IDENTIFYING THE MAFIC COMPONENTS IN LUNAR REGOLITH BRECCIA NWA 3136 S. P. O'Donnell, B. L. Jolliff, R. A. Zeigler, and R. L. Korotev. Department of Earth and Planetary Sciences, Washington University in St. Louis, Campus Box 1169, Saint Louis, MO, 63130. seano@levee.wustl.edu.

Introduction: Northwest Africa (NWA) 3136 is a 95.1 g mafic (15% FeO) regolith breccia that contains a wide variety of lithic, mineral, and glass clasts [1-3]. Previous petrographic descriptions [1,3] and an assessment of its bulk composition [2] suggest it is a mixture of 70–80% low-Ti mare basalt and microgabbro components and 20–30% feldspathic highlands material. This abstract presents results of analyses of a polished section of NWA 3136 wherein we examine the clast lithology and compositions to test the hypothesis that the meteorite indeed contains 70-80 % of a mare component, and if so, to determine the characteristics of the mare component. We consider the alternative hypothesis that the meteorite consists predominantly of mafic components that are not necessarily mare basalt or are not typical mare basalt as represented by the existing lunar mare-basalt suite. At issue is the character of the site from which this meteorite was launched. Was it from a mare-highland boundary, from an area with cryptomare, or from some other relatively mafic but nonmare terrain?

The analyzed sample (3.7×2.9 mm) is a clast-rich breccia with a partially glassy to finely crystalline matrix (Fig. 1). Its high clast content, subrounded lithic clasts, and sparse, glassy portions of the matrix are consistent with a regolith breccia, although our section lacks remnants of agglutinates and glass spherules. The rock is extremely well lithified, as is common among the lunar regolith-breccia meteorites [4]. The clast population contains numerous mineral clasts and a variety of lithic clast types. Among the lithic clasts, we found four main types: intergranular feldspathic basalt, shocked anorthositic norite, impact-melt breccia of gabbronorite composition, and shocked gabbronorite (different from lithic clasts described by [3]). In addition to mineral and lithic clasts, the section contains numerous glassy to cryptocrystalline clasts.

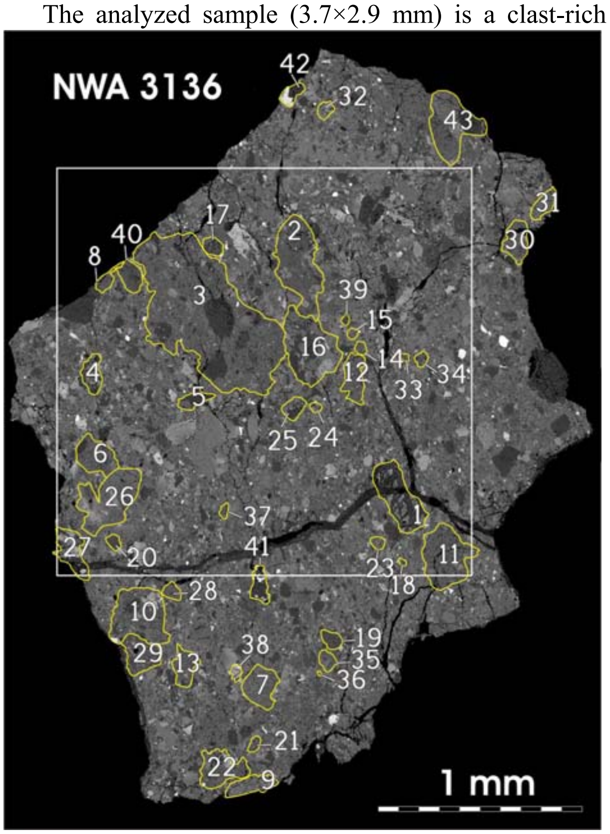

Figure 1. Back-scattered electron (BSE) mosaic of NWA 3136 showing clast boundaries and locations. White square locates the enlarged x-ray image shown in Fig. 2.

Methods: The bulk composition of NWA 3136 was determined by [2] and electron-probe microanalysis (EPMA) of fused-beads. Phase compositions were determined by quantitative mineral and glass analyses and backscattered and x-ray image analysis (Fig. 2) of the section and regions of interest using the JEOL 8200 Superprobe at Washington University. Bulk compositions of lithic clasts were determined by modal recombination (MR).

Petrography: NWA 3136 contains mineral and lithic clasts (<1-950 µm grains) that are blocky to elongated and angular to subangular in a very-fine-grained fragmental to glassy matrix. Identified clasts (Figure 1)

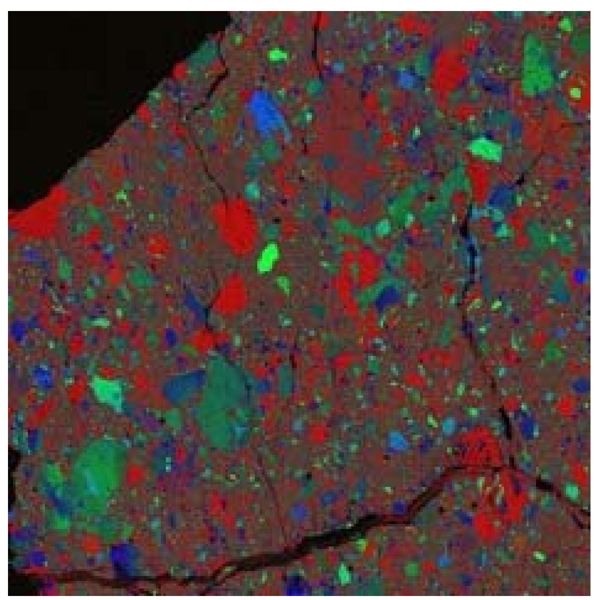

Figure 2. X-ray classification image. Al is in the red channel, Fe is in blue, and Mg, green. In this scheme, plagioclase is red, pyroxene is dark blue to green, and olivine is bright green to light blue.

are heterogeneous in texture and composition and are more fractured than the matrix. Selected clast bulk compositions are given in Table 1 and mafic mineral analyses are plotted in Fig. 3.

Intergranular Olivine Norite, Clast 1. Clast 1 is the largest intergranular clast (370×120 µm) with a basaltic texture but an olivine-noritic composition. The assemblage includes euhedral to subhedral 50–160 µm plagioclase laths (72% modally; An_{96}) and anhedral, intergranular grains of olivine (9%; Fo_{62-65}) and pyroxene (15%; $En_{10-47}Wo_{15-37}$) with minor silica and ilmenite in the intergranular regions.

Shocked Anorthositic Norite, Clast 2. Clast 2 (550×250 µm) contains partially resorbed, relict mineral clasts of pigeonite (18%) with exsolved augite (18%) and plagioclase (4%) set in a glassy matrix (78%) whose composition is dominantly feldspathic (Fig. 4). MR indicates an anorthositic norite composition. Blocky, anhedral, exsolved pigeonite grains ($En_{38.9-40.0}Wo_{14.3-18.1}$; pigeonite host: $En_{40}Wo_{6-13}$) occur up to ~62 µm size and contain augite lamellae (<2.7 µm; $En_{35-38}Wo_{21-35}$). Plagioclase (4%; An_{92-98}) is typically anhedral and <50 µm. Smaller grains of pyroxene, plagioclase, and chromite (<0.4%) occur as individual grains within the feldspathic glassy matrix.

Impact-Melt Breccia, Clast 3. Polymict impact-melt breccia clasts are the most abundant clast type in the section, of which clast 3 (940×440 µm) is the largest. Mineral and lithic clasts contain plagioclase ($An_{91.8-93.9}$), pyroxene (En_{34-75} Wo_{4-26}), olivine (Fo_{84-85}), silica, and accessory minerals ilmenite and chromite in a crystalline matrix (<5 µm). Mineral grains and lithic clasts are anhedral and angular to rounded. MR calculations indicate a bulk composition of ~18% Al_2O_3 and Mg# = 59.

Table 1. Compositions of clasts, glasses, and the bulk meteorite. Clast compositions are derived by MR. Glass composition is an average of 7 analyzed glass clasts (spheroidal to irregular shaped). Bulk meteorite composition is the average of fused bead analyses. Mg# = [Mg/(Mg+Fe)] * 100

	Clast 1	Clast 2	Clast 3	Clast 16	Glass	Bulk Meteorite
	Chemical Composition (wt. %)					
SiO_2	46.07	45.31	46.38	46.40	44.37	45.83
TiO_2	0.26	0.36	0.78	0.57	1.04	1.23
Al_2O_3	26.18	20.44	18.33	15.86	17.86	13.84
Cr_2O_3	0.12	0.24	0.26	0.12	0.30	0.42
FeO	6.68	12.60	11.80	17.55	13.92	15.38
MnO	0.11	0.19	0.16	0.27	0.20	0.25
MgO	4.43	6.88	9.51	4.34	9.66	10.33
CaO	15.86	14.41	11.97	14.37	12.27	11.70
Na_2O	0.26	0.15	0.48	0.19	0.13	0.30
K_2O	0.06	0.01	0.13	0.04	0.03	0.10
Total	100.03	100.61	99.80	99.71	99.77	99.45
Mg#	54.2	49.3	58.9	30.6	55.3	54.5

Shocked Gabbroic Norite, Clast 16. Clast 16 (400×300 µm) is an intergrowth of plagioclase (41%; $An_{95.9}$), subcalcic augite (48%, $En_{17.8}Wo_{26.4}$), calcic pigeonite (9%, $En_{49.3}Wo_{18.4}$), and trace troilite (<1%).

Clast and Glass Compositions: Lithic clast and glass compositions cluster mainly in the range 13-20% but extend to 27% Al_2O_3. The bulk meteorite has about 14% Al_2O_3 indicating that the mineral clasts and fine-grained matrix must be more mafic, perhaps averaging 10-12% Al_2O_3. None of the lithic clasts or glasses is highly feldspathic, nor are there any lithic mare basalt clasts or basaltic glasses. Olivine basalt and "microgabbro" clasts reported by [3] are not seen in our section. Thus the mafic component remains cryptic in our sample. Mafic mineral compositions (Fig. 3) span a wide range of Mg#, however, consistent with basaltic precursors. A mixing analysis using these clast components and known mare basalt compositions suggests that a low-Ti pigeonite/olivine basalt (TiO_2 ~2%, Cr_2O_3 ~0.6%, Al_2O_3 ~9%, and Mg# ~ 45) is needed to balance out the bulk composition.

References: [1] Russell S. S. et al. (2005) *MAPS* 40, A201-A263. [2] Korotev R. L. and Irving A. J. (2005) *LPS XXXVI*, #1220. [3] Kuehner S. M. et al. (2005) *LPS XXXVI,* #1228. [4] Warren P. H. (2001) JGR, 106, 10101-10112.

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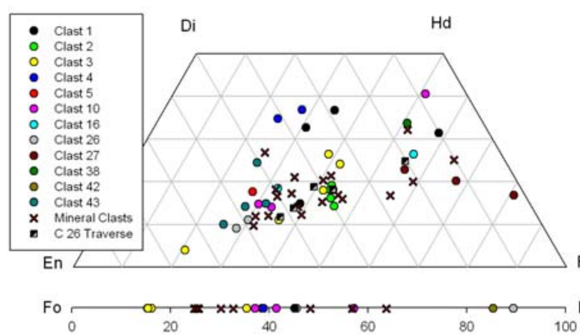

Figure 3. Pyroxene and olivine compositions in NWA 3136.

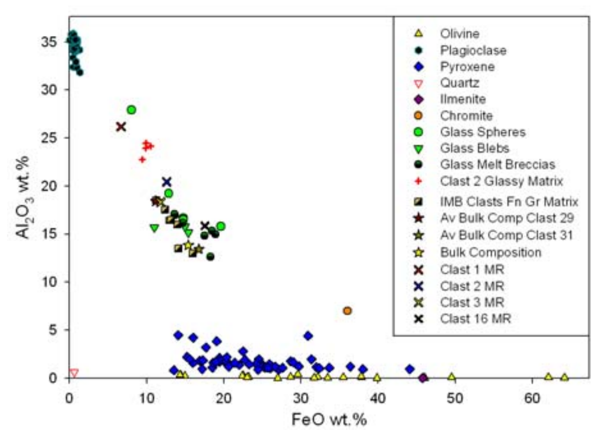

Figure 4. FeO and Al_2O_3 concentrations of minerals, glasses, matrix, and bulk clast compositions from MR.