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Shortening and syn-contractional extension: the burial and exhumation history of the Cenozoic Central Pamir Gneiss domes, Tajikistan

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We present a structural and thermochronologic study of the Cenozoic gneiss domes and their cover in the eastern Central Pamir. Emphasis is laid on flow along the bounding shear zones, faulting in their hanging walls, and geometric analysis by balanced structural cross-sections.

Cenozoic deformation related to the India-Asia collision dominates the structure of the Central Pamir. The gneiss domes form asymmetric, elongate (∼80 km E-W, ∼15 km N-S), en-échelon structures, exhibiting up to upper amphibolite facies metamorphic sedimentary rocks of Phanerozoic age (proven by detrital zircon studies). They are bound by E-trending normal sense shear zones with the northern boundary accommodating most of the displacement. Relics of large-scale thrust sheets and repetitions in the stratigraphic succession document the pre-extensional N-S shortening that thickened the crust.
Structural studies—including fault-slip analysis—in the hanging wall of the normal sense shear zones document four major phases of ductile to brittle deformation in the Cenozoic: A first brittle-ductile phase of N-S shortening includes isoclinal folds and deforms Ordovician to Cretaceous strata. This deformation is overprinted by brittle-ductile N-S extension structures that we relate to the normal sense motion along the bounding shear zones of the domes (cooling ages constrain normal shear to ∼19-14 Ma; Ar-Ar, AFT geochronology). A third phase - brittle N-S shortening - overprinted the older structures. It was followed by the latest stage, E-W dipping normal faults that we relate to rifting along the Karakul rift. These four phases of deformation can be traced throughout the region.
The normal sense North Muskol Shear Zone (NMSZ) defines the northern boundary of the Muskol and Shatput domes and is among the major structures of the region. The metamorphic gradient across the NMSZ reaches from amphibolite-facies ms+bt+grt±sil±ky-schists and gneisses in the footwall to non-metamorphic to greenschist-facies sedimentary rocks in the hanging wall. High grade ductile fabrics include ms+bt+grt mylonites and hornblende growth in boudin necks. The stretching lineation is defined by quartz, feldspar, and biotite; feldspar deforms mostly brittle. In several outcrops, lower grade fabrics with chlorite and chloritized biotite define the stretching lineation. Normal sense brittle-ductile shear bands and faults indicate that top-to-north extension of the NMSZ continued during cooling. Fault gauge, observed at the basement-cover contact of the NMSZ, documents continuous normal sense deformation until final exhumation to uppermost crustal conditions. N-plunging lineations along the NMSZ converge to the most deeply exhumed central part of the Muskol dome. We will discuss possible explanations for this convergence of flow trajectories, including constriction during exhumation and vertical extrusion.