Seismic transect across the central part of Northern Honshu, Japan

*Hiroshi Sato[1], Tatsuya Ishiyama[1], Hirokazu Ishige[2], Naoko Kato[1], Masanao Shinohara[1], Takaya Iwasaki[1,6], Eiji Kurashimo[1], Hidehiko Shimizu[2], Shinji Kawasaki[2], Susumu Abe[2], Makoto MATSUBARA[3], Shin Koshiya[4], Tetsuo No[5], Shuichi Kodaira[5], Naoshi Hirata[1]

1. Earthquake Prediction Research Center, Earthquake Research Institute, The University of Tokyo, 2. JGI, Inc., 3. National Research Institute for Earth Science and Disaster Resilience, 4. Iwate University, 5. Japan Agency for Marine-Earth Science and Technology, 6. Association for the Development of Earthquake Prediction

Northern Honshu, Japan, is known as a classic example of compressive island arc forming a trench-arc-backarc basin. To understand the crustal deformation and the mechanisms devastative earthquakes in the overriding plate, construction of numerical model is needed. To construct an advanced numerical model, the information of lithospheric structure is essential. We conducted a seismic profiling across the central part of Northern Honshu using controlled sources in summer of 2019. The seismic line crosses the epicentral area of the 2011 Tohoku-oki earthquake (M9). For constructing a numerical model on crustal deformation the structural investigation whole lithosphere is required. We aimed two step approach to obtain total lithospheric structure; one is using a controlled source and the other is by passive recording. Here we describe the results of onshore seismic reflection profile the crustal structure obtained by deep seismic reflection profiling. The length of onshore seismic line is 160 km within the total 850-km-long seismic line from Japan trench to the Yamato bank. The air-gun shots in the forearc and backarc sides were recorded by onshore seismic line using 1616 fixed channels. Onshore seismic sources were four vibroseis trucks and three dynamite shots. To obtain the deep crustal image, we used low-frequency signals. The produced sweep frequency by vibroseis trucks was 3 to 40 Hz and seismic signals were recorded by 4.5 and 5 Hz geophones. Sets of 150 stationary vibroseis sweeps were produced at about 10 km interval along the seismic line. Conventional CMP reflection processing and refraction tomography revealed the crustal structure down to 10 km. Together with the velocity structure obtained by earthquake tomography (Matsubara et al., 2019). Lithospheric structure is estimated by velocity structure obtained from active and passive sources, and geological data. With seismic reflection profiles in the forearc (Miura et al., 2005) and backarc (No et al., 2014), the onshore seismic section portrays the first image of the seismic reflection profile across the Northern Honshu arc from the trench to the backarc basin. The basic structure of the overlying plate were formed by the rifting of backarc opening stage. Most of the active faults inherited from the Miocene normal faults. The formation of backarc basins were achieved by the development of multi-rift systems. An axial part of failed rift within a continental crust is marked by a higher P-wave velocity lower crust, thick post-rift sediments underlaid by thick basalts. The failed rift is bounded by faults dipping to the outward of rift axis associated with mafic intrusion in a rift axis. The reverse faulting of the rift-bounding faults produced a fold-and-thrust belt in the post-rift Neogene basin fill. Judging from the tectonic geomorphological and geological features, these faulting and fault-related folding are active in late Quaternary. Detachment in this fold-and-thrust belt commonly accommodates in over pressured mudstone units in the rift basin. The major style of deformation of backarc is basement involved normal faults. Reactivation as reverse fault concentrated along the backarc continental failed rift.

Keywords: Trench-arc-backarc system, Deep Seismic reflection profiling, Seismogenic source faults, Backarc rifting, Northern Honshu

