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Importance of multi-layering and rheology for crustal folding processes

Philippe Yamato (1,2), Boris Kaus (2), Frédéric Mouthereau (3), and Sébastien Castelltort (2)

(1) Géosciences Rennes, UMR CNRS 6118, Université de Rennes 1, France (philippe.yamato@univ-rennes1.fr), (2) E.T.H. Zuerich, Department of Earth Sciences, Zuerich, Switzerland, (3) ISTEP, Université Pierre et Marie Curie, Paris, France

The mechanics of folding and buckling have long been the focus of thorough analytical studies, and of physical and numerical experiments. As a consequence, the folding of one single viscous layer is now well understood. However, the application of such single layer folding does generally not allow us to accurately reproduce the geometry (wavelength) of natural examples of large-scale folded belt.
The Zagros Mountains constitute the most spectacular folded-belt in the world. Subsurface data and recent field studies have documented extensively the geology of this area. The Zagros folded-belt represents then a unique opportunity to test cutting-edge numerical models of deformation.
Through a systematic parametric study, we first show that, using only one single viscous layer, it is impossible to fit both the wavelength and the growth rate known in the Zagros. In the single-layer case, even using more realistic rheologies such as elasticity and plasticity, results does not match the natural observations.
However, we demonstrate that the multi-layered character of the sedimentary cover has a fundamental importance. Based on published stratigraphic logs, isopach maps and original field data, we show that the modern folding theory adequately reproduces realistic folds in the Zagros when an accurate rheological structure of alternating weak and strong layers is used as an input.
In addition, we provide both semi-analytical and numerical solutions to predict the rheological structure of the upper crust and explaining the wavelength and growth rate observed in the Zagros Mountains. These can be used to predict the subsurface crustal structure in other areas (e.g., Siwaliks, Jura).