Using SIMS to evaluate oxygen isotopes in CM chondritic carbonate. M. A. Tyra[1], J. Farquhar[2], Y. Guan[3], L. Leshin[4] [1]Department of Earth & Planetary Sciences, UNM, Albuquerque, NM 87131, [2]Department of Geology and ESSIC, UMd, College Park, MD 21702, [3]Department of Geological Sciences, Arizona State University, Tempe AZ, 85287, [4]NASA/GSFC, Code 600 Greenbelt, MD 20771.

Introduction: The δ^{18}O, δ^{17}O, δ^{13}C, and δ^{14}C compositions of bulk carbonate have been measured from paired Antarctic CM2 chondrites (EET96006, EET96016, EET96017, and EET96019) [1,2]. Further oxygen isotopic compositional constraints are placed here by Secondary Ionization Mass Spectrometry (SIMS) of *in-situ* carbonates. Here we report oxygen isotopic analyses of CM calcite populations for 27 calcium carbonate grains. Some comparisons with the data of Benedix *et al 2003* [3] of CM falls are included.

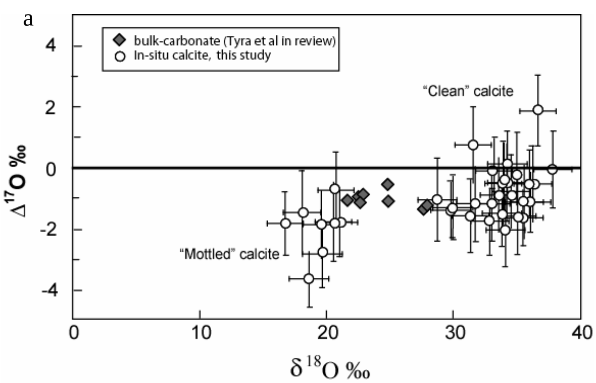
Techniques: Four polished thick-sections were gold-coated with a Hummer 6.2 Anatech sputter-coating unit. Oxygen isotopic analysis of carbonates (δ^{18}O, δ^{17}O) was performed with the ASU CAMECA IMS 6F SIMS with a Cs^+ primary ion beam (10 keV, 25µm spot size). Instrumental Mass Fractionation (IMF) was determined to be 24.88‰ for δ^{18}O and 12.44‰ for δ^{17}O by analyzing a terrestrial calcite standard (Joplin calcite, with a δ^{18}O value of 5.8‰). Uncertainties on individual analyses, taking into account the variation on repeated analyses of the standard, are 1.35 ‰ (1σ) for δ^{18}O and 1.4‰ (1σ) for δ^{17}O. Matrix effects are the cumulative IMF due to variances in sample chemical composition. Because the analyzed calcite is very similar to the composition of the standard (almost pure $CaCO_3$) we do not use additional matrix-effect corrections. Follow up imaging was performed on a JEOL JSM-IC845 scanning electron microscope (SEM).

Results: The data are illustrated in figures 1 and 2. The analyses are grouped on the basis of the carbonate morphology into two basic types of calcite, "mottled" and "clean". Clean calcium carbonate grains occur in isolation in the matrix of the paired samples. These grains are blocky, anhedral, and contain few inclusions. They also have rims of fine-grained material that may be tochilinite ((FeS)·(Mg,Fe)$(OH)_2$). These grains are generally less than 50µm in diameter. Mottled calcium-carbonate grains occur in association within the fine-grained matrix and have a mottled appearance when viewed by SEM with more diffuse, irregular grain boundaries. They range from about 50 µm to 250 µm.

Discussion: The two matrix calcites, clean and mottled, represent different generations of calcite formation. The slopes produced by the two populations within this study represent only the largest calcite in the section due to SIMS spot diameter and therefore may not represent all matrix calcite populations.

Figure 1 presents the SIMS analyses of the four Elephant Moraine meteorites and compares it to the results in Tyra *et al* (in review) [1]. The isotopic results of the two populations are related to calcite type. The δ^{18}O of the two carbonate types, regardless of level of weathering, remain consistent regardless of which sample is analyzed. A comparison of the results of this study (δ^{18}O vs. Δ^{17}O) with the bulk-carbonate results indicates that the bulk-carbonate data lie between the mottled and clean carbonate populations (Figure 2). This may indicate that values reported in Tyra *et al* (in review) are averages of the two dominant calcite populations, but this interpretation would be inconsistent with the trend of the bulk-EET array. Although the *in-situ* SIMS analyses have a positive slope, the bulk-carbonate data possess a trend with a negative slope that approaches the TFL at near δ^{18}O ~ 0‰ and Δ^{17}O ~ 0 ‰. Taken together, the data are interpreted to be the mixing of three reservoirs: clean carbonate, mottled carbonate, and terrestrial carbonate.

a



b

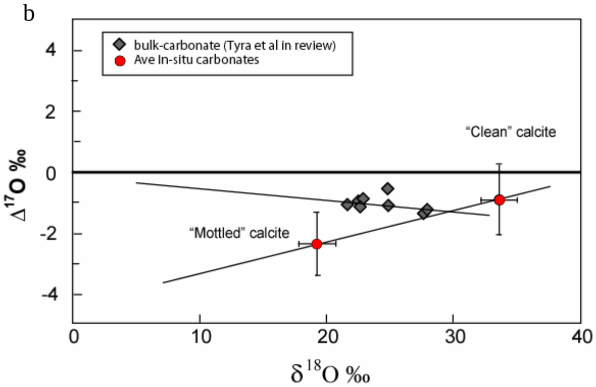


Fig. 1. $\Delta^{17}O$ vs. $\delta^{18}O$ for *in-situ* carbonates from this study and bulk carbonate data [1]. Bulk carbonate $\Delta^{17}O$ values appear elevated and indicate a terrestrial component in the bulk data not found in individual matrix carbonates. Fig. 1-a shows the individual data points and Fig. 1-b shows averages of SIMS data by type.

The $\delta^{18}O$ and $\Delta^{17}O$ SIMS data of this study demonstrate that the CM2 fall bulk carbonate of Benedix *et al.* (2003) [3] could be represented by mixtures of mottled and clean calcite (Figure 2). In this figure, the CM2 fall data appear to be directly related in trend and scope with EET carbonates examined by SIMS. It is possible that the Benedix *et al.* (2003) array could be explained by heterogeneities within calcite types and the amount of calcite present within a sample. If we were to connect the average values of clean and mottled carbonates (SIMS) in a $\delta^{18}O$ vs. $\Delta^{17}O$ plot, we would have a line with a slope of 0.60; The CM2 fall array has a slope of 0.63 $\pm$ 0.01. The CM2 falls data extend further than the EET bulk-carbonate into the fields of both mottled and clean calcites. Because these meteorites were falls with minimal terrestrial processing and the similarities in oxygen isotopes with the two carbonate populations, the Benedix *et al.* (2003) data support two of the three reservoirs that are involved with the EET bulk-carbonate trend.

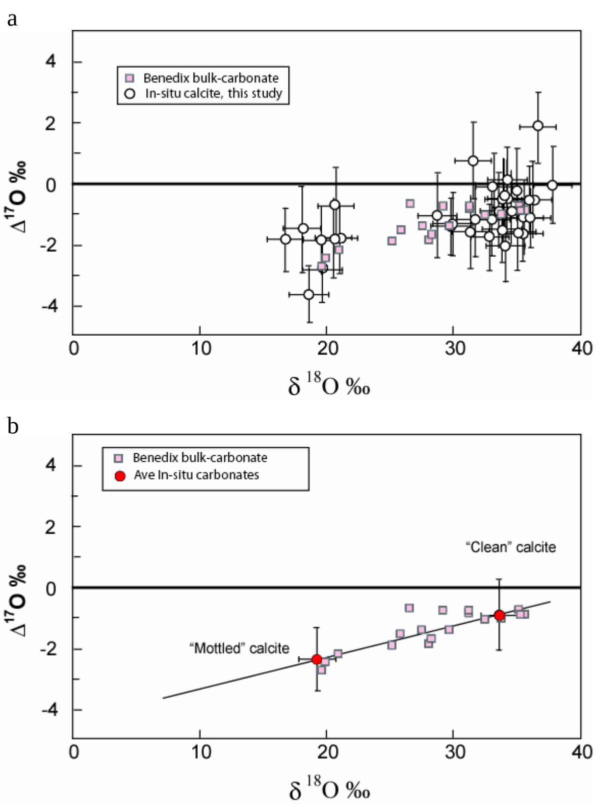


Fig 2. $\Delta^{17}O$ vs. $\delta^{18}O$ data for *in-situ* carbonates (this study) and that of Benedix *et al*. 2003 for CM2 meteorite falls [3].

The CM2 fall data overlap the two calcite populations directly, with no terrestrial component evident. Fig. 2-a shows the individual data points and Fig. 2-b shows averages of SIMS data by type.

References:

[1] Tyra M.A.. et al. (*In Press*) *Geochimica et Cosmochimica Acta*. [2] Tyra M.A. et al. (2004) *LPSC XXXV abstract #1988*. [3] Benedix G. et al (2003) *Geochimica et Cosmochimica Acta, 67 1577-1588.*