

Isotopic measurement of gas hydrate sample simulating environment of icy satellite and icy planet: Equipment development and consideration for observation method

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According to recently observation using Cassini, icy satellites and icy planets are known for having plume including the organic matter, liquid internal ocean and rocky crust (e.g. Porco et al. 2006; Waite et al. 2006, 2009, 2017). From this fact, extraterrestrial life is regarded as being likely to exist in icy satellites and icy planets. Especially in plume gas species, methane (CH₄) is regarded as one of the candidate of signature of biological activity due to CH₄ formation reaction by methanogen. However CH₄ gas in plume is consisted of not only microbial origin but also primitive CH₄ and hydrothermal formation and this fact does not let CH₄ detection is sufficient for conclusion for existence of biological activity by microbe. Therefore, we consider evaluation of the elementary process of CH₄ isotopic fractionation ($\delta^{13}\text{C}$, δD of CH₄) via room experiment important for isotopic observation of icy satellite and icy planet in nearly future.

In this study, we focus on CH₄ hydrate which is reservoir to produce the plume (Kieffer et al. 2006) and want to evaluate isotopic fractionation with its formation. Isotopic fractionation with hydrate formation has been found at only δD of CH₄ (~10‰) at the Earth condition (P: ~10 MPa) (e.g. Hachikubo et al. 2007, 2015; Lapham et al. 2012). In the case of condition of icy satellite and icy planet, pressure range of icy satellite and icy planet is wider than of the Earth, and therefore we need to estimate isotopic fractionation at 10–100 MPa scale. Thus we started design for cell for hydrate formation experiment at ice crust condition (P: ~150 MPa). In presentation, we will mainly introduce progress of the equipment development and observation method.

As next stage, we are also planning analyze isotopic fractionation of surface rocky core, and CH₄ translation process using 3-D flow simulation for evaluate CH₄ isotope changing in icy satellite and icy planet. We will subject to Enceladus, Europe and Triton as target.

Keywords: isotopic observation, isotopic fractionation, methane, icy satellite and icy planet, gas hydrate