Finite Element Modeling of Fracture Reactivation and Bedding Slip During Folding

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We use mechanical models to study the reactivation (opening and shearing) of pre-existing fractures and the evolution of slip on bedding surfaces during the formation of an asymmetric anticline using finite elements and large deformation contact mechanics. The models consist of three layers in frictional contact and the middle layer contains layer-perpendicular fractures. A lower boundary layer is in frictionless contact and serves to transmit displacements that mimic the fold profile at Sheep Mountain anticline, Wyoming, a thrust fault related fold. The upper boundary is subject to normal tractions appropriate for the depth of burial. Lateral boundaries are displaced horizontally to represent the Laramide tectonic shortening. The numerical simulations show the effects of material properties, slip on bedding surfaces, and the ratio of tectonic shortening to vertical uplift on the response of the multilayer system. The model uses frictional contact elements to capture opening and slip of pre- existing fractures and slip on bedding surfaces. The computational results demonstrate the sequence, kinematics, and spatial variations of reactivation, and mode of deformation (opening versus shearing) of bed-perpendicular fractures. We show that fractures located on the hinge are reactivated as joints and that those on the forelimb are predominantly reactivated as thrust faults. We compare the numerical results with fracture data observed at Sheep Mountain Anticline and discuss the similarities and differences between the field observation and the model results. Supported by U.S. Department of Energy, Grant No. DE-FG02-03ER15454, and U.S. National Science Foundation, Grant No. CMG-0417521.