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Impact of lithosphere deformation on stratigraphic architecture of passive margin basins

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The aim of this study is to revise our view of the long-term stratigraphic trends of passive margins to include the impact of the coupling between the lithosphere deformation and the surface processes using a numerical experimentation approach. To do this, we first simulated the syn-rift phase of lithosphere stretching by thermo-mechanical modeling. We then used the deformed lithosphere geometry as input of a 3D flexural modeling including coupling with surface processes to simulate the post-rift evolution of the margin. We then use the corresponding accumulation and subsidence histories as input of the stratigraphic model to simulate the detailed stratigraphic architecture of the basin.

We tested this procedure using synthetic examples of lithosphere stretching based on end-members rheologies of the lithosphere (i.e. strength of the lower crust) for narrow or ultra-wide rifting modes. We determined the stratigraphic architecture of the basins of each conjugate margin using three grain-sizes (sand, silt, and clay) differing in their transport length. In all cases, uplift/subisdence rates decrease with time while the flexure wavelength increases as isotherms are re-equilibrated. Some areas show displacement inversion over time from uplift to subsidence (or vice-versa). As expected, the amplitude of vertical motion of the wide margin cases is very limited with respect to the narrow margin case. Vertical motions are very asymetric on conjugate margins. Accordingly, the stratigraphic architectures and the sedimentation/erosion patterns of the conjugate simulated margins are significantly different mostly because the duration and length of progradation and retrogradation differ. We evaluated the sensitivity of the simulations to parameters controlling (i) the lithosphere deformation, (ii) the continental drainage erosivity (climate) or (iii) erodability (lithology) as well as (iv) base level (eustasy).