

# Non-linear surface interpolation of large deflection fold shapes

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Knowledge of the continuous geometry of geologic folds is essential for predictions about associated deformation, specifically fracturing and hence alterations of fluid flow. Data on the geometry of kilometer-scale folds is becoming available through airborne laser swath mapping (ALSM), which, in general, delivers sparse and non-continuous information on the geometry of particular strata. The raw data must be interpolated to reveal the geometry of individual strata over the entire fold. Interpolations of geologic folds are often carried out assuming a smooth resultant surface but physical processes such as faulting and fracturing may preclude such geometries. A first order physical analog is that of small deflection plate bending in which the middle surface of a thin plate is used as a proxy for the surface to interpolate. The application to geologic folding assumes that layer boundaries deform similar to the middle surfaces of that layer. In the small deflection plate bending analysis lateral forces, shear tractions on the top and bottom surfaces of the thin plate, and in-plane strains in the middle surface are assumed to be negligible. The physical process of folding multiple sedimentary layers may involve some, if not all of these, complications. A physical process based interpolation technique that incorporates more of these complications may thus improve the quality of the more elementary surface interpolations.

We present a interpolation technique that omits the conditions of small deflection and zero strains in the middle plane of the layer and apply the interpolation at Raplee monocline, southwestern UT. We solve the non-linear large deflection plate bending problem using the finite element method, use observed elevations as displacement boundary conditions, and predict elevations throughout the geologic fold where data is absent. The resulting surface reveals a smoothly varying geometry that compares well with previous interpolations. Additionally, we calculate strains in the plane of the surface and compare regions of high strains to areas of high fracture intensity mapped in the field. The method can improve on existing interpolations techniques by addressing the physical process more adequately and predicting regions of high strain along the geologic fold.