Origin of extremely deuterium-rich isotopic compositions of phosphates from LL4-6 ordinary chondrites

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The origin of water in the Earth and asteroids in the Earth's orbit have been recently discussed with chondrites, comets, Kuiper-belt objects and interstellar organic matter (e.g., [1–3]). One of significant possible precursor of H_20 ice in Earth's orbit have been predicted as the delivery from cometary ice and from outside the orbit of Jupiter with the hydrogen isotopic compositions of apatites, fluid inclusions and phyllosilicates in ordinary chondrites (OCs) [1,3-5].

In this study, we applied in-situ measurement technique [2] of water content and hydrogen isotopic compositions of phosphate minerals from LL4-6 OCs by 1270 SIMS [6]. All D/H ratios in the phosphate minerals are D-rich (δD ~ +2000 to +25000). In contrast, water contents of these phosphate shows the range of 10-100ppm and that of LL6 is the highest water content and D-rich isotopic compositions (δD ~ +10000 to +25000). This signature suggests that the Rayleigh fractionation in H_2O during thermal metamorphism in the parent body is not much significant of D-enrichment in phosphates because apatite in LL6 shows the maximum H_2O even in highest temperature metamorphism but the origin of D-rich hydrogen isotopic compositions of LL6 phosphates is resulting from diffusion among phosphates and D-rich water or interstellar organic matter during thermal metamorphism. In this talk, the diffusion sources of H_2O or H_2 to the apatite during thermal metamorphism are discussed with H-diffusivity in apatite [7-8] and the possibilities for the origin of D-rich signature are discussed with fractionated residual water or cometary ice.

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