

Distribution of low frequency earthquakes accompanied with very low frequency earthquakes along the Ryukyu Trench

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We investigated the long-term distribution of low frequency earthquakes (LF) which are accompanied with very low frequency earthquakes (VLF) in the Ryukyu Trench. The VLFs occur regularly by the accumulation of short-term burst-type swarms (about 1-4 days) along the Ryukyu Trench. Takahashi et al. (2015) detected the LFs accompanied with the VLFs using ocean bottom seismometers in the southwestern Ryukyu Trench. However, the long-term distribution of the LFs has not been known along the Ryukyu Trench. Then we detected the LFs for long-term and determined the hypocenter distribution in the Yaeyama and Okinawa region.

First we analyzed the long-term appearance of LFs accompanied with the VLFs. We hi-pass-filtered (1 Hz) to the waveforms of F-net (NIED) seismograms. Then we checked manually whether the LFs are found in the seismograms. The results showed that the appearance of the LFs is from 2 (Amami area) to 16% (Yaeyama area) along the Ryukyu Trench from 2004 to 2013. The LFs were successfully detected when the magnitudes of the VLF is over 4.0, whereas they were not found when the magnitude of the VLF is less than 3.7. Small amplitude of LF would be obscured by noise if magnitude of the VLF is small though LF would be always accompanied with VLF.

Next we determined the hypocenter of the LFs. For the hypocenter determination, we used the short-period seismometers by Japan Meteorological Agency (JMA) in the Ryukyu arc. First we selected the swarm of VLFs using the VLFs catalogue by Nakamura and Sunagawa (2015). Then we analyzed the waveform of the JMA seismometers. The surveyed period is from 2004 to 2013. We analyzed the data in the Yaeyama and Okinawa region where is near the cluster of the VLFs (Nakamura and Sunagawa, 2015). We picked the relative arrival time difference among the stations automatically using envelope cross-correlation method (Obara, 2002). We composited the horizontal waveforms and computed the RMS amplitude with 10 s average. We computed the cross-correlation for each network and we determined the hypocenters when the at least 4 stations satisfy the cross-correlation over 0.85. We used the S-wave velocity structure for the hypocenter determination because the phases are dominant with S wave.

The results show that the epicenters are distributed between south of Yonaguni Island and south of Iriomote Island in the Yaeyama area. Almost events are located between the Ryukyu Trench and Ryukyu arc. Since hypocenters are located out of the seismic network and only S phases are used for the calculation, estimation errors for the NS and EW direction are 70 km and 30 km, respectively. However, the distribution of the LF along the trench direction are similar to those of the VLFs which is estimated using semblance method (Nakamura and Tu, 2015). This suggests that the LFs occur in the similar region as VLFs in the Yaeyama. The LFs are found with accompanied with the occurrence of the large VLFs. The occurrence of the isolated LFs is rare. Moreover, the hypocenters of the LF concentrate at the southeast of south Okinawa Island and southeast of Okinoerabu Island in the Okinawa island area.

The hypocenters of the swarm of LF concentrate at the diameter of approximately 40 km in the Okinawa and Yaeyama areas. The migration of the hypocenters of the swarm activity was not found in the Okinawa and Yaeyama areas. This suggests that the distance of the migration of large LF was limited within 40 km if the hypocenters of the LF swarm migrate.

Keywords: very low frequency earthquake, low frequency earthquake, Ryukyu Trench