SIMS IN-SITU CARBON AND OXYGEN ISOTOPIC COMPOSITION OF DOLOMITE AND CALCITE IN CM1/2 ALH 84049

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Introduction: CM1 carbonaceous chondrites are generally considered to represent the final stage of progressive aqueous alteration of CM2 chondrites. However, based on their mineralogy and oxygen isotopic compositions, they appear to have been altered at higher temperatures and higher water/rock ratios [e.g. 1, 2], than CM2s. Like CM2s, aqueous alteration of the CM1s has resulted in the formation of secondary carbonate minerals, dominantly dolomite although calcite is also present. Oxygen and carbon isotopic data for these carbonates can provide useful data to further constrain the conditions and processes of carbonate formation. However, to date, only bulk oxygen and carbon data exist for carbonates in CM1 chondrites [3, 4], no in situ analyses of carbonates using SIMS have yet been carried out [5]. Here we present carbon and oxygen isotopic for the CM1/2 chondrite ALH 84049, a meteorite that we have studied previously to constrain the timing of carbonate formation. Our goal is to determine whether the carbon and oxygen isotopic values of carbonates covary, whether isotopic compositions of carbonates support multiple generations of precipitation, how they compare to existing bulk data and constrain the isotopic composition of the fluid during alteration. We chose ALH 84049 because it is paired with the previously-analyzed ALH 83100 and contains large, abundant, non-fractured carbonate grains.

Results: Zoned dolomite is dominant with rarer calcite grains. We analyzed a total of 13 separate dolomite grains using the Cameca 7f ion microprobe at Caltech. The $\delta^{13}C$ values for these grains range from 23 to 60 ($\pm$ 2) ‰ with oxygen isotopic values of $\delta^{18}O$ from 25 to 32 ($\pm$ 3) ‰, and $\delta^{17}O$ from 10 to 16 ($\pm$ 3) ‰. We only analyzed three calcite grains for carbon isotopic composition and found a much narrower range of $\delta^{13}C$ values ranging from 10 to 13 ($\pm$ 2) ‰. The oxygen isotopic values for dolomite are quite variable, and appear to exhibit a bimodal distribution, but plot on the lower end of prior bulk carbonate analyses [3, 4]. Carbon isotopic values in both dolomite and calcite, however, differed markedly from prior bulk analyses in ALH 83100 [4].

Discussion: For oxygen, our data show that dolomites lie within the range of prior bulk CM2 analyses, but have isotopic compositions indicative of precipitation from a fluid that has interacted more extensively with anhydrous minerals than some CMs. Carbon isotopic compositions, however, encompass the range of almost the entire bulk-suite of CM meteorites [4]. Carbon isotopic compositions are much more variable than those in CI carbonates [6]. Discrepancies between in-situ analyses and bulk carbonate extractions at 25°C (presumably calcite) and 150-200°C (presumably dolomite) warrant further investigation.

References: [1] Zolensky et al. 1997. *Geochimica et Cosmochimica Acta* 61:5099-5115. [2] Rubin et al. 2007. *Geochimica et Cosmochimica Acta* 71:2361-2382. [3] Benedix et al. 2003. *Geochimica et Cosmochimica Acta* 67:1577-1588. [4] Grady et al. 1988. *Geochimica et Cosmochimica Acta* 52:2855-2866. [5] Tyra et al. 2010. Abstract #2687. 41st Lunar & Planetary Science Conference. [6] Zito et al 1998. Abstract 5170. 61st Annual Meteoritical Society Meeting.