# NOBLE GAS STUDY OF Q-RICH FRACTIONS FROM SARATOV (L4).

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**Introduction:** Heavy noble gases in primitive meteorites are mostly carried by the phase named Q for quintessence. Elemental and isotopic abundances of noble gases in Q have been studied using various methods [1-5]. Except $^{20}Ne/^{22}Ne$ ratios, the Q-gases from various types of meteorites show a uniform isotopic composition.

On the other hand, Q, the phase itself, remains elusive for more than three decades since its discovery in 1975 [6]. Q is most likely carbonaceous matter [7] and it is readily destroyed by oxidants [6]. It has been argued that there are more than one type of Q. Gros and Anders [8] and Busemann et al. [4] proposed that there are two types of Q, having different noble gas concentrations and susceptibility to chemicals. Recently Marrocchi et al. [9] reported ~60 % of the Xe in an Orgueil (CI) HF-HCl residue were lost by pyridine, suggesting the presence of an organic type of Q. However, Busemann et al. [10] did not confirm the loss in residues from other meteorites. Matsuda et al. [11] treated both Allende and Orgueil residues with pyridine and found the Xe concentration of the former remained unchanged, while that of the latter was decreased by 45 %. However, new data on Ivuna (CI) and Orgueil [12], indicating the Xe of residues from these meteorites was unaffected by the pyridine treatment, further added complication.

Here we report noble gas data of Q-rich fractions extracted from Saratov (L4) in the effort to isolate and identify Q. Part of the noble gas data were already reported [13].

**Experimental:** We chose Saratov for this study because meteorites with a higher metamorphic grade (≥ 3.7) contain Q but not diamond [3], which are very difficult to separate each other. Approximately 7.2 g of Saratov were dissolved with HF-HCl followed by the $CS_2$ treatment to remove elemental sulfur, yielding an HF-HCl residue AC. Then three successive colloidal separations, using acetone, mixture of slightly acidified water and iso-propanol, and that of slightly basic water and iso-propanol, were applied to further separate the residue. The separated fractions include *non-colloidal fraction AF*, by the first colloidal separation, *colloidal fraction AG*, produced by the second colloidal separation, and *colloidal and non-colloidal fractions AI and AJ*, produced by the third colloidal separation. The abundances of AG, AI and AJ relative to a bulk meteorite are 26, 88 and 288 ppm, respectively. Noble gases of these three fractions were analyzed by step-wise heating (600°C and 1600°C) with the VG5400 at Osaka University. We determined concentrations of all five noble gases and isotopic ratios of Ne, Ar and Xe.

**Results and Discussion:**

*Elemental and isotopic abundances of noble gases.* The $^{132}Xe$ concentrations of AG, AI, and AJ are $1.3 \times 10^{-6}$, $4.1 \times 10^{-7}$ and $2.1 \times 10^{-6}$ $cm^3STP/g$, respectively (Fig. 1). We note that AJ has the highest Xe concentration that has ever measured for any extra-terrestrial material. The elemental abundance patterns of these fractions (Fig. 2), normalized by $^{36}Ar$ and the average Q-gas composition [4], show that all the fractions are enriched in Xe. Of them, AJ shows a highly fractionated pattern. Its $^{22}Ne/^{36}Ar$ and $^{84}Kr/^{36}Ar$ ratios are the same as the average ratios, but the $^{132}Xe/^{36}Ar$ ratio is 2.34 times the average ratio and the $^{4}He/^{36}Ar$ ratio is 0.28 times the average ratio. The abundances of light noble gases of AG and AI were determined only as upper limits, thus it is not clear whether they also have the He depletion.

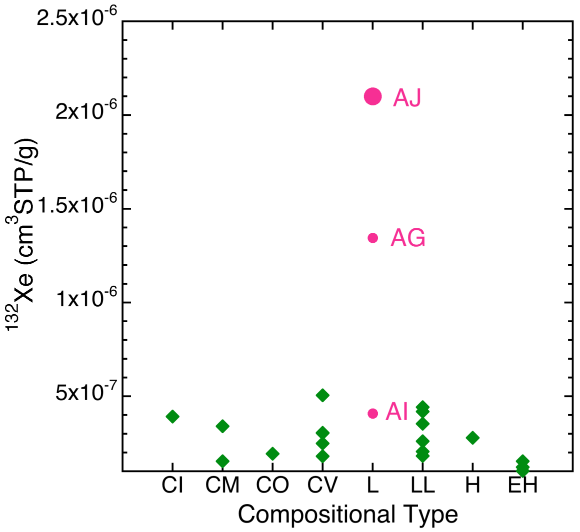

Fig. 1. Xenon concentrations of Saratov fractions AG, AI and AJ and of HF-HCl fractions of meteorites with various compositional types [3, 4].

The Ne isotopic composition of Saratov AC ($^{20}Ne/^{22}Ne = 2.739 \pm 0.034$, $^{21}Ne/^{22}Ne = 0.678 \pm 0.004$) [13] shows the presence of abundant cosmogenic Ne. SEM observation of non-colloidal fraction AF revealed that AF essentially consists of Al, Cr and Fe-rich oxides. From mass balance, we estimated nearly 95 % of

AC consist of the oxide. Therefore, the cosmogenic Ne in AC must be contained in these oxide grains. Although the amount of cosmogenic Ne in AJ was substantially reduced from Saratov AC, the Ne isotopic ratios of AJ indicate there is still cosmogenic Ne (Fig. 3).

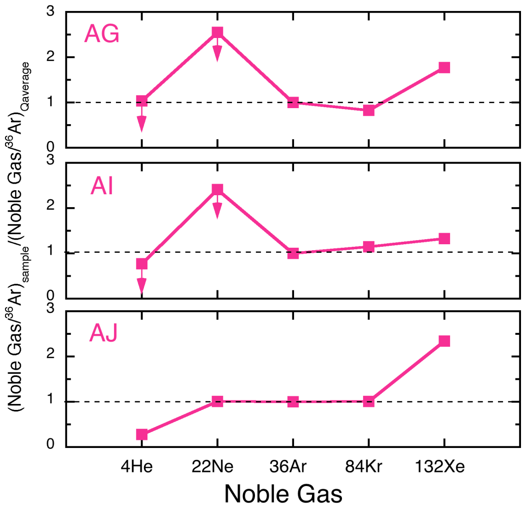

Fig. 2. Noble gas abundance patterns of AG, AI and AJ. Noble gas concentrations are normalized by $^{36}$Ar and the average concentrations of the Q-gases [4]. The arrows indicate upper limits.

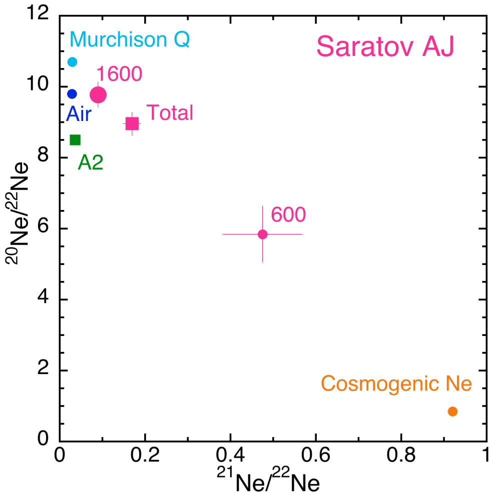

Fig. 3. Neon isotopic composition of AJ.

$^{20}$Ne/$^{22}$Ne ratios of Ne-Q derived from meteorites of various compositional types cluster ~10.1 (Cold Bokkeveld CM2, Lancé CO3.4, Isna CO3.7) and 10.7 (Murchison CM2, Allende CV3, Grosnaja CV3, Chainpur LL3.4, Dimmitt H3.7) [4]. The $^{20}$Ne/$^{22}$Ne ratio of Saratov Ne-Q was determined as the intercept of the line connecting the two temperature fractions and the line connecting Murchison Q and Ne-A2. It is 10.38 ± 0.45. With the errors, it is hard to discern whether Ne-Q in Saratov belongs to either group.

The Xe isotopic ratios of AG, AI and AJ are indistinguishable as those of Xe-Q or P1 within 2 σ errors (Fig. 4).

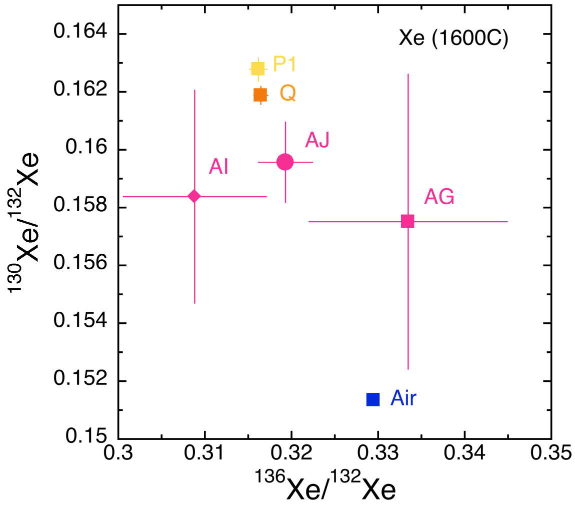

Fig. 4. A $^{130}$Xe/$^{132}$Xe-$^{136}$Xe/$^{132}$Xe plot. The 1600°C fractions are plotted.

*Q in ordinary chondrites*. Presolar SiC and diamond are completely gone in Julesburg, a meteorite of the petrologic type 3.7 [3]. This study, along with our previous study [13], shows Q is still abundantly present in a meteorite with a higher petrologic type of 4. Among Q, SiC and diamond, Q is most resistant to thermal metamorphism. There is a real possibility that Q retains records of the early solar system and beyond.

**References:**

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