12020

Olivine Basalt

312 grams

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 anhderal grains, and as very thin, lathlike, crystals interleathed with plagioclase laths."

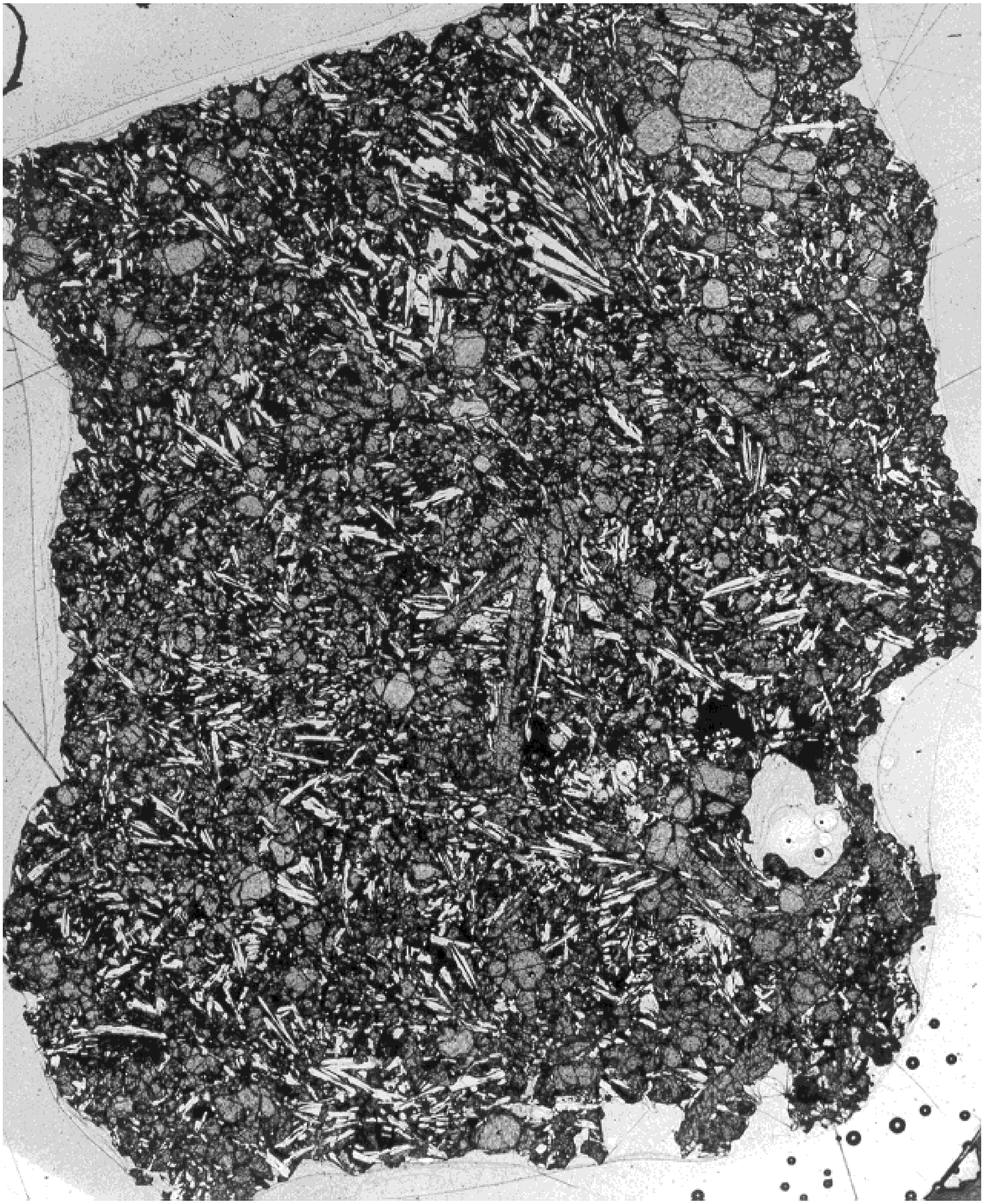


Figure 2: Photomicrograph of thin section 12020,13 illustrating round olivine and elongate pyroxene phenocrysts with variolitic intergrowths of plagioclase and pyroxene needles. NASA S70-30254. Field of view about 2 cm.

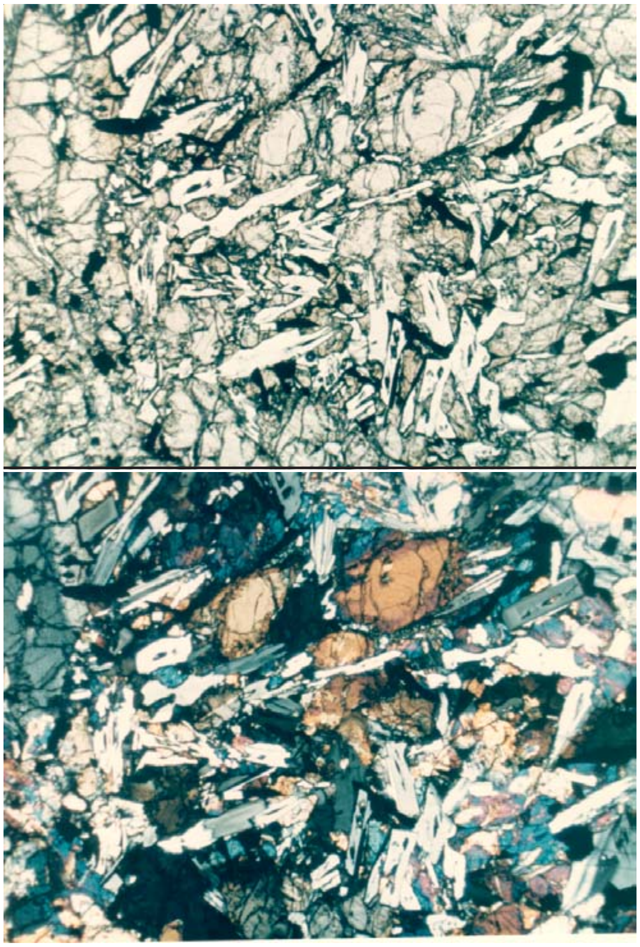


Figure 3: Photomicrographs of thin section 12020,11 (plane-polarized, crossed-nicols). Field of view is 2.6 mm. NASA # S70-49556-557.

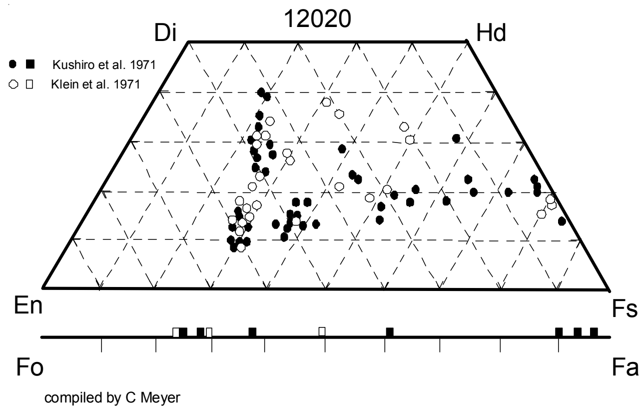


Figure 4: Pyroxene and olivine composition of 12020 (adapted from Klein et al. 1971, Kushiro et al. 1971).

Mineralogy

Olivine: According to Klein et al. (1971) the cores of olivine in 12020 are rather homogeneous (Fo_{70-77}), whereas the rims range from Fo_{70} to Fo_{50} (figure 4). Kushiro et al. (1971) reported a wide range in olivine composition from Fo_{74} to Fo_3.

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 ferroheddenbergite (now there's a name).

Plagioclase: Plagioclase composition in 12020 range from An_{93} to An_{88} (Kushiro et al. 1971). Klein et al. (1971) report An_{98} to An_{80}, with the majority as An_{96}.

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.

Cosmogenic isotopes and exposure ages

Hintenberger et al. (1971) determined exposure ages for 12020 using ^{3}He (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.

There are 13 thin sections.

Mineralogical Mode for 12020

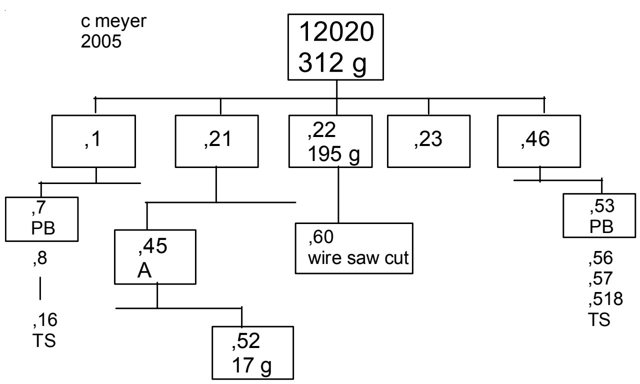
	Neal et al. 1994	Klein et al. 1971	Papike et al. 1976
Olivine	19	15.1	11.4
Pyroxene	51.2	58.6	61.4
Plagioclase	25.9	20	20.7
Opaques			5.6
Ilmenite	0.2		
Chromite +Usp	2.7	4.6	
Mesostasis	0.5	1.7	
"silica"			0.2

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

Summary of Age Data for 12020

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



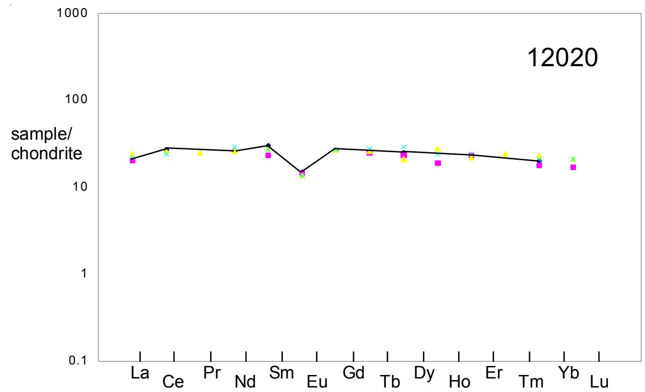


Figure 5: Rare-earth-element diagram for 12020 (idms data from Hubbard connected).

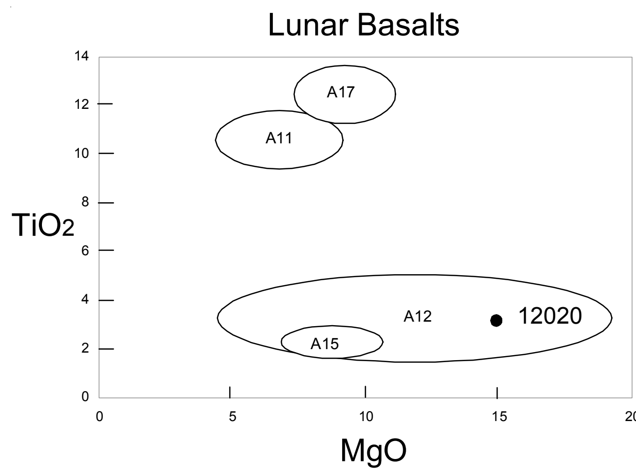


Figure 6: Composition of lunar basalts showing 12020.

Table 1. Chemical composition of 12020.

reference	Kushiro71		Hubbard71		Weismann75		Wanke71		Cuttitta71		Wakita71			Haskin71		Compston71		Anders71	
weight					259 mg						0.444	0.408							
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	(d)		1	(e)			1.03	(f)	0.85	(e)
Sr			93.6	(b)	93.6	(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)			61	(d)	25		(c)			60	(f)		
La							4.82	(c)			5.9	5.6	(e)	5.19	(c)	4	(f)		
Ce			16.1	(b)	16.1	(b)						16.1	(e)	14.5	(c)	11	(f)		
Pr												2.2	(e)						
Nd			12	(b)	12	(b)						12	(e)	13	(c)				
Sm			4.5	(b)	4.5	(b)	3.4	(c)			4.08	4.1	(e)	3.92	(c)				
Eu			0.839	(b)	0.839	(b)	0.82	(c)			0.79	0.76	(e)	0.76	(c)				
Gd			5.43	(b)	5.43	(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)						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	3.7	(e)	3.43	(c)				
Lu							0.42	(c)			0.54	0.52	(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 mcirochem, XRF, emission spec., (e) RNAA, (f) XRF

Table 1b. Chemical composition of 12020.

reference	Neal2001	
weight		
SiO2 %		
TiO2		
Al2O3		
FeO		
MnO		
MgO		
CaO		
Na2O		
K2O		
P2O5		
S %		
sum		
Sc ppm	47	(a)
V	182	(a)
Cr	3615	(a)
Co	66	(a)
Ni	89	(a)
Cu	16	(a)
Zn	89	(a)
Ga	3.35	(a)
Ge ppb		
As		
Se		
Rb	1.13	(a)
Sr	105	(a)
Y	43	(a)
Zr	119	(a)
Nb	8.45	(a)
Mo	1.12	(a)
Ru		
Rh		
Pd ppb		
Ag ppb		
Cd ppb		
In ppb		
Sn ppb		
Sb ppb	30	(a)
Te ppb		
Cs ppm	0.02	(a)
Ba	64	(a)
La	5.87	(a)
Ce	17.6	(a)
Pr	2.53	(a)
Nd	12.9	(a)
Sm	4.38	(a)
Eu	0.73	(a)
Gd	5.78	(a)
Tb	1.11	(a)
Dy	7.11	(a)
Ho	1.41	(a)
Er	3.82	(a)
Tm	0.53	(a)
Yb	3.6	(a)
Lu	0.52	(a)
Hf	3.12	(a)
Ta	0.44	(a)
W ppb	110	(a)
Re ppb		
Os ppb		
Ir ppb		
Pt ppb		
Au ppb		
Th ppm	0.77	(a)
U ppm	0.22	(a)
technique	*(a) ICP-MS*	

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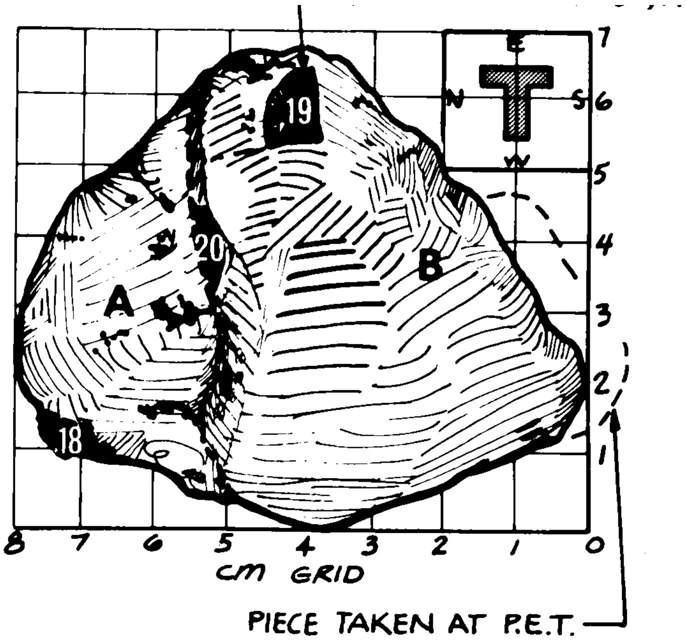
THE CHIPPING OF LUNAR ROCK 12020

DRWG. COMPLETED 7·24·70



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