Zircon U-Pb-Hf Isotope Constraints on the Paleoproterozoic Crustal Evolution of the Aravalli Orogen, NW India

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The conventional whole-rock isotope data provide limited information on the sources of granitoids, particularly when they are severely altered by post-crystallisation processes [e.g., 1-2]. In this context, combined zircon U-Pb-Hf isotopes in conjunction with elemental geochemical data has emerged as a powerful approach to understand sources of such granitoids [e.g., 3-5].

Zircon in situ U-Pb-Hf isotope and whole-rock elemental data unravel two significant discrete late Palaeoproterozoic granitoid emplacement events at 1860-1810 Ma and 1730-1700 Ma in the northern Aravalli orogen. The former magmatic event is recorded by calc-alkaline Andean-type continental arc granitoids, which have been derived from garnet-free and plagioclase-rich sources at shallow depths. The occurrence of 3.3-2.5 Ga inherited zircon grains, 3.0-2.6 Ga Hf-Nd model ages along with significant variation in initial zircon-Hf (εHf_t = -3.7 to -9.0) indicate reworking of heterogeneous Archaean crust during the late Palaeoproterozoic. The younger magmatic event (1730-1700 Ma) is recorded by variably metasomatised granitoids. These rocks show typical A-type granite characteristics (Ga/Al > 2.5, Nb+Y > 60 ppm, high Fe-number, REE, and HFSE). The zircon Hf isotope and whole-rock trace element data indicate that the magmas for these A-type granites were originated from two distinct sources; those with subchondritic εHf_t values, by partial melting of 1.85 Ga calc-alkaline granitoids and others with superchondritic εHf_t values, by mixing of felsic crustal and mafic melts. The granites were generated in a post-collisional setting due to slab break-off, whereby the asthenosphere flowed into the slab window leading to partial melting of predominately 1.85 Ga granitoid crust accompanied by injection of mantle-derived mafic melts.

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