Variation of the subduction structure along the Nansei-Shoto trench

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The Nansei-Shoto subduction zone, extending 1,200 km from Kyushu to Taiwan, has been intensively examined in terms of seismic coupling along the plate boundary and tsunami potentials. On the contrary to other subduction zones nearby, the Nansei-Shoto subduction zone has lacked clear evidence of great megathrust earthquakes (M>8) for the last few hundred years and thus the overall interplate coupling is thought to be weak (Peterson and Seno, 1984). Correspondingly, slow slip events and very low frequency earthquakes are ubiquitously distributed in the forearc region (Nishimura, 2014; Nakamura and Sunagawa, 2015), supporting the idea that the plate interface is “weakly” coupled. One of the exceptional great earthquakes known in the history is the 1911 Kikai-jima earthquake (M8.0) in the northern part of the subduction zone at ~29ºN (Usami, 1996). Recent studies suggest that this earthquake may have been a shallow interplate event that accompanied a large tsunami (Goto, 2013). However, background subduction structure generating such an event in a weakly-coupled condition remains enigmatic.
In order to improve our understanding of the seismic potentials and the controlling factors of the seismogenic process in the Nansei-Shoto subduction zone, JAMSTEC has been working on the integrated seismic project that consists of two-dimensional active-source experiments and extensive passive observations. In 2015, multichannel seismic reflection data were collected along two lines that cross the potential source region of the 1911 Kikai-jima earthquake. Together with refraction/wide-angle reflection data obtained by Japan Coast Guard in the same area, we succeeded in imaging the structure of the subducting slab and the frontal wedge.
The most prominent structural feature we found is a ~100-km-wide low-velocity zone at the seaward edge of the overriding plate within which multiple landward-dipping reflectors are imaged. This structure is very similar to the accretionary prisms in the Nankai subduction zone and is in a great contrast with the non-accretionary frontal wedge (with less than 40 km width) in the southernmost part of the Nansei-Shoto subduction zone. This difference probably comes from the structural variation of the incoming plate and the amount of sediment supply into the trench: To the north lie a series of volcanic ridges of late Cretaceous to early Eocene ages (Amami Plateau, Daito Ridge and Oki-Daito Ridge), while the West Philippine basin to the south exhibits a deep seafloor with little amount of sediments on its top. Large bathymetric highs and volcanic products on the incoming plate may have contributed to produce the accretionary frontal wedge and anomalous earthquakes in the northern part of the Nansei-Shoto subduction zone.

Keywords: Megathrust earthquakes, Plate subduction, Active-source experiments

