Zircon and Whole-rock Hf Isotope Constraints on the Petrogenesis of the Transhimalayan Plutonic Rocks

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Abstract

Zircon' Hf isotope ratios can be used in much the same way as whole-rock Nd isotopes. They, furthermore, often record "hidden" information that allows more detailed studies of the magma generation processes. Based on zircon Hf isotope data obtained in this study, together with associated U-Pb ages, the following conclusions regarding Transhimalayan petrogenesis are reached: (1) There are significant variations in Hf isotopes of magmatic zircons, up to ~15 ε-units in some samples, suggesting magma mixing to be a common process; (2) A "hidden" DM (depleted mantle) component, with $\varepsilon_{Hf}(T)$ values up to +19.8, is identified to be prevalent in the Gangdese magmatic zircons. This DM-type component has never been revealed by any whole rock isotope analysis; (3) While the "conventional" Gangdese magmatism has been known as most active in the Cretaceous and Paleogene, this study identifies a new magmatic episode within the Gangdese belt that occurred in Early Jurassic time resulting from the long-lasting Neo-Tethyan subduction; (4) The S-type granitoids of the northern magmatic belt contain abundant inherited zircons aged from ca. 188 to 210 Ma, in which a crustal component that shows $\varepsilon_{Hf}(T)$= -3.9 to -13.7 and T_{DM}^{C} model ages of ca. 1.4- 2.1 Ga is identified. This implies a major stage of crustal growth in Proterozoic time and remelting of the crustal material in Early Jurassic time; (5) The Oligocene-Miocene adakites contain magmatic zircons that show similar Hf isotope compositions to the Cretaceous-Paleogene Gangdese batholiths, providing a key constraint that allows evaluation of the nature and timing of crustal thickening in southern Tibet owing to the India-Asia collision; and (6) As a whole, the Hf isotope information observed in zircons from the above Transhimalayan rocks demonstrates a temporal variation in $\varepsilon_{Hf}(T)$ values, and thus T_{DM}^{C} ages, that suggests multiple stages of orogenic or crustal formation events.