Geophysical Research Abstracts, Vol. 9, 07872, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-07872

Evolution of plate tectonics

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The viability of plate tectonics in an early, hotter Earth is still an open question. Many observations and geodynamical arguments for both plate tectonics and alternative tectonics have been presented. The Earth was likely to have seen a 200-300 K mantle temperature drop since the Archean. So even if plate tectonics was operating during the bulk of the Earth's history, it is still likely that its appearance was showing secular changes, because rheology, crustal production, and volatile contents are all largely dependent on mantle temperature.

In this work, we combine previous numerical models of mantle melting and depletion and subduction/plate tectonics to study the mantle evolution by means of numerical modeling of the plate tectonic cycle through the Earth's history. We adress the following questions:

- How did upper mantle depletion develop during the Earth's history? How important is the onset timing of plate tectonics in this?

- To what extent does the thermal and chemical evolution of the mantle influence the operation of plate tectonics, both at the production side (ridges) and the subduction side (trenches), the duration of the Wilson cycle, and the break-up of supercontinents?

- What is the influence of the 670-km discontinuity on the upper mantle evolution through time?

Our results show a significant sensitivity of the system to the potential mantle temperature, consistent with theoretical predictions, and therefore also to changing conditions during secular cooling of Earth.