Simulating atmospheric loss and carbonate formation on early Mars using hydrothermal experiments

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INTRODUCTION:

Multi-stranded evidence strongly advocates liquid water once flowed on Mars, yet current surface conditions are outside the stability field of water, indicating the past atmosphere must have been thicker (1-5 bar [1]); probably possessing significant CO_2/SO_2 components. The fate of such a palaeo-atmosphere has been vigorously debated, with hydrodynamic escape and polar ice storage estimates unable to adequately explain atmospheric loss alone, without employing significant crustal carbonation, even when using very conservative initial estimates [2].

This research investigates the rate, fluid dynamics, morphology and quantity of such crustal carbonation through a simplified contolled analogue. From previous study of martian meteorites the authors concluded that observed martian carbonates formed as low temperature fluid weathering products, replacing the original silicate mineralogy.

METHODS AND RESULTS:

To test this conclusion, a 120 day pressure chamber experiment seeks to establish conditions conducive to replicating the meteorite carbonate mineralogy. Based at the British Geological Survey, it consists of eight H_2O filled vessels under constant 80°C and 2 bar. Well analysed 10g samples of olivine, basalt, basalt and pyrrhotite are selected as initial mineralogies. Each sample is saturated with either CO_2, CO_2/SO_2 2:1 mix or N (control). At 5 points during the experiment 12ml will be extracted and analysed using PHREEQC 3 software to calculate fluid geochemical evolution. Post experiment, samples are petrographically reanalysed for petrological changes, and specifically, carbonate growth.

[1] Pollack *et al*. 1987. *Icarus* 71 203-24. [2] Niles and Michalski, 2011. *42nd Lunar and Planetary Science Conference* 2471.