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How collisional inheritance can affect rifted margin architecture

Susanne Buiter (1,2)

(1) Geological Survey of Norway, Trondheim, Norway (susanne.buiter@ngu.no), (2) The Centre for Earth Evolution and Dynamics, University of Oslo, Norway

Many continental rifted margins formed at earlier collision zones. This is not surprising since continental collision causes structural, compositional, and thermal inheritances that favour localisation of rift processes. Rifting may initiate on orogenic thrust faults, inherited collisional sedimentary and magmatic sequences, or on the orogen as a whole, as orogens are thermally weak because of the greater amount of heat producing elements in their thicker crustal root. Here I examine how such collisional inheritances can impact the architecture of rifted margins.

Even though it is well appreciated that many rifted margins built on collision zones, most numerical and analogue extension models start from laterally homogeneous lithospheric layers, without inheritance. Such controlled setups are of great importance since they allow for systematic testing of the effects of parameter variations, such as, extension velocity and crustal rheology. Numerical experiments of continental extension by different modelling groups have robustly documented that a strong lower crust leads to a short continental margin accompanied by high rift flank uplift. A weak lower crust at moderate extension rates can form a long, hyper-extended crust.

My experiments with the finite-element code SULEC build on previous rift experiments to investigate the effects of structural and thermal inheritance on rifted margins. I examine both prescribed inheritances and inheritance that is built in dynamic models of subduction and continental collision. I find that continental rifts can utilise thrust faults and/or the weak former subduction interface, promoting exhumation of previously subducted oceanic crust and sediments. Elevated temperatures in the collisional orogen can weaken its crustal rheology sufficiently to localise rifting. In this case, the weak crust promotes the formation of a hyper-extended margin. But inheritance also lies in the sub-lithospheric mantle, where mantle flow currents produced during subduction and slab detachment influence rift development from below. The level of variations in rifted margin architecture because of structural and thermal inheritances is at least of the same order as caused by variations in extension velocity and crustal rheology, if not surpassing those.