High-Cl apatite as an indicator of KREEP in the breccia of lunar meteorite northwest Africa 773

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The lunar meteorite Northwest Africa 773 (NWA 773) is composed of diverse clasts with basaltic affinities [1] [2]. Many of the clasts appear to represent stages of crystallization of a single magmatic body on the Moon [3]. If true, then NWA 773 can be used as a case study of igneous crystallization in a lunar setting, and clasts in NWA 773 can be used to trace geochemical processing, such as enrichment of H2O in late-stage magmatic liquids [4].

In this context, it is critical to establish which clasts belong to the main crystallization sequence and which clasts are exotic to this sequence. The main sequence is characterized by progressively increasing Fe# (Fe/[Fe+Mg]) and Ti# (Ti/[Ti+Cr]); it begins with olivine cumulate gabbro, progresses to pyroxene gabbro, and culminates in symplectite and alkali-rich phase ferroan (ARFe) clasts [3]. ARFe clasts typically have RE-merrillite, +/- apatite.

We used low-voltage (7 kV) analyses by electron microprobe to analyze Ca, P, F and Cl in apatites from four ARFe clasts, and to calculate OH abundances based on stoichiometry [5]. In three of the four ARFe clasts, apatites yielded low-Cl, variable-OH compositions typical of mare basalts of the Moon [5]. However, apatite from one clast has relatively high Cl-contents with low OH, typical of KREEP lithologies [5].

Abundances of F vs. Cl vs. OH in apatite may vary during igneous crystallization [6], thus it is possible that the Cl-rich apatite formed after fractionation of F as part of the main NWA 773 sequence. However, all previous analyses of apatite in NWA 773 have low Cl contents [4]. Thus, it is more likely that the ARFe with high-Cl apatite is an exotic clast from a KREEP-like igneous body, serving as a reminder that exotic clasts occur in this breccia and supporting an origin from the KREEP-Procellarum Terrane of the Moon.

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