

Rheological control of lateral growth of the Tibetan Plateau: Numerical results

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The collision and continued convergence between the Indian and Eurasian plates in the past ~50 million years has raised the Tibetan Plateau, but whether or not, and how, the plateau has grown laterally remain controversial. Here we show that useful insights can be gained by studying lithospheric deformation across the frontal margins of the Tibetan Plateau. Crossing its northern and eastern sides where the plateau is bounded by the Tarim and Sichuan blocks, the topographic slope is steep and crustal deformation is localized near the margins of the plateau, whereas across northeastern Tibetan Plateau the topographic slope is gentle and crustal deformation is diffuse over a broad transition zone. Using a suite of two-dimensional visco-plastic finite element models, we reproduced the major features of the two types of plateau margins with different rheological contrasts between the Tibetan Plateau and the bounding Asian blocks. Our results suggest that the bounding Asian blocks with a strong mantle lithosphere, such as the Tarim and the Sichuan basins, have restricted the lateral growth of the Tibetan Plateau, although limited lateral expansion of the plateau can occur where the upper crust of these bounding blocks are relatively weak. Major lateral growth of the Tibetan Plateau mainly occurred northeastward, where numerous terranes with relatively weak mantle lithosphere are readily deformed and incorporated into the Tibetan Plateau. This growth-front has reached the strong Alashan and Ordos blocks. Further lateral growth of the Tibetan Plateau depends on whether or not the Tibetan tectonics can weaken the mantle lithosphere of these Asian blocks.