**PRESOLAR GRAINS IN FINE-GRAINED CHONDRULE RIMS: RE-EQUILIBRATION OF OXYGEN ISOTOPIC COMPOSITIONS IN SOME PRESOLAR SILICATES BY HEATING.** P. Haenecour[1,2], C. Floss[1,3], B. L. Jolliff [2], and P. Carpenter[2]. [1]Laboratory for Space Sciences, [2]Department of Earth and Planetary Sciences, [3]Physics Department, Washington University, St. Louis, MO 63130, USA (haenecour@wustl.edu).

**INTRODUCTION.** Circumstellar grains have recently been identified in fine-grained rims around chondrules (FGCRs) in CO3 [1, 2] and CR chondrites [e.g., 3]. Various hypothesis have been proposed to explain the formation of these rims, including accretion in the solar nebula before incorporation of the chondrules into meteorite parent bodies [e.g., 4], and formation by compression-alteration of matrix material around chondrules on the parent body asteroids [e.g., 5].

Our initial investigation of the CO3.0 chondrite, LaPaz 031117 (LAP 031117), showed that its matrix contains high abundances of presolar grains [6]. The presence of several large FGCRs in this meteorite led us to carry out a search for presolar grains in one of these areas [1]. Here we report on additional NanoSIMS oxygen and carbon isotopic measurements in another FGCR from LAP 031117 and discuss the possible destruction or isotopic homogenization of some presolar silicate grains in the FGCRs.

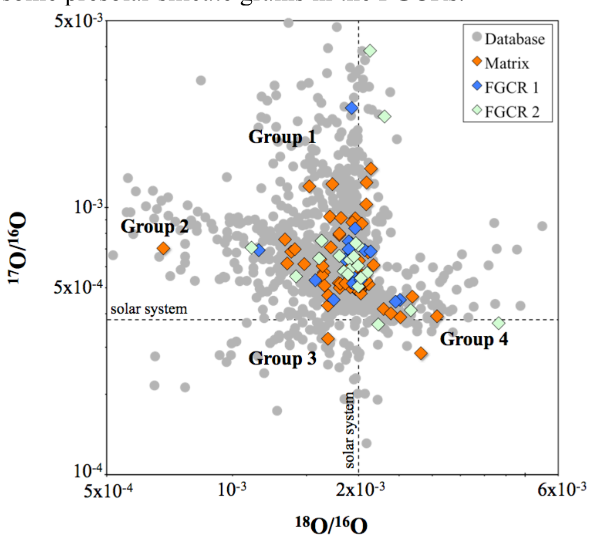


*Figure 1. Oxygen three-isotope plot showing the O-anomalous grains identified in the matrix and two FGCRs in LAP 031117. Other data (grey circles) are from the presolar grain database (http://presolar.wustl.edu/PGD/Presolar_ Grain_ Database.html).*

**EXPERIMENTAL METHODS.** We carried out NanoSIMS 50 raster ion imaging using a focused $Cs^+$ primary beam of ~1 pA (~100 nm in diameter) that was rastered over fine-grained areas of 10×10 $\mu m^2$ ($256^2$ pixels). Secondary ions of $^{12,13}C^-$ and $^{16,17,18}O^-$, as well as secondary electrons, were simultaneously acquired in multicollection mode. We mapped a total of 53,350 $\mu m^2$ (~534 images), including 30,650 $\mu m^2$ in the matrix and 23,700 $\mu m^2$ in two FGCRs. We also acquired X-ray elemental maps and determined the major-element concentrations in several matrix areas and FGCRs using a JEOL JXA-8200 Superprobe. The quantitative measurements were performed at 15 kV accelerating voltage, 40 nA probe current, with a beam size of 10 µm.

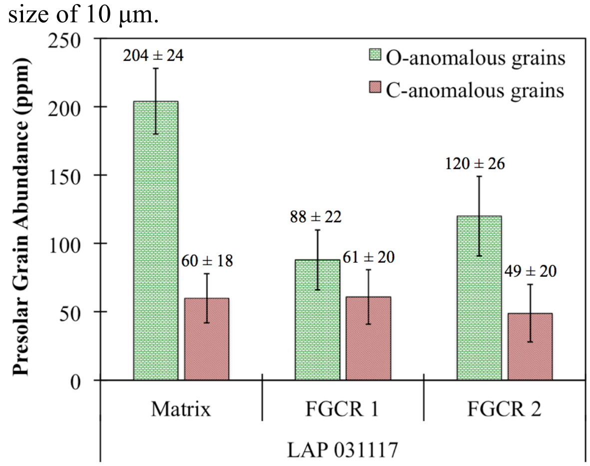


*Figure 2. Comparison of the abundances of oxygen- and carbon-anomalous presolar grains in the matrix and FGCRs of LAP 031117.*

**COMPARISON OF PRESOLAR GRAIN ABUNDANCES BETWEEN THE MATRIX AND FGCRs.** We identified a total of 112 oxygen-anomalous grains in LAP 031117 (75 in the matrix and 37 in the two FGCRs; Fig. 1). We also found 26 carbon-anomalous grains in LAP 031117 (11 in the matrix and 15 in the rims).

The calculated abundances of oxygen- and carbon-anomalous grains in LAP 031117 (161 ± 15 ppm and 58 ± 11 ppm, respectively) are comparable to those determined for other primitive carbonaceous chondrites, indicating that LAP 031117 is a pristine meteorite that did not undergo significant secondary alteration, such as aqueous alteration or thermal metamorphism. The presolar grain abundances are determined from the ratio of total area of the presolar grains to the total area analyzed with errors on the abundances calculated from the respective standard deviations of the grain numbers based on Poisson statistics. The O-anomalous grains consist of both silicates and oxides. However, given the low abundance of presolar oxides (~10 ppm ; [1]) in LAP 031117, the abundance of O-anomalous grains is dominated by presolar silicates.

Comparison of the presolar grain abundances in the matrix and two FGCRs of LAP 031117 (Fig. 2) shows that, within errors, the abundances of C-anomalous grains are the same in the three areas, but the abundance of O-anomalous grains is significantly higher in the matrix (204 ± 24 ppm) than in either of the FGCRs (88 ± 22 ppm and 120 ± 26 ppm). We previously argued against accretion of the matrix and FGCRs from distinct nebular reservoirs because presolar oxide and SiC grain abundances are comparable in both [1]. The similarity in chemical compositions that we observe between the matrix and FGCRs (Fig. 3) provides further evidence for an origin of the matrix and FGCRs from similar nebular reservoir(s).

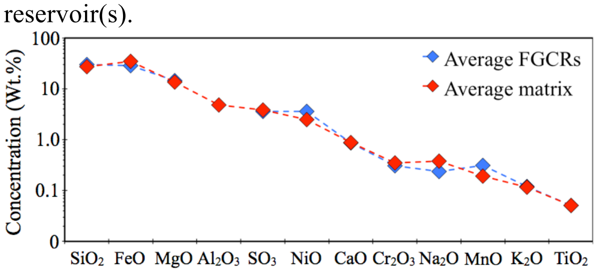


*Figure 3. Comparison of major-element concentrations in the matrix and FGCRs of LAP 031117.*

If the FGCRs and matrix accreted from nebular reservoir(s) with similar presolar grain abundances, the lower abundance of presolar silicates in the FGCRs suggests that the rims may have experienced more heating and/or secondary processing than the associated matrix material. This hypothesis is consistent with the fact that presolar silicate grains are known to be more susceptible to heating and alteration than other, more refractory, presolar phases (e.g., SiC). This secondary processing of the FGCRs could have occurred either in the solar nebula before the incorporation of chondrules into planetesimals, or on the parent body asteroid.

Previous studies [e.g., 4] have suggested that the FGCRs formed by direct dust accretion in the solar nebula. Accordingly, the difference in presolar silicate abundances between the matrix and FGCRs could reflect direct processing during dust accretion onto chondrules. Accretion of the FGCRs may have occurred shortly after their formation, when the chondrules were still hot [e.g., 7], in which case the lower presolar silicate abundance in the FGCRs could reflect re-equilibration of oxygen isotopic compositions of some presolar silicates as a result of heating during dust accretion onto still relatively hot chondrules.

Other studies have proposed that FGCRs formed through the impact-related compression/alteration of matrix material around chondrules on the parent body asteroids. LAP 031117 is only characterized by a shock stage of S1, which seems to argue against such an origin. However, in contrast to the general idea that low intensity impacts (S1) do not significantly affect carbonaceous chondrites, numerical simulations of shock propagation in chondrule-matrix mixtures [8] indicate that the low-pressure metamorphism induced by low intensity shocks is associated with large temperature excursions (>1000 K) in fine-grained areas. While it does not distinguish matrix from FGCRs, this model suggests that these temperature excursions occur predominantly around chondrules, possibly in the FGCRs. Using this model, [9] suggested that timescales as short as 0.1–10 sec could homogenize isotopic anomalies in grains with sizes 100–500 nm, which is similar to the sizes of presolar silicates. These timescales are consistent with the duration of the high temperature excursions associated with low-intensity impacts. These observations suggest that the lower abundance of presolar silicates in the FGCRs than in the matrix might reflect isotopic homogenization of some presolar silicates in the FGCRs owing to temperature excursions following low-pressure impacts on the parent planetesimals. Such temperature excursions might also explain variations in presolar silicate abundances observed between different matrix areas in many primitive meteorites [10], with areas with lower presolar grain abundances more affected by high temperatures than matrix areas with higher presolar grain abundances.

**CONCLUSIONS.** Our study suggests that fine-grained materials (matrix and FGCRs) in CO3 chondrites originated from similar nebular reservoirs. Moreover, the lower abundances of presolar silicates in the FGCRs than in the matrix of LAP 031117 seem to reflect the re-equilibration of the oxygen isotopic composition of some presolar silicates due to heating, either as the result of dust accretion onto relatively hot chondrules, or low-intensity impacts on the meteorite parent body. However, in both cases, the heating does not appear to have affected the abundances of presolar SiC grains; this is consistent with the fact that presolar silicates are less resistant to heating/alteration than more refractory presolar phases.

**REFERENCES.** [1] Haenecour & Floss (2012) LPSC XLIII, #1107. [2] Davidson et al. (2012) *MAPS* 47, A115. [3] Leitner et al. (2012) *MAPS* 47, A394. [4] Metzler K. et al. (1992) *GCA* 56, 2873-2897. [5] Trigo-Rodriguez J.M. et al. (2006) *GCA* 70, 1271–1290. [6] Haenecour & Floss (2011) *MAPS* 46, A85. [7] Beitz et al. (2012) *GCA*, in press. [8] Bland et al. (2012) LPSC XLIII, #2005. [9] Dyl et al. (2012) LPSC XLIII, #2251. [10] Floss and Stadermann (2012) *MAPS* 47, 992-1009.

*This work is supported by NASA grants NNX10AH43G (C.F.) and NNX12AN77H (P.H.).*