PRESOLAR GRAIN INVENTORIES OF THE UNGROUPED C3 ADELAIDE AND THE CV3 RBT 04133.
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Introduction: Presolar grains are particularly abundant in primitive extraterrestrial materials such as IDPs [e.g. 1-3] and the matrices of the least altered chondrites [4-6]. To date, the presolar silicate and oxide inventories of the primitive chondrites Acfer 094 [4-7] and ALHA 77307 [7] have been reported extensively. More recently, the search for presolar silicates and oxides has been extended to the CR [8,9] and ungrouped chondrites [10].

Here we report the presolar grain inventories (silicates, oxides, SiC, and other C-anomalous phases) determined for Adelaide and RBT 04133 by NanoSIMS raster ion imaging. Adelaide (an ungrouped C3) was chosen for this study because (i) it is primitive and (ii) it was previously reported to have a low presolar silicate abundance of ~41 ppm [11] in comparison to Acfer 094 and ALHA 77307; 90-175 [7,12] and 95 ppm respectively [7]. RBT 04133 (a mildly thermally altered CV3) was also analysed as part of an ongoing study [13].

Experimental: NanoSIMS raster ion imaging was used to map pressed fragments of matrix material from Adelaide and RBT 04133 to locate presolar grains and other isotopic anomalies. Individual fragments varied from 10x10 to 20x20 µm^2 in size. Two sets of measurements were performed: (i) to locate C-anomalous phases such as SiC and graphite and N-anomalies (^{12}C-, ^{13}C-, ^{12}C^{14}N-, ^{12}C^{15}N-, ^{16}O-, ^{28}Si-, and ^{24}Mg^{16}O-) and (ii) to locate O-anomalous phases such as oxides and silicates (^{16}O-, ^{17}O-, ^{18}O-, ^{28}Si-, ^{29}Si-, ^{30}Si-, and ^{24}Mg^{16}O-). Total areas of 2600 and 2700 µm^2 were analysed in Adelaide and RBT 04133 respectively.

C and N isotopic compositions were normalized using insoluble organic matter (IOM) standards [14]. O isotopic compositions were normalized to the average composition of matrix within each meteorite.

C-anomalous Grains: Four C-anomalous grains (one SiC and three other C-anomalous phases) were located in each of Adelaide and RBT 04133. On the basis of C and N-isotopic compositions both SiC grains appear to be Y grains but could potentially be X grains within error (Fig. 1). Si isotopic compositions of both SiC grains (determined during subsequent analyses) are solar within 3σ error.

O-anomalous Grains: Seven and four O-anomalous grains were located in Adelaide and RBT 04133 respectively (Fig. 2). The presolar silicate/oxide nature of each O-anomalous grain was determined on the basis of their ^{28}Si, ^{24}Mg^{16}O compositions, and ^{28}Si/^{16}O ratio [16]. Five O-anomalous grains from Adelaide were determined to be presolar silicates whilst the remaining two grains appear to be presolar oxides. Three O-anomalous grains from RBT 04133 were determined to be presolar silicates whilst the remaining grain appears to be a presolar oxide. Si isotopic compositions of all presolar silicates grains are solar within 3σ error.

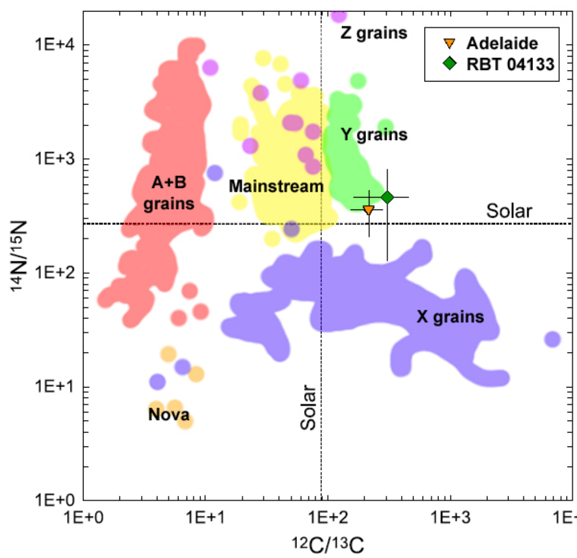

Figure 1. Carbon and nitrogen isotopic compositions of two presolar SiC grains from Adelaide and RBT 04133. Coloured fields represent data from [15] and references therein. Errors are 1σ.

All seven O-anomalous grains from Adelaide and two from RBT 04133 are ^{17}O-enriched and belong to group 1, whilst the remaining two grains from RBT 04133 are ^{17}O and ^{18}O-depleted and from group 3.

Discussion: High abundances (uncorrected for detection efficiencies) of presolar SiC, other C-anomalous, silicate, and oxide grains were found in both Adelaide and RBT 04133 (Table 1). Presolar silicates are the most abundant type of grain found in both meteorites; the abundances of which appear to be higher than in even the extremely primitive Acfer 094 [7,12]. However, abundances were determined here from a relatively small number of grains resulting in large errors (Table 1) based on counting statistics [18].

Oxide grains are present in lower abundance than silicates and are comparable with those reported for Acfer 094 and ALHA 77307 [7]. Silicate/oxide ratios for Adelaide and RBT 04133 are 2.5 and 3 respectively reflecting the amount of processing they have experienced compared to the higher ratios of more primitive meteorites; such as a ratio of 33 for the CR3 QUE 99177 [9]. Lower silicate/oxide ratios are indicative of more extensive alteration because presolar silicates are destroyed before oxides [9]. The low ratio for RBT 04133 is not surprising as it has been shown to be mildly thermally altered [13].

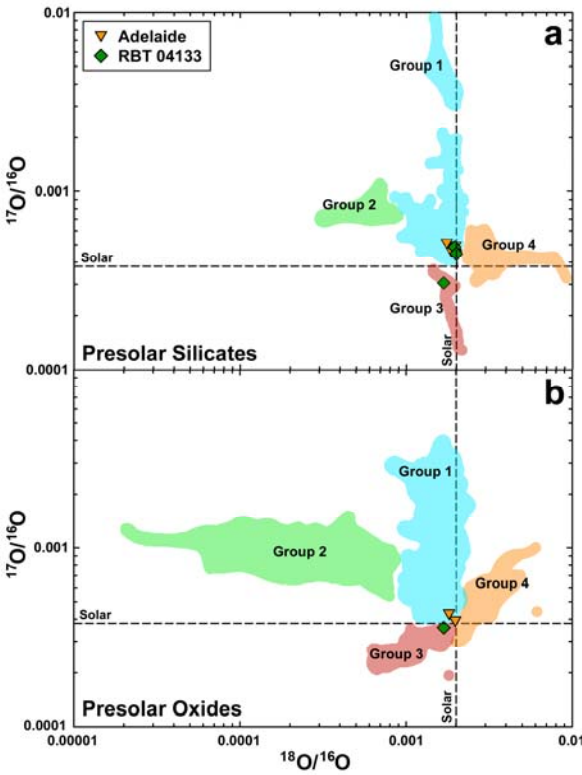

Figure 2. Oxygen isotopic compositions of presolar (a) silicate and (b) oxide grains from Adelaide and RBT 04133. Coloured fields represent data from the Presolar Grain Database for comparison [17].

Table 1. Abundances of presolar grains found in the meteorites studied here. 1σ errors are after [18].

Meteorite	SiC	Other C-anom.	Silicates	Oxides
	PPM	PPM	PPM	PPM
Adelaide	23^{+53}_{-19}	180^{+175}_{-98}	180^{+122}_{-78}	73^{+96}_{-47}
RBT 04133	12^{+28}_{-10}	44^{+43}_{-24}	240^{+234}_{-131}	33^{+76}_{-27}

Adelaide. The combined O-anomalous grain (oxides+silicates) abundance determined here for Adelaide is much higher than that recently reported (250$^{+130}_{-90}$ compared to 55 ppm) [10]. The lower abundance is based on better statistics (22 grains compared to 7 here). However, the O-anomalous grains located in Adelaide during this study were heterogeneously distributed; such heterogeneity was also seen by [10]. Thus the differences in abundances between these two studies may result from inherent sample heterogeneity. The SiC abundance determined here (23 ppm) agrees with those determined by raster ion imaging of IOM for other primitive meteorites (~10-50 ppm) [19].

RBT 04133. The SiC abundance determined here agrees with that determined by raster ion imaging of IOM [13,19]. The presolar silicate abundance is anomalously high as a result of the presence of three relatively large silicate grains (440-650 nm in diameter) in a small analysed area. The uncertainty of this abundance is reflected by the large error based on counting statistics [18] indicating that the actual abundance could vary from ~110 to 470 ppm within 1σ. Thus, this study would benefit from improved counting statistics by expanding the total amount of area analysed. The presence of presolar silicates in RBT 04133 indicates that they can survive thermal alteration of at least ~450ºC [13].

Conclusions: We successfully located a range of different types of presolar grains in-situ in the matrices of Adelaide and RBT 04133. The discovery of presolar silicates in RBT 04133 is significant as it adds constraints to their survival in mildly thermally altered meteorites and few presolar silicates, if any, have been located in CV chondrites.

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