OXYGEN ISOTOPES IN CV CARBONACEOUS CHONDRITES: THE SIGNIFICANCE OF THE CCAM LINE.

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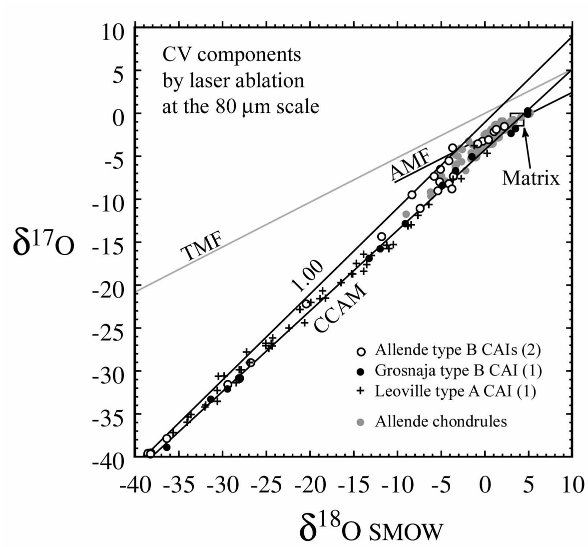
Introduction: Young and Russell [1] proposed that primordial O comprising condensed materials in the early solar system had isotopic compositions represented by a line with a slope of 1.00 on a plot of $\delta^{17}O$ against $\delta^{18}O$. This line deviates from the carbonaceous chondrite (CC) anhydrous mineral line, or CCAM, defined by conventional mineral separate analyses of CC components [2]. Which of these two lines, the slope-1.00 or the CCAM, is primordial has been subject for debate.

Data: We have measured $^{17}O/^{16}O$ and $^{18}O/^{16}O$ in a highly-altered type B CAI from the Grosnaja CV3 carbonaceous chondrite using UV laser ablation. Regression of all of these data yields a line identical to the CCAM in three-isotope space while omission of the analyses with the highest $\Delta^{17}O$ produces a steeper line (slopes of 0.94 vs. 0.97, respectively).

There are now ~170 high-precision UV laser ablation analyses of $^{17}O/^{16}O$ and $^{18}O/^{16}O$ with a spatial resolution of approximately 80 μm, representing 4 CAIs and 9 chondrules from three CV3 meteorites. The spatially resolved data exhibit greater dispersion at high $\Delta^{17}O$ than do analyses of mineral separates despite comparable precision between the two methods. The two data sets are similar at low $\Delta^{17}O$. It is the significance of this dispersion at high $\Delta^{17}O$ defined by the laser ablation data that is at issue.

The laser ablation data (see Figure) define a spread in $\delta^{18}O$ of nearly 10 per mil along a mass fractionation line with a $\Delta^{17}O$ of about –2.7 per mil (the Allende mass fractionation line, or AMF [3]). In many cases the material with the highest $\delta^{18}O$ on the AMF shows obvious signs of alteration, including growth of secondary minerals and Fe and alkali metasomatism [4]. In other cases cryptic alteration is revealed by a novel X-ray microdiffraction method. Presence of such cryptic alteration complicates interpretations of oxygen isotope ratio data.

Discussion: On the basis of the laser ablation data we conclude that the CCAM can not be the loci of primordial oxygen in three-isotope space. If the CCAM were primordial it would require: (1) that there is a correlation between the presence of alteration and primordial oxygen isotope ratios, and (2) that the dominant mechanisms of mass fractionation caused $\delta^{17}O$ and $\delta^{18}O$ to decrease. We regard the first implication of a primordial CCAM as problematical because we are hard pressed to envision a process whereby the most altered materials would preserve the most primitive O-isotopic compositions. The second implication of a primordial CCAM is inconsistent with the fact that both processes likely to have caused mass fractionation, volatilization and fluid flow within a parent body, would have caused mass-dependent increases, rather than decreases, in $\delta^{17}O$ and $\delta^{18}O$. Both objections are overcome if the slope-1.00 line represents primordial oxygen isotope ratios.



References: [1] Young E. D. and Russell S. S. (1998) *Science, 282,* 452–455. [2] Clayton et al. (1977) *EPSL, 34,* 209–224. [3] Young E. D. et al. (1999) *Science, 286,* 1331–1335. [4] Ash R. D. and Young E. D. (2000) *LPSC XXXI.*