15465, 15466, 15467, 15468

Glass with Breccia clasts

376, 119.2, 1.1 and 1.3 grams

Figure 1: Photo of S1 face of 15465. Cube is 1 inch. NASA S71-44190.

Introduction

15465 and companion fragments were returned in the same bag (Butler 1972). They were collected from the rim of Spur Crater (figure 4). 15466 was a separate sample, collected from beneath a rock (Sutton et al. 1972). The other pieces may be broken during transit. Fruland (1985) included 15465 in the Regolith Breccia Catalog.

Figure 2: 15466. Sample is 7 cm across. S71-44187.

Petrography

15465 and 15466 are a collection of breccia fragments cemented together with a vesicular black glass (figure 1 and 2). Within the breccias are numerous lithic clasts. Cameron and Delano (1973) found that ~ 5 – 10 % of 15465 was made up of crystalline rock fragments (mare basalt, KREEP basalt and recrystallized norite). About half of the lithic fragments are KREEP basalt (figure 6). The KREEP basalt fragments contain relatively sodic plagioclase and distinctive pyroxene zoning (figure 9). The fragments of recrystallized norite are brecciated and thermally annealed, but also contain low-Ca, high-Mg orthopyroxene (figure 9). However, Cameron and Delano found that they were *"not simply recrystallized equivalents"* of the KREEP basalt.

McKay et al. (1989) reported that the maturity index for 15465 was $I_s/FeO = 12$ and only 9 for 15467.

Warren and Wasson (1978) studied 2 white clasts (figure 3, table 2).

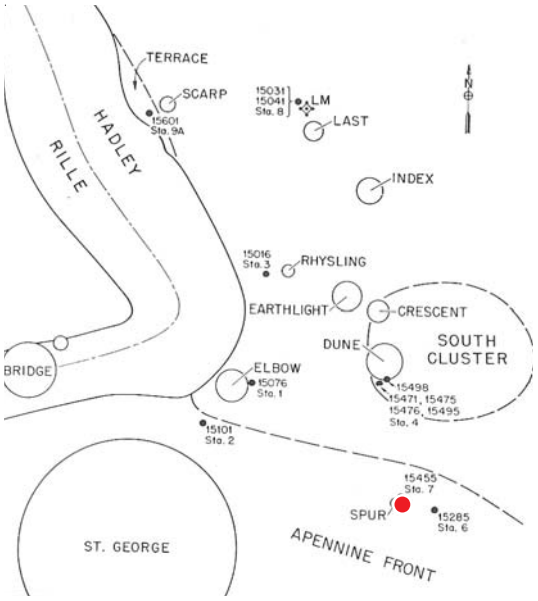


Figure 3: Map of Apollo 15 site showing location of 15465.

Significant Clasts

Mare Basalt

Plieninger and Schaeffer (1976) reported an age of 1.9 b.y. for a mare basalt clast out of 15465.

White Clast

Figure 13 shows a nice white clast.

Chemistry

Blanchard's Ph.D. thesis involved measuring the chemical composition of 15465 (among other samples). However, the sample is inhomogeneous. Simon et al. (1986), McKay et al. (1989), Ehmann et al. (1975) and Ali et al. (1976) reported major elements (table 1). The REE content is rather high (figure 11). Keith et al. (1972) reported K,U and Th for both 15465 and 15466.

Ali et al. (1976) determined the chemical composition of the black glass that binds 15465 and Winzer S.R.

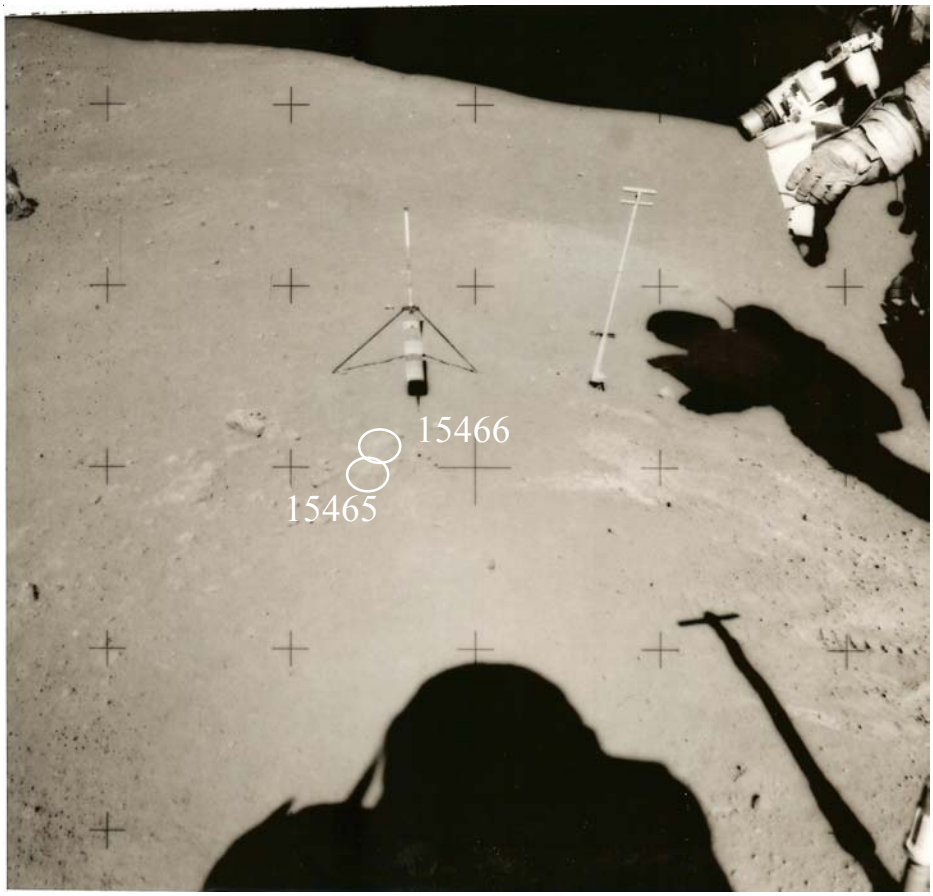


Figure 4: Surface photograph of rim of Spur Crater where 15465 and 15466 were collected. AS15-90-12230

Figure 5: Photo of N1 face of 15465 showing location of white clasts analyzed by Warren. Cube is 1 inch. NASA S71-46576.

(1978) reported the composition of glass in 15466 (table 1).

Moore et al. (1973) determined 45 ppm carbon for 15465 and 210 ppm carbon for 15466 (figure 12).

Radiogenic age dating

Husain (1972) reported an age of 1.09 ± 0.14 b.y. for the glass in 15465 while Plieninger and Schaeffer (1976) obtained an age of 3.91 b.y.

Cosmogenic isotopes and exposure ages

Keith and Clark (1972) determined the cosmic-ray-induced activity of ^{26}Al = 120 and 79 dpm/kg, ^{22}Na = 56 and 36 dpm/kg, ^{54}Mn = 31 and 4 dpm/kg, ^{56}Co = 19 and 5 dpm/kg for 15465 and 15466 respectively.

Other Studies

Rare gas concentrations and isotopic ratios of 15465 and 15467 were reported by McKay et al. (1989).

Processing

15465 was issued to Haskin for Consortium studies and was included in Blanchard's Ph.D. thesis. There are 14 thin sections of 15465 and 6 thin sections of 15466.

Mode for 15465 *(Simon et al. 1986)*

Matrix	<20 micron	45.9 %
	20-90 micron	90-1000 micron
Mare basalt	0.5 %	4.7
Plutonic Rx.	0.1	1.1
Feld. CMB		0.7
Feld. Basalt		0.7
KREEP basalt		2
Granulitic/Poik.		
Reg Bx.	0.8	1.1
Agglutinate		0.8
Pyroxene	11	2.7
Olivine	0.8	0.2
Plagioclase	8.5	2.3
Opaque	0.7	0.1
Glass	7.4	7.9

Mineralogical Mode for 15465

	(McKay et al. 1989)	
	20-500 micron	500-1000 micron
Mare Basalt	1.3 %	0 %
KREEP basalt	12.7	36
Plutonic	1	26.7
Breccias	1.3	12
Olivine	1.7	0
Pyroxene	28	1.3
Plagioclase	20.7	9.3
Opaques	0.3	0
Glass	11.3	4
Agglutinates	6	4

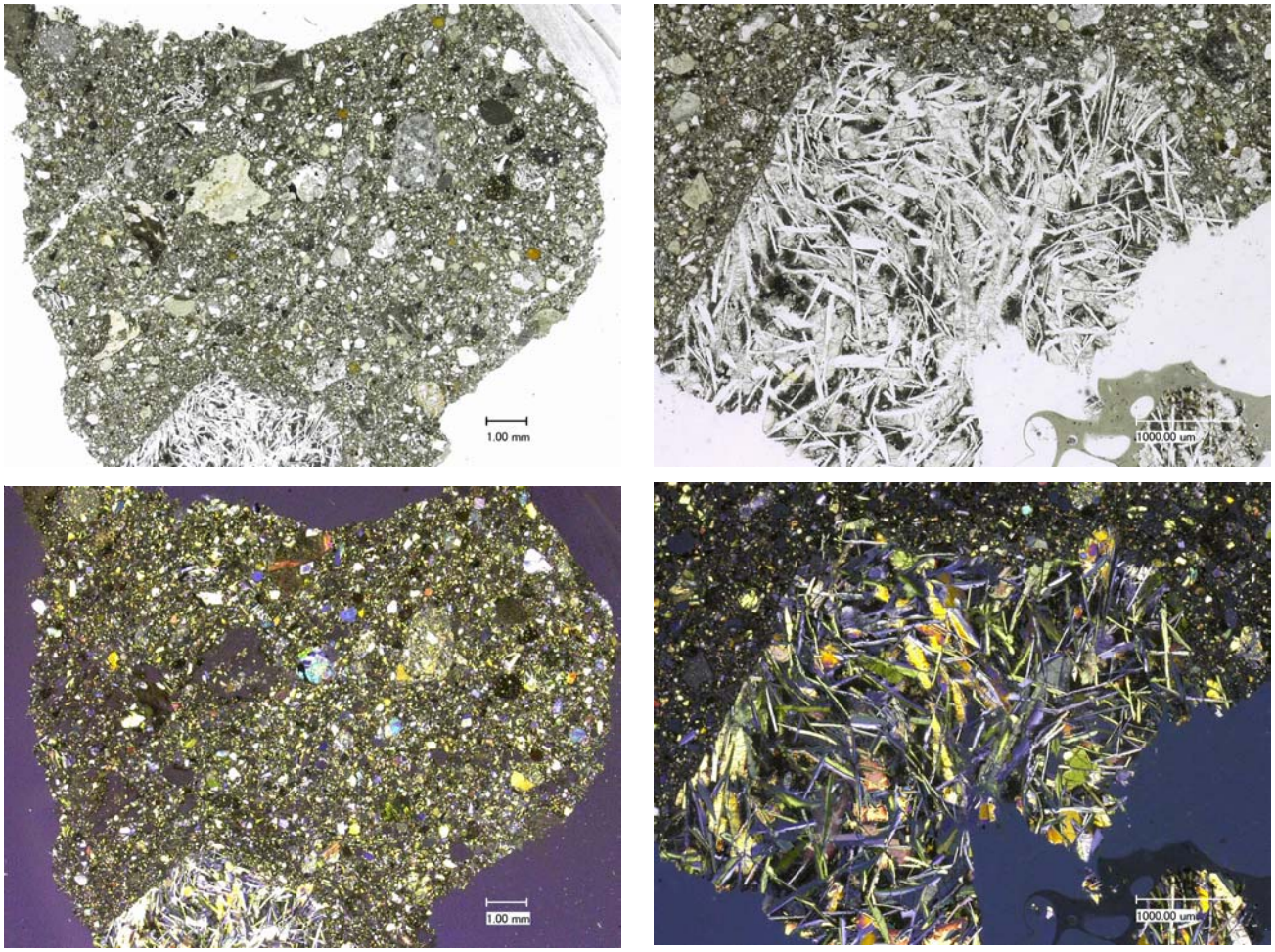


Figure 6: Photomicrographs of thin section of 15465 including clast of KREEP basalt by C Meyer. Scale br is shown. Bottom two figures are with crossed Nicols.

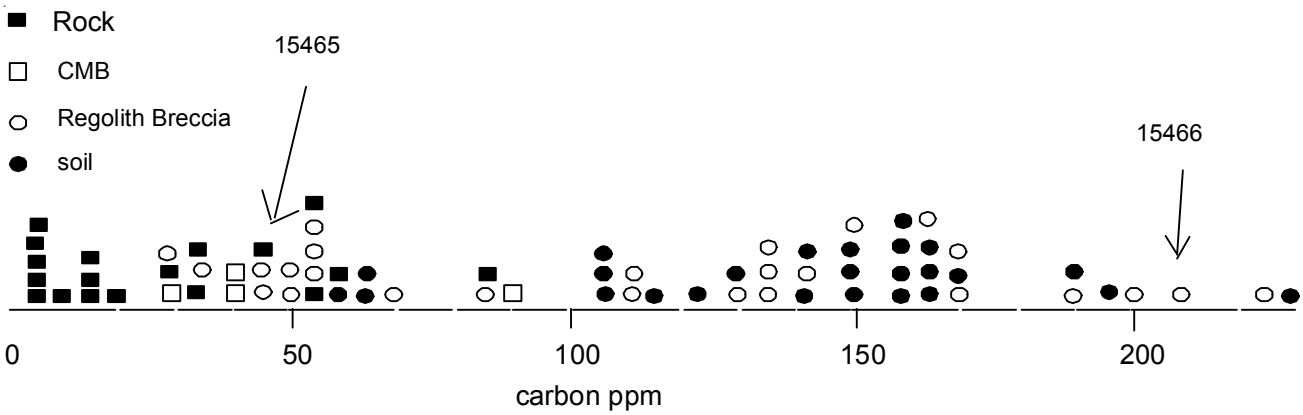


Figure 12: Carbon content of Apollo soils and breccias with 15465 and 15466 shown.

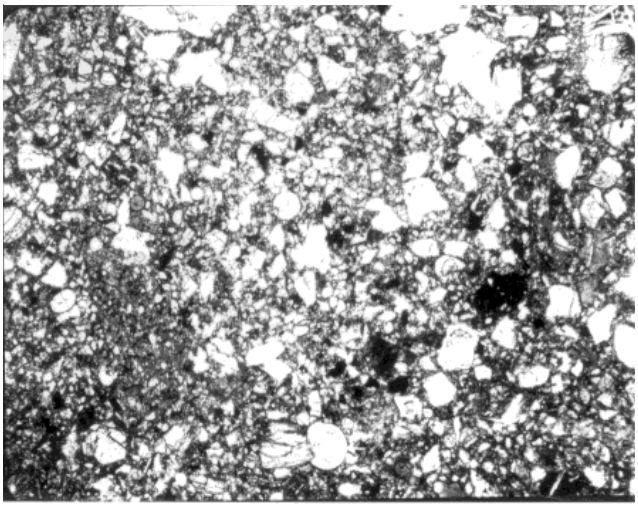


Figure 7: Thin section photo matrix of of 15465 breccia showing glass beads and much coarse material in porous matrix.

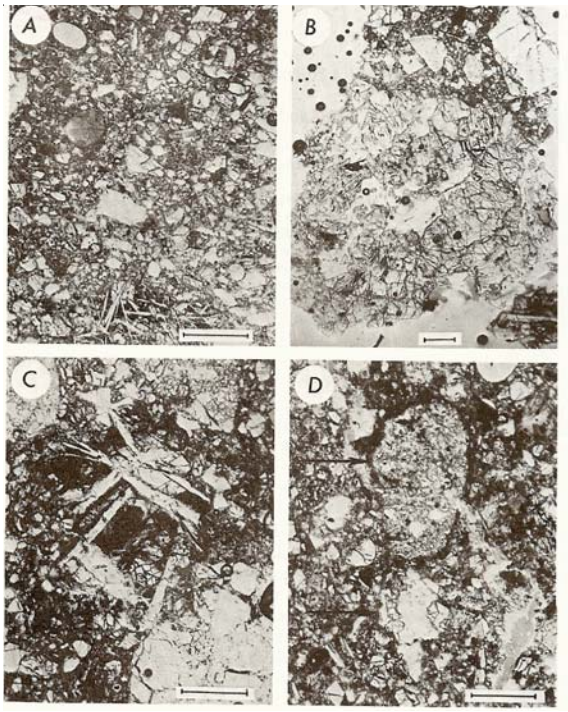


Figure 8: Lithic clasts found in 15465 (from Cameron and Delano 1975). A is matrix, B is mare basalt, C is KREEP basalt and D is recrystallized norite (scale bars are 200 microns).

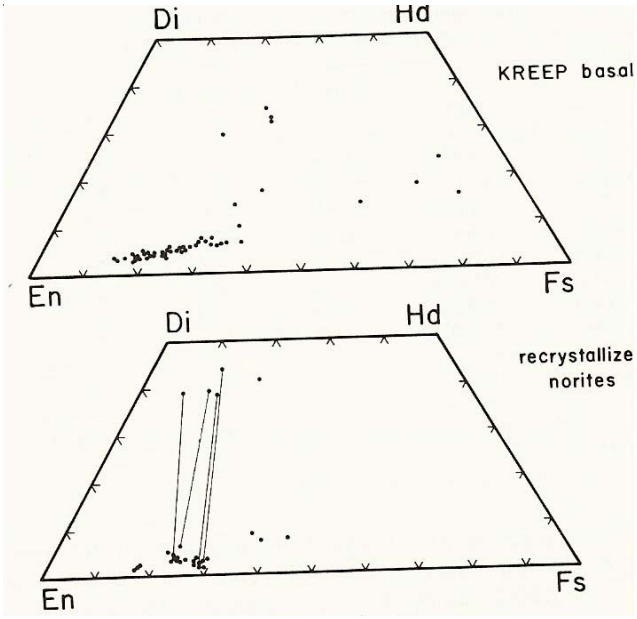


Figure 9: Composition of pyroxene in KREEP clasts in 15465 (from Cameron and Delano 1976).

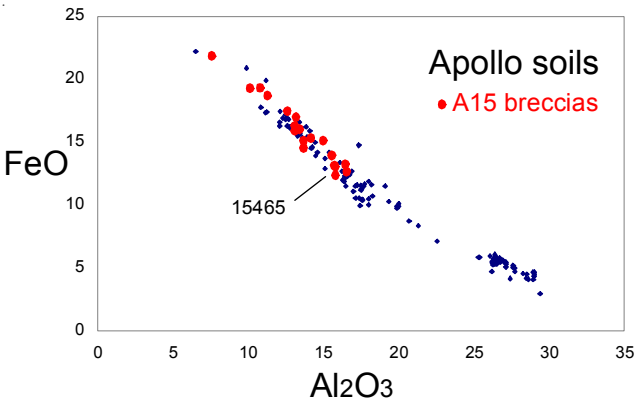


Figure 10: Composition of Apollo soils, Apollo 15 breccias and 15465 matrix.

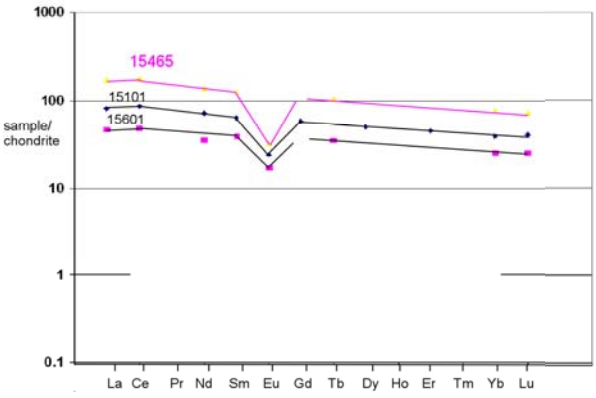


Figure 11: Normalized rare-earth-element diagram for 15465 compared with soils from Apollo 15.

Table 1. Chemical composition of 15465.

							15467		**15466**			**15466**				Glass	Glass	
reference	Kieth 72		Simon86		McKay89		McKay89		LSPET72			Kieth 72			Ehmann75		Ali 76	Winzer78	
weight			(Laul)		Blanchard														
SiO2 %															48.6	(a)		46	(c)
TiO2			1.5	(a)	1.38	(a)	1.9	(a)							1.27	(a)	1.12	1.42	(c)
Al2O3			15.2	(a)	16.3	(a)	15.7	(a)							16.2	(a)	17.8	17.1	(c)
FeO			11.9	(a)	11.7	(a)	11	(a)							11.6	(a)	12.9	11.4	(c)
MnO			0.16	(a)											0.16	(a)	0.15		
MgO			10.2	(a)	10.1	(a)	9.6	(a)							19	(a)		11.5	(c)
CaO			10.5	(a)	10.5	(a)	10.5	(a)							5.6	(a)	6.9	11.1	(c)
Na2O			0.57	(a)	0.61	(a)	0.64	(a)							0.57	(a)		0.76	(c)
K2O	0.28	(b)	0.31	(a)					0.15	(b)		0.19	(b)					0.16	(c)
P2O5			.																
S %																			
sum																			
Sc ppm			23.6	(a)	22.9	(a)	22.6	(a)											
V			83	(a)			61	(a)							66		54		
Cr			2374	(a)	2280	(a)	2090	(a)										2470	(c)
Co			32.5	(a)	30	(a)	27.1	(a)							34		45		
Ni			120	(a)	106	(a)	63	(a)											
Cu																			
Zn																			
Ga																			
Ge ppb																			
As																			
Se																			
Rb																			
Sr			120	(a)	140	(a)	155	(a)											
Y																			
Zr			500	(a)	530	(a)	700	(a)											
Nb																			
Mo																			
Ru																			
Rh																			
Pd ppb																			
Ag ppb																			
Cd ppb																			
In ppb																			
Sn ppb																			
Sb ppb																			
Te ppb																			
Cs ppm					0.38	(a)	0.44	(a)											
Ba			400	(a)	417	(a)	476	(a)											
La			37	(a)	40.4	(a)	50.4	(a)											
Ce			95	(a)	106	(a)	132	(a)											
Pr																			
Nd			60	(a)	61	(a)	78	(a)											
Sm			16	(a)	18.5	(a)	22.8	(a)											
Eu			1.7	(a)	1.8	(a)	1.98	(a)											
Gd																			
Tb			3.45	(a)	3.7	(a)	4.39	(a)											
Dy			22.2	(a)															
Ho			5	(a)															
Er																			
Tm			1.8	(a)															
Yb			11.9	(a)	12.6	(a)	15.6	(a)							11.4		9.8		
Lu			1.68	(a)	1.76	(a)	2.14	(a)											
Hf			11.8	(a)	14.8	(a)	18.3	(a)											
Ta			1.45	(a)	1.68	(a)	2.11	(a)											
W ppb																			
Re ppb																			
Os ppb																			
Ir ppb					2.7	(a)	2	(a)											
Pt ppb																			
Au					1.2	(a)	5	(a)											
Th ppm	5.9	(b)	6.05	(a)	6.3	(a)	7.8	(a)	3.5	(b)		3.5	(b)						
U ppm	1.46	(b)	1.7	(a)	1.76	(a)	2.3	(a)	0.93	(b)		0.86	(b)						

technique: (a) INAA, (b) radiation counting, (c) e probe

Table 2. Chemical composition of clasts in 15465.

reference	Lindstrom89			Warren 78	
weight			c1	c2	
SiO2 %	48.8	(a)	44.3	48.8	(a)
TiO2	0.32	(a)	0.27	0.32	(a)
Al2O3	21.9	(a)	34	21.9	(a)
FeO	5.2	(a)	1.54	5.15	(a)
MnO			0.014	0.01	(a)
MgO	10.5	(a)	0.83	10.5	(a)
CaO	13.3	(a)	19.3	13.3	(a)
Na2O	0.35	(a)	0.34	0.35	(a)
K2O	0.097	(a)	0.02	0.11	(a)
P2O5			.		
S %					
sum					
Sc ppm	9.9	(a)	1.9	9.9	(a)
V					
Cr	1740	(a)		1740	(a)
Co	15.5	(a)	7.5	15.5	(a)
Ni			4	110	(a)
Cu					
Zn			0.98	10.2	(a)
Ga			4	5.7	(a)
Ge ppb			53	80	(a)
As					
Se					
Rb					
Sr					
Y					
Zr					
Nb					
Mo					
Ru					
Rh					
Pd ppb					
Ag ppb					
Cd ppb			3.8	62	(a)
In ppb			0.34	40	(a)
Sn ppb					
Sb ppb					
Te ppb					
Cs ppm					
Ba	110	(a)		110	(a)
La	7.3	(a)	0.6	7.3	(a)
Ce	21	(a)		21	(a)
Pr					
Nd					
Sm	3.04	(a)	0.26	3.04	(a)
Eu	0.99	(a)	0.8	0.99	(a)
Gd					
Tb	0.71	(a)		0.71	(a)
Dy					
Ho					
Er					
Tm					
Yb	2.4	(a)		2.4	(a)
Lu	0.36	(a)		0.36	(a)
Hf	2.4	(a)		2.4	(a)
Ta				0.22	(a)
W ppb					
Re ppb				1.2	(a)
Os ppb					
Ir ppb			0.09	5.9	(a)
Pt ppb					
Au ppb			0.056	0.76	(a)
Th ppm	1.23	(a)		1.23	(a)
U ppm	0.35	(a)		0.35	(a)
technique:	*(a) INAA*				

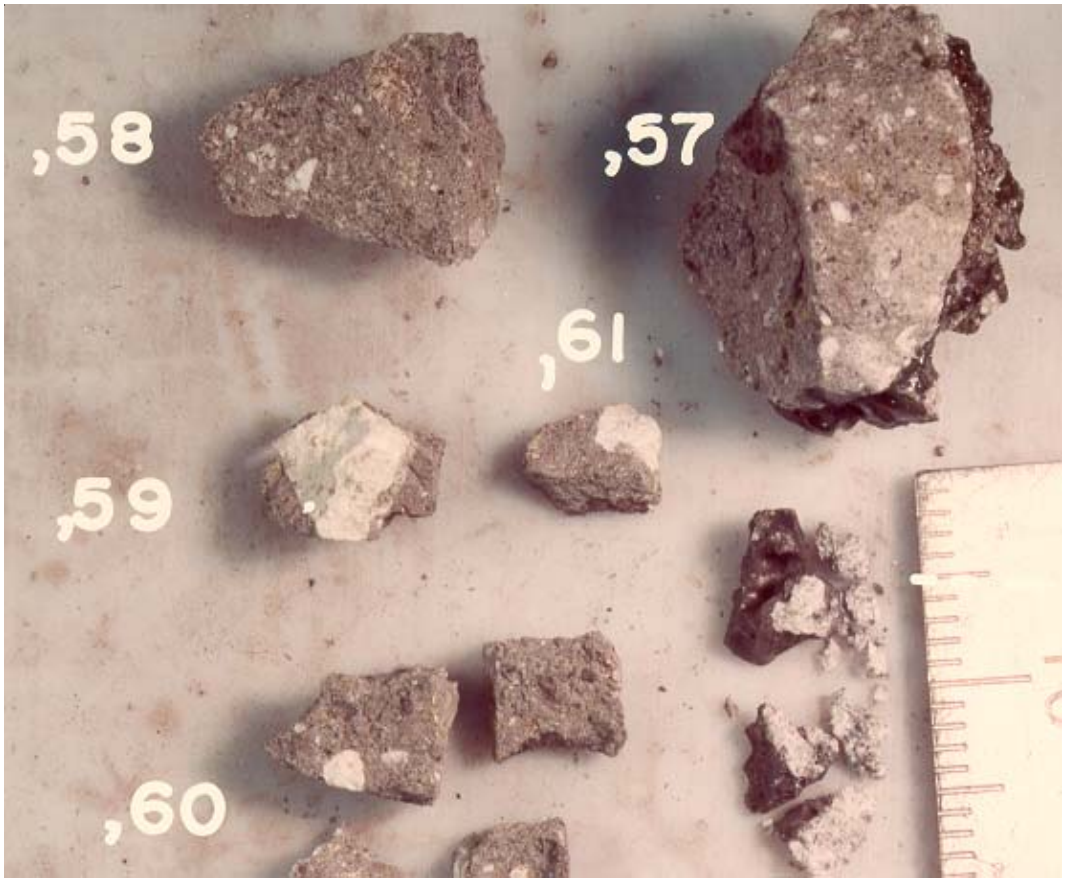
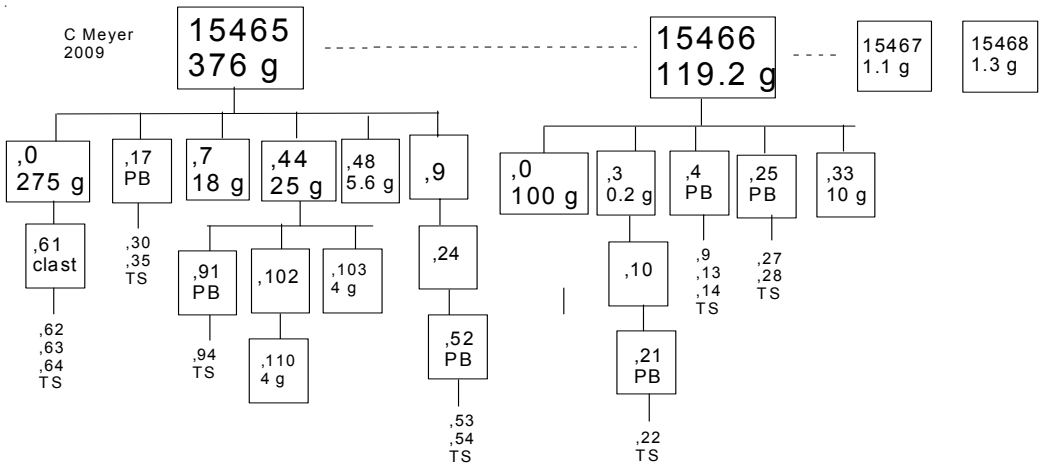


Figure 13: Processing photo of 15465 showing breccia clasts including one large white lithic clast in ,59 and ,61. Scale is cm and mm. NASA S77-23097.



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