



Retrodeforming the Arabia-Eurasia collision zone : Age of collision and magnitude of continental subduction

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When did continents collide, and how is convergence partitioned after collision are first order questions that seem to defy consensus along the Alpine-Himalyan orogen. Estimates on the age of collision for Arabia and Eurasia range from late Cretaceous to Pliocene, based on a wide variety of presumed geologic responses. Both lower Miocene synorogenic strata with growth structures adjacent to the main Zagros fault and upper Oligocene to lower Miocene overlap strata over post-collisional thrusts are derived from Eurasia and require that collision was underway at least by \sim 25-24 Ma. However, upper plate deformation, exhumation and sedimentation are used to argue for an older, 35 Ma collision age. Africa-North America-Eurasia plate circuit rotations, combined with Red Sea rotations provides precise estimates of the relative positions between the northern Arabian margin and the southern Eurasia margin. Plate circuits indicate, from NW to SE along the collision zone 490-650 km of post-25 Ma Arabia-Eurasia convergence and 810-1070 km since 35 Ma.

To assess the consequences of these collision ages for the amount of Arabian continental subduction, we compile all documented shortening within the orogen. The Zagros fold-thrust belt consists of thrusted upper crust that was offscraped from subducted Arabian continental lithosphere. Balanced cross-sections give 105-180 km of Zagros shortening (including estimates from the Zagros proper, 45–90 km, and the Zagros “crush” zone, 60-90 km). Shortening within Eurasia is estimated to be 53–75 km through the Kopet Dagh and Alborz Mountains, plus 38 km across Central Iran. These estimates suggest that the orogen has shortened 200 to 300 km since the early Miocene. Both a 25 and a 35 Ma collision estimate thus requires that a considerable portion of the Arabian plate subducted without recognized accretion of its upper crust. To balance plate circuits and documented shortening requires whole-sale subduction of \sim 500-800 km of continental crust since 35 Ma; for a 25 Ma collision this would be between 190-450 km. The ophiolitic fragments preserved along the suture zone allow us to test the magnitude of possible continental subduction. The Oman Ophiolite preserves the geometry and distance over which ophiolites obducted over the northern margin of Arabia in the late Cretaceous. The distance from the southwestern edge of the ophiolite to the northeastern edge of the continent is 180 km, suggesting that the Arabian continental margin plus overlying ophiolites may have extended \sim 200 km beyond the Main Zagros fault. Assuming that 200 km of Arabian continental margin and overlying ophiolites subducted entirely, except the few remnant ophiolite slivers remaining in the suture zone, would reconstruct \sim 400-500 km of post-collisional Arabia-Eurasia convergence, consistent with a \sim 25 Ma collision age. As much as 500-800 km of continental subduction required by an earlier (\sim 35 Ma) collision age seems unlikely.