

PRESOLAR (CIRCUMSTELLAR AND INTERSTELLAR) PHASES IN RENAZZO: THE EFFECTS OF PARENT BODY PROCESSING. C. Floss and F. J. Stadermann. Laboratory for Space Sciences, Washington University, St. Louis, MO 63130, USA (floss@wustl.edu; fjs@wustl.edu)

Introduction: Like interplanetary dust particles (IDPs), the CR chondrite Renazzo contains abundant isotopic anomalies in both hydrogen and nitrogen [1], attesting to the primitive nature of this meteorite. Renazzo has been suggested as a promising analog for IDPs because it is the only meteorite known to have D-rich hotspots [1] and, like IDPs [2], it shows evidence for several distinct D carriers [1, 3, 4]. We have been using the NanoSIMS to carry out isotopic (C, N, O) imaging studies of IDPs and Renazzo matrix in order to compare the nature and distribution of the primitive matter present in these two types of extraterrestrial material. Several unresolved issues remain, including whether the isotopic characteristics of IDPs and primitive meteorites are similar, whether the phases carrying isotopic anomalies are the same in both materials, and what role parent body processing has played. We have reported results for IDPs elsewhere [5-8]; here we focus on data obtained to date for Renazzo matrix material.

Experimental: Fragments of Renazzo matrix were mechanically separated from the bulk meteorite and mounted on high purity Au foil, together with isotopic standards. The NanoSIMS measurements were made in raster imaging mode, using a Cs⁺ primary beam (~100 nm in diameter); secondary ions were collected simultaneously in five electron multipliers at high mass resolution. The procedures are similar to those we have used for isotopic imaging of IDPs [5-7] and consist of one set of measurements for C and N (¹²C⁻, ¹³C⁻, ¹²C¹⁴N⁻, ¹²C¹⁵N⁻, ²⁸Si⁻) and another for O isotopes (¹⁶O⁻, ¹⁷O⁻, ¹⁸O⁻, ²⁸Si⁻, ²⁴Mg¹⁶O⁻).

Presolar Silicates: Since the discovery of abundant presolar silicate grains in IDPs [6, 9], presolar silicates have also been found in several primitive meteorites [10-12]. We imaged the O isotopes of Renazzo matrix material to search for presolar silicate or oxide grains in this meteorite. Out of 19 fragments imaged, covering an area of ~4900 μm², we found no grains with anomalous oxygen isotopic compositions. Nagashima *et al.* [12] found three presolar silicate grains in NWA 530 and calculated an abundance of ~3 ppm for presolar silicates in this CR chondrite. In contrast, these authors and [10, 11] report significantly higher abundances (30-110 ppm) of presolar silicates in the unique carbonaceous chondrite Acfer 094.

Presolar SiC: Carbon isotopic imaging revealed two grains with large ¹³C excesses (Fig. 1). The ¹²C/¹³C isotopic ratios (49 ± 1; 23 ± 1) suggest that the grains, which are C- and Si-rich and ~300 nm in

size, are mainstream SiC. The presence of SiC in Renazzo matrix fragments is not surprising. Using noble gas abundances, Huss *et al.* [13] estimated the SiC abundance of Renazzo to be 1.86 ppm (matrix-normalized). Based on the C imaging of 13 fragments, with an area of ~3560 μm², we obtain a much higher abundance of ~48 ppm. Although there is a significant statistical uncertainty associated with this number, the difference between the two estimates is so large that the true abundance of SiC in Renazzo must be higher than previously thought. This suggests the presence of SiC populations in Renazzo with Ne-E(H) contents that differ from those assumed by [13].

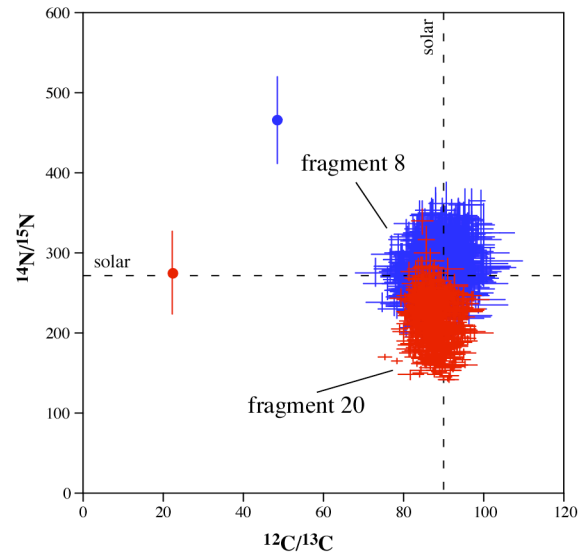


Figure 1. Carbon and nitrogen isotopic compositions (1σ errors) of presolar SiC from Renazzo compared with other sub-regions of the same matrix fragments in which the anomalous grains occur. Note that fragment 20 has a bulk enrichment in ¹⁵N.

¹⁵N Enrichments: Renazzo, as well as other CR chondrites are characterized by enrichments in ¹⁵N [14], that are generally thought to result from low temperature interstellar chemistry [15]. Matrix fragments measured with an ims 3f ion microprobe [1, 16] showed ¹⁵N enrichments up to ~900 ‰, but these measurements could not resolve the microdistributions of ¹⁵N enrichments within the matrix. Of the 13 fragments we analyzed for C and N isotopes in this study, 10 contained enough N to obtain meaningful isotopic data. The results show that ¹⁵N enrichments in Renazzo occur both as

hotspots and as larger regions with so-called ‘bulk’ enrichments. Figure 2 shows the C and N isotopic distributions of fragment 20. Carbon isotopic compositions are normal except for the ^{13}C -rich SiC grain discussed above. Nitrogen compositions, however, vary significantly in different parts of the fragment. Some areas have normal N isotopic compositions, while others are enriched in ^{15}N , with $\delta^{15}\text{N}$ values up to ~ 850 ‰. Of the ten fragments studied, seven have ^{15}N enrichments, either as isolated hotspots associated with discrete sub-grains ($\delta^{15}\text{N} = +220$ to $+760$ ‰) or as larger regions variably enriched in ^{15}N (average $\delta^{15}\text{N} = +70$ to $+190$ ‰). These values are somewhat lower than the corresponding ranges obtained to date for ^{15}N -rich bulk compositions and hotspots seen in IDPs [6, 8].

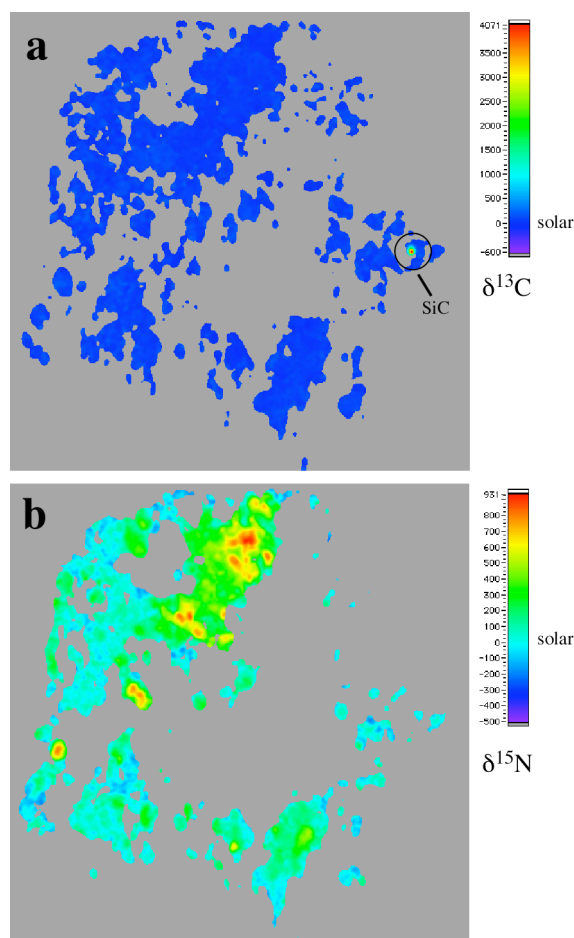


Figure 2. Isotopic images of Renazzo fragment 20: (a) $\delta^{13}\text{C}$ and (b) $\delta^{15}\text{N}$. Image area is $30 \times 30 \mu\text{m}^2$. Gray areas show regions with negligible C and N concentrations, respectively.

Discussion: CR chondrites are thought to be among the most primitive meteorites known and have largely escaped thermal metamorphism [17]. They

have, however, experienced aqueous alteration [18], with maximum temperatures estimated to be ~ 150 °C [19]. Although low temperature aqueous alteration is not likely to destroy presolar phases such as diamonds or SiC [13], it probably would alter presolar silicate grains or re-equilibrate their oxygen isotopes, thus accounting for their low abundances in the CR chondrites studied to date. The presence of some presolar silicates in NWA 530 [12] and their absence from Renazzo may indicate a somewhat greater degree of aqueous alteration in the latter.

Sephton *et al.* [20] carried out laboratory alteration experiments demonstrating that labile ^{15}N -enriched organic material is effectively removed from primitive meteorites during aqueous processing. However, Alexander *et al.* [15] note that Renazzo contains a very low abundance of soluble organics, indicating that it has experienced little hydrolysis. These authors studied the macromolecular organics of a number of primitive chondrites and concluded that, based on N isotopic compositions, Renazzo appears to contain the most primitive organic material. Our data indicate that the distributions and ranges of N isotopic compositions in Renazzo matrix are roughly comparable to those observed in IDPs, suggesting that the primary materials accreted by both types of samples were similar. The somewhat less anomalous compositions found in the Renazzo fragments may be due to the aqueous alteration experienced by this meteorite.

Conclusions: Renazzo is one of the more pristine representatives among primitive chondrites and its matrix material shares many similarities with IDPs. However, the aqueous alteration it experienced affected the abundances and distribution of at least some of its presolar phases. Most notable is the lack of presolar silicates in this meteorite.

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