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Fluctuations in seafloor spreading predicted by tectonic reconstructions and mantle convection models

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The theory of plate tectonics theory has enabled possible the reconstruction of the ancient seafloor and paleo-geography. Over 50 years of data collection and kinematic reconstruction efforts, plate models have improved significantly (Seton et al., 2012) although reconstructions of ancient seafloor are naturally limited by the limited preservation of of very old seafloor. It is challenging to reconstruct ancient ocean basins and associated plate boundaries for times earlier than 200 Ma, since seafloor of this age is not preserved. This means we can merely reconstruct only 5% of the history of the planet in this fashion. However, geodynamic models can now help evaluate how seafloor spreading may evolve over longer time periods, since recent developments of numerical models of mantle convection with pseudo-plasticity can generate long-term solutions that simulate a form of seafloor spreading (Moresi and Solomatov, 1998; Tackley, 2000a; Tackley, 2000b). The introduction of models of continental lithosphere further improves the quality of the predictions: the computed distribution of seafloor ages reproduces the consumption of young seafloor as observed on the present-day Earth (Coltice et al., 2012).

The time-dependence of the production of new seafloor has long been debated and there is no consensus on how much it has varied in the past 150My, and how it could have fluctuated over longer time-scales. Using plate reconstructions, Parsons (1982) and Rowley (2002) proposed the area vs. age distribution of the seafloor could have experienced limited fluctuations in the past 150My while others suggest stronger variations would fit the observations equally well (Seton et al., 2009. Here we propose to investigate the global dynamics of seafloor spreading using state-of-the-art plate reconstructions and geodynamic models. We focus on the evolution of the distribution of seafloor ages because fundamental geophysical observations like mantle heat flow or sea level provide “ground-truth” for modeling this parameter. Both kinematic reconstructions and geodynamic models suggest the rate of production of new seafloor can vary by a factor of 3 over a Wilson cycle, with concomitant changes of the shape of the area vs. age distribution. Geodynamic models show seafloor production time-series contain fluctuations of time scales exceeding 500My that depend on the strength of the lithosphere and the amount of basal heating.

References

Coltice, N., Rolf, T., Tackley P.J., Labrosse, S., Dynamic causes of the relation between area and age of the ocean floor, Science 336, 335-338 (2012).

Moresi, L., Solomatov, V., Mantle convection with a brittle lithosphere: Thoughts on the global tectonic style of the Earth and Venus, Geophys. J. 133, 669-682 (1998).

Parsons, B., 1982, Causes and consequences of the relation between area and age of the ocean floor, J. of Geophys. Res. 87, 289-302 (1982).

Rowley, D. B., History of Plate Creation 180 Ma to Present, Geol. Soc. of America Bull. 114, 927-933 (2002).

Seton, M., Gaina, C., Müller, R.D., and Heine, C., Mid Cretaceous Seafloor Spreading Pulse: Fact or Fiction?, Geology, 37, 687-690 (2009).

Seton, M., Müller, R.D., Zahirovic, S., Gaina, C., Torsvik, T.H., Shephard, G., Talsma, A., Gurnis, M., Turner, M., Maus, S., Chandler, M. (2012), Global continental and ocean basin reconstructions since 200 Ma, Earth Sci. Rev. 113, 212-270 (2012).

Tackley, P.J., Self-consistent generation of tectonic plates in time-dependent, three-dimensional mantle convection simulations, part 1: Pseudoplastic yielding, Geoch. Geophys. Geosys. 1 (2000a).

Tackley, P.J., Self-consistent generation of tectonic plates in time-dependent, three-dimensional mantle convection simulations, part 2: Strain weakening and asthenosphere, Geochem. Geophys. Geosys. 1, (2000b).