Seismic structure beneath the petit-spot area and its implications

*Gou Fujie[1], Shuichi Kodaira[1], Taro Shirai[1], Annke Dannowski[2], Martin Thorwart[2], Ingo Grevemeyer[2], Jason Phipps Morgan[3], Seiichi Miura[1]

1. Japan Agency for Marine-Earth Science and Technology, 2. GEOMAR, 3. Royal Hollowya Univ. of London

The nature of the sedimentary layer on the top of the incoming oceanic plate is one of key controlling factors on the interplate coupling after plate subduction. In the northwestern Pacific margin off NE Japan, the Pacific plate is generally covered with a sedimentary layer consisting of mainly pelagic sediments of a few hundreds meter thick. However, locally thin sediments areas have been found by existing seismic reflection profiles. One of such thin sediments areas is located at the outer rise of the central Japan Trench and the size is roughly 50km square. This area is known as one of petit spot volcano sites; more than 80 petit spot volcanos are expected in this area (Hirano et al., 2006, 2011).

In 2014 and 2015, we conducted OBS-airgun surveys along a 600 km long 2-D seismic survey line crossing the petit spot area. We deployed 88 OBSs at intervals of 6 km and shot a tuned airgun array of R/V Kairei. We applied a traveltime inversion to model P-wave velocity (Vp) structure and found Vp just beneath the shallowest reflector beneath the seafloor is lower in the petit spot area than that in the other areas. To image the detailed seismic structure of the shallow sedimentary layers, we calculated receiver functions using the active-source seismic data. The receiver function analysis is a technique to image P-to-S conversion interface just beneath each OBSs. At most OBSs, only one P-to-S conversion interface is imaged at the expected time of the basement (top of the oceanic crust). But, in the petit spot area, we observed several P-to-S conversion interfaces. Since the deepest interface at the petit spot area is approximately equal to the basement in other areas, we infer that shallower P-to-S conversion interfaces are located within the sedimentary layer and that these interfaces might be related to the intrusion of sills, because we can expect pervasive sill intrusions beneath the petit spot area based on the observation at the outcrop of a petit spot in the central America (Buchs et al., 2013) and on the petit spot model proposed by Hirano et al. (2006).

The seismic coupling between the overlying plate and the subducting plate is probably affected by the nature of the sedimentary layer of the incoming plate, meaning that the subduction of petit spot area might cause the spatial variation in the interplate coupling after subduction. Although each petit spot volcano itself is very small, existing seismic reflection data suggest that the whole petit spot area, roughly 50 km square, is probably characterized by pervasive sill intrusions. Since the size of this petit spot area corresponds to the coseismic rupture area of M7 ~ M8 interplate earthquakes in the subduction zone of the Japan Trench, the subduction of petit spot areas might be one of the causes for a spatial variations in the distribution of interplate earthquakes in this subduction zone.

Keywords: controlled-source seismic survey, Japan Trench, petit spot volcano

