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Tectonically controlled relief evolution in the Northern Tien Shan and Junggar Alatau from the Eocene to the Present

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The Cenozoic Tien Shan and Junggar Alatau mountains developed on the southern part of the Paleozoic Altaid orogen as a far-field effect of the collision of the Indian and Eurasian plates. Highland terrain, active seismicity, and fast GPS-derived motions are evidence of rapid ongoing mountain growth today.
Variations in relief energy, hight-to-width ratio of ranges and apatite fission track (AFT) exhumation ages suggest they rose at different times. The strong dissection of the higher ridges (heights of up to 2km), indicates an earlier onset and higher rates of uplift. At the other end of the spectrum are low, little dissected ridges. According to AFT ages, exhumation in the Junggar Range began at 9 Ma (Jolivet et al., 2010), circa 11 Ma in the central Kyrgyz Range (Sobel et al., 2006) and 10 Ma in the Terskey Alatau. An AFT age of the low Sogety range is 77 Ma, suggesting that the Cenozic exhumation of the ridge was insufficient to expose rocks from below c.3 km depth.
The synclinal lows between the basement highs preserve Cenozoic strata of Eocene to Quaternary age, probably deposited in a once continuous basin (the Ili Basin) and recording the entire history of Tien Shan uplift. Facies pattern of proximal alluvial fans are strictly related to the recent higher mountain areas in the north and in the south. During Middle Miocene, a large lake developed in the basin center. Up to the Middle Miocene sedimentation was accompanied by normal faulting of small magnitude. The main Cenozoic folding and thrusting occurred after that time and before deposition of the Chorgos formation. Shortening was accommodated by reactivation of inherited basement structures, by a switch to reverse or strike-slip motion on normal faults, and the nucleation of new thrusts. The majority of faults which emplace basement rocks over upper Cenozoic sediments dip steeply at angles of 60-70°, and some have throws of more than 200 m. They are marked by topographic steps and contrasting morphology across them. This first phase of deformation was followed by erosional leveling. Well-consolidated caliche layers indicate an extended period of stable soil formation in a (semi-)arid climate. Renewed shoting and uplift led to river incision and the formation of terraces and gave rise to new active faults, but their displacements are still low due to their short lifespans. These faults are presently expressed at the surface as fold scarps. The scarps are underlain by flexures affected in places by small thrust faults. Some of them, judging by their directions, are probably reactivating Miocene faults.
The differences in the timing of range uplift, the progression of Cenozoic folding and the location of the young flexures all indicate migration of thrusting and folding from the borders of the Ili basin toward its center. A similar pattern of tectonic activity shifting from the flanking ridges toward the basin center was also observed in the Issyk-Kul basin (Korzhenkov, et al., 2007).

References

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