The bivergent growth of the Cenozoic Qilian Shan, northeastern Tibetan Plateau: Insights from numerical models

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The Qilian Shan orogenic belt, located in the northeastern margin of the Tibetan Plateau, undergoes intensive Cenozoic structural deformation with large lateral growth since the Miocene. The Cenozoic growth of the Qilian Shan is possibly resulted by the passive subduction of the North China Craton due to the far-field effect of the continuous Indo-Asian collision. Thus, the Qilian Shan can be seen as a syntectonic crustal-scale accretionary wedge above a middle intra-crustal weak layer. To date, the detailed Cenozoic crustal deformation manner of the Qilian Shan and its adjacent two basins remains unclear, especially for the southward propagation towards the Qaidam Basin. Whereas, the spatio-temporal characteristics of deformation distribution between the Qilian Shan and the adjacent two basins are critical to fulfill the lateral growth of the Tibetan Plateau. Hence, we conducted a series of high-resolution 2-D numerical models to investigate factors that influence crustal strain distribution. The first series models are thick-skinned models with single décollement, while Series II are two-décollement layer model, regarding the interaction between thick- and thin-skinned tectonics beneath the two adjacent basins. After 150 km of total convergence, model results suggest that the single décollement layer model is not sufficient in depicting the present-day crustal deformation pattern, while strain localization pattern from two-décollement layer model meets well with the geological and geophysical observations. The Hexi Corridor Basin may be involved with deep-crustal thrusting while the dominant deformation is still thin-skinned tectonics. Series III adds the filling-up sedimentation based on the conditions of Series II. We reveal that the differential sedimentation types between the Qaidam Basin and the Hexi Corridor Basin greatly depress fault propagation towards the Qaidam Basin. Note that, how deformation transfers into the Qaidam Basin remains controversial. To date, the above models still need to evolve. However, in summary, our study highlights the crustal deformation of the two margins of northeastern Tibetan Plateau is controlled by the décollements and differential sedimentation styles.