Self-consistent generation of primordial continental crust in global mantle convection models

C. JAIN[1]*, A. B. ROZEL[1], P. J. TACKLEY[1]

[1]Institute of Geophysics, Department of Earth Sciences, ETH Zurich, Switzerland (*correspondence: charitra.jain@erdw.ethz.ch, antoine.rozel@erdw.ethz.ch, paul.tackley@erdw.ethz.ch)

We present the creation of primordial continental crust (TTG rocks) using self-consistent and evolutionary thermochemical mantle convection models [1]. Formation of primordial continental crust happened by fractional melting and crystallisation in episodes of relatively rapid growth from late Archean to late Proterozoic eras (3-1 Ga) [2] and it has also been linked to the onset of plate tectonics around 3 Ga [3]. It takes several stages of differentiation to generate Tonalite-Trondhjemite-Granodiorite (TTG) rocks or proto-continents. First, the basaltic magma is extracted from the pyrolitic mantle which is both erupted at the surface and intruded at the base of the crust. Second, it goes through eclogitic transformation and then partially melts to form TTGs [4, 5].

TTGs account for the majority of the Archean continental crust. Based on the melting conditions proposed by Moyen [6], we parameterize TTG formation. We vary the ratio of intrusive (plutonic) and extrusive (volcanic) magmatism [7] to study the relative volumes of three petrological TTG compositions as reported from field data [6]. Furthermore, we systematically vary parameters such as friction coefficient, initial core temperature and composition-dependent viscosity to investigate the global tectonic regime of early Earth.

Continental crust can also be destroyed by subduction or delamination. We will investigate continental growth and destruction history in global compressible models spanning the age of the Earth.

[1] Tackley (2008), PEPI 171, 7-18. [2] Hawkesworth & Kemp (2006), Nature 443, 811-817. [3] Shirey & Richardson (2011), Science 333, 434-436. [4] Rudnick (1995), Nature 378, 571-578. [5] Herzberg & Rudnick (2012), Lithos 149, 4-15. [6] Moyen (2011), Lithos 123, 21-36. [7] Crisp (1984), J. Volcanol. Geotherm. Res. 20, 177-211