

Fig. 1. Geographic distribution of volcanoes [25].  
 Fig. 2. Changes in the concentrations of the gases in the atmosphere and the temperature over the years, calculated on the basis of thermodynamic modelling.  
 a, b – the surface layer of the atmosphere; c, d – the lower troposphere.

**GEOSTRUCTURAL WAY OF COMBUSTIBLE GAS MIGRATION INTO DONBASS COAL MINES**

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**Abstract.** Theoretical and practical prerequisites for connection of migration zones and combustible gas accumulation in coal-rock mass with the features of crystalline basement geology and subsurface stress state are considered.

Patterns, criteria, and principles of formation of a minefield with abnormal gas content caused by the influx of hydrocarbon gases from deep –laid deposits have been identified. Considering this, early forecast of the presence of areas with abnormal accumulation of hydrocarbon gas becomes possible.

**Keywords:** Geological structures, gas anomaly prediction, mine gas explosions, mine safety.

Coal mining industry of any country is a critical component of the fuel and energy complex; it provides the raw materials to power sector, metallurgy, chemical sector, and other industrial sectors. Coal mining industry, having been victim of the severe situation related to reconstruction, sees a steady increase of the volumes of coal mining after long—term period of

production output fall, and thus it is becoming one of the key branches of economy.

But, to do the extended mining works on the depth they are currently performed at including severe subsurface conditions, several significant problems related to production and science are to be reviewed. Among most critical ways to solve the problems in

question are enhancement of works performance safety level.

Mining safety problem and forecasting of coalmine methane accumulation areas are closely related to the abnormal emissions of flammable gases into mine workings that is often a cause of explosions of air and methane mix.

The gas dynamic activity of coal beds and sandstones prone to outbursts is related, in numerous scientists' opinion, to sections of formation with high gas content. Based on it, and following an actual data about recorded gas dynamic phenomena and sudden emissions of hydrocarbon gases, the pattern of their distribution over fields of the most dangerous mines of Donbass region can be developed.

As experience of development coal beds show, with increasing of mine works depth, their gas content is rather uneven within mine field and is often not matched with natural methane content, which's values have been detected during geological survey. No doubt that the gas content of production sections does almost all the times not match with data of calculations performed on the basis of natural methane content and depends on geological or man-made factors [1].

Characteristics of spatial distribution of tectonic disturbances are more complex than litostatic ones. It can be stated that litostatic stress is normal, and tectonic stress - abnormal. Distinguishing between tectonic stresses occurred due to planetary factor and stresses induced by secondary deformation processes in geological environment as motions of tectonic blocks, for example, is important. Moreover, stress fields may be changed in course of time and, therefore, there can be identified current stresses and paleostresses that occurred in geological past and have partially or fully relaxed by this time.

Over 50 years ago, a reference of sudden outbursts of coal and gas to regions of contrast tectonic movements has been made and relation of areas of their occurrence to the newest tectonic movements and abnormal stresses has been justified. For example, G.A. Konkov noted that presence of rather intensive tectonic stresses, conditions appear both for sudden outburst sources and for slow generation of free methane.

Application of developed- to -date calculation algorithms for stress fields caused by equilibrium state violation [2] based on geoid anomalies research [3] enables observation of spatial relation of dynamic phenomena in minings with active geodynamic zones of tectonosphere.

Paper [4] states that active geodynamic zones of tectonosphere do appear in stress anomalies caused by equilibrium state violation. Such areas, should stresses acting therein be sufficiently great, demonstrate themselves as seismically active first [5].

In conditions of Donetsk basin, calculations for assessment of geological environment stress state caused by equilibrium state violation has been performed on the basis of data of land gravimeter coverage survey scaled 1:200000 and digital model of terrain. Most of the region's territory, based on original methodology, geoid anomalies have been restored across the grid 4×4 km on land gravimeter coverage data- gravity force anomalies per Faye reduction (Fig. 1).

Geoid abnormalities obtained have become a basis for surveyed terrain stress fields calculations. Several sections to consider have been similarly surveyed within the grid 1×1 km .

Relation of increased gas emissions into mine workings with geostructural anomalies of coal and rock formation can be reviewed for A.F.Zasyadko Coal Mine, Shcheglovskaia-Glubokaia Mine.

#### *A.F.Zasyadko Coal Mine*

These major players of the coal industry do apply their approved concept of continuous coal production volume increasing because of high technical performance with insufficient degree of solution of the problem consisting in safety of mining works at high methane content of deposits being developed. This approach does often lead to uncontrolled and thus hazardous balancing between what can be done and what is desired. This is a key issue for A.F.Zasyadko Coal Mine where works are performed at 1250-1400 m depth and, despite the high level of scientific researches being conducted, complete solution of the problems related to sudden outbursts and other emergencies related to flashes and explosions of mine gas is not successful still.

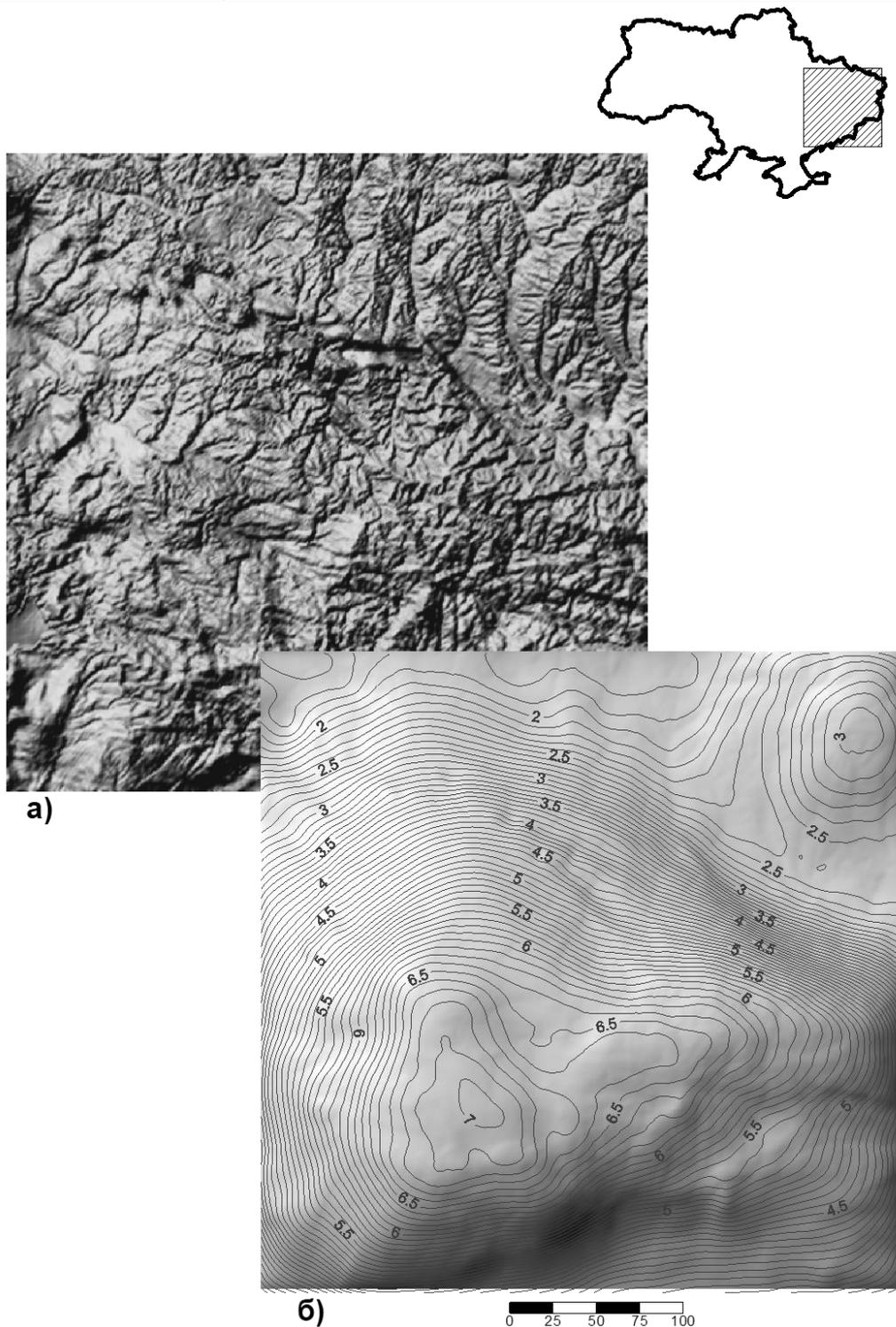


Fig. 1. Faye anomalies black-and-white pattern (a) and geoid anomalies recovery result (б), m.

Gas conditions at A.F.Zasyadko Coal Mine is characterized with considerable methane emissions into production workings where, except typical methane emissions from the depth 400-600 m at western wing of the mine where the low-amplitude disturbances ( $h = 0.3-2.5$  m) are present caused by Vetkovski No. 3 and No. 4 and Semenovski thrusts, blowers have become active as well. They become especially intensive and numerous starting from 700 m depth during heading of Western by-level and airway of  $l_1$  seam.

Sudden outbursts of coal and gas have become predominant among gas dynamic phenomena from the depth below 800 m. From 1990 to 2006, at mining of  $l_1$  seam at the depth 802-1120 m, 58 outbursts of gas and coal have been formally recorded provoked by shock blasting with yield from 4 to 120 t, and 8 sudden outbursts of coal and gas with yield from 8 to 75 t. Most of them have occurred in minings located near flexure bend of coal bearing formation.

The same severe gas dynamic situation was observed at A.F.Zasyadko Coal Mine by mining of  $m_3$  seam in flexure bend area where the synclinal fold axis

passed about 1.5 km eastward of Vetkovskaia flexure. As mine works go deeper, rate of accidents related to emission of gas from host rock and gas dynamic activity of  $m_3$  seam grew up.

#### ***Shcheglovskaja-Glubokaia Mine***

Field of Shcheglovskaja- Glubokaia Mine is located in hanging wall of Frantsuzki thrust and is limited with two large submeridional flexure folds: Vetkovskaia and Burozovskaia (Kalinovski).

Presence of abovementioned flexure folds makes an overall sublatitudinal strike of coal formation more complex. In western part of the area, exposure of Vetkovskaia flexure appears – strike of formations in this location goes from latitudinal one into NW forming a clear sinclinal bend.

Tectonically, the area considered is rather complex; here, the plicative forms of tectonics and disjunctive forms, especially thrusts, are developed. Main tectonic structures include the following thrusts: Frantsuzki, Pastuhovski, Shcheglovski, Sofievski, Ordzhonikidzevski, Grigorievski, Semenovski, Pologi, and Novo - Chaykinski.

Gas capacity of host rock and structural and tectonic complexity of the region are precondition for both intense and short time gas emissions even during geological survey. For example, during drilling of borehole MC-261 (09.01.77) an intense gas emission took place into exposure area of Bezymianny thrust with blowing of the mud fluid to the height up to 10 m. Gas flowrate for this case made from 218.4 to 494.4  $m^3/day$ . The gas emission was observed during 50 days. Considering that average daily flowrate and duration of gas emissions, about 20000  $m^3$  of gas were emitted from boreholes. It should be noted that during the whole period of boreholes drilling six intense gas emissions at depths from 550 to 1145 m were detected.

To consider is that during underground mining works, in the area of exposure of above thrust, from 1964 to 1994 more than forty gas dynamic phenomenon with difference intensity of gas emissions occurred.

Considering that dynamic phenomena in mines relate to sediment formations of Donetsk basin, it is obvious that their relation is to be found in local footprint of stress field caused by equilibrium state violation; it mainly reflects the deformation processes in sediment formations. Meanwhile, relation of local anomalies of stress field to gradient zones of regional anomalies -an evidence of their origin during evolution of fault block crystalline base (Fig.2).

Summarizing the gas dynamic conditions and gravimetric survey data it must be stated that the area covering the mine fields of Shcheglovskaja- Glubokaia Mine and of A.F.Zasyadko Coal Mine, both in fields of

shear stresses and in fields of example and in fields with tension and compression stresses does have a sophisticated structure of linear bound ones; predominant are north-eastern and north-western orientations of fields, including island-type alterations of maximums and minimums

Theoretical speculations regarding relation of dynamic phenomena, migration areas and accumulations of hydrocarbons in coal rock formation with specifics of the stressed condition of geological environment allow using of the stress fields conditioned by violation of equilibrium state as additional forecast criterion to solve problems of forecast the regional zones of dynamic phenomena development in minings. Current assumption for such definition may be the following statement: regional zones of dynamic phenomena development are determined by degree of deformation processes that, in their turn, are expressed in a local component of the stress field conditioned by violation of equilibrium state.

Patterns identified within fields of A.F.Zasyadko Coal Mine and Shcheglovskaja- Glubokaia Mine advocate for assumption of relation of certain stress field components with deformation processes running in sediment formations and creating conditions for occurrence of gas dynamic phenomena.

Studies performed resulted in identification of the following patterns of forming of the anomalies of gas emissions into mine workings of coal mines and distribution of gas dynamic activity zones that do obviously confirm relation of gas dynamic phenomena to seams bending zones:

- 1) local anomalies of stress field relate to with regional anomalies zones; this is an evidence of their origin during evolution of fault block crystalline base;
- 2) most of methane accumulation and gas dynamic phenomena are adjacent to intense shear stresses anomalies and gradient stress area; less areas are adjacent to thrusts exposure areas and relate to compressive stress anomalies;
- 3) forming of areas of methane transition into free state and appearing of ways of its migration do closely relate to increase of voids and permeability of formation exposed to mechanical stresses occurring in contrast tectonic movement areas;
- 4) under exposure to shear stresses, fissures get opened and reservoirs are formed; degassing of formation in this case will be much lower than it is at opening of fissures under exposure to tensile stresses;
- 5) most of dynamic phenomena and methane accumulation zones relate to local folds area; its nature is closely related to the process reflected in local tangent stresses intensity anomalies.

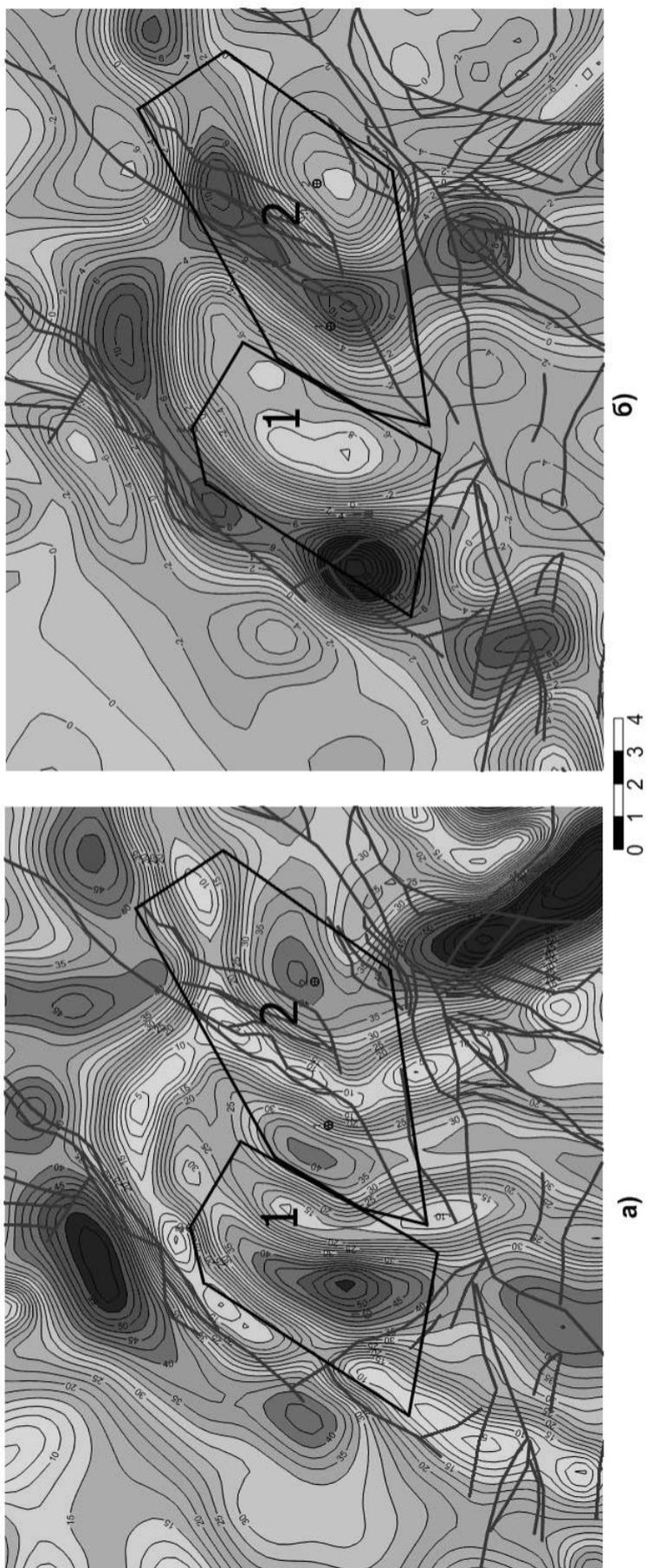


Fig. 2. Pattern of local stresses caused by violation of equilibrium state at fields of A.F.Zasyadko Coal Mine (1) and Shcheglovskaja-Glubokaia Mine fields (2) (coal mine fields are shown as completed objects)

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## РОЛЬ ДИАЛОГА СЕРЕБРОВА-ИКЕДА В ИЗУЧЕНИИ КОСМОСА В ПРОШЛОМ И НАСТОЯЩЕМ

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## THE ROLE OF THE SEREBROV-IKEDA DIALOGUE IN THE STUDY OF SPACE IN THE PAST AND PRESENT

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**Аннотация.** Рассматривается проблема понимания космоса человеком в исследовании диалога между двумя учёными: Александра Сереброва и Дайсааку Икедо. Через диалог строится их понимание космоса и становление современной модели его исследования. В качестве примера успешного исследования представлен метод ДЗЗ (дистанционного зондирования Земли).

**Abstract.** The problem of understanding the cosmos by man in the study of the dialogue between two scientists: Alexander Serebrov and Daisaaku Ikedo is considered. Through dialogue, their understanding of the cosmos and the formation of a modern model of its research are built. As an example of a successful study, the remote sensing method (Earth remote sensing) is presented.

**Ключевые слова:** Александр Серебров, Дайсааку Икедо, модель исследования, космос, ДЗЗ.

**Key words:** Alexander Serebrov, Daisaaku Ikedo, research model, space, remote sensing.

Можно начать с того, что после первого полёта в космос, совершённого космонавтом Юрием Гагариным, прошло уже более 55 лет. Сегодня перед человечеством открыты широкие возможности для исследования безграничного космоса.

В начале XXI века, когда человеческая цивилизация находится на точке поворота, такие вопросы становятся всё более актуальными, и их нельзя будет обходить.

Для того, чтобы разобраться в том, что можно сделать для поисков ответов на основные вопросы по определению космоса, философ Дайсаку Икеда провёл беседу с одним из космонавтов Александром Серебровым, который в течение 12 лет проходил испытания на орбитальной станции «Салют» и «Мир» (1982-1994), пробыв на орбите 373 суток. Он 10 раз выходил в открытый космос; его рекорд, по количеству выходов в космическое пространство, зафиксирован в книге рекордов Гиннеса в 1993 году.

Вообще, если взглянуть на диалог между Икедой и Серебровым, то возникает двойственное

ощущение, относительно того, как воспринимается космос. Диалоги разделены на 12 частей, в каждой из которых представлено своё видение космоса, качественно отличное от простого представления об исследованиях. Особенности каждой части отражены в восприятии Александром Серебровым разделения жизни на мир и космос.

В качестве подтверждения этому можно привести ответную форму диалога Икеды: «И звёзды, и планеты, и цветы, и люди – все состоят из одних и тех же элементов... Всё происходило и происходит из «осколков звёзд». Стало быть, универсум таит в себе биоэнергию – жизнь. А мы, люди, - это отдельные капельки огромного космического океана. Другими словами, мы нераздельны во Вселенной, а Вселенная включает в себя все свои крошечные капельки» [1, с. 38].

Из представленной диаграммы видно, что восприятие мира Александром Серебровым менялось, как по мере возраста, так и по мере постижения им профессионального дела, в качестве космонавта.