# Tertiary Eclogite Facies Metamorphism in the Greater Himalayan Sequence: Evidence from Zircon U-Pb Geochronology and Trace Element Geochemistry

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Mafic and pelitic granulites exposed in the Greater Himalayan Sequence (GHS) in the eastern Himalayan kingdom of Bhutan preserve textural evidence for a precursor high-pressure metamorphic event, the precise conditions of which are generally unrecoverable due to the later high-temperature overprint (Groppo and others, 2007). As high pressure metamorphism is rare in the Himalayas, especially in the eastern parts of the orogen, their thermobarometrical and geochronological evolution place important constraints on the geodynamic evolution of the Himalaya in particular, and continental collisions in general. We report SHRIMP-RG trace element (REE) and U–Pb zircon geochronological data, collected by the same instrument and on adjacent spots of the same crystal. These data suggest that zircons crystallized at 14-15 Ma over a temperature range of ca. 705-815 °C. This age is interpreted to indicate the timing of HP metamorphism due to the lack of negative Eu anomaly, the depleted heavy REE signature and the temperatures of crystallization.

U-Th-Pb Monazite ages indicate that the near-peak T conditions in this area were attained shortly after the somewhat lower grade area underneath separated by a ductile shear zone. Ti-in-zircon and Zr-in-rutile geothermometry further help to establish links between accessory mineral crystallization and metamorphism. Finally, crystallization ages of deformed leucogranites suggest a concomitant shift of deformation along the roof normal-geometry shear zone towards the interior of the orogen (Kellett and others, 2009). These data are consistent with multiple pulses of GHS exhumation in Bhutan from south to north (Hollister and Grujic, 2006), possibly by tectonic forcing over an incoming Indian crustal ramp.

We suggest that rocks in GHS in the eastern Himalaya were buried to greater depths and subjected to greater temperatures than in the central parts of the orogen, and were exhumed rapidly during the later stages of orogenic evolution. The formation of the Himalaya is currently explained by two contrasting tectonic models that differ in their predictions for the sequence of deformation along the main structures. We conclude that deformation and metamorphism distribution in the Bhutan Himalaya is compatible with the predictions of geodynamic models of Himalaya applying concepts of the channel flow hypothesis (Jamieson and others, 2006).

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