APOLLO 16 1-2MM FINES, SAMPLE 65702, CHEMICAL AND PETROGRAPHIC CORRELATIONS; Arch M. Reid, NASA Johnson Space Center, Houston, TX 77058, C. Donaldson and P. Jakeš, Lunar Science Institute, Houston, TX 77058, and R. W. Brown, Lockheed Electronics, Houston, TX 77058.

Sample 65702 is the 1-2 mm fraction of the rake soil collected by the Apollo 16 astronauts at Station 5 on Stone Mountain. Haskin et al. (1) reported on neutron activation analysis for selected particles from this soil. Thin sections of the 20 particles described by Haskin et al. (1) have been studied petrographically and by electron microprobe techniques to examine the relationship between petrography and composition in these fragments.

The particles are aluminous microbreccias, with matrices showing different degrees of recrystallization, with the exception of one particle (5B, see reference 1) that has a quenched texture and has formed from a melt. Defocussed beam electron microprobe analyses of the particles show that they encompass a range of compositions comparable to that shown by the Apollo 16 rocks. (Major element analyses are not reported because of the inherent large errors in this technique.) If the particles are arranged in order of decreasing abundance of trivalent rare earth elements (1), the decrease can be correlated to a decrease in Sm/Eu ratio, an increase in Al, and a decrease in Cr, with little change in the Mg/Fe ratio of the mafic silicates or in the composition of the abundant plagioclase. The particles can also be grouped for petrographic similarity and the petrographic groups can be correlated with the compositional characteristics. The major petrographic types are (1) poikilitic breccias, (2) low grade polymict breccias with abundant glass (either vesicular or non-vesicular) and (3) brecciated anorthosites. Arranged in this order the three groups have progressively higher Al contents and lower REE abundances.

1. Poikilitic breccias (2B, 7C, 7B, 2A, 7A, 6C) have poikilitic (or poikiloblastic) pyroxenes, that are orthopyroxene, pigeonite or augite, enclosing clasts of calcic plagioclase or less commonly olivine. Opaque phases are ilmenite (MgO 6 wt. percent), armalcolite (MgO 8) and metallic iron (Ni 5, Co .6). These particles have similar bulk compositions with estimated 17-21 percent Al_2O_3 and Mg/Mg+Fe $\sim$.7. The major element composition is like that of low or medium K Fra Mauro basalt (2,3). The REE patterns closely resemble the Apollo 16 KREEP of Hubbard et al. (4), a group of Apollo 16 rocks that are also poikilitic. These samples form a well-defined textural and compositional grouping (as noted for the larger rocks by Simonds et al. (5). Particle 6C is an exception having much higher Al and lower REE. The clasts in 6C are mostly feldspar glass, suggesting either rapid cooling, or partial recrystallization of a glassy breccia, or shock induced transformation of feldspar clasts to plagioclase glass.

The correlation between texture and major and trace element composition in this group cannot be coincidental. Simonds et al. (6) suggest that this composition is produced by partial melting of a more aluminous parent during an impact event and that the poikilitic pyroxenes crystallize from an impact-generated melt. The texture may equally well represent the response of a pre-existing rock type to later heating in an impact-metamorphic event.

2. Low grade polymict breccias (vesicular 1C, 1A, 6D: non-vesicular 4A,

APOLLO 16 1-2MM FINES, SAMPLE 65702

Reid, A. M. et al.

2C, 8A) have abundant glass either as clasts and/or in the matrix and also rock and mineral fragments. They are typical agglutinates. Glasses are varied in composition (1A has glasses with 5, 11, 20, 24 and 33 wt. percent Al_2O_3) commonly with high alumina contents, and many contain abundant mineral debris. The pyroxenes present are orthopyroxenes and pigeonites (Mg/Mg+Fe $\sim$.8), feldspars are calcic plagioclases (An_{90-97}) and the dominant opaque minerals are ilmenite (MgO 4 wt. percent) and metallic iron (Ni 5-6, Co .5-.6).

The agglutinates appear to have formed by impact melting and sintering of the lunar soil. They are aluminous with approximately 19-26 wt. percent Al_2O_3 and Mg/Mg+Fe ratios similar to the poikilitic breccias. The more vesicular samples tend to be less aluminous with higher REE concentrations and REE patterns resembling those of the VHA basalts of Hubbard et al. (7). The agglutinates can be subdivided chemically into two groups that correspond with the petrographic subdivision into vesicular and non-vesicular types. These may derive from soils with differing compositions and gas contents.

3. Brecciated anorthosite particles (5A, 5C, 3A, 6A) are microbreccias consisting predominantly of calcic plagioclase both as clasts and in the matrix. The rocks are cataclastic anorthosites that vary in feldspar content and in the extent to which the matrix has recrystallized. Sample 3A, a single plagioclase grain, is grouped here as well as 6A, a highly aluminous fragment that apparently was totally melted and then crystallized to a plagioclase-microcrystalline matrix assemblage. The anorthositic particles have 26-36 Al_2O_3, low REE contents and postive Eu anomalies. Feldspar are calcic plagioclases (An_{95-97}) like sample 3A.

Sample 5B is unique as it has the texture of a quenched melt with elongate, feathery olivine and pyroxene, acicular plagioclase and irregular patches of fine grained mesostasis. Euhedral colorless spinel octahedra are abundant and were the earliest phase to crystallize. The spinels have 70 wt. percent MgO, 26 Al_2O_3, 2.5 FeO and 1.5 Cr_2O_3, corresponding to a spinel with 94 mol. percent $MgAl_2O_4$. Sample 5B is a quenched spinel troctolite, that is rich in both Mg and Al with a very high Mg/Fe ratio and a nearly flat chondrite-normalized REE pattern about 10 times chondritic. Liquids of this composition evidently existed in the highlands either as impact melts of cumulates or as primitive liquids.

These 1-2 mm fragments are of three major types: 1) the poikilitic rocks that resemble KREEP basalts in composition but with lower REE; 2) the agglutinates and low grade breccias formed from polymict soils; and 3) the microbreccias from highly feldspathic highland rocks equivalent to gabbroic anorthosite or anorthosite. Some tentative conclusions can be drawn. 1. The chemical and petrographic characteristics of some highland rocks persist into these small particles. 2. There is a chemically and petrographically distinct group of rocks that have KREEP-like compositions but with lower K and REE abundances. 3. There is a distinct group of highly aluminous 'anorthositic' rocks. 4. Primary highland rocks with Al contents that are intermediate between these two groups will be very difficult to recognize because mixing can produce particles with intermediate chemical characteristics. 5. There is some evidence for high Mg, high Al liquids in the highlands. 6.

APOLLO 16 1-2MM FINES, SAMPLE 65702

Reid, A. M. et al.

Despite the wide spectrum of compositions, the particles all have similar Eu contents. This is consistent with derivation from a suite of highland rocks with a limited range of major element compositions, that are related in part by mixing, but fundamentally by crystal-liquid fractionation involving feldspar, provided the Eu partition coefficient for feldspar-liquid is near unity. This condition implies a rather limited range of redox states as the partition coefficient is known to be sensitive to oxygen fugacity (8,9). 7. If these samples approximate the range of compositions in the lunar crust then the Eu abundance in the crust is approximately 10 times chondritic and the highlands rocks in general are enriched in REE over chondritic values.

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