EGU24-11185, updated on 09 Mar 2024
https://doi.org/10.5194/egusphere-egu24-11185
EGU General Assembly 2024

New Constraints on Late Cenozoic Convergence between the Pamir and South Tianshan from Apatite (U-Th-Sm)/He Thermochronology

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Cenozoic collision between the Indian and Eurasian plates instigated significant intracontinental deformation in Central Asia, giving rise to the Tibetan Plateau and the Himalayan orogen. Simultaneously, it compelled the Pamir to undergo extensive northward movement, accompanied by tens to hundreds of kilometers of crustal shortening. Ultimately, this geological activity culminated in the collision of the Pamir with the South Tianshan. This collision may be a key factor influencing topography and climate change in Central Asia, yet comparatively little is known about the details of the tectonic evolution of the collision zone. In particular, precise determination of the timing of activation of different thrusts in the Main Pamir thrust (MPT), Pamir fold-and-thrust (PFT), and South Tianshan thrust (STT) system remains lacking. Here, we report new apatite (U-Th-Sm)/He (AHe) dates from fourteen samples collected from the hanging walls of these thrusts, situated at the westernmost tip of the Tarim Basin, NW China. Samples collected from the MPT record rapid cooling at ~ 11 ± 1 Ma, samples from the PFT show rapid cooling at ~ 7 ± 2 Ma and ~4-3 Ma, while samples from the STT reveal accelerated cooling at ~11 ± 1 Ma, ~7-6 Ma and ~3-2 Ma. We propose that the observed rapid cooling was caused by thrust-induced exhumation in this region, thus the rapid cooling represents the activity time of thrusts. Combined with previous studies on the onset deformation in the MPT and STT, we develop a model of the convergence between the North Pamir and South Tianshan in our study region since the late Oligocene. Late Oligocene to early Miocene (~20 ± 5 Ma) cooling ages from the MPT and STT hanging walls date the onset of thrusting, indicating the initiation of this convergence. Afterward, the MPT and STT experienced northward and southward propagation during the late Miocene (~11 ± 1 Ma), respectively. Subsequently, during the latest Miocene (~7 ± 2 Ma), the PFT started to form, while simultaneously, the STT propagated southward, resulting in the contact of these two thrusts at the Wuheshalu section. We suggest that the timing of contact of PFT with the STT represents the surface expression of the onset of collision between the Pamir and South Tianshan in the western Tarim basin. Following the initial collision, the PFT gradually propagated northward while the STT propagated southward during the Pliocene to Pleistocene (~3 ± 1 Ma), establishing the present-day superimposed and imbricated thrust system in the Pamir-South Tianshan convergence zone.