Gondwana Research 141 (2025) 164–179

Contents lists available at ScienceDirect

Gondwana Research

journal homepage: www.elsevier.com/locate/gr

Retrieving petrogenetic source, compositional diversity and tectono-magmatic scenario of Tethyan sediment-derived magmatic flare-up: A tale from petrochemical and multi-isotopic (Sr–Nd–B–Hf) systematics

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ARTICLE INFO

Handling Editor: Z. Zhang

ABSTRACT

The Earth's continental crust is predominantly composed of granitic rocks, yet the genesis of pure sediment-derived peraluminous granites (PGs) remains debated. This study investigates the Ordovician Mansehra granitic suite (ca. 476–483 Ma) from the northwestern Himalayas of Pakistan as an example of S-type granites, comparing them with global counterparts from Diancangshan-Ailaoshan (China), Tanggula-Damxung (Tibet), and Karamese (Turkey). Geochemical and isotopic data, including variable zircon εHf(t) values (−37.7 to + 12.6), enriched Sr isotope ratios (($^{87}Sr/^{86}Sr$)i: 0.5678–0.7444), negative εNd(t) values (−13.4 to − 2.9), and a narrow $\delta^{11}B$ range (−15.4 ‰ to − 9.5 ‰), indicate that PGs formed through partial melting of heterogeneous, mature pelitic sources under shallow, low-pressure conditions in the lower–upper crust, with minimal mantle input. Heterogeneous Hf isotopic behavior reflects the disequilibrium melting of variable metasedimentary protoliths. Geochemical modeling highlights fluid-flux melting as the dominant process, except for the Tanggula granites, which exhibit characteristics of fluid-absent melting. Tectonically, the Mansehra PGs are interpreted as products of Proto-Tethyan oceanic subduction beneath northern Gondwana, formed through the disequilibrium melting of exhumed back-arc basin sediments. Slab break-off likely triggered asthenospheric upwelling, enhancing heat flux and driving anatexis and PG production. While global PGs represent different geodynamic evolutionary contexts, they predominantly display significant tectonic events rather than direct contributions to

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https://doi.org/10.1016/j.gr.2025.02.013
Received 24 September 2024; Received in revised form 7 January 2025; Accepted 24 February 2025
Available online 26 February 2025