15311

Soil (rake)

464 grams

Figure 1: Raked area from rim of Spur Crater. AS15-90-12234. The feet on the Gnomon are 50 cm apart.

Introduction

Soil sample 15310 was collected as part of a large rake sample (figure 1) and may contain material rubbed off of the friable rocks collected by the rake. On the other hand, it is certain to also contain some soil collected by the rake and/or attached to the rocks. In any case 15311 is a large soil sample that goes along with 15301 and it has about the same composition..

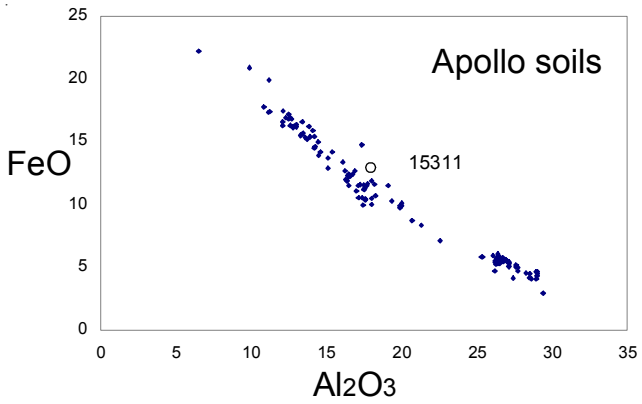

Figure 2: Composition of 15311 compared with other Apollo soil samples.

Petrography

The fines from this sample have not been characterized. An unpublished mode by Heiken and McKay (1972) reported an abundance of green glass particles. Indeed several friable "green glass" clods were included in the rake sample and in the coarse-fines.

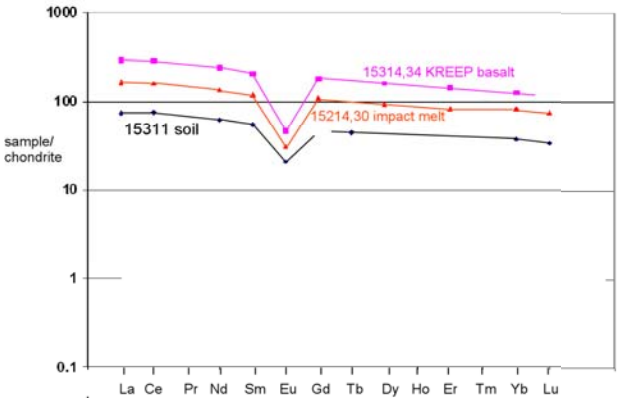

Figure 3: Normalized rare-earth-element diagram for 15311 soil, 15314 impact melt rock and 15314 KREEP basalt (see tables).

The coarse fines (4-10 mm) were cataloged by Powell (1972), Phinney et al. (1972) and Ryder and Sherman (1989). They reported on 5 mare basalt, 1 KREEP basalt, 8 impact melt rocks, 3 green glass clods, 10 regolith breccias and one ropy glass particle in 15434. Compare this with the rake sample which was in the ratio of 7 mare basalt, 2 KREEP basalt, 3 impact melt rocks, 13 green glass clods, 39 regolith breccias and 2 agglutinates (table 2).

Chemistry

Korotev (1987) determined the bulk composition of 15311 (table 1). Several labs reported data on the coarse fines (table 3). Again this "soil" sample reflects the composition of KREEP – either from KREEP basalt or from the impact melt rocks (which themselves carry a high KREEP component) (figure 3).

Modal content of soil 15311

From Morris et al. 1983

(Heiken and McKay 1972)

Agglutinates	9 %
Basalt	5.5
Breccia	15
Anorthosite	
Norite	
Gabbro	
Plagioclase	3
Pyroxene	10
Olivine	1
Ilmenite	2.3
Green Glass	46 %
Yellow Glass	4.5
Glass other	2.5

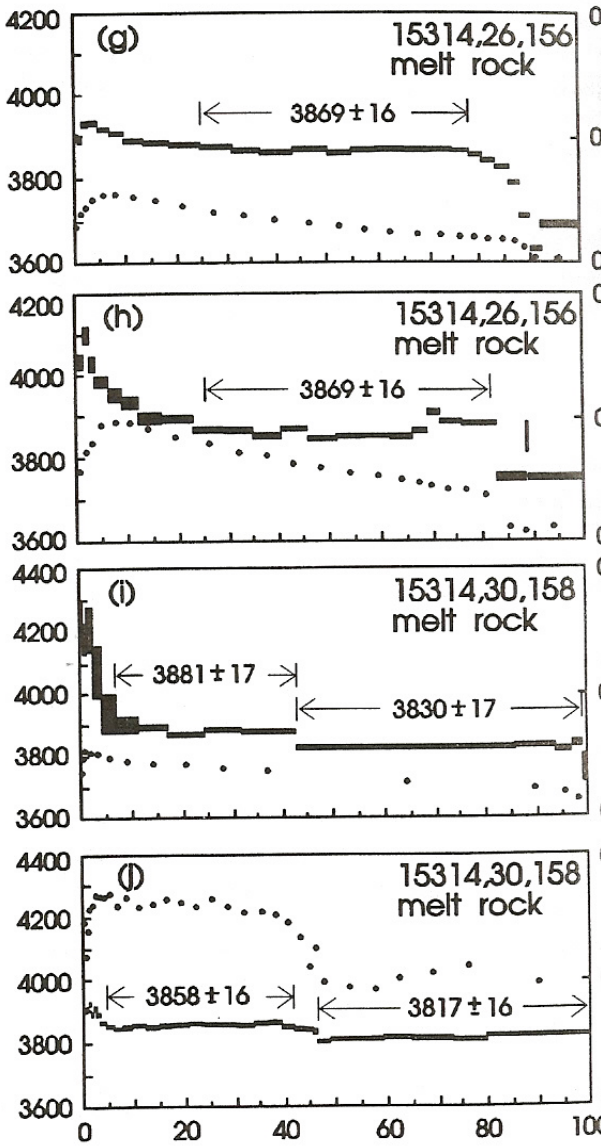

Figure 4: Ar/Ar plateau diagrams for two impact melt rocks from the coarse fines from 14311 (Dalrymple and Ryder 1993).

Summary of Age Data for 15314

	Ar/Ar
Dalrymple and Ryder 1991	3869 ± 16 m.y.
	3881 ± 17 m.y.

As is the case for 15301, this soil has high Mg and Fe due to a significant amount of mafic green glass particles found in abundance in and around Spur Crater (see 15425 – 15427).

Radiogenic age dating

Dalrymple and Ryder (1991, 1993) determined the age of two impact melt rocks found in the coarse-fines using the Ar/Ar dating technique (figure 3), concluding that

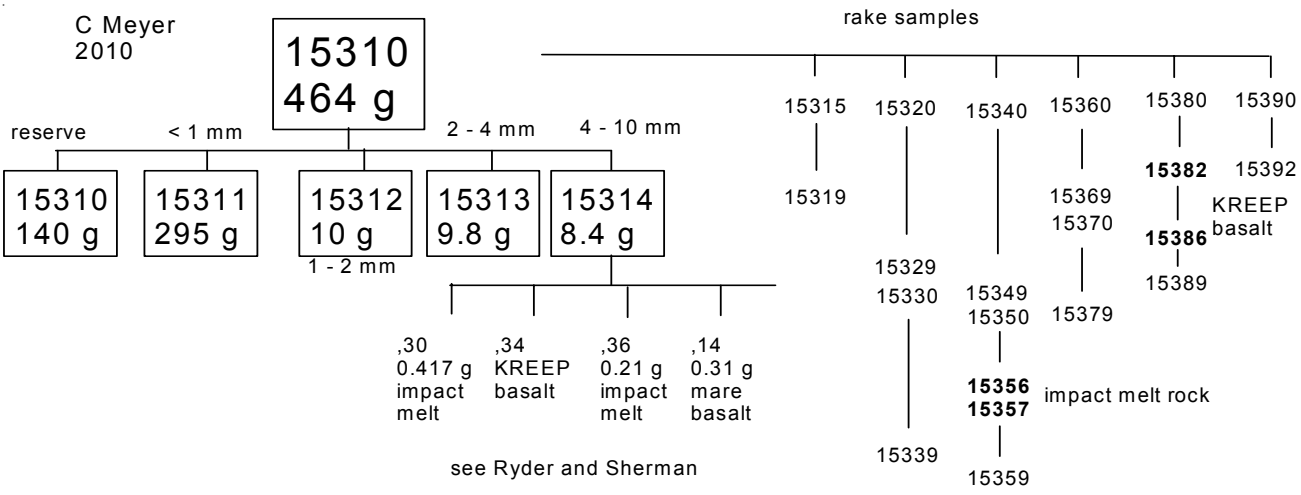

Table 2: Rake samples from 15310.

	grams	Ryder's name.
15315	35.6	regolith breccia
15316	6.1	regolith breccia
15317	0.6	regolith breccia
15318	5.4	regolith breccia
15319	8	regolith breccia
15320	4.7	regolith breccia
15321	0.3	regolith breccia
15322	8.4	regolith breccia
15323	4.4	regolith breccia
15324	32.3	regolith breccia
15325	57.8	dense regolith breccia
15326	2.5	regolith breccia
15327	12.4	clast-rich glassy melt
15328	0.3	regolith breccia
15329	2.2	regolith breccia, glass-coated
15330	57.8	regolith breccia
15331	2.6	regolith breccia
15332	2.3	agglutinate
15333	0.3	regolith breccia
15334	7.5	regolith breccia
15335	6	regolith breccia
15336	0.2	regolith breccia
15337	4.3	regolith breccia
15338	11.1	regolith breccia
15339	0.4	regolith breccia
15340	0.9	regolith breccia
15341	1.6	regolith breccia
15342	7.5	regolith breccia
15343	6.9	regolith breccia
15344	7.9	regolith breccia
15345	12.3	vesicular glass with breccia
15346	3.1	regolith breccia
15347	3.2	regolith breccia
15348	0.3	regolith breccia
15349	2.3	regolith breccia
15350	2.9	regolith breccia
15351	4.2	regolith breccia
15352	2.9	regolith breccia
15353	10.6	regolith breccia
15354	0.3	regolith breccia
15355	5.2	regolith breccia
15356	2	fine-grained impact melt
15357	11.8	fine-grained impact melt
15358	14.6	glassy breccia with KREEP basalt clasts
15359	4.2	fine-grained impact melt
15360	9.3	regolith breccia
15361	0.9	anorthosite breccia
15362	4.2	cataclastic anorthosite
15363	0.5	anorthosite breccia
15364	1.5	anorthosite breccia
15365	2.9	indurated green glass clod
15366	3.3	green glass clod
15367	1.1	green glass clod
15368	0.4	green glass clod
15369	2.5	green glass clod
15370	2.9	green glass clod
15371	0.5	green glass clod
15372	0.8	green glass clod
15373	0.6	green glass clod
15374	1	green glass clod
15375	0.4	green glass clod
15376	1	green glass clod
15377	0.5	green glass clod
15378	3.3	regolith breccia
15379	64.3	mare basalt
15380	5.2	mare basalt
15381	0.3	mare basalt
15382	3.2	KREEP basalt
15383	1.4	glass with basalt
15384	1.4	mare basalt
15385	8.7	mare basalt
15386	7.5	KREEP basalt
15387	2	mare basalt
15388	9	mare basalt
15389	2.8	agglutinate
15390	3.5	glass
15391	0.3	glass
15392	0.4	glass

Table 1. Chemical composition of 15311

reference	Korotev87	
weight		
SiO2 %		
TiO2	1.42	(a)
Al2O3	16.9	(a)
FeO	12.7	(a)
MnO	0.17	(a)
MgO	11.9	(a)
CaO	10.4	(a)
Na2O	0.43	(a)
K2O		
P2O5		
S %		
sum		
Sc ppm	24.5	(a)
V	89	(a)
Cr	2370	(a)
Co	45.9	(a)
Ni	215	(a)
Cu		
Zn		
Ga		
Ge ppb		
As		
Se		
Rb		
Sr	110	(a)
Y		
Zr	260	(a)
Nb		
Mo		
Ru		
Rh		
Pd ppb		
Ag ppb		
Cd ppb		
In ppb		
Sn ppb		
Sb ppb		
Te ppb		
Cs ppm	0.19	(a)
Ba	190	(a)
La	17.1	(a)
Ce	45	(a)
Pr		
Nd	28	(a)
Sm	8.16	(a)
Eu	1.15	(a)
Gd		
Tb	1.6	(a)
Dy		
Ho		
Er		
Tm		
Yb	6	(a)
Lu	0.81	(a)
Hf	6.9	(a)
Ta	0.8	(a)
W ppb		
Re ppb		
Os ppb		
Ir ppb	4.8	(a)
Pt ppb		
Au ppb	4.5	(a)
Th ppm	2.8	(a)
U ppm	0.86	(a)
technique:	*(a) INAA*	

3.87 b.y. was the age of the Imbrium impact ! Wow ! So much information from such small particles !

Processing

15311 was returned in sample collection bag 3 placed in ALSRC#2 (which did not seal).
It is the soil collected and returned along with the rake sample. As such, it probably contains material abraded off of friable rake samples.

PS Samples greater than 1 cm are called "walnuts" and samples in the 4 – 10 mm size range are called :coarse-fines, or "peanuts".

Table 3. Composition of some particles from 15310.

15314	,29,149		,26,97		,30		,30		,32		,34	
reference	Laul87		Ryder87		Wiesman76				Laul87		Hubbard73	
weight	impact melt		impact melt		impact melt		same		impact melt		KREEP basalt	
SiO2 %			48	(b)			48.5	(b)				
TiO2	1.2	(a)	1.37	(b)	1.09	(c)	1.31	(b)	0.97	(a)	2.02	(c)
Al2O3	15.2	(a)	17.3	(b)			16.1	(b)	16.2	(a)	16.7	
FeO	10.2	(a)	8.6	(b)			8.6	(b)			10.4	
MnO	0.125	(a)	0.143	(b)			0.15	(b)	8.7	(a)		
MgO	16.8	(a)	12.8	(b)			13.8	(b)	0.122	(a)	8.56	(c)
CaO	9.4	(a)	10.5	(b)			10.2	(b)	13.2	(a)	7.67	(c)
Na2O	0.4	(a)	0.52	(b)			0.58	(b)	9.7	(a)	0.68	
K2O	0.18	(a)	0.35	(b)	0.3	(c)	0.35	(b)	0.55	(a)	0.53	(c)
P2O5			0.37	(b)			0.34	(b)	0.44	(a)		
S %												
sum												
Sc ppm	16	(a)	21.1	(a)			20.2	(a)	18	(a)		
V	60	(a)							60	(a)		
Cr			1770	(a)								
Co	61	(a)	50.6	(a)			54.4	(a)	30.5	(a)		
Ni	620	(a)	305	(a)			192	(a)	210	(a)		
Cu												
Zn												
Ga												
Ge ppb												
As												
Se												
Rb			15	(a)	8.11	(c)	13	(a)			13.6	(c)
Sr	150	(a)			132	(c)			180	(a)	185	(c)
Y												
Zr	400	(a)	390	(a)	492	(c)	485	(a)	420	(a)	1009	(c)
Nb												
Mo												
Ru												
Rh												
Pd ppb												
Ag ppb												
Cd ppb												
In ppb												
Sn ppb												
Sb ppb												
Te ppb												
Cs ppm			0.37	(a)			0.34	(a)				
Ba	350	(a)	450	(a)	379	(c)	413	(a)	450	(a)	676	(c)
La	41	(a)	45.6	(a)	38.6	(c)	42.2	(a)	40.5	(a)	67.9	(c)
Ce	105	(a)	124	(a)	97.3	(c)	118	(a)	100	(a)	174	(c)
Pr										(a)		
Nd	70	(a)	74	(a)	61.3	(c)	74	(a)	64	(a)	108	(c)
Sm	18.3	(a)	22.1	(a)	17.4	(c)	20.3	(a)	17.2	(a)	30.2	(c)
Eu	1.9	(a)	2.01	(a)	1.7	(c)	1.85	(a)	1.95	(a)	2.58	(c)
Gd	23	(a)			21	(c)			22	(a)	35.9	(c)
Tb	3.7	(a)	4.3	(a)			4.6	(a)	3.5	(a)		
Dy	22	(a)			22.5	(c)			23	(a)	39.2	(c)
Ho	4.9	(a)							5	(a)		
Er					13.2	(c)					22.9	(c)
Tm	1.8	(a)							2	(a)		
Yb	11	(a)	14.9	(a)	13.5	(c)	12.2	(a)	13	(a)	20.5	(c)
Lu	1.7	(a)	2.14	(a)	1.8	(c)	2.03	(a)	1.9	(a)		
Hf	11	(a)	15.6	(a)	12.5	(c)	13.1	(a)			25.7	(c)
Ta	1.5	(a)	1.9	(a)			1.8	(a)				
W ppb												
Re ppb												
Os ppb												
Ir ppb	15	(a)							2.9	(a)		
Pt ppb												
Au ppb	12.7	(a)							4	(a)		
Th ppm	6	(a)			5.89	(c)	7	(a)	6.7	(a)	10.8	(c)
U ppm	1.5	(a)			1.84	(c)	2.5	(a)	1.6	(a)	3.1	(c)

technique: (a) INAA, (b) fused-bead e-probe, (c) IDMS

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