14041, 14042 and 14045

Regolith Breccia

166.3, 103.2 and 65.2 grams

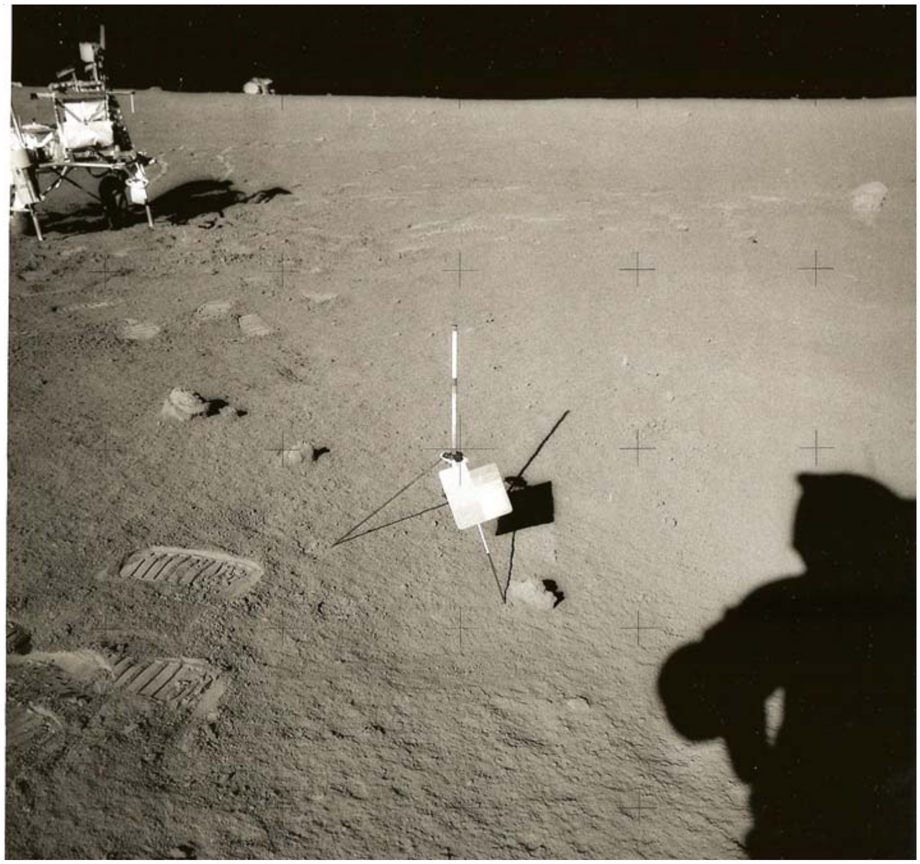

Figure 1a: Sample 14041 - 14045 on lunar surface. MET and LM in distance. AS14-68-9409.

Introduction

Samples 14041 – 14046 are fragments from a fractured clod that broke apart when it was collected. They were returned in doc bags 3N and 4N in ALSRC 1006. The sample collection site was 150 m NE of the LM and 90 m N of North Triplet Crater (Station A). 14043, 14044 and 14046 are residue from the same bags (an additional 11 grams). Double drive tube 14210/14211 was collected from the same location (figure 4).

The Apollo 14 regolith breccias (vitric matrix breccias) are slightly more aluminous than the Fra Mauro breccias (crystalline matrix breccias)(figure 7). Of the various regolith breccias studied, 14042 is the most like an Apollo 14 soil with a relatively high

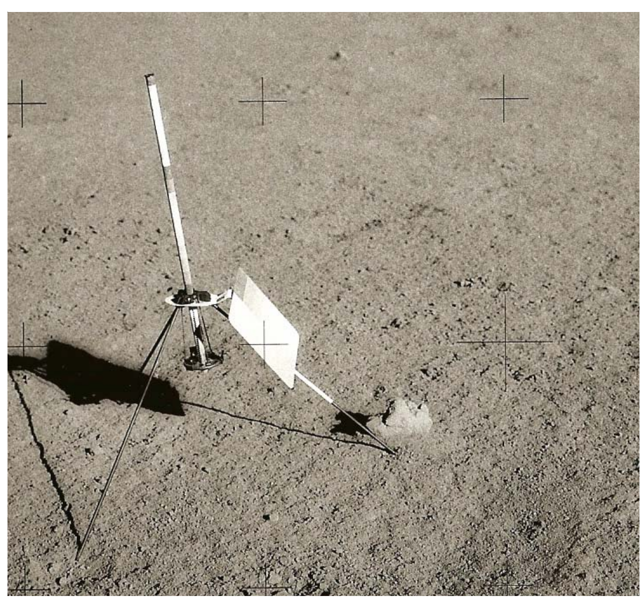

Figure 1b: Another view of 14042. AS14-68-9411.

Figure 2a: Photo of 14041. Sample is 7 cm across. NASA S71-32439.

Figure 2b: Photo of 14042. Sample is 6 cm across. NASA S71-31446.

Figure 2c: Photo of 14045. Sample is 6 cm across. NASA S71-29176.

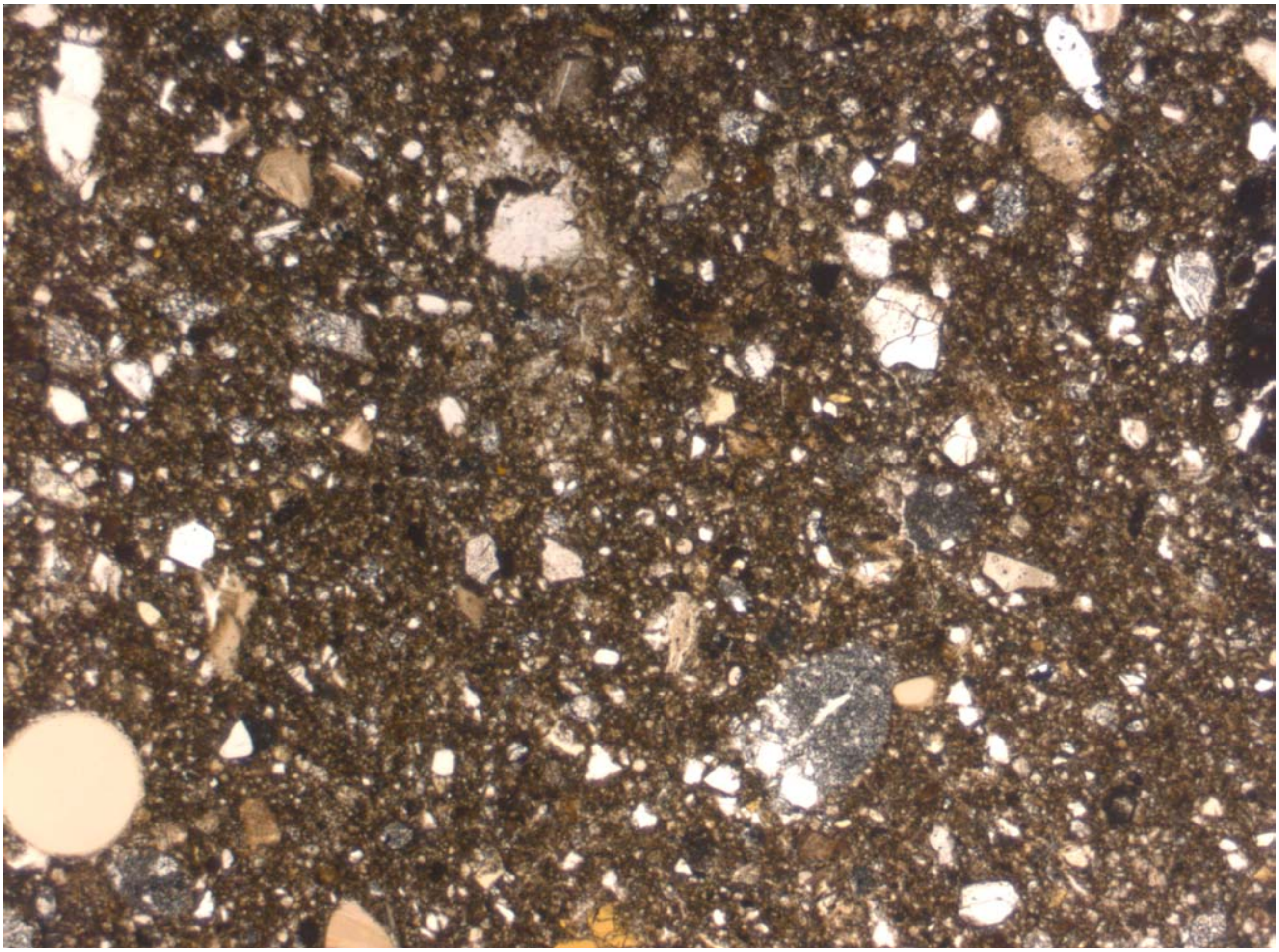

Figure 3: Thin section photomicrograph of 14042,26 showing glass bead (300 micron). Field of view is 2.8 mm. Photo by C Meyer.

percentage of recognizable agglutinate fragments and a high carbon content.

14045 is a blocky, subangular rock with a rough, hackly surface (figure 2). Glass-lined zap pits occur on all but one surface. According to Swann et al. (1977), there are poorly defined internal fractures, but one face of the sample has broad, parallel steps suggestive of fracture control. The sample is a friable, fine-grained clastic rock with very sparse subangular light-colored clasts in a medium-gray matrix.

Petrography

This sample is a very friable, medium grey regolith breccia with very few clasts (Fruland 1983). The matrix contains glass and has a seriate grain size distribution of mineral clasts (figure 3). Chao et al. (1972) and Phinney et al. (1976) found that the matrix was porous (about 35%) containing glass filaments and many tiny grains. Simonds et al. (1977) classify these samples as "vitric matrix breccias" (figure 5).

Simon et al. (1989) studied the mineral mode of 14041 and 14042, comparing mineral and glass chemistry with soils.

Wentworth and McKay (1991) studied the distinct glass particles found in Apollo 14 soil breccias comparing them with those found in the Apollo 14 soil (figure 10). Simon et al. (1989) also studied the glass beads, finding that many glass beads were "highland glass".

Chemistry

The chemical compositions of the various fragments are similar (table 1) and similar to the local soil (figure 7). The carbon content is high (140 ppm; Moore et al. 1972; figure 9).

Cosmogenic isotopes and exposure ages

Keith et al. (1972) determined the cosmic-ray-induced activity of ^{22}Na = 84 dpm/kg, ^{26}Al = 139 dpm/kg and ^{56}Co = 80 dpm/kg.

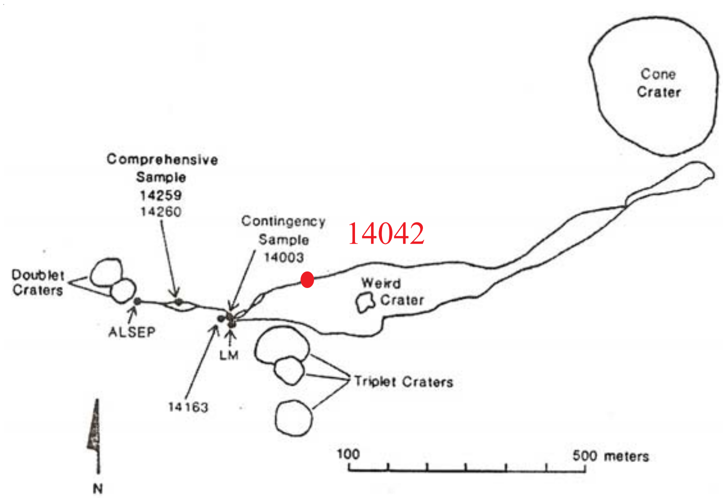

Figure 4: Map of Apollo 14 site with 14042.

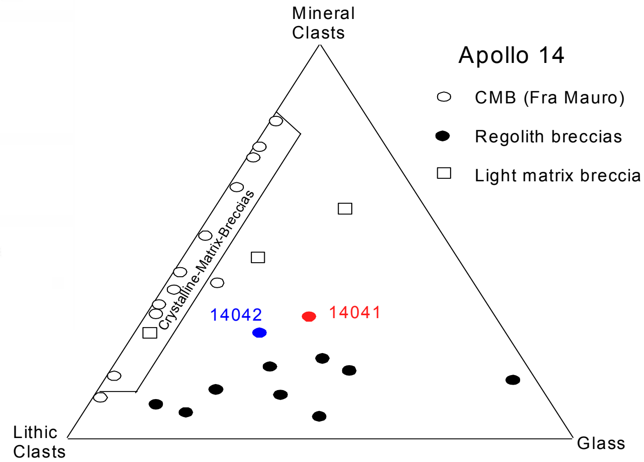

Figure 5: Ratio of clast abundances in Apollo 14 breccias (Simonds et al. 1977).

Processing

These samples were returned in Teflon bags (3N, 4N) in ALSRC 1006, which was sealed.

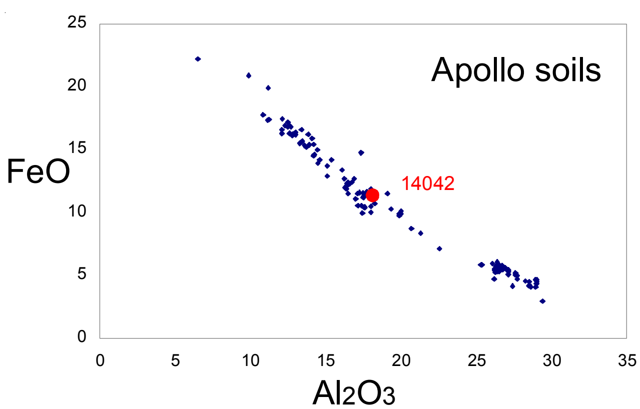

Figure 6: Composition of 14042 compared with all lunar soils.

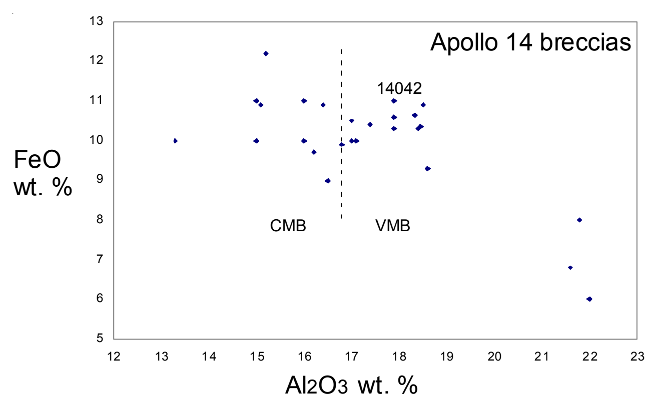

Figure 7: Chemical composition of Apollo 14 breccias (CMB = crystalline matrix breccia; VMB = vitric matrix breccia = regolith breccia).

Mineralogical Mode for 14042

	Simonds et al 1977		Sinon et al. 1989
	14041	14042	14042
Matrix	79.5 %	88	63
Clasts			
Plagioclase	3.5	1	4.6
Mafic	2.5	2	5.1
Breccia	7.5	3	~10
Glass	2	2	9.3
Granulite	4.5	4	1.7
Agglutinate			7.2

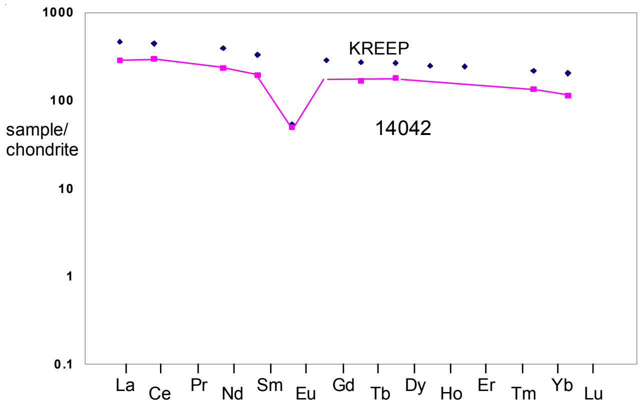

Figure 8: Normalized rare-earth-element diagram for 14042 compared with KREEP.

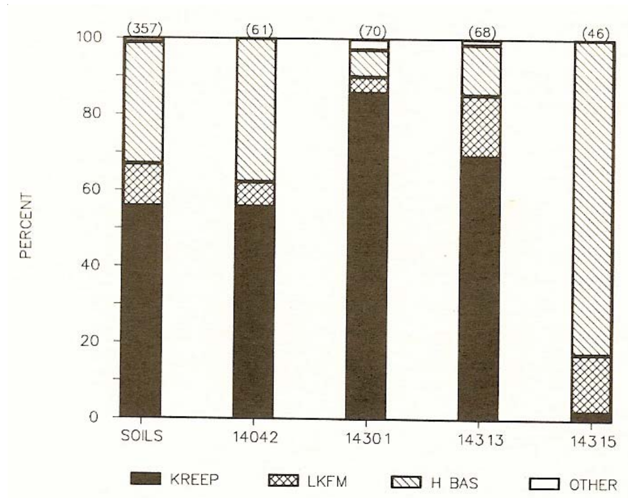

Figure 10: Comparison of glass types (based on composition) in soils and soil breccias from Apollo 14 (Wentworth and McKay 1991).

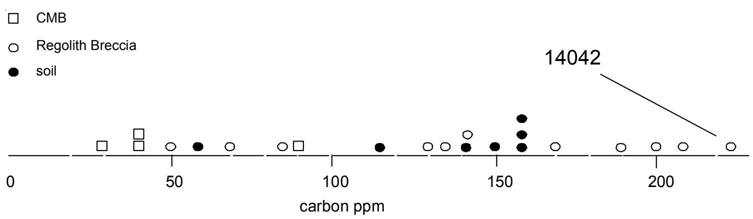

Figure 9: Carbon content for Apollo 14 breccias and soils with 14042 the highest (Moore et al. 1972).

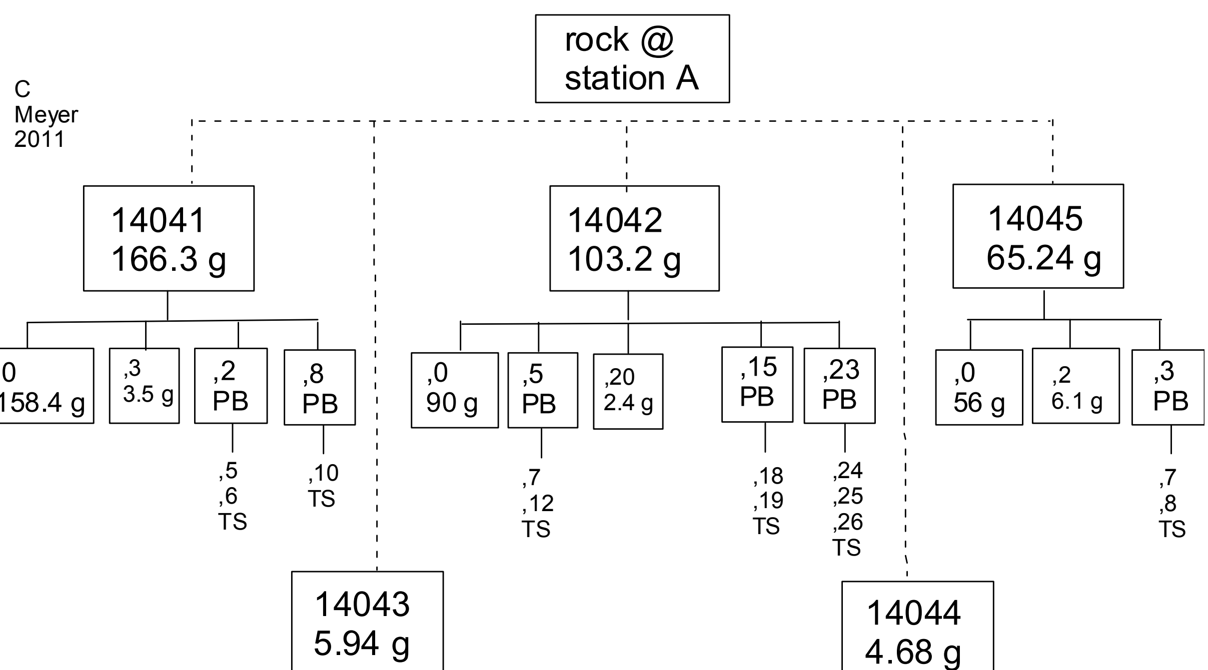

Table 1. Chemical composition of 14042, 14041 and 14045.

	14042		14042		14042		14041	14045		14045	
reference	Simon 89		Christian76		LSPET73		Christian76			Keith72	
weight	156 mg									64.2 g	
SiO2 %			47.52	(c)	51	(a)	47.35	47.4	(c)		
TiO2	1.75	(b)	1.7	(c)	1.8	(a)	1.7	1.69	(c)		
Al2O3	17.9	(b)	18.25	(c)	16	(a)	18.45	18.22	(c)		
FeO	11	(b)	10.41	(c)	9.5	(a)	10.35	10.65	(c)		
MnO	0.153	(b)	0.14	(c)	0.14	(a)	0.14	0.14	(c)		
MgO	9.1	(b)	9.3	(c)	8.6	(a)	9.23	9.33	(c)		
CaO	11	(b)	10.94	(c)	11	(a)	10.9	10.8	(c)		
Na2O	0.67	(b)	0.63	(c)	0.48	(a)	0.73	0.64	(c)		
K2O	0.48	(b)	0.49	(c)	0.63	(a)	0.5	0.49	(c)	0.47	(d)
P2O5			0.47	(c)			0.46	0.48	(c)		
S %											
sum											
Sc ppm	22.8	(b)			30	(a)					
V	47	(b)			74	(a)					
Cr	1370	(b)			1200	(a)					
Co	35	(b)			56	(a)					
Ni	430	(b)			280	(a)					
Cu					19	(a)					
Zn											
Ga											
Ge ppb											
As											
Se											
Rb	20	(b)			14	(a)					
Sr	80	(b)			210	(a)					
Y					110	(a)					
Zr	740	(b)			1030	(a)					
Nb					68	(a)					
Mo											
Ru											
Rh											
Pd ppb											
Ag ppb											
Cd ppb											
In ppb											
Sn ppb											
Sb ppb											
Te ppb											
Cs ppm	0.84	(b)									
Ba	840	(b)			820	(a)					
La	68.4	(b)			70	(a)					
Ce	180	(b)									
Pr											
Nd	108	(b)									
Sm	28.8	(b)									
Eu	2.82	(b)									
Gd											
Tb	6.2	(b)									
Dy	44	(b)									
Ho											
Er											
Tm											
Yb	22	(b)			27	(a)					
Lu	2.8	(b)									
Hf	22.3	(b)									
Ta	3	(b)									
W ppb											
Re ppb											
Os ppb											
Ir ppb	9	(b)									
Pt ppb											
Au ppb	2.7	(b)									
Th ppm	12.2	(b)								13.8	(d)
U ppm	3.2	(b)								3.6	(d)

technique: (a) emission spec. (b) INAA, (c) "microchemical", (d) radiation counting

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