Geophysical Research Abstracts, Vol. 9, 10465, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10465

Second rank fractures and 3D stress & strain local fields of fault with sides friction as ones development's stages evidence: theory, experiment and natural examples (on the basis of «fracture-crack» and «fracture – shear zone» models study).

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The renovate approach to describe tectonic fractures by tectonophysics and mechanic basis is offered. This approach is added to conventional fracture conception, in which fracture is body's destruction surface with finite length (apexes), width and finite 3D content surrounded one. There are arisen the 3D local heterogeneous stress fields in surrounded content, as a result of sides of fracture displacements, which stimulate the second rank fractures development.

The first principal objective is properties investigation of second rank fractures (destruction type, surface orientation, kinematics type). The second principal objective is correlate the properties with origin point of second rank fractures concerning to primary fracture.

The mathematics modeling of 3D local stress field around vertical shear in elastic medium (on analytical solving) is basis of suggested approach. The solving is superposition of two fields: 1. the 2D field of body's balance, destructed by fracture with sides friction in pressure or shear conditions, and 2. the stress field of uniaxial vertical constant or lithostatic pressure. The 2D problem was solved by B. V. Kostrov, and V. N. Fridman [1975], in analytical form by D.N. Osokina, and V. N. Fridman [1987]. This is conception «*fracture – crack*».

This solution account for fracture is described by «*crack*» model (external stress field and sides friction are sated). Two other fracture conceptions are examined also: «*frac-*

ture - shear zone» and «*fracture – dislocation*» [M. A. Chinnery, 1966]. The «fracture – crack» conception is more accurate in natural and model examples, than “fracture - dislocation” conception.

The methodic approach, released in IPE RAS, allows to quantitative study the local stresses and destruction’s areas around fracture – «crack»: the properties of local stress fields 2D and 3D structure; the principal stress axes directions variation in horizontal sections; the over- indexation effect of principal stress axes and appearance of different local stress fields; Coulomb stress fields τ; the brittle and viscous destruction’s areas around fracture; 2D and 3D stress fields around fracture apexes [Osokina, Tsvetkova, 1979; Osokina, Fridman, 1987; Osokina, 1988; Osokina, 2002, 2004, 2006; Osokina, Rebetsky, 2005; et al.].

The structure of local stress fields allows to prognosis the second rank structural paragenesis (gashes, faults, thrusts, strike-slip faults, and folds) on destruction’s areas (essentially around fracture apexes) in plane section for different depth.

The study of stress fields and destruction in model suggested the principal results of theoretical estimates [Stoyanov, 1977, Osokina, Tsvetkova, 1979, Shamina, 1981, Sobolev, Ponomarev, 2003, at. al.].

There are supposed, the set of theoretical solutions for different loading condition and body rheology allows interpreting the natural different scales fracture’s structures for wide range of tasks consist of the structural geometry restorations (dimensions, second rank fractures distribution); the partitioning of fracture development studies; the definition of external stress field, body rheology.

The proposed approach and known direction of study and results of second rank fractures around large fracture (fault) are examines bellow. There are situations of incomplete description or ambiguous interpretation of fractures structures. There are majority of naturally studies descript second rank fractures only for different parts of larger fault structure. It produce the difficulties for interpretations of fault structures.

Therefore, except the local stress field study and second rank fracture prognosis, the importance objectives to compare theoretical solutions with natural examples and to clear up their genesis, age and classification.

The geological faults of different scales (different strained limbs of thrust-folds in Talass Alatau structures, oblique symmetry elevations and depressions around apex of Amur-Lyaodun Fault) are descript on the basis of proposed approach, responded to estimates for «fracture-crack».

The natural second rank structures of ductile and brittle shear zone (before fracture for-

mation) are explained on the basis of mechanics (Cloos, Riedel, Gzovsky, Tchalenko, Stoyanov, Sherman, Bornyakov at. al.). There are en-echelon oblique gashes and fractures in shear zones, which orientations consist of field like to pure shear field [Gzovsky, 1975, Stoyanov, 1977, Seminsky, 2003]. This is the initial stress field and there fractures consist for initial stage of fracture development. The natural structure of second rank around faults does not studied as yet, explaining one on the mechanics basis is ambiguous [Hancock, 1985; Seminsky, 2003 et al.]. Around faults, concerned with shear zone, the second rank fractures like to ones in shear zones, as the new local fracture field arise (generate the fractures with new properties) around after fault formation in shear zone. The initial fractures shall has a parts of fault's branch. Some investigators interpret this fractures as second rank fractures, arisen on shear zone after displacement of fault sides [Hancock, 1985] (also as Peck, Smirnov), or consist for displacement of fault sides, but without concerned with shear zone [Nicolas, 1992]. These conceptions are represented by scheme with combined initial fractures and recent fault. As the result, the second rank fractures geometry is right descriptive, but the genesis is wrong explained and recent fractures are not shown.

The recent local fields and fractures after fault formation are rarely investigated in the most of modern studies of second rank fractures around faults, exception with the rare analysis of theoretical conception of second rank fractures in fault zone and modeling this structures concerning with local field of principal fault is presented in work of Stoyanov [1977].

In presented work investigated the local stress field structure (recent stage) around fractures-cracks. The main properties of field structures: the principal stress (σ_1^1 and σ_2^1) 2D fields partitioning on two pair sectors – «tension» (pressure weakening) and «compression» (pressure reinforcement); turning and partitioning the principal stress axes on the two streams close to fault; the differ local stress fields in opposite fault sides; the principal stress axes over-indexation in 3D field and appearance of areas with different local stress field type (thrusting, shearing, faulting) around fault. The prognosis of second rank fractures (recent fractures) is made on the basis of defining local stress field of fault. There are two groups of fractures, proposed in: a. in areas of destruction near apexes, than stresses are higher than strengths of medium; b. in small apexes zone the stresses are highest.

The feature of this fractures groups and its changing along fault is examined here. The general features of these two groups is the change the orientation and kinematics of displacement on the opposite sides of fault, while first stage second rank fractures crossed the fault without changes. The orientation of fractures in destruction areas is changes from fault apex to centre, following to σ_1^1 – stress axis orientation, for sinistral movement the angles decline in right-hand apex and arise in left-hand apex.

The local stress field remained as shearing and the all second rank fractures in destruction areas are strike-slip faults, for the fractures, arisen in shear zones or massive with initial pure shear field. The local stress field consists of areas with different types, for the fractures, arisen in massive with compressing condition, therefore the different type fractures pairs arise in the opposite fault sides. Thus, on the uniaxial pressure this is pair is strike-slip faults and thrusts, on the biaxial – thrusts (transversely and sub-parallel to principal fault), in other case of loading there are other different pair – fault and strike-slip faults et al.

This study was founded by grant RFBR 06-05-64410.

The literature

Chinnery M.A. (1966) Secondary faulting. I. Theoretical aspect // Canad. Journ. Eath. Sci.,V.3, N 2, P. 163-174.

Gzovskij M.V. (1975) Principles of tectonophisics. Moscow, Nauka, 536 p. [in Russ.]

Hancock P.L. (1985) Brittle microtectonics: principles and practice // J. of Struct. Geol., V. 7. N 3 / 4, P. 437-457.

Kostrov, B.V., Fridman V.N., (1975) Mechanics of brittle destruction under press loadings // Physics of earthquake focus. Moscow, Nauka, pp. 30-45 [in Russ.]

Nicolas A.(1992) Principles of rock deformation. Moscow, Mir. 167 p. [in Russ.]

Osokina D.N. (1988) Hierarchical properties of a stress field and its relation to fault displacements // J. Geodyn. V. 10. P. 331-344.

Osokina D.N. (2000) Research of mechanisms of deformation of a massif in a zone of fracture on the basis of studying a three-dimensional stress field (mathematical modelling) // M.V.Gzovsky and tectonophysics development. Moscow: Nauka. pp.220-245. [in Russ.]

Osokina D.N. (2004) Shear Colomb's stress and areas of various destructive behaviour of massif in vicinities of fracture // Sketches of geophysical researches. Moscow, United Institute of physics of the Earth of Russian Academy of Science, Ñ.351-359. [in Russ.]

Osokina D.N. (2006) Studying of areas of destruction in a zone of influence of fault and the relations of their geometry with parameters of strength of geomassif and a regional stress field on the basis of Colomb's stress calculation. Mathematical modelling // Areas of active tectogenesis in modern and ancient history of the Earth. Materials of 39 Tectonic meetings. Ò. 1. Moscow, GEOS, pp.100-103. [in Russ.]

Osokina D.N., Fridman V.N. (1987) Research of laws of a structure of a stress field in vicinities of a shear fracture with friction between blocks // Stress fields and deformation fields in an Earth's crust. Ìoscow, Nauka, pp.74-119. [in Russ.]

Osokina D.N. and Rebetsky Yu.L (2005) The high stress action and geo-massif fracturing in a zone of the fault influence based on the calculation of the Coulomb stress fields // Regularities of the structure and evolution of the geospheres. Proceedings of YII International Interdisciplinary Scientific Symposium and International Geoscience programme (IGCP-476). Vladivostok: P.33-37.

Osokina D.N., Tsvetkova N.J. (1979) Study of local stress state and the prediction of second rank breaking in vicinity of tectonic faults and in earthquakes' focuses with the third principal stress axis accounting // Stress fields and deformation fields in lithosphere. Moscow, Nauka, pp. 163-184. [in Russ.]

Seminskij K.Z. (2003) Internal structure of continental fractural zones. Tectonophisical aspect. Novosibirsk: Sibir Publishing house of the Siberian Branch of the Russian Academy of Science, branch "Geo", 244 p. [in Russ.]

Stoyanov S. (1977) Mechanism of formation of shear zones. Moscow. Nedra, 144 p. [in Russ.]