Archaean high-grade gneiss terrains as a key to the understanding of early Earth tectonics

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The plate tectonic concept is considered as a unifying theory, since it could successfully link seemingly unrelated geological phenomena. Notwithstanding the wide acceptance of the theory, a greater debate took over charge concerning exact timing of the onset of tectonics on Earth and evidence for the initiation of the same[1-3]. The absence of similar tectonic styles on the terrestrial silicate-rich planets, suggests that the plate tectonic system is not generated automatically on Earth, but triggered due to thermo-mechanical changes causing formation of a dynamic system that enables the planet to dissipate its internal heat. Thus, it is essential to identify and interpret the consequences that have been recorded due to tectonic processes in geological formations through time to unravel the intricacies concerning the evolution of the Earth.

Here, we address the question of "when did plate tectonics begin?" or more precisely, when exactly did the modern-style plate tectonics took over from an earlier style of tectonics by evaluating the genesis of lower-crustal derived metagranitoids from southern India. The contrasting metagranitoid groups comprise (i) metatonalites with characteristic Archaean tonalite–trondhjemite–granodiorite (TTG) affinity and (ii) metagranites showing geochemistry archetypal of the post-Archaean granites. The geochemical features (avge. La_N = 154; Yb_N = 6; Sr/Y 331; $[La/Yb]_N$ = 39; positive Eu anomalies) suggests genesis of metatonalites from partial melting of a subducting slab and/or thickened lower crust composed of mafic source rocks (eclogitic or basaltic crust) in the Neoarchaean (ca. 2.73–2.89 Ga). On contrary, the geochemistry of metagranites (avge. $[La/Yb]_N$ = 20; low Sr/Y and high Rb/Sr, Ba/Sr ratios; negative HFSE and Eu anomalies) show affinity towards crustal derivatives formed by remelting. These spatio-temporal and chemical variations are argued as consequence of differences in the tectonic styles. We propose tectonic scenario for metatonalite petrogenesis as flat subduction of old mafic crust followed by a change in tectonic style from flat to steep transition.

[1] Harrison *et al.* (2005) *Science* **310**, 1947–1950. [2] Stern (2005) *Geology* **33**, 557–560. [3] Bercovici and Ricard (2014) *Nature* **508**, 513-516.