

Large scale mantle heterogeneity: A legacy of plate tectonic supercycles

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The Earth's mantle is divided by the circum-Pacific subduction girdle into the African and Pacific domains, each featuring a large low shear-wave velocity province (LLSVP) in the lower mantle. However, how does this hemispherical-scale mantle structure link to Earth's plate tectonic evolution remains unclear. Pioneer geochemical work recognised the presence of large-scale mantle heterogeneities in the southern hemisphere, termed the DUPAL anomaly. It was thought to be related to either the enrichment of subducted sediments and/or the mixing of more enriched ancient materials from the primordial lower mantle (i.e., the LLSVPs) formed during Earth's early differentiation process unrelated to the billions of years of plate tectonics. More recent work argued for a subduction-related origin for DUPAL-like mantle enrichment in either the deep plume source or the shallower mantle of the African mantle domain. Here we systematically reanalyse all elemental and isotopic data of mantle-derived oceanic igneous rocks that fingerprint the African and Pacific mantle domains. Data from both mid-ocean ridges and plume-related ocean islands and oceanic plateaus illustrate a consistent chemical dichotomy between the two domains, which can best be explained by tectonic supercycles over the past 1 billion years involving two supercontinents and two superoceans.