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The influence of lithospheric rheology on escarpment evolution at divergent margins: a numerical approach

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The evolution of escarpments bordering the coast during the post-rift phase is numerically simulated mostly by landscape surface processes models. However, there are few thermomechanical models that were applied to study the post-rift evolution of these escarpments. In the present work, we used a finite element thermomechanical model to simulate lithospheric extension and evaluate the sensitivity of escarpment amplitude over time under different geological and rheological conditions from the onset of lithospheric extension to the post-rift phase. The results showed that the evolution of escarpment amplitude and its preservation for tens of millions of years are sensitive to crustal and lithospheric thicknesses. We observed that escarpment preservation is higher for scenarios with a thinner crust with a strong lower crust and a thicker lithospheric mantle. This behavior is related to the degree of coupling between the crust and lithospheric mantle that affect the vertical displacement of the lithosphere due to flexural and isostatic response. Additionally, even without surface processes of erosion and sedimentation, the amplitude of the escarpment can monotonically decrease with time due to the lateral flow of the lower crust. This effect is expressive in the scenarios where the effective viscosity of the lower crust is relatively low and the upper crust is rheologically decoupled from the lithospheric mantle. In these cases, the amplitude of the escarpment can decrease from 2-3 km during the rifting phase to less 1 km after 40 Myr after the onset of lithospheric extension. On the other hand, in scenarios where the crust is rheologically coupled, the amplitude of the escarpment after 100 Myr since the lithospheric stretching is only ~25% smaller than maximum amplitude observed during the rifting phase. We conclude that the rheological structure of the lithosphere can play an important role in the formation and preservation of escarpments at divergent margins simultaneously with surface process.