

67935, 67936 and 67937
Basaltic Impact Melt with glass veins
108.9, 61.8 and 59.7 grams

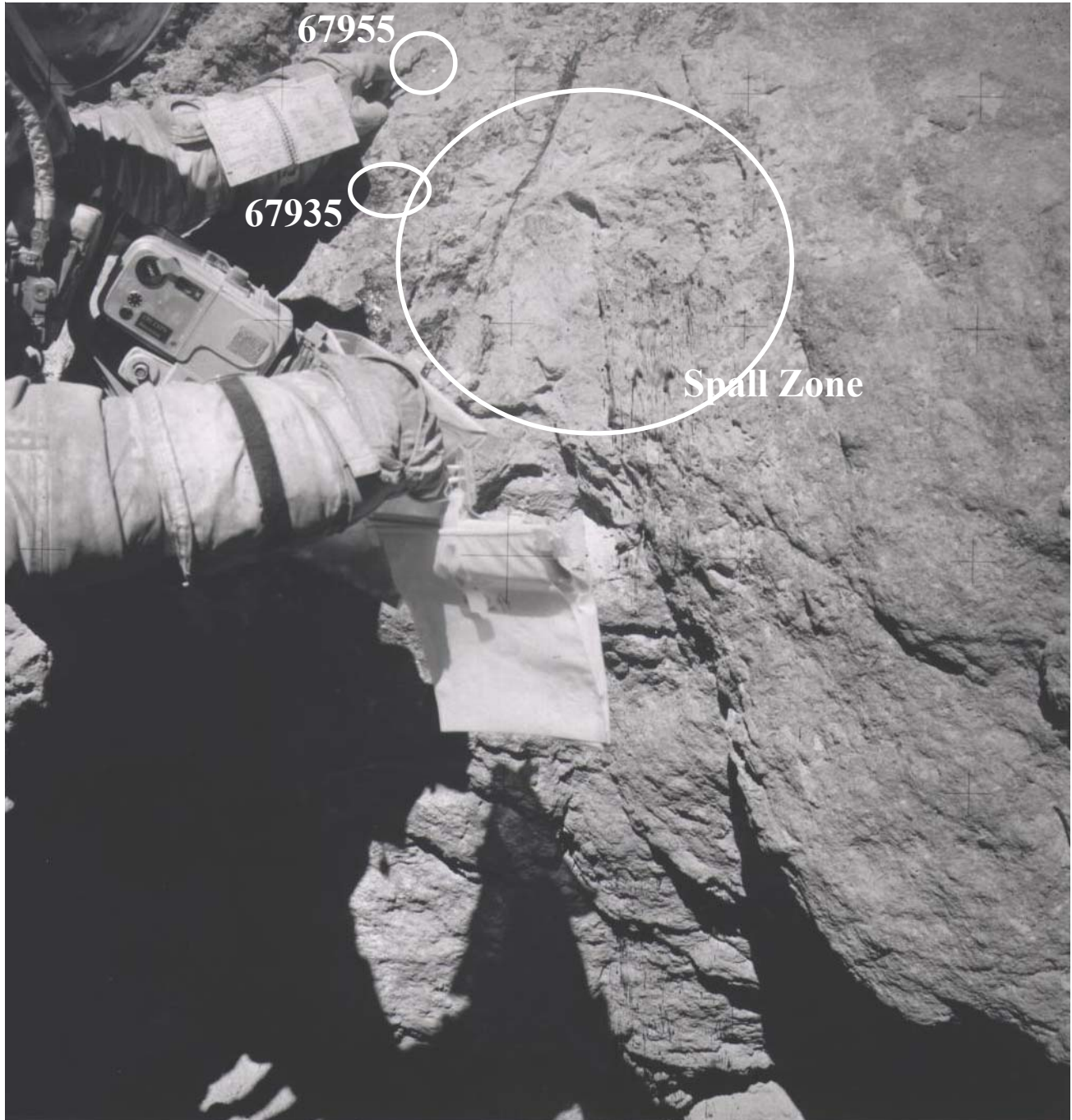


Figure 1: Outhouse Rock on rim of North Ray Crater. Note the spall zone, and sample locations. See also section on 67955. AS16-116-18649



Figure 2: Thin section photomicrograph of 67937,13 (field of view about 3 mm). From Ryder and Norman 1980

Introduction

The Apollo 16 astronauts sampled several areas on this side of Outhouse Rock (figure 1). Samples 67935, 67936 and 67937 were collected from the same area outside the spall zone of a large impact crater (shatter cone). Thin veins of black glass could be seen in the area sampled, and the samples contained this glass within a rather crushed matrix (figures 4 – 9).

Petrography

Ryder and Norman (1980) found that these samples of Outhouse Rock had the texture of fine-grained subophitic basalt (figure 2). They also noted that small clasts of plagioclase or “anorthosite” were included in the basaltic matrix. In general, these samples are poorly described.

Roedder and Weiblen (1977) made a detailed study the glass veins in Outhouse Rock, including rather thick veins in sample 67936. They concluded that the glass veins were probably made at time of excavation of Outhouse Rock from North Ray Crater.

Hunter and Taylor (1981) reported rust in 67935.

Mineralogy

In general, mineral data for 67935 has not been reported.

Chemistry

The chemical analysis shows high Al_2O_3 content for the “basaltic matrix”. Clarke and Keith (1973) and Eldridge et al. (1973) reported K, U and Th for these

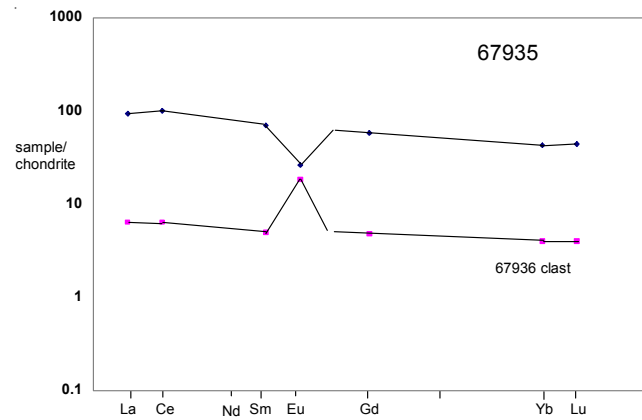


Figure 3: Normalized rare-earth-element diagram for matrix and clast in 67935 (see table).

three samples (table 1). Lindstrom and Salpus (1982) give analyses of the matrix and an aluminous clast (figure 3). Hertogen et al. (1977) determined trace elements, finding high Ni, Ir and Au.

Cosmogenic isotopes and exposure ages

Clarke and Keith (1973) reported the cosmic-ray-induced activity of ^{26}Al = for 67935 and 67936 respectively and Eldridge et al. (1973) reported the cosmic-ray-induced activity of ^{26}Al for 67937. Fruchter et al. (1978) determined the activity ^{26}Al = 51 dpm/kg. and ^{53}Mn = 156 dpm/kg. and discussed the age of the shatter cone.

Other Studies

Roedder and Weiblen (1977) reported rare gas content of veins and matrix of 67936.

Processing

There are 7 thin sections of 67935, 9 TS for 67936 and 5 TS for 67937. These friable samples were chipped, and not sawn.



Figure 4: Photo of 67935. Scale is in cm. NASA S72-53502

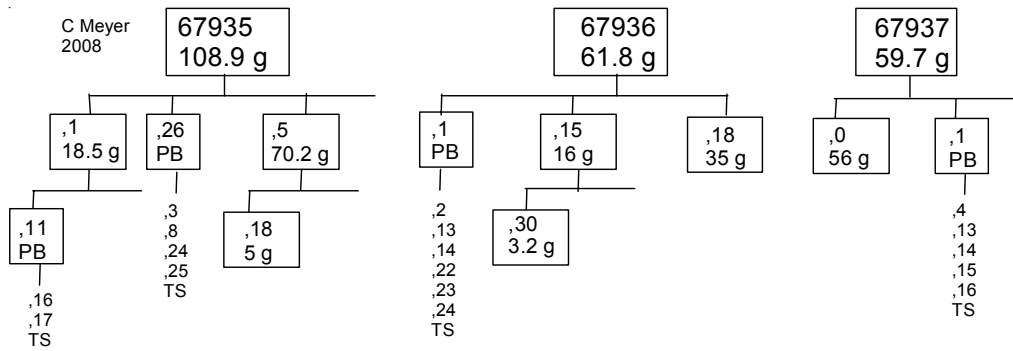


Figure 5: Close-up photo of 67937. Scale is in cm. S79-37057.



Figure 6: Processing photo of 67935,1. Cube is 1 cm. NASA S75-24301.



Figure 7: Processing photo of 67935,5. Cube is 1 cm. NASA S77-21523.

Table 1. Chemical composition of 67935.

reference	67935 Clarke73	67936 Clarke73	67937 Eldridge73 Eldridge75	67935 Hertogen77	67935 Lindstrom and Salpus 82	67936	
weight							
SiO2 %							
TiO2							
Al2O3					20.9	30.7	(c)
FeO					7.52	2.53	(c)
MnO							
MgO					12.6	3.2	(c)
CaO					13	18.1	(c)
Na2O					0.581	0.484	(c)
K2O	0.196	0.194	0.199	(a)			
P2O5							
S %							
sum							
Sc ppm					10.4	5	(c)
V							
Cr					1017	334	(c)
Co					43.6	6	(c)
Ni				659	(b) 695	44	(c)
Cu							
Zn				3.98	(b)		
Ga							
Ge ppb				633	(b)		
As							
Se				233	(b)		
Rb				6.07	(b)		
Sr					192	185	(c)
Y							
Zr							
Nb							
Mo							
Ru							
Rh							
Pd ppb				28.4	(b)		
Ag ppb				1.74	(b)		
Cd ppb				4.1	(b)		
In ppb				2.33	(b)		
Sn ppb							
Sb ppb				2.7	(b)		
Te ppb				8.4	(b)		
Cs ppm				0.325	(b)		
Ba					235	28	(c)
La					21.8	1.51	(c)
Ce					61.2	3.87	(c)
Pr							
Nd							
Sm					10.3	0.736	(c)
Eu					1.45	1.03	(c)
Gd							
Tb					2.1	0.173	(c)
Dy							
Ho							
Er							
Tm							
Yb					7	0.64	(c)
Lu					1.07	0.097	(c)
Hf					8.15	0.53	(c)
Ta					1.19	0.094	(c)
W ppb							
Re ppb				1.37	(b)		
Os ppb				13.9	(b)		
Ir ppb				12.9	(b)		
Pt ppb							
Au ppb				12.3	(b)		
Th ppm	2.9	3.12	3.24	(a)	3.88	0.2	(c)
U ppm	0.84	0.91	0.96	(a) 1	(b) 1.18	0.07	(c)

technique: (a) radiation counting, (B) RNAA, (c) INAA



Figure 8: Photo of 67936. Scale is in cm. NASA S72-53501.

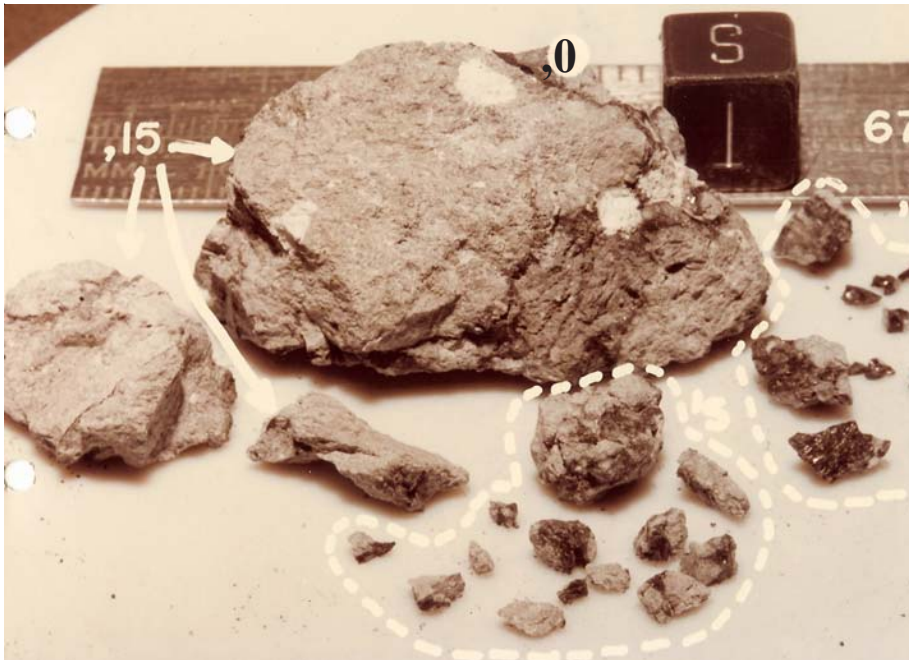


Figure 9: Photo of 67936,0 after splitting. Cube is 1 cm. NASA S74-33202.

References for 67935, 936, 937

- Clark R.S. and Keith J.E. (1973) Determination of natural and cosmic ray induced radionuclides in Apollo 16 lunar samples. Proc. 4th Lunar Sci. Conf. 2105-2113.
- 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.
- 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.
- 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.
- Lindstrom M.M. and Salpus P.A. (1982) Geochemical studies of feldspathic fragmental breccias and the nature of North Ray Crater ejecta. Proc. 13th Lunar Planet. Sci. Conf. A671-A683.
- LSPET (1972c) Preliminary examination of lunar samples. Apollo 16 Preliminary Science Report. NASA SP-315, 7-1—7-58.
- LSPET (1973b) The Apollo 16 lunar samples: Petrographic and chemical description. Science 179, 23-34.
- Maurer P., Eberhardt P., Geiss J., Grogler N., Stettler A., Brown G.M., Peckett A. and Krahenbuhl U. (1978) Pre-Imbrium craters and basins: ages, compositions and excavation depths of Apollo 16 breccias. Geochim. Cosmochim. Acta 42, 1687-1720.
- Roedder E. and Weiblen P.W. (1977b) Shock glass veins in some lunar and meteoritic samples – Their nature and possible origin. Proc. 8th Lunar Sci. Conf. 2593-2615.
- Ryder G. and Norman M.D. (1980) Catalog of Apollo 16 rocks (3 vol.). Curator's Office pub. #52, JSC #16904
- Stöffler D., Ostertag R., Reimold W.U., Borchardt R., Malley J. and Rehfeldt A. (1981) Distribution and provenance of lunar highland rock types at North Ray Crater, Apollo 16. Proc. 12th Lunar Planet. Sci. Conf. 185-207.
- Stöffler D., Bischoff A., Borchardt R., Burgehele A., Deutsch A., Jessberger E.K., Ostertag R., Palme H., Spettel B., Reimold W.U., Wacker K. and Wanke H. (1985) Composition and evolution of the lunar crust in the Descartes highlands. Proc. 15th Lunar Planet. Sci. Conf. in J. Geophys. Res. 90, C449-C506.
- Ulrich G.E. (1973) A geologic model for North Ray Crater and stratigraphic implications for the Descartes region. Proc. 4th Lunar Sci. Conf. 27-39.
- Ulrich G.E. (1981) Geology of North Ray Crater. In U.S. Geol. Survey Prof. Paper 1048, 45-81.
- Wilshire H.G., Stuart-Alexander D.E. and Schwarzman E.C. (1981) Petrology and distribution of returned samples, Apollo 16. in Geology of the Apollo 16 Area, Central Lunar Highlands. U.S. Geol. Survey Rpt