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Ca-phosphates and role of H2O during evolution of lunar rocks Northwest Africa 773 and Apollo 15405

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Ca-phosphates are rich in incompatible elements and are relatively abundant in evolved igneous rocks on the Moon. This study makes use of apatite (Ca10[PO4]6[F,Cl,OH]2) and RE-merrillite (also called whitlockite, Ca16REE2[Mg,Fe]2[PO4]14) to characterize the origin of the following evolved lunar rocks: (1) incompatible element-rich pockets in olivine cumulate clasts in the Northwest Africa 773 breccia (NWA 773, a lunar meteorite); (2) fayalite-hedenbergite-silica symplectites in the NWA 773; (3) FeO-alkali-rich clasts in NWA 773; (4) quartz monzodiorite (QMD) from Apollo sample 15405. The abundance of whitlockite exceeds that of apatite in all of the rocks above except for the symplectites–apatite only was identified in symplectite. This suggests that most evolved lunar rocks are poor in halogens and H2O compared to granitic rocks on Earth, which tend to have higher abundances of apatite.

Low-voltage (7 kV), low-current (2 nA) analyses of lunar apatites in the NWA 773 incompatible pockets, FeO-alkali-rich clasts and symplectites were analyzed for the presence of F and Cl (and by subtraction, OH). Analytical conditions were checked using terrestrial Cerro de Mercado apatite. Fluorine Ka count rates remain steady for the above conditions for apatite with c-axis oriented perpendicular to the electron beam, but drop to below detection after 60 seconds of beam exposure if the c-axis is oriented parallel to the electron beam.

Apatites in the incompatible pockets, FeO-alkali-rich clasts and symplectites are F-rich, but suggest that OH is present (˜F-1.5 Cl-0.05 OH-0.45). If so, H2O was present in the igneous liquid from which clasts in NWA 773 crystallized. Both the FeO-alkali-rich clasts and the symplectites are interpreted as evolved differentiation products from the same magmatic system that produced the olivine cumulate. If this interpretation is correct, then OH must have partitioned away from the FeO-alkali-rich parent material and into the symplectite parent material to result in the distribution of Ca-phosphates in these evolved clasts.

Keywords: lunar rocks, basalts, phosphates