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Structural inheritance during multilayer buckle folding: How pre-existing asymmetries result in parasitic folds with wrong vergence

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Parasitic folds are typical structures in geological multilayer folds; they are characterized by a small wavelength and are situated within folds with larger wavelength (Ramberg, 1963; Frehner and Schmalholz, 2006). Parasitic folds exhibit a characteristic asymmetry (or vergence; i.e. S-, Z-, or M-folds) reflecting their structural relationship to the larger-scale fold.

Here we investigate if and how a pre-existing asymmetry (e.g., from sedimentary structures or folds from a previous tectonic event) can be inherited during buckle folding to form alleged parasitic folds with wrong vergence. We conduct 2D finite-element simulations of Newtonian multilayer folding. The applied model setup comprises a thin layer containing the pre-existing asymmetry sandwiched between two thicker layers, all embedded in a lower-viscosity matrix and subjected to layer-parallel shortening. Thereby we vary the intensity of the asymmetry (open to tight) and its position on the larger-scale fold (from fold hinge to fold limb). During ongoing layer-parallel shortening and buckling, we track the asymmetry's amplitude with respect to the larger-scale fold median line.

When the two outer thick layers buckle and amplify, two processes work against the asymmetry:

- layer-perpendicular flattening and
- the rotational component of flexural flow folding.

Both processes promote de-amplification and unfolding of the pre-existing asymmetry.

We discuss how the efficiency of de-amplification is controlled by the larger-scale fold amplification and conclude that pre-existing folds that are open, exhibit low amplitude, and/or are situated on the limb of the larger-scale fold are prone to de-amplification and may disappear during buckling of the multilayer system. Large-amplitude and/or tight to isoclinal folds and/or folds situated close to the hinge of the larger-scale fold may be inherited and develop into alleged parasitic folds with wrong vergence resembling type 3 fold interference patterns.

References:

Frehner M. and Schmalholz S.M., 2006: Numerical simulations of parasitic folding in multilayers, Journal of Structural Geology 28, 1647–1657.

Ramberg H., 1963: Evolution of drag folds, Geological Magazine 100, 97–110.