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Cenozoic tectonic history of the Western Tien Shan constrained by low-temperature thermochronology

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The NW-SE trending dextral Talas-Fergana fault (TFF) separates the Western Tien Shan from the Central Kyrgyz Tien Shan. This ∼2000 km long structure extends from western Tarim basin in the southeast to the Turgay basin in the northwest. The TFF formed in the late Paleozoic – Early Mesozoic and was reactivated in the Jurassic and Cenozoic. Cenozoic displacement only occurred along the southern segment of the fault and is poorly constrained; Thomas et al. (1993) suggested 100 ± 60 km Cenozoic displacement based on vertical-axis rotation of Tertiary red beds in the Fergana basin.

AFT analysis was carried out on 26 samples collected from vertical profiles and spot samples in the Chatkal, Shandalash, Ugam, Talas and Fergana Ranges associated with structures that merge with the northern active end of the TFF with the goal of constraining the timing of slip. Sampling and thermal modeling of the Talas Range, on the east side of the TFF, show that the range was rapidly being exhumed by the latest Oligocene both near the TFF and at its northern termination. Based on this data and the geometrical relation of the TFF and the structural lineaments of the Talas Range, we interpret the zone as a transpressional pop-up structure kinematically-related to the TFF. A vertical profile in the Shandalash Range, directly to the west across the TFF, suggests a rapid exhumation event at Oligo-Miocene boundary. In this sector, the geometrical relationship of the reverse faults with the main TFF suggests a restraining bend connected to the TFF. Moreover, the timing of exhumation in these two areas suggests that strike-slip movement along the TFF is responsible for the uplift of the Talas pop-up and the development of restraining bends in the Ugam, Shandalash and Chatkal Ranges. Farther south along the west side of the TFF, we collected a vertical profile in the Fergana range in the hanging wall of a thrust sheet that roots into the TFF. A kink in an age-elevation plot suggests the onset of rapid exhumation occurred in the earliest Miocene. In summary, our new AFT results show a rapid exhumation event commenced at ∼25 Ma along the active northern portion of the deformation zone.

At the southern end of the TFF, the Kokshaal (Sobel et al., 2006) and At-Bashi (Glorie et al., 2011) ranges were also being exhumed at ca. 25 Ma. The key to understand this deformation pattern is that both areas are linked to restraining bends along the TFF which experienced a simultaneous onset of rapid exhumation. Furthermore, the Fergana basin, to the west of the TFF, underwent significant counter-clockwise rotation at around the same time period. Therefore, we suggest that strike-slip motion along the TFF commenced at ca. 25 Ma, absorbing the rotation of the Fergana basin and enabling transpressional exhumation of the restraining bends.