

Universality of very low frequency signals from slow earthquakes

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The scaling law for slow earthquake [Ide et al., 2007] provides a unified view of deep tectonic tremors, low frequency earthquakes, and slow slip events (SSE). This view has been strengthened by several kinds of evidence and explanations using theoretical models. One of the strongest evidence is the detectability of intermediate phenomena between seismically observed tremor above 1 Hz and geodetically observed SSE longer than several hours. The signals are especially clear in the very low frequency (VLF) range from 0.02 to 0.05 Hz, where Ito et al. [2007] first discovered signals accompanied with tremors. Since their discovery, similar phenomena have been found in many places, with simultaneous tremor observation. This fact suggests the universality of VLF signals behind tremors, and we can enhance the signal amplitude in the VLF range to overcome environmental noises, by stacking broadband seismograms relative to tremor timing.

We arrange many reference points in a tremor zone, extract VLF signals by stacking broadband seismograms, and determine moment tensor corresponding to the underground deformation. This method was first applied to a wide tremor zone in the Nankai subduction zone [Ide and Yabe, 2014], and then to a small tremor cluster in Taiwan [Ide et al., 2015], the Guerrero tremor region in Mexican subduction zone [Maury et al., 2016], around southern Vancouver Island in Cascadia subduction zone, and the Parkfield section of the San Andreas Fault. In every region, moment tensor solutions consistent with regional plate motion were determined. These solutions will constrain tectonic interpretation in each region. The reliability of solution is not homogeneous: we can constrain solutions with only 500 tremors in Nankai, while noises are too large after stacking 5000 tremors in Parkfield. This is partially due to the different quality of seismic networks, but the size of source is not the same everywhere. Average moment magnitudes corresponding to VLF processes are M_w 2.2-3.0 in Nankai, Guerrero, and Cascadia, but less than M_w 2 in Parkfield. The similarity and difference for these results will provide keys to understand physics that govern these slow deformation processes.

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