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Sediment basin modeling through GOCE gradients controlled by thermo-isostatic constraints

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Exploration of geodynamic and tectonic structures through gravity methods has experienced an increased interest in the recent years thank's to the possibilities offered by satellite gravimetry (e.g. GOCE). The main problem with potential field methods is the non-uniqueness of the underground density distributions that satisfy the observed gravity field. In terrestrial areas with scarce geological and geophysical information, valid constraints to the density model could be obtained from the application of geodynamic models.
In this contribution we present the study of the gravity signals associated to the thermo-isostatic McKenzie-model (McKenzie, 1978) that predicts the development of sedimentary basins from the stretching of lithosphere. This model seems to be particularly intriguing for gravity studies as we could obtain estimates of densities and thicknesses of crust and mantle before and after a rifting event and gain important information about the time evolution of the sedimentary basin.
The McKenzie-model distinguishes the rifting process into two distinct phases: a syn-rift phase that occurs instantly and is responsible of the basin formation, the thinning of lithosphere and the upwelling of hot asthenosphere. Then a second phase (post-rift), that is time dependent, and predicts further subsidence caused by the cooling of mantle and asthenosphere and subsequently increase in rock density.
From the application of the McKenzie-model we have derived density underground distributions for two scenarios: the first scenario involves the lithosphere density distribution immediately after the stretching event; the second refers to the density model when thermal equilibrium between stretched and unstretched lithospheres is achieved. Calculations of gravity anomalies and gravity gradient anomalies are performed at 5km height and at the GOCE mean orbit quota (250km). We have found different gravity signals for syn-rift (gravimetric maximum) and post-rift (gravimetric minimum) scenarios and that satellite measurements are sufficiently precise to discriminate between them.
The McKenzie-model is then applied to a real basin in Africa, the Benue Trough, which is an aborted rift that seems to be particularly adapt to be studied with satellite gravity techniques.

McKenzie D., 1978, Some remarks on the development of sedimentary basins, Earth and Planetary Science Letters, 40, 25-32