Coupled models of mantle convection, plate tectonics, core evolution, magmatism and mantle geochemical evolution.

Paul J. Tackley* & Takashi Nakagawa**.

*Insitute for Geophysics, Department of Earth Sciences, ETH Zurich, Switzerland
**Department of Chemistry and Biotechnology, University of Tokyo, Japan

Three of the main challenges in the field of solid Earth dynamics are (i) understanding why Earth has plate tectonics, (ii) reconciling geochemical and geophysical constraints on mantle structure and evolution, and (iii) understanding the heat balance in the core, i.e., how enough heat to drive the geodynamo can have been extracted from the core throughout geological time without growing the inner core to much larger than its actual size. In recent years much progress has been made on these issues using numerical simulations: A simple visco-elastic rheology has been found to self-consistently give a rough approximation of plate tectonics, mantle convection simulations that include geochemical tracking and melting are beginning to reproduce some geochemical signatures, and it has been found that a chemically-dense layer covering part but not all of the core-mantle boundary can modulate core heat flow in the appropriate manner. This progress is discussed in the context of compressible anelastic, multiphase, visco-plastic numerical models of mantle convection and plate tectonics coupled to a parameterized core heat balance model and including melting and the resulting geochemical evolution of the Earth. Models in both two-dimensional and three-dimensional spherical geometry will be discussed.

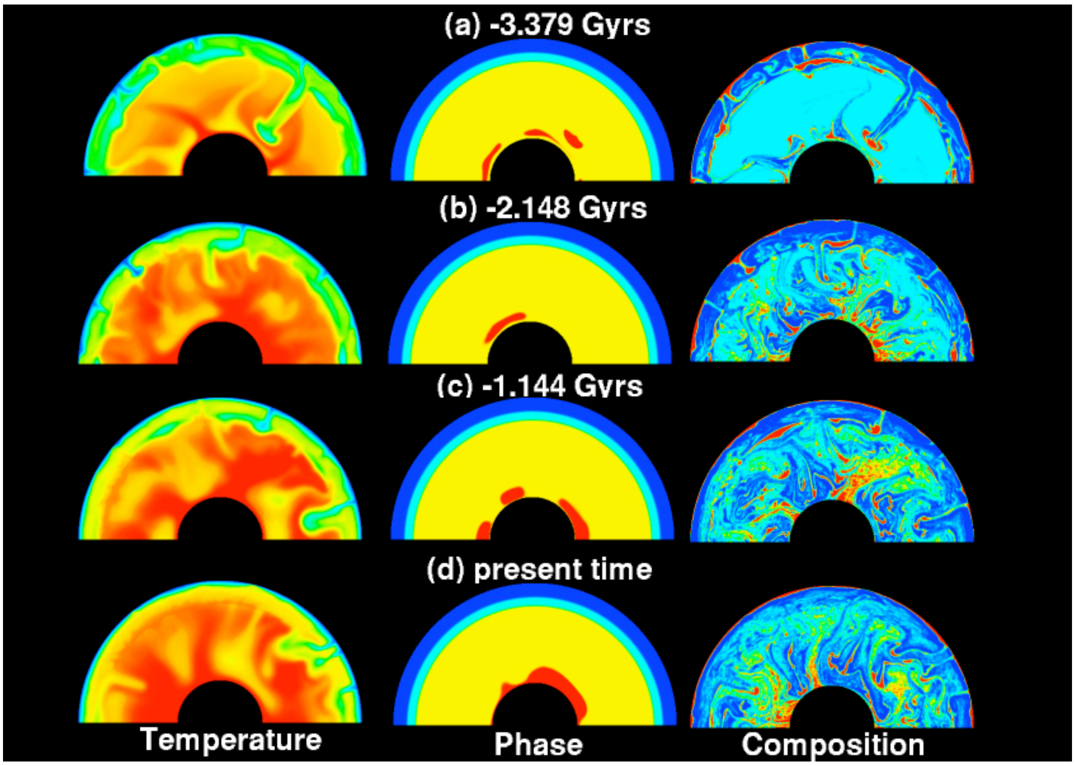

Figure 1. Evolution of (left) temperature, (middle) phase, and (right) composition over 3.4 billion years of model time for a typical simulation.

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