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Effect of contrasting structural and compositional inheritances on the development of rifting margins

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Even though several studies suggest that structural, compositional and thermal inheritances are key parameters in rifting processes, it is still unclear to which extent they control the localization and development of rift structures. To address this question, we perform numerical experiments of lithospheric extension with initial conditions that include structural and compositional inheritances. In both the crust and the mantle we use a bimineralic composition but instead of being randomly distributed, mineral phases are distributed in a way compatible with the wavelength and orientation of the kilometric-scale heterogeneities observed in the seismic reflection data. Our study demonstrates that crustal fabrics resulting from compositional inheritance strongly influence the mechanisms of deformation not only in the early phase of rifting but also during the thinning process. However, inherited structures do not significantly control the location of the break-up and exhumation phase. On the contrary, they appear to be always associated with the development of a detachment fault exhuming mantle to the seafloor.
We show that: 1) Structural and compositional inheritances can explain the distribution and deformation processes observed during the stretching phase: vertical fabrics favor the formation of horst-and-graben whereas horizontal and oblique fabrics favor the formation of core-complexes, 2) Depending of the crustal fabrics, the thinning processes differs and implicates mechanisms involving detachment faulting and sequential normal faulting or alternative models, 3) Structural and compositional inheritances control the thinning processes and consequently the resulting geometry of the margin. Finally, if this study demonstrates also that inherited structures do not significantly control the location of the break-up and mechanism of exhumation phase: the late development of out-of-sequence detachments in some models explain why distinguishing between upper and lower plate margins is not a straightforward process.