Application of an X-ray diffraction method to polished thin section of CO3 chondrites: Mineralogy and thermal history

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Introduction
The X-ray diffraction method is useful for the characterization of stony meteorites, which is independent of the characterization determined by the combination of the observation under an optical microscope and variations of Fa# and Fs# by EPMA. This method enables to obtain the quantitative data as well as to obtain the consistent result with the canonical method. In the present study, CO3 chondrites were examined on mineralogy and the thermal history, using the method.
Studying method
The X-ray diffractometor, SmartLab (RIGAKU), was used for the study. The incident X-ray, CuKa generated from with tube voltage 40 kV and tube current 30 mA, irradiated to the rotating polished thin section in plane through the slit of 10mm square. Ten CO3 chondrites were used, which are shown in the following with the subtype: ALH77307 3.03, Y81020 3.05, Colony 3.0, A881632 3.1, Y983589 3.4, Lance 3.5, A882094 3.5, Y791717 3.5, ALH77003 3.6, and Isna 3.8.
Results and Discussion
The olivine (130) peak is single more than 3.8 subtype, but is splitted less than 3.6, corresponding to ferroan olivine in matrices at lower 2 theta and magnesian olivine in chondrules at higher 2 theta. The subtype clearly correlates with the full width of half maximum of the peak(s). It also correlates with the integrated intensity ratio of the splitted peak, but the subtype 3.0 has exceptionally high Mg/Fe, consistent with the report of amorphous Fe-silicates in matrices in 3.0 (Howard et al., 2014; Bonato et al., 2016). The relative intensity ratio (I_{Mg}/I_{Fe}) except 3.0 can connect with volume ratio (V_{Mg}/V_{Fe}) using the olivine grain size (50 μm in diameter) and ferroan olivine growth with thickness, d, where d implies the mean diffusion length due to the Fe-Mg volume diffusion in olivine during the cooling on the parent body. Also considering the inhibited Mg-Fe diffusion of clinoenstatite, the peak temperature in the parent body is obtained to be 620-900K, which is consistent with the estimation by Schwinger et al. (2016). In addition, the modal abundance for the amorphous Fe-silicate of CO3.0 is estimated to be 11-22%, nearly consistent with those of Bonato et al. (2016) and Howard et al. (2014).
References
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