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Source to sink study of non-cylindrical rifted passive margins: the case of the Gulf of Guinea

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The aim of our project is to analyze quantitatively the post-rift evolution of a transform margin in order to determine how the spatially complex rifting processes that produced a tridimensional stretching of the lithosphere might impact the post rift evolution of the margin and the associated sedimentary systems. More specifically, we investigate its impact on vertical motion (uplift/subsidence), sediment transfer (erosion/accumulation) and stratigraphic architecture of sedimentary basins. We also intend to characterize the stratigraphic signature of independent geodynamic processes potentially affecting the margin during the post rift phase such as mantle dynamic, change in climate and erosion processes (chemical vs mechanical erosion).
In this framework, the Atlantic margin from the Senegal to the Niger Delta is an ideal case study for which we compiled a unique dataset constraining over the Cenozoic: (i) the paleodrainage evolution and the denudation history for the whole area contributing to the sedimentary basins, and (ii) the accumulation history of the latter. From the reconstruction of the 3D geometry of paleo-alteration land surfaces, we show a complete reorganization of the drainage between 45 and 25 Myr. It resulted from the capture by the Niger of a formerly endoreic drainage isolated from the margin by a marginal bulge, as well as, by the incision and downwarp of this bulge by coastal drainage such as the Volta River. This relief had therefore a major impact on the export of sediment to the basins during the Cenozoic and both geomorphologic study and numerical modeling of the 3D flexure of this margin suggest it might be inherited from the rifting phase. Also, we compiled 13 geological sections along the margin to evaluate the accumulation histories of 3 domains: the Senegal basin, the Niger Delta and the Northern Margin of the Gulf of Guinea. All basins showed an acceleration in accumulation rates between 45 and 25 Myr.
The 3D numerical modeling of the whole margin in terms the flexural isostasy coupled to thermal evolution and surface transfer allows linking the domains in erosion/transit and in accumulation. The onshore morphogenetic sequence suggests alternating periods dominated by either chemical or mechanical denudation over the Cenozoic. We therefore tested variations in continental surface processes efficiency using low and high surface processes efficiency to simulate period of chemical and mechanical erosion respectively. We also included an additional (not isostatically compensated) rock uplift in the continental part of the experiment to simulate a deformation event. The resulting accumulation histories do not discriminate whether the late increase in accumulation is related to a climatic or a deformation event. As a difference, the associated stratigraphic trends are different for a climatic (transient progradation/aggradation) or a deformation event (long progradation/aggradation). Further work is in progress to compile the long-term stratigraphic trends along the margin.