

Tectono-magmatic evolution from intra-arc subduction to arc-continent collision: A case study from the central Kohistan magmatic arc, northern Pakistan

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The central part of the Kohistan magmatic arc is a pivotal area to study crustal growth mechanisms related to tectonic transition from intra-oceanic lithosphere subduction to arc-continent collision. We here present geochemical data as well as zircon U-Pb ages and Hf isotope data from a large suite of granitoids from the central Kohistan magmatic arc in northern Swat Kohistan. The data reveal three major stages of magmatism: at 77-71 Ma (stage I), 63-53 Ma (stage II), and 47-44 Ma (stage III). All granitoids are metaluminous to peraluminous ($ASI < 1.1$), contain abundant hornblende, and reveal a negative correlation between SiO_2 and P_2O_5 , similar to I-type granites. Primitive mantle and chondrite normalized trace element patterns reveal an enrichment of LILE, Th, and LREE and depletion in Sr, HFSE, and HREE. The stage I granites are characterized by high silica contents, a peraluminous composition, low mg#, and variable Hf isotope compositions ($\epsilon_{Hf}(t) = -1.2$ to 8.3), suggesting derivation from juvenile crust with minor but variable contributions of detrital and terrigenous sedimentary material, perhaps derived from the Indian plate. All stage II granitoids show low amounts of silica, in addition to high mg#, Ni, and Cr contents, and highly superchondritic $\epsilon_{Hf}(t)$ values (from 5.6 to 13.5), suggesting deviation from a highly depleted to mildly, perhaps subduction-enriched mantle source. The stage III granitoids are potassic to ultrapotassic in composition. Superchondritic $\epsilon_{Hf}(t)$ values (3.8 to 9.2) of the Shahibagh granodiorite indicate juvenile magma input during stage III. Whereas subchondritic $\epsilon_{Hf}(t)$ values (-0.2 to -9.6) of the coeval Diwanger and Jut Banda plutons reveal assimilation of abundant crustal matter at the same time, perhaps related to assimilation of ancient crust during arc-continent collision. Integrated with previous data, we propose that the investigated granitoids of the central Kohistan magmatic arc document the tectonic transition from intra-arc subduction during the stages I and II (between 77 and 53 Ma), followed by arc-continent collision during stage III at $47-44$ Ma.