

# **Sediment structure, ages and unconformities under different rifting styles from numerical modelling**

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Sediments record the history of rifting that leads to the formation of passive margins. However, age control on sedimentary layers observed in seismic sections is often sparse and the interpretation of the geometrical relationships between syn- and post-kinematic sediments and the underlying basement structure is often ambiguous. Numerical modelling can help deciphering how sediment geometries and their unconformities are related to different margin architectural types and so can aid the interpretation of seismic sections. For this purpose, we have developed a 2D visco-elasto-plastic numerical model of extension coupled with a diffusive landscape evolution model. Here, we explore how sediment geometries and unconformities develop in margins characterized by different architectural styles. Our landscape evolution model simulates both subaerial and submarine environments, and tracks timelines inside the sediments so that sediment geometries and ages can be recovered, erosion and sedimentation rates can be calculated and unconformities can be drawn. This allows us to relate sediment structure and ages to the deformation history and margin architectures recovered from the coupled tectonic model. Furthermore, this approach allows for comparison of simulated sediment structures with the ones observed in seismic sections and could potentially help to validate interpretations.

In this work, we show results of margins developed by extending continental crusts of different strengths. The extension of the strongest case results in narrow symmetric margins and rapid breakup. Syn-kinematic sediments are separated from post-kinematic sediments by an unconformity that dates the breakup and sediment age distribution is symmetric across the rift axis. An intermediate strength crust showcases rift migration by sequential faulting, resulting in strong asymmetry with a wide margin (~200 km) where the crust thins smoothly and a narrow conjugate (~50 km) where crust thins abruptly. In this case, both syn- and post-kinematic sediment ages in the wide margin young oceanwards as extension migrates in this direction. A diachronous unconformity separates syn- from post-kinematic sediments and dates the beginning of the sequential faulting phase. The distribution of sediment ages is also asymmetric across the rift axis. In the weakest case, we observe an initial long phase of wide rifting with different faulting episodes, followed by a final, short phase where deformation localizes leading to crustal breakup. The syn-kinematic sediments contain unconformities separating the different faulting episodes that take place within the wide rifting phase. Away from the final breakup location, unconformities separating syn- and post-rift pre-date breakup. In summary, using numerical models we find that the spatial and temporal distribution of sedimentation strongly depends on rifting styles, and that major unconformities separating syn- from post-kinematic sediments generally date migration of the main locus of deformation but rarely date breakup.