LUNAR METEORITE EET 96008, PART II. WHOLE-ROCK TRACE-ELEMENT AND PGE CHEMISTRY, AND PAIRING WITH EET 87521

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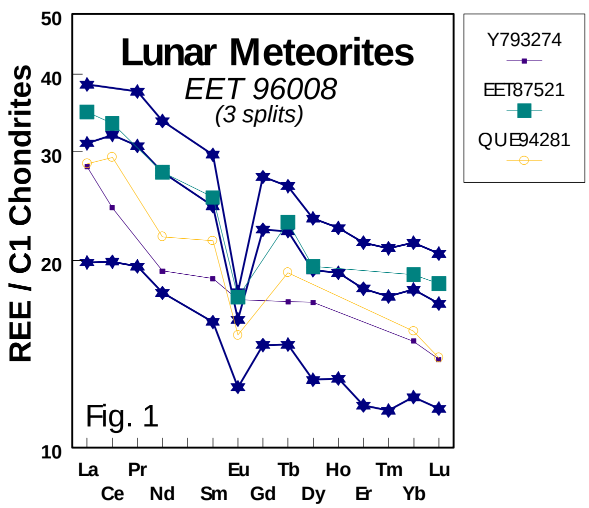
The newly discovered lunar meteorite, EET 96008, is a complex breccia with minor basaltic and mostly highlands clasts, and exhibiting abundant mineralogical evidence of late-stage, igneous melt fractionation. We report trace-element analyses, including the REE and PGEs for several splits of this lunar meteorite. We show that the whole-rock chemistry of this lunar meteorite is nearly indistinguishable from lunar meteorite EET 87521. Mineralogical studies [1] indicate that portions of EET 96008 may either represent a late-stage fractionate of a mare basalt or deep-seated crustal material. However, trace-element modelling leads to the conclusion that EET 96008 (as well as EET 87521) contains a significant KREEP component and is not related to VLT mare basalt, as earlier proposed for EET 87521 [2].

INTRODUCTION -- During the 1995-1996 ANSMET field season, a 52.97 g (4.5 x 3.5 x 1.5 cm) chunk of a lunar meteorite was collected, the 16th (14th if pairings are considered). Preliminary investigation



did not indicate the unusual nature of this sample, which was classified as a "lunar basaltic breccia" [3]. We were allocated three 151 to 172 mg sub-samples of this lunar meteorite [1]. Trace-elements were analyzed by ICP-MS on splits from each of the sub-samples using methods described elsewhere [4]. The remaining material from each of the three sub-samples was then combined and analyzed for the platinum-group elements (PGEs) [5].

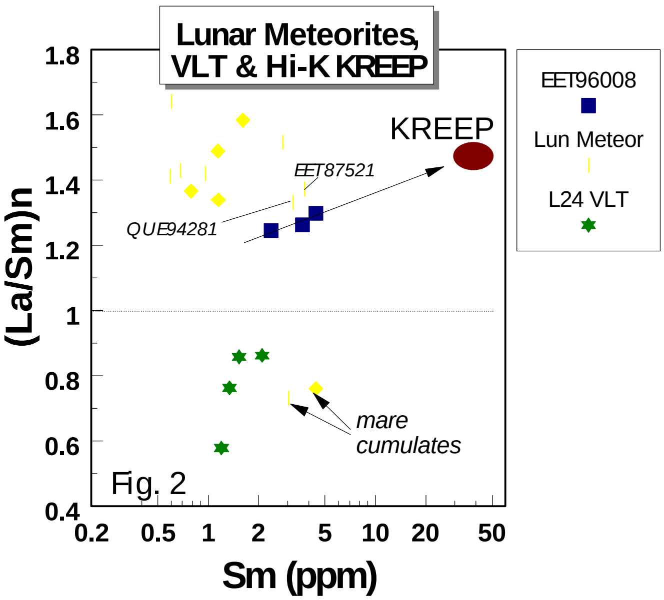
TRACE-ELEMENT CHEMISTRY – Although there is substantial variation among the three splits analyzed for EET 96008 (Table 1), the relative trace-element patterns are indistinguishable. Compared to other lunar meteorites, our three splits of EET 96008 are among those with the highest REE abundances (Fig. 1). Note especially the similarity of these splits to previously analyzed lunar meteorite EET 87521 [2].

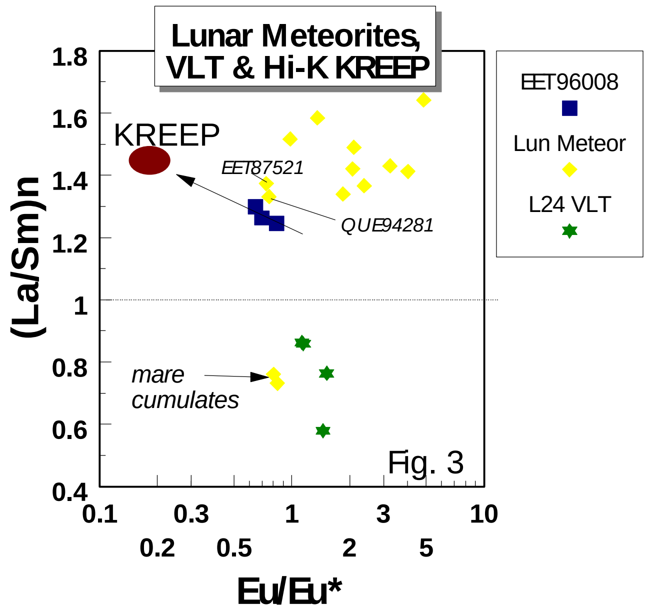
PGE CHEMISTRY – We analyzed the platinum-group elements (PGEs) in a bulk sample of EET96008 which yielded: Ru = 1.2 ppb; Rh = 0.55 ppb; Pd = 3.9 ppb; Ir = 0.93 ppb; Pt = 12.4 ppb. Warren & Kallemeyn [6] analyzed several PGEs/noble metals in two splits of EET 87521 and obtained the following abundances: Re = 0.0113-0.050 ppb; Os = 0.089-0.64 ppt; Ir = 0.095-0.51 ppb; Au = 0.059-0.22 ppb. Thus, although there is nearly an order of magnitude variation between the two splits of EET87521 and only Ir is in common with EET96008, the similarities between the two lunar meteorites persists.

Table 1: Trace-Element Abundances (ppm) in Splits of EET 96008 & Comparison With EET 87521

	,20	,21	,26	EET 87521*
Li	4.39	3.99	5.26	-----
Be	0.82	0.60	0.99	-----
Sc	45.41	40.81	46.71	44.0
V	103.98	128.16	97.01	80
Cr	1785	2530	1467	1470
Ga	6.75	6.32	7.41	5.27
Rb	1.37	0.78	1.89	<4
Sr	112.4	109.2	116.8	104
Y	33.40	26.40	39.82	-----
Zr	112.0	94.3	140.8	140
Nb	6.85	5.00	9.11	-----
Cs	0.06	0.02	0.07	0.041
Ba	80.17	48.47	91.66	88
La	7.30	4.69	9.08	8.3
Ce	19.66	12.28	31.35	20.9
Nd	12.71	8.12	15.36	13.0
Sm	3.65	2.38	4.42	3.86
Eu	0.90	0.70	1.00	0.98
Gd	4.42	2.88	5.38	-----
Tb	0.79	0.52	0.94	0.80
Dy	4.73	3.15	5.73	4.8
Er	2.89	1.87	3.42	-----
Yb	2.86	1.92	3.40	3.19
Lu	0.42	0.28	0.50	0.48
Hf	2.42	1.70	3.02	2.88
Ta	0.34	0.22	0.55	0.37
W	0.18	0.09	0.21	-----
Pb	0.80	0.24	0.99	-----
Th	0.82	0.51	1.10	0.95
U	0.30	0.19	0.35	0.23

* from Warren & Kallemeyn (1989)





PETROGENESIS – The petrology, mineral chemistry [1], and trace-element chemistry of EET 96008 are nearly indistinguishable from lunar meteorite EET 87521 (Table 1). In fact, we suggest that these two lunar meteorites are paired. Warren & Kallemeyn [2] concluded that EET 87521 is "dominated by a single rock type: VLT mare basalt." However, simple trace-element mass-balance considerations do not support such a model for petrogenesis of these paired meteorites (Fig. 2). These two lunar meteorites have higher (La/Sm)n ratios than either the VLT mare basalts (data from Blanchard et al. [7] and Laul et al. [8]) or known mare cumulates in the lunar meteorite collection (Y 793169 and Asuka 881757). With the exception of these two mare cumulates, all other lunar meteorites are demonstrably LREE-enriched, similar to other highlands material such as ferroan anorthosites and KREEP-dominated rocks.

Further evidence of a KREEP connection is seen in the REE patterns of the three splits from EET 96008 (Figs. 1-3). The Eu anomalies in these three samples become more pronounced with increasing LREE-enrichment and increasing REE abundances (Fig. 3). This is typical of samples that have experienced increasing addition of a KREEP component. Furthermore, these three splits project towards high-K KREEP (as per Warren [9]). ***These three splits of EET 96008, as well as sample EET 87521, have no chemical affinities for either VLT mare basalts or those lunar meteorites suggested to be of mare derivation. Their chemistry is best explained by KREEP addition to mostly highlands material.***

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