Apatite as a recorder of volatile elements during magmatic evolution of lunar meteorite NWA 773

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Basaltic breccia clasts in the lunar meteorite Northwest Africa 773 (NWA 773) preserve a record of magmatic evolution on the Moon, with Ca-phosphates (merrillite and apatite) concentrated in diverse late-stage lithologies [1,2]. Preliminary results suggest that apatite is more abundant than merrillite in clasts of ferroan symplectite (sym), whereas merrillite dominates over apatite in alkali-rich phase ferroan rocks (arfs). NWA 773 olivine cumulate (OC) formed during early stages of fractionation, but has rare incompatible element-rich, intercumulus (IC) domains. Merrillite is more abundant than apatite in the intercumulus domains.

To estimate H_2O abundances in NWA 773 apatite, we used an electron microprobe (EPMA) to detect Cl and F, and used $Ca_5(PO_4)_3(X)$ (X = F,Cl,(OH)) stoichiometry to calculate the missing X-component [e.g., 3]. Prior to analyses of NWA 773, we tested EPMA conditions on terrestrial apatite (from Durango, Mexico [4]). Durango apatite was analyzed with c-axis parallel to and perpendicular to the incident electron beam under the following conditions: 7 kV, 2 nA, focused beam rastering at 100,000X (~1 μm across; fine grain-size of some NWA 773 apatite necessitated small spot size). The F K-alpha count rate was constant for 200 s of beam exposure for apatite with c-axis perpendicular to the incident elecctron beam. A similar count rate was detected over the 1st 30 s of analysis with c parallel to the beam, but longer beam exposure caused deviations in count rate.

The same conditions were used to analyze NWA 773 apatites from IC domains and sym clasts. Apatites from these domains appear to be Cl-poor (<0.05 atoms in X-site) and F-rich (0.6 to 0.9 atoms in X), but Cl+F are insufficient to fill the X-site for most analyses (similar to many apatites from mare basalts [3,5]). The most likely missing X-component is OH [5], and it appears to be more enriched in the sym clasts than in the IC domains. The IC domains are from early trapped liquids, whereas the sym clasts formed at later stages, suggesting that H_2O was enriched during evolution of residual liquids in the NWA 773 magmatic system.

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