EVIDENCE FOR MAGMATIC DIFFERENTIATION IN MATRIX LITHOLOGIES OF BASALTIC LUNAR METEORITE EET87521. Marilyn M. Lindstrom, NASA Johnson Space Center, Houston TX, 77058, Rene R. Martinez, Lockheed ESC, Houston TX 77058, and Michael E. Lipschutz, Purdue University, W. Lafayette IN 47907.

EET87521 was identified last year as the first basaltic lunar meteorite (1,2). It is a fragmental breccia consisting of clasts of mare basalt in a matrix of crushed basalt fragments. It also contains dark glass and a few light colored clasts. Its Fe-rich bulk composition (2) is very similar to that of Luna 24 VLT mare basalt. However, EET87521 has significantly higher REE concentrations than most mare basalts, with a LREE-enriched pattern more similar to that of KREEP than to the LREE-depleted patterns common for mare basalts. Because EET87521 is a breccia, bulk analyses are insufficient to determine whether the KREEP-like REE are indigenous to the basalt or added in the brecciation process.

Detailed consortium studies were undertaken with Delaney and Warren to evaluate petrographic and compositional differences among various matrix and clast lithologies. Two prominent light clasts and two basalt clasts were separated and are described by (3). Areas of dark and light matrix were also separated for compositional and petrographic study. The dark matrix contains more dark glass, which preliminary studies by Delaney suggested might be the location of the high REE concentrations. We report here major element and preliminary INAA studies of these light and dark matrix lithologies. RNAA studies of the same samples are in progress.

Compositions of EET87521 matrix lithologies are given in Table 1, where they are compared to Warren's bulk analysis (2), to our analysis of a second basaltic lunar meteorite, Y793274 (4), and to VLT mare basalts. REE are plotted in Figure 1. The dark matrix composition is very similar to the bulk composition, as might be expected because it is the more abundant lithology. There are indeed substantial differences in composition between light and dark matrix, all elements except Si and Ca differ by more than 5%. Most pronounced is the factor of two lower Ti, REE and other incompatible element concentrations in the light matrix. The REE pattern of the light matrix looks like a mixture of KREEP-rich dark matrix and REE-poor VLT basalt. The light matrix is not, however, a simple mixing of mare basalt and KREEP because transition metals are fractionated between the lithologies with Fe, Mn and Sc concentrated by 15-30% in the dark matrix and Mg, Cr, and Ni concentrated by 30-40% in the light matrix. KREEP-mare basalt mixing would have little effect on Ti and Mg, but would concentrate Fe, Sc, Cr, Mn, Co and Ni in the basalt-rich portion and REE and other incompatible elements in the KREEP-rich portion. Addition of a magnesian highland component to the light matrix is unlikely to have caused this fractionation because it would take a significant amount of magnesian olivine or pyroxene to change the mg', and very little highly magnesian (mg'> 70) minerals are observed petrographically (3).

The most likely source of transition metal fractionation between light and dark matrix lithologies is magmatic differentiation in the EET87521 basalts. Mg, Cr, and Ni would be enriched in early-crystallized olivine and pyroxene of a primitive Mg-basalt, while Fe, Mn and Sc would be enriched in later-crystallized phases in an evolved ferrobasalt. Some evidence for this fractionation is seen in the limited more magnesian range of mineral compositions in clasts in the light matrix than in EET87521 overall (3). In fact, the light matrix composition is more similar to those of Y793274 and Apollo 17 magnesian VLT basalt than to bulk EET87521 and Luna 24 ferrobasalts (4). This is illustrated in Figure 2, where bulk compositions are plotted on a triangular diagram of Al_2O_3-FeO-MgO. The light matrix plots with Y793274 and Apollo 17 VLT basalt, while the dark matrix plots with the EET87521 bulk sample, the other two basaltic lunar meteorites, and Luna 24 VLT ferrobasalt. This suggests that magmatic fractionation is an important process in lunar meteorite VLT basalts. However, EET87521 and Y793274 are breccias and mixing may also have occurred. The higher Al contents of Y793274 and EET87521 light matrix (Fig. 2) suggest that a small amount of feldspathic highland component may have been added to the magnesian basalt. The factor of two fractionation of REE and other incompatible elements between light and dark matrix may be too extreme for magmatic differentiation and reflect addition of a small amount of a KREEP component. This is consistent with the high bulk REE concentrations and KREEP-like REE pattern. Further studies of this basaltic breccia are required to evaluate the relative importance of these processes.

References: (1) Delaney J.S. (1989) Science 342, 889-890. (2) Warren P.H. and Kallemeyn G. W. (1989) Geochim. Cosmochim. Acta 53, 3323-3330. (3) Delaney J.S. et al (1991) this volume. (4) Lindstrom M.M. et al (1991) Proc. NIPR Sym. Ant. Met., in press.

MAGMATIC DIFFERENTIATION IN EET87521 Lindstrom M.M. et al.

Table 1. Composition of EET87521, Y793274 and VLT mare basalts.

Sample	EET87521	EET87521	EET87521	EET87521	Y793274	A17VLT	L24VLT
Split	,37	,41	,42	,6	,62B	78526	
Type/Ref	ltmx	dkmx	dkmx	bulk[1]	bulk[2]	bulk[2]	bulk[1]
Wt (mg)	42.7	117	104	278	62.3	533	
SiO2 (%)	46.0	48.3	48.3	48.4	48.3	46.7	46.2
TiO2	0.43	0.76	0.82	1.12	0.57	0.92	0.85
Al2O3	15.1	12.8	12.7	12.6	13.7	10.0	13.1
FeO	15.9	18.4	18.9	19.0	15.1	18.6	18.6
MgO	10.4	7.8	8.0	6.34	9.0	12.2	6.71
CaO	11.5	11.0	11.2	11.6	12.0	10.0	13.0
Na2O	0.32	0.38	0.38	0.41	0.33	0.12	0.30
K2O	0.03	0.06	0.05	0.07	0.06	0.01	0.03
mg'	53	42	43	37	52	54	39
Sc (ppm)	26.8	36.7	42.3	44.0	37.8	51	48
Cr	2380	1910	1710	1470	2200	5070	1600
Mn	1700	1880	2170	1890	1850	2020	2200
Co	52.6	50.4	48.9	46	41.1	45.5	43
Ni	70	53	47	29	70		25
Sr	140	140	90	104	90		105
Ba	35	69	77	88	58		45
La	3.21	6.82	8.1	8.3	4.68	1.2	1.92
Ce	8	18	21	20.9	12.6		6.4
Sm	1.67	3.48	4.10	3.86	2.38	1.0	1.54
Eu	0.64	0.85	0.84	0.98	0.64	0.30	0.68
Tb	0.42	0.67	0.81	0.80	0.48		0.33
Yb	1.44	2.58	3.00	3.19	1.98	1.4	1.41
Lu	0.20	0.39	0.42	0.48	0.27	0.23	0.22
Zr		120	110	140	100		40
Hf	1.55	2.84	2.77	2.88	2.00	0.5	1.05
Ta	0.14	0.32	0.28	0.37	0.20	0.06	0.16
Th	0.35	0.95	1.13	0.98	0.53		0.20

Ref: 1. Warren and Kallemeyn (1989). 2. Lindstrom et al (1991).

Figure 1. REE in EET87521

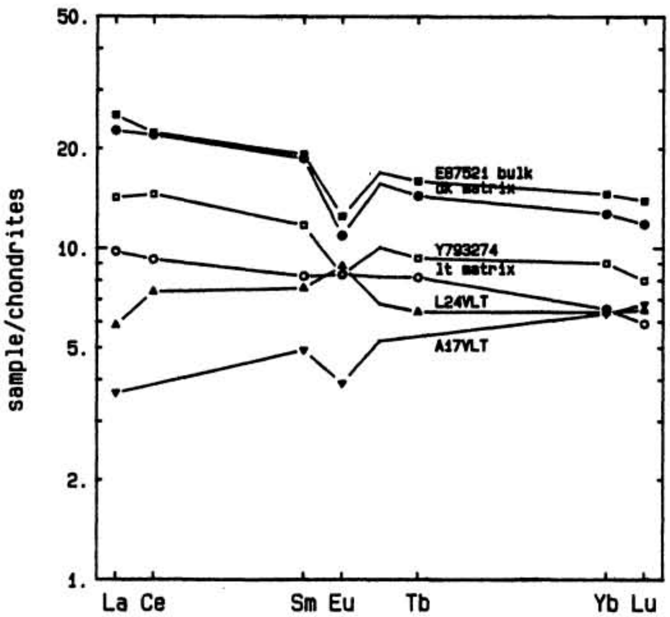

Figure 2. Bulk compositions of lunar meteorites.