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Geometric Evolution of the Northern Chelungpu Fault, Taiwan: Effects of Ramps and Erosion on Fault Structure

The 9/21/99 earthquake in Taiwan ruptured along the ~30œ east-dipping Chelungpu fault. The northern region of the rupture trace was located approximately 1 km into the hanging wall (east) of the older Sanyi fault. The recent rupture indicates that faulting is migrating eastward in an ''out-of-sequence'' manner within the westward-vergent fold-and-thrust belt. We interpret the breaking back to be due to hanging wall deformation and a thickening sequence (>1500 m) of Quaternary fluvial deposits in the hanging wall of he Sanyi thrust, and erosion of the Chelungpu thrust sheet. Resistance to slip along the Sanyi fault increased over time (~1 Ma) as footwall sediments accumulated.
When resistance to slip on the Sanyi fault became greater than for slip on the of the 40-60œ, east-dipping shale beds in the hanging wall, the fault migrated eastward, parallel to bedding. Erosion of the hanging wall by the Tachia river may have also contributed to eastward migration by reducing the wedge taper of the fold-and-thrust belt below a critical value, inducing faulting in the hanging wall in order to thicken the wedge. The bed-parallel, young (~50 ka) structure of the Chelungpu fault contains in a thin, mm-scale gouge zone, whereas the older fault segment contains a wide (>20 m), diffuse fault zone containing may gouge zones. These contrasting properties may have unique fluid-flow properties, causing reservoir heterogeneity. This investigation indicates that hindward migration of an individual fault can occur simultaneous with foreland-progression of the fold-and-thrust belt, producing different fault properties within close proximity and similar tectonic setting.