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Modeling orogeny in Tibet

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Despite of significant achievements in modeling of the orogeny in Tibet, clearly lacking are the models employing realistic composition and rheology of the lithosphere without kinematically predefined motion of mantle. In order to fill this gap I performed a number of numerical tests focusing at the following questions:

- What should be the structure of greater India to fulfill new paleomagnetic data suggesting about 1500 km of shortening of India during 50-55 Mln years of collision, together with seismic images suggesting less than 1000 km of understrusted India beneath Asia?
- Which view on timing of Tibet uplift is more plausible from modeling perspective, view that Tibet was uplifted during the last 20 Mln years due to delamination of mantle lithosphere, or more recent idea of early (>40 Mln years old) high plateau expanding to the North and South?

I perform a 2D thermomechanical modeling using numerical techniques based on explicit (LAPEX2D) integration algorithms [1,2] emploing visco-elasto-plastic temperature- and stress-dependant rheological models, constrained by published laboratory data. Modeling suggests that about 500-700 km of outer part of Greater India had relatively thin (<120 km) and not much depleted (similar to oceanic harzburgites) lithosphere. This lithosphere likely broke off from the thicker and more depleted inner part of Greater India that presently underthrusts Asia. All models support early formation of high plateau and suggest that force required to build Tibet is at least 2 times larger than recently published estimates. The key condition for the orogeny in Tibet appeared to be very weak interface between India and Asia plate, with friction coefficient below 0.05.

References

[1] Babeyko, A. Y., Sobolev, S. V., Trumbull, R. B., Oncken, O. & Lavier, L. L. (2002), Numerical models of crustal scale convection and partial melting beneath the Altiplano-Puna plateau. Earth Planet. Sci. Lett. 199: 373–388..
[2] Sobolev, S. V. & Babeyko, A. Y. (2005), What drives orogeny in the Andes? Geology 33: 617–620.

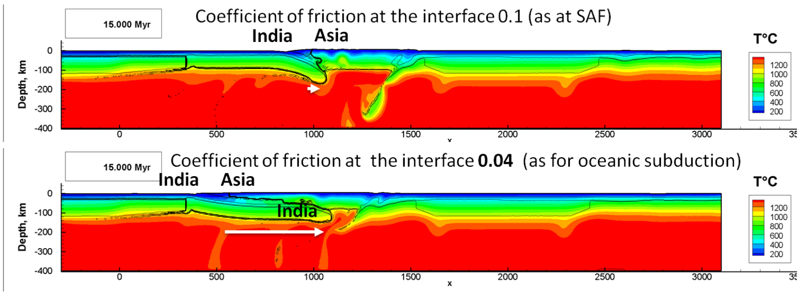

Figure 1: Effect of friction at plates interface on magnitude of Indian underthrusting. At friction of 0.1 (as at the San Andreas Fault) underthrusting is small and most of the convergence is accommodated by shortening of the Asia plate (upper section). At friction of 0.04 (as in the subduction channel in the Central Andes) half of the convergence is accommodated by underthrusting of India and half by shortening of Asia (lower section). White arrows show magnitudes of Indian underthrusting. Computed with LAPEX2D code [1,2].

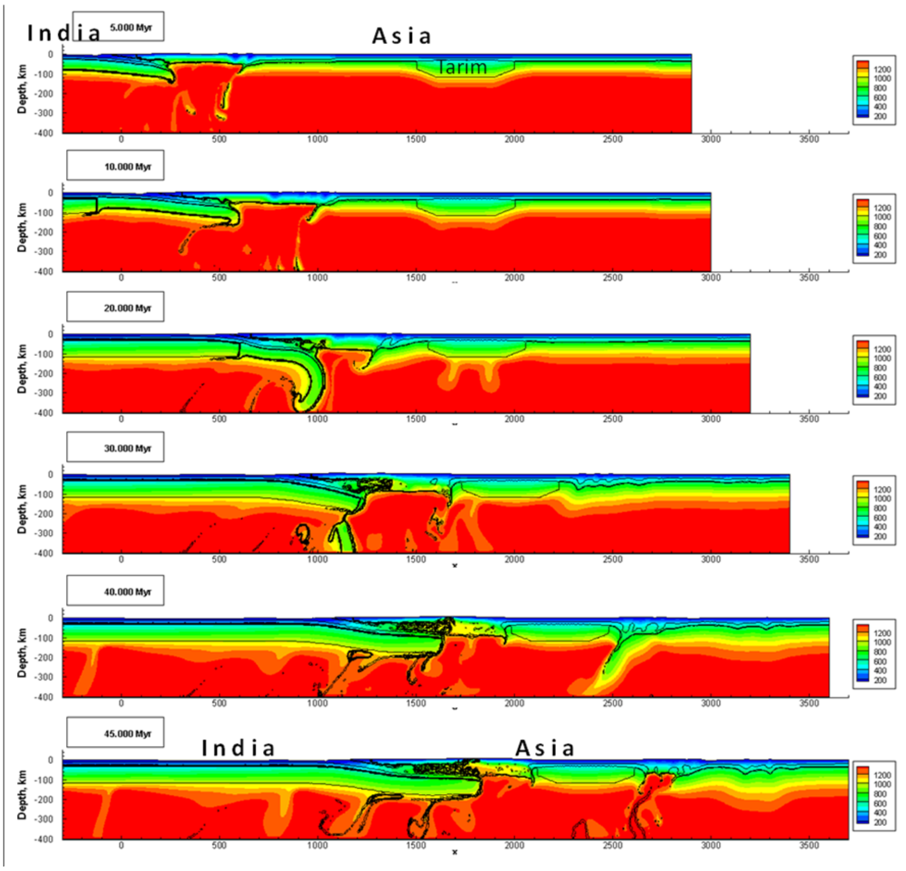

Figure 2: Evolution model for a cross-section across the center of the Tibet Plateau. Colors show distribution of potential temperature in °C. Shown is model time from 0 at 45 Ma, so a 45 Myr model corresponds to the present-day situation. Computed with LAPEX2D code [1,2]