H, D, F, Cl, Nb, Ce, Nd of olivine-hosted melt inclusions in Apollo 12 olivine basalts 12009 and 12004.

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Estimates of the water and volatile element contents of the Moon range from as high as the terrestrial upper mantle to order of magnitude lower levels [1]. The Apollo 12 olivine basalts represent a consanguineous suite of rocks from rapidly cooled olivine vitrophyres (e.g. 12009) to slowly cooled olivine cumulate basalts (e.g. 12040) emplaced in a shallow sill or successive pile of lava flows [2]. Previous measurements of H and D of olivine-hosted melt inclusions of more slowly cooled basalts 12018, 12035 and 12040 suggested significant exchange of H and D with interstial liquids enriched in a low-D component [3]. Here we measure incompatible volatile and refractory lithophile elements in olivine-hosted melt inclusions of more rapidly cooled Apollo 12 olivine basalts 12004 and 12009.

Apollo sample chips 12009,158 and 12004,147 were mounted in low-temperature metals and ^{1}H and D were measured on the Cameca ims 1270 with SCAPS 2-D ion imaging, and F, Cl, Nb, Ce, and Nd were analyzed with the Cameca ims 1280 at Hokkaido University in several analytical sessions using established and internal glass standards. Due to the small size of the melt inclusions, we could not measure the entire suite of elements in any individual melt inclusion. We were able to measure F/Nd=8.5 and Cl/Nb=0.88 in one melt inclusion of 12004,147 which is volatile-rich for lunar samples, but still an order of magnitude lower than Earth, as we have shown previously for all lunar samples [4].

Cl, Nb, Ce, and Nd of olivine-hosted melt inclusions in 12009 are homogenous, while H and D are highly variable. This is consistent with exchange of H and D of olivine-hosted melt inclusions with external reservoirs during cooling [3].

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