Fault mapping and tsunami assessment in the outer-trench region of the Japan - Kuril trenches

*Shuichi Kodaira[1], Yasuyuki Nakamura[1], Tetsuo No[1], Gou Fujie[1], Koichiro Obana[1], Seiichi Miura[1], Toshitaka Baba[2], Naotaka YAMAMOTO CHIKASADA[3], Kentaro Imai[1], Yuichiro Tanioka[4]

1. Research Institute of Marine Geodynamics, Japan Agency for Marine-Earth Science and Technology, 2. Graduate School of Science and Technology,Tokushima University, 3. Earthquake and Tsunami Research Division, National Research Institute for Earth Science and Disaster Resilience, 4. Institute of Seismology and Volcanology, Hokkaido University

Shallow intraplate earthquakes became active in the outer-trench region when a large shallow megathrust earthquake occurred. In some cases, a great normal fault earthquake was observed following a great shallow megathrust earthquake near the trench. The 1933 Showa-Sanriku outer-trench normal fault earthquake (Mw 8.6) following the 1896 Meiji-Sanriku megathrust earthquake (M ~ 8.5) in the Japan Trench are recognized as a pair of those earthquakes. As a general idea, it is proposed that a normal fault earthquake occurs following a large shallow megathrust earthquake when extensional stress from subducting plate is transmitted to the outer trench region. Looking at the Japan Trench after the 2011 Tohoku-Oki earthquake, the seismicity in the outer-trench region is still higher than before at 11 years after the earthquake. According to the GPS-acoustic monitoring in the fore-arc, westward seafloor displacements are observed in the main rupture zone of the Tohoku-Oki earthquake, which is interpreted to be due to viscoelastic relaxation of the oceanic mantle. These observations suggest the need to prepare for a large normal-fault earthquake in the outer-trench region of the Japan Trench. However, because there was little information on outer-trench earthquake faults' structure, geometry, and activity, it was challenging to assess outer-trench earthquakes and tsunamis based on detailed observation data. To address this issue, we conducted a project on mapping the potential fault of a large normal fault in the Japan Trench and tsunami assessment based on the fault map. This project was an integrated research project consisting of large-scale plate imaging, fault imaging by seismic reflection data, earthquake monitoring, bathymetry mapping, and tsunami simulation. As a result of the project, we constructed the map of the potential fault of the large normal fault earthquake (M>7.5) from off Aomori to off Fukushima and simulated tsunami waveform along the coast and the S-net stations. The fault map shows that i) the most of the faults are imaged as high-angle normal faults (dip angle of higher than 45 degree), ii) the seismic reflection images do not show clear reflectors along the faults but show lateral discontinuity of the Moho reflection at the presumed intersection of the Moho of the fault, and iii) lineation of the seismicity down to uppermost mantle is mapped along the fault. One of the crucial findings from the tsunami simulation is that the tsunami waveform calculated from one of the mapped faults explains well with the observed tsunami waveform of the 1933 Showa-Sanriku earthquake. Following the Japan Trench outer-trench project, from 2020, we have started a new project for potential fault mapping and tsunami assessment of the outer-trench region off Hokkaido in the southern Kuril trench. In this project, we map potential faults such as strike, dip, and displacement in the area from the Erimo Seamount to the Nosappu rift zone based on bathymetry and reflection survey data, and tsunami assessment based on the geophysical information. In this presentation, we review the results of the Japan Trench outer-trench project and present the preliminary results of the Kuril Trench project. This work is supported by JSPS KAKENHI Grant Number 15H05718 and 20H00294.

Keywords: Outer-trench, Japan Trench, Kuril Trench, seismic imaging, tsunami

