STILL NOT KEEPING UP WITH THE LUNAR METEORITES – 2017. R. L. Korotev[1] and A. J. Irving[2], [1]Department of Earth & Planetary Sciences and McDonnell Center for the Space Sciences, Washington University, Saint Louis MO 63130; [2]Department of Earth & Space Sciences, University of Washington, Seattle, WA 98195; korotev@wustl.edu

Since our abstract of last year [1], 37 new lunar meteorite stones with a total mass of 30.086 kg have been reported in the Meteoritical Bulletin database [2]. One of the stones is from Oman (Dhofar 2047) and the remaining 36 are from Northwest Africa (NWA). We have obtained compositional data on multiple subsamples of 23 of the stones by INAA [3]. We have also obtained INAA data from another 9 stones approved prior to 2016 (1 Oman, 7 NWA; Table 1). In total, the new data are based on 136 subsamples.

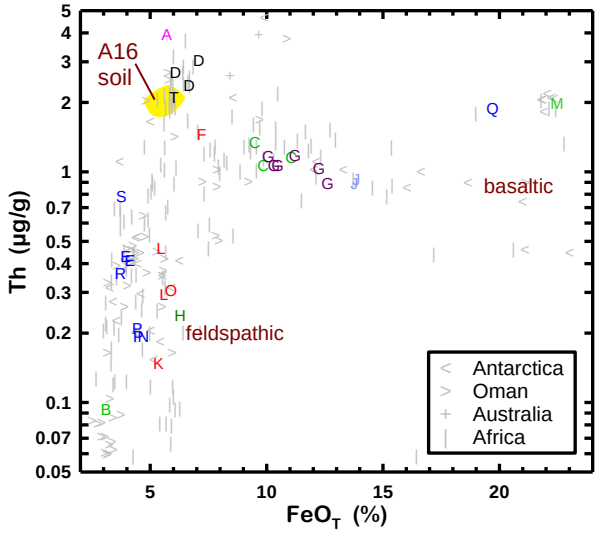

Figure 1. Newly analyzed lunar meteorites are represented by colored letters; see Table 1 for legend. Light gray symbols represent previously analyzed meteorites.

Summary. We assume pairing relationships on the basis on compositional similarities and differences (Table 1; Fig. 1). Eight of the meteorites appear to be unpaired with previously known stones. Seven of the stones are typical feldspathic lunar meteorites in composition. Eleven stones representing three meteorites are of intermediate iron concentration and presumably derive from areas on the lunar surface where mixing between mare and highlands materials mixed. For the petrography of one of these stones, NWA 10989, see [4]. NWA 10597 is an unbrecciated mare basalt identical to NWA 4734 [5]. NWA 10656, an olivine diabase, is yet another lithology of the NWA 773 clan [6].

Lunar meteorites compositionally similar to regolith from Apollo 16. At the time of the Apollo missions the Apollo 16 site was expected to be typical of the feldspathic highlands (FHT) [8]. It was not until there were several feldspathic lunar meteorites [9] and the results of gamma-ray spectrometer onboard Lunar Prospector were assimilated [10] that it became evident that the Apollo 16 site was not typical of the feldspathic highlands because it was 'contaminated' with mafic, Th-rich ejecta from the Imbrium impact into the PKT (Procellarum KREEP Terrane) [11–13]. In terms of the mixing triangle of Fig. 2, the Apollo 16 soils contain about 10–13% Th-rich PKT component.

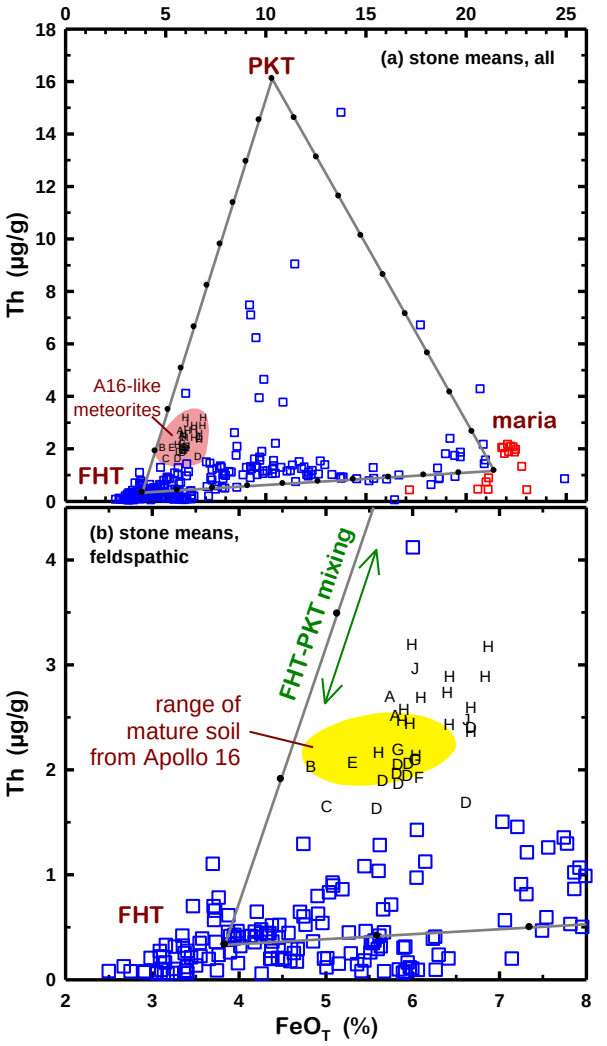

Figure 2. (a) The Apollo mixing triangle of [16] with apices defined by the mean composition of the typical feldspathic lunar meteorites (FHT), the mean composition of the mare basalt meteorites (maria), and Apollo 14 melt breccias PKT, KREEP). The dots represent 10% mixing increments. (b) The 33 stones that have compositions like Apollo 16 soil represent 9 meteorites (Fig. 3b) These stones plot to the high-FeO side of the FHT-PKT mixing line probably because, like Apollo 16 soil, they contain a minor component of mare basalt [17].

Nine lunar meteorites have compositions like Apollo 16 soil (Fig. 2b, 3). For most, the similarity includes

Table 1. Lunar meteorites analyzed since last year's abstract [1]

stone name	where	plot	new, or likely paired with	mass (g)	FeO (%)	Th (µg/g)	comp. type
Dhofar 1769	Oman	A	new	125.4	6.0	4.1	atyp. felds.
Dhofar 2047	Oman	B	303 & pairs	4.95	3.1	0.09	troct. anor.
Galb Inal	NWA	C	10149 & pairs	4050.	9.9	1.1	mafic
La'gad	NWA	D	8455 & pairs	337.74	6.9	3.2	A16-like
NWA 8651	NWA	D	8455 & pairs	598.	6.1	2.7	A16-like
NWA 10141	NWA	E	new	39.	3.9	0.4	typ. felds.
NWA 10172	NWA	C	10149 & pairs	788.	11.1	1.2	mafic
NWA 10258	NWA	F	new	58.	7.2	1.5	nor. anor.
NWA 10317	NWA	G	7834 & pairs	11.0	10.5	1.1	mafic
NWA 10318	NWA	H	5744 & pairs	31.0	6.3	0.24	troct. nor.
NWA 10376	NWA	G	7834 & pairs	20.	10.3	1.1	mafic
NWA 10415	NWA	E	10141	164.	4.1	1.4	typ. felds.
NWA 10461	NWA		n.a.	285.75	n.a.	n.a.	?
NWA 10480	NWA	J	7611 & pairs	33.	13.8	0.9	bas. brec.
NWA 10495	NWA	K	new	15600.	5.4	0.15	nor. anor.
NWA 10509	NWA	L	new	660.	5.5	0.5	nor. anor.
NWA 10546	NWA	G	7834 & pairs	43.35	10.1	1.2	mafic
NWA 10566	NWA	J	7611 & pairs	130.	13.9	0.9	bas. brec.
NWA 10597	NWA	M	4734	350.	22.5	2.0	mare basalt
NWA 10599	NWA	G	7834 & pairs	77.8	12.3	1.0	mafic
NWA 10608	NWA		n.a.	2014.	n.a.	n.a.	?
NWA 10609	NWA	N	10309	43.02	4.6	0.18	typ. felds.
NWA 10621	NWA	D	8455 & pairs	22.	6.7	2.4	A16-like
NWA 10626	NWA	O	new	1849.	5.9	0.3	nor. anor.
NWA 10643	NWA		n.a.	43.56	n.a.	n.a.	?
NWA 10644	NWA	C	10149 & pairs	166.	9.5	1.3	mafic
NWA 10649	NWA	P	8046 & pairs	41.3	4.5	0.19	typ. felds.
NWA 10656	NWA	Q	773 & pairs	262.5	19.7	1.9	ol. diabase
NWA 10665	NWA	R	new	24.73	3.7	0.4	typ. felds.
NWA 10678	NWA	S	new	49.15	3.8	0.8	typ. felds.
NWA 10713	NWA		n.a.	60.2	n.a.	n.a.	?
NWA 10756	NWA	P	8046 & pairs	125.0	4.4	0.21	typ. felds.
NWA 10782	NWA		n.a.	39.0	n.a.	n.a.	?
NWA 10783	NWA		n.a.	22.0	n.a.	n.a.	?
NWA 10798	NWA	L	10509 & pairs	318.6	5.6	0.3	nor. anor.
NWA 10810	NWA	G	7834 & pairs	402.4	11.2	1.2	mafic
NWA 10822	NWA		n.a.	56.	n.a.	n.a.	?
NWA 10823	NWA		n.a.	202.	n.a.	n.a.	?
NWA 10901	NWA		n.a.	68.04	n.a.	n.a.	?
NWA 10902	NWA		n.a.	36.28	n.a.	n.a.	?
NWA 10964	NWA		n.a.	26.	n.a.	n.a.	?
NWA 10973	NWA	T	8010 & pairs	25.	6.0	2.1	atyp. felds.
NWA 10985	NWA		733 & pairs?	250.	n.a.	n.a.	gabbro [7]
NWA 10986	NWA		n.a.	108.2	n.a.	n.a.	?
NWA 10989	NWA	G	7834 & pairs	14.4	12.6	1.0	mafic
NWA 11006	NWA		n.a.	2245.	n.a.	n.a.	?

Abbreviations: A16 = Apollo 16; anor. = anorthosite; atyp. = atypical; bas. = basaltic; brec. = breccia, comp. = compositional; felds. = feldspathic; n.a. = not analyzed; nor. = noritic; ol. = olivine; troct. = troctolitic; typ. = typical

the moderately high concentrations of siderophile elements (e.g., mean Ni = 480 µg/g) that are characteristic of Apollo 16 soils as well as subchondritic Ir/Ni ratios [14]. Given that Th concentrations on the lunar surface decrease continuously with distance from the PKT (e.g., [12]), one might expect a continuum of lunar meteorites plotting along or near the FHT-PKT side of the triangle (Fig. 2). Instead, there is a cluster and there is only one meteorite, Dhofar 1769 (Fig. 1), that plots along the FHT-PKT mixing line of Fig. 2 at higher Th concentration than that for the Apollo-16-like meteorites. The latter cannot all come from the Apollo 16 area and only 3% of the lunar surface falls compositionally within the range of the Apollo 16-like meteorites of Fig. 2 (4.8–6.9% FeO and 1.6–3.2 µg/g Th; from data of [15]). So, why are there so many lunar meteorites with compositions similar to Apollo 16 soil? Fortuity happens?

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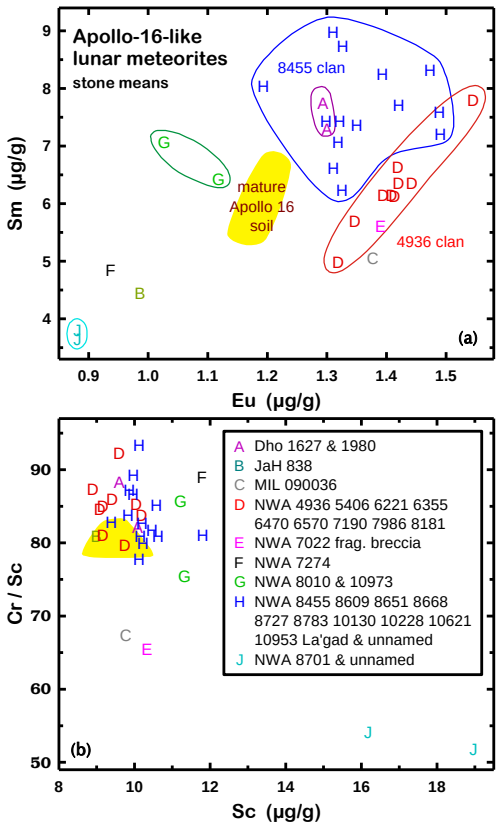

Figure 3. Meteorites of similar composition in Fig. 2b are distinguished from each other by other elements. There is a strong suggestion in the compositional data that NWA 7022 (E) is launch paired with MIL 090036 [C] and that NWA 1627/1980 [A] is launch paired with the NWA 8455 clan [H], which would lower the number of source craters represented here from 9 to 7.