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Crustal anatexis of the Greater Himalayan Crystalline Sequence and its tectonic implications: Insights from Structural, Metamorphic & Chronological Studies along the Kali River Valley, Kumaun Himalaya, India

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The Cenozoic Himalayan Orogeny is the manifestation of continental collision and subsequent underthrusting of the Indian continental plate beneath its Eurasian counterpart. The Himalayan Orogen consists of four major litho-tectonic units: (1) Siwalik unit or the Himalayan Foreland Basin; (2) Lesser Himalayan Crystalline Sequence (LHCS); (3) Greater Himalayan Crystalline Sequence (GHCS); (4) Tethyan Sedimentary Sequence (TSS). These major litho-units are separated by regional scale discontinuities such as the MFT (Main Frontal Thrust), MBT (Main Boundary Thrust), MCT (Main Central Thrust) and STDZ (South Tibetan Detachment Zone) and can be traced across the entire length of the Himalayan arc. The GHCS represents a major part of the Himalayan metamorphic core complex, composed mainly of medium to high grade metasedimentary rocks, Palaeozoic granites and orthogneisses and Cenozoic Greater Himalayan leucogranites. This study contains field observations, P-T pseudosection modelling, zircon U-Pb Geochronology and bulk rock geochemistry of the Greater Himalayan Crystalline Sequence (GHCS) of the Kali River Valley, Kumaun Himalaya to elucidate the interrelationship between crustal anatexis processes and activation of major binding fault zones. Based on structural, metamorphic and zircon U-Pb ages, we delineate the MCT along the Kali River Valley. Field observation suggests that partial melt generated at the base of the GHCS and migrated towards north and eventually, voluminous partial melts were emplaced synkinematically in the form of tourmaline bearing leucogranite within the South Tibetan Detachment Zone (STDZ). P-T pseudosection modelling suggests peak subsolidus metamorphism of 6.5-6.9 kbar and 520°-560°C in garnet stability field at the immediate footwall of the MCT. Samples from lower structural unit i.e. immediate hanging wall of the MCT, lower-middle and middle structural units of GHCS have experienced muscovite dehydration partial conditions at 9.2-9.8 kbar and 720°-725°C , 8.4-8.7 kbar and 700°-710°C, 7.8-8.4 kbar and 700-720°C respectively. Garnet zone persists till the lower-middle structural unit of the GHCS from upper structural level of the Munsiari Formation and kyanite zone started at the middle structural unit of the GHCS along the Kali River Valley. Zircon U-Pb geochronology suggest that the rocks of GHCS have experienced suprasolidus peak metamorphism at 23.10 $\pm$ 0.052 Ma (MSWD=0.23) at immediate hanging wall of the MCT and 27.71 $\pm$ 0.18 Ma (MSWD = 0.25) at the middle structural unit. We suggest the MCT is at least $\sim$23 Ma old, being contemporaneous to the partial melting event that took place at its base. Bulk rock geochemistry of tourmaline bearing leucogranite from the STDZ of the Kali River Valley reveals high Rb/Sr, low Sr/Ba ratio and negative correlation of Ba with Rb/Sr which suggest vapour absent muscovite dehydration melting of their protolith. Based on these observations, we infer that partial melt weakened the overlying Himalayan wedge and triggered gravity collapse that formed the STDZ.