Geodynamic models of non-subduction generation of Archean continental TTG crust

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The tectonic mode in the Archean and when/how continents formed are two key unknowns. Here we investigate these using global simulations of Earth evolution that include self-consistently calculated production of basaltic oceanic crust and TTG continental crust. In our models using StagYY [1] the mantle starts compositionally homogeneous, basaltic crust is formed by partial melting of the mantle and TTG is formed by partial melting of basalt in certain (P,T, H_2O) windows [2]. Produced magma is erupted at the surface and intruded into the crust with a specified ratio.

We find that the tectonic mode was likely neither modern-day plate tectonics nor a rigid lid, but rather, one characterized by abundant mostly intrusive magmatism resulting in a hot, weak, deformable lithosphere – a "Plutonic Squishy lid" (PSL) [3]. In this mode, a thick basaltic crust is recycled at its base by eclogite drips plus episodic delamination of depleted lithosphere [4]. Abundant TTG crust is produced, with a production rate far exceeding typical continental crustal growth curves [5,6]. At the same time it can be destroyed by entrainment in downwellings.

These models thus indicate that (i) subduction was not necessary for the production of early continental crust, (ii) intrusive magmatism was dominant during the Archean (as opposed to "heat pipe" extrusive magmatism), and (iii) Archean tectonics was characterised by a weak, hot deformable lithosphere undergoing extensive delamination as well as significant horizontal motion.

We here compare these model predictions to geological and petrological evidence for Archean tectonics and TTG production.

[1] Tackley (2008) *PEPI* **171**, 7-18. [2] Moyen (2011) *Lithos* **123**, 21-36. [3] Lourenço *et al*. (2018) *GCubed*, submitted. [4] Sizova *et al*. (2015). *Precamb. Res*. **271**, 198-224. [5] Rozel *et al*. (2017) *Nature* **545**, 332-335. [6] Jain (2018), *Doctoral Thesis*, ETH Zurich.