Geophysical Research Abstracts, Vol. 8, 04163, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04163

Impact of Crustal Rheology on Subsidence History and Basin Geometry - Numerical Experiments of Half-Graben Formation

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Two-dimensional finite element techniques are used to study the temporal evolution and spatial distribution of stress and strain during lithospheric extension. Special focus is on formation of large half-grabens, thus, the thermomechanical model includes a pre-existing fault in the upper crust. Numerical models are run for three different initial temperature distributions representing extension of weak, moderately strong and strong lithosphere. In spite of the simple geodynamic boundary conditions selected, i.e. wholesale extension at a constant rate, stress and strain vary substantially throughout the lithosphere. In particular, lithospheric strength exerts a profound control on basin architecture and the surface expressions of extension, i.e. rift flank uplift and basin subsidence. If the lower crust is sufficiently weak, its flow towards the region of extended upper crust can provide a threshold value for the maximum subsidence which can be achieved during the syn-rift stage. In spite of continuous regional extension, corresponding burial history plots show exponentially decreasing subsidence rates which would traditionally be interpreted in terms of lithospheric cooling during the post-rift stage. The models provide templates to genetically link the surface and sub-surface expressions of lithospheric extension, for which usually no contemporaneous observations are possible. In particular, they help to decipher the information on the physical state of the lithosphere at the time of extension which is stored in the architecture and subsidence record of sedimentary basins.