NANOSIMS ISOTOPIC INVESTIGATION OF THE CO3 CHONDRITE DOMINION RANGE 14359.

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Introduction: Primitive chondritic material is most representative of the building blocks of the solar system and contains abundant presolar and interstellar grains, which experienced minimum alteration in the solar system. Bulk isotopic and petrological studies suggested that Dominion Range (DOM) 08006 is the most primitive known CO chondrite [1]. Among all investigated meteorites, DOM 08006 contains the highest abundance of presolar silicates – a sensitive probe of the degree of secondary processing experienced by chondritic matrices [2,3]. The high presolar silicate abundance of DOM 08006 points to a minimal amount of secondary processing, i.e., aqueous alteration and thermal metamorphism, experienced by the meteorite. Preliminary petrological examination suggested a genetic relationship between DOM 08006 and DOM 14359, but, so far, there has been no systematic isotopic investigation of DOM 14359. Thus, we were motivated to conduct detailed microanalyses of DOM 14359 for a direct comparison with DOM 08006 for their inventories of presolar and interstellar grains.

Methods: We first obtained BSE images of the DOM 14359,6 thin section from Johnson Space Center (available at https://presolar.physics.wustl.edu/meteorite-deep-zoom/dom14359_6), based on which we identified fine-grained matrix areas for subsequent isotopic analysis. All isotopic analyses were conducted using the NanoSIMS 50 instrument at Wash U. We carried out H isotope measurements in 33 10×10 μm areas following our developed procedure [4] and C and O isotope measurements in 368 15×15 μm areas following the standard procedure. We used a ~1 pA Cs^+ beam for high-resolution imaging for H, C, and O isotopes and also a ~10 pA Cs^+ beam for H isotopes for a direct comparison with the data collected in the same session for other chondrites [4]. We followed the 4σ criteria for identifying presolar grains and searched for presolar grains using the L'Image software [3]. The identified presolar grains were analyzed for their chemical compositions using the Auger Nanoprobe at Wash U following the procedure described in [5].

Results and Discussion: Out of ~68,000 μm^2 fine-grained area analyzed for C and O isotopes, we identified 163 O-anomalous and 12 C-anomalous grains. Our coordinated Auger analyses of 54 of the 163 grains point to one spinel, two iron oxides, and 51 Mg, Fe-rich silicates, corresponding to a silicate-to-oxide ratio of 18.0. This ratio is consistent with the DOM 08006 result (a ratio of 19.6; [2]) and also with the silicate-to-oxide production ratio of asymptotic giant branch stars (a ratio of 23; [6]), which are believed to be the dominant source of O-rich grains. Based on the determined silicate-to-oxide ratio, our results translate to a matrix-normalized abundance of 118^{+20}_{-18} (2σ) ppm for presolar silicates and 7^{+6}_{-4} (2σ) ppm for presolar oxides (by assuming no size difference between the two). Our inferred presolar silicate abundance for DOM 14359 is about a factor of two lower than those for DOM 08006 [2,3] but agree with the mean of three CO3.0 chondrites from [2], 128^{+22}_{-22} (2σ) ppm. If we assume that all the identified 12 C-anomalous grains are SiC, our result translates to a matrix-normalized abundance of 10^{+8}_{-5} (2σ) ppm. Our inferred presolar SiC abundance for DOM 14359 is consistent with the results for DOM 08006 within uncertainties [2,3], 24^{+30}_{-20} (2σ) and 35^{+25}_{-17} (2σ), but it is statistically lower than the mean inferred for primitive chondritic matrices, 30 ppm [7].

The lowered SiC abundance of DOM 14359 could have been caused by oxidation at enhanced temperatures on the parent body of DOM 14359. The inferred thermal metamorphism is supported by the lack of any D hotspot in the D/H images of DOM 14359. Also, our H isotope analyses of 10 of the 33 matrix areas (using a ~10 pA beam) yielded an average δD = 175±60‰ (1 σ standard deviation) with a measured $^{28}Si^-/H^-$ ratio of 0.3. For comparison, at this $^{28}Si^-/H^-$ ratio, the CM chondrites Murchison and Maribo analyzed in the same session had much lower δD values (δD < 0‰; [4]). If the parent bodies of DOM 14359 and CM chondrites accreted similar chondritic matrix materials [8], the higher δD value of DOM 14359 could have been caused by the loss of hydrogen at an enhanced temperature as inferred from the lowered presolar SiC abundance and the lack of D hotspots.

Conclusions: Our results suggest that DOM 14359 and DOM 08006 are not paired and that DOM 14359 likely experienced a higher degree of thermal metamorphism, resulting in a slightly lowered presolar SiC abundance, the lack of D hotspots, and a high δD value in the fine-grained matrix. It is currently unclear whether its lowered presolar silicate abundance compared to DOM 08006 resulted from enhanced local aqueous alteration or thermal metamorphism. We will conduct more detailed chemical and structural analyses of the matrix using, e.g., TEM, to further investigate the mechanism responsible for the partial destruction of presolar silicates in DOM 14359.

References: [1] Alexander C. M. O'D. et al. (2018) *Geochimica et Cosmochimica Acta* 221:406–420. [2] Haenecour P. et al. (2018) *Geochimica et Cosmochimica Acta* 221: 379–405. [3] Nittler L. R. et al. (2018) *Geochimica et Cosmochimica Acta* 226: 107–131. [4] Vacher L. G. et al. (2021) 52nd LPSC, #2528 (abstract). [5] Floss C. and Stadermann F. (2009) *Geochimica et Cosmochimica Acta* 73: 2415–2440. [6] Leitner J. et al. (2012) *The Astrophysical Journal* 745: 38 (16 pp). [7] Davidson J. et al. (2014) *Geochimica et Cosmochimica Acta* 139: 248–266. [8] Alexander C. M. O'D. et al. (2012) *Science* 337: 721–723.