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Interseismic stress accumulation at the locked zone of Nankai Trough seismogenic fault off Kii Peninsula

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Since 2007, we accomplished drilling, coring and downhole measurements at 13 sites across the Nankai accretionary complex off Kii peninsula using D/V Chikyu. Although the deepest hole is well above the seismogenic fault zone, we found that the stress regime is quite variable across the accretionary prism, and their mechanism is still in discussion.

An important source for such stress variation is the tectonic loading. In order to assess how much stress can possibly be accumulated around the locked zone during one seismic cycle, we conducted a simple 2D plain-strain steady-state elastic model using the finite-element method.

We fixed the geometry of plate interface and prohibited a horizontal displacement at one side (above the plate interface) 200km landward from the trench. Along the plate interface except the locked zone, we allowed free slip only along the fault. The locked zone is defined at 30-100 km landward of the trench, and is assumed as 100% locked (no differential movement). The movement of downgoing lithosphere is given at the landward side boundary 200 km landward of the trench. Since we deal with the total stress accumulation within one seismic cycle, a displacement of 5 m was given as a slab pull. Young modulus in the Kumano forearc basin (1 km thick) is set as 4 GPa taken from sonic log data at Site C0009, whereas that in the underlying domain is set at 50 GPa which would be too high for the accretionary sediment. In that case, estimated stress would be lower than provided below.

Most of the tectonic stress due to 5m of plate convergence is concentrated near the downdip edge of the locked zone. The principal compressional and shear stress on the fault is larger than 5 MPa and 2 MPa, respectively. They roughly agree with the stress drop during the M8 events.

These stresses along the fault, however, gradually decrease seaward to zero level. Tectonic compressional stress near the updip edge is much smaller than near downdip. At Site C0002, it is almost uniform at 0.3-0.5 MPa in the accretionary sediment below the Kumano Basin. In the Kumano basin, the stress further decreases by one order of magnitude.

Since we neglect gravity load, isostatic rebound and horizontal resistance, we cannot estimate the absolute stress level. Thus the results here cannot be compared to the observed downhole stress data, which implies strike-slip regime in the accretionary prism at Site C0002. Still, as mentioned by Wang and He (1999), the fault stress will not deviate too much from its average value. Our results confirm their implication. Furthermore, the small tectonic loading stress suggests that in the shallow part the orientation of principle stress can easily be rotated by near-surface phenomena such as stretching of sediment caused by thrusting of mega splay fault.

Keywords: NanTroSEIZE, stress, locked zone, Young’s Modulus, Poisson’s ratio