Distinct Element Modelling of Fault Growth in Multilayer Sequences

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Normal faults contained within multilayer sequences are often segmented in 3D. Field studies on vertical (i.e. cross-) sections have shown that faults refract in layered sequences, a feature that is generally attributed to either stress refraction or the linkage of overstepping segments. These complexities are due to varying mechanical properties, which also determine the relative timing of localisation (i.e. faulting) within the multilayer. The purpose of this study is to develop models for fault zone growth that are beyond the existing conceptual framework using a combined outcrop analysis and numerical modelling approach. Fieldwork has concentrated on the analysis of small-scale normal faults contained within the Jurassic limestone/shale sequence at Kilve foreshore, Somerset, UK (Fig. 1a).

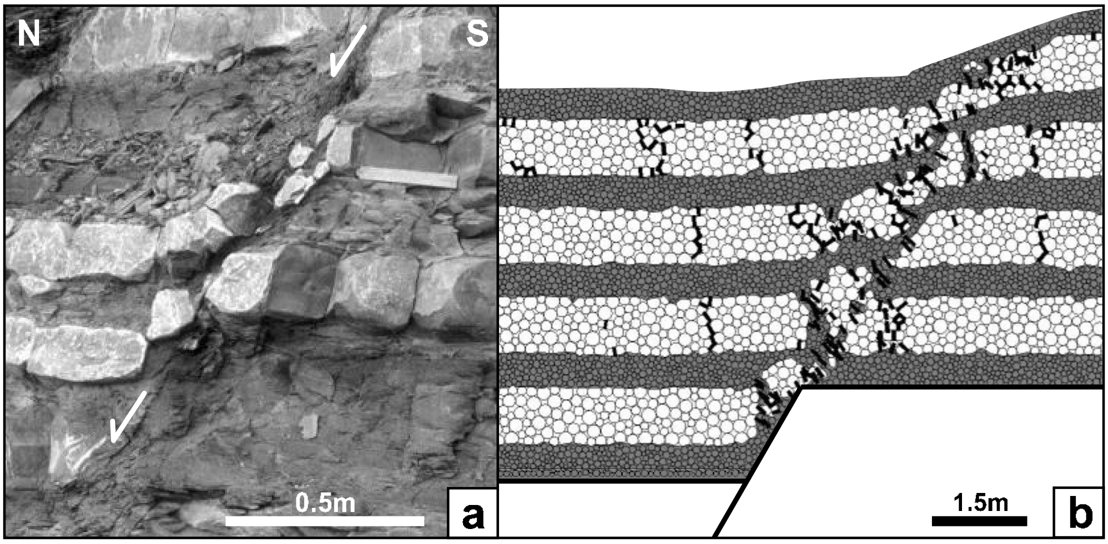

Figure 1: (a) Normal fault in Jurassic limestone/shale sequence at Kilve foreshore, Somerset, UK. (b) Normal fault in distinct element model of interbedded strong (white) and weak (grey) layers. Bold lines indicate broken bonds.

Numerical modelling of the growth of normal faults in layered sequences in 2D (Fig. 1b) is being performed using the Particle Flow Code (Itasca Consulting Group), in which the model material consists of cylindrical elastic particles. The rheologies of both strong (e.g. limestone) and weak (e.g. shale) materials have been calibrated to natural rock properties by means of biaxial compression tests. The propagation of a single fault through the multi-layer is achieved by introducing a pre-cut fault at the base of the model. The models replicate many of the features seen in natural faults and provide a basis for defining the following fault growth history. (i) Initially a low amplitude monocline develops in the competent layer and Mode I fractures form. (ii) Contractional oversteps develop across the incompetent beds and monoclines amplify to form normal drag. (iii) Asperities arising from fault plane refraction and segmentation are progressively removed and incorporated into the fault zone. (iv) The final geometry is a single through-going fault with initial complexities preserved adjacent to this fault.