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Short Communication

# On Necessity of Geological Environment Model Complication for Monitoring its State and Forecast its Stability

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The most important result of geomechanical and geodynamic studies of the past century was the discovery of a close relationship between global geodynamic and local geomechanical processes caused by mining operations, especially in tectonically active zones. No less important result of the research was the conclusion about the fundamental role of the block-hierarchical structure of rocks and massifs for explaining the existence of a wide range of nonlinear geomechanical effects and the emergence of complex self-organizing geosystems. Hierarchical structure is typical for many systems, especially for the Earth's lithosphere, where more than 30 hierarchical levels from tectonic plates with a length of thousands of kilometers to individual mineral grains of millimeter size were identified by geophysical studies. Thus, the earth's crust is not a continuous medium, but a discrete block system and, like any synergetic discrete ensemble, has hierarchical and self-similarity properties [1,2].

The processes of development of oil and gas fields are associated with the motion of multiphase multicomponent media that are characterized by noneqiulibrium and non-linear rheological properties. The real behavior of reservoir systems is determined by the complexity of the rheology of moving fluids and the morphological structure of the porous medium, as well as by the variety of processes of interaction between the liquid and the porous medium [3]. Accounting for these factors is necessary for a meaningful description of filtration processes due to the nonlinearity, non-equilibrium and heterogeneity inherent in real systems. In this case, new synergetic effects are revealed (loss of stability with the appearance of oscillations, the formation of ordered structures). This allows us to propose new methods for monitoring and managing complex natural systems that are tuned to account for these phenomena. Thus, the reservoir system from which to extract oil is also a complex dynamic hierarchical system. When constructing a mathematical model of a real object, it is necessary to use, as a priori information, active and passive monitoring data obtained during the current operation of the facility. In [4,5], modeling algorithms were constructed in the electromagnetic case for 3-D heterogeneities, in the seismic case for 2-D heterogeneities for an arbitrary type of excitation source of an N-layer medium with a hierarchical elastic inclusion located in the J-th layer. A new 2D modeling algorithm for sound diffraction on elastic and porous saturated saturation of a hierarchical structure located in the J-layer of an N-layer elastic medium was developed in the paper [6].

In Hachay et al. [7] Modeling algorithms were constructed in the acoustic case for a 2-D heterogeneity for an arbitrary type of excitation source of an N-layer medium with a separate hierarchical anomalous density, strained and plastic inclusion located in the J-th layer. In the further paper, using the method described in [4-7], an algorithm for modeling the acoustic field (longitudinal acoustic wave) has been developed in the form of an iterative process for solving a direct problem for the case of three hierarchical inclusions of l, m, s-ranks using 2D integral and integro-differential equations. The degree of hierarchy of inclusions is determined by the values of their ranks, which can be different. Hierarchical inclusions are located in different layers above each other: the upper abnormally plastic, the second fluid saturated and the third anomalously dense.

When constructing a complex seismic gravity model without taking into account the anomalous influence of a stress-strain state inside a hierarchical inclusion, called the pillow of the deposit, an analysis of the anomalous acoustic effect using data on the propagation of a longitudinal wave shows that the influence of anomalous elastic parameters in the seismic model cannot be neglected, since they affect on the values of the unknown anomalous densities. If these values are used in constructing a density gravitational model without taking into account the effect of elastic parameters, these density values will not reflect the material composition of the analyzed medium. When constructing an anomalously strained geomechanical model without taking into

account the anomalous influence of density heterogeneities inside the hierarchical inclusion, which is the substrate for a two-phase deposit, the values of the unknown anomalous elastic parameters that cause the anomalous stress state in the pillow using data on propagation of the transverse wave will be determined incorrectly. These values of the elastic parameters will not reflect the real stress state of the analyzed medium located above the fluid containing deposit, which in turn is represented by a hierarchical multi-neighborhood environment. For the first time, the proposed iterative algorithm for modeling a hierarchically complex two-phase medium can be used to control the production of viscous oil in mine conditions and light oil in sub horizontal wells [8].

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