

Did modern-style plate processes operate during early Earth? Insights from P-T-t history of the Archean crust from Singhbhum Craton, eastern India

SABYASACHI CHATTOPADHYAY¹, STEPHEN F. FOLEY², SCOTT ANDREW WHATTAM¹ AND OM PRAKASH PANDEY³

¹College of Petroleum Engineering and Geosciences, King Fahd University of Petroleum and Minerals

²Macquarie University

³King Abdullah University of Science and Technology (KAUST)

Presenting Author: s.chattopadhyay@kfupm.edu.sa

Whether conventional plate tectonics operated in the early Archean, and timing of its onset remains debated [1]. The Singhbhum Craton in India has extensive occurrences of Archean polymetamorphosed Tonalite-Trondhjemite-Granodiorite (TTG) suites of rocks providing an excellent opportunity to address issues of crustal growth and metamorphism in an important segment of the Indian Peninsula [2].

These TTGs were emplaced in two pulses at 3.45–3.44 Ga and 3.35–3.32 Ga [3]. The parental magmas crystallized at temperatures of 815–938 °C. The TTGs underwent their first metamorphism (M_1) at 3.30–3.28 Ga together with supracrustal rocks of the Older Metamorphic Group. Thermobarometry, Ti-in-zircon thermometry and Zr-in-rutile thermometry give P-T conditions of 2.4–4.3 kbar, 695–751 °C for this event. The granitoids were metamorphosed a second time (M_2) at 3.19–3.13 Ga at conditions of ~1.44 kbar and 534–581 °C. This metamorphism was synchronous with emplacement of younger potassic granitoids at 3.16–3.10 Ga. A third low-grade metamorphic event (M_3) at 3.06–2.96 Ga is correlated with extensive fluid-induced alteration of the various mineral assemblages.

The estimated P-T conditions of the M_1 and M_2 are suggestive of high apparent geothermal gradients of ~46–115 °C/km but, it may only be apparent caused due to the perturbation of the geotherm at the time of metamorphism by granitoid plutonism. The regional-scale high dT/dP regime during metamorphism of these TTGs is suggestive of a geodynamic setting analogous to a mobile lid-like convection regime where the hotter Archean crust would have been subject to frequent slab break-off. However, the *clockwise* P-T history as deciphered from this study in tandem with the U–Pb zircon ages (t) and their Sr–Nd–Hf isotope study [4] suggests not only thickening of the crust by ca. 3.1 Ga but also is indicative of modern-style horizontal plate processes toward the generation of TTG pulses.

[1] Condie (1986) *Precambrian Research* 32, 261-278. [2] Saha (1994) *Geological Society of India* 27, 1-341. [3] Upadhyay et al. (2014) *Precambrian Research* 252, 180-190. [4] Upadhyay,