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Analytical modelling of rounded hinge fault-bend folding: geometry and deformation distribution

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It has long been recognised that the motion of thrust sheets over nonplanar thrust faults is one of the most common folding mechanisms in fold-and-thrust belts (Rich, 1934). In this particular fold-thrust style (fault-bend folding; Suppe, 1983), propagation of the thrust predates the translation and folding of the hangingwall. A quantitative theory and kinematic model of fault-bend folding, relating the fold shape to the fault trajectory, was developed by Suppe (1983) assuming self-similar, flexural-slip folding and angular bends in straight fault segments. Fault-bend folding has been successfully applied in most fold-and-thrust belts worldwide for the immediacy and predictive capability of the Suppe's (1983) model. Nevertheless, in many cases the simplicity of the simple-step construction favoured the oversimplification of the actual cross-sectional distributions of dip domains in few, homogeneously-dipping rock panels that only crudely approximate natural, generally more rounded fold shapes. The mismatch between model and natural geometries can be reduced by increasing the number of constant dip panels in the hangingwall (Suppe, 1983; Jamison and Pope, 1996). The increased geometrical complexity of the resulting anticline requires a corresponding increased segmentation of the fault ramp trajectory (e.g. Medwedeff and Suppe, 1997). Eventually, highly segmented fault geometries must be introduced for modelling near rounded fold shapes. To overcome the artefacts that may be produced by the abuse of ramp segmentation and angular fault-bend folding, we explored the use of circular hinge zone in the geometrical construction of fault-bend anticlines. Circular hinge zones provide an alternative, simple solution for the geometrical modelling of near rounded fault-bend anticlines. In this geometrical construction, the dependence of the fold shape upon the fault trajectory is preserved but the direct proportionality between fold roundness and ramp segmentation is released. Eventually, circular folds can develop above straight ramps.

The relationships between fault-fold kinematics and deformation patterns is well known and of primary importance in hydrocarbon exploration and production (e.g. Dahlstrom, 1990). Geometrical modelling of fault-related folding provides a very useful tool for predicting the deformation patterns associated to specific fault-fold kinematics (e.g. Storti and Salvini, 1996). The angular-hinge model of fault-bend folding (Suppe, 1983) produces simple distributions of deformation panels (Salvini and Storti 2001) which may result oversimplified when applied to more rounded fold geometries. The deformation patterns predicted from the geometrical model of rounded-hinge fault-bend folding is significantly different from the previous one. Applications to thrust-related anticlines in the Apennines are discussed.