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FOLDER: A numerical tool to simulate the development of structures in layered media

Marta Adamuszek (1), Marcin Dabrowski (1,2), and Daniel W. Schmid (2)

(1) Computational Geology Laboratory, Polish Geological Institute - NRI,Wroclaw, Poland (marta.adamuszek@pgi.gov.pl),
(2) Physics of Geological Processes, University of Oslo, Norway

FOLDER is a numerical toolbox for modelling deformation in layered media during layer parallel shortening or extension in two dimensions. FOLDER builds on MILAMIN [1], a finite element method based mechanical solver, with a range of utilities included from the MUTILS package [2]. Numerical mesh is generated using the Triangle software [3]. The toolbox includes features that allow for: 1) designing complex structures such as multi-layer stacks, 2) accurately simulating large-strain deformation of linear and non-linear viscous materials, 3) post-processing of various physical fields such as velocity (total and perturbing), rate of deformation, finite strain, stress, deviatoric stress, pressure, apparent viscosity. FOLDER is designed to ensure maximum flexibility to configure model geometry, define material parameters, specify range of numerical parameters in simulations and choose the plotting options. FOLDER is an open source MATLAB application and comes with a user friendly graphical interface.

The toolbox additionally comprises an educational application that illustrates various analytical solutions of growth rates calculated for the cases of folding and necking of a single layer with interfaces perturbed with a single sinusoidal waveform. We further derive two novel analytical expressions for the growth rate in the cases of folding and necking of a linear viscous layer embedded in a linear viscous medium of a finite thickness.

We use FOLDER to test the accuracy of single-layer folding simulations using various 1) spatial and temporal resolutions, 2) time integration schemes, and 3) iterative algorithms for non-linear materials. The accuracy of the numerical results is quantified by: 1) comparing them to analytical solution, if available, or 2) running convergence tests. As a result, we provide a map of the most optimal choice of grid size, time step, and number of iterations to keep the results of the numerical simulations below a given error for a given time integration scheme. We also demonstrate that Euler and Leapfrog time integration schemes are not recommended for any practical use.

Finally, the capabilities of the toolbox are illustrated based on two examples: 1) shortening of a synthetic multi-layer sequence and 2) extension of a folded quartz vein embedded in phyllite from Sprague Upper Reservoir (example discussed by Sherwin and Chapple [4]). The latter example demonstrates that FOLDER can be successfully used for reverse modelling and mechanical restoration.

[1] Dabrowski, M., Krotkiewski, M., and Schmid, D. W., 2008, MILAMIN: MATLAB-based finite element method solver for large problems. Geochemistry Geophysics Geosystems, vol. 9.

[2] Krotkiewski, M. and Dabrowski M., 2010 Parallel symmetric sparse matrix-vector product on scalar multi-core cpus. Parallel Computing, 36(4):181–198

[3] Shewchuk, J. R., 1996, Triangle: Engineering a 2D Quality Mesh Generator and Delaunay Triangulator, In: Applied Computational Geometry: Towards Geometric Engineering" (Ming C. Lin and Dinesh Manocha, editors), Vol. 1148 of Lecture Notes in Computer Science, pp. 203-222, Springer-Verlag, Berlin

[4] Sherwin, J.A., Chapple, W.M., 1968. Wavelengths of single layer folds - a Comparison between theory and Observation. American Journal of Science 266 (3), p. 167-179