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Evolution of forces on Eurasia since the Miocene

R. Govers (1), K. Warners-Ruckstuhl (1), C. Hochard (2), P. Webb (3), R. Wortel (1), G. Stampfli (2), C. van Oosterhout (4), and H. Davies (3)

(1) Utrecht University, Faculty of Geosciences, Earth Science Dept, Utrecht, Netherlands (govers@geo.uu.nl, + (0)30 253 5030), (2) Institut de Géologie et de Paléontologie, Université de Lausanne, Switzerland, (3) School of Earth and Ocean Sciences, Cardiff University, Cardiff, UK, (4) Argo Geological Consultants, The Netherlands

Warners-Ruckstuhl (2012) presents a new approach to mechanically balance the Eurasian plate at Present. It is based on a combination of existing lithosphere and mantle dynamic models, which are tied together using torque balance. The critical difference with respect to global force/stress models is that plate interaction forces are selected in agreement with observations, yet without assumptions on rheology. Mantle buoyancy forces and lithospheric body forces turn out to be important driving forces but do not drive Eurasia in the observed direction; continental collision at Eurasia's southern boundary steers Eurasia northward. The predicted stress field agrees with observations in most regions.

Here, we adopt the same methodology to analyze torque balance of the Eurasia plate at 20Ma with the aim to identify causes for the change in absolute plate motion with respect to the present-day. The geometry of the 20Ma Eurasia plate is similar to that of Today, and is taken from the global Lausanne plate model, as are relative velocities and oceanic ages. We thus incorporate changes in plate boundary forces. We assume that the mantle convective pattern did not change much and use tractions from mantle flow models that mechanically balance the Eurasia plate today. Lithospheric body forces are accounted for in a simplified way because we lack detailed enough information on the plate scale topography.

We find substantial changes in the directions of torque vectors, which we think can explain the documented change in absolute plate motion of Eurasia. We conclude that forces due to collision of India were significantly less at 20Ma.

Warners-Ruckstuhl, K.N., (2012), Dynamics and stress field of the Eurasian plate: a combined lithosphere-mantle approach, Ph.D. thesis Utrecht University, Netherlands, Promotors: R. Wortel and R. Govers.