High Fluid-Pressure Patches beneath the plate boundary fault: A Potential Source of Slow Earthquakes in the Nankai Trough off Cape Muroto

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Pore pressure plays a key role in the generation of earthquakes in subduction zones. However, quantitative constraints for its determination are quite limited. Here, we estimate the subsurface pore pressure by analyzing the transient upwelling flow of drilling mud from borehole C0023A of the International Ocean Discovery Program (IODP) Expedition 370, in the Nankai Trough off Cape Muroto. This upward flow provided the first direct evidence of an overpressured aquifer in the underthrust sediments off Cape Muroto (Figure). To estimate the pre-drilling pore pressure in the overpressured aquifer around a depth of 950–1050 meters below sea floor, we examined the measured porosities of core samples retrieved from nearby IODP wells; we then proceeded to explain the observed time evolution of the flow rate of the upwelling flow by modeling various sized aquifers through solving a radial diffusion equation. It was observed that for a permeability of 10^{-13} m^2, the aquifer possessed an initial excess pore pressure of ~5 to 10 MPa above the hydrostatic pressure, with a lateral dimension of several hundred meters and thickness of several tens of meters. The overpressure estimates from the porosity-depth profile at Site C0023 differ from those at other drill sites in the region, suggesting the possible existence of multiple overpressured aquifers with a patchy distribution in the underthrust sediments of the Nankai Trough. As pore pressure is relevant in maintaining fault stability, the overpressured aquifers may be the source of slow earthquakes that have been observed around the drilling site.

Keywords: Pore fluid pressure, the Nankai Trough, slow earthquake