Neotectonics of Taiwan, with a focus on the Longitudinal Valley suture, eastern Taiwan

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A. The tandem suturing of Taiwan, and its neotectonic architecture

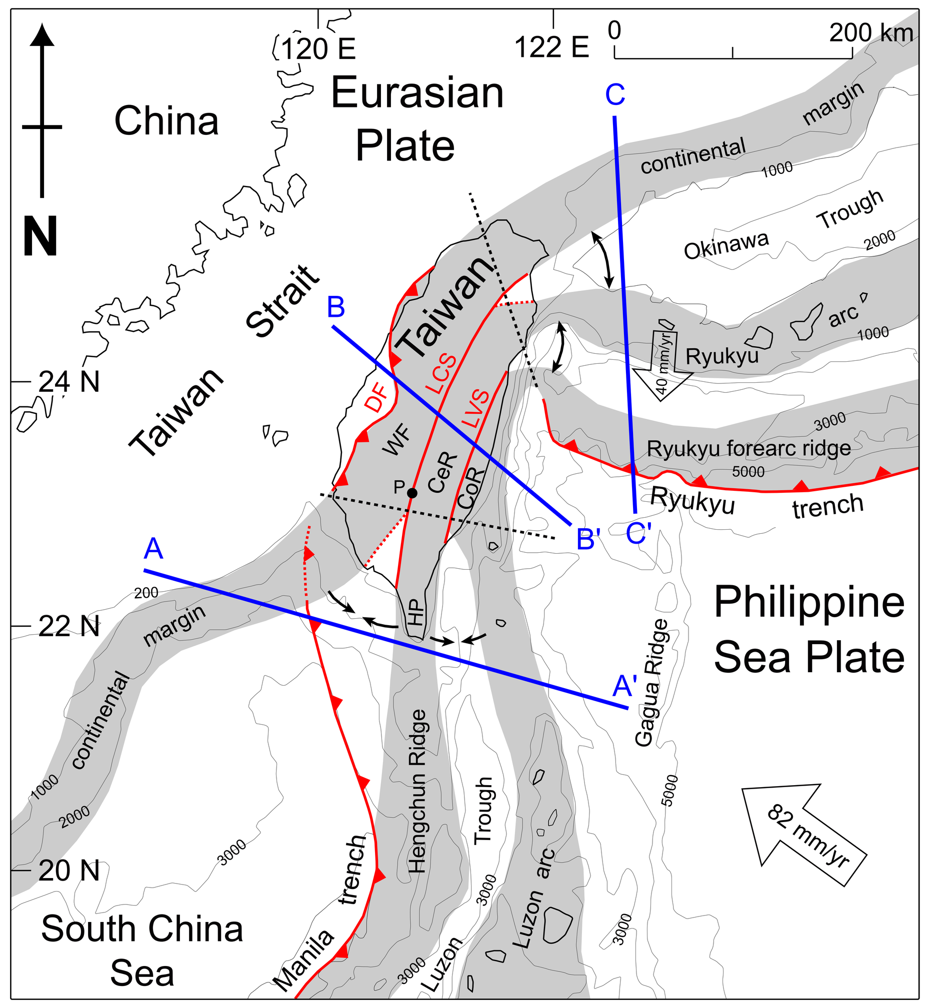

Figure 1. Taiwan is experiencing a tandem suturing of a volcanic arc and a sliver of continental crust to continental margin. In the south, the Luzon volcanic arc is converging on the Hengchun forearc ridge, which is, in turn, converging on the Chinese continental margin. Suturing of these three elements occurs in the middle of the island. In the north, both sutures are disarticulating, to form both the Okinawa Trough and troughs south of the Ryukyu island arc. Black dashed lines are the northern and western limits of the Wadati-Benioff zone of the two subducting systems, taken from the seismicity database of the Central Weather Bureau, Taiwan. Bold lines indicate cross-sections of Fig. 3. DF: deformation front; LCS: Lishan-Chaochou suture; LVS: Longitudinal Valley suture; WF: Western Foothills; CeR: Central Range; CoR: Coastal Range; HP: Hengchun Peninsula; P: Outcrops of pillow lava along the western suture.

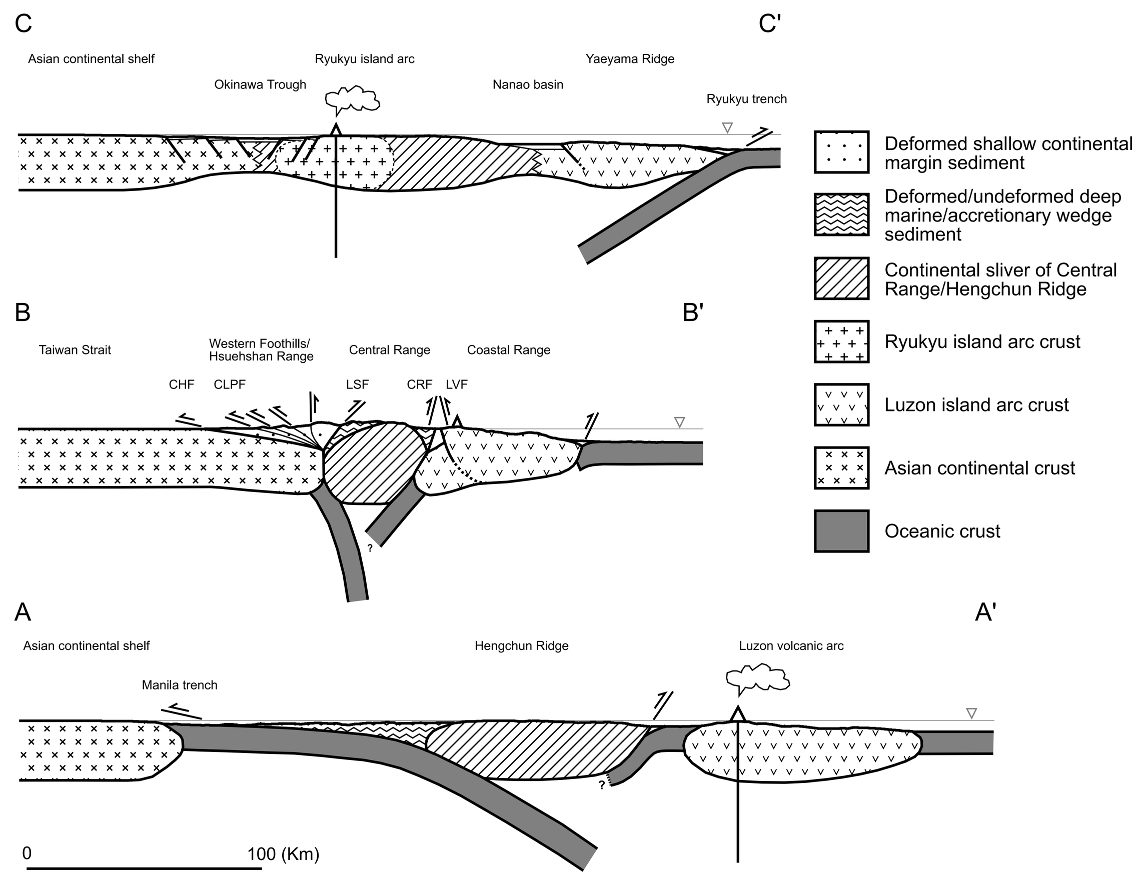

Figure 2. Three schematic crustal cross-sections across Taiwan illustrate three stages in the process of tandem suturing and disengagement. A. Section just south of Taiwan shows the final stages of subduction and consumption of oceanic lithosphere between the three buoyant terranes. B. Section across central Taiwan shows relationship of the three terranes during suturing. C. Section north and east of Taiwan shows the subduction of the Philippine Sea plate and disengagement of the three terranes across the sutures. CHF: Changhua fault; CLPF: Chelungpu fault; LSF: Lishan fault; CRF: Central Range fault; LVF: Longitudinal Valley fault. No vertical exaggeration.

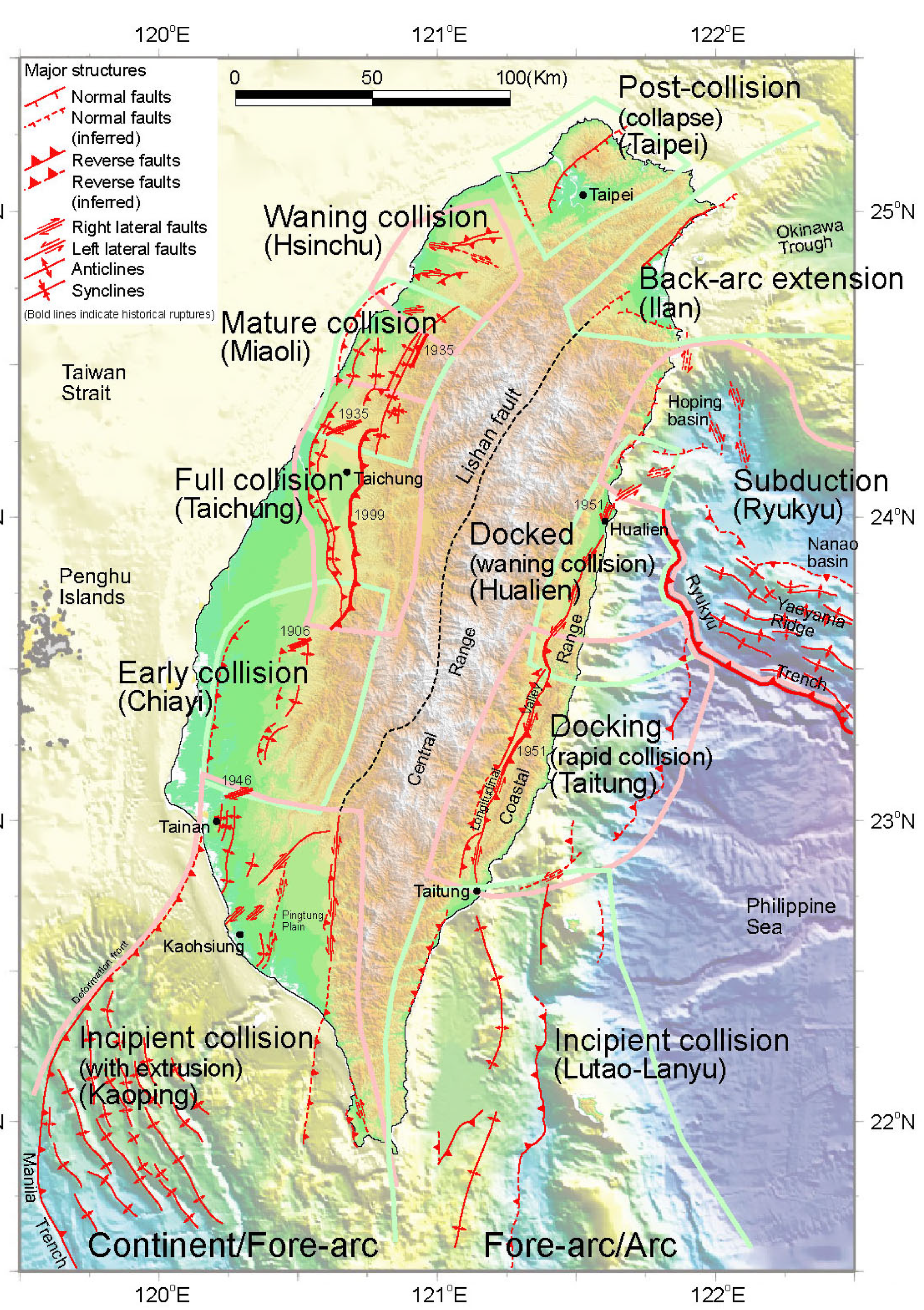

Figure 3. Map of major active faults and folds of Taiwan (in red) shows that the two sutures are producing separate western and eastern neotectonic belts. Each collision belt matures and then decays progressively from south to north. This occurs in discrete steps, manifested as 7 distinct neotectonic domains along the western belt and 4 along the eastern. A particular assemblage of active structures defines each domain. For example, two principal structures dominate the Taichung Domain. Rupture in 1999 of one of these, the Chelungpu fault, caused the disastrous Chi-Chi earthquake. The black structure that runs between the Kaoping and Ilan Domains is the suture between forearc ridge and continental margin.

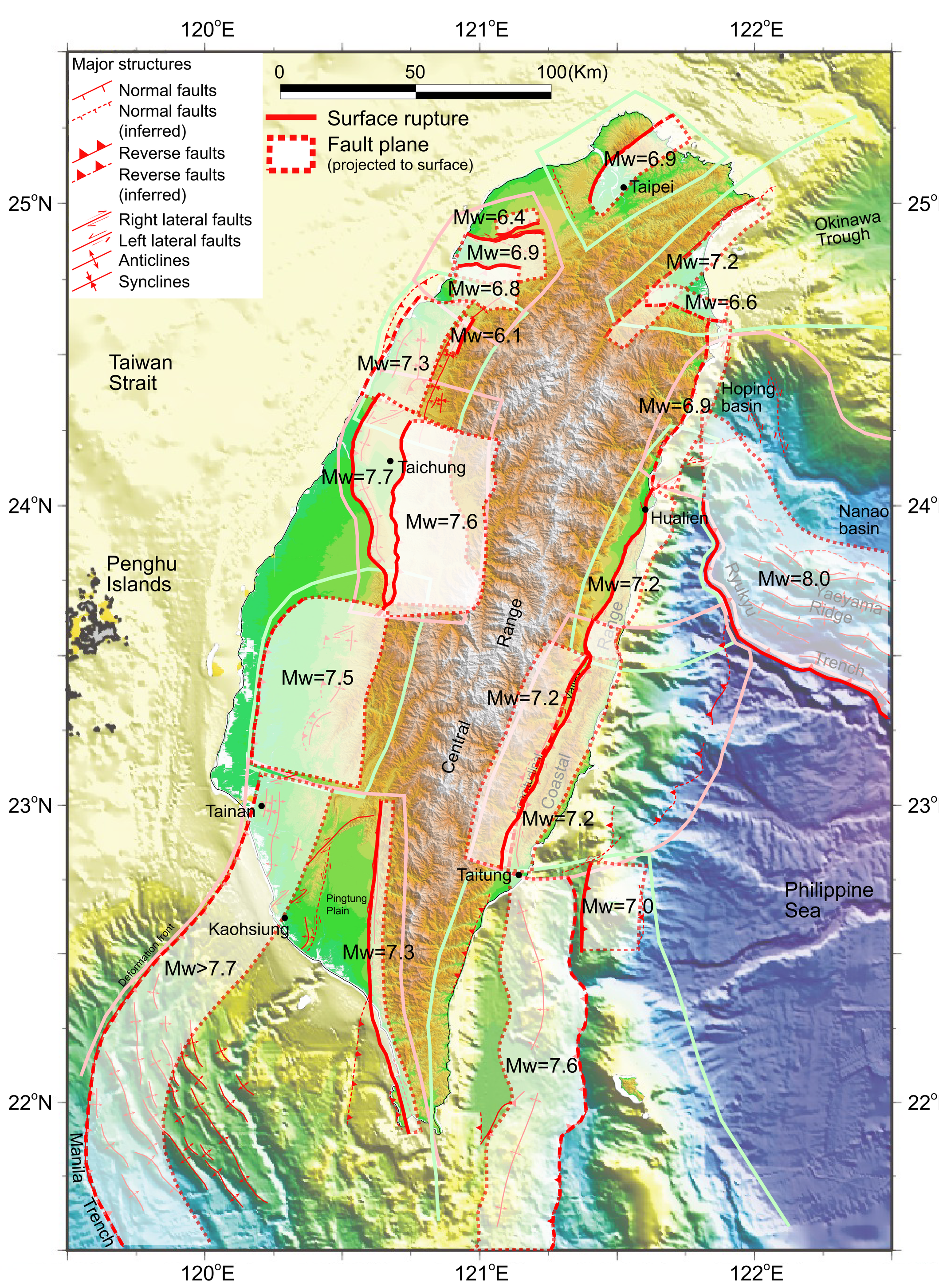

Figure 4. Proposed major sources for future large earthquakes in and around Taiwan. Bold red lines are proposed future ruptures, and the white patches are rupture planes projected to the surface. Here we have selected only a few representative scenarios from Table 1 to show in this figure. Earthquake magnitude of each scenario is predicted value from our calculation.

B. Characteristics and long-term slip rate of the Longitudinal Valley fault

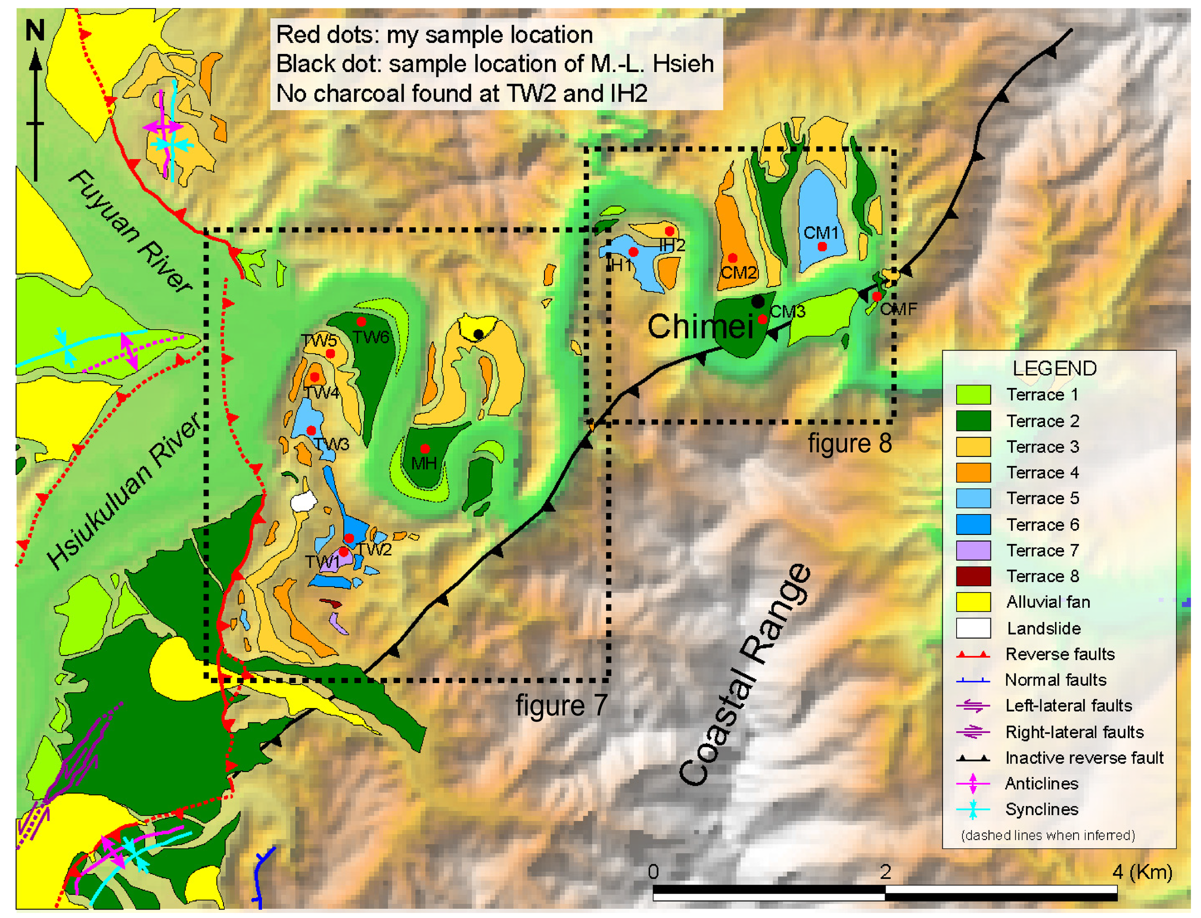

Figure 5. Map of river terraces along the Hsiukuluan River, eastern Taiwan. The age of these river terraces will enable us to determine the local uplift rate, thus providing information about the characteristics and the long-term slip rate of the Longitudinal Valley fault.

Figure 6. As many as seven terraces can be identified here near the small village of Tewu. These terraces recorded the uplift history in this section of the Hsiukuluan River. In order to look for datable materials, such as charcoal in the sediment, we have made several pits into the surface on these terraces (marked by red cross).

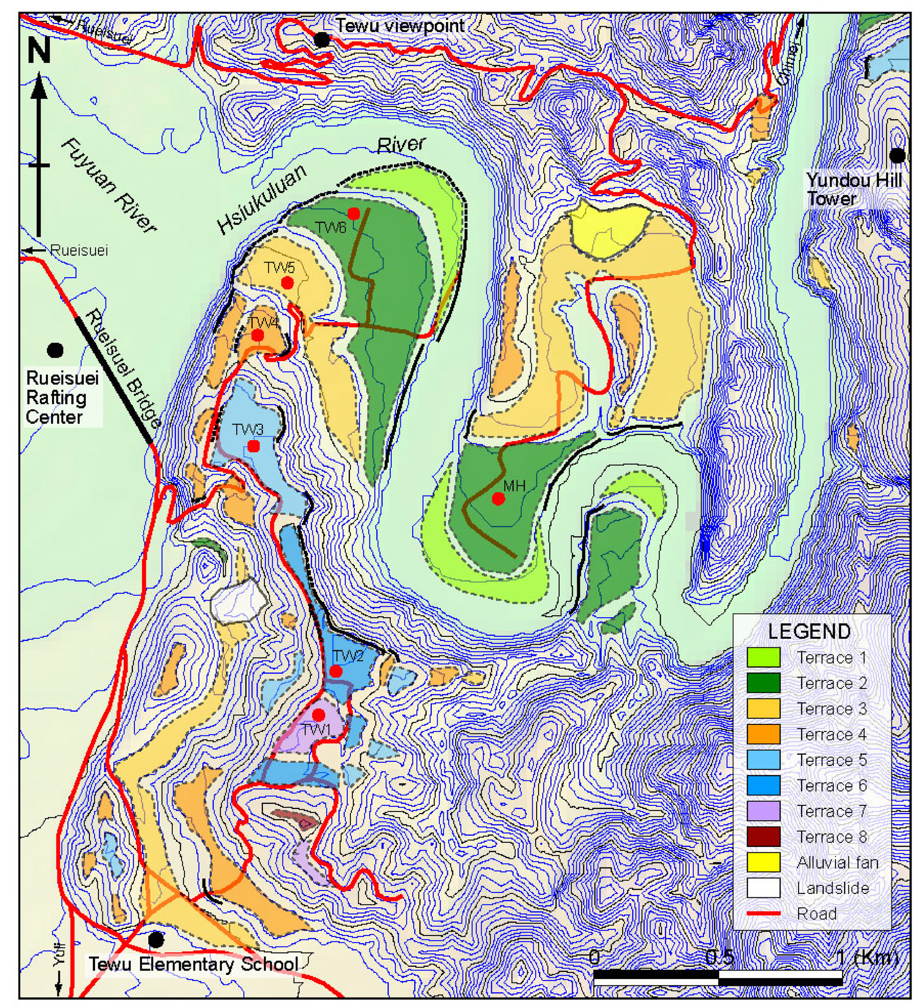

Figure 7. Detailed map of river terraces in Tewu area, showing the distribution of terraces and pit locations. Thin dashed lines are the boundary of terrace surfaces, and bold lines show the strath of terraces, wherever visible in the field.

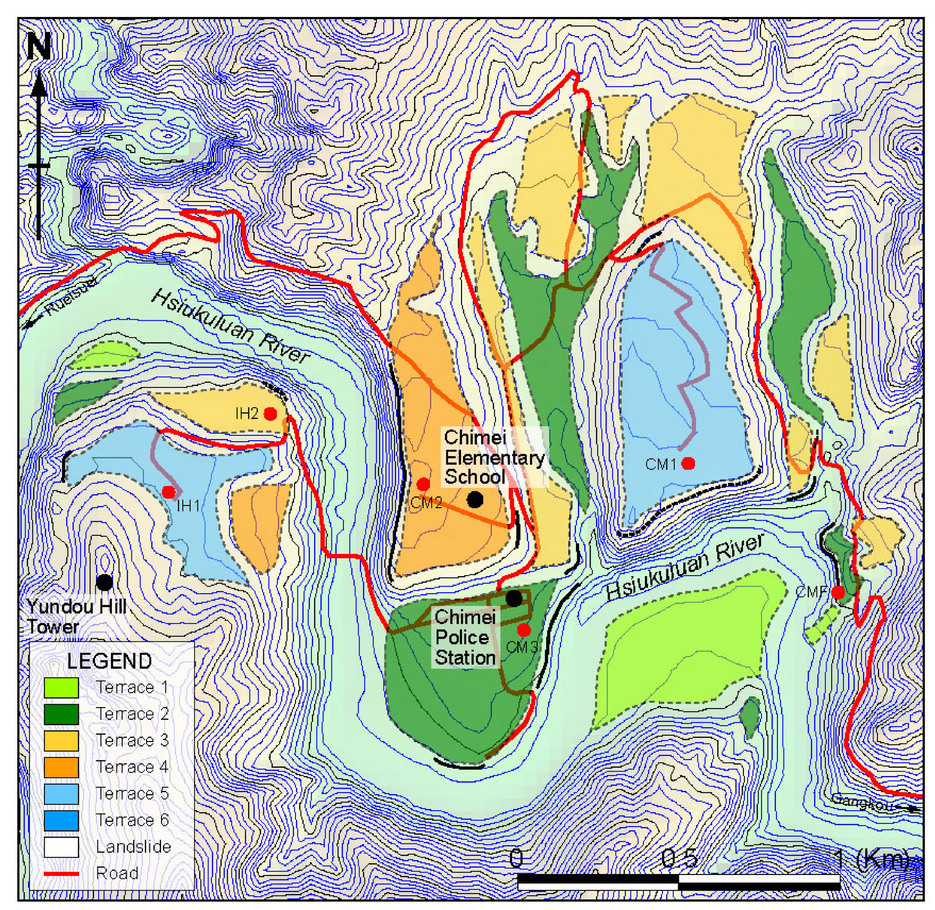

Figure 8. Detailed map of river terraces in Chimei area, showing the distribution of terraces and pit locations. Thin dashed lines are the boundary of terrace surfaces, and bold lines show the strath of terraces, wherever visible in the field.

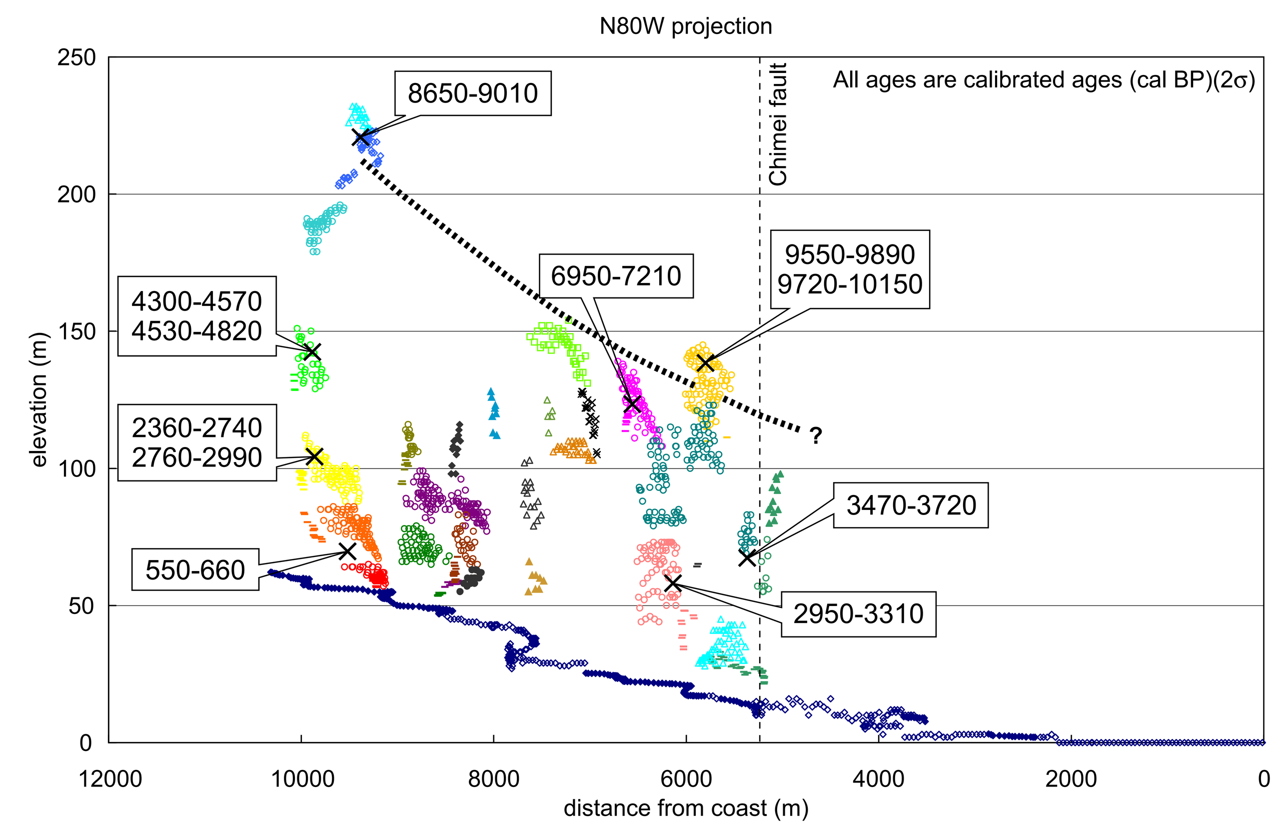

Figure 9. Preliminary correlation of river terraces along the Hsiukuluan River. Each different color represents a different level of terraces. Blue dots indicate the river profile of the Hsiukuluan River. All of the terraces and the river profile were projected on to the plane in local dip direction of the bedrocks (N80W). Our dating results and the correlation of the terraces suggests that the uplift rate of the westernmost Coastal Range is highest currently, and decreases to the east.

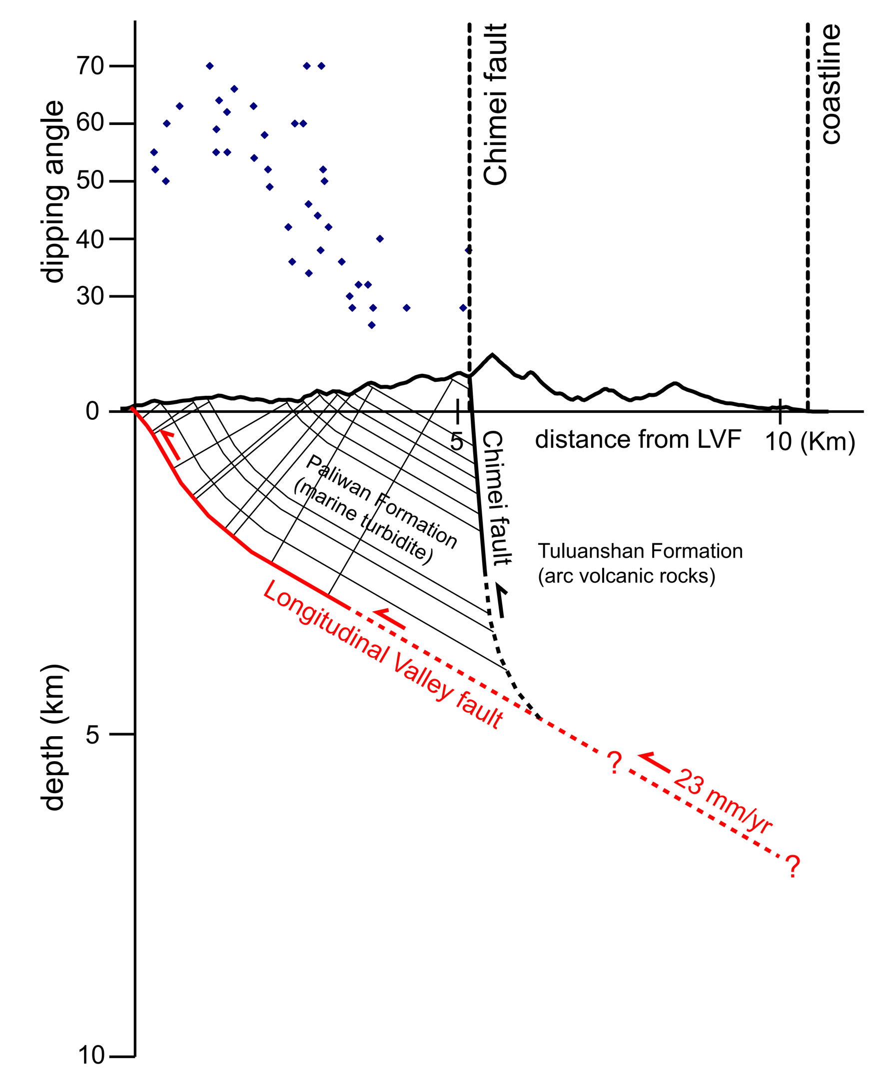

Figure 10. Reconstruction of the subsurface geometry of the Longitudinal Valley fault near Hsiukuluan canyon, from bedrock dip angles. The azimuth of the section is approximately N80W. This model indicates that the slip rate on the fault is about 23 mm/yr and that all of the deformation is accommodated by the slip along the fault plane, with no internal deformation of the beds.