INVESTIGATING XENON ISOTOPIC FRACTIONATION DURING RAYLEIGH-TYPE DISTILLATION. Y. Marrocchi[1] & B. Marty[1]. [1] CRPG-CNRS, 15, rue Notre-Dame des Pauvres, BP 20, F-54501 Vandoeuvre-Lès-Nancy, France (yvesm@crpg.cnrs-nancy.fr).

Introduction: Mechanism leading to the incorporation of noble gases in meteoritic matter remains poorly understood. The main carrier of meteoritic noble gases, known as "phase Q", is formed of carbonaceous material not fully characterized, resulting of acid attack of chondrites by HF/HCl. Study by [1] has revealed that it is mainly composed by aromatic moieties linked by short aliphatic chains. Recent HRTEM observations of organic material in Orgeuil, Leoville and and Vigarano meteorites have shown the presence of curved and frequently twisted and intertwined graphene sheets, abundant carbon-black particles and hollow "sacs" [2]. The authors concluded that low temperature adsorption is the most probable way to incorporate noble gases onto meteoritic matter.

Adsorption processes succeeded to reproduce the elemental fractionation observed in meteorites [3,4,5,6]. However, the major problem for the adsorption model was the absolute abundance of noble gases, which failed to about 4 orders of magnitude to account for the absolute amount of phase Q [4]. We have proposed previously that it is possible to reproduce noble gas meteoritic concentration with low pressure adsorption experiment in the temperature range 70-100K, using kerogen -as the best chemical phase Q analog- and carbon blacks -as possible good phase Q precursors [7]. Astrophysical models [8,9] and observations [10] suggest that temperatures between 60-100K are possible at 3 AU during the T-Tauri phase of solar nebula evolution. Therefore, meteoritic accretion could occurred at low temperature. Any model that derives phase Q noble gases from solar nebula gases should reproduce, in addition of the elementary pattern and the noble gas concentration, the isotopic noble gas fractionation observed in meteorites.

Available data suggest that phase Q noble gases were established in the gas phase of the solar nebula prior to incorporation in meteorites [11]. These authors suggest that isotopic mass fractionation could be generated by some form of Rayleigh distillation. Although equilibrium adsorption is not thought to be isotopically fractionating process [12], adsorption following a Rayleigh distillation could produce the isotopic pattern of phase Q. In order to progress in this field, we have developed an apparatus designed to investigate isotopic fractionation induced by adsorption during Rayleigh distillation experiment.

Experimental: The apparatus consists of stainless steel volume of 10 liters (volume A; Fig. 1) and a quartz finger of 3 cm^3 (volume B; Fig 1). Both volumes are isolated by a automated valves. High vacuum conditions are reached using two rotary and turbomolecular pumps and monitored with ion gauge in the volume A. Usually, 5.10^{-5} mbar of xenon (purity of 99.96 %) was introduced in volume A and its isotopic composition was analyzed by conventional static mass spectrometer (VG 5400) to a precision of 0.5%. Adsorption cycles were performed on sample at 77K and 196 K with various equilibrium times (between gas and sample) and pumping time. The xenon pressure was monitored all along the run of the experiment. At the end of the distillation, the isotopic composition of gas remaining in volume A was measured.

Results : We performed experiments on kerogen (thought to be a good phase Q analog) at 77K and 196K and at a xenon pressure of 5.10^{-5} mbar. Up to 25 cycles were performed, until 99.9 % of xenon was removed from volume A. We do not observe any fractionation using Rayleigh distillation of xenon at the 0.5%/amu level, despite 99.9% of xenon was distillated. This result could be linked to the very low specific surface area of kerogen (4 $m^2.g^{-1}$) and adsorbat/adsorbent interaction parameter (α_a-α_0), which indicate a weak surface energy [7]. The absence of atomic size micropores - which can have a great influence on noble gas trapping [3,4,5] - in the kerogen structure could explained absence of the isotopic fractionation. Despite similarity to phase Q in chemical composition, kerogen may not be a fully appropriate analog for investigating the adsorption processes that could have occured in the protosolar nebula. The nature of the precursors of the phase-Q remains largely unknown. In view of this uncertainty, experiments using sample with higher specific surface area and surface energy than kerogen are underway. In particular, samples of different forms of amorphous carbon with atomic micropores, which present specific surface between 10 and 100 $m^2.g^{-1}$ will be investigated.

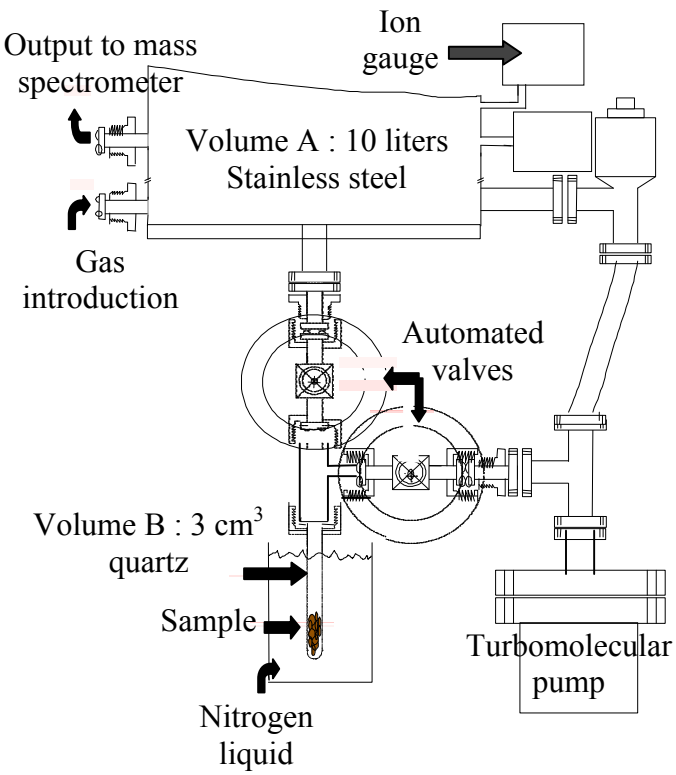

Figure 1: schematic drawing of the Rayleigh-type distillation apparatus.

REFERENCES: [1] Gardinier *et al* (2000) *EPSL* 184, 9-21. [2] Vis *et al* (2000) *MPS* 37, 1391-1399. [3] Wacker *et al* (1985) *GCA* 49, 1035-1048. [4] Zadnick *et al* (1985) *GCA* 49, 1049-1059 [5] Wacker (1989) *GCA* 53, 1421-1433. [6] Pepin (1991) *Icarus* 92, 2-79. [7] Marrocchi *et al* (2004) *In Preparation.* [8] Bell *et al* (1997) *Astrophys. J.* 486, 372-387. [9] Bell *et al*, 1999 . *Astrophys. J.* 526, 411-434. [10] Hartmann *et al* (1998) *Astrophys. J.* 495, 385-400. [11] Ozima *et al* (1998) *GCA* 62, 301-314. [12] Bernatowicz & Podosek, (1986) *GCA* 50, 1503-1507.