BULK OXYGEN-ISOTOPE COMPOSITIONS OF DIFFERENT LITHOLOGIES IN SUTTER'S MILL.

Karen Ziegler[1] and Laurence A.J. Garvie[2]. [1]Institute of Meteoritics, University of New Mexico, Albuquerque, NM 87131, U.S.A. E-mail: kziegler@unm.edu. [2]Center for Meteorite Studies, Arizona State University, Tempe, AZ 85287-6004, U.S.A.

Introduction: The Sutter's Mill (SM) meteorite fall of 2012 is well documented: it is a regolith breccia consisting of CM clasts of different degrees of aqueous alteration and thermal metamorphism [1]. Distinct mineralogies between different stones were interpreted to indicate the presence of more than one carbonaceous chondrite class on the SM parent body [2].

Olivine (ol)-rich and clay/amorphous-rich lithologies were described in several stones, but the relationship between the two is not clear as no stones containing both have been studied [2].

Here we correlate mineralogical data with bulk oxygen-isotope measurements of the clay-rich and the ol-rich lithologies in order to assess the possibility of more than one SM parent material, and the possibility of different alteration environments on the parent body.

Samples: We studied three ol-rich (SM2, 3, 49) and three clay-rich (SM12, 38, 41) SM stones. Samples were characterized by powder x-ray diffraction and bulk oxygen isotopic analysis.

Results: The ol-rich stones contain 75-80 wt.% olivine, little clay/amorphous material, and were likely heated to >700°C, possibly prior to formation of the SM parent body [2]. The clay-rich stones, which contain carbonates and up to 75 wt.% amorphous material and phyllosilicates, are mineralogically distinct, compared to typical CM2 meteorites [2]. Also, the clays in the clay-rich stones are relatively dry compared to CM2 meteorites, consistent with their being heated to higher temperatures [1, 2].

The $\delta^{18}O$ values of the ol-rich stones span a range of over 15‰ ($\delta^{18}O$=11-27‰), whereas those of the clay-rich stones span a narrower, and more negative range of 5‰ ($\delta^{18}O$=13-18‰). Analyses of separate 1-mg-fragments from the same stones show a $\delta^{18}O$ range of up to 6‰. The total range of SM bulk $\delta^{18}O$ values is more positive than the accepted CM field - it is similar to the range of CI and meta-C groups (but has negative $\Delta^{17}O$) - and thus extends the CM field by over 10‰.

Discussion: In general, low-temperature alteration produces minerals with more positive $\delta^{18}O$ values. However, the opposite is found for the SM stones where the $\delta^{18}O$ of the ol-rich materials extends to higher values compared to the clay-rich stones. The carbonates in SM51, which are low-temperature aqueous alteration products, have $\delta^{18}O$=13-37‰, and are interpreted as responsible for the majority of the SM analyses that fall outside the CM field [1]. Two of the ol-rich stones (SM3, 49) are carbonate free, yet they have the most positive bulk $\delta^{18}O$ values of all our SM stones, and overlap with the positive $\delta^{18}O$ values of the SM51 carbonates. Therefore, components other than carbonates alone may be responsible for the positive $\delta^{18}O$ values of many stones.

Conclusion: The results from this study further support the hypothesis that SM lithologies have different origins, and that various secondary processes have affected the lithologies differently. The SM parent body was heterogeneous in its composition.

References: [1] Jenniskens, P. et al. 2012. *Science* 338:1583-1587. [2] Garvie, L. A. J., 2013. Abstract #2148. 44th Lunar & Planetary Science Conference.

Additional Information: We thank Peter Jenniskens (SETI Institute) and Carl Agee (IOM) for provision of samples.