

Dynamics of Africa 75 Ma: from plate kinematic reconstructions to intraplate paleo-stresses

Plate reconstruction studies show that the Neotethys ocean was closing due to convergence of Africa and Eurasia towards the end of the Cretaceous. The period around 75 Ma reflects the onset of continental collision between the two plates, although convergence was still mainly accommodated by subduction, with the Neotethys slab subducting beneath Eurasia. Africa was separated from the rapidly north moving Indian plate by the Owens oceanic transform fault in the northeast and the Mascarena ridge in the southeast. The rest of the plate was surrounded by mid-ocean ridges, that is, the Atlantic ridge in the west and the southwestern Indian ridge with Antarctica in the south. Geologic observations in large basins (Sirt basin, Termit trough, Sudan rifts, Senegal basin, Lamu embayment and Anza rift, Palmyride and Euphrates basins and Mozambique basins) show that, internally, Africa was experiencing plate-wide rifting related to northeast-southwest extension.

We aim to quantify the forces associated with this tectonic setting. To constrain these forces, we use the latest reconstructions of the plate kinematics and geometry, while balancing lithospheric body forces, plate boundary forces and the interaction with the underlying mantle. The contribution of dynamic topography to the body forces is accounted for in the model, based on recent publications of the reconstructed mantle convective tractions. We model intraplate stresses and compare them to the observed strain directions.

We find that the African plate 75 Ma was mainly driven by pull from the Neotethys slab, in combination with lithospheric body forces produced by gradients in gravitational potential energy (GPE), which includes "ridge push". Mechanical equilibrium requires unusually strong resistive tractions on the Neotethys slab. This conclusion is somewhat sensitive to the dynamic topography. A prominent dynamic topography results in a more tensile intraplate setting. Despite India's rapid movement, tractions between India and Eurasia on the Owens transform fault are required to be low. Overall, modeled stress directions agree within uncertainty with the observations in the basins.