

Structure of the western Taiwan thrust belt and its present activity

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To be presented GSA Denver 2004

It has long been known that the Taiwan fold-and-thrust belt is a result of active arc-continent collision. In 1999 the $M_w=7.6$ Chi-Chi classic thrust-belt earthquake shocked the Taiwan island in the early morning but the aftermath has brought about substantial advance in new data and understanding of this active thrust belt, including the role of large earthquakes like Chi-Chi in their growth. Based upon seismic imaging, surface geological data and more than 110,000 relocated small earthquakes, which allow imaging of creeping deep faults, we are able to construct a set of well constrained balanced cross sections including a regional section across central Taiwan. These data also constrain 3D models of several important faults in the thrust belt (including the faults that ruptured during the Chi-Chi earthquake) and of the Taiwan Main detachment under the entire mountain belt.

The structure of the 50 km wide Foothill belt of central Taiwan is classic ramp-flat geometry with the frontal three faults (Changhua, Chelungpu, Shuangtung) stepping up from a shallow detachment (1-6 km) in the Pliocene Chinshui Shale. To the east, under the Tili thrust, this shallow detachment is linked by a deep ramp to the ~10 km deep Taiwan Main detachment illuminated by microseismicity and running in Eocene Shihpachungchi Formation. This deep ramp is localized by the preexisting Shuilikeng normal fault of the rifted margin. The Taiwan Main detachment is gently dipping under the Central Mountains but bends down steeply into the mantle under eastern Taiwan, illuminated by microseismicity to depths as great as 50 km. The total slip on the four main thrusts of the Foothills belt is more than ~40 km (Changhua 2.8 km, Chelungpu 12-14 km, Shuangtung 12 km and Tili >12 km). From geodesy the present interseismic shortening rate is ~1 cm/yr which represents only a small fraction of the total ~7 cm/yr plate convergence. Most plate convergence is currently taken up in eastern Taiwan. In the western Foothills most or all of the slip currently consumed on the active frontal Changhua blind-thrust shear fault-bend fold and on the Chelungpu thrust ramp that slipped 3-10 m in the Chi-Chi earthquake. The spatial distribution of slip in the Chi-Chi earthquake is quite heterogeneous, showing that the long-term displacement must be the summation of many dissimilar earthquakes.