REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

ADVANCED STRUCTURE OF THE CLASSIFICATION OF OIL FIELD RESERVES AND JUSTIFICATION OF THEIR RATIONAL DEVELOPMENT WAYS, BASED ON GEOLOGICAL AND MATHEMATICAL MODELS

Specialty: 2521.01 – "Geology, research and exploration of oil and gas fields"
2524.01 - "Mining and oil-gas field geology, geophysics, surveying and earth surface geometry"

Field of sciences: Earth sciences

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İMZANI TƏSDİQ EDİRƏM
ADNSU-nun Elmi katibi
dosent N.Əliyeva

GENERAL CHARACTER OF THE WORK

The topicality and development degree of the subject. One of the main tasks facing in the oil and gas industry is to reliably strengthen the work on oil strategy and to meet the energy demand for the economic development. This provision is closely linked not only to newly discovered oil fields, but also to hydrocarbon fields with great potential for long-term development.

The research shows that the problem of obtaining regular, comprehensive geological-geophysical, mining information about the deposits, the existing infrastructure, geological control over the development process, certain changes in reservoir parameters, insufficient application of advanced methods, etc. creates difficulties in solving the problem for various reasons.

In order to substantiate the application of appropriate technology in the efficient development of oil fields,first of all, the current geological and field conditions of the fields must be studied, and the volume of approved reserves should be determined.

The worlds' practice of oil extracting industry shows that the measures taken to regulate the flow of high-viscosity oil to the borehole have not been effective because of the complexity in natural conditions in the oil fields. Therefore, the problem of extraction only of 30% of approved reserves is relevant. This problem is even more relevant for Azerbaijan and is constantly under the control of oil-geologists. A detailed study of the geological conditions of these fields has been shown that certain changes in reservoir parameters to-have a significant impact on the development results From the qualitative point of view those resources are classified as "hard-to-extract", which includes tight reservoirs and/or high viscosity oils. Lots of investigations have been devoted to the study of such deposits. Hard-to-extract resources are typical for our republic.

Increasing the ultimate oil recovery factor in hard-to-extract oil fields has been an relevant issue in the world, requiring the creation and application of more advanced, new and effective technology for geological and hydrodynamic modeling and development by taking into account the essential geological and geophysical conditions of the fields.

The object and subject of research. In the process of oil and gas field development, geological and technological parameters are accompanied by numerous factors that are complexly interrelated. These factors depending on natural geological conditions and field development systems factors vary significantly in the oil extraction process. In the process of development there are some geological, field and technological parameters which are facing mutual connection in time and space. The study of these parameters, in addition to studying the reasons for the differences in the degree of development of oil reserves, involves the application of methods to reduce the negative impact of these parameters to increase the final oil recovery factor, which is one of the key issues in field development. Such studies should be iterative, and should be periodic, covering not only the dominant factors affecting oil production, but all geological and technological parameters.

Most of the productive fields that are currently under development in the oil and gas sector of the Republic are in the final stages of development. Productive layers heterogeneity, low permeability of reservoir, is characterized by high oil viscosity.

A large amount of information has been collected on enhance oil recovery (EOR) methods from the long producing reservoirs. Diring the process of characterization of individual layers with different geological conditions, the physical and chemical properties of rocks and fluids, as well as the variability across the field, leads to the elaboration of new development projects of hard-to-extract fields, each individual object requires individual approach. Enhancing oil recovery in hard-to-extract fields and the problem of their involvement into development is relevant for both offshore and onshore fields and is one of the priority issues.

The purpose and goals of the study. Improvement of the structure of oil reserves in the offshore and onshore fields of Azerbaijan, determining the distribution characteristics and substantiating ways of efficient development:

1. Development and comparative analysis of structural models of reserves reflecting the first and current periods of Meso-Canezoic sediments of offshore and onshore oil fields of Azerbaijan;

2. Improving the methodology of classification and distribution of oil reserves of Azerbaijani fields in terms of quality;

3. Classification, geological-mathematical models and sensitivity analysis of hard-to-extract reserves of oil fields of Azerbaijan;

4. Detection of stagnant and poorly drained zones in oil fields according to the new methodology;

5. Geological and field foundation of efficient development of residual oil reserves by application of enhance oil recovery methods.

Research methods. During conducted research study it has been used geological-mathematical models for the efficient development of residual resources based on geological-mining indicators.

Main defended provision:

1. Geological classification, structure and grouping of oil reserves of Azerbaijans' offshore and onshore fields;

2. Qualitative classification of Azerbaijans' oil reserves, new geological-mathematical models of reservoir parameters affecting the development of hard-to-extract resources, reserve allocation methodology;

3. Improvement of efficient extraction of residual oil reserves, new method of determination of still and weak drainage zones in layers, geological substantiation of application of complex geological and technological measures and methods of enhanced ol recovery.

Scientific innovations of the research:

1. Characterizing different periods of Azerbaijani fieldsreserve structures were established and a comparative analysis was conducted, which plays a key role in the reliable forecasting of the oil and gas industry's capabilities of the republic.

2. A new classification of reserves (active and hard-to-extract) from of the offshore and onshore oil fields of Azerbaijan Meso-Canezoic sedimentray sections has been developed and the distribution method has been improved.

3. According to the new classification the geological and technological parameters, positively and negatively affecting the level of extraction were revealed, for the first time multidimensional geological and mathematical models have been developed, the sensitivity analysis has been conducted, the validity and validity of the models

were justified.

4. Based on complex geological data, a new method for identifying stagnant and weak drainage zones in oil fields has been developed and applied in several fields.

5. The application of geological and technical measures and enhance oil recovery methods to intensify the development of residual oil reserves of the fields has been substantiated and the effectiveness has been assessed.

Scientific and practical significance of the dissertation. The classification of reserve in offshore and onshore multi-layer oil fields in Azerbaijan can be used to solve geological and oilfield issues.

Oil delivery models have been taken to define the role of layout parameters that have different impacts on the development of oil fields in Azerbaijan which must be taken into account in regulation of oil production process .

In order to effectively utilize residual reserves, a new method has been developed to identify still and weak drainage zones in the fields, which will enable effective complex geological and technological measures, identify location of new wells and reduce geological undefined.

Approbation and application of the work: The main provisions and results of the dissertation work were discussed:

1. Karger, M., Trofimov, D., Eminov, A., Myasnikov, I., Zakharov, A. The early detection of semi-permeable filtration barriers by using sar interferometry // In 2014 IEEE Geoscience and Remote Sensing Symposium. Québec City, Québec, - Canada: -13-18 July, - 2014, - p. 250-253.

2. Karger, M., Trofimov, D., Eminov, A., Myasnikov, İ., Zakharov, A. Methodology for Early Detection of semi-permeable Filtration Barriers // SPE Russian Oil and Gas Exploration and Production Technical Conference and Exhibition held, - Moscow Russia: - 14-16 October, - 2014, - p. 1-7.

3. Eminov A.S., Aliyeva H.L. Structure oil reserves in Azerbaijan Meso-Canezoic sedimentary // “Academic Science Week – 2015 (ASW – 2015) International multidisciplinary Forum, - Baku: 2-4 November, - 2015, - p. 143-144

4. Shirinov A.T., Eminov A.S. Principles of separation of active and hard-to-extract reserves and the process of their development // International youth forum. Integration processes of the world science in the 21st century, - Ganja Azerbaijan: - 10-14 October, - 2016, - p. 164-166.

5. Ragimov, F.V., Huseynov, R.M., Eminov, A.Sh. Uncertainty & risks while the probabilistic method of estimation of reserves // The International Conference "The Caspian Region: Peculiarities of the geology (the offshore and adjacent oil and gas areas)", - Baku: - 1-3 November, - 2017, - p. 18-19.

Personal contribution by the author. Methodological guide "Current state of development Geological and Mining Indicators of oil fields in Azerbaijan" is used by bachelour and master students who study for speciality" Geological Engineering" at ASOIU and employeers in oil industry.

A new pilot project for oil recovery factors has been applied in accordance with the new methodology proposed for the efficient development of residual reserves in the Pirallahi field.

Proposals to improve the efficiency of the field development have been applied to the fields on the balance sheet of the Azneft PU and additional oil production has been achieved.

The organization where the dissertation has been carried out. The dissertation has been carried out at "OilGasScientificResearchProject" Institute SOCAR.

The volume and structure of the dissertation. Dissertation thesis contains of 5 chapters, conclusions and a list of 144 ublications. Volume of work contains of 179 pages , 22 tables and 56 pages. Introduction 6-pages, 1st chapter – 7 pages, 2nd chapter – 68 pages, 3rd chapter – 22 pages, 4th chapter - 29 pages, 5th chapter – 29 pages, conclution – 1 page, reference – 14 page.

The work contains 219749 characters without tables, figures, graphs and list of reference.

The author is grateful to the scientific supervisor doctor of sciences on geology and mineralogy A.M. Salmanov for his recommendations and help for fulfillment of dissertaion thesis.

The first vice-president of SOCAR, a true member of ANAS, aca-

demician K.B. Yusifzade, the staff of chair of "Oil and gas geology" of ASOIU, employees of "Azneft" PU, who have assisted in carrying out the dissertation with some useful tips and tricks. He expresses his deep gratitude to the staff of “OilGasScientificResearchProject” Institute.

MAIN CONTENT OF THE DISSERTATION

In the introduction justified actuality of the thesis topic and briefly provided information on how to solve raised issues.

Chapter One Modern stage of development of oil geology is related with creation of new geological bases for efficient development of remained reserves on the developed fields along with exploration of oil and gas fields.

At present, the study of the current situation in the long-developed fields of our country shows that it is incorrect to take an unequivocal approach to determining the ways of effective use of existing resources. Complex geological, technological, economic, etc. According to the analysis of the data, the study of a number of issues in the preparation of geological and technological projects is of great importance for the effective completion of the process of development of oil and gas fields.These include:natural conditions of surface hydrocarbon accumulation and distribution boundaries, tectonic failts and their role in the distribution of reservoir fluids, energy properties of fields, resource distribution, field distribution, separation of reservoirs, oil-bearing layout parameters, undergoing different changes (low pressure, displacement of water-oil and gas-oil contours, physical and chemical reservoir and fluid properties summarizing and analyzing the results of research in this area (geological and oilfield and geological-mathematical methods) etc .

Actual problem of development of hard-to-extract oil fields in some oil-producing regions of the world. Currently this problem is relevant for Azerbaijani fields. Therefore, in spite of the large number of oil fields being developed in the country, the rate of production in most of them is low and the current oil recovery factors are low.

It should also be noted that the determination of the parameters that during the development of fields affect the oil recovery coefficient is a great scientific and practical importance (especially for oil fields that are hard to extract). Research on this issue allows to prepare appropriate development projects for the efficient development of field reserves. From the earliest stages of development, same temp exploitation of reserves over the entire area of the field is not possible due to natural (non-uniformity of layers, fracture or fault zones, etc.) and artificial (diversity of well production, uneven artificial impacts, etc.). Therefore, in order to increase the temp of field development and more efficient development of resources, the issue of identifying stagnant and poorly drained zones in the field is also reflected in the dissertation on the basis of a new methodology.

As in a number of oil-producing regions of the world, the problem of developing oil fields with difficult-to-extract reserves is relevant for Azerbaijani fields. Therefore, despite the large number of oil fields under development in the country, the temp of development of many of them is weak, and the current oil production ratios are low. The current stage of development of oil geology is associated with the search and exploration of oil and gas fields, as well as the creation of new geological bases for the efficient development of residual resources in developing fields.

The dissertation is devoted to the problem of creating a geological basis for the maximum use of long-term oil fields existing in the offshore and onshore areas of Azerbaijan. For this purpose, sufficient geological and mining data have been collected, field development processes have been studied in detail and the current state of development has been analyzed.

The following results were obtained after the analysis of the results of the research work carried out on 546 production facilities of 72 oil (22 offshore, 50 onshore) fields.

In the preparation of the work, extensive geological data were collected and systematized. In the different years of research on these problems have been carried out by the following specialists: Yusifzadeh H.B., Abasov M.T., Abramovich M.V., Azamatov V.N., Baybakov N.K.,

Belonin M.D., Buryakovsky L.A., Boxerman A.A., Davis J.S., Mehtiyev S.F., Mirzajanzadeh A.X., Bagirov B.A., Ivanova M.M., Jdanov M.A., Rodionov D.A., Surquchev M.L., Calalov K.I., Abbasov Z.Y., Feyzullaev A.A., Valiyeva E.B., Baharov T.Y., Salmanov A.M., Allahverdiyev I.M., Narimanov A.A., Mehtiyev U.S., Suleymanov B.A., Shaydayev Ch.M., Musaev R.A., Shabanov S.F., Ismayilov F.S., Jafarov R.R., Rzayeva F.M., Gasimli A.M., Maksimov M.I., Harbuh J.U., Golf-Rakht T.D., Mulyavin S.F., Kalkin S.V. and so on.

Within the frame of research it is proposed to solve the abovementioned issues, using the appropriate methods, especially geological and mathematical models [2-6, 9, 12].

The second chapter Azerbaijan is one of the oldest oil and gas producing regions in the world. The development of oil fields with industrial methds have been started in the second half of the XIX century. So far, 81 oil and gas fields (53 onshore, 28 offshore) have been discovered, including 4 fields (Azeri, Chirag, Guneshli, Shah Deniz and Absheron), operated by foreign companies.

72 oil fields (22 offshore, 50 onshore) on the balance of SOCAR have been involved to the study. There were produced 1561.4 mln. tons of up to 01.01.2021 date.

At the same time, according to the researches there are large-scale residual oil reserves on the fields that their current oil recovery factor is 0.32, on active reserves is 0.39, on hard to extract reserves is 0.11 Increasing oil production in the republic is a priority and topical issue facing the geologist with.

The development of the oil industry in our republic related on research, exploration, development, more efficient producing of hydrocarbons of offshore and onshore oil and gas fields. In this regard, development of the residual reserves of oil fields in the Caspian Sea is a great economic importance for the Republic of Azerbaijan. During the exploitation of offshore oil fields, due to the high cost of maintenance of hydraulic structures, it requires a more precise approach for efficient exploitation of the reserves on long term development fields.

Despite the fact that the majority of offshore oil fields in Azerbaijan's have been under development for a long time, each field, iso-

lated block, horizon and well are treated individually and appropriate geological and technical measures are implemented to ensure full recovery.

Currently, there are 22 offshore oil fields, of which 4 are in exploration (South-2, Kapaz, Karabakh, Ashrafi), 2 are in conservativation (Karasu, Hazi Aslanov) and 16 are under development. From this list there are 12 fields (Pirallahi, Gurgan Deniz, Darvin Bankasy, Absheron Bankas;, Garbi Absheron, Neft Dashlary, Palchyg Pilpilasi, Chilov Island, Janub, Gunashli, Gum-Deniz, Spring) and 4 fields (Sangachal-Duvanny-Deniz-Khara-Zira, Bulla-Deniz, Alat-Deniz, 8 Mart) is located in the Baku Archipelago. In total, 154 objects are allocated in these fields, each of which is currently being operated freely.

The industrial development of oilfields onshore begins after the oil flow from the mechanically drilled well in Balakhani-Sabunchu-Ramana (BSR) in 1871. Bibiheybat in 1848, Binagadi in 1896 and Surakhani in 1904 were discovered and involved into the development. Improving resource utilization efficiency firstly depends on the validity of the applied geological and field measurements and the reliable analysis of the results. Despite the fact that the majority of offshore oil fields in Azerbaijan's have been under development for a long time, each field, isolated block, horizon and well are treated individually and appropriate geological and technical measures are implemented to ensure full recovery.Currently, the fields located on the territory of Azerbaijan are subdivided into 6 oil and gas regions and the total number of oil fields is 50.

As of 01.01.2020, 976.2 million tonnes of oil have been extracted from the offshore fields.

The chapter gives a brief overview of the geological data on each deposit [1, 7, 8, 12].

In the summary map of Azerbaijan, there are oil and gas fields located on offshore and onshore, general information about fields, distrubution of initial and residual reserves with graphs, histograms, schemes, figures, the current situation of development of reserves, fields development indicators have been investigated.

The third chapter provides detailed information on the struc-

ture and geological classification of oil reserves of the Meso-Cenozoic deposits of Azerbaijan.

The solution to this issue, which is in the focus of oil industry geologists, involves the use of different approaches and methods, which require a certain grouping of developed objects. Building classification models for development sites and the results of the geological and oilfield analysis of the results of the classification are feasible for the effective completion of the field development.

Despite that numerous are in the final stages of development the scientific and production research let us say that there are still large residual reserves in the reservoirs. The development of oil reservoirs is carried out with the influence of various complex parameters. This leads to different levels of final oil production. The reason for this situation is related to the nature of the development process. The oil extraction process is a dynamic process and the continuous influence of a large number of parameters. The analyzed geological-mining parameters are divided into several groups. For example, the forces that have a positive effect on oil production by pushing oil into the wellbore in a porous environment, and the forces that have a negative effect on oil production that prevent oil to flow into the wellbore, which complicates development.

The dissertation work demonstrates the process of grouping and classification of oil reserves based on certain factors. The classification is based on the parameters adopted in the state balance sheet (GE form 6). Building classification models for development sites and the results of the geological and oilfield analysis of the results of the classification are feasible for the effective completion of the field development. This document describes the oil fields, the effective thickness of the layers, the porosity, the computational coefficient, the physical and chemical properties of the oil (density, viscosity, the percentage of sulfur, paraffin, resin and asphalten), the date of field discovery; date of conservation, production from the beginning of development (separately for the field in general an per zones), depletion of production, rate of development, and so on. such parameters are reflected. However, it is considered appropriate to add other parameters to this form for more complete classification: stratigraphic

sections of the deposits, horizon's depth, oil reserves, geological regimes, level of development (current and final oil ratios). Thus, based on the above-mentioned geological parameters, the classification of the reserves of the considered deposits was carried out and presented in the sequence (Figure 1).

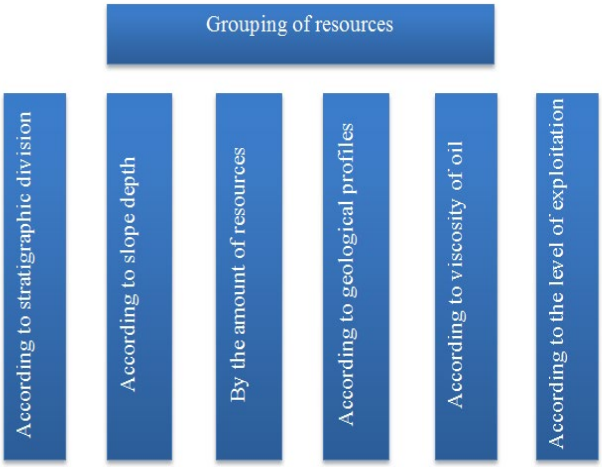

Figure 1. Reserve classification scheme[1]

Researchers highly estimate the oil-field prospectivity of Meso-Cenozoic section on the Absheron NRR. In general, the study of remaining reserves at a greater depths, the analysis of the current state of development and the efficient use of resources is of great practical and scientific importance.

Increasing efficiency of assimilation of proven reserves in onshore and offshore areas of the Republic, first of all, comparative analysis of research of the geological and technical measures and their results, the substantiation of modern geological and technical methods of the fields. Investigation of the current state of the developed deposits does not allow for an unambiguous assessment of the

[1] Bağırov, B.Ə. Neft-qaz mədən geologiyası / B.Ə.Bağırov. - Bakı: ADNA, - 2011. - 311 s.

ways in which waste remaining resources are effectively utilized. Therefore, different approaches are used. In this regard, the grouping of the development facilities by similarity will enable the implementation of identical geological and technological measures (through the implementation of classification procedures).

As a result, it should be noted that this section presents the classification of oil and gas fields of the republic by geological and technological criteria. Based on the classification, it has been established that long-term development of multiple fields, which canbe extracted separately from each facility, allows for the improvement of the relevant development system. Therefore, different approaches are used. In this regard, the grouping of the development facilities by similarity will enable the implementation of identical geological and technological measures (through the implementation of classification procedures).

In many fields upper horizons are more depleted. Therefore the presented methods are more suitable for the lower horizons.

Cluster analysis also allows Identification of factors contributing to the development efficiency.

This document describes the oil fields, the effective thickness of the layers, the porosity, the computational coefficient, the physical and chemical properties of the oil (density, viscosity, the percentage of sulfur, paraffin, resin and asphalten), the date of field discovery, date of conservation, production from the beginning of development (separately for the field in general an per zones), depletion of production, rate of development, and so on. such parameters are reflected.Developed classification and cluster analysis reveal the possibility of commingling of producing layers, which can lead to a shortening of the development lifetime of multilayered fields. In many fields upper horizons are more depleted. Therefore the presented methods are more suitable for the lower horizons. This method is especially important for offshore fields [13, 17, 18, 24].

Chapter four focuses on the quality structure of the oil field reserves. This chapter is divided into three sub-sections. In the first sub-section, the classification of oil reserves, based on the degree of activity is demonstrated.

It should be noted that Azerbaijani oil is one of the highest quality oils in the world.

When analyzing inventory rates, it is apparent that reserves with good geological performance can be termed as “easily extractable reserves,” the term active reserves. In the first sub-section, the classification of oil reserves, based on the degree of activity is demonstrated (table 1).

According to some oil geologists, the parameters of the formation - the viscosity, permeability and thickness of the layers which the main criteria for the definition of difficult-to-extract reserves are should be analyzed separately. According to some, the separation of these three factors was a mistake in principle. Because these indicators determine the hydro permeability of the layer. To solve the problem in terms of quality, it is proposed indicators of hydro permeability, the calculation of which refers to the values of oil viscosity, permeability and layer thickness, given in the table of information on reserves in the State Balance.

Analysis of the geological data of the facilities revealed that 366 of 546 development sites were classified as active reserves. Of these, 123 facilities are operated in the offshore area, and 243 onshore.

Table 1

Distribution of "active reserves" by sea and land (with conventional fuel equivalent)

Field	Number of objects	Production 01.01.2020
offshore	123	531
onshore	243	870
Total	366	1401

Studies in the second half have revealed that if there is a difference between the current technology and the projected and actual prices of each field horizonts, then some geological and technical factors are not fully taken into account in estimating the volume of extracted resources. In the first sub-section, the classification of oil

reserves, based on the degree of activity is demonstrated. The main reasons for such occurrences are the high-heterogeneity of the bearing layers of the fields and the low efficiency of natural regimes, the low solubility of the reservoir rocks, the high solubility of oil and so on. The term "hard-to-extract resources"(HTER) began to be used in the 1970 s.

Experts in the oil industry have found that this problem is due to uncertainty in the determination of quality of oil.

The dissertation includes the opinions, suggestions and criteria for allocation of resources.

As a result of the research it was found that despite the fact that the fields with high viscosity and low permeability were used in the onshore areas of the Republic of Azerbaijan, using the depletion or secondary impact method, the final oil recovery ratio was not more than 30%.

Determining crude prices for these parameters for oil fields of Azerbaijan provides the basis for the separation and grouping of HTER.

From the foregoing, it can be concluded that increasing the level of extraction of HTERs is associated with the application of new technologies, and the selection, grouping, or specification of resource structures, is one of the priority issues to address. Experts in the oil industry have found that this problem is due to uncertainty in the determination of quality of oil.

The main reasons for such occurrences are the high-heterogeneity of the bearing layers of the fields and the low efficiency of natural regimes, the low solubility of the reservoir rocks, the high solubility of oil and so on.

As a result of the classification procedures carried out on approved reserves of the Republic of Azerbaijan, the HTER is divided into three groups according to two basic parameters (permeability of rocks and viscosity of oil). 180 groups are concentrated in these groups, including 31 offshore areas and 149 land areas[2] (Figure 2).

Group I - includes operating objects with a permeability of re-

[2] Bağırov, B.Ə. Azərbaycanın dənizdə ehtiyatı çətin çıxarılabilən neft yataqlarında işlənilmənin başa çatdırılmasının səmərəli yolları / B.Ə.Bağırov, M.Q.Həsənəliyev, A.S.Gəncəliyeva // Azərbaycan Geoloqu, - Bakı: - 2000. №5, - s. 87-95.

servoir rocks less than 0.1 mkm^2 and with oil viscosity greater than 10 mPa • s.

Group II - includes operating objects with a permeability of reservoir rocks greater than 0.1 mkm^2 and with oil viscosity greater than 10 mPa • s.

Group III - includes operating objects with permeability of reservoir rocks less than 0.1 mkm^2 and viscosity of oil less than 10 mPa • s. The third section provides detailed information on the geological and mathematical models of the hard-to-extract of oil fields.

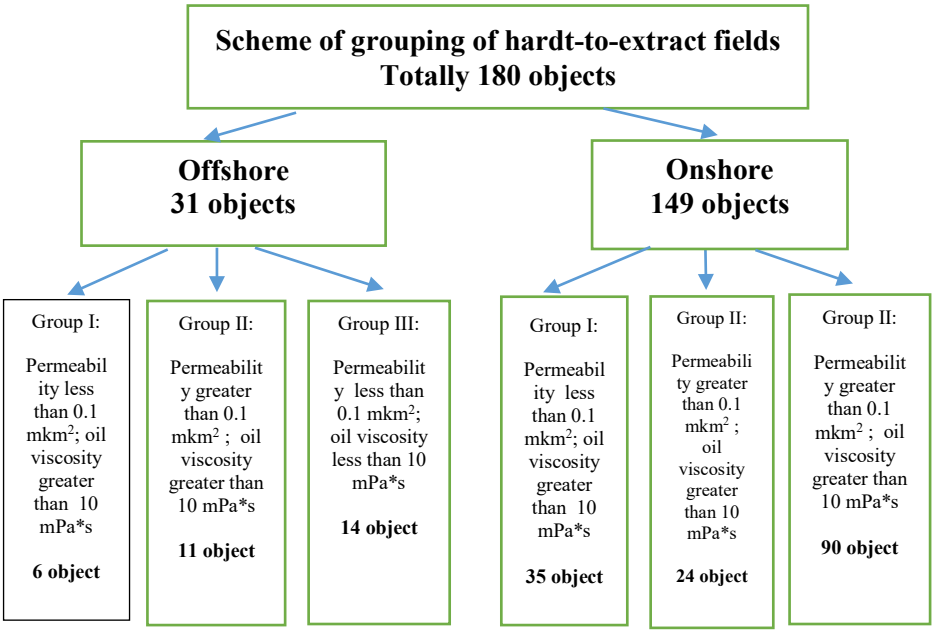

Figure 2. Schematic of groupings of hard-to-extract oil fields reserves

Various explorers have allocated layers of hard-to-extract layers for both offshore and onshore fields in Azerbaijan, and it is known that various deposits have been cited to effectively complete the development of such oil reserves.

From this point of view, the work carried out in the field of

modeling oil production is especially relevant. Modeling methods in petroleum geology are used to determine the specifics of the development of the reserve hard-to extract oil fields.

Mathematical modeling assumes a function of multiple parameters (oil coefficient, rate of development, etc.) which describes the process of development. Among many methods The multi-dimensional correlation-regression method is used more widely.

The main principle behind the acquisition of these models is that during the analysis, parameters that do not significantly affect the correlation coefficient are gradually removed from the model, and more significant ones are maintained for analysis.

In addition, another method of mathematical statistical toolkit the INSCAL method of multidimensional scale is used, which provides a simplified interpretation of geological and mathematical models. The method was first proposed by Takker and Messico.

Thus, in this thesis for the first time oil production model of INDSCAL and correlation-regression analyze with a complex application way realized and obtained. New models were compared with those of earlier models. A schematic illustrating the range of variation of the correlation coefficients of the models obtained for each group for the implementation of various mathematical and statistical methods. The total correlation coefficient for linear correlation-regression analysis for group I objects is (a) P = 0.63; the ratio of the model obtained by applying a multidimensional method is Rc = 0.89, while in the nonlinear models, R total = 0, 80. For Group II facilities (b) this price is 80% and for Group III (c) 77%.

Since the latent variables used in the model are non-dimensional characteristics, the obtained models simplify the interpretation of the models. This means that the factors affecting the oil-productivity capacity in Group 1 facilities are depth, effective thickness, porosity, permeability, viscosity of oil, clay coefficients, sedimentation, and depression. Similar geological and processing indicators also affect oil productivity of the 2nd group facilities, taking into account water cut and reservoir pressure. The 3rd group variables have an effect on the oil productive effective thickness, porosity, viscisity, clay

content, rock consolidation, water cut and depression.[3]

Among many methods The multi-dimensional correlation-regression method is used more widely. The main principle behind the acquisition of these models is that during the analysis, parameters that do not significantly affect the correlation coefficient are gradually removed from the model, and more significant ones are maintained for analysis.Thus, in this thesis for the first time oil production model of INDSCAL and correlation-regression analyze with a complex application way realized and obtained. New models were compared with those of earlier models. A schematic illustrating the range of variation of the correlation coefficients of the models obtained for each group for the implementation of various mathematical and statistical methods.

The results will allow implementation of essential geological and technical measures on time and the efficient use of difficult extracted resources [10, 11, 15, 18, 23, 24].

Chapter Five is devoted to the design of geological and mathematical models for the purpose of estimation of reserve increament in oil fields. This chapter provides sensitivity analysis of a multidimensional array of geological and oillfield parameters for each of the three groups of hard-to-extract oil field reserves. Due to the geological, geophysical, oillfield and development data included into the parameters array, special mathematical operations were performed and graphical descriptions were created to study each of the regularities. “Tornado” diagrams are an example of this.

Built-in Tornado diagrams allow you to check the sensitivity of geological and oilfield factors affecting oil recovery factor. These diagrams qualitatively assess the impact of geological and oilfield parameters on the.recovery factor. Due to the geological, geophysical, oillfield and development data included into the parameters array, special mathematical operations were performed and graphical descriptions were created to study each of the regularities.

Sensitivity diagrams have been developed to evaluate the im-

[3] Абдуллаев, В.Дж.Создание трехмерной геологической модели для повышения эффективности доразработки / В.Дж.Абдуллаев, М.А.Гусейнов, М.М.Исламов [и др.] // Prosedings, - Баку: - 2012. №2, - с. 74-82.

pact degrees quantitatively [14, 19, 20, 21, 22].

In the second half of chapter five, the method of detecting still and weak drainage zones in the oil fields has been developed for the Pirallahi field.

A number of long-term deposits are structurally complex and are accompanied by different rates of development, leading lower pressure of first layer, uneven flow of water and oil and, consequently, uneven distribution of field resources.

The study investigated areas characterized by low values of the use of field resources and identifying the factors that lead to this, as well as for the effective completion of its development justification of relevant geological and oilfield measurements to increase the level of resource utilization, a new approach has been proposed that takes into account the application of new innovations.

The proposed method was implemented in 3 stages:

- First of all, maps of distribution of initial (balance and deducted) inventories by industry were prepared;

- In the second phase, a map of water irragation of production and maps reflecting the drained areas of the field were created;

- In the third phase of the study, settings of prepared maps (mapping of residual oil reserves, diversification and drainage maps) are being carried out.

As a result, new model more perspective local areas was developed which included well of less drainage areas, less waterized but with enough reserves with weak drainage areas. A number of long-term deposits are structurally complex and are accompanied by different rates of development, leading lower pressure of first layer, uneven flow of water and oil and, consequently, uneven distribution of field resources.

The proposed method is based on the complexity of field trends and residual trend maps as a mathematical device that provides a sufficiently reliable solution for the selection of constants areas (zones). The importance and advantage of the method is that it allows the selection of still areas that are clearly different from the general conformity of changes.

In the third half chapter five focuses on the rationalization of

the effective utilization of oil reserves in the fields [16, 17]. This section describes geological and technological measures to reduction of pressure on layer of oil fields in Azerbaijan, reduction of oil production in operating wells, assimilate left oil in layer, ensure leakage of left oil to the bottom of well, watering methods, enhancing oil production of wells drilling of horizontal wells and so on, the effects and efficiencies derived from the application of various methods were evaluated (Figure 3).

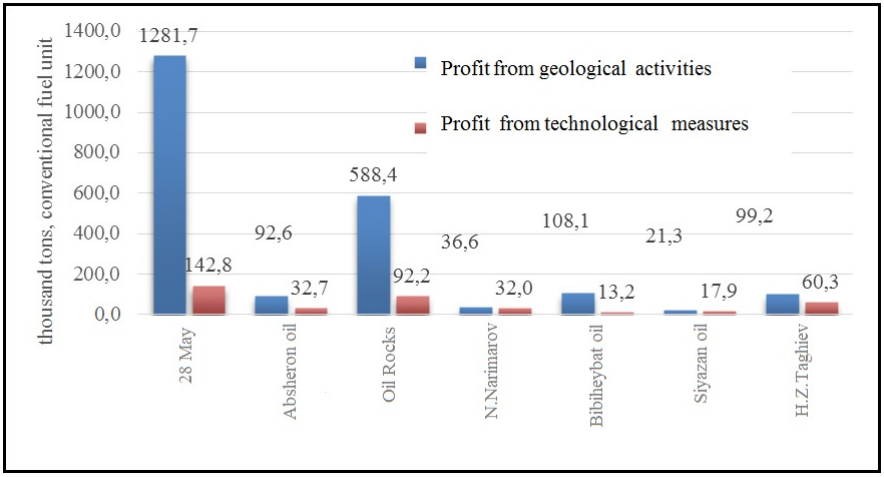

Figure 3. Profit from the geological and technical measures implemented at the Azneft PU OGPC

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methods were evaluated.

It should be noted that the scope of geological and technical measures is very wide. These measures are in the first place in both offshore and onshore fields, both quantitative and qualitative [2, 3].

In general, based on the results of geological and technological projects applied in the fields, high performance in terms of efficiency in offshore and onshore areas was possible due to complex geological and technical measures.

Given the aforementioned, it is advisable to focus on the improvement of the use of new methods, in addition to the use of existing methods for the efficient utilization of residual reserves in long-term processing fields.

CONCLUSION

The following generalized results have been obtained based on the research done on the improvement of the reserve structure in the oil and gas fields being developed in the offshore and onshore areas of the Republic of Azerbaijan and on the rationalization of efficient ways of development by geological and mathematical models:

1. Geological data has been collected, systematized and researched for the efficient development of oil reserves in the offshore and onshore areas of Azerbaijan;

2. The structure of reserves reflecting the early and current periods of Azerbaijan's offshore and onshore oil deposits in the Meso-Cenozoic sediments has been refined, comparative analysis has been carried out, which enabled the use of specific measures for the efficient utilization of residual resources;

3. Improved qualitative classification (active and hard-to-extract) reserves structure of multilayered offshore and onshore fields of Azerbaijan and new method of distribution of residual reserves in reservoirs was done;

4. New geologic-mathematical models of exploitation of difficult extracted resources of offshore and onshore oil fields of Azerbaijan have been created;

5. A new approach has been proposed to identify the positive

and negative factors affecting the ORF in the facilities that have HTER;

6. For the first time, a new method of identifying stagnant and weak drainage areas for efficient utilization of residual oil reserves based on complex geological data has been developed, applied to Pirallahi and similar fields;

7. On the basis of complex scientific researches, the intensification of the development of oil reserves in the fields, the application of geological and technical measures and impact methods for the enhancement of ORF were justified and the effectiveness evaluated.

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