12010

DRAFT

Regolith Breccia

360 grams

Figure 1: Photo of exterior surface of 12010,12 showing patina and micrometeorite craters. NASA S84-39792. Sample is about 2 x 3 inches.

Introduction

12010 was collected from the outer rim of Middle Crescent Crater. It has micrometeorite craters on all sides (Warner 1971, Fruland 1983).

Portions of 12010 have high abundance of solar wind, so it is properly called a "regolith breccia". However, it has few recognizable agglutinate particles, and contains numerous basalt clasts.

Petrography

Several groups have studied 12010. Simon et al. (1985) found that 12010 has a high proportion of mare basalt clasts (26 %). von Engelhardt et al. (1971) reported

Figure 2: Photo of 12010,0. NASA S70-43805. Sample is 6.5 cm across.

glass analyses with high Al content and also gave a lithologic mode (37 % basalt). Anderson and Smith (1971) reported "grey mottled" basalts (impact melt clasts). Sclar (1971) found that 12010 contained glass particles and shocked mineral grains, but did not find diaplectic glass.

Chemistry

Keith et al. (1972) determined the K, U, Th composition of a large piece, giving the best estimate for the whole sample. Based on the low Th determined by Keith et al., it would appear that the trace element analysis by Goles et al. (1971) is to high (figures 6 and 7) and that their split was not representative of the whole. Compston et al. (1971), Wiesmann and Hubbard

Modal Petrology for 12010

	Simon et al. 1985
Mare Basalt	26.3
ANT	
CMB	
Poik	0.3
Regolith bx.	0.2
Agglutinate	1.3
Pyroxene	3.3
Olivine	1.1
Plag.	20.4
Opaques	
Glass	7.3
Matrix	40.8

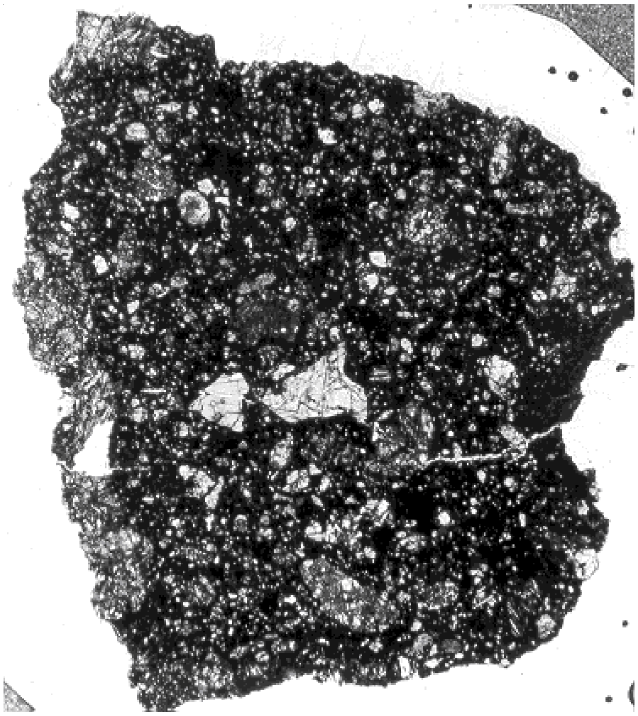


Figure 3: Thin section photomicrograph of 12010,4. NASA S70-25881. Scale is about 1 cm.

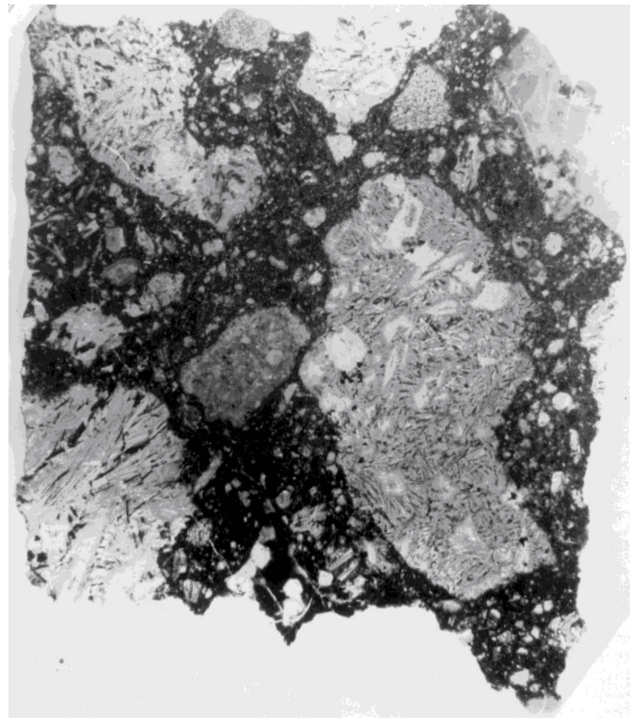


Figure 4: Thin section photomicrograph of 12010,34 showing basalt clasts. NASA S770-46810. Scale about 1 cm.

(1975), and Simon et al. (1985) also reported complete analyses, including isotopic data (table 1).

Simon et al. (1985) calculate that 12010 is approximately 86 % basalt, 3 % anorthosite and 7 % KREEP.

Cosmogenic isotopes and exposure ages

Keith et al. (1972) determined the cosmic-ray induced activity of ^{22}Na = 54 dpm/kg, ^{26}Al = 83 dpm/kg, ^{46}Sc = 5 dpm/kg and ^{54}Mn = 42 dpm/kg for a 289 gram piece of 12010.

Other Studies

Kirsten et al. (1971) found high contents of ^{4}He, ^{20}Ne, ^{36}Ar (solar wind gases) in the dark portions of 12010.

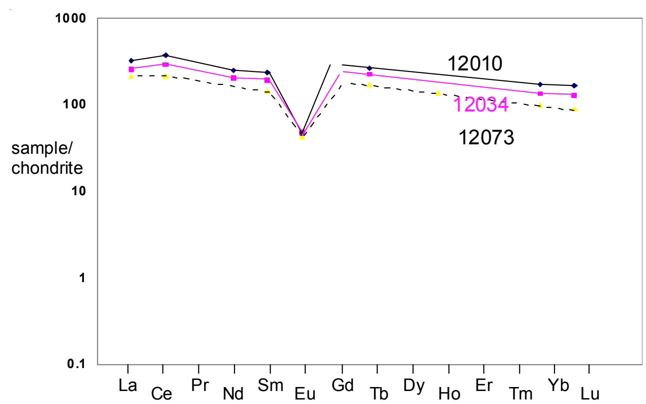


Figure 6: Comparison of REE for three regolith breccias from Apollo 12 (data from Goles et al. 1971 and Wanke et al. 1971).

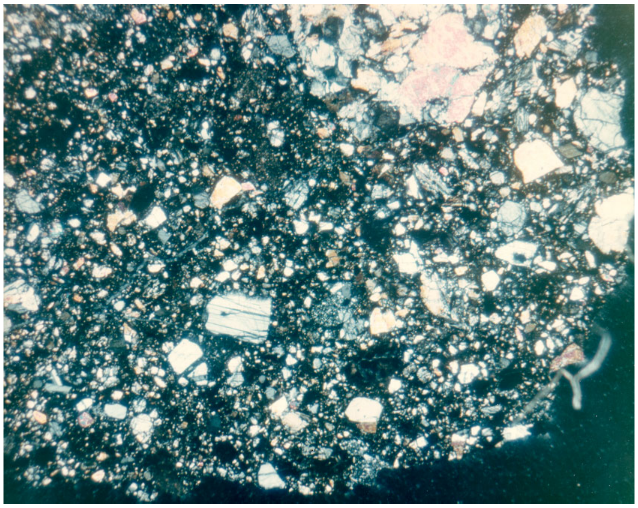


Figure 5a: Photomicrograph showing matrix of thin section 12010,29. NASA S70-45504

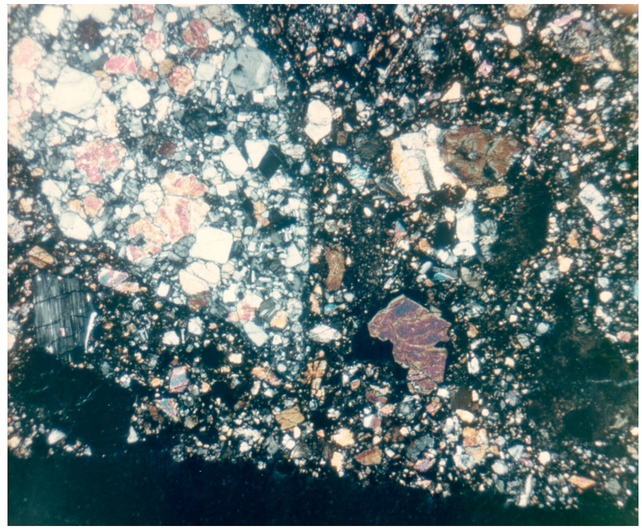


Figure 5b: Photomicrograph of 12010,29 showing clast of highland norite. NASA S70-45505

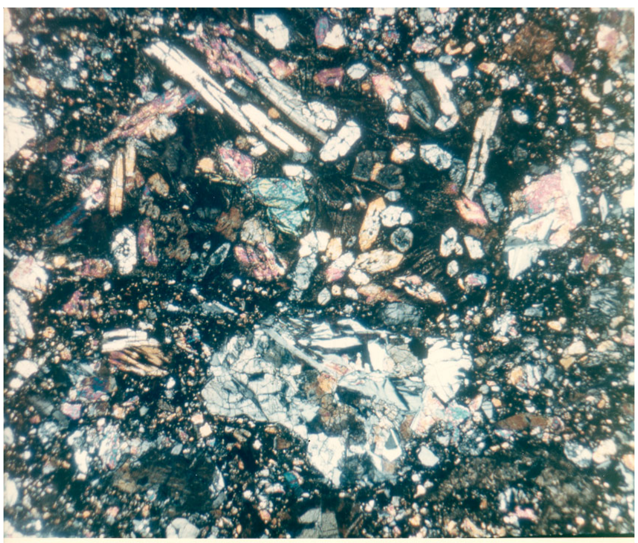


Figure 5c: Photomicrograph of thin section 12010,29 showing two different basalt clasts. NASA S70-45501.

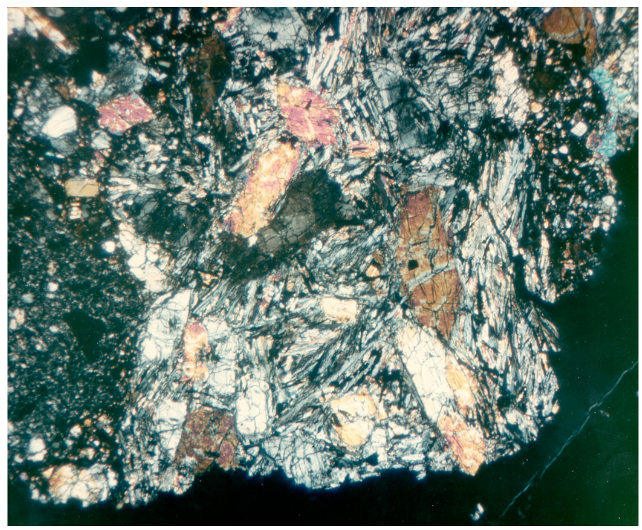


Figure 5 d: Photomicrograph of this section 12010,29 showing clast of variolitic basalt. NASA S70-45616

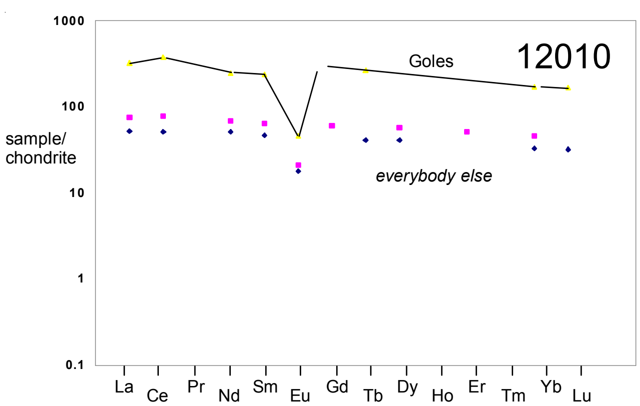


Figure 7: Normalized rare-earth-element diagram for 12010 (the analyses by Simons et al. 1985 and Wiesmann and Hubbard 1975 appear to have been from a more representative portion of 12010).

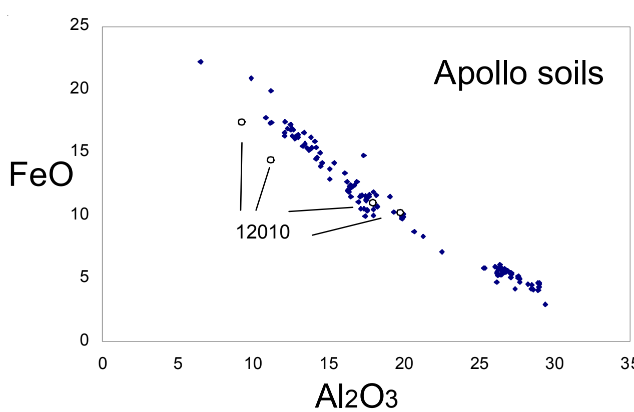
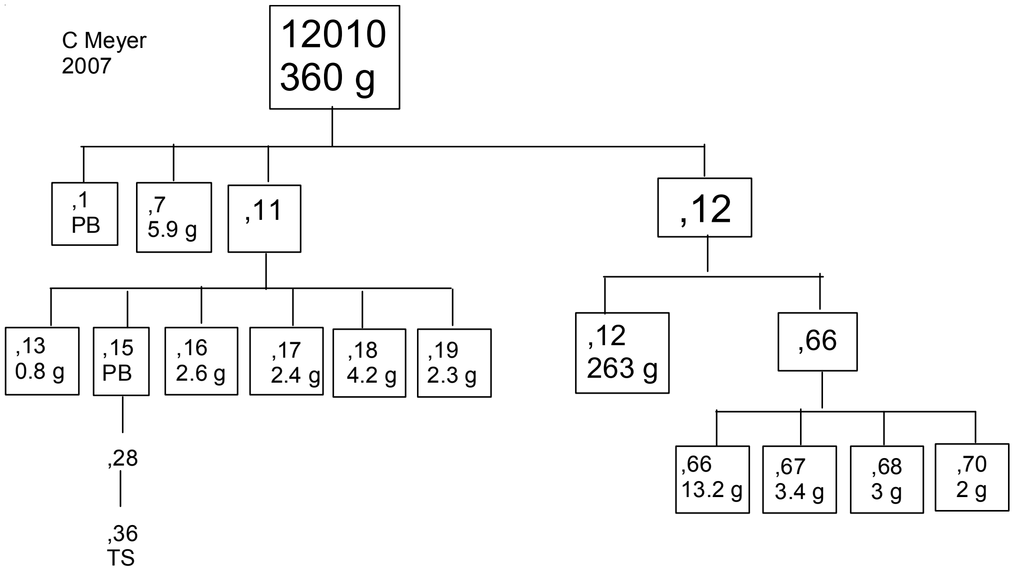


Figure 8: Analyses of soil breccia 12010 compared with those of lunar soils (see table). Take your pick.

Table 1. Chemical composition of 12010.

reference	Simon85		Wiesmann75		LSPET70		Hubbard73		Compston71		Laul 71		Goles71		Keith72	
weight							,37									
SiO2 %					43		46.08	(d)	46.27	(d)			44.5	(e)		
TiO2	2.5	(e)	3.1	(a)	3.67		3.17	(d)	3.3	(d)			2.34	(e)		
Al2O3	9.7	(e)			11.5		10.45	(d)	10.04	(d)			11.94	(e)		
FeO	17.6	(e)			0.18		18.57	(d)	20.33	(d)			13.57	(e)		
MnO	0.27	(e)			19.5		0.26	(d)	0.27	(d)			0.19	(e)		
MgO	11.1	(e)			11		9.2	(d)	8.29	(d)						
CaO	10.3	(e)			10		10.42	(d)	10.81	(d)			9.24	(e)		
Na2O	0.27	(e)			0.53				0.29	(d)			0.84	(e)		
K2O	0.1	(e)	0.157	(a)	0.16		0.16	(d)	0.12	(d)					0.125	(c)
P2O5							0.17	(d)	0.13	(d)						
S %							0.1	(d)	0.07	(d)						
sum																
Sc ppm	48	(e)			50	(b)							32.8	(e)		
V	180	(e)			92	(b)			134				90	(e)		
Cr	3872	(e)	2940	(a)	3050	(b)			2940	(d)			1870	(e)		
Co	40	(e)			39	(b)			34		38	(f)	33.4	(e)		
Ni	60	(e)			80	(b)			32							
Cu									11							
Zn									6		8	(f)				
Ga									2.4		4.1	(f)				
Ge ppb																
As																
Se																
Rb			3.72	(a)	2				2.15		8.8	(f)				
Sr	90	(e)	122	(a)	145				116							
Y					87				51							
Zr	160	(e)	270	(a)	380				175				550	(e)		
Nb									11							
Mo																
Ru																
Rh																
Pd ppb																
Ag ppb											3.7	(f)				
Cd ppb											34	(f)				
In ppb											7	(f)				
Sn ppb																
Sb ppb																
Te ppb																
Cs ppm											0.26	(f)				
Ba	120	(e)	183	(a)	180				125				640	(e)		
La	12.3	(e)	17.7	(a)					9				75.6	(e)		
Ce	31	(e)	47.2	(a)					23				226	(e)		
Pr																
Nd	23	(e)	31.1	(a)									112	(e)		
Sm	6.85	(e)	9.37	(a)									34.9	(e)		
Eu	1	(e)	1.21	(a)									2.58	(e)		
Gd			12	(a)												
Tb	1.5	(e)											9.6	(e)		
Dy	10	(e)	13.8	(a)												
Ho																
Er			8.19	(a)												
Tm	0.83	(e)														
Yb	5.3	(e)	7.49	(a)									27.8	(e)		
Lu	0.78	(e)											4.05	(e)		
Hf	4.3	(e)	7.8	(a)									25.2	(e)		
Ta	0.56	(e)											3.72	(e)		
W ppb																
Re ppb																
Os ppb																
Ir ppb											2.7	(f)				
Pt ppb																
Au ppb											0.82	(f)				
Th ppm	1.45	(e)							1.9				15.65	(e)	2.5	(c)
U ppm	0.4	(e)	0.87	(a)											0.6	(c)

technique: (a) IDMS, (b) OES, (c) radiation counting, (d) XRF, (e) INAA, (f) RNAA



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