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Crustal thickening and the onset of extrusion of the crystalline core of the Himalaya revealed in Himachal Pradesh, NW India

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Understanding extrusion of the Greater Himalayan crystalline (GHC) is a key to the ongoing debate about mechanisms of middle to lower crustal deformation in the India–Asia and other collision zones worldwide. In the central and eastern Himalaya exposure of deep crustal levels of the GHC has removed the rocks preserving record on the prograde evolution of the crystalline during crustal thickening and early stages of extrusion. Shallower levels of the orogen's metamorphic core are exposed in Himachal Pradesh, NW Himalaya, arguably providing the opportunity to study the early tectonometamorphic evolution of the GHC and the onset of its extrusion.

In Himachal Pradesh, the GHC forms a recumbent fold, the Phojal nappe. Like in the rest of the Himalayas the exhumation of the GHC is explained by SW-vergent extrusion between the basal Main Central thrust and the South Tibetan detachment as the roof; structural position and geometry of the South Tibetan detachment are, however, debated in the NW Himalaya. Our new monazite U/Th–Pb data from six metapelite samples of different structural levels of the GHC document the Eocene/Oligocene prograde metamorphic evolution with distinct periods of monazite growth at ∼42, ∼36, and ∼27 Ma. The youngest monazite U/Th–Pb ages (20 ± 2 Ma) are indistinguishable from our biotite and white mica $^{40}Ar/^{39}Ar$ cooling ages (22–20 Ma) and pinpoint the onset of rapid cooling due to SW-ward extrusion of the GHC. Onset of extrusion is thus 8–10 m.yr. earlier compared to the eastern Himalaya.

The samples were collected above and below the structural level that has been proposed as the South Tibetan detachment by some authors, while others dispute its very existence in the area. The respective age patterns are the same within error and thus inconsistent with the existence of a major shear zone at that level. We propose that the South Tibetan detachment pinches out in central Himachal Pradesh and reapers as the Zanskar shear zone further west, while in the study area it is manifested by distributed top-to-the-N shear at the upper structural levels of the Phojal nappe.