

Petrography, H₂O contents and hydrogen isotopic composition of phosphate minerals from LL5-6 ordinary chondrites

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Ordinary chondrites of petrologic types 4 to 6 exhibit a sequence of progressive chemical and textural equilibration, and contain Cl-rich apatite grains (e.g., Jones et al., 2011).

Previous study reported that the water contents of chlorapatite are very low (<100ppm), even though apatite grains in ordinary chondrites seem to have a significant H₂O contents based on a deficit of anions (Jones et al., 2011). As results, they suggest that apatite grains were formed with a dry and halogen-bearing fluid that has been derived by degassing of chondritic melts.

In the preliminary study, we reported the petrography, H₂O contents and hydrogen isotopic compositions in chlorapatite from Mocs L5-6 and Ensisheim LL6 ordinary chondrites using secondary ion mass spectrometry (SIMS). The H₂O contents of apatite grains in Ensisheim (LL6) and Mocs (L5-6) are estimated to be ~60 ppm and ~35 ppm, respectively. These H₂O contents are similar to the previous reported values from LL chondrites (Jones et al., 2011). The hydrogen isotopic compositions of apatite grains from Ensisheim are extremely D-rich (dD= ~ +17000 permil). Remarkably, we found the reaction texture between apatite grain and olivine grain from Ensisheim LL6 chondrite, which reported that of texture from St. Severine LL6 chondrite (Jones et al., 2011). However, the origin of extremely D enrichment of those of Ensisheim LL6 is unclear whether this is resulting from LL6 general characteristics of thermal process of parent body or from unique results of late reaction by fluids only for Ensisheim LL6 chondrite, because of limited study of preliminary examination.

In this study, we will report the petrography of phosphate minerals with other thin sections, LL5-6 (Ensisheim LL6 and Tuxtuac LL5) to compare it with those of Ensisheim LL6 chondrite. Thin section (Tuxtuac) loaned from Natural History Museum, London (NHM) were used in this study. Phosphate grains were identified using elemental X-ray mapping using scanning electron microscope (FE-SEM JEOL JSM 7000-F) and energy dispersive X-ray spectrometry (EDS Oxford INCA Energy) at Hokkaido University.

Phosphate minerals (merrillite and apatite) from Tuxtuac show the reaction texture at the boundary of olivine and phosphate minerals. However, the chemical compositions (P, Cl and Ca) of olivine grain are homogeneously distributed using 5kV, even if those of distribution are enriched in the rim of olivine grain with 15kV X-ray mapping. This suggests that the reaction texture with BSE image might be resulting from the effect of edge crystal. On the other hand, the Cl-zonation in the reaction texture between olivine and apatite from Ensisheim LL6 chondrite with D-enrichment signature are identified with 5KV X-ray mapping.

In the future, we will further examine the petrography of phosphate minerals from other LL4-6 chondrites has already been loaned thin sections from NHM and compare with the petrography, hydrogen isotopic compositions of phosphate minerals to give an constraint for the origin of D-enrichment of phosphate minerals in the Ensisheim LL6 chondrite.

Keywords: apatite, Hydrogen isotope, LL ordinary chondrite, phosphate mineral