MICROANALYTICAL INVESTIGATION OF FINE-GRAINED MATRIX MATERIAL IN ELEPHANT MORAINE 92042: EFFECTS OF PARENT BODY PROCESSING ON PRIMITIVE COMPONENTS.

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Introduction: Most CR chondrites have experienced significant aqueous alteration, leading to hydration of matrix material and low presolar silicate and oxide abundances, although some are less altered and, thus, preserve a more complete record of the earliest components of the solar nebula. They are also noted for the presence of primitive insoluble organic matter (IOM) with localized isotopic anomalies in H, C and N [1–3], and EET 92042 is no exception [4]. These light element isotopic anomalies are traditionally thought to have formed via low temperature ion-molecule reactions, in either the interstellar medium [5] or the protosolar nebula [6,7]. Further isotopic evolution may also have occurred in asteroidal parent bodies [8,9]. We are carrying out systematic microanalytical investigations of CR chondrites that have experienced a range of degrees of aqueous alteration in order to better understand how parent body processing has affected the primitive matrix components, and particularly the IOM, in these meteorites. Here we report preliminary results on the CR chondrite EET 92042, which is classified as petrologic type 2.5 [10].

Experimental: We carried out NanoSIMS raster ion imaging of fine-grained matrix areas in EET 92042 in two sets of separate measurements: $^{12,13}C^-$, $^{16,17,18}O^-$ and $^{12,13}C^-$, $^{12}C^{14,15}N^-$,$^{28}Si^-$, using standard measurement procedures [2, 11]. We measured a total area of 14,400 μm^2 for C and O, and 16,000 μm^2 for C and N. Isotopically anomalous grains or regions were re-located and measured for elemental compositions using the Auger Nanoprobe [12].

Results: We identified 31 O-anomalous grains. Twenty-three of these are Group 1 grains with origins in low-mass red giant or AGB stars [13]; the remainder are Group 4 grains of likely supernova origin [14]. Most of the O-rich presolar grains are ferromagnesian silicates, whose compositions are similar to those observed in the presolar silicate inventories of other primitive meteorites [15]. In addition, we identified 25 SiC grains, most of which are mainstream grains, with origins in low-mass AGB stars [16]. We calculated presolar grain abundances based on the areas of the grains and the total areas measured. The abundance of O-anomalous grains is 31 ± 6 ppm, and the abundance of SiC is 18 ± 4 ppm. EET 92042 also contains abundant regions that are isotopically anomalous in N. Most of the areas are enriched in ^{15}N, consistent with past work on EET 92042 [1], but several are ^{15}N-poor. Similar ^{15}N-depleted areas have also been observed in other CR chondrites [2,3]. Secondary electron and back-scattered electron imaging indicate that the anomalies are hosted by organic matter with a variety of morphologies, as has also been observed in MET 00426 [3].

Discussion: The abundance of O-rich presolar grains in EET 92042 is significantly lower than the maximum abundances (~220 ppm) observed in the CR chondrites QUE 99177 and MET 00426 [11], which were classified as types 2.4 and 2.6, respectively, by [10]. However, the difference we observe in the abundances of O-rich presolar grains clearly demonstrates that EET 92042 has been more affected by aqueous alteration than either QUE 99177 or MET 00426. Raman observations have suggested that the organic matter in EET 92042 is very primitive [17] and this is confirmed by the abundant N isotopic anomalies we observe. Moreover, the range of ^{15}N anomalies that we see in EET 92042 is similar to that observed in QUE 99177 and MET 00426, despite the fact that our O isotopic data indicate a difference in the degree of alteration. This is consistent with conclusions by [17] that insoluble organic matter is not easily affected by aqueous alteration. Nevertheless, Auger elemental mapping suggests that some isotopically anomalous nanoglobules in EET 92042 have been affected by fluid action. The rim of one large (~2 μm) nanoglobule is enriched in Ca, relative to the interior, suggesting interaction with a Ca-rich fluid. Similarly, nanoglobules in a large aggregate exhibit radial fluctuations of N and concentric rings of Fe-rich material, suggesting multiple episodes of aqueous alteration. These observations highlight the diverse ways in which parent body processing affects different components in meteorites and emphasize the importance of classification schemes based on multiple parameters.

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