

12020
Olivine Basalt
312 grams

DRAFT □



Figure 1: Photo of 12020. Scale in cm. NASA # S70-43639.

Introduction

12020 is an olivine basalt with large rounded olivine phenocrysts and elongate pyroxene crystals set in a variolitic groundmass of thin clinopyroxene and plagioclase laths (figure 2). It had one large zap pit on one surface.

Petrography

Klein et al. (1971) describe 12020 as a “medium-grained olivine microgabbro consisting mainly of clinopyroxene, plagioclase and olivine. The clinopyroxene occurs as subhedral laths, up to several mm in length, as smaller anhedral grains, and as very thin, lathlike, crystals interleathed with plagioclase laths.”



Figure 2: Photomicrograph of thin section 12020,13 illustrating round olivine and elongate pyroxene phenocrysts with variolitic intergrowths of plagioclase and pyroxene needles. NASA S70-30254. Field of view about 2 cm.

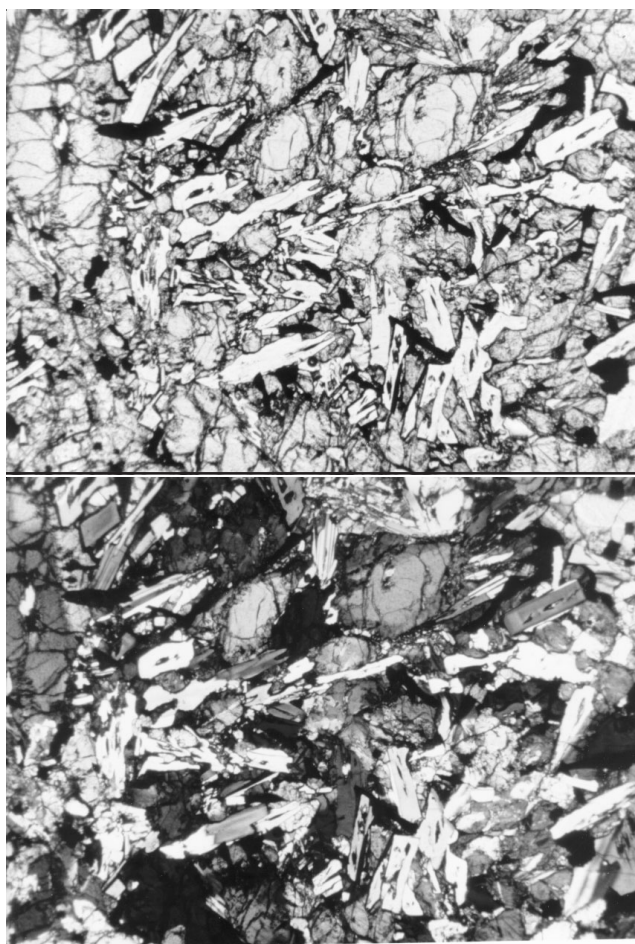


Figure 3: Photomicrographs of thin section 12020,11 (plane-polarized, crossed-nicols). Field of view is 2.6 mm. NASA # S70-49556-557.

Mineralogy

Olivine: According to Klein et al. (1971) the cores of olivine in 12020 are rather homogeneous (Fo₇₀₋₇₇), whereas the rims range from Fo₇₀ to Fo₅₀ (figure 4). Kushiro et al. (1971) reported a wide range in olivine composition from Fo₇₄ to Fo₃.

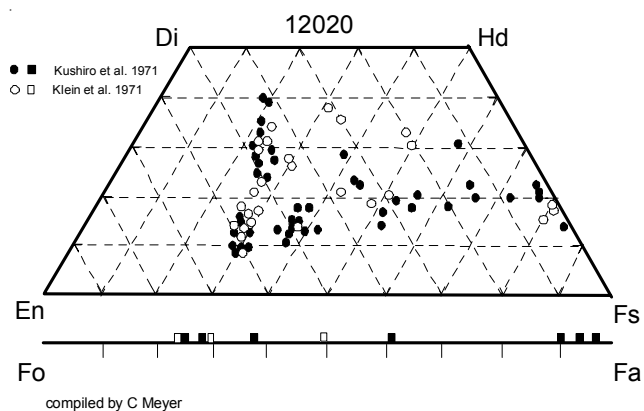


Figure 4: Pyroxene and olivine composition of 12020 (adapted from Klein et al. 1971, Kushiro et al. 1971).

Pyroxene: Kushiro et al. (1971) and Klein et al. (1971) studied the composition of pyroxene in 12020 (figure 4). Pyroxene zones in Fe all the way to ferrohedenbergite (now there's a name).

Plagioclase: Plagioclase composition in 12020 range from An₉₃ to An₈₈ (Kushiro et al. 1971). Klein et al. (1971) report An₉₈ to An₈₀, with the majority as An₉₆.

Chemistry

The rare earth element pattern is relatively flat (figure 5). 12020 is relatively Mg-rich (figure 6), apparently due to accumulation of olivine (Walker et al. 1976).

Radiogenic age dating

Alexander et al. (1972) reported an Ar/Ar age of 3.20 ± 0.03 b.y. for 12020, consistent with that of other Apollo 12 basalts.

Mineralogical Mode for 12020

	Neal et al. 1994	Klein et al. 1971	Papike et al. 1976
Olivine	19	15.1	11.4
Pyroxene	51.2	58.6	61.4
Plagioclase	25.9	20	20.7
Opaques			5.6
Ilmenite	0.2		
Chromite +Usp	2.7	4.6	
Mesostasis	0.5	1.7	
"silica"			0.2

Cosmogenic isotopes and exposure ages

Hintenberger et al. (1971) determined exposure ages for 12020 using ^3He (77 m.y.), ^{21}Ne (71 m.y.) and ^{38}Ar (56 m.y.). The suntan age for 12020 (from etched solar flare track studies) is 2.6 m.y. (Bhandari et al. 1971).

Other Studies

Bogard et al. (1971) reported the content and isotopic composition of rare gases in 12020.

List of Photo #s for 12020

S69-24225	TS
S69-24213	closeup
S69-64130	color mug
S69-64105	
S69-63324-332	B&W mug
S70-43638-640	color mug
S70-19641-644	wire saw cut
S70-49135-144	TS color
S70-25406-408	
S70-25421-424	
S70-30251-253	
S70-25890-893	
S70-27991	
S70-31559-566	TS

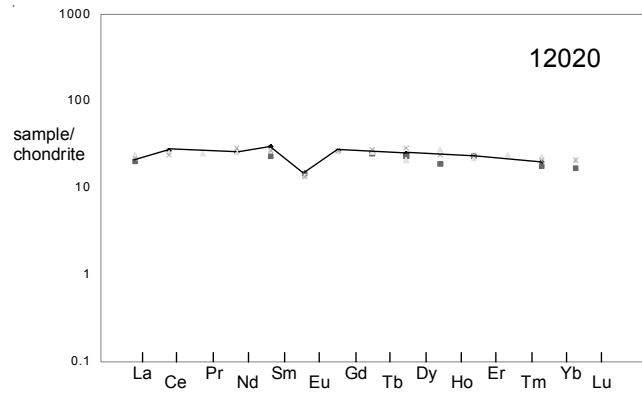


Figure 5: Rare-earth-element diagram for 12020 (idms data from Hubbard connected).

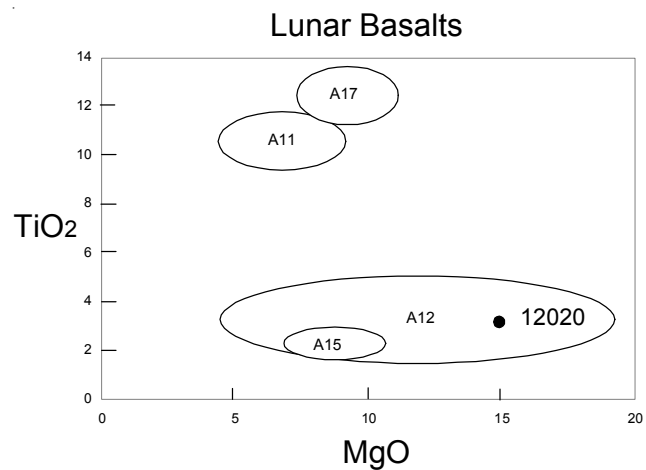


Figure 6: Composition of lunar basalts showing 12020.

Summary of Age Data for 12020

	Ar/Ar	Rb/Sr
Alexander et al. 1971	3.20 ± 0.03	

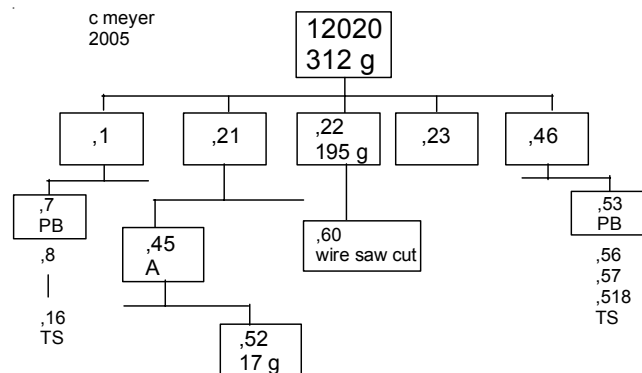


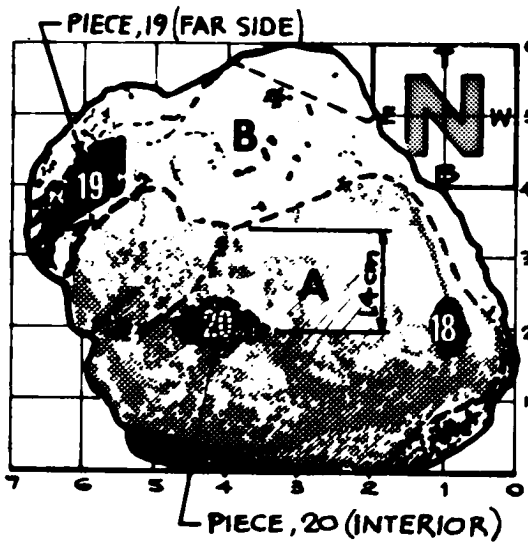
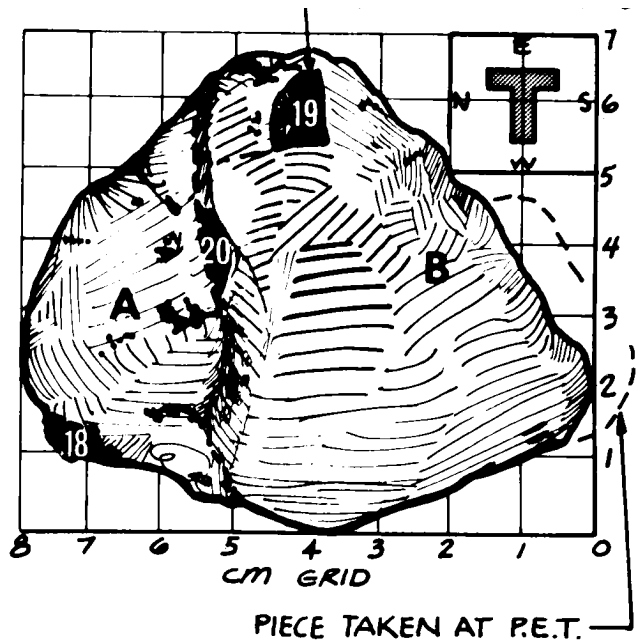
Table 1. Chemical composition of 12020.

reference weight	Kushiro71	Hubbard71	Weismann75 259 mg	Wanke71	Cuttitta71	Wakita71 0.444 0.408	Haskin71	Compston71	Anders71
SiO2 %	44.45 (a)			43.86 (c)	44.6 (d)	42.2 (c)		44.66 (f)	
TiO2	2.54 (a)			2.64 (c)	2.56 (d)	2.7 3 (c)		2.73 (f)	
Al2O3	7.99 (a)			7.2 (c)	8 (d)	8.5 8.3 (c)		7.31 (f)	
FeO	20.65 (a)			21.1 (c)	20.7 (d)	21.8 (c)		21.58 (f)	
MnO	0.26 (a)			0.28 (c)	0.27 (d)	0.253 0.26 (c)		0.28 (f)	
MgO	14.89 (a)			15.65 (c)	14.4 (d)	16.1 (c)		13.91 (f)	
CaO	8.53 (a)			8.12 (c)	8.53 (d)	8.7 8.8 (c)		8.73 (f)	
Na2O	0.21 (a)	0.19		0.17 (c)	0.23 (d)	0.22 0.213 (c)		0.21 (f)	
K2O	0.06 (a)	0.056 (b)	0.056 (b)	0.046 (c)	0.06 (d)	0.069 (c)		0.064 (f)	
P2O5	0.02 (a)				0.08 (d)			0.08 (f)	
S %								0.06 (f)	
sum									
Sc ppm				45.4 (c)	39 (d)	42 (c)			
V					155 (d)	180 200 (e)		146 (f)	
Cr	4653 (a)			4560 (c)	4330 (d)	4187 (c)		3780 (f)	
Co				61 (c)	64 (d)	61 (c)		50 (f)	68 (e)
Ni					77 (d)			50 (f)	
Cu				6.9 (c)	9 (d)			13 (f)	
Zn								4 (f)	0.74 (e)
Ga					4.8 (d)			1.8 (f)	
Ge ppb									
As									
Se									0.114 (e)
Rb		0.997 (b)	0.997 (b)	1.4 (b)	1.4 (d)	1 (e)		1.03 (f)	0.85 (e)
Sr		93.6 (b)	93.6 (b)	(b)	65 (d)			91.4 (f)	
Y					37 (d)	34 (e)		32 (f)	
Zr					119 (d)			97 (f)	
Nb					13 (d)			5 (f)	
Mo									
Ru									
Rh									
Pd ppb									
Ag ppb									0.98 (e)
Cd ppb									1.1 (e)
In ppb						12 (e)			2.7 (e)
Sn ppb									
Sb ppb									
Te ppb									
Cs ppm						0.05 (e)			0.039 (e)
Ba		64.4 (b)	64.4 (b)	(b)	61 (d)	25 (c)		60 (f)	
La				4.82 (c)		5.9 (e)	5.19 (c)	4 (f)	
Ce		16.1 (b)	16.1 (b)	(b)		16.1 (e)	14.5 (c)	11 (f)	
Pr						2.2 (e)			
Nd		12 (b)	12 (b)	(b)		12 (e)	13 (c)		
Sm		4.5 (b)	4.5 (b)	3.4 (c)		4.08 (e)	3.92 (c)		
Eu		0.839 (b)	0.839 (b)	0.82 (c)		0.79 (e)	0.76 (c)		
Gd		5.43 (b)	5.43 (b)	(b)		5.4 (e)	5.3 (c)		
Tb				0.91 (c)		0.96 (e)	1.02 (c)		
Dy		6.13 (b)	6.13 (b)	5.68 (c)		5.2 (e)	7.1 (c)		
Ho				1.07 (c)		1.55 (e)	1.34 (c)		
Er		3.75 (b)	3.75 (b)	(b)		3.5 (e)	3.8 (c)		
Tm						0.59 (e)			
Yb		3.69 (b)	3.28 (b)	2.91 (c)	5.1 (d)	3.8 (e)	3.43 (c)		
Lu				0.42 (c)		0.54 (e)	0.51 (c)		
Hf			0.14 (b)	3.8 (c)		2.4 (c)			
Ta				0.45 (c)					
W ppb									
Re ppb									
Os ppb									
Ir ppb									0.04 (e)
Pt ppb									
Au ppb							(c)		0.36 (e)
U ppm									

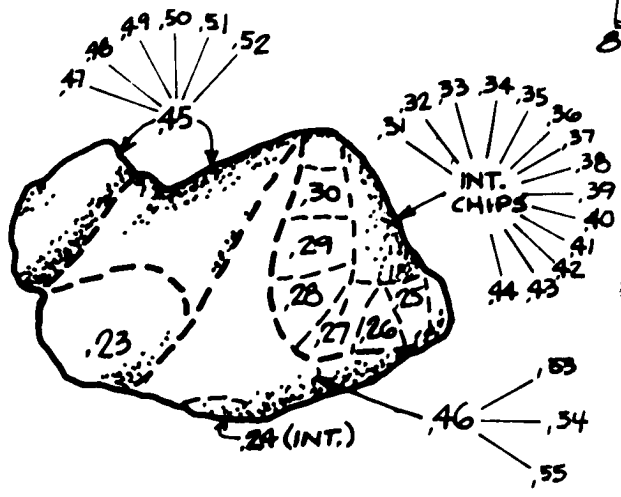
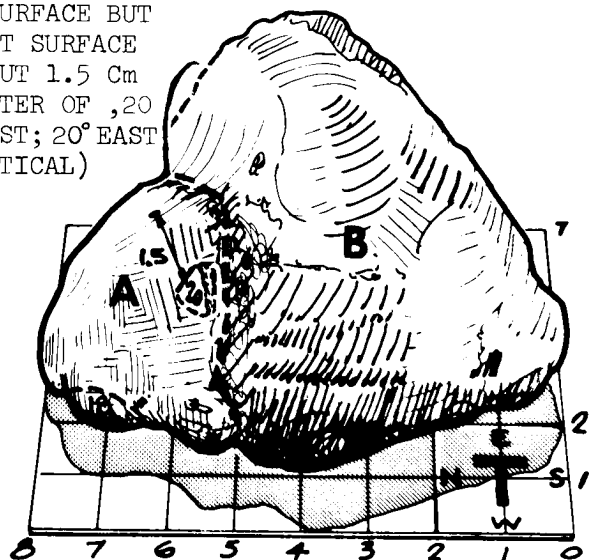
technique (a) conventional wet, (b) IDMS, (c) INAA, (d) mixed microchem, XRF, emission spec., (e) RNAA, (f) XRF

THE CHIPPING OF LUNAR ROCK 12020

DRWG. COMPLETED 7-24-70



PIECE ,20 IS 1.4 Cm STRAIGHT DOWN FROM SURFACE BUT NEAREST SURFACE IS ABOUT 1.5 Cm to CENTER OF ,20 (34° WEST; 20° EAST OF VERTICAL)



OTHER CHIPPING OF PIECE A (12020, 21)