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Tectonic evolution of the Congo Basin using geophysical data and 3D numerical simulations

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The Congo basin (CB) is an intracratonic basin that occupies a large part of the Congo Craton (1.2 million km^2) covering approximately 10% of the continent [1]. It contains up to 9 km of sedimentary rocks from the Mesoproterozoic until Cenozoic age. The formation of the CB started with a rifting phase during Mesoproterozoic with the amalgamation of the Rodinia supercontinent (1.2 Gyr). Afterwards, the main episodes of subsidence occurred during the subsequent Neoproterozoic post-rift phases, which was followed by phases of compression at the end of the Permian and during the Early Jurassic age and other sedimentation episodes during Upper Cretaceous and Cenozoic [2].

We reconstruct the stratigraphy and tectonic evolution of the basin by analyzing seismic reflection profiles. Furthermore, we estimated the velocity, density, and thickness of the sedimentary layers in order to calculate their gravity effect. Afterwards, we calculate the gravity disturbance and Bouguer anomalies using a combined satellite and terrestrial data gravity model. The gravity disturbance obtained from the EIGEN-6C4 gravity model [3] shows two types of anomalies. One with a long wavelength (~50 mGal) that covers the entire area of the Congo basin and a second one with a short wavelength (~130 mGal), having a NW-SE trend, which corresponds to the main depocenters of sediments detected by the interpretation of seismic reflection profiles. These results have been used as input parameters for 3D numerical simulations to test the main mechanisms of formation and evolution of the CB. For this aim, we used the thermomechanical I3ELVIS code [4] to simulate the initial rift phase. The numerical tests have been conducted considering a sub-circular weak zone in the central part of the cratonic lithosphere [2] and applying a velocity of 2.5 cm/yr in two orthogonal directions (N-S and E-W), to test the hypothesis of the formation of a multi extensional rift in a cratonic area. We repeated these numerical tests by increasing the size of the weak zone and varying its lithospheric thickness. The results of these first numerical experiments show the formation of a circular basin in the central part of the cratonic lithosphere, in response to extensional stress, inducing the uplift of the asthenosphere.

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