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Vertical movement of transform passive margins: interactions in 3D between surface transfer, flexural isostasy and thermal subsidence

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Passive margins preserve the terrigeneous sediment resulting from their erosion, and as such, record the dynamics of their relief variation. The thermal evolution of the stretched lithosphere, surface processes (erosion/sedimentation) and flexural isostatic compensation induce vertical movements of the passive margin that can also be altered by the superposition of vertical movement induced by flow in the mantle or tectonically driven deformation. In 3D, complex geometries of the lithosphere stretching may induce lateral effects of the flexure. Our objective is to quantify the contribution of the 3D geometry of the lithosphere stretching on the vertical movements of a transform margin and its consequences in the stratigraphic architecture of the sedimentary basins. The novel aspect of our approach is to integrate the evolution of both domains in erosion and in sedimentation, in a 3D framework involving state of the art numerical modeling tools of the thermo-mechanical evolution of the lithophere and advanced concepts in sequence stratigraphy. Flex3D provides us with a useful tool to determine the influence of the 3D flexure and surface transfer processes on the temporal and spatial evolution of post rift vertical movements of a passive margin in a framework including the thermal evolution of the margin.
We simulated the evolution of various cylindrical and non cylindrical passive margins, with or without surface processes as well as with identical or different surface transport efficiency within the marine and continental domains. These simulations illustrate how significant the 3D geometry of the stretching of the lithosphere on the flexural response and, as a consequence, on surface processes and spatial and temporal distribution of vertical displacements. In particular, the narrower the stretching variations, the larger the lateral flexural effects. These lateral effects may reach up to two fold increase of vertical movement (subsidence and uplift). We then simulated the evolution of a complexly stretched margin similar to the one observed along the Ivory Coast Transform margin. These simulation show that he 3D flexural effects alone can account for characteristic features of the margin: a deep narrow basin (up to 10 km in thickness) in the proximal part of the Ivorian basin and significant denudation amount documented along the Liberia/Ivory Coast margin.