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Pore pressure near the plate boundary decollement in the Nankai Trough, southwest Japan

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We predict pore pressure distribution within the Nankai Trough accretionary prism via a theoretical based approach. The decollement (a detachment that separates a deformed accretionary prism from the underthrust sediments) in the Nankai Trough off the Muroto peninsula is developed within a hemipelagic mudstone sequence and it is well defined by a prominent reverse polarity reflector on seismic profiles. From this polarity reversal, the decollement is inferred to be a low acoustic impedance zone. The low acoustic impedance at the decollement can be explained by high porosity sustained by pore fluid pressure. Because the pore pressure along the decollement influences the frictional characteristics, it plays a key role in the earthquake mechanism and deformation features of the accretionary prism. Many studies of pore pressure prediction from seismic reflection data rely on empirical relations. Here, we present a method for determining pore pressure based on rock physics theory from seismic interval velocities and well data. In our method, we introduce the aspect ratio distribution of pore space. From the aspect ratio distribution calibrated by well data, we calculate theoretical velocities parameterized by effective pressure via Differential Effective Medium (DEM) theory and compare them with seismic P wave velocity derived from 3D reflection tomography. By iteratively fitting the theoretical velocity to the seismic interval velocity, we estimate in situ effective pressure. The results demonstrate the abnormal high pore pressure within the subducting sedimentary sequence. This high pore fluid pressure can account for the weak coupling along the decollement and shallowly tapered geometry of the accretionary prism. The overpressure within the accreted section also increases from the deformation front. Seismic profiles image the tectonic thickening of the accretionary prism that has occurred following displacement along the frontal thrust. This increase of vertical load by the thickened prism and low permeable marine sediment may raise the pore fluid pressure within the accretionary prism. Furthermore, low permeable cap along the decollement may seal the pore pressure of the underthrust sequence, and cause pressure boundary at the decollement.