15410 and 15420

Soils

177.3 and 308.4 grams

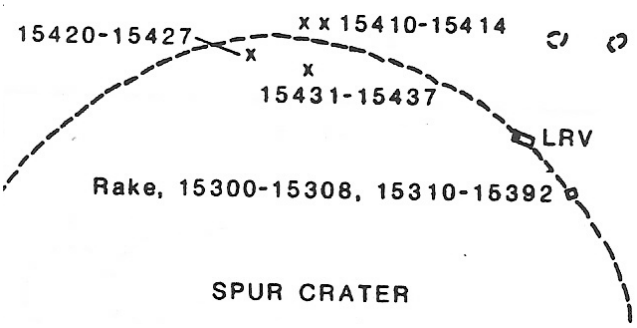


Figure 1: Map of north rim of Spur Crater showing location of samples at station 7, on the Apennine Front.

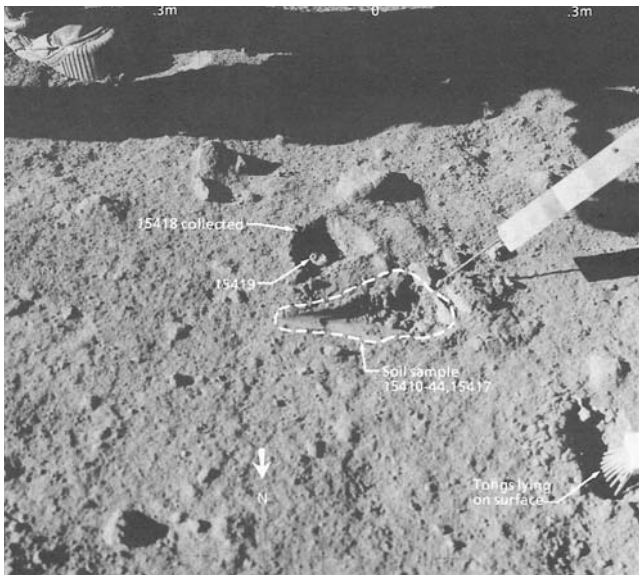


Figure 2: Photo of 15410 and rock 15418 etc., as they were sampled at Spur Crater. AS15-86-11664

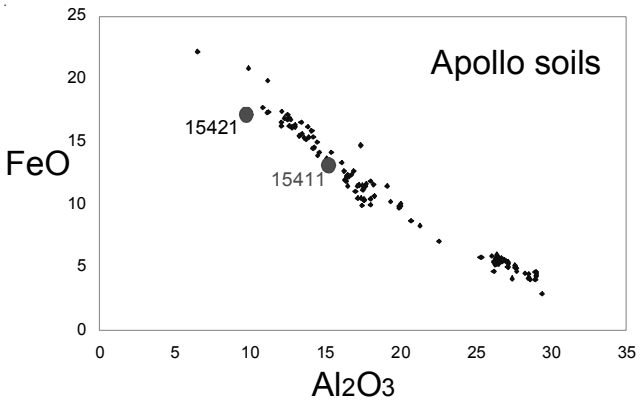


Figure 3: Composition of 15411 and 15421 compared with that of other Apollo soils.

Introduction

15410 and 15420 were collected from the rim of Spur Crater at station 7 (figures 1 and 2).

15420 is the soil that was collected and returned in the bag with 15425 and 15427 (green glass clods) and, as such, contains an abundance of green glass particles derived from these very friable clods.

Petrography

The maturity index (I_s/FeO) for 15411 is 43 (submature)(Morris 1978).

The coarse fines (4-10 mm) from 15414 and 15424 were cataloged by Powell (1972), Phinney et al. (1972) and Ryder and Sherman (1989).

Green Glass

Taylor et al. (1973) gives the composition of green glass from 15421.

Chemistry

The compositions of 15411 and 15421 are tabulated in tables 1 and 2. Note that 15421 has very high Mg and Fe content (figure 3) due to the high content of mafic green glass (see also mode). The REE and large ion lithophile element content of 15411 is dominated by the abundance of KREEP materials (figure 7).

The carbon content of 15411 was reported by Moore et al. (1973) as 74 ppm C (figure 4).

Radiogenic age dating

Dalrymple and Ryder (1991, 1993) tried, but were unable to date melt rocks 15414,2 and ,3 (figure 6).

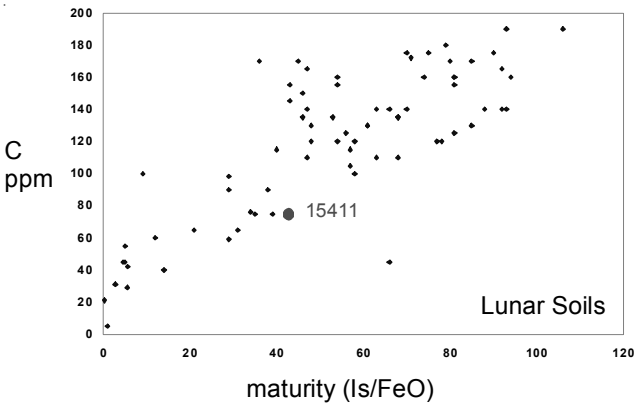
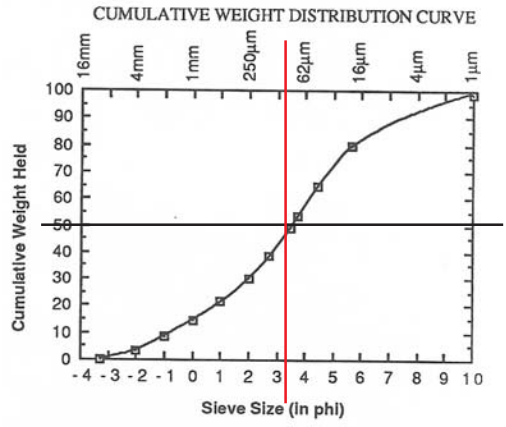


Figure 4: Carbon content (Moore) and Maturity index (Morris) for 15411 compared with all other Apollo soils.



Average grain size = 87 micorns

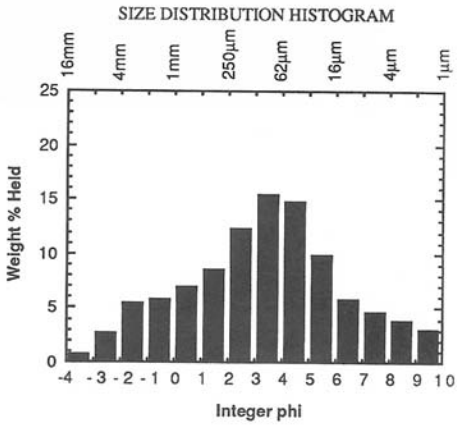


Figure 5: Grain size distribution of 15411 (Graf 1993).

Other Studies

Jordan et al. (1974) determined the concentration and isotopic ratio of the rare gasses in 15421.

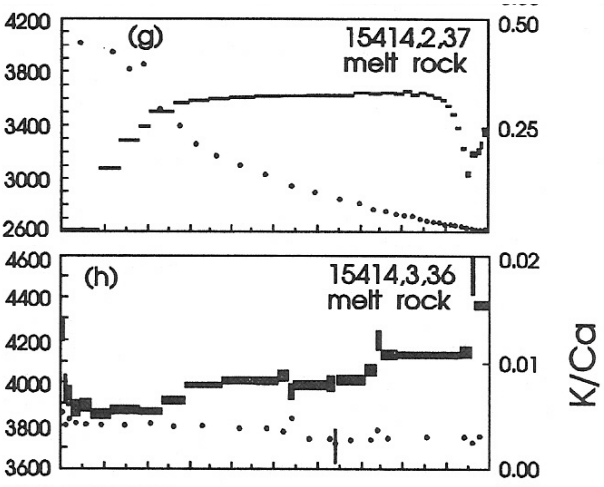


Figure 6: Ar.Ar plateau diagrams for two coarse fine particles from 15414 (Dalrymple and Ryder 1993).

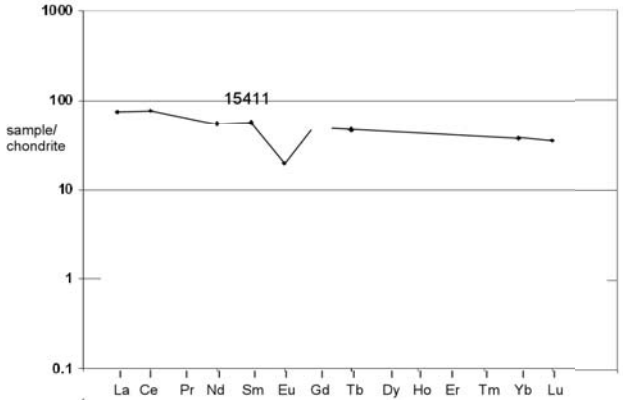


Figure 7: Normalized rare-earth-element diagram for 15411 (Korotev 1987).

Processing

The fines from 15421 are an excellent source for mafic green glass.

Modal content of soil 15420.
From Morris et al. 1983.

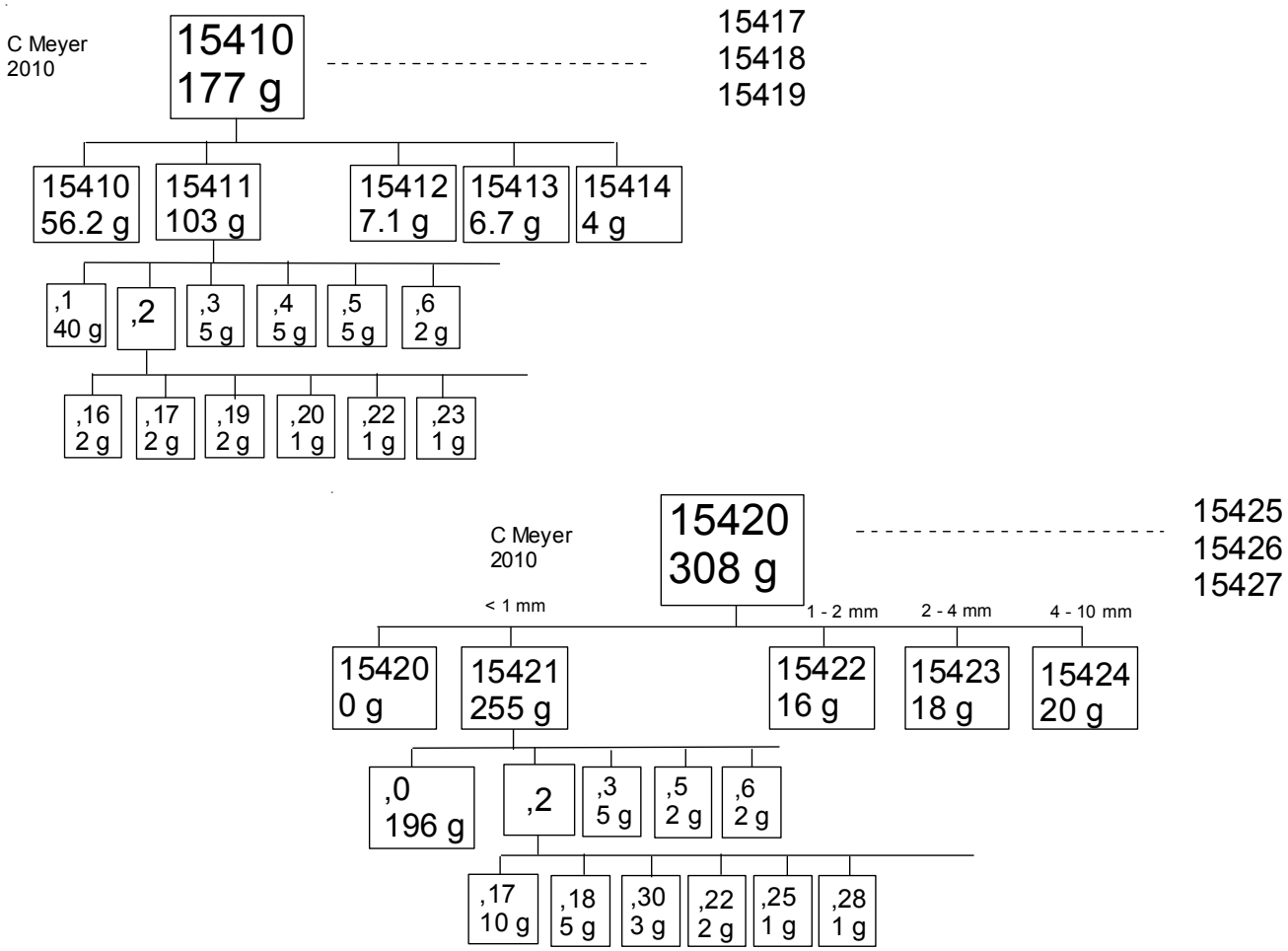
Agglutinates	8.4 %
Basalt	
Breccia	0.3
Anorthosite	0.3
Norite	
Gabbro	
Plagioclase	0.7
Pyroxene	1.6
Olivine	
Ilmenite	
Green glass	82
Glass yellow	7.3

Table 1. Chemical composition of 15411

reference	Korotev87		Willis72		Laul73	
weight						
SiO2 %			46.22	(b)		
TiO2	1.09	(a)	1.09	(b)	1.2	(a)
Al2O3	15.1	(a)	15.08	(b)	15.5	(a)
FeO	13.7	(a)	13.36	(b)	13.1	(a)
MnO	0.16	(a)	0.176	(b)	0.17	(a)
MgO	11.7	(a)	11.74	(b)	12	(a)
CaO	11.1	(a)	10.91	(b)	11	(a)
Na2O	0.4	(a)	0.36	(b)	0.41	(a)
K2O			0.159	(b)	0.16	(a)
P2O5			0.167	(b)		
S %			0.077	(b)		
sum						
Sc ppm	26.4	(a)			23	(a)
V					103	(a)
Cr	2610	(a)	2531	(b)	2271	(a)
Co	49.6	(a)			43	(a)
Ni	215	(a)				
Cu						
Zn						
Ga						
Ge ppb						
As						
Se						
Rb			4.3	(b)		
Sr	105	(a)	111	(b)		
Y			61.5	(b)		
Zr	250	(a)	275	(b)	200	(a)
Nb			17.4	(b)		
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm	0.17	(a)				
Ba	189	(a)	200	(b)	180	(a)
La	17.4	(a)			18	(a)
Ce	46	(a)			51	(a)
Pr						
Nd	25	(a)				
Sm	8.28	(a)			8.4	(a)
Eu	1.09	(a)			1	(a)
Gd						
Tb	1.68	(a)			1.5	(a)
Dy						
Ho						
Er						
Tm						
Yb	6	(a)			5.9	(a)
Lu	0.84	(a)			0.9	(a)
Hf	6.7	(a)			6.4	(a)
Ta	0.84	(a)			0.75	(a)
W ppb						
Re ppb						
Os ppb						
Ir ppb	3.7	(a)				
Pt ppb						
Au ppb	2.7	(a)				
Th ppm	2.7	(a)			3	(a)
U ppm	0.77	(a)			0.9	(a)
technique:	*(a) INAA, (b) XRF*					

Table 2. Chemical composition of 15421.

reference	Korotev87		Taylor73		Chou74	
weight						
SiO2 %						
TiO2	0.71	(a)				
Al2O3	10.4	(a)				
FeO	17.1	(a)				
MnO	0.223	(a)				
MgO	14.6	(a)				
CaO	9.2	(a)				
Na2O	0.31	(a)				
K2O						
P2O5						
S %						
sum						
Sc ppm	32.2	(a)				
V	115	(a)				
Cr	3120	(a)				
Co	64.5	(a)				
Ni	204	(a)			215	(c)
Cu						
Zn					55	(c)
Ga					4.44	(c)
Ge ppb					263	(c)
As						
Se						
Rb			1.65	(b)		
Sr	100			(b)		
Y			37	(b)		
Zr	130	(a)	138	(b)		
Nb			9.6	(b)		
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb					240	(c)
In ppb					46	(c)
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm	0.1	(a)				
Ba	90	(a)	121	(b)		
La	7.83	(a)	10.2	(b)		
Ce	21	(a)	28	(b)		
Pr			3.35	(b)		
Nd	11	(a)	15	(b)		
Sm	3.77	(a)	4.3	(b)		
Eu	0.653	(a)	0.71	(b)		
Gd			5.64	(b)		
Tb	0.81	(a)	0.87	(b)		
Dy			5.7	(b)		
Ho			1.39	(b)		
Er			3.73	(b)		
Tm			0.59	(b)		
Yb	3.02	(a)	3.57	(b)		
Lu	0.449	(a)	0.55	(b)		
Hf	3.11	(a)	2.68	(b)		
Ta	0.4	(a)				
W ppb						
Re ppb						
Os ppb						
Ir ppb	3	(a)			2.5	(c)
Pt ppb						
Au ppb	25	(a)			3	(c)
Th ppm	1.11	(a)	1.49	(b)		
U ppm	0.31	(a)	0.41	(b)		
technique:	*(a) INAA, (b) SSMS, (c) RNAA*					



References for 15411 and 15421.

Butler P. (1971) Lunar Sample Catalog, Apollo 15. Curators' Office, MSC 03209

Chou C.-L., Baedecker P.A., Bild R.W. and Wasson J.T. (1974) Volatile-element systematics and green glass in Apollo 15 lunar soils. *Proc. 5th Lunar Sci. Conf.* 1645-1658.

Dalrymple G.B. and Ryder G. (1991) $^{40}Ar/^{39}Ar$ ages of six Apollo 15 impact melt rocks by laser step heating. *Geophys. Res. Lett.* **18**, 1163-1166.

Dalrymple G.B. and Ryder G. (1993) $^{40}Ar/^{39}Ar$ age spectra of Apollo 15 impact melt rocks by laser step-heating and their bearing on the history of lunar basin formation. *J. Geophys. Res.* **98**, 13,085-13,095.

Frick U., Bauer H., Funk H., Phinney D., Schafer C., Schultz L. and Signer P. (1973) Diffusion properties of light noble gases in lunar fines. *Proc. 4th Lunar Sci. Conf.* 1987-2002.

Graf J.C. (1993) Lunar Soils Grain Size Catalog. NASA Reference Pub. 1265, March 1993

Heiken G.H. (1974) A catalog of lunar soils. JSC Curator

Heiken G.H. (1975) Petrology of lunar soils. *Rev. Geophys. Space Phys.* **13**, 567-587.

Jordan J.I., Heyman D. and Lakatos S. (1974) Inert-gas patterns in regolith at Apollo 15 landing site. *Geochim. Cosmochim. Acta* 38, 65-78.

Korotev R.L. (1987) Mixing levels, the Apennine Front soil component, and compositional trends in the Apollo 15 soils. *Proc. 17th Lunar Planet. Sci. Conf.* E411-431.

Laul J.C. and Schmitt R.A. (1973b) Chemical composition of Apollo 15, 16, and 17 samples. *Proc. 4th Lunar Sci. Conf.* 1349-1367.

LSPET (1972a) The Apollo 15 lunar samples: A preliminary description. *Science* **175**, 363-375.

LSPET (1972b) Preliminary examination of lunar samples. Apollo 15 Preliminary Science Report. NASA SP-289, 6-1—6-28.

Moore C.B., Lewis C.F. and Gibson E.K. (1973) Total carbon contents of Apollo 15 and 16 lunar samples. *Proc. 4th Lunar Sci. Conf.* 1613-1923.

Morris R.V. (1978) The surface exposure (maturity) of lunar soils: Some concepts and Is/FeO compilation. *Proc. 9th Lunar Planet . Sci. Conf.* 2287-2298.

Morris R.V., Score R., Dardano C. and Heiken G. (1983) Handbook of Lunar Soils. JSC 19069

Phinney W.C., Warner J ., Simonds C.H. and Lofgren G.E. (1972) Classification and distribution of rock types at Spur Crater. *In* **The Apollo 15 Lunar Samples,** 149-153. LPI

Powell B.N. (1972) Apollo 15 Coarse Fines (4-10mm): Sample classification, description and inventory. MSC 03228 Curator's Office JSC

Powell B.N., Aitken F.K. and Weiblen P.W. (1973) Classification, distribution and origin of lithic fragments from the Hadley-Apennine region. *Proc. 4th Lunar Sci. Conf.* 445-460.

Ryder G. and Spudis P. (1987) Chemical composition and origin of Apollo 15 impact melts. *Proc. 17th Lunar Planet. Sci. Conf.* in J. Geophys. Res. **92**, E432-446.

Ryder G. and Sherman S.B. (1989) The Apollo 15 Coarse Fines. Curators Office #81, JSC#24035

Swann G.A., Hait M.H., Schaber G.C., Freeman V.L., Ulrich G.E., Wolfe E.W., Reed V.S. and Sutton R.L. (1971b) Preliminary description of Apollo 15 sample environments. U.S.G.S. Interagency report: 36. pp219 with maps

Swann G.A., Bailey N.G., Batson R.M., Freeman V.L., Hait M.H., Head J.W., Holt H.E., Howard K.A., Irwin J.B., Larson K.B., Muehlberger W.R., Reed V.S., Rennilson J.J., Schaber G.G., Scott D.R., Silver L.T., Sutton R.L., Ulrich G.E., Wilshire H.G. and Wolfe E.W. (1972) 5. Preliminary Geologic Investigation of the Apollo 15 landing site. In Apollo 15 Preliminary Science Rpt. NASA SP-289. pages 5-1-112.

Taylor S.R. (1973) Geochemistry of the lunar highlands. *The Moon* **7**, 181-195.

Taylor S.R., Gorton M.P., Muir P., Nance W., Rudowski R. and Ware N. (1973b) Lunar highlands composition: Apennine Front. *Proc. 4th Lunar Sci. Conf.* 1445-1459.

Walker R.J. and Papike J.J. (1981) The Apollo 15 regolith: Chemical modeling and mare/highland mixing. *Proc. 12th Lunar Planet. Sci. Conf.* 509-517.

Willis J.P., Erlank A.J., Gurney J.J. and Ahrens L.H. (1972) Geochemical features of Apollo 15 materials. *In* **The Apollo 15 Lunar Samples**, 268-271. LPI

Willis J.P., Erlank A.J., Gurney J.J., Theil R.H. and Ahrens L.H. (1972) Major, minor, and trace element data for some Apollo 11, 12, 14 and 15 samples. *Proc. 3rd Lunar Sci. Conf.* 1269-1273.