TRACKING THE OXYGEN ISOTOPE EVOLUTION OF AQUEOUS SOLUTIONS DURING ALTERATION OF CM2 CARBONACEOUS CHONDRITES.

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Introduction: The oxygen isotope compositions of carbonate minerals that formed during aqueous alteration of CM2 carbonaceous chondrites can provide valuable information on the nature and intensity of fluid-rock interaction, relative mineralization timescales and crystallization temperatures, e.g. [1-3]. Analysis of bulk samples shows that $\delta^{18}O$ and $\Delta^{17}O$ values differ between CMs [1], and recent ion microprobe work has revealed that individual meteorites can contain populations of grains with very different $\delta^{18}O$ and $\delta^{17}O$ values [4]. Taken together, these findings suggest that the isotopic composition and/or temperature of parent body aqueous solutions varied spatially and/or temporally over sub-meteorite and greater length scales. Here we have sought to investigate further the dynamics of the aqueous system by oxygen isotope analysis of three distinct generations of Ca-carbonate minerals in the LON 94101 CM2 carbonaceous chondrite.

Methods: This study used one thin section of LON 94101, whose carbonate grains were located and imaged using a FEI Quanta 200F field-emission SEM. These grains were then analysed using a NanoSIMS 50L at the Open University (U.K). Analyses were performed in spot mode and with a ~30pA Cs^+ ion beam; ^{16}O was measured on a Faraday cup and ^{17}O and ^{18}O using electron multipliers.

Results and discussion: LON 94101 contains three generations of Ca-carbonate: (i) 5-100 micrometer sized grains of aragonite, (ii) 10-50 micrometer sized grains of calcite, and (iii) a millimeter-sized calcite vein [5]. The aragonite is inferred to have crystallized first (mean $\delta^{18}O$ 39.9±0.6‰, $\Delta^{17}O$ -0.3±1.0‰, 1σ) and was followed by calcite grains (mean $\delta^{18}O$ 37.5±0.7‰, $\Delta^{17}O$ 1.4±1.1‰, 1σ), then the calcite vein (mean $\delta^{18}O$ 18.4±0.3‰, $\Delta^{17}O$ -0.5±0.5‰, 1σ). NanoSIMS data suggest that the calcite grains precipitated shortly after aragonite and from solutions of a similar oxygen isotope value and/or temperature. The calcite vein formed following brittle fracturing of the parent body in response to an impact [5], and from aqueous solutions of very different oxygen isotope value and/or temperature. Taken together, these results indicate that the region of the parent body sampled by LON 94101 was exposed to at least two generations of aqueous solutions. Those that formed the vein calcite were sourced from a different parent body region and entered LON 94101 via a high permeability fracture network.

References: [1] Benedix G. K. et al. 2003. *Geochimica et Cosmochimica Acta* 67:1577–1588. [2] Guo W. and Eiler J. M. 2007. *Geochimica et Cosmochimica Acta* 71:5565–5575. [3] Clayton R. N. and Mayeda T. K. 1984. *Earth and Planetary Science Letters* 67:151–161. [4] Tyra M. A. et al. 2012. *Geochimica et Cosmochimica Acta* 77:383–395. [5] Lindgren P. et al. 2011. *Earth and Planetary Science Letters* 306:289–298.

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