Constraints on the P–T–t evolution in the Garhwal Himalaya (NW India): Implications for early Oligocene regional Barrovian metamorphism and tectonic discontinuities

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The pressure–temperature–time (P-T-t) evolution of the High Himalayan Crystallines (HHC) along the Bhagirathi river in NW India has been investigated to unravel the tectonic and metamorphic history in the Garwal Himalaya. Geothermobarometers reveal that metamorphic grade rapidly increases upwards from garnet schist in the LHS (514-553 ℃, 7.8-8.8 kbar) to kyanite-bearing migmatites in the lower HHC (718-735 ℃, 10.5-12.7 kbar) across the Main Central Thrust (MCT) or Vaikrita Thrust, and then metamorphic grade basically decreases towards the lower HHC (608-695 ℃, 6.5-8.3 kbar). The P-T condition at thermal peak for lowest HHC inferred from pseudosection including XFe and Grs isopleths of garnet core is T =ca. 710-740 ℃ and P =ca. 10.3-12.0 kbar. Residual pressures of quartz inclusions in garnet is estimated using the Raman spectrometer, and it gave a peak pressure of 14.3-14.7 kbar. The P–T conditions and petrographic observation suggest that kyanite-bearing migmatites formed by fluid-present muscovite melting. The Jhala Normal Fault (JNF), showing prominent signatures of younger normal movement following older reverse movements, has been identified within the HHC. The metamorphic grade gradually decreases upwards the top of the HHC (585-630 ℃, 8.9-10.9 kbar) across the JNF. Zircon geochronology reveal that a whole HHC in this area preserve early Oligocene (ca. 35–32 Ma) regional Barrovian-type metamorphism caused fluid-present melting. It could promote the flow in the middle crust and greatly influence the early evolution of the Himalayan crust. Geochronological data from this and previous studies suggest that the HHC experienced prolonged high-temperature metamorphism of ca. 600–700 ℃ more than 15 Myr, and then rapidly cooled and exhumed during 22–13 Ma.

Keywords: Himalaya orogeny, Barrovian metamorphism, northwestern India, P-T-t path

