

15636
Olivine-normative Basalt
336.7 grams



Figure 1: Photo of 15636. NASA S87-45217. Cube is 1 inch.

Introduction

Lunar samples 15636 was collected by rake about 20 meters from Hadley Rille (Swann et al. 1971). At over 300 grams it is the largest of the rake samples. It is a coarse-grained olivine-normative basalt rather typical of Apollo 15. It has not been dated.

Petrography

The texture of 15636 could be described as microgabbroic (figure 2). Anhedral, elongate pyroxene

Mineralogical Mode for 15636

Olivine	18 %
Pyroxene	44.7
Plagioclase	26.3
Opaues	6.2
Mesostatis	1.5
Fayalite	1.9
Cristobalite	1.4

Shervais et al. 1990

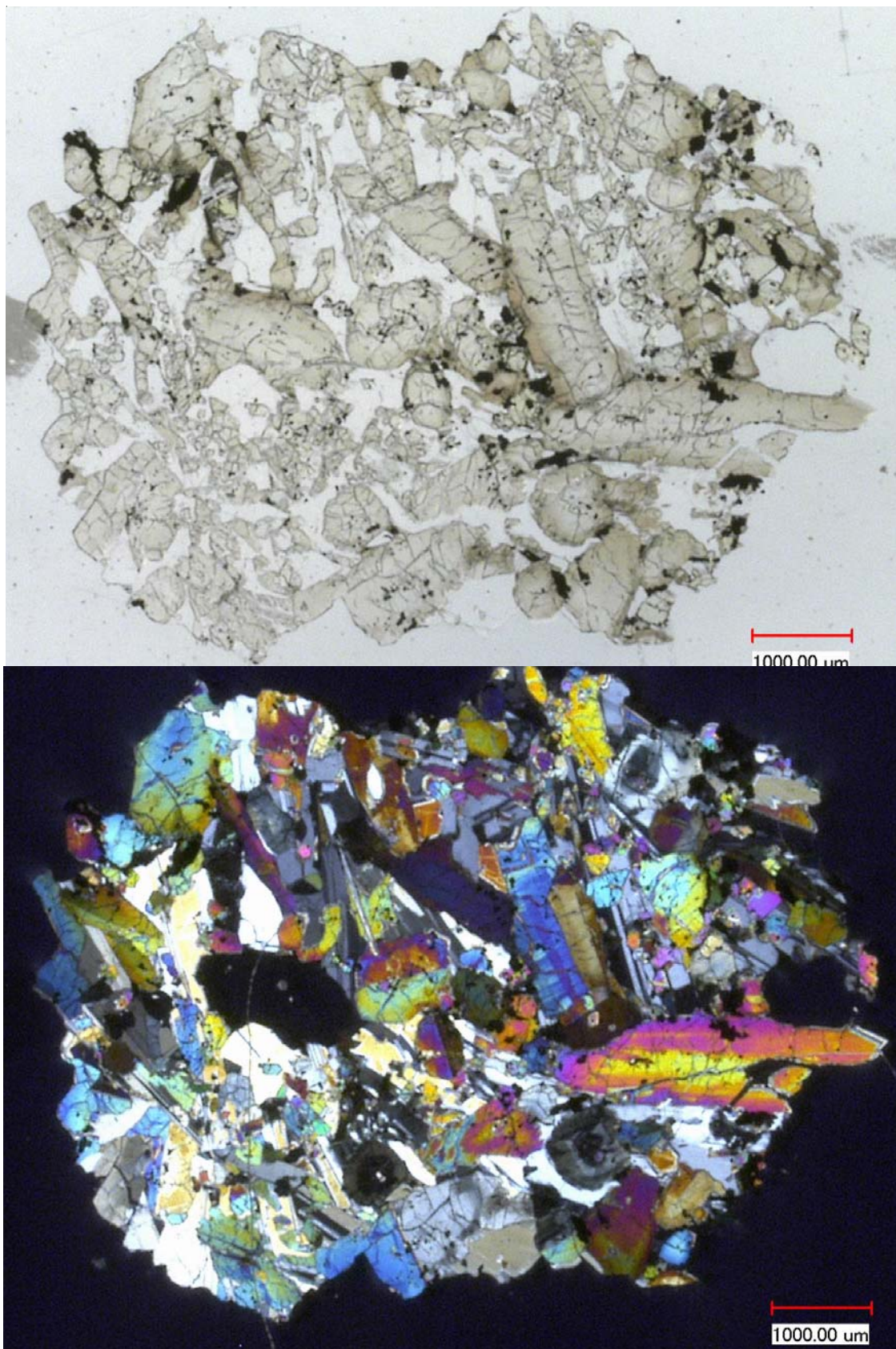


Figure 2: Photomicrographs of thin section 15636,9 by C Meyer @ 30x (bottom is with crossed polarizers).

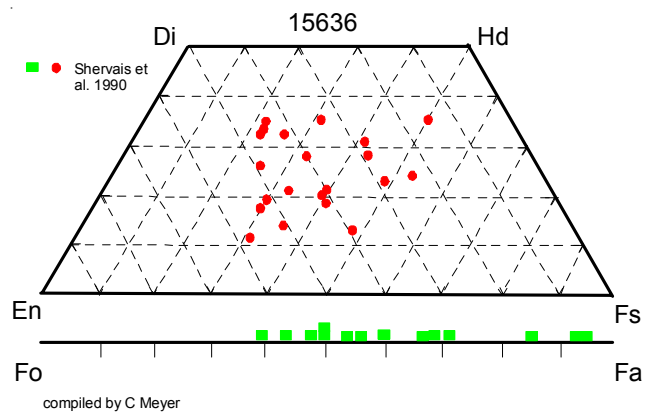


Figure 3: Composition of olivine and pyroxene in 15636 (Shervais et al. 1990).

is 1 to 3 mm, plagioclase is 1 to 2 mm, and larger embayed olivine phenocrysts are scattered throughout (figure 2). Residual phases include cristobalite, fayalite, troilite, ilmenite, ulvospinel and glass (Shervais et al. 1990). Chromite and silicate liquid inclusions are found in olivine. Ilmenite exsolution in ulvospinel is observed.

Shervais et al. (1990) describe an irregularity to the mode of 15636. Some areas are enriched in plagioclase and others in mafic minerals. Mesostasis clots up to 1 mm in size are found restricted to plagioclase-free places.

Shervais et al. (1990) determined the composition of olivine, pyroxene and plagioclase in 15636 (figure 3).

Chemistry

Chappell and Green (1973), Neal (2001), Ryder and Schuraytz (2001), report consistent results but the analysis by Shervais et al. (1990) is low in Al and too high in Fe.

Compston et al. (1972) reported the isotopic composition of Sr.

Other studies

Wolf et al. (1972) and Pearce et al. (1973) determined the magnetic properties.

Processing

This large sample has not been sawn and remains mostly intact. There are three small thin section.

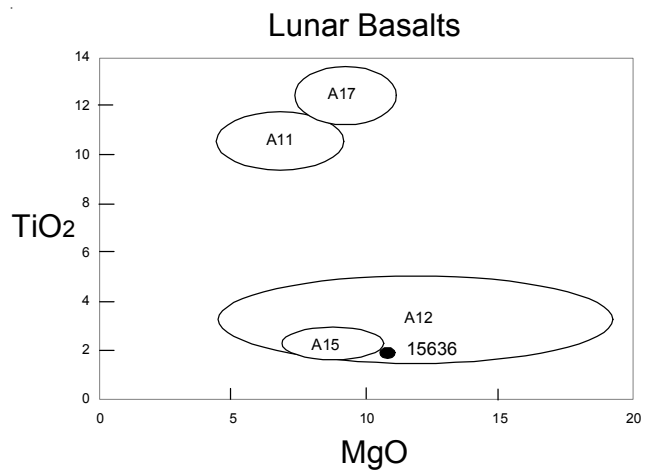


Figure 4: Chemical composition of 15636 compared with that of other lunar basalts.

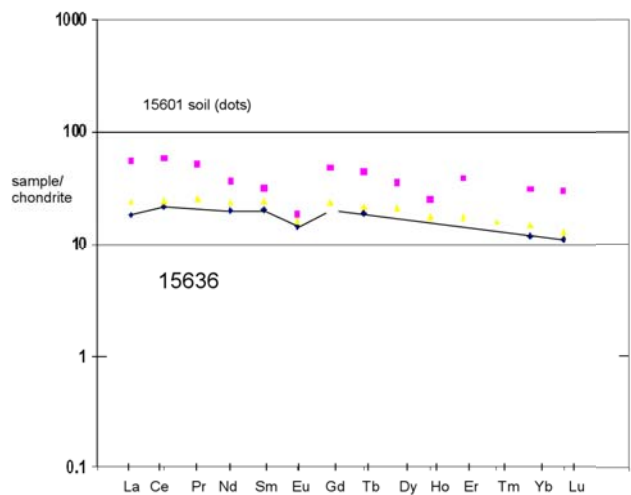


Figure 5: Normalized rare-earth-element diagram for 15636.

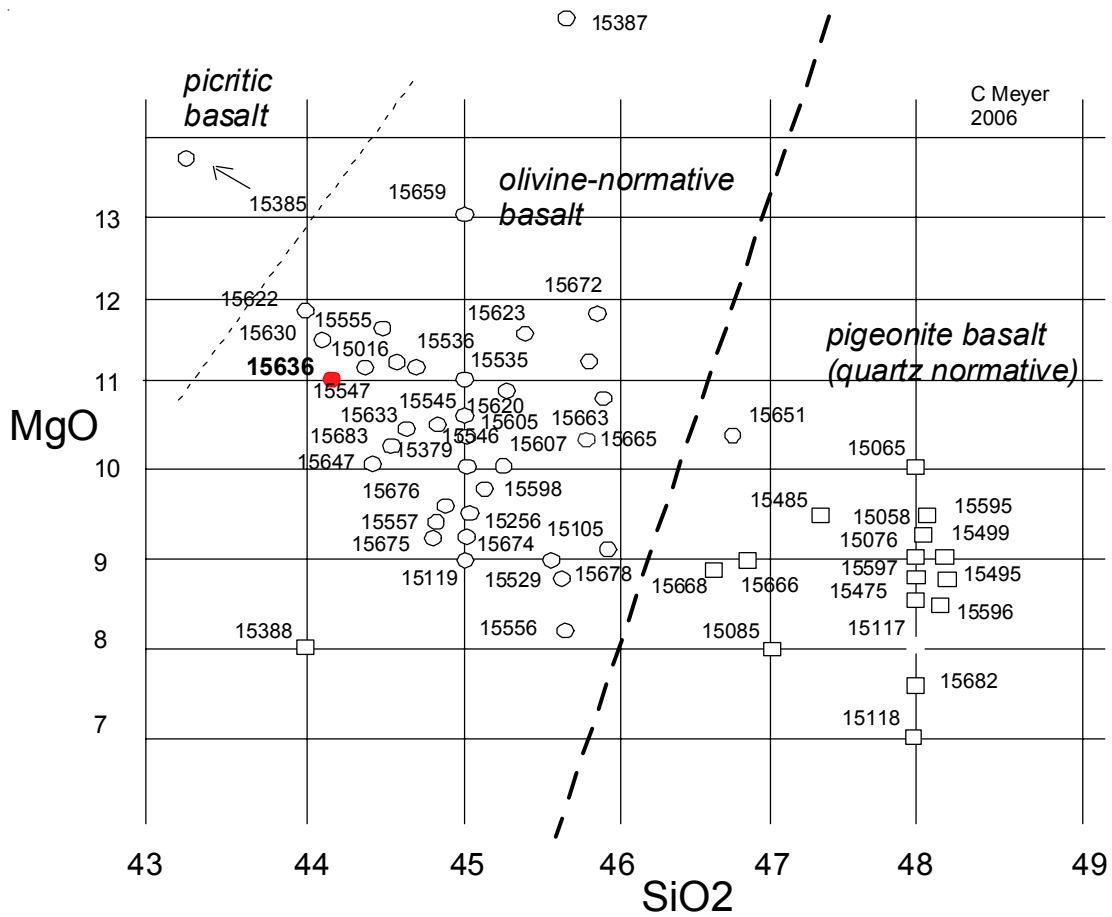


Figure 6: The big picture.

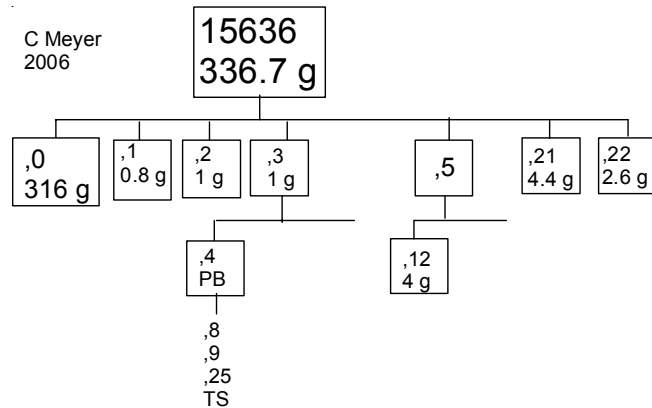


Table 1. Chemical composition of 15636.

reference weight	Chappell73	Ryder2001	Fruchter73	Shervais90	Neal2001
SiO ₂ %	44.58	(a) 44.6	(a)	43.8	(b)
TiO ₂	2.22	(a) 1.98	(a)	2.93	(b)
Al ₂ O ₃	8.55	(a) 9.44	(a)	9.82	(c) 5.87 (b)
FeO	22.67	(a) 21.26	(a) 21.3	(c) 19.55	(c) 26.38 (b) 26.8 (c)
MnO	0.31	(a) 0.27	(a)	0.33	(b)
MgO	11.32	(a) 11.39	(a)	10.72	(b)
CaO	9.58	(a) 9.4	(a)	9	(b)
Na ₂ O	0.26	(a) 0.23	(a) 0.26	(c) 0.25	(c) 0.17 (b) 0.198 (c)
K ₂ O	0.04	(a) 0.038	(a)	0.04	(b)
P ₂ O ₅	0.07	(a) 0.053	(a)	0.07	(b)
S %	0.05	(a)			
sum					
Sc ppm			39.5	(c) 35	(c) 46 (c) 41.4 (d)
V					222 (d)
Cr	3831	(a) 4546	(a) 4500	(c) 3540	(c) 4036 (b) 4225 (c) 5325 (d)
Co			56	(c) 52	(c) 55.6 (c) 70.2 (d)
Ni		64	(a) 86	(c)	90 (c) 99.6 (d)
Cu		6	(a)		13.7 (d)
Zn					17 (d)
Ga	2.9	(a)			3.78 (d)
Ge ppb					
As					
Se					
Rb	0.52	(a) 6	(a)		0.78 (d)
Sr	94.6	(a) 93	(a) 122	(c)	120 (c) 104.6 (d)
Y	21	(a) 22	(a)		26.1 (d)
Zr	77	(a) 75	(a)		180 (c) 116 (d)
Nb	6	(a) 8	(a)		6.3 (d)
Mo					0.07 (d)
Ru					
Rh					
Pd ppb					
Ag ppb					
Cd ppb					
In ppb					
Sn ppb					
Sb ppb					20 (d)
Te ppb					
Cs ppm					0.02 (d)
Ba			43	(c)	88 (c) 52.3 (d)
La			4.25	(c) 2.6	(c) 9.65 (c) 4.92 (d)
Ce			12.9	(c)	27.8 (c) 12.1 (d)
Pr					1.87 (d)
Nd			9	(c)	8.48 (d)
Sm			3.01	(c) 1.9	(c) 6.67 (c) 2.94 (d)
Eu			0.81	(c) 0.66	(c) 1.19 (c) 0.79 (d)
Gd					3.69 (d)
Tb			0.68	(c)	1.44 (c) 0.65 (d)
Dy					4.12 (d)
Ho					0.8 (d)
Er					2.19 (d)
Tm					0.3 (d)
Yb			1.92	(c) 1.3	(c) 3.84 (c) 1.86 (d)
Lu			0.27	(c) 0.22	(c) 0.532 (c) 0.25 (d)
Hf			2.26	(c) 1.3	(c) 4.89 (c) 2.79 (d)
Ta			0.31	(c)	0.69 (c) 0.41 (d)
W ppb					
Re ppb					
Os ppb					
Ir ppb					
Pt ppb					
Au ppb					
Th ppm			0.36	(c)	0.85 (c) 0.43 (d)
U ppm					0.19 (c) 0.12 (d)

technique: (a) XRF, (b) fused bead, electron probe, (c) INAA, (d) ICP-MS

References for 15636

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

Chappell B.W. and Green D.H. (1973) Chemical compositions and petrogenetic relationships in Apollo 15 mare basalts. *Earth Planet. Sci. Lett.* **18**, 237-246.

Compston W., de Laeter J.R. and Vernon M.J. (1972) Strontium isotope geochemistry of Apollo 15 basalts. In **The Apollo 15 Lunar Samples**, 347-351.

Dowty E., Prinz M. and Keil K. (1973b) Composition, mineralogy, and petrology of 28 mare basalts from Apollo 15 rake samples. *Proc. 4th Lunar Sci. Conf.* 423-444.

Fruchter J.S., Stoesser J.W., Lindstrom M.M. and Goles G.G. (1973) Apollo 15 clastic materials and their relationship to local geologic features. *Proc. 4th Lunar Sci. Conf.* 1227-1237.

Gose W.A., Pearce G.W., Strangway D.W. and Carnes J. (1972) Magnetism of Apollo 15 samples. In **The Apollo 15 Lunar Samples**, 415-417.

Lofgren G.E., Donaldson C.H. and Usselman T.M. (1975) Geology, petrology and crystallization of Apollo 15 quartz-normative basalts. *Proc. 6th Lunar Sci. Conf.* 79-99.

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.

Neal C.R. (2001) Interior of the moon: The presence of garnet in the primitive deep lunar mantle. *J. Geophys. Res.* **106**, 27865-27885.

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.

Ryder G. (1985) Catalog of Apollo 15 Rocks (three volumes). Curatorial Branch Pub. # 72, JSC#20787

Ryder G. and Schuraytz B.C. (2001) Chemical variations of the large Apollo 15 olivine-normative mare basalt rock samples. *J. Geophys. Res.* **106**, E1, 1435-1451.

Shervais J.W., Vetter S.K. and Lindstrom M.M. (1990) Chemical differences between small subsamples of Apollo 15 olivine-normative basalts. *Proc. 20th Lunar Planet. Sci. Conf.* 109-126. Lunar Planetary Institute, Houston.

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.