Miocene gneiss domes in the Pamir: extension in a convergent setting

Konstanze Stübner[1,2], Lothar Ratschbacher[2], Raymond Jonckheere[2], Jörg Pfänder[2], Bradley Hacker[3], István Dunkl[1], Klaus Stanek[2], Vladislav Minaev[4], and the TIPAGE Team

[1] Geowissenschaftliches Zentrum, Georg-August Universität Göttingen, Germany, konstanze.stuebner@geo.uni-goettingen.de
[2] Geologie, TU Bergakademie Freiberg, Germany
[3] Earth Research Institute, University of California, Santa Barbara, USA
[4] Tajik Academy of Sciences, Institute of Geology and Seismology, Dushanbe, Tajikistan

The Pamir Mts. of Central Asia have absorbed several hundred kilometers of Cenozoic north-south shortening due to the India–Asia collision. Shortening in the Pamir occurred over a narrow zone of ~500 km N–S distance, compared to >1200 km across the Tibet–Himalaya system further east. In contrast to the Tibetan plateau, high-grade metamorphic rocks are widely exposed in the Pamir and comprise >30 % of the surface outcrops. These rocks occur in at least seven gneiss domes that form E-trending, northward convex belts. As exemplified by detrital U-Pb zircon geochronology, the domes mostly comprise Paleozoic and Early Mesozoic metasedimentary rocks, which experienced Barrovian metamorphism with local migmatization (~600-700°C, ~9-14 kbar). Exhumation from mid- to lower crustal depths was attained during the Miocene; similarities in structure and exhumation histories suggests a common formation mechanism for several of these domes.

The composite Shakhdara–Alichur dome is the largest dome (~300 x 100 km). Doming in the Shakhdara dome started at ~20 Ma and continued until at least 3 Ma. Exhumation was mainly accomplished by a major south-dipping normal shear zone along the southern dome boundary, the South Pamir detachment. To the east, in the Alichur dome, vergence of exhumation switches to top-to-N along the less prominent Yashikul detachment; in the southeastern Pamir plateau, further diminished extension occurred within the Mesozoic cover sediments. The Central Pamir domes (Yazgulom, Gudara, Muzkol-Sarez) show similar north-south extension and Miocene onset, but earlier termination of exhumation.

Apatite (U-Th)/He ages from the Shakhdara may indicate a renewed episode of rapid cooling starting in the late Pliocene or Pleistocene, likely related to incision of the Pjansch river system. The pronounced difference in relief between the Shakhdara dome and the eastern Pamir plateau argues against a purely climatic cause for Pleistocene river incision.

We attribute doming and extension to overall transpressional thickening with long-wavelength–low-amplitude buckling of the entire crust. Concurrent to subsequent mid-upper crustal extension compensates for excess thickening. The tectonics of the southern and central Pamir may be driven by shallow underthrusting of the western edge of the cold and rigid Indian lithosphere, which has detached from the Hindu Kush slab to the west, beneath the hot and thick Pamir crust. In contrast, in the northern Pamir Cenozoic deformation is mostly brittle, started late (Late Miocene-Pliocene), and dome formation (northwestern Pamir Kurgovat dome) involves only 5-10 km of Cenozoic exhumation. Syn-orogenic extension and gneiss dome formation of the amount documented in the central and southern Pamir is unparalleled in the Tibet orogen and provides insights into mid-crustal processes largely concealed in Tibet; it offers new possibilities for understanding collisional orogeny.