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The hottest lavas of the Phanerozoic and the survival of deep Archean reservoirs

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The mantle plume hypothesis is widely accepted for the formation of large igneous provinces and many modern day hotspot volcanoes. Petrologic models suggest that plume-derived melts originate at high mantle temperatures (>1500 °C) relative to those generated at ambient mid-ocean ridge conditions (∼1350 °C). Earth's mantle has also cooled during its history due to heat loss and decrease in radioactive heat production, thus the temperatures of modern day basalts are substantially lower than those produced during the Archean (>2.5 Ga), as recorded by komatiites (>1700 °C). We discovered that the ∼90 Ma Galapagos-related Tortugal Suite accreted in Costa Rica not only record mantle potential temperatures as high as ancient Archean komatiites (∼1800 °C), but we also collected the highest olivine-spinel crystallization temperatures ever reported in the literature (1600 °C). Therefore, to the best of our knowledge, this suite represents the record of the hottest lavas of the Phanerozoic. These type of magmas occurred more frequently during the Archean due to overall higher ambient mantle temperatures, yet our data suggest that anomalously hot, isolated domains still exist in the deep portions of the planet that have survived billions of years of mantle convection and cooling. This finding is in line with the recent results that showed that early-formed 182W/184W mantle heterogeneities, produced during the first 50 million years of planetary accretion, survived to present time and has been sampled by mantle plumes. Our finding supports the existence of primitive Archean reservoirs, although in most plumes cooler ambient mantle entrainment probably dilutes its temperature signature.