15556

Vesicular Olivine-normative Basalt

1542.3 grams

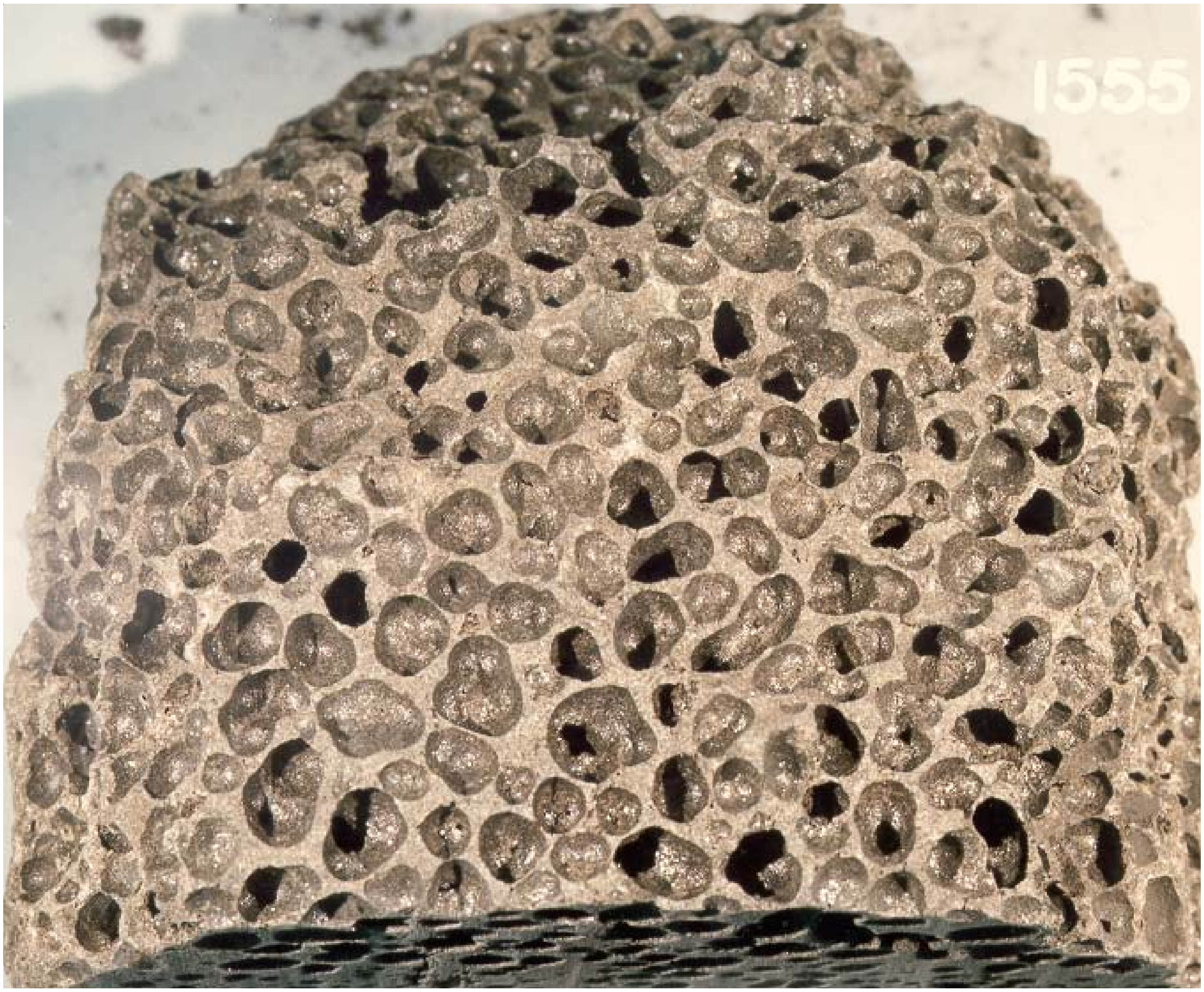


Figure 1: Photo of 15556,0. Largest vesicles are about 6 mm. NASA S87-48187.

Introduction

15556 was collected about 60 meters from the edge of Hadley Rille in an area called The Terrace. The lunar regolith was thin in this area, with abundant rock samples (basalts) exposed (Swann et al. 1971). The sample is ~3.4 b.y. old.

Petrography

15556 is a very vesicular, olivine-normative mare basalt. The vesicle size varies across the sample (4-8 mm), but the grain size of the minerals doesn't vary. McGee et al. (1977), Rhodes and Hubbard (1973) and Ryder (1985) find that it is fine-grained with anhedral phenocrysts (0.4mm) set in a subophitic matrix of pyroxene, plagioclase and ilmenite tablets (0.4 to 0.8 mm). The mesostasis contains glass, silica, troilite and separate grains of iron.

The original sample catalog reports vesicles make up as much as 50% by volume of the sample (figures 1 and 8) and range from 1 to 5 mm in size. Garvin et al. (1972) and Goldberg et al. (1976) studied the vesicles, finding that they were even larger (average = 4.1 mm). Note similarity with sample 15529.

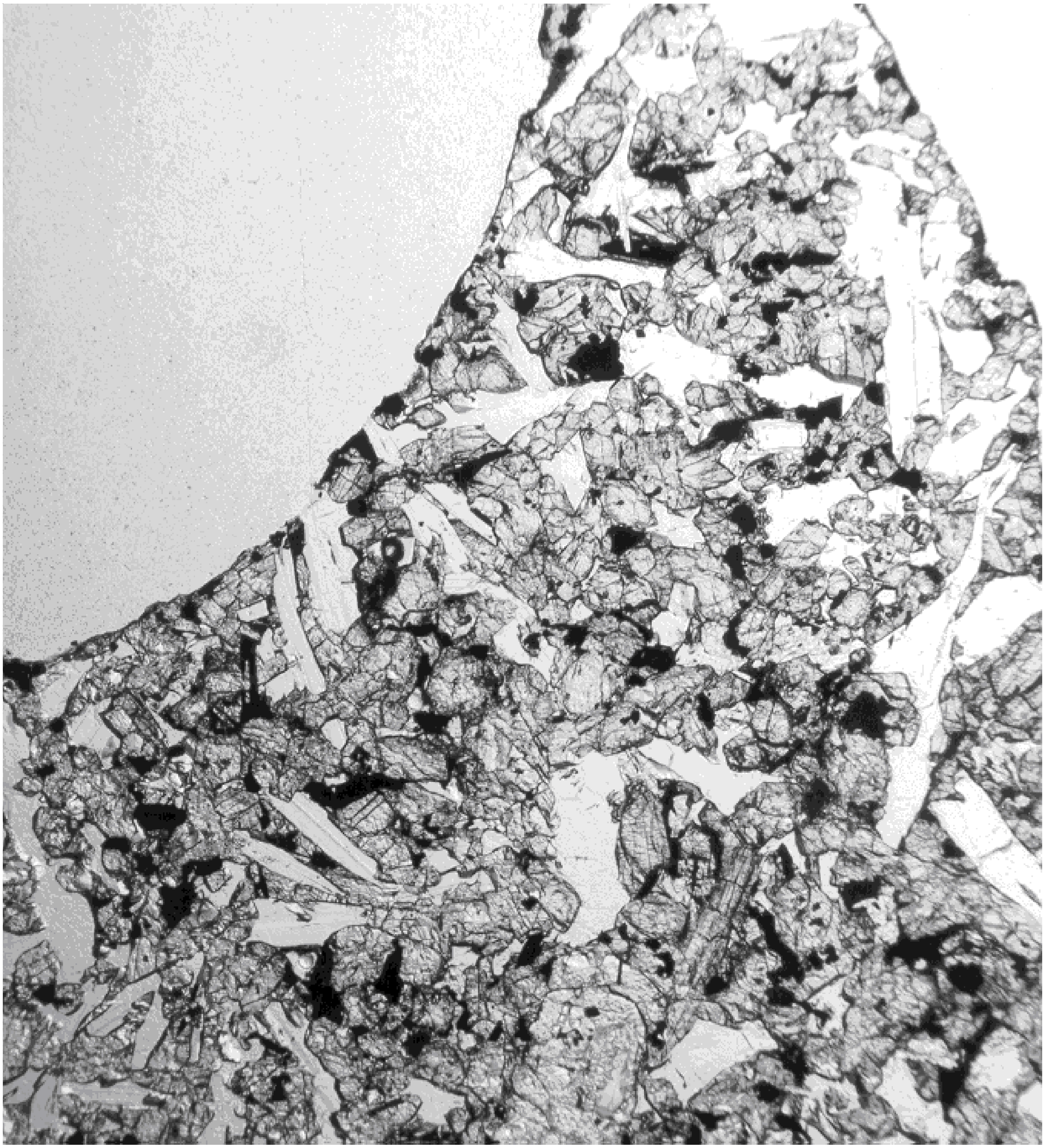


Figure 2: Photomicrgraph of thin section of 15556 showing vesicle wall. Scale about 3 mm. NASA S71-52492. Note relatively high abundance of opaque phases.

Mineralogical Mode of 15556

	Sample Catalog Butler 1971	Rhodes and Hubbard 1973	McGee et al. 1979
Olivine	5	0.1	0.1
Pyroxene	50	57	57
Plagioclase	30	38	38
Ilmenite	3	2.1	2
Spinel	5	1	1
Mesostasis	1	1	1
Silica	5	0.8	1

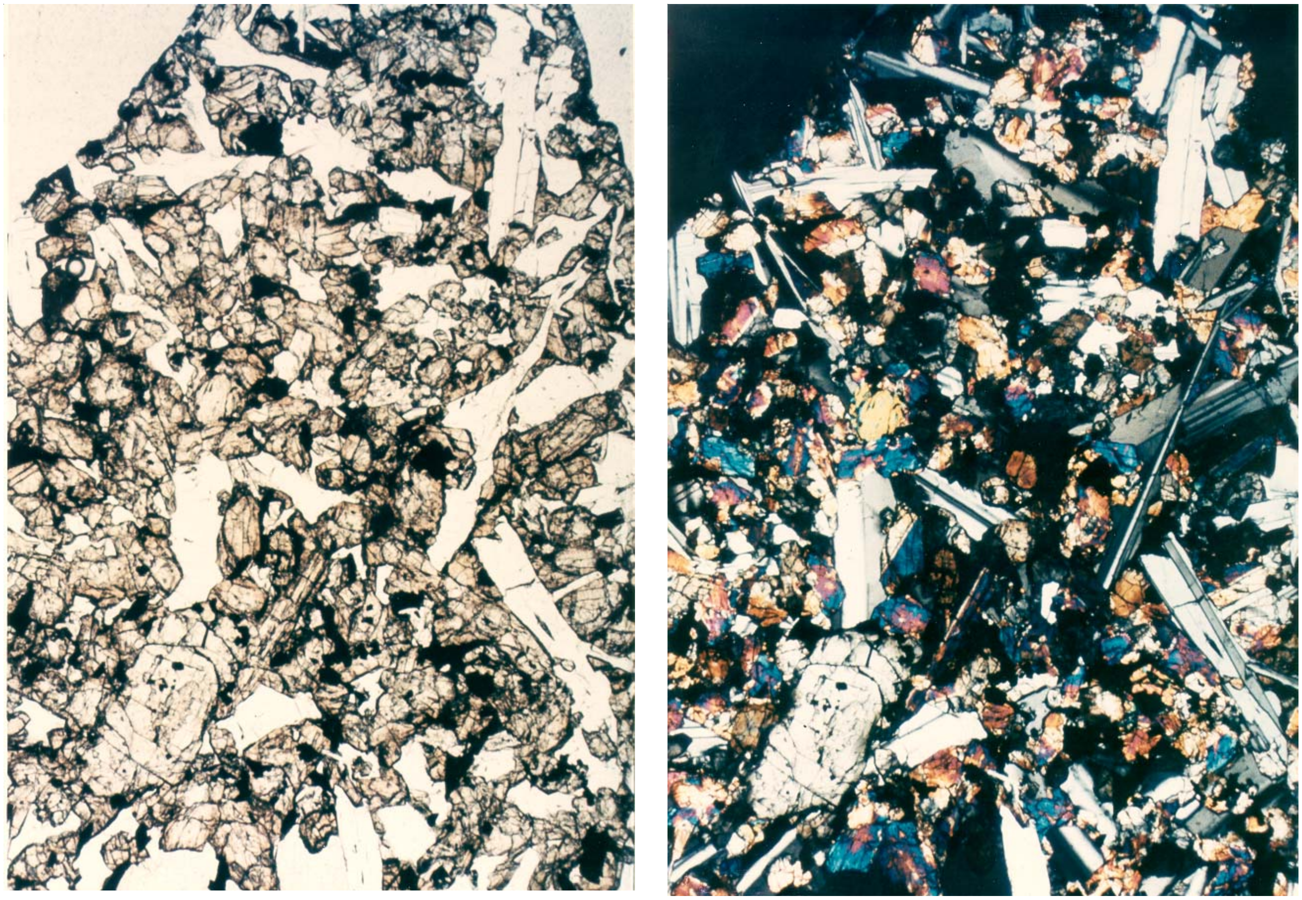


Figure 3: Thin section photos of 15556 (same area as figure 2). a) plane polarized light, b) crossed polarizers. NASA S71-51762-3. Scale about 2 mm.

note: see also figures 10 and 11

The original catalogue reported a large "xenocryst".

Mineralogy

The mineralogy of 15556 has not been well studied. Some pyroxene analyses were reported by Brunfelt et al. (1972) and McGee et al. (1977), El Goresy et al. (1976) studied the chromite, von Englehardt (1979) ilmenite, Huffman et al. (1975) confirmed olivine using Mossbauer and Ryder (1985) found trace 'ragged' olivine and small clinopyroxene (figures 2 and 3). The independent iron grains apparently haven't been analyzed.

Humphries et al. (1972) determined the experimental phase diagram showing that olivine was on the liquidus and arguing for olivine concentration from the original volcanic liquid.

Chemistry

Ryder and Shuraytz (2001) and others analyzed 15556 (figures 5 and 6). Moore et al. (1973) found only 13-16 ppm carbon in 15556. Gibson et al. (1975) reported that the sulfur content was about the same as for 15555 – non vesicular equivalent.

Radiogenic age dating

Kirsten et al. (1972) determined a K/Ar age of 3.4 ± 0.1 b.y.

Cosmogenic isotopes and exposure ages

Rancitelli et al. (1972) determined the cosmic-ray-induced activity of 26Al = 103 dpm/kg, 22Na = 40 dpm/kg, 46Sc = 6.5 dpm/kg, 54Mn = 41 dpm/kg, and 56Co = 11 dpm/kg.

Other Studies

Kirsten et al. (1972) reported analyses for isotopic ratios of rare gases in 15556. Gibson and Andrawes (1978) studied the volatiles released by crushing the rock (nothing happened!). Nagata studied the magnetic properties.

Table 1. Chemical composition of 15556.

reference	Rhodes 73		Wolf 79		Mason 72		Brunfeldt72		Strasheim72		Ryder2001						Rancitelli72	
weight			Ganapathy73															
SiO2 %	45.11	(a)			46.18	(c)			46.2	(f)	45.7	45.7	(a)					
TiO2	2.76	(a)			2.64	(c)	2.05	(e)	2.68	(f)	2.62	2.58	(a)					
Al2O3	9.43	(a)			9.85	(c)	9.24	(e)	9.44	(f)	9.48	9.24	(a)					
FeO	22.25	(a)			21.7	(c)	21.36	(e)	21.62	(f)	21.67	21.89	(a)	21.7	22.2	(e)		
MnO	0.29	(a)			0.32	(c)	0.3	(e)	0.26	(f)	0.28	0.28	(a)					
MgO	7.73	(a)			8.03	(c)			8.09	(f)	8.17	8.67	(a)					
CaO	10.83	(a)			10.72	(c)	9.93	(e)	10.54	(f)	10.56	10.38	(a)					
Na2O	0.26	(a)			0.3	(c)	0.28	(e)	0.22	(f)	0.257	0.273	(a)	0.27	0.27	(e)		
K2O	0.03	(a)			0.09	(c)			0.06	(f)	0.047	0.046	(a)				0.053	(h)
P2O5	0.08	(a)			0.07	(c)			0.08	(f)	0.07	0.07	(a)					
S %	0.08	(a)																
sum																		
Sc ppm							43.1	(e)	35	(f)				45.6	45.9	(e)		
V					165	(d)	266	(e)	255	(f)								
Cr					5200	(d)	3230	(e)	4310	(f)	5740	4452	(a)	5550	4430	(e)		
Co					46	(d)	50.3	(e)	49	(f)				50.2	48.9	(e)		
Ni					65	(d)	50	(e)	57	(f)	63	40	(a)	73	63	(e)		
Cu					10	(d)	7.1	(e)	9	(f)	6	7	(a)					
Zn			2.1	(b)			1.2	(e)										
Ga					5	(d)	3.7	(e)										
Ge ppb			9.8	(b)														
As							0.05	(e)										
Se			142	(b)			0.106	(e)										
Rb			0.1	(b)	<5	(d)	0.84	(e)	3	(f)	6	4	(a)					
Sr					102	(d)	88	(e)	96	(f)	101	99	(a)	126	111	(e)		
Y					50	(d)			32	(f)	24	24	(a)					
Zr					100	(d)			85	(f)	94	92	(a)					
Nb									8	(f)	10	9	(a)					
Mo																		
Ru																		
Rh																		
Pd ppb																		
Ag ppb			0.85	(b)			<7	(e)										
Cd ppb			28	(b)														
In ppb			0.56	(b)			<2	(e)										
Sn ppb																		
Sb ppb			0.13	(b)														
Te ppb			2.7	(b)														
Cs ppm			0.03	(b)			0.032	(e)										
Ba					50	(d)	59	(e)	74	(g)				44	53	(e)		
La							4.8	(e)	3.7	(g)				5.2	5.32	(e)		
Ce							18	(e)	16	(g)				15.8	14.3	(e)		
Pr									2.6	(g)								
Nd									10.8	(g)				13	12	(e)		
Sm							4	(e)	3.95	(g)				3.65	3.85	(e)		
Eu							1	(e)	1.1	(g)				0.96	0.95	(e)		
Gd									4.5	(g)								
Tb							0.77	(e)	0.85	(g)				0.87	0.83	(e)		
Dy							4.4	(e)	5.3	(g)								
Ho							0.91	(e)	1.3	(g)								
Er							3.3	(e)	2.85	(g)								
Tm									0.48	(g)								
Yb							1.59	(e)	2.5	(g)				2.27	2.34	(e)		
Lu							0.39	(e)	0.33	(g)				0.31	0.33	(e)		
Hf							3.1	(e)						2.89	2.77	(e)		
Ta							0.4	(e)						0.39	0.43	(e)		
W ppb							430	(e)										
Re ppb			0.00413	(b)														
Os ppb																		
Ir ppb			0.039	(b)			<0.1	(e)										
Pt ppb																		
Au ppb			0.026	(b)			0.85	(e)										
Th ppm							0.4	(e)						0.46	0.42	(e)	0.56	(h)
U ppm			0.145	(b)			0.21	(e)									0.15	(h)

technique: (a) XRF, (b) RNAA, (c) wet chem., (d) OES, (e) INAA, (f) mixed, (g) MS, (h) radiation counting

Table 1b. Chemical composition of 15556 (cont.).

reference	Neal 2001		
weight			
SiO2 %			
TiO2			
Al2O3			
FeO			
MnO			
MgO			
CaO			
Na2O			
K2O			
P2O5			
S %			
sum			
Sc ppm	52	47	(i)
V	258	266	(i)
Cr	6177	5555	(i)
Co	59	55	(i)
Ni	82	61	(i)
Cu	17	16	(i)
Zn	21	17	(i)
Ga	2.2	4	(i)
Ge ppb			
As			
Se			
Rb	0.99	1	(i)
Sr	114	114	(i)
Y	34	42	(i)
Zr	112	108	(i)
Nb	7	7.3	(i)
Mo	0.08	0.18	(i)
Ru			
Rh			
Pd ppb			
Ag ppb			
Cd ppb			
In ppb			
Sn ppb			
Sb ppb			
Te ppb			
Cs ppm	0.05	0.04	(i)
Ba	60	57	(i)
La	5.8	5.5	(i)
Ce	15.4	15.4	(i)
Pr	2.33	2.35	(i)
Nd	10.7	11.1	(i)
Sm	3.6	3.73	(i)
Eu	0.92	0.95	(i)
Gd	4.81	4.92	(i)
Tb	0.85	0.82	(i)
Dy	5.44	5.34	(i)
Ho	1.09	1.04	(i)
Er	2.98	2.83	(i)
Tm	0.39	0.39	(i)
Yb	2.51	2.39	(i)
Lu	0.31	0.33	(i)
Hf	2.68	3.02	(i)
Ta	0.45	0.59	(i)
W ppb	10	110	(i)
Re ppb			
Os ppb			
Ir ppb			
Pt ppb			
Au ppb			
Th ppm	0.43	0.52	(i)
U ppm	0.13	0.14	(i)

technique: (i) ICP-MS

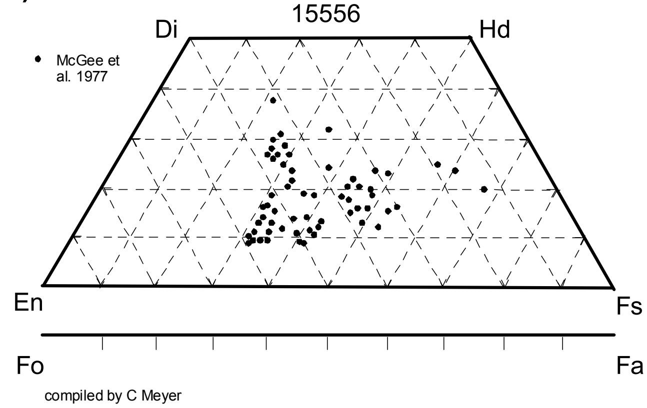


Figure 4: Composition of pyroxene in 15556 (from McGee et al. 1977).

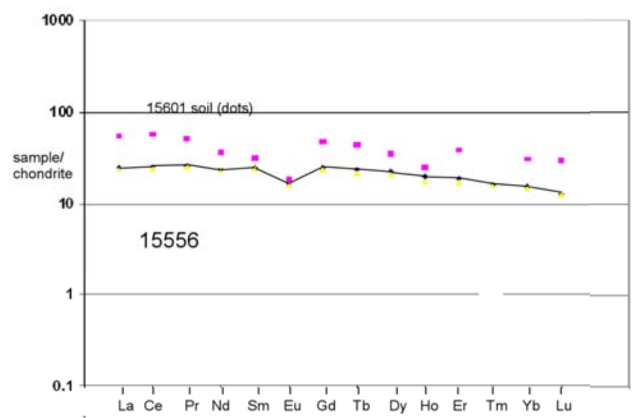


Figure 5: Normalized rare-earth-element diagram for 15556 (data from Neal 2001). Compared with 15610 soil (Wanke et al. 1973).

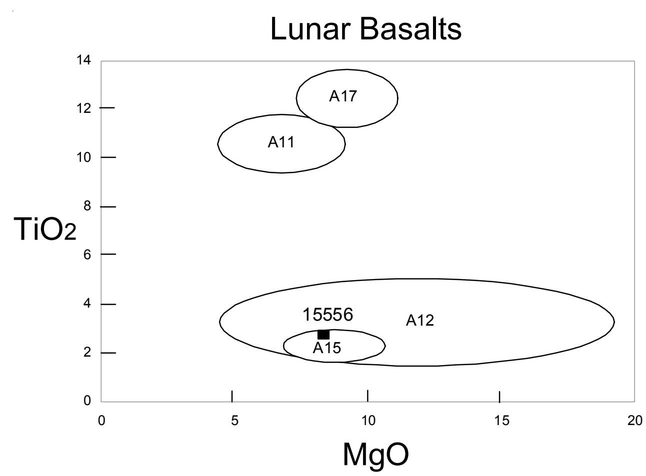


Figure 6: Composition of 15556 compared with other lunar basalts.

note: see also figure 9

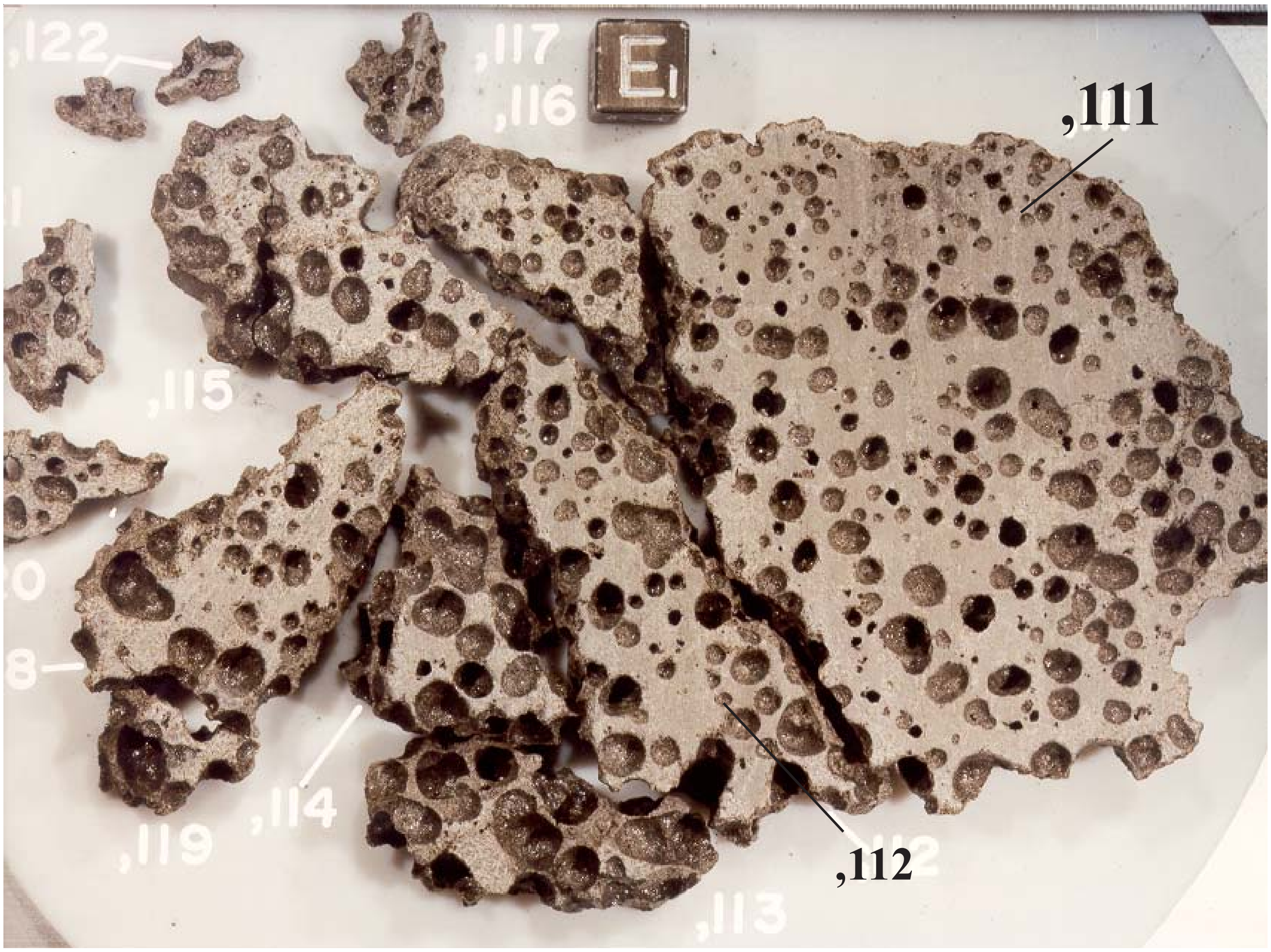
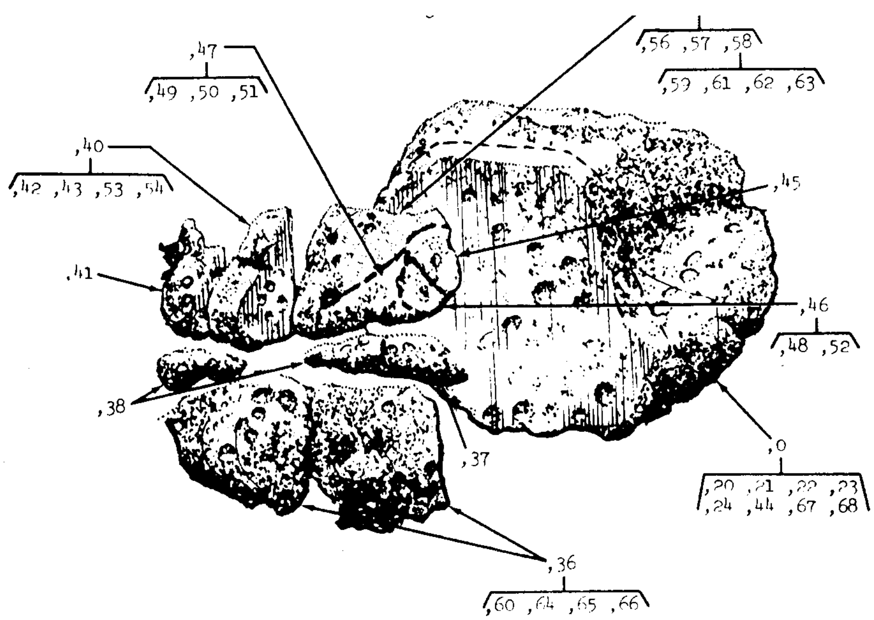


Figure 7: Slab cut from 15556. Cube is 1 cm. NASA S81-37816.



Processing

A slab was cut (figure 7). There are 29 thin sections (*yet still no good petrographic description!*).

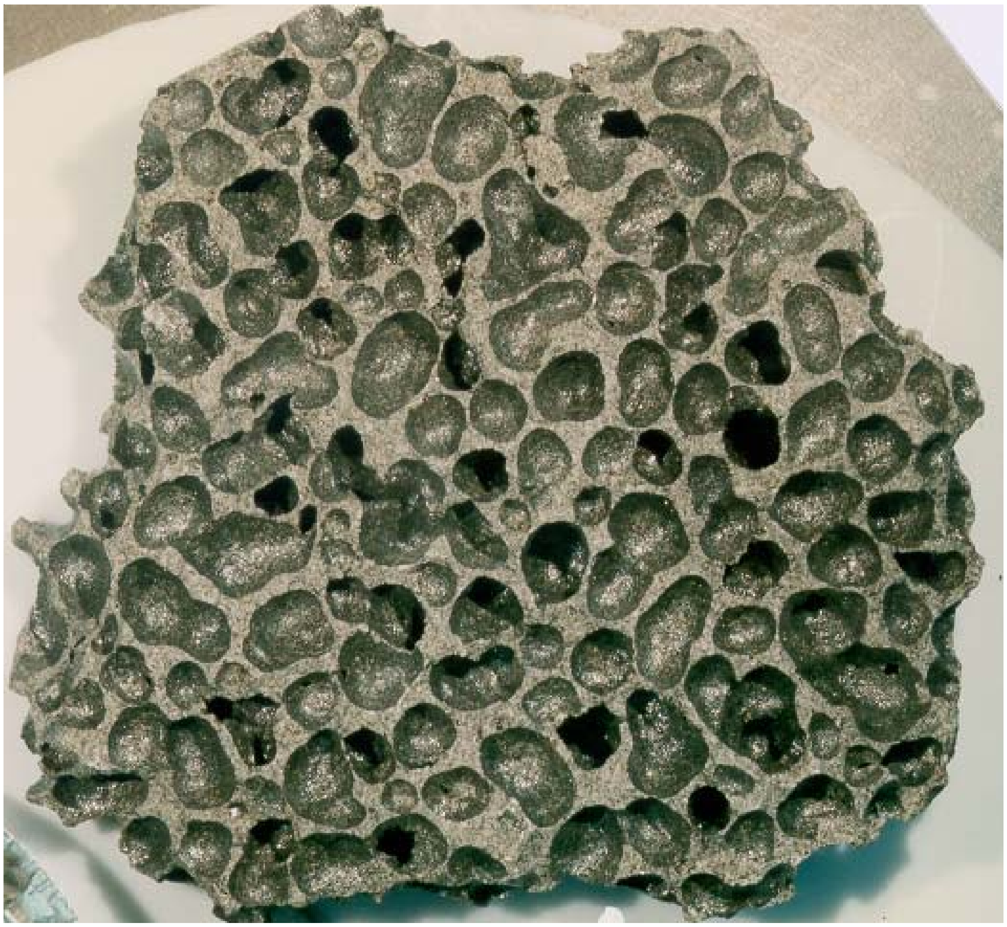
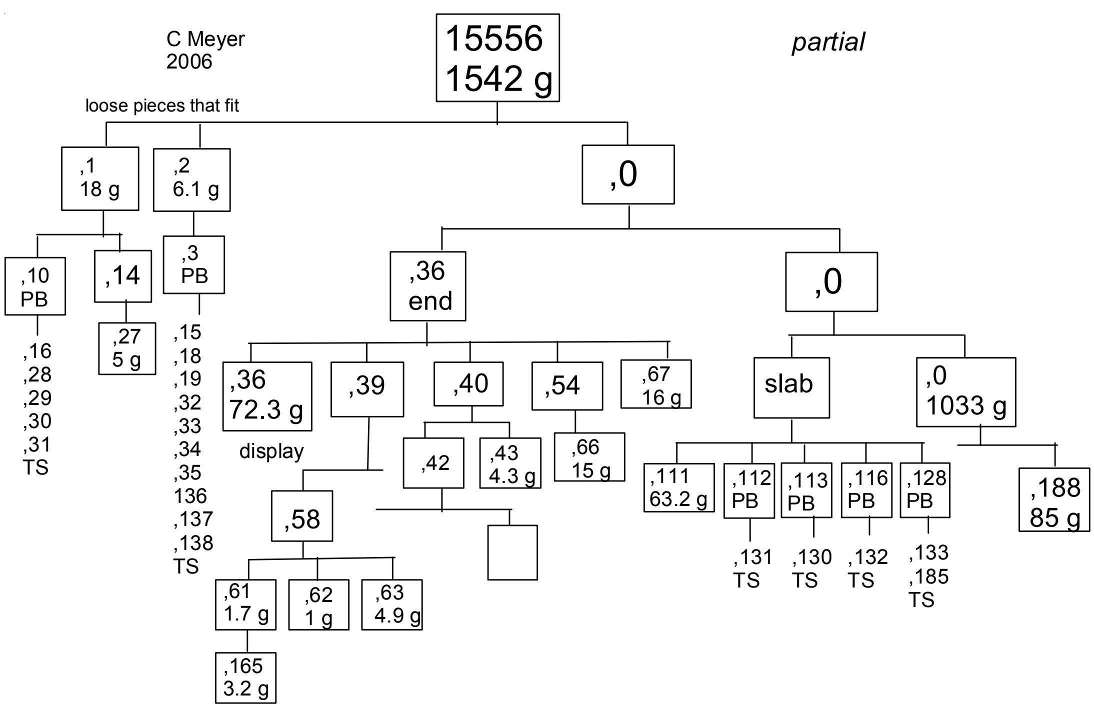


Figure 8: Photo of 15556,188. NASA S97-16862. Large vesicles are about 8 mm.



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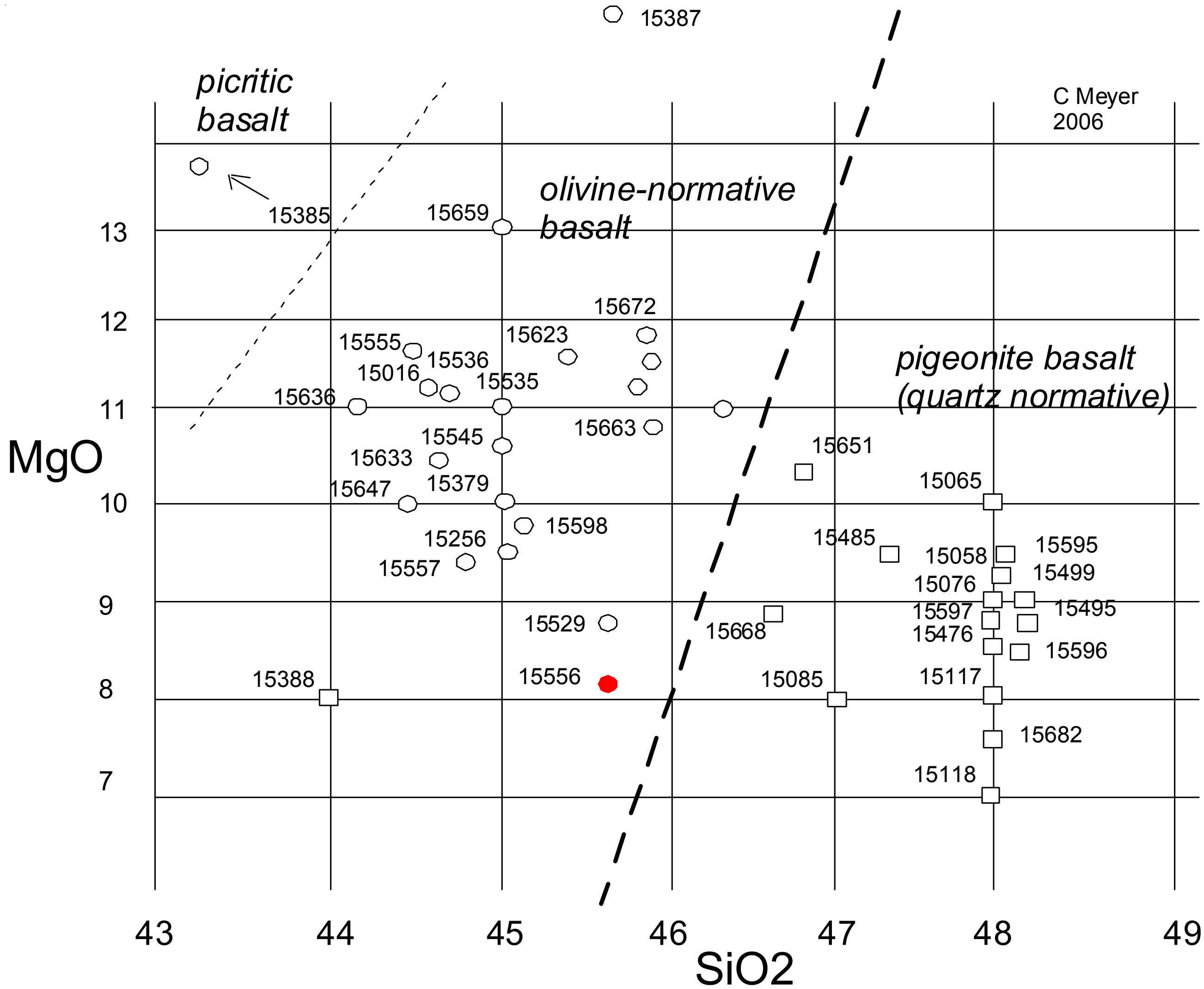

Figure 9: Composition of Apollo 15 basalts with 15556 highlighted.

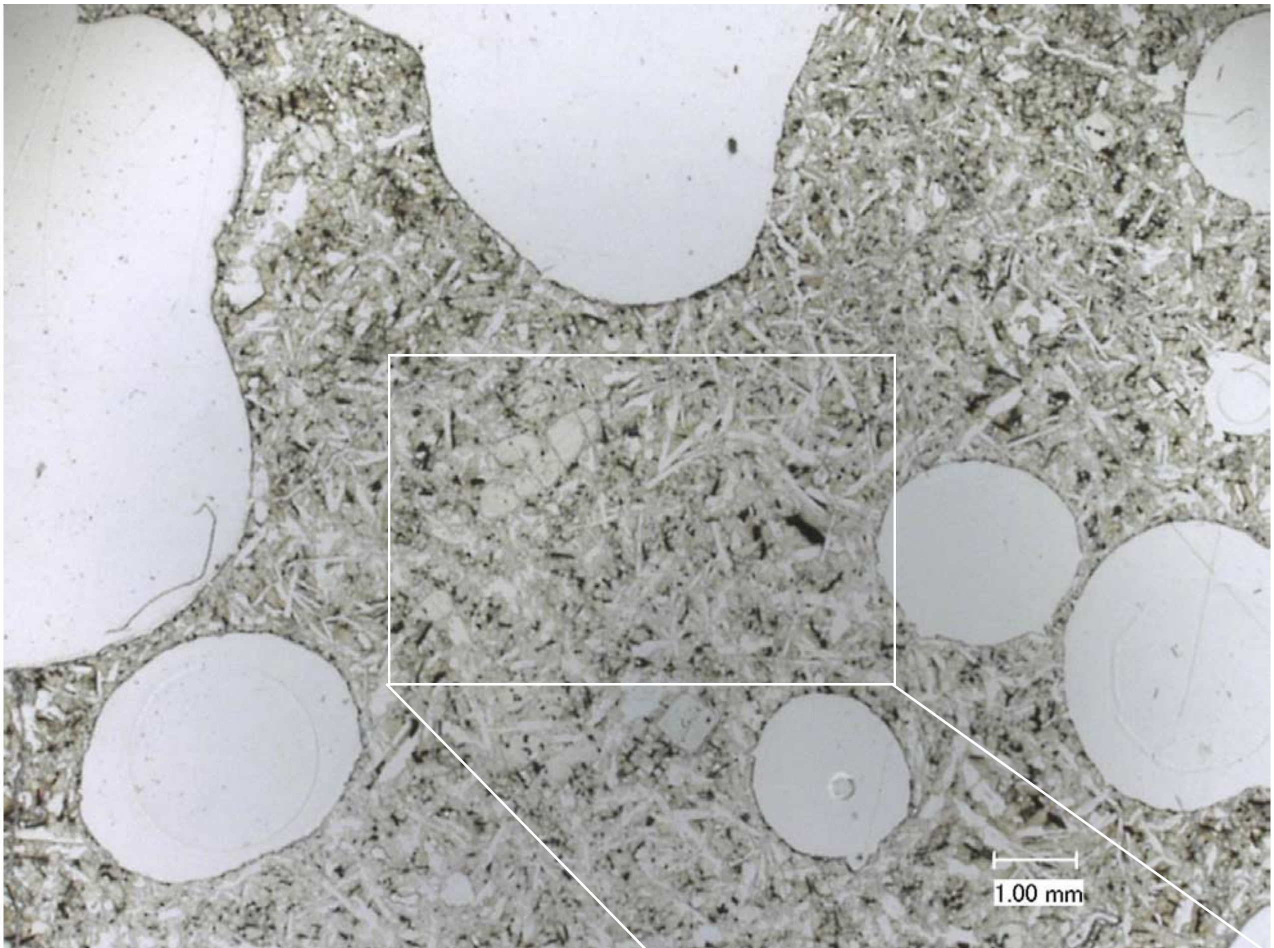

Figure 10: Photomicrographs of thin section 1555,234 by C Meyer @ 20 and 50 x.

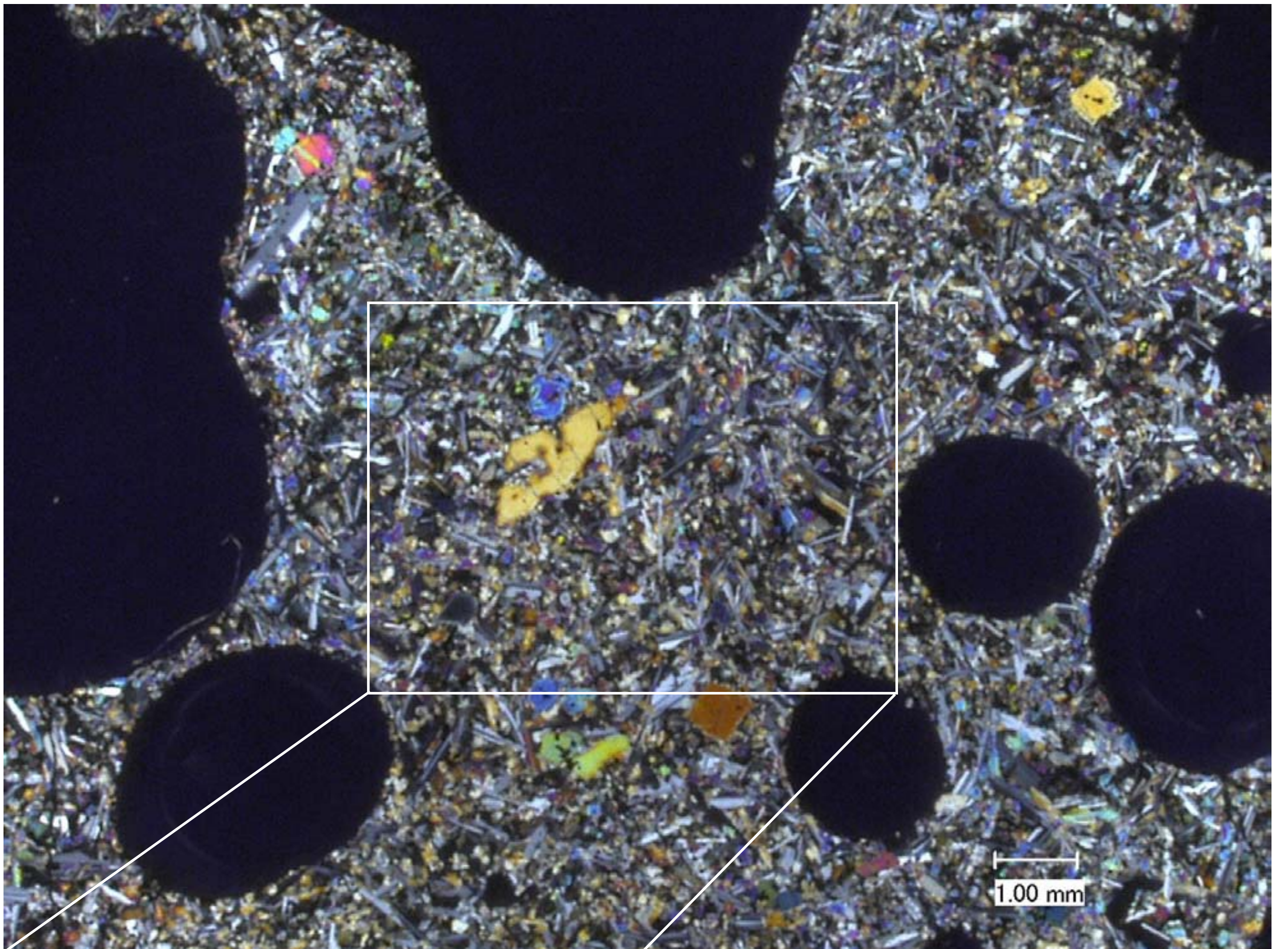

Figure 11: Photomicrographs of thin section 1555,234 by C Meyer @ 20 and 50 x (crossed polarizers).