

NOBLE GAS ANALYSIS OF Q-RICH FRACTIONS FROM ORGUEIL AND ALLENDE. S. Amari¹, J. Matsuda² ¹Laboratory for Space Sciences and the Physics Department, Washington University, St. Louis, MO 63130, USA (sa@wuphys.wustl.edu), ²Department of Earth and Planetary Science, Graduate School of Science, Osaka University, Toyonaka 1-1, Osaka 560-0043, Japan (matsuda@ess.sci.osaka-u.ac.jp).

Introduction: Most of the heavy noble gases are contained in a very small portion of the primitive meteorites. The carrier of these noble gases was named Q for quintessence [1]. Isotopic and elemental abundances of the Q gases have been extensively studied. Huss et al. [2] analyzed noble gases in HF-HCl residues of 14 chondrites from 7 different compositional groups and found the Q-gas concentrations decrease and median Xe release temperatures increase with increasing metamorphic grade. Busemann et al. [3] analyzed noble gases in HF-HCl residues from 6 chondrites with the Closed-System Stepped Etching technique. With the data previously obtained with the same technique, they concluded that isotopic ratios of the Q gases are fairly uniform except ²⁰Ne/²²Ne ratios. Q gases are characterized by the elemental abundance pattern that is highly enriched in the heavy noble gases and close-to-solar isotopic ratios.

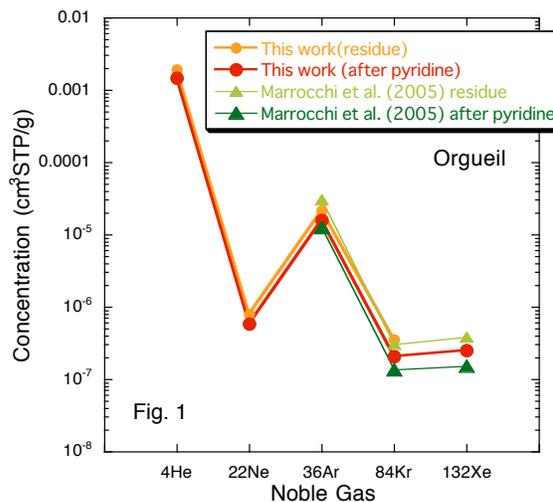
Isotopic and elemental abundances being well determined, Q, the carrier itself, remains elusive although it is most likely carbonaceous matter [4]. Marrocchi et al. [5] treated an HF-HCl residue from Orgueil with pyridine and found that 70–80 % of the Xe that should have been released at or lower than 1300°C steps was lost, whereas only 23 % of Xe in the higher temperature steps was lost during step-wise heating. Since only macromolecular organic matter is affected by pyridine, they proposed the existence of at least two substructures in Q, one of which shows the organic nature. Busemann et al. [6] treated Cs-HF residues from Murchison (CM2), Bells (anomalous CM), EEF 92042 (CR2), and GRO 95577 (CR1) with pyridine but did not find a substantial decrease in Xe concentrations of the pyridine-treated Cs-HF residues relative to those of original Cs-HF residues.

To better understand these two seemingly conflicting results, we produced HF-HCl residues from Orgueil and Allende and treated aliquots of the residues with pyridine and analyzed noble gases of those residues.

Experimental: 1.26 g of Orgueil was first treated with a mixture of toluene and methanol to remove soluble organic matter and was alternately treated with 10M HF-1M HCl and 6M HCl followed by 6MHCl-0.6M H₃BO₃ and 6MHCl treatment to completely dissolve silicates. After the residue was treated with CS₂ to remove elemental sulfur, 11% of the HF-HCl residue was immersed in pyridine for more than 24 hours.

The pyridine was evaporated at 60-90°C. For Allende, we used the Allende HF-HCl residue we already prepared. For both meteorite samples, all five noble gases of the pyridine-treated fractions and the original residues were analyzed by step-wise heating with the temperature steps of 600, 800, 1000, 1200 and 1600°C.

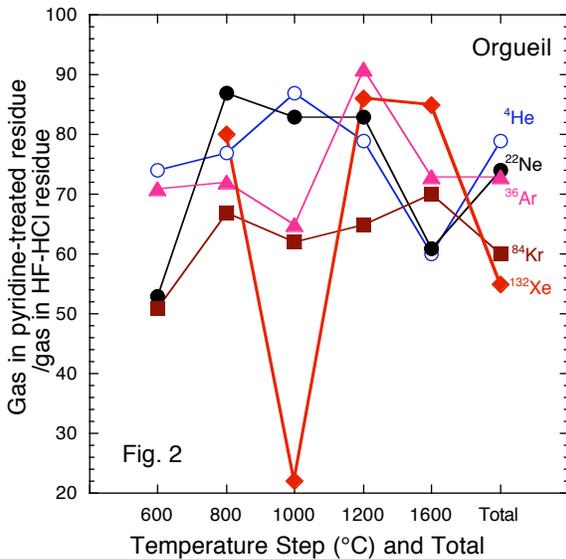
Results and Discussion: Noble gases were lost in the Orgueil residue with the pyridine treatment (Fig. 1). The losses of ⁴He, ²²Ne, ³⁶Ar, ⁸⁴Kr and ¹³²Xe of the pyridine-treated residue were 21%, 26%, 27%, 40% and 45%, respectively, relative to noble gases in the HF-HCl residue (Fig.2), showing that the lost gas had a fractionated elemental abundance pattern enriched in the heavy noble gases. On the other hand, Marrocchi et al. [5] found the losses of ³⁶Ar, ⁸⁴Kr and ¹³²Xe were 59%, 55% and 62%, respectively, indicating a rather uniform loss for all the heavy noble gases.



In the 1000 °C fraction, the Xe concentration is only 20% of that in the HF-HCl residue (Fig. 2). In the 800°C, 1200°C and 1600°C fractions, the Xe concentrations of the pyridine-treated residue are 80%, 86% and 85% relative to those of the HF-HCl residue, respectively. Marrocchi et al. [5] found that at the 1300°C fraction, the Xe concentration in the pyridine-treated residue was 21% of that in the HF-HCl residue. Therefore, our result is consistent with their result. Marrocchi et al. [5] explained the loss of Xe by the pyridine treatment as the result of swelling of macro-

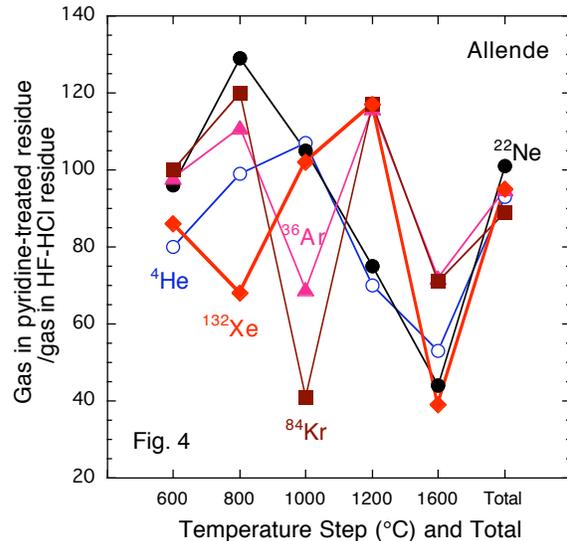
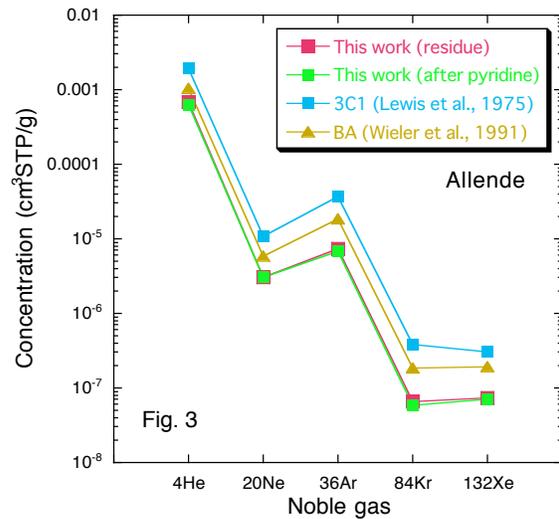
molecular network, resulting in the release of Xe trapped in the network.

$^{130}\text{Xe}/^{132}\text{Xe}$ ratios in our pyridine-treated and HF-HCl residues are 0.1653 ± 0.0007 and 0.1666 ± 0.0008 , respectively, slightly higher than those by Marrocchi et al. (0.1625 ± 0.0006 and 0.1629 ± 0.0005) [5] and that in a HF-HCl residue by Huss et al. (0.1624 ± 0.0005) [2]. Our samples may contain finer SiC grains than those of Marrocchi et al. [5] and Huss et al. [2] because Xe-S concentrations increase with decreasing grain size [7].



As shown in Figs. 3 and 4, noble gas concentrations of the pyridine-treated Allende residue are similar to those of the HF-HCl residue. The losses of ^4He , ^{22}Ne , ^{36}Ar , ^{84}Kr and ^{132}Xe in the pyridine-treated residue are 7%, 0%, 5%, 11% and 5%, respectively, showing no significant effect of the pyridine treatment. Therefore, the same type of organic matter that is present in Orgueil and experience swelling with pyridine is absent in Allende.

Our results as well as those by Marrocchi et al. [5] and Busemann et al. [6] indicate that Orgueil is, so far, the only meteorite containing this type of organic matter. If this type of organic matter originated from the molecular cloud from which our solar system formed, the Orgueil parent body might have been the only one which incorporated this type of organic matter. Or if the noble gases were trapped in this type of organic matter on the parent body, the conditions of parent body processing must have been unique to the Orgueil parent body.



References: [1] Lewis R. S. et al. (1975) *Science*, 190, 1251-1262. [2] Huss G. R. et al. (1996) *Geochim. Cosmochim. Acta*, 60, 3311-3340. [3] Busemann H. et al. (2000) *Meteorit. Planet. Sci.*, 35, 949-973. [4] Ott U. et al. (1981) *Geochim. Cosmochim. Acta*, 45, 1751-1788. [5] Marrocchi Y. et al. (2005) *Earth & Planet. Sci. Lett.*, 236, 569-578. [6] Busemann H. et al. (2008) *Lunar & Planet. Sci.*, XXXIX, Abstract #1777. [7] Lewis R. S. et al. (1994) *Geochim. Cosmochim. Acta*, 58, 471-494.