On the influence of deformation mechanisms of different scales on regularities of response of shear fault zones under nonequiaxal compression loading

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Institute of Strength Physics and Materials Sciences, SB RAS, Tomsk, Russia
astaf@ispms.tsc.ru

Introduction. It is well known that stress state of geological media is nonuniform and complex and one of its main features are constrained conditions. Degree of constraint, determined through a value of applied stresses, greatly influences on deformation mechanisms and fracture regime of the medium. Significant parts of massifs, are in complex conditions, which could be characterized by the scheme "shear+compression". So, deformation of shearing fault zones takes place under nonequiaxial compression conditions. In this current study is the influence of relationship of normal and lateral pressures on the character of deformation and fracture of the geological medium under shear loading. An important feature of the structure of geological media is a multiscale hierarchical organization of the block structure. The structural blocks separated by a "surface relaxations", characterized by lower effective strength in comparison with the material blocks itself. This helps to alleviate the slipping along interblock interfaces and thus leads to occurrence of large number of additional degrees of freedom (mobility) fragments of the medium. Therefore it is important to analyze the role of the block structure of the medium, in particular, the processes of formation of discontinuities and cracks growth at the interfaces of structural elements. This paper is devoted to the theoretical investigation of the effect of this factor on the deformation parameters, shear strength and other characteristics of the response of block-structured medium under constrained shear loading conditions. The study was carried out on the base of computer-aided simulation by movable cellular automaton method.

In this paper, regularities of response of block-structured media under shear deformation were studied on the example of system with blocks of the same size, separated by interfaces. Analogue interblock interfaces constituted zones with reduced strength and deformation characteristics. It promotes the localization and accumulation of irreversible strains on them. Note that in the case of a real geological medium these features are determined by highest content in the interface zones (in comparison with the blocks) of damages, porosity, etc. This model of block-structured medium was realized in the framework of two-dimensional version of the movable cellular automaton method. For the mathematical description of the elastic-plastic response of the blocks and the interfaces applied the model described in, in approximation, a similar to plain-stress state approximation. For automata that simulate the blocks linear response function was used. Response functions of automata that simulate the interfaces were characterized by a long section, corresponding to the accumulation of irreversible deformation. Initial stress state of the sample set by nonequiaxial compression by forces. Constrained specimen was subjected to a shear deformation with a small constant velocity. Degree of nonequiaxiality of compression of the specimen was characterized by the dimensionless parameter, which is defined as the ratio of the relative values of compresses in the horizontal direction force to a specific value of the vertical compressive force. This parameter characterizes the relative magnitude of compression of the system in the direction of shear.

The results of the theoretical investigation of the general regularities of behavior of block-structured, including geology, media in conditions of shear deformation have shown that an important factor in determining the relative contribution of different deformation mechanisms in the integrated mechanical response of the block system is the degree of nonequiaxiality of compression of the specimen. Thus, the increase in compressive stress in the direction of application of shear loading leads to reducing of contribution of deformation mechanisms of low scale levels, leading to the accumulation of irreversible deformation in the interblock interface areas. The reason for this is increasing of the degree of degradation of medium in the initial stress-strain state,

which leads to rapid formation of discontinuities in the most weak interfaces in the process of shear deformation. At high degrees of constraint formation of these "mesoscopic" flaws and their association into interblock cracks become the dominant deformation mechanism in the block-structured medium. Changing of the dominant mechanism of deformation is manifested as a change of the trend and in some cases of the sign of the integral characteristics of the deformation response of the medium, such as shear strength, the ultimate value of shear strain and changing of the width of shearing zone. In general, results suggest the possibility of introducing of some dimensionless parameter characterizing regime of the mechanical response of the medium during shear deformation. This parameter should be a function which links the applied stresses and rheological characteristics of the medium (in particular, the elastic limit of the material of interblock interfaces).

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Recent stress deformation in disjunctive zones on the base of remote sensing data

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Scientific Centre for Aerospace Research of the Earth, IGS,
National Academy of Sciences of Ukraine, Kiev, Ukraine
azimov@casre.kiev.ua

It is identified that by their formation mechanisms the known and forecasted fracture dislocations at a recent stage of their geotectonic development manifest themselves mainly as the zones of stretching. The disjunctive structures of this type are always well decoded on different-scale remote sensing data (RSD) of any region of study. Their geoindicators are characteristic of zones of increased fluid-geological permeability.

Let's consider a territory of the Chernobyl Exclusion Zone and an adjacent region of the Korosten pluton. For its landscape-geological conditions the geoindication constituents of fractures are represented usually by the negative relief forms, super-humid sites with developed species of hygrophilous vegetation, elongated lines of anomalous phototone change to darker hues, etc. At once for mentioned region as an example (specifically for the Tovstyi Lis site within its borders) we classified the basic landscape geoindicators of the discriminating geodynamic fields at the recent tectogenesis stage. The fields are related to the Earth's crust disjunctive structures. Peculiarities of the fields' reflection in the RSD are characterised too [Azimov, 2008; 2009].

During investigation first of all it was taking as a base the framework of a tectonic structure of the studied area (Fig. 1, 2) chosen in the course of the regional research stage [Azimov, 2001; 2002; 2003]. It was worked out in detail within the Tovstyi Lis site and its adjacent areas [Azimov, 2004; 2006; Geological …, 2006]. For example, determination of the rectilinear known and forecasted structural elements of disjunction character (or structural lines, lineaments) on the remote images of high space resolution and topographic materials was performed with using a set of criteria (geoindicators): boundaries of sites with a different degree of the relief dissection and dynamics of erosion processes; rectified boundary segments of hypsometric benches, gradient steps of the relief, river valleys, banks of small lakes and swamps, erosion network, troughs, grooves, gullies, water divides, bent water courses and valleys, linearly elongated chains of suffusion depressions, mikrodepressions, erosion-denudation bodies, sandy ranges, as well as boundaries of the Quaternary deposit complexes and their lithofacies, sections with specific facies of hygrophilous vegetation, elongated lines of anomalous variations of image phototone, etc.

A location scheme for the lineament structures obtained by decoding show high lineaments density, for this reason direct identification of the fracture dislocations is difficult. For finding regularities of the lineaments distribution, their typification was done according to their manifestation indicators at remote images or the site, their relation with geological objects and inter-correlation between each other, elongation, width, etc. Usually zones of decoded lineaments appear to be wider than zones of fractures revealed by geological-geophysical methods. The latter ones are located in the middle of linea-