69955

Cataclastic Anorthosite

75.9 grams

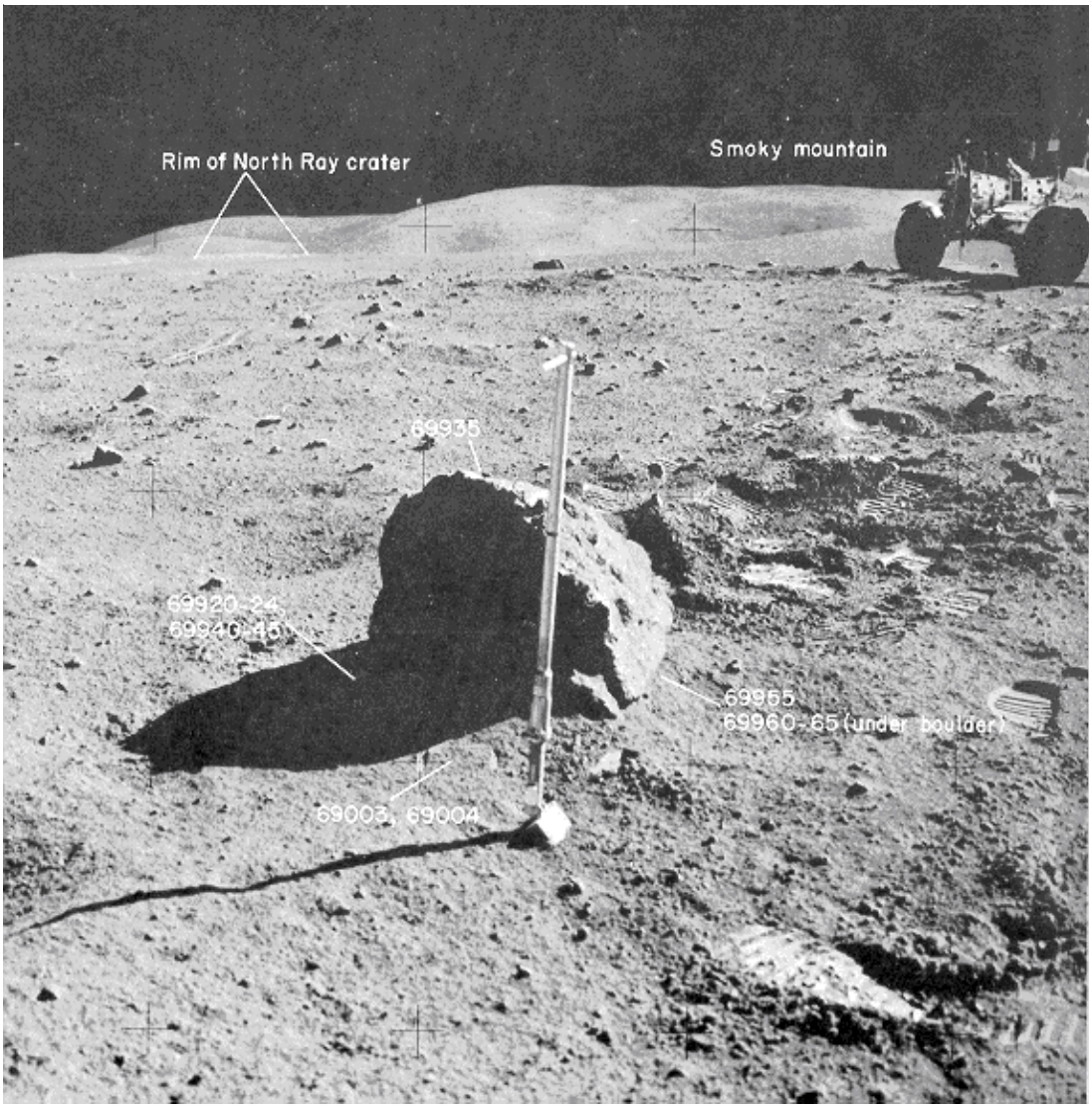


Figure 1: Boulder at station 9, Apollo 16 showing postion of samples 69935 (breccia, top) and 69955 (anorthosite, bottom). This boulder is thought to be from South Ray Crater (Sutton 1981), because it is perched, without a fillet, on the regolith. Boulder is about 0.5 meter in size.

Introduction

Lunar sample 69955 was chipped from the bottom of a 0.5 meter-sized boulder found perched on the lunar regolith (Sutton 1981). Hence, 69955 was a clast in a breccia (represented by 69935). This boulder (figure 1) may have been derived from South Ray Crater (Sutton 1981) or secondary craters from the SRC event (Drozd et al. 1974) at about ~ 2 m.y. See transcript in section on 69935.

Petrography

Petrographic descriptions of 69955 are found in the catalogs by Butler (1972) and Ryder and Norman (1980). The sample is almost entirely made of plagioclase (figures 2 and 3). It was noted that the plagioclase had a greasy luster in hand specimen.

Figure 2: Photo of 69955. NASA S72-40124. Scale at top is in cm.

McGee (1993) described a portion as: *"a rock that is relatively coarse-grained, shocked cataclastic anorthosite. Most of the plagioclase has been converted to maskelynite. Less shocked (still birefringent) patches of plagioclase within the maskelynite are as much as 3 mm across. Pyroxene grains are 0.1-0.08 mm across and have no visible exsolution lamellae. Some relict intergranular texture is preserved in lithic clasts. Plagioclase compositions have a relatively large range. Low-Ca pyroxene compositions are heterogeneous and have a trimodal distribution. High-Ca pyroxene compositions have a fairly narrow range. Rare olivine (Fo_{61}) with included chromite, is present."*

Photos show a thin (2 mm) flat black glass vein running the length of the sample.

Mineralogy

Olivine: not analyzed

Pyroxene: McGee (1993) analyzed pyroxene in 69955 (figure 5). Note the very low Ca orthopyroxene.

Plagioclase: Ryder and Norman (1980) reported that some plagioclase was ~ 5 mm across and some maskelynite is present. Meyer (1979) and McGee (1993) reported trace element analyses of plagioclase (figure 6).

Ilmenite: not reported

Metal: Misra and Taylor (1975) reported Ni and Co contents of metallic iron in 69955, but they show meteoritic values and may be from the glass vein. Hunter and Taylor (1981) reported trace rust and schreibersite.

Chemistry

Krahenbuhl et al. (1973) showed that 69955 was generally poor in meteoritic siderophiles as well as other trace elements. Analyses by Rose et al. (1973) and Laul and Schmitt (1973) show the rock is almost entirely plagioclase (figure 4).

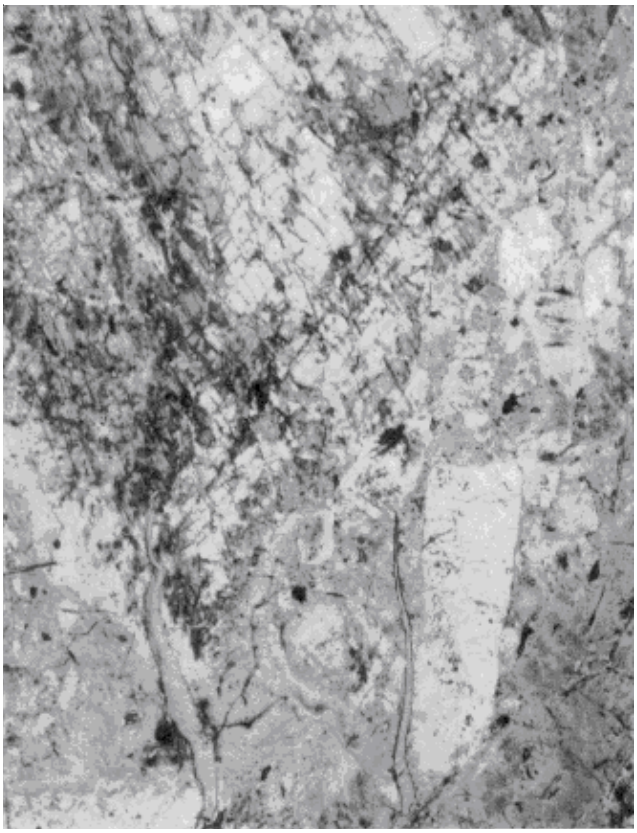


Figure 3: Photomicrograph of thin section 69955,27 (partially crossed polarized light). From Ryder and Norman (1980). Width of field is 2 mm.

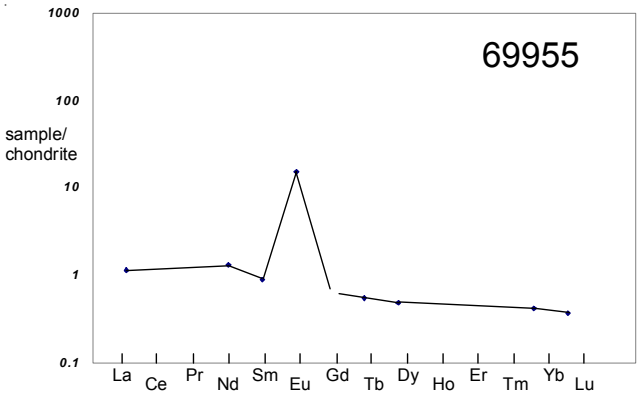


Figure 4: Normalized rare-earth-element diagram for 69955 (data by Laul and Schmitt 1973).

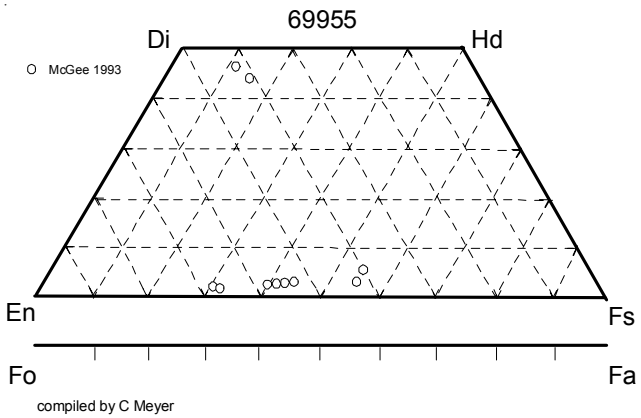


Figure 5: Composition of pyroxene in 69955 (McGee 1993).

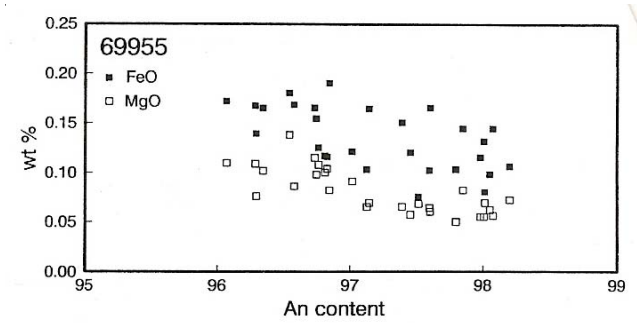


Figure 6: Trace element sin plagioclase (McGee 1993).

Cosmogenic isotopes and exposure ages

Drozd et al. (1974) reported cosmic ray exposure ages $^{81}Kr = 4.23 \pm 0.21$ and $^{21}Ne = 2.13 \pm 0.51$ m.y. Fruchter et al. (1978, 1981) reported the cosmic-ray-induced activity of $^{26}Al = 70$ dpm/kg. and $^{53}Mn = 148$ dpm/kg., finding that the radiation history is not consistent with origin of the boulder from South Ray Crater.

Processing

There are 5 thin sections of 69955. Figure 7 shows how it was broken, not sawn.

Table 1. Chemical composition of 69955.

reference	Rancitelli 73		Rose 73		Laul 73		Krahenbuhl73	
weight	75.8 g				*516 mg*			
SiO2 %			44.1	(b)				
TiO2			0.01	(b)	0.04	(c)		
Al2O3			35.15	(b)	35.5	(c)		
FeO			0.36	(b)	0.49	(c)		
MnO			0.01	(b)	0.011	(c)		
MgO			0.23	(b)				
CaO			19.3	(b)	18.9	(c)		
Na2O			0.42	(b)	0.4	(c)		
K2O	<0.0108	(a)	0.02	(b)	0.01	(c)		
P2O5			0.01	(b)				
S %								
sum								
Sc ppm					0.84	(c)		
V					7	(c)		
Cr			350	(b)	48	(c)		
Co					0.8	(c)		
Ni			43	(b)			9.8	(d)
Cu			1.1	(b)				
Zn							0.37	(d)
Ga			1.2	(b)				
Ge ppb							22	(d)
As								
Se							9.8	(d)
Rb			0.7	(b)			0.15	(d)
Sr			135	(b)				
Y								
Zr								
Nb								
Mo								
Ru								
Rh								
Pd ppb								
Ag ppb							0.58	(d)
Cd ppb							37	(d)
In ppb								
Sn ppb								
Sb ppb							0.21	(d)
Te ppb							1	(d)
Cs ppm							0.011	(d)
Ba			11		10	(c)		
La					0.27	(c)		
Ce								
Pr								
Nd					0.6	(c)		
Sm					0.13	(c)		
Eu					0.87	(c)		
Gd								
Tb					0.02	(c)		
Dy					0.12	(c)		
Ho								
Er								
Tm								
Yb					0.068	(c)		
Lu					0.009	(c)		
Hf					0.024	(c)		
Ta					0.01	(c)		
W ppb								
Re ppb							0.0278	(d)
Os ppb								
Ir ppb							0.289	(d)
Pt ppb								
Au ppb							0.307	(d)
Th ppm	0.14	(a)						
U ppm	0.038	(a)			0.03	(c)	0.026	(d)

technique: (a) radiation counting, (b) microchemical XRF, (c) INAA, (d) RNAA

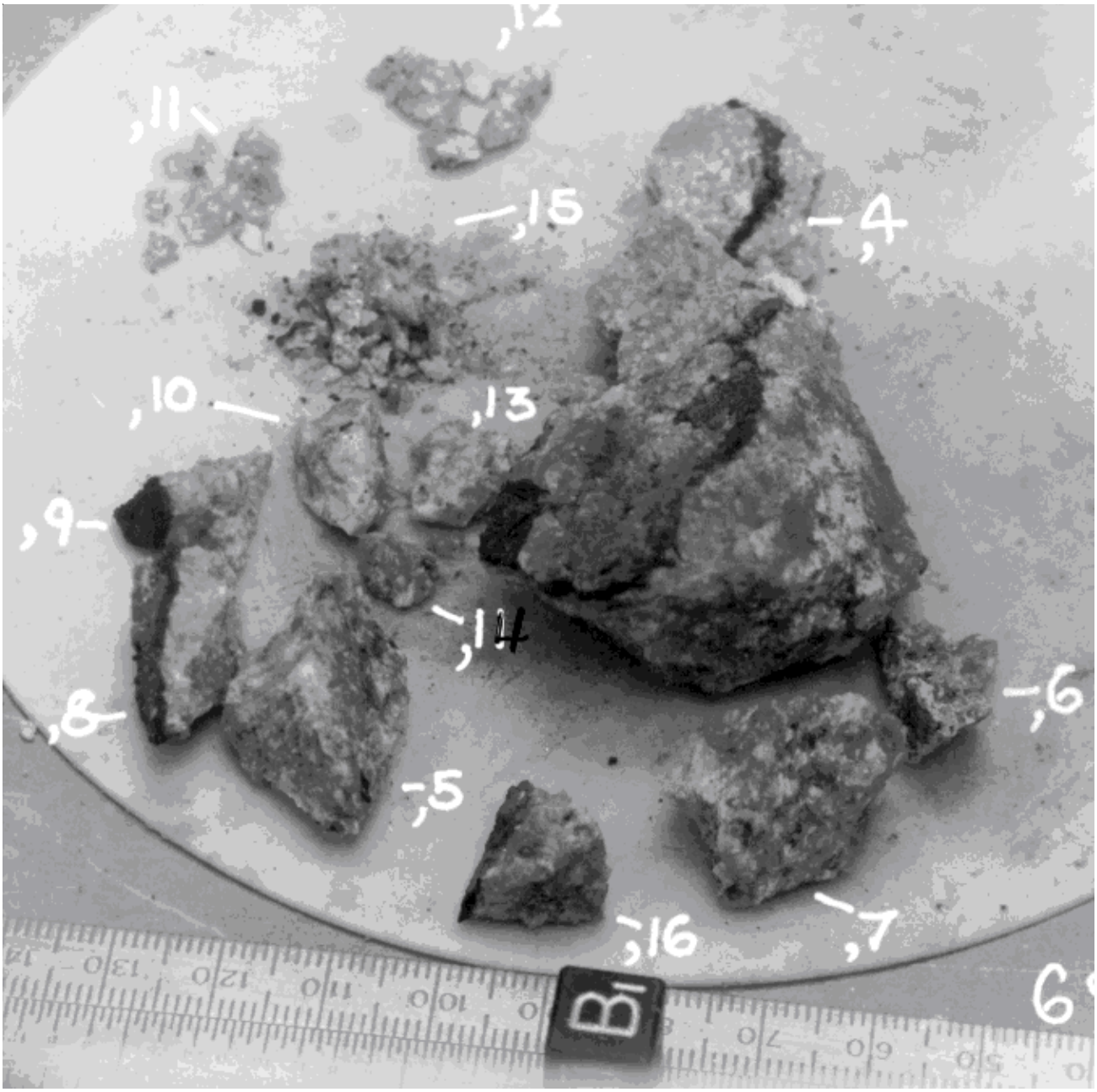
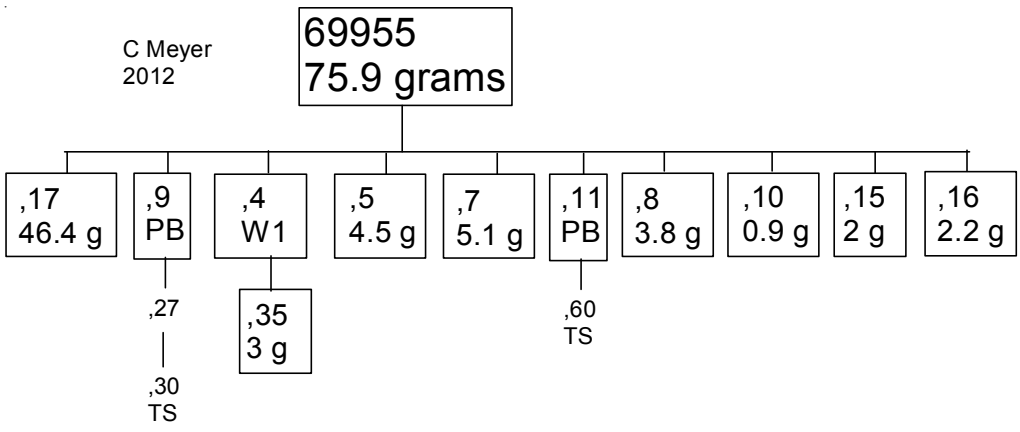


Figure 7: Processing 69955. NASA S73-22189. Cube is 1 cm.



References for 69955

Arvidson R., Crozaz G., Drozd R.J., Hohenberg C.M. and Morgan C.J. (1975) Cosmic ray exposure ages of features and events at the Apollo landing sites. *The Moon* **13**, 259-276.

Behrmann C.J., Crozaz G., Drozd R., Hohenberg C., Ralston C., Walker R. and Yuhas D. (1973b) Cosmic-ray exposure history of North Ray and South Ray material. *Proc. 4th Lunar Sci. Conf.* 1957-1974.

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

Drozd R.J., Hohenberg C.M., Morgan C.J. and Ralston C.E. (1974) Cosmic-ray exposure history at the Apollo 16 and other lunar sites: lunar surface dynamics. *Geochim. Cosmochim. Acta* **38**, 1625-1642.

Fruchter J.S., Reeves J.H., Evans J.C. and Perkins R.W. (1981) Studies of lunar regolith dynamics using measurements of cosmogenic radionuclides in lunar rocks, soils and cores. *Proc. 12th Lunar Planet. Sci. Conf.* 567-575.

Fruchter J.S., Rancitelli L.A., Evans J.C. and Perkins R.W. (1978a) Lunar surface processes and cosmic ray histories over the past several million years. *Proc. 9th Lunar Planet. Sci. Conf.* 2019-2032.

Ganapathy R., Morgan J.W., Higuchi H., Anders E. and Anderson A.T. (1974) Meteoritic and volatile elements in Apollo 16 rocks and in separated phases from 14306. *Proc. 5th Lunar Sci. Conf.* 1659-1683.

Hertogen J., Janssens M.-J., Takahashi H., Palme H. and Anders E. (1977) Lunar basins and craters: Evidence for systematic compositional changes of bombarding population. *Proc. 8th Lunar Sci. Conf.* 17-45.

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.

Krahenbuhl U., Ganapathy R., Morgan J.W. and Anders E. (1973a) Volatile elements in Apollo 16 samples: Possible evidence for outgassing of the Moon. *Science* **180**, 858-861.

Krahenbuhl U., Ganapathy R., Morgan J.W. and Anders E. (1973b) Volatile elements in Apollo 16 samples: Implications for highland volcanism and accretion history of the moon. *Proc. 4th Lunar Sci. Conf.* 1325-1348.

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

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

McGee J.J. (1993) Lunar ferroan anorthosites: Mineralogy, compositional variations and petrogenesis. *J. Geophys. Res.* **98**, 9089-9105.

Meyer C. (1979) Trace elements in plagioclase from the lunar highlands. *In* Papers presented to the Conference on the **Lunar Highlands Crust** (abs). LPI Contr. 394, 111-113. Lunar Planetary Institute, Houston

Misra K.C. and Taylor L.A. (1975) Characteristics of metal particles in Apollo 16 rocks. *Proc. 6th Lunar Sci. Conf.* 615-639.

Pepin R.O., Basford J.R., Dragon J.C., Johnson N.L., Coscio M.R. and Murthy V.R. (1974) Rare gases and trace elements in Apollo 15 drill fines: Depositional chronologies and K-Ar ages and production rates of spallation-porduced ^{3}He, ^{22}Ne and ^{38}Ar vrs depth. *Proc. 5th Lunar Sci. Conf.* 2149-2184.

Rancitelli L.A., Perkins R.W., Felix W.D. and Wogman N.A. (1973) Lunar surface and solar process analyses from cosmogenic radionuclide measurements at the Apollo 16 site (abs). *Lunar Sci.* **IV**, 609-612. Lunar Planetary Institute, Houston.

Rancitelli L.A., Perkins R.W., Felix W.D. and Wogman N.A. (1973b) Primordial radiouclides in soils and rocks from the Apollo 16 site(abs). *Lunar Sci.* **IV**, 615-617. Lunar Planetary Institute, Houston.

Rose H.J., Cuttitta F., Berman S., Carron M.K., Christian R.P., Dwornik E.J., Greenland L.P. and Ligon D.T. (1973) Compositional data for twenty-two Apollo 16 samples. *Proc. 4th Lunar Sci. Conf.* 1149-1158.

Ryder G. and Norman M.D. (1979b) Catalog of pristine non-mare materials Part 2. Anorthosites. Revised. Curators Office JSC #14603

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

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.