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3d numerical modelling of tear faults

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Tear faults, defined as vertical discontinuities, with near fault parallel displacements terminating on some sort of shallow detachment, are difficult to study in “cross section” i.e. 2 dimensions as is often the case for fold-thrust systems. We use a distinct element code modelling frictional-plastic material behaviour to study the evolution of tear faults above a basal detachment. Our study emphasises processes of strain localisation around tear faults in 3 dimensions and its evolution over time with increasing deformation. Field studies suggest that strain in such regions can be distributed across broad zones on minor tear systems, often not easily mappable. Such strain is assumed to be due to distributed strain and displacement gradients which are themselves necessary for the initiation of the tear itself.

Our numerical study shows the effects of a sharp, basal discontinutiy parallel to the transport direction in a shortening wedge of material. The discontinuity is represented by two adjacent basal surfaces of strongly contrasting (0.5 and 0.05) friction coefficient. Model geometry is a rectangular bounding box, 2km x 1km, and 0.35-0.5km deep, with a single, equally displaced driving wall of constant velocity.

We show the evolution of strain in the model in horizontal and vertical sections, and interpret strain localization as showing spontaneous development of tear fault like features. The strain field in the model is asymmetrical, rotated towards the strong side of the model. Strain patterns oscillate in time, suggesting achievement of a deforming, steady state. Clearly, an interplay of rheology, geometry, and kinematics controls the nature of deformation localisation in "faults" in the model.