PETROGRAPHY OF LUNAR METEORITE PCA02007, A NEW FELDSPATHIC REGOLITH BRECCIA.
*R. A. Zeigler, R. L. Korotev, and B. L. Jolliff, Dept. of Earth and Planetary Science, Washington University, 1 Brookings Dr., Campus Box 1169, St. Louis MO, 63130; *zeigler@levee.wustl.edu.

Overview: PCA 02007 is a 22.4 g lunar meteorite collected in 2003 near the Pecora Escarpment in Antarctica [1]. PCA is a feldspathic regolith breccia composed of mature regolith. It is compositionally and texturally similar to other feldspathic lunar meteorites (FLMs) [2] and may be launch paired with Yamato 791197 [3]. Here we present a petrographic description and compositions of mineral clasts, glass clasts, lithic clasts, and the bulk meteorite.

Methods: Our petrographic work is based on two thin sections and one polished thick section. We determined mineral and glass compositions by electron microprobe analysis (EMPA; Table 1a). Bulk lithic clast compositions were determined by broad-beam EMPA and/or modal recombination (Table 1b). Major-element compositions were determined by a combination of instrumental neutron activation analysis (INAA; [3]) and EMPA on fused beads (Table 1c).

Petrography: PCA 02005 is a breccia composed of mineral, glass, and lithic clasts (up to ~2 mm). The mineral clasts analyzed (all >30 µm) are plagioclase (*N*= 153), pyroxene (98), and olivine (59) (the relative proportions of analyzed mineral clasts do not represent a mode as the mafic clasts were targeted preferentially). Minor and trace mineral clasts include silica, ilmenite, spinel, troilite, and Fe,Ni metal. Plagioclase clasts show little compositional variation, $An_{98-92}Or_{<0.3}$, with only one analysis falling outside that range ($An_{88}Or_{0.5}$). In contrast, the olivine (Fo_{82-41}) and particularly the pyroxene ($Wo_{46-2}En_{81-5}$) show a wide range of compositions (Fig. 1). Some pyroxene clasts have exsolution lamellae up to 2 µm wide. Glass clasts (*N*=109) typically occur as shards, but a few spherules are also observed. Glasses are predominantly feldspathic (<7 wt% FeO) in composition with a more mafic group at 14–15 wt % FeO (Fig. 2). Four glasses that appear to have undergone silica volatilization were also found (they are not volatilized to the level of HASP glasses though [4]). Most of the analyzed lithic clasts (Fig. 3) fall into four categories: plagioclase/glass intergrowths (84), intergranular texture (8), quenched texture (3), and regolith breccia clasts (5). Agglutinate clasts are found (but we do not have an exact count at this time). The most abundant lithic clasts have a plagioclase (An_{96}) and glass (average 12 wt % FeO) matrix with textures ranging from very-fine grained to intersertal, frequently with clasts of plagioclase, and sometimes tiny $Fo_{\sim 80}$ olivine grains. The intergranular lithic clasts are dominated by plagioclase (>80% modally; An_{96}), with variable amounts of olivine (Fo_{80-62}) and pyroxene ($En_{77-49}Wo_{35-3}$). The quenched clasts have about equal proportions of plagioclase (~1 wt % FeO; An_{95}) and pyroxene ($En_{27-10}Wo_{51-24}$) ± olivine (Fo_{42-57}). The few clasts of what appear to be an older generation of regolith breccia have a mixture of glass and mineral clasts and a somewhat vesicular texture. The average bulk composition of the intergranular and plagioclase/glass lithic clasts (Table 1) is very similar, and these two clast types have a similar compositional range (Fig. 2), although a slightly more Al-rich distribution (not shown) than the glass clasts. The quenched lithic clasts have a more mafic composition, ranging from 12–19 wt % FeO. One of the thin sections has a highly vesicular fusion crust up to 1 cm thick, that has a composition which is uniform and similar to that of the bulk meteorite determined by EMPA on fused beads (Table 1). A few veins/areas of glass probably formed by shock melting are also observed.

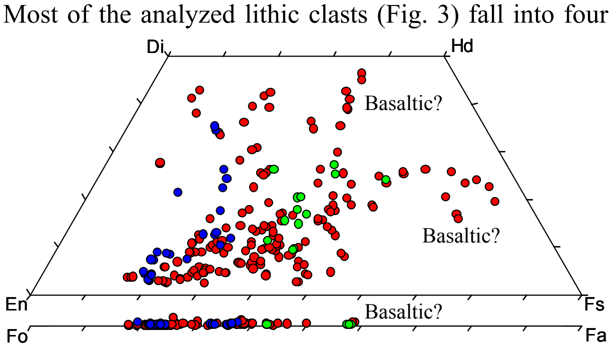

Figure 1: Pyroxene and olivine compositions in PCA 02007. Minerals clasts in red, intergranular lithic clasts in blue, lithic clasts with a quenched textures in green. "Basaltic?" labels indicate compositions that are possibly of mare basalt origin.

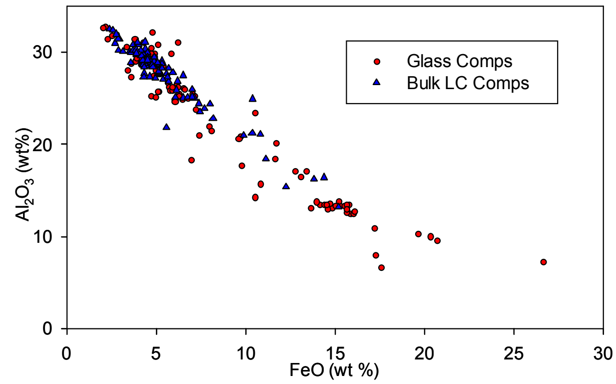

Figure 2: Distribution of compositions of glass clasts (red circles) and bulk lithic clasts (blue triangles) in PCA 02007.

Discussion: The presence of glass spherules and agglutinate clasts qualify PCA 02007 as a regolith breccia [5], as are most other feldspathic lunar meteorites.

PCA 02007 is compositionally more mafic than most FLMs, and there is some chemical evidence for it being launch paired with Yamato 791197 [3]. On the whole, PCA and Y79 are petrographically similar in that both contain pyroxene clasts of similar compositional range and a variety of magnesian feldspathic lithic clasts. There is also evidence of mare material in both Y79 and (probably) PCA. Several VLT basaltic clasts (crystalline and quenched texture) are reported for Y79 [6,7], as well as pyroxene clasts of likely basaltic origin [8]. The evidence of basaltic material in PCA is less compelling: a lithic clast (with a quenched texture) has a bulk composition similar to basalt (e.g., 19 wt % FeO; Table 1), some pyroxene and olivine of likely basaltic origin (Fig. 1), a handful of glasses with basalt-like compositions (>17 wt % FeO), and a group of glasses with a possible high-Al basalt composition (15 wt % FeO; Fig. 2). Although in detail there are some minor petrographic differences between the two meteorites, there is no strong petrographic evidence that the two meteorites derive from regoliths that are geographi cally distant. Thus, petrographic data are consistent with the hypothesis that Y791197 and PCA 02007 might be launch paired.

References: [1] Satterwhite & Righter, eds. (2003) *Ant. Met. News.* **26** (2). [2] Korotev R. L. et al. (2003) *GCA.* **67**, 4895-4923. [3] Korotev R. L. et al. (2004) *This Volume*. [5] Stöffler D. et al. (1980) *Proc. Conf. Lunar Crust*, 51-70. [6] Lindstrom M. M. et al. (1985) *Proc. Ant. Met.* **10th**, 58-75. [7] Ostertag R. et al. (1985) *Proc. Ant. Met.* **10th**, 17-44. [8] Takeda H. et al. (1985) *Proc. Ant. Met.* **10th**, 45-57. **Acknowledgements:** This work was supported by NASA grant NAG5-10485 to L. A. Haskin.

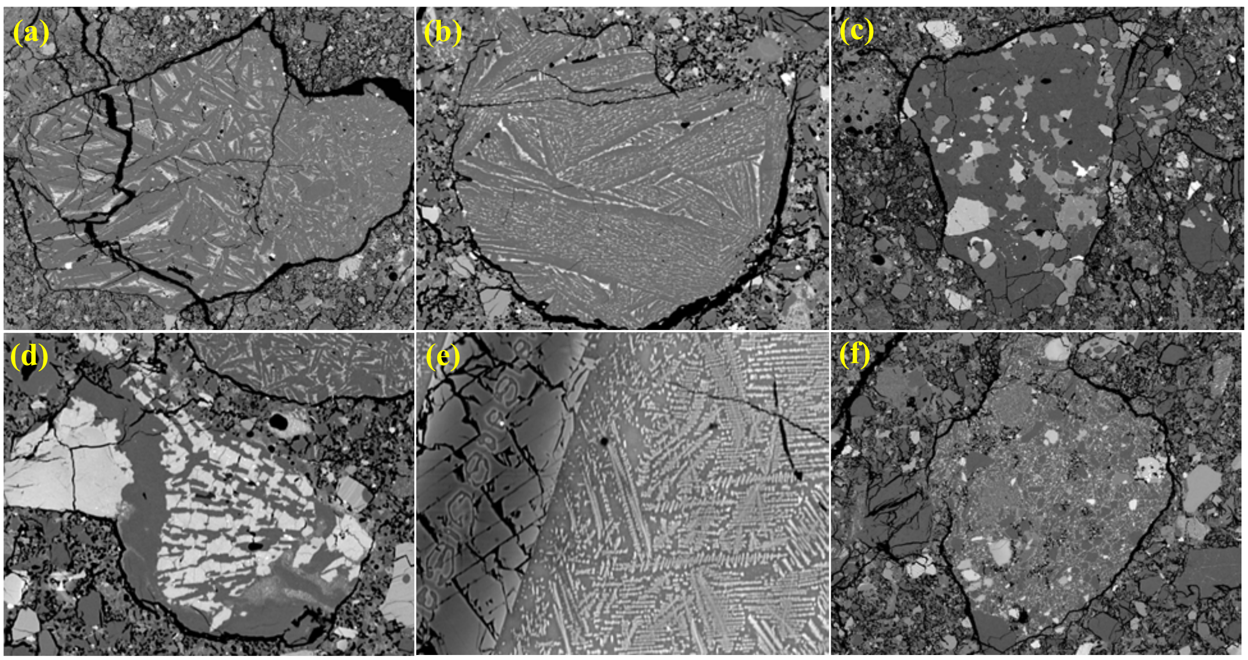

Figure 3: (a) Back scattered electron (BSE) image of a plagioclase (dark grey) and glass (brighter grey) lithic clast (750 μm in longest dimension; LC) with intersertal texture. **(b)** BSE image of a devitrified LC spherule (200 μm) with plagioclase and glass intergrown. **(c)** BSE image of an intergranular LC (500 μm). Olivine is brightest, then pyroxene, then plagioclase. **(d)** BSE image of a quenched LC (200 μm). Plagioclase is dark grey and pyroxene is light grey. **(e)** Devitrified glass clast, with a large, early crystallized olivine on the right (FO_{80}) and tiny olivine in the glass (FO_{50}). Field of view=50 μm **(f)** Regolith breccia LC (350 μm). Bright phases are mafic glass and pyroxene/olivine. Darker clasts are plagioclase.

Table 1a: Glass compositions								Table 1b: Bulk LC compositions							Table 1c: Bulk composition					
Type	GC	GC	GC	GC	GC	GC	GC	LC	LC	LC	LC	LC	LC	LC	,11	,14	,16	,28	,25	Wt
Mineral	gls1	gls2	gls3	gls4	gls5	gls6	lowSi	pg/gls	pg/gls	pg/gls	pg/gls	intgrn	que	que	FB	FB	FB	FB	FC	Ave
(N)/mass	(1)	(3)	(20)	(12)	(20)	(23)	(4)	(1)	(4)	(24)	(44)	(8)	(1)	(1)	16mg	21mg	34mg	12mg	(40)	
SiO_2	45.2	47.3	46.7	46.0	44.5	44.5	37.5	44.8	46.4	44.7	44.1	44.3	45.9	50.2	44.2	44.5	44.7	44.9	44.4	44.6
TiO_2	1.23	2.80	0.54	0.56	0.27	0.22	0.32	0.60	0.57	0.29	0.26	0.16	0.43	0.24	0.28	0.29	0.28	0.29	0.29	0.28
Al_2O_3	7.2	9.9	13.2	19.2	25.6	29.2	31.0	13.1	19.0	26.9	29.3	29.2	13.6	16.2	26.2	26.9	26.4	25.7	26.5	26.4
Cr_2O_3	0.71	0.53	0.53	0.32	0.15	0.11	0.11	0.68	0.36	0.14	0.11	0.09	0.35	0.50	*0.17*	*0.15*	*0.15*	*0.16*	0.11	0.16
FeO	26.7	20.2	15.1	10.2	6.1	4.4	5.5	15.2	10.9	5.8	4.4	3.9	18.9	13.9	*6.42*	*6.24*	*6.25*	*6.15*	6.15	6.26
MnO	0.33	0.26	0.19	0.13	0.08	0.06	0.09	0.19	0.18	0.08	0.07	0.05	0.23	0.24	0.07	0.09	0.09	0.11	0.09	0.09
MgO	13.0	7.2	12.5	10.1	8.1	5.2	7.4	12.6	9.4	6.3	5.0	5.4	10.6	8.0	6.8	6.2	6.7	7.3	7.0	6.7
CaO	6.7	10.6	10.3	11.9	14.9	16.7	17.7	9.7	12.2	15.2	16.2	16.4	9.1	10.8	15.3	15.6	15.3	15.0	15.4	15.3
Na_2O	0.22	0.29	0.08	0.25	0.20	0.22	0.06	0.06	0.32	0.34	0.35	0.31	0.14	0.20	*0.34*	*0.33*	*0.33*	*0.28*	0.16	0.33
K_2O	n.a.	0.06	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	0.02	0.03	0.03	0.02	0.00	<0.02	0.02	0.03	0.02	0.02	<0.02	0.02
P_2O_5	n.a.	0.13	0.02	0.03	0.02	<0.02	<0.02	0.02	0.02	0.05	0.03	<0.02	0.00	0.04	0.03	0.03	0.02	0.03	0.02	0.03
Sum	101.3	99.3	99.3	98.8	99.8	100.5	99.7	96.9	99.4	99.8	55.8	99.8	99.2	100.3	99.8	100.3	100.3	100.0	100.1	100.1

Italicized numbers determined by INAA, others by EMPA. Masses analyzed by INAA are: PCA02207,11 (80 mg); ,14 (135 mg); ,16 (195 mg); ,28 (84 mg) [3].

GC=glass clast, gls=glass, LC=lithic clast, pg=plagioclase, intgrn=intergranular, que=quenched, FB=fused Bead, FC=fusion crust, (N)=number of samples in average,