Regional imaging of the Nankai subduction zone from decades' worth of active and passive seismic data.

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Subduction zones are the sites of the world' s largest and some of its most hazardous earthquakes, either through extended ground shaking or through the generation of tsunamis. Knowledge of the structure and geometry of both the overriding and subducting plates, and of conditions at the interface can contribute significantly to our understanding of subduction zones, potentially revealing controls on rupture area, slip behavior, and spatial variations in the width of the seismogenic zone. However, it is difficult to obtain a detailed synoptic view of subduction zones from seismic methods over areas comparable to those of the largest ruptures, ~100s km. Earthquake tomography studies provide 3-D images but at low resolution, ~30-50 km, while individual onshore-offshore experiments provide higher resolution but are often limited to 2-D profiles and shallower depths.

Here, we bridge this imaging gap for the entire Nankai subduction zone by making use of the largest onshore-offshore and ocean-bottom seismometers (OBSs) dataset ever recorded: air gun sources from multiple offshore experiments recorded by the dense set of permanent stations of the Japanese F-net and Hi-net networks, augmented by large 3-D OBS experiments and carefully selected Earthquake events from existing Japanese agencies catalogs. This dataset has been accumulating over two-decades and potentially includes over 45+ million source-receiver pairs with coverage of the entire Nankai subduction zone. This region has different patterns of seismic rupture and of largely aseismic slip that are only partially understood and have analogs around the world.

Here, we obtain refined 3-D constraints on the width and properties of the frontal prism, the thickness and geological architecture of the forearc crust, and the geometry of the subduction interface. Our tomographic model also places broad constraints on the crustal structure and geometry of the subducting Philippine Sea plate to 50 km depth. We integrate our tomographic model with residual gravity anomalies, regional seismicity, geological observations and seafloor geodetic constraints on slip rate deficits to describe the relationship between crustal structure and fault-slip behavior along the Nankai trough.

Keywords: subduction zone, Nankai trench, traveltime tomography, crustal structure, Kumano pluton, fault-slip processes

