

DETERMINING PARENTAL MAGMAS FOR MARE BASALTS: AN INTERIM PROPOSAL AND SYNTHESIS Gregory A. SNYDER, Lawrence A. TAYLOR, & Clive R. NEAL, Dept. of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410; *now at* Dept. of Earth Sciences, University of Notre Dame, Notre Dame, IN 45565.

The modeling of mare basalt petrogenesis is fraught with pitfalls, foremost of which is the delineation of a parental magma for each basalt type. Delano [1] and others have suggested that the primitive nature (specifically high Mg#) of basaltic glasses should make them logical candidates for mare basalt parents. However, a definitive connection between the glasses and actual mare basalts has yet to be proven (as also realized by Delano [1]). In lieu of a proposal of basaltic glasses as parents for mare basalts, we have determined the parental magma compositions from within each suite, either by calculation or simple inspection.

In delineating parental magma compositions several criteria must be met. The sample under consideration as a parent should (1) be relatively free of phenocrysts or the phenocryst compositions must be "subtracted out" in order to arrive at a liquid composition; (2) be relatively fine-grained as to make it a reliable candidate for a liquid; (3) contain the lowest incompatible element abundances (relative to other phenocryst-free samples) of that basalt type; (4) contain relatively high abundances of compatible elements; and (5) exhibit, in general, the more primitive compositions (highest Mg#) found within each suite. These conventions help alleviate confusion in the mineralogy and chemical composition of the calculated sources that may be inherent in simply averaging a group of samples (Hughes et al. [2,3], and many others, *ad nauseam*); especially those which may have experienced post-magma generation evolutionary processes (e.g. fractional crystallization, AFC, and accumulation of phenocrystic phases). We consider the parental compositions, selected using these criteria, to represent a best estimate of the parental magma for each suite at this time. Furthermore, we would propose their interim use in geochemical modeling, until such time that a connection is proven with picritic glasses (as attempted by Longhi [4]) or better candidates are analyzed from the lunar vaults. As the data base for various mare basalt types grows, the possibility that short-range unmixing is responsible for the inter-group variation can be ruled out. In fact, inter-group variation can often be explained by igneous processes such as fractional crystallization and assimilation (i.e., Shervais et al. [5]; Neal et al. [6]). Therefore, averaging a group of basalts with similar compositions has no merit. The use of average compositions in the modeling of source regions of different mare basalt types is a spurious practice which must be avoided.

To this end, we have made an attempt to compile a list of proposed parental magmas for various basalt types which are given in Table 1. Initial perusal of this table (which is itself but an incipient offering on this matter), leads to the conclusion that a variety of parental magmas (different sources?) for mare basalts may be delineated, and yet, two types are surprisingly similar. As also seen in Figure 1, the proposed parental magma for Apollo 11, Type B3 basalts and that for Apollo 17, Type C basalts are indistinct [7]. This suggests a common source for these two magma types which are from two distinct landing sites, and may indicate the lateral extent of the mantle source for an important high-Ti mare basalt type. Other similarities in parental magmas, and thus, mare basalt sources, may be indicated once a compilation of proposed parental magmas is completed. Work in this vein, toward a synthesis of mare basalt parental magma compositions, is in progress.

Figure 1

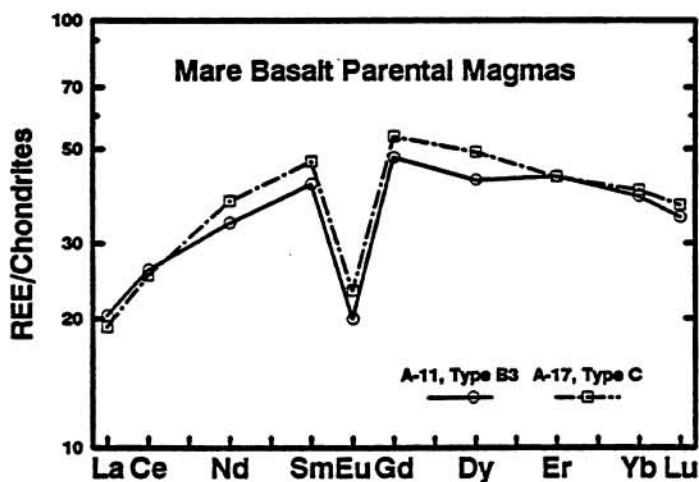


Table 1: Proposed Mare Basalt Parental Magmas

	LMO	A11,B3	A11,HK	A14,HAB	A17,A	A17,B1	A17,B2	A17,C
SiO ₂	46.0	39.60	38.84	44.7	42.9	41.7	38.3	38.5
TiO ₂	0.30	11.10	11.0	2.67	13.5	13.7	14.0	12.3
Al ₂ O ₃	7.0	9.51	8.2	11.8	7.5	8.0	7.8	8.7
FeO	12.4	19.12	21.5	18.2	17.5	17.0	20.5	18.5
MnO		0.28	0.25	0.26	0.23	0.23	0.24	0.26
MgO	27.6	8.10	8.00	11.7	9.0	10.0	9.5	9.7
CaO	5.5	11.07	11.10	9.9	9.0	9.0	8.8	10.1
Na ₂ O	0.6	0.36	0.48	0.44	0.35	0.35	0.33	0.36
K ₂ O	0.06	0.05	0.25	0.05	0.05	0.03	0.04	0.07
P ₂ O ₅		0.04						
Cr ₂ O ₃	0.5	0.47	0.38		(4100)	(4300)	(3300)	0.61
Mg#	80	43	40	53	48	51	45	48
Rb	10.35	0.80		0.90				1.2
Sr	34.2	144		87				160
Ba	10.8	95	240	31				67
Ni								
Co		16.1	29		28	30	27	23
Sc		78	89	64			80	77
La	0.73	6.7	22.3	3.13	4.8	2.8	4.4	6.3
Ce	1.91	22.5	72	8.8				21.8
Nd	1.42	21.1	58	5.9				23.8
Sm	.462	8.4	18.2	2.18	7.0	4.8	5.8	9.5
Eu	.174	1.54	2.06	0.62	1.55	1.20	1.20	1.79
Gd	.613	13.2						14.8
Tb	.112	2.13	4.2	0.66				
Dy	.762	14.5	29	4.39				16.9
Er	.498	9.7						9.67
Yb	.495	8.5	15.1	2.93	7.1	5.1	5.9	8.8
Lu	.076	1.17	2.24	0.44				1.25
Hf		7.7	15.3	1.85	6.8	5.1	5.8	8.7
Ta		1.8	2.2					
Zr			360					

Sources: LMO = Warren (1986) for major elements, 3x chondrites (Nakamura, 1974) for trace elements (as per Taylor, 1982); A11-B3 basalt = sample 10045 (Agrell et al., 1970; Haskin et al., 1970); A11-HK = sample 10085 (Beatty, 1979); A14-HAB = Hughes, et al. (1990); A17-A, A17-B1, A17-B2, = from Neal et al. (1990) and unpublished data, Warner et al. (1975) sample 77516.2 is most primitive; A17-C = average of 74245, 74275, 74247 for trace elements (Rhodes et al., 1976), Warner et al. (1979) and Neal et al. (1990) for major elements.

References: [1] Delano (1986), PLPSC 16, D201-D213; [2] Hughes, S.S. et al. (1989), PLPSC 19, 175-188; [3] Hughes, S.S. et al. (1988), GCA 52, 2379-2391; [4] Longhi (1987), PLPSC 17, E349-E360; [5] Shervais et al. (1983), PLPSC 14, B177-B192; [6] Neal, C.R. et al. (1990), GCA 54, 1817-1833; [7] Snyder G.A. et al. (1990), Mare Basalt Workshop, LPI, in press; [8] Warren (1986), Ann. Rev. Earth Planet. Sci. 13, 201-240; [9] Nakamura (1974), GCA 38, 757-775; [10] Taylor (1982), Planetary Science: A Lunar Perspective, LPI, 481 pp.; [11] Agrell, S.O. et al. (1970), PLSC 7, 93-128; [12] Haskin, L.A. et al. (1970), PLSC 1, 1213-1231; [13] Rhodes, J.M. (1976), PLSC 7, 1467-1489; [14] Warner, R.D. (1979), PLPSC 10, 225-247.