Crustal deformation and block kinematics of Taiwan

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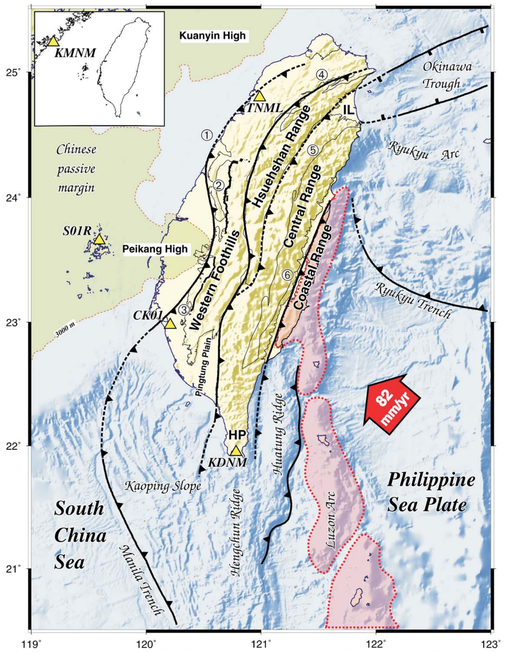
Abstract

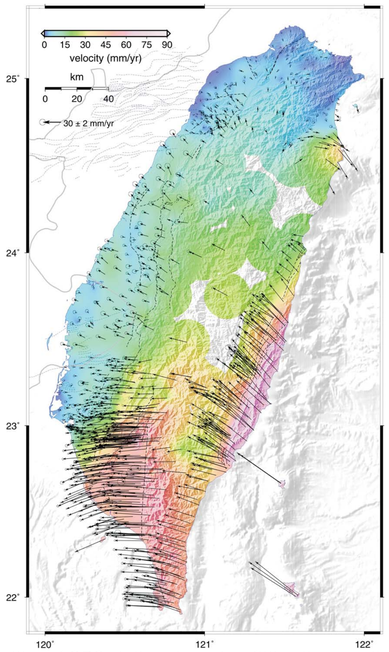
- We analyzed 825 GPS observations in Taiwan to understand the kinematics of present-day interseismic crustal deformation of the Taiwan mountain belt.
- Block rotations are mainly concentrated on northern Taiwan, which are influenced by the presences of basement highs and Philippine Sea plate. On the contrary, block translations are mainly occurred in southern Taiwan.
- Three geological areas are defined in northern Taiwan:
  (a) Waning collision area, the tectonic blocks represent a significant NW-SE internal contraction with a small block rotation rate (<3.0°/Myr).
  (b) Outer range of the transition zone, the tectonic blocks are characterized by a coherent rotation (low internal strain rate of <0.1μstrain/yr) with an angular velocity of ~5.1°/Myr, where the Euler pole is located near its southeastern boundary.
  (c) Inner range of transition zone, the tectonic blocks reveal remarkable NW-SE internal extension with ultra-rapid clockwise rotation (~5.1°/Myr), where the Euler pole is near the southern boundary of the range close to the collision corner. Trench roll-back and back-arc opening are probably superposed on the arc-continent collision-induced rotation in the inner range of the northeast Taiwan mountain belt.
- In southern Taiwan, the interaction between the Peikang basement high and westward propagation of the accretionary wedge results in the material across the southern Taiwan to move toward WSW, sub-parallel to the southern edge of the continental margin, via strain partitioning along several major structures.

Geotectonic Framework



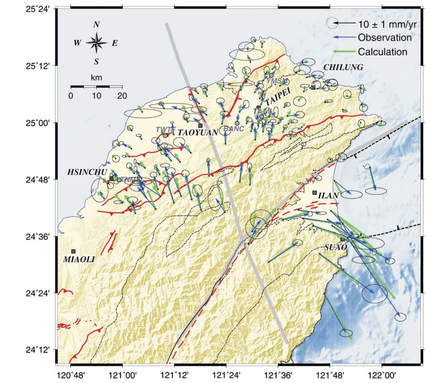
Taiwan, seated at the junction of the Manila and the Ryukyu subduction systems, is a classical case of the ongoing arc-continent collision due to convergence between the Eurasian and the Philippine Sea plates.

GPS Velocity Field

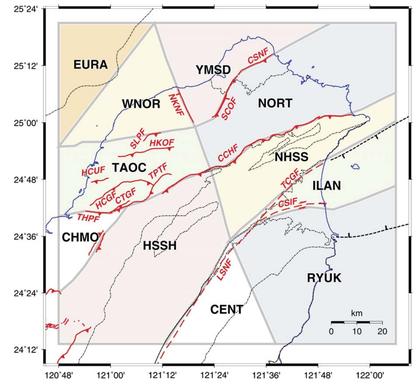


Velocities of GPS stations based on fitting the coordinate time series in a specific time span with a linear function using the least-square regression method. The estimated GPS velocity field is relative to the station, S01R, at the Chinese continental margin.

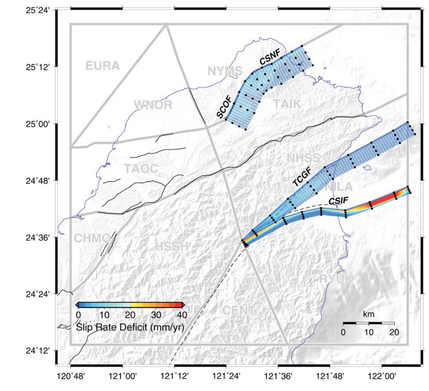
Block Modeling (DEFNODE, McCaffrey, 2002) of Northern Taiwan



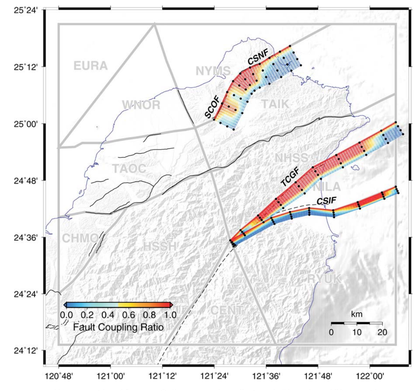
GPS velocities in northern Taiwan with respect to station S01R. Blue arrows are shown as velocities. Green arrows are synthetics. A 95% confidence error ellipse is shown at tip of each vector.



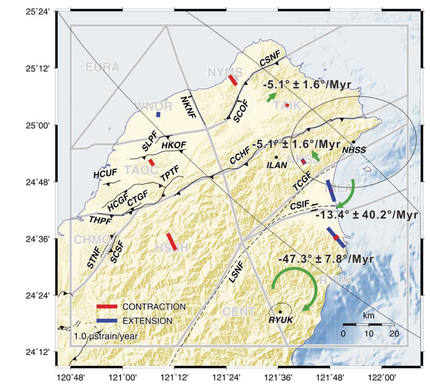
Tectonic block configuration of northern Taiwan. Thick grey lines show the block boundaries. Block names are represented in black bold. Red lines are the positions of major faults.



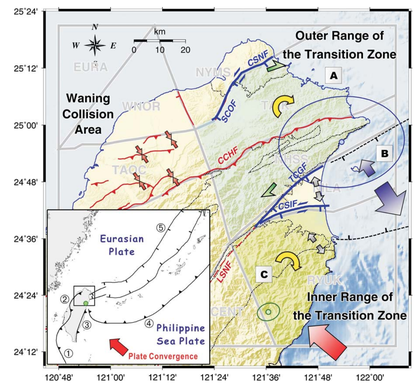
Magnitudes of slip rate deficits on the Chinshan-Sanchiao fault, the Toucheng fault, and the Chaoshui fault in the northern Taiwan.



The coupling ratio (from 0 "creeping" to 1 "locked") on the Chinshan-Sanchiao fault, Toucheng fault, and Chaoshui fault.

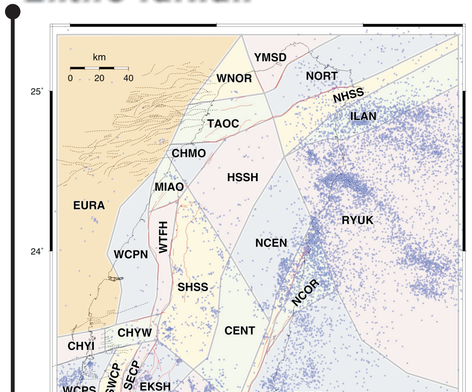


Locations of the Euler poles, angular velocities, and distribution of permanent strain rates for our optimal block model. Black dots show the locations of the Euler poles and their 95% confidence error ellipse are shown with black ellipses, The thick blue bars reflect the amount and direction of principal extension rates and the red ones reflect the principal contraction rates.

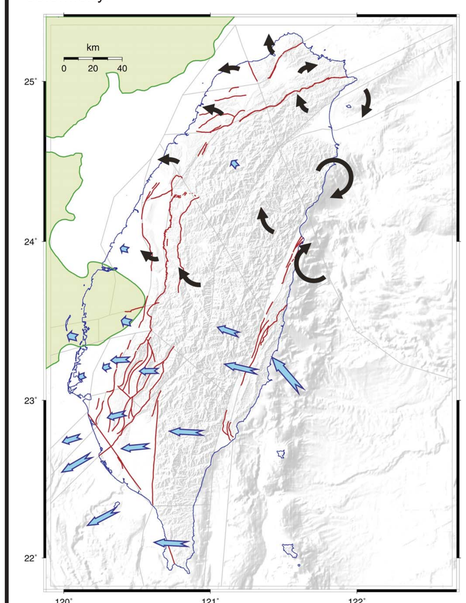


Tectonic model for northern Taiwan. A: right-lateral shear zone. B: back-arc extension in the Okinawa trough. C: plate corner rotation resulted from collision-induced block rotation. The small red and gray arrows represent the direction of contraction and extension, respectively. Numerals, 1-5, are the Manila trench, the deformation front, the Longitudinal Valley fault, the Ryukyu trench, and the Okinawa trough, respectively.

Block Modeling of Entire Taiwan



Tectonic block configuration of Taiwan. Thick grey lines show the block boundaries. Block names are represented in black bold. Red lines are the positions of major faults. Blue circles are distribution of Taiwan seismicity.



Tentative tectonic model of Taiwan. Black arrows denote the direction and magnitude of block rotations. Blue arrows represent the direction and magnitude of block translations.