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# Petrological evidence for rapid heat transfer beneath the Nanga Parbat Massif

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The Himalayan syntaxes (Nanga Parbat and Namche Barwa) expose the youngest (~1 Ma) and most rapidly-exhuming (>10 mm/yr) high-temperature metamorphic rocks in the Himalaya. Models to explain the geodynamic evolution of the syntaxes propose that either surface erosion or deep-seated processes were the principal driver(s) for the formation and rapid exhumation of these rocks. However, discriminating between these drivers is hampered by a lack of clarity over the pressure-temperature-time evolution of these exceptionally young rocks.

We present new thermobarometry, multi-mineral U-Th-Pb petrochronology, and garnet diffusion chronometry on several rocks from the Nanga Parbat Massif (NPM) in the western Himalayan syntaxis to place constraints on the timing, depths, and duration of prograde metamorphism and the thermal peak. Our data suggest that the NPM experienced prograde metamorphism as early as 10 Ma, reaching ~650 °C by 5.7 Ma. Temperatures of ~650°C at >0.5 GPa were maintained until decompression began at 3.5 Ma, which was accompanied by rapid heating at 2.4 Ma to >720 °C, 0.35 GPa. Diffusion modelling of peritectic garnet suggests residence at near peak temperatures lasted <1.5 Myr. This is further supported by apatite depth profiles, which reveal Proterozoic apatite grains inherited from the protolith with remnant Pb growth zonation and a lack of evidence for significant Pb volume diffusion. Simple thermal models require an increase in basal heat flux concomitant with the onset of decompression in order to reproduce our interpreted pressure-temperature-time path. This sequence of events is consistent with detachment or thinning of the underlying mantle lithosphere or focused flow of partially molten mid- to lower- crustal material.

Recent geophysical studies of the lithosphere beneath the eastern Himalayan syntaxis suggest the presence of a localized slab tear/window or possibly slab detachment. Though geophysical studies of similarly high-resolution have not yet been done for the NPM, our petrologic data are consistent with the presence of such a feature beneath the NPM. If correct, this may explain similarities in the timing and tempo of metamorphism and rapid crustal exhumation in the Himalayan syntaxes.