12th International Workshop on Modeling of Mantle Convection
and Lithospheric Dynamics

August 20th to 25th 2011, Döllnsee Germany

Dynamics of fold belts: insights from 3D numerical models of multilayer detachment folding

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Many fold-and-thrust belts are dominated by crustal scale folding that exhibit fairly regular fold spacing. Such is the case of the southern Fars region in the Zagros Mountains, where fold spacing shows a normal distribution around a dominant wavelength of 14 Km ± 3Km, while having a wide variability of length to wavelength ratio [1]. So far it is not fully clear to which extend this is consistent with a crustal-scale folding instability.

In this study we have used high-resolution 3D numerical simulations to analyze how the onset and evolution of detachment folding occurs when a multilayer sedimentary stack overlying a salt layer undergoes compression. The simulations are aimed at providing insights into the basic physics of multilayer detachment folding.

Evolution of the topography of the compressed sequence through time has been studied using curvature analysis based on differential geometry [2]and spectral methods. Amplification of the folding through time shows an initial stage with slow amplification where most of the shortening is accommodated by thickening of the layers, followed by a stage with important increase in the amplification rate. Aspect ratio evolution of dome shaped features in multilayer detachment foldingis similar to the single layer case [3]: they are formed at very early stages with small amplitude but elongated shapes (aspect ratio ¿ 1), and with no prevalent orientation. With time, their aspect ratio increases and they are oriented orthogonal to main compression direction. The observed long length antiforms are the result of several of this dome shaped features getting aligned and merged along time.

Overall, the numerical simulations show a large number of similarities with the southern Fars region of the Zagros fold-and-thrust belt (Figure 1), including a large range of fold aspect ratio and a normally distributed fold wavelength around a dominant one which vary with time due to kinematic amplification and whose value is four to five times smaller than the estimated dominant wavelength at the first incremental stages.

Future work will be focused on addressing the effect of irregular basement geometry, pre-existing salt diapirs and different viscosity structureon the 3D spatial pattern of fold growth.

References

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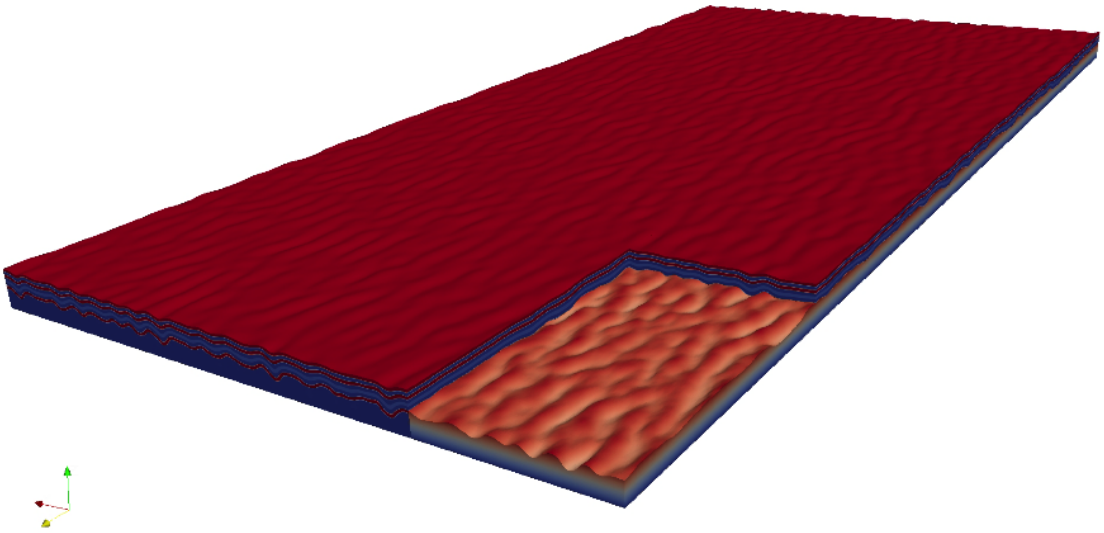

Figure 1: Result of multilayer detachment folding after 9.5 Myrs.ofcompression at a strain rate of $10^{-15}s^{-1}$. Size of the model is 200x320x6.5kmfor which 256x256x13 Q_2P_1 type elements were used (517x517x27 nodes). The simulation was performed in 1024 processors.