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SPECIAL COLLECTION: PERSPECTIVES ON ORIGINS AND EVOLUTION OF CRUSTAL MAGMAS

From the Hadean to the Himalaya: 4.4 Ga of felsic terrestrial magmatism

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Abstract

Detrital zircons as old as nearly 4.4 Ga offer insights into the earliest moments of Earth history. Results of geochemical investigations of these grains have been interpreted to indicate their formation in near-H_2O saturated meta- and peraluminous magmas under a relatively low (15–30 °C/km) geotherm. A key feature in pursuing a petrotectonic model that explains the full spectrum of these observations is their seeming contrast to most Phanerozoic magmatic zircons, specifically their low Ti-in-zircon crystallization temperatures and inclusion assemblages. The ~22 Ma Arunachal leucogranites of the eastern Himalaya appear, however, to be a rare exception to this generality. They show large-ion lithophile covariance trends indicative of wet basement melting together with a normal distribution of magmatic crystallization temperatures about an average of 660 °C. In the same fashion as Hadean zircons, Arunachal leucogranite and host gneiss zircons are dominated by muscovite + quartz inclusions that yield formation pressures of 5–15 kbars. We suggest that the Arunachal leucogranites originated in the hanging wall of a megathrust that carried H_2O-rich foreland sediments to depths of >20 km whereupon de-watering reactions released fluids that fluxed hanging wall anatexis. Modeling suggests the thermal structure of this continental collision environment may have been broadly similar to a Hadean ocean-continent subduction zone. The similarity of these two environments, separated by over 4 Ga may explain seemingly common features of the Hadean and Arunachal leucogranite zircons. Their key difference is the absence of metaluminous magmas in the continental collision environment, which is shielded from juvenile additions.

Keywords: Early Earth, zircon, geochronology, geochemistry, crustal magmas, Himalaya