HYDROGEN ISOTOPIC COMPOSITION OF WATER IN CM- AND CV-TYPE CARBONACEOUS CHONDRITES

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Introduction: Among primitive meteorites, carbonaceous chondrites contain the largest quantity of water and organic matter (OM). Based on their bulk hydrogen isotopic composition, carbonaceous chondrites are good candidates for the delivery of water and molecular origin of life to Earth [1]. Nevertheless, the exact composition of the hydrogen isotopes for water in the different groups of carbonaceous chondrites is not well known and the distribution of water in the protoplanetary disk at the time of planetary body formation needs more constraints.

Water isotopic composition in chondrites is usually approximated by the bulk D/H composition or estimated by mass balance calculations in order to remove the contribution of the organic components (e.g. [2]). However, OM in chondrites is both complex and incompletely known. OM concentration and D/H composition are generally measured after solvent extraction (soluble OM; [3]) or chemical isolation from the rock minerals (insoluble OM; [4]), but about half of the total OM is not accessible with these techniques (e.g. [5]). In this study, we are using a recently developed protocol by secondary ion mass spectrometry (SIMS) [6] to estimate the hydrogen isotope composition of water retained in the hydrated minerals of different groups and types of carbonaceous chondrites.

Methods: We are performing *in situ* hydrogen isotope analyses at a micrometer scale by SIMS (IMS-1280HR at Hokkaido University and at CRPG) to investigate the distribution of water-bearing minerals and deciphering it from the contribution of OM in carbonaceous chondrites. Sub-millimeter pieces of carbonaceous chondrites are pressed in indium mounts and gold-coated for secondary electron microscope observations and SIMS measurements. Carbonaceous chondrites (CM, CV and CI) with different degrees of parent body alteration were selected for investigating both the parent body evolution of H-bearing phases and their primordial isotopic compositions. The simultaneous analyses of the D/H and C/H ratios in the matrix of chondrites allows us to identify mixing lines between the D-rich (and C-rich) OM and the D-poor hydrated minerals. Using the zero intercepts (C/H = 0) of the mixing lines, we calculate the D/H ratio of hydrated mineral end-member [6]. We can thus obtain the hydrogen isotopic composition of water for individual carbonaceous chondrites.

Results and discussion: The isotope signature of the main water component in CM-type carbonaceous chondrites is D-poor (δD = -350 ± 40 ‰) [6]. This D-poor value indicates that water in CM chondrites is not inherited from the outer Solar System such as water in comets [1], but has been equilibrated with H_2 in the inner disk before CM parent body accretion. The constant D/H ratio for water in CM chondrites having different degrees of aqueous alteration (Murchison, Cold Bokkeveld or Sayama) shows that water D/H ratio does not evolve on the CM parent body. Among the six CM chondrites we studied, the Paris meteorite shows a significantly different D/H composition (δD ≥ -69 ± 163‰)[6]. This meteorite is the CM-type carbonaceous chondrite that contains the smallest amount of water and hydrated minerals, with areas that seem to have almost completely escaped hydrous alteration by melted ice [7-8]. In these areas, the D/H ratio of the hydrated minerals is higher than that measured in all the other CM chondrites or in the more altered parts of Paris itself. It might represent the D/H ratio of hydrated phases present in the CM protolith before parent body alteration [6]. Water in the studied CV-type carbonaceous chondrites (CV_{oxB} Kaba, Bali, Grosnaja) shows less depletion in deuterium (δD ≈ -75 ‰) than CM chondrite water. CV chondrites might have partially accreted D-rich water ice grains from the outer Solar System, consistently with their water oxygen isotopic composition [9]. The H and O isotopic features of water in CV chondrites may be related to their older accretion relative to other hydrated carbonaceous chondrites [9].

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