Geodynamic Evolution of The Active Banda Arc-Continent Collision

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Multidisciplinary studies of deformation patterns at a range of temporal scales reveal the incremental tectonic development of the early stages of an active collision zone. The obliquity of collision in the Banda arc provides a way to reconstruct the structural evolution from a subduction zone to a collisional fold-thrust belt over the past 5 m.y. Field studies of each of the islands in the region show various progressive stages of collisional development.

New GPS measurements throughout the transition from subduction to collision indicate how strain is progressively distributed away from the trench to forearc and backarc thrust systems, and along transverse faults. The fault systems divide the collision zone into a series of crustal blocks that have similar directions of motion parallel to the lower plate, but at different rates.

Several emergent islands within the collision zone are rimmed with flights of coral terraces that reveal the pattern of deformation over temporal scales of 104 – 105 years.

Coral terraces on most islands are tilted away from nearby crustal block boundaries. For example, coral terraces are tilted south on the island of Savu away from the Savu thrust and are tilted north on the island of Rote away from the Timor Trough. Age analyses of some of the lowest terraces reveal rock uplift rates of 1.0-1.5 mm/yr.

Beneath the coral terraces are synorogenic sedimentary deposits with abundant planktonic and benthonic forams which reveal the age and depth of origin of the deposit. Long-term surface uplift rates, at temporal scales of 106 years obtained from these data are similar to short-term rates. These data also constrain the age of collision propagation to the west.

Erosional windows through synorogenic deposits reveal the structure of the orogenic wedge and how it evolves through time along orogenic strike. For example, our recent structural analysis of Savu documents the initiation of the retrowedge thrust system, which defines the onset of collision by strain partitioning away from the trench into the interior of the arc-trench system. The retrowedge thrust system accommodates closure of the forearc basin, and eventually the accretion of the arc on the edge of Australia.

Detailed structural field studies in West and East Timor and Rote demonstrate how Australian continental margin cover sequences accrete along at least two different pathways. The upper Cretaceous to Pliocene section stacks up in an imbricate fan above a decollement in thick Jurassic mudstones. The underlying sedimentary units stack up as duplexes beneath this detachment. These different pathways are dictated by the insertion of the leading edge of the forearc into the underthrust continental margin as an accretionary splitting-maul, which wedges into and delaminates the Australian continental margin near the break-up unconformity. Continued accretion beneath the forearc basement lifts it up to form flat lying nappes above accreted Australian continental margin units, which are preserved in the highest structural position of the arc-continent collision.

Retro motion associated with growth of the duplex zone flexes the forearc nappe into an asymmetric anticline with a near vertical, northern forelimb. Continued northward motion detaches the forearc basement nappe from its roots to become a hinterland-verging passive roof thrust.

The final stages of arc-continent collision involve rapid uplift and out-of-sequence thrusting due to impingement of the thrust wedge between the continental shelf of the lower plate and the volcanic arc of the upper plate. This stage of collision is manifest in central Timor where the forearc basin is only 30 km wide due to encroachment of the retrowedge. Rapid uplift rates in this region are manifest by flights of over 25 uplifted coral terraces. Plate convergence partitioned to backarc thrusts at this stage account for up to 75% of the motion between Australian and South East Asian Plates. These backarc thrusts may represent the birth of a new subduction zone that opposes the one clogged by Australian continental margin. ■

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