CARBON AND NITROGEN CONTENTS OF GLASS INCLUSIONS IN OLIVINE FROM THE VIGARANO, KABA, BALI AND ALLENDE CV3 CHONDRITES. Varela, M.E[1]., Metrich, N[2]., Bonnin-Mosbah, M[2]. and Kurat G[3], 1- CONICET-UNS, Dpte de Geologia, San Juan 670, 8000 B. Blanca, Argentina, evarela@criba.edu.ar, 2- Laboratoire Pierre Süe, CEA-CNRS, 91191, Gif sur Yvette, France, mosbah@drecam.cea.fr, metrich@drecam.cea.fr , 3- Naturhistorisches Museum, Postfach 417, A-1014 Vienna, Austria, Gero.Kurat@univie.ac.at

Carbon and nitrogen concentrations have been measured in glass inclusions in olivines of some CV3 carbonaceous chondrites using the $^{12}C(d,p_0)^{13}C$ and $^{14}N(d,p_0)^{15}N$ nuclear reactions. Knowledge of carbon and nitrogen contents of the constituents of chondrites is essential to understand their primordial chemistry and to constrain the physico-chemical conditions prevailing during mineral growth in the solar nebular. Several attempts have been made to measured carbon abundances in meteorites using Nuclear Reactions Analysis (NRA) (1-3), Raman microprobe (4) and SIMS (5). Here we present new results on our systematic search for carbon and nitrogen in primary glass inclusions and their host olivines. This study was carried out using the nuclear microprobe facilities of Pierre Sue Laboratory (Saclay, France).

Methods: The analytical conditions follow those of [6] but have been modified in order to lower the detection limit of C in both, glasses and olivines. Using a surface barrier detector of 1000-1500 µm of depleted zone and a total integrated charge of incident deuterons ranging from 0.5 to 3.5 µC, the detection limits for glasses ranged from 15 to 45 ppm and for olivines from 30 to 40 ppm.
To measure nitrogen concentration in olivines, a second detector was placed in front of the surface barrier detector to count the α_0 particles of the reaction [^{14}N (d, α_0)^{15}N] with acquisition times of 4-5 h per point. For glasses, a 48 µm mylar screen was placed in front of the surface barrier detector instead of a second detector which allowed separation the p_0 from α_0 particles and thus eliminated interferences in the N region. These two detection methods were used because the employ of a second detector is much more efficient in minimized the Mg interferences in a Mg-rich matrix. The detection limit was of 20 ppm N in olivines and 10 ppm N in glasses. For C and N the error is of 10% and 10 –15 %, respectively for all concentration measured.

Samples: Glass inclusions consist of glass + bubble with sizes > 10x10 µm^2 and they occur in isolated olivines and olivines of aggregates or chondrules with variables FeO contents from the Vigarano, Kaba, Bali and Allende CV3 meteorites (PTS Vigarano no number, Kaba from A576, Bali J2662 and Allende no number, all from NHM, Vienna).

Results: A total of 11 glass inclusions (Bali –3, Kaba –3, Vigarano -5) have been analysed for C and N contents of the glasses. Representative analyses are presented in Table1. Glass inclusions are rich in SiO_2 (38 – 56 wt%), Al_2O_3 (19 – 31 wt%) and CaO (12 – 23 wt%). Sodium contents vary generally between <1 and 7-wt%. However, some inclusions in Vigarano and Bali have exceptionally high Na_2O contents (11 – 15 wt%). Carbon and nitrogen contents of all glass inclusions from these meteorites varied from 220 to 2000 ppm and 30 to 500 ppm, respectively. The mean carbon and nitrogen contents of glasses in glass inclusions of each meteorite is as follows: Bali 1000 ppm C, 170 ppm N; Kaba 980 ppm C, 190 ppm N; Vigarano 300 ppm C, 140 ppm N. Olivines from the studied meteorites, the chemical composition of which are given in Table 1, have all low carbon (40- 70 ppm) and nitrogen (< 20 ppm) contents.

Discussion: The latest improvements made in the NRA technique, mainly those performed for nitrogen, allow us to advance in the detection of this element in olivines by minimising the effect of interference from Mg. These new results show that the olivines from the studied meteorites show constant low contents of carbon and nitrogen (Table 1) suggesting that these elements do not enter the structure of olivines of the CV3 carbonaceous chondrites. No correlation can be established between the FeO content of the olivines and their carbon content, similar to what has been previously present for Allende (7). Thus, the redox conditions prevailing during formation or during

secondary processing that could have governed the variation in FeO content of olivines do not have a direct relationship with the contents of carbon in olivines.
Conversely, glasses of glass inclusions in the same olivines exhibit highly variable contents of carbon and nitrogen. Glasses of glass inclusions are characterized by having a highly refractory (Si-Al-Ca-rich) composition. However, some inclusions can have high Na_2O contents. The alkali metasomatic process that replaced Ca by Na appears not to have affected carbon in those glasses having the most refractory composition (e.g., Kaba) and those with the lowest carbon content (e.g., Vigarano). Glasses of glass inclusions in olivines from Kaba, Bali and Vigarano have low N contents (30 – 200 ppm) and highly variable Na_2O contents (0 - 16 wt%). Conversely, glass inclusions from Allende olivine characterised by a minor Na_2O variation (3 – 7.5 wt%) have extremely variable N contents (40 – 1160 ppm).
Carbon and nitrogen seem to behave differently. Glass inclusions form the oxidised group (Allende, Kaba and Bali) differ in their mean carbon content ($\cong$ 1000 ppm) from those of the reduce group (Vigarano $\cong$ 300 ppm).

However, the nitrogen content of glasses does not show any regular variation with chondrite class. Kaba, Bali and Vigarano glasses have similar low mean N contents (140 – 170 ppm), which are different from that of Allende (600 ppm). This situation does not allow us to speculate on the nature of the C and N species present either in the glass or in the olivine. Searches utilising FTIR failed to give conclusive results. The highly heterogeneous distribution of both elements between different glass inclusions can be taken as an indication for heterogeneous trapping of unknown solid precursors.

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References: [1] Heyman D. et al., (1988) Meteoritics, 23, 131-137; [2] Makjanic J. et al., (1990) Nucl. Instr. Meth.B49, 514-517; [3] Van der Stap CCAH et al., (1986) J. Geophys. Res. 91, D373-D377; [4] Makjanic J. et al., (1989) Meteoritics, 24 , 49-55; [5] Hannon P. et al:, (1998) Geochim. Cosmochim. Acta, 62, 903-913; [6] Varela ME et al. (1998) Lunar Planet. Sci. Conf. XXIX, #1585; [7] Varela ME et al. (1999) Lunar Planet. Sci: Conf. XXX, #1341.

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Table 1: Representative analyses of glass inclusions and host olivines of Kaba, Bali, Vigarano and Allende CV3 chondrites. Major elements (wt%), carbon (ppm) and nitrogen (ppm) contents.

	Glass inclusions						Olivines				
	K2	K3	B2	B1	V2	V6	K	V	Allende		
SiO_2	42.7	42	39.2	38.7	49.9	56.3	42.5	41	42.4	45.7	47.1
TiO_2	0.98	1.06	1.1	1.07	0.98	0.87	0.02	0.07	0	0.09	0
Al_2O_3	28.7	29.2	29	30.9	25	21.5	0.27	0.29	0.29	0	0
Cr_2O_3	0.16	0.26	0.08	0.18	0.32	--	0.09	--	0	0	0.61
FeO	0.15	0.28	0.28	0.4	1.81	0.53	0.33	1.04	0.4	6.5	3.65
MnO	0.02	--	0.09	--	--	0.11	0.06	0.02	0	0.17	0
MgO	3.6	3.19	2.08	1.78	1.29	0.61	56.1	57.4	56.1	46.2	47.8
CaO	22.6	24	23.2	19.3	5.3	13.9	0.53	0.2	0.77	0.37	0.54
Na_2O	--	--	4.1	6.4	13.8	5.6	--	--	--	0.12?	0.13?
K_2O	--	--	0.03	--	0.56	--	--	--	--	--	--
Total	98.9	100	99.2	98.7	98.9	99.4	99.9	100	100	99.1	99.8
C ppm	250	2090	1620	nd	390	220	<70	40	60	nd	nd
N ppm	190	30	nd	170	85	150	nd	nd	nd	<20	<20

K = Kaba; B = Bali; V = Vigarano; nd = Not determined.