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A Microstructural and Thermochronometric View of the Early Stages of Continental Collision from the Greater Caucasus in the Republic of Georgia

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The Arabia-Eurasia collision provides a unique view of early collisional processes, as it features both a younger onset of collision and slower convergence rates relative to its along-strike India-Eurasia counterpart. Within the India-Eurasia collision, mid-crustal crystalline rocks exposed in the Himalayas have been exhumed from depths greater than 20 km along the Main Central Thrust (e.g. 1). Along the northern margin of the Arabia-Eurasia collision in the western Greater Caucasus, the Main Caucasus Thrust (MCT) juxtaposes a ∼400 km-long WNW-ESE-striking exposure of Paleozoic crystalline basement to the north against dominantly Mesozoic metasedimentary cover to the south. The Caucasus MCT is commonly assumed to be a first-order Cenozoic structure in the range, though this has not been established by data reported in the international literature.

We contend that lower Cenozoic deformation temperatures in the Greater Caucasus crystalline basement along the MCT relative to those along the Himalayan Main Central Thrust indicate shallower structural levels of basement exposure. This contrast reflects earlier stages of orogenesis in the Arabia-Eurasia collision. Basement rocks in the Himalayas show evidence for quartz-plastic deformation at temperatures greater than 500°C (e.g. 2), and 40Ar/39Ar thermochronologic dates confirm cooling beneath these temperatures took place during the Cenozoic India-Eurasia collision (e.g. 3). To constrain deformation temperatures in the Greater Caucasus, we evaluate quartz dynamic recrystallization textures in the context of field observations along the MCT in the Svaneti and Kazbegi regions of the Republic of Georgia. We employ U-Pb geochronology and low-temperature thermochronology to provide constraints on the age of rocks involved in this deformation and the magnitude of exhumation that can be ascribed to the Cenozoic Arabia-Eurasia collision.

Fieldwork and microstructural analyses along the MCT in both regions reveal ∼100 m-thick north-dipping zones of high strain. Greenschist-facies mineral assemblages along with bulging (BLG) and subgrain rotation (SGR) dynamic recrystallization textures in quartz indicate deformation temperatures of ∼300-500°C within these shear zones. This quartz-plastic deformation affects quartzite with a maximum depositional age of ∼197 Ma in Kazbegi and thus post-dates the early Jurassic. Zircon (U-Th)/He dates of Eocene to Oligocene age (∼31-39 Ma) in Svaneti and of Miocene age (∼7-8 Ma) in Kazbegi indicate Cenozoic exhumation from temperatures greater than ∼180°C. Pliocene to Pleistocene (∼2-6 Ma) apatite (U-Th)/He ages provide evidence for recent rapid exhumation in this active orogen. These results are compatible with, although not uniquely diagnostic of, low-temperature quartz-plastic deformation in the Greater Caucasus during the Cenozoic.

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