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Deterministic chaos in frictional wedges.

Baptiste Mary (1), Bertrand Maillot (1), and Yves M. Leroy (2)

(1) Département Géosciences et Environnement, Université de Cergy-Pontoise, France (baptiste.mary@u-cergy.fr) , (2) Ecole Normale Supérieure, Laboratoire de Géologie, Paris, France (leroyy@geologie.ens.fr)

A triangular wedge, composed of a frictional material such as sand, and accreting additional material at its front, is the classical prototype for accretionary wedges and fold-and-thrust belts. The Sequential Limit Analysis method is applied to capture the internal deformation to these structures resulting from a large number of faulting events during compression. The method combines the application of the kinematic approach of limit analysis to predict the optimum thrust-fold and a set of geometrical rules to update the geometry accordingly, at each increment of shortening. It is shown that the topography remains planar to first order with an average slope predicted by the critical Coulomb wedge theory. Failure by faulting occurs anywhere within the wedge at criticality and its exact position is sensitive to topographic perturbations resulting from the deformation history. The convergence analysis in terms of the shortening increments and of the topography discretisation reveals that the timing and the position of a single faulting event cannot be predicted. The convergence is achieved nevertheless in terms of the statistics of the distribution of the faulting events throughout the structure and during the entire deformation history. These two convergence properties plus the perturbation sensitivity justify the claim that these compressed frictional wedges are imperfection sensitive, chaotic systems. This fundamental system has to be understood before considering the influence of softening on activated ramps and of erosion which are also discussed.