The High-Grade Crustal Domes of the Pamir

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In contrast to Tibet, the Pamir expose multiple domes of Cenozoic high-grade lower crustal rocks. The Pamir thus present an opportunity for understanding the role of the lower crust in continent collisions, in plateaux formation and in the exchange of material between the crust and mantle. These roles can be evaluated by measuring the distribution in space and time of ages of magmatism, ages of crustal thickening, ages of exhumation, depths of exhumation, and deformation associated with formation and exhumation of the domes. Here we report on the depths, temperatures, and exhumation histories of several key domes of the Pamir.

Quantitative constraints on P-T conditions were obtained by 1) assessing mineral parageneses via optical and electron microscopy, 2) measuring mineral compositions by electron microprobe, 3) using *Perple_X* and bulk-rock compositions to calculate pseudosections and mineral compositions, and 4) using *Thermocalc* to calculate positions of equilibria. The most easily interpretable rocks are pelites with garnet ± kyanite ± staurolite + biotite + muscovite + oligoclase + quartz + rutile or ilmenite, but information was also extracted from semi-pelites with garnet + biotite + muscovite + oligoclase + quartz + rutile or ilmenite, and mafic rocks with garnet + hornblende + clinopyroxene + oligoclase–andesine + quartz + rutile or ilmenite. Intrusion, recrystallization, and cooling histories were determined by SIMS and LA-ICP-MS U-Pb zircon and monazite, Rb/Sr mica, $^{40}Ar/^{39}Ar$ hornblende and mica, fission-track and (U-Th)/He apatite dating.

For the northern Pamir Kurgovat dome we find peak conditions of ~600°C and 6 kbar. Hornblende and biotite ages indicate that this metamorphism is Jurassic–early Cretaceous, overprinting Devonian arc intrusions. The central Pamir Yazgulem and Muskol–Sares domes yield similar P-T conditions. Magmatism is late Eocene and early Miocene; the domes show rapid cooling from metamorphic zircon crystallization to near-surface conditions at ~15 Ma. The southwestern Pamir Shakhdara dome gives higher peak metamorphic conditions at ~700°C and 10 kbar; metamorphism, migmatization, and leucogranite intrusion is variable in age but mostly early–mid Miocene. Cooling ages depend on position of the samples to the dome bounding normal shear zone in the south; rapid cooling is mid-Miocene and younger. Robinson and others (2007) reported similar peak metamorphic conditions and mid-Miocene and younger rapid cooling for the Kongur Shan dome.

These data, combined with those of earlier studies (e.g., Hubbard, 1989; Schwab and others, 2004), indicate that the bulk of the Pamir high-grade crystalline rocks were at ~35 km depth in the early Miocene and then exhumed to shallow crustal levels over ~10 Myr. The similar metamorphic and cooling histories of the Kongur Shan, close to the active front of the Pamir, and the Shakhdara dome, in the Pamir hinterland, might reflect the dual intra-continental subduction of the Pamir and the Hindu–Kush slabs.

References

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