A estimation of methane released to the atmosphere from methane hydrate in PETM

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Isotopic records across the 'Paleocene-Eocene thermal maximum' (PETM) indicate that Earth's surface tempratures soared by more than 4 degree during a brief time interval (within 10^4 years), about 55 million years ago. There also was a coeval -2.5 permil excursion in ^{13}C of the ocean-atmosphere carbon reservoir. It has been hypothesized that this excursion signifies transfer of 1500 to 3000 gigatonnes of carbon from oceanic hydrates to the ocean-atmosphere carbon reservoir. However, the global warming caused by methane hydrate has been hardly quantitatively researched. This study simulate global warming by methane hydrate using the numerical model.

Global warming by the methane hydrate release is greatly different whether methane is dissolved in the ocean or reached the atmosphere. We estimated the ratio of the methane released to the atmosphere to total methane hydrate collapse

considering the behavior of the bubble of the methane in seawater using the numerical model. The model consists two parts: (1) the development of the methane bubble released from the seafloor: (2) methane concentration in the seawater. We estimated the ratio of methane released to the atmosphere to methane flux from the seafloor.

We estimated methane bubble and methane concentration in water

column. It assumed standerd flux ($2.5 * 10^{-5}$mol/cm^{2}s) is given from 1000m in the seafloor and the seawater rest. We found that the methane begins to reach the atomosphere and 100% of methane reaches the atomosphere 250 days after given flux from the seafloor. Considering the oxidation in the seawater, methane begins to reach the atomosphere and 60% of methane reaches the atomosphere 300 days after given flux from the seafloor.

We applied the model to the Norwegian Sea which is a candidate of methane hydrate collapsed in PETM. We assumed that(1) the methane flux

from the seafloor is uniform in this area, (2) the speed of the current is vertically uniform, and (3) an orthogonal direction to the current is infinity. We estimated the methane concentration of the seawater in this area when the water column is advected with the current. We found that about 20% of methane from the methane hydrate reaches the atomosphere assuming the depth of water is 1000m and that the speed of current is 2cm/s and 1500GtC of methane hydrate collapse within 10yr. We found that the

methane does not reach the atomosphere when collapsing period is longer than 25yr.