Width of the strain concentration in the San-in Shear Zone as observed by a dense GNSS network

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The San-in Shear Zone (SSZ) is is a ~N80ºE right-lateral shear zone in southwest Japan with a 30- to 50-km width, where seismic activity and high strain rates have been observed. Although no major active fault is identified in the SSZ, deformation in the area can be modeled by assuming a 5 mm/yr deep creep on a vertical fault with right-lateral motion and conjugate Riedel shears within the shear zone can reconcile the seismotectonics in the area (Nishimura and Takada, 2017). GNSS velocities are well explained by a model having a deep creep on a vertical fault plane, however, it is not clear the extent of the shear zone in the lower crust or how the overall E-W trending right-lateral slip is accommodated by the active faults within it. Thus, we evaluate the width of the shear zone beneath the SSZ utilizing the available GNSS data in the area.

We analyze daily coordinates from continuous GNSS stations in southwest Japan from 1 January 2014 to 31 December 2018. The network is composed by GEONET stations and original stations in the SSZ operated by Kyoto University since December 2014 near the source regions the 2000 Western Tottori and the 2016 Central Tottori earthquakes. Precise daily coordinates for the GNSS sites are calculated with the GNSS-Inferred Positioning System and Orbit Analysis Simulation Software (GIPSY-OASIS), version 6.2 using the Precise Point Positioning processing strategy with ambiguity resolution (Zumberge et al., 1997; Bertiger et al., 2010).

We utilize the horizontal displacement rates distribution with respect to site 0344 (35.09ºN, 134.59ºE) for our analysis. Two major earthquakes affected the crustal deformation in the area during the analyzed period: the 2016 Kumamoto earthquakes (M_w 7.0) and the 2016 Central Tottori earthquake (M_w 6.2). Coseismic and postseismic corrections are applied for the perturbed stations.

We estimate the width of the SSZ for Eastern, Central, and Western Tottori by assuming parallel vertical dislocations below 13 km depth (Omuralieva et al., 2012) in the shear zone. Optimized models based on the horizontal displacement along three profiles reveal different widths of the shear zone (i.e., 72 km in Western Tottori, 38km in Central Tottori and 55 km in Eastern Tottori). They suggest that ductile flow in the lower crust is distributed in a channel beneath the SSZ. However, models with a single vertical fault in the middle of the shear zone are within the data 2 sigma confidence interval. Current GNSS network provides a limited contribution to constraining the width of the shear zone in the lower crust.