STARDUST IN THE CO3.0 CHONDRITE NWA 8631: LOW ABUNDANCE OF PRESOLAR SILICATES.

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Introduction: Only a handful of primitive meteorites are characterized by high presolar silicate abundances [1], and CO3.0 chondrites (e.g., ALHA 77307, LAP 031117 and DOM 08006), in particular, are highly unequilibrated and minimally altered carbonaceous chondrites that contain among the highest presolar silicate abundances (150-200 ppm) found in meteorites [2-4]. Like type 3 ordinary chondrites, these meteorites are classified into a metamorphic sequence from type 3.0 (e.g. ALHA77307) to 3.8 (e.g., Isna) based on their mean Cr contents in ferroan olivine from type II chondrules [5, 6]. Recently, a new possible CO3.0 chondrite (a 37-gram single stone), Northwest Africa 8631 meteorite (NWA 8631), was found in the Sahara Desert in Nothern Africa. Initial characterization showed that ferroan chondrule olivines in NWA 8631 have a mean Cr_2O_3 content (0.35 ± 0.06 wt.% [7]) that is similar to that in the highly primitive CO3.0 chondrite, DOM 08006, suggesting that it is also a type 3.0 CO chondrite. However, it was also noted that both the matrix abundance (~53%) and average chondrule size (240 ± 130 µm) are larger than usual for CO chondrites [7]. Here, we report preliminary data on the presolar grain abundances in this meteorite suggesting that it may not be a type 3.0 CO chondrite.

Sample and Experimental Methods: We obtained a polished section of NWA 8631 from the meteorite collection at the European centre research and teaching in environmental geosciences (CEREGE; Aix-en-Provence, France). We then carried out raster ion imaging of carbon and oxygen isotopes in fine-grained matrix areas in NWA 8631 using the NanoSIMS 50 at Washington University. A focused Cs^+ primary beam of ~1 pA (~100 nm in diameter) was rastered over areas of 10×10 µm^2. Secondary ions of $^{12,13}C^-$ and $^{16,17,18}O^-$, as well as secondary electrons, were simultaneously acquired in multicollection mode. We measured a total area of 8,400 µm^2.

Results and Discussion: To date, we have identified a total of nine presolar grains in NWA 8631, including six O-rich presolar grains (five ^{17}O-rich grains and one ^{18}O-rich grain) and three C-anomalous grains. Based on the classification proposed by [8], four grains belong to Group 1, with excesses in ^{17}O and sub-solar to solar $^{18}O/^{16}O$ ratios, and are believed to have originated from the envelopes of low- to intermediate-mass AGB stars of close-to-solar metallicity. Another grain is characterized by an extremely high $^{17}O/^{16}O$ ratio ($^{17}O/^{16}O = 7.4 \pm 0.1 \times 10^{-4}$), higher than the upper limits ($^{17}O/^{16}O = 6 \times 10^{-3}$) predicted by model calculations of the first and second dredge-up in low- and intermediate-mass AGB stars [9]. These Extreme Group 1 grains may originate from ONe nova [10]. However, all nova models also predict very large depletions in ^{18}O that are not observed in most nova oxide-silicate grains, suggesting mixing of the nova ejecta with solar composition material. Finally, the last grain is characterized by an excess in ^{18}O relative to solar (Group 4) and may have formed in the ejecta of a Type II supernova [11].

The three C-anomalous grains are all enriched in ^{13}C relative to solar and are likely SiC grains. One grain is likely a mainstream SiC ($^{12}C/^{13}C = 53.8 \pm 0.4$), with an origin in a low-mass AGB stars of close-to-solar metallicity. The two other grains are characterized by $^{12}C/^{13}C$ ratios between 12-16 and are possible AB SiC grains, whose origin(s) are still unclear, with born-again AGB stars, J-type stars, Type II supernovae or novae as possible stellar sources [12].

Based on the nine presolar grains identified, we calculated O- and C-anomalous grain abundances of 99^{+315}_{-57} ppm and 83^{+250}_{-6} ppm, respectively. While our data are still limited, the abundance of O-rich grains is significantly lower than what has been observed in other CO3.0 chondrites [2-4], indicating that this meteorite might have experienced more secondary processing (aqueous alteration or thermal metamorphism). Our preliminary observation thus suggests that, despite its initial classification, NWA 8631 is likely not a type 3.00 CO chondrite but is of higher petrologic type (possibly 3.1 or 3.2). We will continue our NanoSIMS search for presolar grains in this meteorite to better characterize its presolar grain abundances. Using Auger spectroscopy, we will also determine the elemental compositions of the presolar grains that we identified to investigate any further evidence of secondary processing.

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