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Reflection of processes of two phase filtration in oil saturated hierarchic medium by data of active wave geophysical monitoring

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Abstract

It is provided a comparison of no equilibrium effects by independent hydro dynamical and electromagnetic induction influence on an oil layer and the medium, which it surrounds. Using the developed earlier 3-*d* method of induction electromagnetic frequency geometric monitoring we showed the opportunity of defining of physical and structural features of hierarchic oil layer structure and estimating of water saturating by crack inclusions. It had been constructed an algorithm for 2*D* modeling of sound diffraction on porous fluid saturated intrusion of hierarchic structure, located in the layer number *J* of *N*-layered elastic medium.

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Keywords: Hierarchic medium, elastic, porous, two phase, seismic field, algorithms of modeling, method of mapping and monitoring.

1. Introduction

The processes of oil deposits development are linked with the movement of many phase many components media, which are characterized by no equilibrium and nonlinear rheological features. The real behavior of layered systems is defined by the complexity of the rheology of moving fluids and morphology structure of the porous medium and also by the great variety of interaction between the fluid and the porous medium [1]. It is needed to take into account these features for informative describing the filtration processes due to nonlinearity, no equilibrium and

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heterogeneity, which belong to real systems. By that new synergetic events can be revealed (that are loss of stability with oscillation occurring, forming of ordered structures). That allows suggesting new methods of control and management of complicated natural systems that are tuned on the account of these phenomena. Thus the layered system, from which it is needed to work out the oil, is a complicated dynamical hierarchical system.

2. Development of a mathematical model with use the results of active and passive geophysical monitoring

By constructing of the mathematical model of the real object it s needed as the a priori information to use data of active and passive monitoring, that we can obtain during the object exploitation. The solution of inverse problems has a large significance for oil industry, because the oil layer refers to the number natural systems that cannot be observed by direct measurements as a whole. The results of last year's research showed that in the evolution of dynamical systems play the no stabilities, the origin of them the theory of self organization or synergetic studies. The information about their manifestation in the oil reservoir by its working out one can obtain only using the monitoring data, sensitive to its hierarchic structure. It should be noted, that for studying the thin structure of the discrete hierarchic media, more sensitive are geophysical fields, which depend from space and time or frequency parameters- that are electromagnetic and seismic fields. Additionally to that these fields, excited by local sources due to the geometry of the normal field, have a focusing property or localization property that allows distinguishing the given resolution.

In the Institute of geophysics a planshet method of electromagnetic induction research had been developed in the frequency-geometrical variant, that differs from the tomography methods and wide is used for mapping and monitoring high complicated no stationary geological media for surface and underground (mine) variants. Adaptation of that method to underground research in mining's holes for defining rock massif structures, state and their dynamics by man-made influence allowed providing volume geophysical research in geological medium [2,3]. A new complex volume method of electromagnetic induction and seismic (in dynamical variant) research allows constructing a volume geoelectrical and elastic model of rock massif structure. In mining conditions for deposits of different matter content with use of that method, zones of rock massif heterogeneities had been revealed. It had been received criterions, which allowed to provide the grading of these zones on zones of hidden fracture and contact(different modules) zones, that had been confirmed by geological and geomechanical data [4,5,6], it had been researched the staging of detection these zones by seismic and electromagnetic data.

The analyses of the results of electromagnetic induction monitoring in natural conditions allows formulating following conclusions: the rock massif structure of different matter content corresponds to the model of hierarchic structure of the discrete medium; we could using our system of observation to deduce two hierarchic levels. The disintegration zones, revealed by the data of electromagnetic monitoring in the surrounding hole space are located non symmetrical in the roof and sole and discrete: that is there are intervals of the whole absent the maximum change in the massif, that is under a man-made influence occurs directly in the morphology of the space location of these zones depending on time.

For considering the behavior of the two phase rock massif in a frame of the model of hierarchical medium of arbitrary rank we developed an algorithm for solution of direct 2-*D* problem for seismic field in the dynamical variant. At that the model of the local hierarchical heterogeneity of the *L*-th rank is presented as a porous fluid saturated inclusion. The hierarchical inclusions of other ranks are presented as elastic heterogeneities in a frame of the approximation, when the parameter Lame μ=0, either in the inclusions, or in the imbedded medium. For that case the seismic dynamical problem can be considered independently for the cases of distribution of longitudinal and transversal waves. Here we shall consider the first case for the suggested model. The obtained results can be used for choose of joining criterions of seismic research methods of high complicated media.

3. Algorithm of modeling for longitudinal wave propagation in the medium with hierarchic inclusions.

The idea that was suggested in the paper [7] for the solution of the direct problem for 2D case of longitudinal wave propagation through a local elastic heterogeneity with a hierarchical structure, located into the J-th layer of the