THERMALLY METAMORPHOSED ANTARCTIC CM AND CI CARBONACEOUS CHONDRITES IN JAPANESE COLLECTIONS, AND TRANSFORMATION PROCESSES OF PHYLOSILICATES. J. Akai and S. Tari, Department of Geology, Faculty of Science, Niigata University, Ikarashi 2-nocho, 8050, Niigata 950-21, Japan.

Since the first discovery of thermal metamorphism of CM and CI chondrites [1,2] many interests were focused on these materials and some data have been accumulated [1–10]. It is very characteristic in contrast to non-Antarctic carbonaceous chondrites. In the metamorphism, phyllosilicates changes to olivine, through some intermediate structures [4,5,7–9]. The cause of this metamorphism has also variously estimated [11–14]. Some shock effect experiments have been carried out to ascertain these possibility, using shock experiment [15]. However the possibility of heating by shock events was considered to be less. Hiroi et al. [13,14] suggested possible thermal metamorphism in many of the C, G, B and F type asteroids. They interpreted it due to thermal metamorphism after extensive aqueous alteration in parent body. The different degrees of thermal metamorphism may depend partly on the different degrees of water contents and depths. More data are necessary to ascertain these scenarios or have the other. The ratio of thermally metamorphosed carbonaceous chondrites/unheated carbonaceous chondrites may become the fundamental data.

The objectives of this study are (1) Using as many Antarctic CM and CI type carbonaceous chondrites specimens available as possible, we wanted to obtain the ratio in Antarctic meteorites. In this study we searched for the mineralogical evidences of metamorphism in the constituent minerals. (2) We further describe constituent minerals by TEM. (3) Summarizing previous data also, the author will describe the thermal transformation process of phyllosilicates.

The following 14 Antarctic carbonaceous chondrites specimens were examined (carbonaceous chondrites which have been examined by the author are also contained here): CI1: Y-82162; CI2: Y-86720, B-7904; CM2: Y-74662, Y-791198, Y-793321, Y-793595, Y-82042, Y-82054, Y-82098, Y-86695, A-881334, A-881458, and A-881955.

These specimens can be grouped as follows, based on the degree of thermal metamorphism although some are not fully examined yet. Estimated temperatures are also shown for some specimens. Intensely metamorphosed specimens include Y-86720 (700–850°C), Y-82162 (600–800°C), B-7904 (750–900°C), Y-82054, Y-82098, Y-86695, and A-881334. Weakly, or very weakly metamorphosed specimens include Y-793321 (300–500°C), Y-793595 (<250°C?), A-881458 (<250°C?), Y-82042 (slightly to nonmetamorphosed?). Unheated specimens include Y-74662, Y-791198, and A-881955.

These data indicate that thermally metamorphosed Antarctic CM and CI carbonaceous chondrites are dominated in contrast to non-Antarctic chondrites. These characteristics correspond to the past flux of meteorite falls to the Earth. In this study, very weak metamorphism was suggested in several specimens (Y-793595, A-881458, etc.). More detailed examinations may be , in some cases, necessary to detect very weak metamorphism on the other specimens which have been previously reported as unheated. Thus, continuous metamorphic degrees from very weak to intense ones are expected, assuming inner heating processes in the parent body.

Recent investigation on Y-793595 indicated that polygonal serpentine which is rarely found in the terrestrial environments were contained. The other characteristics of phyllosilicates and related layer lattice minerals are almost similar to those in non-Antarctic carbonaceous chondrites: tochilinite, and regularly mixed layer minerals of tochilinite and serpentines, etc., were found for these unheated or very weakly metamorphosed CM2 specimens.

In Y-793595 and A-881458 which may have experienced very weakly metamorphism, characteristic streaks with 14-Å diffraction maxima from patchy structures were associated with main 7-Å spots. (Fig.1a,b) This may correspond to initial stage of decomposition of 7-Å serpentine structure. Summarizing these data, the decompositional sequence (stages) of serpentine minerals during thermal metamorphism were estimated: Ordered 7-Å serpentine → patchy textures with broad 14-Å diffraction spots → decomposed intermediate transitional structure with halo diffraction → domain formation of olivine structure with broad olivine diffraction spots → ordered olivine structure (with or without void structures [16]). Sometimes two or more stages are contained in the same grains. These mineralogical processes can be schematically summarized (Fig. 2).
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Fig. 2. Schematic transformation process of serpentine during thermal metamorphism.