

The Arc-Continent Collision in Taiwan: a New View of a Classic Orogen

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We present a new compilation of magnetic, geologic, GPS and seismic data from the arc-continent collision in Taiwan and propose that: 1) an unusually wide zone of transitional crust (~300km) was subducted prior to the ultimate collision between the arc and a continental margin promontory now centered beneath central Taiwan, and 2) transitional crust is first subducted to ~50 km in southern Taiwan and then detaches from the down-going lithosphere and, due to its positive buoyancy, drives uplift (up 15 mm/yr) and extensional deformation in the central part of the orogen.

The continental margin promontory in Eurasian crust resulted in a three-fold division of the fold and thrust belt as it developed from 2-3 Ma to present. In southern Taiwan, continental crust of normal thickness (~ 30 km, e.g., the Peikang High) limited westward propagation. In the north, thick sedimentary sequences of the Taishi Basin allowed the thrust belt to propagate substantially west of the promontory, resulting in a left-lateral offset between the northern and southern belts. In central Taiwan, in the area of the promontory, progressively younger thrusts rotated CCW as the northern belt advanced and the southern belt remained pinned by continental crust, resulting in a sigmoidal shaped orogen in map view. The partially subducted promontory currently lies beneath the area that slipped during the 1999 Chi-Chi earthquake and partially defines the Puli topographic embayment.

Integration of a suite of new and recently re-interpreted profiles of the 3-D crustal velocity structure with seismic and geomorphic data from the southern Central Range suggest a crustal-scale, west-verging thrust in the south whereas the hanging wall of the same crustal-scale surface in the north is dominated by extensional deformation. The extent and geometry of the thrust in the south is indicated by contours of P-wave velocity that are progressively overturned from south to north, placing high Vp rocks above low Vp rocks. The interpreted thrust dips gently east (15-20 degrees) and carries pre-Tertiary metamorphic rocks and Eocene to Miocene rocks with a well-developed slaty cleavage in its hanging wall. The thrust is interpreted to cut up section to the west and link with the basal detachment of the fold-and-thrust belt. Further north, in central Taiwan, this crustal-scale surface separates an aseismic zone below from a dense cluster of seismicity above. Focal mechanisms for the earthquakes are dominated by NE-SW extension. Leveling data along the South Cross-Island Highway also indicate unusually high uplift rates (up to 15 mm/yr) and Vp attenuation studies suggest anomalously high temperatures and/or the presence of fluids. Vp tomography data also suggest detachment of the crust from the mantle in this area of central Taiwan.

Finally, the hanging wall of the thrust/normal fault also correlates with anomalous areas of low topographic relief that straddle the crest of the central and southern parts of the range. The areas of low relief are fringed by stream channels with relatively high stream gradient indexes and do not appear related to weaker rock types, glacial erosion, or lower rock uplift rates along the range crest. We propose that the surfaces represent

relict topography that formed prior to a recent acceleration in rock uplift rate, consistent with the presence of a propagating, crustal-scale thrust in the south and detached crust in the north. Taken together, these results raise questions about the notion of steady state topography and critically tapered wedges in Taiwan.