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Dynamic evolution of global mantle isotopic anomalies linked to supercontinent-superocean evolution since 700 Ma

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The present-day isotopic composition of Earth's mantle is highly heterogeneous, featuring both enriched and depleted regions, shaped by a complex history of depletion and re-enrichment over 4.5 billion years of Earth evolution. The spatial configuration of such large-scale heterogeneity has long been recognised as not stochastic, but the timing and mechanisms that caused such heterogeneity are still a matter of debate. Here, we compile radiogenic isotope data of mid-ocean ridge and plume-induced basalts from both present-day oceanic lithosphere and that of past oceans preserved in sutures for the past 900 Ma of the relatively isotopically enriched African mantle domain. Our Nd isotopes dataset shows that both the upper mantle and plume-derived rocks of the African mantle domain exhibit a relatively homogenous composition similar to the prevalent mantle (PREMA) estimates until *ca.* 400 Ma when plume-derived rocks start becoming isotopically enriched with maximum enrichment reached in the mid-Cretaceous. After mid-Cretaceous, plume-derived rocks of the African Domain shift to a gradual depletion trend, getting closer to the prevalent mantle value with time. Contrastingly, plume-derived rocks of the Pacific Domain have very few isotopically enriched compositions recorded until the inception of the more recent enriched plumes (e.g. Samoa and Pitcairn). Our results show enrichment in the African Domain that can be interpreted as resulting from the introduction of continental crustal materials to the mantle during the assembly and the early stage of the break-up of Gondwana and Pangea. We also interpret the distinct compositional evolutions of the African and Pacific plume-derived rocks in the current ocean lithosphere to result from the supercontinent cycle, where the outward retreat of the subduction girdle during the break-up of Pangea drives the depletion trend observed in the African Domain for the past ca. 100 Myr as well as the appearance of extreme enrichment in sections of the Pacific Domain.