A possibility of cyclic ridge subduction off the Tokai district inferred from integrated active seismic studies

Shuichi Kodaira[1], Jin-Oh Park[2], Ayako Nakanishi[1], Tetsuro Tsuru[1], Kohichi Uhira[3], Aki Ito[1], Yoshiyuki Kaneda[4]

[1] IFREE, JAMSTEC, [2] JAMSTEC, IFREE, [3] JAMSTEC, [4] JAMSTEC,Frontier

http://www.jamstec.go.jp

Active seismic studies to reveal the seismogenic zone structure have been widely carried out in the Nankai Trough since the last five years. A subducted seamount suggesting a barrier preventing a lateral propagation of the co-seismic rupture during the 1946 Nankaido Earthquake has been successfully imaged off the cape Muroto. In terms of the rupture process of the 1944 Tonankai Earthquake, both seismic and tsunami data show the co-seismic ruptures were concentrated at the east of the Kii peninsula and did not extend to the Tokai district. Historic earthquake data also show that a recurrence interval of the mega-thrust earthquake off the Tokai district is not as regular as at other areas in the Nankai Trough. A key question is, therefore, if there is significant structural factor to prevent the rupture in this area. Even though the Paleo-Zenisu Ridge is proposed to subduct off the Tokai district, no clear seismic image has been obtained.

In July to August of 2001, an integrated onshore-offshore wide-angle seismic survey has been conducted from the Nankai trough off the Tokai district to the central Japan. Seventy ocean bottom seismographs (OBSs) were deployed with spacing of 3 km along the offshore profile (210 km long), while 328 mobile seismic stations were deployed with about 500 m spacing on the onshore profile (216 km long). Seismic signals from an air-gun array (total volume of 200 L) and five land-explosions (500 kg) were recorded both by the OBSs and land stations. Multichannel seismic (MCS) reflection data were also acquired along a part of the offshore profile. In this study, we modeled the wide-angle seismic data recorded by OBSs as well as the MCS data in order to obtain the subduction structure off Tokai district.

Data quality of the wide-angle data was generally excellent. Clear first arrival can be traced along the entire profile indicating a possibility of deep penetration of the seismic ray. We thus applied a first arrival tomography as a first step of the modeling. Results show following characteristic structures: i) root of the Zenisu Ridge extends down to 15-20 km depth consisting of thicker lower crustal body (Vp = 6.6 - 7.4 km/s), ii) slightly thickening of subducted oceanic crust is recognized at immediately landward the Nankai trough suggesting the possible Paleo-Zenisu Ridge. But, crustal volume of the Paleo-Zenisu might be significantly smaller than the present day Zenisu Ridge, iii) abrupt thickening of middle (Vp =6.0 - 6.4 km/s) and lower (Vp=6.6-7.4 km/s) crust toward the Izu island arc is observed at the southern end of the profile.

Since the first arrival tomography does not reveal reflector images, a pre-stack depth migration, which is widely used for imaging MCS data, was applied for the wide-angle seismic data. An advantage of the depth migration of wide-angle data is that deeper reflectors (e.g. a top and bottom of subducting oceanic crust) can be imaged using a large amplitude post critical reflection phase. We have, so far, completed to migrate farther offsets wide-angle data (farther than 20 km) for imaging the bottom of the crust. This migrated image clearly shows the geometry of the base of the Paleo-Zenisu Ridge and the present day Zenisu Ridge as well as the Izu island arc. We will, in the next step, migrate nearer offset wide-angle data combined with MCS data to image the shallower part of subduction structure focusing on the geometry of the top of the Paleo-Zenisu Ridge.

Due to the structure representing the subducted Paleo-Zenisu Ridge and existence of sub-parallel ridge structure recognized at the western edge of the Izu island arc (the present day Zenisu Ridge is the northern most ridge among them), a cyclic ridge subduction might be suggested beneath the Tokai district where a recurrence interval of the mega-thrust earthquake is not as regular as at other areas in the Nankai Trough.