Refraction/wide-angle reflection study for 2018 seismic profiling in the northernmost part of the Suruga Bay

*Takaya Iwasaki[1], Hiroshi Sato[2], Hisatoshi Baba[3], Kayoko Tsuruga[4], Yasuhisa Tanaka[5], Tatsuya Ishiyama[2], Makoto Matsubara[6], Shinji Kawasaki[5], Naoshi Hirata[2]

1. Association for the Development of Earthquake Prediction, 2. ERI., the University of Tokyo, 3. School of Marine Science and Technology, Tokai University, 4. Tokyo University of Marine Science and Technology, 5. JGI, Inc., 6. National Research Institute for Earth Science and Disaster Resilience

The Fujikawa fault system, which bounds the western flank of western Izu collision zone, shows the highest slip rate in the onshore Japanese islands and cuts the important transportation network connecting Tokyo and Chubu, Kansai metropolitan areas. For the evaluation of seismic hazards and risk, it is essentially important to develop a seismogenic source fault model. As a part of “the Integrated Research Project for the Fujikawa-kako Fault Zone” funded by the Headquarters for Earthquake Research Promotion, onshore-offshore seismic profiling was undertaken in the northernmost part of the Suruga Bay in 2018. A 64-km profile line was laid out from the Izu Peninsula (the northernmost part of the Izu-Bonin Arc) to the Tokai district (the SW Japan Arc), crossing the northernmost part of the Suruga Trough and westward dipping major active fault systems developed in the SW Japan Arc (Sato et al., 2019). In the onshore area, 312 receivers were set with 150-250 m spacing and 4 dynamite shots were fired. On the onshore part of the seismic line, 5 OBX’s and 18 OBS’s were deployed to record very dense air gun shooting (1576 shots with 50 m interval) (Tsuruga et al., 2018, 2019; Baba et al., 2019). The preliminary results from the seismic reflection processing of this profile was presented by Turuga et al. (2019) and Sato et al. (2019). In this paper, we show the first velocity structure model derived from the refraction/wide-angle reflection analysis for these onshore-offshore seismic data.

In the present study, we conducted travel-time analysis for 17 super-gather record sections from onshore and offshore seismic traces to investigate the entire structure of this profile including the collision/subduction of the Izu-Bonin Arc and probably the back arc basin developed west of this arc. Our modelling procedure consists of three steps. The first step was devoted to determine the shallowest part of the crust using near offset (<~10 km) travel times of the onshore shots and offshore OBX and OBS’s. In the next step, we modelled the subduction geometry in the shallower part (down to 5-8 km depths) from the offshore shots recorded on the land receivers with aid of the multi-channel reflection image (Tsuruga et al., 2018, 2019). In the last step, the velocity structure of the deeper part (down to 8-12 km depths) was constructed using all of the travel time data at relatively far offsets (>30~40 km).

The obtained velocity model has the following seismological features. Beneath the western part of the profile (the SW Japan Arc), the uppermost crust is composed of three layers with P-wave velocities (Vp) of 3.0-3.5 km/s, 4.0-4.5 km/s and 5.0-5.3 km/s, overlying 5.5 km/s body. The total thickness of these layers is about 4 km. The uppermost crust of the Izu Peninsula consists of slightly undulated four layers with velocities of 2.1-2.6, 3.2-3.5, 4.2-4.5 and 4.8-5.1 km/s, respectively. These layers, 3-4 km thick in total, are situated on the crystalline part of the upper crust of the Izu-Bonin Arc which is modelled by 5.2-5.6 and 5.8-6.0 km/s layers. The boundary of the upper and lower crust is located at a depth of about 8 km. The lower crustal velocity is roughly estimated as 6.6 km/s using travel times at far offsets from the onshore shots. The uppermost structure beneath the Suruga Bay is characterized by a low velocity (2-4 km/s) sedimentary wedge whose maximum thickness is 3-4 km. In our present model, the crust of the Izu-Bonin Arc side is subducted beneath the SW Japan Arc with an angle of about 21-22 degrees. In the seismic reflection image from the onshore-offshore data revealed very strong seismic events in the eastern side of the Tokai district at a depth of 10-12 km (Sato et al., 2020). This location is consistent with the top

of the subducted lower crust of the Izu-Bonin Arc in our model. Other reflections observed from the land shots suggests the westward dipping boundaries within or below this lower crust.

Keywords: Fujikawa fault system, Izu-Bonin Arc, Suruga Trough, Southwest Japan Arc, collision/subduction structure, refraction/wide-angle reflection analysis

