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南海沈み込み帯におけるメタンハイドレートBSRの分布と浅部温度構造
Distribution of methane hydrate BSRs and shallow thermal structure in the Nankai subduction zone

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Thermal structure in subduction zones influences pore pressure and diagenesis such as consolidation, dewatering, cementation, and constrains physical propertiies of fault-slip plane. Methane hydrate is a clathrate that consists of water and methane. Recently, it attracts attentions not only for marine resources but also for estimates of thermal information below the seafloor using the characteristics of its stabilization under low-temperature and high-pressure conditions. Precise two-dimensional thermal structure ranging from the seafloor to BSR depths is calculated taking topographic effect into account, because subsurface heat flow is affected by bathymetry features.

Geothermal gradients in rougher topography tend to be widely different from that in flat seabeds. To remove this effect, I evaluated the effect by conducting the simple two-dimensional thermal calculation of Blackwell et al. (1980). Additionally, I calculate the Base of Gas Hydrate Stability zone (BGHS) taking into consideration the thermal structure coupled with the topographic effect.

A deepening trend of BSR depths landward of trough floor is confirmed as suggested in previous studies. This observation yields countertrend because the BSR depth should be deepest in the trough floor as methane hydrate is stable under low-temperature and high-pressure conditions. Thus, observed BSR depths suggest that heat flow actually decreases landward of the trough floor.

The investigated BSR depths are constrained from deep heat flux, and vary basically landward of the trough floor. But, in this study, BSR depths are deeper around anticline parts and shallower around sycline. Theoretically, the convex-upward seabed is subject to cooling owing to cold bottom seawater, while the convex-downward one is less subject to the cooling. Evaluations of this kind of topographic effect suggest that sycline can be explained by only the topographic effect. Thus, thermal regime calculated from BSR depths does not change in sycline or slope areas.

In this study, the BSR was confirmed for the first time at the prism toe. The detailed BSR distribution map can contribute to disaster prevention because BSRs have potential to being fault-slip planes. In the Nankai area, geothermal gradient values scatter, but the values can be explained by considering subducting plate age, topographic effect, and sedimentation or erosion. In addition, while distances from seafloor to BSR depths are different even under the same water pressure, the calculation taking topographic effect into account revealed to be able to explain these depth changes. Moreover, the calculated thermal structure over BSR depths considering topographic effect seems to be accurate, because estimated BGHS depths and BSR depths fit well together. Understanding precise BSR depths enables to precisely estimate deposited amount of methane hydrate. This study provides thermal information essential for seismic simulations in subduction zones and for laboratory experiments as analogues to seismic ruptures in plate boundary faults.

Keywords: Nankai sucduction zone, methane hydrate BSRs, shallow thermal structure