12052

Pigeonite Basalt

1866 grams

Revised

Figure 1: Photo of broken side of 12052 showing vugs. Sample is 6.5 cm high. NASA # S70-44633.

Summary of Age Data for 12052

	Ar/Ar	Rb/Sr	Nyquist 1977 (recalculated)
Murthy et al. 1971		2.92 ± 0.18 b.y.	
Compston et al. 1971		3.28 ± 0.19	(3.22 ± 0.19)

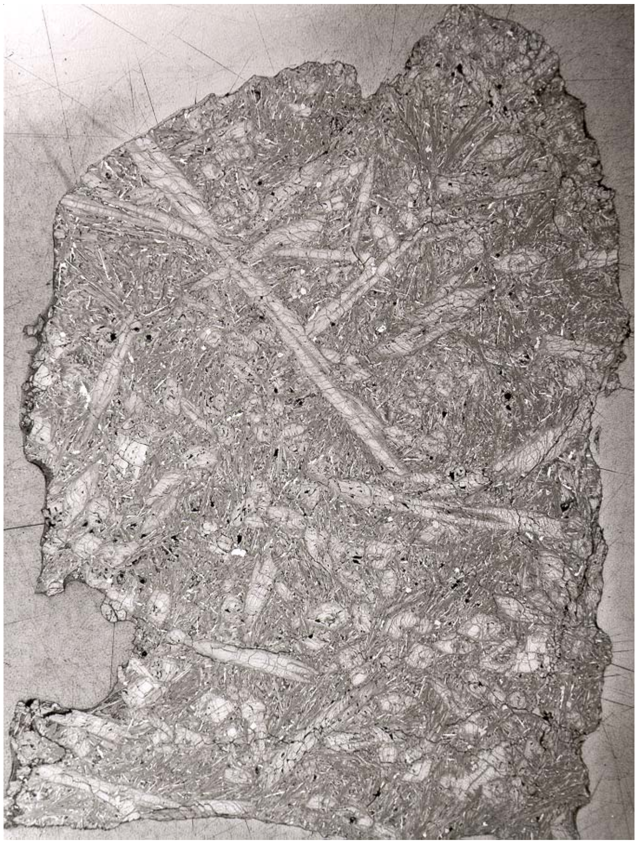


Figure 2a: Reflected light photo of thin section 12052,6. Scale about 3 cm. NASA #S70-30232.

Figure 2b: Transmitted light photo of thin section 12052,6. NASA #S70-25409.

Introduction

12052 is a porphyritic pigeonite basalt about 3.2 b.y old. It was rounded and covered with zap pits on all sides, before it was broken (figures 1 and 9).

Petrography

Bence et al. (1970) reported that 12052 is composed of "euhedral and skeletal phenocrysts of olivine and clinopyroxene (pigeonite cores with augite rims) surrounded by a groundmass including high-iron clinopyroxene, chrome spinel, ilmenite, pyroxferroite and anorthite". Bence et al. (1971) described the rock as "porphyritic" with variolitic groundmass (figures 2 and 3). Champness et al. (1971) explain that "this rock consists of elongated phenocrysts of pyroxene (3-4 mm) in random orientation, together with skeletal or rounded olivine crystals (1 mm) in a finer-grained variolitic groundmass of pyroxene-plagioclase and opaques minerals, chiefly ilmenites, which are parallel to the pyroxene laths."

Mineralogy

Olivine: Champness et al. (1971) report olivine is Fo_{71-58}.

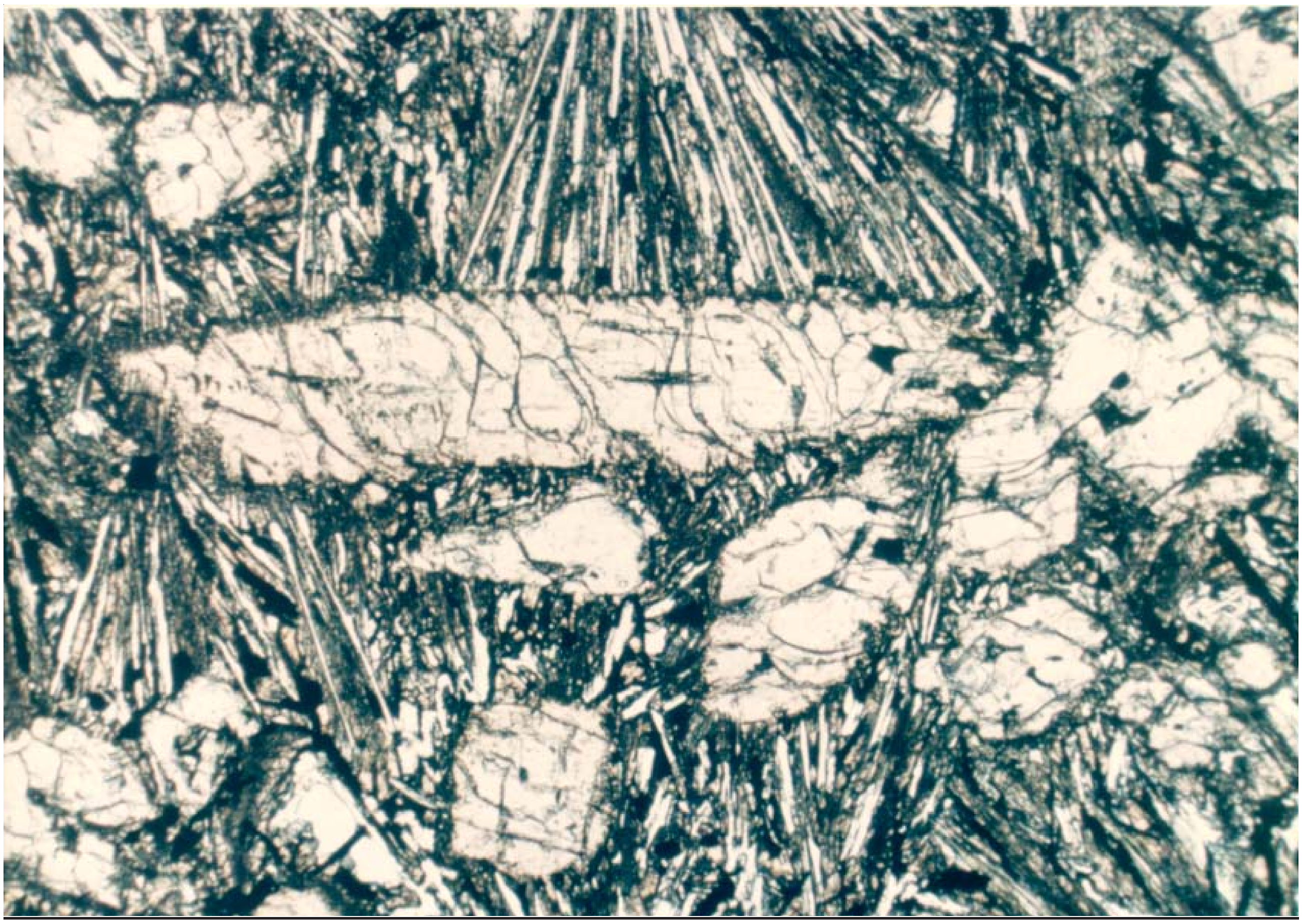
Pyroxene: Bence et al. (1970, 1971) studied the complex zoning patterns in the large pyroxenes in 12052. Pigeonite cores have sharp boundaries with augite rims (figure 4). Pyroxene

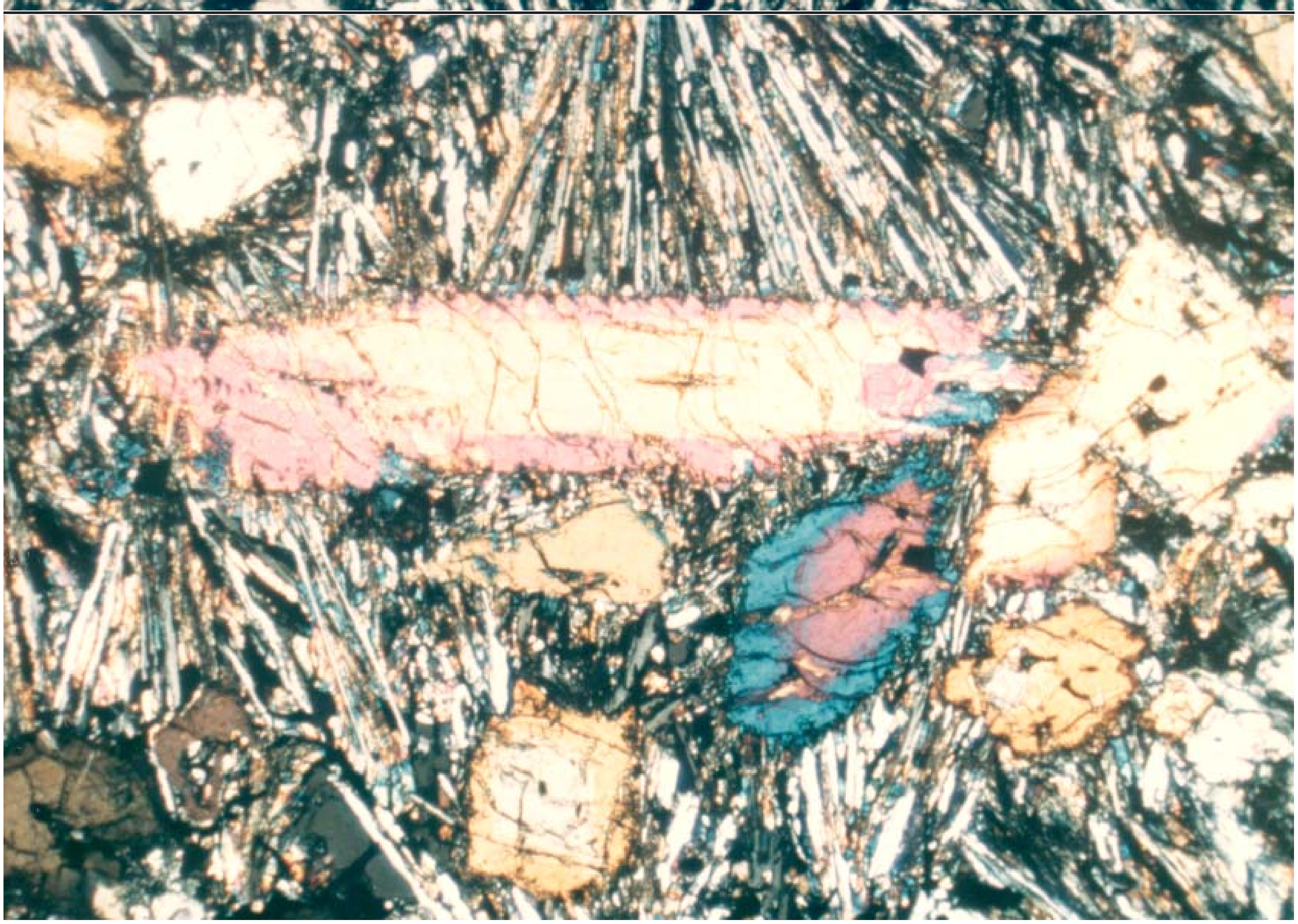
→

Figure 3,a,b: Photomicrographs of thin section 12052,7 showing zoned pyroxene phenocrysts in cross section and variolitic groundmass. Scale is about 2.5 mm across. NASA #S 70-49562-563.

Mineralogical Mode for 12052

	Neal et al. 1994	Papike et al. 1976	Champness et al. 1971
Olivine	1	3.9	5
Pyroxene	57.9	68.1	
Plagioclase	31.7	17.2	
Opaques		10.8	7
Ilmenite	3.5		
Chromite +Usp	2.5		
mesostasis	3		
"silica"			trace





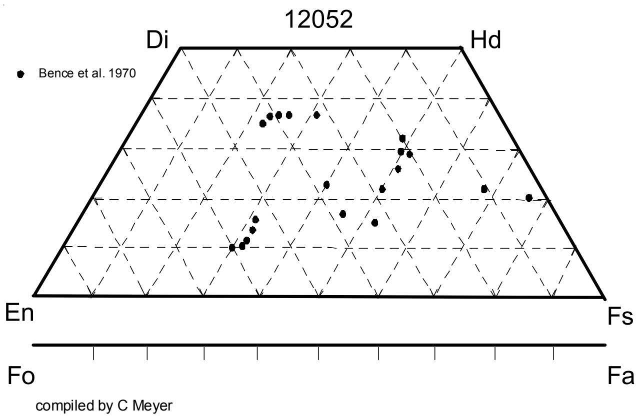


Figure 4: Bence et al. (1970, 1971) determined the composition of pyroxene in 12052.

rim and groundmass pyroxene is increasingly Fe-rich. Papike et al. (1971) and Takeda (1971) reported crystallographic data and discussed epitaxy and exsolution of pyroxenes in 12052. Champness et al. (1971) used high-voltage TEM to study fine structure (exsolution).

Plagioclase: Plagioclase crystals in 12052 are narrow (55 microns) (Baldridge et al. 1979).

Ilmenite: Ilmenite in 12052 occurs as lath-shaped crystals up to 400 micron long and 50 micron wide, typically found intergrown with plumose plagioclase-pyroxene aggregates of the groundmass (Gibb et al. 1970).

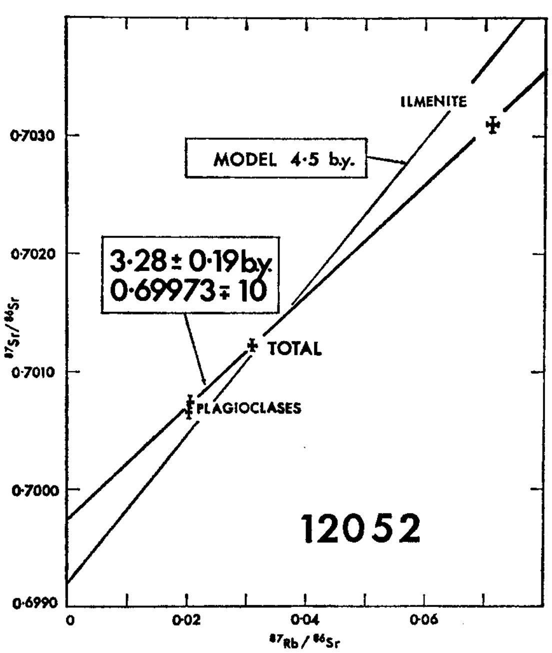


Figure 7: Rb/Sr isochron diagram for 12052 (from Compston et al. 1971).

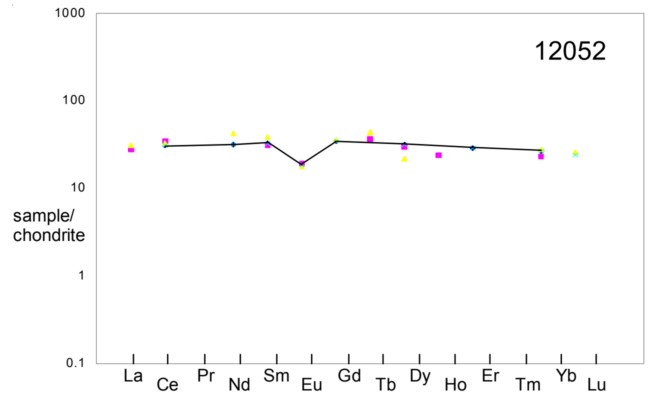


Figure 5: Normalized rare-earth-element diagram for 12052 (data from Wanke et al. connected).

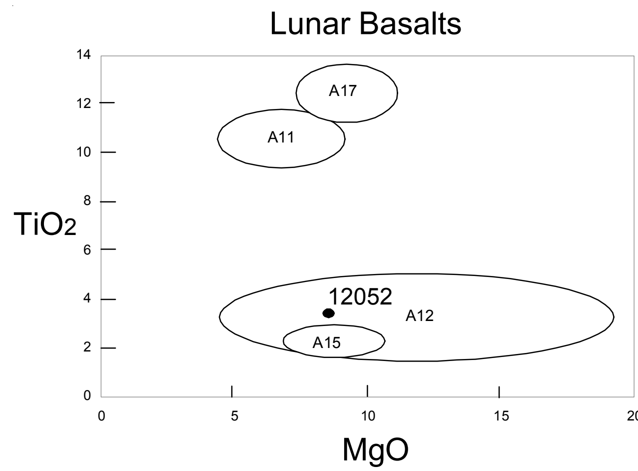


Figure 6: Composition of 12052 compared with that of other lunar basalts.

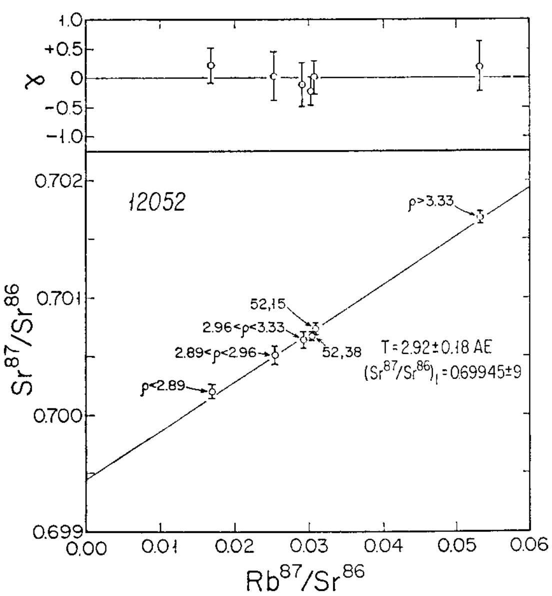


Figure 8: Rb/Sr isochron for 12052 (from Murthy et al 1971).

Table 1a. Chemical composition of 12052.

reference	Maxwell71		Kushiro71		LSPET70		Murthy71			O'Kelly71		Wanke71		Schnetzler71		Compston71			
weight			1 g							201 g				204 mg					
SiO2 %	46.59		46.49	(f)	42	(c)						47.3	(a)			46.13	(g)		
TiO2	3.3		3.18		3.6							2.5	(a)			3.35	(g)		
Al2O3	10.24		10.29		11							10.1	(a)			9.95	(g)		
FeO	19.82		19.93		21							19.6	(a)			20.7	(g)		
MnO	0.258		0.27		0.31							0.28	(a)			0.28	(g)		
MgO	8.14		8.44		10							8.46	(a)			8.07	(g)		
CaO	10.7		10.82		11							11.9	(a)			10.89	(g)		
Na2O	0.27		0.28		0.45							0.24	(a)			0.26	(g)		
K2O	0.067		0.07		0.069		0.054	0.058	(d)	0.065	(e)	0.067	(a)	0.064	(d)	0.071	(g)		
P2O5	0.083		0.03													0.08	(g)		
S %																0.07	(g)		
sum																			
Sc ppm	52.3	(b)			52							50.6	(a)						
V	160	(b)			105											149	(g)		
Cr	3675	(b)	3763		3700							3490	(a)			3140	(g)		
Co	42	(b)			42							38.4	(a)			34	(g)		
Ni	23	(b)			32							39	(a)			6	(g)		
Cu	16	(b)										39	(a)			8	(g)		
Zn																9	(g)		
Ga												3.9	(a)			2.1	(g)		
Ge ppb												60	(a)						
As												0.006	(a)						
Se																			
Rb					0.8		1.12	1.26	(d)					1.26	(d)	1.22	(g)	1.26	(d)
Sr	85	(b)			135		105	110	(d)			110	(a)	116	(d)	113.7	(g)	113.8	(d)
Y	48	(b)			42											40	(g)		
Zr	150	(b)			170											121	(g)		
Nb																7	(g)		
Mo																			
Ru																			
Rh																			
Pd ppb																			
Ag ppb																			
Cd ppb																			
In ppb												7.8	(a)						
Sn ppb																			
Sb ppb																			
Te ppb																			
Cs ppm																			
Ba					50		66	69	(d)			70	(a)	75	(d)	70	(g)		
La	7.4	(a)										6.52	(a)			5	(g)		
Ce	20	(a)										21	(a)	18.8	(d)	12	(g)		
Pr																			
Nd	19.5	(a)												14.7	(d)				
Sm	5.8	(a)										4.5	(a)	4.91	(d)				
Eu	1.01	(a)										1.08	(a)	1.04	(d)				
Gd	7.1	(a)												6.87	(d)				
Tb	1.62	(a)										1.35	(a)						
Dy	5.3	(a)										7.44	(a)	7.74	(d)				
Ho												1.34	(a)						
Er														4.55	(d)				
Tm	0.72	(a)																	
Yb	4.5	(a)										3.7	(a)	4.32	(d)				
Lu	0.64	(a)										0.58	(a)	0.651	(d)				
Hf	3.1	(a)										3.8	(a)						
Ta	0.77	(a)										0.44	(a)						
W ppb												150	(a)						
Re ppb																			
Os ppb																			
Ir ppb												3.6	(a)						
Pt ppb																			
Au ppb												0.9	(a)						
Th ppm										1.03	(e)	1.28	(a)						
U ppm										0.27	(e)	0.356	(a)						

technique: (a) INAA, (b) OES, (c) , (d) IDMS, (e) radiation couting, (f) conventional wet, (g) XRF, (h) SSMS

Table 1b. Chemical composition of 12052.

reference	Taylor71		Tatsumoto71			
weight						
SiO2 %						
TiO2						
Al2O3						
FeO						
MnO						
MgO						
CaO						
Na2O						
K2O						
P2O5						
S %						
sum						
Sc ppm	54	(h)				
V	160	(h)				
Cr	3300	(h)				
Co	42	(h)				
Ni	21	(h)				
Cu	5	(h)				
Zn						
Ga						
Ge ppb						
As						
Se						
Rb						
Sr	110	(h)				
Y	48	(h)				
Zr	130	(h)				
Nb	6	(h)				
Mo	0.03	(h)				
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb	0.16	(h)				
Sb ppb						
Te ppb						
Cs ppm	0.03	(h)				
Ba	65	(h)				
La	6.3	(h)				
Ce	21	(h)				
Pr	2.6	(h)				
Nd	17	(h)				
Sm	6.3	(h)				
Eu	0.9	(h)				
Gd	9	(h)				
Tb	2	(h)				
Dy	9.6	(h)				
Ho	2.7	(h)				
Er	7.2	(h)				
Tm	1.1	(h)				
Yb	5.3	(h)				
Lu						
Hf	4.6	(h)				
Ta						
W ppb						
Re ppb						
Os ppb						
Ir ppb						
Pt ppb						
Au ppb						
Th ppm	1.15	(h)	1.282	1.231	1.411	(d)
U ppm	0.3	(h)	0.365	0.347	0.404	(d)

technique: (a) INAA, (b) OES, (c) , (d) IDMS, (e) radiation couting, (f) conventional wet, (g) XRF, (h) SSMS

Chromite-ulvöspinel: Gibb et al. (1970) determined the composition of Al-chromite cores and Ti-ulvöspinel rims.

Iron: Champness et al. (1971) report about 2 % Ni and 1.5 % Co in metallic iron grains.

Chemistry

The major element composition was determined by Maxwell and Wiik (1971), Kushiro et al. (1971) and Compston et al. (1971). Trace elements were determined by Taylor et al. (1971), Wanke et al. (1971) and Schnetzler et al. (1971)(figure 5).

Radiogenic age dating

Murthy et al. (1971) determined a Rb-Sr mineral isochron with age 2.92 ± 0.18 b.y. (figure 8) and Compston et al. (1971) determined 3.28 ± 0.19 b.y. (figure 7).

Cosmogenic isotopes and exposure ages

Burnett et al. (1975) determined an exposure age of 230 ± 40 m.y. by ^{81}Kr/^{83}Kr and Marti and Lugmair (1971) determined 129 ± 7 m.y by ^{81}Kr/^{83}Kr. Hintenberger et al. (1971) also determined exposure ages for 12052 using ^{3}He (120 m.y.), ^{21}Ne (140 m.y.) and ^{38}Ar (130 m.y.).

Other Studies

Bogard et al. (1971) and Hintenberger et al. (1971) reported the content and isotopic composition of rare gases in 12052.

Processing

A large amount of 12052 was used for the biopool sample.

List of Photo #s for 12052

S69-62806 – 62819	
S69-63832 – 63834	
S70-44847 – 44848	12052,1
S70-44630 – 44639	12052,2
S70-49562 – 49563	TS color
S70-49835 – 49836	TS color
S70-17972 – 17973	TS color
S75-34165 – 34170	mug color
S75-34269	sawing
S75-34255 – 34257	saw cut

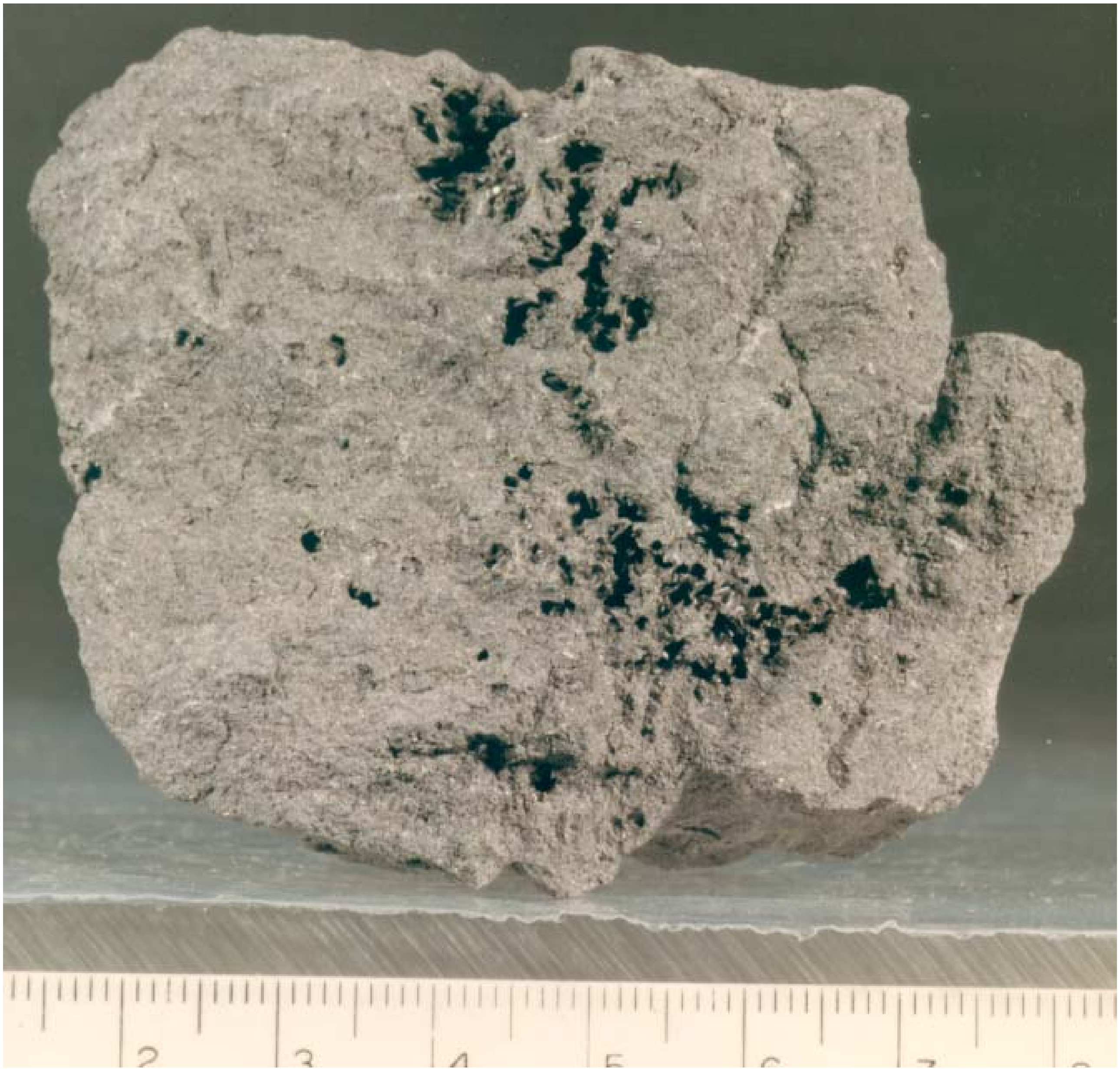
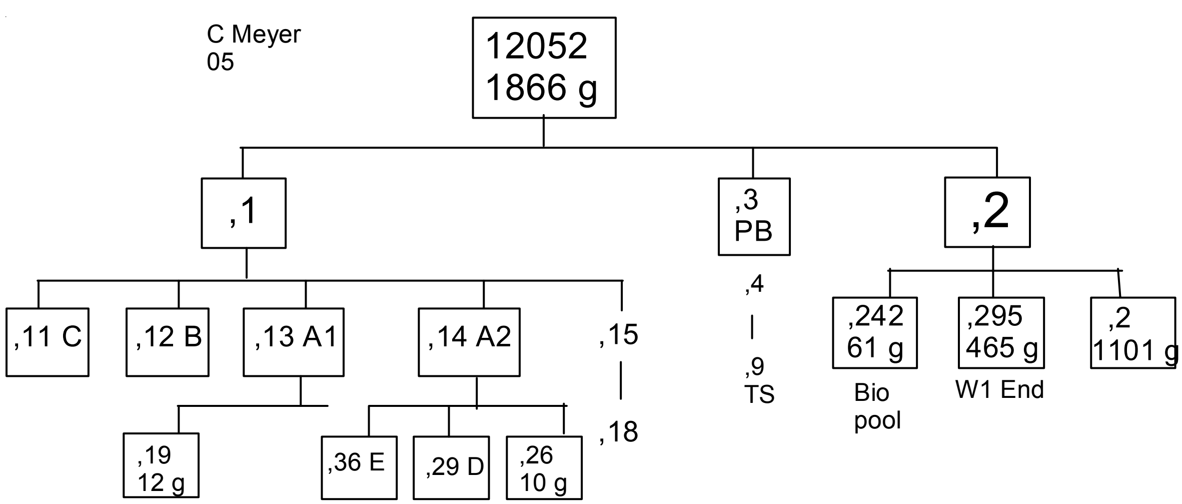
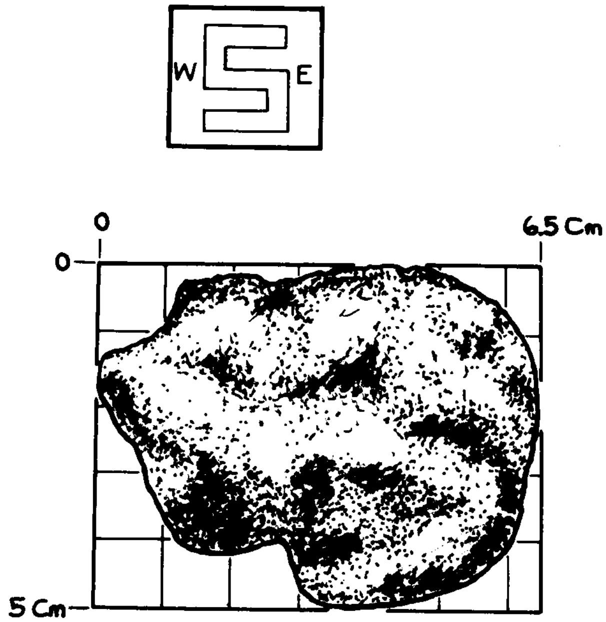


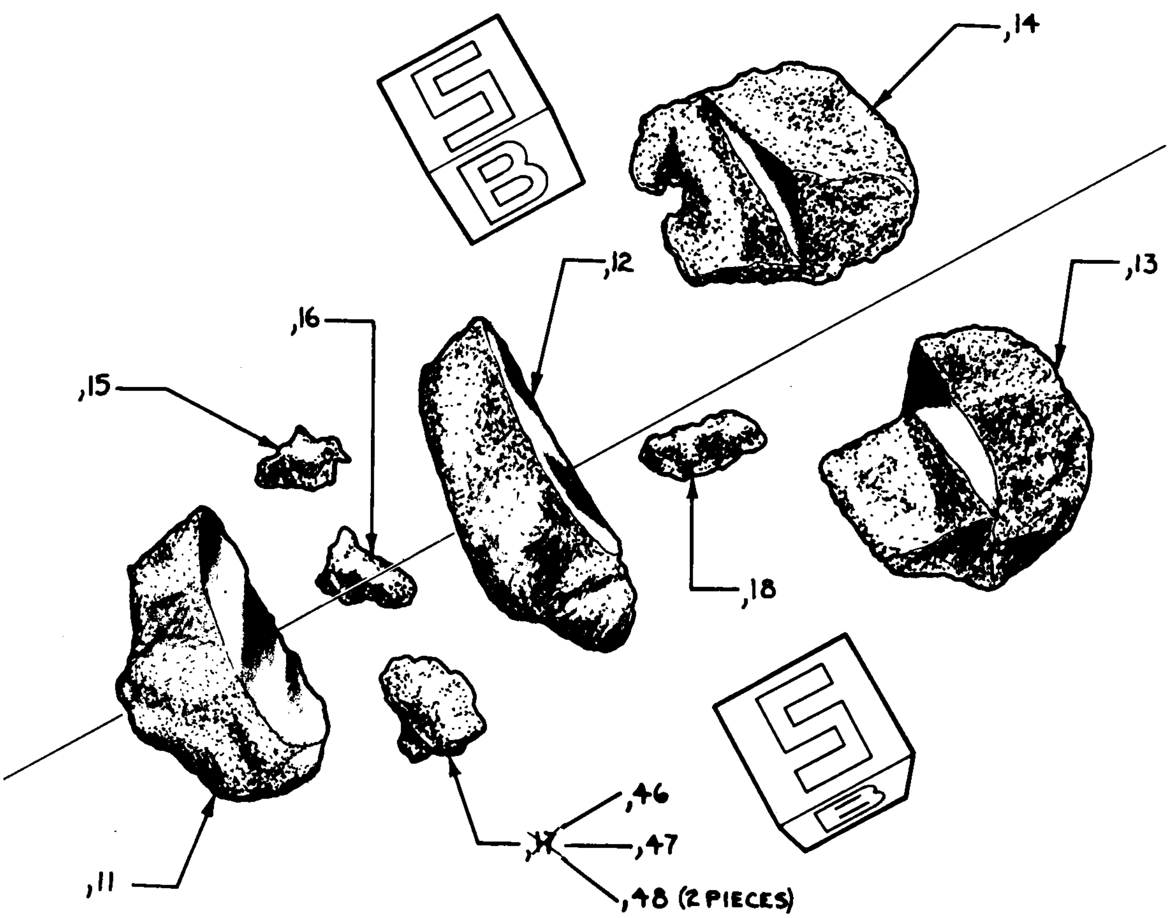
Figure 9: Photo of broken surface of 12052,1 showing pyroxene crystals in vugs. NASA #S70-44847. Scale 1 cm.





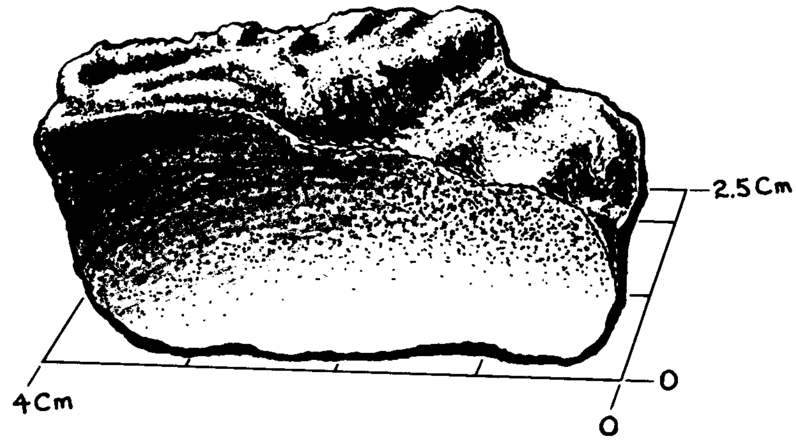
THE CUTTING AND CHIPPING OF LUNAR ROCK 12052,1

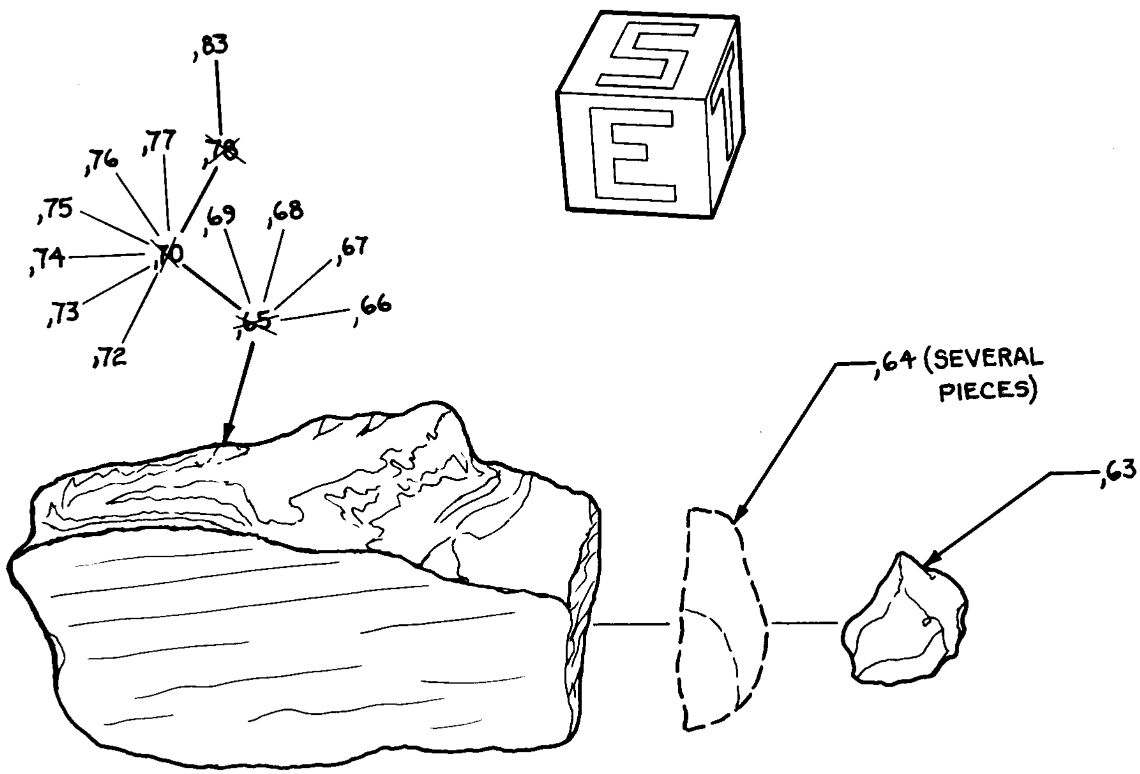
DRAWING 1



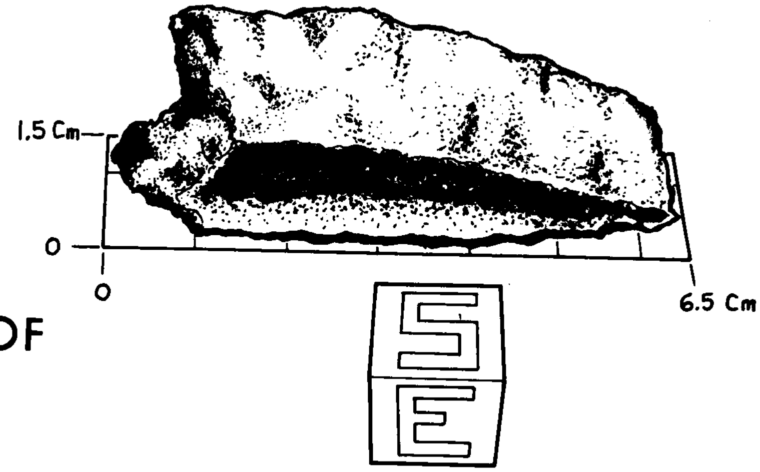
THE CUTTING AND CHIPPING OF LUNAR ROCK 12052,11

DRAWING 2

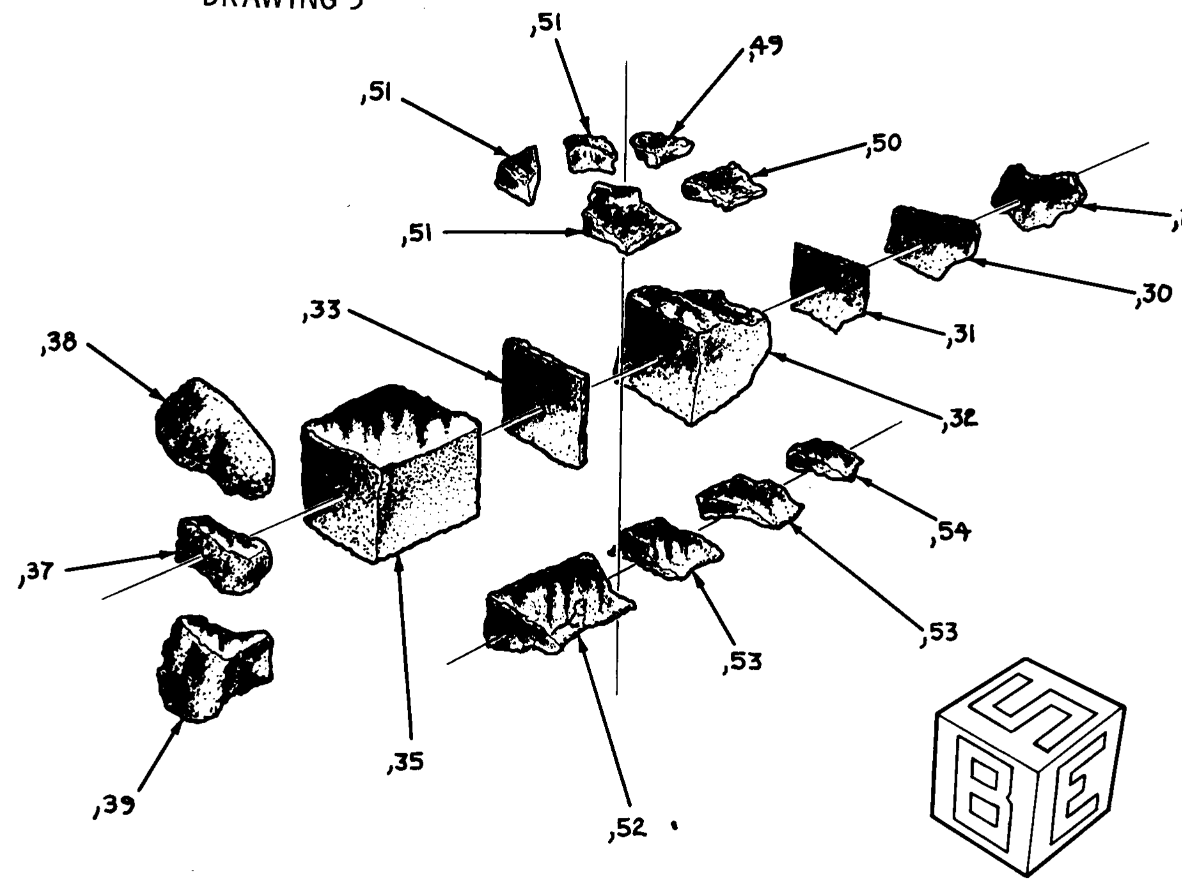




THE CUTTING AND CHIPPING OF LUNAR ROCK 12052,12

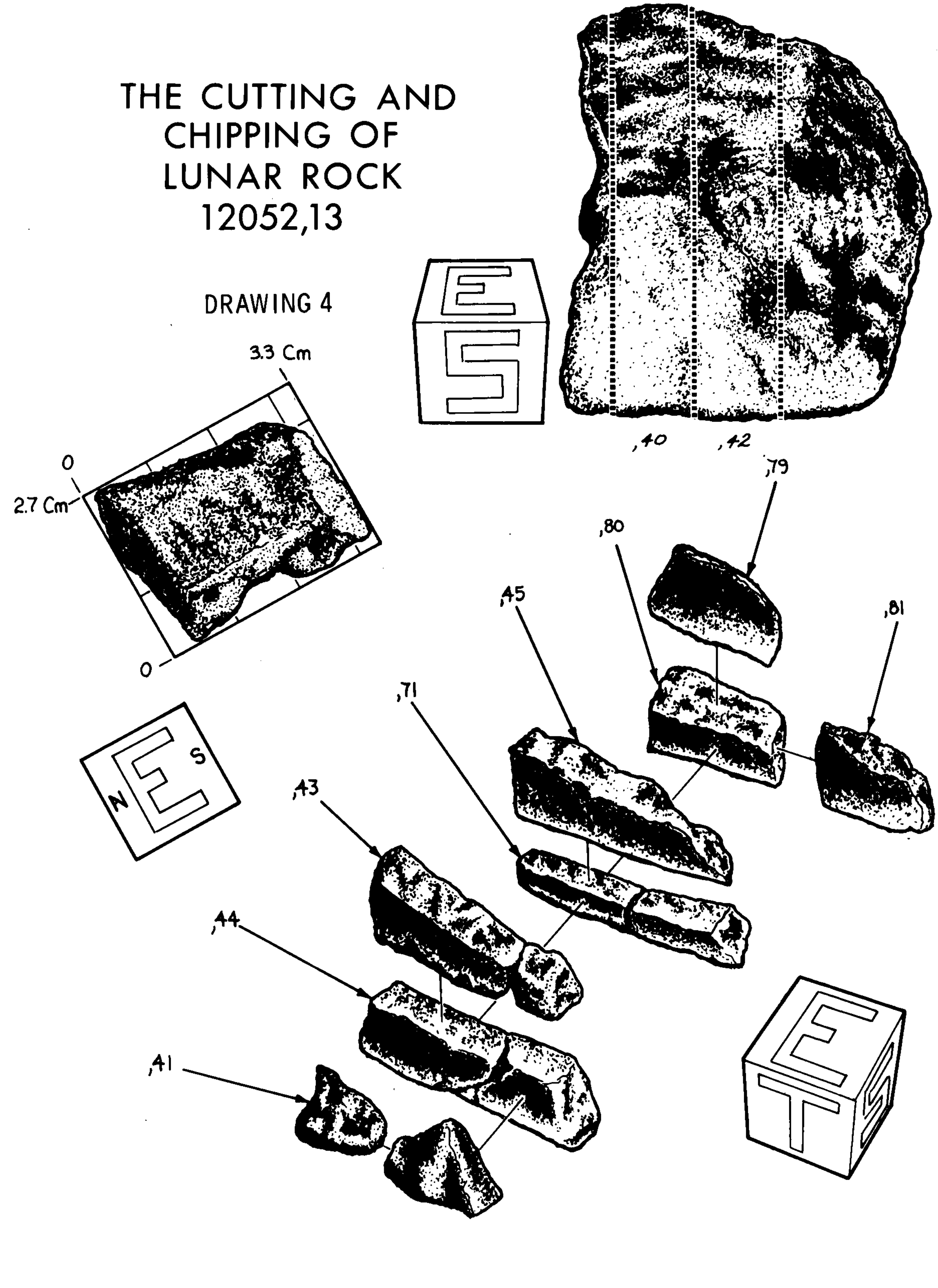


DRAWING 3



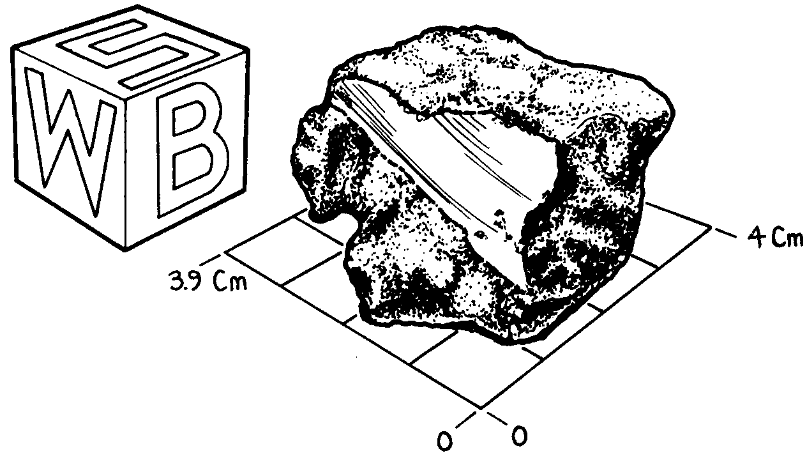
THE CUTTING AND CHIPPING OF LUNAR ROCK 12052,13

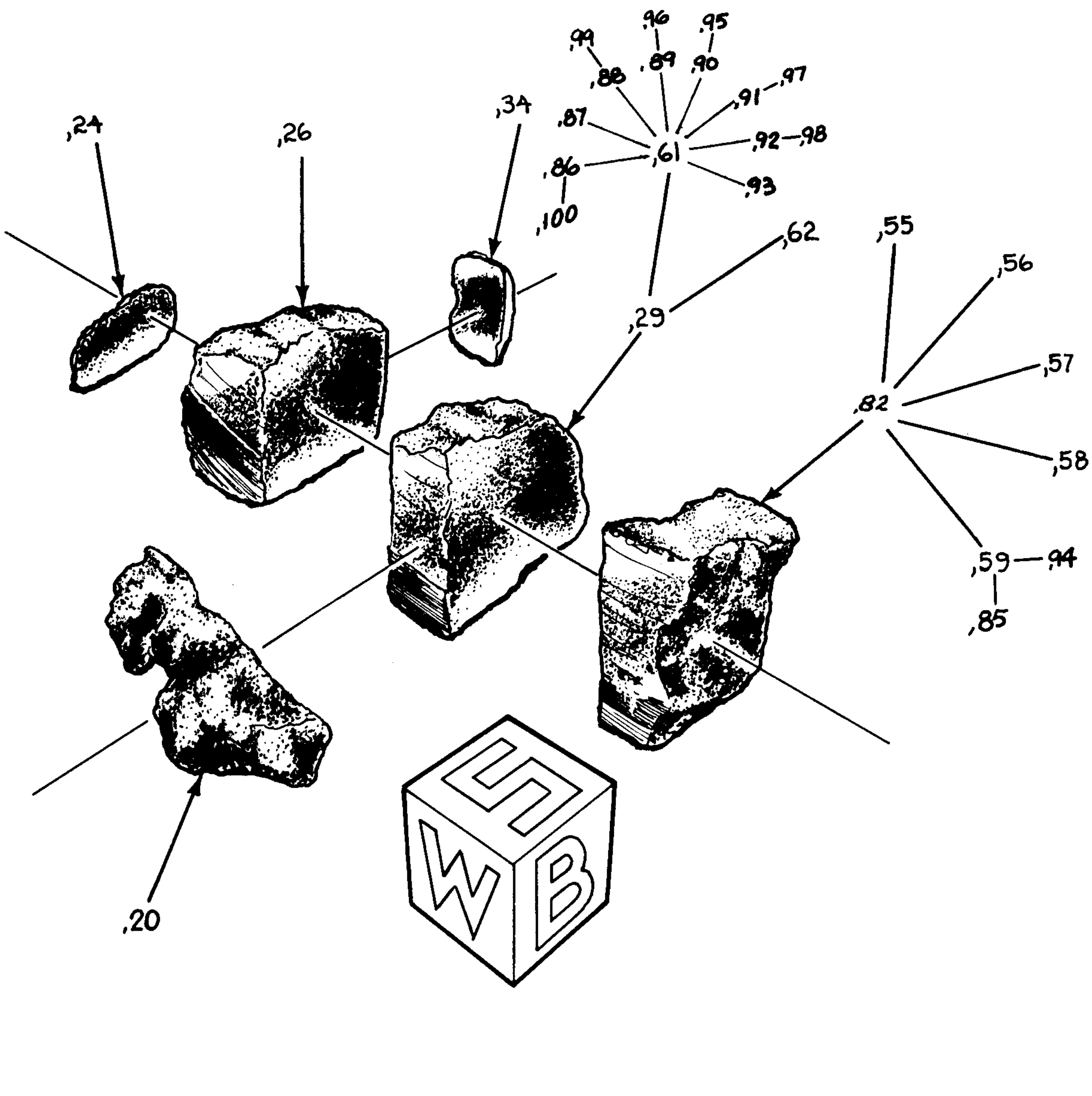
DRAWING 4



THE CUTTING AND CHIPPING OF LUNAR ROCK 12052,14

REVISION 1 11-4-70





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