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Active intracontinental deformation by oblique subduction of corrugated oceanic slab, Kinki Triangle, central Japan

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Driving mechanisms of intracontinental crusts at subduction margins have been a fascinating research problem to understand dynamic interaction between subducting oceanic slabs, overriding continental crusts, and subduction-induced mantle flow. While pioneer works in both active and ancient orogens attributed long-wavelength subsidence to subduction-induced mantle flow, spatial and temporal correlation between migrating broad subsidence and contractional deformation and subduction is elusive in general and remains less understood. In this study, we present geologic and seismic evidence for this correlation mainly driven by dynamic interaction, using datasets on subsidence and active faults from Pliocene and Pleistocene intracontinental sedimentary basins. Kinki Triangle region (KT), well known as dense networks of active faults including seismic source of the 1995 Kobe earthquake, is located on the hangingwall block of the Philippine Sea (PHS)-Eurasian (EUR) plate boundary and contains Pliocene to Pleistocene sedimentary basins distributed over 300 km from the Nankai trough. In our view, Quaternary tectonics in the KT region in central Japan has been strongly controlled by a motion of the PHS plate. Northwestward migration of long-wavelength, ca 1500-m-thick sedimentary basins and coeval thrusting are linked to reinitiation of PHS subduction since early Pliocene suggested by arc magmatism. In addition, paleogeography of sedimentary basins are consistent with location of the northern edge of the arch-shaped PHS slab, based on present and past direction of plate convergence vectors and assumption that the shape of the shallow and flat PHS slab and PHS-EUR convergence rate have been uniform. By deploying four vibroseis trucks, airguns and explosives (100-300 kg) as seismic sources, and 2756 channels with 10 Hz geophones and hydrophones, a 115-km-long, deep seismic reflection profiling across the Lake Biwa, marked by large negative gravity anomaly and rapid subsidence since late Pliocene to present, was carried out to reveal detailed structure of the underlying continental crust and deeper geometries of major active faults. Coupled with this new deep seismic reflection profile imaging upward corrugated very shallow Philippine Sea slab underthrust beneath the continental lower crust beneath actively subsiding and deforming area, we interpreted that the migration of the subsidence has been formed by downward drag of the lower crust by NW subduction of the shallow and flat PHS slab. More westerly subduction of the PHS since 1.5 Ma might increase along-arc component of compression within the EUR lithosphere above shallow, upward concave PHS slab. In conclusion, we ascribe mechanism of this strong correlation in time and space between reinitiated PHS subduction and intracontinental deformation to downward drag of the continental lithosphere and/or mechanical erosion of the lower crust above highly oblique subduction of the arch-shaped, very shallow oceanic slab.