Repeated Long-term Slow Slip Events beneath the Hamanako-lake area and seismic activity in the crust

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The Long-term Slow Slip Event (LSSE) beneath the Hamanako-lake area, which had continued from 2001 to 2005, has become active again since 2013 and continued to, at least, 2015 (GSI, 2017; JMA, 2017). It is known that the periods of changes in seismic activity in ‘the crust of the central western Shizuoka of Tokai region’ (abbreviated to ‘the crust’) correlates with the periods of LSSE (JMA, 2014). The crustal seismicity becomes low during LSSE and it becomes active during resting of LSSE. If such temporal correlation exists between the crustal seismic activity and LSSE, then the seismic activity should have become active with resting of LSSE since 2016, though it is not reported until now (JMA, 2018). Here we try to clarify the details of space-time distribution of seismic activation and quiescence in the crust correlating to LSSE, especially after 2016.

The eMAP is used for showing seismic activation and quiescence (Aketagawa and Ito, 2008; Hayashimoto and Aketagawa, 2010; Yoshikawa et al., 2017). The method is based on the occurrence probability of the seismicity for evaluation period calculated from the Poisson distribution with the average seismicity for reference period, which is counted in every circular or spherical regions centered at all hypocenters. We have analyzed seismic activity in the Tokai area for checking applicability of the eMAP by NIED catalogue of hypocenters, and could confirm that the spatial distribution of activated zone was similar to that of the asperities obtained by Matsumura (2007).

We investigated the correlation between LSSE and the crustal seismic activity by means of the seismic quiescence and activation observed in Tokai area using de-clustered data from JMA catalogue of hypocenters. In the figure, spatial distribution of the occurrence probability for the hypocenters shallower than the plate boundary is shown by plane views and that for the hypocenters in all depths to 50km is shown by vertical views beneath the rectangular zone. The occurrence probability is evaluated in the following periods: (a) LSSE1 (2001–2005), (b) resting (2006-2012), (c) LSSE2 (2013-2015) and (d) resting (2016-2017), compared with the period (1997.10-2000). We can see three bands of activated zones perpendicularly to the major axis of rectangle in the plane view and those inclined to SE in the vertical view for the period of LSSE1. Then we can see expanding of the activated zone both in the plane and vertical views for the resting period (b). The distribution of the activated and quiescent zones for LSSE2 becomes similar to that for LSSE1. And the activated zone extends to NW from the middle of the rectangle for the resting period (d). By the number of the earthquakes in the NW part of the rectangle zone, we could confirm that the seismicity becomes lower for LSSE and higher for resting of LSSE and that the activity becomes remarkable after the latter of 2017. However the activated zone in the resting period (d) seems too small for detection of changes in the crustal seismic activity distinctly.
The spatial distribution of the contraction vectors around the Hamanako-lake area inferred from the GNSS data of GSI shows that maximum axes of contraction indicate a clear NW–SE direction for the periods of resting of LSSE (1997-2001; 2006-2012; 2016-2017), whereas they are not clear for the periods of LSSE (2001-2005; 2013-2015). Since active crustal seismicity seems correlating to large contraction for resting of LSSE, it may represent recovery of the stress state to the ordinary state caused by steady plate motion, which should be kept monitoring further.

Keywords: Seismic activity, Slow slip event, Hamanako-lake

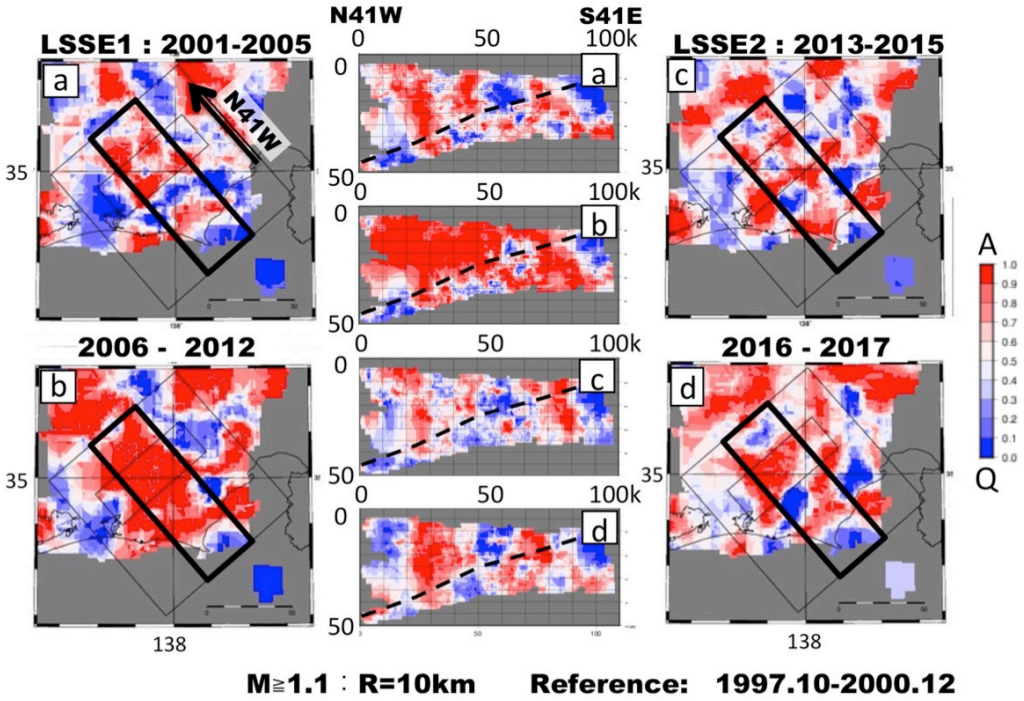

Figure Seismic quiescence and activation in the Tokai region. Left and right pictures show plane views of occurrence probability in the crust. Middle ones show vertical views projected in N41W–S41E beneath the rectangular zone with bold lines. Broken curves, the plate boundaries. Red and blue colors, the most active and the most quiescent cases, respectively. GMT (Wessel and Smith, 1991) is used for illustration.

