Tectonomechanics Colloquium
5. & 6. May 2014
ETH Zurich

www.tecmech2014.ethz.ch

3D folds: Growth rates and linkage using the vorticity dominant wavelength

Marcel Frehner[1], Thomas Philippe[1] and Dave A. May[1]

[1]Geological Institute, ETH Zurich, Switzerland (marcel.frehner@erdw.ethz.ch)

Geological folds are inherently 3D structures. Therefore, a fold also grows in three dimensions (Grasemann and Schmalholz, 2012). Various studies exist that consider one of the three possible growth directions individually, but the simultaneous growth of a fold in all three directions has not been quantified yet. Here we study this 3D fold growth in two parts.

First, we study and quantify the growth of a fold structure in all three directions from a single perturbation numerically using a finite-element algorithm. Upright symmetrical single-layer folds are considered. The higher-viscous layer exhibits a single point-like initial perturbation. Horizontal compression in one direction leads to a folding instability, which grows from this perturbation in all three directions (Figure 1).We demonstrate that in the two lateral directions the fold structure grows at very similar rates, but in the vertical direction the growth rate is larger. Generally, all three normalized fold amplitudes are of the same order, particularly at early folding stages.

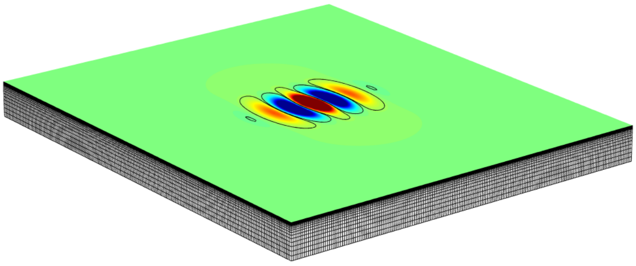

Figure 1: 3D fold growth from point-like initial perturbation in all three directions. Uniaxial shortening is applied in horizontal direction on the front-left and back-right surfaces. Colors represent topography.

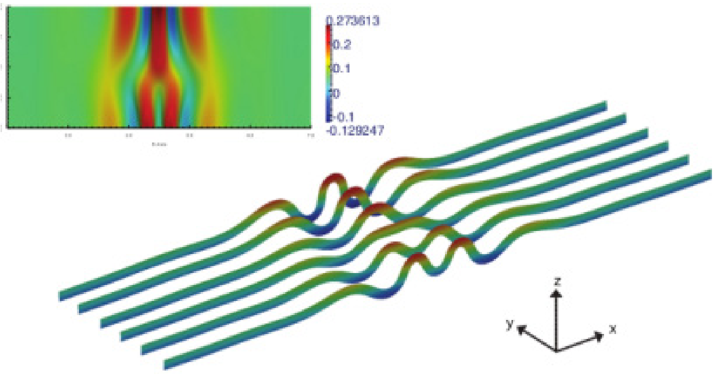

Figure 2: Triple-linkage: slices of a fork-structure. At the junction, a double hinge fold with a flat topography can be observed. Colors represent topography.

In the second part, we study the lateral growth (i.e., fold elongation) of two or more folds towards each other. As the fold structures elongate, they eventually link with each other (Grasemann and Schmalholz, 2012). In particular we study the triple-linkage and fork-linkage scenario of a solitary embryonic fold growing towards a binary fold structure (consisting of two folds; Figure 2). We construct a phase diagram highlighting the various linkage structures as a function of the geometric parameters. It turns out that the vorticity field of the two opposite fold structures determines whether or not and how the two structures link. The planar vorticity field of a fold (as seen in plan-view) exhibits a characteristic wavelength, distinctively different from the well-known dominant fold wavelength and appears to be the characteristic length controlling the linkage process.

<u>Cited / related work</u>

Grasemann B. and Schmalholz S.M., 2012: Lateral fold growth and fold linkage, Geology 40, 1039–1042.