Event size distribution of shallow very-low-frequency earthquakes off the Kii Peninsula

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On 1 April 2016, a M6 class earthquake occurred off the Kii Peninsula along the plate boundary between the overriding Amur plate and subducting Philippine Sea plate. After this event, an intensive activity of shallow very-low-frequency earthquakes (sVLFEs) was observed. The sVLFE activity continued about two weeks. At the same time, an episode of slow-slip event (SSE) was also observed in the same region (Araki et al. 2017). Nakano et al. (2018) determined the centroid moment tensor (CMT) solutions of the sVLFEs and found that the sVLFEs and SSEs share common source regions and almost identical time histories of moment release. In this study, I investigated the size distributions of sVLFE CMT solutions to study the source heterogeneities.

The sVLFE sources were distributed in an oval region measuring approximately 30 km by 50 km with its long axis parallel to the trough, at depths between 6 and 10 km. CMT solutions were obtained for 288 events, with moment magnitude (Mw) between 2.2 and 4.1. Smaller events were not well determined because of lower signal level compared to background noise. Neither power-law nor exponential distribution models well match the event size distribution; the observed distribution seems to follow one between these two typical distributions.

Next, I investigated spatial variations of the size distributions. Because smaller events were not well detected determined, I only used events larger than or equal to Mw 3.2 to investigate the size distribution. Using events within 10 km radius of center of each grid set at every 0.05 degree in longitude and latitude, negative of the slope of event size distribution assuming power-law (b-value) or exponential (lambda-value) distributions were obtained by fitting a straight line to the observed event size distributions.

The event size distributions systematically differ east and west of longitude about 136.6 or 136.7. In total, the eastern activity has lower b-value (1.8) or lambda-value (1.5e-15 / Nm), indicating relatively rich in larger events, compared to that of the western activity (b=3.0, lambda=4.3e-15 / Nm). This distinct differences would reflect heterogeneities of source characteristics as the stress level, stressing rate, frictional properties along the fault, and so on.

Differences in the source properties might cause differences in observed waveforms. I compared the stacked power spectra of vertical component seismograms at stations KMD16 and KMC11, located at the boundary between the eastern and western clusters. Because the eastern cluster is relatively rich in larger events which produce better S/N ratio in the frequency range between 0.1 and 1 Hz, in which noise due to microseism is larger, I only used events between Mw 3.2 and 3.5. Average magnitudes of stacked events were 3.3 for both clusters. It seems that the eastern cluster are slightly rich in the frequency components higher than 0.5 Hz, but further careful studies are necessary to conclude that.

To clarify heterogenious structures along the plate boundary by using slow events would help our understandings of earthquake generations and its diversity.

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