A SIMS TRACE ELEMENT STUDY OF PRESOLAR GRAPHITES FROM ORGUEIL. M. Jadhav[1], K. Nagashima[1], and G. R. Huss[1], [1]Hawai‘i Institute of Geophysics and Planetology, University of Hawai‘i at Mānoa, Honolulu, HI 96822. E-mail: manavi@higp.hawaii.edu

Introduction: Traditionally, much of the information about stellar nucleosynthesis and evolution gleaned from presolar grains has been obtained from the non-solar isotopic ratios measured in these grains. In addition to isotopic studies, a few quantitative trace-element measurements have been carried out on bulk SiC fractions [e.g., 1] and individual presolar SiC grains [e.g., 2 – 5]. Amari et al. [2] compared the observed trace element abundance patterns in presolar SiC grains to results of condensation calculations for circumstellar environments to associate grains with different C-rich stellar environments [6]. Measurements of rare earth element isotopes like Eu and Nd [7 – 9] in mainstream SiC grains have been compared to astronomical observations of carbon-enriched metal poor stars and s-process predictions of AGB stars, indicating the importance of determining REE abundances in presolar grains.

In contrast with the previously mentioned studies of presolar SiC grains, there are few published studies attempting to quantify the abundance and distribution of trace elements in presolar graphite grains. This is primarily due to the fact that isotopic studies of graphites and elemental ratios measured in subgrains during TEM studies of ultra-microtomed slices of graphites, have indicated that presolar graphite grains have much lower trace element abundances compared to presolar SiC grains [e.g., 10 – 14]. Low-density (LD) graphite grains are made of turbostratic layers of poorly crystallized graphite and are good accommodators of trace elements in their structure; in addition, each grain is known to contain abundant TiC subgrains (~ 2400 ppm of the graphite; [13]) that have their own unique trace element compositions. Thus, LD graphite grains are better candidates for trace-element measurements compared to high-density (HD) grains that have well-crystallized onion-like structures. Isotopic and TEM measurements have indicated that trace elements, like Mg, Al, Si, and Ca, appear to have been incorporated into the parent grain during primary graphite crystallization [12, 15]. Other trace elements like Ti, Zr, Ru, Mo, Fe, and Ni are found concentrated within early crystallizing subgrains [13, 14] that were later incorporated into the parent graphite grain.

Knowledge of the condensation behavior of trace elements in presolar grains can provide a wealth of information on the physical and chemical conditions in the cooling outflows of the stars around which these grains condensed.

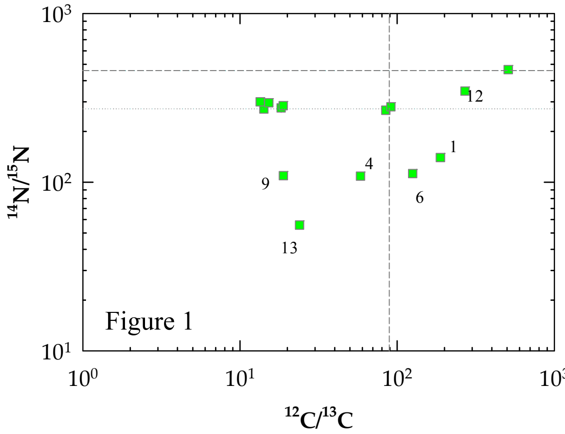
In this study, thirteen individual LD graphite grains from the OR1d ($\rho \sim 1.75–1.92$g cm^{-3}) density fraction of Orgueil were measured for the trace elements, Mg, Si, Ca, Sc, Ti, V, Fe, Ni, Rb, Sr, Y, Zr, and Nb, using SIMS. We present here some of the preliminary data from these measurements.

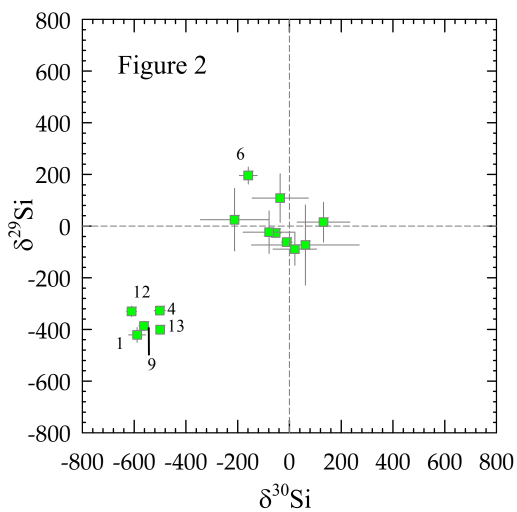
Experimental details: Thirteen LD Orgueil (OR1d: $\rho \sim 1.75 - 1.92$ g cm^{-3}) graphite grains (diameters = 5 – 11 µm) were picked with a micromanipulator and transferred to a clean gold-foil mount to reduce contamination from surrounding macromolecular carbon. We used the University of Hawai‘i’s Cameca ims 1280 ion microprobe to measure ions of $^{12}C^+$, $^{24}Mg^+$, $^{28}Si^+$, $^{44}Ca^+$, $^{47}Ti^+$, $^{51}V^+$, $^{56}Fe^+$ (Stage1) and $^{12}C^+$, $^{45}Sc^+$, $^{56}Fe^+$, $^{60}Ni^+$, $^{62}Ni^+$, $^{85}Rb^+$, $^{86}Sr^+$, $^{89}Y^+$, $^{90}Zr^+$, $^{93}Nb^+$ (Stage 2) by magnetic peak jumping. A 30 – 60 pA O^- primary beam focused to ~ 1 µm was rastered over 12×12 µm^2 regions surrounding the graphite grains and scanning ion images were collected. We flooded the sample chamber with O_2 to enhance the ion yield of the measurements. After collecting trace element data, a Cs^+ primary beam was used to measure C, N, and Si isotopic ratios of the grains. Scanning ion images of the isotopic data were collected in a combination of both multi-collection and peak-jumping mode. Isotopic ratios were calculated from regions of interest using L’image software.

Due to the lack of a good graphite standard with known concentrations of the measured trace elements, we present ion counts normalized to ^{12}C counts in this abstract. We did measure a graphite standard, USGS24, for all elements presented here. An attempt to obtain known concentrations of these elements for USGS24 through ICP-MS measurements will be made in the near future. Synthetic SiC grains were used as standards for the C, N, and Si isotopic measurements.

Results: Six out of the 13 grains measured have large ^{28}Si and/or ^{15}N excesses (Figures 1 and 2) indicating an origin in type II supernovae. These grains are numbered in Figures 1 & 2. Grains 1, 9, 4, and 13 have both ^{15}N and ^{28}Si excesses. Grain 12 is only enriched in ^{28}Si (not ^{15}N) and grain 6 has ^{15}N and ^{29}Si excesses. All errors are 1σ.

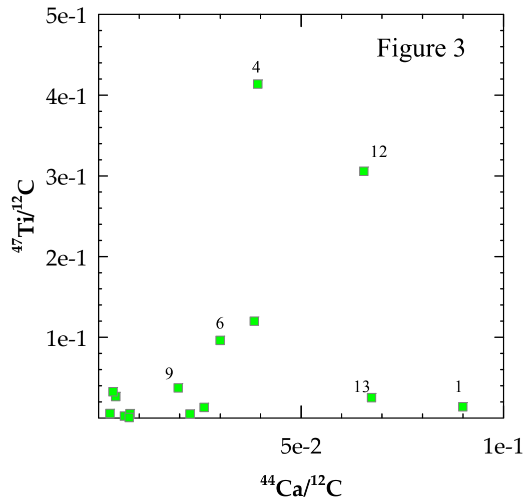
The $^{24}Mg/^{12}C$ ratio in the grains ranged from 0.02 – 8, $^{28}Si/^{12}C$ from 0.2 – 8, $^{44}Ca/^{12}C$ from 0.003 – 0.1, $^{47}Ti/^{12}C$ from 0.002 – 0.5, $^{51}V/^{12}C$ from 0.0002 – 0.6, and $^{56}Fe/^{12}C$ from 0.03 – 13. There was a large amount of ^{24}Mg and ^{56}Fe contamination on the sample mount and grains from an unknown source. The $^{24}Mg/^{12}C$ and $^{56}Fe/^{12}C$ ratios in the grains were affected by this contamination and are upper limits.

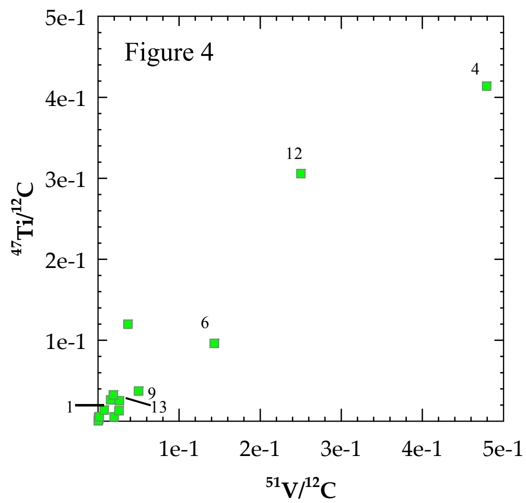




A large fraction of Orgueil LD graphites are known to condense in supernova (SN) ejecta, as indicated by ^{15}N, ^{18}O, ^{28}Si excesses and high derived values of $^{26}Al/^{27}Al$, $^{41}Ca/^{40}Ca$, and $^{44}Ca/^{40}Ca$ ratios measured in the grains [12]. In Figure 3, we plot ^{47}Ti versus ^{44}Ca concentrations in the grains. There is a rough correlation between these concentrations indicating that ^{44}Ca excesses in the grains are due to the decay of the short-lived radionuclide, ^{44}Ti, synthesized in core-collapse SNe. The lack of correlation in 3 of the 6 SN grains is likely due to the poor spatial resolution of our measurements wherein we are unable to resolve the signal from the sub-micron TiC subgrains from which the ^{44}Ca excesses originate. Figure 4 shows a better correlation between the Ti and V contents in the grains. Titanium and V are often found correlated in (Ti,V)C subgrains in graphite grains [13].

The remaining trace element data along with a discussion will be presented at the meeting.





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