ONLINE ETCHING OF A NEUTRON-IRRADIATED ACID-RESISTANT RESIDUE OF ALLENDE – CLUES TO THE CHARACTER AND ORIGIN OF PHASE Q?

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Introduction: "Phase Q" is the still enigmatic, potentially carbonaceous or multi-phase, carrier [e.g., 1-3] of most primordially trapped Ar-Xe and some He and Ne in meteorites [3]. The characteristic "Q" noble gas signatures are found in all primitive chondrites, some achondrites and even comet and interplanetary dust [e.g., 3-6]. Its physical properties, composition, origin, but also location and timing of the formation are not entirely understood. Here, we present noble gas results of an etch run of an HF/HCl-resistant residue (insoluble organic matter, IOM) extracted from Allende that has been n-irradiated, in order to potentially shed more light on the properties and formation of phase Q.

Experimental: IOM from 4 meteorites ($CV3_{ox}$, $CV3_{red}$, EH4, H3.7) were n-irradiated (~24h, thermal flux $\sim 6 \times 10^{18}$ n cm^{2}) at the Petten (NL) reactor. This first noble gas study on irradiated IOM was performed on $CV3_{ox}$ Allende, the smallest sample (<1 mg). All stable isotopes of He-Xe as well as ^{37}Ar and ^{39}Ar were released in 17 steps (total duration 68 days) with our in-vacuum all-gold and platinum etch facility [3,7] and analyzed with a custom-built mass spectrometer [3].

Results: The noble gases in the first steps were strongly dominated by terrestrial atmospheric and n-induced components whereas the release of the Q-gases was observed mostly only in the last steps, under the harshest etch conditions. Large enrichments in $^{80,82}Kr$ and ^{128}Xe in the first steps of the etch run relative to Q-gas in unirradiated Allende IOM [8] or air show the irradiation was successful and that some Br and I were present prior to the irradiation. Some halogens might not be part of the Q carrier as the release patterns for n-induced isotopes are different to those of the Q-gases. However, excess ^{128}Xe and ^{129}Xe appear correlated in several steps. If interpreted as age information and using irradiation standard Shallowater, this could imply that the closure of parts of phase Q for Xe and halogens was tens of Ma after Shallowater Xe closure (4562 Ma ago). A similar interval has been discussed for phases in $CV3_{red}$ Efremovka [9]. The lack of detectable ^{37}Ar and ^{39}Ar suggests that Ca and K are not an abundant part of phase Q, which may support its carbonaceous character. Because of the small mass, only two steps released abundant ^{3}He. The $^{3}He/^{4}He$ ratio ($1.6\text{-}1.7 \times 10^{-4}$) is in the typical Q range [3,8]. Some observed features are affected by the very small sample mass, which caused the generally present atmospheric noble gases from acid or adsorption to dominate. However, the release pattern may also imply the n-induced modification of phase Q, possibly increasing the Q-gas retentivity or adsorption of air. The next etch experiment on a much larger residue of a $CV3_{red}$ chondrite will help better understanding these issues.

References: [1] Ott U. et al. 1981. *GCA* 45:1751-1788. [2] Marrocchi Y. et al. 2015. *Geophys. Res. Lett.* 42:2093–2099. [3] Busemann H. et al. 2000. *M&PS* 35:949-973. [4] Busemann H. and Eugster O. 2002. *M&PS* 37:1865-1891. [5] Busemann H. et al. 2010. *LPSC* 41:1947. [6] Marty B. et al. 2008. *Science* 319:75-78. [7] Riebe M. et al. 2014. *LPSC* 45:1991. [8] Wieler R. et al. 1991. *GCA* 55:1709-1722. [9] Gilmour J. D. et al. 2005 *GCA* 69: 4133-4148.