DISTRIBUTION AND ABUNDANCE OF PRESOLAR SILICATE AND OXIDE STARDUST IN CR CHONDRITES. J. Leitner[1], P. Hoppe[1], and J. Zipfel[2], [1]Max Planck Institute for Chemistry, P.O. Box 3060, 55020 Mainz, Germany (jan.leitner@mpic.de), [2]Forschungsinstitut und Naturmuseum Senckenberg, Sektion Meteoritenforschung, Senckenberganlage 25, 60325 Frankfurt, Germany.

Introduction: Primitive meteorites, interplanetary dust particles (IDPs), and cometary dust host small quantitites of isotopically anomalous stardust grains that have formed in the winds of evolved stars or in the ejecta of stellar explosions [e.g., 1]. Presolar silicates and oxides are among the most abundant types of circumstellar dust. More than 10 years have passed since the discovery of the first silicate stardust grains in primitive meteorites [2,3], and to date, ~750 presolar silicate grains have been identified [4], the majority of them in the most pristine meteorites. [e.g., 5–7]. Presolar grain abundances vary among different materials and even among individual meteorites of the same class, reflecting metamorphic processes on the parent bodies and also potential heterogeneities in the solar nebula. CR chondrites are among the most primitive meteorites with petrologic types of 1–3. Their mineralogy has been affected by varying degrees of aqueous alteration [8]. Previous studies of individual CRs revealed either low presolar grain abundances for CR2 [9,10] or high ones for the most pristine members of the group [6, 7,11], with the CR2 Northwest Africa (NWA) 852 lying in between [12]. More recently, differences in the presolar silicate abundances between fine-grained chondrule rims (FGRs) and interchondrule matrix (ICM) in CR chondrites have been reported [13], suggesting different alteration paths for the different reservoirs of fine-grained materials.

Here, we report new results from our search for presolar silicates and oxides in CR chondrites.

Samples & Experimental: Fine-grained material was identified by backscatter electron (BSE) microscopy in thin sections of the CR chondrites Elephant Moraine (EET) 92161, Graves Nunataks (GRA) 95229, GRA 06100, Meteorite Hills (MET) 00426, Miller Range (MIL) 07525, NWA 530, NWA 801, NWA 6957, and Renazzo. A ~100 nm primary Cs^+ beam was rastered over 10×10 µm²-sized sample areas (256×256 px) with an integration time of ~44–55 minutes in the NanoSIMS 50. $^{16,17,18}O^-$, $^{28}Si^-$, and $^{27}Al^{16}O^-$ ion images were acquired in multi-collection mode. O-anomalous grains are considered as presolar if the anomaly is more than 5.3σ away from the average value of the surrounding matrix and visible in at least two subsequent image planes.

Results & Discussion: We scanned ~110,000 µm² of fine-grained material in the CR2s of this study

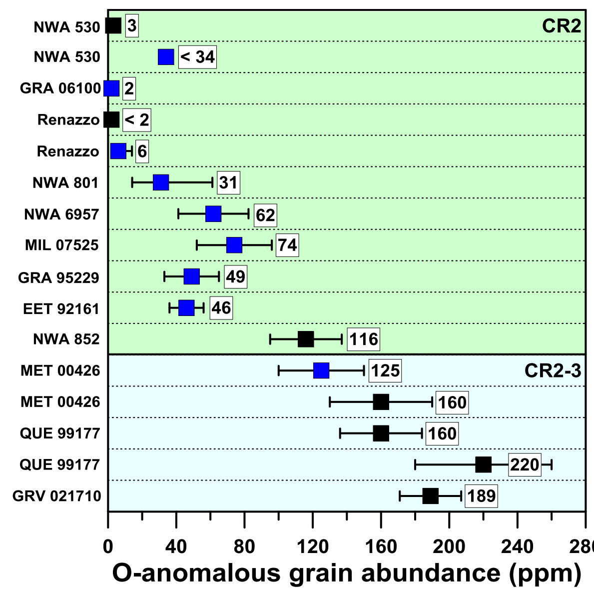

Figure 1. *Presolar O-anomalous grain abundances for the fine-grained fractions of the meteorites from this study (blue symbols), together with data from previous investigations (black symbols) [6,7,9–12].*

(40,500 µm² in FGRs), as well as ~11,500 µm² in the CR3 MET 00426 (5,600 µm² in FGRs).

Presolar grain inventories. A total of 56 presolar grains (52 silicates, 4 Al-rich oxides) have been identified in the CR2 chondrites. 41 grains (73 %) are enriched in ^{17}O and belong to the O-isotopic Group 1, originating from 1.2–2.2 $M_{\odot}$ AGB stars [14,15]. Four grains (~7%) are depleted in ^{18}O and enriched in ^{17}O and fall into Group 2. One grain is depleted in $^{17,18}O$, belonging to Group 3. Seven grains (~13%) display enrichments in ^{18}O, originating from supernova explosions, and three grains (~5%; 2 silicates, 1 oxide) show extremely high $^{17}O/^{16}O$-ratios of (6-39) $\times 10^{-3}$.

In MET 00426, we found 25 grains (24 silicates, 1 oxide). 19 grains (76 %) are of Group 1, one silicate belongs to Group 2, and 5 silicates have enhanced $^{18}O/^{16}O$ ratios, being of supernova origin. These percentages comply within (2σ-)error limits with those derived from the presolar grain database [4].

Presolar grain abundances. For NWA 801, NWA 6957, MIL 07525, GRA 95229, and EET 92161, we obtained O-anomalous grain abundances for the "bulk" fine-grained material (i.e., interchondrule matrix + fine-grained rims) of ~30–75 ppm (Fig.1), while the values for Renazzo, GRA 06100, and possibly NWA 530 are significantly lower. These abundances are lower than those of the pristine CR2/3-chondrites QUE 99177, MET 00426, and GRV 021710, indicating more severe aqueous alteration in the CR2 chondrites (Fig.1). The low abundance for presolar O-anomalous grains in Renazzo can be well explained with a higher degree of aqueous alteration than for the other CR2s studied here [8]. GRA 06100 has experienced a combination of thermal equilibration and aqueous alteration [18], most likely destroying the majority of presolar silicates and oxides in this meteorite. However, the presolar grain inventories are still dominated by silicate grains, although they are less resistant to aqueous alteration than refractory oxide grains. Therefore, the presolar silicate/oxide ratio has been proposed as an indicator for the degree of alteration affecting the respective meteorite [7]. While the presolar silicate abundances in primitive meteorites are generally well-constrained, the presolar oxide abundances are typically based only on small grain numbers, introducing large statistical errors to the respective silicate/oxide ratios. Only a few sample sets have been studied to an extent that allows a meaningful comparison at least at the 1σ-error-level (Fig.2). The ratios for the CO3.0 chondrite Alan Hills (ALHA) 77307 and the CR3 average are higher than the respective ratios for the CR2 chondrites, Acfer 094, and Adelaide (both C3-ungrouped.). However, they are still below the value estimated for AGB star ejecta by [12], indicating some aqueous alteration. Acfer 094 retained a high presolar grain abundance, together with a lower silicate/oxide ratio (~7). The CR2s and Adelaide show similar silicate/oxide-ratios, but lower presolar grain abundances, indicating more extensive alteration (for Adelaide, it was shown that thermal metamorphism had an effect on the presolar grain population [17]). The CR2 NWA 852 is different from the other CR2s studied here; its presolar grain abundance and the silicate/oxide-ratio indicate a higher intrinsic presolar grain concentration that was modified by aqueous alteration [12].

Conclusions: The range of observed presolar O-anomalous grain abundances in the CR chondrites shows some correlation with the degree of alteration. To identify any significant heterogeneities in the grain distributions, comparison with other alteration scales is necessary. The approach by [19] to measure the bulk O-isotopic compositions of the respective matrices of CR chondrites shows a good match with the presolar grain abundances determined so far. Overlap between the sample set from [19] and presolar dust concentrations is still small, and better statistics on the presolar grain abundances and the silicate/oxide-ratios are crucial. Variations of the O-isotopic composition of matrix within individual meteorites [19] and the observed range of presolar silicate and oxide abundances indicate that aqueous alteration occurred very heterogeneously on small scales on the CR parent asteroid(s).

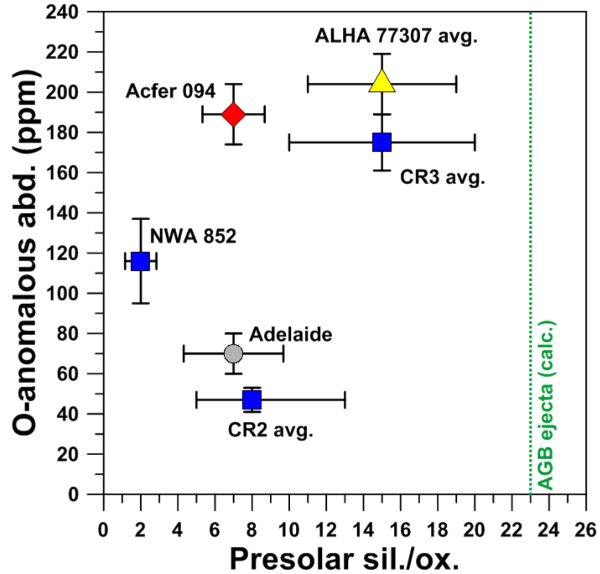

Figure 2*. Presolar silicate/oxide ratios (calculated from the respective presolar grain abundances) plotted versus the O-anomalous grain abundance for the CR2 chondrites from this study (average). For comparison, data for NWA 852 [12], Adelaide [16], Acfer 094 [5], ALHA 77307 [6,17], and CR3 chondrites [6,7,11, this study] are shown. All errors are 1σ.*

Acknowledgements: We thank Elmar Groener for technical assistance on the NanoSIMS and Antje Sorowka for support on the SEM. We acknowledge support by DFG through SPP 1385.

References: [1] Zinner E. (2014) In Meteorites and Cosmochemical Proc., Chap. 1.4 (ed. A. Davis), pp. 181. [2] Nguyen A. N. & Zinner E. (2004) *Science, 303*, 1496. [3] Mostefaoui S. & Hoppe P. (2004) *ApJ, 613*, L149. [4] Hynes K. M. & Gyngard F. (2009) *LPS XL*, Abstract #1198. [5] Vollmer C. et al. (2009) *GCA, 73*, 7127. [6] Nguyen A. N. et al. (2010) *ApJ, 719*, 166. [7] Floss C. and F. J. Stadermann F. J. (2009) *GCA, 73*, 2415. [8] Krot A. N. et al. (2002) *MAPS, 37*, 1451. [9] Floss C. and Stadermann F. J. (2005) *LPS XXXVI*, Abstract #1390. [10] Nagashima K. et al. (2004) *Nature, 428*, 921. [11] Zhao X. et al. (2013) *ApJ, 769*, 49. [12] Leitner J. et al. (2012) *ApJ, 745*, 38. [13] Leitner J. et al. (2013) *MAPS, 48*, #5175. [14] Nittler L. R. et al. (1997) *ApJ, 483*, 475. [15] Nittler L. R. et al. (2008) *ApJ, 682*, 1450. [16] Floss C. & Stadermann F. J. (2012) *MAPS, 47*, 992. [17] Bose M. et al. (2012) *GCA, 93*, 77. [18] Abreu N. M. & Bullock E. S. (2013) *MAPS, 48*, 2406. [19] Schrader D. L. et al. (2014) *EPSL, 407*, 48.