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Very low frequency earthquakes near the western region of the Ryukyu subduction zone

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Very low frequency earthquakes (VLFEs) have been observed near the trench axis along the Ryukyu Trench in four distinct regions: south of Yonaguni-Ishigaki, south of Okinawa island, south of Amami Oshima and east of Kyushu (Tu et al., 2009). The previously identified events of VLEFs in the Yonaguni-Ishigaki region are generally characterized with a simple waveform and well-constrained mechanisms by the inversion scheme. In the present study, the focus is on the Yonaguni-Ishigaki region to examine a temporal change of activity and its relation to the slow slips based on GPS data. In this study we used the data from the Yonaguni station (YNG) together with Ishigaki station (IGK) that was set up as part of the F-net stations. This 2003 enhancement of the network significantly improved the accuracy of the hypocenter and mechanism determination of VLFEs in the western margin of the Ryukyu Trench. However, in 2003 the noise levels were high at some stations. Thus, only the data between 2004 and 2010 have been analyzed. VLFEs selected for analysis are chosen from the seismograms based on the following criteria: 1) recognizable VLFEs among 2004-2010 seismograms that were filtered through the bandpass of 0.02-0.05Hz; 2) events are not listed on PDE, JMA, and CWB (Taiwan Central Weather Bureau) catalogs; and 3) earthquakes that were recorded by at least 5 stations. The present study examined the number of VLFEs as an index of the seismic activity. Among the VLFEs in Yonaguni-Ishigaki region, the smallest VLFE is M2.0, occur as swarm type in a series of events, and sometimes as a single event. The swarm-type events are generally smaller than M3.0 comprised of a sequence of many VLFEs within 2- to 6-hour duration. Intervals between VLFEs are about 2-10 minutes. However, it was noted that no VLFE that is continuous for several days to 1-2 weeks was seen in this region. The peak of these activities will appear every 2-3 months with the longest lasting about six months. Furthermore, during a sequence of large waves from either large teleseismic event or a medium- to large-size local earthquake, VLFEs signals are masked and unidentifiable for 30 minutes or even up to 1 day, which totaled to about 10% of the whole observation period. In an earlier study, slow-slips in this region have been detected beneath the lands at depths 40-50km by analyzing GPS data (Heki and Kataoka, 2008; Nakamura, 2009). Moreover, Heki and Kataoka (2008) ascertained episodic slips that occurred every six months. In the present study, however, VLFE activity was not correlated with such slow slip activity from 2004 to 2010 observation period. Furthermore, unlike events off coast of Tokachi, the Kii peninsula and Kyushu, the occurrence of VLFEs in the present study area shows no correlation with teleseismic or local earthquakes. In the present region, if the shear stress increases on the VLFE patches due to continuous subduction plate loading, these patches would eventually rupture when cumulative stress reaches a yield stress without external disturbances. In the future study, we will include correlation between the VLFEs activity and the seismic moment.

Keywords: Very low frequency earthquake, Ryukyu trench, seismicity, slow slip, subduction, accretionary prism