The use of fold nucleation as a shear sense indicator

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The development of shear sense indicators is controlled by the vorticity of the flow in the rocks. Vorticity is a measure of the average rate of rotation of the material lines. In shear zones there are two important parameters that control the formation of folds: (1) conservation of vorticity related to local variation in shear strain rate; and (2) a shortening component of deformation parallel to the shear plane. A rotation of the slip plane in the same sense as the vorticity of the deformation must accompany a slower strain rate on a portion of the shear plane in order to conserve the vorticity of the flow. This can occur if: (a) the shear plane is planar, parallel-sided, and of infinite extent; (b) the flow field is progressive simple shear; (c) the material in the zone is mechanically homogeneous; (d) the material obeys a linear viscous flow law. It has been demonstrated experimentally that kink-bands form when a shear plane is undergoing a shortening. In natural folds, nucleation in shear zones is controlled by a combination of shortening parallel to the foliation and the need to conserve vorticity. The folds preferentially nucleate at the point where a fast strain rate caused by foliation-parallel-slip decreases to the bulk shear strain rate. The fold develops an asymmetry that is consistent with the sense of shear and the axial plane lies in the extensional field of flow so that the fold can be amplified with continuing strain. The fold nucleates to conserve vorticity and maintain strain compatibility in the deforming material. The sense of shear is indicated by the side that contains the acute angle between the axial plane of the fold and the shear plane.

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