The Geodynamics of Asian continental tectonics: insights from numerical modeling

Fabio A. Capitanio[1], Anne Replumaz[2], Nicolas Riel[1]

[1] School of Geosciences, Monash University, Clayton, VIC 3800, Australia, fabio.capitanio@monash.edu
[2] Institute des Sciences de la Terre, Université de Grenoble 1, CNRS, Grenoble, France

The evolution of continental tectonics must ultimately relate to the fundamental processes of the dynamic Earth. Here, we propose that the enigmatic Asian tectonics is best seen in the broad context of the continent interactions with the Tethys plate subduction. Using three-dimensional numerical models, we show how continent entrainment, slab breakoff and forced convergence during oceanic subduction result in coupled convergent margin-upper plate interiors deformations. Continent subduction destabilizes the convergent margin, forcing neighboring oceanic trench migrations and extension in the upper plate. As slab breakoff ceases subduction along the continental margin, convergence is here accommodated by indentation and extrusion, and faulting and large-scale rotations towards the retreating trench ensue. When modeled far-field force raises above the margin's subduction forces, the whole subduction zone advances, driving indenter migrations and resisting oceanic trench retreat. The varying balance between margin and far-field forces causes upper plate-scale rotations, while thickening and compression migrate within the plate interiors. The models yield large-scale deformation and motion patterns remarkably similar to the Cenozoic Asian tectonics phases. The comparisons with observables allow inferences on the driving mechanisms of Southeast Asian margin migration and Sundaland extension, extrusion tectonics and Tibet thickening, and widespread tectonics migrations far in Asian plate, providing relevant insights in the dynamics of continent interiors.

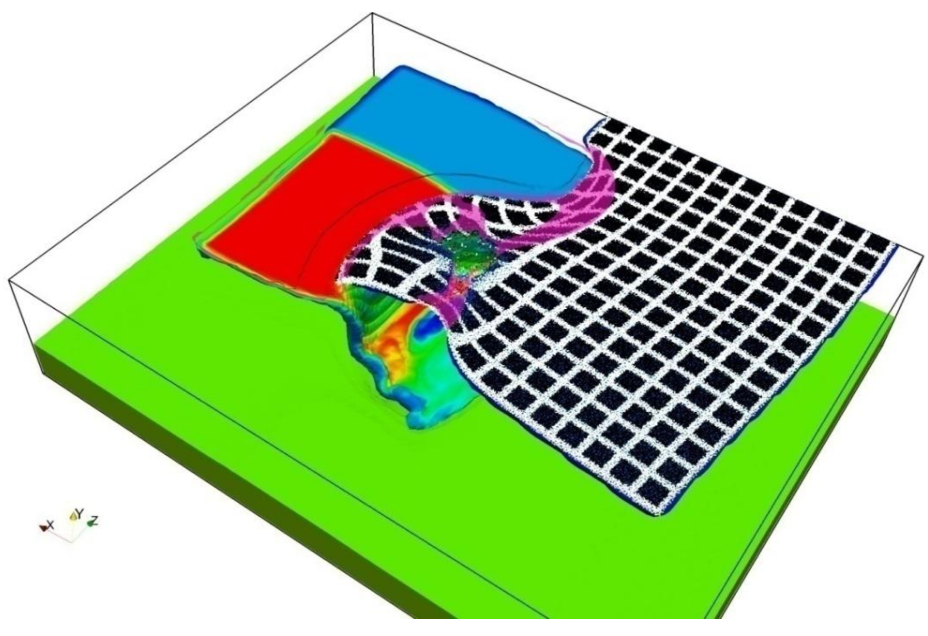

Figure 1. Top view of the numerical model of subduction of heterogeneous lithosphere and forced convergence, and coupled upper plate deformation. In this model the subducting plate hosts oceanic and continental lithospheres (red and blue, respectively, colorscale for density contrast with the mantle). Black and white dots are the Lagrangian particles in the upper plate model, gridded for reference. In purple shading the areas of largest strain rate on the upper plate. Extreme thinning is indicated by sparse particle distribution, and indicates oceanisation. In green the surface of the lower mantle. Upon continent subduction the oceanic trench has migrated driving back-arc stretching, eventually leading to spreading. Breakoff along the subducting continent margin and far-field forces drive large migration of the plate and indentation of the upper plate. The margin motions result in upper plate thickening and thinning along the advancing and retreating margin, respectively. Because margin migrations are combined, upper plate deformation is partially accommodated by large-scale extrusion and faulting.

Cite as: Capitanio, F.A. et al., 2014, The Geodynamics of Asian continental tectonics: insights from numerical modeling, in Montomoli C., et al., eds., proceedings for the 29th Himalaya-Karakoram-Tibet Workshop, Lucca, Italy.