Shallow very-low-frequency (VLF) earthquake activities along the Nankai trough in 2015

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In 2015, we observe shallow very-low-frequency (VLF) earthquakes along the Nankai trough by DONET, a permanent ocean-floor observation network. The activity started off the Shiono-misaki in August, which is followed by the activity off the Kii channel in September. In October the activity moved beneath the Kumano fore-arc basin. I investigated their source location and mechanism. Previous VLF activities along the Nankai trough are observed in 2004 (Obara and Ito, 2005), 2009 (Sugioka et al., 2012), and 2011 (To et al., 2015).
I determined the source location and mechanism of the VLF events by a waveform inversion using the SWIFT system (Nakano et al., 2008). Bband-pass filtered waveforms between 20 and 30 s, of which VLF signal is dominant, are used for the inversion.
Obtained CMT solutions show that the VLF sources are concentrated in several clusters located off the Kii channel, off Shiono-misaki, and Kumano fore-arc basin. These clusters well overlaps those reported by Obara and Ito (2005). The sources in the Kumano fore-arc basin can be divided into two clusters, which are located east and west of the previous major activity reported by Sugioka et al. (2012).
The source depth is between 7 and 10 km, corresponding to the base of the accretionary prism. The focal mechanism solutions represent low-angle thrust; one of the nodal planes is almost horizontal and the slip direction is almost perpendicular to the dip of slope of the sedimentary wedge. These results infer that the VLF events are caused by a slip along the plate boundary beneath the accretionary prism. We note that the dip of slope of the sedimentary wedge above the cluster off the Kii channel rotates about 60 degrees eastward due to the subduction of a seamount, but the rake angle of the obtained focal mechanism is very similar to those in the other clusters.
The obtained magnitude is at most about 4. The b-value obtained from the frequency-magnitude distribution is 2.4, inferring low stress level at the source.
I found that the occurrence of each event corresponded to minimal (not always the minimum) of ocean-bottom pressure caused by the ocean tide observed at DONET stations. This feature is evident in the activities off the Kii channel and off the Shiono-misaki. The correspondence to the low pressure was not evident in the activity beneath the Kumano fore-arc basin because of the swarm activity, although several events before the swarm activity corresponded to minimal of ocean-bottom pressure.
Assuming almost horizontal fault plane for the VLF sources, unclamping the fault by the decrease of hydrostatic pressure would promote VLF events. The tidal pressure change is about 10 kPa, comparable to the stress drop estimated for VLF earthquakes (Ito and Obara, 2006), which would be enough to perturb the state of stress at the source. But the truth would not be as simple as this because several of VLF events did not occur at minimum of the pressure. Combined effect of tidal force and external loading, a proposed model for deep non-volcanic tremor (e.g. Nakata et al., 2008; Ide and Tanaka, 2014), would be necessary to model the trigger of VLF earthquakes.

Keywords: DONET, off Kii channel, off Shiono-misaki

