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1. The Kertch-Taman Oil Region. By V. Obruchev.
2. The Berekei Oil Region. By A. Pritula.
3. The Transcaucasian Oil Regions. By N. Khaliaev.
4. The Oil Regions of the Eastern Coast of the Caspian Sea. By D. Sokolov.
5. The Fergana Oil Region. By A. Pritula. 1926.
6. The Cukhta Oil-Bearing Region. By S. Obruchev.

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**THE COUNCIL OF PETROLEUM INDUSTRY**

**V. OBRUCHEV**

**PROF. OF MINING ACADEMY OF MOSCOW**

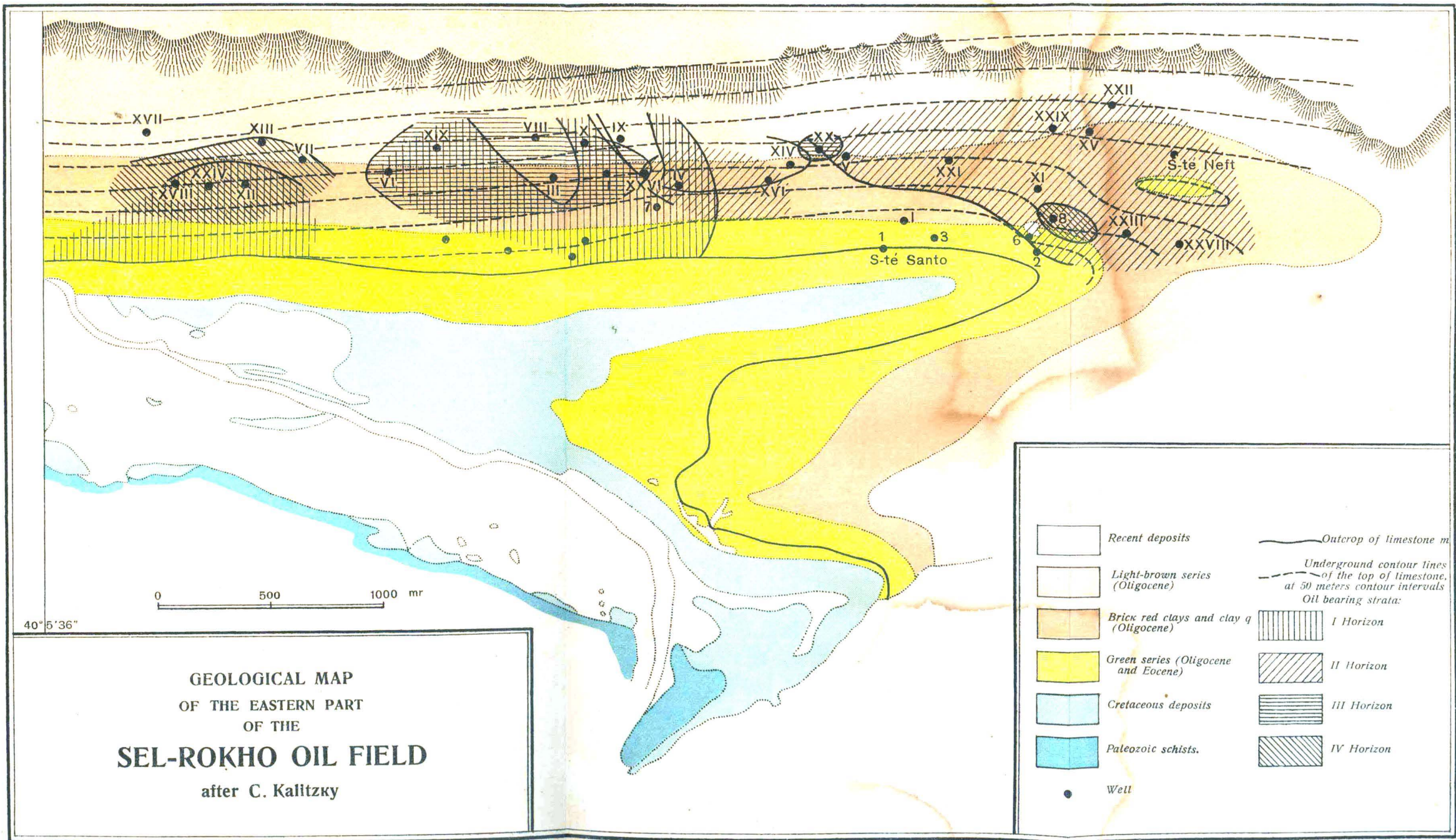
**THE KERTCH - TAMAN  
OIL REGION**

**With 20 figures and 2 maps**

**PUBLISHED BY THE COUNCIL OF PETROLEUM INDUSTRY.  
MOSCOW—1926**

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**GEOLOGICAL MAP**  
**OF THE EASTERN PART**  
**OF THE**  
**SEL-ROKHO OIL FIELD**  
 after C. Kalitzky

THE COUNCIL OF PETROLEUM INDUSTRY

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S. OBRUCHEV

GEOLOGIST OF THE GEOLOGICAL COMMITTEE

THE OUKHTA OIL-BEARING  
REGION

With 26 figures and a map

PUBLISHED BY THE COUNCIL OF PETROLEUM INDUSTRY  
MOSCOW—1926

Москва. Главлит 63.889.

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«Мосполиграф», 16-я типография, Трехпрудный, 9.

## GENERAL DESCRIPTION

*Geography.* The Oukhta (Ukhta) oil field is situated within the Autonomous Region of Komi (inhabited by natives Komi or Zyrians), in the northeastern part of the latter, viz., in the former Pechora District of the Archangel province, partly in the Ust-Sysolsk district of the Vologda province. The tract of land which in 1909 was pronounced by the Ministry of Commerce and Industry as a proven oil-bearing area, comprises 13,700 square kilometers and extends from 62°45' to 64° north latitude and from 22° to 24° east longitude (Pulkovo). The area on which test holes for oil have been actually drilled and positive showings of oil have been discovered is much smaller—barely about 1,300 sq. km. and occupies the region of the middle courses of the rivers: Oukhta (with the tributaries of the latter: Yarega, Chut and Domanic) and Sed-Yu with its tributary Lya-Yol. Both these rivers are left-hand tributaries of the Izhma river, which in turn falls into the Pechora river.

*Orography.* The Oukhta region is situated on the southern extremity of the Timan mountain range. This part of the range is a low, slightly hilly territory, densely forested with coniferous trees, the monotony of the landscape being interrupted by river valleys cut into the ground to a depth of several dozen meters. The valley of Izhma at the point where the latter is joined by the Oukhta river is 70 m. above sea-level, the source of the Oukhta river being situated about 150—160 m. above sea-level. The river valleys, as well as frequently the flat watershed areas, are covered with swamps. Southwest of this territory, on the watershed between the basins of the Pechora and Severnaia Dvina rivers, there extends a flat elevated part of the range, with the hills reaching 325 m. in height (Pot-Churk).

*Climate.* As the district lies at a distance of only 300 km. from the polar circle, its climate is naturally severe. According to the

observations made by Mr. Stukachev during 3 years, the average yearly temperature does not fall below  $+1^{\circ}$  C and is about equal to the average temperature prevailing on the White Sea shores. The average temperature of June and July is  $+19^{\circ}$  C, that of January is  $-36^{\circ}$  C. In January and February the frost frequently attains  $47^{\circ}$  C. Northerly, northeasterly and southwesterly winds predominate, which in summer carry rains continuing sometimes whole months. Snow falls at the end of October and holds till the end of May, the snow cover being of great thickness. The most favourable seasons for field operations are spring and autumn, when there are no rains, nor mosquitoes. The period from November till March is hardly suitable for drilling operations, owing to the intense cold. There is no permanently frozen ground within the district.

*The population* of the district is very scarce and consists chiefly of Zyrians and partly of Russians. The following inhabited localities are the nearest to the oil fields: a number of villages on the Izhma river, some 40 km. from the center of the petroliferous district, and a small village Volok, 80 km. from the latter point, at the head of the river Oukhta, near the «volok» to the Shonvukva river («Volok» is a place where boats are dragged across the watershed between two navigable rivers, a portage).

The Zyrians occupation is agriculture, cattle-breeding and hunting; they are characterized by their independence and intelligence. Formerly they showed great unwillingness to work in mining enterprises, and did so only for high wages. The oil fields have to be supplied with labour from more thickly populated places of the Vologda province, wages being naturally higher than in districts with developed industry, in the case of skilled workmen being about double.

*Ways of communication.* The communication with the Oukhta oil region is very difficult and slow. There are three routes leading to the region:

1. From Kotlas by steamer up the Vycheгда river to Ust-Vym, a distance of 320 km.; further by boats up the Vym river, then up the Vukva river and its tributary Shonvukva to the «volok», or portage, 6 km. long, near the village Volok; further by the Oukhta river,—a distance of 480 km., totalling 800 km. From Kotlas by railway to the northern trunk line (Viatka)—383 km., or by steamer to the same trunk line (Vologda)—601 km. A part of the journey up the lower course of the Vym river may be made either by small



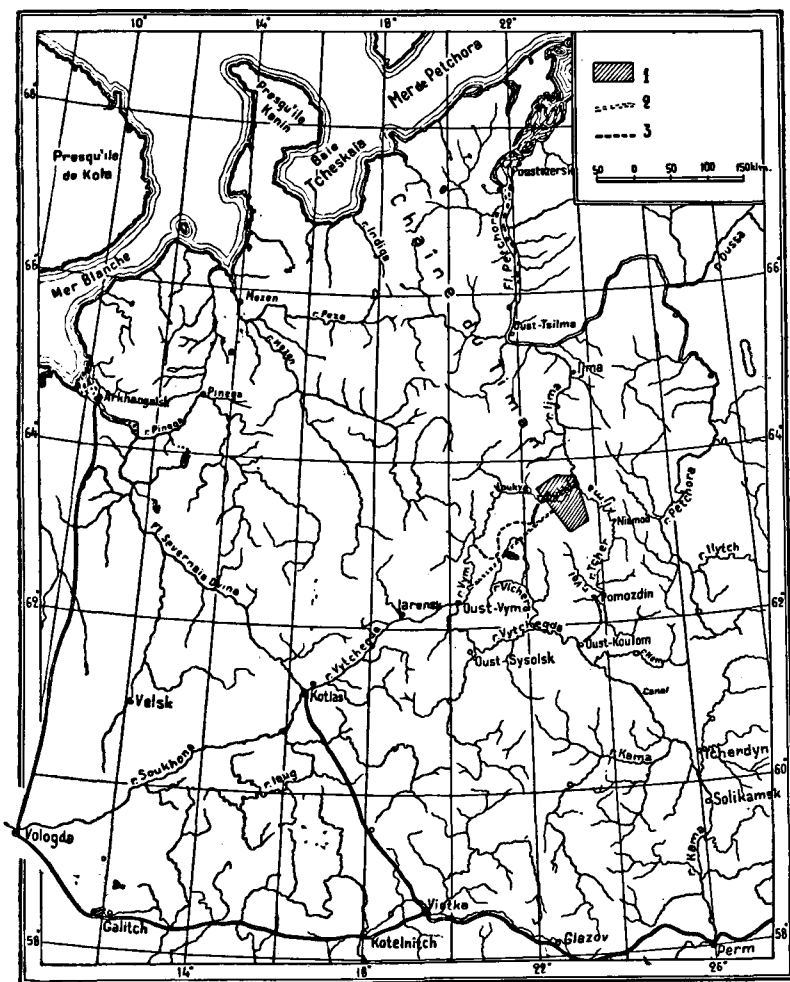


Fig. 1. Map of Northern Russia: 1—the Oukhta oil-bearing region; 2—winter road; 3—summer road.

draught steamer, such steamers running sometimes as far as the village Veslianskoe (127 km.), or by a highway to the village Turie (101 km.). The portage from Shonvukva to Oukhta is one of the best «voloks» on Timan, horses and vehicles being always obtainable there. This route takes from 8 to 16 days. As an alternative of the latter there is another way: from the village Veslianskoe by boats up the Veslianka and Ropcha rivers, across a portage to the Tobysh river and by the latter river as far as Oukhta. The «volok» here is 47 km. long, but the river channels, having been cleared in 1913, are by far deeper than the rivers of the preceding route, where at the times of shallow water the boats in places have to be carried. In winter the journey from Oukhta to Kotlas can be made in 6 days, owing to driving in sledges being quicker and the route being shorter by 160 km. (the sledge road leads along an opening in the forest cleared of trees from the village Polovniki, on the Vym river, as far as Sidorovskaya Kazarma on Oukhta).

2. The second route leads from Archangel by sea to the mouth of the Pechora river, thence by small draught steamer to the mouth of the Izhma river and further 149 km. by boats to Oukhta, the total distance aggregating about 2,180 km. Owing to the irregularity of the navigation on the Pechora river, the whole journey takes from 10 days to one month. This route is open from the 20th of July till the middle of September.

3. The third route, less used than the first two, is as follows: by steamer up the Vychegda river as far as Ust-Kulom, thence in carts to the village Pomozdin, further by boats up the Vychegda river and its right-hand tributary Cher Vychegodsky to the «volok» leading to Cher Izhensky (1.5 km.), and along the latter and Izhma in boats as far as Ust-Oukhta. Sometimes steamers go as far as the village Pomozdin. If the route were not shortened by the horse journey from Ust-Kulom to Pomozdin, it would be longer than the first route by 400 km. and its only advantage is that it passes through a more populated territory. Furthermore, this route is important because between Ust-Kulom and Pomozdin there begins the Severo-Ekaterinensky channel, which connects the Vychegda river with the Kama river (Severnaia Keltma, the channel, Djurich, Yuzhnaia Keltma). The channel is now abandoned, but in case of the development of the Oukhta district it may be restored, if it is necessary to connect the district with the Volga basin.

Rivers are the only means of communication within the oil region. The Oukhta river is quite navigable by boats from the «volok» to the mouth, for a distance of 120 km.; its width in its upper course near the «volok» is 40—50 m., near the oil fields—from 85 to 90 m., and below Domanik—up to 120 m. The grade of the river in this distance is 65 m., the maximum depths along the channel vary from 1 to 2 m. The navigation is obstructed by rapids; the largest of them, Idji-di-kos, has a grade of 2 m. within a distance of 850 m. The tributaries of the Oukhta and Sed-Yu rivers are navigable by small boats almost to their upper reaches or at least to the point where the river is divided into its northern and southern sources (Voi-vozh and Lun-vozh—into which every river is invariably divided by the Zyrians). Boats are propelled by oars or else with the aid of iron-strengthened poles (see the accompanying photographs). There are no bridle-ways of common roads; hunters' paths along the rivers and in the areas between the latter are very few; thus, river navigation is necessarily the only way of communication.

*General condition of work.* The Oukhta district is an entirely desolate territory situated at a distance of a thousand kilometers from centers of civilization. The nearest post and telegraph offices are in the village Izhma, on the Izhma river, and in the village Ust-Vym, on the Vychehda river, 250—480 km. from the region; the administrative center of the region, Ust-Syssolsk, is 600 km. from it. An industrial enterprise on Oukhta would have to rely exclusively on its own means; all supplies would have to be brought from Vychehda or from the village Izhma, materials and machines—from Archangel or Kotlas; as said before, the majority of workmen would likewise have to be engaged from remote places. The primitive means of transportation and communication, as well as the severe climate are likewise unfavourable for the development of the mining industry; but, of course, they do not make such development quite impossible, inasmuch as, for example, the operations in Alaska are carried on under conditions by far more difficult.

The abundance of timber (pine, fir, larch, cedar) is a great advantage of the district; building stone can also be had in sufficient quantities (limestones of the Devonian and Carboniferous systems).

## GEOLOGY AND THE OCCURENCE OF OIL

Two quite opposite views exist concerning the geology of the Oukhta region, and finding of the true solution is not only a problem of high scientific interest, but is likewise of great commercial importance. The first explorer of Timan, Keyserling (1843), considered that the strata here are involved in a gentle anticline which is not complicated by faulting and trends in the direction of the Timan range, that is to say, northnorthwest. He referred the Domanik formation to the Lower Devonian or Silurian and believed it to be the most ancient formation of Oukhta.

Chernyshev, Academician and Director of the Geological Committee, who explored Timan in 1889—1890, subjected Keyserling's scheme to severe criticism. According to his opinion, the rocks with *Spirifer Anossofi*, lying in the flanks of the anticline, are to be placed in the Middle Devonian, while the Domanik occupying the axial portion, and the oil-bearing Under-Domanik formation contain a typical Upper Devonian fauna. Such a determination of the age of the mentioned formations necessarily involves the assumption that the central part of the fold has sunk along fault planes and a graben (trough) has thus been formed, having an elongated elliptical shape. In such a case the petroliferous area lies only within the trough. However, Chernyshev's assumption has not been proven by subsequent drilling. The wells, having penetrated the Sub-Domanik formation, did not encounter the expected Middle Devonian with *Spirifer Anossofi*, but, sunk below a thin layer of basal conglomerate, entered a thick series of old sericite schists. Nevertheless, Chernyshev's scientific authority (especially with reference to the stratigraphy of the Paleozoic beds) influenced the geological thought to follow the old course.

In 1918 K. P. Kalitsky put forth the following assumption, which was intended to reconcile the facts with theory: after the deposition of the Middle Devonian the latter was eroded in the central part of the region, and the Upper Devonian sediments were deposited immediately on the sericite schists in a bay which was thus formed.

At last, in 1923, D. V. Nalivkin, geologist, having reexamined and redefined the Devonian faunas of Central and North-Western Russia and Timan, arrived at a conclusion that the beds with *Spirifer Anossofi* which are spread in the said regions differ from the Middle Devonian strata with *Spirifer Anossofi* of the Urals,

being actually the Upper Devonian sediments overlying the Domanik. Therefore, nothing prevents our returning to Keyserling's idea, viz., the existence of an undisturbed anticlinal fold. Based on data resulting from his investigations, D. Nalivkin draws the following conclusions of considerable practical importance:

1. Oil-bearing beds may be encountered not only in the center of the dome, but on its flanks as well.



Photograph by Bessonov.

Fig. 2. View of the Oukhta river (from the mountains near the river).

2. The area of the oil-field and its oil reserves should be estimated at a higher figure compared with previous estimations.

Of course, only deep drilling can prove the correctness of either opinion,—in case of the discovery of the Domanik or some older rocks of the Middle Devonian below the beds with *Spirifer Anossofi*. I think it possible, however, to base the present description of the stratigraphy of the Oukhta region on the scheme brought forth by Keyserling and Nalivkin. The correctness of the latter scheme is in my opinion proven by the fact that I was able to show the erroneousness of Chernyshev's scheme in a similar case during investigations in Central Russia, near Voronezh. In the latter place

**GEOLOGICAL STRUCTURE.** As has been previously stated, the rocks of the Oukhta region are folded into an anticline with gently dipping flanks, trending north-northwest and gradually plunging northward and southward. The fold is, thus, a very flattened elliptical dome, in the middle of which, between the Oukhta and Lya-Yol rivers, the rocks of the petroliferous series crop out, while the other above cited formations are exposed in concentric belts,



Photograph by S. Obruchev.

Fig. 3. Timan, at the portage from Cher-Vychevodsky to Cher-Izhemsky.

closing with the Permian on the west and the Mesozoic on the east (see fig. 5). Strata dip at angles varying from  $2^{\circ}$  to  $4^{\circ}$ .

The second structural axis of the southern Timan lies in the western portion of the latter, in the region of the old sericite schists; the Devonian series slightly rises towards the latter but the schists are isolated from the Devonian by a fault striking in the same prevalent north-northwesterly direction. A. Zamiatin believes that within the Paleozoic there are, besides the one mentioned, still some other faults of the same direction.

**OIL-BEARING HORIZONS.** The characteristics of the oil-bearing series are interpreted chiefly according to the results of the drilling operations conducted in 1910—1913 on behalf of the Government,

the strata contemporaneous to the Domanik rocks also lie below the beds with *Spirifer Anossofi*, and Chernychev considered them to have subsided, owing to rockslides. My investigations have shown that in reality the first series is older than the latter and lies quite normally.

The Oukhta region composed of the following rocks in the order of their age:

I. THE SERICITE SCHISTS of the Pre-Cambrian of Lower-Paleozoic age, over 450 m. thick.

II. THE UPPER DEVONIAN ROCKS.

1. Sub-Domanik oil-bearing formation. At the base of it lies basal conglomerate up to 7.5 m. thick, overlain by alternating blue, gray and red-brown marls and clays and, partly, sandstones. The formation includes 3 oil-bearing horizons (for particulars see below). The total thickness reaches 250 m.

2. Domanik,—calcareous and argillaceous bituminous shale with an abundant fauna of Cephalopoda. Thickness—75 m.

3. Over-Domanik formation,—blue marls with layers of micaceous sandstones and argillaceous limestones. Thickness—120 m.

4. Marls, sandstones, limestones, dolomites with *Spirifer Anossofi*, etc. (the Middle Devonian of Chernyshev); the lower strata of this formation are petrographically similar to the Over-Domanik formation, but are distinguished from the latter by their fauna. Thickness 210 m.

5. Gypsiferous formation (clays and dolomites). 40 m.

6. Limestones, marls and clays with *Rhynchonella livonica*. (90 m.)

The total thickness of the Devonian reaches 785 m.

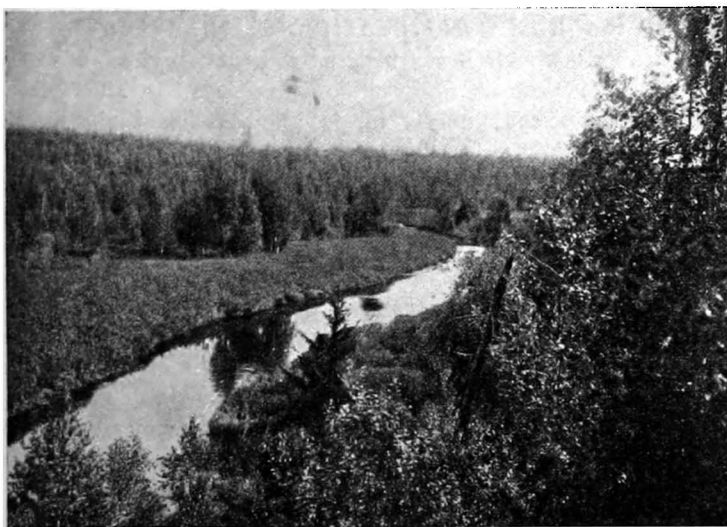
III. CARBONIFEROUS ROCKS rest on the west and in the Sed-Yu valley on the eroded surface of the Devonian, and are composed of limestones and marls.

IV. PERMIAN ROCKS occupying the upper course of Oukhta, are represented by varicoloured marls.

V. MESOZOIC CLAYS (Volga stage and Cretaceous) crop out only on the boundary of the district on the Izhma river.

VI. POST-TERTIARY DEPOSITS (ancient alluvium and boreal transgression) occupy the river valleys along the western and eastern borders of the district.

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**OIL-BEARING HORIZONS.** The characteristics of the oil-bearing series are interpreted chiefly according to the results of the drilling operations conducted in 1910—1913 on behalf of the Government,



under the supervision of V. Stukachev, and drilling operations performed in 1913 by the Russian company «Nefi». The data are somewhat contradictory. According to Stukachev, the oil-bearing series consists, as a rule, of the following horizons (beginning with the lowest):

1. On the sericite schists (defined by Stukachev as metamorphic sandstones) lie bituminous gray sandstones varying in thickness from 103 to 166 m. The uppermost part of these sandstones represents the 2nd more prolific oil-bearing horizon of Oukhta. Sandstones being tested by benzine yield a coloured extract.

2. Bluish viscous clays, marls and shales, their thickness varying from 4 to 90 m.

3. Brown-red marls, 6—43 m. thick.

4. Greenish-blue and gray marls, clays and shales, 17—124 m. thick. Within these strata lies the 1st oil-bearing horizon, which is poorer than the horizon mentioned above, and rests immediately on the brown-red marls.

The data obtained by the company «Nefi» are not sufficient for the definition of similar horizons within the oil-bearing series. They rather tend to show that the whole formation consists of the alternating gray, blue and brown-red marls, clays and shales. The oil-bearing strata lie within this formation, and have been encountered chiefly in connection with the layers of sandstones. The western wells of the company exhibit approximately the same sequence of the oil-bearing horizons, as the wells drilled by the Government; the only well on the eastern border of the district encountered the lower horizon at a much greater depth, only 40 m. above the sericite schists. It is to be supposed that the second horizon is not developed in this portion of the district, and instead of it the 3rd horizon, lying deeper, is saturated with oil. We have thus, three horizons lying below the base of Domanik beds: the 1st—at a depth of 40—55 m., the 2nd—at 120—130 m., and the 3rd—at 205—207 m. <sup>1)</sup>

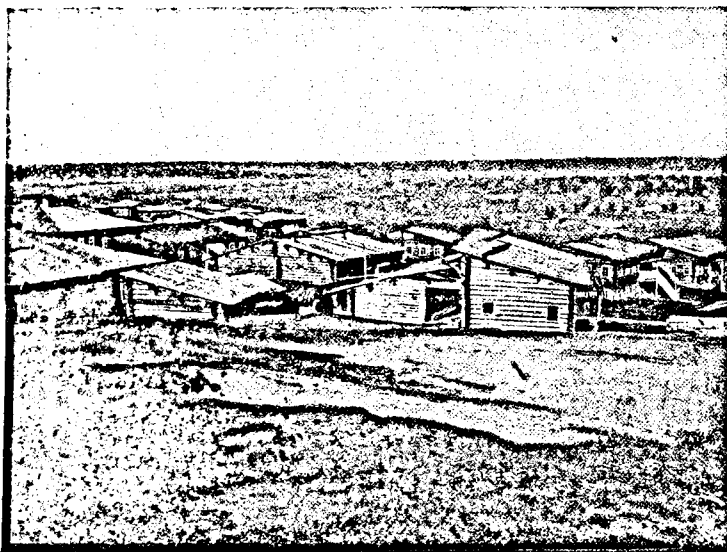
The accompanying three sections illustrate the foregoing. Section of fig. 6 is prepared by Stukachev according to the logs of drill holes sunk by the Government Mining Department; sections

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<sup>1)</sup> The well No. 2, owned by the State and located on the bank of Lya-Yol, the only well within the southern part of the region, encountered the 2nd oil-bearing horizon at a vertical distance of 121 m. from the 1st (i. e., at 170 m. from the Domanik), consequently, deeper than it should have normally been.

of fig 7—AB (longitudinal) and CD (latitudinal) are prepared according to the data of all the wells drilled in the district. On section AB, besides the already indicated rocks, an intrusive sheet of diabase is marked, which was encountered in Voronov's well on the Yarega river.

The oil-bearing horizons of Oukhta are saturated very feebly: the 1st yields not more than 50 kg. a day, the 2nd yielded during 2 months 300 kg. daily (the well No. 3 on Chut, owned by Govern-



Photograph by S. Obruchev.

Fig. 4. A Zyrian village in Timan.

ment), the 3rd, on Chibiu, from 150 to 650 kg. (particulars see below).

The oil-bearing horizons are gas-bearing as well. There are strong escapes of gas from second horizon, as, for instance, in the well No. 3 of the Mining Department, on Chut, where gas ejected water and oil over the mast which was 20 m. high. The upper horizon, as well as the Domanik, yields only small quantities of gas.

*Water-bearing horizons.* There are the following water-bearing horizons:

- 1) Fresh-waters over the Devonian clays, below the alluvium.

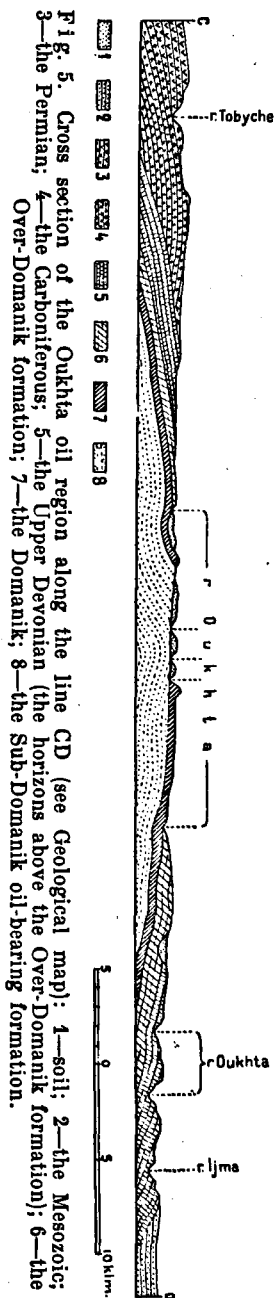


Fig. 5. Cross section of the Oukhta oil region along the line CD (see Geological map): 1—soil; 2—the Mesozoic; 3—the Permian; 4—the Carboniferous; 5—the Upper Devonian (the horizons above the Over-Domanik formation); 6—the Over-Domanik formation; 7—the Domanik; 8—the Sub-Domanik oil-bearing formation.

2) Alkaline-salt waters,—a strong flow (sometimes overflowing) from the Domanik.

3) Alkaline-salt waters from the formation underlying the 2nd oil-bearing horizon (Stukachev's bituminous sandstones). A strong flow, the salinity about 3° Baumé, temperature about 7°C.

4) Alkaline-salt waters from the sericite schists; the flow is abundant.

*Occurrence of oil.* Seeps of oil were known in the Oukhta region as early as in the end of the 17th century (Witsen). According to the description of T o l u b e i e v, engineer, «the oil film on the Oukhta river and its tributaries produces an impression of a petroleum river. Oil issues on the river banks and forms pools, from which it flows in wide streams falling into the river».

During the geological investigations conducted by A. Z a m i a t i n, the following indications of oil were recorded on the area within which oil-bearing series, the Domanik and Over-Domanik formations, have been found:

1. Seeps of black liquid oil occur in many places; they are most numerous on the axis of the anticline, on the area of the lower course of Chut, a left-hand tributary of Oukhta, and along Yarega, a right-hand tributary of Oukhta. To the south, another group of seeps is known, situated likewise on the axis of the anticline, on the Lya-Yol river.

2) Inflammable gas issues near the mouth of the Tsibiu (Chibiu) river, in the bed of the Oukhta river.

3) The Domanik is bituminous in many places, viz., to a greater extent along the Oukhta and Chut rivers and to a lesser extent on the Lya-Yol river, while the

southernmost outcrops of the Domanik along the Vezh-Vozh river are only slightly bituminous or sometimes non bituminous.

4) Alkaline-salt water flows from the casing-heads of the shallow test holes, which are pretty numerous on the Oukhta river banks. The wells spout water with inflammable gas and oil films, to a height of 1 m.

5) Near Sidorovskaia Kazarma, on the bank of the Gas-Yol river, there is a well with a constant escape of gas; when lighted, it burns continuously, so that it has to be extinguished.

6) Dolomites, marls and limestones of the upper strata with *Spirifer Anossofi*, gypsiferous beds and others, when struck, yield a kerosene odour; this is particularly observed along the banks of the Siuz-Yu, B. Kyran and other rivers.

7) There are found in the Domanik shells of *Goniatites* and *Brachiopoda*, whose cavities are frequently filled with oil. Likewise shells which occur in the beds with *Spirifer Anossofi* contain bituminous substances.

8) Sulphurous springs are reported in the following places:  
a) on the right-hand bank of the Krokhal river—alkaline-salt cold water containing sulphur dioxide spouts from a cast-iron pipe;  
b) a less copious flow of the sulphurous water is observed on the left bank of Oukhta, near the Bolshoi Porog (Great Rapids).

The largest seeps of oil are shown on the accompanying map.

Zyrians tell of numerous swamps covered with a film of petroleum which are situated on the watershed areas. There are many reports of fabulous oil springs in the swamps. Oil seeps are often said to exist in the upper part of the course of the Vychegda river, on the southern prolongation of the Oukhta anticline. The latter seeps are of a great importance, but unfortunately they have not been yet located by geologists.

The present article was in print when I received information from Professor A. A. Chernov, stating that he has examined the bituminous limestones (Carboniferous) and dolomites (Permian), together with asphalt nests, all of which had been discovered by him earlier in the upper course of the Izhma river, between the villages of Kush-Kodz and Niamod. The said deposit lies east of the southern prolongation of the Oukhta anticline, at a distance of 60 km. southeast from the center of the oil region. The presence of faulting in the vicinity of this deposit enables one to suppose that oil was yielded by the Devonian series. These outcrops of bitumen are of great importance, as proving assumptions of a much

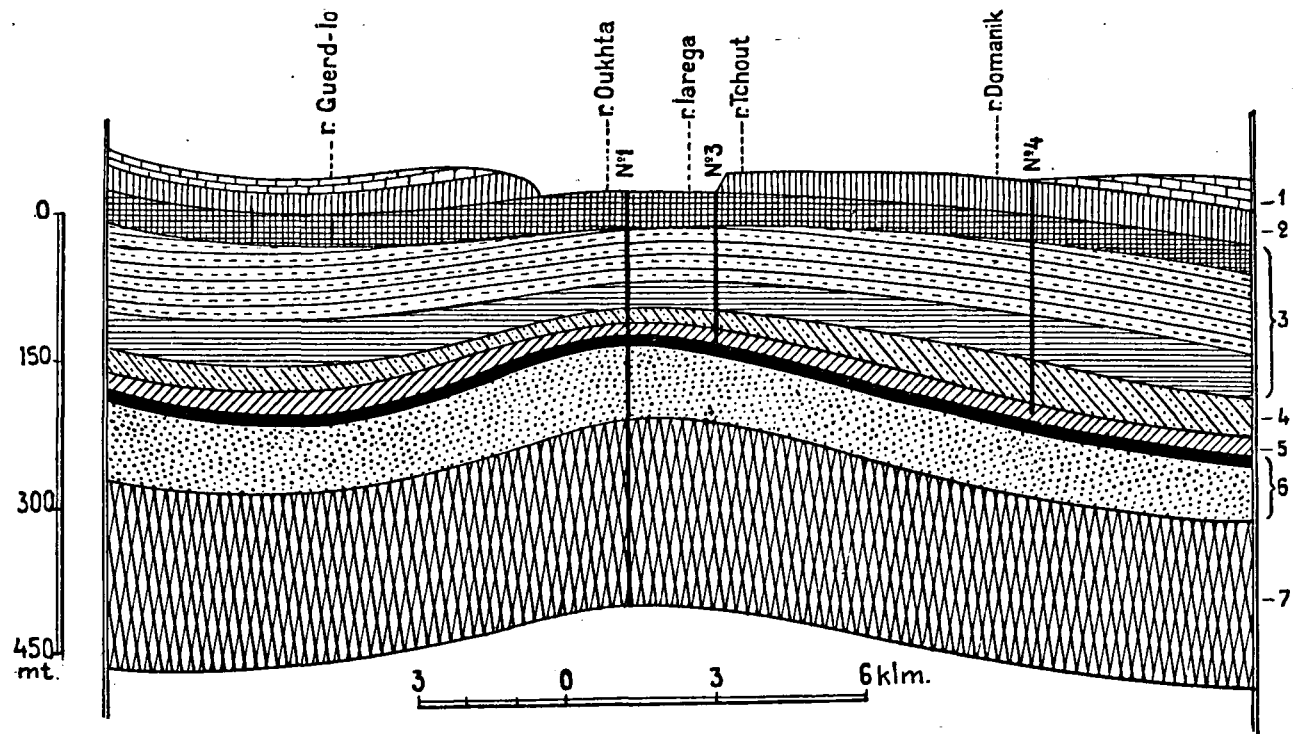


Fig. 6. Cross section of the central portion of the Oukhta oil region, after to V. Stukachev. Governments wells: No. 1—on Oukhta; No. 3—on Chut; No. 4—on Domanik. Formations are marked as follows: 1—the Over-Domanik formation; 2—the Domanik; 3—blue clays, marls and argillaceous shales, which are petroliferous in their lower portion; 4—brownish-red marls 5—blue clays; 6—gray bituminous sandstones (the oil-bearing horizon in the Upper portion is marked with black; 7—the sericite shists (blue sandstones).

greater extension of the Devonian oil horizons. Chernov's article, describing the new deposit, will soon appear in print.

*Origin of oil.* According to D. Nalivkin, the oil-bearing series consists of lagoon, bay and, possibly, delta deposits. Such basins are most favourable places for the accumulation of organic matter and the formation of petroleum. The latter is, thus, of primary origin. The assumption of A. Chernov that the Oukhta oil is not associated with certain series, but migrates along fault planes so that it may be encountered in marked quantities in the Mesozoic rocks, is so far too little verified.

### THE HISTORY OF EXPLORATION

The first scientific description of the Oukhta oil region was made by Keyserling (1843).

During the period 1860—1870 the Oukhta oil deposit was investigated and explored (details are given below) by M. Sidorov, the well known merchant and promoter of the industrial development of North Russia.

In 1889—90 an expedition operated on Timan, under the guidance of T. Chernyshev, Academician, who prepared the first map of the Oukhta region and described its stratigraphy and geologic structure. Prospecting work was also been done by the expedition; hand-drilled holes did not exceed 12 m. in depth.

In 1891 I. P. Boklevsky, mining engineer, examined the Oukhta oil field and sunk a few shallow drill holes.

In 1895 drilling operations were performed by Von-Wangel; over 20 shallow wells were drilled in various places of the Oukhta region; the deepest one reached the depth of 177 m. In the same year Oukhta was visited by V. Veber, geologist, on behalf of Von-Wangel.

In 1902 — 1904 A. P. Pavlov, Academician, and A. A. Chernov, geologist, investigated the Oukhta region. The latter has published a paper on the genesis of the Oukhta petroleum.

In 1906 V. J. Beloborodov, engineer, investigated the economic conditions and mineral resources of the region.

In 1905—1908 test drilling was carried on by Voronov, Abakovsky and the concern Hansberg, Kornilov and Co. Voronov drilled a well on the bank of the Yarega river (114 m. deep), Abakovsky—on the Chut river (79 m.) and the Hansberg Co.—on the left-hand bank of the Oukhta river (110 m.).

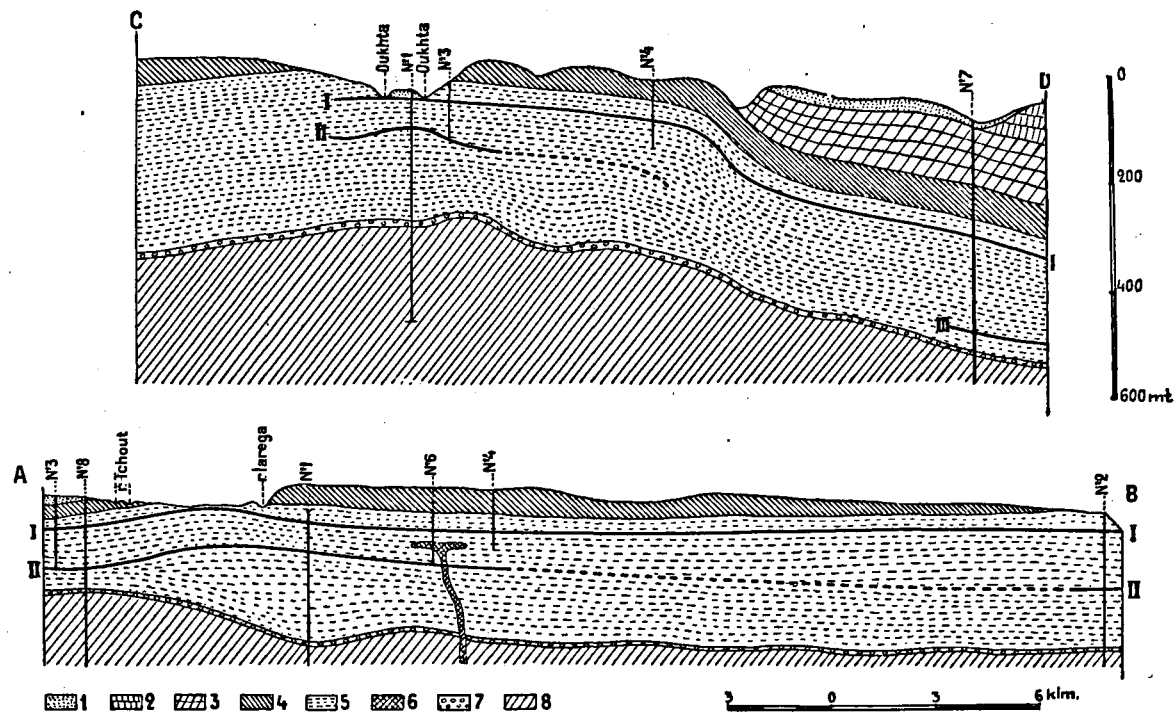


Fig. 7. Sections of the central part of the Oukhta region: AB—longitudinal section, CD—cross section (see the map). Governments wells Nos. 1—4: Nos. 1—on Oukhta; No. 2—on Lya-Yol; No. 3—on Chut; No. 4—on Domanik; No. 6—Voronov's on Yarega; No. 7—of the «Nefte» Company on Chibiu; No. 8—of the «Nefte» Company on Chut, the Karlovsky property. Rocks are marked as follows: 1—soil; 2—limestones with *Spirifer Anossofi*; 3—Over-Domanik formation; 4—Domanik; 5—Sub-Domanik oil-bearing formation; 6—diabase; 7—basal conglomerate; 8—sericite schists. I—III—oil-bearing horizons.

In 1907 explorations were conducted by P. I. Polevoi, on behalf of Voronov, and by Anderson, the geologist engaged by Nobel Company. The former has slightly modified the section prepared by Chernyshev.

In 1909 a group of French capitalists sent some experts to Oukhta.

In 1909—1910, on behalf of the Geological Committee, the Oukhta oil field was examined in detail by A. Zamiatin, geolo-



Photograph by S. Obruchev.

Fig. 8. Timan. Typical landscape, with forests of broad-leaved trees.

gist, while the adjacent district of the upper Oukhta and tributaries of Vym, northwest of the latter fields were investigated by N. Yakovlev. Reports and maps published by these geologists serve as guides for all subsequent investigations.

In 1910—1913 four test wells, ranging in depth from 149 to 427 m., were drilled under the supervision of V. Stukachev, engineer, on behalf of the Mining Department.

In 1913 the Russian Company «Neft» drilled four deep wells (from 200 to 657 m.) and sunk ten hand-drilled holes.

In 1918 K. P. Kalitsky and A. A. Stoianov, geologists, were sent to Oukhta by the Geological Committee.



In 1919 the Chief Petroleum Committee sent to Oukhta a large geological party, which, however, was unable to penetrate beyond the middle course of the Vym river, owing to the occupation of the Oukhta region by white troops.



Photograph by S. Obruchev.

Fig. 9. Timan. River encumbered by wood.

In 1920 the Archangel Economic Council cleaned the well located on Chibiu, formerly owned by the «Nef» Company.

#### PROSPECTING AND EXPLOITATION

The Oukhta oil region is the oldest in Russia. To Russians the Oukhta oil became known and was utilized long before the present oil producing regions were joined to Russia. There are reports that in 1697 Peter I sent to Holland some specimens of the Domanik rock, to be analysed. The further history of the Oukhta oil industry is such:

In 1745 NABATOV erected in Ust-Oukhta a refinery; the kerosene produced was sent to Moscow apothecaries in quantities of about 16 tons per annum, up to the end of the XVIII century; the total oil production amounted to 60 tons per annum. Crude oil was sent

abroad. After Nabatov's death the refinery was burnt down and the oil production stopped.

In 1746 FEDOR PRIADUNOV built a refinery on Oukhta. «Above the very spring, spouting oil, a quadrangular log hut has been erected». In 1751 Priadunov was thrown into prison at the Berg-Collegium (Mining Committee) in Moscow, owing to the non-payment of the tithe money (royalties) amounting to 35.23 roubles for the oil produced in 1751, and died in confinement. After his death the plant passed to Nagavikov, a Vologda merchant, then to Mingalev, a peasant, and further to Bazhenov, a merchant of Yarensk.

In 1860, M. SIDOROV, who endeavoured to promote the development of all the mineral resources of North Russia, took interest in the Oukhta oil. In 1872, upon the investigation of the oil field and after lengthy solicitations to secure a prospecting permit (during 6 years the authorities obstructed in every way Sidorov's activity), Sidorov drilled a well on the bank of the Oukhta river, near the mouth of the Neft-Yol stream; the well was sunk to a depth of 52 m., with an initial diameter of 16 inches (?) and a final one of 5 inches. At this depth the drilling tool broke. According to the well log, there are in all eight oil-bearing beds, four of which were encountered within the last 4.5 m. from the bottom of the well, and two gas-bearing beds. The flow of oil steadily increased. All this oil seemingly rose from the 1st horizon. Sidorov ordered a set of tools for drilling to a depth of 200 m. with a diameter of 13½ inches, but such heavy tools could not be transported to Oukhta, the drillers brought from abroad fled away; Sidorov himself died soon afterwards, and all his numerous undertakings were abolished. The «Sidorov Property» (Sidorov's tract of land) and the «Sidorovskajia Kazarma» (a house) remained, to serve as memorials of this man (the house, however, was burned in the XX century).

In 1889—1890 a number of shallow wells were drilled by T. CHERNYSHEV, during his expedition to Timan; they were drilled with Voislav's hand drilling tools with bits 2 inches in diameter. The deepest well No. 3 on Chut reached a depth of only 12 m. When the well penetrated through the layer of limestone interbedded in the blue marls, oil appeared at a depth of 6 m.; the oil was first spouted continuously for 3 hours, whereupon it was ejected periodically, every 30 or 45 minutes, alternating with water. At a distance of ¾ km. from the well No. 3, up the river Chut, on

the left-hand bank of the latter, a well, No. 4, was drilled from which a stream of oil likewise issued at a depth of 3 m. from the blue marls. All these flows came from the first horizon.

In 1891 A. M. GALIN obtained an exclusive right for the term of 12 years of working the Oukhta oil field, as well as a license for manufacturing illuminating oils in quantities of 80,000 tons free of excise tax. Till 1895 nothing was done by him.



Photograph by S. Obruchev.

Fig. 10. Timan. Zyrian huntsman's hut.

In 1895 B. I. VON-WANGEL entered into partnership with Galin and started drilling operations; during that year he drilled 6 wells ranging from 3 to 6 inches in diameter, and from 50 to 177 m. in depth. In 1896 they had about 20 wells most of which were shallow. The deepest well, No. 2, 177 m. deep, was located on the right-hand bank of the Chut river, on the northern border of Sidorov's lease,  $1\frac{1}{4}$  km. from the mouth of the river (No. 10 on our map). It seems that at a depth of approximately 100—105 m. the 1st oil-bearing horizon was passed through, from which large quantities of gas issued, while the flow of oil reached 50 kg. per day; oil and gas were struck at a depth of 9 m., and their flow was continuously increased to the 1st horizon. Below the latter salt

water appeared. The well was stopped in a hard calcareous sandstone. Further prospecting operations were suspended, owing to want of capital.

In 1900 count KANKRIN obtained an exclusive right of oil production within the Oukhta region for a term of 5 years, but up to the expiration of the latter, May 5, 1905, no prospecting operations were started.



Photograph by Bessonov.

Fig. 11. Oukhta at the mouth of the Nefte-Yol creek.

In 1907 I. A. VORONOV organized an expedition with the participation of P. I. Polevoi, a Russian geologist, and Andersen, a Swedish geologist, and in the autumn of the same year sunk a well on the beds of Under-Domanik formation in the valley of Yarega (No. 6 on our map). The drilling was supervised by N. E. Pars'hin, engineer; the well, 4 inches in diameter, reached a depth of 194 m. The first oil-bearing horizon was encountered at a depth of about 50 m.; the flow of gas was strong, that of oil being weaker. Below a sill of diabase, 12 m. thick, the well encountered at a depth of 65 m. a bed of petroliferous sandstone, in which drilling was stopped. Oil flowed in continuous small streams. Water was not shut of. The flow of oil markedly increased with the depth, the

thickness of the 2nd horizon in this well being considerable. Beginning with the sill of diabase, diamond drilling was applied.

In 1908 ABAKOVSKY sunk a 4-inch well on the left-hand bank of Chut, at a distance of 300 m. from the mouth of the latter. The drilling was performed first with the diamond drill, and further a rod drilling tool was used. The drilling operations were supervised by B a t s e v i c h, a mining engineer. In the first 25 m. of the hole the Domanik rocks were penetrated, then at a depth of 45 m. appeared large quantities of gas followed by oil. From a depth of 79 m. the well yielded 30 kg. of oil. There was no water at all.

Abakovsky had also conducted prospecting operations in 1904. Beginning from 1899 A. G. HANSBERG took part in the exploration and development of the natural resources of the Pechora region. In 1905 he founded an oil enterprise in the Oukhta district under the title of «The Northern Oil Partnership, founded by A. G. Hansberg, A. P. Kornilov and Co.». In June 15<sup>th</sup> 1905 the company drilled a well, 14 inches in diameter, on the Varvarinsky lease, on the left-hand bank of Oukhta, near Sidorovskaia Kazarma. By July 24<sup>th</sup> 1908 the well was sunk to a depth of 110 m., and stopped in sandstones. Drilling operations lasted about 600 working days; the reason for the suspension of the work was want of capital. In winter, till January 1908, only one shift was at work, in consequence of the strong exudation of gas, until the electric lighting was established. V. S o k o l o v estimated the number of oil and gas-bearing beds, penetrated by this well, to be 21, but the proven oilbearing horizons were seemingly encountered at 68 m. and 110 m. (possibly also at 93 m.).

Beside this well there was drilled on the Varvarinsky lease a 4-inch test well, 64 m. deep, which flowed intermittently; a column of water was thrown out of the well every 60—90 minutes, whereupon oil flowed during a few minutes. According to some reports, which, however, have not been checked, both the wells yielded in total about 2.5 tons per day.

In 1910—1913 test drilling was undertaken by the MINING DEPARTMENT with a view to ascertain the commercial value of the Oukhta oil region. By 1910 there were on the Oukhta about 1,000 oil claims; the banks of the Oukhta river as well as its tributaries were covered by locating posts, but any accurate data concerning the value of the oil-bearing territory were absent. The

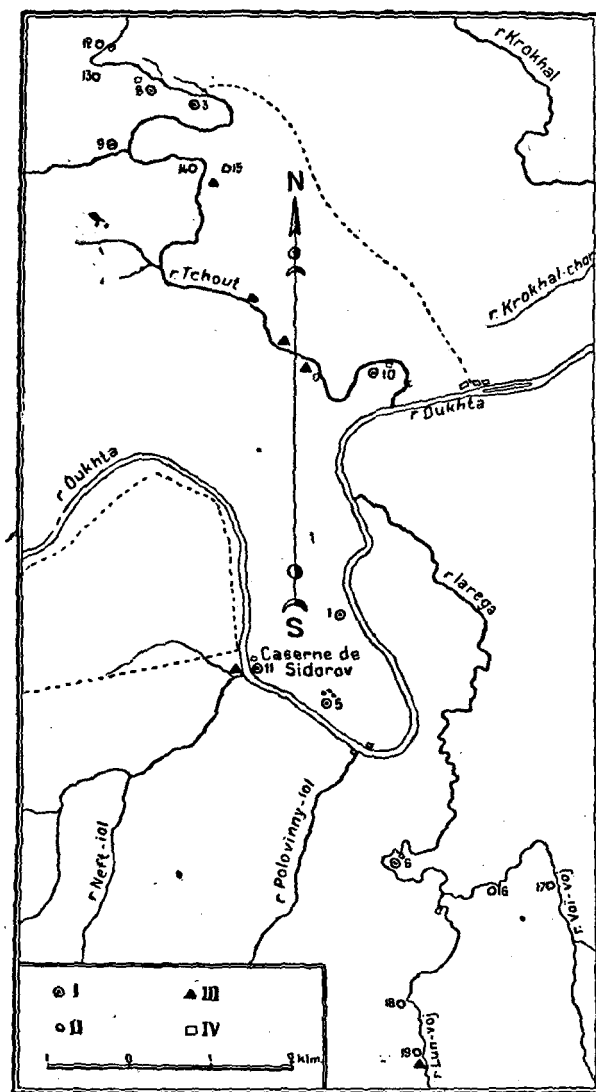


Fig. 12. Map showing distribution of wells of the central portion of the Oukhta district: I—deep wells; II—shallow wells of the «Neft» Company; III—oil seeps; IV—buildings.

Number of wells: 1—Government's well on Oukhta; 2—Government's well on Chut; 3—Hansberg's well on Oukhta; 4—Voronov's well on Yarega; 5—Well of the «Neft» Company on Chut, the Karlovsky property; 6—d-o, the Vladimirsky property; 7—B. Wangel's well on Chut; 8—Sidorov's well on Oukhta; 9—shallow wells of the «Neft» Company; 10—Sorokhtinsky well; 11—Samsousovsky well; 12—Valentinovsky well; 13—Petrovsky well; 14—Voi-vozh well; 15—Gorny well; 16—Nikolayevsky well; 17—Vladimirsky well.

The following wells are beyond the area covered by this map: 18—Government's well No. 2 on Lya-Yol; 19—Government's well No. 4 on Domanik; 20—a well of the «Neft» Company on Chibiu (see geological map on separate sheet).

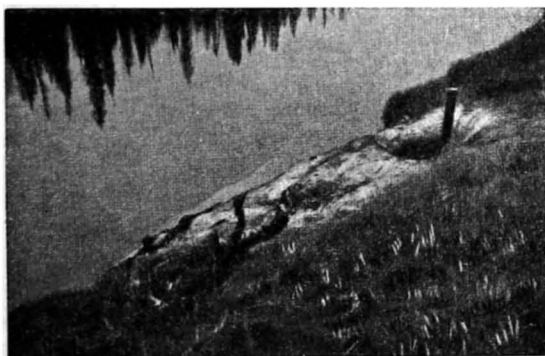
drilling undertaken by the Mining Department was conducted under the guidance of V. S t u k a c h e v, an engineer; wells were drilled by standard cable tools with the use of Keystone's drill No. 25. As the rocks were solid, it was possible to drill without immediate lowering of casing; the speed of drilling varied from 12 to 18 feet (3.7—5.5 m.) in a twelve hours' shift. Wells were located in the following places:

1) No. 1—on the left-hand bank of the Oukhta river, above the Yarega mouth, on the southwestern flank of the anticline, at a distance of 400 m. from the crest of the latter (No. 1 on the map). The well, 427 m. deep, penetrated the 1st oil-bearing horizon embedded in the sandy marl at a depth of 55 m., the 2nd horizon embedded in a compact argillaceous sandstone at a depth of 82.3 m. The first horizon yielded daily about 130 kg. of oil of specific gravity 0.918, the second about 570 kg., sp. gravity 0.886. The second horizon represented a bed of sandstone, 7.6 m. thick, separated from the underlying bituminous sandstone, 166 m. thick, by a layer of marl, 1.5 m. thick. The extracted oil was heavy, with a sulphurous odour; alkaline-salt water was encountered not only in the underlying old «metamorphous sandstones» (the well penetrated the latter for 187 m.), but likewise in the formation of gray-blue marls and limestones overlying the 1st oil-bearing horizon. According to Stukachev, both the latter facts are due to the proximity of the earth's surface and to fractured rocks near the axis of the anticline. The bituminous sandstones yielded fluid oil only from its upper horizon, while gas issued also at a depth greater than 210 m. The marls yielded strong flows of gas at a depth of 40 m.

2) The well No. 2 was drilled on the bank of the Lya-Yol river, 30 km. south of the first, on the northeastern flank of the anticline, near the axis of the latter (No. 2 on the map). The drilling was stopped likewise in the Precambrian sandstones (which were penetrated by the hole for 50 m.) at a depth of 320 m. The oil-bearing horizon was encountered at a depth of 41 m., in gray marls (slightly impregnated); the upper portion of the bituminous sandstones, which was struck at a depth of 180 m., did not yield any fluid oil. There was a meager flow of gas from the 1st horizon. Oil seeps are found on the banks of the Lya-Yol river in places where the upper horizon crops out; the latter is, thus, drained and has here no practical value. There are 2 water-bearing horizons on the banks of Lya-Yol: 1) a feeble flow of fresh water at a depth of 23—30 m., 2) alka-

line-salt water issuing from the bituminous sandstones at a depth of 210—270 m. salinity—0.5° Baumé, temperature +7.3° C. The rocks are intensely fractured, owing probably to the proximity of the axis of the anticline).

3) The well No. 3, sunk on the right-hand bank of the Chut river, 8 km. NNE of the well No. 1 (No. 3 on the map). The drilling was stopped at a depth of 149 m. in oil-bearing sandstones. The 1st oil-bearing horizon was encountered at a depth of 75 m., the second—at 149 m. The first one yielded small quantities of gas and oil, the second—a strong flow of gas which ejected water, oil and even



Photograph by Bessonov.

Fig. 13. Seeps of oil in Oukhta.

wooden plugs to a height of 20 m. The gas was under a high pressure and had a pronounced odour of kerosene. The pumping of oil from this horizon was carried on during 5 months. The daily output was at first only 80 kg., but gradually increased and attained its maximum on the 46th day, when 700 kg. were bailed. The average daily output during the two first months was approximately 300 kg. Thereupon its production declined and by the end of the fifth month the output was equal to only 30 kg. per day. During 150 days a total of 30.7 tons was bailed. The exudation of gas continued for a long period of time, and the gas pressure attained 140 lbs. per square inch (9.84 kg. per square centimeter), with the well shut, and 10 lbs. per inch (0.70 kg. per square centimeter), when outflowing through a two inch tube. Further deepening of the well was refrained from, to prevent flooding by



alkaline-salt waters from the underlying sandstones. Sp. gravity of oil—0.779 <sup>1)</sup>).

4) The well No. 4 was located on the Domanik river (a right-hand tributary of the Oukhta), on the northeastern flank of the anticline, 6 km. away from the axis of the latter. The well penetrated the Domanik rocks, 53 m. thick, and the formation of blue-gray and red marls, to a depth of 225 m. The 1st horizon, slightly saturated with oil, was encountered at a depth of 94 m. (gas issued in small quantities, and insignificant quantities of oil not exceeding 10 kg. per day). Sp. gravity—0.886. The Domanik rocks yielded a strong flow water with a marked odour of sulphuretted hydrogen, to 738,000 liters per day.

A summary of Stukachev's data concerning the lithological character of the oil-bearing series and the section prepared by him according to well logs are given above in the description of oil-bearing horizons. Stukachev holds that the porosity of the sandstones of the lower horizon equals 0.08 of the volume; only the uppermost beds of the horizon, which lie immediately under the argillaceous cap, are believed by him to be oil-bearing, while the lower portions of the sandstones are saturated with alkaline-salt waters. The oil-bearing formation may be estimated 1.5—7.5 m. thick, which equals 1/70—1/15 of the whole thickness of sandstones. The oil always contains water which is mechanically mixed with it and amounts to 5 per cent of the volume of oil.

In 1913 THE RUSSIAN COMPANY «Neft» sunk four deep wells in the Oukhta region by means of the standard cable tools, using the drilling machine of Keystone and Star; the same Company sunk also ten hand-dug wells.

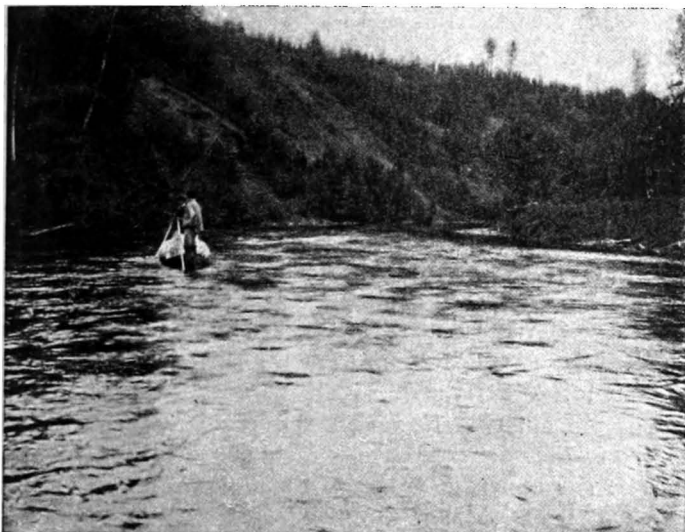
The report of A. Zamiatin and the saved well logs of some of the wells give the following particulars concerning the wells of the said Company.

1) Well No. 1 was drilled on the plot Karlovsky on the right-hand bank of the Chut river, 1 km. from the Mining Department's well No. 3 (No. 8 on the accompanying map); it reached a depth of 657 m., the 1st petroliferous horizon encountered at a depth of 84 m., the 2nd—at a depth of 143—147 m. The first horizon yielded drops of oil and some gas, the second showed the same results (according to Zamiatin; in the well log this horizon is not indicated at

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<sup>1)</sup> Possibly, this is a misprint—the figure should have been apparently 0.879, because fractions distilled from this oil have sp. gravity of 0.73—0.84.

all). At a depth of 182 m. (according to the well log) drops of oil and salt water were encountered. At 193.5 m. the hole penetrated a bed of conglomerate, 7.5 m. thick, and entered the sericite schists. In order to ascertain the presence of oil in the strata underlying the oil-bearing series, the well was sunk further to 463.5 m. through the sericite schists, but no indications of oil were discovered, and



Photograph by S. Obruchev.

Fig. 14. Timan. Cher-Vychegodsky river in its mountainous banks.

the drilling of the well was stopped without reaching the rocks underlying the schists.

2) Two wells were sunk on the Vladimirsky property situated 1 km. south of the Karlovsky property. The first well, which was a deep one (No. 9 on the map), struck oil-bearing horizons at the depth of 64 m. and 160 m; the well ended in the sericite schists. Another one, located at point 20 m. distant from the first, was drilled by hand only to the first horizon (at a depth of 67 m.). The top water in the first well was carefully shut off; the absence of water flow between the oil-bearing horizons permitted the extraction of oil from both of them at the same time. Trial bailing yielded on the first day 220 kg. of oil, on the 10 th day—30 kg., and after the output decreased to 15 kg. per day; the well yielded

totally about 3 tons. The second well yielded from the upper horizon at first about 50 kg., and subsequently not more than 15 kg., like the first well.

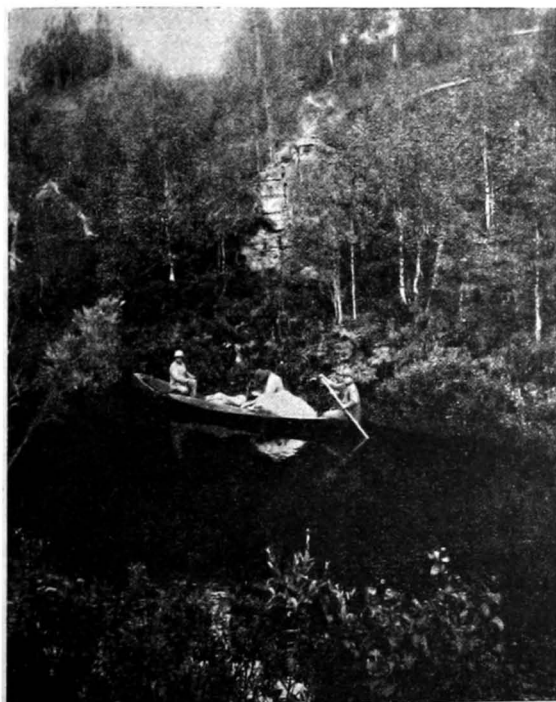
3) The wells located on the Gorny, Nikolaevsky and Vladimirsky properties on the Yarega river and drilled by hand gave oil and gas from the first horizon; the well sunk on the latter property struck a flow of oil amounting to 30 kg. per day.

The other five wells drilled by hand in the central part of the Oukhta region struck only gas and water.

4) With a view to ascertaining the conditions of the oil-bearing horizons on the flanks of the anticline, the company sunk three wells on a tract near the Chibiu river, a left-hand tributary of the Oukhta river, at a distance of 12—13 km. from the mouth of the former. Well No. 1 (drilled by the standard cable tools) was located at a short distance west of the line of the so called fault of Chernyshev and Zamiatin, or, according to the map prepared by the latter, even east of the fault, that is, the well possibly furnishes a positive evidence in favour of Nalivkin's scheme. The well drilled through alluvium, 7.6 m. thick, the Over-Domanik clays, 98.5 m. thick, the Domanik rocks 76 m. thick, in which it encountered a feeble flow of sulphureted hydrogen at a depth of 143 m., further down it encountered the 1st oil-bearing horizon, with feeble gas and rare drops of oil at 234 m., the second horizon, with a strong flow of gases and drops of light oil, at 387—389 m. The second horizon is represented by greenish-blue clay with sandstone; below some layers of coarse-grained sandstone issuing an odour of petroleum were met with. At a depth of 428 m. the sericite schists were encountered, within which the drilling was stopped at a depth of 478 m. Fresh water was encountered at the level of the Oukhta river, at 6.4 m. and at 16.5 m., a feeble flow of alkaline salt water at 117 m., a strong flow of the same water which overflowed the well—at 143 m.; both these flows were from the Domanik rocks. At a depth of 234 m. still another feeble flow of alkaline salt water was encountered, which possibly was also derived from the Domanik rock. Two strings of casing were lowered into the well; the last string was stopped at a depth of 412 m. The second oil bearing horizon yielded a gas fountain; a trial bailing of the well gave a daily output up to 500 kg., but at the end of the month only 115 kg. In order to open all the flows of oil in the well the string of casing was raised 36 m., whereupon the well yielded on the first day 650 kg., but a fortnight later

the output dropped to 160 kg. During 80 days 16.8 tons of oil were extracted. Water was carefully excluded.

Two other wells were sunk on the same property to the depth of 279 m. and 85 m. respectively. The first of them, located at a distance of 32 m. from well No. 1, penetrated, according to the well log, alluvium, 8 m. thick, the Over-Domanik series,



Photograph by S. Obruchev.

Fig. 15. Timan. A cliff of limestone in the narrow valley of Cher-Vychevodsky at the portage.

118.5 m. thick, the Domanik rocks, 72.5 m. thick; further downward the hole entered the sandy-argillaceous formation. At a depth of 244 m. the well struck gas (the 1st oil-bearing horizon); fresh water—at a depth of 14 m. Oil and salt water were not encountered.

In 1920 the ARKHANGELSK ECONOMIC COUNCIL cleaned the well on the Chibiu, formerly owned by the «Neft» Co., and recommenced

the exploitation of the old oil wells. During the winter 1920—21 about 33 tons of oil were extracted, but further production ceased, owing to large cavings in the well.

### COMPOSITION AND COMMERCIAL VALUE OF THE OIL

There are about 20 analyses of the Oukhta oil. They were summarized in an article prepared by A. Vaipolin. Here we cite but some of the most important analyses taken from the said article. The most complete analysis of the oil derived from Wangel's well was made by Prof. A. Berkenheim. The results of the analysis are as follows:

The oil was thick and dark-brown; its specific gravity equalled 0.8832 at 17.5° C; the viscosity at 20°, as compared with water at the same temperature, was  $E_{20}=9$ ; flash point 21° C (at barometric pressure of 747.9).

The results of the first distillation are shown in the following table; the 1st fraction comprises all products distilled at a temperature below 150°, including water contained in the petroleum.

Fractions.	Sp. grav.	Grammes.	Yield (per cent).
I. 28° to 150°C . . . . .	}	990	12.0
to 200°C . . . . .			9.2
II. 200° to 250°C . . . . .	0.820	342	7.3
III. 250° to 270°C . . . . .	0.832	630	13.4
IV. 270° to 300°C . . . . .	0.815	265	5.6
		2.227	47.5

Specific gravity of all the fractions was taken at 15.5—16° C. Percentage of residuum, sp. gravity 0.957, was 50 per cent.

The fractions obtained at the first distillation (2227 gr. in total) were subjected to the second fractional distillation. The latter was started with the first fraction, to which the other fractions were subsequently conveyed in the process of distillation.

Fractions.	Weight (grammes).	Yield. (per cent).	Total.	Volume (cubic cm).	Yield (per cent).	Total.
<b>I. Benzines . . . . .</b>						
20°—100°C . . . . .	76	1.62	} 7.88	106	2.00	} 9.00
100°—120°C . . . . .	96	2.05		103	2.00	
120°—150°C . . . . .	197	4.21		260	5.00	
<b>II. Kerosines</b>						
150°—200°C . . . . .	404	8.63	} 26.57	501	9.55	} 30.76
200°—250°C . . . . .	574	12.26		705	15.20	
250°—270°C . . . . .	226	5.68		419	6.01	
<b>III. Solar oils.</b>						
270°—300°C . . . . .	212	4.53	} 7.77	250	4.70	} 8.10
300°—320°C . . . . .	153	3.24		180	3.40	
<b>Total up to 320°C</b>			<b>42.22</b>			<b>47.86</b>
<b>IV. Cracked products of low boiling point (secondary benzines).</b>						
27°—100°C . . . . .	36	0.77	} 1.56	51	0.96	} 2.14
100°—120°C . . . . .	13	0.03		16	0.30	
120°—150°C . . . . .	35	0.76		47	0.88	
<b>V. Residuum, boiling point above 300°C.</b>						
	126		2.67	143	2.70	
			<u>46.45</u>		<u>52.70</u>	

The specific gravity of «cuts» of the secondary distillation was determined with the aid of the Mor-Westfal balance at 17° C.

Fractions.	Sp. gravity.	Viscosity (Engler).
22°—100°C . . . . .	0.7140	—
100°—120°C . . . . .	0.7378	—
120°—150°C . . . . .	0.7577	—
150°—200°C . . . . .	0.7846	1.00
200°—250°C . . . . .	0.8136	1.17
250°—270°C . . . . .	0.8379	1.33
270°—300°C . . . . .	0.8479	1.56
300°—320°C . . . . .	0.8520	2.00
above 320° . . . . .	0.8700	—

The flash point of the 150°—200° fraction was proved to be 15° C, i. e., below the standard (28°); the flash point of the other fractions was above the standard and above the limit of the apparatus of Abel-Pensky (40°). Viscosity was determined at 20° C in relation to water of the same temperature.

The residuum obtained upon the first distillation, amounting to about 50 per cent, represents a thick viscous fluid with specific gravity (at 17.5°) 0.957 (determined with the aid of an areometer). 300 gr. of residuum were subjected to further fire distillation for the determination of the yield of lubricating oils. During the distillation the temperature very soon exceeds 360° C, and of the whole quantity of residuum, the yield of distillate is 175 gr., i. e. 30 per cent. of the total amount of crude oil; a hard asphalt-like residuum is left in the distillation flask. 175 gr. of the lubricating oil obtained upon the distillation were frozen, to determine the paraffin content.

Being exposed to cold the whole sample solidifies and yields 2.25 gr. of crude paraffin; the content of the latter in the petroleum is therefore about 0.5 per cent.

The samples of oil brought from Oukhta in the autumn of 1918 at the initiative of the Putilov Works were examined in the laboratory of the Chief Petroleum Committee. The same samples have also been analyzed in the laboratory of the Putilov Works.

According to the analyses made by the Chief Petroleum Committee, Prof. M. M. Tikhvinsky refers these oils to the type of high tarry oils, deprived of paraffin. Benzine can be extracted only from Chibiu oil—these oils are not suitable for the manufacture of lubricants, while the Sidorov oil can be used only as fuel; but even for this purpose it cannot be used because of its high viscosity, unless it is diluted with a lighter oil.

But Tikhvinsky's conclusion is too pessimistic, being based on the analyses of oils which are evidently enriched with tarry substances; these oils were taken from abandoned wells, or even from pits near the wells,—and were exposed to the air for a long time. Therefore, only one analysis, viz., that of the Chibiu well, which is the newest, deserves attention. This analysis reads as follows:

Total quantity of oil . . . . .	520 cubic cm.
Quantity of settled water . . . . .	none
Specific gravity at 15°C . . . . .	0.8944
Viscosity after Engler at 50°C . . . . .	4.33
Flash point after Brenken . . . . .	40°C.
Percentage of tar (the so-called excise method)	78%

Distillation after Engler:

Initial boiling point . . . . .	99°C
Fraction below 150°C . . . . .	7.9%
Fraction 150—270°C . . . . .	26.0%
Specific gravity of the fraction at 15°C	0.8028
Fraction 270—285°C . . . . .	7.1%
Residuum above 285°C . . . . .	58.7%
Loss . . . . .	0.3%
Cold test . . . . .	under 3°.

A. Vaipolin gives the following comparative table of the fractions yielded from some samples of the Caucasian, Pennsylvanian and other oils:

	Specific gravity.	Fractions below 150°.	Fractions (Per cent) 150—300°.	Total.
Pennsylvanian I . . . . .	0.817	14.6	31.1	45.7 per cent.
» II . . . . .	0.801	21.5	29.2	50.7 »
Baku I . . . . .	0.870	4.05	38.85	42.9 »
» II . . . . .	0.880	0.63	37.28	38.9 »
Balakhany I . . . . .	0.871	6.1	32.6	38.7 »
» II . . . . .	0.882	1.0	40.9	41.9 »
» III . . . . .	0.894	9.38	20.16	29.5 »
Oukhta I <sup>1)</sup> . . . . .	0.883	7.88	31.1	39.0 »
» II <sup>2)</sup> . . . . .	0.878	10.46	40.26	50.7 »
» III <sup>3)</sup> . . . . .	0.879	11.61	21.84	75.0 »
		Cracked kerosene	41.54	
» IV <sup>4)</sup> . . . . .	0.894	7.9	33.1	41.1 »

From the examination of all the analyses of the Oukhta oil A. Vaipolin draws the following conclusions:

The percentages of respective fractions in different analyses are not equal: for instance, some samples contain practically no benzine (1 per cent), while other samples show from 4 to 11.6 per cent of it; the yield of kerosene varies from 21 per cent to 40 per cent; thus, the total percentage of distillates of some oils amounts to 25 per cent. of the crude petroleum, whereas for

<sup>1)</sup> Wangel's well, analyst Berkenheim (the lower horizon).

<sup>2)</sup> Hansberg's well, horizon unknown.

<sup>3)</sup> Mining Department's well No. 3 on the Chut river, analyst Alexeyev, from the depth of 151 m. (the lower horizon?). Specific gravity is shown by Stukachev to be 0.779, probably, erroneously.

<sup>4)</sup> Well of the Co. «Nefte» on Chibiu, analysis of the Chief Petroleum Committee (the lower horizon?).



some other oils this percentage inclusive of the products of cracking reaches 75 per cent.

The same applies to the percentage of other fractions, likewise of paraffin.

The yield of lubricating oils is not considerable (in some particular cases it may be as high as 30 per cent), but the Oukhta oil is not sufficiently studied in this respect.

As to paraffin, its percentage in the oil, as is ascertained by different analyses, is variable; for example, B e r k e n h e i m's analysis (oil from Wangel's well) shows 0.5 per cent. of paraffin, the analysis of the Laboratory of the Mining Institute (I. A. A v a l o v analyst, oil from the Chut river, Wangel's well)—1.25 per cent.; K. T u m s k y points out a case where the oil yielded 2.4 per cent. of paraffin.

Yielding by distillation variable percentages of fractions, the oils derived from different wells differ from each other also in physical properties, such as viscosity, specific gravity, colour, etc. For instance, the oil of Sidorov's and Hansberg's (Varvarinsky) wells is thick and of a greenish colour, while the oil from the wells on the bank of the Chut river (those of Wangel, Mining Department No. 3, etc.) is less thick and has a comparatively low specific gravity. The oil from the deep wells of Chibiu is still more fluid. The oil from the Lya-Yol river is less thick than the oil from Sidorov's well.

When exposed to the air, the oil densifies (becomes more tarry), its specific gravity considerably increases; such oil will, of course, yield a lesser amount of light fractions than the fresh samples of oil just extracted from the well. These circumstances should be borne in mind, especially when the results of the analyses of the Oukhta oil are estimated: some investigators took the samples of oil direct from the wells by means of a bailer; other investigators (who visited the wells after the operations had been stopped) caught oil, that flowed with gases and water at a casing head, or simply gathered oil in pits near the wells.

It should be likewise taken into consideration that different conditions under which the distillation of even the same sample of oil was performed may be responsible for variations in results, which doubtlessly occurred in some cases.

As may be seen on the table cited above, the percentage of the illuminating oils yielded by the Oukhta oil is not below the respective percentage obtained from Caucasian petroleum, while

the lighter oil equals in this respect the Pennsylvanian oil, in spite of a by far higher specific gravity of the Oukhta oil.

It should be also mentioned that the figures in the above table are not quite comparable with each other, because the conditions of the distillation were not identical in all cases. The figures should necessarily vary within a small percentage, depending on whether the distillation was conducted with superheated steam or by means of open fire, with greater or smaller quantities of oil, or, possibly, was a distillation on a commercial scale.

The specific gravity of the distillates of the Oukhta oil (fractions of the second distillation by Berkenheim) is somewhat lower than that of the corresponding fractions of the Caucasian oil, but is higher than the specific gravity of the distillates of the Pennsylvanian oil:

	150°—200°	200°—250°	250°—300°
Pennsylvanian oil . . . . .	0.757	0.788	0.806
Caucasian oil . . . . .	0.786	0.824	0.861
Oukhta oil . . . . .	0.784	0.813	0.843
		to 0.803	to 0.829 <sup>1)</sup>

W. K i n d holds that a relatively low specific gravity of the corresponding fractions of the Oukhta oil somewhat increases the value of the latter, as compared with the Caucasian oil, inasmuch as the fractions to be turned for manufacturing kerosene mixtures may have higher boiling points, than the fractions used for that purpose in the Caucasus oil regions; besides, the fractions of the Oukhta oil may be taken in that case in greater quantities, than the latter fractions; however, the Oukhta oil is in this respect inferior to the American oils. In the Pennsylvanian kerosene the fractions boiling above 290° C. amount to 26 per cent by volume, whereas the respective percentage for the Caucasian oil barely reaches 5.4 per cent.

The gas from the Mining Department's well No. 1 (Oukhta) has, according to N. I P o d k o p a i e v's analysis, the following composition:

Methane (CH <sub>4</sub> ) . . . . .	99.2 per cent.
Carbon dioxide (CO <sub>2</sub> ) . . . . .	0.6 » »
Oxygen (O) . . . . .	0.2 » »

<sup>1)</sup> Analysis by I. D. Avalov of the oil from Wangel's well.

## SUMMARY

The following conclusions may be drawn from the available data:

1. The structural feature of the Oukhta oil field represents a dome-like anticline with gently dipping flanks, unaffected by any considerable dislocations.

2. The oil-bearing area is not confined within the so-called graben (trough) of 1,300 square km., in which the rocks of the Over-Domanik, Domanik and Sub-Domanik formations are exposed. Test drilling may be conducted along the axis of the anticline northward and southward, as well as on the flanks, outside the mentioned area. It is evident, that to reach the oilbearing formation, the well must be drilled through the Domanik rocks, 75 m. thick, the Over-Domanik formation, 120 m. thick, as well as through the overlying strata of the Devonian, 300 m. thick (depending on the location of the well).

3. In the central part of the elongated dome the oil-bearing horizons lie at a depth of 40—55 m. and 120—130 m. below the bed of Domanik; in the southern part, on the Lya-Yol, the second horizon has been struck at a depth of 170 m., while in the eastern one it was encountered at a depth of 205 m., and may be here considered to be the third horizon; thus, in different parts of the region different horizons are saturated with oil. The discovery of oil in deeper strata, i. e., in the sericite schists cannot be expected. The oil is seemingly of primary origin.

4. The central part of the elongated dome is more or less thoroughly tested, while the southern and eastern parts are tapped only by one well each.

5. The daily output per well does not exceed 700 kg., the average being 300 kg. The maximum production of one well during 5 months is 33 tons. The best producer was a well located on the flank (Chibiu).

6. Specific gravity of the oil derived from the upper horizon is 0.923—0.928, from the lower—0.894—0.879. The oil from the central part of the dome often is thick, as well as the oil from the well located in the southern part (Lya-Yol). This is due to the fact that the crest of the anticline is eroded in those places, the oil-bearing series is exposed, and the oil-horizons are near the surface. The best, lightest oil is yielded by the well located on the flank (Chibiu).

7. The best samples of oil, warranted not tarry, yield 7.88 to 11.61 per cent of benzine and 31.1 to 63.38 per cent of kerosene, consequently, the Oukhta oil is not inferior to the Caucasian or even in some cases to the Pennsylvanian oil.

8. The average production of the Oukhta wells is not large indeed, but it should be taken into account that the best results were obtained by a well sunk on the anticline flank, whereas the flanks have almost not been tested, as the attention of investigators was directed towards the central part of the dome, owing to the attractiveness of the oil films on the Oukhta river, and in accordance with Chernychev's structural scheme.

9. In the Oukhta oil field only its central part should be considered as a tested area; the flanks with greater reserves of a more valuable oil, and the northward and southward plunging slopes of the axial part of the dome are yet to be tested, and their prospecting may yield interesting results.

10. Oil production in the Oukhta region with the present yield of the wells (should the above said prospecting give no better results) is not profitable. The development of this oil region is possible only after the construction of new roads and the establishment of new ways of communication, with the development of other natural resources of Timan, particularly of the forest industry.

It is to the question of a possible alteration of the economic possibilities of the Pechora region we shall now pass.

#### FUTURE POSSIBILITIES OF THE DISTRICT

During the last century more than 15 schemes were offered for linking the White Sea by means of a water-way with the Baltic and Caspian Seas and the basin of the Ob river. Some of these projects embrace also the Oukhta region. There are three schemes of water routes between the Severnaya Dvina and the Pechora rivers: first, by the Vym, Shonvukva, Vukva, Oukhta; secondly, by the Veslianka, Tobysh, Oukhta and finally, by the Vychegda, Vychegodsky Cher, Izhemsky Cher and Izhma. There are, further, several projects connecting the Pechora, Kama and Ob rivers. All these projects are of considerable importance for the development and prosperity of the Oukhta region, in which the water communication always played a predominant part, but so far as the transportation of oil is concerned, the route which

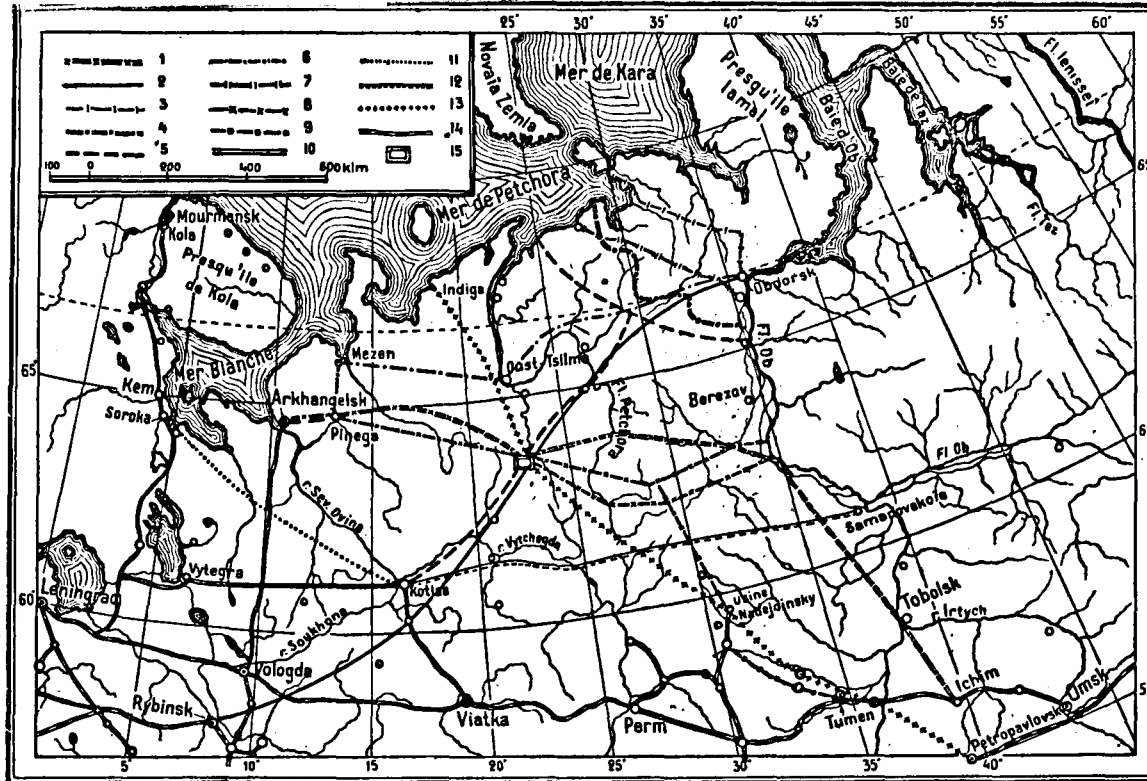


Fig. 16. Map of the projected railway of Northern Russia: 1—the Ob-Arkhangelsk Rly (Pereshnov's project); 2—the Rybinsk-Obdorsk Rly (Vrioni's project); 3—the Ob Rly (Golokhvastov's project); 4—the Knorre's Rly; 5—the Beloborodov's Rly; 6—the Arkhangelsk-Obdorsk Rly (Zhuravsky's); 7—the Polar-Ural Rly (Gette's); 8—the fundamental project of the Eastern-Ural-White-Sea-Ob Rly (Voltmann); 9—a probable prolongation of the latter; 10—the Kotlas-Vytegra-Svir Rly; 11—Kotlas-Soroka; 12—the Samarovskoie-Kotlas Rly; 13—the Petropavlovsk-Indiga Rly; 14—the present railways; 15—Oukhta oil region.

is only open for a few months in the year will hardly answer the wants of the oil industry. Therefore, the projects of railways crossing the North Russia are by far more important from the view-point of the industrial development of the region. On the accompanying map the most important of the proposed lines are roughly marked; along some of these lines surveying has been already accomplished.

Those of the projects which link up the lower course of the Ob river with the ocean-shore between Pechora and Vaigach (the so-called polar roads) hardly deserve attention. Now that the Arctic Sea Route is about to be realized, such projects, as were prepared with a view to avoid the Kara Sea, are at present to be put aside, as being of secondary importance. Among the southern railways, the latitudinal road from Kotlas up to the Samarovsk village on the Ob river was recognized in 1916 (by a special Government commission) to be of primary importance, while the way connecting Ob with the White Sea (from Arkhangelsk through Oukhta to the Ob, Voltman's project) was defined as being of secondary importance. Both these routes, as well as a modification of the latter with a branch southward, to Nadezhdinsky Zavod (the terminus of the Bogoslovsk railway branch), are important not only for the development of the adjacent territories, but also for lowering the transportation cost for goods exported from Siberia. The realization of the projected line Ob-Arkhangelsk would reduce the freight for cereals from Novonikolaievsk to London (according to pre-war prices) to 30 — 34 kopecks per pood, instead of 67 kopecks via Leningrad, and 55 kop. via Kotlas. Such reduction is due not only to a shorter distance to the port, but also to the transportation of goods by water for a considerable portion of the route. It has been estimated that about 1,500,000 tons of goods might be transported from Siberia by such a railway, to say nothing of the cargo traffic connected with the eventual exploitation of forests along the projected line.

Both lines projected by Voltman do not embrace the basin of the Vychegda, where the floating of wood in rafts is carried on on a large scale, but pass through the basins of Pechora and Mezen, where the woods (which are, however, of a quality inferior to that of the Vychegda woods) are not utilized at all. It is difficult now to estimate the future export of timber, but, according to the most conservative estimates, the latter should yield

an amount at least as great as that of transit goods from Siberia<sup>1)</sup>.

Of all the other projects of railways giving the Oukhta region an outlet to the sea, the line Petropavlovsk—Nadezhdinsky Zavod—Oukhta—Indiga attracted much attention in connection with the discovery of an unfreezing harbour in the bay of Indiga, within the Cheshskaia bay. In 1921 surveying was done along this line by N. I. Maslov, engineer, but it has been found out since that the Indiga harbour has important defects; therefore, the line leading to Arkhangelsk seems to be the most convenient one.

In 1919—1920 new surveying was accomplished of the projected railway line Moscow—Oukhta.

Upon the construction of the Ob-White Sea railway, the distances from the Oukhta oil region to Ob, Arkhangelsk and Sverdlovsk (Ekaterinburg) will be respectively 550 km., 670 km. and 1000 km., so that the freight per one pood of the Oukhta oil to the basin of the Ob river and to the Urals will be 3—4 kop. lower than the freight of the Baku oil. Central Siberia may be provided with the Oukhta oil from Arkhangelsk by the Arctic Sea Route.

The cost of transportation of the Oukhta oil to foreign markets will be likewise lower, because the distance Baku—Batum is 300 km. longer than the distance Oukhta—Arkhangelsk, while the distance from the latter to the ports of North and Central Europe is by one half less than from Batum. The pipe lines along the projected lines will materially facilitate the competition with other oil regions.

Under such conditions of the marketing, the oil production of the Oukhta region will become profitable. No wells with a production equal to that of the Baku wells, are, of course, to be expected at the present time; the yearly output per one well is likely to amount to about 150 tons, and the development should be planned in accordance with the said production.

The use of the standard cable system of drilling, central powers for pumping wells, the drilling of open holes without reaming, and a comparatively shallow depth of oil-bearing horizons will make profitable the exploitation of a well with the output of even less than a quarter of a ton per day, and will permit the extraction of oil in quantities sufficient for the development of a large enterprise.

<sup>1)</sup> For detailed estimates refer to the articles indicated below (Nos. 15—17. of the list).

Still greater profits may be derived from a development of other mineral resources and of forests in the region. But the discussion of the conditions for the development of such a combined industrial concern is beyond the scope of the present paper. It is to be stated, however, that the discovery of large coal deposits, made by A. Chernov in the region of the right-hand tributaries of the Pechora river, may entirely change the economical conditions and have a favourable influence on the development of the Oukhta oil region.

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