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# Stress and strain evolution of folding rocks

Maria-Gema Llorens (1), Albert Griera (2), Paul Bons (1), Enrique Gomez-Rivas (3), and Ilka Weikusat (4)

(1) Department of Geosciences, Eberhard Karls University of Tübingen, Germany (maria-gema.llorens-verde@uni-tuebingen.de), (2) Departament de Geologia, Universitat Autònoma de Barcelona, Spain, (3) Department of Geology and Petroleum Geology, University of Aberdeen, Scotland, (4) Alfred-Wegener-Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany

One of the main objectives of structural geology is to unravel rock deformation histories. Fold shapes can be used to estimate the orientation and amount of strain associated with folding. However, much more information on rheology and kinematics can potentially be extracted from fold geometries (Llorens et al., 2013a). We can study the development of folds, quantify the relationships between the different parameters that determine their geometries and estimate their mechanical evolution. This approach allows us to better understand and predict not only rock but also ice deformation. One of the main parameters in fold development is the viscosity contrast between the folding layer and the matrix in which it is embedded (m), since it determines the initial fold wavelength and the amplification rate of the developing folds. Moreover, non-linear viscous rheology influences fold geometry too (Llorens et al., 2013b).

We present a series of 2-dimensional simulations of folding of viscous single layers in pure and simple shear. We vary different parameters in order to compare and determine their influence on the resulting fold patterns and the associated mechanical response of the material. To perform these simulations we use the software platform ELLE (www.elle.ws) with the non-linear viscous finite element code BASIL.

The results show that layers thicken at the beginning of deformation in all simulations, and visible folds start earlier or later depending on the viscosity contrast. When folds start to nucleate the layer maximum shear strain decreases, moving away from the theoretical trend for homogeneous strain (no folding). This allows the accurate determination of the onset of folding. Maximum deviatoric stresses are higher in power-law than in linear-viscosity materials, and it is initially double in pure shear than in simple shear conditions. Therefore, folding a competent layer requires less work in simple than in pure shear. The maximum deviatoric stress difference between pure and simple shear is less pronounced in power-law materials. It also depends on the original orientation of the layer relative to the shear plane, being the shortening rate initially relatively low when the layer makes a low angle with the shear plane. The mechanical behaviour is similar in pure and simple shear when the layer is oriented at a relative high angle (45º).

M-G Llorens, PD Bons, A Griera and E Gomez-Rivas (2013a) When do folds unfold during progressive shear?. Geology, 41, 563-566.

M-G Llorens, PD Bons, A Griera, E Gomez-Rivas and LA Evans (2013b) Single layer folding in simple shear. Journal of Structural Geology, 50, 209-220.