14259

Comprehensive Soil

2576.8 grams

CDR Get one (bag) for the fines and we'll start – I'd just say, just grab an undisturbed site out of each quatrant, we didn't hit with our feet. Cut it down to about a centimeter level – and fill the bag that way.

LMP Okay. You want the medium-size scoop or the big scoop for this?

CDR No actually – the trenching tool, now the medium size scoop is the best. All you've got to do is cut the surface to a depth of about a centimeter in an undisturbed area here – where we haven't picked up the rocks. Okay?

LPM Okay, I'll start over here in this undisturbed area.

CDR Yes, just get that area and then right here in this area. And fill up the bag to the line. Now I'll head on back to a little farther, get a foodball-size rock.

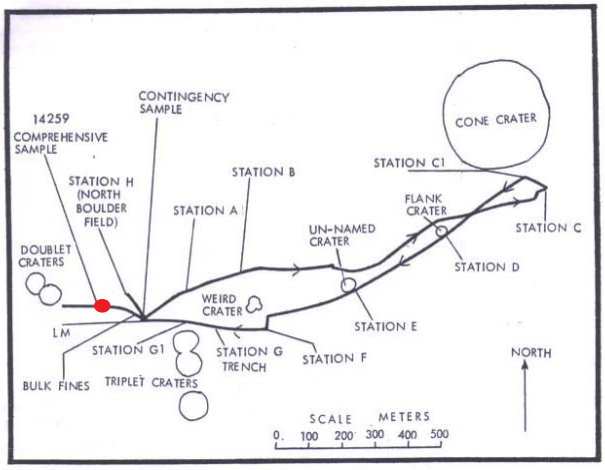


Figure 1: Sketch map of Apollo 14 sampling sites showing position of 14259 between LM and ALSEP.

Figure 2: Smooth area between LM and ALSEP where comprehensive sample was taken. NASA AS14-67-9388. Very few rocks.

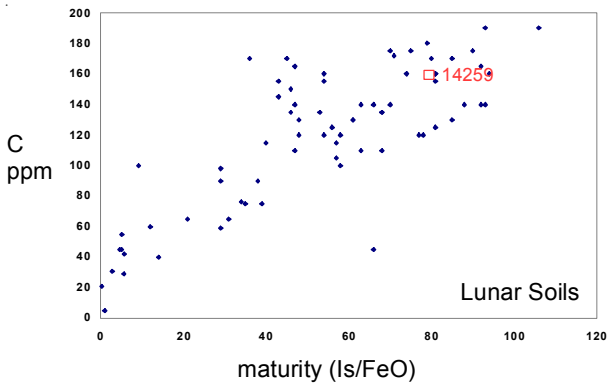


Figure 3: Carbon content and maturity index for 14259 compared with other lunar soil samples (data from Morris 1978 and Moore et al. 1972).

Introduction

A large soil sample was collected about 100 meters west of the LM after first picking up a suite of small rock samples (14264 to 14288) with the thongs (figure 2). This suite of samples, called a "comprehensive sample", is comparable to rake samples and their soils collected on later missions.

As the transcript indicates, soil sample 14259 was collected from an the top 1 cm in an undisturbed area. It was found to be mature and to have relatively high "activity" due to cosmic ray bombardment. Portions of 14259 were used for quarantine and as "organic reserve".

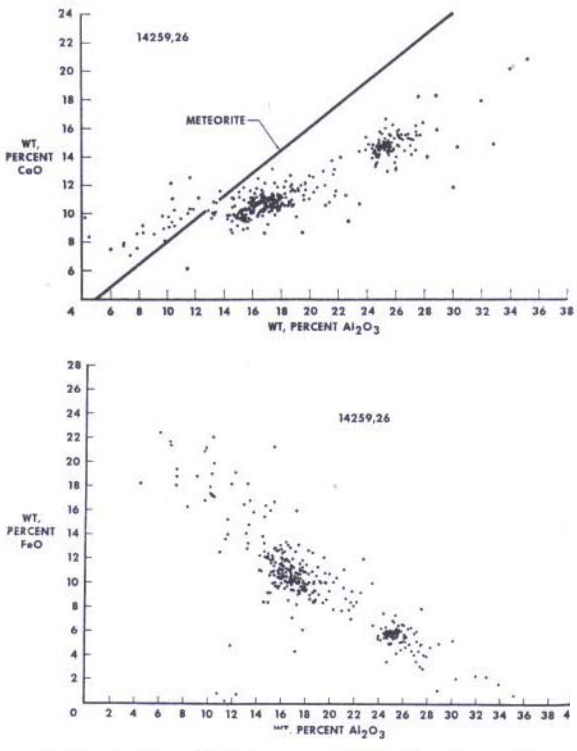
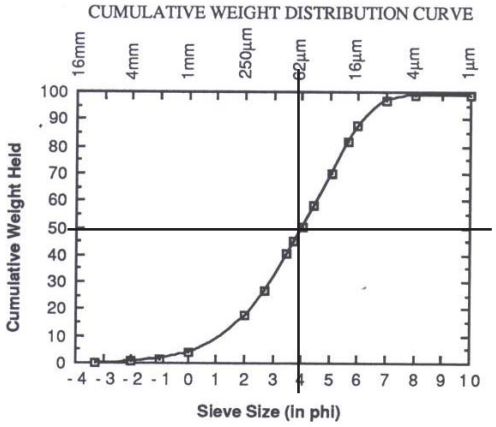


Figure 4: Chemical composition of glass particles in soil 14259 (Apollo Soil Survey). Note the 2nd cluster at ~ 26% Al2O3.



Average grain size = 68 microns

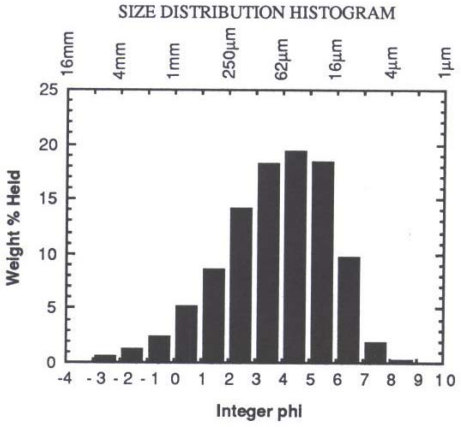


Figure 5: Grain size distribution for 14259 (Graf 1993, from data by McKay et al. 1972).

Petrography

Morris (1978) reported the maturity index I_s/FeO = 85 (mature). The high agglutinate count (McKay et al. 1972; von Engelhardt et al. 1972) and high carbon content (Moore et al. 1972) also indicate that this is a very mature soil.

McKay et al. (1972), von Engelhardt et al. (1972) and King et al. (1972) reported the grain size distribution (figure 5) and Finkelman (1973) studied the finest fraction.

Phinney et al. (1975) and Carlson and Walton (1978) cataloged the small rock fragments from the area of the soil sample (table 3).

Modal content of soils 14259

90 – 150 microns
From McKay et al. 1972

Agglutinates	51.7%
Basalt	1
Breccia	25.3
Anorthosite	
Norite	
Gabbro	
Plagioclase	4.7
Pyroxene	4.3
Olivine	
Ilmenite	
Glass other	12.8

Mineal mode for 14259

From Apollo Soil Survey

Glass	47.7
Feldspar	24.6
Plag.	23
K-spar	1.1
Mask.	0.5
Pyroxene	21.5
Opx.	8.7
Cpx.	4.6
Augite	8.2
Olivine	3.8
Oxides	1.7
Metal	0.7
Sulfide	0

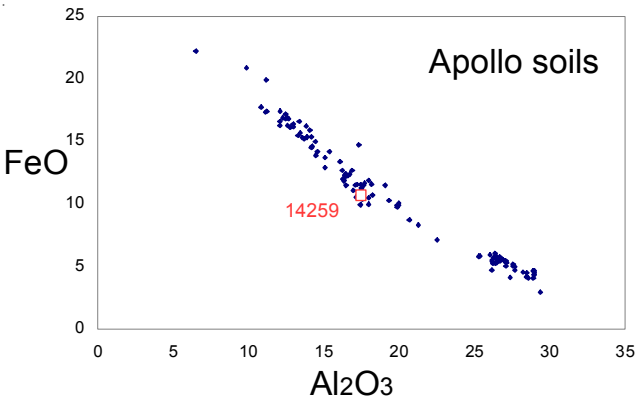


Figure 6: Composition of Apollo soil samples with 14259.

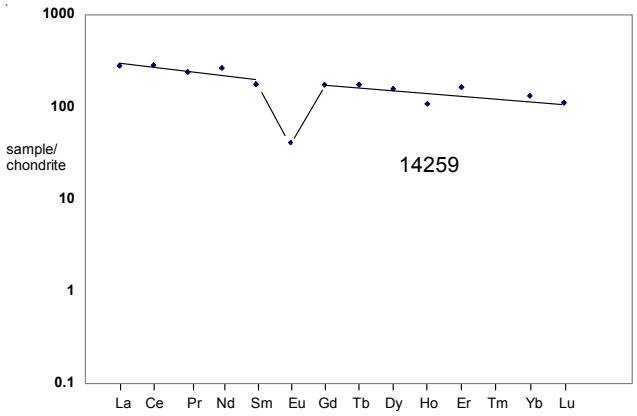


Figure 7: Normalized rare-earth-element diagram for 14259 (data from Wanke et al. 1972).

The Apollo Soil Survey (JSC) found groupings or clusters in the plots of glass compositions (figure 3, table 2). One of these groupings (Al_2O_3 = ~26 wt. %) was also found to be present in other lunar soils (Reid et al. 1972) and may represent an average of the lunar highlands.

Chemistry

LSPET (1971), Rose et al. (1972), Lindstrom et al. (1972), Wanke et al. (1972), Strasheim et al. (1972), Morgan et al. (1972), Baedecker et al. (1972), Willis et al. (1972) and Keith et al. (1972) all reported measurements of the chemical composition of 14259 (table 1). Moore et al. (1972) reported 160 ppm carbon (figure 3).

Cosmogenic isotopes and exposure ages

Keith et al. (1972) determined the cosmic-ray-induced activity of ^{22}Na = 91 dpm/kg., ^{26}Al = 222 dpm/kg, ^{46}Sc = 0.7 dpm/kg., ^{54}Mn = 60 dpm/kg and ^{56}Co = 60 dpm/kg. for 14259. Begemann et al. (1972) obtained ^{26}Al = 212 dpm/kg. and ^{36}Cl = 16.5 dpm/kg. Wahlen et al. (1972) measured ^{22}Na = 89 dpm/kg., ^{26}Al = 170 dpm/kg. and ^{53}Mn = 44 dpm/kg

Other Studies

Tatsumoto et al. (1972) studied the U, Th and Pb sytematics and Heymann et al. (1972) reported rare gas data.

Processing

It is not now known which bags, exactly contained this soil. Phinney et al. (1975) claim two weigh bags were used #1007? and #1039. Portions were split and given different sample numbers (see figure). Some was used for quarantine and some for "organic reserve".

Small rock samples sieved from this soil are tabulated along with the rocks picked up by thongs (table 3).

Table 1. Chemical composition of 14259.

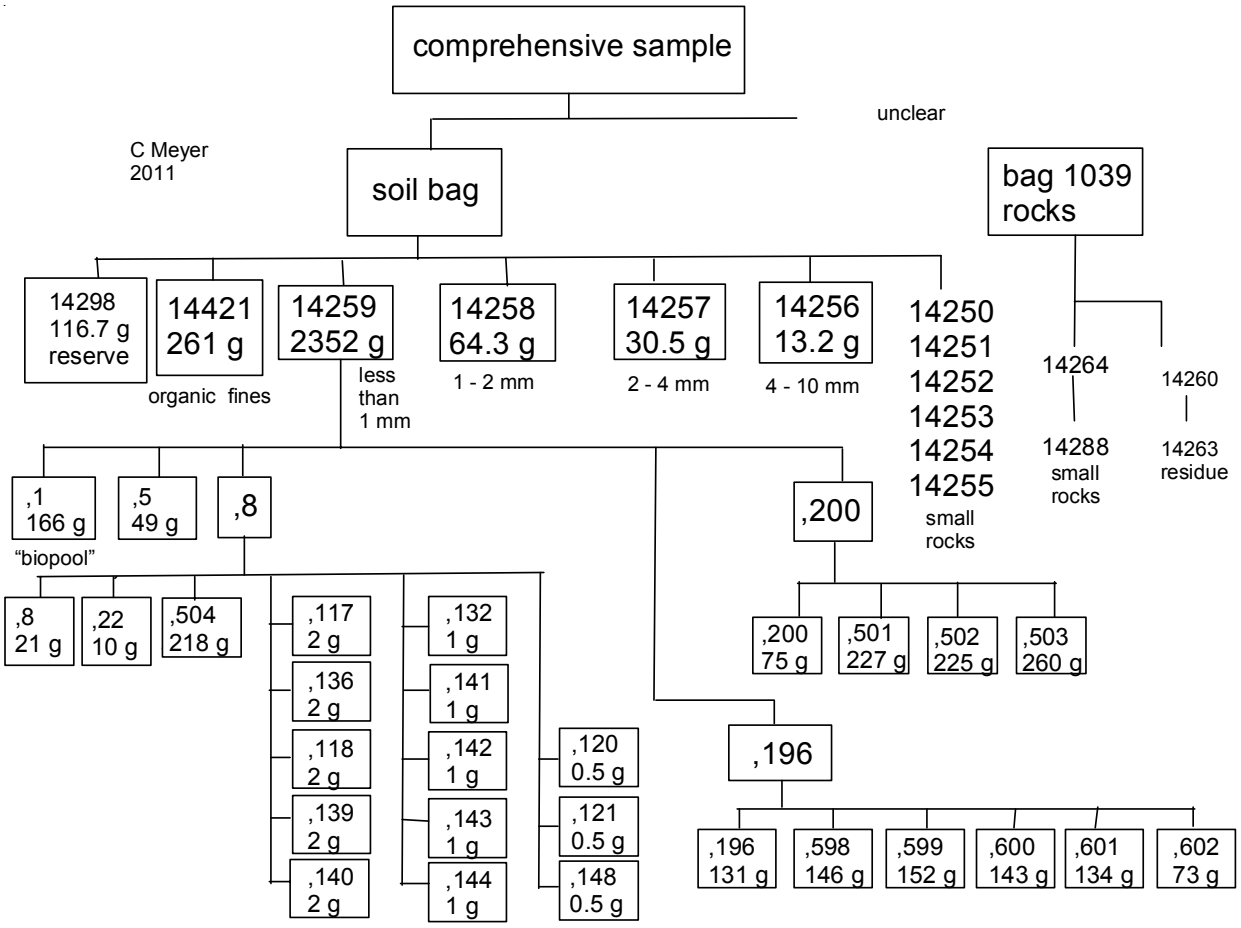
reference	LSPET 71		Rose 72		Lindstrom72		Wanke72		Strasheim72		Morgan72		Baedecker72 Wasson 73		Keith72		Willis72	
weight																		
SiO2 %	48		48.16	(b)			47.5	(f)	48.15	(c)							46.94	(f)
TiO2	1.8		1.73	(b)			1.42	(f)	1.82	(c)							1.75	(f)
Al2O3	18		17.6	(b)			17.4	(f)	16.99	(c)							17.31	(f)
FeO	10		10.41	(b)	10.3	(a)	10.3	(f)	10.58	(c)							10.6	(f)
MnO	0.18		0.14	(b)			0.13	(f)	0.136	(c)							0.139	(f)
MgO	9.2		9.26	(b)			9.28	(f)	9.32	(c)							9.55	(f)
CaO	11		11.25	(b)			10.8	(f)	10.71	(c)							11.06	(f)
Na2O	0.52		0.61	(b)	0.68	(a)	0.63	(f)	0.65	(c)							0.6	(f)
K2O	0.5		0.51	(b)			0.48	(f)	0.47	(c)					0.5	(e)	0.484	(f)
P2O5			0.53	(b)					0.46	(c)							0.46	(f)
S %																	0.101	(f)
sum																		
Sc ppm	21	(g)	28	(b)	21.9	(a)	23	(a, d)										
V	50	(g)	62	(b)					34	(c)								
Cr	1400	(g)	1780	(b)	1290	(a)	1310	(a, d)									1370	(f)
Co	39	(g)	38	(b)	37.5	(a)	36	(a, d)	33	(c)								
Ni	320	(g)	440	(b)			380	(a, d)	330	(c)			414	(d)				
Cu	14	(g)	19	(b)			12.3	(a, d)	16	(c)								
Zn			24	(b)			22	(a, d)	53	(c)	22	(d)	27	(d)				
Ga			4.4	(b)			7.6	(a, d)					6.7	(d)				
Ge ppb							590	(a, d)					750	(d)				
As							0.076	(a, d)										
Se																		
Rb	10	(g)	12	(b)			19	(a, d)	14	(c)	15.4	(d)					13.8	(f)
Sr	170	(g)	150	(b)					248	(c)							173	(f)
Y	170	(g)	285	(b)					210	(c)							200	(f)
Zr	720	(g)	800	(b)	590	(a)			720	(c)							961	(f)
Nb	40	(g)	67	(b)					54	(c)							61.3	(f)
Mo																		
Ru																		
Rh																		
Pd ppb							20	(a, d)										
Ag ppb											26.5	(d)						
Cd ppb											83	(d)	93	(d)				
In ppb							34	(a, d)			34	(d)	37	(d)				
Sn ppb																		
Sb ppb																		
Te ppb											50	(d)						
Cs ppm					0.75	(a)	0.67	(a, d)			0.62	(d)						
Ba	570	(g)	1100	(b)	740	(a)			974	(c)							855	(f)
La	46	(g)	77	(b)	57.8	(a)	66	(a, d)										
Ce					178	(a)	170	(a, d)										
Pr							21	(a, d)										
Nd							120	(a, d)										
Sm					26.5	(a)	26	(a, d)										
Eu					2.63	(a)	2.29	(a, d)										
Gd							34	(a, d)										
Tb					5.9	(a)	6.3	(a, d)										
Dy							38	(a, d)										
Ho							6	(a, d)										
Er							26											
Tm																		
Yb	24	(g)	30	(b)	21.4	(a)	21.5	(a, d)										
Lu					3.05	(a)	2.7	(a, d)										
Hf					22.5	(a)	21	(a, d)										
Ta					3.9	(a)	2.8	(a, d)										
W ppb							1700	(a, d)										
Re ppb											1.3	(d)						
Os ppb																		
Ir ppb							16	(a, d)			18.6	(d)	12.5	(d)				
Pt ppb																		
Au ppb							5.5	(a, d)			6.6	(d)	10.7					
Th ppm					14	(a)	14.3	(a, d)							14.4	(e)		
U ppm					3	(a)	3.79	(a, d)							3.5	(e)		

technique: (a) INAA, (b) microchemical, (c) various, (d) RNAA, (e) radiation counting, (f) XRF, (g) emission spec.

Table 2: Average composition of glass types in 14259.

from Apollo Soil Survey

name	Mare	FraMauro	Anor.Gab.	Gab.Anor.	granite	low-Si
proportion	11%	58%	28%	1%	1.50%	0.50%
SiO2	45.5	48	45.2	47.4	71.5	38
TiO2	2.8	2	0.36	0.14	0.4	0.2
Al2O3	10.9	17.1	25.6	31.3	14	34.5
FeO	18.1	10.6	5.6	3	1.8	1.2
MgO	11.2	8.7	7.8	2.2	0.7	5.6
CaO	9.6	10.8	14.8	14.8	2	20
Na2O	0.4	0.7	0.25	1	1	
K2O	0.32	0.6	0.1	0.2	6.5	



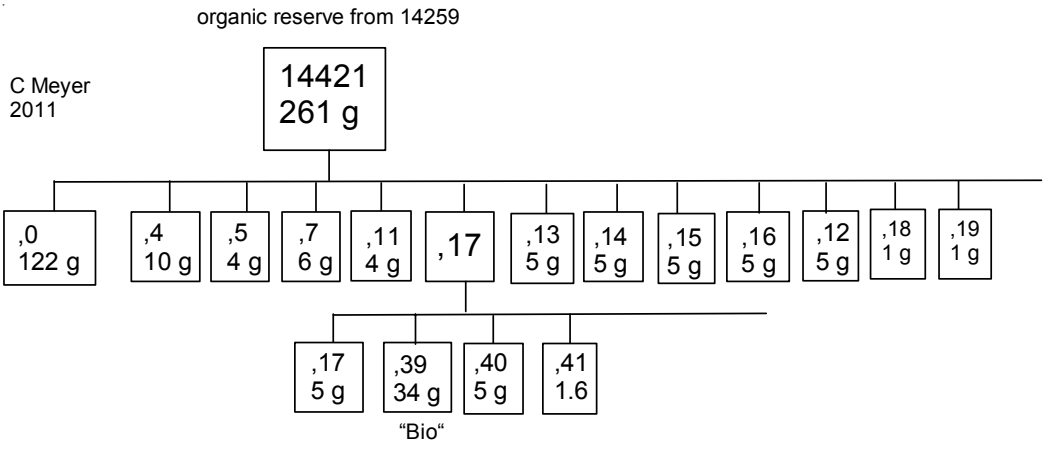


Table 3: Small rocks from 14259 area.

	wt. grams	name
14250	4.06	regolith breccia
14251	1.51	regolith breccia
14252	0.86	regolith breccia
14253	1.01	crystalline matrix bx.
14254	1.23	glass
14255	22.15	glass coated soil bx.
14264	118	vitric matrix breccia
14265	66	glass coated soil bx.
14266	7	fragmental breccia
14267	55	glass matrix breccia
14268	23	glass matrix breccia
14269	17	glass matrix breccia
14270	25.5	crystalline matrix bx.
14271	97.4	glass matrix breccia
14272	46.6	glass matrix breccia
14273	22.4	glass matrix breccia
14274	15.2	crystalline matrix bx.
14275	12.5	glass matrix breccia
14276	12.75	KREEP basalt
14277	7.6	glass matrix breccia
14278	7.6	breccia
14279	5.7	breccia
14280	6.2	glass matrix breccia
14281	12	glass matrix breccia
14282	1.9	glass matrix breccia
14283	1.25	crystalline matrix bx.
14284	1.5	breccia
14285	2.2	breccia
14286	4.4	breccia
14287	1.1	breccia
14288	3.4	glass matrix breccia
14260	~ 300	soil from rock bag

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