Geophysical Research Abstracts
Vol. 16, EGU2014-11954, 2014
EGU General Assembly 2014

Initiation of plate tectonics, damage and inheritance

Yanick Ricard (1) and David Bercovici (2)
(1) CNRS/Univ Lyon, Geology, Villeurbanne, France (ricard@ens-lyon.fr), (2) University of Yale, New Heaven, USA

The initiation of plate tectonics on Earth is a critical event in our planet's history. The time lag between the first proto subduction about 4Ga to global tectonics by 3Ga, suggests that plates and plate boundaries became widespread over a 1Gyr period. We hypothesize that during this period, transient mantle flow and migrating proto-subductions lead to lithospheric damage and eventually fully formed tectonic plates driven by subduction alone. We demonstrate this process using a grain evolution and damage mechanism (Bercovici and Ricard, 2012) with a composite rheology, which are compatible with field and laboratory observations of polycrystalline rocks coupled to an idealized model of pressure-driven lithospheric flow (wherein a low pressure zone is equivalent to the suction of convective downwellings). In the simplest case, for Earth-like conditions, a few successive rotations of the driving pressure field yield relic damage zones that are inherited to form a nearly perfect plate, with passive spreading and strike-slip margins that persist and localize further, even as flow is only driven by subduction. For Venus hotter surface conditions, accumulation and inheritance of damage is negligible; hence only subduction zones survive and plate tectonics does not spread, which corresponds to observations. After plates are developed, continued changes in driving forces, combined with inherited damage and weak zones, promote increased tectonic complexity, such as oblique subduction, strike-slip boundaries that are subparallel to plate motion, and spalling of minor plates.