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Fold Geometry Toolbox: Automated determination of fold shapes, strain, and material properties

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The shape characteristics of folds contain substantial information regarding the degree of shortening and rheological behavior of rocks. The theory of folding establishes the link between the mechanical properties of the involved materials and a simple set of geometrical parameters: arc length, amplitude, thickness, and wavelength. Hence, it is crucial to define and determine these parameters objectively and accurately.
We present a numerical toolbox called the Fold Geometry Toolbox (FGT) that allows for automated estimation of arc length, amplitude, wavelength, and thickness of both single and multilayer fold trains. The advantage of FGT over existing methods is that it uses normalized and parameterized data representations, which ensures that the outcome of the analysis is invariant to rigid body motions and dilation. Amplitude and wavelength depend on an accurate detection of hinges and inflection points, which are in turn dependent on the interface curvature. Noise in the data, original or due to digitization, can strongly affect curvature. In FGT the original curvature is smoothed by a Gaussian filter. The resultant set of inflection points is subjected to an additional filter that eliminates folds with insignificant curvatures and arc lengths. The hinges are the points where the curvature attains its local extremum between two inflection points. In the hinge detection procedure, a polynomial approximation to the filtered signal is additional option.
Several definitions of the amplitude, wavelength, and thickness are implemented in FGT. The resulting shape parameters are used to determine strain and material properties from the folding theory and modelling experiments. We use analytical and numerical solutions for folding of elastic or viscous layers embedded in elastic or viscous matrix. FGT is a fast, robust, and user-friendly tool for a quantitative analysis of fold shape and determination strain and material properties.