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Strain and vorticity analysis using minor faults and associated drag folds

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One of the aims of structural geology is to determine and quantify the amount and type of deformation that rocks experienced. Structural geologists usually analyze a variety of structures that record deformation, such as folds, fractures, boudins, veins, etc. Recently, much attention has been given to small faults and their associated drag folds in mostly ductile rocks. These structures have been labelled as flanking structures (Passchier, 2001; Grasemann and Stüwe, 2001) and have been classified in many types depending on their geometry and kinematics (Grasemann et al., 2003). In this contribution we present a new method to determine finite strain and the kinematics of deformation using isolated, discrete minor faults and their associated drag folds.

Slip along a fault will cause heterogeneous deformation in the vicinity of the fault, and in the case of foliated rocks this deformation usually produces drag folds around the fault. Our analysis is based on the deformation of foliation at a single, straight fault in an otherwise homogenously deforming medium. The fault is supposed to have a limited extent and the foliation plane is considered the reference plane. The method takes in account three parameters easily measurable in the field: the orientation (A) of the fault with regard to the foliation, the drag angle (B) between the fault and the curved foliation close to the fault plane, and the ratio (L/T) of the thickness of a reference layer measured parallel to the fault at the fault and the thickness of the same layer away from the fault, but measured perpendicular to the layer. Unique graphs for the evolution of A, B and L/T can be plotted for progressive strain, for a certain

starting orientation of the fault and a certain vorticity angle.

If there is a population of isolated faults with drag folds in the field, this method assumes that all of them start off with a similar orientation but at different stages during progressive deformation. Then, each fault system observed in the field represents a different stage of development, and all data points should lie close to a single line in these graphs. The smallest estimated value for the initial fault angle (A_0) should be close the fault that has experienced the lowest amount of strain, and that the total amount of strain can be estimated from that for the most developed fault system observed.

The applicability and accuracy of this model has been successfully tested in analogue models and also using numerical simulations based on Finite Element Models. It has been applied, as an example, to a real field case study in Rabassers de Dalt outcrop (Cap de Creus, Girona, Spain).

References:

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