Press Releases

December 20, 2017
JAMSTEC

Shallow Very Low Frequency Earthquake Zones in Nankai Trough Corresponds to Low Velocity Zones in Toe of Accretionary Prism
- A step to identify structural factors for occurrence of such earthquakes -

Overview

Patch-like low-velocity zones (LVZs) are distributed in the Nankai accretionary prism[*1], which are spatially correlated with epicenters of the shallow very low frequency earthquakes (sVLFE)[*2], and very low frequency earthquake activity is low in a region where such feature cannot be seen, according to a study led by Dr. Takashi Tonegawa at the Japan Agency for Marine-Earth and Science (JAMSTEC: Asahiko Taira, President) and his colleagues. This project was carried out jointly with the National Research Institute for Earth Science and Disaster Resilience (NIED).

In the Nankai Trough off the Kii peninsula, a cabled network, the Dense Oceanfloor Network System for Earthquakes and Tsunamis (DONET)[*3], has been deployed for monitoring seismic activities. The scientists attempted to estimate the one-dimensional shear wave velocity structure[*4] beneath these stations with a nonlinear inversion technique, simulated annealing, using the displacement–pressure ratios of the Rayleigh wave[*5].

Spatial correlation between the LVZ and sVLFE has been reported only one location within the accretionary prism toe in Kumamo-nada. These new results, however, presented other two sporadic LVZs in the prism toe from one-dimensional shear wave velocity profiles at the 49 cabled stations. In addition, the spatial correlation between the LVZ and sVLFE indicates that the high sVLFE activity is activated in the patch-like mechanically weak volumes where fluid concentration reduces the shear strength of faults.

LVZs with mechanically weak volume in the prism toe along the margin-parallel direction in the Nankai, subduction zone potentially influence coseismic rupture propagation and tsunamigenic slip on megathrust earthquakes. As seismic LVZs are likely to affect tsunami height and strong ground motion, these new findings are expected to contribute to further assessment of the effect of LVZs and its impacts on earthquakes.

This work is supported by JSPS KAKENHI Grant Number 15K17753.

The above results were published in the *Nature Communications* on December 11, 2017 (JST).

Title: **Sporadic low-velocity volumes spatially correlate with shallow very low frequency earthquake clusters**
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*1 Accretionary prism: The Philippine Plate is subducting along the Nankai Trough beneath southwest Japan. Accretionary prisms are formed by sediments scraped off from the downgoing plates. These accretionary prims and the Philippine Sea Plate are significantly related to seismic activities around shallow parts of the plate boundary.

*2 Shallow very low frequency earthquakes: They show a lower stress drop than ordinary earthquakes and radiate low-frequency waves. Although such earthquakes are detected at the depth of 30km of the Philippine Plate, they are referred as“shallow”very low frequency earthquakes as they occur near the toe of accretionary prism of the Philippine Sea. Shallow very low frequency earthquakes usually occur in shallower parts than asperities.

*3 Dense Oceanfloor Network System for Earthquakes and Tsunamis (DONET): The DONET is a submarine cabled real-time seafloor observatory network for the precise earthquake and tsunami monitoring. Started its operation in 2011, DONET1 is deployed at the depth of 1,900 - 4,400m in the Kumano-nada, while DONET 2 is installed at the depth of 1,000 - 3,600m along off Cape Shiono-misaki to Cape Muroto-misaki. Each station has a broadband seismometer, an absolute pressure gauge and a differential pressure gauge. The system allows sea floor observations in real time at 51 stations, which were not available before. Collected data are transmitted to JAMSTEC, NIED and the Japan Meteorological Agency.

*4 One-dimensional shear wave velocity structure: It means shear wave velocity structure per depth of sea floor meters.

*5 Rayleigh wave: Rayleigh waves propagate along the surface of the earth. They are produced by earthquakes, and also disturbances of the solid Earth by atmosphere and ocean waves. When they are triggered by mega-earthquakes, they travel an extremely long distance up to 10,000 km.

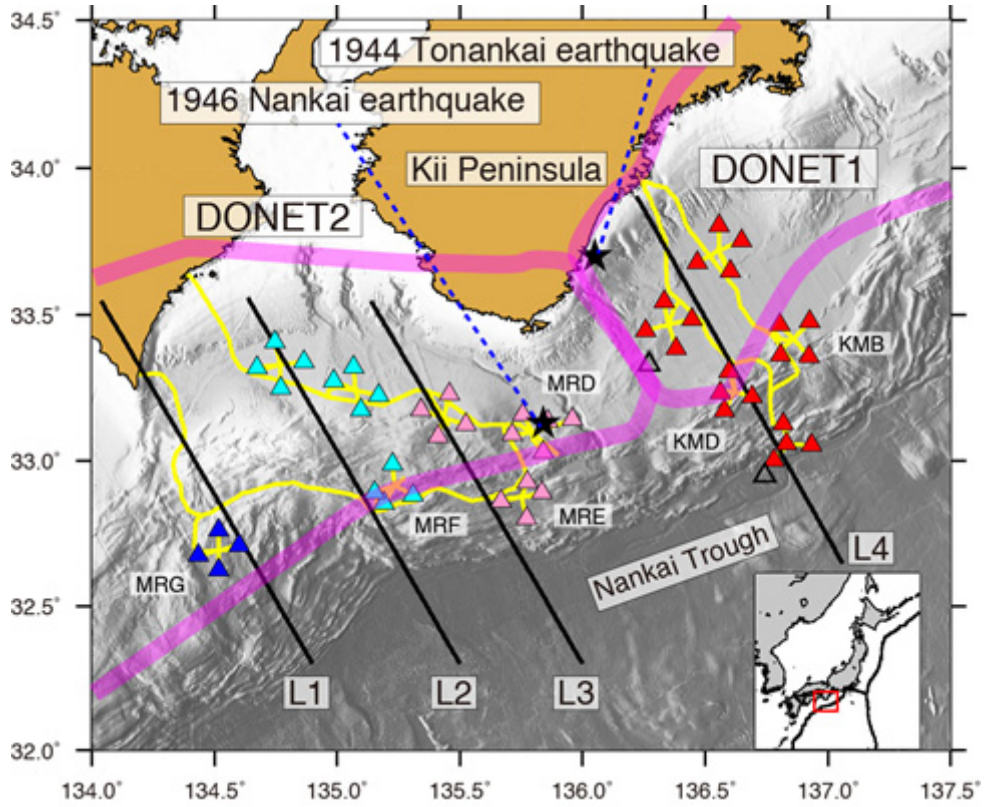

Figure 1. Locations of stations in DONET1 and DONET2, and lines. Red triangles are DONET1 stations, and blue, pale blue, and pink triangles are DONET2 stations. Labels with three capital letters represent the node name. One-dimensional shear wave velocity (Vs) profiles at the stations are projected onto lines L1–L4 in Fig. 2. Stars represent the locations of rupture initiations for the 1944 Tonankai and 1946 Nankai earthquakes, and magenta line shows seismogenic zones for future great earthquakes.

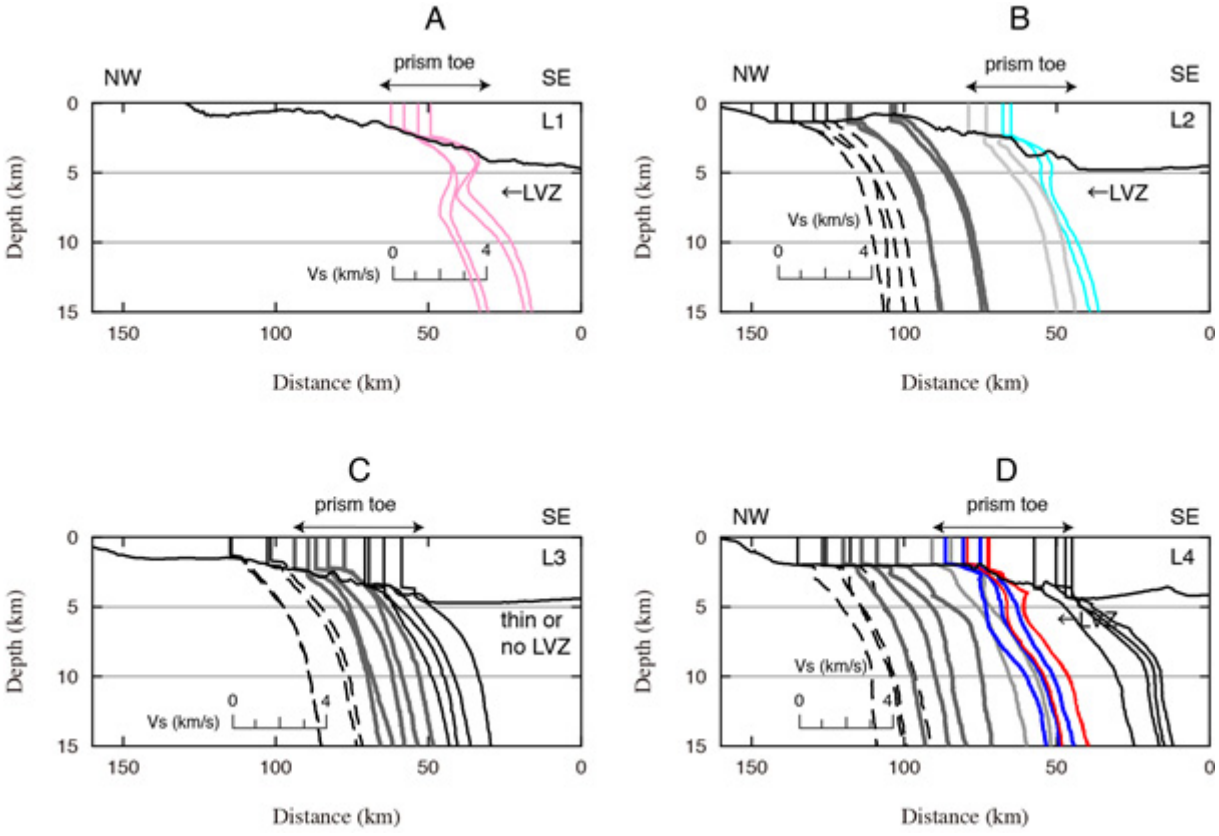

Figure 2. Vs profiles for each line. Vs profiles for a L1, b L2, c L3, and d L4 (Fig. 1). Station locations (Fig. 1) are projected onto L1–L4 and corresponding Vs profiles are

plotted at the projected location. Pink, pale blue, blue, and red lines represent the LVZ feature at nodes MRG, MRF, KMB, and KMD (Fig. 1), respectively. Black solid, dashed, and gray lines correspond to Vs profiles at stations belonging to the same nodes, but without the LVZ feature. Light gray lines in d correspond to Vs profiles at KMD and KMB (Fig. 1) without the LVZ feature. Solid line at each panel indicates bathymetry along each line.

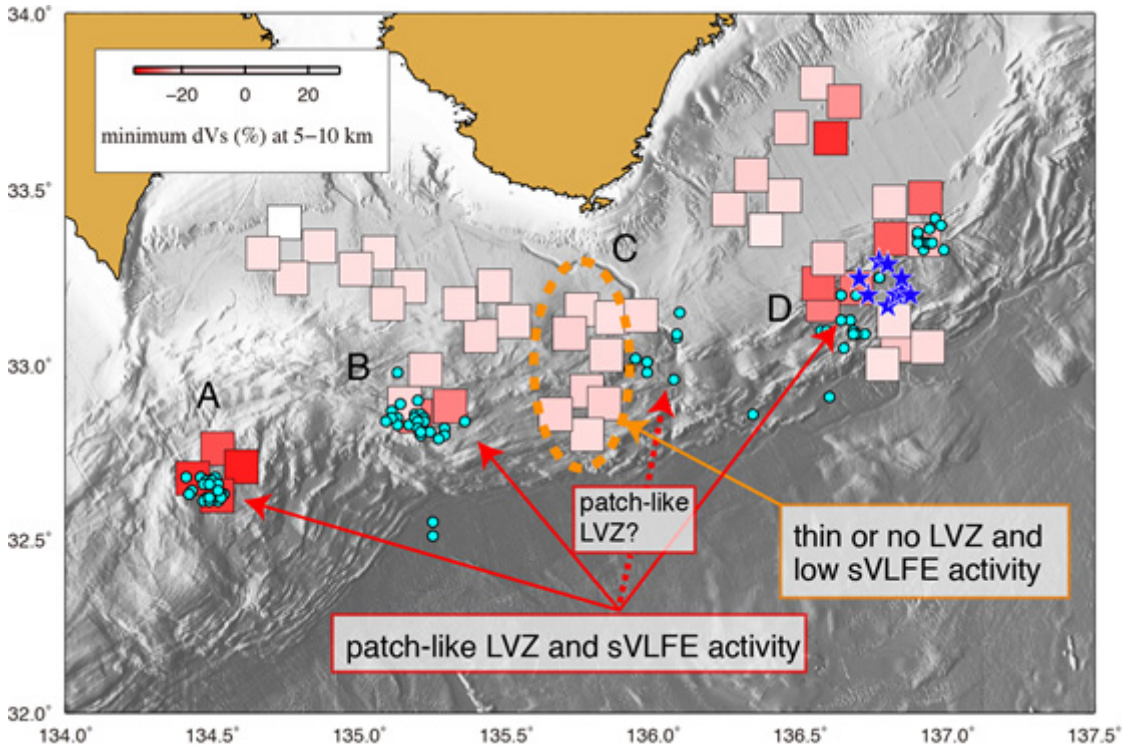

Figure 3. Spatial relationship between LVZ and sVLFE determined by seafloor records. The intensity of red in the squares indicates the degree of low velocity in the depth range of 5–10 kmbsl. Locations of squares correspond to station locations. Pale blue circles and blue stars show epicentres of sVLFEs determined from seafloor records.

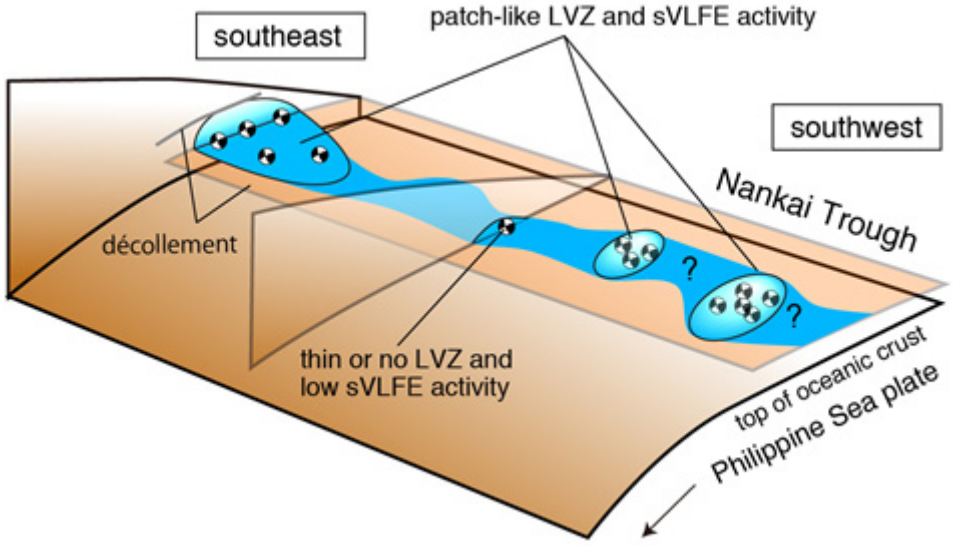

Figure 4. Schematic for scattered LVZs in Nankai accretionary prism toe. The LVZs are sparsely distributed in the prism toe and the shear strength of faults inside the LVZs is weakened by the presence of fluid. The occurrence of sVLFEs may be promoted in the LVZ. Gray line and plane indicate two interpretation of the décollement location according to previous studies.

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