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Late Paleozoic tectonomagmatic evolution of the western southern Tian Shan, Tajikistan

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The 2500-km-long Tian Shan orogenic belt constitutes a dominantly Paleozoic amalgmation of Eurasia that has been overprinted by the Mesozoic and Cenozoic Cimmerian and Indo–Eurasian collisions. This southernmost unit of the Central Asian Orogenic System (CAOS) is divided N–S by discontinuous suture zones that reflect its complex assemblage and E–W by the Talas–Fergana dextral (modern kinematics) fault zone. The western southern Tian Shan in Tajikistan/Uzbekistan is poorly studied compared to the rest of the orogen in Kyrgyzstan/China, but a dominant signal of late Paleozoic magmatism synchronous to widespread magmatism documented along strike provides an intriguing opportunity to investigate regional tectonic processes at this time.

The late Carboniferous–early Permian Gissar batholith is the southern Tian Shan's southernmost lithotectonic unit. Zircon U-Pb weighted-mean crystallization ages for Gissar granitoids range from ∼310–290 Ma, are youngest in the east, and define a primary stage of arc magmatism related to closure of the Turkestan ocean. A ∼280 Ma crystallization age was obtained for a Ne syenite, which corresponds to small, "post-collisional," alkaline intrusions in 1:200,000 Soviet geologic maps. Zircon ϵHf in Gissar granitoids generally decreases with decreasing zircon U-Pb age from +5—10. Zircon ϵHf in the young Ne syenite is +1–+6. Taken together, these trends indicate a progressive shift from juvenile to intermediate magmatism over 20 Myr, followed by a marked return to juvenile magmatism within 10 Myr.

The Garm "metamorphic" massif is situated within the eastern Gissar batholith and is derived from greater depths than the rest of the batholith, as indicated by its defining features: (i) Discontinuous outcrops of Bt+Grt quartzofeldspathic gneisses/schists; and (ii) Presence of igneous garnet in granitoids. Zircons from the Garm quartzofeldspathic gneisses/schists exhibit pronounced Pb-loss discordia that are consistent with ∼amphibolite-facies metamorphism; crystallization ages are early Paleoproterozoic and Neoproterozoic, suggesting peri-Gondwanan affinity. Metamorphic (consistently low Th/U) rims of zircons from a Garm Bt+Grt quartzofeldspathic gneiss span 324–284 Ma and define a protracted episode of amphibolite-facies metamorphism for the Garm massif that overlaps with both main-stage Gissar and post-collisional magmatism. This overlap favors delamination over post-orogenic extension as a mechanism for producing the "post-collisional," juvenile magmatism.

The Zerafshan unit (north of the Gissar–Garm unit) comprises a Paleozoic volcano-sedimentary sequence that has been metamorphosed to ∼greenschist facies. Chl±Bt schists exhibit zircon U-Pb age spectra similar to those in the Garm massif but with subordinate Paleoproterozoic peaks. Pb-loss discordia are present but weak for Zerafshan zircons, consistent with ∼greenschist-facies metamorphism.

Detrital-zircon U-Pb age spectra for modern river sands (which drain the Garm massif and Zerafshan unit) and Cretaceous sandstones (which unconformably overlie the Garm massif) reproduce the main and "post-collisional" stages of magmatism found in the igneous rocks, as well as the Paleoproterozoic and Neoproterozoic ages found in the metasedimentary rocks. A match between a 450 Ma Zerafshan meta-andesite and a peak in a Cretaceous sandstone, taken together with consistency between detrital- and igneous-zircon ϵHf values, suggests that the Cretaceous sandstones were sourced from the Tian Shan rather than age-equivalent terranes in the Pamir.

Overall, the igneous and detrital U-Pb and Hf datasets document a late Paleozoic tectonomagmatic evolution of the Gissar arc that is consistent with development of an Andean-style active continental margin followed by ocean closure, continental collision and delamination.