Modeling of methane bubbles released from seafloor gas hydrate

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Massive methane release due to decomposition of methane hydrate in the sea-floor sediments is a potential cause of global warming. However, the degree of global warming has not been estimated due to uncertainty over the proportion of methane flux from the sea-floor to reach the atmosphere. Massive methane release would result in methane-saturated seawater, thus some methane would reach the atmosphere. In this study, we discussed the possibility of the methane release to the atmosphere focusing on methane saturation in the water column required for methane bubble to reach the atmosphere.

We calculated the ratio of methane released into the atmosphere to methane input from the sea-floor and the methane saturation in the water column, using a one dimensional numerical model integrated over time predicting methane bubbles and methane concentration in the water column under the condition of continuous methane input from the sea-floor to the water column. We found that some methane bubbles reach the atmosphere even when the methane saturation fraction in the water column is much lower than 100%. We compared the amount of methane input from the sea-floor necessary for methane bubble to reach the atmosphere to the amount of methane in the sediment in the form of methane hydrate and free gas. In most cases, our results suggest that the typical amount of methane in the sediment is significantly lower than the required minimum amount of methane input. It is, therefore, suggested that the massive quantity of methane bubbles released from the sea-floor would not reach the atmosphere directly but would be dissolved in the seawater.

The global warming suggested at the Paleocene/Eocene Thermal Maximum (PETM) at 55 Ma which is considered to be caused by massive methane release should have been caused by the decomposition of methane hydrate in the sediments having an unusually large hydrate fraction. With regard to global warming due to human activities, the release of methane bubbles due to methane hydrate decomposition may not be significant enough to accelerate total global warming.