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Simulating brittle fault growth from linkage of pre-existing structures

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Many researchers have proposed conceptual models of fault development that are based on the linkage of pre-existing structures such as isolated faults, joints or veins. To date, such models largely use theoretical mechanics to explain the detailed damage zone geometries observed in linkage structures. In this paper, we present the first numerical simulations of the temporal and spatial development of geometrically complex fault linkage structures using the finite element model for fault damage zone evolution, MOPEDZ. Simulations show spatial and temporal fault zone evolution for a range of pre-existing joint (or fault) geometries and stress conditions. Simulations show that linkage geometries are governed by three key factors: the stress ratio; the original joint geometry, such as contractional or dilational configurations; and the orientation of the principal stress. Simulated linkage structures display close correspondence to field observations of fault zone geometry, with all secondary and tertiary damage features being reproduced. This comparison validates the numerical modeling approach and allows us to confidently predict the likely stress conditions for observed linkage geometries at a range of well-documented field sites. The research also demonstrates that given information on the regional stress conditions, numerical modeling can be used to predict fault zone geometries, and hence, identify the most (and least) likely structures for promoting fluid flow.