

14055
Regolith Breccia
111 grams

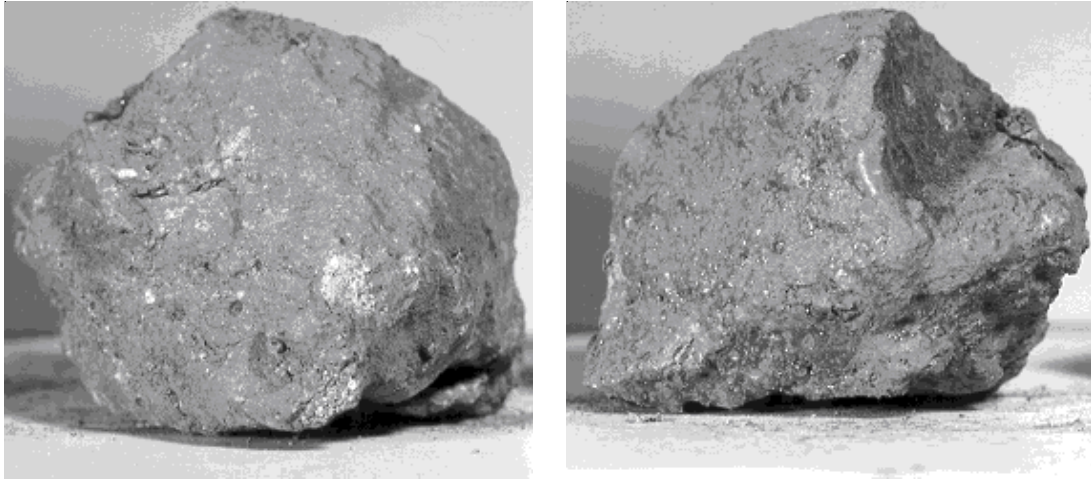


Figure 1: Photos of 14055, showing two sides. Sample is about 4 cm round. NASA S71-29572 and 29565.

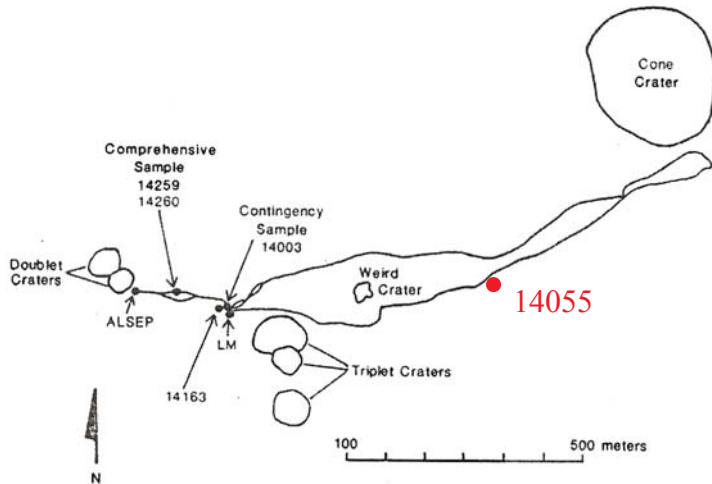


Figure 2: Map of Apollo 14 showing location of 14055.

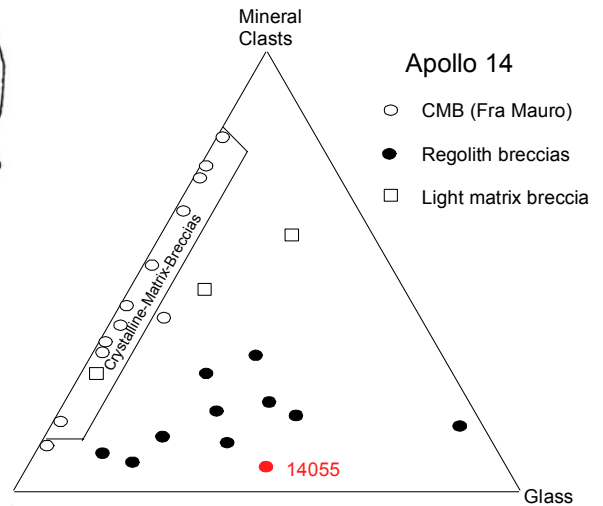


Figure 3: 14055 is not a Fra Mauro breccia, but rather a vitric matrix breccia made from the A14 soil.

Transcript from station E

LMP This is a big crater. It's 40, 50 meters across. It has a fairly sharp crater in the south edge of it, which is –

CC Okay, that looks like it may be the one by E.

LMP - 20, 30 feet across. Yes, I think that's it Fredo. And it's – no, it's at least 50 or 60 feet deep.

CDR Why don't we just grab a couple from right here.

LMP Yes, Okay.

CDR That baby came apart. Very soft.

LMP Yes, it's falling apart as you pick it up, very crumbly, isn't it?

CDR Very, ver soft rock – rim of that crater, plus another one very close to us with crystals in it, now, going into bag

LMP 15-N.

Introduction

From the transcript, it is clear that the astronauts put two friable samples in bag 15N, but when it was opened in the LRL there were seven fragments with a lot of “residue”. 14055 and 14058 are more coherent than the other fragments (figure 1). They are also blocky, subangular to subrounded rocks lightly covered with glass-lined zap pits. The samples are friable, fine-grained clastic rocks with 5 to 15 % of subrounded light-colored clasts in a medium-gray matrix.

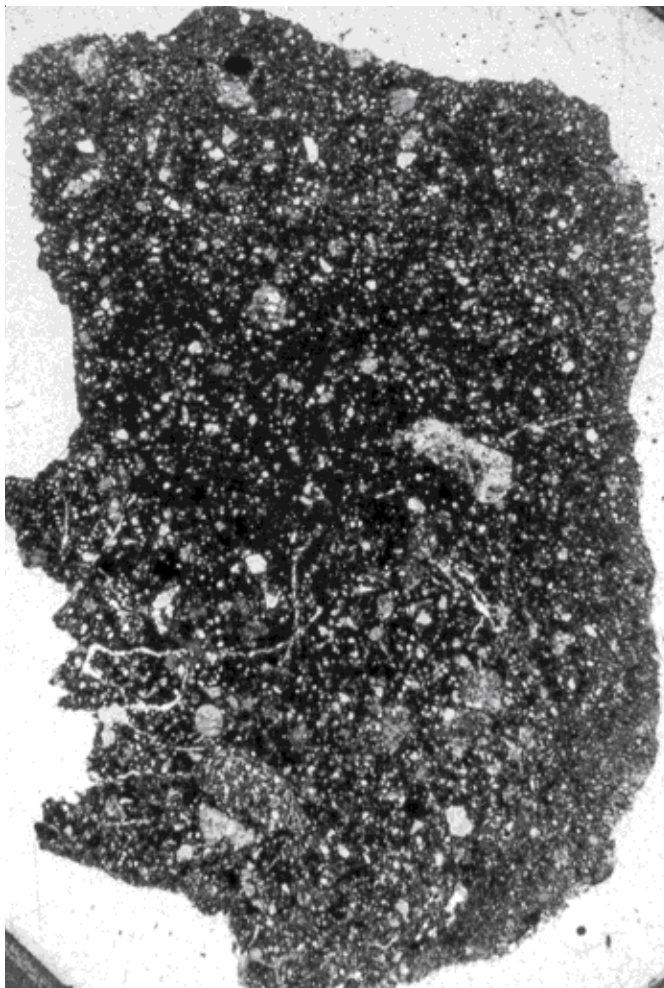


Figure 4: Photomicrograph of thin section 14055,9. Section is 1 cm long. S71-43119.

Mineralogical Mode for 14055

	Drozd et al. 1977
Mineral fragments	28.7 %
Lithic fragments	14.9
Colored glass	5.5
Agglutinate glass	49.5
Colorless glass	0.6
Chondrules	0
Devitrified glass	0.6

Mineralogical Mode for 14055

	Simonds et al. 1977	Simon et al. 1989	Drozd et al. 1976
Matrix	72 %	55.9	
Clasts			
Plagioclase	1	4.1	
Mafic	0.5	5.9	
Breccia	9		
Glass	5.5	8.6	6.7
Granulite	11	1.4	
Agglutinate		8.9	49.5

14055 originally had a thin layer of brown glass on one side, which has since mostly rubbed off.

Simon et al. (1989) and Drozd et al. (1976) reported a high percentage of agglutinates in 14055, while Simonds et al. (1977) found a lot of fine-grained matrix material (figure 3). The sample Drozd et al. studied may have included the glass splash on the outer surface.

Unusual fragments of ropy glass are seen in thin sections (figures 5 and 8).

Stoffler et al. (1979) consider 14055 a classic regolith breccia. Fruland (1983) and Simon et al. (1989) included 14055 in their suite of regolith breccias from Apollo 14.

The Apollo 14 regolith breccias (vitric matrix breccias) are slightly more aluminous than the Fra Mauro breccias (crystalline matrix breccias).

Petrography

Both rocks collected at station E were friable and returned in the same bag (15N). Swann et al. (1977) reported that 14058 may be part of 14055, while 14056, 14057, 14059, 14060 and 14061 are very friable and may be pieces of the other sample. Fruland (1983) and Simon et al. (1989) included 14055 in the suite of regolith breccias. It is very like 14042, 14047 and 14049.

Chemistry

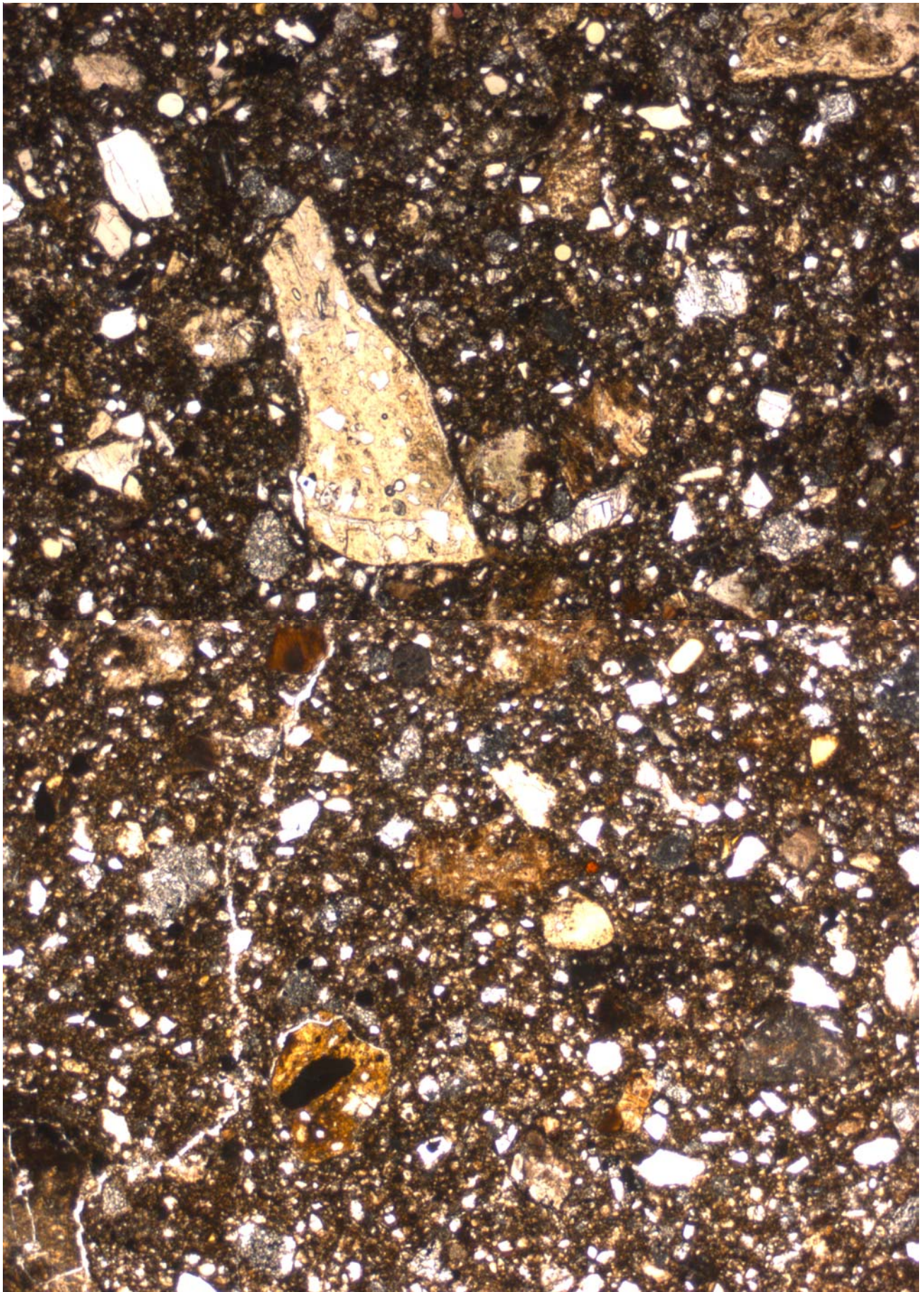
The chemical composition of 14055 is remarkably similar to that of the Apollo 14 regolith (as measured on 14163) – see table.

Other Studies

Drozd et al. (1975) determined Kr and Xe concentration and isotopic ratios. Hart et al. (1972) studied the solar flare tracks. Horz et al. (1972) studied the micrometeorite craters.

Next page Figure 5: Photomicrograph of thin section 14055,42 showing large fragment of ropy glass. Photo by C. Meyer.

Scale = 2.8 mm across



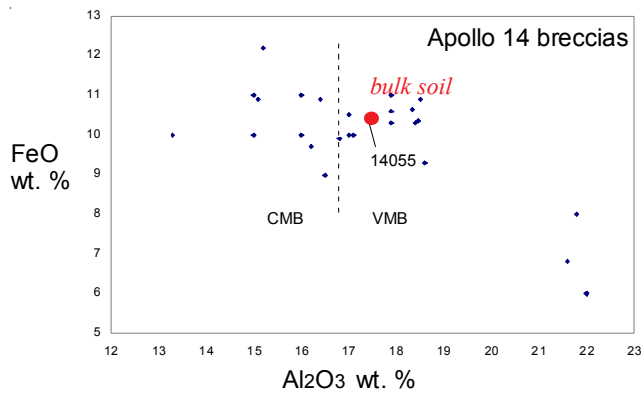


Figure 6: Composition of 14055 compared with other Apollo 14 breccias and bulk soil 14163.

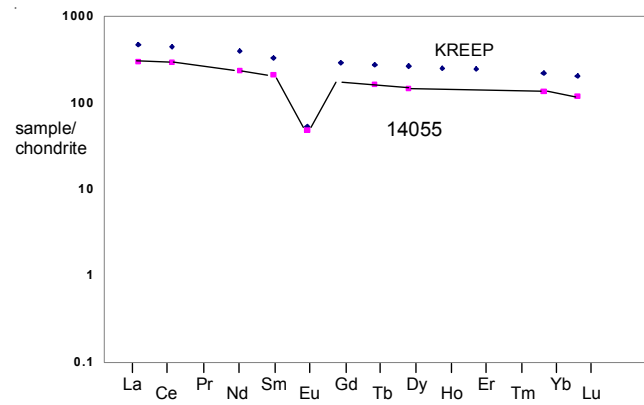


Figure 7: Normalized rare-earth-element diagram for 14055 compared with KREEP.

Processing

14055 was returned in ALSRC 1006, which was sealed. It was originally designated as a “posterity” sample – to be studied later.

There were no surface photos taken at station E. Twedell et al. (1978) made maps of the surface of 14055 (figure 9). There are 14 thin sections.

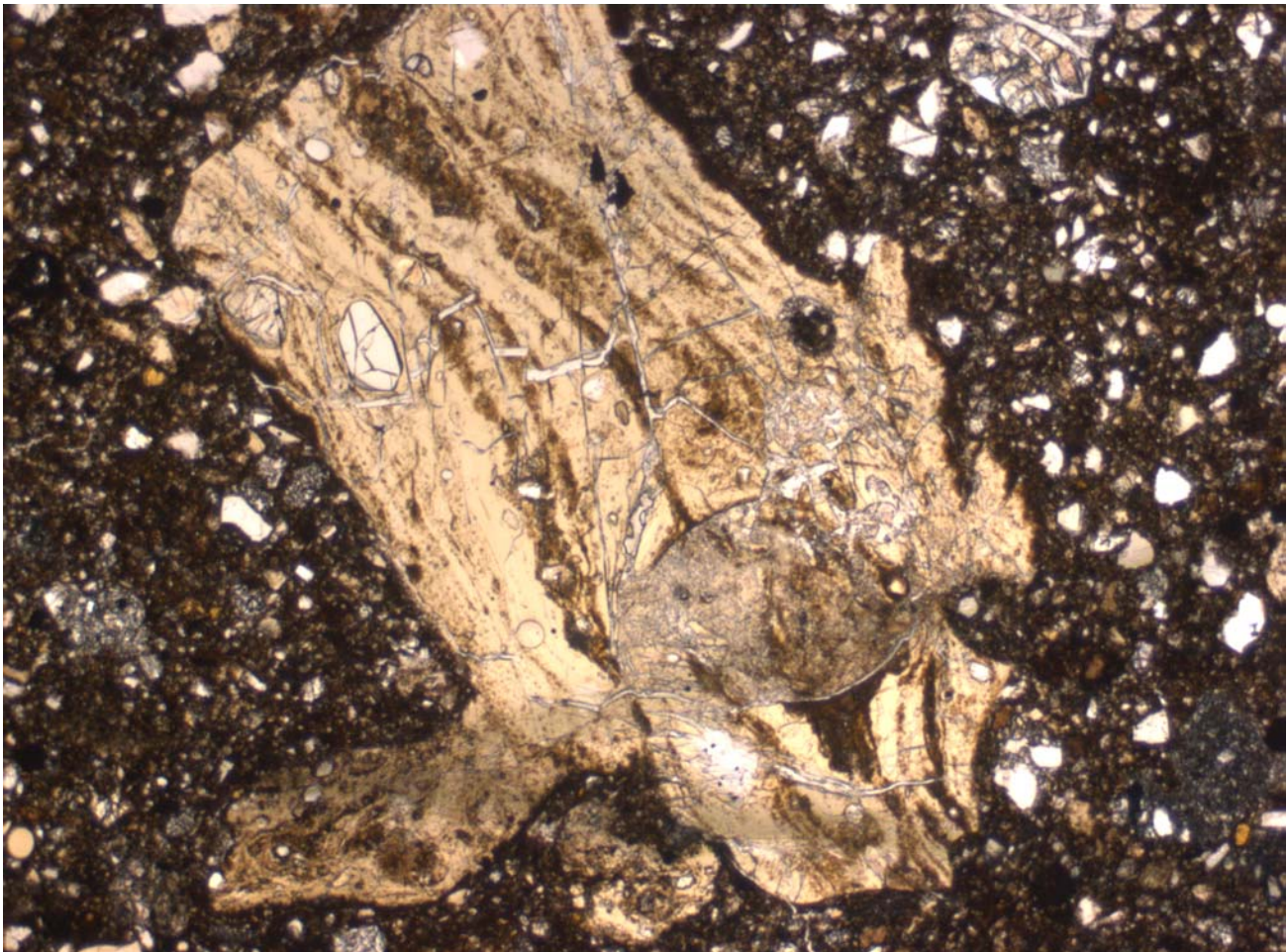


Figure 8: Ropy glass fragment in 14055.. Scale is 2.8 mm across.

Table 1. Chemical composition of 14055.

reference	Simon89		14163
weight	154 mg		Lau180
SiO ₂ %			47.3
TiO ₂	1.73	(a)	1.6
Al ₂ O ₃	17.4	(a)	17.8
FeO	10.4	(a)	10.5
MnO	0.126	(a)	0.135
MgO	10	(a)	9.6
CaO	10	(a)	11.4
Na ₂ O	0.73	(a)	0.7
K ₂ O	0.59	(a)	0.55
P ₂ O ₅			
S %			
sum			
Sc ppm	21.8	(a)	21.7
V	47	(a)	45
Cr	1280	(a)	1368
Co	32	(a)	33
Ni	390	(a)	350
Cu			
Zn			
Ga			
Ge ppb			
As			
Se			
Rb	19	(a)	
Sr	120	(a)	170
Y			
Zr	730	(a)	
Nb			
Mo			
Ru			
Rh			
Pd ppb			
Ag ppb			
Cd ppb			
In ppb			
Sn ppb			
Sb ppb			
Te ppb			
Cs ppm	0.63	(a)	
Ba	910	(a)	800
La	71.4	(a)	66.7
Ce	179	(a)	170
Pr			
Nd	107	(a)	100
Sm	31	(a)	29.1
Eu	2.7	(a)	2.45
Gd			
Tb	6	(a)	5.9
Dy	36	(a)	36
Ho			8.6
Er			
Tm			3.2
Yb	22.1	(a)	21.2
Lu	2.9	(a)	3
Hf	20.6	(a)	22.5
Ta	3	(a)	2.9
W ppb			
Re ppb			
Os ppb			
Ir ppb	5	(a)	
Pt ppb			
Au ppb	6.2	(a)	
Th ppm	12	(a)	13.3
U ppm	3.1	(a)	3.5
technique:	(a)	INAA	

References for 14055

Carlson I.C. and Walton W.J.A. (1978) **Apollo 14 Rock Samples**. Curators Office. JSC 14240

Chao E.C.T., Minkin J.A. and Best J.B. (1972) Apollo 14 breccias: General characteristics and classification. *Proc. 3rd Lunar Sci. Conf.* 645-659.

Drozd R., Hohenberg C. and Morgan C. (1975) Krypton and xenon in Apollo 14 samples: Fission and neutron capture effects in gas-rich samples. *Proc. 6th Lunar Sci. Conf.* 1857-1877.

Drozd R.J., Kennedy B.M., Morgan C.J., Podosek F.A. and Taylor G.J. (1976) The excess fission xenon problem in lunar samples. *Proc. 7th Lunar Sci. Conf.* 599-623.

Hart H.R., Comstock G.M. and Fleischer R.L. (1972) The particle track record of Fra Mauro. *Proc. 3rd Lunar Sci. Conf.* 2831-2844.

Hörz F., Morrison D.A. and Hartung J.B. (1972) The surface orientation of some Apollo 14 rocks. *Modern Geology* **3**, 93-104.

LSPET (1971) Preliminary examination of lunar samples from Apollo 14. *Science* **173**, 681-693.

Fruland R.M. (1983) **Regolith Breccia Workbook**. JSC 19045

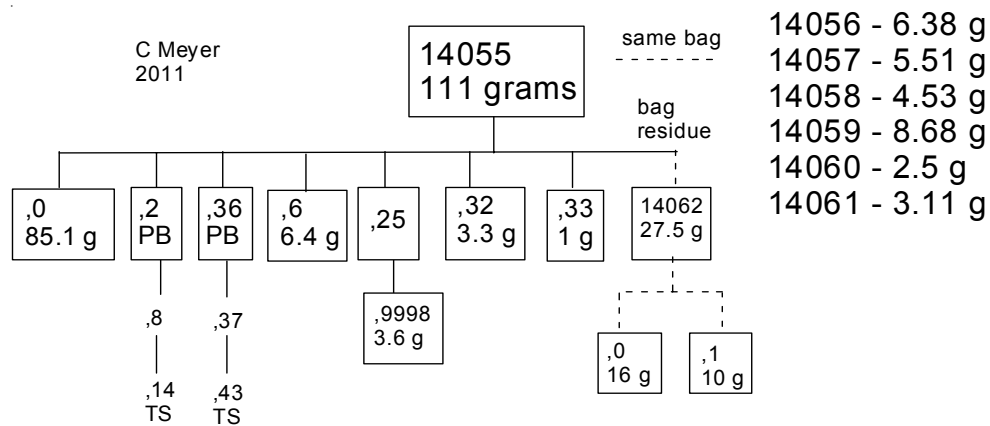
Simon S.B., Papike J.J., Shearer C.K., Hughes S.S. and Schmitt R.A. (1989) Petrology of Apollo 14 regolith breccias and ion microprobe studies of glass beads. *Proc. 19th Lunar Planet. Sci. Conf.* 1-17.

Simonds C.H., Phinney W.C., Warner J.L., McGee P.E., Geeslin J., Brown R.W. and Rhodes J.M. (1977) Apollo 14 revisited, or breccias aren't so bad after all. *Proc. 8th Lunar Sci. Conf.* 1869-1893.

Stoffler D., Knoll H.-D., Reimold W. and Schulien S. (1976) Grain size statistics, composition and provenance of fragmental particles in some Apollo 14 breccias. *Proc. 7th Lunar Sci. Conf.* 1965-1985.

Stöffler D., Knoll H.-D. and Maerz U. (1979) Terrestrial and lunar impact breccias and the classification of lunar rocks. *Proc. 10th Lunar Planet. Sci. Conf.* 639-675.

Sutton R.L., Hait M.H. and Swann G.A. (1972) Geology of the Apollo 14 landing site. *Proc. 3rd Lunar Sci. Conf.* 27-38.



Swann G.A., Trask N.J., Hait M.H. and Sutton R.L. (1971a) Geologic setting of the Apollo 14 samples. *Science* **173**, 716-719.

Swann G.A., Bailey N.G., Batson R.M., Eggleton R.E., Hait M.H., Holt H.E., Larson K.B., Reed V.S., Schaber G.G., Sutton R.L., Trask N.J., Ulrich G.E. and Wilshire H.G. (1977) Geology of the Apollo 14 landing site in the Fra Mauro Highlands. U.S.G.S. Prof. Paper **880**.

Swann G.A., Bailey N.G., Batson R.M., Eggleton R.E., Hait M.H., Holt H.E., Larson K.B., McEwen M.C., Mitchell E.D., Schaber G.G., Schafer J.P., Shepard A.B., Sutton R.L., Trask N.J., Ulrich G.E., Wilshire H.G. and Wolfe E.W. (1972) 3. Preliminary Geologic Investigation of the Apollo 14 landing site. In *Apollo 14 Preliminary Science Rpt.* NASA SP-272. pages 39-85.

Twedell D., Feight S., Carlson I. and Meyer C. (1978) **Lithologic maps of selected Apollo 14 breccia samples.** Curators Office. JSC 13842

von Engelhardt W., Arndt J., Stoffler D. and Schneider H. (1972) Apollo 14 regolith and fragmental rocks, their compositions and origins by impacts. *Proc. 3rd Lunar Sci. Conf.* 753-770.

Warner J.L. (1972) Metamorphism of Apollo 14 breccias. *Proc. 3rd Lunar Sci. Conf.* 623-643.

Williams R.J. (1972) The lithification of metamorphism of lunar breccias. *Earth Planet. Sci. Lett.* **16**, 250-256.

Wilshire H.G. and Jackson E.D. (1972) Petrology and stratigraphy of the Fra Mauro Formation at the Apollo 14 site. U.S. Geol. Survey Prof. Paper **785**.

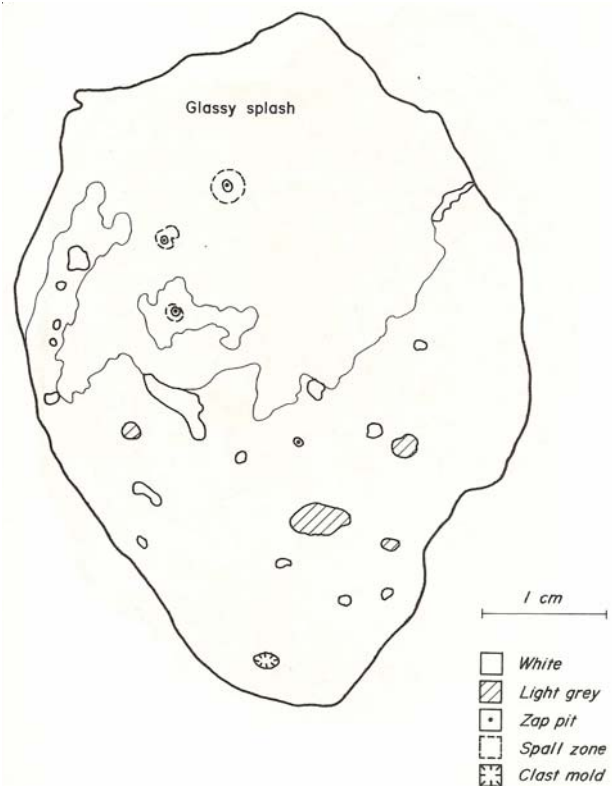


Figure 9: Map of original surface of 14055 showing large glass splash (Twedell et al. 1978). S77-23605.