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Ar/Ar geochronology in the western Tianshan (northwestern China): from Carboniferous (ultra)high-pressure metamorphism and thrusting to Permian strike-slip deformation and fluid ingress

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The Tianshan belt (northwestern China) is a major tectonic element of the southern Central Asian Orogenic Belt that contains a number of ophiolitic mélanges and (ultra)high-pressure metamorphic belts formed after closure of oceanic and back-arc basins that resulted in terrane collisions. Deciphering its tectonic evolution is thus crucial for understanding the amalgamation of Central Asia. We produce robust $^{40}Ar/^{39}Ar$ laser-probe evidence that the Tianshan is a Late Palaeozoic (ultra)high-pressure metamorphic collision belt, not a Triassic one, as suggested by some SHRIMP zircon ages in recent literature. Instead of trying to date the peak pressure conditions we focused on $^{40}Ar/^{39}Ar$ analysis of white mica formed during retrograde recrystallisation when the (ultra)high-pressure metamorphic rocks of the Changawuzi-Kekesu complex were exhumed. Exhumation was coeval with their northward thrusting over the southern margin of the Yili terrane, the easternmost element of the Kazakhstan composite superterrane, which produced main phase tectonic structures. The Yili terrane comprises a Proterozoic basement covered by metasediments, intruded by Early Carboniferous granites when it formed part of a continental margin arc. During the Permian deformation was partitioned in vertical brittle-ductile strike-slip fault zones that reactivated these suture zones and in which bimodal magmatism was concentrated. We also investigate the effects of these events on the isotopic ages of mica.

$^{40}Ar/^{39}Ar$ laser-probe dating of white mica reveals that the strongest retrogressed blueschists immediately above the basal thrust fault of the Changawuzi-Kekesu belt gave the youngest plateau age of 316 $\pm$ 2 Ma (1σ). White mica in greenschist-facies metamorphic quartzite from the ductilely deformed metasedimentary cover of the Yili terrane's crystalline basement, taken at about 1 km below the thrust contact with the overlying Changawuzi-Kekesu belt, yielded a plateau age of 323 $\pm$ 1 Ma (1σ). Elsewhere, such metasediments yielded plateau ages (1σ) of 253 $\pm$ 1 (muscovite) and 252 $\pm$ 1 (biotite) Ma, whereas biotite from an undeformed ca. 340 Ma-old granite intruding the Yili terrane's southern margin gave a 263 $\pm$ 1 Ma plateau age (1σ). The 263-252-Ma-old samples were taken between 2 and 5 km across strike from the Permian Qingbulak–Nalati strike-slip fault, and within the 15–20 km wide zone with steeply dipping tectonic fabrics used by intruding Permian granites, and associated mineralisations. We interpret these Permian ages by recrystallisation of the mica by (late magmatic?) fluid flow channeled into these steep zones. Laser-probe dating of mylonite whole-rock samples from the North Tianshan – Main Tianshan strike-slip fault zone yielded $^{40}Ar/^{39}Ar$ spectra with step ages in the 255–285 Ma range, which date the movement on this ductile shear zone. The picture is emerging that a convective fluid system partly driven by magmatic heat, existed in a strongly fractured and weakened crust with an elevated heat flow, leading to regional-scale isotope resetting. We suggest that surprisingly young isotopic ages for early orogenic (ultra)high-pressure metamorphism are similarly due to fluid-mediated recrystallisation, leading to the erroneous view that the Tianshan is a Triassic orogenic belt.