EXPERIMENTAL INVESTIGATION OF FRACTIONATION DURING SOLIDIFICATION OF AN INCOMPATIBLE-ELEMENT-RICH LUNAR BASALT FROM APOLLO 12.

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Introduction: Apollo 12 sample 12032,366-18 is a basaltic rock fragment with KREEP enrichment (K, REE, P, and other incompatible elements) [1,2], including mesostasis regions that may have formed in part by silicate-liquid immiscibility (SLI). The mesostasis of 12032,366-18 is texturally unlike other samples that exhibit SLI; the high Si and K, and the inclusion of high-Z phases make this mesostasis occurrence unusual.

In this work, we seek to understand the phase relationships and constrain the processes that led to formation of mesostasis in 12032,366-18 through a series of crystallization experiments designed to reproduce the liquid line of decent for the sample's bulk composition. Because of its small size and possibly non-representative modal mineralogy (Fig. 1) experiments were designed to investigate whether the observed bulk composition would reproduce the existing assemblage, including the mesostasis.

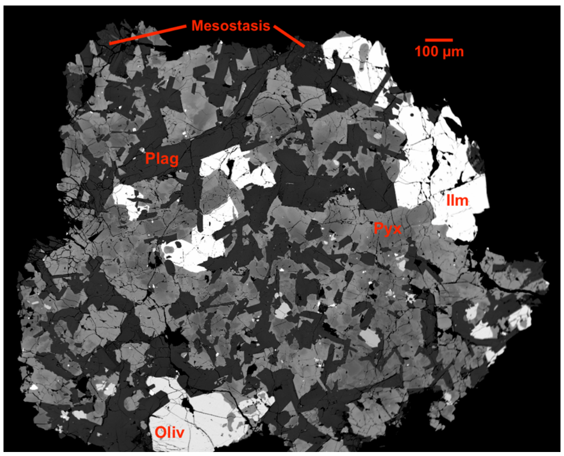

__Figure 1:__ Backscattered-electron (BSE) image of 12032,366-1. Note zoning in pyroxene and the several mesostasis regions at the top of image.

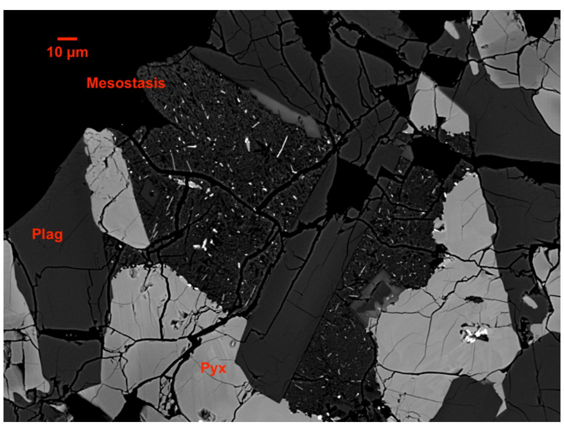

__Figure 2:__ BSE image of mesostasis region in the top left of Fig. 1. The mesostasis includes SiO_2, Ba-K-feldspar, Fe-Ti oxide, zircon, and Ca-phosphate.

Results and Discussion: Sample 12032,366-18 contains high- and low-Ca pyroxene zoned to Fe-rich compositions, plagioclase, Fe-rich olivine, and ilmenite. Several regions of mesostasis have a fine-grained matrix rich in Si and K. The mesostasis has ~80 wt% SiO_2, which is unlikely to have formed by fractional crystallization.

A experimental series at 1-atm pressure and lunar-like fO_2 (iron-wüstite) was conducted to explore fractional crystallization systematics. The mineralogy and chemistry of precipitated phases closely match those observed in the lunar sample. SLI was encountered at temperatures below 1000ºC, and at 985ºC, SLI was extensive. An example of the compositions of coexisting Fe-rich and Si-rich melt phases is given in Table 1. The Si-melt is not as rich in Si as the mesostasis in 12032,366-18, but the Si content of the Si-melt increases as temperature of the experiment decreases. Merrillite crystallization occurred after the onset of SLI.

Conclusions: Low-P experiments support crystallization of 12032,366-18 from a liquid similar to its analytically determined bulk composition, including the occurrence of Fe-rich olivine and ilmenite. Fractional crystallization of the major mineral assemblage led to late-stage SLI beginning ~1000ºC, which can explain the occurrence of the mesostasis in 12032,366-18.

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References: [1] Jolliff et al. (2005) *Lun. Plan. Sci.* 36, #2357; [2] Barra et al. (2006) GCA **70**, 6016-6031.

Table 1: Average compositions of Fe-melt and Si-melt at 985ºC. Zr is concentrated in the Fe-rich melt, while the K is concentrated in the Si-rich melt.

	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	BaO	Na_2O	K_2O	P_2O_5	ZrO_2
Fe-melt	46.22	2.70	7.37	23.54	0.30	1.27	11.39	0.47	0.55	1.32	2.07	0.92
Si-melt	67.05	0.94	11.62	8.27	0.09	0.18	3.79	0.45	0.85	5.36	0.37	0.32