High Chlorine of KREEP: Implications for the volatile content of the Moon

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As we continue to assess the volatile inventory of the Moon as a whole, different types of lunar lithologies give contrasting views. Apatite in mare basalts appears to indicate generally low volatile contents at the time of apatite saturation, while the picritic green and orange mare glasses indicate volatile contents similar to parts of the Earth's upper mantle. Apatite in KREEP has been dry and generally Cl-rich, with high δ^{37}Cl. A volatile-rich lunar magma ocean would likely lead to volatile saturation at the base of the lunar crust, where the KREEP liquid is expected to reside at the end of magma ocean crystallization. Here we measure the F and Cl content of late-stage glasses in contact with apatite in KREEP basalts 15382 and 15386, as well as volatile contents and D/H of apatite in 15382. We find 300 ppm OH in apatite, on the low end of lunar basaltic apatite hydroxyl contents, and high δD of +1364±96‰ (2σ).

The Cl contents of late-stage glasses in 15382 and 15386 are generally 300-400 ppm Cl, ranging almost up to 1000 ppm Cl. The F content is correspondingly high as well, but with a high Cl/F (wt) ~10. We calculate the content of Cl and F in 15382 whole rock to be 27 ppm and 313 ppm, respectively. The main carrier of Cl in 15382 and 15386 is glass, not apatite. If we use P as a proxy for KREEP, we calculate 101 ppm Cl and 1159 ppm F in urKREEP. If we compare volatile/refractory trace elements with similar incompatibility, we obtain Cl/Nb (wt) = 0.37 and F/Nd (wt) = 2.5 for KREEP basalt 15382. These ratios are similar in the olivine-hosted melt inclusions of 74220, suggesting similar Cl/Nb and F/Nd between KREEP and the most volatile-rich lunar samples. Considering the different magmatic histories between KREEP basalt and the orange glasses, similarities in these ratios are surprising and will be discussed.