CONSORTIUM BRECCIA 73255: PETROLOGY OF APHANITIC LITHOLOGIES. O.B. James and J.W. Hedenquist, U.S. Geological Survey, Reston, VA. 22092

Introduction. 73255 is one of the Apollo 17 light-gray breccias and is closely related to 73215 and the black and gray competent breccias from Boulder 1, Station 2[1]. The breccia formed as a fragment-laden melt, i.e., a mechanical mixture of cold clasts and hot melt, during a large lunar impact (probably the Serenitatis basin-forming event). Consortium studies thus far have concentrated on characteristics of the bulk breccia and its melt fraction. A petrographic overview and exposure history data were presented previously [2], and companion abstracts report rare-earth-element, light-element, and Rb-Sr data [3], transmission electron microscopy (TEM) observations [4] and ^{40}Ar-^{39}Ar results [5].

Megascopically, the breccia is a gray aphanitic rock in which are embedded a variety of fragmental materials. The sample is a fist-sized oblate spheroid; its size, shape, and internal structures appear to have been retained from the time of the breccia-forming event [2]. It has a large core in which the aphanite is nonvesicular, and a 0-1-cm-thick rind in which the aphanite is highly vesicular.

Nature of the aphanites. In thin section, the aphanites are seen to consist of 5-μm to 1-mm lithic and mineral clasts set in a dark groundmass of minute grain size (<5μm); few clasts <5μm across appear to be present. Texture of the groundmass varies from subophitic to variolitic to graphic, and indicates that the groundmass crystallized from a melt. The TEM studies [4] confirm that the groundmass has igneous texture and verify its melt origin.

Nonvesicular core aphanite: The core aphanite contains only a few percent pores; these are tiny vesicles and vugs. Its groundmass is most commonly subophitic, with grain size averaging ∿2μm. Point counts were made on two 1.4 x 0.6 mm areas of such aphanite ∿2 cm apart in the rock. The results, normalized to zero porosity, showed 72-74% groundmass, 8-13% plagioclase clasts >5μm, 6-7% mafic-mineral clasts >5μm, and 6-14% lithic clasts.

Cryptocrystalline aphanite: Particles of cryptocrystalline aphanite occur within the core aphanite. They are globules and ovoid bodies ∿30μm to ∿1 mm across and have abrupt contacts with surrounding aphanite. They are characterized by an extremely fine grained (<1μm) groundmass having a texture that is seen by TEM to be subophitic [4]. Clast content, from visual estimates, is the same as or lower than that in surrounding aphanite. Porosity is generally lower; vugs are absent, but locally sparse tiny vesicles are present.

Vesicular rind aphanite: The rind aphanite has abundant vesicles 10-500 μm across; its groundmass shows a distinctive subophitic texture, having relatively coarse grain size (∿4-5μm) and blocky pyroxene grains. Point counts were made on two 1.4 x 0.6 mm areas of such aphanite from opposite surfaces of the rock. The results showed 21-34% vesicles and vugs; the other constituents, normalized to zero porosity, were 65-75% groundmass, 12-21% plagioclase clasts, 11-12% mafic-mineral clasts, and 3% lithic clasts.

Core-rind contact: The core-rind contact is generally abrupt, with vesicle content and groundmass grain size changing rapidly over a few hundreds of micrometers. Locally, the contact is less abrupt, and aphanites having different vesicularities have complex relationships. In some areas, the contact is marked by a 1- to 2-mm-thick zone of slightly vesicular aphanite; this rock

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has smaller and fewer vesicles than the rind aphanite, groundmass texture identical to that in the core aphanite, and gradational contacts with both core and rind. In some areas, slightly vesicular and nonvesicular aphanite are mutually inclusive; each forms globules 1-2 mm across within the other. A point count on one area of slightly vesicular aphanite showed 7.5% vesicles and vugs; the other constituents, normalized to zero porosity, were 77% groundmass, 10% plagioclase clasts, 9% mafic-mineral clasts, and 4% lithic and other clasts.

Rinds: Many large clasts have aphanite rinds distinguished from surrounding aphanite by darker color, and lower porosity or an abundance of tiny vesicles. Clast content and groundmass grain size are about the same as those in surrounding aphanite, or clasts are fewer and the groundmass is finer grained. Locally, the outer margins of these rinds are marked by concentrations of mineral clasts.

Clast-aphanite contacts. Structures at the margins of several large clasts suggest that at least some of the clast-melt mixing took place while the clasts were being granulated. One clast has especially instructive contacts: breccia groundmass forms thin dikelets near and parallel to its edge; locally at its margin it is finely granulated and intimately penetrated by groundmass. The evidence for injection of melt into the clast, and for the simultaneity of melt injection with granulation, suggests that the melt and the clast were under some confining pressure when they came into contact.

Groundmass bulk composition. Defocused-beam microprobe analyses were made of the groundmasses in various aphanites; areas analyzed were 30μm across and free of >5μm clasts. Because of the very fine grain size of the groundmasses, the data were corrected assuming a homogeneous target; this procedure yields Na_2O, Al_2O_3 and TiO_2 contents that may be slightly higher than the true values [6]. Analyses of areas in two thin sections are listed in Table 1; areas analyzed in two other thin sections show compositions identical to those listed.

Discussion. All areas of nonvesicular, slightly vesicular, and vesicular aphanite on which point counts were made contain nearly the same proportion of groundmass, ∿70%. As the groundmass contains few tiny clasts, this value should be a good estimate of the volume of melt in the fragment-laden melts that crystallized to form the aphanites.

Composition of the groundmass is virtually identical in all the aphanites analyzed, establishing that they are all cogenetic. Their extremely fine groundmass grain size indicates very rapid crystallization; thus, little digestion of clasts should have taken place after the clast-melt mixing, and the groundmass composition should be close to that of the original melt. This composition is noritic and is very similar to the melt compositions in fragment-laden-melt rocks from Boulders at Stations 2 and 7 [8,9], and in breccia 73215 [7]. It has been suggested that all the Apollo 17 fragment-laden-melt rocks are cogenetic, formed in the same impact event [10]; the similarity of melt compositions supports this hypothesis. If indeed all these rocks were formed in the same event, their proximity to the Serenitatis basin strongly suggests that the event was the Serenitatis basin-forming impact.

Determining the regime in which melt and clasts were mixed is important for understanding the impact process. During an impact event, a small amount of impact melt is injected into fractured rock bordering the crater cavity; during such injection, mixing could take place [11]. As the crater cavity ex-

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pands, its floor is lined with a sheet of impact melt plus granulated rock, and the material in this sheet moves radially outward to be ejected at the crater lip; mixing could take place in the melt sheet [12,2] or in the curtain of ejected debris [1]. The ejected debris is deposited, in some places causing secondary cratering; mixing could take place during such deposition [13]. In the Apollo 17 fragment-laden melts, the clast-melt mixing was apparently extremely thorough, and took place while the melt was quite hot, had very low viscosity [7,12], and was under some confining pressure. Thus, the most likely mixing regimes are those related to the early stages of the impact event, i.e., during injection of melt into fractured rock bordering the crater cavity, and during movement of the melt sheet across the crater floor.

The textural differences among the various types of aphanite in breccia 73255 indicate that these aphanites formed from distinct masses of fragment-laden melt that had different viscosities and volatile contents, were mechanically mixed, and did not homogenize. The regime in which this mixing took place has not yet been resolved. Most contacts between different aphanites are fairly sharp, and globules of some types are included within others; these relationships indicate that the fragment-laden melts were distinct materials having different physical properties. If the differences among the aphanites were due solely to differences in quenching, the most vesicular ones should have the finest grained groundmasses, but the reverse relationship is observed. If instead the aphanites differed in volatile content, diffusion rates in the more volatile-rich melts would have been greater, and coarser grained groundmasses could have crystallized; the most vesicular aphanites should have the coarsest grained groundmasses, as is observed. The forms of bodies of the various aphanites are consistent with this hypothesis: the finest grained and least vesicular (least volatile rich) appear to have been most viscous; and the coarsest grained and most vesicular (most volatile rich) appear to have been least viscous.

Table 1. Groundmasses in 73255 aphanites

	1	2	3	4	5
SiO_2	48.3	48.5	47.6	48.2	48.4
TiO_2	1.01	0.96	0.87	0.99	1.10
Al_2O_3	17.6	17.6	17.4	17.4	17.4
FeO	8.84	9.37	9.03	9.12	9.45
MgO	11.5	11.2	11.8	11.4	12.2
CaO	11.4	11.2	11.2	11.3	11.1
Na_2O	0.54	0.59	0.54	0.56	0.43
K_2O	0.38	0.47	0.30	0.38	0.35
Total	99.57	99.89	98.74	99.35	100.43
No. areas	11	8	15	56	8

1. Nonvesicular core aphanite in 73255,314
2. Vesicular rind aphanite in 73255,314
3. Cryptocrystalline aphanite in 73255,314
4. Average of all analyses of nonvesicular, vesicular, slightly vesicular, and cryptocrystalline aphanites in 73255,314
5. Rind on ANT-suite clast in 73255,315

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