

14049
Regolith Breccia
200.1 grams



Figure 1: Photo of 14049. Edge of cube is 1 inch. NASA S71-29143.

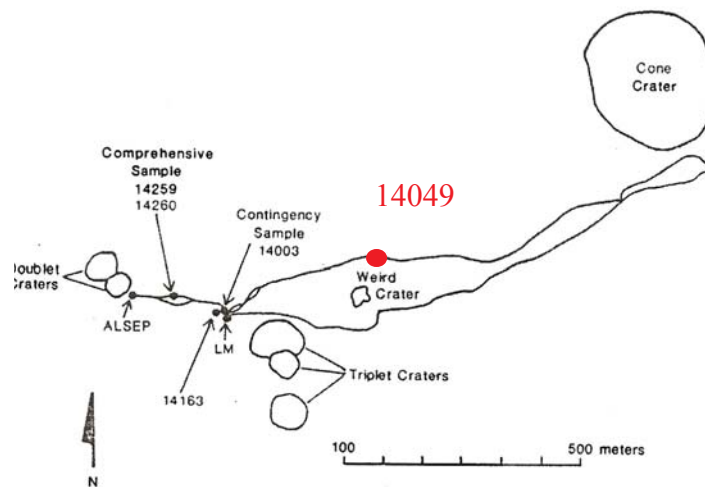


Figure 2: Map of Apollo 14 showing traverse for EVA 2.

Introduction

The Apollo 14 regolith breccias (vitric matrix breccias) are slightly more aluminous than the Fra Mauro breccias (crystalline matrix breccias). 14049 is a blocky, subrounded rock lacking zap pits and having only a few very poorly developed, irregular fractures. The sample is a very fine-grained clastic rock having less than 1 % of subrounded light-colored clasts in a medium-gray matrix. It has a high carbon content and surely was derived from local soil as an “instant rock”.

14049 was analyzed by LSPET (1971) and is similar to other Apollo 14 regolith breccias, 14042 and 14047.

Mineralogical Mode for 14049

	Simonds et al. 1977	Simon et al. 1989
Matrix	78 %	60
Clasts		
Plagioclase	2	4.8
Mafic	1	3.7
Breccia	8.5	
Glass	2	8.1
Agglutinate	3	11.6
Granulite	6	1.2
Mare basalt	0.5	0.7
Felds basalt	0.5	0.4

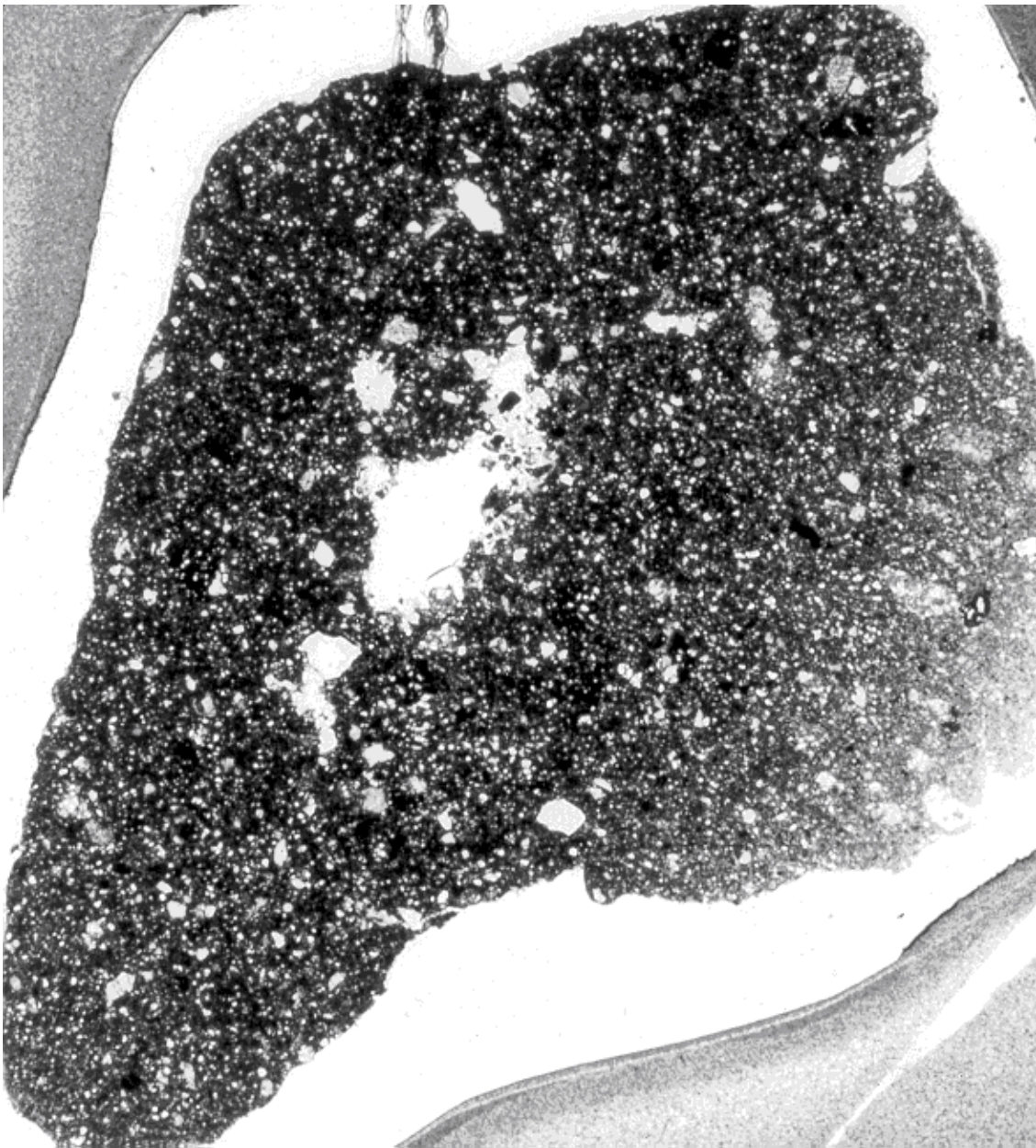


Figure 3: Thin section of 14049. Scale about 1 cm. S71-43103

Petrography

Fruland (1983) and Simon et al. (1989) included 14049 in the suite of regolith breccias. Simonds et al. (1977) found that it had a high percentage of brown glass (figures 4 and 5). Simon et al. (1989) reported a high percentage of agglutinates (generally rare in regolith breccias).

Delano (1987) studied the proportions of glass types in Apollo 14 breccias, placing them in a sequence of

Next page Figure 5: Photomicrograph of this section 14049,40. Note bubble in epoxy. Photoby C Meyer

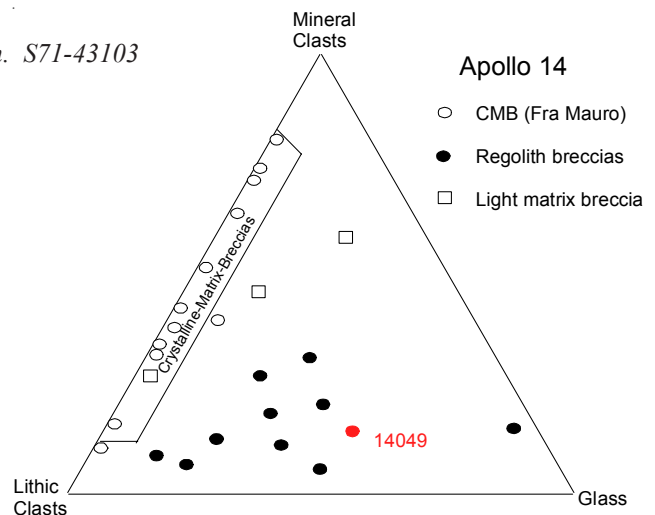
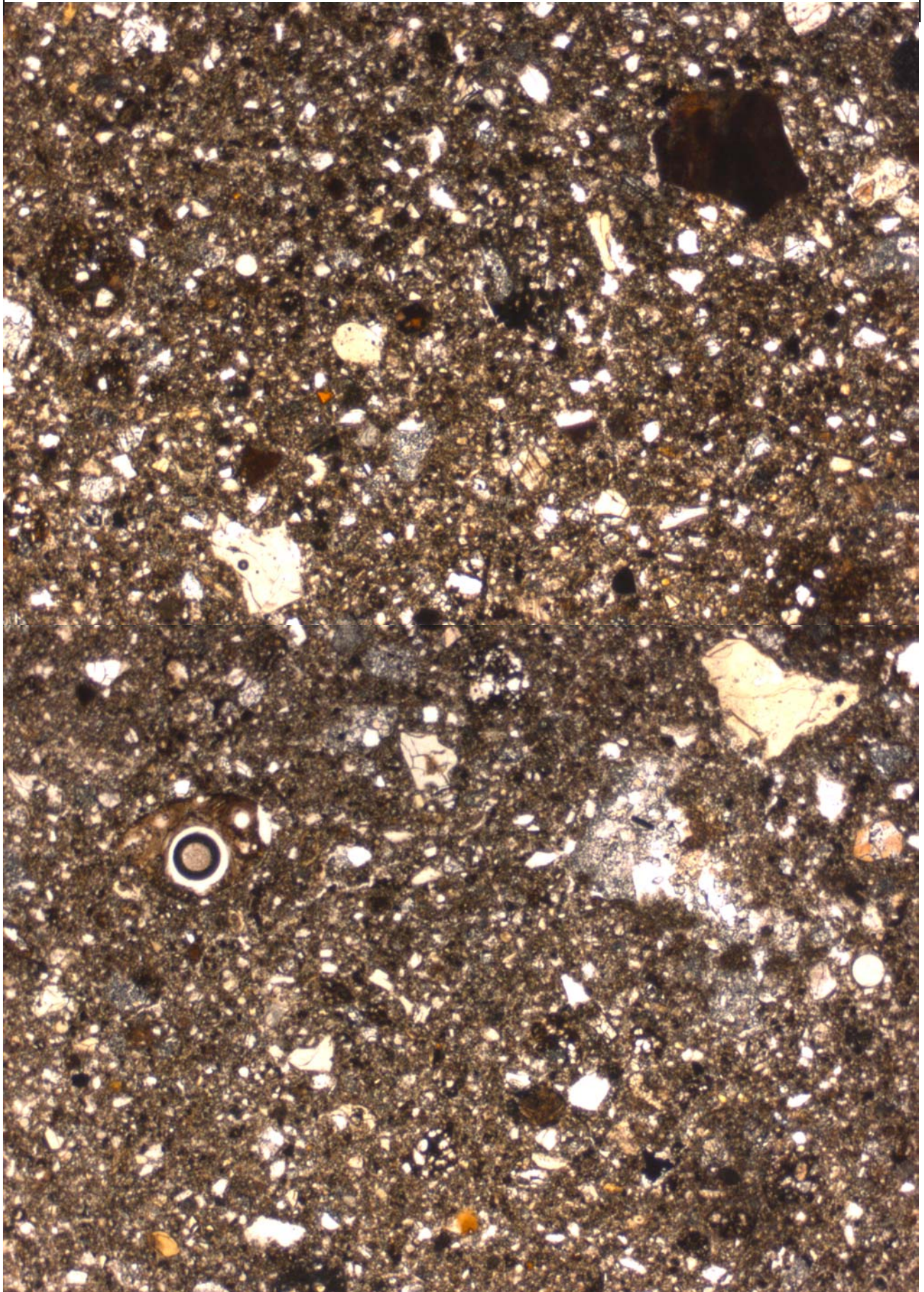


Figure 4: Simonds diagram for Apollo 14 breccias.

Scale = 2.8 mm across



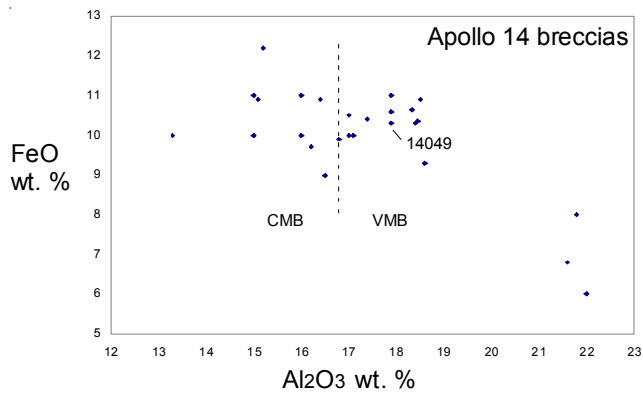


Figure 6: Composition of Apollo 14 breccias.

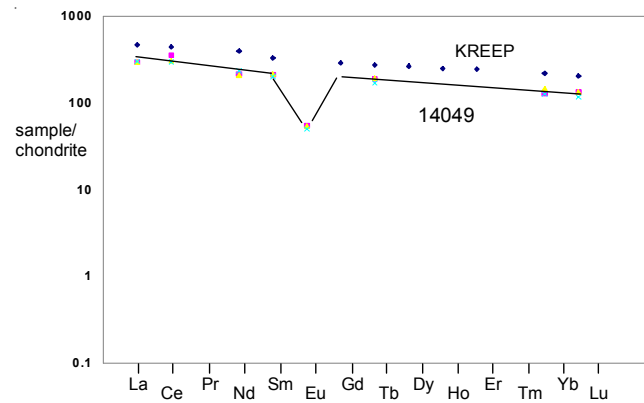


Figure 7: Normalized REE diagram for 14049.

oldest to youngest, and finding similarity of 14049 with 14047, but not with 14301. Chen et al. (1982) studied the phase diagram for VLT basalt (found as a glass in 14049).

Chemistry

Rose et al. (1972), LSPET (1971), Philpotts et al. (1972), Lindstrom et al. (1972) and Simon et al. (1989) all analyzed 14049, finding it very like local soil (figures 6 and 7).

The carbon content of 14049 is 135 or 190 ppm (Moore et al. 1972)(figure 8). Goel et al. (1972) determined 71 ppn nitrogen (also an indication of implanted solar wind).

Other Studies

Gose et al. (1972) and Pierce et al. (1972) reported the magnetic properties.

Dran et al. (1972) determined the density of fossil solar flare and comic ray tracks.

Holland et al. (1972) reported the carbon compounds.

Processing

14049 was returned in ALSRC 1006, which was sealed. There are 8 thin sections.

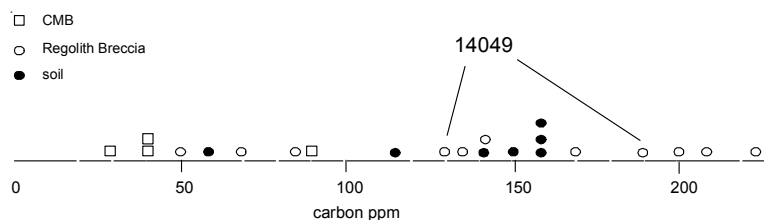
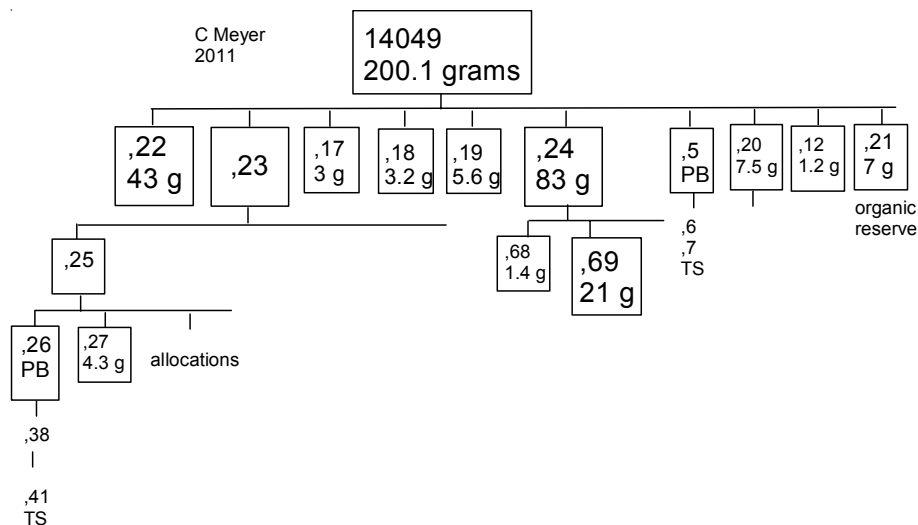


Figure 8: Carbon content for Apollo 14 soils and breccia (Moore et al. 1972).

Table 1. Chemical composition of 14049.

reference weight	Simon89 151 mg	Philpotts72	Lindstrom72 512 474		Rose72	LSPET73
SiO ₂ %		48.3	(b)		47.81	(c) 49
TiO ₂	1.78	(a) 1.75			1.79	(c) 1.7
Al ₂ O ₃	17.9	(a) 16.2			17.44	(c) 17
FeO	10.3	(a) 10.83	10.4	10.7	(a) 10.44	(c) 10
MnO	0.126	(a) 0.14			0.14	(c) 0.18
MgO	10	(a) 10			9.08	(c) 11
CaO	10.5	(a) 10.63			11.13	(c) 8.9
Na ₂ O	0.76	(a) 0.74	0.78	0.82	(a) 0.75	(c) 0.85
K ₂ O	0.58	(a) 0.6			0.56	(c) 0.53
P ₂ O ₅		0.44			0.56	(c)
S %						
sum						
Sc ppm	21.6	(a)	21.7	21.9	(a) 22	(c) 25
V	45	(a)			42	(c) 48
Cr	1250	(a)	1260	1280	(a)	1300
Co	31	(a)	35.6	36.4	(a) 28	(c) 40
Ni	400	(a)			295	(c) 260
Cu					18	(c) 16
Zn					23	(c)
Ga					4.4	(c)
Ge ppb						
As						
Se						
Rb	12	(a)			14	(c) 14
Sr	150	(a)			150	(c) 200
Y					240	(c) 220
Zr	780	(a)			900	(c) 880
Nb					44	(c) 52
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm	0.84	(a)				
Ba	860	(a)	900	830	(a) 990	(c) 670
La	71.4	(a)	69.8	70.2	(a) 70	(c) 63
Ce	181	(a)	216	185	(a)	
Pr						
Nd	107	(a)	98	95	(a)	
Sm	29.8	(a)	31.1	31.8	(a)	
Eu	2.82	(a)	2.97	3.04	(a)	
Gd						
Tb	6.2	(a)	7	7	(a)	
Dy	39	(a)				
Ho						
Er						
Tm						
Yb	20.7	(a)	21	23.8	(a) 19	(c) 28
Lu	2.84	(a)	3.26	3.26	(a)	
Hf	22.8	(a)	24.3	24	(a)	
Ta	3.1	(a)	5	4.8	(a)	
W ppb						
Re ppb						
Os ppb						
Ir ppb	7	(a)				
Pt ppb						
Au ppb	23	(a)				
Th ppm	13.1	(a)				
U ppm	3.3	(a)	3.6	3.4	(a)	

technique: (a) INAA, (b) AA, (c) "microchemical"



References for 14049

Carlson I.C. and Walton W.J.A. (1978) **Apollo 14 Rock Samples**. Curators Office. JSC 14240

Chao E.C.T., Minkin J.A. and Best J.B. (1972) Apollo 14 breccias: General characteristics and classification. Proc. 3rd Lunar Sci. Conf. 645-659.

Chen H.-K., Delano J.W. and Lindsley D.H. (1982) Chemistry and phase relations of VLT volcanic glasses from Apollo 14 and Apollo 17. Proc. 13th Lunar Planet. Sci. Conf. A171-A181.

Delano J.W. (1987) Apollo 14 regolith breccias: Different glass populations and their potential for charting space/time variations. Proc. 18th Lunar Planet Sci. Conf. 59-65.

Dran J.C., Duraud J.P., Maurette M., Durrieu L., Jouret C. and Legressus C. (1972) Track metamorphism in extraterrestrial breccias. Proc. 3rd Lunar Sci. Conf. 2883-2903.

Frulan R.M. (1983) Regolith Breccia Workbook. JSC 19045

Goel P.S. and Kothari B.K. (1972) Total nitrogen contents of some Apollo 14 lunar samples by neutron activation analysis. Proc. 3rd Lunar Sci. Conf. 2041-2050.

Gose W.A., Pearce G.W., Strangway D.W. and Larson E.E. (1972) Magnetic properties of Apollo 14 breccias and their

correlation with metamorphism. Proc. 3rd Lunar Sci. Conf. 2387-2395.

Holland P.T., Simoneit B.R., Wszolek P.C. and Burlingame A.L. (1972) Compounds of carbon and other volatile elements in Apollo 14 and 15 samples. Proc. 3rd Lunar Sci. Conf. 2131-2147.

Lindstrom M.M., Duncan A.R., Fruchter J.S., McKay S.M., Stoesser J.W., Goles G.G. and Lindstrom D.J. (1972) Compositional characteristics of some Apollo 14 clastic materials. Proc. 3rd Lunar Sci. Conf. 1201-1214.

LSPET (1971) Preliminary examination of lunar samples from Apollo 14. Science 173, 681-693.

Moore C.B., Lewis C.F., Cripe J., Delles F.M., Kelly W.R. and Gibson E.K. (1972) Total carbon, nitrogen and sulfur in Apollo 14 lunar samples. Proc. 3rd Lunar Sci. Conf. 2051-2058.

Pearce G.W., Strangway D.W. and Gose W.A. (1972) Remanent magnetization of the lunar surface. Proc. 3rd Lunar Sci. Conf. 2449-2464.

Pearce G.W., Gose W.A. and Strangway D.W. (1973) Magnetic studies on Apollo 15 and 16 lunar samples. Proc. 4th Lunar Sci. Conf. 3045-3076.

Philpotts J.A., Schnetzler C.C., Nava D.F., Bottino M.L., Fullagar P.D., Thomas H.H., Schumann S. and Kouns C.W. (1972) Apollo 14: Some geochemical aspects. Proc. 3rd Lunar Sci. Conf. 1293-1305.

Rose H.J., Cuttitta F., Ansell C.S., Carron M.K., Christian R.P., Dwornik E.J., Greenland L.P. and Ligon D.T. (1972)

Compositional data for twenty-one Fra Mauro lunar materials. Proc. 3rd Lunar Sci. Conf. 1215-1229.

Simon S.B., Papike J.J., Shearer C.K., Hughes S.S. and Schmitt R.A. (1989) Petrology of Apollo 14 regolith breccias and ion microprobe studies of glass beads. Proc. 19th Lunar Planet. Sci. Conf. 1-17.

Simonds C.H., Phinney W.C., Warner J.L., McGee P.E., Geeslin J., Brown R.W. and Rhodes J.M. (1977) Apollo 14 revisited, or breccias aren't so bad after all. Proc. 8th Lunar Sci. Conf. 1869-1893.

Sutton R.L., Hait M.H. and Swann G.A. (1972) Geology of the Apollo 14 landing site. Proc. 3rd Lunar Sci. Conf. 27-38.

Swann G.A., Trask N.J., Hait M.H. and Sutton R.L. (1971a) Geologic setting of the Apollo 14 samples. Science 173, 716-719.

Swann G.A., Bailey N.G., Batson R.M., Eggleton R.E., Hait M.H., Holt H.E., Larson K.B., Reed V.S., Schaber G.G., Sutton R.L., Trask N.J., Ulrich G.E. and Wilshire H.G. (1977) Geology of the Apollo 14 landing site in the Fra Mauro Highlands. U.S.G.S. Prof. Paper 880.

Swann G.A., Bailey N.G., Batson R.M., Eggleton R.E., Hait M.H., Holt H.E., Larson K.B., McEwen M.C., Mitchell E.D., Schaber G.G., Schafer J.P., Shepard A.B., Sutton R.L., Trask N.J., Ulrich G.E., Wilshire H.G. and Wolfe E.W. (1972) 3. Preliminary Geologic Investigation of the Apollo 14 landing site. In Apollo 14 Preliminary Science Rpt. NASA SP-272. pages 39-85.

von Engelhardt W., Arndt J., Stoffler D. and Schneider H. (1972) Apollo 14 regolith and fragmental rocks, their compositions and origins by impacts. Proc. 3rd Lunar Sci. Conf. 753-770.

Warner J.L. (1972) Metamorphism of Apollo 14 breccias. Proc. 3rd Lunar Sci. Conf. 623-643.

Williams R.J. (1972) The lithification of metamorphism of lunar breccias. Earth Planet. Sci. Lett. 16, 250-256.

Wilshire H.G. and Jackson E.D. (1972) Petrology and stratigraphy of the Fra Mauro Formation at the Apollo 14 site. U.S. Geol. Survey Prof. Paper 785.