Kinematics and exhumation history of the Central Range, Taiwan

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Analyses of structure, incremental strain histories, GPS observation and thermochronometry in the eastern Central Range of Taiwan provide insights into the kinematics and exhumation processes within the metamorphic core of the Taiwan arc-continent collision. The obliquity between the Luzon arc and the Asian passive margin results in a collision that propagates southward through time, and this time-space equivalence allows north to south variations in structural and thermal history to be evaluated in the context of mountain belt evolution. The results of these analyses are consistent with a three-dimensional displacement field that is fixed relative to the geometry of a thin-skinned double-sided wedge associated with the strain partitioning related to margin-parallel component into the interior of the mountain belt.

There are four general structural events in the eastern Central Range of Taiwan. D1 involves west-vergent folding and development of a slaty cleavage/schistosity with growth of fibrous overgrowths and ellipsoidal chlorite-mica aggregates. D2 is represented by east-vergent folds that deform the earlier fabrics and are associated with crenulation cleavages. D3 structure is north-vergent fold mainly observed in southeastern Taiwan. D4 is defined by brittle normal faults that crosscut all the earlier fabrics. Results of fabric analysis indicate that the ductile deformation changes from west-directed thrusting through left-lateral shearing to back-thrusting from west to east. Chlorite-muscovite aggregates are prolate as a result of crack-seal growth oriented parallel to the cleavage and the regional stretching lineation as the D1b portions of pressure shadow. Maximum stretch of aggregates ranges from 190 to 602 percentage.

Using published GPS measurements and geological data, we have investigated the current deformation rates and the regional kinematics for the southern region of the Central Range, Taiwan. The Central Range is a fault-bounded structural high cored by pre-Tertiary basement. The new results from station-to-station evaluation of GPS data along the Southern Cross-Island Highway suggest a complex pattern of deformation across this region. The difference between the ductile and brittle deformation histories in the Central Range reflects the particle paths of accreted Asian crust within the mountain belt. As crust passes west to east relative to the Philippine Sea Plate, the rocks exhumed in the west have experienced an early history in the deeper parts of a west-vergent thrust belt followed by left lateral shear during exhumation. In contrast, the rocks in the east record an early history within the west-vergent thrust belt that is overprinted by ductile left lateral shear and the contrasting kinematics at the east-facing wedge and the boundary with the Longitudinal Valley.

Results of T-t path analysis from different locations illustrate that the eastern Central Range has a very similar thermal history from north to south, indicating the mountain belt reaches a thermal steady state. The fission track results north of the boundary between reset and unreset values depict constant ages at varying distances north of the boundary, suggesting that thermochronometers in the northern, more mature areas of the orogen record a balance between uplift and erosion. The fission track data are also consistent with south-to-north development of an exhumational steady state. The robust results of idealized exhumation processes suggest that partitioning of exhumation processes have strong relationships with dip of backstop, accretion time, and exhumation rate at the surface. The depth dependence of ductile thinning and estimation of accretion rate do not influence the partitioning of exhumation processes.