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Stress-strain relation model of brittle shear zones

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ABSTRACT: The presented method deals with the determination of deformation parameters of a fault strained body for a special case of a brittle shear zone with undeformed walls. Starting point is the idea of linearity of the relation between the stress in an evenly fractured body and the resulting deformation of the body. If this presumption is met, paleostress tensor can be calculated from a set of striated faults and, consequently, strain parameters of the brittle shear zone comprising these striated faults can be determined. The orientation of the brittle shear zone wall is determined relative to principal axes of the paleostress tensor as well as the direction of the resulting displacement along the brittle shear zone wall and the ratio between the displacement magnitude and the width change of the zone.

1 INTRODUCTION

Striated faults are one of the most effectively analysable types of brittle structures. These are ruptures on which shear movement prevailed. The direction of the movement is registered in the form of striae. Striae originated partly by mechanical graving of solid components of the rock material into the fault plane, and partly represent features produced at the brittle-ductile transition (Will & Wilson 1989). It is questionable which factors influence the striae orientation on the fault plane. Absolute majority of the interpretation methods presume that the striae direction is identical with the direction of maximum shear stress on this fault plane (e.g. Bott 1959, Angelier 1984, among others). According to the conclusions of M.S. Wilkerson & S.Marshak (1991), slip direction on a fault plane results not only from stress, but also from state (which factorizes into horizontal tectonic stress and overburden) and pore pressure. As the complete description of all the three factors in nature is difficult, the presented method stems from the original presumption of M.H.P. Bott (1959).

Methods analysing striated faults can be generally divided into dynamic and kinematic methods (Marrett & Allmendiger 1990). In both cases is the input information represented by a set of striated faults measured in a certain geological body or its part. The dynamic methods (Angelier et al. 1982, Angelier 1984 and many others) result in the determination of the parameters of paleostress tensor responsible for the movements studied. The kinematic methods should determine the finite deformation of the body due to a population of faults within a body or, in the case of a brittle shear zone, the resulting displacement along its wall. S.Wojtal (1989) proposed a method based on the combination of known displacements on the individual faults comprising a brittle shear zone. R.Marrett & R.W. Allmendinger (1990) described a technique of stress tensor determination from the P-axes and T-axes of individual faults. The mean values of P-and T-axes of the individual faults are close to the P-and T-axis of the brittle shear zone as a whole, thus determining its orientation and kinematics. T.T. Cladouhos & R.W. Allmendinger (1993) determine the finite deformation of a fractured body from tensor summation moments. The aim of the present paper is to determine the deformation of a brittle shear zone from the parameters of the paleostress tensor, which is in turn determined from the individual faults comprising the zone.

2 BASIC TERMS

The object of the analysis is a geological body or its part which is fractured by a number of individual faults with different orientations. It is supposed that the body behaves brittle when deformed, i.e. only movements along these faults occur. Rheological parameters of the fractured body do not depend on the material characteristics of the rock, but on fault distribution and on friction coefficients of the faults. The behaviour of elements bounded by these faults approximates a rigid body.

2.1 *Strain in brittle shear zone*

Speaking about the deformation of a fractured body, we may distinguish between incremental and finite deformation. Incremental deformation denotes movement along any individual fault disrupting the body. Finite deformation denotes such deformation of the body which results from the movements along all individual faults