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Active intraplate deformation as geodynamic responses to oblique shallow subduction of a flat slab: example from central and southwest Japan

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Subduction of a flat slab has been recognized as one of the primary driving mechanism of wide intracontinental subsidence farther away from the subduction leading edge in many subduction margins. In most cases, however, quantitative and qualitative limitations on chronological constraints prevent comprehensive understanding of these geodynamic linkages. In this study, we show distinct, geologic and seismic evidence for spatial and temporal correlation between plate subduction and intercontinental deformation, mainly driven by dynamic interaction between subducting Philippine Sea (PHS) plate and overriding continental crusts of central and southwest Japan (Eurasian plate) along the Nankai–Tonankai subduction zone since Pliocene. Based on analyses of Pliocene to Pleistocene tectonic histories by use of rich dataset of Neogene stratigraphy, drainage network evolution, and shallow to deep seismic reflection profiles, depocenters of wide sedimentary basins and active thrusting have migrated northward since ca. 5 Ma to present from forearc to backarc of the southwest Japan arc. Median tectonic line, active dextral strike-slip fault as a forearc sliver along the Nankai, is located north of the upward extension of the downdip limit of the interseismic locked zone. Southwest Japan north of the MTL, underlain by the subducting slab with steady state slip (Nakanishi et al., 2002; Kodaira et al., 2004), appears tectonically less inactive than central Japan and has behaved as a less deformed rigid block. Contrastingly, Quaternary active intraplate deformation has been prominent north of the inactive MTL above a shallow flat segment of the PHS plate along the Tonankai. Deep seismic reflection profile images upward corrugated very shallow PHS slab being contact with continental lower crust beneath actively deforming area. We interpreted temporal and spatial correlation of oblique subduction of the shallow and flat, corrugated PHS slab as an essential mechanical role to enhance downward drag of the overriding plate and synchronous strong compressional stress field in the crust. More westerly PHS subduction since middle Pleistocene, suggested by unconformity in the forearc basin deposits and change of sense of fault slip along the active MTL cause stronger horizontal stress in the overriding plate, consistent with increasing geologic slip rate on active structures with this plate configurations. In shorter timescales, during four repetitions of the Nankai subduction zone earthquakes since 17th century, numbers of intraplate large (M>6.5) earthquakes occurred above or near the PHS flat slab are much larger than other surrounding regions. This also may suggest mechanical link between subduction processes and seismicity in the overriding plate.