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# Relating modes of extension to the spatial and temporal distribution of major sediment unconformities at passive margins

Miguel Andrés-Martínez (1,2), Marta Pérez-Gussinyé (1,2), John Armitage (3), and Jason P. Morgan (4)

(1) University of Bremen, Geosciences, Bremen, Germany (andresma@uni-bremen.de), (2) MARUM Center for Marine Environmental Sciences, Bremen, Germany, (3) Institut de Physique du Globe de Paris, Dynamique des Fluides Géologiques, Paris, France, (4) Royal Holloway University of London, Earth Sciences, London, United Kingdom

Rifting is a regional process which results in thinning of the crust over hundreds of kilometres. However, basins where deposition takes place could have different subsidence histories due to local graben-bounding fault kinetics. A change in the rift dynamics often results in a displacement of the basin depocenters, with subsequent erosion of old sediments and later deposition, creating an unconformity. Unconformities of regional character are typically studied to unveil the overall rift deformation history, and major ones separating syn- and post-kinematic sediments are often associated with break-up of the continental crust. However, evolution of the basement deformation is typically challenging to study since reflection images are usually diffuse at these depths and boreholes are typically scarce, which complicates the dating of the sediments overlying the basement. Consequently, relating the deformation styles and rift evolution to unconformities is not straight forward.

We use numerical models in order to approach the meaning of regional unconformities and to study the sedimentation patterns under different modes of extension. Our models solve 2D Stokes flow for rocks treated as non-Newtonian bodies, together with heat conservation equation. Viscosities and densities depend on temperatures. Elasticity and plasticity are plugged-in in the mechanical formulation. We also use strain softening to simulate faulting and shear zones. The top boundary is a free-surface so that tectonics result in topography. Additionally, we update this topography every time step using a sediment transport model, and we store information about depositional times, paleo-depths and erosional events. These models allow for the recovery of the basement deformation during rift evolution simultaneously to the recovery of sedimentation history. Here, we run models with different crustal rheologies to reproduce different extensional modes. This allows us to contrast sedimentation patterns and unconformities under variable kinetic scenarios, from regional to faulted-block scales.

We find that unconformities are generally associated to a change in the locus of extension. In models with intermediate-strength crust, sequential faulting takes place, so that only one fault is active at a time and occur in the hanging wall of the previous fault, resulting in asymmetric conjugate margins. In this case a major unconformity separates syn- and post-kinematic sediments. Both syn- and post-kinematic sediments young oceanwards and the unconformity dates the time in which extension abandons the area in favour of new faults forming oceanwards. Models with weaker crusts display extension along a wide region, with overprinting of different faulting phases. Eventually, deformation localizes in a narrow region due to cooling, and crustal break-up occurs. In this case, a first set of unconformities separates different phases of faulting inside the syn-kinematic sediments, and later unconformities separate syn-kinematic and post-kinematic sediments, dating the time at which extension localizes. We also find that unconformities date the crustal break-up only when they develop in the vicinity of the break-up locus. This stresses on that terms such as syn- and post-rift sediments and break-up unconformity should be handled carefully when seismic interpretation is done, and also provides support for unconformities as rifting story-tellers.