15610, 15633, 15641, 15643 and 15663

Coarse Olivine-normative Basalt

1.5, 7.4, 6.9, 17.9 and 10.5 grams

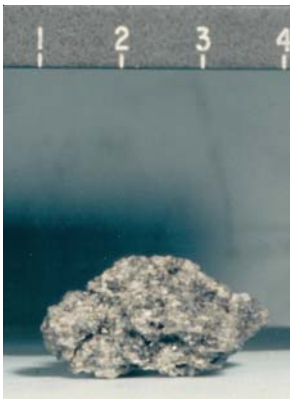

Figure 1: Photo of 15633. Scale is in cm. S71-49291.

Figure 2: Photo of 15641. Cube is 1 cm. S71-49555.

Figure 3: Photo of 15643. Cube is 1 cm. S71-49783.

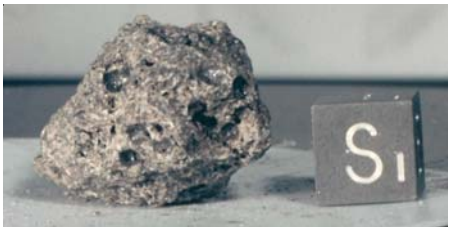

Figure 4: Photo of 15663. Cube is 1 cm. S71-49717.

Introduction

These small samples of coarse mare basalt were collected from near the Hadley Rille at station 9a. 15610 is a "walnut" (>1 cm) from the large 15600 soil, while the other particles are rake samples from an adjacent area. There is evidence for olivine addition/ subtraction to the liquid composition (see section on 15614).

15663 was dated at 3.26 b.y.

Petrography

Rake fragments 15610, 15633, 15641, 15643 and 15663 are grouped together because they are *relatively* coarse-grained samples of the abundant olivine-normative Apollo 15 basalt clan (typical example 15546). *However, "coarse" may not be the appropriate word, because their average grain size is only about 1 mm.*

Most olivine grains are less than 1 mm; the larger ones contain silicate melt inclusions. Pyroxene grains are up to 2 mm and somewhat elongate. They are chemically zoned from pigeonite to Fe-rich augite. Plagioclase grains up to 3 mm, poikilitically enclose small pyroxene, otherwise intergrown with pyroxene. Chromite is found in pyroxene and is overgrown with

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Mineralogical Mode

	15610	15633	15641	15643	15663
Olivine	13 %	18	17	13	8
Pyroxene	51	52	52	60	58
Plagioclase	25	21	26	21	27
Opaques	8	6	6	4	6
Silica	0.6	1	0.3	0.5	1
Meostasis	2.4	2	0.7	1.5	

Dowty et al. 1973

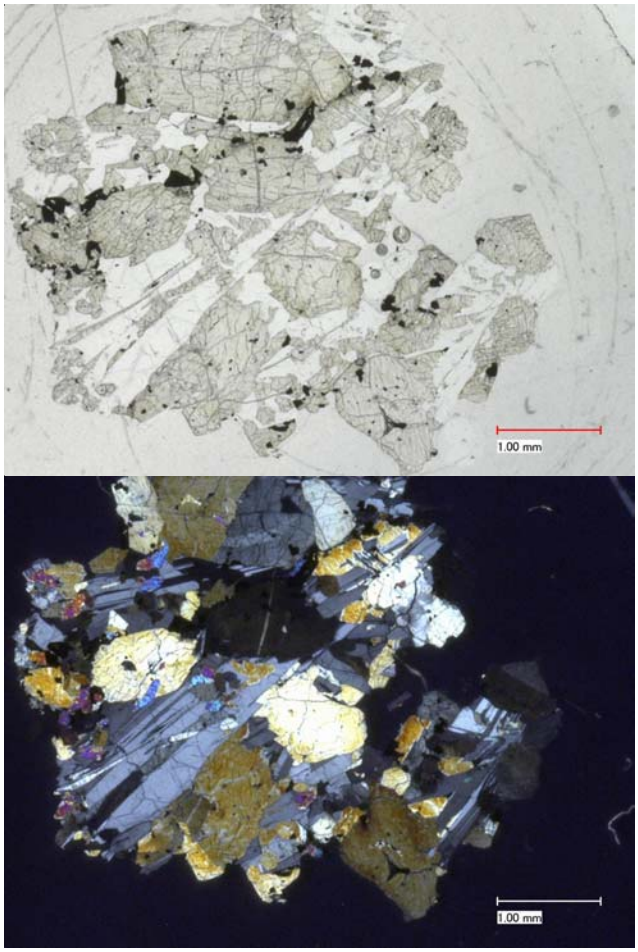

Figure 5a: Photomicrographs of thin section 15610,6 by C Meyer @ 50x.

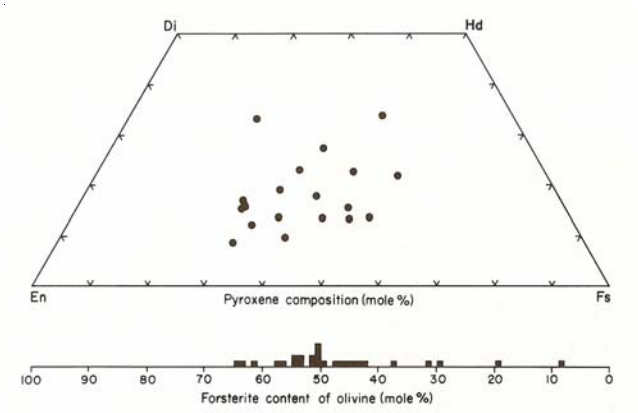

Figure 5b: Pyroxene and olivine composition of 15610,6 (Dowty et al. 1973).

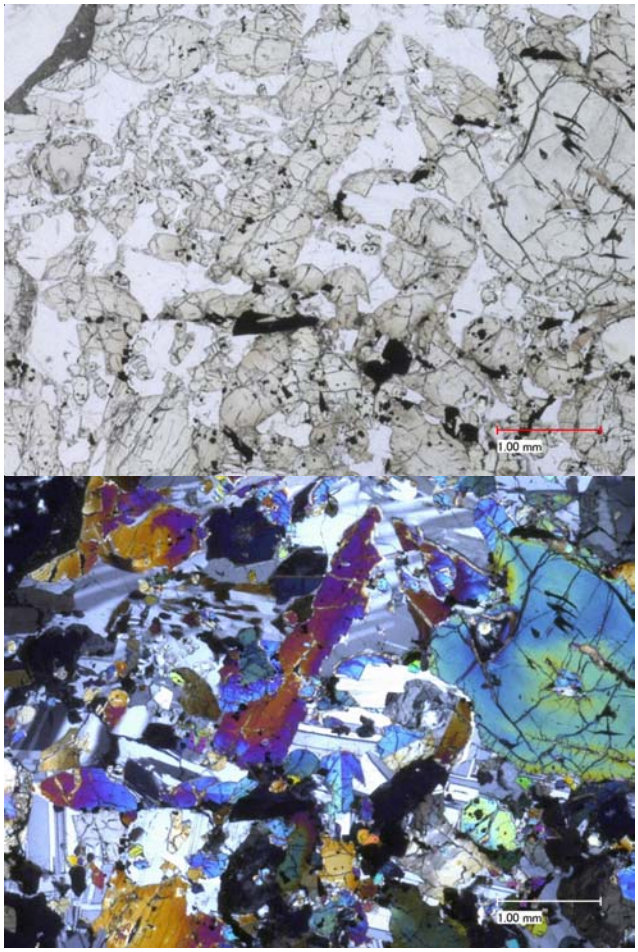

Figure 6a: Photomicrographs of thin section 15633,3 by C Meyer @ 50x.

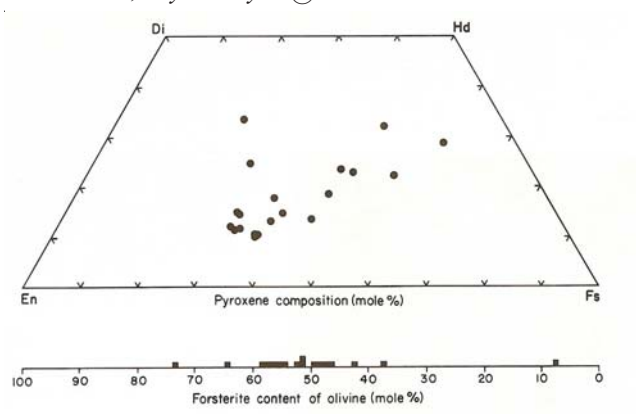

Figure 6b: Pyroxene and olivine composition of 15633 (Dowty et al. 1973).

ulvospinel when it is interstitial. Minor phases include cristobalite, fayalite, ilmenite, troilite, Ni-Co-Fe metal and Fe-rich glass (Nehru et al. 1974). Dowty et al. (1973) provided microanalyses of olivine, pyroxene and plagioclase (figures 5 -9).

Chemistry

The bulk analyses of 15610, 15633, 15641, 15643 and 15663 are all similar to other olivine-normative Apollo 15 basalts (tables, figure 12). The trace element content is always the same (figure 11). However, the variation in Mg content and Fe/Mg ration indicates addition of various amounts of cumulate olivine (figure 10).

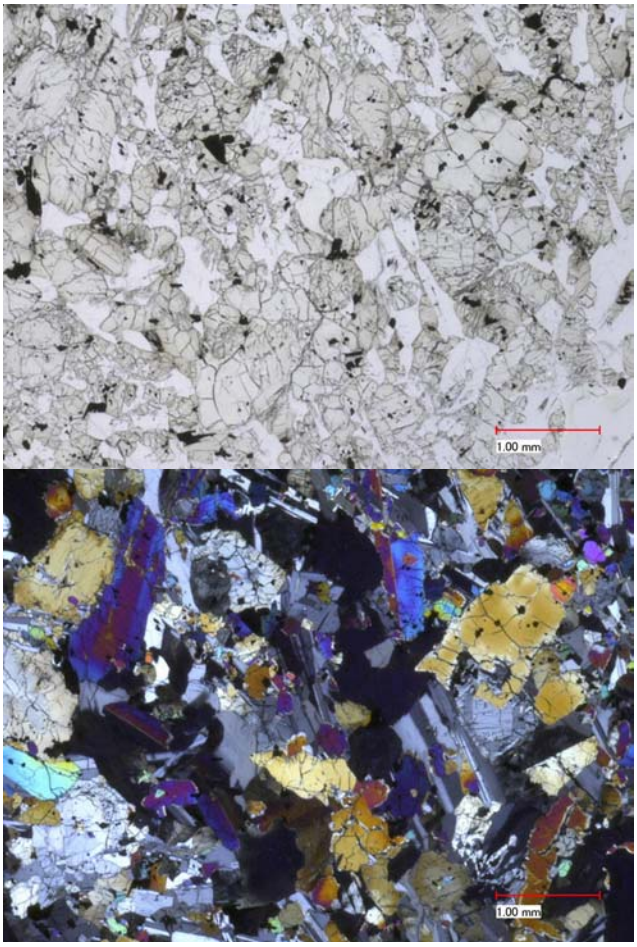

Figure 7a: Photomicrographs of thin section 15641,8 by C Meyer @ 50x.

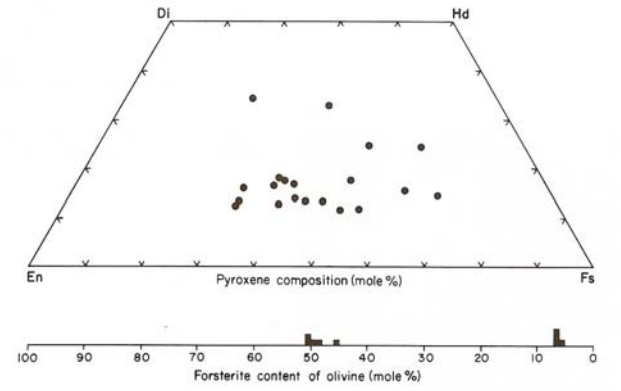

Figure 7b: Pyroxene and olivine composition of 15641 (Dowty et al. 1973).

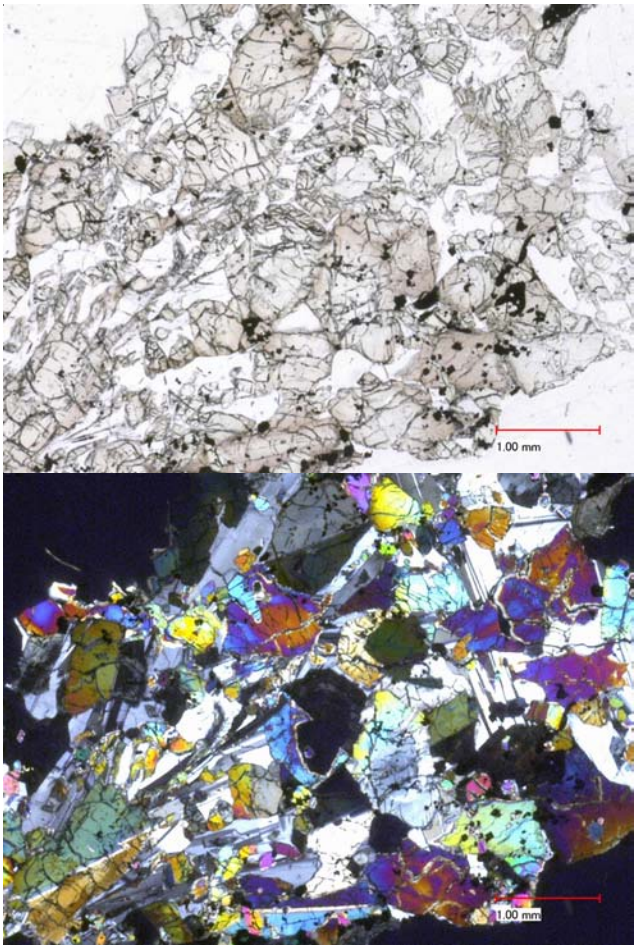

Figure 8a: Photomicrographs of thin setion 15463,15 by C Meyer @50x (bottom is with crossed polarizers).

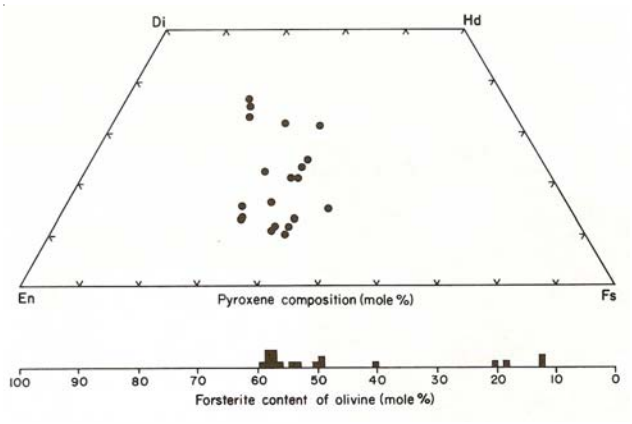

Figure 8b: Pyroxene and olivine composition of 15643 (Dowty et al. 1973).

Radiogenic age dating

15633 has been dated by the Ar/Ar plateau technique at 3.26 ± 0.05 b.y. (Husain 1974) (figure 13).

Cosmogenic isotopes and exposure ages

Husain (1974) determined an exposure age of 66 m.y. for 15633 by ^{38}Ar.

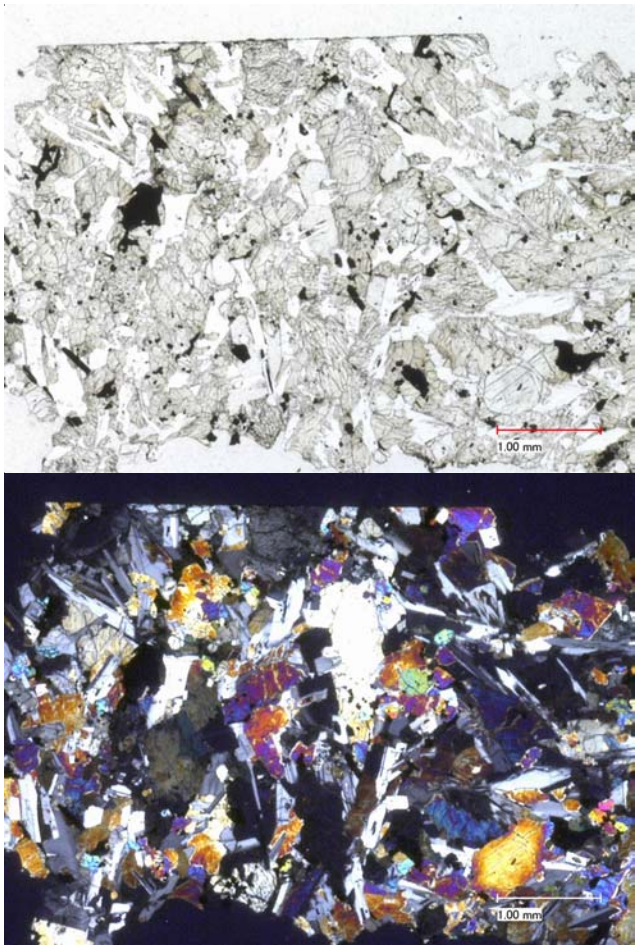

Figure 9a: Photomicrographs of thin section 15663,11 by C Meyer @ 50 x (bottom is with crossed polarizers).

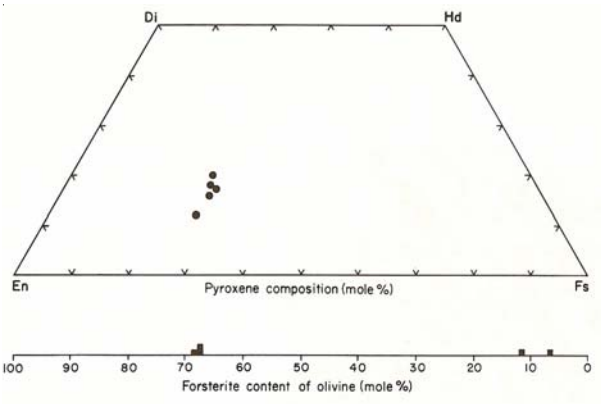

Figure 9b: Pyroxene and olivine composition of 15633 (Dowty et al. 1973).

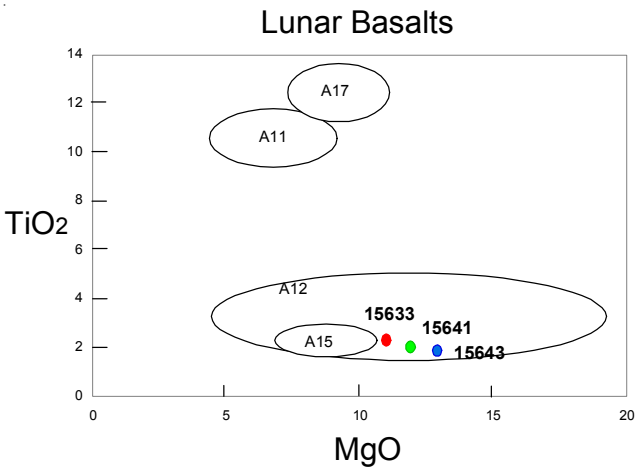

Figure 10: Chemical compostio of 15633, 15641 and 15643, compared with other Apollo basalts.

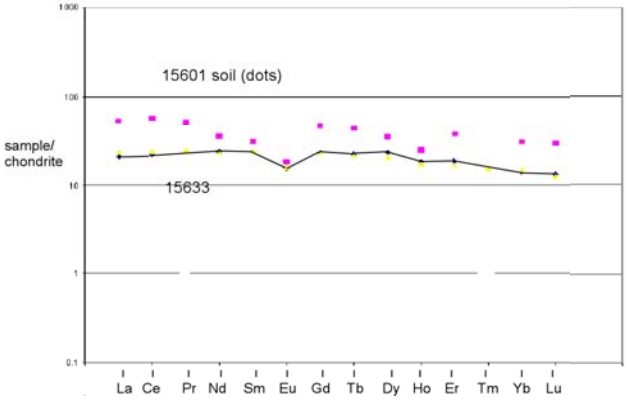

Figure 11: Normalized rare-earth-element diagram for 15633, compared with soils sample 15601.

Other Studies

Poupeau et al. (1972) studied solar flare tracks in 15641.

Processing

15663 was sawn.

There are 2 thin sections of 15610, 2 thin sections of 15633, 3 thin sections of 15641, 2 thin sections of 15643 and 4 thin sections of 15663.

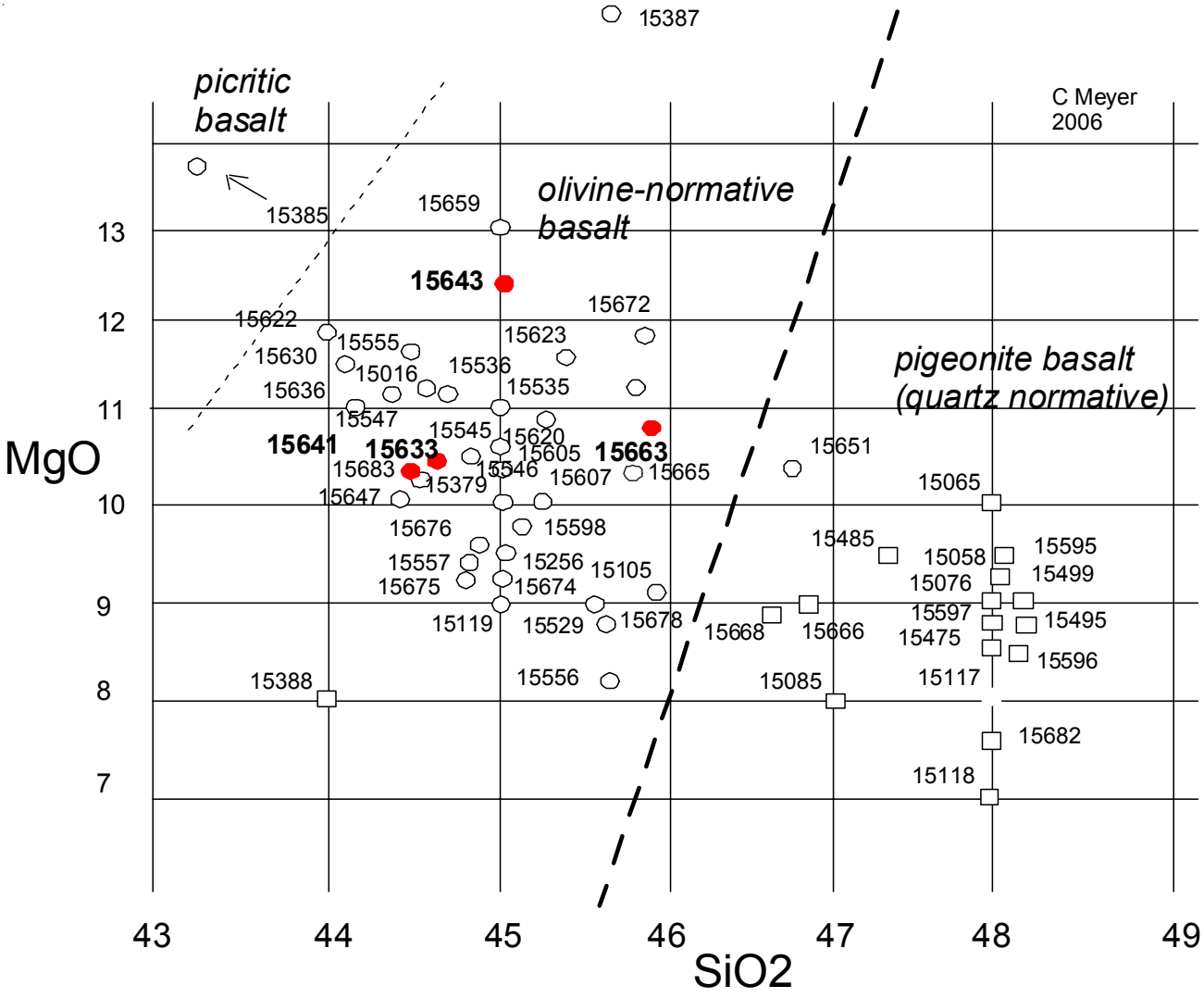

Figure 12: The really big picture.

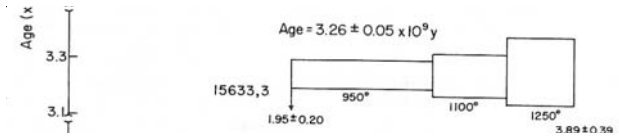

Figure 13: Ar/Ar plateau diagrams for 15633 (Husain).

Table 1. Chemical composition of 15633.

reference	Helmke73		Ryder88		Ma76		Dowty73	
weight								
SiO2 %			44.6	(b)			46.4	(c)
TiO2			2.7	(b)	2.2	(a)	1.28	(c)
Al2O3			8.5	(b)	8.8	(a)	8.5	(c)
FeO			23	(b)	23	(a)	22.2	(c)
MnO	0.3	(a)	0.35	(b)	0.269	(a)	0.28	(c)
MgO			10.5	(b)	11.1	(a)	12.7	(c)
CaO			9.1	(b)	9.3	(a)	8.6	(c)
Na2O			0.26	(b)	0.247	(a)	0.27	(c)
K2O					0.033	(a)	0.02	(c)
P2O5			0.11	(b)			0.05	(c)
S %								
sum								
Sc ppm	47	(a)	41.1	(a)	41	(a)		
V					225	(a)		
Cr	3930	(a)	3963	(a)	4092	(a)	3216	(c)
Co	56	(a)	54	(a)	50	(a)		
Ni					101	(a)		
Cu								
Zn								
Ga	2.9	(a)						
Ge ppb								
As								
Se								
Rb	0.5	(a)						
Sr								
Y								
Zr								
Nb								
Mo								
Ru								
Rh								
Pd ppb								
Ag ppb								
Cd ppb								
In ppb								
Sn ppb								
Sb ppb								
Te ppb								
Cs ppm								
Ba					45	(a)		
La	4.93	(a)	4.93	(a)	4.3	(a)		
Ce	13.4	(a)	12.8	(a)				
Pr								
Nd	10.8	(a)						
Sm	3.54	(a)	3.38	(a)	2.9	(a)		
Eu	0.88	(a)	0.844	(a)	0.74	(a)		
Gd	4.6	(a)						
Tb	0.81	(a)	0.8	(a)	0.6	(a)		
Dy	5.7	(a)			4.2	(a)		
Ho	1.04	(a)						
Er	3	(a)						
Tm								
Yb	2.26	(a)	2.01	(a)	1.8	(a)		
Lu	0.328	(a)	0.323	(a)	0.36	(a)		
Hf	2.5	(a)	2.39	(a)	2.3	(a)		
Ta					0.38	(a)		
W ppb								
Re ppb								
Os ppb								
Ir ppb								
Pt ppb								
Au ppb								
Th ppm			0.45	(a)				
U ppm								

technique: (a) INAA, (b) fused-bead e-probe, (c) broad-beam e-probe

Table 2. Chemical composition of 15641.

reference	Dowty73		Ma78		Ryder88	
weight						
SiO2 %	44.4	(b)			46.5	(c)
TiO2	2.18	(b)	1.9	(a)	1.9	(c)
Al2O3	10.1	(b)	8.8	(a)	9.3	(c)
FeO	21.3	(b)	21.9	(a)	21.2	(c)
MnO	0.24	(b)			0.38	(c)
MgO	10.2	(b)	12	(a)	11.1	(c)
CaO	9.7	(b)	9.2	(a)	9.9	(c)
Na2O	0.37	(b)	0.252	(a)	0.34	(c)
K2O	0.06	(b)	0.034	(a)	0.09	(c)
P2O5	0.07	(b)				
S %						
sum						
Sc ppm			37	(a)	37.4	(a)
V			212	(a)		
Cr			4110	(a)	3749	(a)
Co			52	(a)	53	(a)
Ni			75	(a)		
Cu						
Zn						
Ga						
Ge ppb						
As						
Se						
Rb						
Sr						
Y						
Zr						
Nb						
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm						
Ba			55	(a)		
La			4.4	(a)	4.03	(a)
Ce					11.8	(a)
Pr						
Nd						
Sm			3.1	(a)	2.8	(a)
Eu			0.77	(a)	0.769	(a)
Gd						
Tb			0.6	(a)	0.65	(a)
Dy			3.5	(a)		
Ho						
Er						
Tm						
Yb			1.9	(a)	1.82	(a)
Lu			0.26	(a)	0.264	(a)
Hf			2.3	(a)	1.91	(a)
Ta			0.39	(a)		
W ppb						
Re ppb						
Os ppb						
Ir ppb						
Pt ppb						
Au ppb						
Th ppm					0.47	(a)
U ppm						

technique: (a) INAA, (b) broad-beam e-probe, (c) fused-bead e-probe

Table 3. Chemical composition of 15643.

reference	Dowty73		Laul73		Cuttitta73		Ryder78	
weight								
SiO2 %	45.4	(a)			44.8	(c)	45.8	(d)
TiO2	1.87	(a)	1.1	(b)	2.01	(c)	1.98	(d)
Al2O3	7.2	(a)	10	(b)	9.08	(c)	8.8	(d)
FeO	23.7	(a)	23.1	(b)	21.28	(c)	22.2	(d)
MnO	0.27	(a)	0.26	(b)	0.28	(c)	0.35	(d)
MgO	12.5	(a)	13	(b)	12.2	(c)	11.5	(d)
CaO	8.6	(a)	9	(b)	9.48	(c)	9.4	(d)
Na2O	0.25	(a)	0.27	(b)	0.27	(c)	0.29	(d)
K2O	0.03	(a)	0.018	(b)	0.05	(c)		
P2O5	0.07	(a)			0.09	(c)	0.11	(d)
S %								
sum								
Sc ppm			30	(b)	32	(c)	39.2	(b)
V			150	(b)	156	(c)		
Cr			3038	(b)			3718	(b)
Co			57	(b)	74	(c)	54	(b)
Ni					145	(c)		
Cu					8.6	(c)		
Zn								
Ga					4.1	(c)		
Ge ppb								
As								
Se								
Rb								
Sr					140	(c)		
Y					23	(c)		
Zr			<170	(b)	59	(c)		
Nb								
Mo								
Ru								
Rh								
Pd ppb								
Ag ppb								
Cd ppb								
In ppb								
Sn ppb								
Sb ppb								
Te ppb								
Cs ppm								
Ba			60	(b)	43	(c)		
La			2.4	(b)			4.6	(b)
Ce			7.6	(b)			12.1	(b)
Pr								
Nd								
Sm			1.8	(b)			2.92	(b)
Eu			0.82	(b)			0.81	(b)
Gd								
Tb			0.3	(b)			0.79	(b)
Dy			2.3	(b)				
Ho								
Er								
Tm								
Yb			1.3	(b)			1.98	(b)
Lu			0.2	(b)			0.293	(b)
Hf			1.1	(b)			2.1	(b)
Ta			0.2	(b)				
W ppb								
Re ppb								
Os ppb								
Ir ppb								
Pt ppb								
Au ppb								
Th ppm							0.612	
U ppm								

technique: (a) broad beam e-probe, (b) INAA, (c) "microchemical", (d) fused-bead e-porbe

Table 4. Chemical composition of 15663.

reference	Helmke73		Ryder88			Dowty73	
weight							
SiO2 %			45.8		(b)	44.5	(c)
TiO2			2.05		(b)	2.89	(c)
Al2O3			8.3		(b)	8.4	(c)
FeO			21.8	22.3	(b)	22.2	(c)
MnO	0.28	(a)	0.34		(b)	0.26	(c)
MgO			10.8		(b)	10.3	(c)
CaO			9.1		(b)	10.1	(c)
Na2O			0.23	0.25	(b)	0.37	(c)
K2O						0.08	(c)
P2O5			0.1		(b)	0.07	(c)
S %							
sum							
Sc ppm	47	(a)	39.9	44.6	(a)		
V							
Cr	3930	(a)	3865	4333	(a)		
Co	56	(a)	53.7	54.7	(a)		
Ni							
Cu							
Zn							
Ga	2.9	(a)					
Ge ppb							
As							
Se							
Rb	0.5	(a)					
Sr							
Y							
Zr							
Nb							
Mo							
Ru							
Rh							
Pd ppb							
Ag ppb							
Cd ppb							
In ppb							
Sn ppb							
Sb ppb							
Te ppb							
Cs ppm	0.017	(a)					
Ba							
La	4.93	(a)	4.81	5.23	(a)		
Ce	13.4	(a)	11.2	15.4	(a)		
Pr							
Nd	10.8	(a)					
Sm	3.54	(a)	3.2	3.52	(a)		
Eu	0.88	(a)	0.813	0.867	(a)		
Gd	4.6	(a)					
Tb	0.81	(a)	0.814	0.888	(a)		
Dy	5.7	(a)					
Ho	1.04	(a)					
Er	3	(a)					
Tm							
Yb	2.26	(a)	2.06	2.4	(a)		
Lu	0.328	(a)	0.313	0.334	(a)		
Hf	2.5	(a)	2.2	2.57	(a)		
Ta							
W ppb							
Re ppb							
Os ppb							
Ir ppb							
Pt ppb							
Au ppb							
Th ppm			0.529	0.6	(a)		
U ppm							

technique: (a) INAA, (b) fused-bead XRF, (c) broad-beam e-probe

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