Overpressured underthrust sediment in the Nankai Trough forearc revealed by high-frequency receiver function inversion

*Takeshi Akuhara[1], Takeshi Tsuji[2], Takashi Tonegawa[3]

1. Earthquake Research Institute, The University of Tokyo, 2. Kyushu University, 3. Research and Development center for Earthquake and Tsunami, JAMSTEC

Active-source seismic surveys have resolved the fine-scale P-wave velocity (Vp) of the subsurface structure in subduction forearcs. In contrast, the S-wave velocity (Vs) structure is poorly resolved despite its usefulness in understanding rock properties (e.g., pore fluid pressure). Passive-source analyses are sensitive to Vs, but the low-spatial resolution hampers a direct comparison to the Vp model obtained by active-source surveys.

This study performs the receiver function inversion for stations from the seafloor cabled network (DONET1) deployed at the Kumano-nada in the central Nankai subduction zone. First, we calculate high-frequency receiver functions using the multichannel deconvolution method. Then, the resultant receiver functions are inverted for the one-dimensional seismic velocity structure beneath each station using a transdimensional Markov-chain Monte Carlo sampler. Since the receiver functions are less sensitive to the absolute values of Vs (but sensitive to Vs contrast), we employ the exiting Vs models from Rayleigh wave admittance as prior constraints.

The resulting high-resolution velocity structures show a thin (~1 km) low-velocity zone, or high Vp/Vs zone, beneath the outer ridge: It is located ~6 km below sea level and exhibits Vs ~1.2 km/s and Vp/Vs ~2.3. By comparing the results to the established Vp models based on active-source surveys, we conclude that this low-velocity zone reflects a high pore pressure zone within the underthrust sediment. We infer that this overpressured underthrust sediment hosts slow earthquake activities and that the accompanying strain release helps impede coseismic rupture propagation further updip.

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