12022

Ilmenite Basalt

1864.3 grams

Figure 1: PET photo of 12022,0 with caked on dirt (before dusting). NASA photo # S69-64108.

Introduction

Neal et al. (1994) classify 12022 as an ilmenite basalt while James and Wright (1972) had termed it an ilmenite-bearing olivine basalt. It has been dated at 3.2 b.y. All surfaces, except perhaps the flat end, were apparently covered with micrometeorite craters (Hörz et al. 1971), making this rock less than ideal for cosmic-ray depth profiles.

Petrography

The petrography of 12022 is discussed in Weill et al. (1971), Brett et al. (1971), McGee et al. (1977). McGee et al. describe 12022 as "a medium grained porphyritic basalt characterized by subhedral olivine (0.3 mm) and pyroxene (1-2 mm) phenocrysts. Several olivine phenocrysts are epitaxially overgrown with pyroxene. The matrix consists of feathery intergrowths of parallel feldspar tablets (0.05-1 mm), subrounded ilmenite laths (0.03-0.2 mm), anhedral pyroxene crystals (0.6-0.8 mm) and minor glassy mesostasis".

Ilmenite in 12022 has an interesting cross-cutting, parallel, skeletal habit.

Mineralogy

Olivine: Butler (1972) determined the minor element content of olivine in 12022.

Pyroxene: Weill et al. (1971) and Brett et al. (1971) determined that the cores of pyroxene phenocrysts in 12022 are Ca-rich, zoning outward to Fe-rich (figure 4). The zonation of minor elements (Al, Ti, Cr) in pyroxene in 12022 is discussed in Bence and Papike (1972).

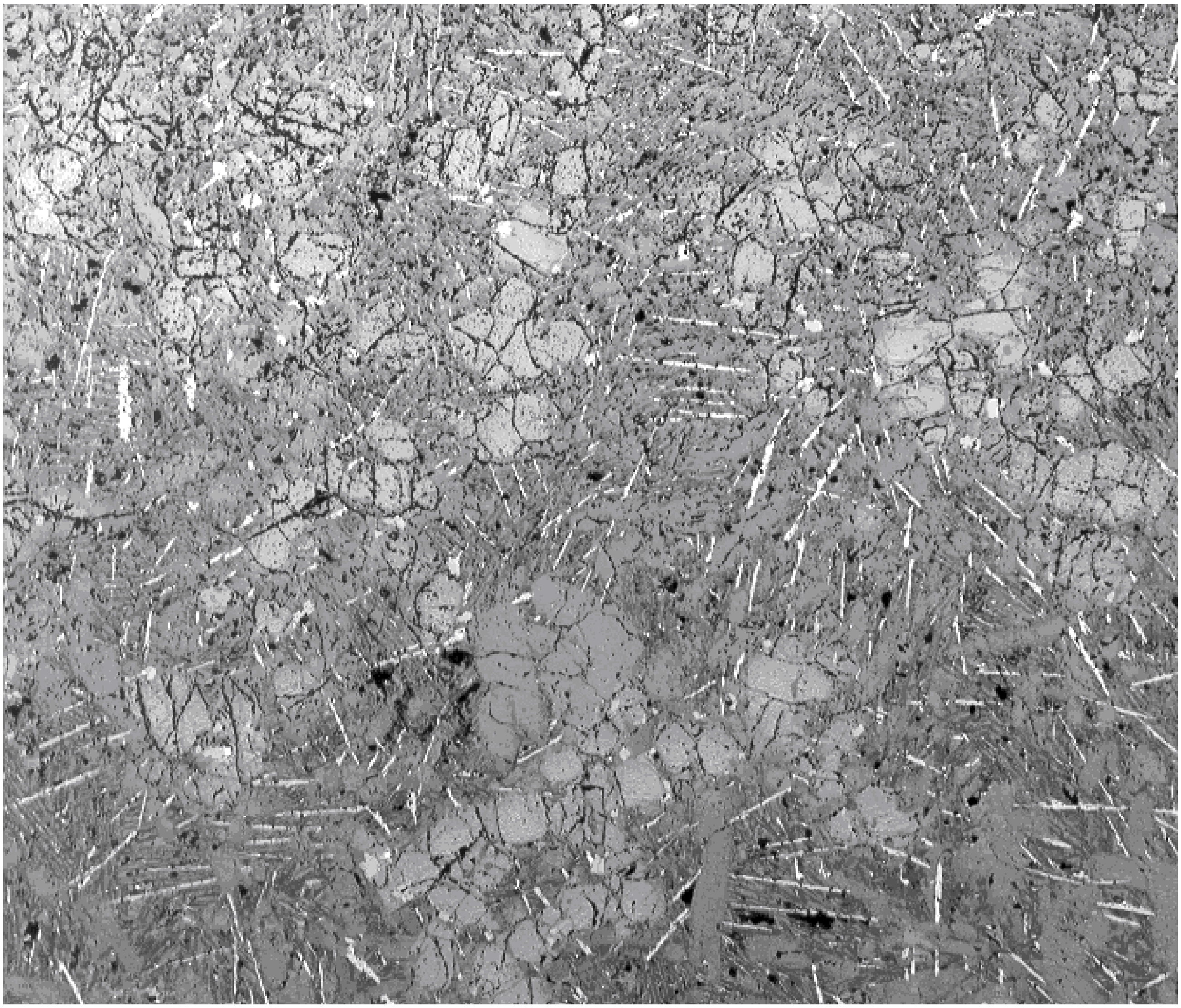


Figure 2: Refected light photo of thin section 12022,10 showing alignment of ilmenite, clumps of pyroxene phenocrysts in fine-grained variolitic groundmass. Field of view 1 cm. NASA photo # S70-24742.

Plagioclase: Plagioclase is An_{91-85}.

Opaques: Ilmenite laths occur in groups, cutting trough the matrix but not intersecting the phenocrysts (McGee et al. 1977). Subrounded octahedra of Cr-spinel, with or without rims of Ti-spinel, occur in the matrix and as inclusions in olivine and pyroxene phenocrysts.

Mineralogical Mode of 12022

	McGee et al. 1977	Neal et al. 1994	Brett et al. 1971
Olivine	16-33	19.5	16.5
Pyroxene	30-59	56	58.6
Plagioclase	12-26	12.2	12
Opaques	9-23	~9	11.2
"silica"		0.2	
mesostasis	1	2.3	1.6

Metal: Brett et al. (1971) determined the Ni content of minute metallic iron grains in 12022 (figure 5).

Chemistry

Kushiro et al. (1971), Engel et al. (1971) and Snyder et al. (1997) determined relatively high TiO_2 for 12022 (figure 7). Numerous investigators determined trace elements (table 1, figure 6). Kaplan and Petrowski (1971) determined about 20 ppm carbon and 800 ppm sulfur in 12022. Moore et al. (1971) reported about 40 ppm carbon and 44 ppm nitrogen. Rees and Thode (1972) reported 914 ppm sulfur.

Radiogenic age dating

Alexander et al. (1972) determined an age for 12022 of 3.18 ±0.04 b.y. by the Argon plateau method. Snyder

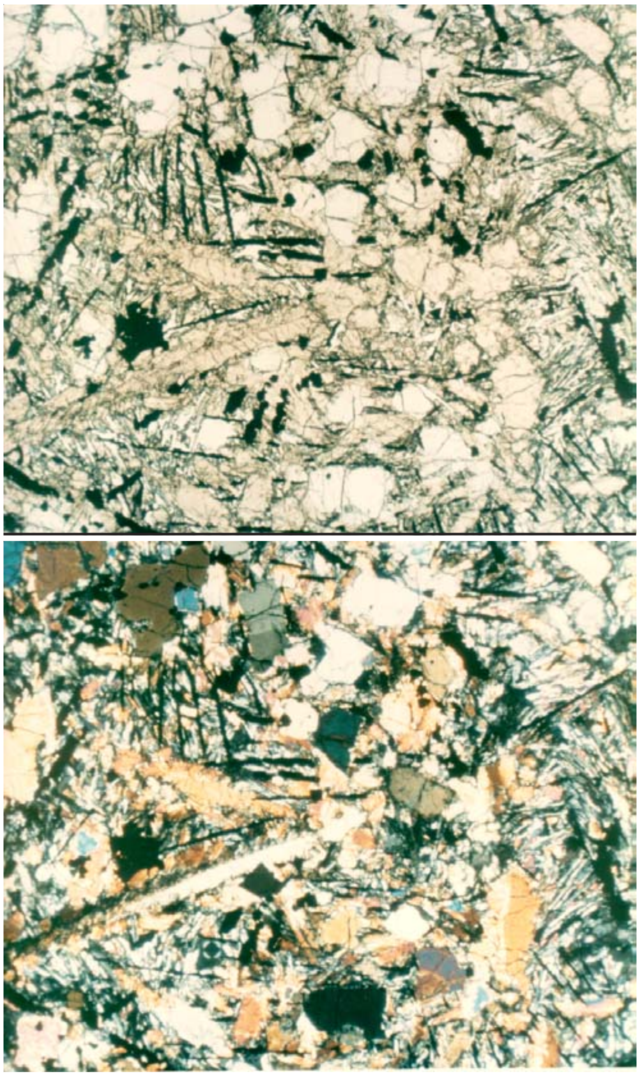


Figure 3: Photomicrographs of thin section 12022,9 (plane-polarized, crossed-nicol). Field of view 2.6 mm. NASA phot #s S70-49455-456

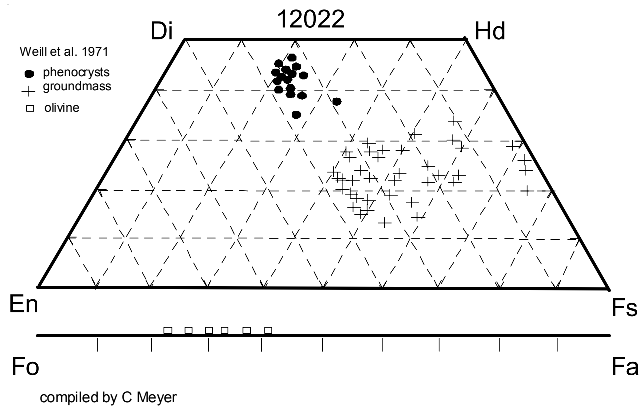


Figure 4: Pyroxene and olivine composition for 12022 (adapted from Weill et al. 1971, Brett et al. 1971).

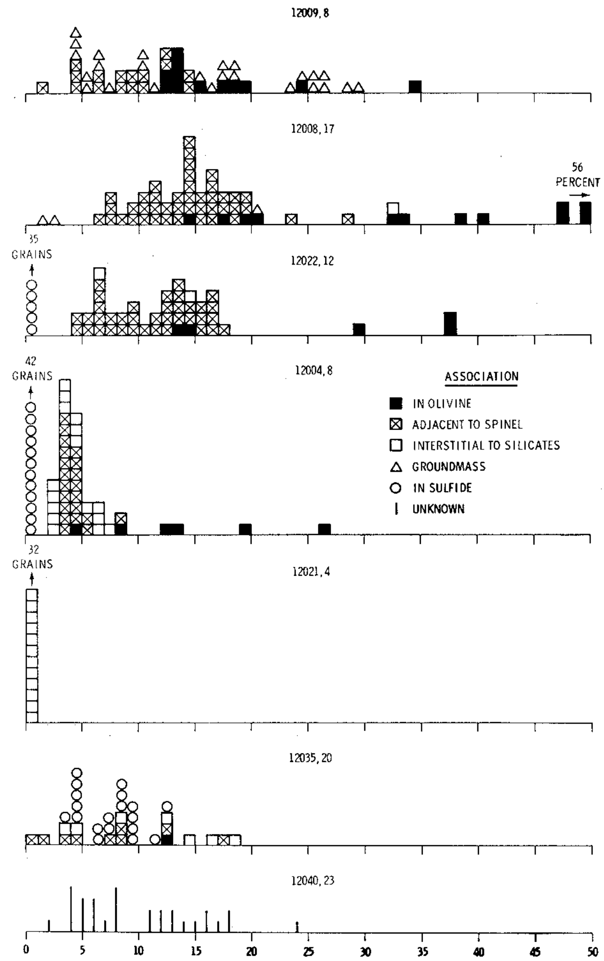


Figure 5: Histogram of Ni conentrations of metal grains in 7 lunar samples (lifted from Brett et al. 1971).

et al. (1997) reported the isotopic composition of Sr and Nd.

Cosmogenic isotopes and exposure ages

Not reported !

Other Studies

Bogard et al. (1971) reported the content and isotopic composition of rare gases in 12022. Barber et al. (1971) determined the track density and erosion rate (figure 8).

Table 1a. Chemical composition of 12022.

reference	Kushiro71		LSPET70	Hubbard71		Weismann75		Murthy71		Haskin71		Engel71		Taylor71		Tats71	
weight	1 g			188 mg		188 mg											
SiO2 %	42.33	(a)	36									43.2	(a)				
TiO2	4.54	(a)	5.1									5.16	(a)				
Al2O3	9.12	(a)	11									9.04	(a)				
FeO	22.06	(a)	22									21.44	(a)				
MnO	0.26	(a)	0.17									0.25	(a)				
MgO	11.58	(a)	13									10.43	(a)				
CaO	9.37	(a)	11									9.56	(a)				
Na2O	0.29	(a)	0.36	0.24								0.47	(a)				
K2O	0.07	(a)	0.068	0.065	(b)	0.065	(b)	0.051	(b)			0.07	(a)				
P2O5	0.02	(a)										0.13	(a)				
S %																	
sum																	
Sc ppm			52									55		55	(d)		
V			65									180		150	(d)		
Cr	3831	(a)	2650									3800		3300	(d)		
Co			36									44		52	(d)		
Ni			40									42		42	(d)		
Cu												8		5	(d)		
Zn																	
Ga																	
Ge ppb																	
As																	
Se																	
Rb			0.17	0.738	(b)	0.738	(b)	0.819	(b)								
Sr			160	143	(b)	143	(b)	138	(b)			130		140	(d)		
Y			62									68		64	(d)		
Zr			160									180		135	(d)		
Nb														6	(d)		
Mo																	
Ru																	
Rh																	
Pd ppb																	
Ag ppb																	
Cd ppb																	
In ppb																	
Sn ppb														0.39	(d)		
Sb ppb																	
Te ppb																	
Cs ppm														0.03	(d)		
Ba			38			59.5	(b)	148	(b)			70		60	(d)		
La										5.81	(c)			6.3	(d)		
Ce				17.4	(b)	17.4	(b)			16.7	(c)			19	(d)		
Pr														3	(d)		
Nd				14.4	(b)	14.4	(b)			19	(c)			16	(d)		
Sm				5.38	(b)	5.38	(b)			6.31	(c)			6.4	(d)		
Eu				1.26	(b)	1.26	(b)			1.32	(c)			1.4	(d)		
Gd				7.71	(b)	7.71	(b)			9.2	(c)			9.7	(d)		
Tb										1.56	(c)			1.8	(d)		
Dy				9.37	(b)	9.37	(b)			10.8	(c)			12	(d)		
Ho										1.87	(c)			3	(d)		
Er				5.42	(b)	5.42	(b)			5.8	(c)			8.2	(d)		
Tm														1.3	(d)		
Yb				5.69	(b)	5.06	(b)			5.34	(c)	10		7.2	(d)		
Lu										0.767	(c)						
Hf						0.18	(b)							5.2	(d)		
Ta																	
W ppb																	
Re ppb																	
Os ppb																	
Ir ppb																	
Pt ppb																	
Au ppb																	
Th ppm														0.75	(d)	0.71	(b)
U ppm														0.17	(d)	0.198	(b)

technique: (a) conventional wet, (b) IDMS, (c) INAA, (d) SSMS, (e) RNAA

Table 1b. Chemical composition of 12022.

reference	Baedecker71		Snyder97		Neal2001	
weight						
SiO2 %			43.2			
TiO2			5.16			
Al2O3			9.04			
FeO			21.44			
MnO			0.25			
MgO			10.43			
CaO			9.56			
Na2O			0.47			
K2O			0.07			
P2O5			0.13			
S %						
sum						
Sc ppm					59.6	(f)
V					156	(f)
Cr			3300	(f)	3004	(f)
Co			52.6	(f)		
Ni			47.4	(f)	29.1	(f)
Cu			17.6	(f)	15.7	(f)
Zn	2	(e)	11.5	(f)	11.3	(f)
Ga	3.9	(e)	4.24	(f)	3.64	(f)
Ge ppb						
As						
Se						
Rb			0.841	(f)	0.78	(f)
Sr			142.5	(f)	147.5	(f)
Y			64.2	(f)	51	(f)
Zr			160.1	(f)	122	(f)
Nb			7.04	(f)	6	(f)
Mo					0.11	(f)
Ru						
Rh						
Pd ppb						
Ag ppb			105	(f)		
Cd ppb	6.4	(e)				
In ppb	1.6	(e)				
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm			0.058	(f)	0.03	(f)
Ba			58.4	(f)	57	(f)
La			6.5	(f)	5.59	(f)
Ce			17.9	(f)	16.9	(f)
Pr			3.35	(f)	2.93	(f)
Nd			19.2	(f)	15.3	(f)
Sm			6.58	(f)	5.63	(f)
Eu			1.45	(f)	1.3	(f)
Gd			7.94	(f)	8.74	(f)
Tb			1.66	(f)	1.48	(f)
Dy			10.39	(f)	10.2	(f)
Ho			2.1	(f)	2.09	(f)
Er			5.81	(f)	6.13	(f)
Tm			0.82	(f)	0.84	(f)
Yb			5.36	(f)	5.51	(f)
Lu			0.78	(f)	0.77	(f)
Hf					4.25	(f)
Ta			0.381	(f)	0.39	(f)
W ppb					160	(f)
Re ppb						
Os ppb						
Ir ppb	0.09	(e)				
Pt ppb						
Au ppb						
Th ppm			0.987	(f)	0.63	(f)
U ppm			0.28	(f)	0.19	(f)

technique: (e) RNAA, (f) ICP-MS

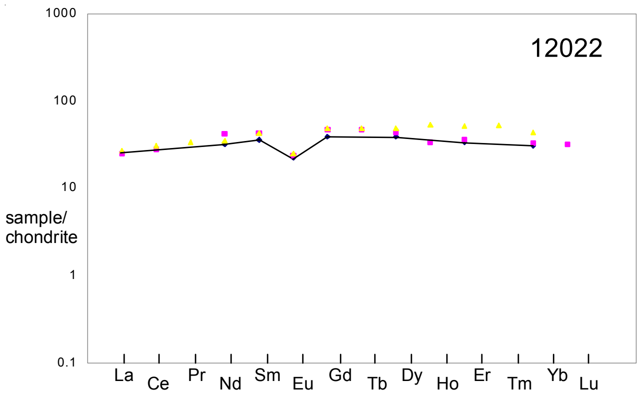


Figure 6: Comparison of rare-earth-element composition of 12022 by neutron activation analysis (Haskin et al. 1971) and spark-source mass spectroscopy (Taylor et al. 1971) with isotope dilution mass spectroscopy (line, Hubbard and Gast 1971, Wiesman et al. 1975).

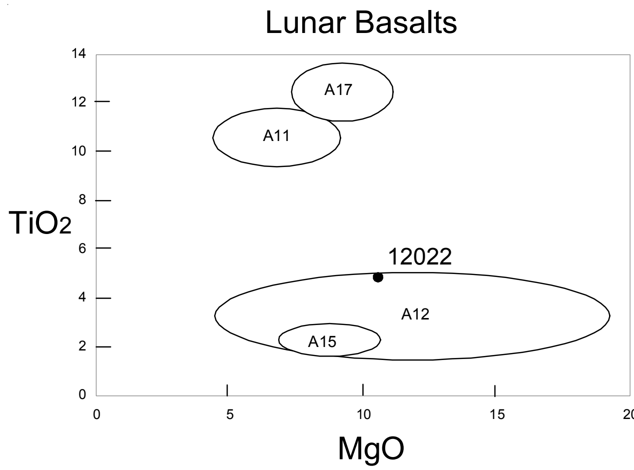


Figure 7: Composition of 12022 compared with that of other lunar basalts.

Helsley (1971) found that 12022 has significant magnetic remanance and Chung et al. (1971) determined the dielectric properties.

Gibson and Hubbard (1972) experimentally studied the volatile depletion for 12022.

Processing

A thick slab (B ,14) was cut from the middle of 12022 with a circular saw (figure 9) and a column (,17) was cut from the slab with a wire saw (figure 12). End piece (A ,13) was also subdivided with a wire saw (figure 10). A large piece of 12022 is on public display in Wales, England (figure 13).

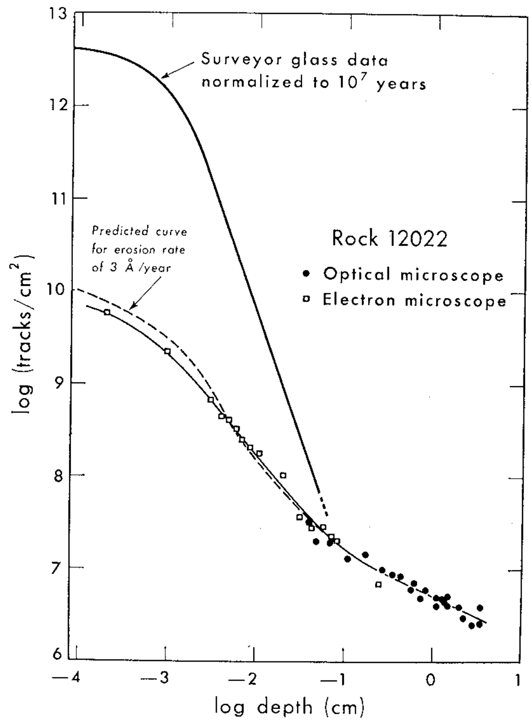


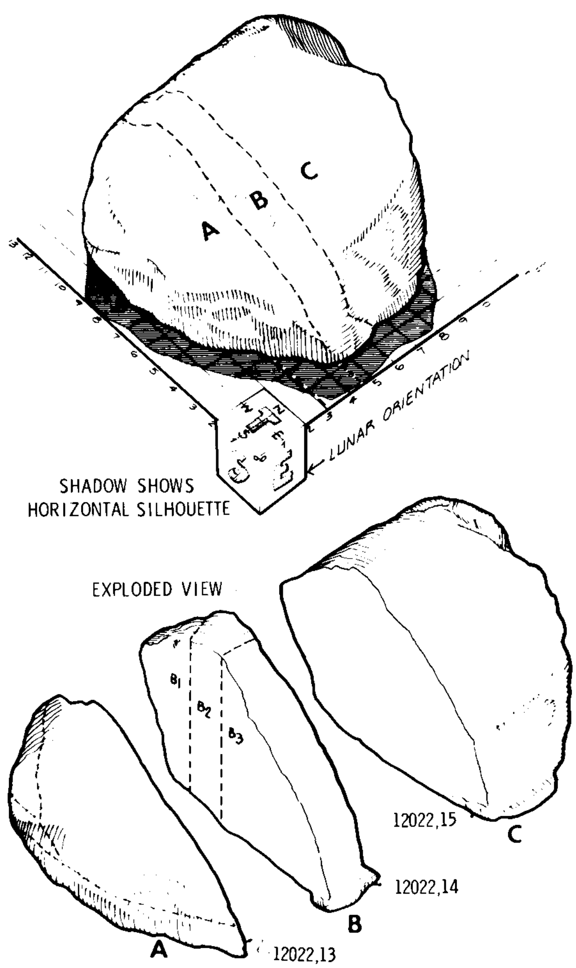
Figure 8: Track density as function of depth in 12022 (from Barber et al. 1971).

List of Photo #s for 12022

S69-64083	color mug
S69-64108	color mug
S70-16784 – 785	TS color
S70-20956	TS color
S70-49560 – 561	
S70-49455 – 460	TS color
S74-24900 – 902	display
S79-27121 – 122	TS color

THE CUTTING OF LUNAR ROCK NO. 12022

DRAWING COMPLETED MAY 13, 1970



THE CUTTING OF SLICE 'A' NO. 12022,13

DRAWING COMPLETED MAY 29, 1970

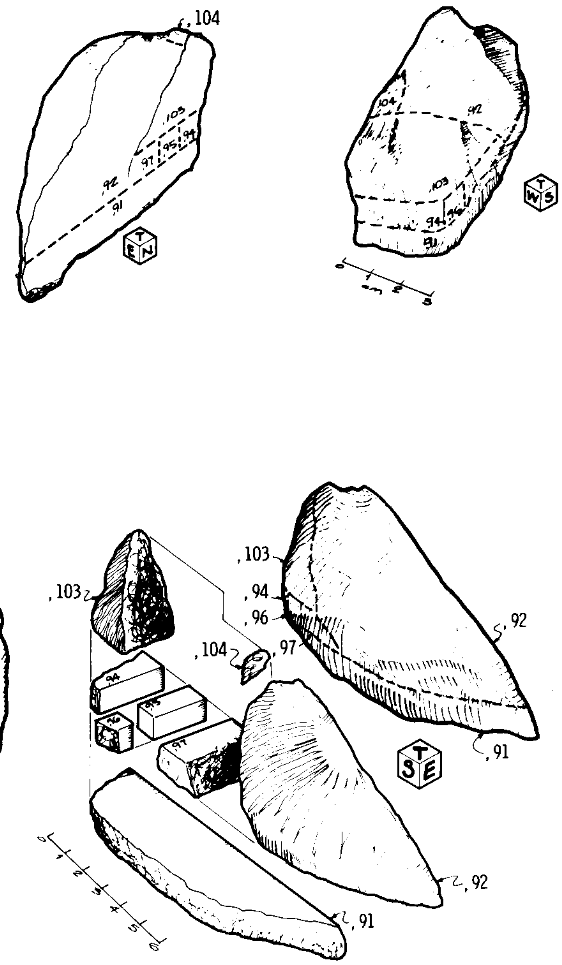
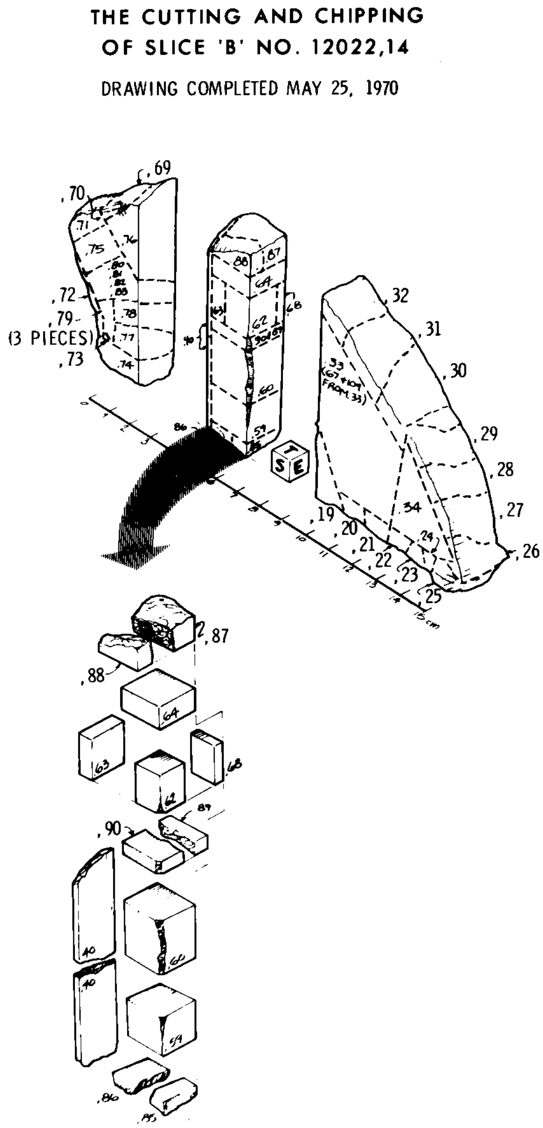


Figure 9: Group photo of 12022,0 after 1.5 mm slab was cut.

Figure 10: Group photo of 12022,13. Scale is in mm.



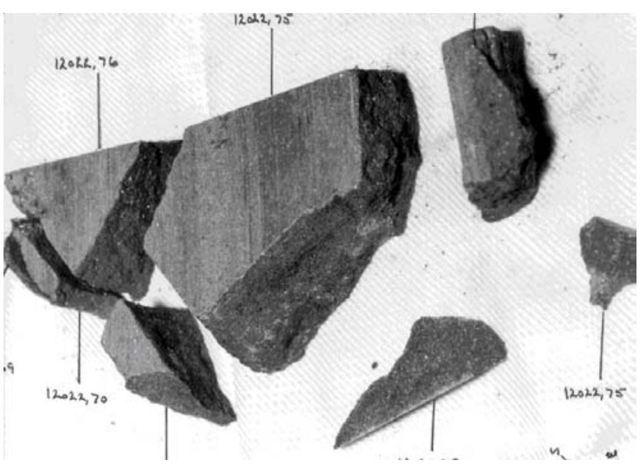


Figure 11: End piece of slab 12022, 14.

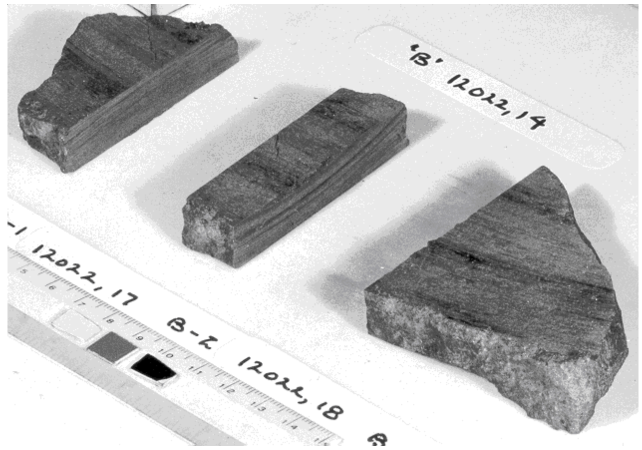
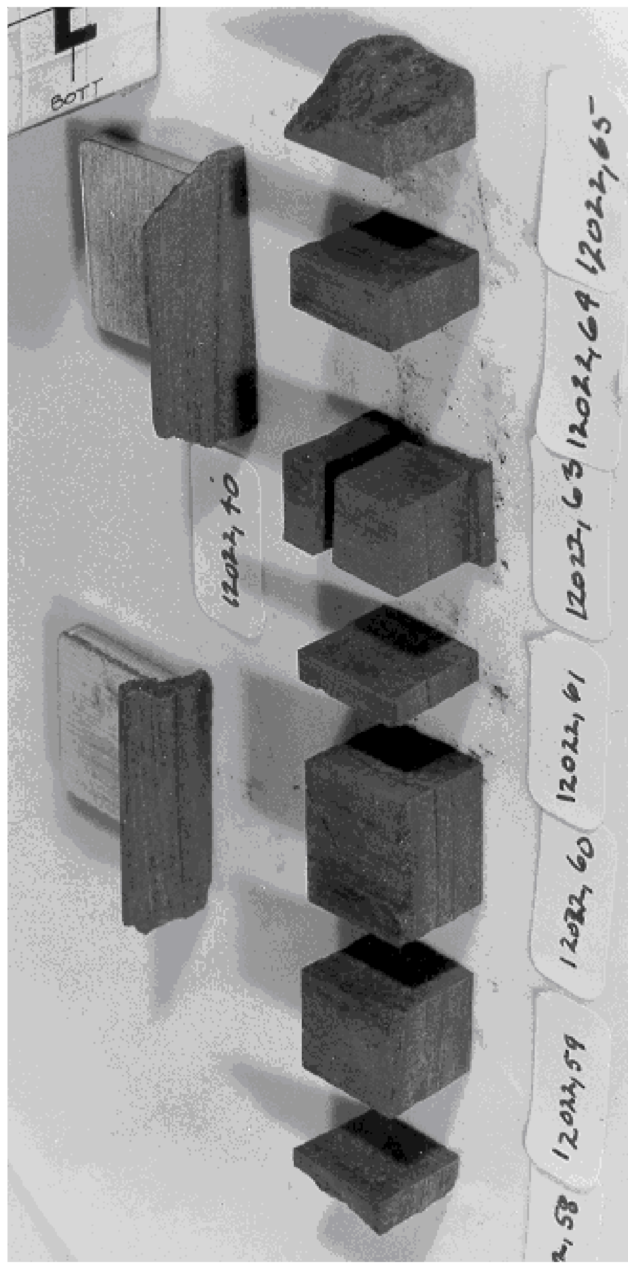


Figure 12: Column (12022,17) cut from slab (12022,14). Scale in mm.



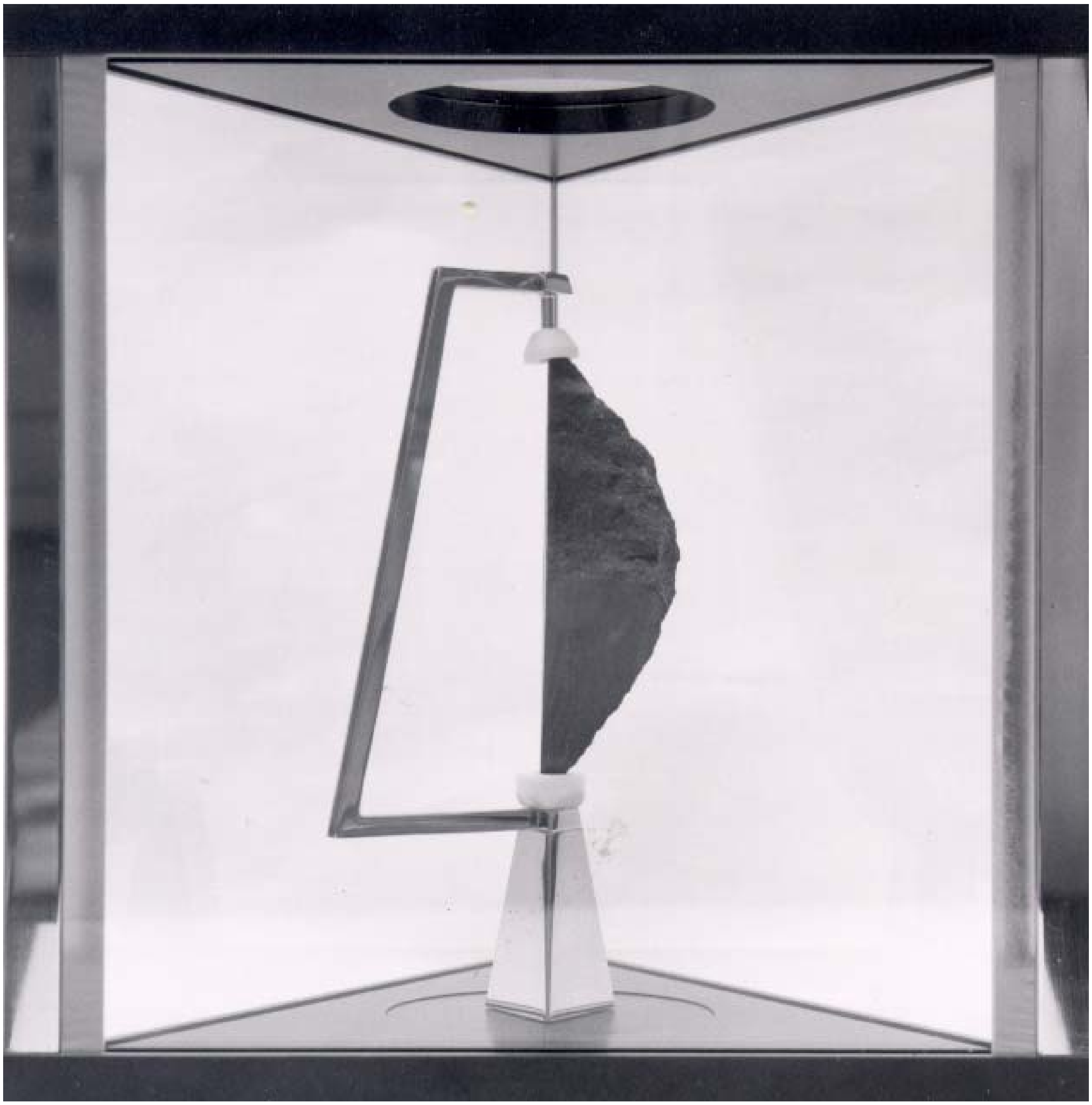


Figure 13: Display case for 12022,92. NASA S74-24901.

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