DRAFT

12073

Regolith Breccia

407.7 grams

Figure 1: Photo of 12073,17. Scale unknown. NASA S70-44335

Introduction

12073 was collected from the rim of a 6 meter crater near the LM, along with the contingency samples. It was possible to orient the sample based on photography taken from the LM and in the LRL (Schoemaker et al. 1970).

12073 is a typical regolith breccia, with seriate fragmental texture, high porosity and abundant glass fragments with various shapes and colors. It contains a high content of solar wind rare gasses.

Petrography

Fruland (1983) and Simon et al. (1985) included 12073 in their study of regolith breccias. It is coherent with porous matrix and has a chaotic fragmental texture and seriate grain size distribution. The overall color is brown and includes agglutinate glass. There is a wide

Figure 2: Photo of 12073,17 - about 4 inches long. NASA S70-44334.

Mode for 12073

	Chao et al. 1971
Basaltic rock	6.4
Anorthositic rock	1
Mineral fragments	11.9
Glass-welded aggregate	16.4
Devitrified glass	4.4
Heterogeneous glass	2.5
Homogeneous glass	1.9
Basaltic microbreccia	1.6
Anorthositic microbx.	2.7
Shocked	0.2
Less than 25 microns	29.6
Pore space	21.3

Modal Petrology for 12073

	Simon et al. 1985
Mare Basalt	2.4
ANT	
CMB	
Poik. Bas.	2.4
Regolith bx.	2.8
Agglutinate	0.1
Pyroxene	4.3
Olivine	1
Plag.	1.2
Opaques	0.1
Glass	7.3
Matrix	50.8

variety of glass, including spheres, ropy glass and shards. Much of the glass is brown, but also colorless, pale yellow and orange. Black glass has microcrystalline quench texture. Some ropy glass is clast-laden and displays flow texture. Chao et al. (1971) reported 21 % pore space. Waters et al. (1971) studied the fine detail of the matrix, reporting that there is an "abundance of minute particles of glass that are molded plastically against the clastic fragments of the rock, and also against each other until they fill almost every available space". McKay et al. (1971) reported "accretionary lapilli similar to those found in Apollo 11 soil breccias".

Dence et al. (1971) and Chao et al. (1971) describe and give analysis of various glass fragments found as inclusions in 12073. They note the high K and P in some of this glass. Anderson and Smith (1971) reported "grey mottled" basalts (impact breccias).

12073 had a high density of micrometeorite craters on the surface (Horz et al. 1971, Morrison et al. 1972)(figure 7).

Significant Clasts

Alkali Anorthosite (,120)

Warren and Wasson (1980) and Warren et al. (1981) described and analyzed a white clast from 12073 (is it the same one illustrated in Fields et al. 1971?). It has an excessive amount of Eu (figure 5). Warren (1993) list it as possibly pristine (low siderophiles), and gives

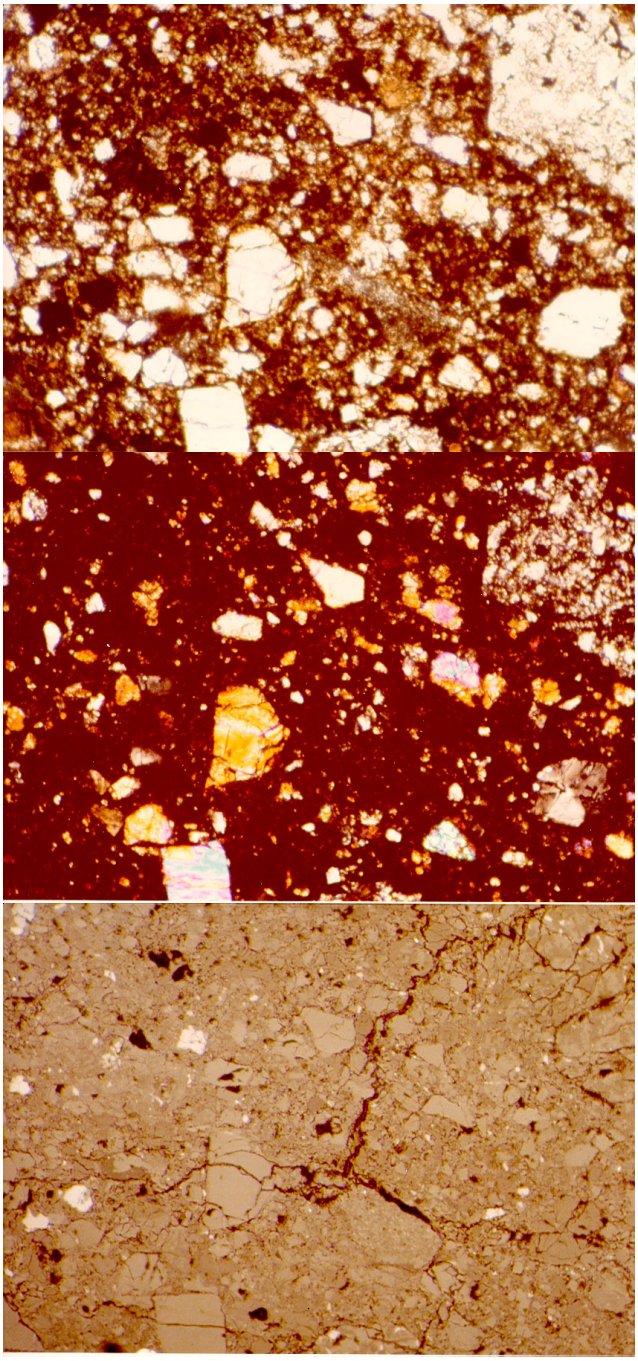


Figure 3: Photomicrographs of thin section 12073,5 - all of same area, all 1.3 mm across. a) transmitted light, NASA S79-27392, b) cross-polarized light, NASA S79-27393, c) reflected light, NASA S79-27391.

the mineral analysis (99% feldspar, $An_{78.6}$; pigeonite En_{41}).

Basalt

Wiesmann and Hubbard (1975) analyzed a basalt clast (table, figure 5).

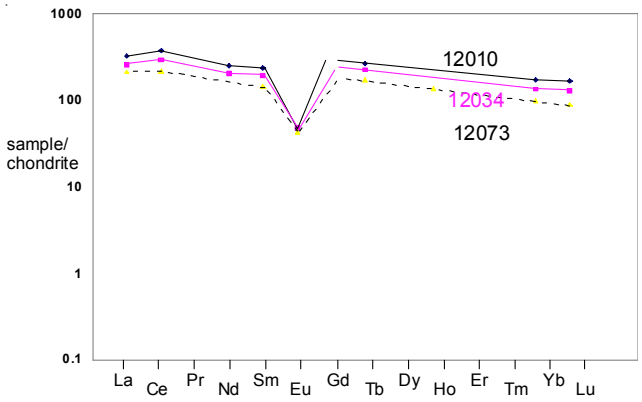


Figure 4: Comparison of REE for three regolith breccias from Apollo 12 (data from Goles et al. 1971 and Wanke et al. 1971).

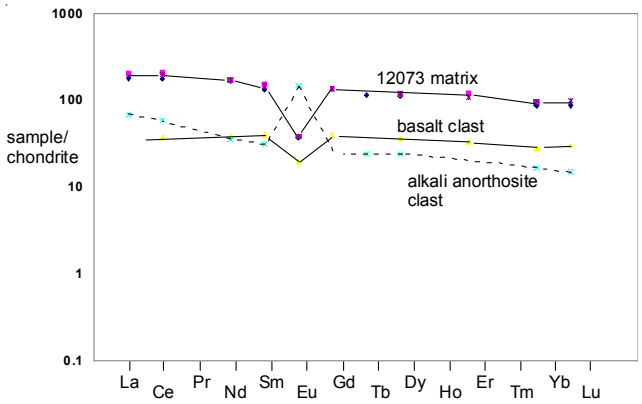


Figure 5: Normalized rare-earth-element diagram for matrix and two clasts in breccia sample 12073 (data for matrix from Hubbard et al. 1971, Schnetzler et al. 1971, Simons et al. 1985; data for basat clast from Wiesmann and Hubbard 1975; data for anorthosite from Warren et al. 1981).

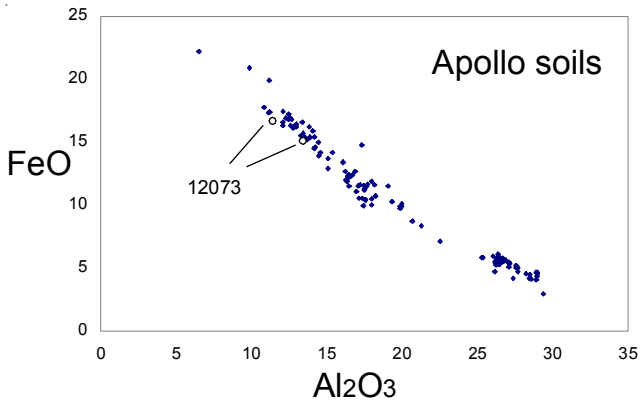


Figure 6: Composition of two portions of regolith breccia 12073 (see table).

Chemistry

12073 has the chemical composition of an Apollo 12 soil (figure 4) and has been analyzed by numerous investigators (table 1). Wanke et al. (1971), Morrison et al. (1971), Schnetzler and Philpotts (1971) and Simon et al. (1985) all have analyses consistent with the K, U, Th of the whole rock (O'Kelley et al. 1971).

Using a least-squares chemical mixing model, Meyer et al. (1971) calculated that 12073 was made up of about 45 % local basalt, 6 % anorthosite, 43 % KREEP and 1% meteorite. Simon et al. (1985) calculate that 12073 is approximately 44 % basalt, 6 % anorthosite and 47 % KREEP. McKay et al. (1971) calculated 41 % KREEP. This is a higher KREEP content than most Apollo 12 soils.

Cosmogenic isotopes and exposure ages

O'Kelly et al. (1971) determined the cosmic ray induced activity of 12073 as ^{22}Na = 63 dpm/kg, ^{26}Al = 110 dpm/kg, ^{46}Sc = <10 dpm/kg, ^{54}Mn = 28 dpm/kg and ^{56}Co = 47 dpm/kg.

Other Studies

Kirsten et al. (1971) and Heymann et al. (1971) reported rare gas contents and isotopic ratios and found high contents of (solar wind gases).

Processing

12073 has several penetrating fractures and broke before it was received in Houston.

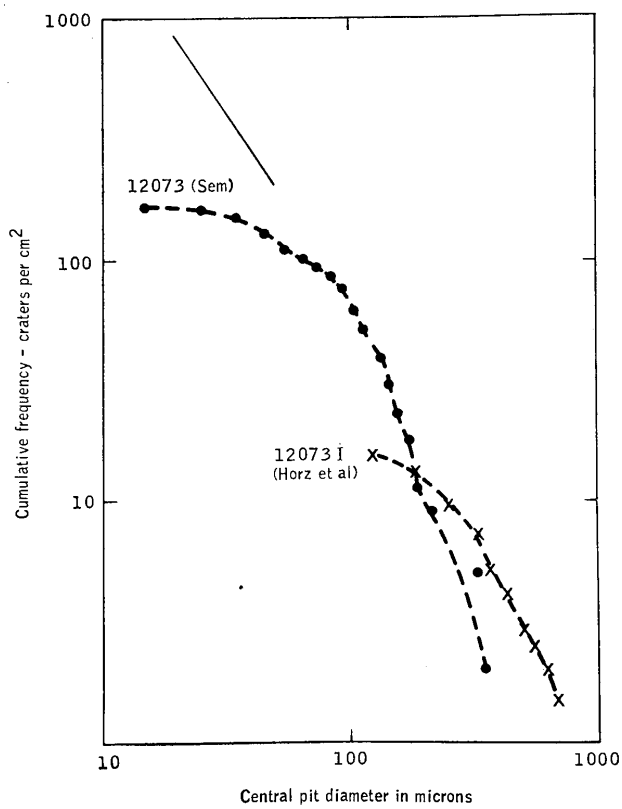
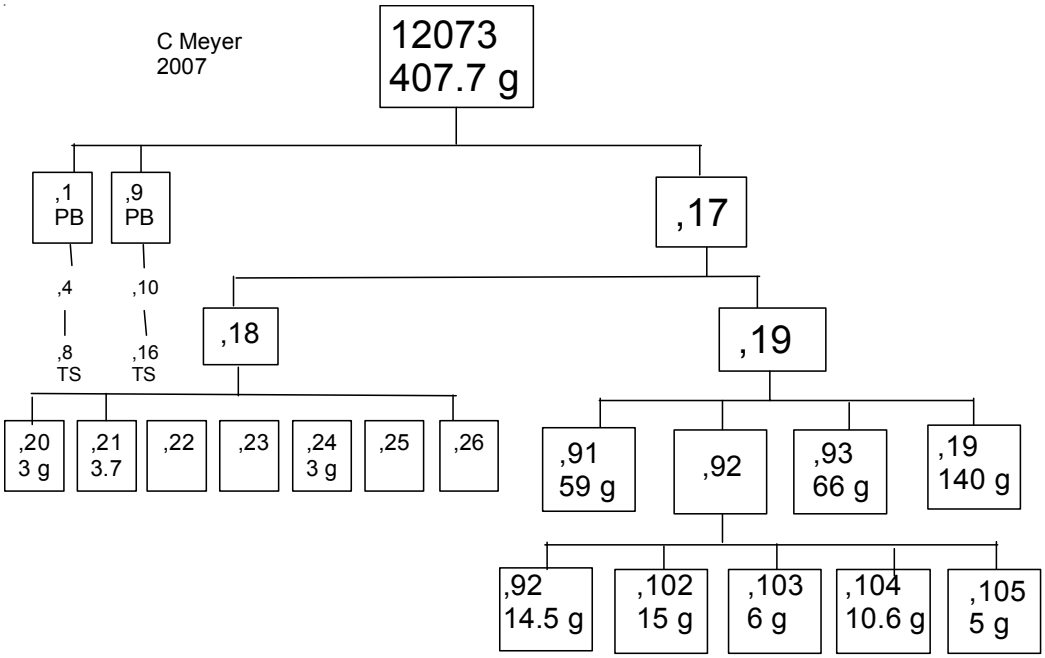


Figure 7: Micrometeorite count for surface of 12073 (Morrison et al. 1972).

Table 1. Chemical composition of 12073.

reference	Simon85	O'Kelly71	Morrison71	Hubbard71 Wiesmann75		LSPET70	Wanke71	Laul71	Warren81	Schnetzler71
weight		405 g		126 mg	8				clast	131 mg
SiO2 %					basalt	41	47.3		48.35	
TiO2	2.3		2.17			3.1	2.17		0.13	
Al2O3	12.2		13.2			15	13.92		32.32	
FeO	15.4		14.4			17	14.67		1.11	
MnO	0.2		0.23			0.13	0.2		0.02	
MgO	10.3		7.63			11	8.81		0.35	
CaO	10.6		10.6			11.5	11.2		15.8	
Na2O	0.52		0.65	0.62	0.52	0.5	0.6		2.14	
K2O	0.31	0.36 (a)	0.38	0.41	(b)	0.25	0.4		0.25	0.38 (b)
P2O5										
S %										
sum										
Sc ppm	37		28 (d)			42 (c)	36.2 (d)		1.97 (d)	
V	100		83 (d)			50 (c)				
Cr	2326		2200 (d)			2800 (c)	2260 (d)		98 (d)	
Co	36		39 (d)			30 (c)	38.2 (d)	35 (f)	7.1 (d)	
Ni	140		120			350 (c)	230 (d)		71 (d)	
Cu			6.8 (d)				5.7 (d)			
Zn			6.8 (d)					6.5 (f)	1.16 (d)	
Ga			4.4 (d)				5.1 (d)	4.5 (f)		
Ge ppb							110 (d)		32 (d)	
As			30				26 (d)			
Se								190 (f)		
Rb			9.2 (d)	9.26	1.89 (b)	4.9 (c)	11.3 (d)	9.2 (f)		10.2 (b)
Sr	150		174	163	105 (b)	230 (c)	190 (d)			164.8 (b)
Y						180 (c)				
Zr	470		390 (d)			1200 (c)			310 (d)	
Nb			13 (d)							
Mo										
Ru										
Rh										
Pd ppb							10.2 (d)			
Ag ppb								2.7 (f)		
Cd ppb								19 (f)		
In ppb							12.5 (d)	6.5 (f)		
Sn ppb										
Sb ppb			3 (d)							
Te ppb								100 (f)		
Cs ppm			0.3 (d)				0.5 (d)	0.39 (f)		
Ba	450		650 (d)	571	83.1 (b)		390 (d)		620 (d)	565 (b)
La	42.1		50 (d)	48.4	(b)		49.8 (d)		16.2 (d)	
Ce	106		120 (d)	127	22.4 (b)		131 (d)		35 (d)	120 (b)
Pr										
Nd	74		86 (d)	76.7	17.2 (b)				16 (d)	76.8 (b)
Sm	19.3		25 (d)	22.4	5.85 (b)		21.4 (d)		4.63 (d)	21.6 (b)
Eu	2.1		2.4 (d)	2.17	1.1 (b)		2.44 (d)		8.4 (d)	2.19 (b)
Gd			31 (d)	26.9	7.8 (b)					26.8 (b)
Tb	4.2		5.3 (d)				6.2 (d)		0.87 (d)	
Dy	27		31 (d)	28.6	8.7 (b)		31 (d)		5.8 (d)	28.9 (b)
Ho			6.3 (d)				7.58 (d)			
Er				18.9	5.29 (b)					17.4 (b)
Tm	2.2		2 (d)							
Yb	14.2		15 (d)	15.5	4.61 (b)		16 (d)		2.7 (d)	16 (b)
Lu	2.12		1.9 (d)		0.724 (b)		2.17 (d)		0.37 (d)	2.43 (b)
Hf	12.6		12 (d)				21.7 (d)		1.4 (d)	
Ta	1.7		2.7 (d)				2.1 (d)		0.18 (d)	
W ppb			0.86 (d)				1.21 (d)			
Re ppb									37 (d)	
Os ppb								(d)		
Ir ppb							8.8 (d)	4.5 (f)	0.11 (d)	
Pt ppb										
Au ppb			(d)				2.7 (d)	2 (f)	1.71 (d)	
Th ppm	7.8	8.45 (a)	10 (d)			8.2 (a)	8.17 (d)		1.2 (d)	
U ppm	2	2.19 (a)	2.2 (d)			2 (a)	2.32 (d)		0.9 (d)	

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



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