15674, 15675, 15676, 15678 and 15683

Olivine-normative Basalt

35.7, 34.5, 25.5, 7.5 and 22 grams

Figure 1: Photo of 15674 with 1 cm cube for scale. S71-49833.

Figure 2: Photo of 15675 showing micrometeorite pits. Scale in cm. S71- 49826.

Figure 3: Photo of 15676 showing micrometeorite pits. Scale is 1 cm. S71-49861.

Figure 4: Two views of 15678. Cube is 1 cm. S71-49858 and 49860.

Figure 5: Photo of 15683. Cube is 1 cm. S71-49883.

Mineralogical Mode

	15676	15678
Olivine	9	7
Pyroxene	59	55
Plagioclase	27	30
Opaques	4	7
Silica	0.5	
Meostasis	0.5	1

Dowty et al. 1973

Introduction

These sample were collected by rake from the edge of Haddley Rille (see section on 15614). Two of them have been dated at 3.37 b.y. Compositionally they are all samples of fine-grained olivine-normative basalt (figure 5) and they include relict partially-resorbed phenocrysts of olivine. Several samples were directly exposed to the micrometeorite environment. Exposure ages have been determined for two of them (164 m.y. and 310 m.y. respectively).

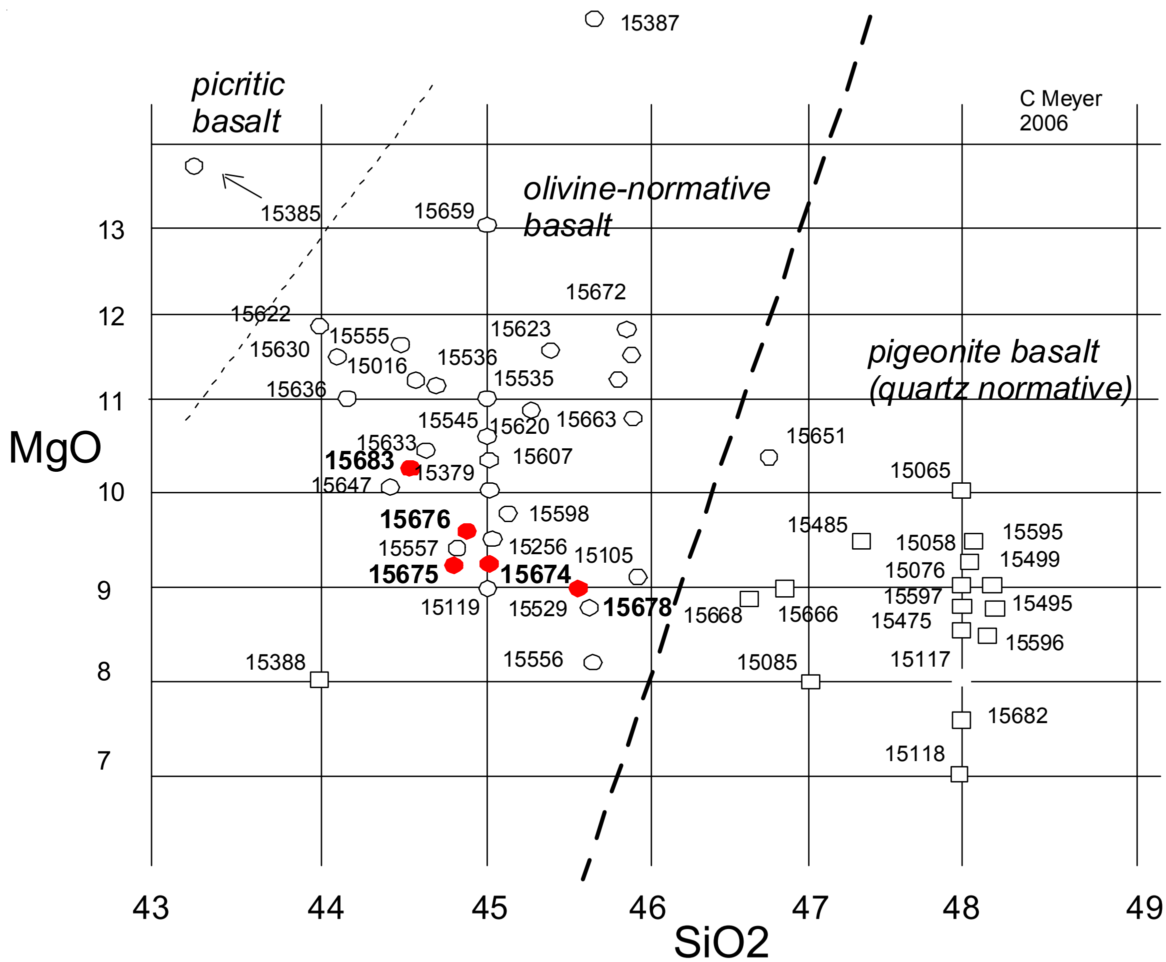


Figure 5: Chemical composition of Apollo 15 basalts.

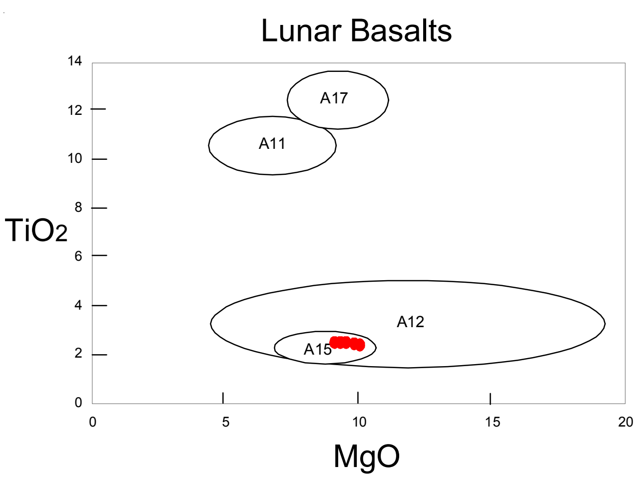


Figure 6: Chemical composition of 15674 - 15683 compared with that of other Apollo basalt samples.

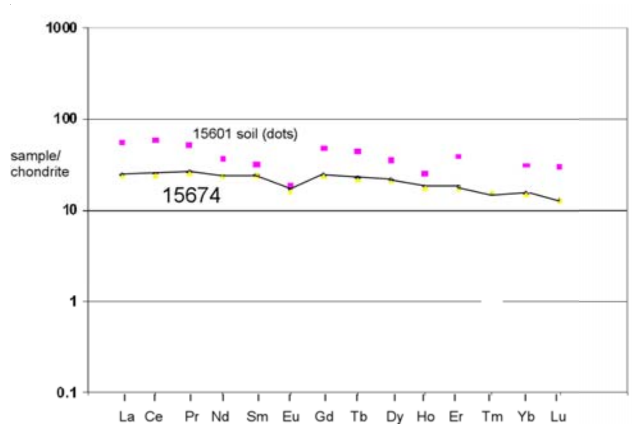
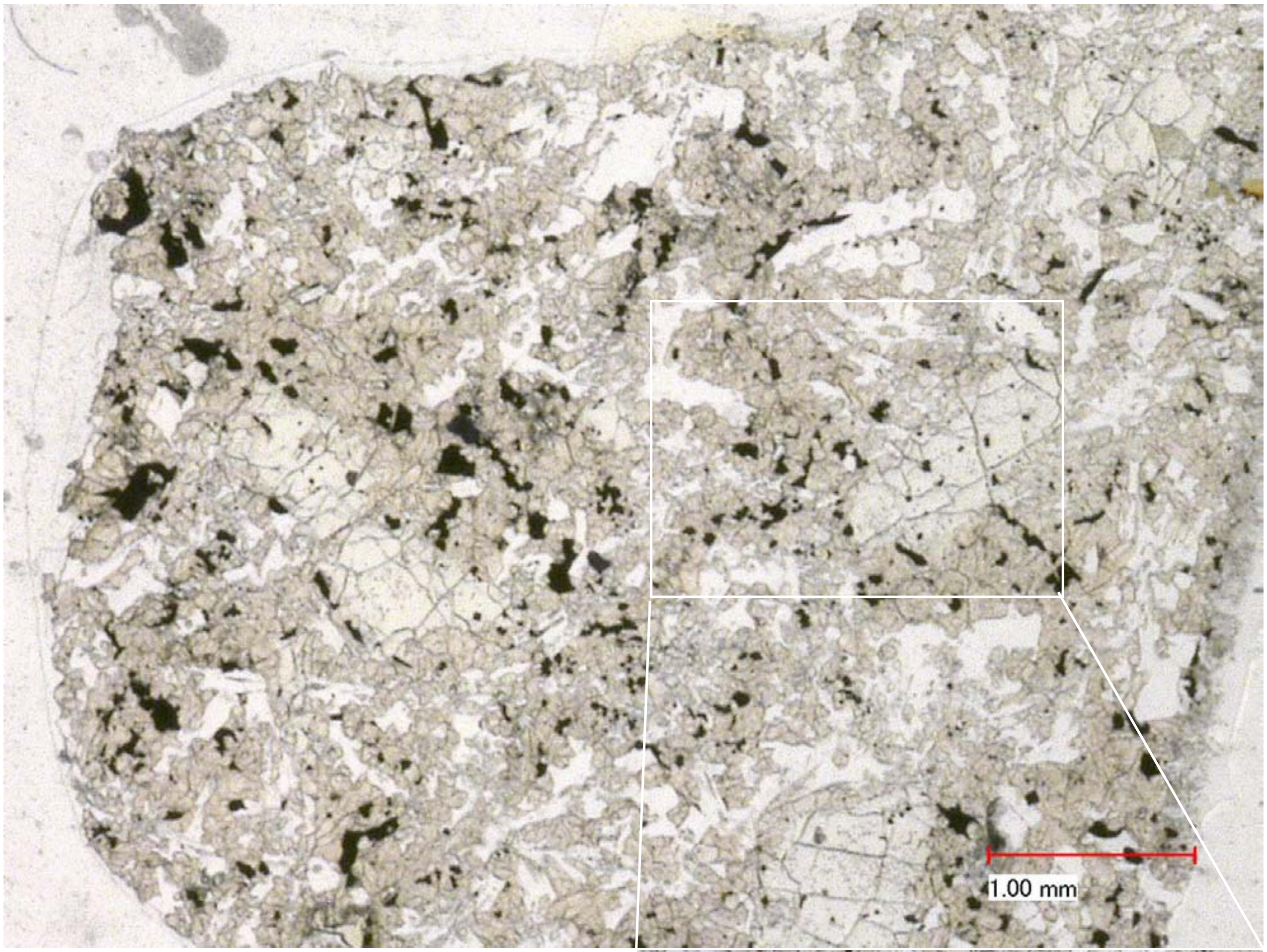


Figure 7: Normalixzed rare-earth-element diagrsm for 15674



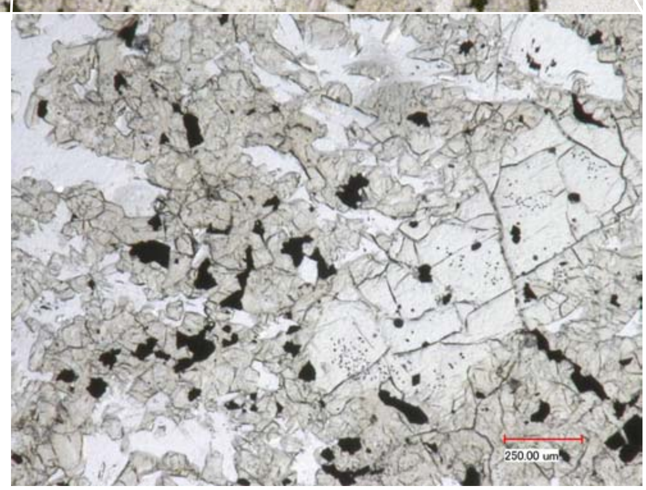


Figure 8a: Photomicrographs of thin section 15674,5 by C Meyer @ 50 and 150x.

Petrography

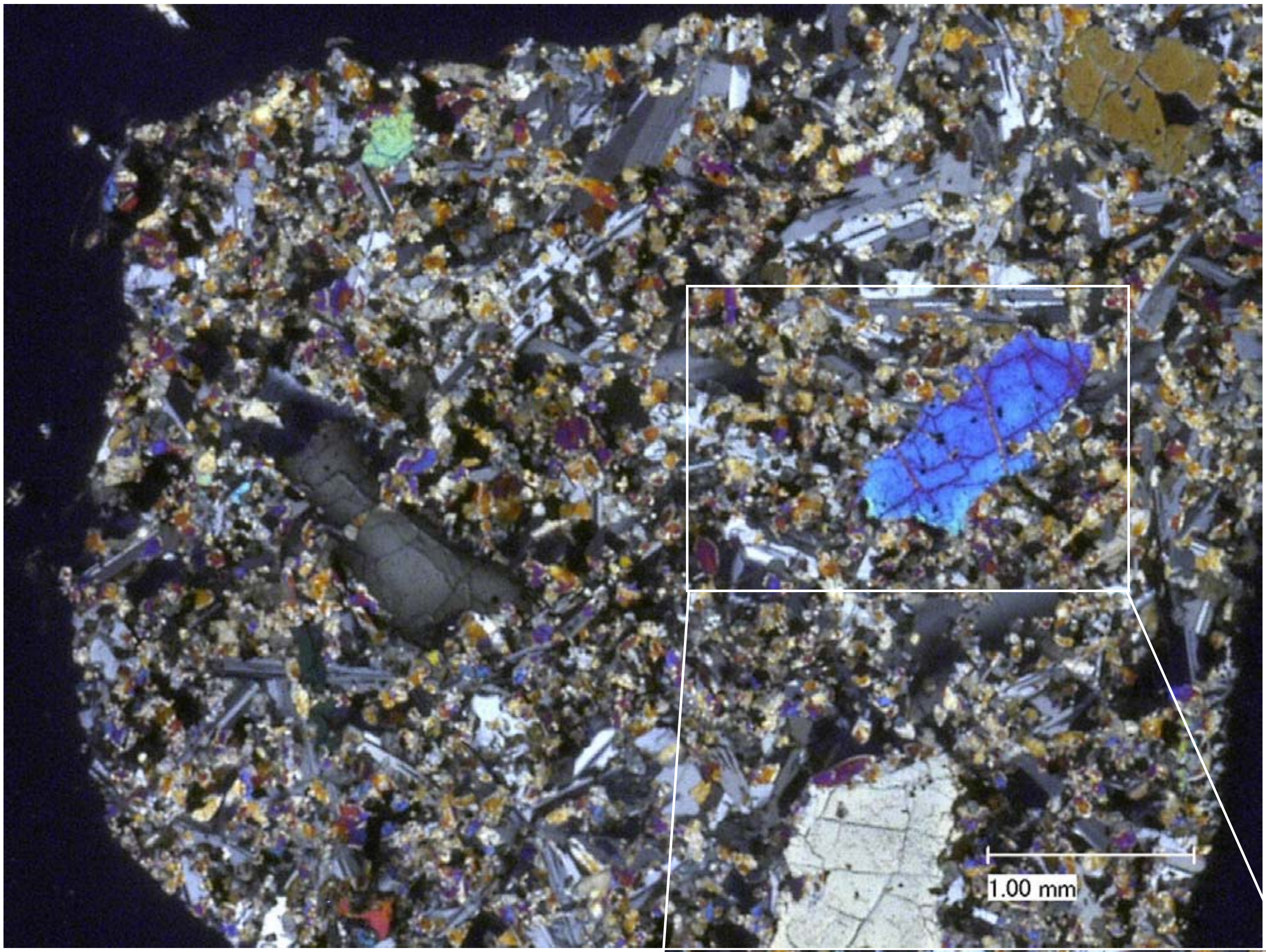
Dowty et al. (1972) and Nehru et al. (1973) studied 15676 and 14678, analyzing all the phases. Ryder (1985) provides the only description of 15674, 15675 and 15683 (no analyses). The dominate phase, pyroxene, occurs as small granular grain enclosed in and interstitial to plagioclase laths (subophitic texture). Small olivine phenocrysts have embayed margins and clearly reacted with the liquid during later crystallization. Opaque minerals occur in clumps. Metallic grains of Ni-Co-Fe are present.

Chemistry

Chappell and Green (1973), Fruchter et al. (1973), Laul and Schmitt (1973), Ma et al. (1976, 1978), Cuttitta et al. (1973), Helmke et al. (1973), Neal (2001) and Ryder and Schuraytz (2001) all analyzed these fine-grained samples finding essentially the same thing within error (tables 1 and 2, figures 5 - 7). They are all typical Apollo 15 olivine-normative basalt.

Radiogenic age dating

Husain (1994) used the Ar/Ar plateau technique to determine the ages of 15678 and 15683 (3.37 b.y.) which is typical of Apollo 15 basalt. Compston et al. (1972) determined the isotopic composition of Sr for 15674.



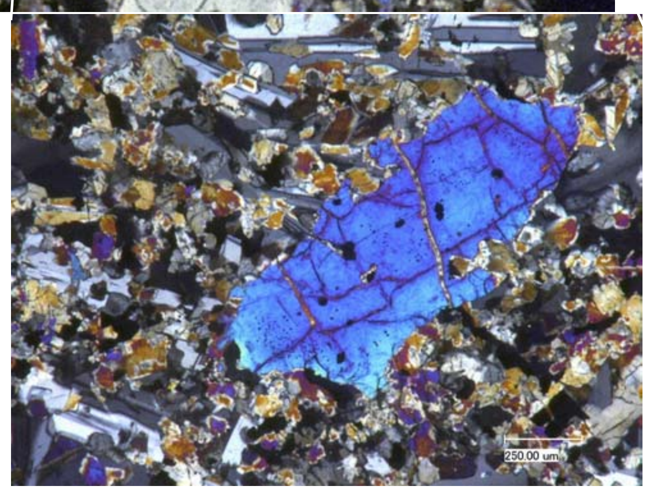


Figure 8b: Photomicrographs of thin section 15674,5 by C Meyer @ 50 and 150x (crossed polarizers).

Cosmogenic isotopes and exposure ages

Husain (1994) determined exposure ages of 15678 and 15683 of 164 m.y. and 310 m.y. respectively using the ^{38}Ar technique.

Other Studies

Gose et al. (1972) and Pearce et al. (1973) determined the magnetic properties of 15675.

Processing

There is only one thin section of 15674, one thin section of 15675, 4 thin sections of 15676, 2 of 15678 and 2 thin sections of 15683. 15676 was sawn; the others were only chipped.

Summary of Age Data

	Ar/Ar	
Husain 1974	3.38 ± 0.05 b.y.	15678
	3.36 ± 0.05 b.y.	15683

References for 15674, 15675, 15676, 15678 and 15683.

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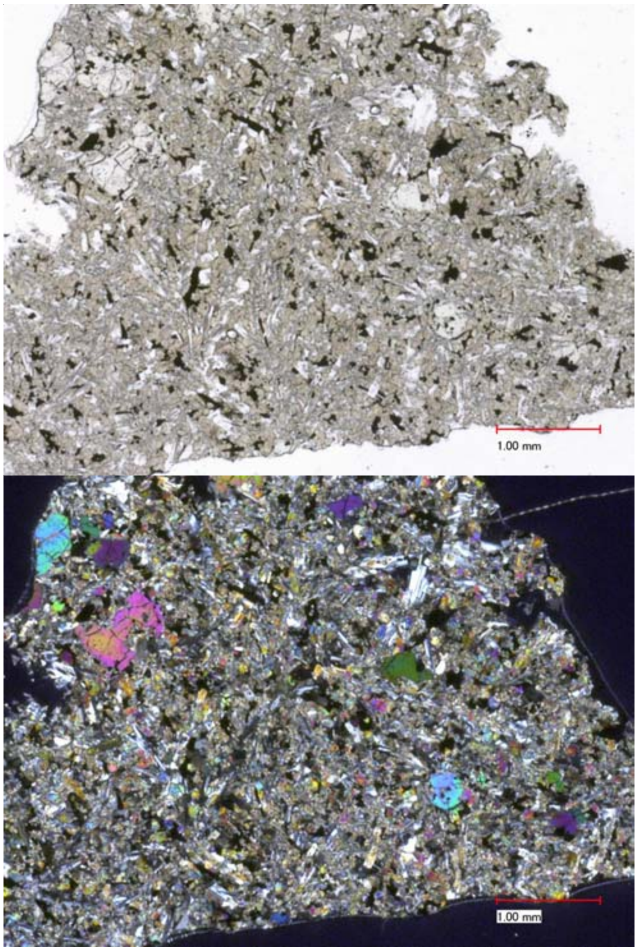

Figure 9a: Photomicrographs of thin section 15676,14 by C Meyer @50x.

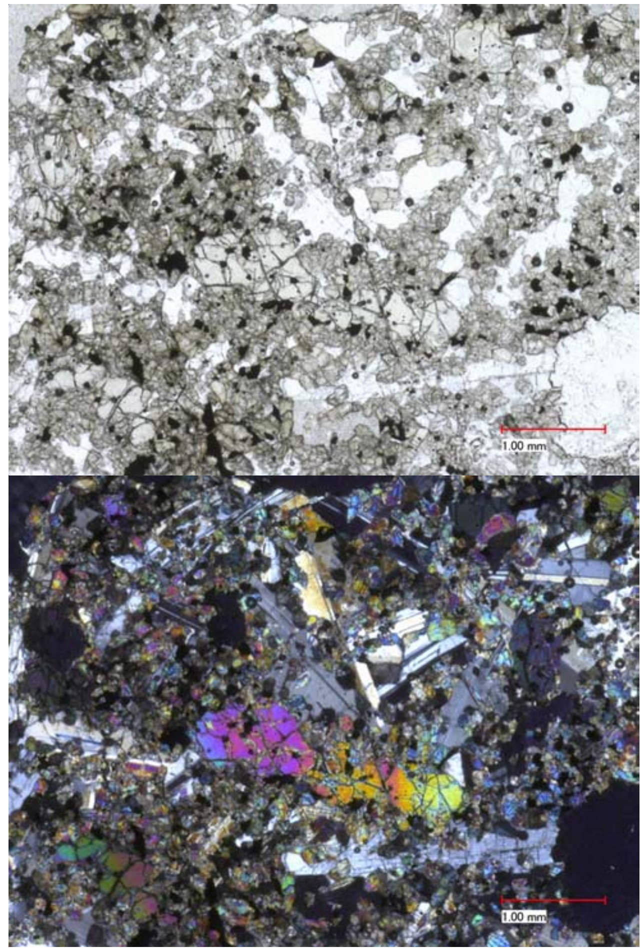

Figure 10: Photomicrographs of thin section 15683,2 by C Meyer @50x.

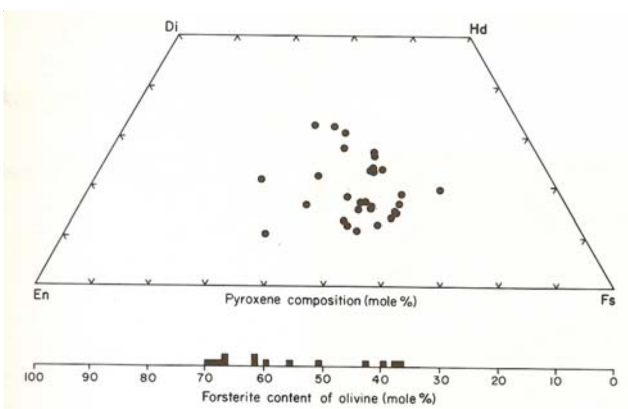

Figure 9b: Pyroxene and olivine composition of 15676 (from Dowty et al.).

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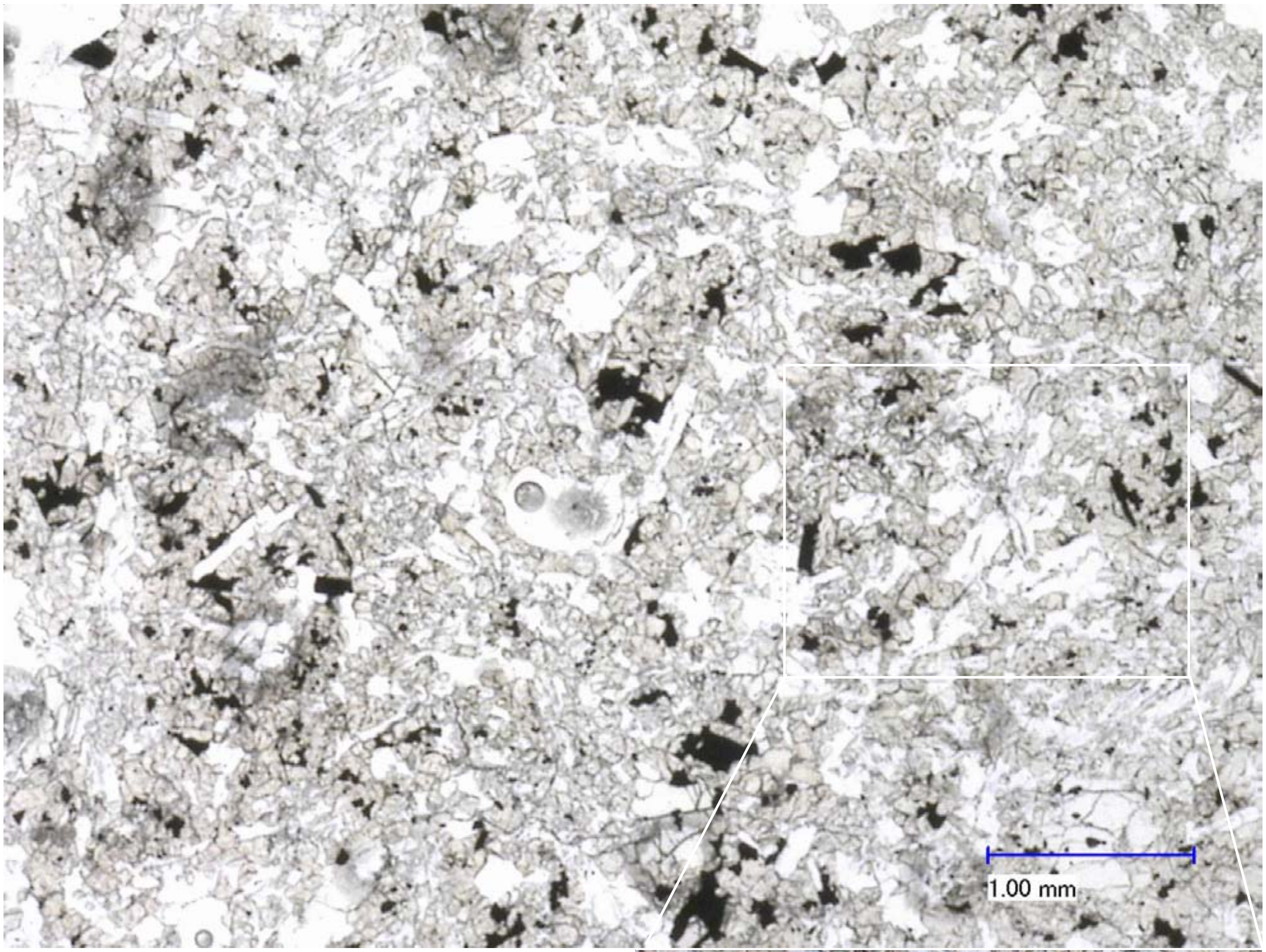

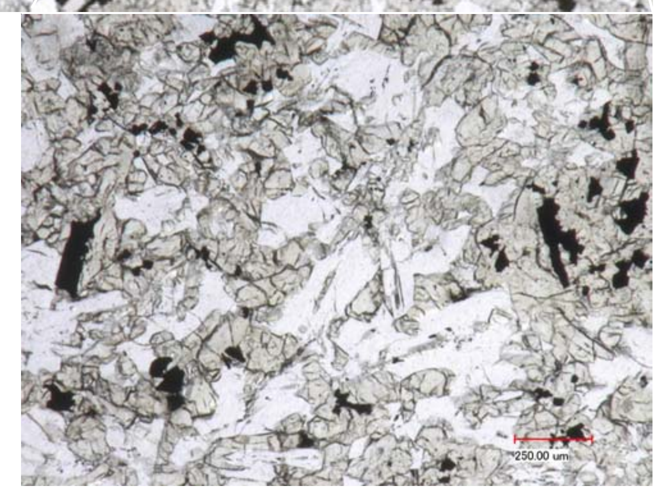

Figure 11a: Photomicrographs of thin section 15678,6 by C Meyer @ 50 and 150x.

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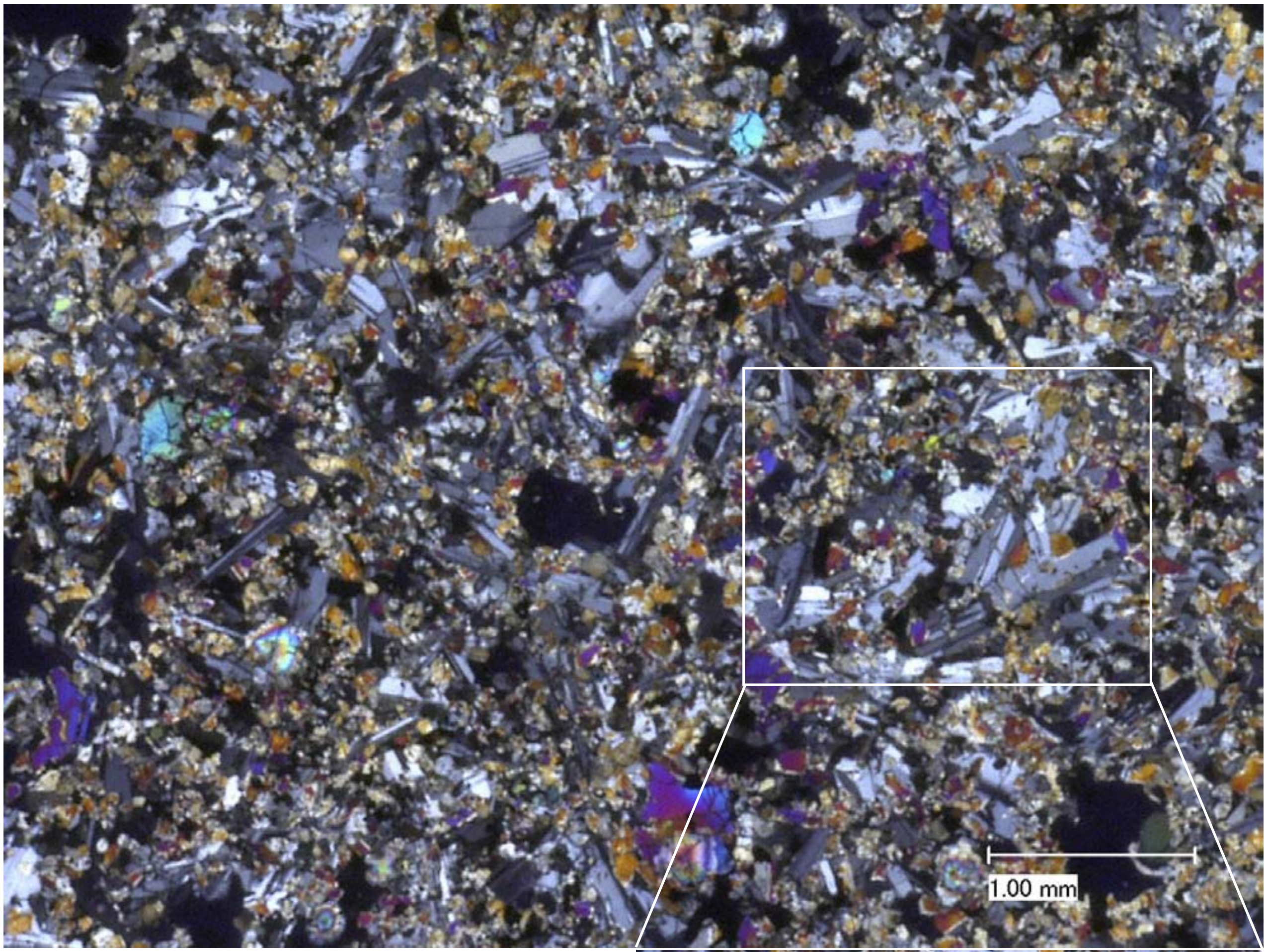

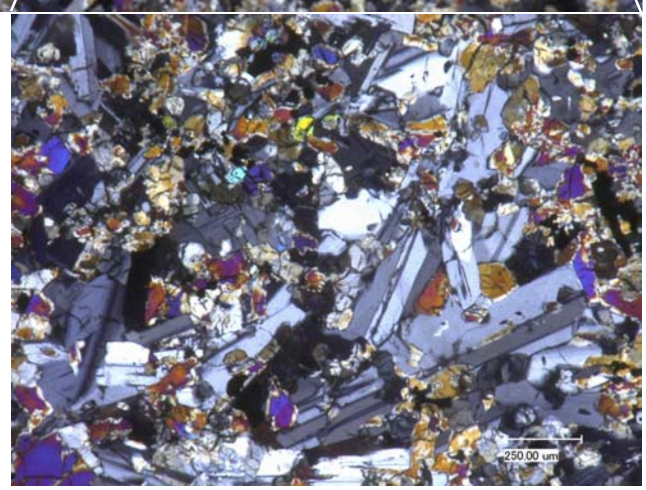

Figure 11b: Photomicrographs of thin section 15678,6 by C Meyer @ 50 and 150x (crossed polarizers).

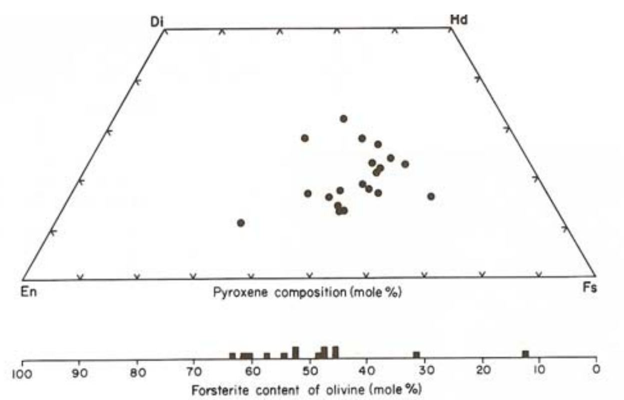

Figure 11c: Composition of olivine and pyroxene in 15678 (Dowty et al. 1973).

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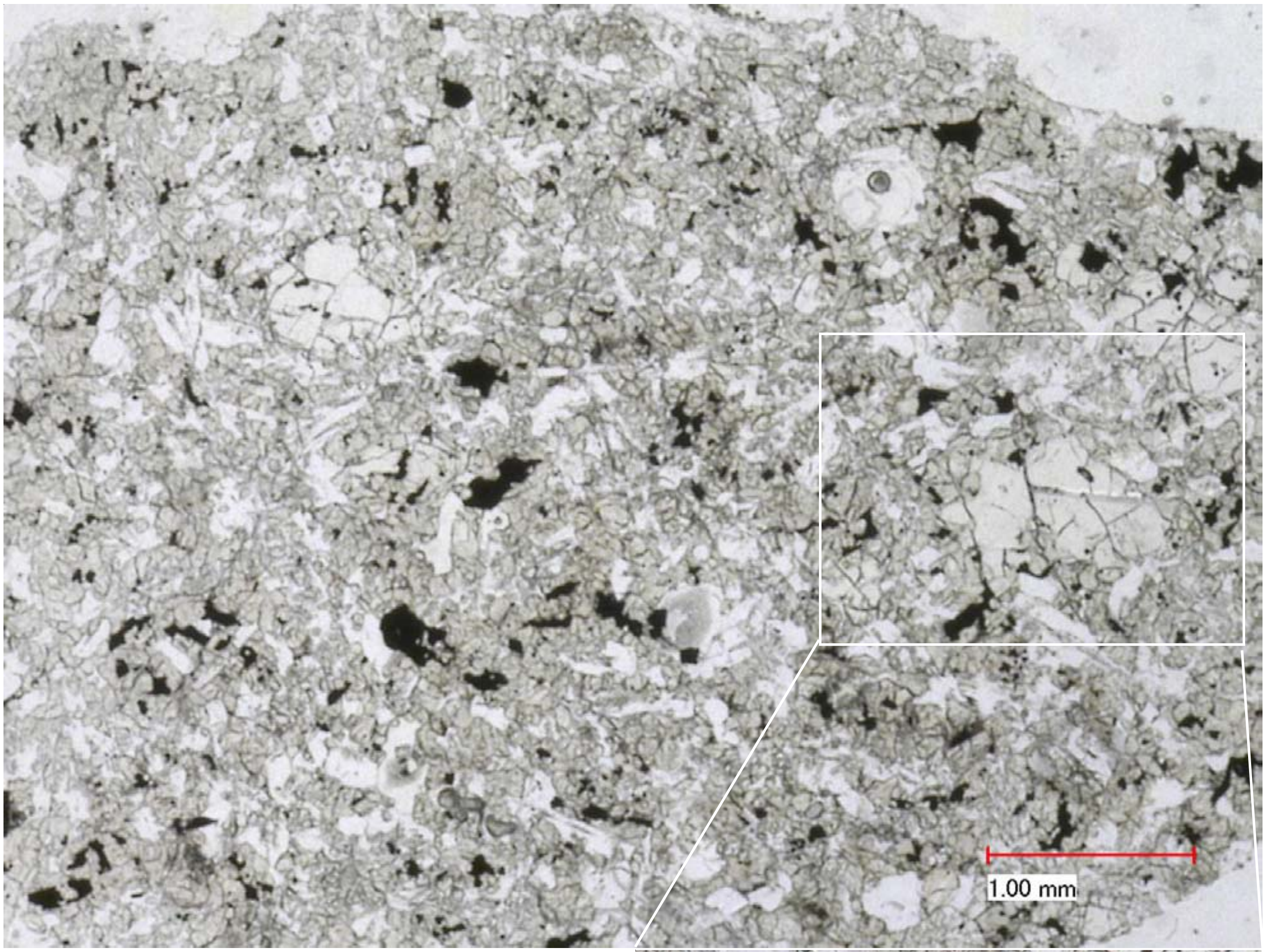

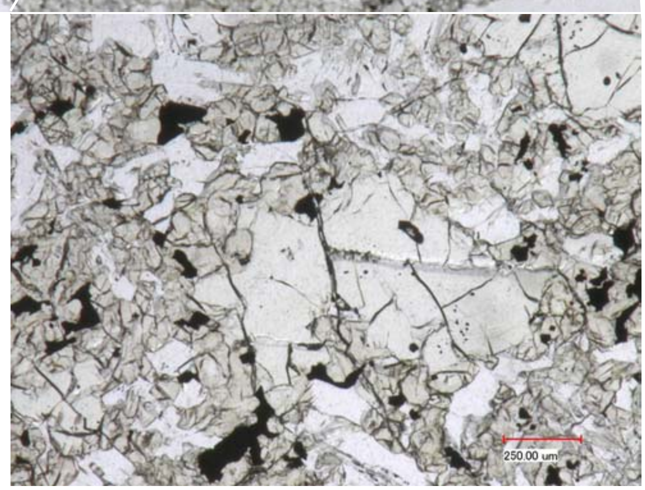

Figure 12a: Photomicrographs of thin section 15678,7 by C Meyer @ 50 and 150x.

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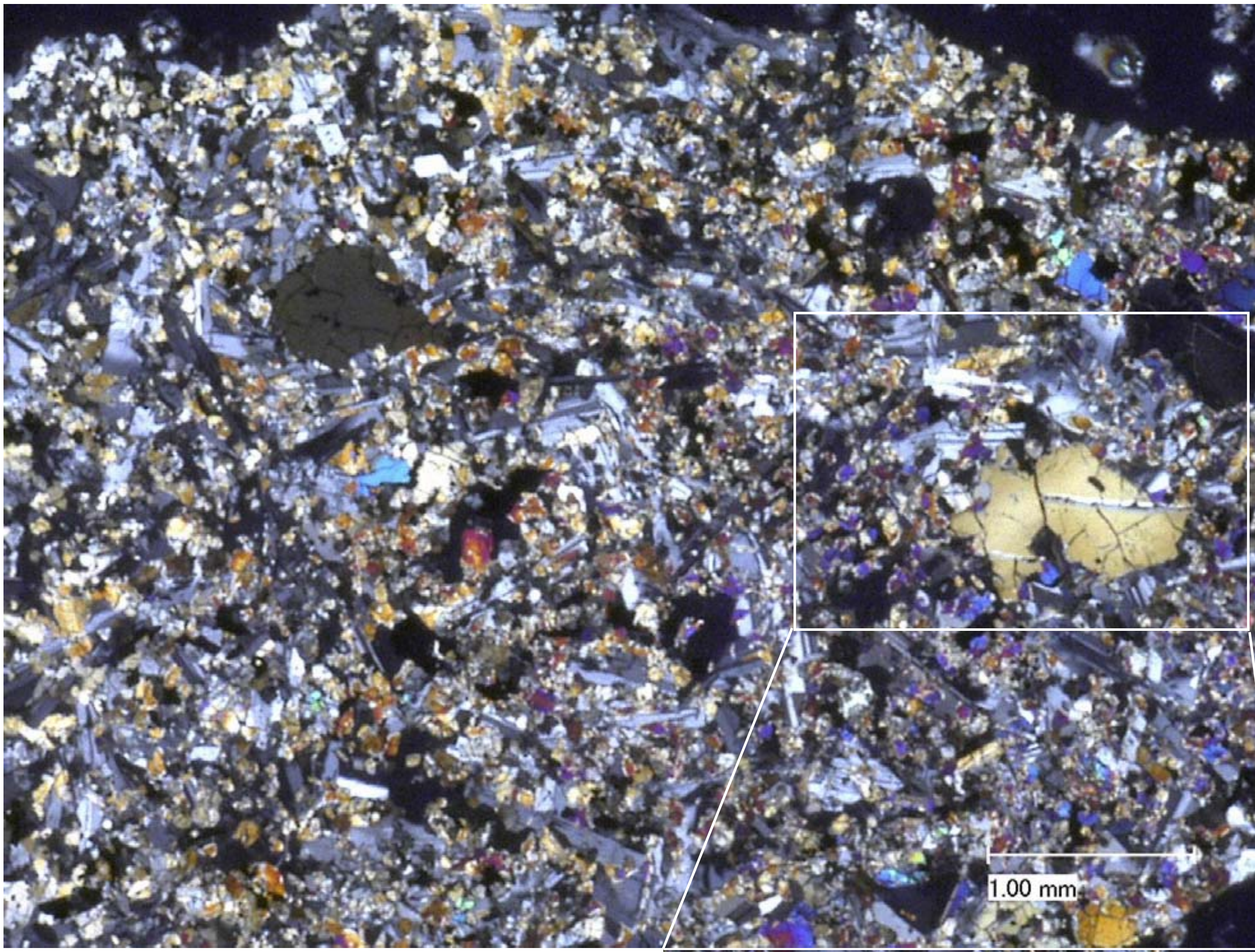

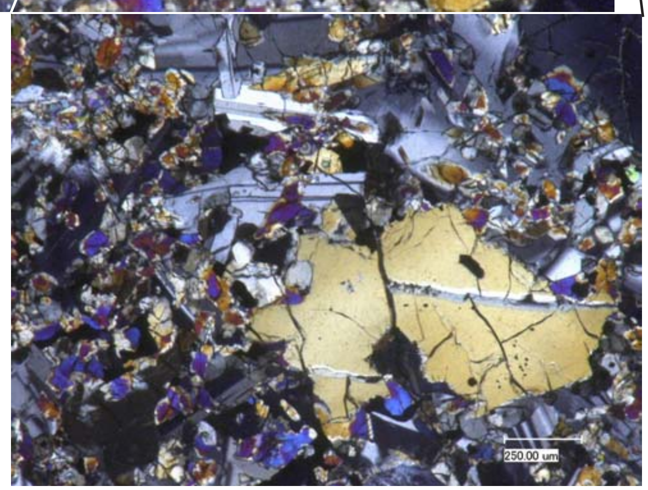

Figure 12b: Photomicrographs of thin section 15678,7 by C Meyer @ 50 and 150x (crossed polarizers).

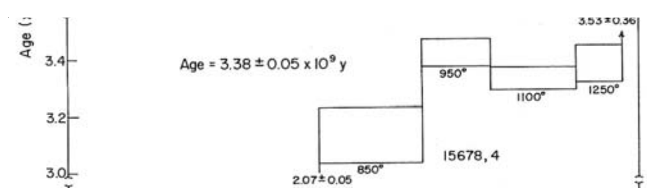

Figure 12: Ar/Ar plateau diagram for 15678 (Husain 1974).

Table 1. Chemical composition of 15674 and 15675.

	15674		15674		15674		15674		15675		15675		15675	
reference	Neal2001		Fruchter73		Chappel73		Ryder2001		Neal2001		Ryder2001		Ma78	
weight														
SiO2 %					45.04	(c)	44.6	(d)			44.7	(d)		
TiO2			2.9	(b)	2.58	(c)	2.54	(d)			2.55	(d)	2.2	(b)
Al2O3			8.1	(b)	8.95	(c)	9.17	(d)			9.19	(d)	9	(b)
FeO			21.5	(b)	22.78	(c)	22.28	(d)			22.3	(d)	21.4	(b)
MnO					0.31	(c)	0.28	(d)			0.28	(d)	0.26	(b)
MgO					9.36	(c)	9.45	(d)			9.28	(d)	10	(b)
CaO					10.15	(c)	9.97	(d)			9.94	(d)	9.1	(b)
Na2O			0.26	(b)	0.28	(c)	0.243	(d)			0.24	(d)	0.26	(b)
K2O					0.05	(c)	0.044	(d)			0.046	(d)	0.044	(b)
P2O5					0.08	(c)	0.067	(d)			0.07	(d)		(b)
S %					0.06	(c)								
sum														
Sc ppm	48.2	(a)	42	(b)			43.5	(b)	43.6	(a)	43.3	(b)	42	(b)
V	254	(a)							247	(a)			189	(b)
Cr	4229	(a)	3940	(b)	3216	(c)	3840	(b)	5875	(a)	3770	(b)		
Co	55.9	(a)	52	(b)			49.6	(b)	53	(a)	49.4	(b)	46	(b)
Ni	56.5	(a)					72	(b)	53	(a)	66	(b)	65	(b)
Cu	17	(a)					14	(b)	16	(a)				
Zn	20	(a)							22	(a)				
Ga	3.88	(a)			3.1	(c)			3.64	(a)				
Ge ppb														
As														
Se														
Rb	1	(a)			0.65	(c)			1.07	(a)				
Sr	112	(a)			101	(c)	83	(b)	122.6	(a)	88	(b)		
Y	32	(a)			24	(c)	24		36	(a)	25			
Zr	112	(a)			89	(c)	91		125	(a)	91			
Nb	7.35	(a)			7	(c)	12		7.84	(a)	9			
Mo	0.21	(a)							0.54	(a)				
Ru														
Rh														
Pd ppb														
Ag ppb														
Cd ppb														
In ppb														
Sn ppb														
Sb ppb									60	(a)				
Te ppb														
Cs ppm	0.03	(a)							0.03	(a)				
Ba	58	(a)					46	(b)	58.6	(a)	56	(b)	65	(b)
La	5.7	(a)	4.2	(b)			5.16	(b)	5.65	(a)	5.25	(b)	5.3	(b)
Ce	15	(a)					14	(b)	15.6	(a)	15.7	(b)		
Pr	2.3	(a)							2.39	(a)				
Nd	10.7	(a)					7	(b)	11.4	(a)	14	(b)		
Sm	3.56	(a)	3.2	(b)			3.78	(b)	3.7	(a)	3.74	(b)	3.6	(b)
Eu	0.94	(a)	0.87	(b)			0.92	(b)	0.95	(a)	0.94	(b)	0.87	(b)
Gd	4.7	(a)							5.18	(a)				
Tb	0.82	(a)	0.6	(b)			0.83	(b)	0.85	(a)	0.79	(b)	0.7	(b)
Dy	5.16	(a)							5.52	(a)			4	(b)
Ho	1.01	(a)							1.05	(a)				
Er	2.87	(a)							2.92	(a)				
Tm	0.37	(a)							0.38	(a)				
Yb	2.46	(a)	2.3	(b)			2.33	(b)	2.5	(a)	2.36	(b)	2.2	(b)
Lu	0.31	(a)	0.26	(b)			0.31	(b)	0.31	(a)	0.32	(b)	0.31	(b)
Hf	2.79	(a)	2.2	(b)			2.65	(b)	2.72	(a)	2.77	(b)	2.5	(b)
Ta	0.51	(a)	0.47	(b)			0.41	(b)	0.49	(a)	0.41	(b)	0.48	(b)
W ppb														
Re ppb														
Os ppb														
Ir ppb														
Pt ppb														
Au ppb														
Th ppm	0.16	(a)					0.46	(b)	0.5	(a)	0.47	(b)		
U ppm	0.05	(a)							0.13	(a)				

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

Table 2. Chemical composition of 15676, 15678 and 15683.

	15676	15676	15676	15676	15676	15676	15678	15678	15683	15683	15683
reference	Dowty73	Ma76	Neal2001	Laul73	Cuttitta73	Ryder2001	Helmke73	Dowty73	Helmke73	Neal2001	Ryder2001
weight											
SiO2 %	44.2 (b)				44.1 (e)	44.7 (d)		45.5 (b)	45.8 (f)		44.5 (d)
TiO2	3 (b)	2.6 (c)		2.7 (c)	2.66 (e)	2.55 (d)		2.64 (b)	2.91 (f)		2.41 (d)
Al2O3	8.9 (b)	8.5 (c)		9.5 (c)	8.76 (e)	9.16 (d)		9.4 (b)	8.04 (f)		8.99 (d)
FeO	22.4 (b)	21.7 (c)		22.5 (c)	23.03 (e)	22.32 (d)		22.6 (b)	22.8 (f)		22.03 (d)
MnO	0.27 (b)	0.27 (c)		0.27 (c)	0.28 (e)	0.28 (d)		0.3 (b)			0.284 (d)
MgO	9.2 (b)	9.1 (c)		8 (c)	9.82 (e)	9.51 (d)		9 (b)	9.6 (f)		10.33 (d)
CaO	9.5 (b)	9.3 (c)		10.7 (c)	10.1 (e)	9.93 (d)		10.3 (b)	9.37 (f)		9.62 (d)
Na2O	0.31 (b)	0.275 (c)		0.275 (c)	0.31 (e)	0.25 (d)		0.38 (b)	0.297 (f)		0.235 (d)
K2O	0.01 (b)	0.042 (c)		0.048 (c)	0.06 (e)	0.044 (d)		0.05 (b)	0.053 (f)		0.042 (d)
P2O5	0.08 (b)				0.11 (e)	0.064 (d)		0.08 (b)			0.064 (d)
S %											
sum											
Sc ppm		40 (c)	47 (a)	42 (c)	37 (e)	43.4 (c)	42.8 (c)		40.5 (c)	46.7 (a)	41.8 (c)
V		197 (c)	254 (a)	200 (c)	190 (e)					220 (a)	
Cr			4195 (a)	3387 (c)		3860 (c)	4230 (c)	3284 (b)	3970 (c)	4018 (a)	4230 (c)
Co		44 (c)	58 (a)	43 (c)	60 (e)	50.5 (c)	49 (c)		49 (c)	59.4 (a)	53 (c)
Ni		45 (c)	60 (a)		63 (e)	50 (c)				64.8 (a)	76 (c)
Cu			18 (a)		0.25 (e)					15.7 (a)	7 (c)
Zn			22 (a)						3 (c)	24 (a)	
Ga			3.92 (a)						4.1 (c)	4.11 (a)	
Ge ppb											
As											
Se											
Rb			1.02 (a)				0.6 (c)		0.8 (c)	0.99 (a)	
Sr			115.5 (a)		130 (e)	120 (c)				111 (a)	112 (c)
Y			32.8 (a)		27 (e)	24				32 (a)	27 (c)
Zr			118 (a)	<230 (c)	70 (e)	90				105 (a)	88 (c)
Nb			7.22 (a)							7.27 (a)	6 (c)
Mo			0.03 (a)							0.07 (a)	
Ru											
Rh											
Pd ppb											
Ag ppb											
Cd ppb											
In ppb											
Sn ppb											
Sb ppb										10 (a)	
Te ppb											
Cs ppm			0.12 (a)				0.029 (c)		0.038 (c)	0.03 (a)	
Ba			59.8 (a)	<120 (c)	56 (e)	59 (c)				59.6 (a)	50 (c)
La		5.9 (c)	5.72 (a)	5.3 (c)		5.08 (c)	4.05 (c)		5.26 (c)	5.8 (a)	4.83 (c)
Ce			14.9 (a)	15 (c)		13.6 (c)	10.5 (c)		14.6 (c)	15 (a)	13.9 (c)
Pr			2.28 (a)			(c)				2.31 (a)	
Nd			10.5 (a)			9 (c)	8.6 (c)		11.1 (c)	11 (a)	10 (c)
Sm		3.5 (c)	3.66 (a)	3.8 (c)		3.66 (c)	2.97 (c)		4.2 (c)	3.6 (a)	3.42 (c)
Eu		0.82 (c)	0.89 (a)	1 (c)		0.91 (c)	0.82 (c)		0.98 (c)	0.92 (a)	0.89 (c)
Gd			4.78 (a)			(c)	4 (c)		5.6 (c)	4.73 (a)	
Tb		0.59 (c)	0.81 (a)	0.7 (c)		0.77 (c)	0.68 (c)		0.93 (c)	0.81 (a)	0.76 (c)
Dy		4.6 (c)	5.18 (a)	4.4 (c)		(c)	4.9 (c)		5.96 (c)	5.27 (a)	
Ho			1.02 (a)			(c)	0.87 (c)		1.06 (c)	1 (a)	
Er			2.85 (a)			(c)	2.9 (c)		2.9 (c)	2.72 (a)	
Tm			0.37 (a)			(c)				0.38 (a)	
Yb		2.1 (c)	2.42 (a)	2.5 (c)		2.31 (c)	2.02 (c)		2.44 (c)	2.38 (a)	2.12 (c)
Lu		0.39 (c)	0.32 (a)	0.4 (c)		0.31 (c)	0.277 (c)		0.362 (c)	0.31 (a)	0.29 (c)
Hf		2.6 (c)	2.77 (a)	3.1 (c)		2.66 (c)	2 (c)		2.5 (c)	2.75 (a)	2.66 (c)
Ta		0.39 (c)	0.51 (a)	0.6 (c)		0.39 (c)				0.46 (a)	0.38 (c)
W ppb										50 (a)	
Re ppb											
Os ppb											
Ir ppb											
Pt ppb											
Au ppb											
Th ppm			0.38 (a)			0.47 (c)				0.51 (a)	0.45 (c)
U ppm			0.12 (a)							0.14 (a)	

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