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Fold geometry and constitutive behaviour

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Abstract: In this paper we examine the constitutive behaviour of single layered systems and the resulting fold geometries. The classical dominant wavelength treatments of Biot and Ramberg are discussed in terms of current knowledge about non-linear systems, and their work is compared with finite element calculations, which demonstrate that the time constants for buckling amplification versus those for viscous relaxation play a key role in determining fold evolution. For viscous, non-linear (specifically, power law) materials, the critical wavelength which is amplified is less than that predicted for a linear-viscous material.

For purely viscous materials deforming in three dimensions, two wavelengths are always amplified no matter if the deformation history is biaxial shortening, plane shortening or shortening plus extension in the plane of the layer. These two wavelengths combine to give the impression of superimposed fold systems; in a particular section plane through the fold system this may result in fold system profiles that are a-periodic.

Fold growth in elastoviscous materials is found to be extremely strain rate dependent. Elastoviscous materials undergo a spectrum of responses ranging from the domination of homogeneous shortening and weak buckling at relatively low strain rates, to little layer parallel shortening and predominantly buckling deformation at relatively high strain rates (for a given set of physical parameters).

Extending our analysis to more complex non-linear materials, we find examples of fold packet evolution in elastoviscous systems that do not lead to periodic fold trains. Finally the effects of microstructure evolution during folding are investigated, which demonstrate the effects of a history dependent rheology.

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