Paper Number: 2904

Rheological implications of sediment transport for continental rifting and its impact in margin geometry and major unconformities

Andrés-Martínez, M.[1], Pérez-Gussinyé, M.[1], Armitage, J.[2] and Morgan, J.P.[3]

[1]University of Bremen, Geosciences Department, Klagenfurter Straße, 28359 Bremen Germany, miguel.andres-martinez87@live.rhul.ac.uk
[2]Institut de Physique du Globe de Paris, 1 Rue Jussieu, 75005 Paris, France
[3]Royal Holloway University of London, Department of Earth Sciences, Egham Hill, Egham, Surrey, TW20 0EX, UK

The inner dynamics of the Earth such as mantle convection, geochemical reactions and isostasy have been typically interpreted as the main engine of plate tectonics and crustal deformation. However, nowadays it is well established that processes transporting material along the surface of the Earth influence the inner dynamics.

Surface processes play a key role particularly during rifting, where great subsidence rates occur at synrift basins while shoulder uplift provides rock to be eroded for later infilling of these basins. Erosion implies unloading of the crust which favours uplift, and sedimentation at basins results in loading which favours subsidence. Consequently, erosion and sedimentation amplify stresses and the flexural response of the lithosphere in situations with extensive faulting. These changes to the stress field may be large enough to result in changes in the evolution of rifting and its modes of extension. Additionally, higher subsidence rates and thermal blanketing due to sediments may result in higher geotherms and consequently, a weaker/more-viscous behaviour of the crustal rocks. This would also have a large impact on the deformation style during extension.

Here, we explore the interactions between surface processes and tectonics using numerical modelling. Experiments are run with the absence of sediment transport and with different sediment transport regimes for 35 and 40 km crustal thicknesses.

Tests with higher transport coefficient show more effective localization of deformation into upper crustal faults which results in effective crustal thinning, larger blocks and longer-lived faults. Our experiments also prove that more effective surface processes reduce the length of margins generated by sequential faulting. For our end member situations, high sedimentation rates lead to pure shear extension of the crust induced by high temperatures, which finally results in broad extension and symmetric margins.

Furthermore, our model allows for the recovery of predicted sediment stratigraphic patterns. Major unconformities that separate synrift from sag-basin-type sediments are observed in these pseudo-strata patterns. Here, we also address the meaning of these major unconformities and their relationship to the time of breakup.