Paradigm oil and gas complex of Russia at the present stage

A E Kontorovich, L V Eder and I V Filimonova

Trofimuk Institute of Petroleum Geology and Geophysics, Siberian Branch of the Russian Academy of Sciences, 3 Koptyug Ave., Novosibirsk, 630090, Russia
Federal Research Center of Coal and Coal Chemistry, Siberian Branch of the Russian Academy of Sciences, 18, Sovetskiy Ave., Kemerovo, 650000, Russia

E-mail: KontorovichAE@ipgg.sbras.ru

Abstract. The paper presents the features of the Russian oil complex development paradigm in the 20th century, including the priority search and development of unique and major fields; expansion of the oil industry geographical location; priority input into the development of reserves that are characterized by high quality characteristics. It is substantiated that at the present stage there is a need to change the development paradigm as well as the transition from extensive to intensive development, including the development of sedimentary basins of the Russian shelf of the Arctic Ocean; poorly studied petroleum provinces in the east of the country; unique oil resources of nonconventional sources; complex and rational use of residual reserves of unique and major fields.

1. Introduction

So far, the bowels use paradigm in the fuel and energy sector of Russia has been predominantly extensive, characterized primarily by a quantitative increase in the production of raw materials with a relatively unchanged technical potential.

The extensive development path provided for the expansion of the geography of the oil-and-gas production industry at the expense of new provinces on the continental part of Russia; priority search and development of unique and major fields; priority input into the development of reserves characterized by high quality characteristics; increasing the processing of raw materials with the production of relatively low quality products. The extensive development path, on the one hand, creates opportunities for growth in the economy and its individual sectors because it increases production resources, and, on the other hand, it limits the opportunities for qualitative growth.

At the present time, a paradigm shift in the development of Russia’s resource and raw materials complex should occur. The paradigm shift is connected with the transition from an extensive to an intensive trajectory of development. A qualitative leap and a sharp increase in the innovative character of the raw material industries development must occur for sustainable development of the economy as a whole, taking into account both the importance of the raw material complex in its structure, and, separately of the raw materials industries and resource regions. Such a change should occur regarding the integrated development of Russia’s resource regions and enhance the efficiency of Russia’s bowels use system throughout the entire production chain, starting from geological exploration and ending with the formation of processing capacities and the transport system for raw materials and products of their processing.

2. Methods of research
The methods of economic, normative, comparative and expert analysis have been used in the work. To justify the parameters of the paradigm shift in the development of Russia's oil and gas complex, a combined approach has been used which involves a combination of macro-forecasting methods and a method of comparing the main targets of subsoil use policy and the associated complex institutional effects.

3. Results and discussion

The paradigm of the Russian oil complex development in the twentieth century

The paradigm of the Russian oil complex development strategy in the twentieth century was focused on a predominantly extensive development path, which includes the following main features:

1) priority search and development of unique and major fields;
2) expansion of the geography of the oil industry at the expense of new provinces on the continental part of Russia (moving from West to East) [1];
3) Priority input into the development of reserves characterized by high quality characteristics (porosity, permeability, viscosity and density).

The oil industry at the present stage; the need to change the development paradigm and transition from an extensive to an intensive development

At present, the significant structural changes are taking place in the structure of the mineral and raw materials base, which in essence will determine a new development paradigm of the Russian oil industry for the long term.

Firstly, a qualitative change in the structure of the fields being developed, in terms of developing unique and major fields and increasing the share of medium-sized and small fields in the structure of reserves is taking place.

Secondly, the geography of oil production in Russia is significantly changing with the increasing role of the eastern regions of Russia and its sea shelves [3].

Thirdly, there is a significant reduction in the amount of recoverable reserves in the fields prepared for commercial production, while increasing the number of such fields;

Fourth, there is a significant quality loss of oil reserves, due to the increase in the share of hard-to-recover oil reserves.

Fifth, there are changes in the structure of oil reserves by categories with an increase in the share of reserves of highly reliable categories already involved in development.

The role of unique and major fields at the present stage

At present, the raw materials base structure of the oil industry in Russia has changed significantly. The role of unique and major fields in the oil production has decreased. As of January 1, 2016, 11 unique and 87 major oil fields remained in the Russian Federation in terms of residual oil reserves. About 3.7% of all unique and major oil, gas and oil-and-gas fields account for about 56% of residual oil reserves (Figure 1). At the same time, there are still a number of problems related to the development of unique and major fields. First of all, these are high depletion, water cut and relatively low production rates.

Small and smallest fields are the main category of discovered fields at the present moment and for the long term

Small and smallest fields are the main category of newly discovered fields at present

As a result, the role of medium-sized, small, and in the medium term the smallest fields is sharply increasing. In the 21st century only small fields were discovered in the main oil producing regions of Russia. In the Orenburg region, the Republic of Tatarstan and the Republic of Bashkortostan, the share of discovered fields with the reserves of less than 1 million tons makes up almost 70-90%. In Khanty-Mansiysk Autonomous Okrug (KhMAO) and Tomsk region this figure is just under half. At the same time, the average level of the discovered field in the KhMAO, which is the largest oil region, does not exceed 3 million tons. As a result, according to a new scale classification of fields on average, the smallest fields are discovered, with the recoverable oil reserves no more than 5 million tons.
Figure 1. The share of unique and major fields in Russia in (a) initial recoverable oil reserves, (b) current recoverable oil reserves.

Structural shifts in the production geography

Western Siberia is the main center of the Russian oil industry, where more than 56% of Russian oil is produced. However, over the last decade, the region's share in the production structure has decreased by 12%. In 2016, oil production in Western Siberia amounted to 309.6 million tons. Eastern Siberia and the Far East are regions with the most dynamically developing oil production. So, while in 2008 their share in the oil production structure was less than 3%, in 2016 they produced 12%. Since 2012 a gradual increase in oil production has been taking place in the European part of Russia. Thus, production increased from 151.4 million tons in 2012 to 169.3 million tons in 2016 (figure 2).

Figure 2. Structure of oil production in Russia by macroregions, %.
The deterioration of the oil reserves structure, associated with the increase in the share of hard-to-recover oil reserves

The structure of the explored oil reserves in Russia is continuously deteriorating. The share of hard-to-recover reserves in the overall structure of oil reserves is growing rapidly. Under the hard-to-recover reserves, in this case we mean the accumulation of oil in low-permeability reservoirs, in subgas and water cut zones, multilayer reservoirs with relatively low thickness of oil-saturated reservoirs, viscous and dense oil (Table 1). To date, the actual reserves have been developed on average by 75%, while the hard-to-recover reserves have been developed only by 35%.

### Table 1. The structure of oil reserves by regions with differentiation in terms of the oil quality characteristics.

| Federal Districts | Share of oil reserves with high density by region, % | Share of oil reserves with high viscosity by region, % | Share of oil reserves with low permeability, % |
|-------------------|---------------------------------|---------------------------------|---------------------------------|
|                   | 0.87-0.9 g/cm³ | More than 0.9 g/cm³ | More than 30 MPa*s | Less than 0.05 mm² |
| Northwestern      | 11.9             | 39.8             | 31.5             | 16.7             |
| Southern          | 4.7              | 21.7             | 12.1             | 15.8             |
| North-Caucasian   | 1.2              | 2.1              | 2.1              | 48.1             |
| Privolzhsky       | 30.9             | 26.7             | 25.2             | 27.9             |
| The Urals         | 17.1             | 10.3             | 8.1              | 58.2             |
| Siberian          | 7.6              | 15.7             | 0.2              | 30.3             |
| Far Eastern       | 17.2             | 4.4              | 1.9              | 2.1              |
| Shelf of the Russian Federation | 16.7 | 21.6 | 4.5 | 11.6 |
| Russian Federation | 18.4           | 16.4             | 12.2             | 44.0             |

The new development strategy paradigm of raw materials and oil production in the Russian Federation

Major structural shifts in the resource and raw materials base and oil production in Russia determine the need for a new paradigm for the oil-and-gas industry, since the old one has largely been realized and exhausted.

In the 21st century, the main new objects of prospecting, exploration and development of oil fields, as well as the priority tasks of the oil-and-gas industry of the Russian Federation will be:

1) sedimentary basins of the Russian shelf in the Arctic Ocean;
2) poorly investigated provinces on land (Leno-Tunguskaya province) [4];
3) large objects not entered into development in the northwest of Western Siberia in the Yamal-Nenets Autonomous District [5];
4) unique oil resources from nonconventional sources (Bazhenov suite, etc.);
5) rational use of residual reserves of unique and major fields [6, 7, 8, 9];
6) prospecting, exploration and development of small, smallest and medium-sized fields in mature petroleum basins. [10, 11].

4. Conclusions

At the present time, a paradigm shift in the development of Russia’s resource and raw materials complex should take place. The paradigm shift is connected with the transition from an extensive to an intensive trajectory of development. The intensive path of development is connected, first of all with the innovative approach to extraction and use of mineral raw materials. In the oil and gas complex in the sphere of production, such key areas are the development of hard-to-recover and nonconventional...
hydrocarbons, the shelf of the Arctic Ocean; poorly studied provinces in hard-to-reach arctic regions; rational use of residual stocks of unique and major deposits; prospecting, exploration and development of small, smallest and medium-sized deposits in mature oil and gas provinces.

Acknowledgements
The authors are grateful for financial support of the Russian Science Foundation No. 16-18-10182, as well as to the Russian Foundation for Basic Research No. 15-06-090994, 16-36-00369, 17-06-00537.

References
[1] Kontorovich A E, Eder L V and Nemov V Yu 2013 Neftyanoe Khozyaystvo (Oil Industry) 1 4–8
[2] Kontorovich A E, Eder L V, Filimonova I V, Mishenin M V and Nemov V Y 2016 Russian Geology and Geophysics 57(12) 1653–67
[3] Korzhubaev A G, Filimonova I V, Eder L V and Sokolova I A 2009 Neftyanoe Khozyaystvo (Oil Industry) 3 14–7
[4] Kontorovich A E, Korzhubaev A G, Filimonova I V and Eder L V 2008 Neftyanoe Khozyaystvo (Oil Industry) 5 24–7
[5] Kontorovich A E, Eder L V and Nemov V Yu 2012 Neftyanoe Khozyaystvo (Oil Industry) 7 66–70
[6] Tagaeva T O, Gilmundinov V M and Kazantseva L K 2017 Economy of Region 14(7) 165–77
[7] Tagaeva T O 2011 Source of the Document Studies on Russian Economic Development 22(3) 331–8
[8] Kryukov V A, Bozo N V and Malysheva Y V 2005 9th Russian-Korean Int. Symp. on Sci. and Tech., KORUS-2005 898–903
[9] Nikitenko S M and Goosen E V 2017 IOP Conf. Series: Earth and Environmental Science 53 012018
[10] Sharf I, Filjushin V, Shenderova I and Kochetkova O 2015 IOP Conference Series: Earth and Environmental Science 27(1)
[11] Nikitenko S M, Goosen E V and Sablin K S 2016 IOP Conference Series: Earth and Environmental Science 45 012001