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Analysis of subsidence and thermal evolution of a new-real estate domain: the sedimentary prism approach

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The thermal evolution and subsidence history of deep water rifted margins remains poorly understood. Indeed, in the last decade it has been shown, using modelling, that the thermal state is a first order parameter controlling both rifting and lithospheric breakup. Most of the current research tends to combine paleo-thermochronometry with thermo-mechanical modelling to better constrain the thermal and subsidence evolution during rifting and lithospheric breakup. In this study a new indirect method is proposed to evaluate the thermal state during early seafloor spreading. This method tries to estimate the thermal structure as a function of rates of accretion, sedimentation and subsidence. It is based on seismic observations, drill hole data and a detailed analysis of the sedimentary architecture of the late syn- to early post-rift infill here referred to as the “sedimentary prism”. The obtained results are compared with the subsidence and thermal evolution of oceanic lithosphere describe by Stein & Stein (1992). The method allows us to estimate the potential thermal support at the onset of seafloor spreading and to analyze the paleo-bathymetry at breakup.
The first studied example is the Liberia margin, a divergent segment of the African Equatorial Atlantic margin bordered by major transform faults. This margin presents a well-expressed sedimentary prism imaged by high quality 2D seismic lines and calibrated by several wells. Preliminary results suggest that: 1) lithospheric breakup is diachronous and the early spreading is dominated by local conditions along the margin; and 2) First-order backstripping of the sedimentary prism indicates that the bathymetry at breakup was shallower and that subsidence rates were lower than those predicted by the Stein & Stein (1992) model. These results suggest a potential thermal support during lithospheric breakup.
The proposed approach could be a promising method to study the thermal state and evolution of first oceanic crust. It also provides information on the initial kinematic evolution during early seafloor spreading, which is crucial for plate kinematic restorations. These preliminary results from the Liberia margin have to be validated and calibrated by other examples. Future studies will test this approach on magma-rich margins, young margins where the thermal state of breakup is still preserved and fossil analogues. These studies will provide new insights on the thermal state and bathymetry of ultra-distal margins and first oceanic crust.