

Numerical simulation of methane hydrate dissociation in response to pressure decrease by periodic uplift

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Several theoretical studies have investigated characteristics of dissociation of MH in marine sedimentary environment by increase of bottom-water. In the present study, we present a numerical model of dissociation of pore-space MH in sandy sediment in response to periodic events of rapid pressure decrease. This model is based on one-dimensional heat conduction equation of uniform physical properties and takes into account the latent heat of formation and dissociation of MH. The pressure in sediment is assumed as hydrostatic. The upper boundary as seafloor is set to a constant temperature. A constant heat flow is supplied in the lower boundary. This model also assumes for the sediment with pore-space MH that when pressure changes from MH stability to gas+water, temperature of the sediment decreases to the temperature of hydrate stability boundary at the decreased pressure by endothermic dissociation of MH. We apply the numerical model to investigate characteristics of dissociation of MH and the effects of the dissociation of MH on the subbottom thermal regime in response to pressure decrease by periodic uplift that occurs every 100 years. For the numerical computation, different values of initial water depth, saturation of MH, displacement of uplift and thickness of pore-space MH layer in sediment are assigned to investigate how these parameters contribute to the dissociation of MH in response to the periodic uplift. Dissociation of MH progresses as follows: In the sediment where the phase change occurs from hydrate to gas+water by uplifting of the formation, endothermic dissociation of MH makes temperature of the sediment decrease to the temperature of hydrate stability boundary at that depth. This endothermic dissociation of MH produces small negative thermal disturbance in the thermal structure at the depth. Then temperature in sediment changes to heal the thermal disturbance. During this process, dissociation of MH progresses at the base of gas hydrate stability (BGHS) at the depth until the next occurrence of uplift. The endothermic dissociation of MH at BGHS decreases temperature of sediment around there. This acts as self-cooling of the sediment and results in slow dissociation of MH. Dissociation of MH becomes faster for the model of shallower initial water depth, larger displacement, or low MH saturation. On the other hand, thickness of pore-space MH sediment layer only controls completion time of dissociation of MH. This study is supported by MH21, Research consortium for methane hydrate resource in Japan.

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