# QUANTITATIVE PROGNOSIS OF OIL AND NATURAL GAS FIELDS

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**ABSTRACT:**

Technology of practical use of remotely-sensed data is shown. A developed method is allowing perform computations for quantitative estimate the potential of petroleum, natural gas and minerals on the different territories. The scale of works is 1:10,000 to 1:200,000. Prognosis estimation of the territory potential is based on the relationship between the features of oil-and-gas content and discontinuous structures with diverse scale level. The forecast of pools location is carried out on the basis of the complex attributes. As a result of study we have quantitative estimating the probability for determining forecasted objects in each point of the research area. The research point responds to the minimal area, which is identified in satellite digital imagery (5x5м, 15x15м, 30x30м etc.). The results of the successful use of the method in different territories are documentary proof.

Die Technologie und der praktische Einsatz von auf Distanz gewonnenen Daten wird in der Studie gezeigt. Eine entwickelte Methode ist zur quantitative Einschätzung von Territorien in Bezug auf Öl, Gas und Mineralien gedacht. Der Maßstab der Arbeiten ist 1:10,000 bis 1:200,000. Die Progrnosenschätzung der Wahrscheinlichkeit eines Territoriums basiert auf der Verwendung der Verwandtschaft der Eigenschaften von Öl-und-Gas Inhalten und explosiven Strukturen auf einer anderen Maßstabsebene. Die Voraussage von Lagerstätten wird auf der Basis der komplexen Attribute vorgenommen. Als Ergebnis der Studie wurde eine quantitative Einschätzung der Wahrscheinlichkeit, die Objekte der Voraussage zu finden, für jeden Punkt des Forschungsgebietes erhalten. Die Forschungsarbeit beantwortet das kleinste Gebiet, das in digitaler Satellitenabbildung dargestellt wird (5x5м, 15x15м, 30x30м etc.). Die Ergebnisse der erfolgreichen Anwendung der Methode in verschiedenen Territorien werden betrachtet.

## 1. INTRODUCTION

Different countries are constantly increasing expenditures to search for pools. Increased expenditures on augmenting the depths of the drilling wells and costs of basic methods of exploration are defined.

The decrease of expenditures and increase of efficiency of search works are possible in two ways:

1) Complex use of comparatively inexpensive methods for exploration on the remotely- sensed data are based.
2) Preliminary results of prognosis are used for all studied territory.

Efficiency increases due to abbreviated exploration on non-perspective territories. Even the insignificant increase of exploration efficiency provides income. It is incomparable with expenditures on implementation of traditional exploration.

Tradition approach using the remotely-sensed data for the study the faults-mosaic and folds structure. The research results are represented as maps. It hampers using these maps for prognosis of territories in a complex with data of other exploration methods.

We developed the method of using remotely-sensed data for complex exploration of oil-and gas content. These results can be used together with the results from other types of research for complex prognosis of perspective territories. This method was patented (# 32050, 2008).

This method was used to explore oil-and-gas content for different provinces of Dneprovo-Donetsk depression, West-Siberia, Timano-Pechora and Sakhalin Island. These provinces are located in a variety of geological landscapes. In most cases, the prognosis results are confirmed by the data from the exploration wells.

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## 2. BASIC STATUTES OF METHODS OF RESEARCH

### 2.1. Sequence of implementation of works

The offered method contains some basic stages of research. In each stage are used the special methods of analysis. On the first stage the collection and systematization of all material about the geological formation of the territory, the data of the oil-and gas content, results of geophysical survey and landscape terms are conducted. All remotely-sensed data are collected and analyzed. Special attention is devoted to reception and checking of data of geographical co-ordinates of the wells and results of the drilling.

By results of researches the representations about geology, tectonics, structure and oil-and-gas content of area of works, factors of the control of pools, landscape conditions and other are formed. Results are prepared in the GIS environment. The choice of research methods will be based on these data.

The second stage contains structural interpretation of the remotely-sensed data. The faults, breakings and circular structures are selecting. The faults-mosaic and scheme of morphological structures are constructed. Special attention is devoted to the permeability of rocks.

The third stage contains several types of methods for calculating the potential of research territory. In the beginning perspective meanings are defining for separate search features. Then spatial-probabilistic estimation is used to analyze the values for all the search features. The method of spatial-probabilistic estimation is used (Nagorskiy and other, 1970, 1971, 2004).

The fourth stage is analysis the received results, estimates authenticity and recommends further research Two groups of principal and different methods of research the during works are used. The first groups of methods are used for interpretation of remote-sensing materials and construction of morphometry. As a

result, we have the initial quantitative information for search features, which the possible, can be controlling of the pools. Another group of methods is allowing the assessing of connection of the searches of features, which was selected, with the objects of prognosis for the complex estimate of prognosis of territory.

These exploration methods include the traditional methods and methods developed by authors or with their participation. Methods, which were developed by authors in this article, are submitted.

### 2.2. Methods of structural of research

For the study of anticline structures of sedimentary cover is used the method of selection of anomalous values of the height field of modern relief. Relief is created from the Shuttle satellite data. For most regions the anticlines in modern relief are revealed as raising. Authenticity of the selected anticline fields are estimating by comparing seismic research data and materials of structural interpretation.

We use the structural interpretation results of multispectral space images as the initial information for studying breaks, knots of cross breakings and circular structures. We used the structural interpretation results of multispectral space images as the initial information for studying breaks, knots of cross breakings and circular structures. The structural interpretation of multispectral images is conducted by sight by known methods of interpretations (Kats and et. 1988, Aerospace research, 1988, Barret, Kurtis, 1979, Kravtsova and Dr., 1985, Kronberg, 1988, Multispectral remote sensing, 2006, et.). Parallel comparative analysis of interpretation of multispectral images and topographical maps is performed for control and delete the man-made lineaments. It is very important to fulfill the works for territory that have the high loading man-made. If the multispectral images did not show of the lineaments or they are expressed badly, interpretation is conducted on the topographical maps. The 3D relief model will be interpreted.

As a result of interpretation, the maps are created for breaks, circular and plicate structures and scheme of breakings and blocks structures for the studied territory. All information is present in a vector form. It allows the constructed maps to be juxtaposed with other different geologic-geophysical data and prepared in GIS. It is very important for further use.

### 2.3. Method of study of crack permeability of rocks

The special attention is given to studying breaks of rock permeability. It is one of important search features. Traditional methods studies of permeability of breaks are use of study for rock exposure, in the production excavation and of core drilling. These methods are expensive and labor intensive and limited the opportunities of study of breaks permeability of rocks.

We developed method of rock permeability study for poorly naked territory and large areas. Method is based on lineaments study. Lineaments are characterized by different sizes of break in the earth's surface such as large faults, raised strips, fracture zones, fold structures and etc. Lineaments are characterized by different sizes of break in the earth's surface such as large faults, raised strips, fracture zones, fold structures and etc.

Due to inherent evolution of rock structure, a new relief is reorganized and the ancient relief is saved. Naturally, lineaments can give generalize and integrate schemes of breaks of the earth's crust. As a result of joint action of several exogenous processes, the numerous lineaments for any territory may be detailed. Lineaments have diversity of orientation and extent. In the process of structural interpretation of multispectral images for the study of crack permeability of rocks all lineaments are selecting. Their quantity does not depend on size, orientation or landscape of indicators. Our method differs from the structural interpretation method with the purpose of studying faults and folds. The number of selected lineaments are considerably more that the quantity of faults and breaks, which are selected by other methods of research (Mesheryakov, 1965, Golbrayh and et., 1968, Chebanenko, 1977, Tyapkin, 1998, Palienko and et. 2005, Multispectral remote sensing, 2006, and other).

Furthermore we must to know such the parameter of permeability of zone of exploration as fissire opening. It is impossible to do on the remotely-sensed data. We assume that within the limits of every lineament system all fissures are characterized by nearest values of opening. The common quantity of fissures of every system can be evaluate for cracked rock permeability (i.e., rock crack permeability can be quantitative value estimated in every point of territory as the quantity or total length of lineaments of every system, attributed to unit of area).

The results of studying rock break permeability are represented in a quantitative form. It is very important and allows mathematical methods to be used for processing and analysis. The results of special research showed that the accumulation of hydrocarbons did not have maximal or minimal permeability values. These values are conformed to intermediate (optimum) of permeability. The quantitative analysis methods determine optimum interval values for these features. They can be incorporated with other search features, and first of all, with the geophysical research data. It is necessary and important for reliable evaluate of potential of territory.

For the decision of tasks of prognosis to present the lineament maps in a quantitative form are necessary. The methods of lineament analysis include:

1). Analysis of orientation regularity and selection of borders of the lineaments.

2). Select of indexes for quantitative description of the lineaments field.

3) Analysis and interpretation of geological maps for graph tightness and total length of lineaments for every system.

The characteristic features of this analysis method are:

1) The attention is focused for localization of the borders of the lineament systems. The modal values of every system are second-rate. This analysis provides of the orienting the maximums and minimums on the graphs of azimuth distribution of extending lineaments.

2) For the selection of the systems of lineaments are using the graphs of dispensation of their distribution azimuths. The graphs are constructed with differing sites of initial points.

3) The interval width is specially selected for lineament groupings. This value is used to construct and analyze graphs of azimuth distribution of extended lineaments. Easily is showed that the quantity of the lineament systems, which is possible select on the analyzed graphs, relies on the interval width of grouping which is used to construct these graphs.

The analyses of regularity of orientation of lineaments are conducted in two stages. The first stage is calculated azimuth trends of all selected lineaments within the limits of separate blocks or local areas with the relatively homogeneous measured geological structure. The significant distribution values for azimuths of extended lineaments from normal distribution are determined. Meaningful distinctions testify to existence of the separate lineaments systems. For reliability, the nonparametric statistical criteria of Pirson ($\chi^2$) are used to estimate separate maximums and minimums.

The second stage is selecting of the general lineaments systems for explored territory only. The data are used on separate blocks to construct azimuth distribution of modal values of local maximums

and minimums. Authenticity of their selection has been verified for clearness of border definition of the separate lineament systems and their general modal of values for all research territory. The effectiveness of further of research is depended on authenticity of selection of the lineaments systems.

Then the estimation of conformity of the allocated systems of lineaments to systems of cracks and breaks of research region established by other authors must be carried out.

The same analysis method uses orientation of linear anomalies of the physical fields and geophysical data on the studied territory. Two indexes for quantitative description of the lineament fields are used: the quantity (density) and summary of total length of lineaments. These indexes for unit of territory are counted. These two indexes are associated, but they do not duplicate and each complements the other.

For each of the systems are calculated the quantity and total length of lineaments. Limits of the extended sliding window are used for this calculation. Windows are oriented in accordance with azimuths of extended modal (most often met) lineaments of every system. The sizes of the sliding window depend on the value of pool depth and quantity of selected lineaments.

Data of special research are ascertained functionally interdependence of the extent and value of depth of breaks (Nechaev and other, 1991, Petrov, 1974, Rugich, 1977, Rugich, Sherman, 1978, Sankov, 1989, Chernishev, 1983, Sherman, 1984, and other). The account of this dependence is used at a choice of the size of a window of averaging. For this purpose the analysis of distribution of potential of objects in researched area on occurrence depth will be carried out. The maps of density and total length of lineaments are defined with the help of sliding windows of averaging; the sizes of windows are defined proceeding from occurrence depths of the basic horizons of accumulation for prognosis pools.

At a choice of the sizes of sliding window the quantity of lineaments in window is accountable factor. The calculating the quantity of lineaments occurring in a sliding window is necessary for determination of quantity of windows with the zero values. The quantity of the sliding windows with the zero values of graph tightness or total length of lineaments must not exceed 10% from a common quantity. It is defined experimentally. Otherwise maps of potential are impossible for interpretation and have small information for the prognosis research.

In the process of prognosis researches and for geological interpretation of maps of closeness and total length of lineaments the method of spatial correlation of values of these maps with the pools (deposits) and structures selected by the geologic and geophysical data is used.

For realization of methods and algorithms of analysis of lineaments fields are written the author's complex programs in Delphi. We developed programs for the decision of tasks which had not been included in well-known software's. The programs are used to analyze lineaments orientation, excretions of the systems of lineaments, creation of maps of graph tightness and total length of lineaments, creation of maps of knots of crossing of lineaments and transformations of data. The data formats of our programs are compatible with well-known software. Calculation control and verification of the results are tested in GIS, ERDAS Imagine or MapInfo Professional.

The following sequence of operations was set in the total:

1) Visual decoding of space images with use of the program of ERDAS Imagine.
2) Translation of data vector for the format accepted in the developed program.
3) Data analysis and receipt of results with use of the developed program.
4) Construction of maps in an isolines form by the Surfer program.
5) Translation of the file of raster format got by Surfer program.

For the control of calculations and verification of results the data in GIS-program are visualization.

### 2.4. Basic prognosis method of oil-and-gas content for territory with remotely-sensed data

The method of spatial-probabilistic prognostication is used for oil-and-gas content estimate of the territory. The program, based on this method, creates maps in the quantitative form for studied territory. This maps are used for predict potential oil and gas content of territory. The program uses any quantity of search features. The minimum area of prognosis potential are corresponded to pixel size of satellite image used for created of the prognosis maps.

The complex informative features are formed in the beginning. For this purpose is used the program of spatial-probabilistic prognostication for calculating the probabilities of interconnection of informative features with the objects of prognosis Self-descriptiveness of attributes is established by comparison of distributions of meanings of analyzed attributes within the limits of known objects of the forecast with distribution of their meanings which were defined for a uniform network in the most investigated territory. For comparison of distributions the Pirson criterion is used. In a case wide disagreement the functions of the relation of plausibility are used. On them the interval of meanings of an attribute is defined, to which the objects of the forecast are connected and the probability of interconnectivity of objects with the values of every search feature are calculated. Then the multidimensional functions of likelihood for complex analysis of all search features are used. The results of complex analysis prognosis of territory are maps of potential of oil-and-gas content in isolines.

The next stage is containing the analyses of maps of prognosis of potential oil-and-gas content in isolines. Local perspective areas are selected with the use of expert appraised results. All information, which for diverse reasons was not used in the process of prediction, is used. As result we have the calculated potential values for selected areas. Then for calculated of the values are realizing ranking and are prepared the recommendations for conducting research on perspective areas.

Characteristics of the spatial-probabilistic prognostication method are: realization of semantic control of the results on the all stages of works; possibility of removal of spurious of features and inexplicable results.

The potential maps are created on the results of remotely-sensed data or in a complex with different geological explorations (if they are available).

The important question is the authenticity of the prognosis results. Undoubtedly, only drilling can verify the reliability of the prognosis. It is rarely on the practice. If in the region are known pool areas, part of them are not used to estimate potential of territory. They are used as control points to verify the authenticity of search features in every case. The control points are determined in every case.

### 2.5. Results of prognosis research

These research methods were used to creation prognosis maps for oil and gas pools of the following provinces: West Siberian (Latitudinal Priobie and Yamalo-Nenetskiy autonomous region), Sakhalin (North-Sakhalin and West-Sakhalin pools), Timano-Pechora and Dneprovo-Donetsk.

The explorations were conducted the south-east of the Dneprovo - Donetsk Province on a territory of about 1000 sq. km. Relief of research territory is hilly with by the many ravines. Small

rivers present a hydrographical network. A greater part of district area consists of field crops.

Three oil and three gas pools in the terrigenous-carbonate sediments of lower - middle carbon are present in the research territory. Three oil and three pools in the lower - middle carbon also are located in the research area. The pools are small areas of no more than 5 sq. km. They are inherent to local dome sedimentary cover. Twenty local structures are selected based on seismic works data. Most structures are not studied by drilling. The territory and adjoining area are studied by seismic exploration and prospecting wells.

The initial information for prognosis research are maps of lineaments and circular structures; they were created on the results of the structural interpretation of the multispectral images of satellite Landsat and the 3-D digital model of relief from the Shuttle satellite data. Data of 15 wells were selected. They had results of testing for oil or gas.

For the creating of maps of the forecast oil-and-gas content the connection of objects of the forecast with numerical meanings of the following attributes were analyzed:

1) Density and total length lineaments for each of 8 systems lineaments.
2) Density of units of crossing lineaments of all systems.
3) Marks of high of a modern relief established on digital model of a relief.
4) Character of moving of territory on the neotectonic of stage of evolution. Were estimated a direction (relative rise or lowering) and amplitude of moving (in numbers).

As a result of calculation is determined, that the all mentioned features maybe use for quest of oil and gas as they are interrelated with the prognosis objects. This connection has the complicated character. This connection has the complicated character; the objects of prognosis avoid both maximum and minimum values. They are conformed to the intermediate values of features. These compares are very well with data of previous researchers (Nevskiy, 1955, Pospelov, 1963 and others).

The pools are located outside the limits of anticline dome practically for all potential areas. They are disposed on anticline limbs or between local domes. Results of drilling are confirming these inferences on separate structures within the limits of the studied area and in other regions.

For all areas of exploration the maps of potential oil-and-gas content are constructed in the scales of 1:50000 and 1:25000. On the maps the many relatively small areas with the highest potential for pool discovery are selected.

The smaller area has the higher potential value. Areas with high potential inside areas with more low perspective practically always are disposed. Most potential areas have complex form and are characterized by elongated orientation.

As a rule, the potential areas which were selected on the maps of scale 1:25000 and 1:50000 are coincided from 60 to 80 percent. In other words, results of regional explorations the results of the detailed research are confirmed. Exploration reliability on coinciding data is validated

The potential areas are located in the form of strips on the created maps and are composed in the three bands of N-W - sub-latitude; are crossing all studied area. The selected strips have sub-parallel direction for the border of the Dneprovo-Donetsk depression. For pools of the Dnepr-Donetsk Region this type of strips distribution is inherent.

Results of exploration: area having no potential is 66%; area with low potential is 28 %; area with middle potential is 5% and area with high potential is 1% of all studied territory. There are 131 local potential areas with sizes from 0.5-1.0 to 2-4 sq. km. The 25 potential areas are recommended as primary objects for detailed exploration; their territory is 75 sq. km. (Fig.1).

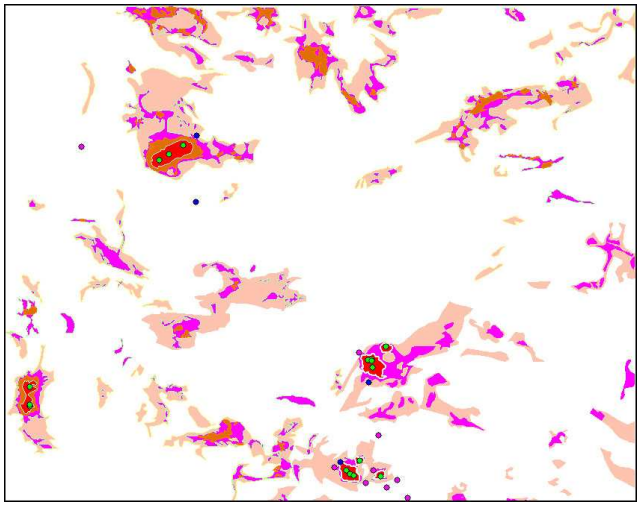


Figure1. Map of potential of oil-and-gas content of the S–E of path of Dneprovo-Donetsk depression, the scale 1:50000.

Legend:

| | | | |
|---|---|---|---|
| | Areas are maximum potential | | Non potential area |
| | Areas are high potential | | Productive wells |
| | Areas are middle potential | | Well are brine water and oil film |
| | Areas are low potential | | Well are brine water |

At first, authenticity of results of the conducted prognosis research was confirmed by indirect data. Three known pools with maximum values of potential were characterized. They are located outside the studied territory but in proximity of its border. Information for these pools was not used in the research process. After completion of prognosis researches on the remotely sensing data, on the flanks of two industrial of pools of territory, the works for the search of new accumulation of hydrocarbons were conducted by the method of vertical seismic prospective (VSP). VSP data confirmed the results of our prognosis data.

One of prospective areas, selected on the prognosis map was tested using a prospecting borehole. The potential production of oil is obtained. In addition, on the seismic exploration data was selected the point for prospecting boreholes within the limits of the local structure. Our data identified this local structure as non potential. An exploration well was drilled on this local structure. The drilling data was confirmed that this local structure has no potential.

In the Sakhalin Province the researches for oil-and-gas content were conducted within the limits of the North- Sakhalin area. Greater part of exploration area is occupied by grassy-shrub vegetation with tailings of larch forests and the medley of birch trees. A hydrographical network is weak; permanent rivers and brooks are absent. The area is described as wavy relief. The west part is transformed to off-shore lowland.

Within the limits of the exploration area, on the test boreholes data were uncovered the multimass of the sandstones, aleurolites, argillites and clays. It is data from the Pliocene Age to the Upper Cretaceous Period. Location of the territory of the mega-anticline of sub-meridional direction is related by the numerous broken breakings. Forming of structures of area with phase of tektogenezis of Sakhalin is related (Late Pleistocene). The large breaks of the sub-meridional direction influenced on the organization of the sedimentary framework. The multihorizon oil-and gas field is located within the limits of the work area.

Natural gas forms an independent pool. Gas cap is higher than the petroleum field and gas was found in the dissolved condition in the petroleum. The pool is characterized by the single hydrodynamic system characterized.

Sixteen pools are located here. Occurrence depths are from 1160м to 2710м. All pools are relating to a type of the mass-pool roof and tectonic of shielded. Productive layers are sand and sandstone. They are characterized by the lithological of changeability. The sizes of oil and gas fields are small. They occupy the limited areas in the pool in pool roof of the isolated blocks of each bed.

The studied pool is multihorizon. The difference of depth layer of pools exceeds 1.5 km. Prognoses of oil-and-gas content were calculated separately for the layers that are located at the different depths. Source of the initial information for potential of researches are the maps of lineaments and ring structures; they are constructed on the results of structural interpretation of multispectral images Landsat satellite and digital model of relief on the data of the Shutlle satellite. The processing of results interpretation was carried out according to the stated above technique of works. The studied pool is multihorizon. The difference in depth of layers of pools exceeds 1.5 km. Prognoses of oil-and-gas content were calculated separately for the layers that are located at the different depths. Maps of graph tightness and total length of lineaments were created for this. These maps were created with use of the sliding windows; the sizes of windows were determined from the requirements of known dependence between the sizes of a window of average value and occurrence depth of the investigated object.

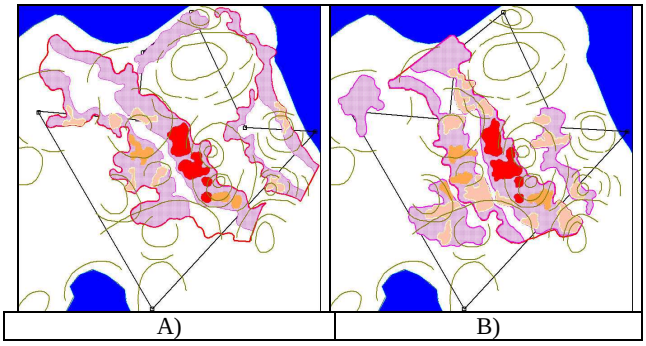
On the drilling data, disposition frequencies of pools non-uniformly are located; they are grouped in two horizons. The pools of overhead horizon are located at depths from 1160 m to 1950 m. The maximal quantities of pools are located on depths about 1750 m. The gas fields for this horizon prevail. The pools of lower horizon are located at depths from 2080 m to 2710 m. The maximal quantities of pools are found on the depth about 2400 m. The petroleum layers are prevailing. Separate maps of pool prognosis were created for different upper and bottom horizons. The sizes of sliding windows were chosen taking into account the depth values of maximal quantity of pools. Data of 23 prospecting holes were used for exploration as objects of teaching.

For creating of maps of the potential of oil-and-gas content the connection of objects of the forecast with meanings of the following features was analyzed:

1) Tightness of graph and total length of lineaments for each of 8 lineament systems.
2) Remoteness from the axis of maximum of graph tightness and total length of lineaments for all systems.
3) Tightness of graph of knots of crossing of lineaments for all systems.
4) By the marks of hypsometry of relief; they on the digital model of relief are determined; model is created on the remotely sensed data.

On the result of research were determined all search features which had influence on the location of known pools. All analyzed features not depended from the occurrences depth. They can be used as of the searches features. The prognosis objects avoid both maximal and minimum values. They conform to the intermediate values of features.

Further the probability of connection of objects of the forecast with all complexes of attributes separately for objects of the top and bottom horizons was appreciated and the maps of the forecast of pools for each of horizons are constructed (Fig. 2).




A) Map of potential for horizon 1750 m

B) Map of potential for horizon 2400 m

Figure 2. Potential map of oil-and-gas content for license site in limits of the North-Sakhalin Basin, the scale 1:50000.

Legend:

| | | | |
|---|---|---|---|
| | Contour of license site | | Areas are low potential |
| | Border of potential areas | | Faults are interpretation on the remotely sensed data |
| | Potential regions | | Water surface |
| | High potential areas | | Land surface |
| | Potential areas | | |

On the map of potential of pools are 38 percent non-potential areas of upper horizon and 52% of the bottom horizon. The areas, which have not received potential values, occupy 45 % and 34% of the work area. The potential areas occupied 14 % and 11 % for all work areas. Only 3 % of the territory has high potential for both of maps.

The comparative analysis created of map potential showed they have as many distinctions as they have in common. On both maps the areas with increased meanings potential are three strips in direction N-NW. The greatest area of maximum potential value is located in the central part of the exploration territory. It is well visible on maps of potential for lower and upper horizons. Productive wells are located in the limits of this strip. The other two strips occupy fewer areas and are characterized by lower potential values.

Their spatial location well is coordinating with prospective on geologic-geophysical data of pools localization, but that requires check by test drilling.

The 21 local potential areas with the high potential values are located on maps of potential pools within the limits of the selected strips. Potential areas are small; their sizes are from 0.145 to 1.0 sq. km. In most cases, the planned location of the potential areas on the prognosis maps spatially coincides with the upper and bottom horizons.

As a result exploration is recommended to conduct detailed seismic survey and semi-wild-cat well for two potential local areas. Conducting complex of detailed geophysical researches is recommended for the other three areas. The results of this exploration will be determining the potential requirements for drilling a prospecting hole or exploratory well.

For areas with lower potential, the explorations are executed only after results are verified for the best potential areas.

The results of exploration allow asserting that the investigated site is perspective as on detection of new pools within of the known area of research and on discovery of new pools to

west and to east from the researches territory. Drilling confirms the reliability of prognosis research results.

Results of our exploration on the north of Western Siberia and the Yamalo-Nenetskiy Region were tested by drilling. Two prospecting wells were recommended within the limits of two potential areas. Both prospecting wells are producing an efficient oil production rate.

The above mentioned results of works for forecasting pools on the remotely sensed data and estimations of reliability of the received results by test drilling in areas with completely different physics-geographical conditions, geological structures and type of deposits, on our opinion, convincingly testify to an opportunity, reliability and expediency of realization of such researches with use of the offered technique of works.

## 3. CONCLUSION

Analysis of results of works by the quantitative prognosis estimation of oil-and-gas content, were fulfilled with the use of the developed technology, on territory about 18.000 sq. km. Their result allows doing the following conclusions:

1). The offered technology of works allows executing quantitative prognosis estimation of potential of pools for territories with different natural-climatic conditions, geological structure and character of structures. Authenticity of results of prognosis in most cases is confirmed by data of the boring drilling.

2). The results of prognosis estimation of oil-and-gas content of territory are appeared in a quantitative form. It allows executing the complex analysis of its data with materials of geologic-geophysical researches and is increasing probability of reliability and efficiency of results of prognosis.

3). Prognosis researches are conducted operatively for different territories, regardless of time of year, in the different natural-climatic conditions and in the required scales. Result is shorted time for acceptance of decisions on conducting of the detailed explorations.

4). Concentration of works on the most perspective sites, were selecting on the results of quantitative prognosis estimation of oil-and-gas content of territory, allows to shorten financial expenditures and period of conducting of the exploration. For example, prognosis works for license site about 1000 sq. km. on territory of Russia was executed for 7 months, and was shorted the financial expenditures on 2.500.000 USD. Detailed survey for oil-and-gas accumulation for territory about 12.000 sq. km on the Arabian peninsula for 7 months was executed.

5) The offered technology of works can be used and for prognosis estimation of potential of territory on the discovery of ore mineral resources.

## REFERENCES

V.I. Lyalko, M.A. Popov. 2006. Multispectral remote sensing in nature management. “Scientific book project”. Kiev. p. 360.

D.M.Trofimov, L.P.Polkanova. 1988 Aerospace of research are fulfill for regional stage of geological survey on an oil and gas. Nedra. Moscow. 160 p. (in Russian).

E. Barret, L. Kurtis. 1979. Introduction in space physical geography. M. Progress. (in Russian).

Y.G. Kats, A.V. Tevelev, A.I. Poletaev. Bases of space geology. Nedra. Moscow. 988- 235 p. (in Russian).

V. I. Kravtsova, E.K. Kozlova, Y.I. Fivenskiy. 1985. Space images (methodical guidance). MGU. Moscow.. (in Russian).

P. Kronberg. 1988. Remote study of Earth. Bases and methods of the remote researches in geology. Mir. Moscow. p. 349. (in Russian).

V.A. Nagorskiy. 1970. Evaluation of sequences of geological objects and features are used how the basis of quantitative prognostication. Edition “Questions of geochemistry, mineralogy, petrology and ore-bearing rock”. Naykova dymka. Kiev. p.163-169. (in Russian).

V.A. Nagorskiy, A.V. Netreba, V.S. Tepikin. 2004. The «Kiev-Geoprognoz system» how a new level of spatial-stochastic geologic-geophysical, geochemical and aerospace information for the use for effective prognostication of minerals. Edition “The theoretical and applied aspects of geoinformation” V.1. Kiev. p. 81-89 (in Russian).

V.A Nagorskiy, L.A Prikazchikov, V.V Skvortsov, A.Y. Hodorovsky. 1971. Spatial-probabilistic prognostication. Bases of scientific prognosis of deposits of ore and non-metallic minerals. VSEGEI. Leningrad.. p. 68-69. (in Russian).

V.A. Nevskiy. About some regularity placing of hydrothermal of mineralization in the large breaking and more shallow faults. IGN AS USSR. V.162. 120-129 p. (in Russian).

U.V.Nechaev, E.A. Rogogin. 1991. Analysis of the tectonic fragmentation of seat region of the Spitak`s earthquake.. Report AS USSR. v.320 №6. p. 1441-1445 (in Russian).

Patent 32050 Ukraine. MPK (2006) G01V 9/00, G01V 11/00. The method of prognostication of deposits of minerals. V.I. Lyalko, V.A. Nagorskiy, A.J.Hodorovsky, A.A.Apostolov, A.B.Vostokov. 04. 25. 2008. Bulletin #8 (in Ukrainian).