DIVERSITY OF IMPACT MELT COMPOSITIONS AT THE APENNINE FRONT.

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To provide information on the variety of impact melts in the Apennine Front, Apollo 15 landing site, and hence constrain the sources of its materials, we are analyzing 14 known melts for major and trace element chemistry. The samples, known from petrographic observations to be impact melts, are: the previously studied large rocks 15405, 15445, 15455; rake samples 15308, 15357, and 15359 for which some data was available; rake samples 15356 and 15436, for which data was not available; and 6 coarse fines identified by [1]. All are fine-grained and fairly clast-poor. Chips of 50-100 mg were ground to powder. In most cases a small portion was fused into a glass bead for major element analyses with the microprobe, which are not complete. The remaining powder was used for INAA, which is essentially complete (except for 15455 which suffered some sample loss in the reactor).

Rare earths are shown in the Figure, and selected other provisional data are shown in the Table (all INAA except MgO and TiO_2). The Figure also shows (shaded) the field for Serenitatis (A17 boulder) samples. For those samples previously analyzed, the close matches for rare earth and other elements indicate that the sample masses were adequate to characterize the sample. The most significant discrepancies are a) 15359: 0.5% TiO_2 determined by [2], b) 15308: 1.3% TiO_2, 13.4% MgO determined by [2], and c) 15455: 13.3% MgO determined by [3]. The present major element analysis for 15455 agrees closely with that previously determined for 15445 by XRF [4].

On the basis of rare earths, the samples appear to fall into 5 main groups (Fig.). Three samples form a high rare earth group A, and include 15405, which is not basin related (1 b. y. old). Its foederati have lower FeO and Sc and probably represent an event distinct from the 15405 event. Four samples form group B; but 15434,13 is distinctly different in FeO (substantiated by fused bead, which also shows this sample has 15% MgO and Mg* of 78) and must represent a separate event. Four samples of "KREEP-rich noritic breccias" (which on the basis of their description and a photomicrograph are almost certainly impact melts) analyzed by Drake et al.[5] are virtually identical and fall into group B. Group B is a surprise to us. It is higher in rare earths than any local soils, and its high FeO and Sc suggests that it is not a mixture of other melt compositions. Three samples fall into a group C, which is identical with the Serenitatis melts in rare earths, FeO, and Sc, as suggested by Spudis [6] on the basis of previous analyses. 15356 was described as high alkali [7], but the present data show no significant difference from 15359. Group D contains 15445, and probably 15455; it is higher in FeO, and on the basis of previous analyses in MgO, than the "Serenitatis"-like group C. Group E contains a single sample which is very unusual in having a positive Eu anomaly and a non-KREEP-like rare earth pattern. It is aluminous (22.3% Al_2O_3), and contains 2.4% TiO_2 with an Mg* of 65.9. An impact melt clast in 15459 might be similar, but published data is somewhat ambiguous.

The apparent groupings of these impact melts (which appear to represent 7 distinct compositions or events) might be illusory, and disappear into a continuum with further analyses. Ratios of the refractory elements Sc, Ti and Sm are consistent with groupings, but do not prove them (Table). Including previous reliable analyses of the same rocks in the diagram does not close the gaps between groups. We can say that (a) melts like 15445/15455 (Imbrium?) appear to be rare (b) melts at least similar to "Serenitatis" melts do occur, (c) a previously unrecognized group with Sm $\sim$120X chondrites not only exists, but is well-populated (d) a wide variety of impact melts is present (e) none of the groups is like common Apollo 14 or 16 melts or soils. It is clearly not yet possible to define the dominant composition of "low-K Fra Mauro" (LKFM) at the Apollo 15 site, one of our objectives [8]. We plan to identify and analyze more impact melts in the Apollo 15 collection to more completely understand the range and dominant compositions, but dating and siderophile element ratios would prove most useful in defining individual events.

# on Fig.	1	2	3	4	5	6	7	8	9	10	11	12	*	13
Sample	15405	15414	15434	15304	15314	15434	15357	15314	15359	15356	15308	15445	15455	15414
Split	,112	,34	,6	,66	,144	,13	,14	,146	,10	,7	,8	,243	,257	,35
Group	A	A	A	B	B	B	B	B	C	C	C	D	D	E
MgO	8.3	9.0	-	-	-	15.2	14.3	-	12.6	13.3	11.7	-	16.0	9.0
TiO_2	1 8	1.4	-	-	-	1 2	1.2	-	1.2	1 1	1.0	-	1.6	2.4
FeO	11.5	9.6	8.2	11.4	11.0	8.2	11.1	11.3	8.8	9.5	7.5	10.4	-	7.8
Sm ppm	39.4	39.1	39.7	25.5	21.9	21.7	21.9	20.5	16.8	14.6(?)	12.3(?)	10.6	-	1.8
Eu ppm	2.4	2.7	2.4	2.0	2.1	1.9	1.8	1.8	1.6	1.8	1.8	2.2	-	1.2
Cr ppm	1532	1164	938	1833	1770	1806	1128	1810	835	1363	963	1127	-	703
Sc ppm	23.4	19.3	17.7	22.2	20.1	21.8	20.7	20.2	16.2	13.8	13.5	18.1	-	14.9
Co ppm	16.9	19.1	19.6	36.4	50.2	42.8	37.9	54.7	25.8	55.6	23.6	39.3	-	16.8
Hf ppm	29.1	27.8	28.2	16.3	15.5	15.0	15.1	13.2	12.0	10.4	8.8	7.3	9.2(a)	1.5
Sc/Sm	0.59	0.49	0.45	0.87	0.92	1.00	0.95	0.98	.96	.94	1.10	1.71	-	8.1
Ti/Sm	272	210	-	-	-	342	325	-	409	451	467	-	-	7745
Ti/Sc	461	428	-	-	-	342	345	-	426	480	425	512	-	956

(a) Microprobe

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[1] Simonds, C. et al. (1975) Lunar Science VI, 744. [2] Murali A. V. et al. (1977) Lunar Science VIII, 700. [3] Taylor, S. R. (1973) The Moon, 7, 181. [4] Ridley, W. I. et al., (1973) J. Geol. 81, 621. [5] Drake, M. et al.(1973) EPSL 20, 245. [6] Spudis, P. D. (1980) Conference on Multiring Basins, Abstracts, LPI Contr. 414, p. 83. [7] Dowty, E. et al. (1973) U. New Mexico, Inst. Meteoritics, Sp. Pub. No. 8. [8] Ryder, G. and Spudis, P. D. (1985) Lunar Planet. Sci. XVI, 722.