PYROXENE COMPOSTION IN LUNAR METEORITE NWA 2727 AND COMPARISON TO NWA 7007.

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Introduction: Lunar meteorite NWA 2727, found in 2005, is one of the suite of presumably paired stones that are related through petrologic similarity of clast components and that has been designated the "NWA 773 suite" [1-6]. NWA 2727 is an immature regolith breccia consisting of four fragments with a total mass of 191.2 g [1]; it is rich in components of basalt and gabbro [1,2]. Reported olivine, plagioclase and pyroxene compositions of NWA 2727 are similar to those of NWA 773 and NWA 3160 [2]. Texturally, NWA 2727 is similar to the breccia described in NWA 3333 [5]. On the basis of pyroxene textures and composition, NWA 2727 is also paired with NWA 7007, a breccia dominated by ferrogabbro [4]. Here we describe the assemblage and mineral chemistry of the large pyroxene-megacryst and gabbroic clast in NWA 2727 (Fig. 1). Other prominent clast types occurring in our thin section include basaltic vitrophyres, symplectites, and mineral and lithic clasts of the olivine-gabbro cumulate lithology (Fig. 1). Our objective is to describe the mineral assemblage of the ferroan gabbro clast in NWA 2727 and to demonstrate its relationship to the ferroan gabbro lithology in NWA 7007 [4].

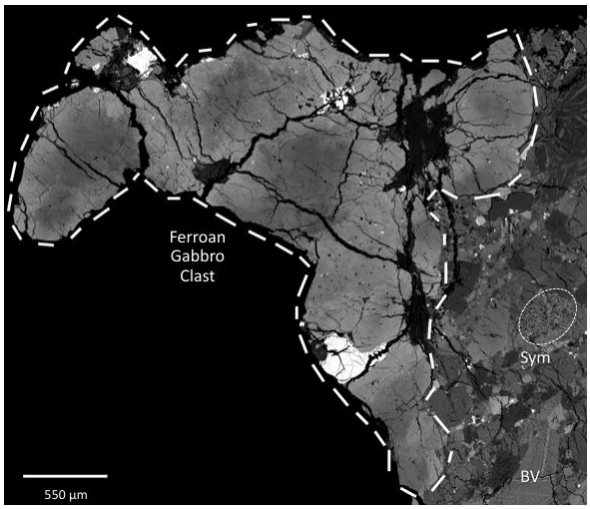

Figure 1. BSE image of a polished thin section of NWA 2727. A ferroan gabbro clast is outlined with a dashed white line and consists mainly of pyroxene with several "enclaves" of intercumulus minerals. Also seen is a symplectite, "Sym", outlined in a white, olivine gabbro cumulate lithology "OGC," and a basaltic vitrophyre "BV."

Methods: Chemical compositions of NWA 2727 minerals, backscattered electron (BSE) imaging, and X-ray compositional imaging were done using electron-probe microanalysis (EPMA) with the Washington University JEOL JXA-8200 microprobe.

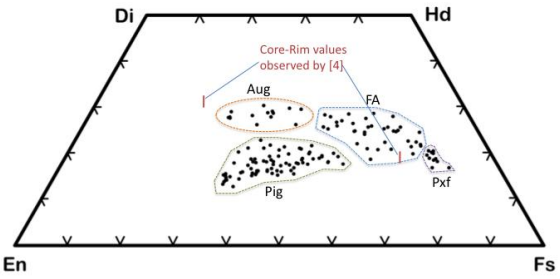

Figure 2a. Pyroxene quadrilateral of the ferroan gabbro clast in NWA 2727. All measurements fall in the ranges of pigeonite, augite, ferroaugite (FA) and pyroxferroite (Pxf). The core – rim values observed by Kuehner et al. [4] are represented by red bars.

Average Composition of Pyroxene and Plagioclase

	Pig.	Aug.	FA	PxF	Plag.	K-Spar	Ba-K-Spar
SiO_2	50.20	49.93	47.52	46.80	49.18	67.29	57.63
TiO_2	0.44	0.63	0.81	0.63	-	-	-
Al_2O_3	1.38	2.08	1.25	0.71	29.90	18.69	19.63
Cr_2O_3	0.53	0.72	0.23	0.06	-	-	-
FeO	24.34	18.47	31.54	39.27	1.13	1.23	0.39
MnO	0.40	0.32	0.44	0.52	-	-	-
MgO	14.41	12.58	6.56	3.88	0.03	0.00	0.00
CaO	7.25	14.43	10.27	7.18	15.22	1.38	0.22
Na_2O	0.02	0.02	0.03	0.01	1.66	0.33	0.21
BaO	-	-	-	-	0.25	0.95	8.29
K_2O	-	-	-	-	1.25	10.13	13.22
Total	99.0	99.2	98.6	99.1	98.6	100.0	99.6
Mg/(Fe+Mg)	0.51	0.55	0.27	0.15	-	-	-
Wo/An	17.3	28.1	24.3	18.7	76.9	9.6	1.1
En/Ab	42.4	39.4	20.5	12.2	15.2	4.2	2.0
Fs/Or	40.3	32.5	55.2	69.2	7.5	83.9	81.2
Cn	-	-	-	-	0.5	2.4	15.7

Figure 2b. Table of average composition of the pyroxene (Wo,En,Fs) megacryst and feldspar (An,Ab,Or,Cn) in the ferroan gabbro clast.

Petrography: NWA 2727 contains a ~3 mm sized pyroxene-rich ferroan gabbro clast. This pyroxene megacryst contains enclaves of feldspar, silica, ilmenite, and troilite. Initial measurement of a plagioclase grain in the ferroan gabbro clast has a composition of $An_{76.9}Ab_{15.2}Or_{7.5}Cn_{0.46}$. Adjacent to the plagioclase is a high-Ba potassium feldspar with a composition of $An_{1.1}Ab_{2.0}Or_{81.2}Cn_{15.7}$. Grains of silica, including one intergrown with potassium feldspar ($An_{9.6}Ab_{4.2}Or_{83.9}Cn_{2.4}$), are also present (Fig. 3), along with a trace of phosphate grains.

Pyroxene in the ferroan gabbro clast has areas with compositions of pigeonite and augite ranging from $Fs_{26.3}Wo_{28.8}En_{44.9}$ to $Fs_{72.9}Wo_{16.5}En_{10.6}$. (Fig. 2a) Average compositions are summarized in the Table (Fig. 2b). This pyroxene grain shows significant zoning in Fe, Mg, and Ca and, to a lesser extent, Al.

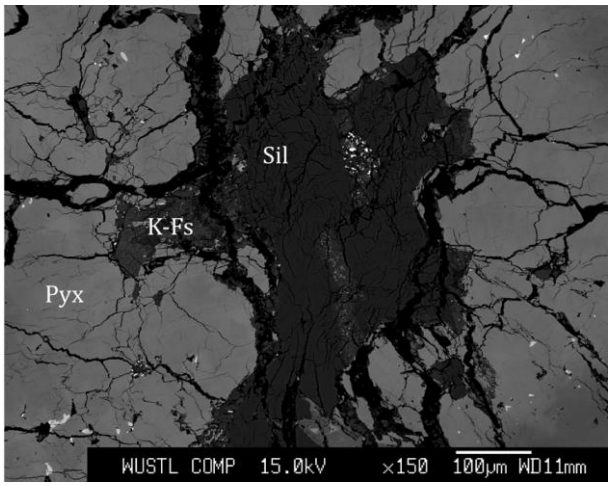

Figure 3. BSE image of an enclave of intercumulus minerals in the pyroxene megacryst showing an intergrowth of silica and potassium feldspar.

Comparison of pyroxene compositions to NWA 7007: The composition of the pyroxene megacryst in NWA 2727 is similar to pyroxene grains found in NWA 7007 [4] (Fig. 2), with compositions in both extending to Fe-enrichment typical of pyroxferroite (see below). The composition of pyroxene in NWA 7007 is reported as $Fs_{22.5}Wo_{31.2}$ to $Fs_{66.1}Wo_{19.7}$ with FeO/MnO of 46-66 [4]. FeO/MnO (molar) in NWA 2727 ranges from 49 to 82 with higher values corresponding to the more Fe-rich pyroxene compositions. Kuehner et al. [4] also described Fayalite-hedenbergite-silica symplectite in NWA 7007, likely resulting from the sub-solidus breakdown of pyroxferroite [7]. Although the large pyroxene clast in NWA 2727, itself, does not contain symplectite, a similar symplectite to that described in NWA 7007 occurs in breccia adjacent to the ferroan gabbro clast in NWA 2727.

Discussion: Preliminary compositional analysis of minerals and vitrophyres present in NWA 2727 relate the clasts in the breccia to either the olivine gabbro cumulate (OGC) or the NWA 3333 basaltic suite. The high levels of iron in the pyroxene along with the high Ba potassium feldspar and silica inclusions demonstrate that the gabbroic assemblage represents late-stage crystallization. The presence of pyroxferroite implies that the grain must have crystallized relatively

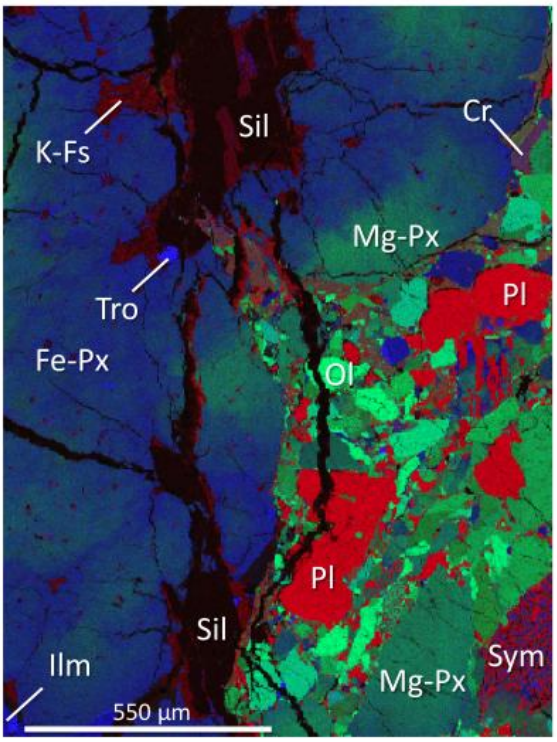

Figure 4. X-ray composite image of NWA 2727. Al is in the red channel, Mg in green, and Fe in blue. Zoning of iron and magnesium can be seen in the pyroxene megacryst along with intermixed silica (black) and potassium feldspar (dark red). Inclusions of ilmenite and troilite are seen in bright blue. Adjacent to the pyroxene rich megacryst is breccia. Olivine appears bright green, plagioclase, bright red, chromite, purple, and pyroxene varies between green and blue. The symplectite is composed of olivine, pyroxene, silica and plagioclase.

rapidly, perhaps in a shallow intrusive, in order to preserve a composition within the "forbidden zone" and to not form separate grains of hedenbergite, fayalite and silica.

Future work will focus on determining possible petrogenetic linkages between the ferroan gabbro and other clast lithologies in NWA 2727 and the NWA 773 clan.

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References: [1] Connolly H.C. et al. (2006) Meteorological Bulletin, No. 90; [2] Zeigler R.A. et al. (2007) LPS *XXXVIII*, Abstract #2019; [3] Jolliff B.L. et al. (2007) LPS *XXXVIII*, Abstract #1489; [4] Kuehner S.M. et al. (2012) LPS *XXXXIII*, Abstract #1519; [5] Gibson K.E. et al. (2010) LPS *XXXXI*, Abstract #2593; [6] Bunch T.E. et al. (2006) LPS *XXXVII*, Abstract #1375; [7] Liu, Y. et al. (2009) *Meteoritics & Planet Sci.*, *44*, 261-284.