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Very-low-frequency earthquakes along the decollement of the Nankai trough

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There is a long history of studies of submarine very low frequency (VLF) earthquakes since the celebrated discovery by Wadati (1928). After over 80 years, we for the first time detected a swarm of VLF earthquakes by broadband ocean bottom seismometers (BBOBS) placed just above the source region in the Nankai trough accretionary prism, where the seismic crustal structure is well known. The nearby BBOBS records show permanent seafloor displacements of 0.1-0.5 mm with rise times ranging 20-60 s. These rise times are anomalously long as compared to those of ~1 s for ordinary earthquakes with comparative magnitudes ($M_w \sim 4$). We made a waveform inversion for the source location and source mechanism for the selected 11 events, taking the heterogeneity of crustal structure into account. All the events but one are located roughly along the plate boundary as plate boundary-parallel thrust faults. Their source time functions show anomalously long durations, quantitatively consistent with the observed seafloor displacements at each site. Despite such long source durations, VLF events are extremely rich in high frequency components (~5 Hz). Anomalously long source duration and anomalously rich high frequency wave radiation are two unique features of VLF events, suggesting simultaneous, interrelated occurrence of shear failure across and hydrofracturing within the decollement at the base of the accretionary prism.

Keywords: Very-low-frequency earthquake, Nankai trough