62295

Impact melt Breccia

250.8 grams

Figure 1: Photo of 62295. NASA S72-44492 - about 8 cm across. Micrometeorite bombardment smoothed the surface and nearly broke the rock.

Introduction

Lunar sample 62295 is a blocky coherent impact melt rock with numerous micrometeorite pits on one side and none on the other (figure 1). It contains abundant Mg-rich olivine along with minor Mg-Al spinel and has a high Ni and Ir content. It was collected near Buster Crater and is 3.87 b.y. old, with cosmic ray exposure 300 m.y.

62295 is unusual in that it has a very high Mg/Fe ratio, and has also been terned a "troctolitic vitrophyre."

Petrography

McGee et al. (1977) describe 62295 as a clast-bearing impact-melt breccia characterized by randomly oriented plagioclase laths (up to 0.8 mm) intergrown with skeletal olivine crystals resulting in a variolitic texture (figure 2). The intersticies are filled with a

Mineralogical Mode for 62295

	McGee et al. 1977	Ryder and Norman 1980	Walker et al. 1973
Olivine	25	25	28.3
Pyroxene	1		
Plagioclase	55	55	33.5
Mesostasis	15	15	31.6
Spinel		5	6.5
Opaque	4		

Figure 2: Photomicrographs of thin section 62295,69. Top is S79-27425(plane polarized light), middle is S79-27426 (crossed polarized light), bottom is S79-27424 (reflected light). All are 2.5 mm across.

complex mesostasis and relict clasts of plagioclase, rare lithic clasts and conspicuous barred olivine-like bodies scattered randomly throughout the rock. Octahedra of tiny pink Mg-rich spinel commonly occur in plagioclase. Both irregular vugs (up to 1 mm) and spherical vesicles (up to 0.4 mm) are relatively common.

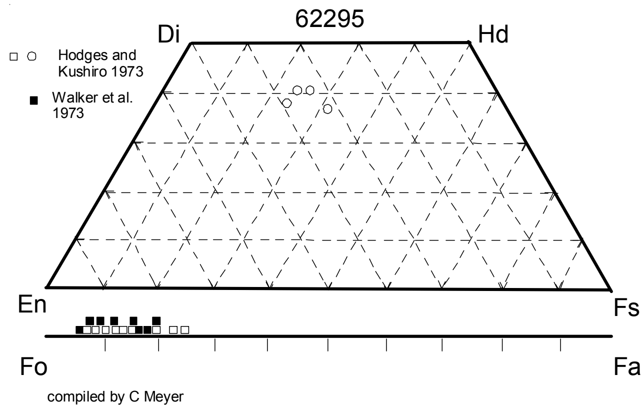


Figure 3: Pyroxene and olivine composition of 62295 impact melt with xenocrysts.

Brown et al. (1973) and Norman and Ryder (1980) describe 62295 as a fine-grained, mesostasis-rich basaltic impact melt with the mineralogy of a “spinel troctolite”. Xenocrysts of Mg-rich olivine, Ca-rich plagioclase, pink spinel and metal grains (with attached schreibersite) are found throughout (figure 4).

Walker et al. (1973) found reaction rims on some inclusions along with evidence of extremely rapid crystallization. Weiblen and Roedder (1973) studied melt inclusions in the olivine and plagioclase.

Mineralogy

Olivine: Olivine is present as xenocrysts (Fo_{90-95}) and as fine skeletal grains (Fo_{75-92}) in the matrix (spiniflex texture). Steele and Smith (1975) reported on the minor elements in olivine.

Pyroxene: Clinopyroxene with ferroaugite composition is a minor phase found only in the mesostasis (figure 3).

Plagioclase: McGee et al. (1979), Hodges and Kushiro (1973), Walker et al. (1973) and Vaniman and Papike (1981) determined plagioclase was An_{95-91}.

Spinel: Pink Mg, Al- spinel is 9-16% chromite.

Metal: Misra and Taylor (1975) and Taylor et al. (1976) studied metal particles in 62295 (figure 5).

Schreibersite: Hunter and Taylor (1981) reported abundant schreibersite. Schreibersite in 62295 is Ni rich (Brown et al. 1973).

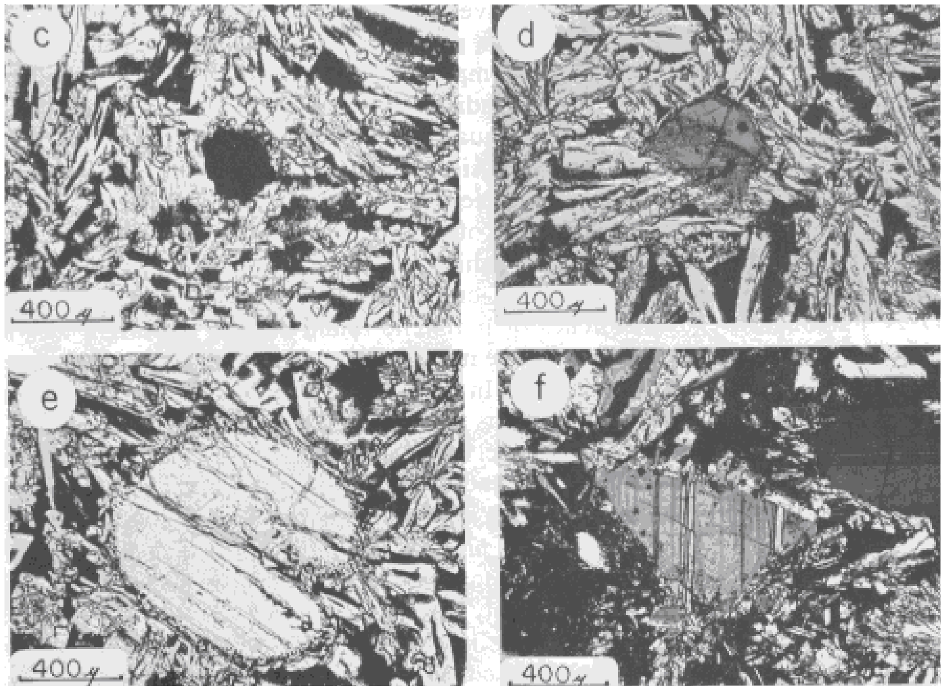


Figure 4: Thin section pictures of small xenocrysts in 62295: c) iron grain, d) pink spinel, e) olivine with reaction rim, f) plagioclase with spinel rim (this is part of figure 3 in Walker et al. 1973).

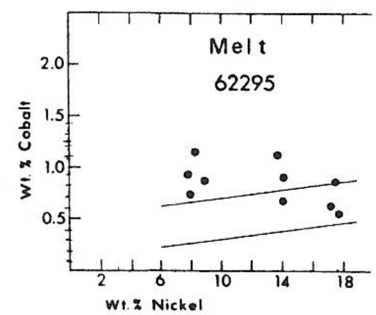


Figure 5: Ni and Co content of iron grains in 62295 (Misra and Taylor 1975).

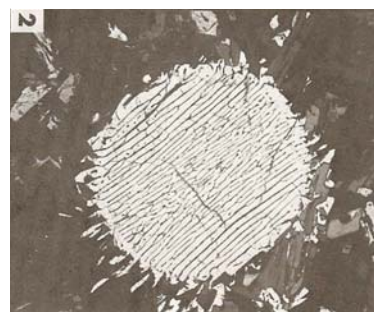


Figure 6: Barred olivine "chondrule" in 62295 (figure lifted from Roedder and Weiblen 1977). About 700 microns across.

Chemistry

The bulk analysis of 62295 by Eldridge et al. (1973) is consistent with the small samples analyzed by Rose et al. (1973), Wanke et al. (1976) and Hubbard et al. (1973). The sample is very Mg rich (table 1) and plots near the coetectic on the multisaturated equilibrium phase diagram (figure 8). It contains substantial Ni and Ir, indicating meteoritical contamination of the melt. The rare earth element content is high (figure 7).

Radiogenic age dating

Nyquist et al. (1973) determined the Sr isotopic composition. Turner et al. (1973) determined the age (3.89 b.y.) of 62295 by the Ar/Ar plateau technique (figure 9). Mark et al. (1974) determined a Rb/Sr isochron of 4.0 b.y. (figure 10). Norman et al. (2006) repeated these measurements with perhaps better instrumentation and got essentially the same result (3.866 ± 0.012 b.y.)(figures 11 and 12).

Cosmogenic isotopes and exposure ages

Eldridge et al. (1973) determined the cosmic-ray-induced activity of ^{26}Al = 110 dpm/kg and ^{22}Na = 59 dpm/kg. Turner et al. (1973) determined an exposure age of 310 m.y. by ^{38}Ar. Marti et al. (1974) determined a ^{81}Kr exposure age of 235 m.y. Bhandari et al. (1973) reported on the solar flare tracks in 62295.

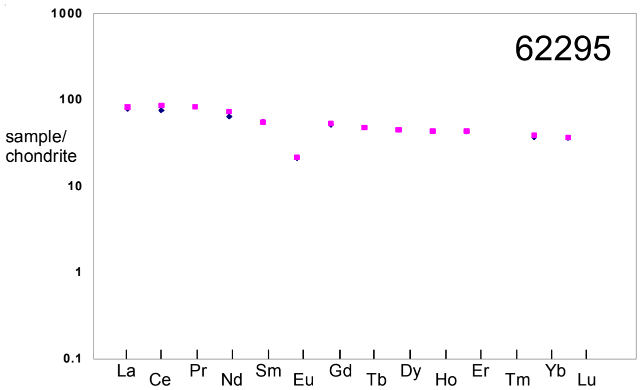


Figure 7: Normalized rare-earth-element composition of 62295 (data from Hubbard et al. 1973 and Wanke et al. 1973).

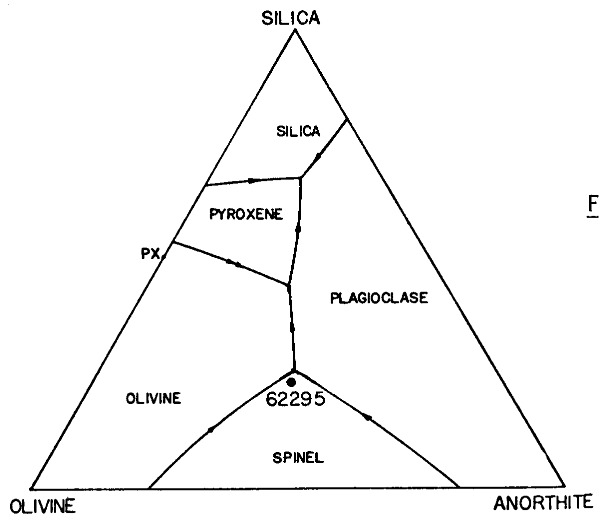


Figure 8: Composition of 62295 plotted on pseudoquaturnary phase diagram determined by Walker et al. 1973.

Other Studies

Taylor and Epstein (1973) reported the oxygen isotope composition of 62295 and Lightner and Marti (1974) reported Xe isotopes.

Walker et al. (1973), Hodges and Kushiro (1973) and Ford et al. (1974) experimentally studied phase equilibria as function of temperature and pressure (figure 14), but these experiments seem meaningless if the rock is an impact melt.

Morrison et al. (1973) and Neukum et al. (1973) studied the microcraters on the exposed surface of 62295 (figure 16).

Brecher et al. (1973) studied the magnetic properties and Todd et al. (1973), Wang et al. (1973) and Katsube and Collett (1973) studied the physical properties of 62295.

Processing

The rock broke in three pieces along existing cracks (figure 13). One piece (,5), was sawn apart (figures 15 and 17). This is an "oriented sample", but it has not been studied as such. There are 33 thin sections of 62295. The research on 62295 is well summarized in the catalog by Ryder and Norman (1980).

Table 2	U ppm	Th ppm	K ppm	Rb ppm	Sr ppm	Nd ppm	Sm ppm	technique
Nyquist et al. 1973				4.59	138.6			idms
				4.69	136.5			idms
Mark et al. 1974			562	4.02				idms
Eldridge et al. 1973	0.82	3.2	630					counting
Wiesmann 1975	0.88	3.47	605	4.59	139	29	8.3	idms
Wanke et al. 1976	0.76	2.7		5.58	132	33	8.1	INAA

Table 1. Chemical composition of 62295.

reference	Hubbard73	Wiesmann75			Krahenbuhl 73		Rose73		McKinley84		Eldridge 73		Wanke 76		
weight															
SiO2 %							45.16	(c)	45.3	(d)			45.1	46	(f)
TiO2	0.685	0.68	0.67	(a)			0.7	(c)	0.72	(d)			0.72		(f)
Al2O3	20.3						20.05	(c)	20.5	(d)			20.8	21	(f)
FeO	5.84						6.4	(c)	6.2	(d)			6.3	6.4	(f)
MnO							0.09	(c)	0.09	(d)			0.08	0.08	(f)
MgO	14.3						14.85	(c)	14.7	(d)			14.7	14.9	(f)
CaO	10.6						11.85	(c)	11.6	(d)			12		(f)
Na2O	0.46	0.46	0.43	(a)			0.48	(c)	0.44	(d)			0.46	0.45	(f)
K2O	0.073	0.073	0.074	(a)			0.11	(c)	0.08	(d)	0.076	(e)	0.079	0.079	(f)
P2O5							0.15	(c)	0.14	(d)			0.15		(f)
S %															
sum															
Sc ppm				(a)			9.2	(c)					10.3	10.5	(f)
V				(a)			23	(c)							
Cr	773	773	1009	(a)			1300	(c)					1270	1295	(f)
Co							34	(c)					23	19.6	(f)
Ni					215	(b)	313	(c)					330	280	(f)
Cu							10	(c)					18.1		(f)
Zn					16.5	(b)	18	(c)					22.1		(f)
Ga							2.6	(c)					2.74		(f)
Ge ppb					642	(b)							800		(f)
As													110		(f)
Se					186	(b)							310		(f)
Rb	4.59	4.59	4.692	(a)	5.8	(b)	6.4	(c)					5.58		(f)
Sr	139	139	137	(a)			100	(c)					132	142	(f)
Y													59		(f)
Zr		247		(a)			210	(c)					283	300	(f)
Nb							12	(c)					18		(f)
Mo															
Ru															
Rh															
Pd ppb															
Ag ppb					2.9	(b)									
Cd ppb					4.9	(b)									
In ppb															
Sn ppb															
Sb ppb					0.88	(b)									
Te ppb					12.5	(b)									
Cs ppm					0.53	(b)							0.56	0.49	(f)
Ba	187	187	182	(a)			135	(c)					197	184	(f)
La	18.6	18.6	18.1	(a)									19.2	19.5	(f)
Ce	45.9	45.9	46	(a)									52.2	53.4	(f)
Pr													7.4		(f)
Nd	29	29		(a)									33	36	(f)
Sm	8.3	8.3	8.05	(a)									8.1	8.17	(f)
Eu	1.18	1.18	1.15	(a)									1.21	1.19	(f)
Gd	10.1	10.1	10.2	(a)									10.4		(f)
Tb													1.76	1.79	(f)
Dy	10.8	10.8	10.6	(a)									11	10.6	(f)
Ho													2.4	2.4	(f)
Er	6.85	6.85	6.69	(a)									6.9		(f)
Tm															
Yb	6.06	6.06	5.86	(a)			6.4	(c)					6.29	6.48	(f)
Lu	0.879	0.879	0.863	(a)									0.905	0.883	(f)
Hf		6.3		(a)									6.55	6.74	(f)
Ta													0.78	0.82	(f)
W ppb													372		(f)
Re ppb					0.336	(b)							1.2		(f)
Os ppb															
Ir ppb					3.58	(b)							5.5	3.8	(f)
Pt ppb															
Au ppb					3.1	(b)							7		(f)
Th ppm		3.47		(a)							3.2	(e)	2.7	2.74	(f)
U ppm	0.882	0.88	0.87	(a)	0.935	(b)					0.82	(e)	0.76		(f)

technique: (a) IDMS, (b) RNAA, (c) microchemical, (d) strange, (e) radiation counting. (f) INAAand RNAA

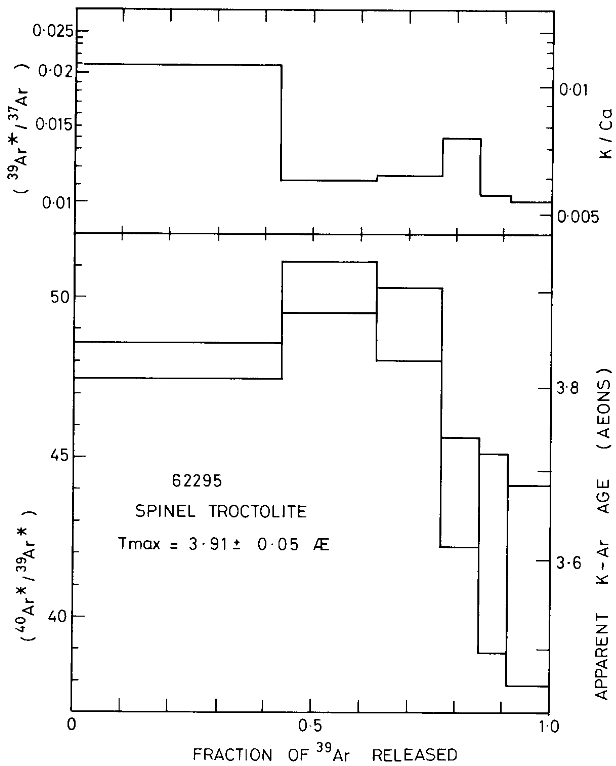


Figure 9: Ar plateau diagram for 62295 (Turner et al. 1973).

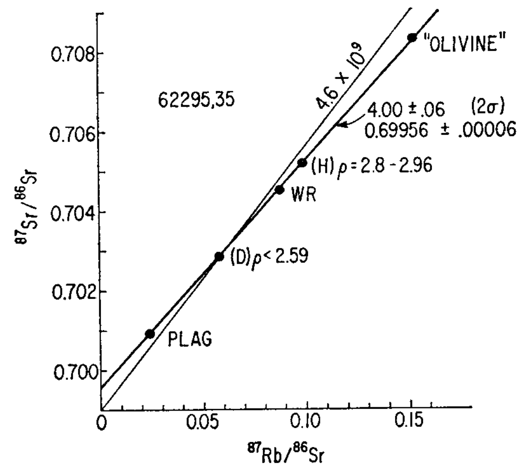


Figure 10: Rb/Sr internal mineral isochron for 62295 (Mark et al. 1974).

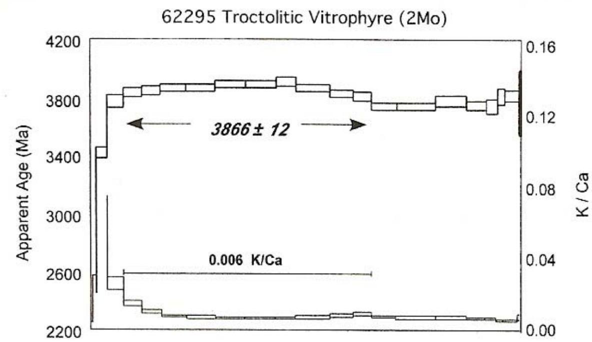


Figure 11: Ar/Ar plateau diagram for 62295 (Norman et al. 2006).

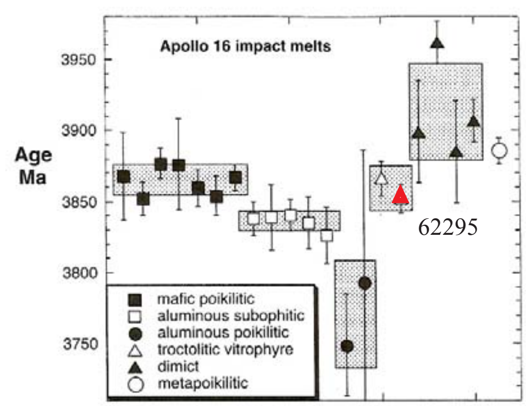


Figure 12: Ages of Apollo 16 samples collected by Marc Norman, with 62295 highlighted.

Summary of Age Data for 62295

	Ar/Ar	Rb/Sr
Turner et al. 1973	3.89 ± 0.05 b.y.	
Mark et al. 1974		4.00 ± 0.06
Caution : Old decay constants !		
Norman et al. 2006	3.886± 0.012	

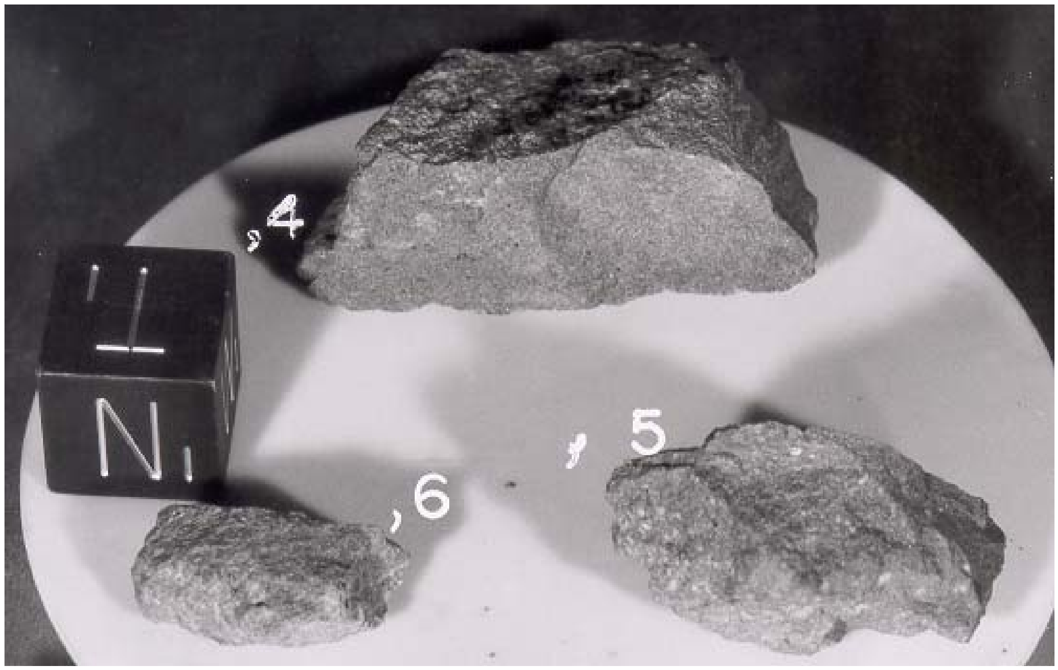


Figure 13: Pieces of 62295. NASA S72-42839. Cube is 1 inch.

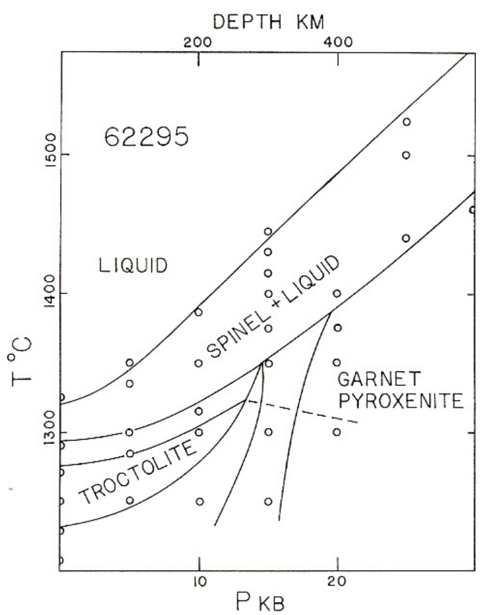


Figure 14: Experimental phase diagram for 62295 (Walker et al. 1973).

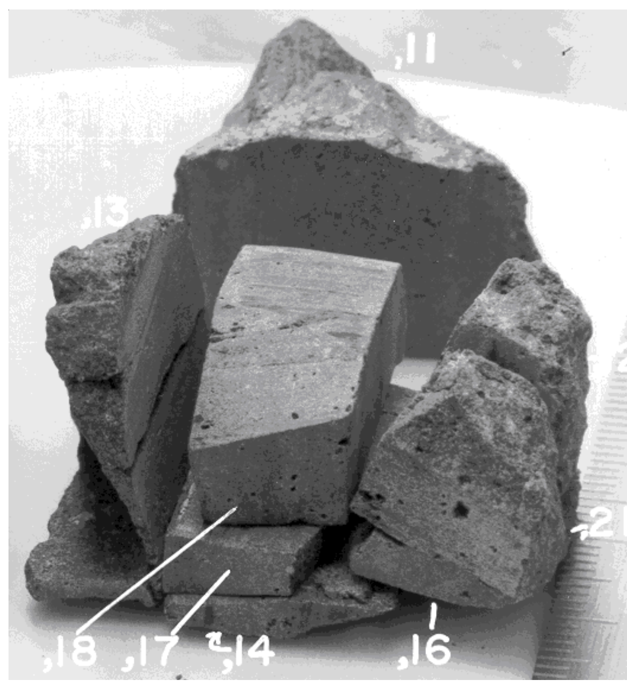


Figure 15: Cutting diagram for 62295,5. NASA S72-50656. Sample is about 1 inch.

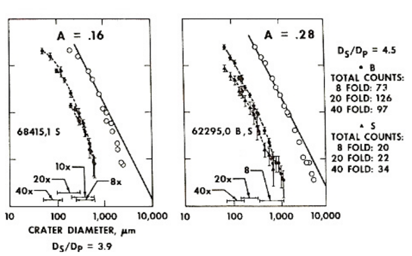
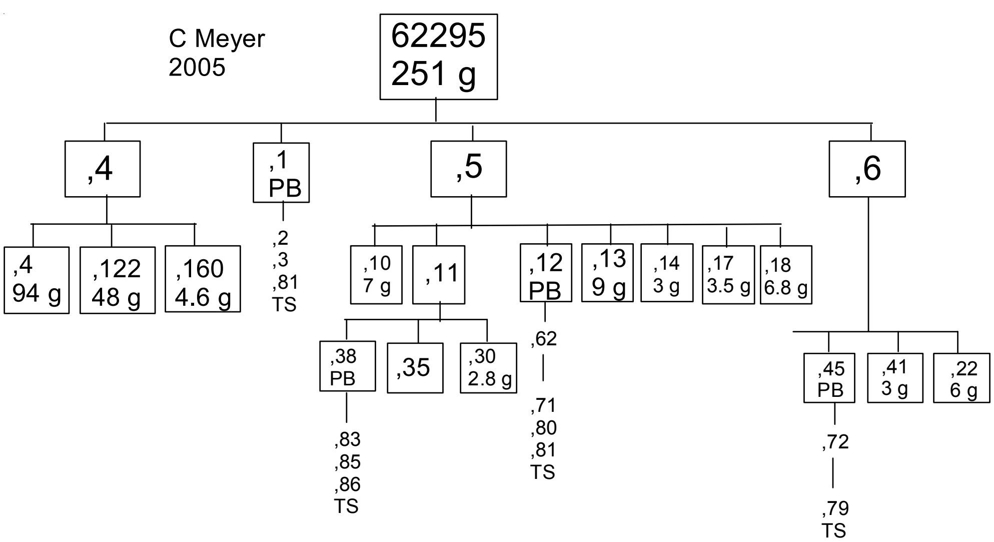


Figure 16: Density distribution of micrometeorite craters on exposed surface of 62295 and 68415 (Neukum et al. 1973).

Figure 17: Exploded parts diagram for 62295,5. NASA S72-50654. Large cube is 1 inch.



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