

Driving stress of the 2013 M_w 5.8 Awaji Island earthquake, Japan, inferred from well-constrained focal mechanisms and its seismotectonic implication

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A driving stress of the 2013 M_w 5.8 reverse-faulting Awaji Island earthquake was investigated using well-constrained focal mechanism solutions. The stress tensor inversion and the slip tendency analysis revealed that the stress field within the source region deviates from the surrounding area, in which the stress field locally contains a reverse-faulting component with NNW–SSE compression. This local fluctuation in the stress field is indispensable to produce the reverse-faulting earthquake. The existing knowledge on regional-scale stress (tens to hundreds of km) could not predict the occurrence of the Awaji Island earthquake, emphasizing the importance of estimating local-scale (< tens of km) stress information. We suggest that the local-scale stress heterogeneity has been formed by local tectonic movement, i.e., the formation of flexures in combination with recurring deep aseismic slips. The coseismic Coulomb stress change induced by the disastrous 1995 M_w 6.9 Kobe earthquake increased along the fault plane of the Awaji Island earthquake, while the postseismic one was negative. We concluded that the gradual stress buildup due to the interseismic plate locking along the Nankai trough overcame the postseismic stress reduction in a few years, pushing the Awaji Island earthquake fault over its failure threshold in 2013. The observation that the earthquake occurred in response to the interseismic plate locking has an important implication in terms of seismotectonics in southwest Japan, facilitating further research on the causal relation between the inland earthquake activity and the Nankai trough earthquake. Furthermore, this study highlighted that the dataset before the mainshock may not have sufficient information to reflect the stress field in the source region due to the lack of earthquakes in that region, because the earthquake fault is generally locked prior to the mainshock. Further research is needed for estimating the stress field in the vicinity of an earthquake fault via pre-mainshock seismicity alone.

Keywords: 2013 Awaji Island earthquake, stress, seismotectonics