66095
“Rusty Rock”
Impact Melt Rock
1185 grams

Revised

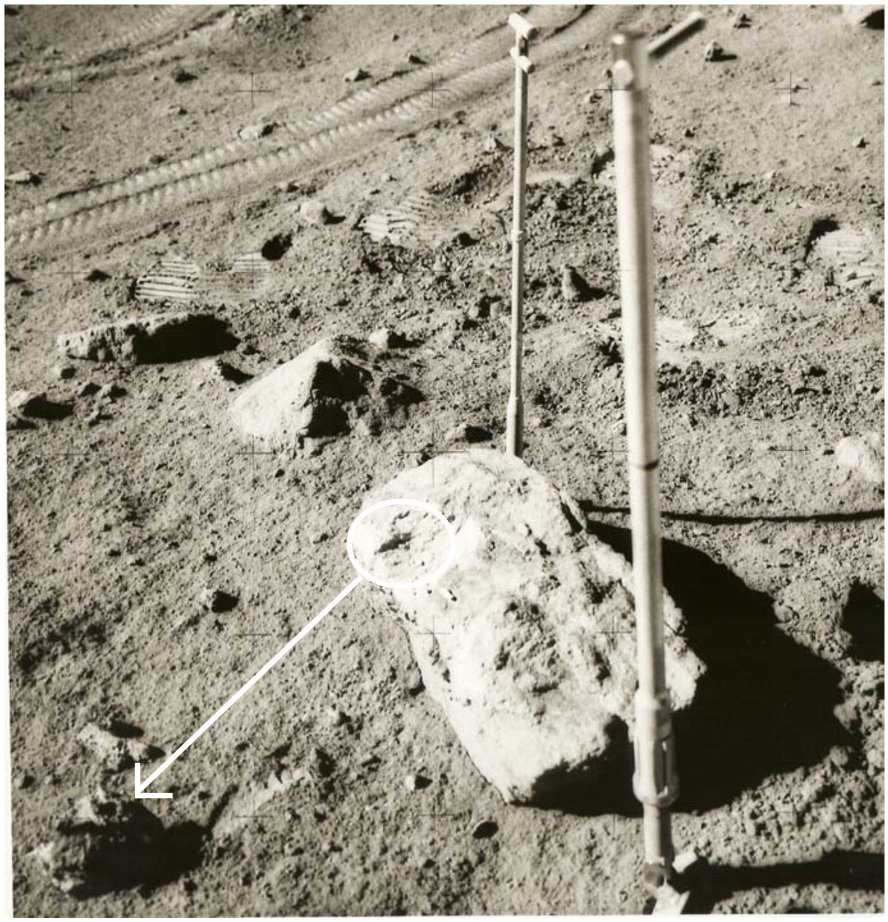


Figure 1: 66095 was chipped from a small boulder (0.5 m). AS16-108-17632.

LMP Let me whack this thing right here. It’s so good that I can’t pass it up. All right, there’s a good place to whack.
CDR Oh, that’s hard – you got it! Demolished it.
LMP That’s a great rock. Look at that! I’m sorry we didn’t get it documented before, but that’s a good sample. I think it’s a crystalline rock.
CC Okay, let’s go ahead and document it now - - so we get the location of the one that’s still in place. It didn’t look like it moved.
CDR No, he didn’t move anything there. I’m going to do an up-sun on this documentation (107-17523-25)
LMP Okay, I’ll get a cross-sun here. It’s a grayish bluish – rock, Tony, in the matrix with some white clast in it. The matrix is so fine-grained, I can’t tell, but it’s definitely got a blue cast to it and there are inclusions of a whitish – it looked like plag to me.
CDR And then, needle-like black crystals in it, too. I see one in there that’s a millimeter wide by 3 mm long, and some other needle-like crystals in it.
LMP Here’s another piece – came off the same rock.
CDR It has this white clast in it. It’s got to be a breccia, Charlie.

“One of the most striking features of the moon is its great depletions in volatiles, such as C, N, H_2O, Pb, Bi and Tl. Apparently these elements were left behind in the solar nebula when the moon accreted. For an understanding of the moon’s chemistry, it would be of interest to know the magnitude of this depletion, relative to cosmic or terrestrial abundances. The only elements for which this can be estimated with some confidence are Tl and Pb ——.”

Krahenbuhl et al. 1973

Figure 2: Photo of 66095, fresh broken side. Cube is 1 cm. S72-39284 (faded)

Figure 3: Close-up photo of metallic salts or "rust" on surface of 66095 (location unknown). Note the appearance of a crust under the colored salts. Field of view about 1 cm. NASA S72-48424.

Figure 4: Photo of top surface of 66095 (note the zap pits and penetrating fracture). Cube is 1 cm. NASA S72-41445.

Introduction

Lunar sample 66095 was collected from a boulder on the rim of a 10 meter crater at the base of Stone Mountain (figure 1). During the original examination of 66095 by (M. Bass in Butler 1972), an unusual amount of colored stain (figure 3) was reported on the surface and interior of 66095 (LSPET 1973). In thin section it was also noted that the iron grains within 66095 were also "rusted" (figure 8). The original descriptions were that of "limonite" or "goethite", but X-ray determination (Taylor et al. 1973, 1974) showed that some of it was the hydrous mineral phase akaganite (FeOOH). Although this observation led to 66095 being labeled "Rusty Rock", the enrichment in ^{204}Pb, Zn, Cl and other volatile elements in 66095 indicates that portions of this sample contain substantial sublimates of unknown origin. Thus this sample has greater importance that the term "Rusty Rock" might

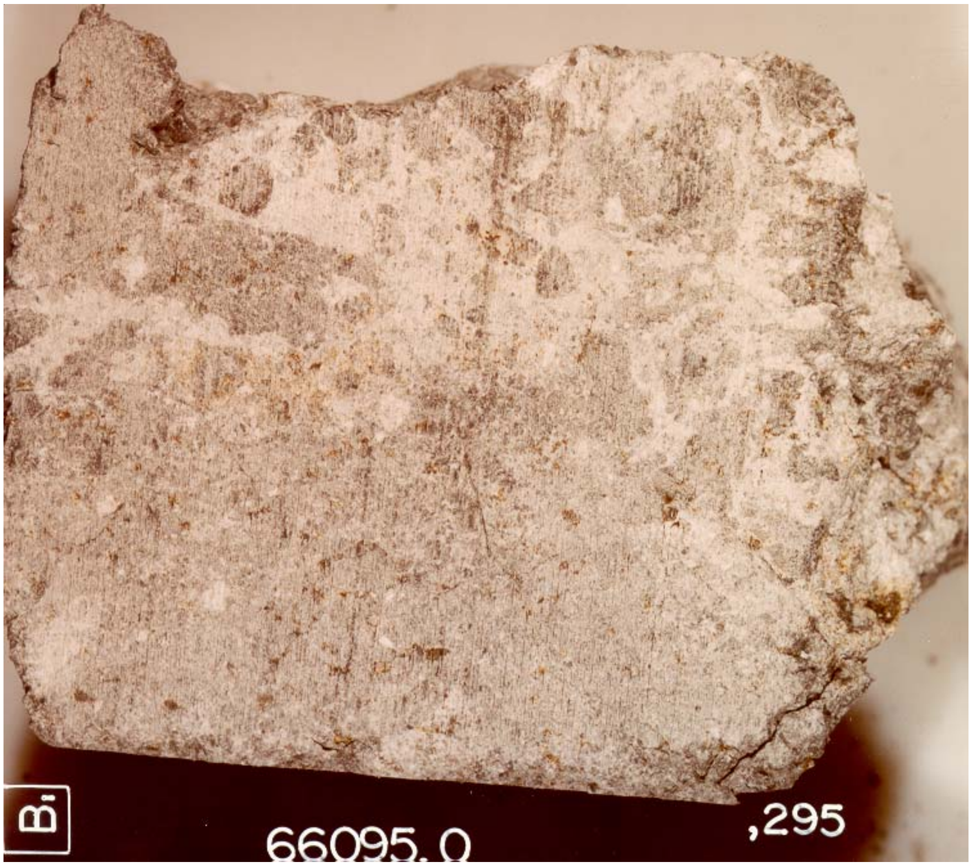


Figure 5 : Sawn surface showing interior of 66095. S

otherwise portray and deserves renewed attention by chemists studying the transport of volatiles on the Moon!

The crystallization age of 66095 is 3.8 b.y. and cosmic ray exposure is 40-80 m.y. One side (B, S) of 66095 has abundant zap pits (figure 4). The sample is generally lacking in cavities.

It is possible that anhydrous metal salts (chlorides?) in 66095 combined with the moisture in the LM, CM, tropical Pacific and/or individual terrestrial laboratory, yielding terrestrial-like hydrogen and oxygen isotopic signatures (Friedman et al. 1974; Epstein and Taylor 1974). However, it is difficult to see how moisture penetrated into the sample to "rust" the interior metal grains.

Petrography

Most of 66095 (~80%) is composed of a fine-grained, subophitic to ophitic impact melt-rock (figures 5, 6 and 7), which also contains a wide variety of lithic clasts (from basalt to anorthosite) (Garrison and Taylor 1980, Hunter and Taylor 1981). The suite of lithic clasts found in 66095 contains every highland rock type except norite. The matrix and many of the clasts have high meteoritic siderophiles (Ir, Au).

66095 contains a wide variety of fine-grained clasts of melt-rock ranging in texture from porphyritic to poikiloblastic to intergranular (Hunter and Taylor 1981). These appear to have a high REE content and all appear to be reworked (i.e. have high Ir, Au).

The types of plutonic clasts that are found in 66095 are best indicated by the plagioclase, mafic mineral composition diagram (figure 10). The intergranular and cataclastic anorthosites appear to be related to the Mg-gabbro trend, while the troctolitic anorthosites appear to be ferroan. A brief description of clasts analyzed is found as an appendix to Hunter and Taylor (1981).

Although numerous Apollo 16 rocks exhibit some rust around metallic iron grains, 66095 is unusual in that it has abundant evidence of alteration. Alteration is found in the interior as well as on the surface. In thin section, the thin grey margins to metallic iron grains indicates

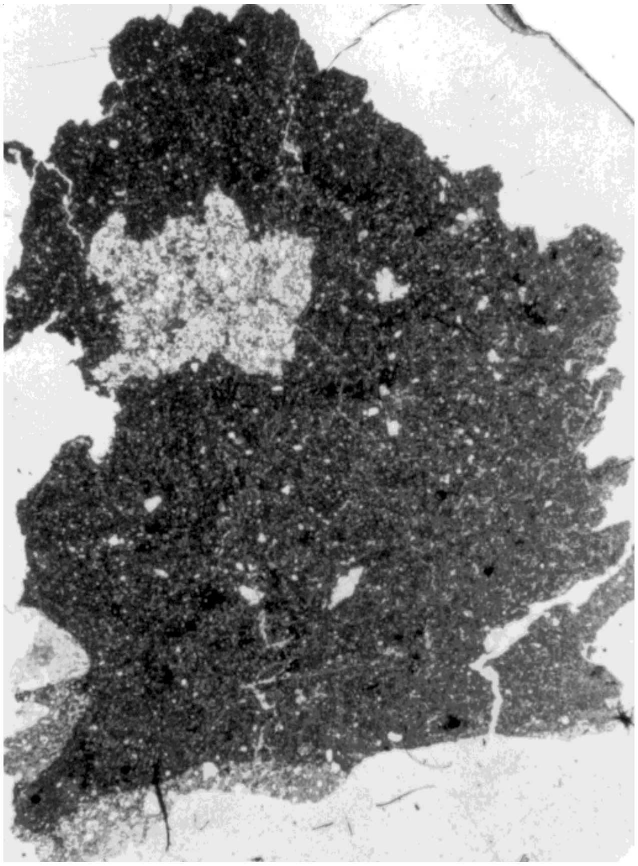


Figure 6: Photomicrograph of thin section 66095,11 illustrating clast in melt-rock matrix. Field of view is ~1cm. NASA S72-43649.

rusting *insitu*. The brown stain extends into the silicates surrounding the iron grains. It is difficult to believe that this is the result of terrestrial alteration.

Mineralogy

Olivine: Garrison and Taylor (1980) determined that olivine was uniform in composition (~Fo_{77}) throughout the rock.

Pyroxene: Pyroxene compositions in various lithologies of 66095 are poorly documented. Garrison and Taylor (1980) state that pyroxene was variable $W_7En_{72}Fs_{20}$ to $Wo_{17}En_{65}Fs_{18}$. Vaniman and Papike

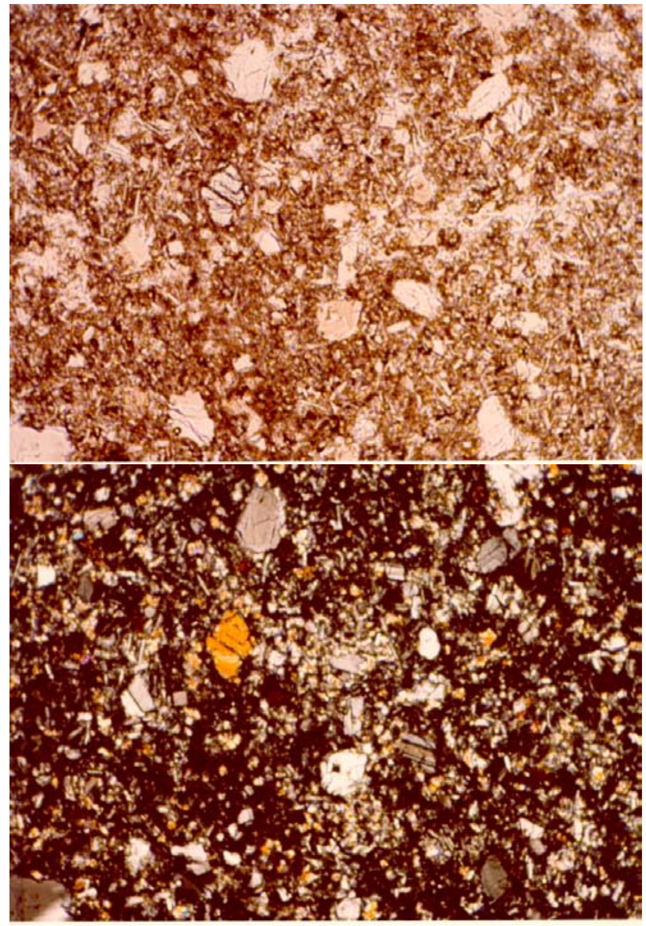


Figure 7: Photomicrographs of thin section 66095,86 illustrating poikilitic and intergranular texture of melt-rock matrix including small mineral clasts. Field of view is 1.3 mm. Top view is plane-polarized light; bottom is with crossed-polarizers). NASA S79-27744 and 27745.

(1980) also reported pyroxene compositions (figure 11), probably for the melt-rock matrix. Based on these preliminary results, 66095 seems to be a bit different compared with other lunar samples.

Plagioclase: Garrison and Taylor (1990) reported that the plagioclase was locally uniform but slightly variable

Mineralogical Mode for 66095

	Taylor et al. 1973	**Vaniman and Papike 1980**		**Ryder and Norman 1980**
Olivine	35	10.2		10
Pyroxene		30.6		30
Plagioclase	50	45		50-60
Opaques	3			tr.
Metal		1.2		tr.
Glass		1.4		tr.
Xenocrysts	10-15	8.5	plagioclase	20

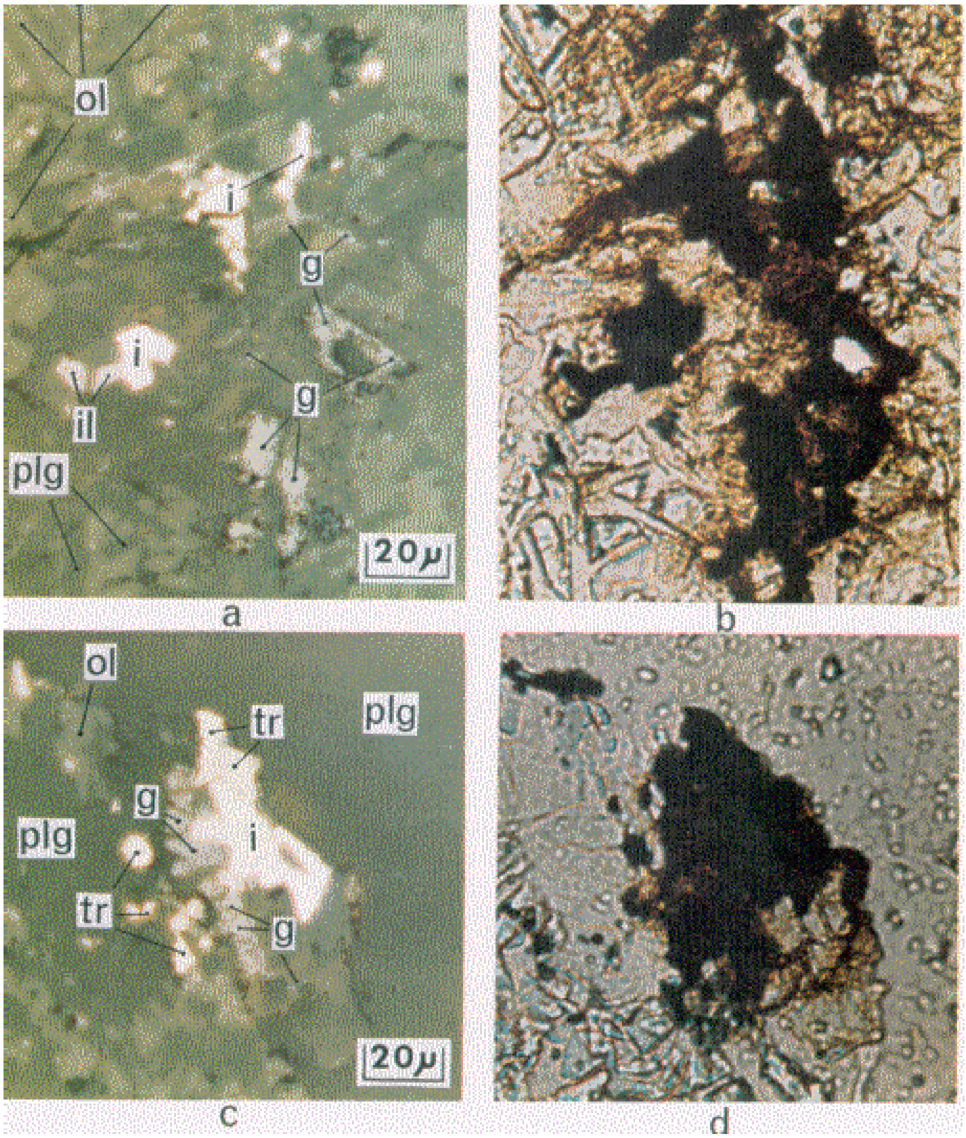


Figure 8: Reflected and transmitted light photomicrographs of opaque mineral assemblages in 66095 (iron, troilite, goethite) with surrounding "rust" in silicates (from Taylor et al. 1973). Scale is shown.

	% of rock		% of clast population	
PRIMARY CLASTS				
Anorthosite	0.8%	10.1%	3.6%	45.7%
Troctolitic anorthosite	2.3%		10.4%	
Fra Mauro basalt	2.1%		9.5%	
Plagioclase clasts	4.9%		22.2%	
Olivine clasts	tr		tr	
Pink spinel clasts	tr		tr	
2ND GENERATION CLASTS				
Cataclastic anorthosite	3.9%	12.0%	17.6%	54.2%
Gabbroic anorthosite	1.4%		6.3%	
Highland basalt	6.7%		30.3%	
MATRIX	77.9%		—	
	100.0%		99.9%	

Table of clast content found in 66095 (from Garrison and Taylor 1980).

Figure 9: Photo of freshly broken surface of 66095,13, showing anorthosite clast and region of mixed anorthosite and melt rock material. Sample is 11 cm across. NASA S79-34547.

in different areas (An_{89-94}). Bell and Mao (1973) report the minor element content of plagioclase.

Spinel: Rare grains of pink Cr-pleonaste spinel are found as mineral clasts in the matrix (Garrison and Taylor 1981).

Metallic iron: El Goresy et al. (1973) and Garrison and Taylor (1980) found that the Co and Ni in iron grains within clasts was slightly unusual, compared with that of iron in the matrix (figures 12 and 13). Misra and Taylor (1975) studied the Fe-Ni and schreibersite relationships.

Sphalerite: El Goresy et al. (1973) reported sphalerite rimming troilite in 66095 (table 8). Taylor et al. (1973) and El Goresy et al. (1973) reported that sphalerite contained ~28 % FeS.

Cohenite: El Goresy et al. (1973) show a picture of cohenite (Fe_3C) needles in an iron grain in 66095 and give an analysis.

Schreibersite: Schreibersite was reported already in the original catalog (Butler 1972).

Goethite: Goethite was reported surrounding metal grains (Butler 1972, El Goresy et al. 1973, Taylor et al. 1973) (figure 5). El Goresy et al. (1973) give several analyses – with variable Cl contents (table 7).

Akaganite: Taylor et al. (1974) determined that some of the "rust" in 66095 was the hydrous iron oxide akaganite (FeOOH). They found it contained 1-3 % Cl, which may be evidence that the origin of the rust was by oxidation and hydration of $FeCl_2$ (lawrencite ?).

Salts: El Goresy et al. (1973) recognized that the volatile metals were probably "salts" because Reed et al. had found that the chlorine was mostly leachable in hot water. They even promised to identify *"the proper nature of these compounds"* in a later report *(didn't happen)*.

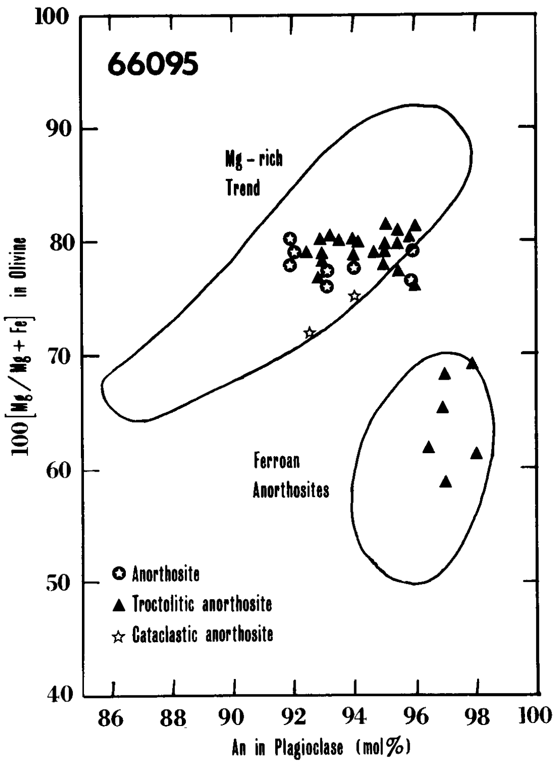


Figure 10: Plagioclase and pyroxene composition of clasts in 66095 (from Garrison and Taylor 1980).

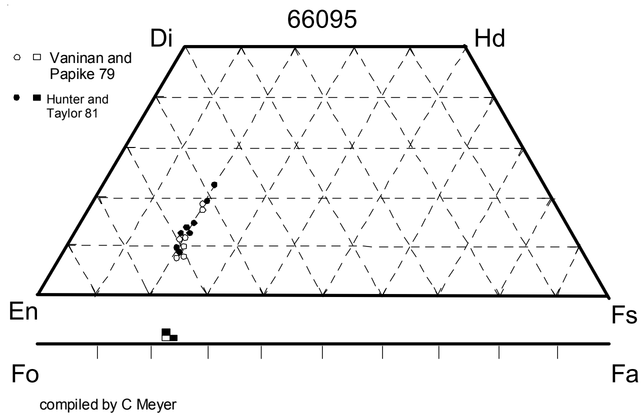


Figure 11: Pyroxene and olivine in matrix of 66095 (from Vaniman and Papike 1979 and Hunter and Taylor 1981).

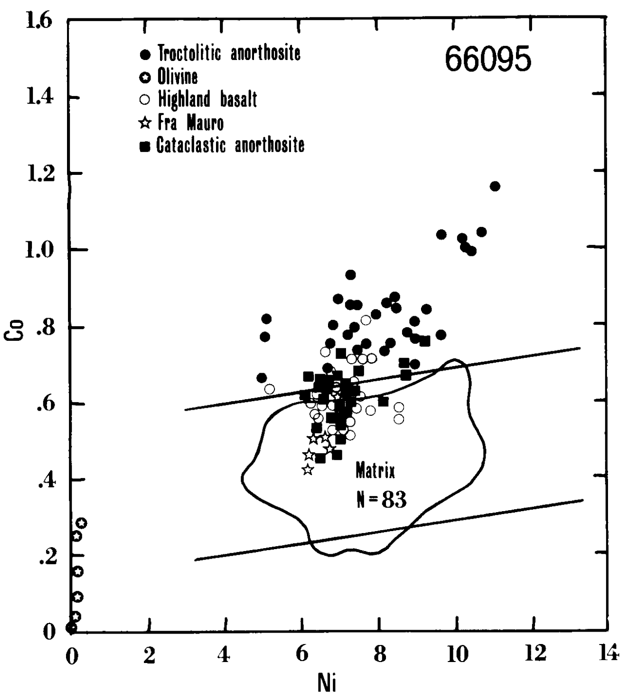


Figure 12: Composition of metallic iron grains in 66095 (from Garrison and Taylor 1980).

Chemistry

Garrison and Taylor (1980) noted that *"the concept of whole-rock chemistry is meaningless"* in the case of a multi-component breccia like 66095. Nevertheless, what is known about the composition of 66095 is tabulated herein and the rare-earth-elements are plotted as usual (figure 10a, b). Note that the general similarity to dimict Apollo 16 breccias.

Ebihara et al. (1992) and Wanke et al. (1981) both analyzed portions of the same clasts, but generally got different results for the elements that can be compared, presumably because of sample inhomogeneity for such small splits.

Volatiles: Nunes and Tatsumoto (1973) found that "66095 contained a remarkably high amount of Pb, 85% of which is not supported by U or Th". Krahenbuhl et al. (1973) found that 66095 was "strikingly enriched in volatile elements such as Br, Cd, Ge, Sb, Tl and Zn". This was confirmed by Ebihara et al. (1981, 1992) who found that In is also included in this list (Tables 4 and 6). Allen et al. (1974) found high amounts of ^{204}Pb, as well as high Tl, Zn, and Bi, in 66095. Hinthorne and Anderson (1974) determined

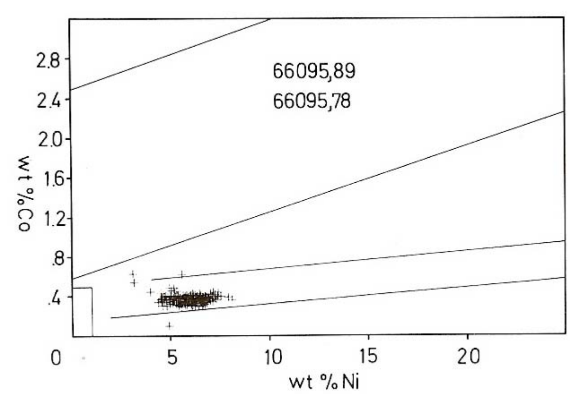


Figure 13: Composition of iron grains in 66095 as determined by El Goresy et al. (1973).

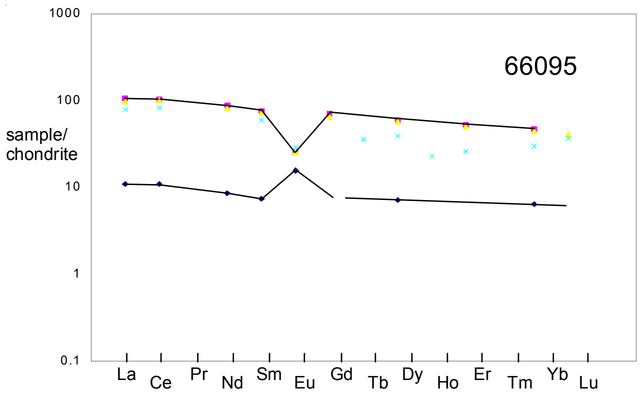


Figure 14: Normalized rare-earth-element diagram for 66095 (data from Hubbard et al. 1973 connected).

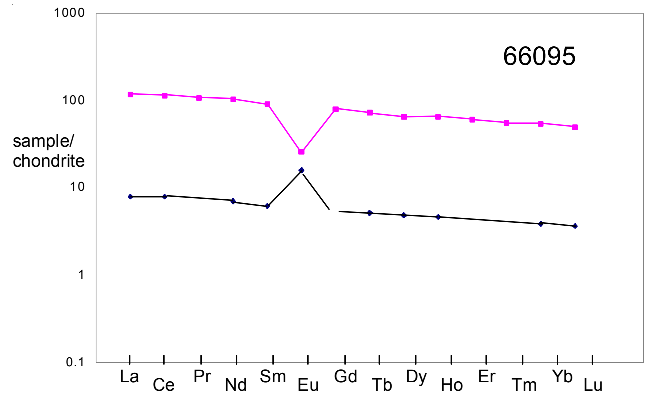


Figure 15: Normalized rare-earth-element diagram for 66095 (data from Wanke et al. 1981). Average of four basalt clasts and 5 anorthosite clasts)

the isotopic composition of Pb in Cl-rich regions with the ion miocroprobe. Jovanovic and Reed (1976) found that Ru and Os were the "highest ever" in 66095. Jovanovic and Reed (1981) determined very high contents of Cl, Br and I in clasts and matrix of 66095. Everything points to a fumarolic source for the volatile elements in 66095, as was first discovered and articulated by Krahenbuhl et al. (1973).

Epstein and Taylor (1974) and Friedman et al. (1974) carefully studied the temperature release and isotopic composition of H_2O released from 66095. Samples of 66095 were found to have far more H_2O than any other rock sample and somewhat more H_2O than any lunar soil. However, isotopic analysis indicated that the ä ^2H and ä ^{18}O were similar to that of terrestrial water.

Cirlin and Housley (1980) used thermal release curves to show that the volatiles (Pb, Zn and Cd) were present on the surfaces of grains from 66095 (figures 16 and 17). In an interesting set of experiments, Jovanovic and Reed (1981) showed that the Cl and Br were easily leached from clasts, matrix and whole rock samples of 66095 (Table 5). Wanke et al. (1981) showed that Zn and Cl were closely correlated (figure 18).

Radiogenic age dating

Turner et al. (1973) measured the Ar/Ar plateau age (figure 19). Nunes and Tatsumoto (1973) determined the U-Th-Pb systematics and Pb/Pb age (figure 20). Nyquist et al. (1973) reported Rb-Sr data for whole rock.

Cosmogenic isotopes and exposure ages

Turner et al. (1973) determined an ^{37}Ar exposure of 40-80 m.y. (figure 19). Rancitelli et al. (1973) determined the cosmic-ray-induced-activity of ^{22}Na = 44 dpm/kg. and ^{26}Al = 107 dpm/kg. Fruchter et al. (1978) determined 26Al and 53Mn giving exposure age of 0.9 and 1.4 m.y. respectively. Bhandari et al. (1973) determined a solar flare track density indicating exposure age of 1 m.y.

Other Studies

Nagata et al. (1973), Pearce et al.(1973) and Brecher (1975) determined the magnetic properties. Weeks (1973) provide electromagnetic resonance spectra. Tsay and Live (1976) and Tsay and Baumann (1977) found evidence for trace Fe+3 by ESR.

Heymann and Hubner (1974) determined rare gas contents.

Kerridge et al. (1975), Gibson and Moore (1973), Friedman et al. (1974) and Des Marais (1978) studied the isotopic composition of sulfur and carbon.

Processing

66095 was returned in a bag, so it would have seen the oxygen in the LM and, briefly, water vapor in the South Pacific. 66095 originally broke in two large pieces (see crack in figure 2). A large piece (,14) was pulled apart by the Rusty Rock Consortium (Larry Taylor). A piece (,60) was sawn into smaller pieces (figure 21).

There is an excellent description of 66095 in the original Apollo 16 catalog (by M. Bass in Butler 1972)

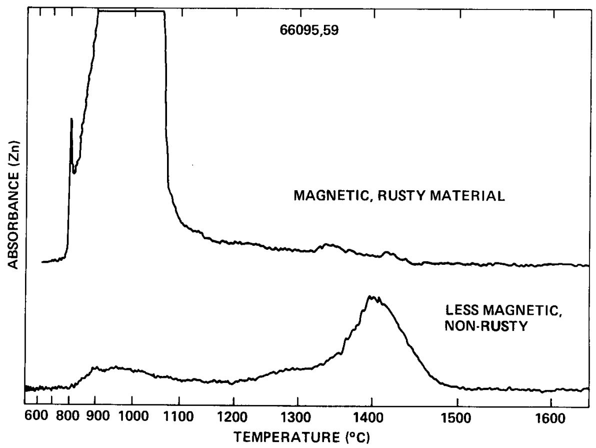


Figure 16: Temperature release profile for Zn from rusty grain in 66095 (from Cirlin and Housley 1980).

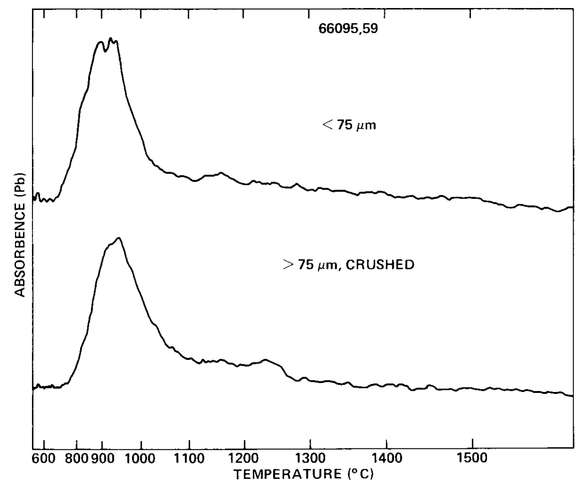


Figure 17: Temperature release profile for Pb from 66095 (from Cirlin and Housley 1980).

Table 5: Cl and Br fractions dissolved by hot water leach from 66095 whole rock, matrix and clasts (from Jovanovic and Reed 1981).

Sample*	% Leached by H_2O Cl	% Leached by H_2O Br
66095,		
271 TA	98	81
255 AB	29	82
357 CA2		83
264 B1	47	80
353 B3		89
242 Mx	61	70
17 wr, ext.	78	81
23 wr, int.	74	62

* See Tables 1 and 2 for sample descriptions.

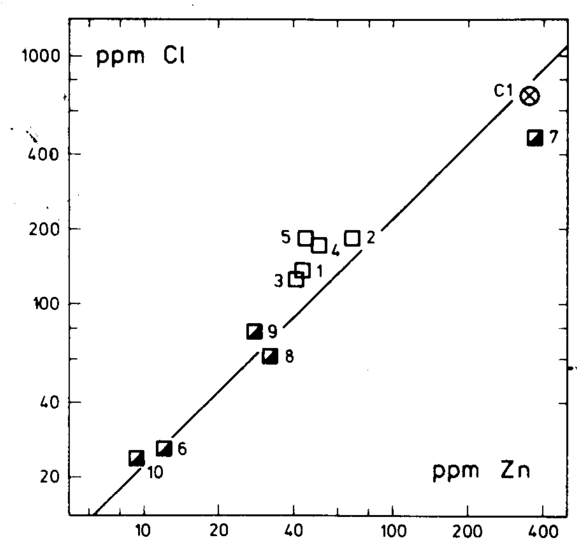


Figure 18: Correlation of Zn and Cl in 66095 clasts (from Wanke et al. 1981).

and research reported before about 1980 is discussed by Ryder and Norman (1980). Garrison and Taylor (1979) prepared a "guidebook" for "Rusty Rock", but apparently didn't get to examine the surface of 66095,1 (end piece in remote storage). Hunter and Taylor (1981) report preliminary results of the Rusty Rock Consortium (VAPOR) and the appendix therin, describes the sample splits sent to consortium members. Ebihara et al. (1992) compare data with that of Wanke et al. (1981) for subsamples of 66095 allocated to both groups.

Editorial Comment

Lighting conditions in lunar sample processing cabinets are not uniform, making careful observation of subtle color changes difficult at best.

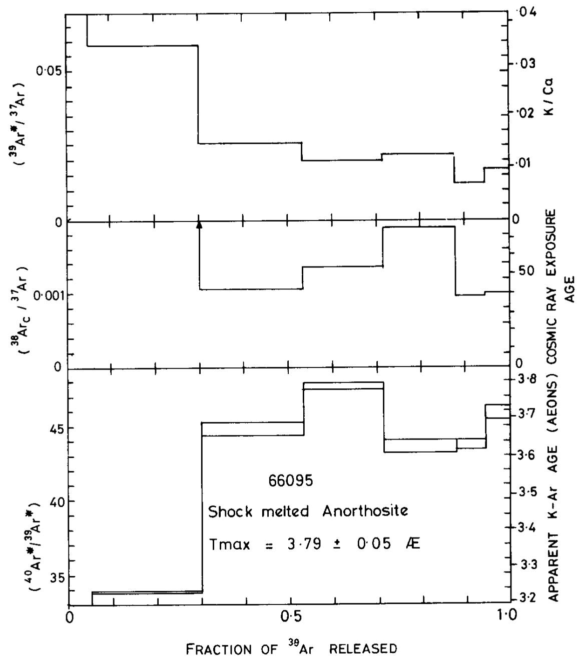


Figure 19: Ar/Ar "plateau" age for 66095 (Turner et al. 1973).

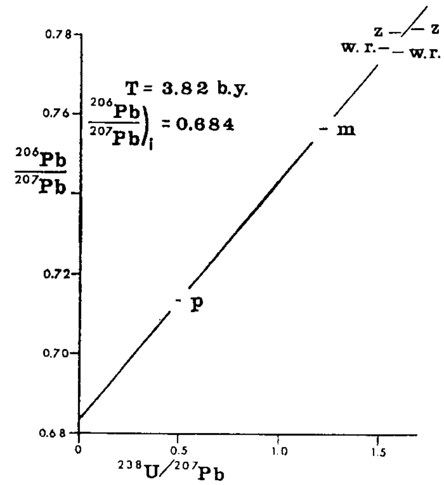


Figure 20: Pb/Pb isochron for 66095 (from Nunes and Tatsumoto 1973).

Summary of Age Data for 66095

	Ar/Ar	Pb/Pb
Turner et al. 1973	< 3.79 ± 0.05 b.y.	
Nunes and Tatsumato 1973		3.82 b.y.

Table 1a. Chemical composition of 66095.

reference	LSPET 73		Duncan 73		Wiesmann 75 Hubbard 74			Krahenbuhl74		Brunfelt 73		Nakamura 73		Nava 74	Jovanovic 73	
weight					,37	,36		Krahenbuhl73				215 mg.			Jovanovic 76	
SiO2 %	44.47	(a)	44.92	(a)	44.07		(a)					45.86		44.9		
TiO2	0.71	(a)	0.77	(a)	0.18	0.73	(b)			0.5	(e)	1		0.6		
Al2O3	23.55	(a)	23.66	(a)	30.02		(a)			25.9	(e)	24.45		23		
FeO	7.16	(a)	7.46	(a)	3.03		(a)			5.53	(e)	6.26		6.86		
MnO	0.08	(a)	0.08	(a)	0.05		(a)			0.07	(e)	0.08				
MgO	8.75	(a)	8.92	(a)	4.72		(a)			9.3	(e)	8.17		9.66		
CaO	13.69	(a)	13.52	(a)	16.65		(a)			12.9	(e)	13.74		13.48		
Na2O	0.42	(a)	0.45	(a)	0.35	0.39				0.46	(e)	0.48		0.48		
K2O	0.15	(a)	0.158	(a)	0.08	0.15	(b)			0.09	(e)	0.157		0.146		
P2O5	0.24	(a)	0.251	(a)	0.06		(a)					0.222		0.24		
S %	0.12	(a)	0.09	(a)	0.14		(a)									
sum																
Sc ppm										6.8	(e)					
V										110	(e)					
Cr	1010	(a)			578	823	(b)			860	(e)			890		
Co										44	(e)					
Ni	258	(a)	477	(a)				1100	(c)	710	(e)					
Cu			1.6	(a)						3.9	(e)					
Zn			39.5	(a)				50.5	(c)	92	(e)					
Ga										3.8	(e)					
Ge ppb								2140	(c)							
As																
Se								314	(c)							
Rb	3.9	(a)	4.15	(a)	1.591	3.61	(b)	3.9	(c)	11	(e)					
Sr	159	(a)	154	(a)	162.7	162	(b)									
Y	72	(a)	70	(a)												
Zr	322	(a)	340	(a)												
Nb	18	(a)	20.6	(a)												
Mo																
Ru															48	(c)
Rh																
Pd ppb																
Ag ppb								7.9	(c)							
Cd ppb								328	(c)							
In ppb										680	(e)					
Sn ppb																
Sb ppb								6.9	(c)							
Te ppb								20	(c)						80	(c)
Cs ppm								160	(c)	0.4	(e)					
Ba			237	(a)	36	233	(b)			150	(e)	229.3	(b)			
La					2.57	24.9	(b)			18.5	(e)	22.66	(b)			
Ce					6.56	63.2	(b)			50	(e)	61.26	(b)			
Pr																
Nd					3.87	40	(b)					37.36	(b)			
Sm					1.09	11.2	(b)			8.8	(e)	10.6	(b)			
Eu					0.88	1.43	(b)			1.63	(e)	1.419	(b)			
Gd						14	(b)					12.67	(b)			
Tb										1.3	(e)					
Dy					1.75	14.4	(b)			9.4	(e)	13.9	(b)			
Ho										1.3	(e)					
Er						8.34	(b)			4.1	(e)	7.99	(b)			
Tm																
Yb					1.04	7.63	(b)			4.9	(e)	7.23	(b)			
Lu										0.9	(e)	1.002	(b)			
Hf										5	(e)					
Ta										0.44	(e)					
W ppb																
Re ppb								2.13	(c)							
Os ppb															81	(c)
Ir ppb								16.6	(c)							
Pt ppb																
Au ppb								17.9	(c)							
Th ppm	2.7	(a)								2.2	(e)					
U ppm					0.138	1.04	(b)	1.02	(c)	1	(e)				0.9	(c)

technique: (a) XRF, (b) IDMS, (c) RNAA, (e) INAA

Table 1b. Chemical composition of 66095.

reference	Rancitelli73		Allen 74		Nunes and Tats73			Hughes 73		
weight	501 g				WR1	WR2				
SiO2 %										
TiO2										
Al2O3										
FeO										
MnO										
MgO										
CaO										
Na2O										
K2O	0.15	(d)								
P2O5										
S %										
sum										
Sc ppm										
V										
Cr										
Co										
Ni										
Cu										
Zn			18	(b)						
Ga										
Ge ppb										
As										
Se										
Rb										
Sr										
Y										
Zr										
Nb										
Mo										
Ru										
Rh										
Pd ppb										
Ag ppb								2.5	4.6	(e)
Cd ppb										
In ppb										
Sn ppb										
Sb ppb										
Te ppb										
Cs ppm										
Ba										
La										
Ce										
Pr										
Nd										
Sm										
Eu										
Gd										
Tb										
Dy										
Ho										
Er										
Tm										
Yb										
Lu										
Hf										
Ta										
W ppb										
Re ppb								3	1.6	(e)
Os ppb								20	11	(e)
Ir ppb								33.2	13.7	(e)
Pt ppb										
Au ppb								18.1	15	(e)
Th ppm	3.77	(d)			3.815	3.746	(b)			
U ppm	0.96	(d)			1.026	1.004	(b)			

technique: (b) IDMS, (d) radiation counting, (e) INAA

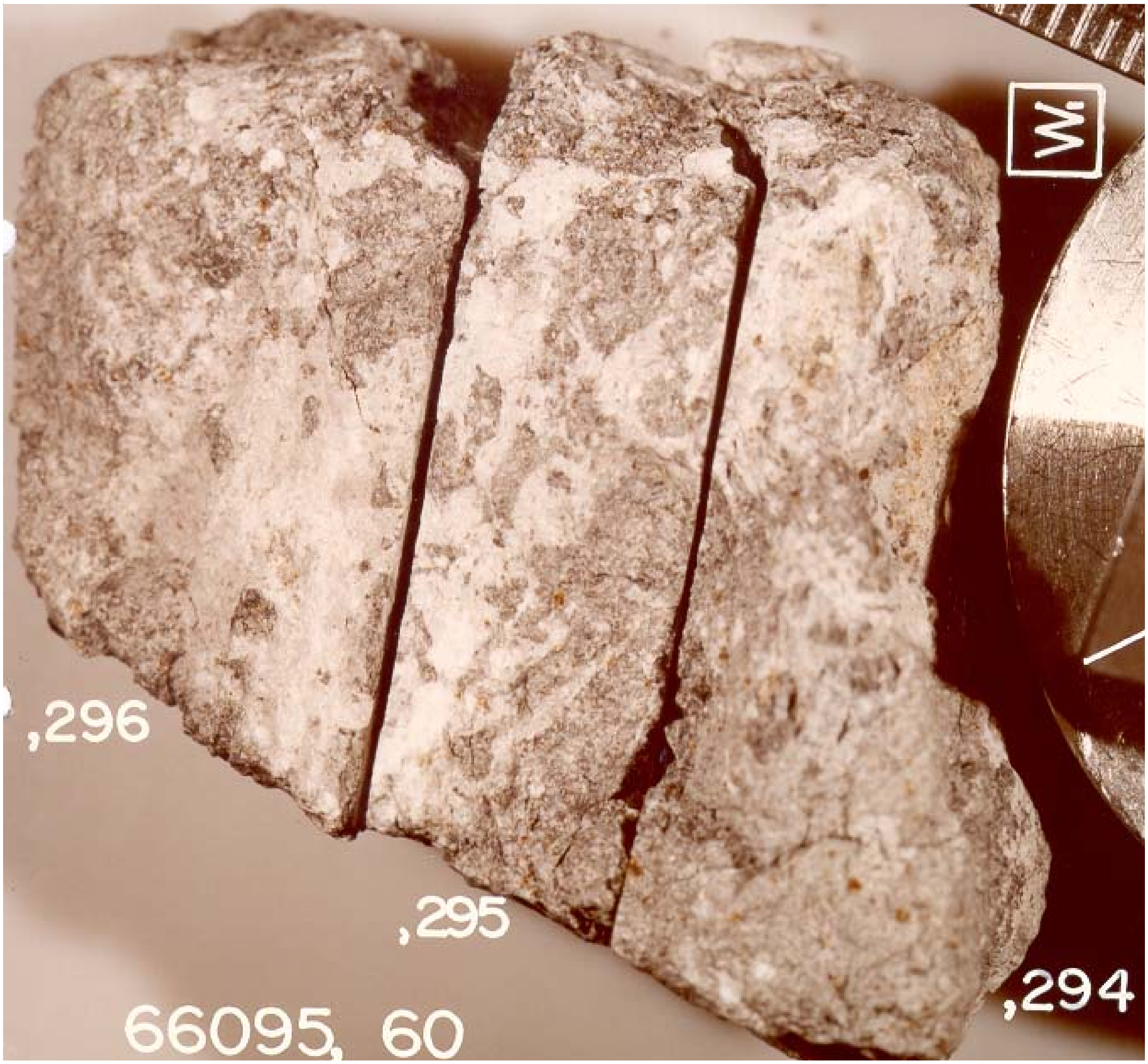


Figure 21: Photo of 66095,60 showing subdivison of white clast intermingling with dark matrix. Field of view is 4 cm. NASA S80-36986.

Table 2. Light and/or volatile elements for 66095.

	Krahenbuhl73	Jovanovic	Allen	Ebihara	Wanke81
Li ppm		10			10
Be					
B					
C					
S					
F ppm		32			25
Cl		203			400
Br	0.825	1			2
I ppb		12			
Pb ppm					
Hg ppb		1.6			
Tl	175		275	273	
Bi	0.27		12		

Table 3. Chemical composition of clasts in 66095.

reference	Wanke et al. 1981 (abstract)										
weight	1	2	3	4	5	6	7	8	9	10	
SiO2 %	matrix	glass	bas.	bas.	bas.	bas-anor.	Anor.	Anor.	Anor.	Anor.	
TiO2	0.95	0.7	0.82	0.82	0.9	0.3	0.27	0.15	0.12	0.07	(a)
Al2O3	21.3	22.1	21.4	19.3	20.2	30.2	29.3	32.7	33	34.6	(a)
FeO	7.5	8.6	7.32	8.88	9.6	3.05	3.31	1.41	0.59	0.69	(a)
MnO	0.08	0.08	0.086	0.09	0.086	0.046	0.046	0.02	0.01	0.01	(a)
MgO	9.38	8.89	10.5	10	10.5	2.47	3.23	1.59	0.8	0.5	(a)
CaO	12.7	13.4	13.4	12.7	11.96	18.2	17	18.6	18.9	19.4	(a)
Na2O	0.46	0.5	0.45	0.46	0.46	0.38	0.43	0.4	0.39	0.41	(a)
K2O	0.15	0.16	0.14	0.16	0.17	0.03	0.07	0.06	0.047	0.017	(a)
P2O5											
S %											
sum											
Sc ppm	11.6	10	11.1	11.6	11.6	6.29	5.72	2.94	1.29	0.95	(a)
V	28.5	30.3	34.3	31.5	31.6	18.2	12.8				(a)
Cr	1062	1050	1092	1150	1185	375	390	244	92.4	196	(a)
Co	53.6	96.6	33.5	72.8	92.9	5.9	9.14	5.57	1.86	1.67	(a)
Ni	910	1820	740	1410	1710	32	61	95	24	71	(a)
Cu											
Zn	42.5	68	40	50	45	12	362	32	27.6	9.1	(a)
Ga	4.05	5.7	3.37	4.09	5.41	3.3	4.14	3.52	3.8	3.55	(a)
Ge ppb											
As	0.24	0.57	0.11	0.36	0.4		0.092				(a)
Se											
Rb	5	7.3		6	6.9		2	2.7	1		(a)
Sr	153	140	153	140	148		148	157	154	203	(a)
Y											
Zr	235	315	384	386	390			52			(a)
Nb											
Mo											
Ru											
Rh											
Pd ppb											
Ag ppb											
Cd ppb											
In ppb	0.19	0.077	0.14	0.14	0.125		1.71	0.13	0.15	0.042	(a)
Sn ppb											
Sb ppb											
Te ppb											
Cs ppm	0.18	0.22		0.27	0.23		0.1	0.12	0.05		(a)
Ba	271	187	262	269	283	23	26	35	23	9.5	(a)
La	27.3	23	26.5	28.8	28.9	1.97	1.37	3.79	1.68	0.61	(a)
Ce	71.6	62.9	68.2	70	66.8	4.6	3.48	10.2	4.54	1.37	(a)
Pr	10.4	8	9.55	9.62	9.4			1.4			(a)
Nd	47.8	39.8	45.2	49.4	47.8	3.38	2.56	6.59	2.82	0.93	(a)
Sm	13.1	10.7	12.65	13.9	14	1.03	0.75	1.79	0.79	0.245	(a)
Eu	1.49	1.32	1.44	1.48	1.47	0.86	0.89	0.86	0.84	1.01	(a)
Gd	15.5	12.3	14	16.1	17.7	1.5	1.08	2.2		0.25	(a)
Tb	2.62	2.15	2.45	2.79	2.87	0.22	0.19	0.35	0.15	0.043	(a)
Dy	15.6	12.5	14.7	16.7	17.5	1.37	1.2	2.1	0.99	0.26	(a)
Ho	3.61	2.67	3.37	3.84	3.88	0.3	0.23	0.48	0.23	0.056	(a)
Er	9.74	7.1	8.63	10.2	10.2			1.34	0.6		(a)
Tm	1.44	1.2	1.32	1.31	1.38	0.13	0.1	0.19	0.084		(a)
Yb	8.57	7.03	8.37	9.29	9.37	0.75	0.61	1.2	0.49	0.12	(a)
Lu	1.18	0.97	1.18	1.26	1.27	0.11	0.092	0.17	0.071	0.0122	(a)
Hf	9.53	7.9	8.85	10.2	10.1	0.72	0.49	1.21	0.52	0.091	(a)
Ta	1.08	0.97	1.04	1.13	1.15	0.084	0.08	0.14	0.064	0.0091	(a)
W ppb	380	580	360	570	680						(a)
Re ppb											
Os ppb											
Ir ppb	21	47	13	26	38		1.6	1.5	1.1	0.42	(a)
Pt ppb											
Au ppb	15.4	69.2	14	24	33		2.7	2.9	0.25	2.1	(a)
Th ppm	3.57	3.06	3.41	3.73	3.78	0.18	0.2	0.46	0.2	0.055	(a)
U ppm	1.19	0.84	1.02	1.12	1.08	0.05	0.062	0.13	0.054	0.014	(a)

technique: (a) INAA, RNAA

Table 4. Chemical composition of clasts in 66095.

reference	Ebihara et al. 1981 (abstract)							
weight	matrix	glass	anor.	anor.	troc.	bas.	bas.	bas.
Rb	4.43	3.61	5.5	1.89	0.06	1.05	2.7	2.46
Pd ppb	61.2	48.1	1.15	21	0.34		57	96
Cd ppb	143	58	1574	206	5.8	22	136	177
In ppb	128	56	1280	156	1.4	16	131	150
Ce	33	55	2.2	7.2	1.2	12	70	54
Ir ppb	42	25	1	3	0.003	0.7	18	61
U ppm	1.07	0.86	0.022	0.116	0.002	0.174	1.05	0.95
Tl ppb	273	113	406	210	2.4	20	132	108
technique: RNAA								

Table 6. Chemical composition of matrix and clasts in 66095.

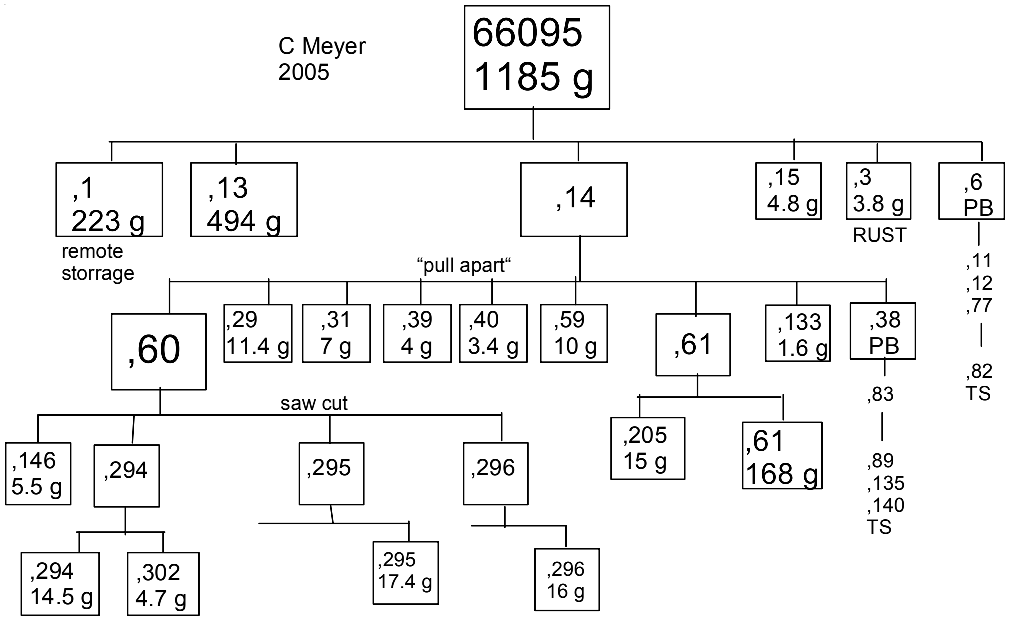
reference	Ebihara et al. 1992								
weight	matrix								
Ni	1260	26.6	350	17.5	3.3	991	1100	2520	(a)
Zn	13.8	183	22.9	5.21	0.292	23.2	15.6	25	(a)
Ga									
Ge ppb	2890	897	1090	142	3.3	2960	1910	3550	(a)
Se	326	442	29	47	0.75	1150	429	366	(a)
Rb	4.43	5.51	1.89	1.05	0.062	3.61	2.7	2.46	(a)
Pd ppb	61.2	1.15	21	1.5	0.8	48.1	58	97	(a)
Ag ppb	2.55	2.18	2.8	0.9	0.33	11.5	3.03	2.76	(a)
Cd ppb	143	1574	206	22.1	5.83	58.1	136	177	(a)
In ppb	128	1280	156	15.8	1.37	56	131	150	(a)
Sn ppb	700								
Sb ppb	12.3	8.1	3.76	1.9	0.52	14.6	4.4	8.87	(a)
Te ppb	23.6	9.23	11.4	4.79	3.01	176	28.8	30.3	(a)
Cs ppm	0.192	0.212	0.097	0.046	0.002	0.178	0.131	0.12	(a)
Tl ppb	273	406	210	20	2.37	113	131.9	108	(a)
Bi ppb	1.36	0.9	2.14	1.4	2.26	1.5	6.8	24.7	(a)
Ba									
La									
Ce	33	2.25	7.24	11.7	1.18	54.8	69.7	53.8	(a)
Pr									
Nd	20.3	1.64	4.6	7.64	0.933	35.6	43.8	38.4	(a)
Sm									
Eu	0.862	0.937	1.13	1	1.19	1.5	1.52	1.39	(a)
Gd									
Tb	1.5	0.142	0.22	0.466	0.0338	2.23	2.52	2.38	(a)
Dy									
Ho									
Er									
Tm									
Yb	4.2	0.532	0.872	1.54	0.0585	7.05	8.52	5.51	(a)
Lu	0.617	0.082	0.153	0.22	0.0084	1.04	1.16	1.04	(a)
Re ppb	4.2	0.076	0.332	0.063	0.004	2.67	1.77	5.81	(a)
Os ppb	44	0.84	2.74	1.38	0.03	30	17	51.4	(a)
Ir ppb	41.7	0.964	3	0.736	0.007	24.8	18.5	61.3	(a)
Au ppb	24.1	0.82	5.76	0.39	0.006	18	21	39	(a)
Th ppm									
U ppm	1.07	0.0223	0.116	0.174	0.0023	0.862	1.05	0.95	(a)
technique	*(a) RNAA*								

Table 7: Goethite in 66095 (El Goresy et al. 1973)

	1	2	3	4	5	6	7	8	9
FeO	77.2	79.2	72	71.4	72.8	76.8	71.5	67.7	81.8
NiO	5.9	3.9	2.7	6.3	2.3	3.5	4.5	3.1	1.6
CaO	0.13	1.1	1.9	1.2	2	0.18	0.16	0.6	0.5
P2O5	0.07	0.16	0.18		0.05	0.27	0.6	0.02	0.4
SO3	0.65	0.34	0.25	0.76	0.22	0.3	0.26	0.22	0.33
Cl	2.6	0.8	0.9	3.9	0.9	5.2	0.8	4.4	4.2
total	86.6	85.6	77.9	83.6	78.2	85.7	77.8	76	88.8

Table 8: Composition of “sphalerite” in 66095 (El Goresy et al. 1973)

	1	2	3	4	5	6	7
Zn	50.2	51	48.1	49.5	47.9	48.9	49.6
Fe	16.2	14.8	16.7	16.3	16.6	15.4	16.1
S	33.8	33	33.8	32.2	34.1	33.9	34.1
total	100	99	99	98	99	98	100



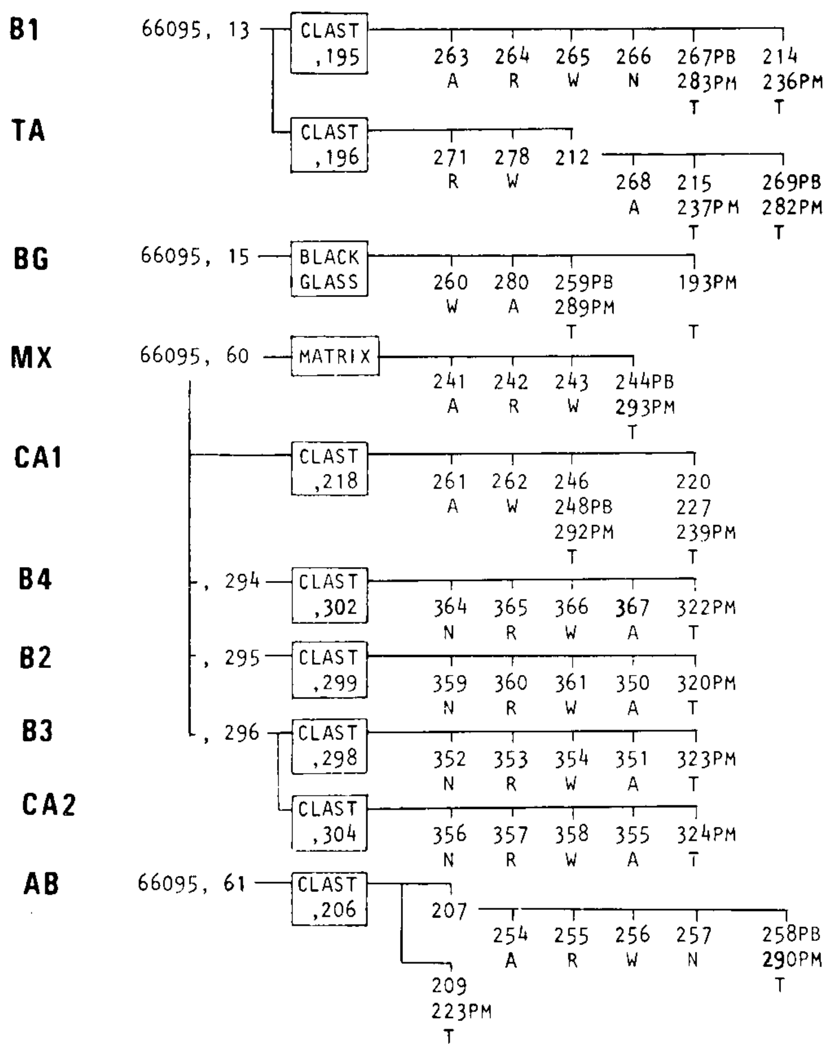
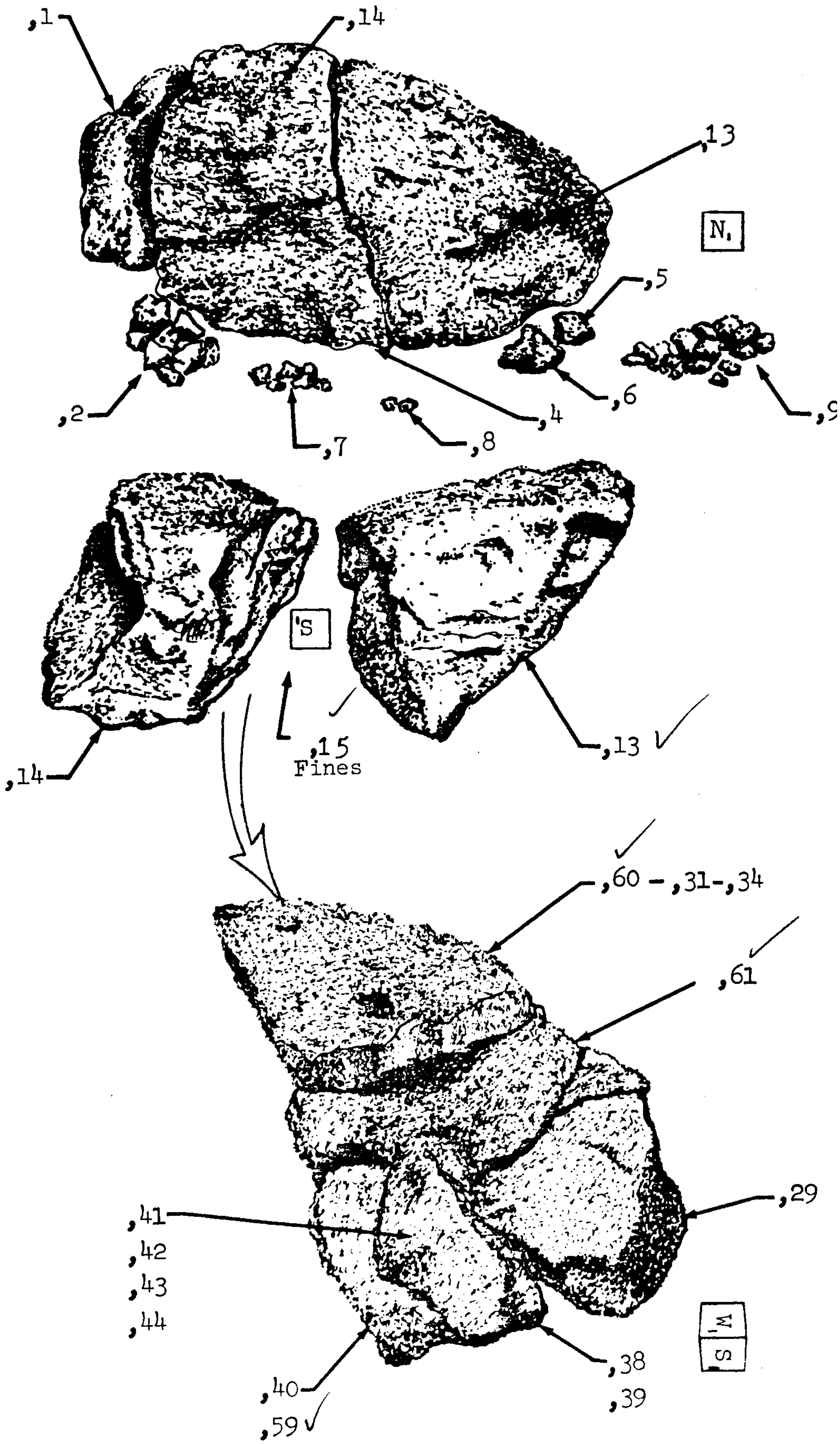


Fig. A1. Genealogy and distribution of allocated samples. A = Anders, N = Nyquist, R = Reed, T = Taylor, W = Wänke. PB = Potted butt, PM = Probe mount.

Subdivison of 66095; illustrated.



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