How to form hyperextended continental margins

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Many passive continental margins are characterised by along-strike differences in margin width, onshore topography, fault patterns, and offshore sediment thickness. For example, it has been suggested that the mid-Norwegian margin may be hyper-extended, thus displaying highly thinned continental crust extending towards the oceanic domain over a wide region, whereas other continental domains of the margin are much narrower. In the past decade, numerical experiments of continental rifting have converged to a fair understanding of the role of crustal rheology and extension velocity in shaping passive margins. A relatively "strong" lower crust leads to fast lithospheric break-up and a short margin accompanied by high rift flank uplift. A "weak" lower crust at moderate extension rates delays break-up and thus leads to formation of a long, hyper-extended crust. However, unless along-strike differences in crustal strength are invoked, these experiments cannot explain along-strike differences in margin width.

We use 2D numerical experiments to show how hyper-extension may be further promoted by testing two examples of natural variations in the rift system. We first highlight the impact of collision-phase inheritance on rifted margin architecture. Elevated temperatures in the collisional crustal nappe stack weaken its crustal rheology, thus promoting hyper-extension. We then show that sedimentation may alter margin architecture for cases with an intermediate strength lower crust by shifting the style of break-up from fast break-up with a sharply tapered margin to prolonged rifting with the development of hyper-extended crust. Natural along-strike variations in collision-phase inheritance combined with the interplay between crustal rheology and surface processes can therefore provide an explanation for variations in margin architecture observed in passive margins such as the Atlantic margin systems.