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Unraveling African plate structure from elevation, geoid and geology data

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The aim of our project is to simulate the long-wavelength, flexural isostatic response of the African plate to sediment transfers due to Meso-Cenozoic erosion - deposition processes in order to extract the residual topography driven by mantle dynamics. Our work will be based on the reconstruction and subtraction of two continental-scale erosional-depositional surfaces of Eocene and Late Cretaceous ages and their offshore extensions.
The first step of our project consists in computing crustal and lithospheric maps of the African plate considering its various crustal geological components (cratons, mobile belts, basins, rifts and passive margins of various ages and strengths). In order to consider these heterogeneities, we compute a 2D distribution of crustal densities and thermal parameters from geological data and use it as an input of our modeling. We combine elevation and geoid anomaly data using a thermal analysis, following the method of Fullea et al. (2007) in order to map crustal and lithospheric thicknesses. In this approach, we assume local isostasy and consider a four-layer model made of crust and lithospheric mantle plus seawater and asthenosphere. In addition, we compare our results with crustal thickness datasets compiled from bibliography, existing global models such as CRUST 1.0, and tomographic lithospheric models.
The obtained crustal thicknesses range from 30 to 45km, with the thickest crust confined to the northern part of the West African Craton, the Kaapvaal craton, and the Congo cuvette. The crust in the East African Rift appears unrealistically thick (40-45 km) as it is not isotatically compensated, highlighting the dynamic effect of the African superswell. The thinnest crust (30-35km) follows a central East-West trend coinciding with Cretaceous rifts and the Cameroon volcanic line. Pan-African mobile belts yield intermediate values of ca. 35-40 km. The lithosphere reaches 250 km beneath cratons, but remains globally thin (ca. 150-180 km) compared to tomographic models and considering the age of most geological provinces. As for the crust, the thinnest lithosphere is located in areas of Cretaceous-Jurassic rifting.

References:

Fullea J., Fernàndez M., Zeyen H., Vergés J., 2007. A rapid method to map the crustal and lithospheric thickness using elevation, geoid anomaly and thermal analysis. Application to the Gibraltar Arc System, Atlas Mountains and adjacent zones. Tectonophysics 430, 97-117.