Non- double couple source components of long-term SSE: toward understanding of interseismic process for large earthquake generation

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Various types of slow events including slow slip events (SSEs) are detected, and they are explained as fault slip along plate boundary. However, the generation mechanism of SSEs is still debated.
Recently, geological study reveals lots of veins are preserved in tectonic mlanges which were formed along plate interface with the depth of shallow slow earthquake source (<15km) (Ujiie et al., 2016). The veins were formed to fill open cracks, and they are concentrated in the zone of ˜60m thickness. The deformation of normal direction to the plate interface such as the open crack means low normal stress. This can be key phenomenon to understand the SSE generation mechanism. Based on a theory of slip stability, ordinary earthquake is defined as strong unstable slip, while slow slip is defined as weak unstable.
Slip stability is defined as the ratio of K/Kcrit=KL/ σ (b-a), where K is a stiffness of a fault system, Kcrit is a critical one, σ is normal stress, and (b-a) and L are parameters used in rate- and state-dependent friction law (Ruina, 1983). The larger K/Kcrit indicates the more stable (i.e. weaker unstable) slip tends to occur. It shows low normal stress make slip more stable in a unstable zone along the plate boundary (i.e., the plate interface tends to generate SSE). Therefore, non- double couple deformation at the plate interface, especially normal component, will help to understand the generation mechanism of SSEs.
Thus our purpose is to detect the non- double couple deformation at SSE source from another evidence, and we select the Tokai long slow slip event (LSSE) as the target event because the cumulative Mw is 7.1 and large detectable geodetic signals are expected at GNSS observation points. In the following data analysis, we especially focus on a ratio of tensile deformation to fault slip in order to examine how large the source deformation of normal direction is during SSE.
We use finite rectangular fault model as Tokai LSSE source and GEONET F3 solution as crustal deformation data. To estimate the LSSE source model, we use relative displacements in 2001-2003 to 1998-2000 as the reference one in both horizontal and vertical components. Optimized Tokai LSSE source model is located at eastern Aichi Prefecture with the ratio of (tensile deformation) : (fault slip) =1:6 (and estimated values are 1.6cm tensile dislocation and 9.7cm fault slip).
This result of tensile deformation is consistent with the geological result. It will help to understand SSE generation mechanism (e.g., comparing both ratio of tensile dislocation to fault slip).
This result depends on the fault geometry of the model, thus the source model need to be reexamined by using realistic plate interface model along Nankai Trough. Then deeper & larger tensile source will be estimated along the interface.
In the presentation, we will discuss the validity of the results from the point view of another geodetic (e.g., gravity) and petrological results.

Keywords: slow event, Tokai SSE, generation mechanism, tensile deformation