Time will tell: Using geospeedometry to distinguish between early precambrian and later tectonic styles

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Metamorphic rocks record the tectonic evolution of crustal blocks [1]. Plate tectonics has operated on Earth since some point in the pre-cambrian. A central question is: *Was the tectonic style the same during early plate tectonics*?

Thermomechanical modelling indicates that a peeling-off dominated plate tectonics occured during the Archean- early Proterozoic, when the upper mantle was hotter than today [2]. Peeling-off plate tectonics involves removal of the lower crust + lithospheric mantle during orogenesis and allows the convecting mantle to upwell. Consequently, the peeled-off orogenic lithosphere remains hot for a longer duration and the rocks exhuming/cooling through them are expected to cool slowly. This contrasts with tectonic styles in present-day orogens with lower mantle potential temperature where slab break-off dominates. Cooling rates of rocks are expected to be rapid in such settings. Additionally, peeling off tectonics is associated with more magmatism, and the formation of high as well as low pressure granulites.

We have studied early-Paleoproterozoic (~2.48 Ga metamorphic age, [3]) high-P mafic granulites (~800 °C, 13-14 kbar) from Southern India where diffusion chronometry indicates that the rocks cooled from ~800 °C (peak) to ~600 °C, at ~5-30 °C/Myr [4]. Similar cooling rates were obtained from the ~2.8 Ga metasedimentary granulites of Wyoming Province [5]. These cooling rates at high temperatures (>600 °C) are significantly lower (by an order of magnitude) than those obtained from recently cooled rocks, like Higher Himalayan rocks [6]. This indicates that the Archean/early-Paleoproterozoic granulites cooled within a hotter ambient orogenic structure compared to the present-day orogens. We, therefore, suggest that the initial form of plate tectonics might have involved a lot of peeling-off and was different from present-day plate-tectonics.

[1] Brown (2006), *Int Geol Rev 49, 193–234.* [2] Chowdhury et al. (2016), *Nat Geosci 10, 698-703.* [3] Anderson et al. (2013), *Geology 40, 431-434.* [4] Chowdhury et al. *(in review), J Petrol* [5] Guevara et al. (2017), *J Metamorph Geol.* [6] Sorcar et al. (2014), *Contrib Mineral Petrol 167(2), 957.*