



Exploring the formation and evolution of rifted margins: numerical experiments using thermo-mechanical and surface processes models

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Geological observations have demonstrated that continental rifting and ocean spreading can lead to the formation and evolution of a wide range of passive margin settings with various tectonic and geomorphologic characteristics. Many of these characteristics illustrate the way extension is distributed across the system but the controlling factors are still largely unknown. Among others issues that need to be addressed is the presence of high elevated escarpments along mature passive margins, such as in southern Africa, which raises the question of how the relief evolved since rifting onset. Understanding such systems requires an integrated approach looking at interactions between tectonics and surface processes on a range of spatial and temporal scales. We use high-resolution numerical experiments coupling a 2D upper-mantle-scale thermo-mechanical model with a plan-form 2D surface processes model (SPM) to investigate the factors controlling the style of deformation. The experiments consist in simple extension models with different crustal / lithospheric thicknesses (normal-like lithosphere to thick cratonic-like lithosphere) and explore the effects of rheological and compositional variability of the layer components of the crust and the lithosphere. Tomography and geochemistry evidences suggest a possible counterflow in the lower lithosphere in parts of the African western margins. We discuss the effect of a gravitationally driven lithospheric counterflow of depleted lower lithosphere (compositionally less dense than sublithospheric mantle) on the rift geometry and the effect of the isostatic responses in terms of uplift or subsidence on the surrounding topography. We also explore a range of erosion, deposition, basin filling scenarios and discuss the interactions between tectonics and surface processes. Numerical model results are compared to natural settings to allow discussion of both constraints and limitations.