Mg-Suite; and 3) Alkali Suite (e.g., [4-6]).

The lunar highlands have suffered much reworking and brecciation through meteorite bombardment. This bombardment presents the lunar petrologist with perhaps an insurmountable challenge - that of determining if highland samples are pristine, and if so, are they monomict? In this paper, pristine is used to define a sample free of meteorite contamination, and monomict to describe a sample comprised of only one lithological component. We present whole-rock and mineral data from 21 highland samples from the Apollo 14 site which highlight these problems. All samples were taken as clasts from polymict breccias 14303, 14304, 14305, and 14321. Generally, all have granulated textures, or thin sections are comprised of many individual grains due to disaggregation of the clast upon extraction. Also, much of the feldspar has been maskelynitized. In the following discussion, sample numbers in parentheses represent the INA sample, and the first number is that of the thin section. Where only one number is used, it is that of the INA sample.

CLASSIFICATION OF THE APOLLO 14 HIGHLAND SAMPLES - The mineralogy (Table 1) allows the clasts to be classified as FAN, Mg-Anorthosite, or Alkali Anorthosite. Two clasts are part of the FAN suite [14303,171(170) and 14305,490(490)], and the rest fall within the field of the Mg-Suite (Fig. 1). The modal mineralogy (Table 1) was calculated from mineral chemistry and major-element whole-rock data (Table 2). This approach defined 4 dunites, 1 olivine pyroxenite, 3 troctolites, 5 norites, and 8 anorthosites. Two clasts (14305,451 and 14305,539) have no companion thin section and were defined as anorthosites on the basis of whole-rock chemistry.

PROBLEMS OF PETROGENETIC INTERPRETATION - The different rock-types display a wide range ofREE compositions (Fig. 2). The dunites should theoretically contain low REE abundances, according to experimentally determined Kd data [7,8]. However, these dunites contain La up to 20 x chondritic abundances (Fig. 2a). Also, the anorthosites show a wide range of La abundances, from 12 to 90 x chondritic. These anorthosites with the highest REE abundances exhibit a marked decrease in the size of the positive Eu anomaly (14304,490,14304,171, and the rest fall in the negative Eu anomaly suite). The positive Eu anomaly of the most differentiated dunite in our study is included in our study as an FAN sample [14305,489(489)]. The variation in the dunite is core-to-rim, but in the norite it is intergrain. Furthermore, the major-element whole-rock chemistry (Table 2) could not be reconstructed using the observed mineral compositions. This suggests different component(s) have been included in the INA sample of this clast or not all components are present in the thin section. The major element chemistry of troctolite 14305,538(538) also could not be reconstructed from mineral analyses, and this sample also contains a brown impact glass. Furthermore, if pigeonite is used to plot this sample on Fig. 1, it falls in the alkali anorthosite field; if olivine is used, it plots in the Mg-Anorthosite field. These observations, with the brecciated nature of these samples, suggest that norite 14304,490(489) and troctolite 14305,538(538) are polymict samples. The remaining clasts exhibit relatively homogeneous mineral chemistries (Table 1) and all whole-rock major-element data can be reconstructed using the analyzed mineral compositions. Therefore, we suggest that while these samples may not be strictly pristine, they are essentially monomict in that they contain only one lunar lithology. If the whole-rock major-element data could be reconstructed, yet there was inter-grain heterogeneity, such a statement could not be made.

Another problem in the study of these Apollo 14 clasts is that of sample size. The INA sample weights range from 10 to 106 mg, and as the highland samples are coarse-grained cumulates, the problem of representative sampling is a major consideration. It is this which must be demonstrated that these clasts do not represent mixtures of two (or more) lunar lithologies. If these clasts are mixtures, then any claim to re-equilibration. A range of mineral compositions is observed in two samples: dunite 14305,489(489) has a range be-