Slip tendency maps for compressional and extensional stress states on a shallow decollement in Nankai Trough

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Stress state along a subduction plate interface is one of important controls for wedge architectures, fault activations and seismogenic behaviors. In a shallow portion of a subduction plate interface, a large displacement along decollement could be expected for tsunamigenic events (Fujiwara et al., 2012) as well as slow earthquakes such as very low frequency earthquakes and slow slips have been observed (Araki et al., 2017, Nakano et al., 2018). Paleo-stress state has been estimated using micro-fault inversion method from exhumed accretionary complexes and oceanic accretionary wedges, which shows the stress state changes between compression and extension states with almost horizontal and vertical principal stress axes. The stress change could be related to seismic cycle.

In this study, we examined geographical features of a shallow decollement using 3D seismic profiles and mapped slip tendencies on the decollement with compressional and extensional stress state to discuss an effect of distribution of slip tendency on the fault slip behaviors. Slip tendency is a shear stress ratio to normal stress on a fault surface when a regional stress state is applied on a fault surface.

The target transect of the 3D seismic profiles is located at the Nankai Trough off Kii Peninsula, SW Japan where Philippine Sea Plate subducted into Eurasian Plate, and IODP NantroSEIZE project has been operated. The 3D seismic profiles had been reprocessed to make reflectors clear using an updated technology. We traced the shallow decollement to make geographic features (3D surface) by Petrel. We analyzed dip angle and dip azimuth for 50 m mesh of the surface. The characteristics of geographic features of the shallow decollement are 1) almost horizontal with dip angle ranging 5-15, 2) dip azimuth directing 300-350˚ (NW-NWN) in average. In addition, some narrow zones with dip azimuth directing 50-150˚ (SE-SES) are identified, which shows a relatively high frequency reliefs striking NE-SW direction. Some of these are related to the geography of oceanic basement.

Compressional and extensional stress states were applied on the surface to examine a change in slip tendency with change in stress state. We assumed that compressional one has (150, 0) sigma 1 and (90, 90) sigma 3 and others has (150, 0) sigma 3 and (90, 90) sigma 1. The 0.6 of friction coefficient was assumed as the maximum value. We calculated differential stresses for compressional and extensional stress states to make a plane with idealized attitude to applied stress state reactivated. This assumption implies that the estimated slip tendency is the maximum value.

Resulted slip tendency represents a strong relationship with geomorphic features. In compressional stress state, large slip tendency (0.4-0.5) distributes on the surface with dip azimuth directing 300-350˚ whereas small slip tendency (0.1-0.2) corresponds to the surface with dip azimuth directing 50-150˚. In extensional stress state, the similar distribution with that in compressional stress state is identified but the

difference between the dip azimuths is very small; slip tendency ranges 0.1-0.2. The differences between slip tendencies in compressional and extensional stress states is almost similar to that for compressional stress state because slip tendency for extensional stress state is almost 0.1-0.2.

If we take the difference in slip tendency as a kind of stress drop, relatively small stress drop are observed on the surface with dip azimuth directing 50-150˚, which is distributed in NE-SW zones. Nakano et al. (2018) found that VLFs in the region migrates toward NE, which is consistent with the directions of zones with stress drop is small. The area for VLFEs could be limited in these zones where the slip tendency is small both in compressional and extensional stress states, implying that the material with very low friction coefficient and/or high pore fluid pressure are expected to make a plane reactivated with small slip tendency.

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