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Evolution of a Subduction Zone

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The purpose of this study is to understand how Earth's surface might have evolved with time and to examine in a more general way the initiation and continuance of subduction zones and the possible formation of continents on an Earth-like planet. Plate tectonics and continents seem to influence the likelihood of a planet to harbour life, and both are strongly influenced by the planetary interior (e.g. mantle temperature and rheology) and surface conditions (e.g. stabilizing effect of continents, atmospheric temperature), but may also depend on the biosphere.

Employing the Fortran convection code CHIC (developed at the Royal Observatory of Belgium), we simulate a subduction zone with a pre-defined weak zone (between oceanic and continental crust) and a fixed plate velocity for the subducting oceanic plate (Quinquis et al. in preparation).
In our study we first investigate the main factors that influence the subduction process. We simulate the subduction of an oceanic plate beneath a continental plate (Noack et al., 2013). The crust is separated into an upper crust and a lower crust. We apply mixed Newtonian/non-Newtonian rheology and vary the parameters that are most likely to influence the subduction of the ocanic plate, as for example density of the crust/mantle, surface temperature, plate velocity and subduction angle.

The second part of our study concentrates on the long-term evolution of a subduction zone. Even though we model only the upper mantle (until a depth of 670km), the subducted crust is allowed to flow into the lower mantle, where it is no longer subject to our investigation. This way we can model the subduction zone over long time spans, for which we assume a continuous inflow of the oceanic plate into the investigated domain.
We include variations in mantle temperatures (via secular cooling and decay of radioactive heat sources) and dehydration of silicates (leading to stiffening of the material). We investigate how the mantle environment influences the subduction of the oceanic crust in terms of subduction velocity and subduction angle over time.

We develop scaling laws combining the subduction velocity and angle depending on the mantle environment (and thus time). These laws can then be applied to continental growth simulations with 1D parameterized models (Höning et al., in press) or 2D/3D subduction zone simulations at specific geological times (using the correct subduction zone setting).

References:

- Quinquis, M. et al. (in preparation). A comparison of thermo-mechanical subduction models. In preparation for G3.
- Noack, L., Van Hoolst, T., Dehant, V., and Breuer, D. (2013). Relevance of continents for habitability and self-consistent formation of continents on early Earth. XIII International Workshop on Modelling of Mantle and Lithosphere Dynamics, Hønefoss, Norway, 31. Aug. - 5. Sept. 2013.
- Höning, D., Hansen-Goos, H., Airo, A., and Spohn, T. (in press). Biotic vs. abiotic Earth: A model for mantle hydration and continental coverage. Planetary and Space Science.