RAMAN SPECTROSCOPIC STUDY OF ALLENDE (CV3) AND SARATOV (L4) CHEMICAL RESIDUES AND ITS IMPLICATION TO PHASE Q.

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Introduction: The noble gases have played important roles to study various events during the evolution of our solar system. The planetary noble gases in meteorite are highly enriched in heavy noble gases. They are carried by so-called “phase Q” . Phase Q is in a HF/HCl resistant residue (about 0.5% of the bulk meteorite) of the meteorite, but is destroyed by oxidants such as HNO_3, $Na_2Cr_2O_7$ etc. Phase Q is now identified as carbonaceous material [1], but its precise chemical state is not yet known. In this study, we compared the Raman spectroscopic data of the original HF/HCl residues (Q-rich) and their etched residues (Q-poor) for Allende (CV3) and Saratov (L4), in order to examine the carbon feature of the phase Q. Both phase Q and presolar diamond are preserved in the Allende meteorite, but presolar diamonds are not detected in ordinary chondrites of petrologic type >3.8 [2]. Thus we hoped to be able to determine the phase Q in Saratov without the disturbance of presolar diamond.

Sample and Experimental: We prepared the original HF-HCl residues using a chemical procedure commonly used to concentrate Q. The etched residues were prepared with an oxidant from the original residues. We also prepared a colloidal fraction for the Allende original residue. The noble gas measurements were carried out using the VG5400 noble gas mass spectrometer in Osaka University. The Raman spectroscopy was carried out using a Raman microscope (Kaiser Hololab 5000, Kaiser Optical Systems, Inc.) with a 532nm YAG laser.

Results and Discussion: The noble gas and Raman data of the Allende chemical residues are given in Matsuda et al. [3]. As for Saratov, only the noble gas data of the HF-HCl residue and a bulk sample are given in Matsuda et al. [4]. We confirmed that the heavy noble gases were surely enriched in the original residues (Q-rich) but depleted in the etched residue (Q-poor) in both chondrites.

Noble gas concentrations in the colloidal fraction of Allende original residue are a factor of 2-4 higher than those in the non-colloidal fraction [3]. The Raman spectroscopic parameters show that the colloidal fraction of the original residue is more amorphous compared to the non-colloidal fraction in Allende [3]. The ion irradiation evolves the carbon into more amorphous [5], indicating that the “plasma model” [6] is a plausible one as the origin of phase Q [3]. As for Saratov, the original residue contains only a portion of the trapped heavy noble gases, but they are largely removed in the etched residue, suggesting that phase Q is surely present in Saratov but is damaged by thermal metamorphism [4].

The Raman spectroscopic parameters such as peak positions and intensity ratios of the original residues are very much different for Allende and Saratov. The Raman spectroscopic parameters of the original residues have changed discretely after the oxidation in both meteorites. This suggests that the oxidization not only dissolves out the oxidizable carbon but also changes the whole carbon structure. After the oxidation, the D band positions at about 1350 cm^{-1} increased in both meteorites, but the intensity ratio of D and G bands (I_D/I_G) decreased in Allende but increased in Saratov. The different change of I_D/I_G ratios may be due to the difference stage of graphitic carbon for Allende and Saratov. Allende carbon is in the stage of nanocrystalline graphite to amorphous carbon (Stage 2 in Ferrari and Robertson [7]) where the decrease of I_D/I_G ratio indicates the evolution to amorphous state. Meanwhile, Saratov carbon is in the stage of graphite to nanocrystalline graphite (Stage 1 in Ferrari and Robertson [7]) where the increase of I_D/I_G ratio indicates the evolution to amorphous state. Thus our Raman data indicate that the oxidation changes the carbon structure to more amorphous (disordered) state in both meteorites.

Our results indicates that release of Q-gases is simply due to the disordered rearrangement of carbon structure by oxidation [1,8], although there still is a possibility that phase Q consists of very fine grains of a discrete phase and it is always covered by the major disordered carbon under the Raman spectroscopic observation [3].

References: [1] Ott U. et al. (1981) *Geochim. Cosmochim. Acta,* 45,1751-1788. [2] Alexander C. M. O' D. et al. (1990) *Earth Planet. Sci. Lett.*, 99, 220-229. [3] Matsuda J. et al. (2010) *Geochim. Cosmochim. Acta,* 74, 5398-5409. [4] Matsuda J. et al. (2010) *Meteorit. Planet. Sci.,* 45, 361-372. [5] Brunetto R. et al. (2009) *Icarus,* 200, 323-337. [6] Matsuda J. and Yoshida T. (2001) *Meteorit. Planet. Sci.,* 36, A127. [7] Ferrari A. C. and Fobertson J. (2000) *Phys. Rev.*, B61, 14095-14107. [8] Ott U. (2002) *Rev. Mineral. Geochem.,* 47, 71-100.