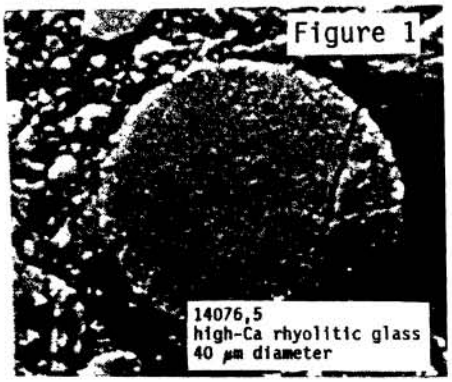
GLASSES AND A "HASP"-MIMICKING MINERAL OR MINERAL INTERGROWTH IN APOLLO 14 REGOLITH BRECCIAS; D. Vaniman[1], G. Heiken[1], P. Warren[2], and E. Jerde[2]. [1]Earth and Space Sciences, MS D462, Los Alamos, NM 87545; [2]Institute of Geophysics, University of California, Los Angeles, CA 90024

Three samples within a suite of 29 Apollo 14 regolith breccias are petrographically unique. These unique samples are represented by polished thin sections 14004,77 (=rock chip 14004,55), 14315,26 (=rock chip 14315,24), and 14076,5 (=rock chip 14076,1). Because the 14076 sample contains no agglutinate fragments and has very low I_s/FeO [1], it lacks some of the characteristics typical of many regolith breccias. However, the preservation of some rhyolitic glass spherules (Figure 1) among otherwise angular fragments in a porous matrix indicates that this sample is a regolith breccia. All three of the unique breccias deviate from the typical Apollo 14 Fra-Mauro soil and regolith breccia [1,2] composition; the major petrographic discriminant for these odd samples (aside from the "chondrules" in 14315) is glass compositional distributions that differ from the typical distribution in the other regolith breccias.

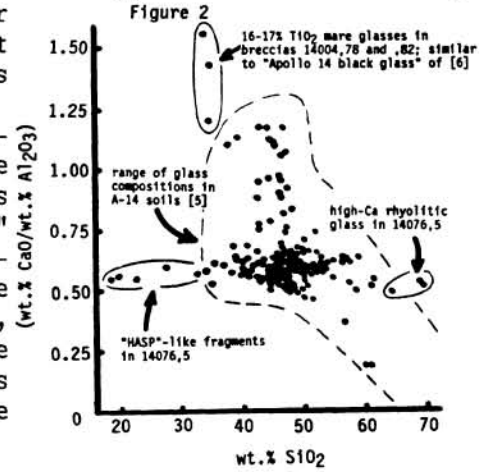


The results of 250 glass analyses are summarized in Table 1, where the distribution of glass types in the 26 "typical" Apollo 14 regolith breccias are contrasted with these three odd breccias. The distributions of glass compositions correspond with the bulk compositions of specific samples. The more aluminous composition [2] of 14315,26 is reflected in its abundance of anorthositic gabbro glasses; the "chondrules" in this sample also have an anorthositic gabbro composition. The higher concentration of incompatible elements in 14004,77 (30% more than A-14 regolith; [2]) is in accord with its sole glass constituent of Medium-K Fra Mauro type with no dilution by more anorthositic and incompatible-element poor glasses. Sample 14076,5 appears to be most foreign to the Apollo 14 site, because it lacks any Fra Mauro glass constituents.

Table 1
Glass Compositions in Apollo 14 Regolith Breccias
Classification Adapted from [3] and [4]

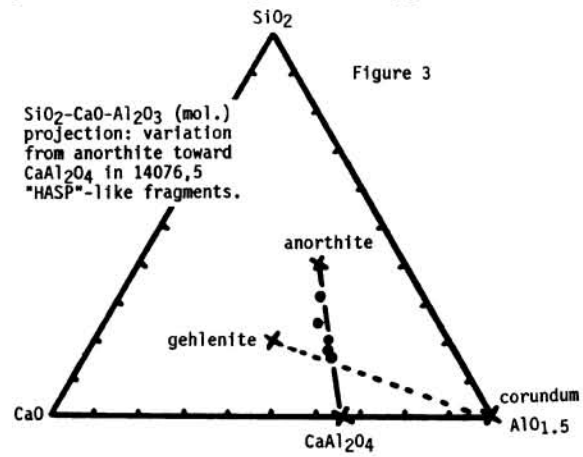
	"typical"	14076,5	14315,26	14004,77
"HASP"-like	0	5	0	0
Plagioclase Glass	9	7	0	0
Gabbroic Anorthosite	10	4	3	0
Anorthositic Gabbro	34	1	8	0
Low-K Fra Mauro	25	0	1	0
Medium-K Fra Mauro	94	0	2	9
Rhyolitic (typical)	3	0	0	0
High-Ca Rhyolite	0	3	0	0
Mafic	4	0	0	0
Mare	22	0	0	0

In addition to its lack of Fra Mauro glasses, sample 14076,5 is also distinctive because it contains two glass or devitrified glass types (high-Ca rhyolite and high-Al/Si-poor "HASP" fragments) that are not found in the other breccias. The high-Ca rhyolite and the "HASP"-like fragments can be distinguished in Figure 2, where the 250 glass analyses of this study are compared with the range of glass compositions from Apollo 14 cores and surface soils [5]. The



high-Ca rhyolite (7.0 wt.% CaO, with low K_2O, 3.7 wt.%) plots in a distinctive region because of its high CaO/Al_2O_3 ratio. This rhyolitic glass is not a simple impact mixture between granitic compositions and Fra Mauro-type soil; as with its host breccia, the origins of the high-Ca rhyolite are obscure. The "HASP"-like fragments are distinctive because they range to very low (18 wt.%) SiO_2 content. These fragments present some particularly difficult problems in intrpretation and may include a new mineral type or a complex intergrowth of known minerals.

The Problem of Devitrified "HASP" and a "HASP"-like Mineral(?): In sample 14076,5 there are several large (0.1 to 0.3 mm) irregular fragments of "HASP"-like composition (SiO_2=35-18%, Al_2O_3=42-53%, CaO=22-29%, MgO=0.6-0.2%). Unlike most other highland HASP glasses [4], these are much lower in Fe, Mg, Ti and Si-range and higher in Ca and Al. This difference seems to be particularly characteristic of Apollo 14 [4,7] and the origins of the Apollo 14 "HASP"-like materials may be very different from the impact Si volatilization suggested for true HASP [4]. The "HASP"-like fragments in 14076,5 are devitrified on a fine scale, except for the most Si-poor fragment which optically appears to be a single crystal and has a stoichiometry near ($Ca_3Al_6Si_2O_{16}$). Crystals of similar composition with nepheline-type structure have been formed as solid solutions along the anorthite-$CaAl_2O_4$ join by devitrification of synthetic glasses below 1000°C [8]. Figure 3 shows that the "HASP"-like compositions in 14076,5 follow this join; the "HASP"-like mineral(?) occurs where this trend meets the gehlenite-corundum join. This may not be fortuitous, for both uniaxial-negative melilites (i.e. gehlenite) [9] and corundum [10] have been found or suggested in Apollo 14 fines. We note, however, that this mineral(?) in 14076,5 has apparent biaxial optic properties, unlike the uniaxial positive $Ca_3Al_6Si_2O_{16}$ that has been synthesized [8]. Some explanations may be (1) anomalous biaxial properties due to shock deformation, (2) crystallization as a different polymorph, or (3) this may not be a mineral but rather a fine-scale intergrowth (gehlenite + corundum?; anorthite + $CaAl_2O_4$?) with anomalous optics. TEM study will be necessary to determine the true nature and significance of these "HASP"-mimicking fragments.



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