ORIGIN OF ISOTOPICALLY LIGHT NITROGEN IN CV3 CARBONACEOUS CHONDRITES.

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Introduction: It has been shown previously that CR carbonaceous chondrites of petrological types 2 and 3 and CO3 carbonaceous chondrites contain small amounts of isotopically light nitrogen ($\delta^{15}N$ up to -150‰), which can only be revealed through stepped combustion analysis of bulk samples [1,2]. This is thought to happen due to a shielding effect in which the carrier phase(s) of the light nitrogen is located in the meteorite matrix, not in direct contact with oxygen until the shielding is destroyed at relatively high temperature during step combustion analysis. This results in identifiable separation of the light-nitrogen carrier from the bulk (nitrogen-rich) macromolecular material, which oxidizes at lower temperatures; something that is not achieved by commonly used chemical separation methods [3]. We argued previously that the carrier phase of the light nitrogen is neither presolar nanodiamonds nor SiC but Q phase, the carrier of planetary noble gases, and that the nitrogen can be as light as the solar value. We predicted that since Q is widespread in meteorites so should be the isotopically light nitrogen component [2]. In the present study we extended our stepped combustion experiments to a suite of CV3 carbonaceous chondrites to further investigate this possibility.

Samples and experimental: We analysed 5 bulk CV3 samples: Allende, Leoville, Acfer 272, Bali and Grosnaja. The stepped combustion experiments have been performed on the Finesse mass spectrometric system [1] in the temperature range 200-1400 ºC (100 ºC increments) with simultaneous analyses (abundance and isotopic composition) of He, Ne, Ar, N and C, except for He isotopes. Here we mostly focus on measured N and ^{36}Ar data.

Results: There is a clear signature of isotopically light nitrogen in all the samples analysed. It appears in the temperature range from 500 to 1110 ºC as a gradual excursion of $\delta^{15}N$ from about 0 to -25 to -90‰ (for different samples) before reverting to ~0 ‰; and in some samples it is associated with the main N release. Planetary ^{36}Ar (from Q) is released in the same temperature range. The minimum $\delta^{15}N$ is observed at 600-800 ºC and in most cases does not coincide with maximum ^{36}Ar release (Fig.1).

Discussion: The first question to answer is whether or not the isotopically light nitrogen is associated with presolar nanodiamonds which are known to carry nitrogen with $\delta^{15}N$ ~ -350‰. Using a simple two-component mixing model we calculated the amounts of nitrogen with $\delta^{15}N$ = -350‰ while using the other component (isotopically heavy nitrogen) released before and after the excursion to the light nitrogen. Using C/N ratio (average value of 320) measured in nanodiamonds extracted from CV3 chondrites [4, 5] we calculated equivalent concentrations of nanodiamonds in our samples to be 600-1500 ppm. The range of nanodiamonds concentrations in this type of meteorites, determined by independent methods, is 290-620 ppm (average of 460 ppm) [6]. Taking into account that our culculated concentration of nanodiamonds in Allende is 600 ppm, for which other method gives only 340 ppm [6], and that our caculations for other samples give the range 760-1500 ppm, we conclude that most of isotopically light nitrogen found in CV3 meteorites is not associated with nanodiamonds. The alternative explanation for the source of the isotopically light nitrogen is phase Q, which appears to be confirmed by the release of planetary ^{36}Ar in the same temperature range as the isotopically light nitrogen.

Conclusion: Our previous suggestion of the widespred presence of isotopically light nitrogen (associated with Q) in meteorites is confirmed by new stepped-combustion analyses of CV3 carbonaceous chondrites.

References: [1] Verchovsky A. B. et al. (2012) *LPS* LXIII, Abstract#2645. [2] Verchovsky A. B. (2017) *Geochemistry Inrenational* 55, 957-970. [3] Verchovsky A. B. et al (2002), EPSL 199, 243-255. [4] Russell et al. (1996) Meteoritics 31, 343-355. [5] Unpublished data for Leoville and Allende nanodiamonds (OU, 1994). [6] Huss G.R. et al. (2003), GCA 67, 4823-4848.

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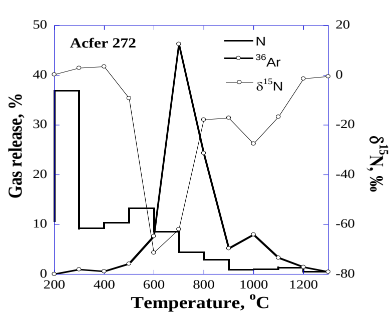

Figure 1. ^{36}Ar and nitrogen release patterns and nitrogen isotope profile observed during stepped combustion of bulk Acfer 272 CV3 carbonaceous chondrite.