# Earth's Adolescence: Isotopically tracking the transition from the Hadean to the Modern Earth

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Chemical evolution of the crust and mantle has been strongly connected through plate tectonic processes for at least the last 2 Gyr. The questions remain, however, of how and when did plate tectonics become the predominant geodynamic framework for the Earth and what came before? We address these by investigating patterns of radiogenic isotopic variations through the geologic record to the oldest, ~ 4.0 Ga rocks. As changes in patterns of isotopic evolution are linked to changes in mantle dynamics and associated melting regimes, tracking these signatures in geologically well-characterised rocks can be used to discover the nature and evolution of tectonic processes. For example, Phanerozoic and Proterozoic crustal rocks demonstrate well-defined "coupled" $^{176}$Hf-$^{143}$Nd isotopic evolution [e.g. 1] reflecting specific source and melting characteristics. In contrast whilst the major and trace element compositions of >3.6 Ga rocks have analogs in younger rocks in accord with a continuum of crust formation processes, $^{143}$Nd and $^{176}$Hf isotopic patterns are distinct *"decoupled"* from those seen in younger rocks; the majority of juvenile Eoarchean rocks worldwide are now shown to have near chondritic initial $^{176}$Hf isotopic compositions [e.g., 2] with variable $^{143}$Nd. Additionally many >3.6 Ga rocks also possess extinct nuclide anomalies in the form of $^{142}$Nd and $^{182}$W isotopic signatures; these are largely absent in modern terrestrial samples and are evidence of chemical fractionation processes occurring within the first ca. 10-300 million years of Solar System history.

The image emerging from the variations of radiogenic isotopic signatures from both long and short half-life decay schemes is of initiation of some form of plate tectonics prior to 3.6 Ga, with the period from 3.6 Ga to 3.0 Ga marking a global transition from signatures dominated by early differentiation processes, likely associated with planetary accretion and formation, to more modern style regimes. Here, we track this isotopic change in key regions and demonstrate how these changes places limits on the timing and style of transition from early to modern Earth.

[1] Chauvel et al., (2014) *EPSL,* **388**, 48-58. [2] Hiess and Bennett, (2016) *Chem. Geology* **427,** 125-143.

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