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Unravelling the deformation and erosional history of the Kyrgyz Central Tien Shan

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The deformation and erosional evolution of the Kyrgyz Tien Shan, south of lake Issyk Kul, has been established using low temperature thermochronology to spatially and temporally quantify exhumation. The tectonic and climatic forces that controlled the evolution can be differentiated by comparing the timing of deformation and erosional changes throughout the mountain belt.

We expect that a climatically-driven pulse of exhumation occurred synchronously across the region, while a tectonically-driven pulse would have propagated over space and time. Our goal is to use thermochronology to unveil the underlying cause of exhumation.

Periods of rapid exhumation date the onset of deformation in the Teresky Range, the northernmost range of the study area, to between ∼27-19 Ma and indicate that the range grew diachronously along strike. The timing of onset is comparable to those in the southern and eastern Tien Shan, and suggests that the mountain belt first started accommodating Indo-Eurasian shortening at this time. To the north-east in the Kyrgyz Range, published onset ages of ∼11-9 Ma coincide with the initiation of internal deformation within the Teresky Range. All of these late Miocene cooling ages likely occurred in response to an increase in shortening at this time. Unfortunately, there are no structural markers to provide precise age or displacement constraints on internal deformation; therefore, thermally modelled cooling pathways are used as an age control. New apatite (U+Th)/He (AHe) data will greatly improve the lower temperature resolution of these models, accurately dating and quantifying differential exhumation across these internal structures.

The southern part of the study area has experienced insufficient erosion to exhume rocks with post-Oligocene reset apatite fission track (AFT) ages. New AHe data will provide the first constraints on Cenozoic exhumation in these ranges. A larger thermochronology data set will provide a complete chronology for the sequence of mountain building, and will allow the growth of ranges over time to be assessed.

The rate that deformation propagates into intra-montane basins represents an important component of the accommodation of shortening, especially in a thick-skinned tectonic setting like the Tien Shan, which is dominated by high angle reverse faults that are inefficient at absorbing horizontal shortening. Therefore, it is likely that an increase in shortening at ∼11 Ma, would also have been accompanied by propagation of deformation into intra-montane basins, causing the sediments to be uplifted and eroded, leading eventually to the overall enlargement of the basement ranges.

The largest basin in the study area is Issyk Kul. Previous AHe data from the northern margin of the Teresky range shows that faulting propagated basin-ward in the last 10 Ma, suggesting that basement ranges grew at this time at the expense of the adjacent basin.

Elsewhere within the study area there is evidence that intra-montane strata from smaller basins have subsequently been mostly removed; often these are only identified through time-temperature modelling that detects the thermal effect that the strata had on underlying rocks.

New AFT and AHe data will soon be available that will allow us to evaluate the importance of the increase in shortening at ∼11 Ma. Improved temporal controls on a range's internal deformation and the periods when it expanded should allow us to better understand the driving forces behind such changes, and the consequences they have on topography and sedimentation.