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The transition from oceanic to continental subduction, illuminated by multi-scale deep transects of the oblique Taiwan arc-continent collision

Yu-Huan Hsieh (1), John Suppe (2,3), Char-Shine Liu (1,4), and Hsin-Hua Huang (5)

(1) Ocean Center, National Taiwan University, Taipei, Taiwan (luckyuki9@gmail.com), (2) Department of Earth and Atmospheric Sciences, University of Houston, Texas 77204, USA, (3) Department of Geosciences, National Taiwan University, Taipei, Taiwan, (4) Institute of Oceanography, National Taiwan University, Taipei, Taiwan, (5) Institute of Earth Sciences, Academia Sinica, Taipei, Taiwan

Taiwan is the currently fastest convergent arc-continent collision on Earth (∼90 mm/y), in which both plates subduct, with 30-40 mm/y classic subduction of the Eurasian lithosphere and 50-60 mm/y secondary subduction of forearc and arc lithosphere of the Philippine Sea plate. We present a set of 5 multi-scale geophysical/geologic transects across the oblique transition of the Eurasian plate boundary from continental rise to shelf subduction. The multi-scale transects extend from the surface to ∼400 km depth, using high-resolution local and regional tomography, OBS data and well-located seismicity to define the deep crustal and lithospheric structure, whereas surface geology, geodesy, high-resolution bathymetry, PSDM seismic reflection data, OBS data, local tomography and seismicity are integrated to define the uppermost crustal structures and kinematics above the subduction interfaces (5-10 km depth).

On the Eurasian plate, the uppermost sedimentary basins are shortening and deforming as a largely west-vergent fold-and-thrust belt that roots into the 5-10 km deep thin-skinned detachment of the Eurasian subduction interface, whereas the lower sediment basins, lower crust and mantle lithosphere are subducting under the accretionary complex of the Taiwan mountain belt and Manila Trench. The subduction interface under the metamorphic rocks of the Taiwan Central Range and Hengchun Ridge is imaged as a widespread velocity inversion at ∼10 km depth, locally illuminated by seismicity. Subducted Eurasian lithosphere in imaged tomographically extending to the mantle transition zone, with Benioff-zone seismicity extending to ∼300 km depth, but only within transitional oceanic mantle lithosphere.

On the Philippine Sea plate, the shallow parts of the Luzon Trough forearc basin, the Luzon Arc and the Huatung Basin to the east are shortening as a thin-skinned largely east-vergent fold-and-thrust belt (but west-vergent in the Luzon Arc of the Taiwan Coastal Range) above a shallow ∼5 km detachment, currently consuming ∼60 mm/y. Deeper lithosphere of the Luzon forearc and arc is subducting in secondary west-vergent subduction, as first proposed by Chemenda et al. (2001) and now imaged tomographically to at least ∼90 km depth. This transient subduction, which accounts for ∼125 km collapse of the forearc, Luzon Arc and Huatung Basin of the western edge of the Philippine Sea plate, is associated with a change in motion of the Philippine Sea plate ∼2 Ma. The subduction rate of Eurasian lithosphere has remained at ∼30 mm/y since about 15 Ma, therefore it is an open question to what extent the secondary subduction of the Philippine Sea forearc is a necessary expression of the transition from oceanic to continental subduction, nevertheless the possibility remains compelling in light of the mechanical arguments of arc and forearc weakness presented by Chemenda et al. (2001).