COMBINED TOF-SIMS AND NANOSIMS ANALYSIS OF GENTLY SEPARATED PRESOLAR SIC GRAINS.

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Introduction: Presolar silicon carbide (SiC) grains been extensively studied due to their relatively large size, abundance, and high concentration of trace elements. Over 10,000 individual SiC grains have been analysed [1] but nearly all of these were extracted from meteorites with the use of harsh acids, which have been shown to damage the grain surfaces [2,3]. In addition, some presolar SiC grains have been shown to have grain coatings [4], whilst others show evidence for implanted material [5,6]. For this reason, this study will focus on presolar SiC grains isolated using a 'gentle separation' method [7], which avoids the use of acids and so preserves the grain surfaces and coatings.

Methods: 110mg of Murchison matrix material was processed using the gentle separation method. The material was broken into individual grains using freeze-thaw disaggregation. Size separation was carried out to isolate grains in the 1-20 micron size range - in this range, SiC grains are abundant, and large enough for comprehensive analysis [8]. This fraction was then separated by density by settling the grains in two different heavy liquids. Presolar SiC grains have a density of 3.1 – 3.2 gcm^{-3}, so heavy liquids of 3.05 and 3.24 gcm^{-3} were used to remove material above and below these densities.

Samples were prepared by distributing grains onto a gold foil imprinted with a finder grid. Presolar SiC grain searches were carried out using a Zeiss Sigma SEM with high efficiency detectors, enabling carbon and silicon mapping for direct identification.

Following identification, the grains are analysed by Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) [9] which acquires all masses simultaneously, thus allowing the analysis of major and trace element abundances. Sputtering removes successive layers of the grain, allowing the reconstruction of a depth profile of the grain and the distribution of trace element abundances within it. When much of the grain is sputtered, analysis of $\delta^{13}C$, $\delta^{15}N$ and $\delta^{29,30}Si$ using a Cameca NanoSIMS 50L allows for classification of the grain type.

References:

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