15605, 15606 and 15607

Olivine-normative Basalt

6.1, 10.1 and 14.8 grams

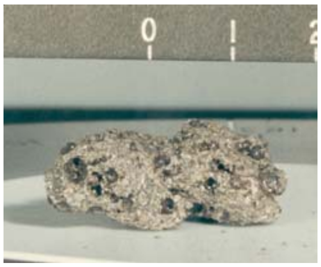


Figure 1: Photo of 15605. Scale is 1 cm. S71-44944.

Figure 2: Photo of 15606. Scale is in cm. S71-44940.

Figure 3: Photo of 15607. Scale is in cm. S71-44933.

Mineralogical Mode

Olivine	16 %
Pyroxene	47.8
Plagioclase	25.4
Opaques	6.4
Silica	0.6
Meostasis	1.4

Shervais et al. (1990)

Mineralogical Mode

Olivine	8
Pyroxene	56
Plagioclase	30
Opaques	5
Silica	1

Dowty et al. 1973

Introduction

15605, 15606 and 15607 are small fragments of Fe-rich mare basalt collected as >1 cm "walnuts" from largest soil sample 15600 (see section on 15600). They were supplemented by a large number of rake samples (see section on 15614 et.). 15605 is coarse-grained, 15606 is medium-grained and 15607 is fine-grained. 15606 is very vesicular. They are all examples of olivine-normative basalt with low silica content and with some olivine.

15607 has been dated at 3.27 ± 0.12 b.y.

Petrography

The texture of 15605, 15606 and 15607 is intergranular with numerous small olivine and pyroxene grains embedded in larger plagioclase (figure 4 – 6). Ryder (1985) terms 15605 "gabbroic", but with an average grain size of only 1 mm, it is too fine grained for that!

The olivines in these fragments are not phenocrysts and generally have pyroxene overgrowths. Some have chromite and Ni-Fe inclusions. Pyroxene is the dominant mineral and is chemically zoned. Plagioclase grains are lath-shapped and up to 2 mm long. Interstitial phases include fayalite, cristobalite, ilmenite, spinel, troilite and K-rich glass.

Mineralogy

Olivine: Shervais et al. (1990) reported 16% olivine chemically zoned Fo_{54-28}.

Pyroxene: Dowty et al. (1973) and Shervais et al. (1990) reported the composition of pyroxene (figures 4c and 6b). Pyroxene is chemically zoned towards Fe-enrichment.

Plagioclase: Dowty et al. (1973) and Shervais et al. (1990) measured the composition of plagioclase (An_{92-82}).

Metallic Iron: Dowty et al. (1973) reported iron grains with Ni = 4.3-7.7%, Co = 1.4 -1.8%.

Spinel: Chromites are zoned to ulvospinel (Dowty et al. 1973; Nehru et al. 1974).

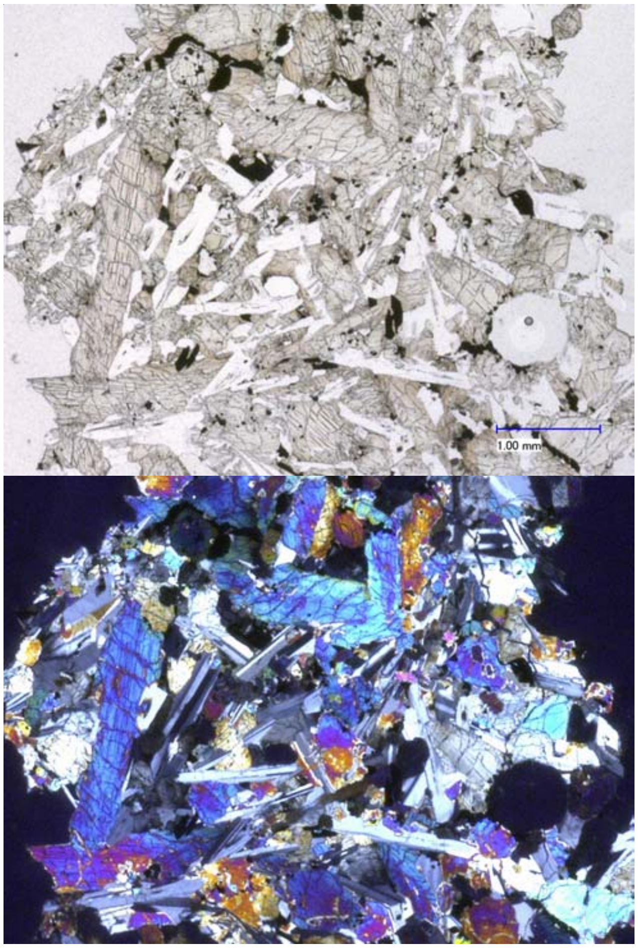


Figure 4a: Photomicrograph of thin section 15605,6 by C Meyer @ 50x.

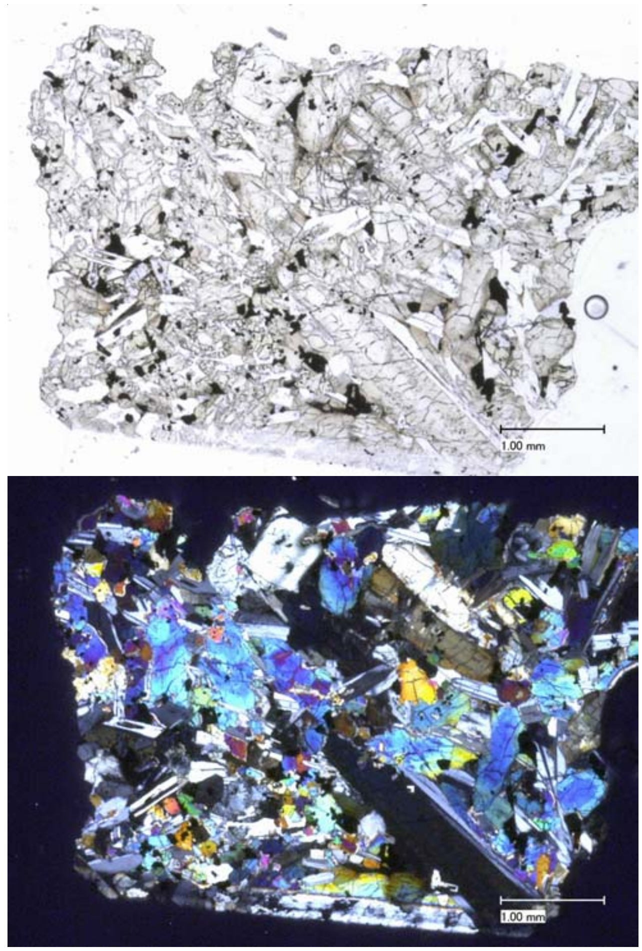


Figure 4b: Photomicrograph of thin section 15605,9 by C Meyer @50x.

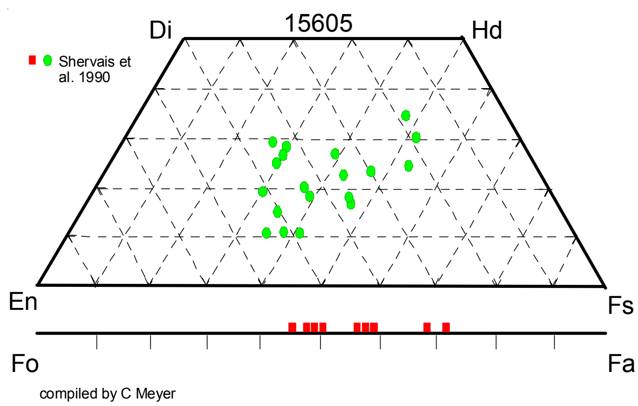


Figure 4c: Composition of olivine and pyroxene in 15605.

Chemistry

Shervais et al. (1990), Ryder and Schuratyz (2001), Christian et al. (1973), Ma et al. (1976) and 1978), Helmke et al. (1973), Laul and Schmitt (1973) and Neal (2001) have analyzed these fragments (see table and figures 7 and 8). Chemically, these three fragments are typical of the abundant olivine-normative basalts found at Apollo 15 (figure 9).

Radiogenic age dating

Husain (1974) reported a high temperature Ar/Ar plateau age of 3.27 ± 0.12 b.y. for 15607. Plieninger and Schaeffer (1976) tabulated laser probe data for individual phases.

Cosmogenic isotopes and exposure ages

Husain (1974) reported an exposure age of 300 m.y. for 15607.

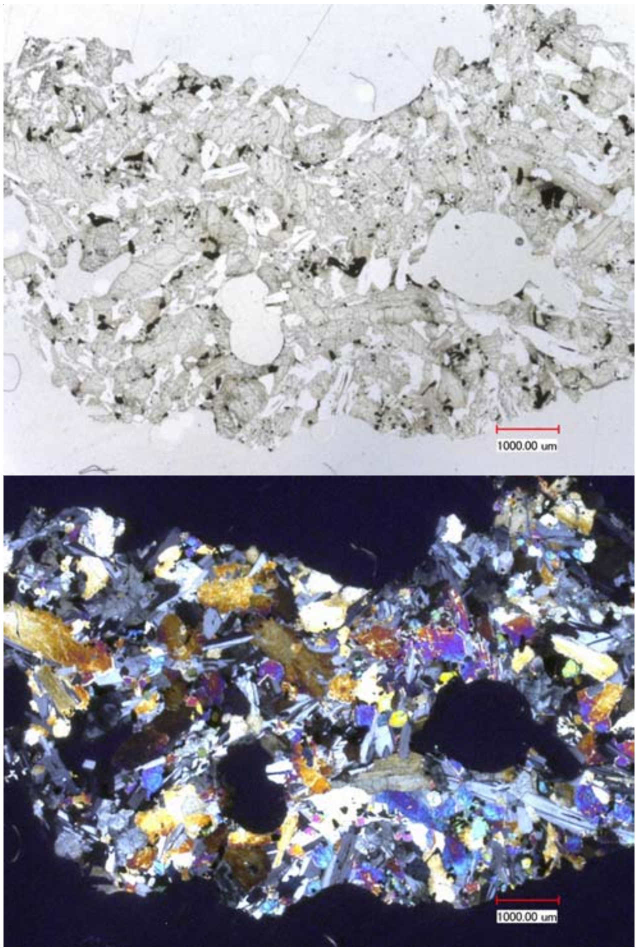


Figure 5: Photomicrographs of thin section 15606,6 by C Meyer @ 30x.

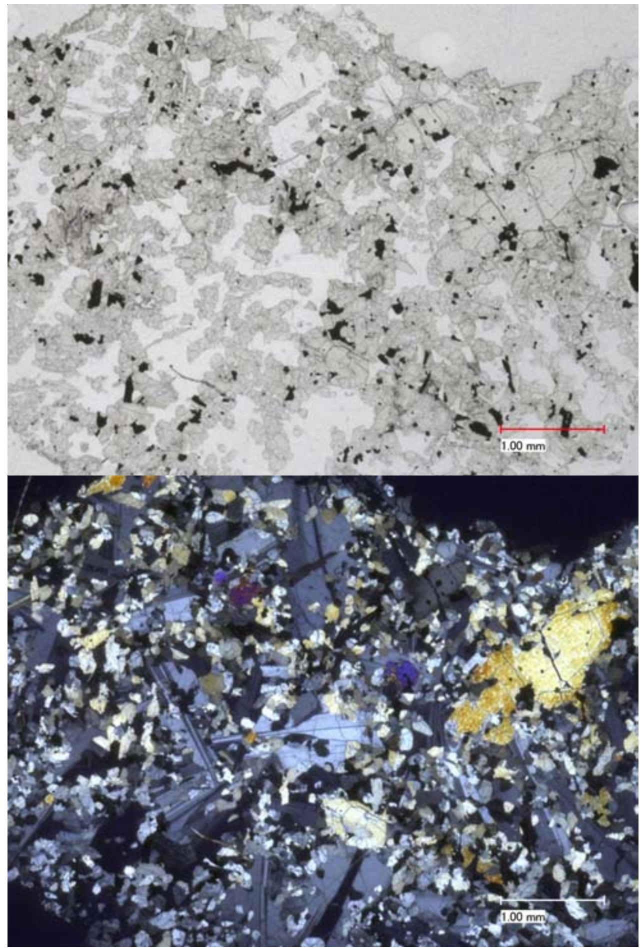


Figure 6a: Photomicrograph of thin section 15607,8 by C Meyer @50x.

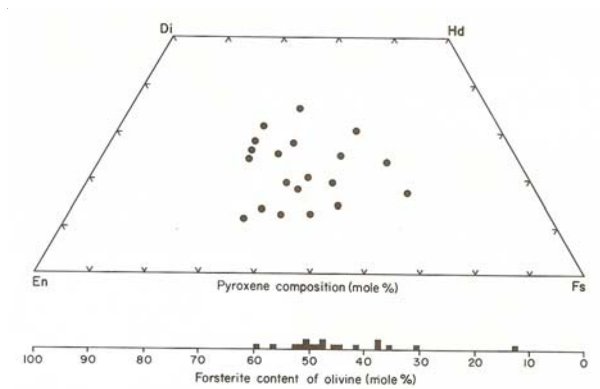


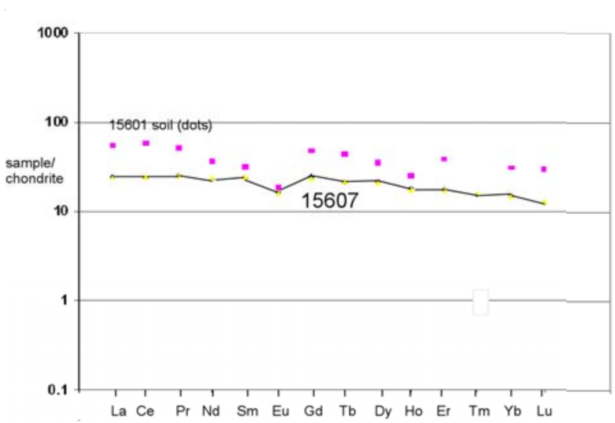
Figure 6b: Pyroxene and olivine composition of 15607 (from Dowty et al 1973).

Other Studies

Gose et al. (1972) and Pearce et al. (1973) have measured the natural magnetic intensity of A15 basalts including 15606.

Processing

There are three thin sections of 15605, two thin sections of 15606 and three thin sections of 15607.



Fugyre 7: Normalized rare-earth-element diagram for 15607, compared with 15601 soil.

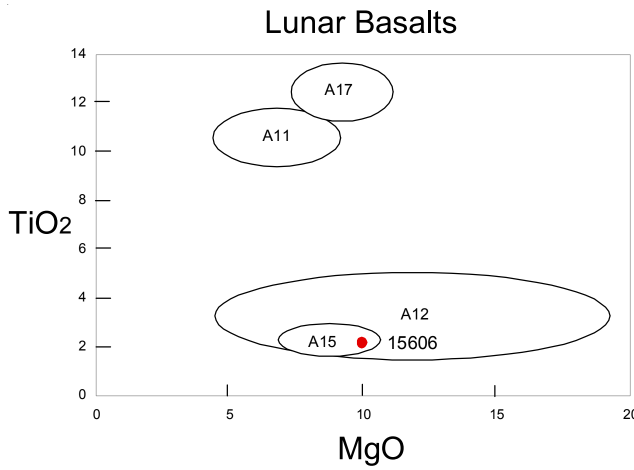


Figure 8: Composition of 15606 compared with other Apollo basalts.

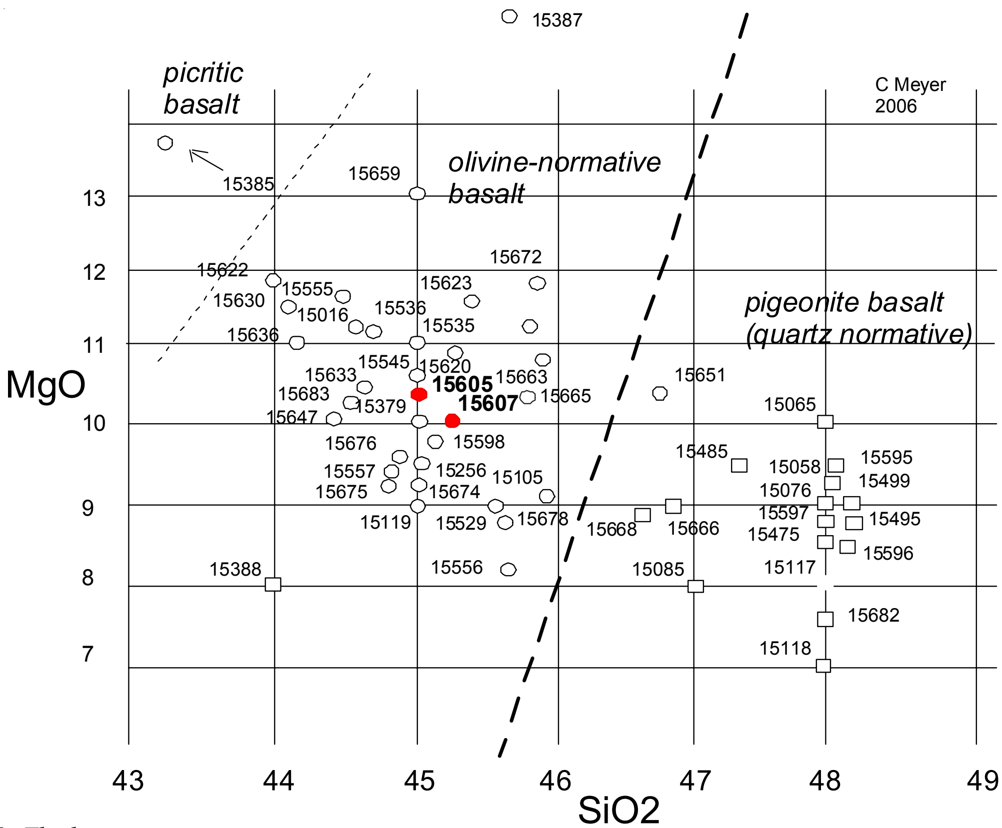
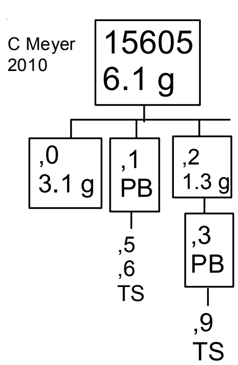
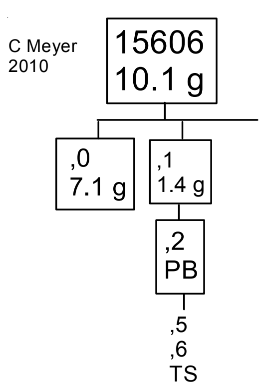


Figure 9: The big picture.





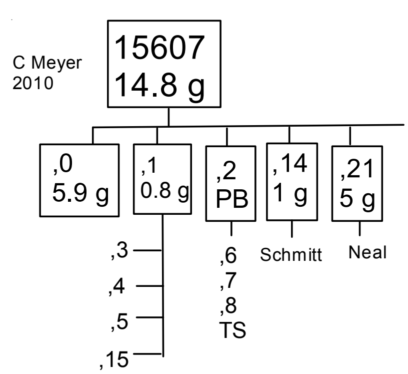


Table 1. Chemical composition of 15605, 15606 and 15607.

	15605		**15605**		**15606**		**15607**		**15607**		**15607**		**15607**		**15607**			**15607**	
reference	Ma78		Shervais90		Helmke73		Dowty73		Ryder2001		Neal2001		Christian73		Ma76			Laul73	
weight	0.5 g		A+B																
SiO2 %			45	(c)	47.7	(e)	44.6	(b)	45.2	(b)			45.55	(d)					
TiO2	2.1	(c)	2.27	(c)	2.51	(e)	2.58	(b)	2.45	(b)			2.51	(d)	2.4	2.6	(c)	2.4	(c)
Al2O3	9.1	(c)	8.14	(c)	8.72	(e)	8.8	(b)	9.01	(b)			8.55	(d)	9	9	(c)	8.9	(c)
FeO	22.3	(c)	22.5	(c)	22	(e)	22.3	(b)	22.23	(b)			22.33	(d)	23.3	23	(c)	23.7	(c)
MnO	0.268	(c)	0.32	(c)		(e)	0.24	(b)	0.28	(b)			0.29	(d)				0.27	(c)
MgO	11	(c)	10.46	(c)	10	(e)	9.7	(b)	9.95	(b)			9.96	(d)	11.1	11.1	(c)	10	(c)
CaO	10.1	(c)	9.92	(c)	9.56	(e)	9.8	(b)	9.83	(b)			10.1	(d)	8.9	8.9	(c)	10.2	(c)
Na2O	0.257	(c)	0.24	(c)	0.26	(e)	0.33	(b)	0.24	(b)			0.35	(d)	0.263	0.274	(c)	0.251	(c)
K2O	0.051	(c)	0.03	(c)	0.053	(e)	0.02	(b)	0.044	(b)			0.05	(d)	0.048	0.046	(c)	0.044	(c)
P2O5			0.06	(c)			0.09	(b)	0.065	(b)			0.08	(d)					
S %																			
sum																			
Sc ppm	42	(c)	44	(c)	41.8	(c)			43	(c)	47	(a)	44	(d)	40	40	(c)	38	(c)
V	232	(c)									213	(a)	185	(d)	194	213	(c)	200	(c)
Cr			4242	(c)	4610	(c)			4180	(c)	4269	(a)			3989	3900	(c)	3722	(c)
Co	51	(c)	50.6	(c)	49	(c)			54	(c)	62	(a)	60	(d)	48	46	(c)	50	(c)
Ni	40	(c)	55	(c)					65	(c)	67	(a)	51	(d)	37	73	(c)		
Cu									7		16	(a)	20	(d)					
Zn											20	(a)							
Ga					3.7	(c)					4	(a)	4.7	(d)					
Ge ppb																			
As																			
Se																			
Rb					0.71	(c)					0.99	(a)							
Sr			115	(c)					85		111	(a)	125	(d)					
Y									26	(c)	31	(a)	44	(d)					
Zr			130	(c)					88		99	(a)	75	(d)					
Nb									7		6.9	(a)							
Mo											0.03	(a)							
Ru																			
Rh																			
Pd ppb																			
Ag ppb																			
Cd ppb																			
In ppb																			
Sn ppb																			
Sb ppb											30	(a)							
Te ppb																			
Cs ppm					0.044	(c)					0.03	(a)							
Ba	45	(c)	51	(c)					49	(c)	59	(a)			38	55	(c)	50	(c)
La	5.4	(c)	5.7	(c)	5.56	(c)			4.98	(c)	5.62	(a)			5.3	5.1	(c)	5.8	(c)
Ce			15.9	(c)	14.3	(c)			14	(c)	14.4	(a)						15	(c)
Pr											2.24	(a)							(c)
Nd					11.9	(c)			10	(c)	10.3	(a)							(c)
Sm	3.6	(c)	4	(c)	3.84	(c)			3.61	(c)	3.44	(a)			3.5	3.4	(c)	3.2	(c)
Eu	0.84	(c)	0.945	(c)	0.92	(c)			0.89	(c)	0.91	(a)			0.77	0.74	(c)	1.1	(c)
Gd					4.8	(c)					4.79	(a)							(c)
Tb	0.7	(c)	0.91	(c)	0.8	(c)			0.78	(c)	0.77	(a)			0.76	0.65	(c)	0.8	(c)
Dy	4.5	(c)			5.6	(c)					5.17	(a)			5.5	3.4	(c)	4.8	(c)
Ho					1.09	(c)					1	(a)							(c)
Er					3.2	(c)					2.77	(a)							(c)
Tm											0.37	(a)							(c)
Yb	2.3	(c)	2.47	(c)	2.45	(c)			2.23	(c)	2.42	(a)			2.3	2.3	(c)	2.6	(c)
Lu	0.29	(c)	0.341	(c)	0.34	(c)			0.31	(c)	0.3	(a)			0.38	0.38	(c)	0.39	(c)
Hf	2.5	(c)	3	(c)	3.4	(c)			2.69	(c)	2.56	(a)			2.9	2.7	(c)	3.3	(c)
Ta	0.45	(c)	0.42	(c)					0.38	(c)	0.51	(a)			0.47	0.43	(c)	0.7	(c)
W ppb											40	(a)							
Re ppb																			
Os ppb																			
Ir ppb																			
Pt ppb																			
Au ppb																			
Th ppm			0.45	(c)					0.4	(c)	0.51	(a)							
U ppm			0.17	(c)							0.14	(a)							

technique: (a) ICP-MS, (b) broad beam e-probe, (c) INAA, (d) microchem, (e) AA

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