COSMOGENIC NOBLE GASES IN SINGLE CHONDRULES FROM CV AND CR CHONDRITES. U. Beyersdorf-Kuis[1,2], M. Trieloff[2], J. A. Cartwright[1], J. Bennett[3] and U. Ott[1], [1]Biogeochemistry Department, Max Planck Institute, Joh.-J.-Becherweg 27, 55128 Mainz (Germany). E-mail: uta.beyersdorf@mpic.de. [2]Institute of Earth Sciences, University of Heidelberg, Im Neuenheimer Feld 236, 69120 Heidelberg (Germany). [3]ANSTO, Lucas Hights, NSW 2234 (Australia).

Introduction: Previous studies [1-4] have indicated in several cases an excess of cosmogenic noble gases in chondrules relative to matrix, i.e. their nominal cosmic ray exposure (CRE) ages exceed those of the bulk meteorites. For this "pre-irradiation" there are two possible settings: 1) In a parent body regolith for which at least in one case the evidence is strong [4], and 2) In a solar nebula setting. We have analyzed individual chondrules and matrix from the primitive meteorites Allende, Vigarano (both CV3) and El Djouf 001 (CR2) to search for pre-irradiation effects.

Methods: Chondrules were separated using a freeze-thaw technique, similar to that described by [5]. Abundances of important target elements were determined by instrumental neutron activation (INAA). Noble gas measurements (He, Ne, Ar) were performed on the same material analyzed by INAA, which eliminates problems of sample inhomogeneity present in previous studies. Here, we present chondrule and matrix results for neon. CRE ages were obtained using the production rate P_{21} calculated following [6].

Results and Discussion: Results are summarized in Tables 1 (target element abundances), 2 (noble gas results and CRE ages) and 3 (comparison of chondrules vs. matrix).

Table 1: Target element abundances for the production of cosmogenic neon ($^{21}Ne_c$) of matrix (mat) and chondrules (ch) from Allende (Al), Vigarano (Vi) and El Djouf 001 (El).

	weight	Mg	Al	Si*	Ca	Fe	Ni
Al-mat	38.7	13.3	1.24	18.0	1.38	25.1	1.39
Al-ch3	5.28	20.6	1.94	17.3	1.09	15.9	1.38
Al-ch6	1.30	19.6	2.20	17.2	2.05	16.0	1.12
Vi-mat	21.6	13.9	1.74	18.2	2.17	21.3	1.25
Vi-ch1	0.58	17.7	1.66	25.5	2.05	6.49	0.26
Vi-ch2	1.31	11.2	1.24	21.5	2.76	20.4	0.39
Vi-ch3	0.37	24.8	1.15	16.9	1.42	12.8	0.90
El-mat	13.0	8.87	1.06	18.5	1.18	28.6	1.87
El-ch2	1.70	13.7	1.08	20.5	1.18	22.2	0.37
El-ch3	17.0	22.4	1.16	21.4	1.12	8.43	0.89
El-ch4	7.80	19.3	1.81	19.6	2.45	13.5	0.79
El-ch6	1.43	18.3	1.29	22.6	1.39	10.4	0.92
El-ch7	4.63	16.0	1.10	21.2	1.02	17.1	1.05

*Weights are given in mg, abundances in wt%. *Si was calculated by converting the other major elements into oxides, and assuming the remainder to be SiO_2. Where values are marked in gray, concentrations were below the detection limit. The listed values (also used in calculating P_{21}) are 1/2 the detection limit.*

Neon isotopes and components: Figure 1 is a three-isotope plot for neon showing our data together with literature data. Except for chondrules Vi-ch2 and El-ch7, neon is dominated by cosmogenic gases, while matrix samples contain abundant trapped neon. El Djouf 001 matrix is dominated by trapped solar wind, which prevents determination of the cosmogenic $(^{22}Ne/^{21}Ne)_c$ ratio required for a shielding correction (see Table 2).

Table 2: Concentrations of $^{21}Ne_c$, shielding parameters $(^{22}Ne/^{21}Ne)_c$, production rates ($P_{21\text{-corr}}$), and CRE ages ($T_{21\text{-corr}}$) of matrix (mat) and chondrules (ch) from Allende (Al), Vigarano (Vi) and El Djouf 001 (El). $P_{21\text{-corr}}$ and $T_{21\text{-corr}}$ were calculated with shielding correction according to [6].

	$^{20}Ne_{tr}$	$^{21}Ne_c$	$(^{22}Ne/^{21}Ne)_c$	$P_{21\text{-corr}}$	$T_{21\text{-corr}}$
Al-mat	3.71 (30)	1.89 (7)	1.05 (2)	0.41	4.62
Al-ch3	-	2.64 (11)	1.05 (3)	0.57	4.60
Al-ch6	-	2.47 (11)	1.06 (2)	0.53	4.65
Vi-mat	11.1 (92)	1.50 (8)	1.06 (3)	0.42	3.60
Vi-ch1	1.00 (19)	2.41 (23)	1.05 (3)	0.57	4.25
Vi-ch2	14.0 (1.27)	1.57 (9)	1.08 (7)	0.33	4.82
Vi-ch3	-	2.33 (12)	see text		
El-mat	178 (11.4)	0.87 (4)	see text		
El-ch2	2.98 (28)	1.27 (7)	1.24 (3)	0.20	6.37
El-ch3	3.99 (37)	2.33 (13)	1.15 (2)	0.40	5.85
El-ch4	4.14 (36)	2.15 (9)	1.18 (1)	0.31	6.93
El-ch6	0.79 (30)	1.90 (13)	1.17 (2)	0.31	6.07
El-ch7	13.2 (1.11)	1.95 (9)	1.21 (3)	0.24	7.96

Uncertainties are given in parentheses. Abundances of $^{20}Ne_{tr}$ and $^{21}Ne_c$ in units of 10^{-8} cc/g. $P_{21\text{-corr}}$ and $T_{21\text{-corr}}$ are given in 10^{-8} cc/(g Ma) and Ma, respectively.

Abundances of target elements and production rates: Concentrations of cosmogenic neon ($^{21}Ne_c$) in chondrules are generally higher compared to the matrix (Table 2). This is a result of a higher abundance of magnesium, which is the most important target element [6, 7] (Table 1).

CRE ages compared with literature data: To compare our CRE ages with literature data, it is necessary to use shielding-corrected production rates to account for any difference in sample inhomogenity. The small sample weight of Vigarano chondrule Vi-ch3 causes large analytical errors, thus inducing a large uncertainty of the shielding parameter $(^{22}Ne/^{21}Ne)_c$. Similarly, for El Djouf 001 matrix, no reliable shielding parameter could be determined, due to the large contribution of solar wind Ne (Table 2, Figure 1). CRE ages for Al-

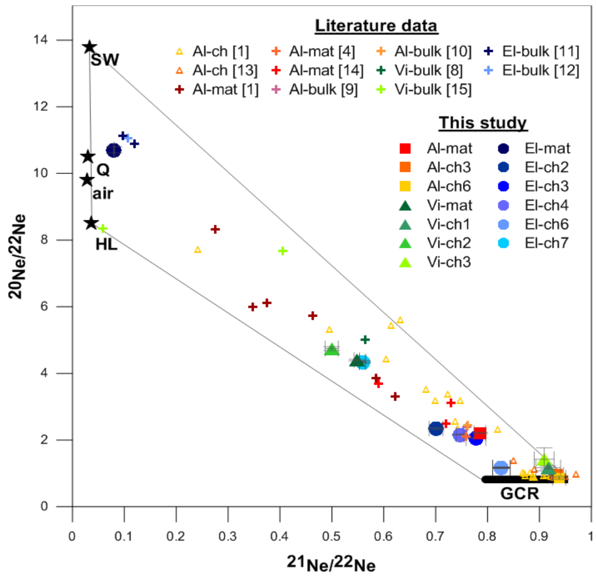

Figure 1: Three isotope plot of neon for Allende (Al), Vigarano (Vi) and El Djouf 001 (El) chondrules (ch) and matrix (mat). Data from previous analyses of chondrules (triangles) and bulk/matrix (crosses) are also plotted [1, 4, 8-15]. Values for solar wind (SW) [16], Q gas [17], air [18], neon produced by galactic cosmic radiation (GCR) [19] and HL gas [20] are also shown.

lende chondrules agree with previous studies [2, 4]. Also the concentration of $^{21}Ne_c$ and CRE age for Allende matrix are comparable to former studies [4, 8-10]. Our CRE age for Vigarano matrix is lower than previously reported [8], while CRE ages of El Djouf 001 chondrules are in the range of previous bulk analyses [11-12].

Comparison of chondrules and matrix: Our chondrule and matrix samples originate from the same meteorite fragment, where they experienced identical shielding. Therefore, a reliable comparison is best performed using "nominal" (or "uncorrected) ages, with differences in "nominal" production rates reflecting different concentration of target elements only. This approach avoids uncertainties introduced by the often imperfect shielding correction. For Allende matrix and chondrules, "nominal" CRE ages are indistinguishable (Table 3), i.e. we find no evidence for pre-irradation, in accordance with [4]. Vigarano chondrules Vi-ch1 and Vi-ch2 by comparison show higher "nominal" CRE ages than the matrix, which suggests some kind of pre-irradiation. Interestingly, Vi-ch2 also contains abundant solar wind gases (Table 1, Figure 1). For El Djouf 001, "nominal" CRE ages of all analyzed chondrules are elevated compared to the matrix, pointing towards pre-irradiation of El Djouf 001 chondrules. Like Murchison [4], this meteorite contains abundant solar wind (Table 1; Figure 1), so pre-irradiation may have taken place in the parent body regolith. Still, pre-irradiation in the solar nebula cannot be ruled out.

Table 3: "Nominal" $P_{21\text{-}1.11}$ and $T_{21\text{-}1.11}$ of matrix (mat) and chondrules (ch) from Allende (Al), Vigarano (Vi) and El Djouf 001 (El).

	$P_{21\text{-}1.11}$	$T_{21\text{-}1.11}$
Al-mat	0.30	6.21
Al-ch3	0.43	6.15
Al-ch6	0.41	5.95
Vi-mat	0.32	4.72
Vi-ch1	0.40	5.95
Vi-ch2	0.28	5.63
Vi-ch3	0.50	4.68
El-mat	0.23	3.78
El-ch2	0.32	4.01
El-ch3	0.47	4.98
El-ch4	0.41	5.19
El-ch6	0.40	4.71
El-ch7	0.36	5.43

$P_{21\text{-}1.11}$ and $T_{21\text{-}1.11}$ are given in 10^{-8} cc/(g Ma) and Ma, respectively, and were calculated without shielding correction, i.e. for $(^{22}Ne/^{21}Ne)_c = 1.11$.

Conclusions and future work: We have analyzed important target elements and noble gases in chondrules and matrix from three carbonaceous chondrites to search for pre-irradiation effects. "Nominal" CRE ages of Allende chondrules and matrix are indistinguishable, providing no evidence for pre-irradiation. In contrast, El Djouf 001 and Vigarano chondrules show elevated "nominal" CRE ages relative to the matrix. Whether El Djouf 001 and Vigarano chondrules were pre-irradiated in the parent body regolith or in a solar nebula setting cannot be distinguished at present. Twelve additional samples have been selected for future work, based on $^{21}Ne_c$ and chondrule size. Due to the highly primitive nature and only incipient alteration of CR3 chondrites [21], we will focus on these, because they may have better retained potential evidence for pre-irradiation.

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