Migration of shallow low frequency tremors in the central Ryukyu arc

*Tsutomu Takahashi[1], Yasushi Ishihara[1], Yojiro Yamamoto[1], Aki Ito[1], Ryuta Arai[1], Ayako Nakanishi[1], Seiichi Miura[1], Shuichi Kodaira[1], Yoshiyuki Kaneda[2]

1. JAMSTEC, 2. Kagawa University

Ryukyu arc, southwestern Japan, shows high activities of various slow earthquakes such as slow slip events (SSEs) (e.g., Heki & Kataoka 2008; Nishimura 2014), very low frequency earthquakes (VLFEs) (e.g., Ando et al. 2012) and shallow low frequency tremors (e.g., Yamashita et al. 2015). In this area, offshore seismic observations have important roles to improve accuracies of their locations and spatial extents. We conducted a passive seismic survey around Amami islands to elucidate detailed activities of regular and slow earthquakes and seismic structures. We deployed 30 short-period ocean bottom seismographs (OBSs) and 5 temporal onshore stations at 25~40 km interval. Deployed OBSs recorded ground motion from Mar. 2019 to July or Aug. 2019.

During this observation, we observed many regular earthquakes and several sequences of shallow low frequency tremors. We estimated epicenters of about 630 tremors by the envelope correlation method. Focal depths are fixed at 15km with consideration for our seismic refraction survey in this area (Takahashi et al. 2020, JpGU). All tremors distribute between Amami islands and Ryukyu trench. Distance from the Ryukyu trench to tremors is about 20~80km. Most tremors locate at the source area of 1995 Amami earthquake (M7.1) (e.g., Yamada et al. 1997). Many aftershocks of the Amami earthquake distribute in the subducted slab. Arai et al. (2017) found large normal faults intersecting the subducted slab at north of tremor area. These imply a complex geometry of plate surface and fractured structures in the slab at the tremor area.

The most active sequence of tremors occurred from 3/5/2019 to 19/5/2019. This activity started at southern part of the tremor area, and migrated north for about 70 km. Migration speed is about 4.0~4.5km/day. Similar migration speed was observed for shallow VLFEs in Hyuga-nada (Tonegawa et al. 2020) and Kumano-nada (Nakano et al. 2018) at Nankai subduction zone. Yamashita et al. (2015), in contrast, observed fast migrations (30~60 km/day) of shallow low frequency tremors in Hyuga-nada. They also pointed out rapid reverse migrations. Such reverse migration was not clearly seen in our case.

A large cumulative slip of SSEs is observed near the Amami plateau (Nishimura 2014). In this large slip area, we observed low actively of shallow tremors. Tremor migration we observed stopped at south of the large slip area. Arai et al. (2017) found a subducted seamount near the large slip area of SSEs. It implies that the subducted seamount affects tremor migration. We may say that complex geometries of plate surface or fractured structures in the subducted slab may have important roles for slow earthquake activities in the central Ryukyu arc.

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