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Accommodation of transpressional strain in the Arabia-Eurasia collision zone: new constraints from (U-Th)/He thermochronology in the Alborz Mountains, N Iran

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Oblique convergence of lithospheric plates and their ultimate collision generates transpressional deformation on a variety of spatial scales. Transpressional strain may be accommodated either through oblique slip or through strain partitioning into discrete deformation domains of kinematically linked dip-slip and strike-slip faults. The variability and complexity of fault geometry and associated kinematics can result from a long-term history of deformation, and may include a change in shortening direction or the reactivation of inherited structures, which ultimately produces highly disparate patterns of faulting and exhumation in space and time. Documenting and assessing such variability is a first-order goal for unraveling long-term tectonic processes in orogens.

The Alborz Mountains of N Iran form an intracontinental orocline in the northern sector of the Arabia-Eurasia collision zone. At present the range accommodates about one third of oblique plate convergence. The spatiotemporal evolution of deformation appears to result from the interaction between the relatively rigid South Caspian Basin in the north and the slowly deforming Central Iranian Block and Iranian Plateau to the south. Overall, the Alborz Mountains provide a well suited environment to investigate how changes in the kinematic regime affect an orogen and to improve our general knowledge about accommodation of transpressional strain in a collisional setting.

The southwest mountain front of the Alborz Mountains constitutes a complex thin-skinned transpressional duplex (here defined as the North Tehran Transpressional Duplex) comprising NW-striking frontal ramps that are kinematically linked to inherited E-W-striking, right-stepping lateral to obliquely oriented ramps. New zircon and apatite (U-Th)/He data provide a high-resolution framework to unravel the evolution of collisional tectonics in this region. Our data record two pulses of fast cooling associated with SW-directed thrusting across the NW-striking frontal ramps at $\sim$ 18-14 and 9.5-7.5 Ma, resulting in the tectonic repetition of a fossil zircon partial retention zone and a cooling pattern with a half U-shaped geometry. Uniform cooling ages of $\sim$ 7-6 Ma along the southernmost E-W striking oblique ramp and across its associated NW-striking frontal ramps suggest that the ramp was reactivated as a master throughgoing, N-dipping thrust.

We interpret this major change in fault kinematics and deformation style to be related to a change in the shortening direction from NE to N/NNE. This reduction in the obliquity of thrusting may indicate the termination of strike-slip faulting (and possibly thrusting) across the Iranian Plateau. This suggests that by $\sim$ 7-6 Ma, the Iranian Plateau had probably reached elevations similar to the present-day through lithospheric shortening and thickening, mantle delamination, or a combination thereof. It is not clear, however, if this event coincided or triggered the plate-tectonic reorganization within the collision zone at $\sim$ 5 Ma. Furthermore, we suggest that $\sim$ 7-6-m.y.-old S-directed thrusting predated inception of the westward motion of the South Caspian Basin, which is thought to have triggered transtensional deformation in the internal domain of central Alborz Mountains, mostly likely since the Pleistocene.