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The dynamics of the Eurasian plate and the intraplate stress field in the Middle-Late Eocene

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The forces driving and resisting plate motion together with the resulting intraplate stresses are analyzed for the Eurasian plate at 40 Ma with the aim to obtain a force model for which the stresses give the best fit to stress observations. Forces acting on a lithospheric plate can be categorized into three groups: i) edge forces due to interaction with neighboring plates; ii) lithospheric body forces and iii) mantle tractions.

The direction of the edge forces is based on the boundary types of the Eurasian plate taken from the Lausanne Plate Tectonic Reconstruction (LPTR) from Stampfli and colleagues. Lithospheric body forces include ridge push, slab pull and topographic body forces and for these forces both the direction and magnitude can be computed. Since the uplift history of the Tibetan Plateau and the Himalayas is only incompletely constrained, the sensitivity of the model to uncertainties in the topography (and thus the topographic body forces) at 40 Ma is investigated. Mantle tractions acting on the bottom of a lithospheric plate consist of (i) 'passive' tractions due to the relative motion of the lithosphere with respect to the mantle and ii) 'active' tractions due to the actively convecting mantle. Warners-Ruckstuhl et al. (2012) found that for the present-day Eurasian plate both passive and active tractions are relevant. This suggests that these tractions were also important in the past. Here we use tractions for the Eurasian plate from the global mantle circulation model by Webb (2012), which is based on mantle convection code TERRA, driven by a 300 Myr integration of the LPTR.

The Eurasian plate is assumed to be in mechanical equilibrium. The modeled intraplate stress field resulting from different force sets is compared to paleostress observations to select the force model that best fits the data. We find that in models with small active tractions and lithospheric body forces, the magnitude of collision forces at the boundary between India and Eurasia is small.

Warners-Ruckstuhl, K. N., R. Govers, and M. J. R. Wortel (2012), Lithosphere-mantle coupling and the dynamics of the Eurasian plate, Geophys. J. Int., 189: 1253-1276. doi: 10.1111/j.1365-246X.2012.05427.

P. J. Webb (2012), Mantle circulation models: constraining mantle dynamics, testing plate motion history and calculating dynamic topography, Ph.D. Thesis Cardiff University, UK, Promotor: J. Huw Davies.