

## The differences among C03 chondrites from the X-ray diffraction

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### 1. Introduction

The X-ray diffraction method is one of a powerful tool for studying the subtle differences of thermal metamorphism and initial condition of unequalibrated chondrites. The X-ray gives the global feature of constituent mineral phases including submicron-sized matrices. The petrologic type of the C0 chemical group, constituting a group of carbonaceous chondrites, is three, which is subdivided into 3.0-3.9. In the present study, the X-ray powder diffraction patterns were obtained from the polished thin sections of the C03 chondrites, and new insights were obtained on the differences among the subtypes.

### 2. Experiments

The X-ray diffractometer, SmarLab (RIGAKU), at National Institute of Polar Research installed in 1994 was used for the present study. The sample stage of the automatically sample change (ASC10) was used for the sample holder of the polished thin sections (PTSs), Y-81020 C03.0, Colony C03.0, Y-791717 C03.3, Lance C03.5, ALH-77003 C03.6, Isna C03.8, A-882094, and Y983589. The X-ray was generated from the Cu target and K beta was removed using the Ni filter. Tube voltage and tube current were 40 kV and 30 mA, respectively. The scan speed of the solid-state detector (D/tex Ultra 250) was 0.4degree/min. The width of the incident X-ray was 10 mm. The PTS was rotated within the plane during the measurements at 100 rpm. It was confirmed that the method gives the consistent diffraction pattern with the powder X-ray diffraction method (Imae, 2015). The half width and intensity of the diffraction was analyzed using the program by the software Visual Basic 6.0 runtime.

### 3. Results and discussion

The diffraction of olivine (130) is doublet when the subtype is less than 3.5, corresponding to ferroan olivines in matrices (Fa~35-45) at lower diffraction angle and magnesian olivines in the type I chondrules at higher diffraction angle. It is single when the subtype is more than 3.6. In more detail (Fig. 1), the half width increases and the peak position shifts lower (to ferroan) at higher diffraction angle when the subtype changes from 3.0 to 3.5, but the peak vanishes more than the subtype of 3.6. On the other hand, the half width decreases and the peak intensity increases at lower diffraction angle when the subtype changes from 3.0 to 3.8. The series of sensitive change occurs during the weak thermal metamorphism accompanying the Mg-Fe diffusion in olivines and bulk sample.

The (22-1) of clinoenstatite was detected irrespective of the subtype, and the (321) of orthoenstatite was also identified irrespective of the subtype (Fig. 2). It is considered that the orthoenstatite in lower petrologic subtype is high temperature type formed during the chondrule formation although that in higher subtype may be low temperature type formed during the thermal metamorphism on the C0 parent body. The unique occurrence of the orthoenstatite phases would suggest that the thermal history during the chondrule formation is different from that for the ordinary chondrites. The result is consistent with that by Imae et al. (2013) based on the EPMA.

### 4. Acknowledgment

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### 5. References

Imae N. et al. (2013) *Geochim. et Cosmochim. Acta* 100, 116-157.

Imae N. (2015) NIPR Symposium on Antarctic Meteorites.

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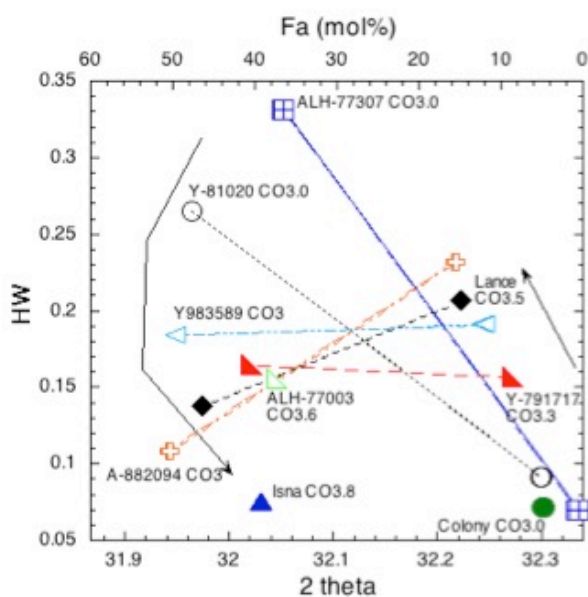


Fig. 1. The relationship between olivine (130) and half width of the diffraction for various subtypes of the CO3 chondrites.

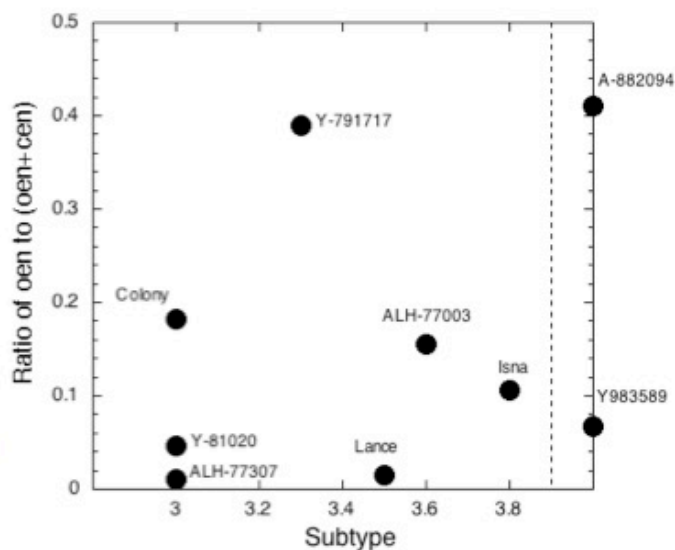


Fig. 2. The ratios of orthoenstatite (oen) to two phases of enstatites (opx+cpx) for various subtypes of the CO3 chondrites. Cen=clinoenstatite.