4D GEOMECHANICS IN INTEGRATION OF ENERGY EVOLUTION, RESERVOIRS AND OIL FORMATIONS AS PER A. EINSTEIN'S FORMULA

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ABSTRACT

The authors present the theory is numerical / analytical method of multi-scaled *4D* geo-mechanics – geo-dynamics of energy integration in geophysical rhythms of Eigen-solution of Navier-Stokes equations for multi-level geological time-space of evolution in structural compacted mass transfer at the basis of Newton's Differential Law $Q'=\rho dS\cdot\partial^2\xi/\partial t^2$ following the integration formula of A. Einstein - $\boldsymbol{E}(\boldsymbol{u},t)=\rho VC^2+ +\int^V\int^T\rho\langle uv\rangle dtdx$. They establish the geophysical seismic rhythms of geological cycles in deep structural formations of the Volga-Urals and Siberia and Kamchatka at dissipative emission, adsorption and nuclear magnetic resonance. The authors propose the systematic velocity model of convective diffusion drift of $\rho\langle uv\rangle$ in deep phase components of heterogenic structures with complexly structured geology in off-shore and global aeration of Middle Ridges from the Urals to the Rocky Mountains. They have also considered the energy time-space of more than 4.5 billion years to find the organic markers of quantum photo-synthesis and multiple circulating energy waves in physical and chemical reactions of compacted formation genesis in fissile and relict shales, including the facies with symmetrical absolutely-saturated porosity of classical fields.

Keywords: *evolution, phase knobs, conductivity, relaxation, basin*

INTRODUCTION

The present-day changing infrastructure of dynamic processes in the world economy, social and anthropological processes, ecology and global geological warming forces scientists to resolve the innovative fundamental problems. We need new conceptual and phenomenological, evolutionary/topological integrated energy models of genesis synthesis and development evolution of the substance from molecules of gas, fluids and phase knobs of reservoir formations in the geosphere, anthroposphere up impulse reflection and neurons. It is necessary to create structural models to evaluate geological risks in processes of commissioning and development of compacted shale and low-permeable reservoirs, extra-heavy oil with and natural bitumen, having reserves in energy resources several times higher than the traditional ones. To explore, drill and develop the reservoirs in formations with deep genesis it is required to have *4D* systematic parametrical geo-mechanical solutions in integrated models of fluid dynamics of the stress-deformed status of heterogeneous bodies 0. The similar fundamental tasks include the geo-informative modeling of geophysical synergy rhythms in deep genesis, as a “standard integration of *TOTAL and N+1”* substance.

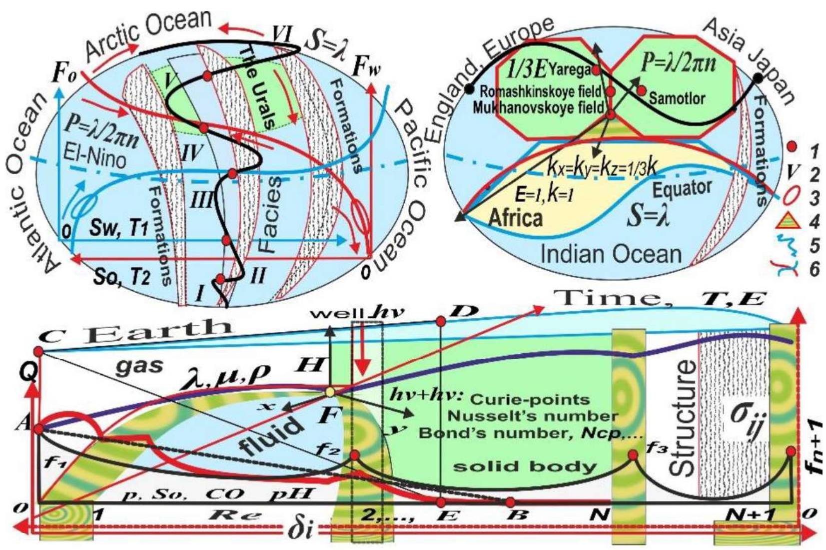

Fig. 1. Heterogenic Stress Stable Phase Diagram of Reservoir Integration Conductivity and evolution of Earth’s Geodite Geology

Let’s consider the heterogenic stable diagram of evolution-integrated processes of material synthesis and development in view of scales in its molecular-dynamic mobility and define phase permeability in deformed porosity and shale content for heterogenic structure of solid bodies in formations of dispersed condensation, e.g. at well bottom-hole, in well-to-well space and at the facies boundaries (Fig. 1), where 1 – phase knobs, 2 – geological cycles, 3 – nematic phase components, 4 – elements of facies, 5 – longitudinal wave S, 6 – phase permeability; CDE – filtration zones, AB – Darcy law, Q – rate (quality), Re – Reynolds number, CO – concentration of shale contents, phase carbonization and crystalline water, f_i – geophysical rhythms of contacts, F – additive contacts of geophysical synergy, p, So – pressure, phase saturation, (1,..,N) – nematic components of seismic emission, hv – integration energy constant, δ_i – sheared layer, fracturing.

APPLIED METHODS

At the basis of mass transfer solution integration in deformed porous media we have defines phase permeability on energy-conducting multi-level reservoirs, and conducted *4D* energy integration of space and time as per A. Einstein’s formula

$$\boldsymbol{E(u,t)} = \rho VC^2 + \int^V\!\!\int^T \rho\langle uv\rangle dtdx \qquad (1)$$

Here, correlation $\rho\langle uv\rangle$ of density ρ and pulsing $\langle uv\rangle$ horizontal and vertical velocities 0. The proposed method eliminates Heisenberg's uncertainty principle thus relating energy with time by $\Delta\boldsymbol{E}\Delta t \geq h$ correlation. We followed the structurally compact geo-dynamics of diffusive-porous kinetics in mass transfer according to Newton's Law ($Q'=\rho dS\partial^2\xi/\partial t^2$) and integrated global synergy of energy subduction in the ocean-off-shore and deep aeration driftage of the continents, Middle Oceanic Ridges of the Urals and the Rock Mountains. We have fixed the boundary harmonic conditions of geophysical rhythms in the synergy of deep structures of the Urals and Siberia (dissipative zones of Fresnel and Poisson spots, absorption of kinetic and potential energy, adsorption and nuclear-magnetic resonance) and have proposed the systematic *4D* petro-physics in the integration of multi-scaled repositions and mobility of evolution structural systems 0, including the oil and gas hydrocarbons. We have also obtained the integral correlation of diffusive-molecular dependence in velocities of phase components inside heterogenic stress-stable structures with mineral resource base and region zoning, Fig 2.

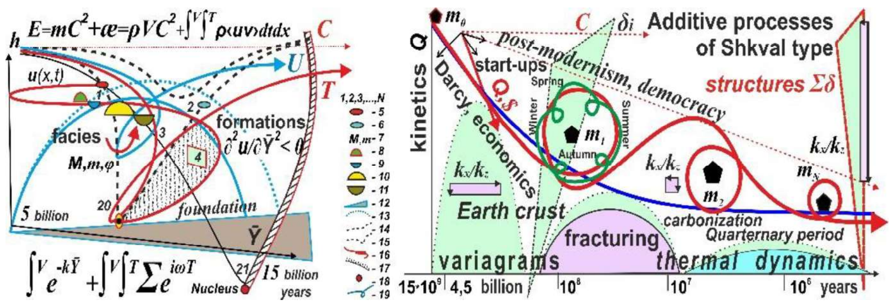

Fig. 2. Multi-scaled Integration Method for Eigen-solutions of Geological Evolution and Additive Procedures Through the use of A. Einstein's Formula

Legend for *1,..,N* – material status, 4 – structure element, *5* – ozone holes ω_0, *6* – Polar lights ω_k, *7* – impulse moments (mass), *8* – Zhiguly dislocation , *9* - facies, 10 – fields (formations), *11* – allochthones of Domanik, *12* - foundation, *13* - stratosphere. Here, *14* – curvature of space; *15* – nematic of phases (regmatic fracturing); *16* – velocity profile (deformation); *17* – the Ural Mountains; *18* – stress-stability regions, *19* - evolution, *20* – nucleus of the Earth, *21* – Poisson points (zones of Fresnel). The authors of the paper propose the method of evolutionary-topological energy physical-hydrodynamic petro-saturation of the profile and the use of multi-scaled многомасштабных self-similar integration solutions as per A. Einstein's. The created geo-dynamic models provide for the complex construction of geophysical, geological and field studies the similar *3D* grid of stratified pools that contain the information on reservoirs and lithological barriers, fluidal contacts, porosity, permeability, oil- and gas-saturation. To saturate the geological grid with filtration capacity properties they have used various methods of interpolation: stochastic and deterministic, evolutionary-analytical and topological, including stress-stability deformations of geological time-space micro-structure, Fig. 2.

ENERGY INTEGRATION OF CONVECTIVE DIFFUSION STRUCTURE

Let's consider the multi-level multi-potential flow of deformed structure with thickness *H*, porosity *m* with minimum velocity u^* and capillary imbibition of scale $l^*=\nu/u^*$, where, ν – kinetic viscosity. At the structure contacts permeable as per

Darcy and deformed relaxation time structure there appear the pulsing impulses and pressure. We use structurally compacted kinetics of seismic geo-dynamics for mass transfer of velocity shifts in deep off-shore area and combined compacted – de-compacted aeration of the Ural Mountain Ridge 0. Let's give the additional boundary conditions to geophysical rhythms of dissipative zones of Fresnel and Poisson points, like absorption structure and nuclear-magnetic relaxation. At the basis of the equations for the deformed porous space we will define the quality of multi-level reservoirs 0, 0.

The task to calculate kinematic and dynamic characteristics of the sheared layer that is affected by the pulsing pressure loads is made as follows 0. The system of these equations is resolved as the generalized Hooke's law (Newton)

$$\sigma_{ij,j}=\rho\partial^2\xi_i/\partial t^2;\ \sigma_{ij}=\mu(\xi_{i,j}+\xi_{j,i})+\lambda\delta_{ij}\xi_{i,i} \qquad (2)$$

Here, $\sigma_{ii}/3=p$ - pressure, ξ - shifts, $\lambda,\ \mu$ - Lame's parameters. Viscous-elastic relaxation $\mu(t)=\mu_o+\Sigma^n_{j=1}\mu_j e^{-t/\tau j}$ is described by a relaxation time spectrum τ_j for shear and elasticity modules:

$$\mu(\omega)=\mu_o+\Sigma^n_{j=1}\quad \mu_j(\omega\tau_j)^2/(1+(\omega\tau_j)^2)-i\Sigma^n_{j=1}\quad \mu_j\omega\tau_j/(1+(\omega\tau_j)^2),\quad \lambda(\omega)=\lambda_o-2/3(\mu(\omega)+\mu_o),\quad (3)$$

Fluid movement is describes by the equations on conservation of movement numbers by Navier-Stokes and continuity

$$\partial v_i/\partial t+v_j v_{i,j}-\langle v_j v_{i,j}\rangle+v_j U_{i,j}+U_j v_{i,j}=-1/\rho\partial p/\partial x_i+\nu\nabla^2 v_i;\ v_{i,i}=0;\quad vU'_2=u^{*2}+\langle v_1 v_2\rangle,\ (4)$$

Where, $\langle v_j v_{i,j}\rangle=1/4(v_{i,j}v_j^*+v_{i,j}^*v_j)$, *- complex combination, U_i, v_i – mean pulsing velocity. Additional boundary conditions:

$$\sigma^{q-1}|_{x2=hq}=\sigma^{q}|_{x2=hq},\ \xi^{q-1}|_{x2=hq}=\xi^{q}|_{x2=hq},\ q=1\text{-}N.$$

The first layer is stable $\xi|_{x2=0}=0$ or free $\sigma|_{x2=0}=0$, at $\eta=(R_0\text{-}x_2)/l^*=0$:

$$u=\partial\xi_1/\partial t-\xi_2U'_y,\ v=\partial\xi_2/\partial t-\xi_1U'_y,\ \partial u/\partial\eta+ikv=\sigma_{12}/\rho u_*^2,\ -p+\partial v/\partial\eta=\sigma_{22}/\rho u_*^2 \qquad (5)$$

The differential equations (4) have the solution in a form of progressive waves $F=s(x_2)exp[i(k_1x+k_3z-kCt)]$, where $s=\varphi,\psi$ – longitudinal and transversal waves, k – wave number, C – phase velocity. Neglecting the velocity quadratic pulsing we get

$$v_i(\eta)=a_ie^{-k\eta}+1/k\int G_i(t)\ sh\ ik(\eta-t)dt,\quad p(\eta)=b_oe^{-ik\eta}+1/ik\int G(t)\ sh\ ik(\eta-t)dt \qquad (6)$$

In this case the alternating dimensionless values are $G_1=\Theta_1+v_2U'+ik_1p$, $G_2=\Theta_2+p'$, $G_3=\Theta_3+ik_1p$, $\Theta_i=-ikcv_i$, $G=-ik_1U'v_2$, $U'=1+\langle v_1v_2\rangle$, a_i,b_o – are constants. So, we get integral solutions for correlation $\rho\langle uv\rangle$ distributed parameters of multi-potential mass transfer and of front Σ_R, where beside the linear part (as per Darcy) there are the integral components of combined permeability. Combining the mean inflow by Dupuis $U=Q/(2\pi RHmu^*)=ln(\eta/æ)+C_æ$ with convective-diffusive outflow (6) at the boundary of Σ_R, we get $æ=mu^*/RU'(R)$ and $C_æ=U(R)/u^*\text{-}ln(R/æ)$. Additive energy boundary Σ_R of zonal-film phase contact and front structure forms the complex combined phase-selective anisotropy of porous outflow permeability «*3d*-day and *3d*-night» with viscous-elastic conductivity for geophysical rhythms in compacted matrix.

INTRINSIC TIME-SPACE POLARIZATION FORMS

Equation (2), registered in a cylindrical system of coordinates, have the form of differential equations of Bessel's type 0. Solutions in the resulted system are registered in a form of longitudinal and transversal waves with complex wavenumber *k* for the equation of the fourth-order:

$$\varphi(z_\varphi)=a_1J_o(z_\varphi)+a_2Y_o(z_\varphi);\ \psi\ (z_\psi)=a_3\ J_1(z_\psi)+a_4Y_1(z_\psi) \qquad (7)$$

Where, $J_o(z_\varphi)$, $Y_o(z_\varphi)$ - *Bessel's functions,* $z_s=k_sr$, $s=\varphi,\psi$. *Satisfying the boundary conditions we get a system of equations of the fourth-order. This result in characteristic equation of intrinsic frequencies in sheared layer (convective-diffusional fracturing* δ_i*)* det $\{A\}=0$, *where* $\{A\}$ *– characteristic matrix. Fig. 3, a) presents calculated phase velocities* $c_\phi = c/c_o$ *and attenuation factors* Im(k) *of permeable membrane that depends upon the frequency* $\omega_\kappa=\omega h/c_o$, *where* $c_o=(\mu(3\lambda+2\mu)/(\lambda+\mu)\rho)^{1/2}$. *Practically starting from zero frequency there appear the bending wave that is definds by Young's modulus. When the frequency is increasing phase, velocity is aiming towards the transversal wave velocity. At intrinsic velocities there are sharp reductions in attenuation factors. At frequency* $\omega_\kappa \sim 1$ *amplitude becomes several times larger than the thickness of sheared layer thus forming powerful transversal outbreaks of seized-up densityu.Anisotropy factor becomes less than* 1, *thus increasing the deformation velocity, especially for heavy shale-fluid and shale formations in overlapping layers and outbreaks of displacing agents during the development process.*

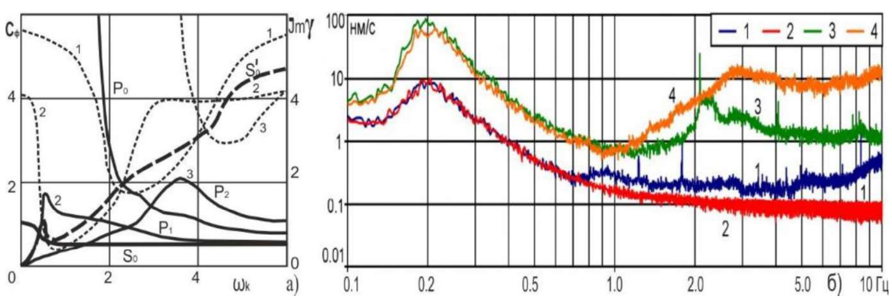

Fig.3. (a) Calculated amplitudes of phase velocities and attenuation factors, longitudinal S and transversal P waves in a layer of dissipative structure and (b) field seismic amplitude-frequency spectrum

With zero shear stresses the diffusion in dissipation equalized by velocity is $\Phi=\omega/4\int i\ \{[\lambda^*(\omega)-\lambda(\omega)]\varepsilon_{ii}\varepsilon_{ii}^*+[\mu^*(\omega)-\mu(\omega)]\varepsilon_{ij}\varepsilon_{ij}^*\}dx$, where ε_{ij} - deformation. The same time when the normal stresses are attenuated the tangential stresses are increasing and pressure gradients are re-birthing into tangential stresses. Symmetrical pressure is split into asymmetrical stresses, the radial velocity of the mean outflow – into molecular-diffusive pulsing impulses. Anisotropy factor of permeability becomes lesser that *1*. Sheared stresses that coincide in the direction with the mean velocity, i.e. if torque is coinciding with filtration flow direction, they increase the diffusion ‹*p*v› and impregnation velocity ‹uv›. Otherwise, they reduce them thus making the displacement front more selective, re-distributive, heterogenic phase by density and concentration.

Fig. 3, b) presents field amplitude-frequency spectrum obtained at seismic stations (1-4) located within the boundaries of Voronezh crystalline massif at the ancient East-European platform. Studies 0 show that within the frequency range from 0.1 to 0.3 Hz the micro-seismic noise is mainly formed by microseism of de-compacted migration channel that is out-coming from the Atlantic Ocean. The analysis of daily changes in micro-seismic noise within the frequency range from 1.0 to 8.0 Hz had shown that the correlation of time variations in micro-seismic noise in this frequency range is allocated to the fact that the formation of relatively high-frequency component is affected by the geological structure and anthropogenic load.

RESULTS

Applying the analytical methods of evolutionary integration of geophysical synergy additive rhythms with geological cycles as per the formula of A. Einstein, we have resolved the problem of global multi-scaled high amplitude geomodelling of regional natural mineral resources. Using the example of multi-scaled petro-physics of *4D* heterogenic stability in Terrigenous and Carbonate reservoirs of the Zhiguli dislocation in the Volga-Urals Oil Province 0 for facies element 4 (Fig.1-3), Jurassic fault ridges in Siberia gas pipe formations at Taymyr and Sakhalin, we are presenting the solution in *4D* geomechanics of velocity drift. We have obtained the geophysical field of compacted impulse mass transfer of southern and northern oceanic oscillations and El Nino oceanic stream (evolution as per O.Yu. Schmidt, type of Bessel or Kozyrev beams). The paper presents the multi-scaled dynamic solutions of heterogenic stable structures of geophysical cells in seismic zones of Fresnel and Poisson points. Here we consider the global process of deep-water ocean off-shore harmonic drifts in view of secondary aeration rhythms of Middle Oceanic Ridges of the Urals and the Rockies with harmonic boundary conditions of compacted time-space. Applying the physical and mathematic integration method of additive synergy of geophysical rhythms with seismic emission of phase components in carbonic reservoir systems in conditions of mass conservation, we get impulse moments and energy in view of gravitational stability constants.

We propose proven innovative evolutionary topological solutions in the development of reservoir qualities by complex tracing of geological evolution. We have used the structural dynamic method of phase conductivity, additive geology of Carbonate evolution covering the period of for more than 4.5 billion years. We have created stable algorithms of filtration fields in deep genesis porous concentration that is combines with filtration-diffusive matrix and molecular mobility of drift velocity. We have creates and tested the *4D* integral model of «*3d*-day and *3d*-night» geo-mechanics and fluid dynamics of the reservoirs 0, combines with conductivity of katagenesis various stages in maturity, mineral concentration and fracturing of the mountain destruction.

The task with the integration of geological cycle evolutions, deep genesis of time space in complicated systems with mineral material resource location is resolved. Aa a result of synergy in geophysical rhythms of integration (Fig. 4) with the numerous inverted seismic emission we have created the gravitational models of gas and oil dislocations in the area of global aeration of the Middle Oceanic Ridge in the Urals. Asymmetrical examples of stages in geological evolution like the shifting of the Earth's gravitational nucleus geodite by 500 *km* and the birth of the Moon are additive phenomena of geophysical synergy.

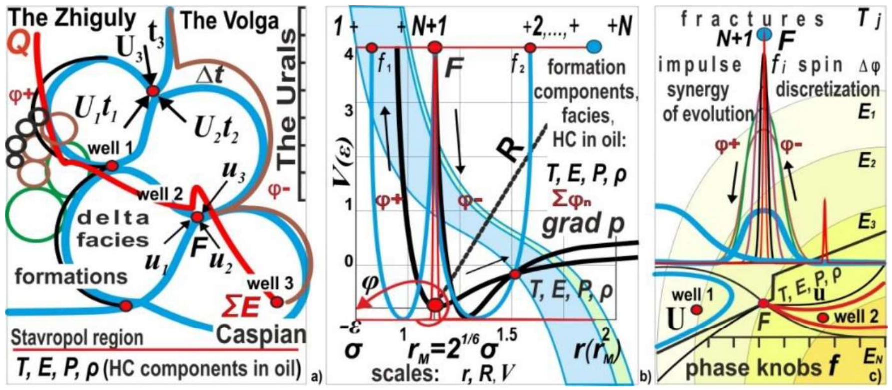

Fig. 4. Zoning of geo-energy fluid-dynamics impulses in evolution and development of heterogenic-phase facies systems of the Urals

CONCLUSION

We propose the convective-diffusional multi-scaled method of 4D geomechanics in mass-transfer as by Bessel's beam for the integration model of geophysical zones (by Fresnel and Poisson), geo-spheres as per A. Einstein's formula. There are the proofs verified by the long-time lab and field studies that are numerically tested by evolution-topological intrinsic solutions for geological structure of time space.

In zones with sheared dislocation there are the areas with emitted significant potential energy, with the transition of mechanical energy into thermal energy thus speeding up the processes of mass transfer. The emitted thermal energy of dynamic processes is in many times activating the processes of vertical and lateral migration, forming abnormally high formation pressures, the introduction of water-cut sectors and reservoir traps.

Dissipative sheared layers are correlated with convective diffusion of capillary jammed phases. Diffusive properties in sheared layers are defining the optimum-resonant character of velocities. In cases with the growth in critical wave number, there is reduction in diffusive and dissipative functions. Blocking the process of mass transfer by a sheared layer increases the residual saturation thus reducing phase displacement.

Dispersion analysis of intrinsic fluctuations in sheared layer of seismic emission and displacement front had shown that fixed phase jammed layers have no actual phase velocities and this goes to filtration suppression and attenuation in stagnant sectors.

We have obtained the solution on fluid dynamics for the structures with many-time inverted core dissolution and destruction. We propose the adaptive compacted packaged models of natural and man-made synthetic reservoirs. We have created an integrated conductivity model for various maturity structures of stages in katagenesis, many-time conversion of dissolution and destruction. We have obtained the energy integration of facies geophysical synergy in Buzuluk depression and the development of Zhiguli dislocation in the area of the Volga-Urals and the Caspian, as well as for the horsts of Jurassic and Taymyr in Siberia.

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