Parasitic folds with wrong vergence: How asymmetries can be inherited

Timothy Schmid*, Marcel Frehner*

*Geological Institute, ETH Zurich, Sonneggstrasse 5, CH-8092 Zurich (schmidti@student.ethz.ch)

An S-shaped asymmetric parasitic fold develops on the right limb of a larger upright antiform (Ramsay & Huber, 1989). Here, the opposite asymmetry is investigated by conducting two-dimensional numerical simulations of multilayer folding. The finite-element method is employd to model compression and folding of a multilayer stack with linear viscous rheology (Figure 1).

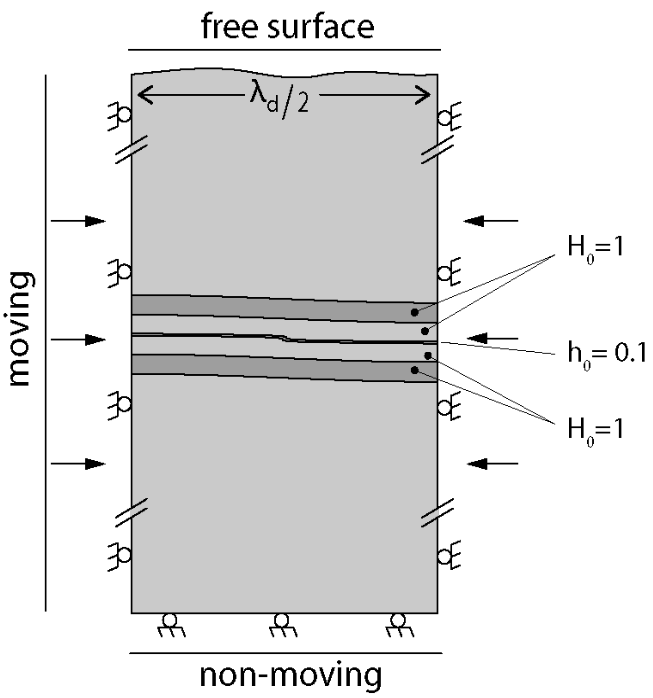

Figure 1. 2D model box with a free-slip boundary condition at the bottom and on the left and right side. On the top, the model is bounded by a free surface and the model is shortened horizontally. A thin layer containing a pre-existing asymmetry is surrounded by a matrix embedded between two thick layers. The thick-layer system has a different dominant wavelength than the thin layer. To obtain new asymmetries on the thin layer during compression, a random perturbation is added to the thin layer.

The simulations investigating the behavior of the pre-existing asymmetry during compression are divided into three settings:

1. Investigation of the initial angle of the pre-existing asymmetry and its influence on the development of new asymmetries.
2. Behavior of the multilayer system during folding, if the horizontal position of the pre-existing asymmetry varies.
3. Influence of the large scale initial amplitude on buckling and shearing of parasitic folds.

The simulations with varying initial angle of the pre-existing asymmetry show retaining asymmetries during the compression, especially for overturned asymmetries. Horizontally shifting the pre-existing asymmetry suggests that the horizontal position disturbs the sinusoidal development of the thick layer during folding.

Pre-existing asymmetries are most pronounced with a small initial perturbation of the thick layer. In addition, newly formed asymmetries show similar traits. The influence of the initial perturbation of the thick layer on thin layers is already investigated in Frehner (2006) but without pre-existing asymmetries.

The geometry of the thin layer, particularly the horizontal position of the pre-existing asymmetry, has an unforseen effect on the amplification of the thick layer during folding. Further, the random perturbation causes small differences in the thin layer position that causes results that differ remarkably from each other.

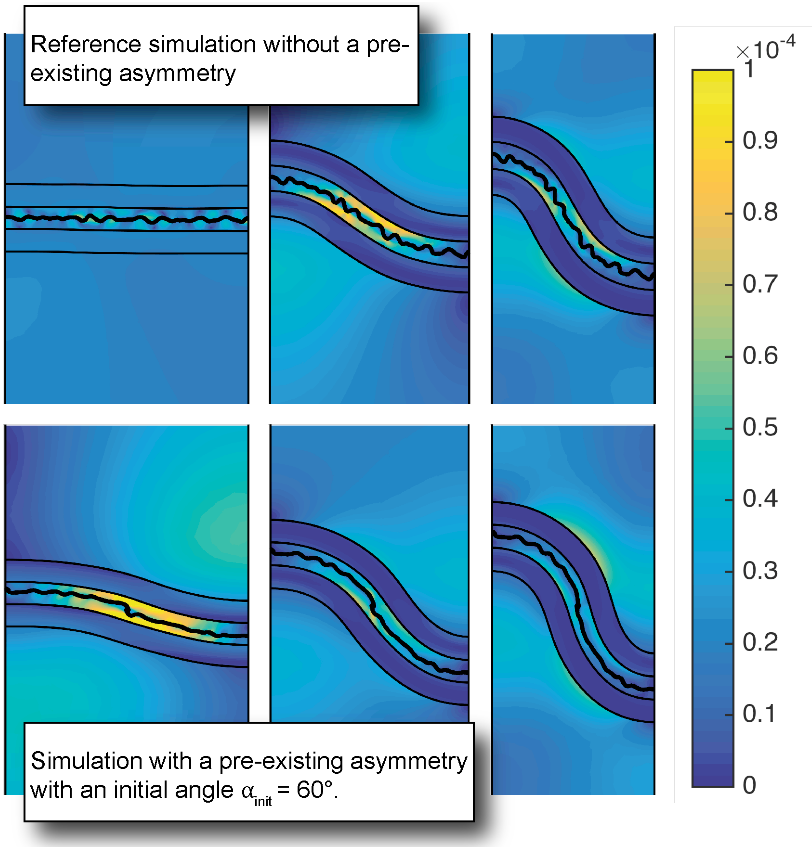

Figure 2. Time-lapse images of a reference simulation without pre-existing asymmetry (top) and a simulation with a pre-existing asymmetry, respectively (bottom). The pre-existing asymmetry has a remarkable influence on the thick layer system behaviour during amplification. For example, the pre-existing asymmetry initiates the second phase of deformation (Frehner 2006) sooner than for the reference simulation.

REFERENCES

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Ramsay, J.G. & Huber, M.I., 1989: The techniques of modern structural geology, Vol.1: Strain analysis, 4th edition, Academic Press, London, ISBN 0-12-576921-0