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Paleocene Katisho ultramafic-mafic-intermediate igneous rocks in the Ladakh Batholith, northern Pakistan: Implications for the transition from intra-oceanic to Andean type arc setting

Zahid Hussain [a b], Chuan-Lin Zhang [a] ✉, Masumeh Sargazi [a], Irfan Maqbool Bhat [c], Ye Xian-tao [a], Zhi-Hao Song [a], Muhammad Farhan [d], Zaheen Ullah [e], Tehseen Zafar [f], Amjad Hussain [g], Syed Asim Hussain [h]

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Highlights

- The Katisho ultramafic-mafic-granodiorite intrusive complex were emplaced at ca. 66.6 Ma.
- Primitive magma of the complex was originated from partial melting of a depleted lithospheric mantle source.
- The Paleocene intrusions was genetically related to the subduction rollback of the Neo-Tethyan Oceanic slab.

Abstract

The Kohistan-Ladakh Arc records terrane accretion and continental growth history from the opening to the closure of the Neo-Tethys. However, its role in the Neo-Tethys evolution and implication for continental crustal growth remain debated. This study present the first comprehensive dataset on the newly identified Katisho ultramafic-mafic-intermediate rocks within the Ladakh Batholith, including field and petrographic features, in-situ zircon U—Pb ages and Lu—Hf analysis, mineral chemistry, bulk-rock elemental and isotopic (Sr—Nd) compositions, aiming to have a better understanding the building up of the Kohistan-Ladakh arc and its role in the Neo-Tethys evolution. The Katisho gabbros and granodiorites, located on the northwestern side of the Ladakh Batholith, contain irregular ultramafic enclaves. Zircon U—Pb dating reveals that the gabbro and granodiorite were emplaced coevally at ca. 66.6 Ma. Geochemical signatures, such as enriched LILE, depleted HFSE, and consistent LREE-enriched REE patterns, show typical features of the arc-related calc-alkaline magmatisim. Their depleted whole-rock Sr ($[^{87}Sr/^{86}Sr]_i$ = 0.7041 to 0.7045), Nd [εNd(t) = +2.4 to +3.2], and zircon Hf [εHf(t) = +4.1 to +11.1] isotopic compositions, along with their elemental features (enriched LILE, low FC3MS values [0.4–0.6], and Cpx: Grt ratio = 6:1) collectively demonstrate a common origin from a depleted lithospheric mantle source, predominantly spinel-bearing peridotite metasomatized by slab-derived fluids. The diverse type of the intrusions can be attributed to the fractional crystallization of a common primary mafic magma. This study, combined with previous research, concludes that the Paleocene Katisho intrusions were genetically related to the rollback of the Neo-Tethyan Oceanic slab beneath the Asian margin. This magmatic phase marks the transition of the Kohistan-Ladakh arc from an intra-oceanic arc to an Andean-type continental margin, prior the India-Asia collision.