A COMBINED CARBON AND OXYGEN ISOTOPIC ANALYSIS OF ALH84001 CARBONATES WITH NANOSIMS

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Introduction: ALH84001 is the oldest known martian meteorite we have on Earth (4.56 Ga) [1], the carbonates within ALH84001 precipitated ~3.9 Ga [2]. Of all the current martian meteorites ALH84001 has the largest quantity of carbonates (1 % vol) and variations in mineralogy, especially the carbonate "rosettes", with an ankerite core commonly surrounded by an alternating layer of siderite-magnesite-siderite. The age, quantity, isotope range and diverse mineralogy make ALH84001 carbonates ideal candidates to provide insights into the primordial martian conditions.

Isotopes: $\delta^{18}O$ and $\delta^{13}C$ measurements of carbonates in ALH84001 by ion microprobe vary from -10 to +27‰ [3-8] and +27 to +64‰ [8, 9] respectively, studies by acid dissolution and stepped combustion of bulk material fall within these ranges [10, 11, 12]. The variation in both $\delta^{18}O$ and $\delta^{13}C$ requires a significant change in fluid composition and/or temperature during formation. Owing to the small size of these rosettes (50-250 μm), few studies have related micron scale mineralogical variations with $\delta^{18}O$ and $\delta^{13}C$. To rectify this issue we are using The Open University's Cameca NanoSIMS, an ion microprobe instrument that combines submicron ion beam spot sizes with high sensitivity.

Standards: 15 standards (8 dolomites, 3 magnesites, 2 siderite, 1 ankerite and 1 calcite) were used for instrumental mass fractionation and matrix corrections. All the carbonate standards have been mapped with EDX and calibrated to a NIST 19 reference on a Thermo-Finnigan DELTA Advantage mass spectrometer for VPDB and VSMOW values.

Analytical: Isotopic analyses were conducted across two rosettes with 5 μm point analysis. A focused ion beam was used to prepare a flat surface which reduced contamination compared to past methods of resin and polish. In addition, parallel analysis of MgO, FeO, CaO and Si provided an indication of any mineralogical variation in the experimental study. A cameca SX100 electron microprobe (OU) will be used to quantitatively characterize the mineralogy at each analysis site.

Implications: The results from this study will further constrain the relationship between isotopic and compositional variations across the rosettes. These results will aid future numerical and synthetic formation studies that aim to determine the primordial conditions which these carbonates formed. These carbonate formation conditions represent a period when Mars may have been much warmer and wetter environment and is hence of great interest for future martian missions.

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