Pluton crystallization and petrogenesis in the Eastern Hindu Kush, NW Pakistan

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New in situ U-(Th)/Pb zircon and monazite geochronology and geochemical analyses from plutonic bodies in the Hindu Kush range, NW Pakistan, provide insight on the crustal growth and tectonic evolution of the southern Eurasian margin. These new data outline a protracted magmatic history that spans the Cambrian to the Neogene (~538 to 23 Ma) and record a variety of petrogenetic associations variably influenced by within plate, volcanic arc, and collision tectonic environments.

Major and trace elements of the Kafiristan pluton reflect two different phases, both of which indicate a source derived from partially melted lower crust consistent with an anorogenic tectonic environment. Zircon geochronological data from both phases overlap between 538 and 487 Ma. We interpret that this protracted magmatic event is related to extensional plutonism during rifting and detachment of Cimmerian blocks from Gondwana.

The geochemical signatures of Tirich Mir pluton may be attributed to partial melting of lower crust/mantle wedge material. There is significant heterogeneity in the geochemistry, which may reflect upper crustal contamination during magma ascent. Zircon from the Tirich Mir pluton yield an age of 126 ± 1 Ma contemporaneous with northward subduction of the Paleotethys along the southern margin of Eurasia following the accretion of the Hindu Kush-Karakoram blocks in the Mesozoic.

Petrography and and mineral assemblages outline distinct felsic and intermediate phases within the Buni-Zom pluton; however, geochemical signatures indicate a similar deep crust-mantle wedge source for both. Specimens from the two phases yield indistinguishable U-Pb zircon ages that indicate the Buni-Zom body was emplaced during Early Cretaceous at ca. 107 Ma. Combined with the data from the Tirich Mir body, the Buni-Zom pluton helps outline a semi-continuous subduction environment along the southern margin of Eurasia throughout the Early Cretaceous.

The Garam Chasma pluton is the youngest plutonic body in the study area. It yields an Early Miocene crystallization age (23.5 ± 0.1 Ma; Th-Pb on monazite) and a geochemical signature consistent with derivation from a sedimentary source. The age of the Garam Chasma pluton coincides with widespread melting generated during crustal thickening and anatexis across the Himalayan arc.

These new geochemical data and geochronologic constraints from the Hindu Kush not only provide crucial constraints on the melt production in the region prior to the Cenozoic India-Eurasia collision but also help provide insight into the pre-Himalayan tectonomagmatic evolution of the southern margin of Eurasia.

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