EXPERIMENTAL STUDIES ON THE METAMORPHISM OF INTERSTELLAR ORGANIC MATERIALS IN METEORITES' PARENT BODIES. N. Hirakawa[1], H. Nakano[1], and A. Kouchi[2], [1]Kyoto University of Education, Fushimi, Kyoto 612-8522, Japan (din65047@kyokyo-u.ac.jp), [2]Institute of Low Temperature Science, Hokkaido University, Sapporo 060-0819, Japan.

Introduction: Interstellar dusts in molecular clouds consist of silicate core, organic materials and ice. Those dusts were heated and partially evaporated when the solar nebula was formed. We experimentally determined the distribution of these materials in the solar nebula [1, 2]. At heliocentric distance between 2 and 3 AU, organic materials evaporated partially, which led to the occurrence of organic materials-covered silicate grains. At heliocentric distance larger than 3 AU, interstellar organic materials on silicate dusts remained without evaporation and ice condensed on the dusts. These dusts grew by aggregation into planetesimals and then into meteorites parent bodies. It is therefore acknowledged that materials of meteorites parent bodies in 2-3 AU were organics and silicates, and that in >3 AU ice, organics and silicates.

Interstellar organic matterials were metamorphosed in meteoritic parent bodies, through aqueous alteration and subsequent thermal metamorphism at >3 AU. It is considered that the aqueous alteration is closed-system reaction and thermal metamorphism open-system one. Nakano et al. [3] performed aqueous alteration experiments (100, 200 °C) using high-pressure cell and subsequent heating experiments in vacuo at 50-600 °C, and compared elemental composition with carbonaceous chondrites' data. However, there has been no experiment simulating on the metamorphism occurred in the meteoritic parent bodies in 2-3 AU. In this study, we have performed simulation experiments on closed-system reaction (300-450 °C) and subsequent open-system reaction (400, 600 °C) using interstellar organic materials analogs. In addition, we also performed higher temperature aqueous alteration experiments like Nakano et al. [3] to know the results under subcritical and supercritical water conditions.

Experimental: *Preparation of organic material analogs*. It is very difficult to obtain sufficient amounts of organic materials formed in simulating experiments (UV-irradiation of impure ice at 10 K). Therefore, we prepared interstellar organic material analogs, which we call MC, by mixing the chemical reagents based on analytical data of laboratory synthesized organic materials [1].

Experiments with/without water. The interstellar organic materials (MC: 10 g) and H_2O (0 or 10 g) were put and heated in the Hastelloy high-pressure reactor, and this experiment is considered to heating experiments under closed-system condition. The samples were heated at 100-450 °C for 5-200 hours (Table 1). After the experiments, samples were freeze-dried under vacuum at -20 °C to remove remaining H_2O. Table 1 shows the list of samples in the present experiments.

Table 1 Conditions for closed-system heating experiments

Name of runs	Samples	Heating temperatures
MC_w 100 °C	MC(10 g)＋H_2O(10 g)	100 °C
MC_w 200 °C	MC(10 g)＋H_2O(10 g)	200 °C
MC_w 300 °C	MC(10 g)＋H_2O(10 g)	300 °C
MC_w 400 °C	MC(10 g)＋H_2O(10 g)	400 °C
MC 400 °C	MC(10 g)	400 °C
MC 450 °C	MC(10 g)	450 °C

Experiments on thermal metamorphism. Next, we have simulated thermal metamorphism of MC_w 100-400 °C and MC 400, 450 °C in parent bodies by evaporation experiment under vacuum. This is because the thermal metamorphism on parent bodies of carbonaceous chondrites could be simulated by evaporation experiments under open-system condition [3]. 100 mg samples of MC_w 100-400 °C and MC 400, 450 °C in silica glass vessel were heated electrically in a vacuum chamber (10^{-5}-10^{-6} Pa) which was evacuated by a turbo molecular pump. The samples were heated at 400 °C or 600 °C for 80 hours. After cooling to room temperature, the mass of residues were measured and an elemental compositions (C, H, N) were analysed by an elemental analyzer.

Results and discussion: Figure 1 shows the weight (wt%) of residues (MC_w and MC) after closed-system heating and subsequent open-system heating. For MC_w 300, 400 °C, most (99.8wt%) of the MC evaporated. This is probably due to the decomposition of MC by subcritical or supercritical water. For MC 400, 450 °C, on the other hand, 9-13wt% of the residue were remained. This might be caused by the polymerization of MC. Although Nakano et al. [2] showed by simple heating experiments of MC in vacuo that the amount of organic materials on dusts in >3 AU is larger than that in 2-3 AU, present study clearly shows that the amount of organic/carbonaceous materials remaining in the meteorites does not always reflect the amount of organic materials on dusts.

Figure 2 shows the C and N contents of carbonaceous chondrites and heating residues of MC 400 °C [400, 600 °C], 450 °C[400, 600 °C] (the heating temperatures in vacuo are shown in the square brackets). Note that the change in C and N contents of the heated residues of MC 400 °C appear to have similar values to those of carbonaceous chondrites. The C and N contents of CI, CM and CO, CV chondrites groups appear to have similar values to those of MC 400 °C[400 °C] and MC400 °C[600 °C], respectively. Nakano et al. [3] pointed out that linear distribution of C, N contents observed in carbonaceous chondrites reflects not only the difference of the temperatures of thermal metamorphism but also the difference of the temperature on aqueous alteration in the parent bodies. However, present study suggests another possibility that the C and N contents of the carbonaceous chondrites could be explained by thermal alteration and the subsequent thermal matamorphism of the interstellar organic materials without water.

References: [1] Kouchi A. et al. (2002) *ApJ*, ***566***, L121-L124. [2] Nakano H. et al. (2003) *ApJ*, ***592***, 1252-1262. [3] Nakano H. et al. (2002) *Proc. Jpn. Acad. Ser. B*, ***78***, 277-281.

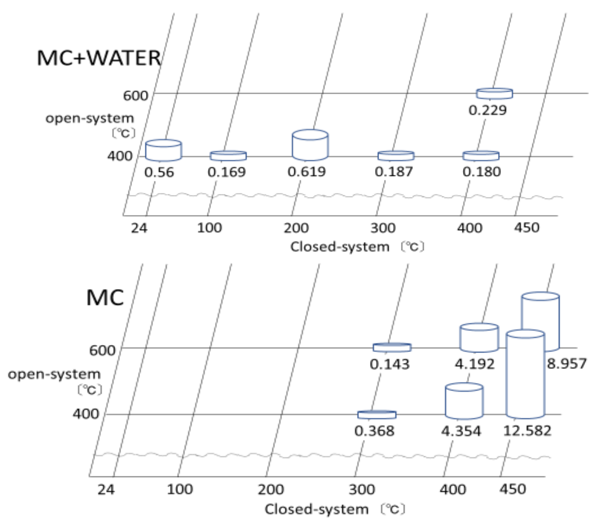

Fig. 1. The mass of residues (wt%) after closed-system heating and subsequent open-system heating. The upper and lower figures show when MC were heated with and without water, respectively.

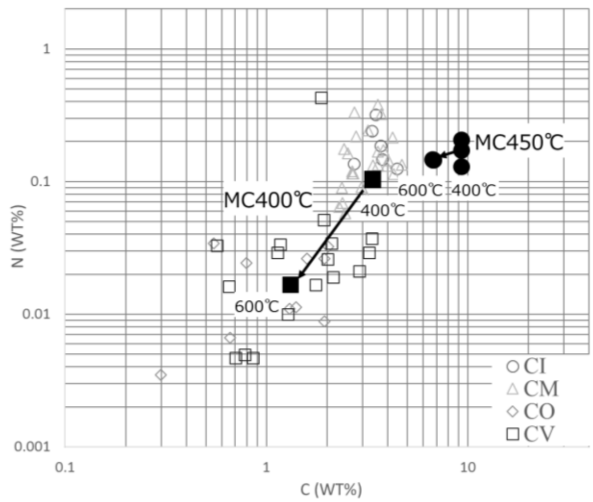

Fig. 2. C and N contents of carbonaceous chondrites and MC residues. Data of carbonaceous chondrites are taken from Nakano et al. [2].