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Geometrical dependence of the stress and slip tendency acting on the subduction megathrust of Nankai seismogenic zone off Kumano

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Slip tendency of a pre-existing fault, a measure for its closeness to failure, is governed not only by the regional stress and fault strength, but by its geometry (dip/strike) and overburden as well. We attempt to estimate the slip tendency near the updip edge of Nankai seismogenic zone megathrust, from the reprocessed 3D PSDM seismic volume with an improved velocity model and from International Ocean Discovery Program (IODP) NanTroSEIZE drilling data off the coast of Kii Peninsula, central Japan.
Plate boundary fault surface is manually picked from 3D seismic volume. The fault surface, with its depth ranging 3500 to 6500 m below sea floor, is divided into 3 groups; low dip (10-15º) trending NW∼N on the NE portion, intermediate dip (∼25º) trending north on the western portion, and high dip (30-40º) trending NW on the SE portion. We then calculate the overburden (Sv) by converting 3D velocity to bulk density. Sv ranges from 100 MPa near SW edge to 160 MPa on the NE corner. High Vp anomaly above the fault in the NE portion can increase Sv by ∼2 MPa. To derive horizontal principal stresses (SH and Sh) and pore fluid pressure (Pp), we assign a ratio of horizontal to vertical principal stress, r (=SH/Sv) and a ratio of pore fluid pressure to vertical stress, λ (=Pp/Sv) from IODP drilling data. The direction of SH and slip on the fault are set parallel to the plate convergence vector (N55W). Assuming a triaxial condition (SH>Sh=Sv), slip tendency (Ts) can be calculated from the dip angle and dip azimuth of the fault surface, r and λ. Ts is low (∼0.1) in low-angle dip region, whereas it is high (>0.2) in high-angle dip region. Ts in the latter region roughly coincides with its maximum, suggesting that the high-angle fault is optimally oriented under this condition. Low Ts in the low-angle dip region would correspond to a weaker portion due to excess pore fluid pressure, assuming that the fault surface should slip simultaneously. Using the pore pressure ratio (λ*∼0.85) beneath the fault zone estimated by Tsuji et al. (2014), the fault beneath IODP site C0002 is very close to failure, if r>1.2.
Drilling into the fault zone at Site C0002 will provide a ground-truth evidence on the stress and strength at the fault, which can in turn be extrapolated to the 3D fault zone and we can make an important step toward a better understanding of the slip likelihood of the Nankai seismogenic zone megathrust.