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From rifting to subduction: the role of inheritance in the Wilson Cycle

Stéphane Beaussier, Taras Gerya, and Jean-Pierre Burg
ETH Zurich, Geological institut, ERDW, Zurich, Switzerland (stephane.beaussier@erdw.ethz.ch)

The Wilson Cycle entails that oceans close and reopen. This cycle is a fundamental principle in plate tectonics, inferring continuity from divergence to convergence and that continental rifting takes place along former suture zones. This view questions the role of inherited structures at each stage of the Wilson Cycle.

Using the 3D thermo-mechanical code, I3ELVIS (Gerya and Yuen 2007) we present a high-resolution continuous model of the Wilson cycle from continental rifting, breakup and oceanic spreading to convergence and spontaneous subduction initiation. Therefore, all lateral and longitudinal structures of the lithospheres are generated self-consistently and are consequences of the initial continental structure, tectono-magmatic inheritance and material rheology.

In the models, subduction systematically initiates off-ridge and is controlled by the convergence-induced swelling of the ridge. Geometry and dynamics of the developing off-ridge subduction is controlled by four main factors: (1) the obliquity of the ridge with respect to the convergence direction; (2) fluid-induced weakening of the oceanic crust; (3) irregularity of ridge and margins inherited from rifting and spreading; (4) strain localization at transform faults formed during ocean floor spreading. Further convergence can lead to obduction of the oceanic crust and segments of ridge after the oceanic lithosphere is entrained into subduction. We show that the main parameters controlling the occurrence and geometry of obducted ophiolite are the convergence rate and the inherited structure of the passive margins and ridge.

Our numerical experiments results show the essential role played by inheritance during the Wilson Cycle and are consistent with nature observations such as the tectonic history of the Oman subduction-obduction system.

REFERENCES

Gerya, T. V., and D. A. Yuen. 2007: “Robust Characteristics Method for Modelling Multiphase Visco-Elasto-Plastic Thermo-Mechanical Problems, Physics of the Earth and Planetary Interiors, 163 (1-4), 83–105.