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REPORT

on the study

ANALYSIS OF OIL AND GAS WELLHEAD SAMPLES FROM WELL 4
OF YELLEY-IGAISKAYA PROSPECT

AGREEMENT LI5548 DATED 1.02.2018

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ABSTRACT

Analysis of oil and gas wellhead samples from well 4 of Yelley-Igaiskaya prospect was completed.

By oil chromatography mass-spectrometry a set of molecular parameters were calculated, based on distribution of saturated, aromatic and heteroatomic compounds. Genetic typification of the fluids under study was performed by combination of molecular parameters and carbon isotope composition. Assumptions are proposed regarding the sources of oil and gas in various development objects of Yelley-Igaiskoye field.

KEY WORDS. West Siberia, Yelley-Igaiskaya prospect, molecular parameters, carbon isotope composition, geochemical studies, catagenesis, oil.

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COST ESTIMATE

for performance of works as follows:

Analysis of oil and gas downhole samples from well 4 of Yelley-Igaiskaya prospect

№	Types of works/tests	Measuring unit	Amount	Unit cost, rub. with VAT (18%)	Total cost, rub. with VAT (18%)	Status	Executor
1	Acceptance and registration of samples	sample	3	166,47	499,41	completed	Laboratory of geochemistry and reservoir oils OOO TomskNIPIneft
2	Oil wellhead sample analysis				80 348,84		
2.1	Oil gravity at 20°C	sample	2	443,92	887,84	completed	
2.2	Kinematic viscosity (at 20°C)	sample	2	1 220,77	2 441,54	completed	
2.3	Kinematic viscosity (at 50°C)	sample	2	1 220,77	2 441,54	completed	
2.4	Fractional composition up to 300 °C	sample	2	1 220,77	2 441,54	completed	
2.5	Molecular weight	sample	2	2 663,50	5 327,00	completed	
2.6	Total sulphur	sample	2	1 109,79	2 219,58	completed	
2.7	Tar and asphaltenes content	sample	2	3 440,35	6 880,70	completed	
2.8	Paraffin content	sample	2	6 658,74	13 317,48	completed	
2.9	Freezing point	sample	2	1 109,79	2 219,58	completed	
2.10	Water volume fraction	sample	2	554,90	1 109,80	completed	
2.11	Content of mechanical impurities in contaminated samples	sample	2	2 774,48	5 548,96	completed	
2.12	Paraffin saturation point	sample	2	17 756,64	35 513,28	completed	
3	Compositional analysis of associated gas C ₁ -C ₁₀	sample	1	7 213,64	7 213,64	completed	
4	Geochemical analysis of oil and gas samples				107 982,54		
4.1.	Oil type analysis (extraction and identification of qualitative content of saturated aromatic hydrocarbons, tar and asphaltenes)	sample	2	9 988,11	19 976,22	completed	
4.2.	Chromatomass spectrometry analysis of saturated fraction at SIM regime	sample	2	14 538,25	29 076,50	completed	
4.3.	Chromatomass spectrometry analysis of aromatic fraction at SIM regime	sample	2	14 538,25	29 076,50	completed	
4.4.	Carbon isotope composition of liquid and solid samples (oil, saturated fraction, aromatic fraction, tar, asphaltenes)	sample	10	1 886,64	18 866,40	completed	
4.5.	Isotope composition of methane carbon	sample	1	2 108,60	2 108,60	completed	
4.6.	Carbon isotope composition of gas components C ₂ -C ₅ at a component content of not less than 0.1 %	sample	1	8 878,32	8 878,32	completed	
5	Preparation of minutes of quantitative chemical analysis. Preparation of an Expert Judgement supported by factual information (10 % of the cost of works under the agreement)		10% of the cost of works		19 604,44	completed	
Total with VAT (18%), rub.:					215 648,87		
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1. ANALYSIS METHOD

1.1. Definition of oil physical and chemical properties

Physical and chemical properties were defined for oil samples: density, sulphur content, molecular mass, and content of paraffins, tars, asphaltens, as well as fractional composition and setting point.

Density – is one of the most important and widely used properties of oil and its fractions. For oil under study the density was defined with aerometer under 20⁰C by GOST 3900-85.

Cinematic viscosity was defined under 20 and 50⁰C by GOST 33-2000.

Total sulfur in oil was defined with HORIBA instruments by XF method, GOST P 51947-2002. GOST P 51947-2002 establishes the method for sulphur definition from 0,0150 % to 5,00 %.

Molecular mass of oil was defined by GOCT 153-39.2-048 with CRYETTE cryoscope.

Paraffin content was defined by removal of asphaltic and tarry matter from oil, its extraction, adsorption and subsequent precipitation of paraffin with acetone and toluene composition under 20 °C below zero (GOST 11851).

Asphaltenes and tar content was defined by method of Russian National Institute for Oil Refinery.

Fractional composition of oil was defined by GOST 2177-99, allowing for establishment of initial boiling point and number of fractions from 100 °C to 300 °C and temperature gradient of 50 °C.

Setting point of oil was defined by GOST 20287.

Paraffin saturation point was defined by GOST 39.034-76.

Mass fraction of water was defined by GOST 2477-2014.

Mass fraction of solids in oil was defined by GOST T 6370-83.

1.2. Group analysis of oils and extracts (separation of saturated, aromatic hydrocarbons, tars and asphaltens)

After deasphalting by a forty-fold excess of petroleum ether (Gaultier method), the oils were separated by liquid adsorption chromatography method to fractions containing saturated, aromatic hydrocarbons and tars [1].

Separation was performed in 500mm. glass column with inner diameter of 10 mm. ASKG silica gel with a grain size of 200-500 μm was used as adsorbent. Silica gel was poured in the column in small portions and compacted by tapping until the adsorbent level stopped decreasing. Prior to separation, the silica gel in the column was wetted with petroleum ether to eliminate wetting heat and reduce the channeling possibility. After that, oil diluted with petroleum ether was placed in the column.

Elution was carried out stage-wise, with petroleum ether and benzene. Fractions eluted with petroleum ether contained paraffin-naphthenic hydrocarbons, and fractions eluted with benzene contained sulfur-aromatic concentrate. Solvent was distilled from the obtained fractions. Quality control of separating oil into fractions was ensured by chromatographic mass spectrometry.

1.3. Chromatography Mass-Spectrometry Analysis

The separated oil fractions were analyzed by gas chromatographic-mass spectrometry on a Hewlett Packard 6890/5973 apparatus with an HP-1-MS column (30 m, 0.25 mm) in linear temperature programming mode (3 min 45° C, 45° C to 310° C, heating speed 3°C / min, thermostating time - 20 minutes under 310°C). The data was collected and processed with ChemStation software.

Based on the data of chromatographic mass spectrometry, the composition and molecular weight distribution of a number of hydrocarbon classes were established; their relative content was calculated, as well as a number of geochemical parameters reflecting both, the genetic characteristics of the samples, and the catagenesis effect. Used molecular parameters are listed in Table 1.1.

Table 1.1 – List of molecular parameters, obtained during the analysis of oil and chloroform extracts from rock

Parameter	Calculation formula; (characteristic ion)	Description	Reference
P/Ph	<i>Pristane/Phytane</i> (m/z 57)	Pristane and Phytane content ratio	Tisso B., Velte D., 1981
Ki	$(P+F)/(H-C_{17}+H-C_{18})$ (m/z 57)	Isoprenoid index, ratio of sum to prostanoid isoprenoids and phytane to phytane and sum of H-C ₁₇ and H-C ₁₈	Petrov Al. A., 1974
4MDBT/1MDBT	4MDBT/1MDBT (MDBT – methylthiophene, m/z 198)	Methylthiophene ratio	Radke M. et al., 1986
MPI-1	$I_{5.5}(2MP+3MP)/(0.69P+IMP+9MP)$ (P-phenanthrene, m/z 178; MP –methylphenanthrene, m/z 192; 0.69-difference factor during calculation by mass fragmentograms and by flame-ionization detector)	Methylthiophene index	Radke M. et al., 1986
C29/C27St	C ₂₉ /C ₂₇ , m/z 218	Content ratio of C ₂₈ and C ₂₉ steranes	Grantham P.J. et al., 1988
C28/C29St	C ₂₈ /C ₂₉ , m/z 218	Content ratio of C ₂₈ и C ₂₉ steranes	Grantham P.J. et al., 1988
S/(S+R) C29 St	S/(S+R), % (S и R – S и R isomers 5α,14α,17α(H)-Stigmastane, m/z 218)	Content ratio of S and R isomers of C ₂₉ steranes	Seifert W.K. et al., 1986
ββ/(ββ+αα) C29 St	ββ/(ββ+αα), % (ββ и αα – S и R isomers 5α,14β,17β (H)- Stigmastane и 5α,14α,17α(H)- Stigmastane, m/z 218)	Content ratio of ββ and αα isomers of C ₂₉ steranes	Seifert W.K. et al., 1986
DIA/REG	Dia/Reg (Dia – sum of S and R isomers 13β,17α(H)-Diacholestane, Reg – sum of S and R isomers 5α,14α,17α(H)-Cholestane and 5α,14β,17β(H)-Cholestane, m/z217)	Dia- and regular C ₂₇ steranes ratio	Mello M.R. et al., 1988
Ts/(Ts+Tm)	(Ts – 22,29,30- Thrisnorneogopane, Tm – 22,29,30- Thrisnorgopane, m/z 191)	Ts and Tm ratio	Seifert W.K. et al., 1978
H31S/(S+R)	S/(S+R), % (S и R – isomers 7α,21β (H)-29-Homohopane, m/z 191)	Content ratio of S and R isomers of C ₃₁ hopane	Ensminger A. et al., 1977; Seifert W.K. et al., 1980
H/(H+M)	H/(H+M) (H-hopane, M-moretane, m/z 191)	Hopane-Moretane index	Seifert W.K. et al., 1980
C35/C34Hop	S and R C ₃₅ hopane isomers ratio to S and R hopane isomers C ₃₄ (m/z 191)	Hopane ratio	Peters K.E. et al., 2005
H29/H30	C29 hopane to C30 hopane (m/z 191) ratio	Hopane ratio	Peters K.E. et al., 2005
TA(I)/TA(I+II)	TA(I)/TA(I+II) Sum of TA(I) – pregnane and 20-methylpregnane, TA(II) – sum of 20S and 20R holestane, 20S and 20R stigmastane, 20S and 20R ergostane, (m/z 231)	Parameter, based on triaromatic steroids content ratio	Beach F. et al., 1989
ABI	2C21/(C20+C22), ratio of C15-alkyl benzene (C21) to sum of C14-(C20) and C16- alkyl benzenes (C22), (m/z 91)	Alkyl benzene index	Goncharov I. V. and other, 2013
MA/Alk	Ration of n- alkyl benzenes C13-C16 (m/z 91) to n-alkanes C13-C16 (m/z 57)		Goncharov I. V. and other 2013
Ks	Ratio of C26- alkane to C25 and C27		Goncharov I. V. and other, 2013

In order to obtain correct data suitable for comparative analysis, the components that are most resistant to weathering and oxidizing were considered in this work. Such an approach allowed to eliminate impact of random factors (improper storage of samples, difference in conditions of samples preparation and analysis, etc.).

Values of peak areas obtained by integration of peaks in mass-chromatograms by a certain characteristic ion were taken as a basis for calculation of geochemical parameters.

Correct comparison of results and correct conclusions are impossible to be made without a metrological evaluation of results received. In other words, in order to draw the line and answer the question “friend-or-foe”, one needs to be sure that variations of the values lie beyond the error of analytical determination. In order to do this, it is necessary to know the error of method that is defined by analysis of parallel samples. The quality of chromatography mass-spectrometry analysis was controlled in accordance with the laboratory internal standard for which the oil sample taken from well 2r of Yuzhno-Cheremshanskoye field of Tomsk Oblast was taken (the interval of 2676-2683 m, J₁³ formation).

1.4. Carbon isotope analysis of oils and their fractions

Determination of carbon isotope composition of oils and their chromatographic fractions was executed at isotope mass-spectrometer DELTA V ADVANTAGE (manufactured by Thermo Fisher Scientific, Bremen, Germany) featuring element analyzer Flash 2000 and universal interface ConFlo IV that provides commutation of isotope mass-spectrometer and element analyzer. From auto-sampler, the sample is fed into reactor where carbon is oxidized and in the form of CO₂ is then fed into the mass-spectrometer.

The method of mass-spectrometry of isotope relations does not imply absolute measurements. When isotope relations are defined, it is necessary to use comparison with calibrated standards. As it is necessary to minimize errors caused by tools, it is recommended to measure gas-standard immediately before or after peak measurement of gas-sample. The measurement result is calculated using the following equation:

$$\delta (\text{‰}) = \left(\frac{R_x - R_{std}}{R_{std}} \right) * 1000,$$

where

- R – relation of heavy isotope to light isotope;
- x – index that identifies the measured sample;
- std – index that identifies the standard sample.

To control reliability of the results of measurements, IAEA – NBS-22 (mineral oil) with the value of $\delta^{13}\text{C}_{\text{VPDB}} = -30.03 \text{ ‰}$ and IAEA-CH-7 (polyethylene) = $-32,15\text{‰}$ standard samples were analysed in every 9-10 samples.

For each of the analysed sample, not less than 3 parallel measurements were done. The results were considered to be correct in case the deviation among parallel measurements did not exceed 0.1 ‰.

1.5. Determination of gas composition

Composition of the gas sample was determined at gas chromatograph equipped with FID detector.

Gas chromatographic determination of gas components was performed according to GOST 31371.7-2008 (Method A).

Analysis setting.

Analysis of the gas samples was performed at gas chromatographs Crystal 5000.2 and Crystal 2000 M.

The following components were determined with chromatograph Crystal 5000.2 equipped with 3 TCD module (3 thermal conductivity detectors):

Composition of *hydrocarbon part* C_2-C_5 and carbon dioxide was determined with the help of packed column made of stainless steel ($L = 3 \text{ m}$, $\varnothing_{\text{internal}} = 2 \text{ mm}$) filled with Haysep R 80/100 mesh and TCD №1.

Methane, nitrogen and oxygen were identified with the help of TCD 2 and steel packed column with NaX 60/80 mesh ($L = 2 \text{ m}$, $\varnothing_{\text{internal}} = 3 \text{ mm}$).

Hydrogen and helium were separated from other components at the packed column filled with CaA 60/80 mesh ($L = 4 \text{ m}$, $\varnothing_{\text{internal}} = 3 \text{ mm}$) and were detected with TCD 3.

Gas analysis setting:

Initial programming temperature, °C	40
Final programming temperature, °C	200
Temperature programming speed (up to 130 °C), °C/min	9
Temperature programming speed (from 130 to 200 °C), °C/min	15
Vaporizer temperature, °C	210
Detector 1 temperature (TCD1), °C	210
Detector 2 temperature (TCD2), °C	210
Detector 3 temperature (TCD3), °C	210
Gas vehicle 1 (analysis of HC, oxygen, nitrogen, carbon dioxide)	Helium

Gas vehicle 1 velocity flow through the column, ml/min	35
Gas vehicle 2 (analysis of hydrogen and helium)	Argon
Gas vehicle 2 velocity flow through the column, ml/min	15

Composition of *hydrocarbon part C₆-C₁₀* was identified at chromatograph Crystal 2000M equipped with FID, a flame-ionization detector, a capillary column HP-1 (30 m × 0.319 mm × 3.00 μm).

Analysis setting for identification of C₆-C₁₀ hydrocarbons

Initial programming temperature, °C	40
Final programming temperature, °C	150
Temperature programming speed, °C/min	6
Vaporizer temperature, °C	160
Detector temperature, °C	180
Gas vehicle	Helium
Gas vehicle velocity flow through the column, ml/min	61.5

Quantitative calculation executed by chromatograph was performed with the help of Chromatec Analytic (version 2.5).

1.6. Carbon isotope analysis of gas components

Determination of carbon isotope composition of methane and carbon dioxide, as well as C₂-C₅ gas components of wellhead samples of gas was performed at DELTA V ADVANTAGE to which, through ConFlo IV interface module, TRCE GC ULTRA gas chromatograph is connected equipped with GC Isolink module.

Separation of gas components in chromatograph takes place at PoraPlot Q capillary column (50 m • 0.32 mm • 10 μm). The temperature regime of the capillary column depends on the component identified.

When carbon isotope composition of methane is performed, heat block of capillary column has the following temperature programming regime:

Initial programming temperature, °C	35 (isotherm 12 min)
Final programming temperature, °C	200 (isotherm 10 min)
Temperature programming speed °C/min	20
Vaporizer temperature, °C	120
Gas vehicle velocity, ml/min	2

Temperature programming regime of the heat block of capillary column when carbon isotope composition of C₂-C₅ components is identified:

Initial programming temperature, °C	40
Final programming temperature, °C	150 (isotherm 20 min)
Temperature programming speed °C/min	10
Vaporizer temperature, °C	120
Gas vehicle velocity, ml/min	2

The volume of gas sample introduced into the capillary column depends on concentration of component identified within the analysed sample and is determined individually for each of the case based on the result of gas component analysis.

When isotope composition of minor components of gas mixtures is identified, a chromatograph uses a system of backflush that excludes entry of large quantities of macrocomponents into ion source of mass-spectrometer and thus excludes overload of electronic amplifiers.

Identification of $\delta^{13}\text{C}$ value of an individual component is possible in case its presence in the gas mixture makes 0.1 vol.% and higher.

For each analysed component, not less than 3 parallel measurements were performed. The results were considered to be correct in case the deviation among the parallel measurements did not exceed 0.2 ‰.

To control reliability of measurement results, gas mixtures manufactured by AIR LIQUIDE were analysed containing methane with a known isotope composition:

Thermo 1.1 High: $\delta^{13}\text{C}_{\text{VPDB}}(\text{CH}_4) = -45,5 \text{ ‰}$,

Thermo 1.2 High: $\delta^{13}\text{C}_{\text{VPDB}}(\text{CH}_4) = -24,1 \text{ ‰}$.

2. ANALYSIS RESULTS

2.1. Physical and chemical oil analysis

According to the task, physical and chemical analysis were performed for two oil samples taken from well 4 of Yelley-Igaiskaya prospect from two testing objects:

- 1) Object № 9, J₅ formation, perforation interval: 2764-2772 m;
- 2) Object № 10, J₁ (2-3-4) formation, perforation intervals: 2661-2664 m, 2656-2659 m, 2641-2643 m.

The results are presented in Table 2.1 and in the Protocols of Quantitative Chemical Analysis (Appendix).

Table 2.1 – Physical and chemical parameters of oil from well 4 of Yelley-Igaiskaya prospect

Parameter identified	Measurement unit	Yelley-Igaiskoye field, well 4, object 9	Yelley-Igaiskoye field, well 4, object 10
In-house laboratory code		P180192	P180193
Sampling date		10.01.2018	25.01.2018
Sampling conditions		J₅ formation	J₁(2-3-4) formation
Perforation interval		2764-2772 m	2661-2664 m, 2656-2659 m, 2641-2643 m
Density at 20 °C	kg/m ³	781.3	826.1
Mass fraction of total sulfur	mass %	0.0762	0.325
Mass fraction of asphaltenes	mass %	0.58	0.78
Mass fraction of silica-gel tars	mass %	2.0	4.2
Mass fraction of paraffines	mass %	0.4	0.9
Molecular weight		156.0	186.0
Fractional composition:			
Initial boiling point	°C	70.0	63.0
Distillation yield			
up to 100 °C	vol.%	1.0	2.0
up to 150 °C	vol.%	21.0	11.0
up to 200 °C	vol.%	48.0	25.0
up to 250 °C	vol.%	67.0	43.0
up to 300 °C	vol.%	81.0	64.0

According to the data presented in Table 2.1, the values of physical and chemical parameters of analysed oil samples taken from different objects are significantly different. Oil from J5 is characterized by a substantially lower density, viscosity than oil from J1 (2-3-4). The content of sulfur, paraffins, tars is lower J5 oil. The biggest difference is observed in sulfur content. Fractional composition of J5 sample is characterized by a bigger content of light fractions, up to 300 °C 81.0 % distils off, in oil from J1 (2-3-4) – 64.0 %. Fractional composition of J5 sample is not completely clear. Light fractions that distil off before 100 °C are almost absent. On the other part, compared to the other samples, the content of heavy fractions is lower in this oil, 81 % of oil distils off before 300 °C. Perhaps, this is conditioned by analysis features.

Based on the results of analysis, according to GOST P 51858-2002, analysed oils can be characterized in the following way:

- 1) Object № 9, J₅ formation, perforation interval: 2764-2772 m;
 - sulfur content – low sulfur (sulfur mass fraction – up to 0.60 % inclusive);
 - according to density and fractional composition it refers to type 0 (very light oil).
- 2) Object № 10, J1(2-3-4) formation, perforation interval: 2661-2664 m, 2656-2659 m, 2641-2643 m.
 - according to sulfur content low sulfur (mass fraction of sulfur – up to 0.60 % inclusive);
 - according to density and fractional composition it refers to type 1 (light oil).

The analysed oil samples from objects J5 and J1 (2-3-4) differ according to their physical and chemical characteristics not only between the two of them, but also from the oil samples that had been previously taken from this well in 2015 and 2016.

The previous samples did not differ from each other according to their physical and chemical properties, insignificant variations can be explained by sampling and storage conditions. They are even lighter than oil from J5 formation, are characterized by low density among all the samples analysed starting from 2015. They are also notable by the low content of sulfur, paraffins, tars and asphaltenes among all the analysed oil samples taken from this well.

2.2. Hydrocarbon group analysis

Oil samples that were submitted to the lab were separated into fractions using the method of column liquid chromatography (see Section 1.2) in order to identify group composition and further isotope analysis. The results are presented in Table 2.2.

Table 2.2 – Group composition of oils from well 4 of Yelley-Igaiskoye field

Perforation interval, m	Formation	Sampling date	PNF	Aromatics
			mass %	
2661-2664, 2656-2659, 2641-2643	J1 (2-3-4)	25.01.2018	65.66	26.85
2764-2772	J5	10.01.2018	82.06	13.92

It can be seen from Table 2.2 that, according to group composition, oils from different productive horizons differ from each other. Oil sample from J5 formation is characterized by a higher content of paraffine-naphthenic fraction compared to oil from J1 (2-3-4). According to the presence of aromatic hydrocarbons (HC), oil from J5 formation differs significantly from oil from J1. In this oil (J5), the aromatics content is two times less than in oil from J1. Such a low content of aromatics is typical for oils produced by nonmarine organic matter (OM).

2.3. Chromatography mass-spectrometry of oil analysis

Within the frame of this work, it was required to analyse saturated and aromatic fractions of two oil samples submitted for analysis using chromatography mass-spectrometry.

Oil fractions (saturated and aromatic) were analysed using Hewlett-Packard 6890/5973 chromatography mass-spectrometer in SIM regime.

Based on the results of analysis, molecular parameters were calculated that are based on relation of component areas (biomarkers). Calculated values of molecular parameters for analysed oil fractions are shown in Table 2.3. Molecular parameters given in the table characterize the nature and genesis of initial OM.

Table 2.3 – Some molecular parameters calculated on the basis of the results of chromatography mass-spectrometry analysis of oil fractions (saturated and aromatic) from well 4 of Yelley-Igaiskoye field

Sampling interval, m	Formation	Sampling date	P/Ph	Ki	4MDBT/ 1MDBT	C28/C29 St	C29/C27 St	C35/ C34Hop	ABI	MA/Alk	Ks
2990-3000	Pz w.c.	2016	1,75	0,23	4,10	0,44	2,42	h.c.	2,13		
2661-2664, 2656-2659 2641-2643	J1(2-3-4)	25.01.2018	1,43	0,41	2,18	0,84	0,93	0,86	1,15	2,15	0,71
2764-2772	J5	10.01.2018	1,97	0,23	2,40	0,75	1,08	0,82	1,70	0,98	0,93

Continuation of Table 2.3

Sampling interval, m	Formation	Sampling date	S/(S+R) St-C29	bb/(aa+bb) St-C29	Ts/ (Ts+Tm)	H/(H+M)	H29/ H30	H31 S/(S+R)	DIA/ REG	TA(I)/ TA(I+II)	MPI-1
2990-3000	Pz w.c.	2016	0,49	0,55	0,54	0,88	0,66	0,60	0,68	0,23	0,67
2661-2664 M, 2656-2659 M, 2641-2643 M	J1(2-3-4)	10.01.2018	0,55	0,50	0,42	0,90	0,61	0,58	2,17	0,25	0,56
2764-2772 M	J5	25.01.2018	0,55	0,51	0,48	0,89	0,70	0,60	1,58	0,22	0,55

Note:

Full names of molecular parameters are provided in Table 1.1

MA/Alk – Relation of n-alkyl benzenes of C13-C16 composition (m/z)

l.c. – low content of components

Ks – Relation of C26- alkane to C25 and C27

It can be seen from Table 2.3 that the analysed oils were sampled from different formations and that the oils differ from each other both according to their facies-genetic and catagenetic parameters.

The oils are not biodegraded, they are generated by organic matter in the main oil formation stage (MOFS).

P/Ph relation values in oils vary from 1.43 to 1.97. Such values of P/Ph relation in general are indicative of weak reducing environment of OM that generated these oils. Oil from J1 is generated by OM that was formed in a more reducing environment than oil from J5.

The value of C35/C34Hop parameter exceeding the value of 0.5 also indicates reducing conditions of OM accumulation.

The type of bioproducts participating in OM formation can be identified according to proportion of steranes of C27 - C29 composition. Predomination of steranes of C29 composition is indicative of high role of ground vegetation in formation of initial OM, predomination of steranes of C27 composition – of OM of marine origin. Also, high content of C29 steranes can be observed in rocks of ancient age (over 350 million years), including Paleozoic age [2]. In addition, relation of C28/C29 steranes and ABI parameter (predomination of C21 n-alkyl benzene in the family of C20-C22 homologs) were calculated in all of the samples [3]. It is recommended to apply these coefficients together with C29/C27 steranes relations in order to relate OM to Paleozoic and rocks of a more ancient age.

In analysed oils, C29/C27St relation is not high: in oil from J1 it equals 0.93, in oil from J5 – 1.08. Apart from the obtained C35/C34Hop relation values it is indicative of predominantly marine genesis of OM initial for the oils.

According to ABI parameter, oils are notably different which is indicative of their different genesis (source). In oil from J5, a higher-than-usual value of ABI parameter is observed which can refer OM that generated this oil to Paleozoic type. In oil of Bazhenov (marine OM, reducing environment) and Togura (nonmarine OM, oxidizing environment) types, ABI values do not exceed 1.20 – 1.40 [3]. Higher-than-usual C29/C27 steranes relation characteristic of Pz OM, is not observed in oil from J5. Low values of C29/C27 steranes relations are encountered in the group of oils of Paleozoic genesis occurring in the south-east of West Siberia; the same oils are characterized by a lower domination of C15-alkylbenzene in homologous compound (ABI parameter equals about 1.4 – 1.5). These parameters allow to refer oil from J5 to Paleozoic genesis, however, C28/C29St value in this oil is quite high (0.75), which exceeds the range of changing values of this relation characteristic for Paleozoic age OM. For OM of Paleozoic rocks, C28/C29 steranes relation should not exceed 0.5 making about 0.3-0.5. Besides, in J5 oil, P/Ph

relation also lies somewhat beyond the range of changing of this relation for Paleozoic oils of Tomsk Oblast (south-east of West Siberia). For Paleozoic oils of Tomsk Oblast P/Ph values not exceeding 1.70 – 1.80 are typical.

Low K_i values in oil from J5 formation indicate its high catagenesis which is characteristic for Paleozoic deposits. However, facies-genetic molecular parameters (P/Ph, C28/C29St) state of a minor input by Lower Jurassic OM.

Oil from J1 is characterized by quite low ABI parameter value, C28/C29St values are characteristic for Jurassic deposits. Besides, in oil from J1 formation, higher-than-usual values of DIA/REG parameter are observed (2,17), which is conditioned by lithofacies conditions (clay/carbonate rocks), as well as catagenesis of initial OM. For OM of oil source rocks with substantial fraction of clays, DIA/REG values exceeding 0.6 – 1.0 are typical, for OM of rocks with mainly carbonate constituent – lower than 0.6 – 1.0. However, this parameter is significantly influenced by catagenesis. Relation of diasteranes and regular characteristics of mineral composition of oil sources deposits are recommended to be used in case of a close thermal maturity of rocks [2].

High DIA/REG value in oil from J1 formation is indicative of a mainly clay constituent of oil source rock, however, it can be quite low due to higher-than-usual catagenesis of initial OM. Oil from J5 also has higher-than-usual relation of diasteranes to regular ones (1.58), which can point at both input of clay constituent of oil source rock and can be conditioned by high catagenesis of OM that generated this oil. It should be noted that in oil from the weathering crust samples in 2016, having Paleozoic catagenesis, this relation is quite low making 0.68 (Table 2.3).

In analysed oils, molecular parameters of catagenesis based on sterane coefficients ($S/(S+R)C_{29}$, $\beta\beta/(\beta\beta+\alpha\alpha)C_{29}$) and relation of hopane and moretane of C30 ($H/(H+M)$) composition reached equilibrium/critical concentrations (Table 2.3). OM generated oil from J5 and J1 is at the main oil formation stage. It is difficult to evaluate OM catagenesis according to these parameters. Most often, these parameters are applied as reliable criteria of thermal maturity of OM of rocks at initial stage of transformation into oil [2].

In oil from J1, K_i value is higher than in oil from J5, which points at different catagenesis of OM that generated these oils. OM that participated in generation of oil from J1, is at a lower stage of catagenesis than OM that participated in generation of oil from J5 formation. Other molecular parameters of H_{29}/H_{30} , $T_s/(T_s+T_m)$, $TA(I)/TA(I+II)$, DIA/REG, 4MDBT/1MDBT canogenesis also confirm this assumption (Table 2.3).

Lower-than-usual K_i values in oil from J1 (0.4) point at quite high catagenesis of oil source rock OM that participated in generation of this oil. However, quite low catagenesis of

Bazhenov formation OM is observed in this region; its OM did not enter the main oil formation stage. That is why when the reservoir was formed in J1, migration of oil HC from Bazhenov formation from the direction of Tamradskaya depression can be assumed, OM of Bazhenov formation of which is characterized by a higher extent of thermal maturity. Catagenetic molecular parameters (Ki, MPI-1) point at a mixed nature of oil (Paleozoic, Togura, Bazhenov formation) obtained from testing object of J1 (2-3-4) formation.

In such a way, the entirety of molecular parameters calculated in oil of Yelley-Igaiskoye field, from **J1 (2-3-4) formation** is indicative of a mixed genesis (Figure 2.1). Bazhenov formation OM took part in generation of oil from testing object of J1 (2-3-4), besides, input of Paleozoic OM is observed and, possibly, OM of Lower Jurassic deposits.

The entirety of molecular parameters (Table 2.3) calculated for oil of Yelley-Igaiskoye field from productive **J5 formation** reflecting facies-genetic features of formation and accumulation of OM and its catagenesis, point at mainly Paleozoic genesis (Figure 2.2). The source of analysed oil from J5 formation was marine OM of Paleozoic. Insignificant presence of OM of Lower Jurassic deposits (high P/Ph, C29/C28St) can't be excluded.

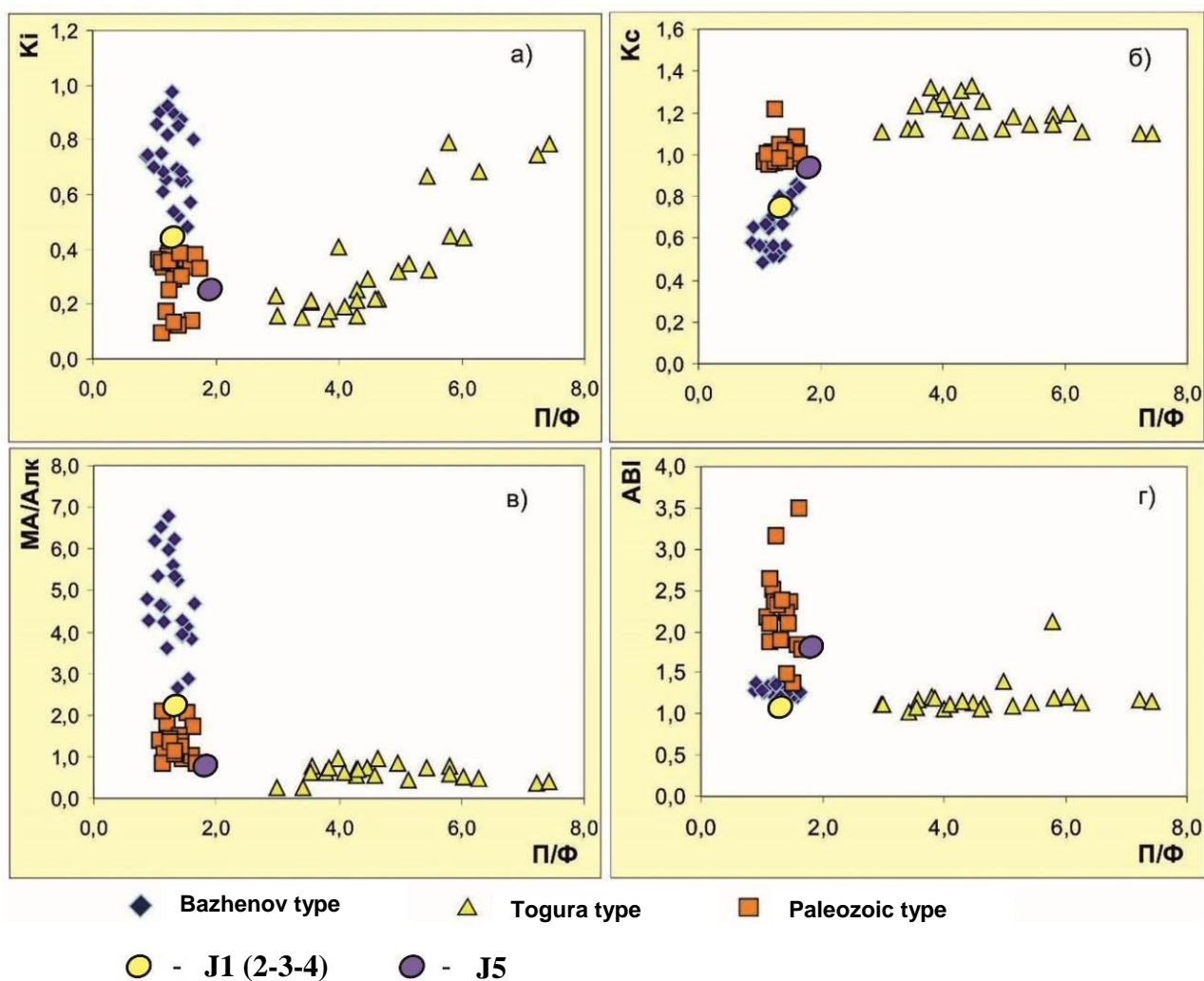


Figure 2.1 – Genetic types of analysed oils

2.4 Analysis of carbon isotope composition of oil samples

Within the frame of this work, it was necessary to execute isotope analysis of 2 oil samples and their chromatographic fractions, amounting to 10 samples in total. Results of measurements are presented as $\delta^{13}\text{C}$ value (measuring unit - permille (‰)) and were normalized to PDB international standard.

In Table 2.4 and in Figure 2.2, $\delta^{13}\text{C}$ values of oil and their chromatographic fractions are shown.

As it can be seen from Table 2.4, scattering of $\delta^{13}\text{C}$ values for initial analysed oils is not high. However, the character of variation of carbon isotope composition by fractions allows to divide oils according to genetic type of organic matter participating in their generation. In Figure 2.3, variation limits of carbon isotope composition of oil and

Table 2.4 – Carbon isotope composition of oils and their chromatographic fractions

Perforation interval, m	Formation	Sampling date	Oil	PNF	Aromatics	Resins	Asphaltenes
2661-2664, 2656-2659, 2641-2643	J1(2-3-4)	25.01.2018	-30,85	-31,04	-30,50	-29,47	-30,44
2764-2772	J5	10.01.2018	-30,18	-30,17	-29,41	-29,37	-29,74

Note: PNF – paraffine-naphthenic fraction

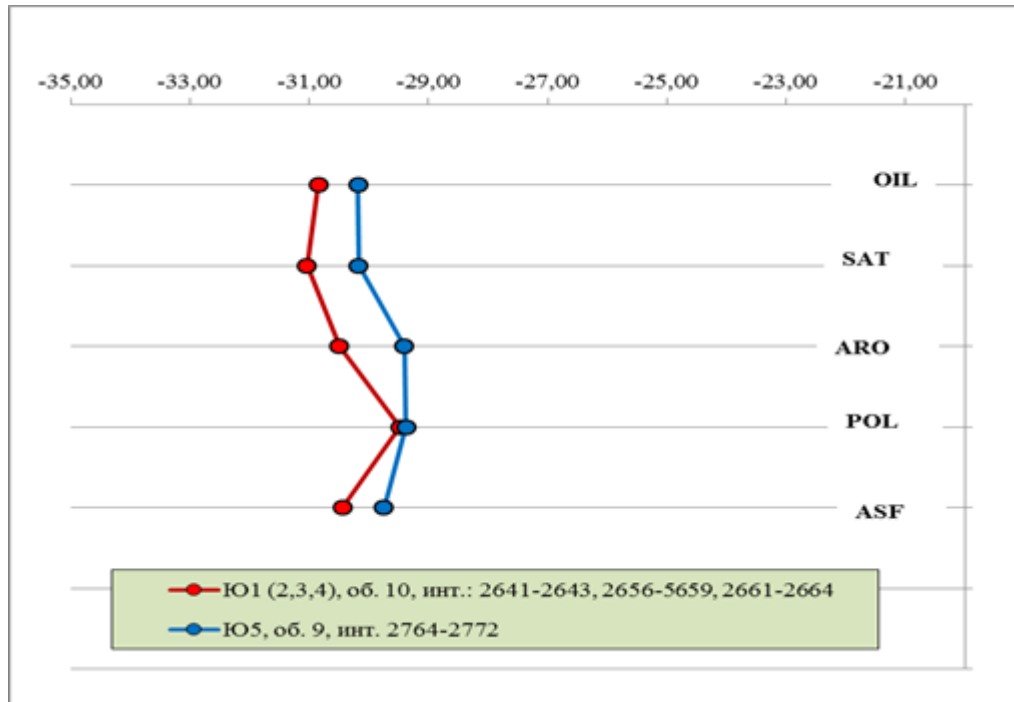


Figure 2.2 – Carbon isotope composition of analysed oil samples and their chromatographic fractions

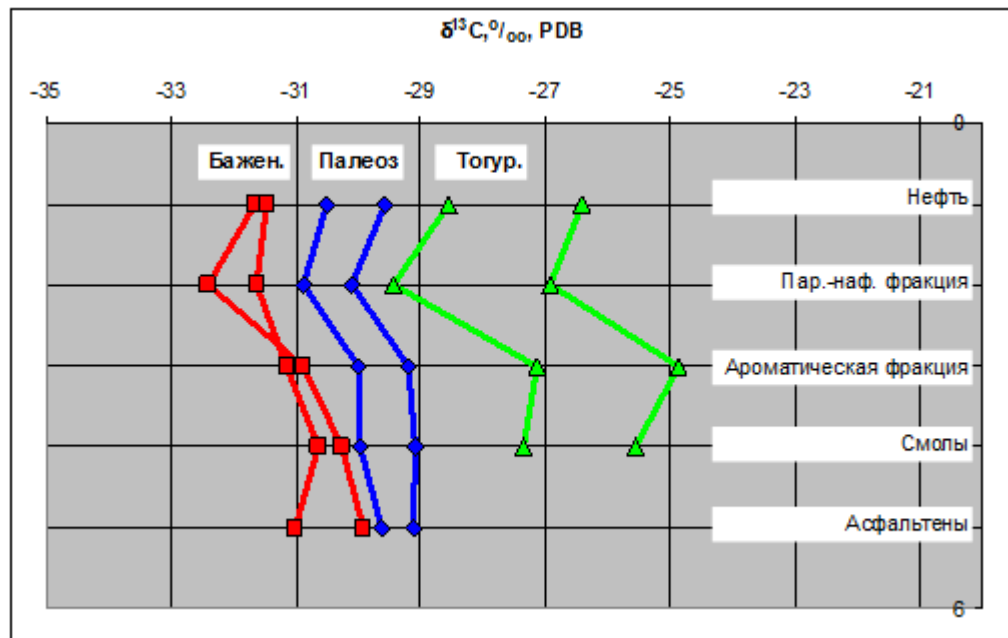


Figure 2.3 – Isotope curves of different genetic types of oils of Tomsk Oblast

their fractions, characteristic for genetic types of oils identified in Tomsk Oblast are shown. Comparing Figures 2.2 and 2.3, it can be noticed that the oil (and its fractions) from J1 (2-3-4) formation fits into the region of extreme values of $\delta^{13}C$, typical for Bazhenov type, bordering

with the variation range of isotope curves of Paleozoic type. Variation limits of $\delta^{13}\text{C}$ values in oil and its fractions from J5 formation are characteristic to oils of Paleozoic genesis, organic matter of which accumulated at reducing environment with participation of marine bioproducers. In all of the samples, a regular weighting up of carbon isotope composition from paraffin-naphthenic fraction to asphaltenes takes place. However, in oil from J1 (2-3-4) formation, the fraction of resins is substantially benefited by heavy carbon (Figure 2.2).

2.4. Compositional analysis of the gas sample

A gas sample taken from J5 (perforation interval: 2764-2772 m) was received for analysis. Gas chromatographic determination of gas components was performed according to GOST 31371.7-2008 (Method A). Results of determination of compositional analysis of the gas sample are presented in Table 2.5 and the Protocol (Appendix).

Table 2.5 – Compositional analysis of gas sample of Yelley-Igaiskoye field

Component (content, % mole ratio)	Yelley-Igaiskoye field, well 4, object 9, J5 formation; Perforation interval: 2764-2772 m
Helium	0,0118
Carbon	0,0333
Carbon dioxide	1,22
Nitrogen	1,17
Methane	91,64
Ethane	3,06
Propane	1,64
Isobutane	0,450
n-Butane	0,343
Isopentane	0,161
n-Pentane	0,116
C6 sum	0,092
C7 sum	0,048
C8 sum	0,0130
C9 sum	0,0019

The main component of analysed gas is methane. Its content in the gas sample is about 91.64 vol.% which characterizes gas as a dry gas. The content of nitrogen and rare gases (helium, etc.) amounts to 1.17 and 0.0118 vol.%, correspondingly. The content of carbon dioxide in the sample equals 1.22 vol.%.

The main factors affecting the gas composition are the type of oil source organic matter and its catagenesis, as well as the processes of transformations within the formation – water flush, chemical and biochemical oxidization.

Our multiple analysis of solution gases from various reservoirs of Tomsk Oblast [7] revealed that oils generated by marine organic matter (Bazhenov and Paleozoic types) contain gas in which the relation of isobutane to normal butane is lower than 0.5 – 0.6 (Figure 2.4). In oils that are genetically related to nonmarine oxidized organic matter this relation is higher than 1.2.

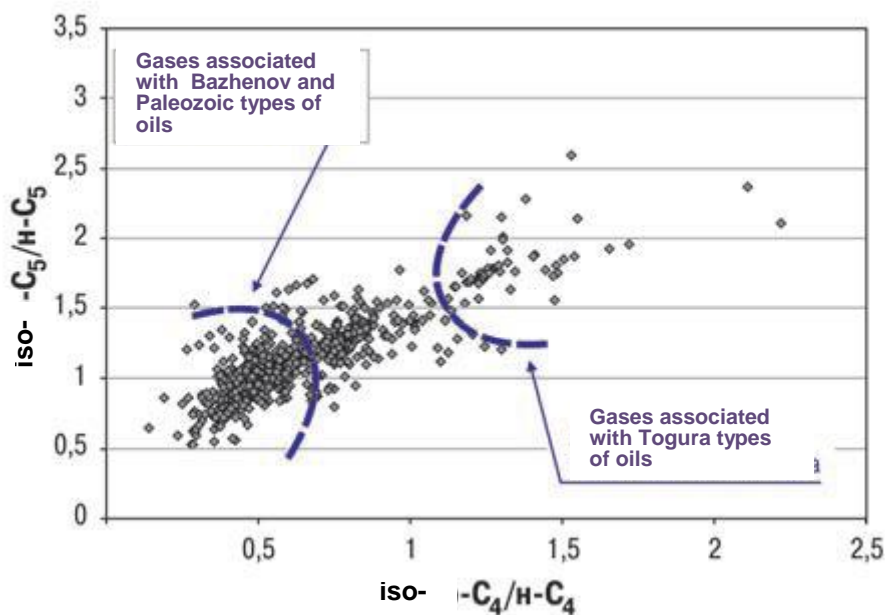


Figure 2.4 – Isomeric composition of butanes and pentanes of solution gases of south-east of West Siberia

Relation of isobutene to normal butane in the analysed gas sample of Yelley-Igaiskoye field makes 1.3 which can indicate both biochemical oxidization and participation of oxidized organic matter in its generation. Molecular parameters of liquid component of the fluid (oil) from this formation, analysed within the framework of this study, is indicative of its primarily marine genesis at reducing environment (see Section 2.2, Table 2.3). However, as it has been previously mentioned, participation of organic matter of Lower Jurassic can't be ruled out from oil generation of this formation. Reservoir temperatures in this region exclude biochemical

oxidization of the fluid deposited in this formation. Most likely, higher-than-usual values of isobutane against normal one are the consequence of mixing of the fluid of the Paleozoic genesis with the gas of nonmarine oxidized organic matter of Lower Jurassic deposits which affected more (to a significant extent) the gas component of this formation. Such a phenomenon is not rare for this region. For example, if to consider the entirety of solution gases of Tomsk Oblast, it can be seen that by these parameters they form a continuous family (Figure 2.4). I.e., the number of reservoirs where the gas component is represented by products of generation of different oil and gas source rocks is substantially wider than is considered to be the case [4].

2.5. Analysis of isotopic composition of the gas sample

For methane and gas components of C2-C5 composition, measurement of carbon isotope composition was done. In total, 5 gas samples were analysed. The measurement result, as usual, was represented as $\delta^{13}\text{C}$ value (in permille units - ‰). $\delta^{13}\text{C}$ – shifting of the stated relation within a sample against PDB international standard was calculated according to the following equation:

$$\delta^{13}\text{C} (\text{‰}) = \left\{ \left[\left(\frac{^{13}\text{C}}{^{12}\text{C}} \right)_{\text{sample}} : \left(\frac{^{13}\text{C}}{^{12}\text{C}} \right)_{\text{standard}} \right] - 1 \right\} \times 1000.$$

Growth of $^{13}\text{C}/^{12}\text{C}$ relation (and $\delta^{13}\text{C}$ value) corresponds to isotopic weighting up of carbon within the sample. Determination of $\delta^{13}\text{C}$ value in an individual component is possible in case its presence makes about 0.1 vol.% and more. The random error of $\delta^{13}\text{C}$ (1σ) value measurement made 0.2‰. PEF-1 with the value of $\delta^{13}\text{C} = -31.8\text{‰}$ was used as a laboratory standard. The results of analysis of carbon isotope composition of gases are shown in Table 2.6.

Table 2.6 – Results of determination of carbon isotope composition of components of the gas sample taken from well 4 of Yelley-Igaiskoye field

Perforation interval, m	Formation	Sampling date	$\delta^{13}C$, ‰						
			Methane	Ethane	Propane	Isobutane	n-Butane	Isopentane	N-pentane
2764 - 2772	J5	14.01.2018	-47.5	-31.5	-29.2	-28.5	-28.4	-27.3	-27.3

In Figure 2.5 the comparison of curves of molecular and isotopic composition of gas components carbon (C1 - C5) for analysis within the framework of this work for gas sample from J5 formation and gas samples of south-east of West Siberia. In addition, isotopic composition curves for gas samples taken in 2015a. Multiple research of gas samples of Tomsk Oblast allowed to divide them into three genetic types according to their isotopic composition of carbon. Organic matter of the relevant oil and gas source rock of the region took part in generation of gases of each of the types: Bazhenov formation, Lower Jurassic, Paleozoic [4]. As it can be seen from Figure 2.5, gas sample from J5 formation of Yelley-Igaiskoye field that was studied within the frame of this work, as well as gas samples taken in the same field in 2015, fits into the region of curves of molecular and isotopic composition of carbon typical to gases of Paleozoic genesis. Generation of gases of the Paleozoic genetic type is by all means connected with organic matter of a marine genesis accumulation of which took place at reducing environment. Fitting of analysed gases of Yelley-Igaiskoye field, according to their carbon isotope composition, into region of gases of this genetic type, confirms their marine genesis and reducing environment of initial organic matter generation.

According to the diagram (Figure 2.6), the initial organic matter is also of the marine type. The curve has a characteristic smoothed shape which reflects a strong catagenesis of oil source organic matter. In such a way, gas component of J5 formation is represented by predominantly isotopically heavy gas generated by organic matter of Paleozoic, as well as Togura.

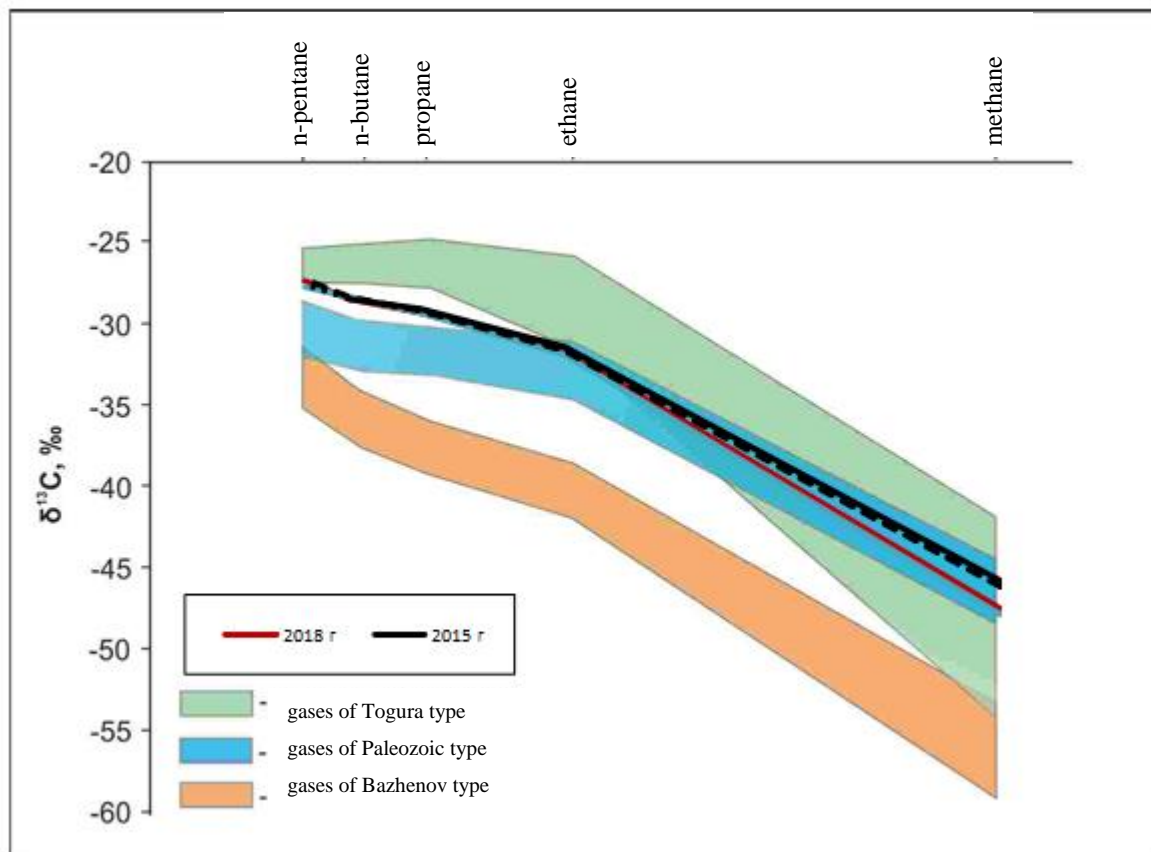


Figure 2.5 – Carbon isotope composition of analysed gases of Yelley-Igaiskoye field (2018 and 2015) and gases of three genetic types of south-east of West Siberia (Tomsk Oblast)

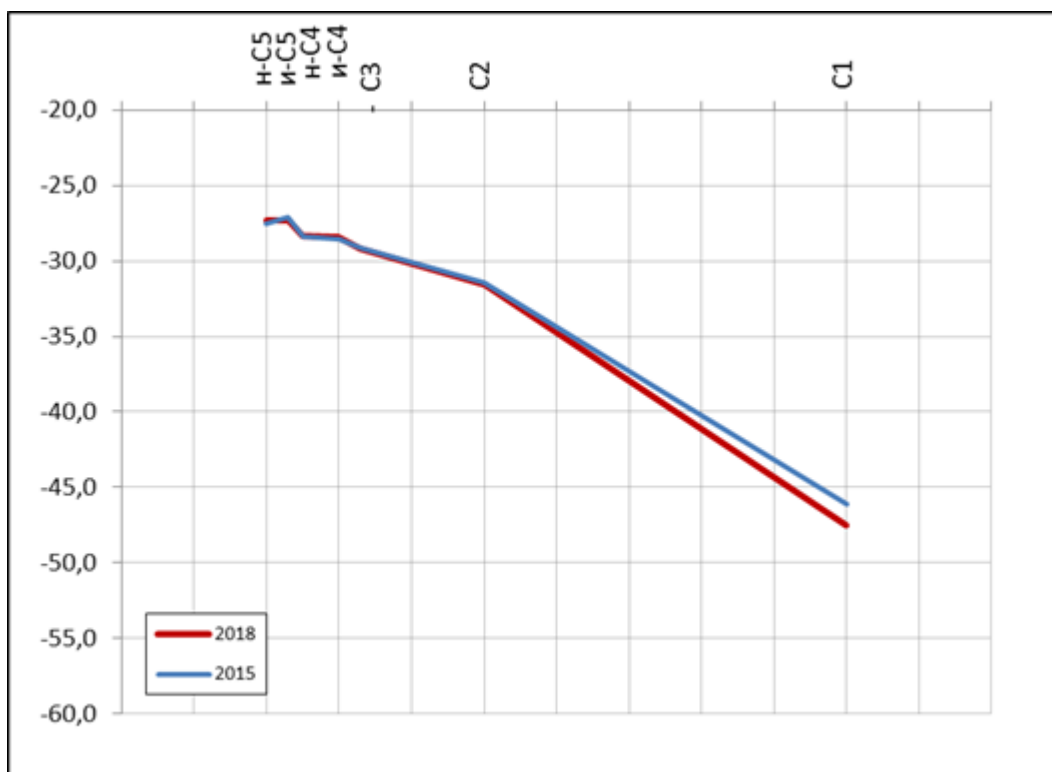


Figure 2.6 – Comparison of curves of carbon molecular and isotope composition of gas components (C1 - C5) of Yelley-Igaiskoye field samples

CONCLUSION

The analysis of the obtained results allows to draw the conclusions as follows:

1. According to physical and chemical parameters, the samples that were received for analysis from ___ prospect differ both from one another and from the samples that had been received for analysis earlier from the aforementioned prospect (in 2015 and 2016). The oil from J5 formation is significantly lighter; it is characterized by a low content of sulfur, wax, tars compared to oil from J1 formation.
2. Based on the set of molecular and isotope parameters (facies-genetic and catagenetic), it was found that the source of the analysed J1 (2-3-4) formation sample was, for the most part, a marine organic matter of Bazhenov formation and Paleozoic with a slight participation of organic matter of Lower Jurassic deposits (Togura type of organic matter). While the organic matter of Lower Jurassic deposits and Paleozoic within ___ prospect obviously reached oil window threshold, it is unlikely that the Bazhenov formation organic matter in this area reached the necessary maturity. That is why the source of generation of oil of the Bazhenov genetic type should be explored in adjacent depressions.
3. The source of oil from J5 formation is a marine organic matter of Paleozoic with a minor participation of organic matter of Lower Jurassic deposits.
4. The analysed gas sampled from the reservoir of J5 formation is of a mixed nature. The gas component of J5 formation is represented predominantly by isotopically heavy gas generated by organic matter of Paleozoic at the late stage of catagenesis. However, gas component composition is indicative of the input made by the Lower Jurassic organic matter.
5. For a more detailed answer to the question on the fluids' nature, localization of their "kitchen area" and identification of the mechanism of reservoirs' accumulation in ___ prospect, additional research is required involving analysis of samples from neighbouring areas.

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APPENDIX

Protocols of Quantitative Chemical Analysis

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Accreditation certificate No. ROSS RU.0001.512150
634027, Tomsk, pr. Mira, 70

Date of issue: 13 October 2015
Tel.: (3822) 611800 ext. 2190, fax (3822) 611880

PROTOCOL OF TESTING RESULTS No. 120

Date: 14.06.2018

Copy number: 1

Customer's name and address: OOO Bakcharneftegaz, 634021, Tomsk, pr. Frunze, 111

Test item: oil
Date of receipt of test item: 17.04.2018
Sampling date: 10.01.2018
Testing period: 18.04.2018 – 08.06.2018
Sample code: P180192
Sampling location and zone: Yelley-Igaiskoye field, well 4, zone 9
Sampling conditions: Formation J₅, perforation interval: 2764-2772 m

Parameter identified	Measuring unit	Regulatory document for testing method	Testing results	Precision, ±Δ	Comment
Density	kg/m ³	GOST 3900-85 i.1	781.3	1.1	at 20°C
Kinematic viscosity	mm ² /s	GOST 33-2000	2.106	0.036	at 20°C
Kinematic viscosity	mm ² /s	GOST 33-2000	1.326	0.023	at 50°C
Mass fraction of sulfur	%	GOST R 51947-2002	0.0762	0.0113	-
Mass fraction of paraffin	%	GOST 11851-85 (method A)	0.4	0.2	-
Mass fraction of water	%	GOST 2477-2014	1.0	0.1	-
Mass fraction of solids	%	GOST 6370-83	0.26	0.14	-
Fractional composition: - distillation yield	°C % vol.	GOST 2177-99 (method B)	Initial boiling point – 70.0 up to 100°C – 1.0 up to 150°C – 21.0 up to 200°C – 48.0 up to 250°C – 67.0 up to 300°C – 81.0		
Freezing temperature	°C	GOST 20287-91 (method B)	minus 21.0	6.0	-

/Head of the laboratory (stamp, signature) V.V. Samoilenko/Acting head of the laboratory:
Veklich M.A.)

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The testing results are applicable only to the testing item that undergone tests.
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Appendix to
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dated 14.06.2018
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Test item: oil
Date of receipt of test item: 17.04.2018
Sampling date: 10.01.2018
Testing period: 18.04.2018 – 08.06.2018
Sample code: P180192
Sampling location and zone: Yelley-Igaiskoye field, well 4, zone 9
Sampling conditions: Formation J₅, perforation interval: 2764-2772 m

Parameter identified	Measuring unit	Regulatory document for testing method	Testing results	Precision, ±Δ
Mass fraction of asphaltenes	%	VNIINP Institute methodology	0.78	0.11
Mass fraction of silica-gel tars	%	VNIINP Institute methodology	2.0	0.3
Molecular weight		OST 153-39.2-048-2003	156.0	6.7
Paraffin saturation point	°C	OST 39.034-76	minus 3.0	3.0

/Head of the laboratory (stamp, signature) V.V. Samoilenko/Acting head of the laboratory:
Veklich M.A.)

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Date of issue: 13 October 2015
Tel.: (3822) 611800 ext. 2190, fax (3822) 611880

PROTOCOL OF TESTING RESULTS No. 121

Date: 14.06.2018

Copy number: 1

Customer's name and address: ООО Bakcharneftegaz, 634021, Tomsk, pr. Frunze, 111

Test item: oil
Date of receipt of test item: 17.04.2018
Sampling date: 25.01.2018
Testing period: 18.04.2018 – 08.06.2018
Sample code: P180193
Sampling location and zone: Yelley-Igaiskoye field, well 4, zone 10
Sampling conditions: Formation J1(2-3-4), perforation interval: 2661-2664 m, 2656-2659 m, 2641-2643 m

Parameter identified	Measuring unit	Regulatory document for testing method	Testing results	Precision, $\pm\Delta$	Comment
Density	kg/m ³	GOST 3900-85 i.1	826.1	1.1	at 20°C
Kinematic viscosity	mm ² /s	GOST 33-2000	4.640	0.079	at 20°C
Kinematic viscosity	mm ² /s	GOST 33-2000	2.472	0.042	at 50°C
Mass fraction of sulfur	%	GOST R 51947-2002	0.325	0.033	-
Mass fraction of paraffin	%	GOST 11851-85 (method A)	0.9	0.4	-
Mass fraction of solids	%	GOST 6370-83	3.30	0.14	-
Fractional composition: - distillation yield	°C % vol.	GOST 2177-99 (method B)	Initial boiling point – 63.0 up to 100°C – 2.0 up to 150°C – 11.0 up to 200°C – 25.0 up to 250°C – 43.0 up to 300°C – 64.0		
Freezing temperature	°C	GOST 20287-91 (method B)	minus 20.0	6.0	-

/Head of the laboratory (stamp, signature) V.V. Samoilenko/Acting head of the laboratory:
Veklich M.A.)

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Appendix to
Protocol of testing results No. 121
dated 14.06.2018
Copy number: 1

Customer's name and address: ООО Bakcharneftegaz, 634021, Tomsk, pr. Frunze, 111

Test item: oil
Date of receipt of test item: 17.04.2018
Sampling date: 25.01.2018
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Sample code: P180193
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Parameter identified	Measuring unit	Regulatory document for testing method	Testing results	Precision, $\pm\Delta$
Mass fraction of asphaltenes	%	VNIINP Institute methodology	0.78	0.11
Mass fraction of silica-gel tars	%	VNIINP Institute methodology	4.2	0.6
Molecular weight		OST 153-39.2-048-2003	186.0	8.0
Paraffin saturation point	°C	OST 39.034-76	minus 1.0	3.0
Mass fraction of water	%	GOST 2477-2014	81.0	2.9

/Head of the laboratory (stamp, signature) V.V. Samoilenko/Acting head of the laboratory:
Veklich M.A.)

OA O TomskNIPIneft
Laboratory of geochemistry and crude oil

Accreditation certificate No. ROSS RU.0001.512150
 634027, Tomsk, pr. Mira, 70

Date of issue: 13 October 2015
 Tel.: (3822) 611800 ext. 2190, fax (3822) 611880

PROTOCOL OF TESTING RESULTS No. 122

Date: 14.06.2018

Copy number: 1

Customer's name and address: OOO Bakcharneftegaz, 634021, Tomsk, pr. Frunze, 111
 Item name (according to accreditation scope) flammable natural gases for industrial and household/heating purposes
 Test item: gas
 Date of receipt of test item: 17.04.2018
 Sampling date: 14.01.2018
 Testing period: 27.04.2018
 Sample code: P180194
 Sampling location and zone Yelley-Igaiskoye field, well 4, zone 9
 Sampling conditions: Formation J₅, perforation interval: 2764-2772 m

Parameter identified, measuring unit	Regulatory document for testing method	Testing results	Extended absolute uncertainty of testing results, $\pm U(X)$ at $K=2$	Comment
Mole fraction of helium, %	GOST 31371.7-2008 (method A)	0.0118	0.0009	
Mole fraction of hydrogen, %		0.0333	0.0022	
Mole fraction of carbon dioxide, %		1.22	0.07	
Mole fraction of nitrogen*, %		1.17	0.05	
Mole fraction of methane*, %		91.64	0.08	
Mole fraction of ethane, %		3.06	0.12	
Mole fraction of propane, %		1.64	0.10	
Mole fraction of i-butane, %		0.450	0.027	
Mole fraction of n-butane, %		0.343	0.021	
Mole fraction of i-pentane, %		0.161	0.010	
Mole fraction of n-pentane, %		0.116	0.007	
Mole fraction of hexanes, %		0.092	0.006	
Mole fraction of heptanes, %		0.048	0.003	
Mole fraction of octanes, %		0.0130	0.0013	
Density, kg/m ³	GOST 31369-2008	0.7506	0.0030	estimated value, T=20°C P=101.325 kPa
Specific gravity		0.6231	0.0025	
Net heating value, MJ/m ³		35.38	0.08	estimated value, T=25°C P=101.325 kPa
Higher Wobbe index, MJ/m ³		49.61	0.15	

Note: * - mole fraction of methane was determined according to analysis, nitrogen was measured individually.

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 Veklich M.A.)

The Protocol cannot be partly reproduced without a written permission of Head of the laboratory.
 The testing results are applicable only to the testing item that undergone tests.
 The sample was taken by the Customer. The laboratory shall not be held liable for sampling.

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Appendix to
Protocol of testing results No. 122
dated 14.06.2018
Copy number: 1

Customer's name and address: ООО Bakcharneftegaz, 634021, Tomsk, pr. Frunze, 111

Test item:	gas
Date of receipt of test item:	17.04.2018
Sampling date:	14.01.2018
Testing period:	27.04.2018
Sample code:	P180194
Sampling location and zone	Yelley-Igaiskoye field, well 4, zone 9
Sampling conditions:	Formation J ₅ , perforation interval: 2764-2772 m
Test item:	gas

Parameter identified, measuring unit	Regulatory document for testing method	Testing result
Mole fraction of nonanes, %	GOST 31371.7-2008 (method A)	0.0019
Molar weight, kg/kmol	Estimation method	17.967

/Head of the laboratory (stamp, signature) V.V. Samoilenko/Acting head of the laboratory:
Veklich M.A.)