**Noble Gases in Carbonaceous Chondrites – The Effects of Aqueous Alteration as Monitored by CR and Other Carbonaceous Chondrites.**

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**Introduction:** The volatile elements in early solar system materials are important tracers for understanding the formation of the terrestrial planets and their atmospheres. Noble gases complement the information that is carried, e.g., by the halogens, H, C, N and the rock-forming volatile elements [e.g., 1-3]. Carbonaceous chondrites (CC) represent, next to cometary matter, the least altered extraterrestrial materials available and are likely to have significantly contributed to the inner planet volatiles [3]. We have undertaken a comprehensive study aiming to (i) determine the noble gas content of the most primitive members of each CC group and (ii) understand the effects of parent body processing on their primordial volatile inventories. Here we present results of a large number of CR chondrites whose petrologic types have previously been determined, based on petrology, mineralogy and O isotopes as well as on H, C and N isotopic and elemental compositions [4,5]. We compare our CR chondrite results to those from other primitive CCs (CI, CO, CM, ungrouped) and describe an important Ar-rich component that is present in the most primitive chondrites whose abundance quickly diminishes with progressive aqueous alteration. It is essentially completely lost in type 1 CIs and CRs and may survive only in the least aqueously altered CM2s [6].

**Experimental:** We measured bulk samples (typically 5-30 mg) of more than 25 CR and other CCs in one total extraction step each at ~1700 °C [cf. 7]. Extractions at ~1750 °C proved the completeness of the main extractions. Blank corrections were for almost all samples and isotopes essentially negligible, or within a few % of the released amounts. More than 30 CMs have been studied separately [6].

**Results and Discussion:** All samples show the expected abundant primordially trapped noble gases. Only a few CR chondrites show solar wind (SW) Ne with ²⁰Ne/²²Ne near or >12. These samples originate from the CR chondrite parent body’s regolith. More importantly, some samples including MIL 090657 and LAP 04720 have trapped ²⁰Ne/²²Ne of >9, significantly higher than the typically dominating Ne-HL (²⁰Ne/²²Ne ≈8.5 in presolar diamonds [8]). This could possibly be due to a subtle SW-Ne contribution as found in CI Ivuna [9], which can be detected only by closed system step etching. The release of air Ne (²⁰Ne/²²Ne ~ 9.8) is excluded based on the Ar isotopic composition. Ne-Q has similar ²⁰Ne/²²Ne ratios of 10.1-10.7, but Ne-Q is much less abundant than Ne-HL [10]. It is also possible that this a new Ne component. Indeed, an etch experiment on MIL 090657 identified two new, isotopically distinct trapped Ne components (one contains ~35% of the total ²⁰Ne) [11]. Other CR samples including GRA 06100 (heated [4]), Gao-Guenie (b) and, perhaps, Dhofar 1432 that are among the most aqueously altered CR2s [5], and GRO 95577 (the only CR1), do not show this new Ne component but are dominated by Ne-HL, with a small addition of Ne-E to GRO 95777 (from presolar SiC or graphite) [8]. This is consistent with the carrier of this new Ne component being water-soluble [11]. Helium and Ne show variable additions of cosmogenic ³He and ²¹Ne. The ³⁶Ar/³²Ar ratios are typical for Q-Ar, and cosmogenic ³⁸Ar contributions are minimal. Xenon is dominated by Q-Xe [10].

Trapped ³⁶Ar is the most suitable noble gas component to indicate aqueous alteration. Most CR2s and CO3.0 DOM 08006 have much higher concentrations compared to CR1 GRO 95577, GRA 06100, the CIs, Sutter’s Mill (C-ungrouped) and many CMs [6], where only the least aqueously altered CM2s, e.g., QUE 97990, NWA 10827 and LEW 85312 show similarly high trapped ³⁶Ar. DOM 08006 is the most primitive CO3. It contains the highest trapped ³⁶Ar concentration of all CO3s, which decreases with increasing metamorphic grade, showing that the carrier of the ³⁶Ar-rich component is also affected by metamorphism [12].

In summary, in addition to the well-known presolar and Q noble gas components, CCs carry primordially trapped components that are very susceptible to aqueous alteration. One Ne-rich component [11] is lost with progressing aqueous alteration of the CRs. An Ar-rich (“sub-solar”) component (known to be carried in HF-soluble minerals, [e.g., 13]) is present in CR2s and CO3.0 but mostly lost in CR1, CIs and CMs.