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Investigating the water contents and hydrogen isotopic compositions of lunar apatite

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The initial studies of Apollo rock samples concluded that the Moon was an anhydrous planetary body [1]. Recently there has been a change of opinion with several research groups detecting copious amounts of water, up to 6050 ppm from a range of lunar glasses, melt inclusions and apatite [2-7]. Here we report results from insitu ion microprobe analysis of apatite grains from Apollo mare basalt 12064 and lunar basaltic meteorite Miller Range MIL 05035.

The δD_{SMOW} values for 3 apatite grains in 12064 range from +822 to +998 ‰, with the hydroxyl content ranging from ~2800 to 4744 ppm. Five apatite grains were analysed in MIL 05035 with δD values ranging from -137 to +830 ‰. Hydroxyl content ranges from ~470 to 2690 ppm. The analytical setup for MIL 05035 was such that it yielded relatively low count rates for ^{2}H (an order of magnitude less than those obtained for 12064), and this in turn introduced large errors into the analysis.

The results for ilmenite basalt 12064 are among the highest δD measured so far from lunar apatites [7] being more tightly constrained in both δD and water content. The results plot well outside the range for terrestrial water (+100 ‰ to -500 ‰) [8, 9], suggesting that the hydrogen isotopic composition measured in these apatites has not been compromised by terrestrial contamination. Cometary material has a high δD and therefore, it could be interpreted that at least some lunar hydrogen is of cometary origin [7-9]. The roles of other processes which potentially contribute to elevated D/H ratio in lunar apatites need to be further investigated.

We recorded δD values overlapping with terrestrial δD values for MIL 05035. However, it is unclear if any of the observed isotopic variation relates to the low, and variable hydroxyl content in this rock.

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