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Contrasting Roles of Water during Crystallization of Lunar vs Terrestrial Gabbros: Constraints from Apatite in Lunar Meteorite NWA 2977, Apollo 15 Quartz Monzodiorite and a Gabbroic Sill from Murotomisaki Japan

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The compositions and effects of water and other volatile components on petrogenesis in lunar rocks have been undergoing revision based on detection of hydrogen among other volatiles in lunar samples [1]. In this study, we conduct electron probe microanalysis (EPMA) of apatite to evaluate role of water during crystallization of two lunar and one terrestrial igneous rock: (1) olivine cumulate gabbro (OCG) of lunar meteorite NWA 2977 (of the NWA 773 clan [2]): (2) Apollo 15 quartz monzodiorite (QMD, 15405,56 [2,3]); (3) pyroxene feldspar gabbro of the Murotomisaki gabbroic sill (MGS [4]). Synthetic apatite crystals from the study of [5] were provided kindly by D. Harlov and were used as EPMA standards. In every locality analyzed, we selected at least one spot for replicate analyses to evaluate changes in F and Cl over time during EPMA. Abundances of X-site OH were calculated as 1-F-Cl after normalization to 5 Ca atoms per formula unit (apfu).

EPMA from all 3 samples indicate F-rich apatite (>0.5 apfu F). Apatite from QMD is Cl-rich (0.1-0.2 apfu) and water-poor (OH<0.2 apfu) compared to the other samples. All EPMA from MGS indicate water present, from 0.15 to 0.5 apfu OH, whereas water appears to be present in some, but not all apatite from OCG (0<OH<0.35 apfu). Apatite OH-contents based on EPMA have wide uncertainties [3] and inferring source F:Cl:OH ratios is complex given the variable compatibilities of F, Cl and OH in apatite [6]. Nonetheless, the EPMA data presented here indicate differences among the samples investigated: a water-poor, Cl-rich volatile component for the QMD [3] and a volatile component with minor, but variable H2O for the NWA 773 clan OCG [7].

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