NEW INSIGHTS INTO THE NORTH-CENTRAL AFRICAN LITHOSPHERE FROM THE GOCE GRAVITY AND GRAVITY GRADIENT FIELDS

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The gravity satellite missions GRACE and GOCE have boosted the resolution of the global Earth gravity models (EGM), opening new possibilities of investigation. The EGMs must be distinguished in models based on pure satellite or mixed satellite-terrestrial observations. Satellite-only models are truly global, whereas satellite-terrestrial models have inhomogeneous quality, depending on availability and accuracy of the terrestrial data set. The advantage of the mixed models (e.g. EGM2008 by Pavlis et al. 2008) is their greater spatial resolution, reaching nominally 9 km, against the 80 km of the pure satellite models of satellite GOCE. The disadvantage is the geographically varying reliability due to problems in the terrestrial data, compiled from different measuring campaigns, using various acquisition methods, and different national geodetic reference systems. We present a method for quality assessment of the higher-resolution fields through the lower-resolution GOCE-field and apply it to northern Africa. In future this technique can help to plan new gravimetric acquisition campaigns in areas where the field is less known and where the new data can be optimally integrated to increase resolution. We find that the errors locally are as great as 40 mGal, but can be flagged as ”bad areas” by our method, leaving the “good areas” for reliable geophysical modeling and investigation.

We analyze gravity and gravity-gradients (e.g. Braitenberg et al., 2011) and their invariants over North-Central Africa derived from the EGM2008 and GOCE (Migliaccio et al., 2010) and quantify the resolution in terms of density variations associated to crustal thickness variations, rifts and magmatic underplating. We focus on the Benue rift and the Chad lineament, a 1300 km gravity high arcuate feature which links the Benue to the Tibesti Volcanic province, and we show that the lineament has no expression in topography or outcrop and is entirely covered by the sediments of the Chad basin contrary to the WCARS rift where a central gravity low is found. The Benue rift and the Chad line in the past have been supposed to be part of a triple rift junction (Burke and Whiteman, 1973), and the Chad line a rift basin (Browne and Fairhead,1983, Fairhead, 1988; Fairhead and Green, 1989; Guiraud et al., 2005; Moulin et al., 2010). The existing seismological investigations are integrated to constrain the lithosphere structure in terms of seismic velocities, crustal thickness and top asthenosphere boundary, together with physical constraints based on thermal and isostatic considerations (McKenzie stretching model). Our modeling shows that the gravity signal in the Benue rift can only be explained if the rift is underplated with a density which is intermediate to mantle and lower crustal density and if it has undergone depth-dependent differential stretching. The positive arched Chad anomaly is best explained by a superficial huge high density crustal body, extending for about 1300 km, about 50 km wide, and a few km thick. The body is covered by sediments and is not directly observable, so it can be only investigated by geophysical methods and geodynamic models. It follows the outline of the more easterly found Precambrian basement, and is suggested to be a structural element of the Saharan metacraton.

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