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Broadhaven revisited: a new look at models of fault–fold interaction

Adam J. Cawood and Clare E. Bond

Department of Geology & Petroleum Geology, School of Geosciences, University of Aberdeen, UK
(adam.cawood@abdn.ac.uk)

Coastal exposures of Carboniferous-age strata in SW Wales are recognised for their excellent preservation of Variscan deformation. The classic fold-thrust outcrop at Broadhaven, Pembrokeshire, is a particularly well-known example, and an oft-cited 'type example' of fault-related folding, following work by Williams & Chapman (1983). The outcrop has been important for generating conceptual models of fault-fold interaction, and was one of the sites where distance-displacement data were first used to infer thrust slip/propagation ratios. Here we employ the virtual outcrop method to digitally map and measure this classic locality. 3D reconstruction of the outcrop by digital photogrammetry allows us to extract high-density structural measurements, reassess the existing model of structural development, and re-evaluate the link between faulting and folding at the site.

We find that high-resolution digital measurements record greater variability in thrust displacement and bed thicknesses than previously documented at the site. Distance-displacement data record the influence of mechanical anisotropy on slip/propagation ratios through the deformed multilayer. Bed thickness changes are linked to this variability in thrust displacement, highlighting transitions in strain accommodation patterns. Fracture analysis shows that fracture intensity is closely linked to structural position and bed thickness changes, and that fracture orientations record the existence of discrete mechanical boundaries through the structure. These results record complex patterns of strain distribution and multi-phase deformation. Evidence for temporal and spatial variability in strain distribution suggests that multiple kinematic and non-kinematic models of deformation are required to faithfully describe even this apparently simple structure. We use this detailed field evidence to propose an alternative to and develop, for multi-layered stratigraphy, the ductile bead model of Elliot (1976), as exemplified at Broadhaven by Williams & Chapman (1983).

References

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