Nearside lunar mantle halogen composition from mare basalts.

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The heavy halogens (Cl, Br and I) are an important set of volatile elements that play a key role in inner Solar System planetary processes. The heavy halogens are controlled by fluid mobility, but are not strongly affected by partial melting processes, making them a useful tool for tracing the distribution and behaviour of other volatile elements. Chlorine isotope studies imply that the lunar mantle is anhydrous [1]. This is consistent with major degassing of volatiles by hydrodynamic escape as a result of a giant Earth-Moon forming impact [2, 3]. Previous SIMS analysis of lunar glass beads and apatite suggest, however, that the lunar mantle may contain volatiles in abundances comparable to present day MORB [4, 5]. Seven mare basalts from a range of Apollo missions were selected as representative of partial melts of the lunar mantle across 1 billion years of lunar history (~4.2 to 3.2 Ga). Constraining mare basalt halogen composition can help to refine our understanding of volatile origin and evolution in the lunar mantle. To analyse the halogens, neutron irradiation first converted the samples' constituent Cl, Br and I into their respective noble gas isotopes ^{38}Ar, ^{80}Kr and ^{128}Xe. The noble gases were then liberated using CO_2 laser heating for measurement by Noble Gas Mass Spectrometry (NGMS). During the samples' residence close to the lunar surface environment, *in situ* cosmogenic noble gas isotopes, and fission-derived Kr and Xe would have formed. A technique is being developed to discern the halogen-derived noble gases from the *in situ* components (and from trapped components, e.g. solar wind). The initial (uncorrected) results indicate that Cl appears to be dominated by cosmogenic input with $^{38}Ar/^{36}Ar$ ratios of ~1.5. However, appreciable amounts of I-derived Xe and Br-derived Kr have been measured within the nearside mantle-derived mare basalts yielding $^{128}Xe/^{130}Xe$ molar ratios of 1.5 to 2.05, and $^{80}Kr/^{82}Kr$ molar ratios of 1.5 to 2.9 respectively.

[1] Sharp, D. et al. (2001) *Science* **329**, 1050-53. [2] Day, J.M.D. et al. (2017) *Sci. Adv.* **3**, 1602668. [3] Wang, K. & Stein, B.J. (2016) *Nature Lett.* **538**, 7626. [4] Saal, E.A. et al. (2008) *Nature Lett.* **454**, 192-5. [5] Barnes, J.J. et al. (2016) *Nature Comm.* **7**, 11684.