Numerical simulations of parasitic folding in multilayers

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We use the finite element method to simulate slow viscous (Newtonian) flow in two dimensions without gravity and to model asymmetric (S- and Z-shaped) and symmetric (M-shaped) parasitic folds during multilayer folding. During multilayer folding, the matrix between stiffer layers shows a deformation close to pure shear in the hinge area and a combination of pure and simple shear in the limb areas. Thinner layers placed between thicker layers develop symmetric parasitic folds in the hinge, and eventually asymmetric parasitic folds in the limbs of the larger fold. Our results verify numerically the theory that asymmetric parasitic folds develop from symmetric buckle-folds that are sheared by the hingeward relative displacement of the thick layers in the limbs of the first-order fold. To develop asymmetric shapes, the amplitudes of the parasitic folds must exceed a critical value before the first-order fold begins to amplify. Otherwise the parasitic folds are unfolded during flattening that takes place in the limb area between the thick layers. More than five thin layers are necessary to generate distinct asymmetric parasitic folds for the applied model setting. More layers generate higher amplification rates in the thin layers and, hence, higher amplitudes.

Figure 1: Asymmetric, S- and Z-shaped, parasitic folds in folded, foliated metagabbros, Val Malenco, Southern Swiss Alps (picture courtesy of Jean-Pierre Burg).

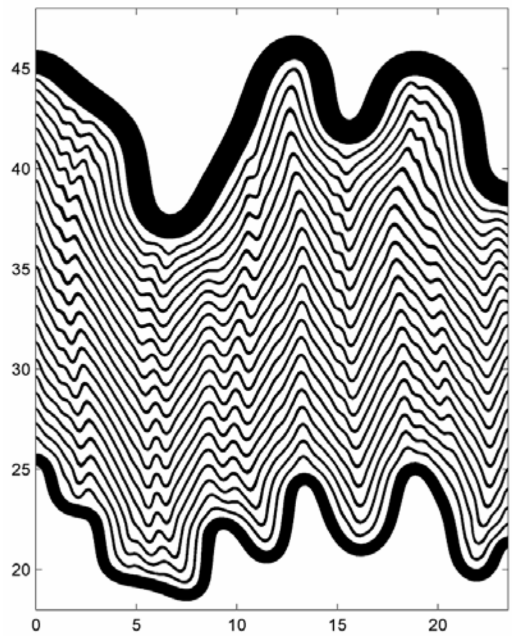

Figure 2: Numerical simulation of parasitic folding after 50% shortening shows both S- and Z-shaped asymmetric, and M-shaped symmetric parasitic folds. The two external layers initially had a bell-shaped, the thin layers a random perturbation. In all layers a true wavelength selection took place. The folds in the external layers have different wavelengths due to their different thickness.