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Estimation of effective pressure in Nankai accretionary margin using physical properties of sediments

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Effective pressure within accretionary wedge and along decollement in subduction zone affects both on strength of sediments in wedges and friction strength along decollement or mega-splay faults. Those strengths control widely wedge architecture, stress state, and seismic behavior. Therefore, estimation of effective pressure is critical to understand wedge state and seismicity in subduction zone.

In this study, we estimate effective pressure along decollement from shallow to deep up to shallow seismogenic zone, and also along mega-splay fault in Nankai trough combining physical properties of sediments with information from seismic profiles in Nankai Troguh.

For shallow decollement, from deformation front to ˜25 km landward, we followed Tobin and Saffer (2009) to estimate effective pressure. They used velocity-porosity relationship obtained from sediments only in the toe and reference sites. Porosity was converted from velocity along decollement obtained by seismic data in Nankai Trough. The porosity was converted to effective pressure based on porosity-effective pressure relationship at reference site. We have newly made porosity-velocity relationship with additional data from rocks in Shiamnto Belt to cover wider range of porosity. The estimated effective pressure based on the newly modified porosity-velocity relationship represents less than 10 MPa, which is very consistent with the result of Tobin and Saffer (2009).

For deeper decollement, about 5 km depth, effective pressure was estimated using elastic properties of hanging-wall and footwall bounded by fossil seismogenic fault in Mugi melange, Shimanto Belt. The elastic properties were measured in laboratory under controlled effective pressure. Amplitude variations with offset (AVO) analysis were taken for the estimation. By comparison between AVO parameters from seismic data and the elastic properties, appropriate effective pressure was estimated as about 15MPa in hanging-wall and about 10 MPa in footwall.

Finally, for deep mega-splay fault, ˜8-10km deeper portion, effective pressure is also estimated by elastic properties of hanging-wall and footwall bounded by Nobeoka thrust, Shimanto Belt. AVO analysis was also conducted to compare AVO parameters from seismic data and the elastic properties. The estimated effective pressure is about 50 MPa in hanging-wall and 5MPa in footwall although the coincidence between AVO parameters was not so good. The bad coincidence is probably due to anisotropy of elastic property especially in hanging-wall. At least, the difference in effective pressure between hanging-wall and footwall is larger than other portions.

Distribution of effective pressure in subduction zone from shallow to deep was examined in this study. About 5-15 MPa of effective pressure are distributed along shallow to deep decollement up to shallower portion of seismogenic zone. 5MPa in footwall and about 50MPa in hanging-wall of effective pressure are obtained along deep mega-splay fault. This low effective pressure in footwall both in decollement and mega-splay fault lead to low friction along those faults. This estimation is for the modern state based on the seismic data.

Keywords: Nankai Trough, effective pressure, physical properties, velocity, porosity