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Estimation of heat flow from bottom-simulating reflectors and significance of topographic effects in the Nankai subduction zone

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Bottom-simulating reflectors (BSRs) indicating the lower boundaries of methane hydrate stability zone, which are confirmed from seismic reflection profiles with high-amplitude and reverse-polarity waveforms paralleling the seafloor, are present from the prism slope to forearc basins in the Nankai subduction zone. The depth of methane hydrate BSRs is controlled by subseafloor temperatures and pressures, and thus provides subseafloor geothermal information over a wide area effectively without probe penetration or in-situ borehole temperature measurement. Although the presence of BSRs in the Nankai Trough is well investigated, distribution of BSRs in the whole Nankai Trough area has not been compiled. In this study, we mapped the distribution of BSRs in the Nankai subduction zone from offshore Tokai to Hyuga using 140 seismic reflection profiles obtained by R/V Kairei, Kaiyo, and Polar Princess, to understand variations in BSR depths below the seafloor and heat flow values derived from BSR depths. BSR depths increase landward from the trench, while heat flow values decrease landward from the trench. In general, BSR depths are 350–450 meter below seafloor (mbsf), and heat flow values are 40–50 mW/m2. BSR depths, however, can occasionally display a considerable difference in depth, reaching shallow depths of 200 mbsf or as deep as 700 mbsf. A large difference can also be identified from the heat flow values that range at 25 or 110 mW/m2 off Hyuga and Shikoku. The highest heat flow 110 mW/m2 off Shikoku is thought to be caused by advective fluid flow because of dipping sedimentary layers and flat seafloor. The dipping sedimentary layers, which could be confirmed from seismic reflection profile, would play a role as fluid flow path. Other high heat flow 97 mW/m2 obtained off Kii Peninsula is thought to be caused by topographic effect. This high heat flow value is estimated to be 61 mW/m2 after topographic correction, and this is not an anomalously high value. On the other hand, the lowest value of 25 mW/m2 off Hyuga is estimated to be 30 mW/m2 after topographic correction. This value is not anomalously low considering relatively old plate age in the Nankai subduction zone. Almost all the regional high or low heat flow values (i.e. shallow or deep BSR depths) could be explained by advection and topographic effect in this study.