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Complementary distribution of various slip events on the plate boundary around Shikoku, southwest Japan

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A wide variety of interplate faulting phenomena have been found in the western Nankai Trough subduction zone around Shikoku, southwest Japan. The Nankai megathrust earthquake occurred in 1946, followed by the significant afterslip. Long-term slow slip events repeated beneath the Bungo Channel in 1997, 2003, and 2009-2010. In addition, short-term slow slip events accompanying deep low frequency tremors occur almost every 6 months. Such a diversity of faulting phenomena may be attributed to the heterogeneous distribution of frictional properties on the plate interface. Then we infer that those different types of faulting behaviors should have complementary distribution one another. There have been several studies demonstrating complementarity of the coseismic slip and the following afterslip. On the other hand, spatial relationship between the afterslip and slow slip events has not been investigated so far. Thus we analyze leveling, tidal, and GPS records to examine complementarity of various faulting phenomena on the plate interface after the 1946 Nankai earthquake.

For this purpose, we conduct inversion analyzes of geodetic data to estimate slip distribution during the coseismic (1929-1947), the postseismic (1947-1964), and the slow-slip periods (1997, 2003, 2009-2010). We apply the same geodetic inversion code with the same three prior constraints: 1) the slip distribution is smooth, 2) the slip direction is in accordance with the plate motion, 3) the low frequency tremor distribution delineates the deeper limit of the fault slip. Relative weights of prior constraints are determined by the ABIC minimum criterion.

As a result, the coseismic slip of the 1946 Nankai earthquake occurred shallower than 20km depth. The afterslip occurred at the deeper extension, in the depth range of 20-30km, beneath the central as well as the eastern Shikoku. On the other hand, the slow slip events occur at the depth of 20-40km to the west, and the slow slip area does not overlap with the afterslip distribution. Based on this analysis, we conclude that the slow slip and the afterslip are spatially separated. Since the 1946 afterslip and the Bungo Channel slow slip events occur in the same depth range, the variability in slip behavior and thus the frictional properties may be ascribed to the dip angle or some other structural features such as the amount of oceanic sediments, rather than the temperature.

Keywords: Shikoku, Nankai Trough, Nankai earthquake, afterslip, slow slip event