61195

Ancient Regolith Breccia

588 grams

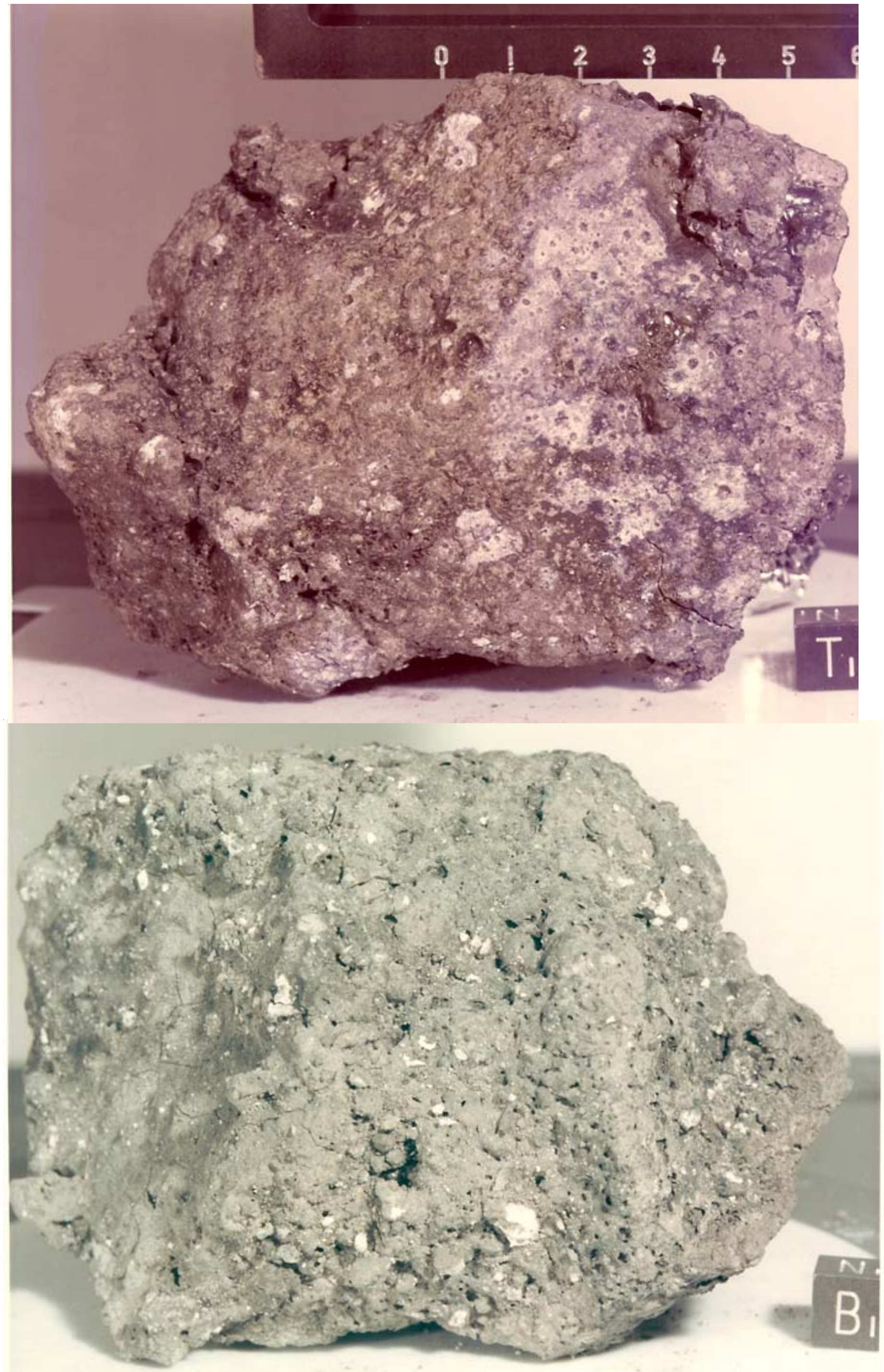


Figure 1: Top and bottom of 61295, showing that it was probably a glass-covered "bomb", where the glass was chipped off by meteorite bombardment on top. Cube is 1 cm. S72-37972 and 973.

Figure 2: W1 face of 61295, with glass coating and white clast on top corner. S72-37974

Figure 3: E1 face of 61195 with numerous micrometeorite "zap" pits. S72-37976. Cube is 1 cm.

Introduction

According to Ryder and Norman (1980), 61195 is a coherent, medium grey breccia with a glassy matrix and abundant clasts (figure 1). James (1981) classify it as a "shocked regolith breccia" and Fruland (1983) included it in the suite of regolith breccias. It was covered on all sides with a vesicular black glass which has been chipped off by micrometeorite bombardment (See et al. 1986). It was collected from the rim of Plum Crater. Zap pits are surrounded with wide spall zones (figure 3). The matrix is dense and the maturity index is low (McKay et al. 1986).

Figure 4: Thin section photo of devitrified glass bead in matirx of 61195. Field of view is 2 mm. Polarized light.

Petrography

McKay et al. (1986) and Simon et al. (1988) concluded that 61195 was an "ancient regolith breccia" , because it had high $^{40}Ar/^{38}Ar$. The matrix contains abundant glass including spheres; some of which are recrystallized (figure 4). Mineral clasts (plagioclase, pyroxene and olivine) exhibit shock features. Rounded lithic fragments include granoblastic anorthosite, anorthositic norite, cataclastic anorthosite, basaltic and poikilitic impact melt and recrystallized vitric material. Accessory phases include spinel, Fe-metal, ilmenite, troilite, schreibersite and 'rust' (Hunter and Taylor 1981).

See et al. (1986) and Morris et al. (1986) studied the glass coating on 61195.

Mineralogical Mode for 61195
(from Simon et al. 1988)

	20-90 micron	90-1000 micron
Matrix < 20 micron	42.9 %	
Mare basalt	0	1.3
KREEP basalt	0	1
Feldspathic basalt	0	0
Plutonic rock frag.	0.2	5.7
Granulite	0	0
Poik. rocks	0.5	2.5
Impact melts	0.3	8.5
Regolith brec.	0	2.6
Agglutinate	0	0
Plagioclase	6.1	8.7
Olivine	1	0.2
Pyroxene	1.6	0.3
Opaques	0.5	0
Glass	3.2	12.3

Figure 5: N1 face of 61195. S72-37977. Cube is 1 cm.

Significant clasts

A relatively large white clast exposed on the T1- W1 corner of 61195 (figures 2 and 7) does not appear to have been studied.

Chemistry

Chemical analyses by various groups (Eldridge 1973, Wanke et al. 1974, McKay et al. 1986 and Simon et al. 1988) are in relative agreement (table, figure 6).

Radiogenic age dating

None

Cosmogenic isotopes and exposure ages

Eldridge et al. (1973) reported the cosmic ray induced activity of ^{26}Al = 54 dpm/kg and ^{22}Na = 42 dpm/kg. The exposure age has not been determined.

Processing

A slab was cut through 61195 (figure 7). There are 17 thin sections.

List of Photo #s

Lunar Sample Compendium by C Meyer 2006

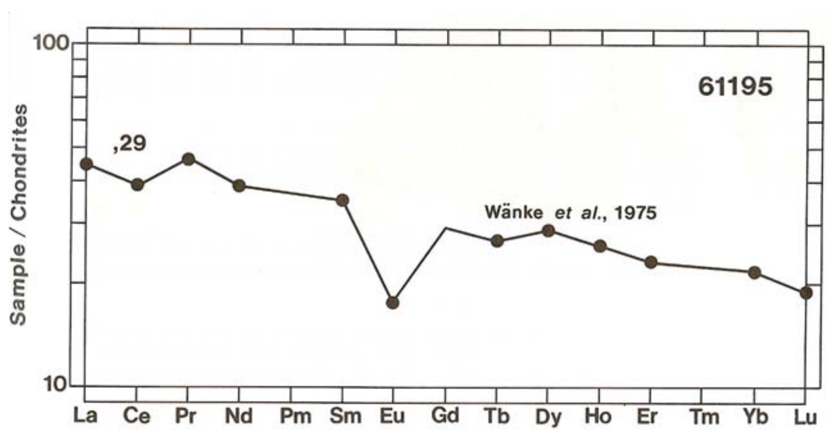


Figure 6: Normalized rare-earth-element diagram for 61195 matrix (Wanke et al. 1975).

Table 1. Chemical composition of 61195.

reference	Eldridge73		Simon88	McKay86		Wanke 75		See86		Morris86	
weight								glass		glass	
SiO2 %						45.4		43.92	(d)		
TiO2			0.7		(b)	0.5		0.46	(d)		
Al2O3			29		(b)	26.8		27.93	(d)		
FeO			4.6	4.55	(b)	5.12		4.84	(d)	4.75	(b)
MnO			0.058		(b)	0.08		0.05	(d)		
MgO			5.1		(b)	5.56		5.94	(d)		
CaO			18.1	15.7	(b)	15.4		16.01	(d)		
Na2O			0.47	0.441	(b)	0.46		0.23	(d)	0.36	(b)
K2O	0.06	(a)	0.094		(b)	0.11		0.06	(d)		
P2O5						0.17					
S %						0.07					
sum											
Sc ppm			7.6	8.09	(b)	8.53	(b)			8.23	(b)
V			17		(b)						
Cr			601	650	(b)	680				675	(b)
Co			24.7	18.9	(b)	27				21	(b)
Ni			320	248	(b)	410				256	(b)
Cu						3.76					
Zn						9.71					
Ga						3.85					
Ge ppb						1630					
As						90					
Se						0.44					
Rb			3.1		(b)	3.86					
Sr			70	176	(b)	166					
Y						37					
Zr			130	140	(b)	194	(b)				
Nb						11.8					
Mo											
Ru											
Rh											
Pd ppb						8.4					
Ag ppb											
Cd ppb											
In ppb											
Sn ppb											
Sb ppb											
Te ppb											
Cs ppm			0.13	0.1		0.144					
Ba			110	103		152				154	(b)
La			9.2	9.23		14.6				10.9	(b)
Ce			23.1	24.2		34				31.8	(b)
Pr						5.2					
Nd			15.9	14		23					
Sm			4.29	4.24		6.3				5.26	(b)
Eu			1.21	1.12		1.2				1.6	(b)
Gd			5.4			7.23					
Tb			0.89	0.79		1.25				0.92	(b)
Dy			6			8.3					
Ho			1.3			1.83					
Er						4.6					
Tm											
Yb			3	3		4.37				3.58	(b)
Lu			0.44	0.439		0.64				0.52	(b)
Hf			3.2	3.38		4.58				3.82	(b)
Ta			0.35	0.55		0.55				0.54	(b)
W ppb						0.35					
Re ppb						0.56					
Os ppb											
Ir ppb			6.5	6.2		11.3					
Pt ppb											
Au ppb			1.3	5.1		6.1					
Th ppm	1.13	(a)	1.38	1.85		2.3				2.26	(b)
U ppm	0.3	(a)	0.41	0.39	(b)	0.72				0.47	(b)

technique: (a) radiation counting, (b) INAA, (c) RNAA, (d) e. probe

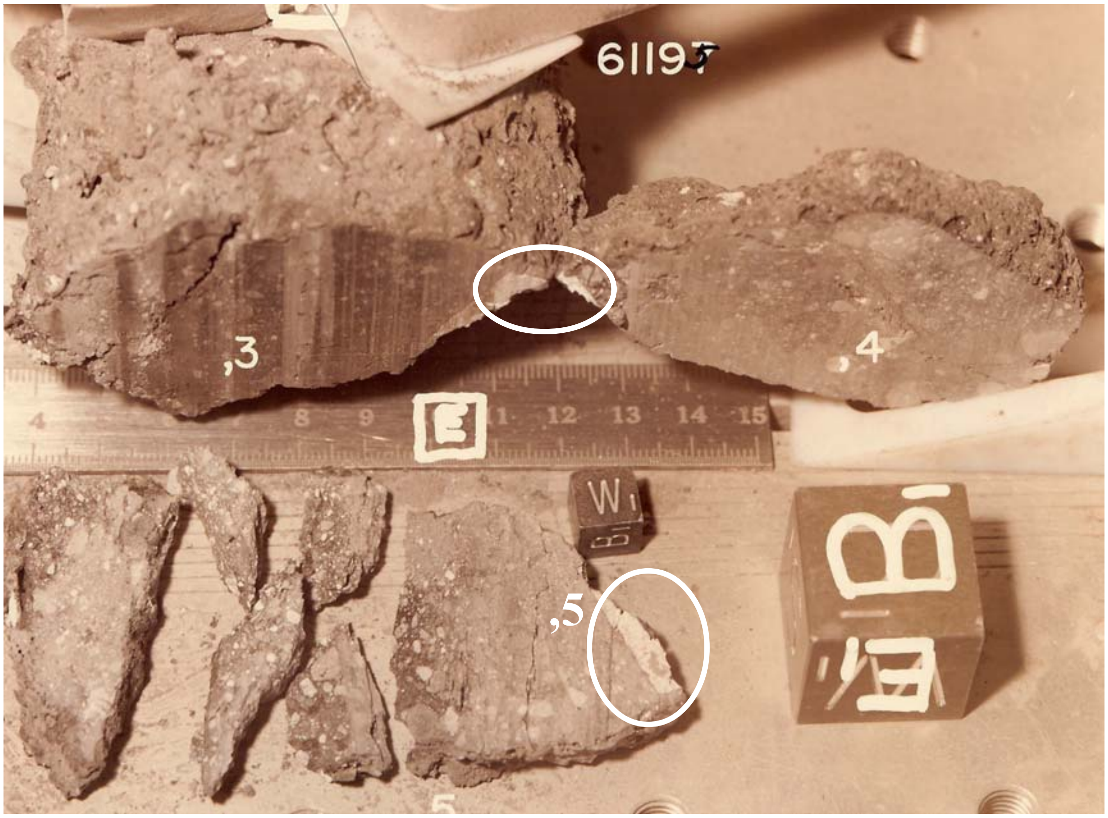
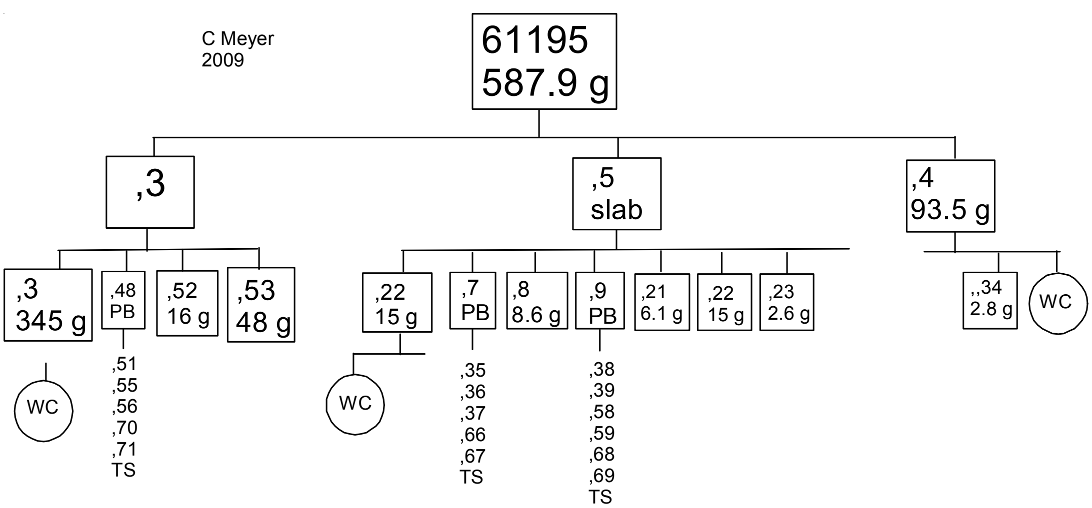


Figure 7: Group photo of 61195 after saw cuts. White Clast (WC) is circled. Big cube is 1 in. S73-31174



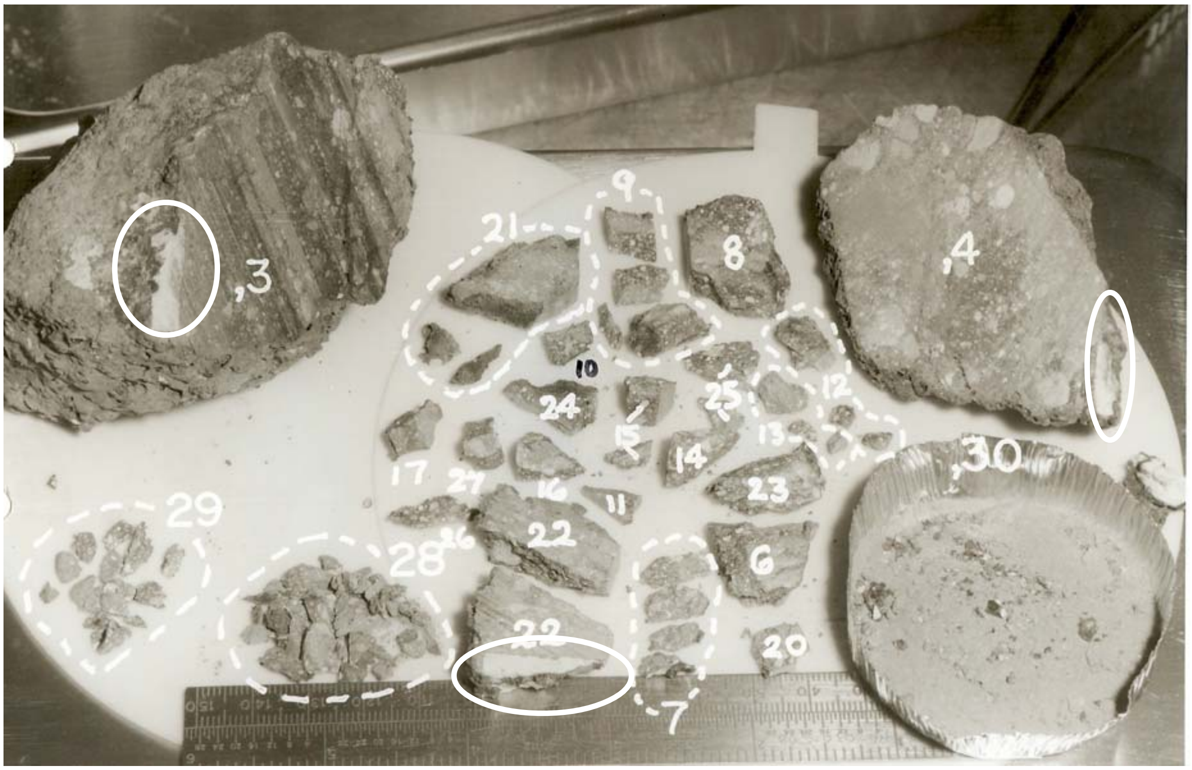


Figure 8: Group photo of 61195 after saw cuts (chips are from slab). White clast (WC) is circled. S73-31060.

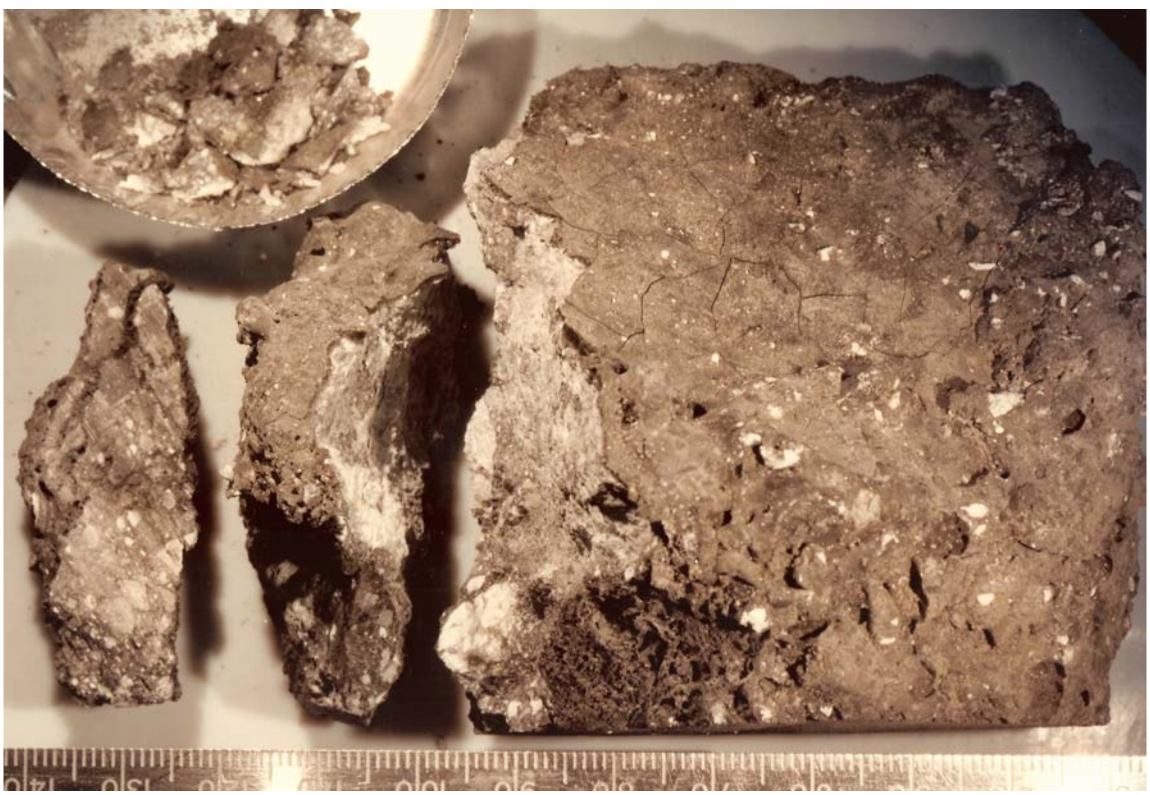


Figure 9: 61195,3 subdivision. Scale is in cm. S83-26029.

Figure 10: 61195,3 subdivison. Cube is ~1 cm. S83-26030.

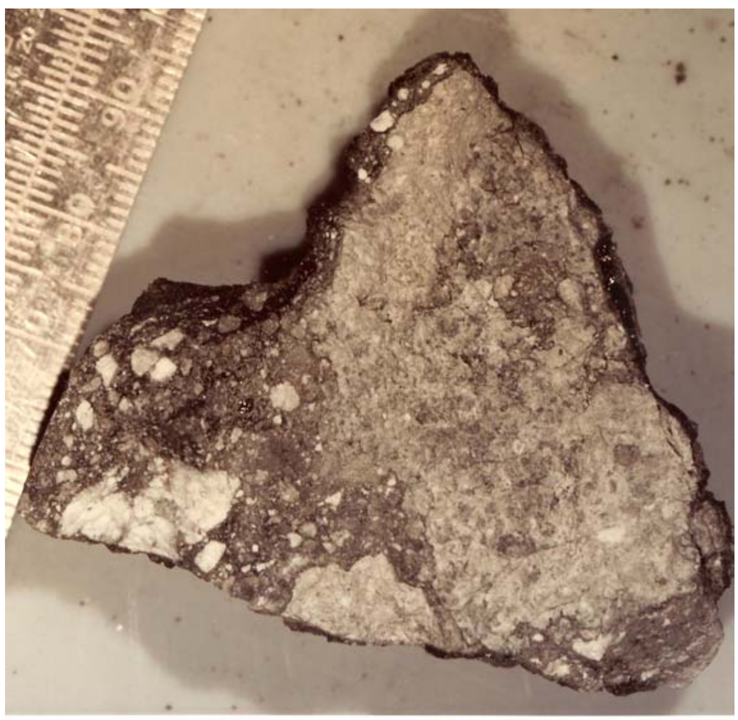


Figure 11: 61195,53 showing new clasts. Scale is in cm. S83-26031.

References for 61195

Butler P. (1972) Lunar Sample Information Catalog Apollo 16. Lunar Receiving Laboratory. MSC 03210 Curator's Catalog. pp. 370.

Eldridge J.S., O'Kelley G.D. and Northcutt K.J. (1973) Radionuclide concentrations in Apollo 16 lunar samples determined by nondestructive gamma-ray spectrometry. *Proc. 4th Lunar Sci. Conf.* 2115-2122.

Hunter R.H. and Taylor L.A. (1981) Rust and schreibersite in Apollo 16 highland rocks: Manifestations of volatile-element mobility. *Proc. 12th Lunar Planet. Sci. Conf.* 253-259.

James O.B. (1981a) Tentative classification of the Apollo 16 breccias (abs). *Lunar Planet. Sci.* **XII**, 506-508.

LSPET (1973) The Apollo 16 lunar samples: Petrographic and chemical description. Science 179, 23-34.

LSPET (1972) Preliminary examination of lunar samples. Apollo 16 Preliminary Science Report. NASA SP-315, 7-1—7-58.

McKay D.S., Bogard D.D., Morris R.V., Korotev R.L., Johnson P. and Wentworth S.J. (1986) Apollo 16 regolith breccias: Characterization and evidence for early formation in the megaregolith. *Proc. 16th Lunar Planet. Sci. Conf.* in J. Geophys. Res. 91, D277-D303.

Morris R.V., See T.H. and Horz F. (1986) Composition of the Cayley Formation at Apollo 16 as inferred from impact melt splashes. *Proc. 17th Lunar Planet. Sci. Conf.* in J. Geophys. Res. **90**, E21-E42.

Nagle J.S. (1982) Subcrater lithification of polymict regolith breccias. *Proc. 13th Lunar Planet. Sci*. in J. Geophys. Res. **87**, A131-A146.

Ryder G. and Norman M.D. (1980) Catalog of Apollo 16 rocks (3 vol.). Curator's Office pub. #52, JSC #16904

See T.H., Horz F. and Morris R.V. (1986) Apollo 16 impact-melt splashes: Petrography and major-element composition. *Proc. 17th Lunar Planet. Sci. Conf.* in J. Geophys. Res. **91**, E3-E20.

Simon S.B., Papike J.J., Laul J.C., Hughes S.S. and Schmitt R.A. (1988) Apollo 16 regolith breccias and soils: Recorders of exotic component addition to the Descartes region of the moon. *Earth Planet. Sci. Lett*. **89**, 147-162.

Sutton R.L. (1981) Documentation of Apollo 16 samples. In Geology of the Apollo 16 area, central lunar highlands. (Ulrich et al.) U.S.G.S. Prof. Paper 1048.

Wänke H., Palme H., Baddenhausen H., Dreibus G., Jagoutz E., Kruse H., Palme C., Spettel B., Teschke F. and Thacker R. (1975a) New data on the chemistry of lunar samples: Primary matter in the lunar highlands and the bulk composition of the moon. *Proc. 6th Lunar Sci. Conf.* 1313-1340.