EFFICIENCY EVALUATION OF HANDLING OF GEOLOGIC-GEOPHYSICAL INFORMATION BY MEANS OF COMPUTER SYSTEMS

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Abstract. Development of oil and gas resources, considering difficult geological, geographical and economic conditions, requires considerable finance costs; therefore their careful reasons, application of the most perspective directions and modern technologies from the point of view of cost efficiency of planned activities are necessary. For ensuring high precision of regional and local forecasts and modeling of reservoirs of fields of hydrocarbonic raw materials, it is necessary to analyze huge arrays of the distributed information which is constantly changing spatial. The solution of this task requires application of modern remote methods of a research of the perspective oil-and-gas territories, complex use of materials remote, nondestructive the environment of geologic-geophysical and space methods of sounding of Earth and the most perfect technologies of their handling. In the article, the authors considered experience of handling of geologic-geophysical information by means of computer systems by the Russian and foreign companies. Conclusions that the multidimensional analysis of geologic-geophysical information space, effective planning and monitoring of exploration works requires broad use of geoinformation technologies as one of the most perspective directions in achievement of high profitability of an oil and gas industry are drawn.

1. Introduction

Now domestic oil-producing enterprises are rather well equipped with modern computers, workstations and telecommunication systems, but it has not led to revolutionary changes in information technologies for oil production yet. Informatization of oil-extracting production requires creation of information systems with functions of monitoring of oil extraction, the operational geological field analysis of systems of development of fields, mathematical modeling of oil storage tanks and the forecast of key parameters of development.

One of the integral aspects of quality management systems of industrial enterprises is the requirement of continuous positive development of all its processes. In this regard, it is necessary to realize the principle of "continuous enhancement" [2]. To become competitive in already saturated market of three-dimensional seismic exploration, the traditional geophysical companies began to invest heavily in upgrade of the computer centers. For this purpose, they attract the system integrators specializing in the field, establishing certain criteria of the prices, optimum efficiency and
performance of technical solutions taking into account all aspects of technology of handling of geophysical information.

One of such pilot system integrators working in the CIS is the ROY International Consultancy Inc company. Its main activity – project development and implementation of corporate computer systems, in particular for computer centers of an oil and gas industry. The ROY International company founded in 1988 is the leading system integrator specializing in development of big computer systems for corporate computer centers. ROY International – the supplier of the reliable and safe systems of an enterprise scale, largest in the CIS, based on UNIX. Over last years, ROY International developed and implemented in the different CIS countries of 300 projects of upgrade and reconstruction of the computer centers, having established more than 2000 high-productive workstations and the Sun servers, having adapted the main software (S) available in the world, having organized networks, etc.

The purpose of this work is efficiency analysis of handling of geologic-geophysical information by means of the latest computer systems (on the example of LLC TNG Group).

Object of a research is LLC TNG Group - the largest oilfield service entity of Russia. The company has all methods of geophysical investigation which are almost existing in world practice.

LLC TNG Group carries out geologic-geophysical works for investigation and operation of oil and gas deposits, renders a full range of geophysical services in oil and gas wells, including horizontal, control of development of fields, the most modern methods of linear and volume seismic exploration, electro-, gravi-, magnetic explorations, space decryption, drilling of operational wells (inclined and directed, horizontal), repair of wells of old fund (drilling of side and side horizontal trunks), including information and technological support, handling of geologic-geophysical information by means of the latest computer systems.

As a part of society, three main directorates headed by deputy directors general of LLC TNG Group function:

1) directorate of prospecting geophysics;
2) directorate of trade geophysics;
3) directorate on geology.

For carrying out seismic exploration, modern seismoprospecting telemetric complexes of the American and French productions are used: Input/Output System-4 (Vectorseis), Input/Output System-2, SN-428XL, SN-408XL, SN-408UL, SN-388 and domestic linear Progress-L systems. In case of works, both explosive and non-explosive sources of seismic fluctuations are used.

The directorate on geology, which enters in a field of activity, is engaged in handling and interpretation of geophysical and geological information, representation of the received results to the Customer and also the current control of respect for technologies of researches and interpretation at all stages. Availability of the powerful computer center equipped with a modern program and technical equipment allows solving objectives successfully:

- handling and interpretation of seismic data (2D, 2D/3C, 3D, 3D/3C);
- complex analysis of geologic-geophysical information;
- development of original techniques of interpretation;
- creation of geological, hydrodynamic fields;
- reinterpretation of materials GIS of an old well stock and forming of the Databank.

The chosen innovative way of development allowed the company to add to the arsenal the modern high-information geophysical equipment, unique developments, powerful electronic and computing tools in recent years. Availability of modern technologies, highly professional specialists, implementation of own scientific developments provide LLC TNG Group in the conditions of a fierce competition in the market of high rating of geophysical services and a successful cooperation with leading oil companies among which there are PJSC Tatneft, P JSC Gazprom, Lukoil, and others.

2. Materials and methods
The methodology of mathematical modeling in the second half of the 20th century was considerably enriched due to fast development of the region of scientific knowledge in which tools of a so-called
computing experiment are created. This research technology proved the efficiency in case of the solution of such tasks as development of an atomic and hydrogen bomb, creation of nuclear power engineering, space technologies, etc. Thanks to these achievements of the 20th century, the computer experiment firmly took roots today in many fields of science, the equipment, designing and designing. Sciences about Earth didn't become an exception. The computing experiment is successfully applied as to the solution of fundamental tasks on a structure and a geogenesis, and in scientific and applied sections where estimates of parameters of specific geological objects are of interest.

Development of oil and gas resources, considering difficult geological, geographical and economic conditions, requires considerable finance costs therefore their careful reasons, application of the most perspective directions and modern technologies from the point of view of cost efficiency of planned activities are necessary. For ensuring high precision of regional and local forecasts and modeling of reservoirs of fields of hydrocarbionic raw materials, it is necessary to analyze huge arrays of the distributed information, which is constantly changing spatially. The solution of this task requires application of modern remote methods of a research of the perspective oil-and-gas territories, complex use of materials remote, nondestructive for the environment of geologic-geophysical and space methods of sounding of Earth and the most perfect technologies of their handling.

The multidimensional analysis of geologic-geophysical information space, effective planning and monitoring of exploration works requires broad use of geoinformation technologies as one of the most perspective directions in achievement of high profitability of an oil and gas industry. Effective implementation of repeatedly increased potential modern, nondestructive the environment of remote methods of a research of oil-and-gas structures, is possible on condition of the maximum use of data of remote sensing of Earth. Search new and increase in informational content and reliability of the existing methods of analytical and nondestructive control of the environment, is determined by need of enhancement of methods of handling of materials of aerial photography and space shooting.

In Russia interpretation of geographic information systems (GIS) is made generally with use of the determined methods, and resultant assessment is dot. Only for calculation of separate parameters in models statistical methods, various averaging methods and weighings are used. At the same time in the USA, Japan and other foreign countries, inventories of oil and gas are determined and affirm as a type of functions of distribution of probability. However, especially at early stages of development of fields of data for creation of functions of distribution of probabilities in each parameter happens insufficiently. Besides transactions with these functions in probability theory are very bulky, and for the solution of practical tasks the Monte Carlo method is most often used.

Error of various devices and sensors, the conducted researches, availability in a number of parameters of a possibility only of their indirect assessment is resulted in need of carrying out calculations in the presence, it is inaccurate for the set parameters and coefficients of the equations. Replacement of this inaccurate set of sizes by the determined (dot) sizes complicates considerably the procedure of calculation, results in need of their iterative matching for receipt of acceptable results. In this case, assessment of an error of the received result is also complicated. Very often the structure of parameters and coefficients of the equations includes at the same time sizes with various nature of uncertainty: interval, indistinct, stochastic, heuristic (on the basis of an expert evaluation). Therefore there is a need of submission of all information in a single, formal language of the theory of indistinct sets with submission of characteristics of the inexact set of sizes in the form of indistinct functions.

Creation of an automated system for the operational interpretation using a mathematical apparatus of the fuzzy logic integrated with the summary geophysical database and with a hardware complex will allow one to draw preliminary conclusions directly at the logging computing station that will promote reduction in cost of development and increase in accuracy of the analysis of geophysical information in case of its subsequent interpretation.

In 2015 implementation of the new scientific and technical program of the Union State of Russia and Belarus for development of new high-productive technologies of the investigation and use of hydrocarbons ("SCYTHIAN SUBSOIL") calculated for four years began. The main applied objectives solved within "SCYTHIAN SUBSOIL" are tasks of planning and quality control of seismic
observations, data processing of seismic exploration, creation of deep seismic images, seismic inversion, geological and hydrodynamic modeling and stock counting of fields of hydrocarbonic raw materials and other target minerals. Initially, the developed software solutions will use data of seismic researches, trade geophysical surveys of wells, results of laboratory researches of a core and fluids, hydrodynamic trade well surveys, interpretations of GIS and others. It is as a result supposed to reach cost reduction by 3–5% for development of oil and gas deposits due to optimization of laying of exploratory, operational wells and kickoff of side trunks, risk minimization of drilling of "empty" wells, assessment of hardly removable inventories and the choice of appropriate technology of their production. Besides, creation of hydrodynamic model is direct on a geological grid, and with preserving all structural features it will give the chance of carrying out joint operation of geologists and hydrodynamics engineers within one project on the integrated model.

3. Results and discussions

The characteristic of productive activity of LLC TNG Group showed that availability of modern technologies, high professionalism of specialists, implementation of own scientific developments provides the companies in the conditions of a fierce competition in the market of oilfield service services the high rating and a successful cooperation with leading companies of Russia, the FSU and beyond.

The organization of monitoring the development of oil fields by geophysical and hydrodynamic methods is the important direction in case of control of development of oil fields. Preliminary descent of deep measuring systems on a cable in intervals of a research allows conducting geophysical, hydrodynamic and other surveys of a well without stopping the deep and pumping equipment.

Further let us carry out efficiency analysis of handling of geologic-geophysical information by means of the latest computer systems:

1. The efficiency of application of a technique "Technology of studying of anisotropy of the environment along the basic seismic horizons, for the purpose of preparation of projects under horizontal well-drilling" consists in separation of the basic seismic data into several sets corresponding to certain directions of distribution of a seismic wave [6, 7]. From each of these, sets further receive azimuthal cubes of seismic data. Further, along the traced horizon in a required time frame on each of azimuthal cubes, the analysis allowing one to choose the prevailing direction of anisotropy connected with this or that prevailing direction of jointing of a productive part of a geological section is performed. The obtained data can be considered when designing horizontal trunks of wells, for their optimum orientation. This technique was successfully tested and applied on several license areas. On one of the squares, the horizontal trunk with the subsequent works of GRP, which confirmed the received result, was drilled.

2. The efficiency of use of a technique "Land observations by method of microseismic issue – control of GRP" is that in the course of the microseismic monitoring of the hydraulic fracturing (HF), continuous registration of the wave field before technogenic impact (several hours) is performed during production of GRP (usually 30-60 min.) and within several hours after it, which allows one to estimate change of level of microseismic issue during and after GRP. Besides, for correction of average speed from a source to receivers, a surface process of perforation of a well without fail is registered. Determination of a spatial provision of sources of microseismic events in the course of microseismic monitoring of GRP allows estimating an azimuth (direction), length and asymmetry of a crack of a gap of the layer. It should be noted that hydraulic fracturing of the layer (GRP) is one of the most widespread methods of stimulation of wells on fields of hydrocarbons which significantly increases a production surplus.

Data of two actions for indicators of amount, costs and economic effect are consolidated in table 1.
Table 1. Summary assessment of results of efficiency of handling geologic-geophysical information by means of computer systems

| Actions | Increase in amount of works, thousand rubles. | Current costs, thousand rubles. | Economic effect, thousand rubles. |
|---------|--------------------------------------------|--------------------------------|---------------------------------|
| Technique “Technology of studying anisotropy of the environment (connected with jointing of rocks, zones of tectonic violations and breaks) along the basic seismic horizons for the purpose of preparation of projects under horizontal well-drilling” | 3 650.8 | 2 738.1 | 912.7 |
| Technique “Land observations by method of microseismic issue – control of GRP” | 900.5 | 675.4 | 225.1 |
| Total | 4 551.3 | 3 413.5 | 1 137.8 |

Thus, summary assessment of results of the offered actions specifies an increase in amount of works by 4 551.3 thousand rubles; in case of costs - in the amount of 3 413.5 thousand rubles. Economic effect of use of these technologies made about 1138 thousand rubles.

4. Conclusion
The analysis of a condition of the equipment and technology of LLC TNG Group showed that the entity renders almost a full range of services in the field of geophysical surveys and works in the drilled and operating wells.

Experiment of LLC TNG Group on handling geologic-geophysical information by means of computer systems revealed that using modern program technologies information conditions for forming of complete idea of a condition of the carried-out work, estimates of its efficiency, forecasting of tendencies of development of process of drilling or stimulation of work of wells and acceptance of reasoned management decisions are created. That finally leads to an increase in efficiency of investments in construction of oil and gas wells or their repair.

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