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THE ACTIVE DETACHMENT OF TAIWAN ILLUMINATED BY SMALL EARTHQUAKES: CRITICAL-TAPER WEDGE MECHANICS AND CONTROL OF FIRST-ORDER TOPOGRAPHY

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We use 110,000 small (average M_L=2) earthquakes to locate and map active faults in 3-D within the Taiwan arc-continent collision. The upper crustal structure is dominated by a nearly horizontal band of small earthquakes at ~10 km depth, which is interpreted to seismically illuminate the main detachment zone of the mountain belt. The existence of a through-going detachment has been controversial in Taiwan, therefore this study provides new data. The small earthquakes also illuminate other fault zones that abut the detachment zone, confirming its through-going nature.

The detachment zone steepens below eastern Taiwan to 30–90 degrees and reaches depths of 30–60 km. Knowing the geometry of the main detachment, we could measure directly for the first time the wedge tapers over the entire E-W width of the mountain belt. We concluded that above 15-20 km depth the wedge is at critical taper and shows homogeneous brittle behavior, while below this depth larger tapers are consistent with a wedge that is undergoing the brittle-plastic transition. The 3-D shape of the detachment zone in relation to topography allows a new test of critical-taper wedge mechanics and suggests that the shape of the detachment controls the reversal of topographic slope across the Taiwan mountain belt.

The observed tapers are significantly smaller than those previously assumed for Taiwan on the basis of extrapolation of detachment dip at the toe, and imply a substantially weaker detachment. The very weak apparent basal friction for Taiwan strengthens the observation that very large faults such as the San Andreas are apparently very weak, for reasons that are as yet uncertain.

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