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The role of bedding in the formation of fault–fold structures, Portalegre-Esperança transpressional shear zone, SW Iberia

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Fold-fault structures within a major transpressional shear zone of the SW Iberian Massif were investigated by combining geological mapping, cross-section analysis and microtectonic studies. A significant example of contractional deformation is displayed in the Portalegre-Esperança Shear Zone (PESZ) where a heterogeneous Ordovician stratigraphic sequence, showing a strong competence contrast between quartzites, slates and quartzo-feldspathic rocks favoured strain localization and fault nucleation that controlled fold formation. The presence of pelitic layers within the thick-bedded quartzites had probably provided weakness zones that were more favourable for the strain localization than the previous foliation present in the quartzites. The quartzites and the quartzo-feldspathic rocks (granites and volcaniclastic rocks) accommodated heterogeneous high strain developing different degrees of mylonitization. The quartzites with protomylonitic textures are dominant and represent coarse-grained siliciclastic sediments that suffered metamorphism and partial dynamic recrystallization. Ultramylonites occur within discrete high-strain shear zones. It is probable that the strain localization in the PESZ involved both the effect of having layers of different competence and layers or stratigraphic contacts with rocks that experienced grain size reduction dominated by cataclasis and dislocation creep.

Folds within quartzites with sub-horizontal to gently plunging hinges vary from closed to open in thick-bedded quartzites and from tight to closed in thin-bedded quartzites. Observed changes in structural style of deformed quartzites, slates and quartzo-feldspathic rocks are interpreted to result from the constraints imposed by the mechanical properties of the different lithologies.

As the folds tightened during shortening, the alternating zones of contrasting competence favoured the disruption of the bedding. The deformation history in the PESZ was dominated by thrusting and strike-slip faulting along incompetent layers that locally developed staircase geometry and transected the lower Ordovician stratigraphic sequence. The kinematic model proposed for the PESZ is consistent with the models of transpressional shear zones stretched along strike with the development of coeval strike-slip and low angle oblique-slip faults associated to active buckle folds with axes parallel to the principal extension direction.

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1. INTRODUCTION

Faulting and folding are intimately related and represent the effects of combined brittle and ductile processes during deformation (Strayer and Hudleston, 1997). There are a wide variety of folds associated with faults (Ramsay and Huber, 1987; Price and Cosgrove, 1990; Butler, 1992). The geometry of these folds is controlled by the orientation and shape of the associated faults (Davis and Reynolds, 1996). Folds formed as a consequence of faulting include: fault–bend folds (Suppe, 1985), due to flexure of the hanging-wall as it is displaced over a thrust ramp, and fault propagation folds (Suppe, 1985), in which the fold geometry is determined by the fault shape and the accommodation of the loss of displacement at the fault tip of a thrust ramp. Folds formed earlier than the thrusts, referred to as break-thrust folds (Fischer *et al*., 1992; Gutiérrez Alonso and Gross, 1999) are related to high-angle faulting of the limb of a fold. Complex associations of folds and faults can also develop in imbricate fans or duplexes as a result of the progressive collapse of either the hanging-wall or the footwall (Boyer and Elliott, 1982). Deformation of imbricate fault systems by displacements along stepped surfaces is heterogeneous in space as a result of fault–fold interactions at different scales (Chester, 2003). The models of thrust sheet movement over stepped and curved fault surfaces, leading to the development of ramp-related folds, consider the fault geometry and the mechanical properties of the bedding as major influences on the kinematics of deformation (Strayer and Hudleston, 1997; Chester, 2003).

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