



Shallow structure and fault architecture of an active creeping thrust fault: the Chihshang fault at Chinyuan (Taiwan)

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The Chihshang fault is a 35-km-long active segment of the Longitudinal Valley fault, which is situated along a plate suture between the Philippine Sea and the Eurasian plates in eastern Taiwan. In this study, we combined geological analysis of fault structure in Holocene unconsolidated gravel layers and current geodetic measurements to provide complementary information to decipher the near-surface structure of this reverse fault with a rapid creep rate of about 3 cm/yr. We conducted a variety of measurements and analyses at 'Chihshang Active Fault Observatory' in Chinyuan village, including surface-rupture mapping, three shallow boreholes drilling and core analysis and kinematic analysis of geodetic measurements. We found that the Chihshang fault has a three-branch fault system with a rather diffused fault zone in the Chinyuan alluvial fan, which is composed of at least 100 m thick alluvial deposits. Outside of the Chinyuan River channel, the Chihshang fault exhibits a single fault system with a sharp lithological contact. Combining the levelling results and subsurface profiles from trench excavation, we interpret that the three fault branches locally developed a pop-up structure in a 50-m-wide zone within alluvial gravel layers. Based on the ratio between the levelling vertical displacements and the creep meters and GPS horizontal displacements, we obtained dip angles of 34-42°, 60-65° and 16° for two west-vergent thrusts and an east-vergent backthrust, respectively, for these three branches. This pop-up was estimated to develop at the uppermost 30-40 m unconsolidated gravel layers during the last few thousand years above the main fault with a dip angle of about 42°. By compiling the ages data in the boreholes, trenches and terraces, we estimated a long-term relative uplift rate of 2.2-2.4 cm/yr in the hangingwall of the Chihshang fault and an average alluvial sedimentation rate of about 1.0-1.2 cm/yr during the past a few thousands years. As a result, the uplift rate for each of the three fault branches at the Chihshang Observatory was slightly less than the deposition rate of the Chinyuan River. Consequently, no geomorphic fault scarp can be observed in area of the three-branch fault system.