WATER CONTENT, CHLORINE AND HYDROGEN ISOTOPE COMPOSITIONS OF LUNAR APATITE.

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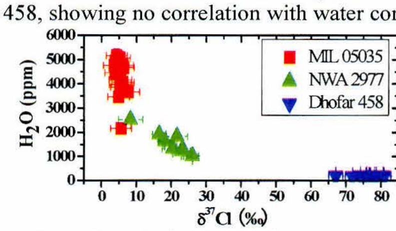
Introduction: The Moon has been thought to have a bulk planetary water content < 1 ppb [1]. Recent ion microprobe analyses have shown that lunar samples contain up to 7000±1000 ppm OH^- (reported as equivalent H_2O) in apatite and 4-46 ppm in igneous glass [2-6]. These studies suggest that the mantle sources of at least some lunar magmas contain from 64 ppb to 200 ppm [4-6]. Sharp et al. [6] report an apparently contradictory observation —that ^{37}Cl values of lunar samples vary from -1 to 24‰, with an upper extreme they argue demands devolatilization of anhydrous melts. We examine this issue further through measurements of water content, δ^{37}Cl, and δD of apatite from lunar meteorites MIL 05035, NWA 2977, and Dhofar 458.

Results: Nine apatite grains were examined with the Cameca NanoSIMS 50L and 7f Geo at Caltech. Apatite grains from two basaltic meteorites (MIL 05035 and NWA 2977) yielded δ^{37}Cl values from 3.8±3.1 (2σ) to 26.2±1.8 ‰ and water contents from 1100±120 to 5200±280 ppm, comparable with those previously reported for lunar apatite [4-7]. One apatite grain from a feldspathic breccia (Dhofar 458) has extremely high δ^{37}Cl of 67.2±2.0 to 81.1±2.0 ‰, and a relatively low water content averaging 240±40 ppm. δD of apatite varies from -110±30 ‰ in NWA 2977 to 400±80 ‰ in MIL 05035, and to 510±130 ‰ in Dhofar 458, showing no correlation with water content or δ^{37}Cl.



Discussion: Our study shows that lunar apatite exhibits a large range of δ^{37}Cl even in individual crystals that contain significant amounts of water. These findings appear to be inconsistent with the interpretations of Cl isotope data presented in Sharp et al. [6]. We suggest our observations for lunar basalts might be explained if the major volatile species responsible for degassing of Cl from lunar magmas are metal chlorides, which could account for the large fractionation of Cl isotopes [7]. Uncorrelated δD and δ^{37}Cl values of apatite indicate that the fractionations of H and Cl isotopes were decoupled in the lunar samples we examined. The high δ^{37}Cl values of the apatite in Dhofar 458 are exceptional compared to our and previous data for apatites in basaltic rocks. We suggest such extreme values in this impact breccia reflect sampling a reservoir of extremely heavy Cl isotopes on the lunar surface, possibly produced by repeated ^{35}Cl loss during multiple shocks events or gardening processes.

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