Search for Q: single grains Xe isotope analysis of carbonaceous residue from Yilmia

Conference or Workshop Item

SEARCH FOR Q: SINGLE GRAINS Xe ISOTOPE ANALYSIS OF CARBONACEOUS RESIDUE FROM YILMIA. A.B. Verchovsky[1], J. D. Gilmour[2] G. Holland[2], M. A. Sephton[1], I. P. Wright[1], I. A. Franchi[1]. [1]*Planetary and Space Sciences Research Institute, The Open University, Milton Keynes, UK.,*[2]*Department of Earth Sciences, University of Manchester, UK.*

Abstract. Analyses of Xe in single carbonaceous grains from Yilmia (HF-HCl resistant residue) using RELAX revealed an extremely heterogeneous distribution of Xe concentrations. So far no grains have been found which contain a Xe concentration that is compatible with Q.

Introduction. The nature of phase Q, the carrier of one of the major noble gas component in the Solar System [1] remains uncertain. All attempts to isolate it by physical methods have failed [1-3]. The best result achieved so far (using grain size and density separation) results in only a few times enrichment of the carrier. Recently we have shown that being carbonaceous in nature, the carrier is nonetheless distinct from the majority of carbon matter present in meteorites. For instance, the chemical properties of Q are such that during parent body metamorphism in reducing conditions (i.e. as would have been in evidence in the parent bodies of enstatite chondrites) the nature of the phase becomes distinctive from the major graphitic materials. This eventually leads to significantly different combustion temperatures of the component during laboratory stepped combustion experiments. Indeed we have observed this for the Yilmia enstatite chondrite. However even in this, seemingly favourable case, Q cannot be physically separated from the majority of graphitic material present in the meteorite. This presumably indicates that Q is somehow closely physically associated with graphitic grains.

In order to understand how the different phases are related to each other we decided to analyse single carbonaceous grains from Yilmia HF-HCl residue for Xe using the high sensitivity RELAX instrument [4]. Calculations of the expected Xe concentrations based on the bulk analyses of the Yilmia residue indicate that it can be as high as 10^{-5} cc/g, so that a grain with size of about 10-20 μm would contain 10^{-14} cc Xe, which is well above the detection limit for the RELAX machine.

Experimental. A sample of HF-HCl resistant grains from Yilmia was put on a glass slide as an acetone suspension. After drying a number of grains were analysed using Raman spectroscopy in order to identify carbonaceous grains and characterise their structural features. It was found that, judging from the first order carbon lines at 1350 and 1585 cm^{-1}, there is a great variety in the crystallinity of the graphite grains. The glass slide with the sample was subsequently put into the laser chamber of the RELAX extraction system and after baking out for several hours at $200^{o}C$ the same grains characterised by Raman were analysed for Xe using laser (1064 nm Nd:YAG) extraction in continuous wave heating at a spacial resolution about 20 μm. All together we analysed about 50 grains in the size range 10-40 μm.

Results. Only seven out of the 50 grains analysed yilded Xe above (factor of 2-4) the procedural blank level (1-1.5 10^{-16} cc ^{132}Xe). The $^{129}Xe/^{132}Xe$ ratio, measured at that level of Xe with precision 4-7%, shows a systematic difference from atmospheric Xe (1.08 in average vs. 0.98) indicating that atmospheric contamination plays a minor role. The concentration of Xe in the grain with highest measured yield ($5x10^{-16}$ cc) is about $6x10^{-8}$ cc/g which is two orders of magnitude less that expected for Q. Moreover, the concentration of Xe measured in all the grains we analysed is less that 10^{-9} cc/g - almost two orders of magnitude less that in the bulk sample. No correlation was found between Raman specrta of the grains and amount of Xe in them

Discussion. First of all we have to conclude that: (a) the grains are extremely heterogeneous with respect to Xe content; (b) the grains sampled in the study are not statistically representative for the bulk sample, so that grains with much higher (perhaps even higher than estimated) concentrations remains to be found. We are convinced that the low Xe concentrations observed here (and indeed, the presence of mainly Xe-free grains) is not an artefact of our preparation procedure (for instance, it is not due to degassing by the laser Raman probe because non-irradiated grains were also found to contain no Xe). There could still be a sampling bias and this we need to investigate further.

Such huge fluctuations in the Xe concentration is not expected in the case of gas adsorption on the grain surfaces as suggested by labyrinth theory [5]. The relationship between Q and graphitic grains in the sample remains uncertain, however it is now clear that Q is not equally associated with all carbon grains. We hope to extend the number of single grains analysed by RELAX to at lest few hundred in the near future. If we continue to find a dearth of Xe associated with carbonaceous grains, this means that the ultimate concentration of Xe within the Q phase must become relatively higher and higher.

.

References. [1] Lewis R. S. et al. (1975) *Science*, 190, 1251; [2] Verchovsky a. B. et al. (2001) *Meteoritics and Planet. Sci*. 36, 212; Amari S. et al. (2001*) Meteoritics and Planet. Sci.* 36, 10; [4] Gilmour J.D. et al. (1994) *Rev. Sci. Inst*. 65, 617; [5] Zadnik M. G. et al. (1985) *GCA*, 49, 1049.