Geophysical Research Abstracts,
Vol. 11, EGU2009-8328, 2009
EGU General Assembly 2009
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Surface topography changes in North Africa derived from combined lithosphere and mantle modelling

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Northern Africa hosts several large intracratonic basins which record sedimentary processes since their formation in the (Pre)Cambrian. The absence of larger-scale normal faults indicates that they are not typical rift basins. Until now, no conclusive formation mechanism has been identified, though various processes (such as magmatism, phase changes, hydrothermal circulation and glacial loading) have been proposed. Here we focus on the contribution of deep-seated mantle processes to changes in surface topography. Traditionally, mantle flow models have relied on simplified translation of vertical stresses to changes in surface topography by using local isostasy or an elastic lithosphere. We evaluate the role of the brittle-elastic-viscous lithosphere rheology in controlling surface topography.

We use models of mantle flow driven by density anomalies that are converted from seismic tomography, with prescribed surface plate motions and mantle viscosity structure inferred from mineral physics and surface observations. Density anomalies are advected backward in time. This approach provides reasonably accurate results back to 70 Myr ago and our models therefore span the entire Cenozoic. The mantle flow and pressure fields in the reference frame of the moving African plate are applied to lithosphere finite element models with an elastic-linear viscous-plastic rheology. Our first results focus on the Taoudenni, Kufrah and Chad basins. The Chad basin experienced Cretaceous extension and this allows us to evaluate the effects of rifting in combination with mantle processes.