FERROAN GABBRO AND LEUCOGABBRO LITHOLOGIES IN NWA 3170, POSSIBLE PETROGENETIC LINK, AND COMPARISON TO NWA 2727. S. N. North-Valencia, B. L. Jolliff and R. L. Korotev, Dept. of Earth & Planetary Science, Washington University in St. Louis, MO, 63130, USA (snorth@levee.wustl.edu)

Introduction: Lunar meteorite Northwest Africa (NWA) 3170 is one of the eleven paired meteorite stones in the "NWA 773 clan" [1-3]. The NWA 773 clan is a breccia consisting of five lithologies: olivine gabbro (OG), olivine phyric basalt (OPB), ferroan gabbro (FG), leucogabbro (LG), and a fragmental or regolith breccia. NWA 3170 is composed of olivine gabbro, ferroan gabbro, and leucogabbro, along with a breccia component (Fig. 1). The main mass is ~60 g and was found in 2007 [1]. There is some alteration (i.e. Ca-rich veins) in the slab studied, resulting from weathering in a hot-desert environment.

The FG and LG lithologies are similar to those found in NWA 2727 [2]. The FG lithology has only recently been found in NWA 773 clan members NWA 2727 and NWA 7007 [2,4,5]. The LG lithology has also only recently been found in NWA 2727 and NWA 3170, first reported here. This work is aimed at understanding how the FG and LG lithologies fit into the petrogenesis of the NWA 773 clan meteorites.

Petrography of NWA 3170: The sample of NWA 3170 that we have investigated is a thick polished slab (Fig. 1) composed of 40.4% OG, 14.8% LG, 3.6% FG, and 41.20% breccia. Pyroxene, olivine and plagioclase are the major minerals present. Minor K-feldspar, silica, and ilmenite also occur. Trace minerals include armalcolite, troilite, phosphates, zirconolite and spinel

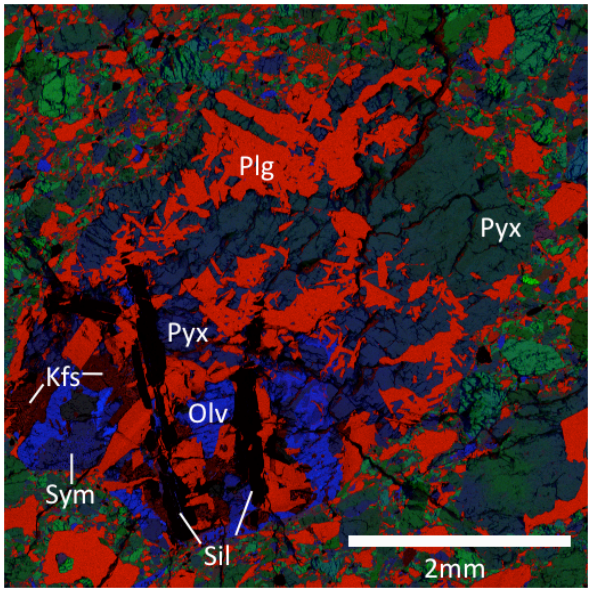

Figure 1. RGB image of ferroan gabbro NWA 3170, with Al in the red channel, Mg in green, and Fe in blue. Olv = olivine, Plg = plagioclase, Pyx = pyroxene, Kfs = potassium feldspar, Sil = silica, and Sym = symplectite.

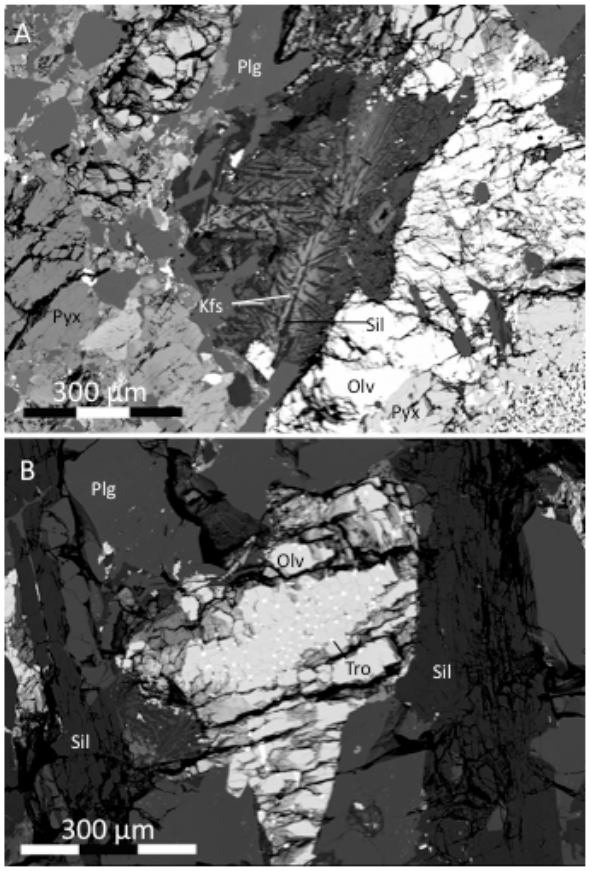

Figure 2. A. BSE image of a K-feldspar and silica granophyre in contact with fayalitic olivine, plagioclase, and pyroxene in the ferroan gabbro of NWA 3170. The Kfs grain is zoned in Ba, where brighter areas correspond to higher Ba content. B. BSE image of a fayalitic olivine grain in the ferroan gabbro of NWA 3170, with troilite inclusions. labels: Plg = plagioclase, Pyx = pyroxene, Kfs = K-feldspar, Sil = silica, Olv = olivine, and Tro = troilite.

Pyroxene and plagioclase dominate the breccia, with minor olivine. Symplectites are common in the breccia, and are composed of hedenbergite, fayalite, and silica, resulting from the breakdown of pyroxferroite [6]. Ilmenite, chromite, troilite, and phosphates are also present.

Olivine gabbro is prominent in our section of NWA 3170. It is composed of 24.6% olivine ($Fo_{0.67\text{-}0.70}Fa_{0.30\text{-}0.33}$), 35.9% pyroxene ($Wo_{12.6\text{-}34.9}En_{49.1\text{-}66.7}Fs_{16.0\text{-}25.2}$), and 39.5% plagioclase ($An_{88.5\text{-}93.0}Ab_{5.8\text{-}9.6}Or_{0.7\text{-}1.9}$) with minor to trace amounts of ilmenite, troilite and phosphates. The modal mineralogy is higher in plagioclase and pyroxene, and lower in olivine than those reported for NWA 773 [7-10]

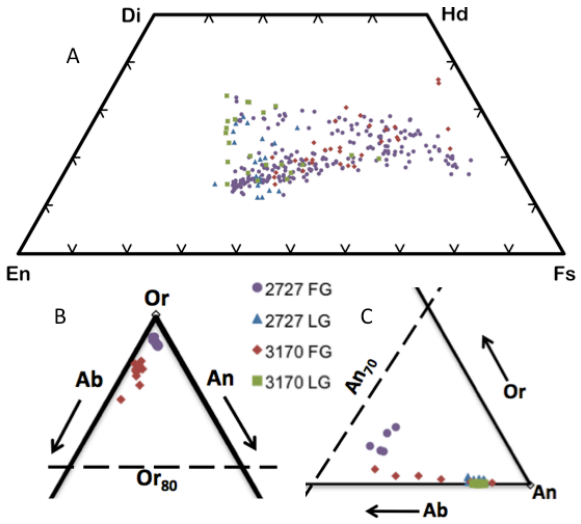

Figure 3. A. Pyroxene quadrilateral for the ferroan gabbro (FG) and leucogabbro (LG) in NWA 2727 and NWA 3170. B. Feldspar ternary near the K-feldspar end-member. for the FG and LG in NWA 2727 and NWA 3170. C. Feldspar ternary near the anorthite end-member. NWA 2727 FG is higher in K than NWA 3170 FG. The LG from NWA 2727 and NWA 3170 is nearly identical in composition.

The leucogabbro is composed of 61.8% plagioclase ($An_{92.2\text{-}93.7}Ab_{6.0\text{-}7.5}Or_{0.1\text{-}0.3}Cn_{0.0\text{-}0.1}$) laths and 38.2% pyroxene ($Wo_{14.4\text{-}32.6}En_{24.8\text{-}54.3}Fs_{21.4\text{-}55.6}$). Pyroxene is zoned in Mg-Fe (Fig. 2). Trace minerals include ilmenite, troilite and phosphates.

The ferroan gabbro is a complex lithology dominated by Mg-Fe zoned pyroxene ($Wo_{14.4\text{-}35.9}En_{5.3\text{-}45.8}Fs_{36.6\text{-}67.2}$), and plagioclase ($An_{78.0\text{-}94.7}Ab_{4.9\text{-}19.6}Or_{0.3\text{-}2.4}Cn_{0.0\text{-}0.1}$). K-feldspar ($An_{0.9\text{-}2.9}Ab_{5.0\text{-}10.1}Or_{74.4\text{-}91.9}Cn_{1.3\text{-}17.2}$) is also present, and is zoned in Ba, with up to ~8.5 wt% BaO (Fig. 2A). Olivine ($Fa_{97.80\text{-}98.26}Fo_{1.74\text{-}2.20}$) is present with both melt inclusions and troilite inclusions (Fig. 2B). A Qtz-Hed-Fay symplectite occurs along the margin of the ferroan gabbro clast in NWA 3170.

Comparing NWA 3170 and NWA 2727: The LG and FG lithologies in NWA 3170 are also found in NWA 2727. The modal mineralogy of the FG differs between NWA 2727 and NWA 3170. NWA 2727 is dominated by one very coarse pyroxene megacryst, with only minor feldspars, pyroxene, silica, and oxides. Olivine is absent in NWA 2727 FG. In NWA 3170, plagioclase, pyroxene and olivine are the major phases and silica, K-feldspar and oxides are minor minerals. The FG lithology has similar pyroxene compositions in NWA 3170 and NWA 2727 (Fig. 3A). However, NWA 2727 FG pyroxene compositions extend to higher Mg contents. Plagioclase in NWA 2727 FG is elevated in K compared to NWA 3170 FG (Fig. 3C).

The LG is similar in NWA 2727 and NWA 3170. Both have a cumulus texture containing coarse laths of plagioclase and coarse pyroxene. Pyroxene is heavily fractured in both samples. Plagioclase in the LG of NWA 2727 ($An_{91.0\text{-}93.7}Ab_{5.8\text{-}8.1}Or_{0.5\text{-}1.1}Cn_{0.0\text{-}0.1}$) is very similar in composition to plagioclase in the LG of NWA 3170 (Fig 3C). LG Pyroxene compositions in NWA 2727 ($Wo_{11.7\text{-}27.0}En_{35.9\text{-}49.4}Fs_{26.0\text{-}41.2}$) and in NWA 3170 have similar averages ($Wo_{19.3}En_{46.7}Fs_{33.9}$ and $Wo_{22.6}En_{44.0}Fs_{33.4}$, respectively). Modal recombination of the LG in NWA 2727 and NWA 3170 gives a nearly identical bulk composition, further supporting that the LG in NWA 2727 and in NWA 3170 is related (Table 1).

Petrogenesis of LG and FG: The petrogenesis of the lithologies of the NWA 773 clan has been attributed to formation in a shallow magma chamber, with a fraction of the melt removed after ~20% crystallization of olivine to form the OPB present in some NWA 773 clan members [7]. The melt remaining in the chamber solidified to form the OG [7]. After ~85% crystallization of the melt body, remaining intercumulus material could have solidified into the FG lithology [11]. The similarities in plagioclase and overlap in pyroxene composition between the FG and LG lithologies suggest that their petrogenesis may be linked.

Table 1. Bulk Compositions of Leucogabbro

	NWA 2727	NWA 3170
SiO2	47.64	47.81
TiO2	0.15	0.19
Al2O3	20.69	20.06
FeO	9.16	9.08
MgO	6.92	6.64
CaO	14.69	15.23
Sum	**99.26**	**99.01**

Table 1. Bulk composition of major oxides of the LG in NWA 2727 and NWA 3170, done by modal recombination.

Conclusions: NWA 3170 is a complex breccia composed of OC, FG and LG lithologies, along with a significant breccia component. The LG in NWA 3170 is texturally and compositionally similar to the LG in NWA 2727, suggesting that these clasts are two pieces of the same lithology. The FG in NWA 3170 has different modal mineralogy than the FG in NWA 2727, but this may be a function of non-representative sampling of the coarse gabbro. Pyroxene and plagioclase compositions of the FG in NWA 3170 and NWA 2727 are similar. Compositional overlap of pyroxene in the FG and LG lithologies suggest that the petrogenesis of these lithologies may be linked, but further petrogenic modeling is needed to confirm the link.

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