15546 and 15547

Coarse-grained, olivine-normative Basalt

27.8 and 20.1 grams

Figure 1: Photo of 15546. NASA S71-44923. Sample is 3.5 cm across.

Figure 2a: Photo of 15547. NASA S71-44948. Sample is 3.5 cm across.

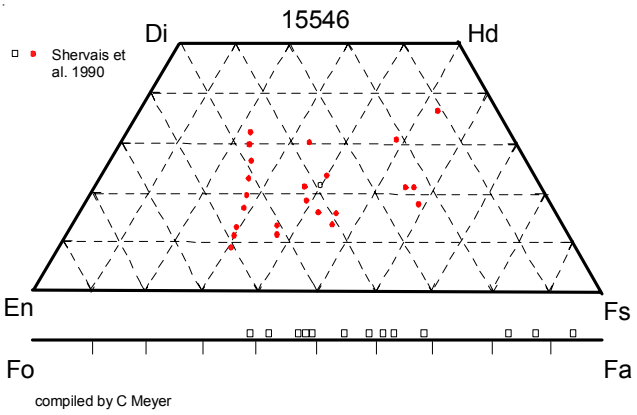


Figure 1b: Pyroxene and olivine composition of 15546 (Shervais et al. 1990).

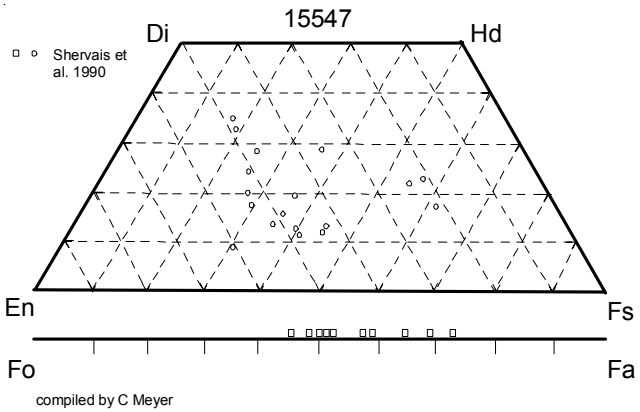


Figure 2b: Pyroxene and olivine composition of 15547 (Shervais et al. 1990).

Introduction

Lunar samples 15546 and 15547 were collected from near the edge of Hadley Rille in an area called The Terrace (see picture in 15595). The lunar regolith was thin in this area, with abundant rock samples (basalts) exposed (Swann et al. 1971).

Petrography

Ryder (1985) and Shervais et al. (1990) give the only description. The samples are similar, with a rather coarse-grained, granular texture (figures 3 and 4). Olivine grains are found in the centers of pigeonite. Opaque minerals are found in groups (segregations?)(figure 3). The mesostasis includes

Mineralogical Mode for 15546 and 15547

	Sample Catalog		Shervais et al. 1990	
	Butler 1971	**15547**	**15546**	**15547**
Olivine	1 %	10	13	17
Pyroxene	55	50	48	47
Plagioclase	45	40	29	27
Silica			1.3	3
Opaques	1	2	5	3
Fayalite			1.4	1
Mesostasis			1.8	1.4

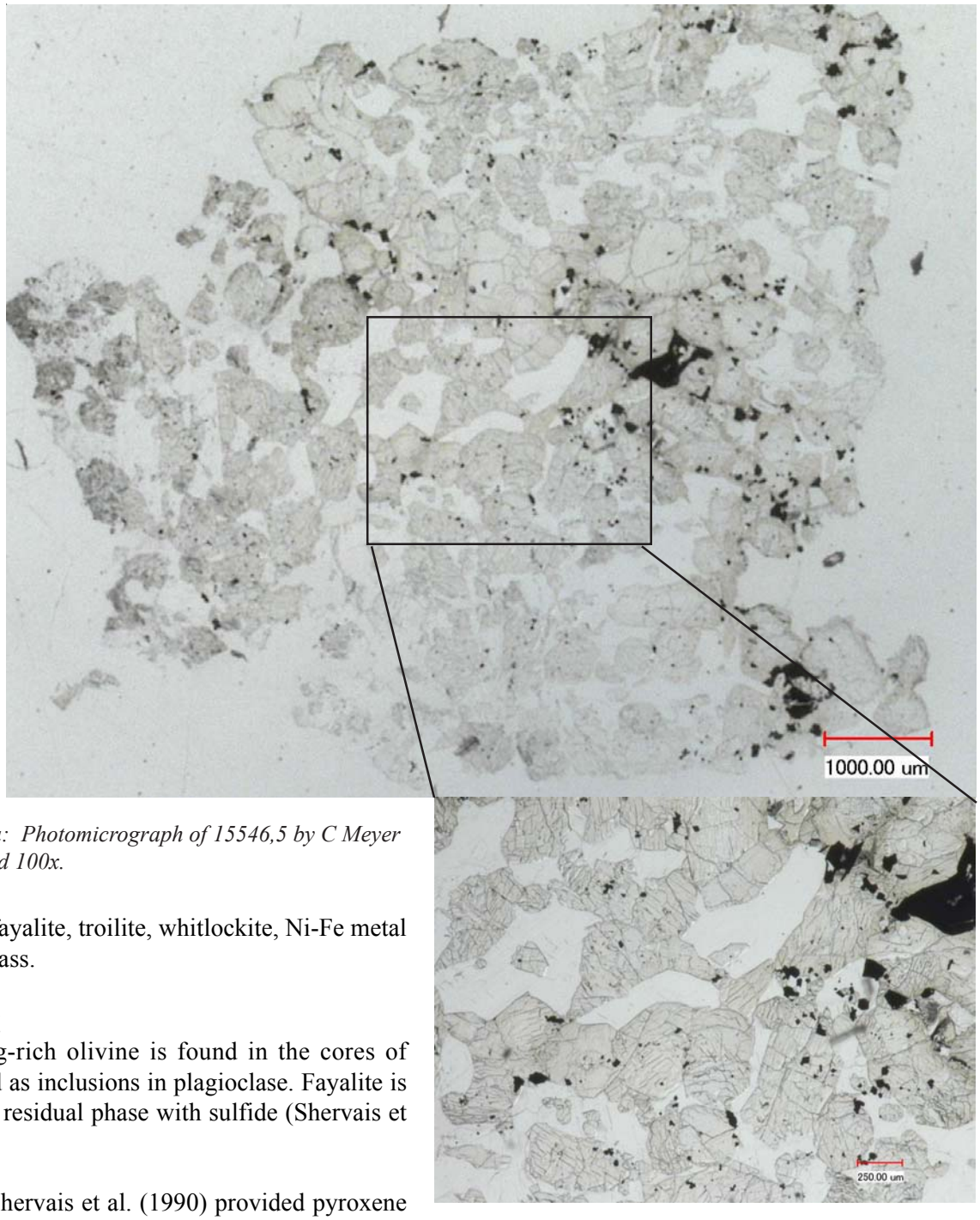


Figure 3a: Photomicrograph of 15546,5 by C Meyer at 30x and 100x.

cristobalite, fayalite, troilite, whitlockite, Ni-Fe metal and brown glass.

Mineralogy

Olivine: Mg-rich olivine is found in the cores of pyroxene and as inclusions in plagioclase. Fayalite is reported as a residual phase with sulfide (Shervais et al. 1990).

Pyroxene: Shervais et al. (1990) provided pyroxene analysis (figures 1b and 2b).

Plagioclase: Shervais et al. (1990) determined plagioclase is An_{90-80}.

Silica: Ryder (1985) reports that crystobalite is ubiquitous.

Chemistry

Shervais et al. (1990), Ryder and Schuraytz (2001) and Neal (2001).have analyzed 15546 and 15547 (table 1)(figures 5 and 6). They are typical olivine-normative basalts (figure 7).

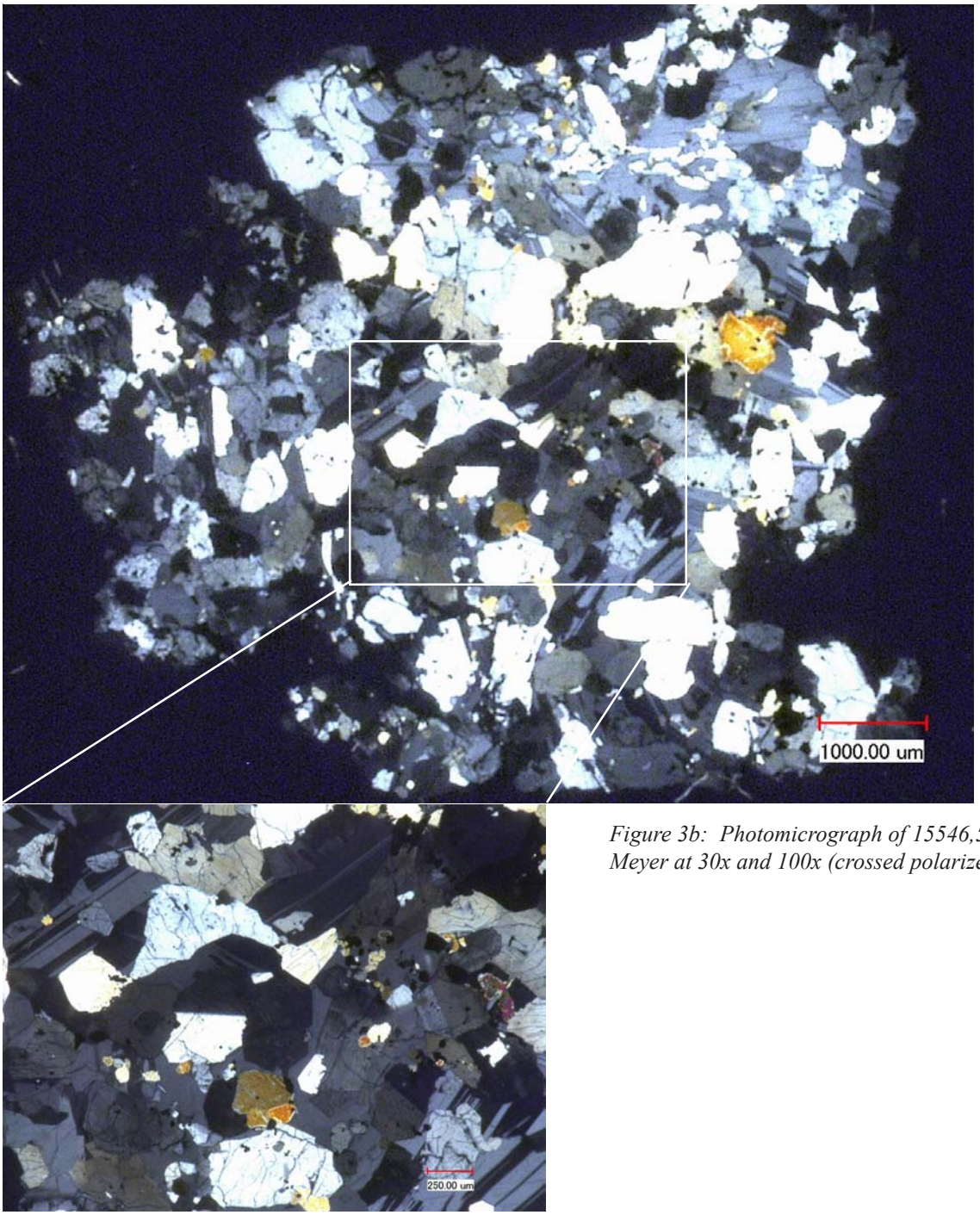


Figure 3b: Photomicrograph of 15546,5 by C Meyer at 30x and 100x (crossed polarizers).

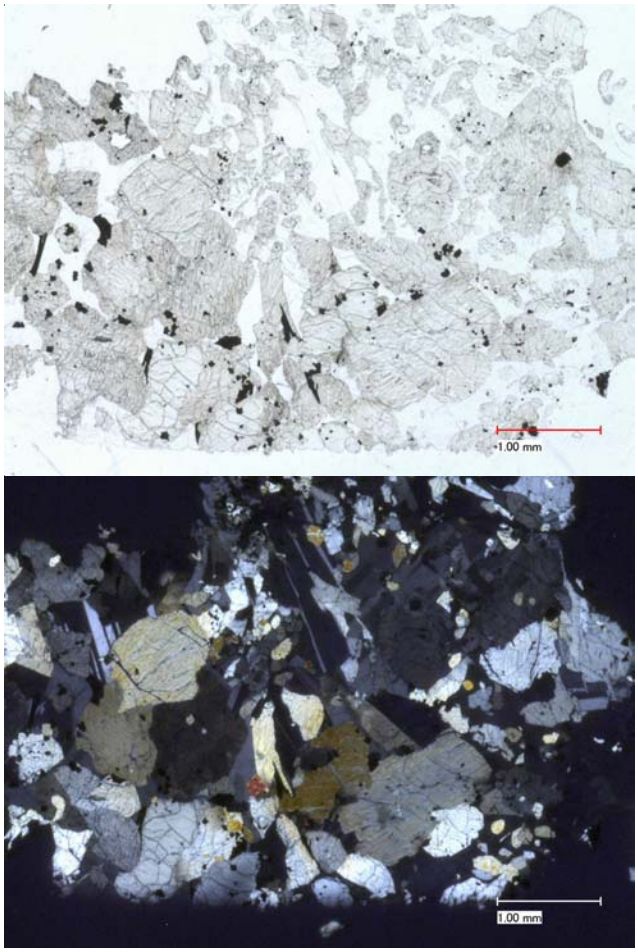


Figure 4: Photomicrographs of thin section 15547,6 by C Meyer @ 30x (bottom is with crossed nicols).

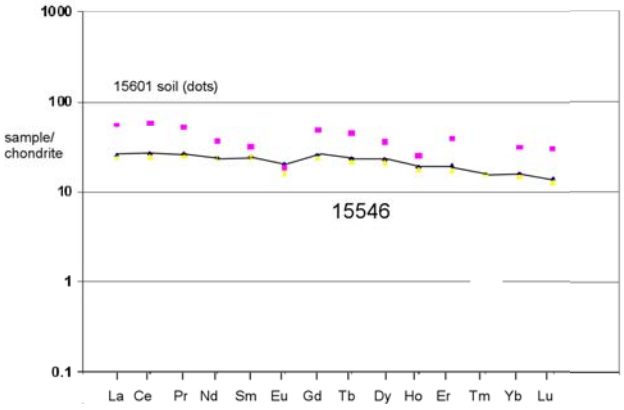


Figure 5: Normalized rare-earth-element pattern for 15546 compared with soil 15601.

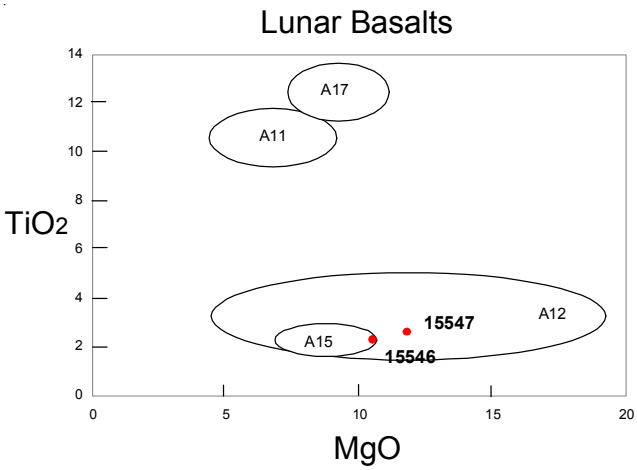


Figure 6: Chemical composition of 15546 and 15547 compared with that of other lunar basalts.

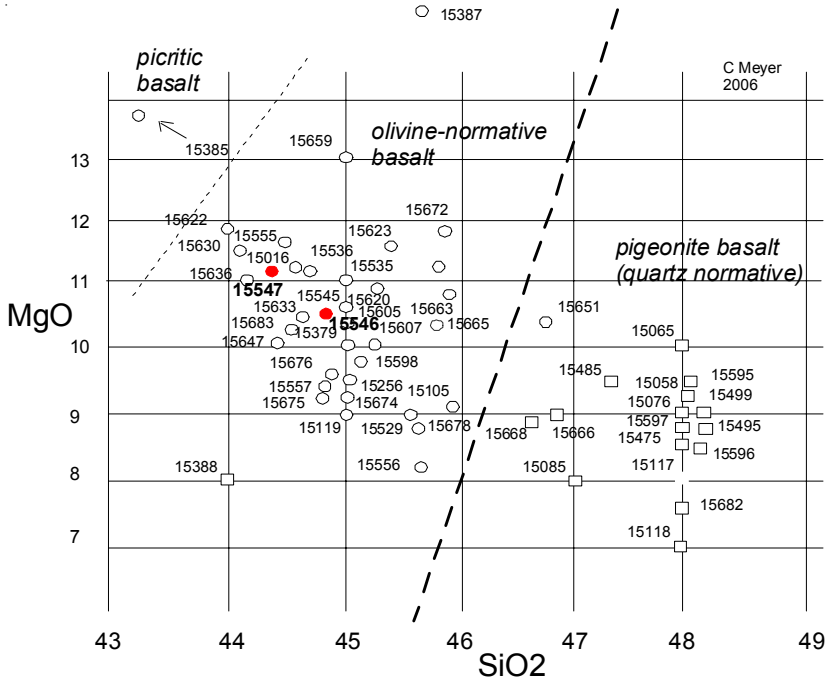
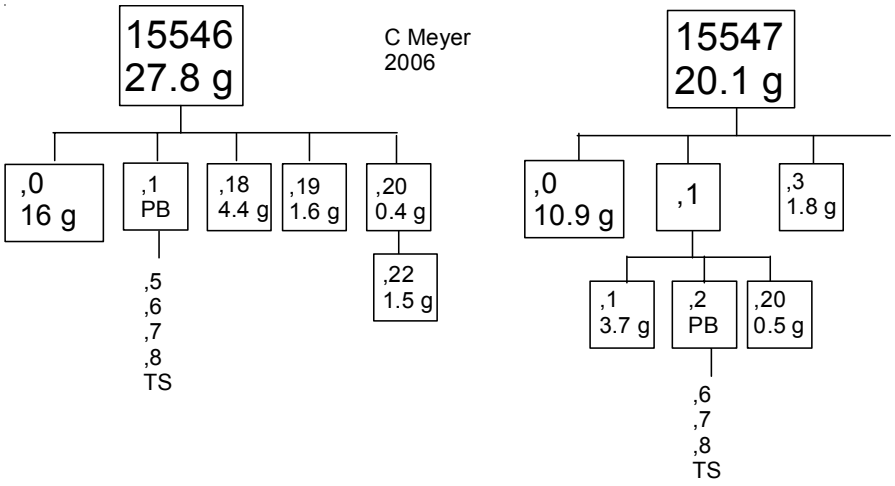


Figure 7: The big picture.

Table 1. Chemical composition of 15546 and 15547.

	15546				15546	15546			15547				15547	15547	
reference	Ryder2001				Neal2001	Shervais90			Ryder 2001				Neal2001	Shervais90	
weight	5 g					0.3 g			4.4 g					A+B	
SiO2 %	44.8	(a)				45.2	(c)		44.3	(a)				43.8	(c)
TiO2	2.43	(a)				1.98	(c)		2.3	(a)				2.47	(c)
Al2O3	8.55	(a)				8.78	(c)		8.29	(a)				7.43	(c)
FeO	22.4	(a)	22.8	(b)		21.08	(c)	20.1 (b)	22.75	(a)	22.8	(b)		24.44	(c)
MnO	0.282	(a)				0.28	(c)		0.283	(a)				0.32	(c)
MgO	10.43	(a)				11.41	(c)		11.35	(a)				11.23	(c)
CaO	9.59	(a)				9.91	(c)		9.26	(a)				9.15	(c)
Na2O	0.232	(a)	0.251	(b)		0.27	(c)	0.28 (b)	0.216	(a)	0.244	(b)		0.24	(c)
K2O	0.046	(a)				0.02	(c)		0.044	(a)				0.04	(c)
P2O5	0.069	(a)				0.04	(c)		0.069	(a)				0.07	(c)
S %															
sum															
Sc ppm			42.8	(b)	43.3 (d)			41.6 (b)			40.9	(b)	52 (d)	41.9	(b)
V					254 (d)								316 (d)		
Cr	4354	(a)	4320	(b)	4323 (d)	4447	(c)	4270 (b)	4657	(a)	4570	(b)	6253 (d)	4310	(c)
Co			55.2	(b)	58.2 (d)			51 (b)			58	(b)	71.3 (d)	57.6	(b)
Ni	97	(a)	74	(b)	65.8 (d)			75 (b)	62	(a)	83	(b)	85.6 (d)	65	(b)
Cu	13	(a)			16.8 (d)				11	(a)			15.4 (d)		
Zn					20.6 (d)								19.4 (d)		
Ga					3.9 (d)								3.9 (d)		
Ge ppb															
As															
Se															
Rb	*5*	(a)			1.02 (d)				6	(a)			1.04 (d)		
Sr	93	(a)	124	(b)	106 (d)			120 (b)	92	(a)	114	(b)	106 (d)	105	(b)
Y	26	(a)			31.7 (d)				23	(a)			31.5 (d)		
Zr	89	(a)			107 (d)			<150 (b)	90	(a)			115 (d)	110	(b)
Nb	12	(a)			6.94 (d)				16	(a)			7.12 (d)		
Mo					0.1 (d)								0.36 (d)		
Ru															
Rh															
Pd ppb															
Ag ppb															
Cd ppb															
In ppb															
Sn ppb															
Sb ppb					(d)								40 (d)		
Te ppb															
Cs ppm					0.03 (d)								0.03 (d)		
Ba			47	(b)	60.2 (d)			39 (b)			58	(b)	55.4 (d)	52	(b)
La			5.39	(b)	5.89 (d)			2.64 (b)			5.09	(b)	5.28 (d)	5.34	(b)
Ce			15.4	(b)	15.7 (d)			8.1 (b)			15.5	(b)	15.1 (d)	15.2	(b)
Pr					2.29 (d)								2.28 (d)		
Nd			11	(b)	10.7 (d)						9	(b)	10.5 (d)		
Sm			3.83	(b)	3.57 (d)			2 (b)			3.57	(b)	3.59 (d)	3.83	(b)
Eu			0.9	(b)	0.95 (d)			0.71 (b)			0.86	(b)	0.87 (d)	0.875	(b)
Gd					4.99 (d)								4.8 (d)		
Tb			0.84	(b)	0.83 (d)			0.46 (b)			0.74	(b)	0.82 (d)	0.85	(b)
Dy					5.4 (d)								5.04 (d)		
Ho					1.03 (d)								0.97 (d)		
Er					3.05 (d)								2.72 (d)		
Tm					0.38 (d)								0.36 (d)		
Yb			2.37	(b)	2.54 (d)			1.4 (b)			2.18	(b)	2.3 (d)	2.35	(b)
Lu			0.32	(b)	0.33 (d)			0.19 (b)			0.29	(b)	0.29 (d)	0.332	(b)
Hf			2.82	(b)	2.83 (d)			1.55 (b)			2.55	(b)	2.63 (d)	2.88	(b)
Ta			0.41	(b)	0.44 (d)			0.2 (b)			0.38	(b)	0.4 (d)	0.41	(b)
W ppb					10										
Re ppb															
Os ppb															
Ir ppb															
Pt ppb															
Au ppb															
Th ppm			0.38	(b)	0.59 (d)			0.17 (b)			0.4	(b)	0.49 (d)	0.49	(b)
U ppm					0.18 (d)			0.13 (b)					0.12 (d)	0.15	(b)

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



References for 15546 and 15547

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

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.

Ryder G. (1985) Catalog of Apollo 15 Rocks (three volumes). Curatoial 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.