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Diverse crystallization trends in NWA 773 basalts

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At least three distinct crystallization trends in mafic rocks from the Moon can be extracted based on textural distinctions and pyroxene analyses from the Northwest Africa 773 (NWA 773) clan of lunar meteorites. The NWA 773 clan consists of brecciated and unbrecciated meteorites with a characteristic olivine gabbro cumulate lithology and other mafic rocks [1-5]. This study focuses on zoning trends in pyroxene within the olivine cumulate, in more evolved co-magmatic rocks that occur as breccia clasts, and a distinct mafic lithology characterized by fine-grained pyroxene+feldspar-rich groundmass [6,7]. Electron microprobe analyses for this study are from NWA 773 and NWA 2727.
Three trends can be distinguished based on Ti# (Ti/[Ti+Cr]) and Fe# (Fe/[Fe+Mg]) in pyroxene. (1) The main olivine gabbro cumulate clast (OGC) of NWA 773 [see 6,7]; smaller clasts of OGC in the breccia; co-magmatic, later-stage, coarse-grained, zoned pyroxene+feldspar-rich clasts, symplectite and extremely ferroan clasts with fayalitic olivine and silica and/or feldspathic glass form common trend with Ti# and Fe# both increasing in pyroxene. We refer to this as the ”main trend” of NWA 773 breccia. The large clast of OGC in NWA 773 was originally considered the most magnesian (most primitive) endmember of the main trend [6,7], but we have identified a slightly more magnesian clast with abundanct Cr-rich spinel.
(2) Within the olivine cumulate, pyroxene shows a wide range of Ti# but little variation in Fe# [6]. In this study, we collected pyroxene analyses along transects toward intercumulate K,Ba-feldspar-bearing pockets. These pockets are rich in incompatible elements and are considered products of residual liquids trapped between cumulate crystals (see Fig. 2B of [6]). We analyzed pyroxene adjacent to five pockets in NWA 773. In 7 of 9 transects in pyroxene, Ti# increases with minimal change in Fe# (”pocket trend”). Plagioclase feldspar adjacent to four of the five pockets showed a decrease in An-content (increase in Ab) approaching the pocket. These results are consistent with the interpretation of the pockets as residual liquids trapped in the cumulate.
(3) One group of texturally distinct clasts in the breccias of NWA 773 and NWA 2727 has a groundmass of fine, elongate, parallel crystals of feldpsar and pyroxene (straw-texture, see Fig. 6D of [6]). Pyroxene phenocrysts in the straw-textured clasts show complex zoning patterns. Fe-rich groundmass pyroxene analyses are similar to the main trend, but several analyses from the pyroxene phenocrysts have higher Ti# at a given Fe# than the main trend (straw-textured trend).
We infer that: (1) the main trend formed from fractional crystallization in the main body of NWA773 liquid; (2) the pocket trend formed from fractional crystallization as pyroxene grew toward trapped liquids in the cumulate; (3) the straw-textured trend formed from a separate mafic liquid with higher Ti#.
References: [1] Bunch et al., 2006, LPSC 37, #1375; [2] Jolliff et al., 2007, LPSC 38, #1489; [3] Zeigler et al., 2007, LPSC 38, #2109; [4] Zhang et al., 2010, MaPS 45, p. 1929-1947; [5] Nagaoka et al., 2011, LPSC 42, #1864; [6] Fagan et al., 2003, MaPS 38, p. 529-554; [7] Jolliff et al., 2003, GCA 67, p. 4857-4879.