DIVERSITY OF GRANULITIC BRECCIA CLASTS FROM FELDSPATHIC FRAGMENTAL BRECCIA 67975; James J. McGee, U.S. Geological Survey, Reston VA 22092

A preliminary petrologic study of lithic clasts extracted from feldspathic fragmental breccia 67975 and originally identified as granulites indicated that the clasts consisted of a variety of lithologies [1,2]. However, only five of the fourteen samples originally classified as granulites were available for the petrologic study; these five samples had the most complete chemical data and represented the three textural types (termed "light green", "light gray", and "dark gray") identified by Lindstrom [2] during selection and binocular inspection of the fourteen samples. The study of these five samples (one dark gray clast, two light gray clasts, and two light green clasts) indicated that the dark gray and light green groups each represented single lithologies: the dark gray clast is a feldspathic microporphyritic melt breccia (FMMB), and the light green clasts are apparently metamorphosed mafic melt breccias. The study of the light gray clasts indicated that they comprise a diverse group of lithologies: four texturally distinct rock types were identified in the two samples studied [1].

Additional INAA data [3] and thin sections have been obtained for the remaining nine samples of the 67975 "granulites;" the results of petrographic examination, backscattered electron (BSE) imaging in the SEM, and electron microprobe analyses of these samples are reported herein. Sample numbers are those reported with the INAA data by [2,3]. The samples were fragmented by Lindstrom prior to INAA analysis. The thin sections of four of the samples (23Gr-2, 138Gr, 9Gr-2, 49Gr-3) consist of single particles with surface areas of 2-6 mm^2; the thin sections of the other five samples are composed of multiple mm-sized particles with total areas ranging from 10-25 mm^2. The nine samples comprise four additional samples from the dark gray group (samples 9Gr-1, 9Gr-2, 49Gr-2, and 49Gr-3) and five samples from the light gray group (samples 23Gr-2, 45Gr, 116Gr, 127Gr, and 138Gr); the two light green clasts studied previously [1] are the only members of the light green group. Modal, grain size, and mineralogical data for the nine clasts are summarized in Table 1.

Dark gray clasts. Petrographic and BSE examination of the four dark gray samples indicate that they are all FMMBs and are quite similar to the one dark gray sample (49Gr-1) studied previously. These samples consist of abundant fragments of plagioclase with seriate grain size (10 to 350 μm) set in a very fine-grained matrix (2-20 μm) of plagioclase and mafic minerals. The mafic minerals are generally too fine to analyze quantitatively with the electron microprobe, but the limited amount of quantitative microprobe data obtained and the qualitative SEM and microprobe energy dispersive analyses (EDA), as well as the BSE images obtained with the SEM, indicate that pyroxene and olivine are present in approximately equal proportions. Overall the mafic minerals make up approximately 10-15% (by vol.) of the samples and form narrow, elongate "sprays" of poikilitic grains only 10-50 μm wide but as much as 400-500 μm long. Some heterogeneity of the Ca content in the pyroxenes was detected. Rare chromite (45% Cr_2O_3, 32% FeO, 12% Al_2O_3) blebs, occasionally as large as 20 μm across, occur in the FMMBs. In addition to the abundant plagioclase fragments, a polygonal aggregate, 500 μm across, of plagioclase is present in one sample (9Gr-2), and another sample (49Gr-2) contains two shocked plagioclase clasts with mosaic texture and patchy extinction; compositions of these clasts are like those of the rest of the plagioclase fragments in each sample. Sample 49Gr-2 also contains a 75 μm fragment of red Cr-pleonaste spinel (46% Al_2O_3, 24% FeO, 20% Cr_2O_3, 10% MgO) and a large (0.3 x 0.4 mm) lithic clast of gabbroic anorthosite. The gabbroic anorthosite clast has subophitic pyroxene and olivine that are coarser grained than, but compositionally similar to, the pyroxene and olivine in the surrounding breccia matrix (Table 1). Plagioclase in the gabbroic anorthosite clast averages more calcic ($An_{97.4}$) than the plagioclase in the rest of its host FMMB ($An_{96.6}$) and in all of the other FMMBs analyzed in the suite of dark gray samples.

Light gray clasts. Three distinctive lithologies make up the bulk of the light gray samples; these lithologies are similar to those that constitute the light gray samples studied previously [1]. The most abundant lithology makes up all of samples 116Gr, 127Gr, and 138Gr, and two of the ten discrete grains that make up sample 45Gr. This lithology is a granulitic breccia consisting of 10-50 μm granoblastic plagioclase (commonly with 120° grain junctions) intergrown with granoblastic to poikiloblastic pyroxene and olivine. The mafic minerals constitute 15-20% (by vol.) of these granulitic breccias; the lithology in sample 45Gr has approximately equal proportions of pyroxene and olivine, whereas in the other samples, pyroxene is more abundant than olivine. Low-Ca pyroxene is more common than high-

Ca pyroxene in all the samples. Samples 116Gr and 127Gr, which are relatively magnesian (Table 1), have homogeneous pyroxenes, whereas the relatively ferroan samples 138Gr and 45Gr (Table 1) have pyroxenes with fine-scale (1-5 μm) exsolution lamellae. Angular mineral grains >50 μm across are common and are mostly of plagioclase, but some are of olivine and pyroxene, and a few are of ilmenite. Some of the granulitic breccias also contain a few small lithic clasts of anorthosite.

A second lithology constitutes the bulk (8 out of 10 grains, or ~75% by vol.) of sample 45Gr. The lithology is a hornfels with extremely fine grained (<1 μm) mafic minerals intergrown with 2-10 μm plagioclase. The mafic minerals are too fine to analyze with the microprobe, but SEM-BSE images indicate that they consist of a mixture of pyroxene and olivine plus a higher average-atomic-number phase that is probably either oxide or sulfide. Several relatively large (15-25 μm) grains of chromite (42% Cr_2O_3, 32% FeO, 12% Al_2O_3) are also present. The hornfels encloses abundant angular plagioclase fragments, with seriate grain size ranging from 10 to 100 μm. Also present in the hornfels are: one 10 x 25 μm ovoid inclusion of silica mantled by a 2-3 μm rim of a mafic mineral that is probably pyroxene; and shocked lithic clasts of anorthosite, one of which is relatively large (300 x 500 μm).

The third lithology present in the light gray clasts is an intergranular rock consisting of an intergrowth of lathy to granoblastic plagioclase and poikilitic to intergranular pyroxene and olivine; the mafic minerals are generally finer-grained than the plagioclase. Sample 23Gr-2 is the only sample that contains this lithology. The lithology contains abundant plagioclase fragments, several of which are relatively large (up to 400 μm), twinned laths. No mafic mineral clasts are present. This lithology is nearly identical to the intergranular lithology in light gray clast 23-2, described previously [1].

Summary. In general, the textures and mineralogies of the nine samples indicate that the same lithologies previously identified in the dark gray and light gray clasts by [1] are present in these nine samples. However, the granulitic breccia lithology, and to a lesser extent the hornfels, in the light gray clasts are more abundant in this group of samples than in the samples studied previously. The granulitic breccias have textures that are similar to each other and mineral compositions that reflect their bulk chemistries; they probably formed from different precursors but under the same conditions, probably as a result of impact brecciation, mixing and subsequent annealing in a thermal ejecta blanket. The FMMBs are polymict breccias that formed by crystallization of fragment-laden melts, also produced during impact brecciation/melting events. The homogeneous texture and very fine grain size of the hornfels indicate that this lithology represents a crystallized, rapidly quenched melt which, again, was most likely impact-produced.

Noteworthy in its absence from the five light gray clasts studied is the mafic-rich granulitic lithology that was observed previously in one of the light gray clasts (23-3). This mafic-rich granulitic lithology makes up approximately half of sample 23-3 and has relict diabasic texture which, combined with the mafic and ferroan nature of the lithology, indicated that it may have been derived from a ferroan anorthositic norite precursor. Additional samples of this lithology would have aided in evaluating the nature of its precursor(s).

References: [1] McGee J.J. (1987) PLPSC 17, E513. [2] Lindstrom M.M. (1984) PLPSC 15, C50. [3] Lindstrom M.M., written communication.

TABLE 1

Sample	Lithology	Grain Size μm	Mafics Vol. %	Plag % An	Lo-Ca Pyx Mg'	Hi-Ca Pyx Mg'	Oliv Mg'	Bulk Mg' [2,3] [100xmolar(Mg/Mg+Fe)]
23Gr-2	INTERGRAN	10-20	5-10	95.8	69	72	63	60
45Gr	HORNFELS	<1-10	10	95.7				65
45Gr	GRAN BREC	15-50	10-15	96.3	66	70	59	65
116Gr	GRAN BREC	10-100	10-20	95.1	73	79	69	69
127Gr	GRAN BREC	5-50	15-20	96.4	77	81	73	73
138Gr	GRAN BREC	15-50	20	96.6	58	67	50	54
9Gr-1	FMMB	2-20	5-10					69
9Gr-2	FMMB	2-20	5-10	96.3	68	67	55	67
49Gr-2	FMMB	2-20	10-20	96.6	69		66	67
49Gr-2	GAB ANORTH	25-200	10	97.4	69	74	64	
49Gr-3	FMMB	2-20	10-20					66