Miocene gneiss domes in the Pamir: linking graviational collapse of thickened crust to shortening in the Tajik foreland

K. Stübner[1], L. Ratschbacher[2], S. Abdulhameed[2], L. Gagala[2], and Project TIPAGE members

[1] *Dept. of Geosciences, Univ. of Tübingen, Germany*
[2] *Institute of Geology, TU Bergakademie Freiberg, Germany*
konstanze.stuebner@uni-tuebingen.de

Cenozoic gneiss domes comprise one third of the surface exposure of the Pamir and allow an unparalleled view into deep crustal processes of the India–Asia collision. The largest of these is the ~350 × 90 km Shakhdara–Alichur dome of the southwestern Pamir, Tajikistan and Afghanistan. These composite gneiss domes exhumed crust from up to 30–40 km depth along two opposite-verging normal shear zones, the south-dipping South Pamir shear zone and the north-dipping Alichur shear zone. Smaller domes have been recognized in the central and northern Pamir.

Comprehensive structural [1] and geochronologic and thermochronologic data [2] unravel the formation of the Shakhdara–Alichur gneiss domes by footwall exhumation of low-angle detachments. Crustal thickening in the Oligocene caused prograde metamorphism and peaked in widespread migmatization of the southwestern Pamir crust in the late Oligocene to early Miocene. The onset of doming at 21–20 Ma is attributed to graviational collapse of the weak, partially molten crust. Dome formation resulted in ≤90 km N–S extension in the southwestern Pamir at rates of ≤10 cm/yr in the Miocene and Pliocene; extensional doming ended at ~2 Ma. Isostatic surface uplift of the dome basement drove river incision at ≤1.0 mm/yr contrasting with low erosion rates (0.1–0.3 mm/yr) in the southeastern Pamir hanging wall cover; this contrast is reflected in the high-relief topography of the southwestern Pamir compared to eastern Pamir plateau. Overall, erosion of the basement domes was minor, preserving most of the extruded deep crust, including the top of the South Pamir shear zone at peak elevations throughout the dome.

Extension in the Pamir is coeval with ongoing convergence between India and Asia. It opposes shortening in a fold-thrust belt north of the domes and in particular in the Tajik depression, where an evaporitic décollement facilitated upper crustal shortening. Gravitational collapse of the Pamir-plateau margin drove core-complex formation in the southwestern Pamir and shortening of the weak foreland adjacent to the plateau. Overall, this geometry defines a ‘vertical extrusion’ scenario, comprising frontal and basal underthrusting and thickening, and hanging gravitationally driven normal shear. The main difference between the Pamir and the Himalaya is the intense erosion of the Greater Himalayan crystalline rocks, which is in contrast to negligible erosion affecting the Pamir gneiss domes; this is an effect of a drastically different climatic scenario, with the Himalaya dominated by the Monsoon and the Pamir by the Westerlies.

[1] K. Stübner, L. Ratschbacher, D. Rutte, K. Stanek, V. Minaev, M. Wiesinger, R. Gloaguen, and Project TIPAGE members, The giant Shakhdara migmatitic gneiss dome, Pamir, India–Asia collision zone, I: Geometry and kinematics, Tectonics (in press).
[2] K. Stübner, L. Ratschbacher, C. Weise, J. Chow, J. Hofmann, J. Khan, D. Rutte, B. Sperner, J. Pfänder, B. Hacker, I. Dunkl, M. Tichomirowa, M. Stearns, and Project TIPAGE members, The giant Shakhdara migmatitic gneiss dome, Pamir, India–Asia collision zone, II: Timing of dome formation, Tectonics (in press).

Key words: Pamir, gneiss dome, syn-orogenic extension, gravitational collapse, exhumation of deep crust