The nature and prediction of regional zoning for dynamic phenomena in mines of the Donets Coal Basin

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The Donets Coal Basin is the basic fuel and energy region of Ukraine. Promotion of safety measures (accident prevention) in mining is the main industrial and functional problem of coal-mining companies that requires the very careful attention and scientific learning. In coal mines of the Donets Coal Basin as, it must be said, in other coal regions, where coal is being mined underground, at all times there is a real hazard of dynamic phenomena in mine entries. First of all a hazard is due to gas-dynamic phenomena — sudden outbursts [Antsiferov et al., 2009]. Generally, sudden outbursts occur after a number of preliminary stages defined by many factors. Together with man-induced impact on rock mass being mined, geological factor is also involved. One of the main characteristics which define the role of geological factor in occurrence of dynamic phenomena in mine entries is tectonic stresses. At its core the natural component of the mechanism of dynamic phenomena in mine entries, in many respects, is similar to earthquake-generating mechanism. The type of dynamic phenomenon is determined by properties of rock mass itself. Neo-tectonic activity within the limits of one or another territory plays the determining role in maintenance of significant level of present tectonic stresses. Accordingly one of the urgent problems in research into geological causes for occurrence of geodynamic phenomena in mine entries is prediction of geodynamically active zones. Strictly speaking, idea to investigate zoning of dynamic phenomena within the limits of the Donets Coal Basin attracting information on neo-tectonic activity is not new (G. A. Konkov, V. S. Vereda, V. A. Privalov et al.). The authors of this work also hold the opinion on confinedness of dynamic phenomena in mine entries to dynamically active zones of tectonosphere.

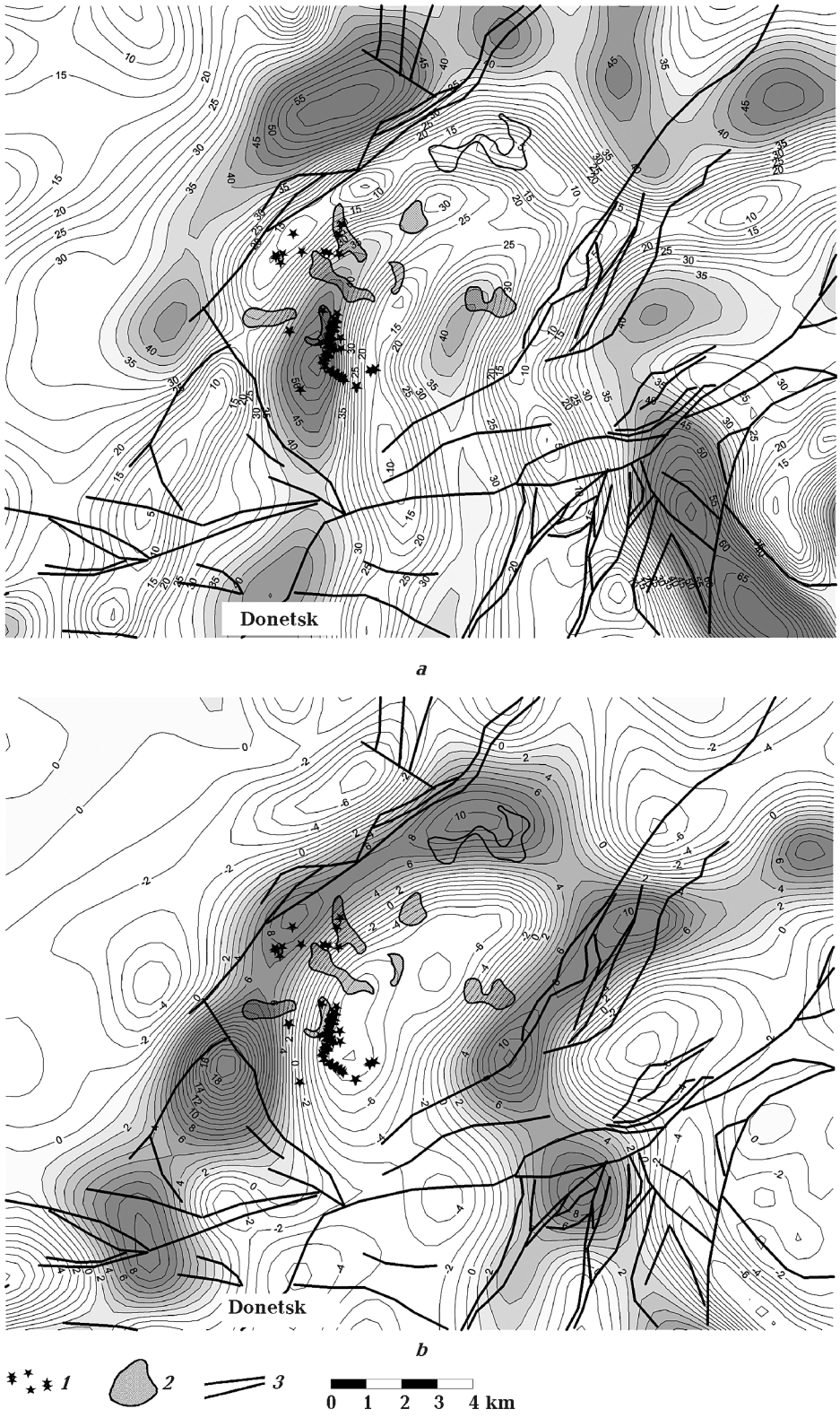
The objective of this work is to consider the main methodical provisions for identification and some outcomes of prediction of regional zoning of dynamic phenomena in mines of the Donets Coal Basin.

The basis for the suggested approach is the equilibrium-state model of the rotated Earth proposed by K. F. Tyapkin and called *geoisostasy* which is the subject of considerable literature [Tyapkin, 1980]. At present based on the analysis of geoid anomalies [Dovbnich, 2008] algorithms are elaborated for computation of tectonosphere stress fields caused by disturbance of equilibrium state. In previously published works [Dovbnich, Demianets, 2009] it was shown that geodynamically active zones of tectonosphere manifest themselves in stress anomalies due to disturbance of equilibrium state. First and foremost, such zones, on the assumption that stresses acting in them are sufficient, manifest them as seismically active. Elements which are tectonic base for seismic generating structures are embodied in stresses under consideration.

The working hypothesis in predicting regional zones for development of dynamic phenomena in mine entries can be the following statement: regional zones for development of dynamic phenomena are defined by degree of deformation processes that develop in sedimentation mass, which in their turn are embodied in stress field local component caused by disturbance of equilibrium state.

In conditions of the Donets Coal Basin assessment of subsurface stressed state caused by disturbance of equilibrium state was made on the basis of land gravity measurement data of the scale 1: 200,000 and relief digital model.

Based on the computed stresses we generated prediction layout of regional zones for development of dynamic phenomena for greater territory of the Donets Coal basin. A detailed comparison of computed stress fields with gas-dynamic phenomena occurred during mining of seams m_3, l_4, l_1 and k_8 (A. F. Zasyadko Mine) was made (Figure). At the first stage comparison of gas-dynamic phenomena occurred during mining of seams m_3, l_4, l_1 and k_8 with local stresses computed by land gravity measurement data was made. The most of phenomena are confined to the



Comparison layout of gas-dynamic phenomena (A. F. Zasyadko Mine) and local geoisostatic stresses (kPa): *a* — shear stresses, *b* — compression-tensile stresses (*1* — gas-dynamic phenomena, *2* — predicted zones of methane accumulation, *3* — tectonic faults).

anomaly of intense shear stresses. Most zones of methane accumulation predicted by a set of independent techniques are also connected with this anomaly. At the second stage for more detailed analysis of deformation processes in sedimentation mass within the limits of mine field analysis of attitude of coal seam m_3 was made. As an outcome we received a layout of local folding that complicates close monoclinal bedding of this seam and represents difference of the seam surface and its approximating surface which is polynomial of third order. Comparing a layout of local folds with dynamic phenomena and predicted zones of methane accumulation we can insist that majority of them is confined to gradient zone of local folds. The nature of this zone is closely connected with the processes that are embodied in anomalies of intensity of local shear stresses. Regularities determined within the limits of A. F. Zasyadko Mine field confirm assumptions on connection of certain components of stress field caused by disturbance of equilibrium state with deformation processes developed in sedimentation mass and zones of development of dynamic processes embodied in it.

The authors are convinced that in investigation of dynamic phenomena in geologic environment, independently of their scale — earthquakes, rock bursts, gas-dynamic phenomena and others — the most important element is study of all whole factors, starting from planetary and ending by local ones, which result in disturbance of equilibrium state of the planet and cause occurrence of mechanical stresses in the outer shells of the Earth.

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Computer-aided investigation of fault zone deformation response to low-amplitude dynamic mechanical actions

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An important direction in mechanics is investigation of features of mechanical response of geological media. An important feature of geomedium is that its fragments are in complex stressed state. Relation of internal stresses to strength characteristics of interfacial regions (faults and cracks) appreciably defines deformation and relaxation capacity of the mechanism concerned with relative block displacement. As the shear stress at an active block boundary reaches limiting (threshold) value, its local deformation mode can change qualitatively from slow deformation (creeping) to dynamic deformation (referred to as unsTable sliding). Note that according to modern notion, acts of dynamic block sliding are seismogenerating events those magnitude can reach 6—7. Thus, an urgent task in geomechanics is to develop methods of estimating the local stress state at active interfaces of fragments of rock massifs or the earth's crust. Theoretical studies as well as experiments on prestressed rock samples and fragments of plane discontinuities in rock massifs revealed an important effect consisting in deformation response of geomedium to dynamic perturbations of stress state in form of irreversible relative displacement of blocks. This allowed different authors to formulate the idea