

Further evidence for the influence of a subducting-ridge on the spatial strain accumulation and release pattern in the shallow eastern Nankai Trough, based on VLFE distribution

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We investigated the distribution and focal mechanisms of very low frequency earthquakes (VLFs) located in the shallow part of the eastern Nankai trough. While they are mainly explained as low angle thrust faulting along the plate boundary (Sugioka et al., 2012; Nakano et al., 2016), along the strike variation in their distribution has also been observed, likely caused by a subducting-ridge (Toh et al., 2018). Such variations could be closely related to the strain release pattern, or the tsunamigenic potential, of this region, thus warrant a further comprehensive study.

We used 3 component records of broadband ocean bottom seismometers equipped in Dense Oceanfloor Network system for Earthquakes and Tsunamis 1 (DONET1). Records of VLFE activities that occurred immediately beneath the network in 2015, 2016 and 2017 for 1-2 weeks each year, are used. Through visual inspections, we detected 335 VLFs whose signals are observed at least 6 stations on vertical component filtered between 16-32s.

Instead of estimating the source parameters for one after another for all the events, we searched for densely located event groups inferred by similarities of the maximum amplitude variations measured per event, and, so far, worked only on the grouped events. The purpose of this event selection process is to get an overview of the distribution using the simple quantity (i.e. max. amplitude variation) that can be evaluated for every VLFE, and to avoid a bias that may be caused by eliminating events that are merely difficult to process (i.e. do not fit synthetic waveforms) mostly due to complicated long source time functions that characterize VLFs. The grouping is conducted by a hierarchical density-based clustering method HDBSCAN (Campello et al., 2003), and 197 events were grouped into 26 groups that consists of 2 to 35 events.

We determined the centroid origin time, location and 5-component of moment tensor of VLFs that maximize the normalized variance reduction (VR) between the observed and synthetic velocity waveforms. The waveforms are bandpass filtered either between 16-32s or 20-50s, depending on signal duration and S/N per event. The time and location are grid-searched at intervals of 0.01 degree in horizontal, 1 km in depth between 5 and 10km bsl., and 1 s in time. At each grid, the moment tensor is estimated using the code TDMT_INV (Dreger, 2003) that conducts full-waveform linearized inversion in time domain. Green's functions are calculated using the code by Herrmann (2013) based on wavenumber integration. We used a 1D structural model based on a 2D model obtained by an active source survey (Nakanishi et al., 2008). Although the 1D structure is assumed, the large variations in station elevation (1.9-4.3 km bsl) are considered in Green's function calculations.

We obtained 50 events with good VR (>65%). Among the 26 groups, 6 groups ended up with no events of high VR, mostly due to being located outside of the network. Almost all the VLFs are reasonably explained by low angle thrust faulting. From the obtained distribution, the strong influence of the subduction-ridge located on the northwestern side of DONET1 is inferred. On the southwestern side

where there is no ridge-subduction, VLFs are distributed beneath outer-ridge toward the trench axis. The estimated depths for the ones located beneath the outer-ridge are deep (7–10km with median at 8km), which are consistent with the depth of the plate boundary of this area. In contrast, on the northeastern side, VLFs are mostly distributed landward of outer-ridge and their estimated depth are shallow (5–8km with the median at 7km) as previously suggested (To et al., 2015). The shallow depths can be explained by the uplifted plate boundary in this area due to the subducting-ridge. Furthermore, they are located to landward of the peak of the subducting-ridge, which can be reasonably explained by the change in shear stresses and pore pressures caused by the subducting-ridge.

Keywords: Nankai trough, Very low frequency earthquake (VLFE), Accretionary prism, HDBSCAN, Broadband ocean bottom seismometer