Total energy of deep low-frequency tremor in the Nankai subduction zone

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Deep low-frequency tremor was first discovered in the Nankai subduction zone of southwest Japan, and is now known to occur in other subduction zones along the Pacific Rim. Because tremor usually occurs simultaneously with short-term slow slip events spatially and temporally, clarifying tremor activity is considered to be an important role to understand the slip process on the megathrust plate interface.

In this study, we estimated the total seismic energy of deep low-frequency tremor in the Nankai subduction zone, southwest Japan, over an 11-year period from 2004 to 2015. For precise estimation of the energy, continuous time sequences of tremor activity were carefully detected using a new procedure designed to minimize false-negative detections. By the result of spatial distribution of accumulated total energy of tremor, we found high-energy area in the western Shikoku region. Tremor activity rate, defined as the yearly average of total tremor energy per unit square, was investigated in each area throughout the Nankai subduction zone. Tremor activity rate averaged in 11 years is very high in near Bungo channel region compared to other regions. In the Bungo channel, the long-term SSE is known to occur at every six or seven years and activate nearby tremor activity. During the analyzing period, the long-term SSE occurred in 2010 and 2014. The tremor activity rate in this region in these two years increases to at least two or three times higher than that of quiescent period without the occurrence of long-term SSEs. This may indicate that external stress perturbations from the source of long-term SSEs in the Bungo Channel increased tremor activity by a factor of two to three. Slip on the plate interface in the tremor source region may be accelerated by nearby long-term SSEs. The relationship between tremor activity and nearby long-term SSEs in the Bungo Channel is consistent with the characteristics of tremor energy. We also note that tremor activity rate in this region is higher than that of other region even in the quiescent period.

In general, the tremor activity rate is high and low in areas west and east of the Kii Channel, where the plate geometry is complicated, respectively. In this comparison, tremor activity rate during quiescent period is used for Bungo channel region. The plate convergence rate shows the same spatial pattern as that for tremor activity. We infer that tremor activity is influenced by accumulated strain due to plate convergence. Strain at the plate boundary may be well accumulated where the plate convergence rate is high; tremor activity begins as a result of accumulated strain. In some areas in eastern Shikoku, the tremor activity rate is extremely low, although the plate convergence rate is relatively high. This may occur because the dip and convergence directions differ. Another possibility is that heterogeneous structures reduce the coupling between subduction rate and strain accumulation. Further investigation of this region is needed to constrain the tremor source mechanism.

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