ISSN 1070-3632, Russian Journal of General Chemistry, 2011, Vol. 81, No. 6, pp. 1262–1276. © Pleiades Publishing, Ltd., 2011.
Original Russian Text © N.N. Gerasimov, 2010, published in Rossiiskii Khimicheskii Zhurnal, 2010, Vol. 54, No. 2, pp. 17–28.

The Resource Potential as the Basis for Sustainable Development of the Komi Republic

N. N. Gerasimov

"RN-Severnaya Neft'" LLC under RosNeft' Company, ul. Sovetskaya 21a, Syktyvkar, 167000 Russia
e-mail: nordoil@inbox.ru

Received January 10, 2010

Abstract–Reserves of mineral resources in Komi are estimated. Prospects of development of the industrial branches of this region (oil-gas, coal and metallurgical, as well as electric power engineering), are examined.

DOI: 10.1134/S1070363211060338

The history of the Komi republic vividly illustrates the leading role of its resource potential. It was true in the years when as soon as the lands entered the Moscow state, they became an object of exploration of a specially designated state expedition, sent by the Tsar Ivan III to the Tsyl'ma River in search of copper and silver ores. It was true in the recent past, when for a quarter of a century the only plant in the world extracting radium from mineralized underground waters worked successfully near Ukhta. It is relevant to recollect that the Pechora coal basin, the large-scale commercial development of which started during the World War II, took upon itself the greatest load in terms of energy raw materials supply for the war front and home front, under the conditions of the Donetsk basin occupation and in the following period of its coal mines restoration. Gas from Vuktyl in the 1960s defined the vector of the USSR gas industry development, and the Usinsk oilfield became a starting position, a reference point in the post-war history of the republic as an oil treasury of our country. It is from here that the large-scale systematic exploration of resources of the Timan-Pechora oil-and-gas province started.

The total amount of mineral resources that have been extracted in Komi since the beginning of exploration is as follows: 1.36 bln tons of coal (in Vorkuta 847 mln tons and in Inta 513 mln tons) and raw hydrocarbon materials in the amount exceeding 1 bln tons of oil equivalent (including 525 mln tons of oil). The first 10 mln tons of bauxites had been supplied to consumers from the Middle Timan bauxite mine by 2008.

In the foreseeable future the development strategy of the Komi Republic will continue to rely on its resource potential [1], which determines the region development rate, "growth points" of production, target investments into various branches of economy, distribution of productive forces, infrastructure formation, and many other social and economic issues of tomorrow. The resource potential and reserves of major mineral resources are presented in Table 1.

Let us outline the major geological areas and "growth points," forming the "face" of the republic now and in future, and short- and medium-term objectives to be addressed. In addition, it is necessary to take into account that serious corrections can be introduced in the contents and implementation periods of the regional plans due to the economic globalization factors, competition on the global market of mineral resources, and the global economic crisis.

Fuel and Energy Complex

The status and prospects of the fuel and energy complex (FEC) of the region are determined, first of all, by coal and hydrocarbon deposits, concentrated in the Pechora coal basin and the Timan-Pechora oil-and-gas province. Arising problems of energy resources deficiency in the world and energy resources prices put on the agenda the issues of exploration of the region shale deposits.

Mineral coal. The Pechora coal basin is the second in Russia in terms of resources, containing a whole range of fossil fuels, essential for the development of

Table 1. The Komi Republic mineral resource potential

Name of mineral resources	Resource potential, total	Prospected and inferred reserves
Oil, mln tons	2180	702
Gas condensate, mln tons	155	27
Natural gas (non-associated), bln m^3	1673	180
Mineral coal, mln tons	77600	7555
Oil shale, mln tons	55500	550
Manganese ores, mln tons	15000	3893
Placer gold, kg		44551
Barite ore, mln tons		2
Sulphur, mln tons		1.3
Cement raw materials, mln tons		492
Gypsum, mln tons		148
Glass raw materials, mln tons		14
Rock salt, thousand tons	5000000	2750

coke chemistry, energy sector, and non-conventional coal application directions.

A critical point for the beginning of the Pechora coal basin large-scale commercial exploration was G.A. Chernov's discovery of the Vorkutskoye coal deposit in 1930. On September 13, 1932 the first coal barge started its journey along the Pechora River, from the Yedzhyg-Kyrta mine to Arkhangelsk. On September 1, 1934 the first mine of the Vorkutskoye deposit was put into commercial operation.

The Pechora coal basin is shaped as an irregular triangle, its area exceeding 130000 km^2, stretching from south to north from 63° northern latitude to the Kara Sea. Its eastern border goes along the western slope of the Polar Urals; its western border is the Chernyshev Ridge.

Pechora coals are represented by a wide variety of brands and grades (from long-flame coals to anthracites): there is a clear shift from the former to the latter when moving from the south-west to the north-east. The Pechora coal basin is viewed by Vorkuta geologists as a foredeep area of the Urals Hercynian geosyncline.

The coal presence in the basin is connected with the Lower Permian period (Kungurian: Vorkutskaya, Seydinskaya, and Intinskaya series) and the Upper Permian period (Kazan: Payemboyskaya series). An example of the Lower Permian coal formation is the Vorkutinskoye and Usinskoye deposits, as well as the Intinskaya group of deposits; the Upper Permian coal formation is represented by the Pay-Khoy deposits.

The most well-developed Vorkutskoye deposit from the geological point of view is a synclinal fold stretching to the north-east, which is almost 30 km long and 12 km wide at average. Coal-bearing deposits are associated with the Lower Permian Vorkutskaya series, reaching 1500 m in thickness. Out of 132 layers and interlayers with the total thickness of 51 m, 34 strata have the productive thickness of 0.6–4.3 m with the interstratal distance varying from 12 to 19 m. The strata dip angle at the synclinal fold wings varies from 10° to 30° and at the northern closing the dip angle reaches 50°.

Qualitative characteristics of coals are presented in Table 2.

The total geological resources of the Permian coals in the Pechora basin amount to 268 bln tons, including 175 bln tons classified as conditioned. By now approximately 30 coal deposits and occurrences have been discovered within the Pechora basin. The Russian Reserves Register as of January 1, 2008 takes account of the resources in 11 coal deposits of the Pechora basin, amounting to 7100.6 mln tons (under $A+B+C_1$

Table 2. Qualitative characteristics of coals of the Pechora coal basin

Deposit	Brand	Ash content, %	Moisture content, %	Volatile content, %	Plastic layer thickness, mm	*S*, %	*P*, %	Calorific value, kcal kg^{-1}
Vorkutskoye	Zh	7–30	1–4	25–37	12–36	0 .1–2 .5	0 .01–0 .30	8300–8700
Vorgashorskoye	Zh	8–29	1–5	28–37	7–22	0 .5–2 .4	0 .01–0 .02	7800–8200
	D	20–48	2–4	36–45	0–7	1 .0–4 .0	–	7800–7900
	G	12–38	2–4	32–38	7–14	0 .5–3 .7	0 .01–0 .14	7800–8100
Intinskoye	E	10–39	2–10	31–44	–	0 .8–7 .2	–	7100–7800
Yunyaginskoye	K	7–32	1–2	20–27	13–31	0 .5–2 .2	0 .01–0 .08	8500–8700
Usinskoye	Zh	7–39	1–4	25–36	9–36	0 .1–2 .5	0 .01–0 .32	8000–8600
	G	12–35	1–4	32–37	8–20	0 .4–5 .0	0 .01–0 .32	7900–8600
Seydinskoye	G	19–37	1–4	32–37	4–15	0 .9–2 .9	0 .01–0 .21	7600–7900
	D	19–39	1–6	32–41	0–5	0 .4–2 .5	0 .02–0 .26	7600–7800

categories) in total. Coking coal reserves under A+B+C_1 categories account for 44.2% of the basin balance reserves. Within this amount the most valuable brands, ZH (fat coal), KZH (coking fat coal), K (coking coal), OS (lean caking coal), account for 70.9%, with the biggest percentage taken by ZH coals, 64.9%.

At different periods the industry has involved in development the following 10 coal deposits of the basin: Vorkutskoye, Intinskoye, Khal'meryurskoye, Vorgashorskoye, Yunyaginskoye, Yedzhyg-Kyrtinskoye, Kozhimskoye, Nechenskoye, Sharyu-Zaostrenskoye, and Tal'beyskoye.

The peak of coal production in the Pechora basin with 31.5 mln tons of extracted coal was reached in 1988. Since then there has been a reduction in coal production to the level of just above 14 mln tons in 1998. The major reasons of the production decrease are as follows: no new mines have been constructed in the coal basin since 1975, in compliance with the restructuring plan low-profit mines have been closed due to the high wear and tear level of the mining equipment and the production completion at the most productive coal strata and reserves at major depths and remote flanks of coal fields.

At present coal is extracted by the following enterprises: "Vorkutaugol'" OJSC (Vorkutskoye deposit: "Severnaya," "Vorkutinskaya," "Komsomol'skaya," and "Zapolyarnaya" mines, with the total production capacity of 6.85 mln tons), "Vorgashorskaya-2 Mine" CJSC (Vorgashorskoye deposit: 1 mine of 4.2 mln tons capacity), Mine-office "Intinskaya Coal Company" OJSC (Intinskoye deposit: "Intinskaya" mine of 3.3 mln tons capacity), and "Yunyaginsky Coal Surface Mine" JV (Yunyaginskiy deposit: 1 surface mine of 500 thousand tons capacity). The breakdown of the produced coal includes ZH (49.6%), D (18.5%), GZHO (27.4%), and K coals (4.5%).

Here it is relevant to mention a successful practice of developing a coal surface mine under polar climate conditions, which is revolutionary for the Pechora basin. Open works in the Yunyaginskiy coal deposit are performed by "Yunyaginsky Coal Surface Mine" JV (previously known as "Yunyaginskoye" LLC) on the territory of Yun'-Yaga mine closed in 1996. "Yunyaginskoye" LLC was established in the city of Vorkuta; in 2001 it obtained the required license and started the surface mine construction in parallel with experimental-commercial coal mining. During the following years the coal production figures have reached 3 mln tons. Thus, it has been proven that it is possible to produce coal through open mining works under the Far North climatic conditions, and the coal reserves previously written off the reserves register have been repeatedly involved in commercial exploration.

The major coking coal consumers are as follows: "Severstal'" OJSC, Novolipetskiy, Nozhnetagilskiy,

and Magnitogosrkiy metallurgical complexes, Moscow coke-gas plant, "Nosta" OJSC, and "Mechel" OJSC. Part of coking coal is exported. Among the consumers of power-generating coal there are enterprises of forest, pulp and paper, and wood-processing industries, municipal service enterprises of the North-West region of Russia and the Komi Republic, enterprises of the Russian Energy Ministry and Transport Ministry system, as well as local enterprises.

As of 1 January 2008, 9 mine fields with the total capacity of 31.8 mln tons of coal per year were in reserve for construction of new mines, including 5 coking coal fields (18.3 mln t/y), 4 of which containing the most valuable brands (13.2 mln t/y).

The following development directions of the republic fuel and energy complex in the field of coal production and coal deposits exploration have been defined:

(1) Exploration of coking coals of the Usinskoye deposit, located in the north-east of the Pechora basin, 40–50 km south-west of the developed Vorkutskoye deposit. It is the only full-scale reserve of the Pechora basin for maintaining the production of coking coal in Vorkuta district. The deposit reserves put on the reserves register reach 1.46 bln tons of ZH_1 and ZH_2 coals; the mining and geological conditions at minor depth of bedding are similar to the conditions of the most tectonically quiet mine fields of the Vorkutskoye deposit.

(2) Exploration of power-generating coals in the Seydinskoye deposit. The deposit is located in the north-eastern part of the Pechora coal basin. The northern part of the deposit belongs to the Nenets Autonomous Area, the southern part (largest), to the Komi Republic. The deposit reserves put on the reserves register are represented by D coals in the amount of 8.5 bln tons. In terms of geology, there are two shallow dipping (the main area inclination angles of 4°–9°) strata e_3 and e_2 of 4 and 5.2 meters in thickness. Favorable mining and geological conditions make it possible to develop the strata applying mechanical complexes with longwall production of 3 mln tons per year. Major coal strata are located close to the surface (~70 m) and there is a realistic opportunity for open works.

(3) The possibility is considered to bring back to life Vorkutinskaya mine no. 33 (with reserves of 141 mln tons of ZH_1 and ZH_2 coals), closed in the course of the coal industry restructuring in the mid 1990s.

(4) The possibility to use methane as an accompanying resource from coal strata of the Pechora basin. Forecast methane resources in coal deposits of the basin amount to 1.9 trln m^3, including 1.5 trln m^3 of methane resources in coal strata more than 0.5 m thick. It is only relevant to consider methane as an accompanying resource for the north-eastern part of the Pechora basin, with coal brands ranging from G to A. Coal deposits in the southern part of the Kosyu-Rogovskaya Depression and the Chernyshev Ridge are unpromising, which, however, does not rule out occurrences of free methane in lithological or tectonic traps. The issue of using coal-mine methane as a boiler and furnace fuel is of priority for "Vorkutaugol'" OJSC. The mines annually emit 620 mln m^3 of pure methane into the atmosphere, which is equivalent to 945 thousand tons of coal. In this amount of emitted methane, 250 mln m^3 per year are removed from the mines through degasification, and the remaining amount – through ventilation. In terms of its calorific value, the amount of degasified methane corresponds to 390 thousand tons of coal per year. For Vorkuta, where there are no natural gas pipelines, the use of methane captured through degasification is a relevant solution for sites located near methane production, i.e. in boiler-houses and drying facilities of coal-washing plants at mining sites. At the mines of "Vorkutaugol'" OJSC the amount of conditioned methane (concentration exceeding 30%) accounts for more than 99% of the total amount of methane, captured through degasification.

Industrial use of captured coal-mine methane was started in "Vorkutinskaya" mine in 1975, where 4 boilers were converted to gas-firing. Later, 14 more steam boilers with the total capacity of 150 t/h have been converted to methane combustion at the following mines: "Vorkutinskaya" 4, "Zapolyarnaya" 3, "Komsomol'skaya" 6, and Vostochnoye RSU 1.

(5) Another high-priority task is the revision and re-appraisal of the available reserves. As it has been outlined before, the stratum production thickness for balance reserves was accepted at the level of 0.6 m; while today strata below 1.3 m in thickness are not developed in the Pechora basin.

Oil and gas. Oil deposits are located in all stratigraphical levels of the platform part of the Timan-Pechora province, from the Ordovician to the Jurassic

period. Gas deposits are mostly associated with the tectonic elements of the Pre-Urals foredeep.

The Komi Republic, which embraces the southern part of the Timan-Pechora oil-and-gas province, is an old oil producing district; its geographical location determines its important role in the formation of transport routes for the delivery of raw hydrocarbon materials to the global market.

The peak of the oil industry development and revival in the region was during the 1980s, when after start of works in the northern part of the Timan-Pechora oil-and-gas province, the highest level of oil production, 19.2 mln tons, was reached. After the drop in the production rate in the mid 1990s, for the last five years there has been a minor increase in oil production (of approximately 500 thousand tons per year), which is still an increase. This production growth has resulted from putting small-scale deposits into operation, increasing drilling activities and starting new oil-wells, improving the development technology and the use of operating wells, applying special methods aimed at oil production increase and wells stimulation on a wide scale.

During the history of exploration in the republic approximately 138 deposits of raw hydrocarbons have been discovered. The accumulated extracted amount of hydrocarbons has exceeded 1 bln tons of oil equivalent, including oil (525 mln tons), non-associated gas (412 bln m^3), gas condensate (48.6 mln tons), and dissolved gas covering the remaining volume. The percentage of extracted resources has reached 56.5% of all discovered reserves, including 46% of oil and 72% of gas.

The percentage of commercial grade oil, which is difficult to extract, accounts for 69% of the remaining hydrocarbon reserves. Development of oil pools of this type requires application of expensive oil extraction technology, in particular at such deposits as the Yaregskoye deposit (low-gravity oil) and the Usinskoye deposit (permo-carboniferous stratum).

The majority of oil and gas deposits have been already licensed. The distributed reserves include 104 deposits with the total volume of C_1 category oil of 573.2 mln tons of oil equivalent. The undistributed reserves account for a little more than 30 deposits with the total volume of extractable oil of 43.8 mln tons of oil equivalent and non-associated gas of 36.0 blm m^3. As a whole, the republic current status with regard to commercial reserves can be considered satisfactory. However, it is evident that the development degree of the deposits is extremely high. The percentage of commercial reserves under development has already reached 91%, including 80% accounting for the producing deposits, the majority of which has entered the phase of maximum production or decreasing production.

The exploration degree of the initial total resources has exceeded 40%, including 47% for oil and 36% for gas; the unexplored part of the total resources on the republic territory remains quite large as yet; however, the scope of prospective and identified structures is formed by objects of minor extractable resources.

Active deposits on the territory of the republic make it possible to extract approximately 12.5–13 mln tons of oil (including gas condensate) annually till 2010. Start of exploration of the deposits under preparation and prospecting will make it possible to increase the amount by 2.5–3.0 mln tons. Thus, in the medium term oil production in the Komi Republic will be stabilized at the level of 15–15.5 mln tons annually, and in the Timan-Pechora province as a whole there will be stable growth of 38–40 mln tons per year.

It is necessary to mention that development of oil deposits is accompanied by extraction of associated oil gas in the amount of 1.2 bln m^3, only 65% of this gas being used and the remaining percentage being "flared." When the benchmark of 40 mln tons annually is reached, it will increase the volume of extracted gas up to 3.0 bln m^3.

The Sedyel'skoye gas deposit (discovered in 1935 near Ukhta) and later the unique Vuktyl'skoye gas-condensate deposit (discovered in 1964 on the right bank of the Pechora River middle reach) opened the gas era in the economy of the USSR and defined the rates of the gas industry formation in the country.

The Vuktyl'skoye deposit is localized in carbonate rocks of the mid-carboniferous age, shielded by a thick pack of hypso-anhydrites of the Kungurian age, ensuring the pool survival and abnormally high formation pressure.

The deposit structure is an elongated anticline rampart 80×6.3 km in size, with two domes. The depth to the roof is 2,200 m and the pool height in the anticline fold exceeds 1.400 m. The balance reserves of gas and gas condensate reach 700 bln m^3 in total.

Vuktyl was the first gas giant in the country with the production rate of 19 bln m^3/y at the beginning of

the 1970s. Today the deposit is in the final development phase, producing 2.7 blm m^3 annually, but due to its location on the major gas lines, it serves as a regulatory storage.

The following activities are planned in the field of hydrocarbon resources exploration:

(1) Intensive preparation to exploration of a group of the northern deposits (3 blocks of the South Khoreyverskaya Depression, the Gamburtsev Rampart deposits, and the Trebs-Titov deposits).

(2) Taking into account the depletion of the province oil deposits, an emphasis is placed on application of new methods and technologies increasing oil production rates of the strata, first of all, at low-gravity oil deposits (Yaregskoye and Kharyaginskoye deposits, and the Permo-Carboniferous oil pool of the Usinskoye deposit). For instance, application of steam treatment technology in oil wells of Yarega (unique in the world) has made it possible to increase the oil production rate of the strata from 11–12 to 55%, and test application of the technology based on injecting steam into the system of parallel horizontal wells makes it possible to increase oil extraction rates up to 66%.

(3) Approximately 50% of the Timan-Pechora province reserves are involved in production. The reserves increment analysis for the last decade (reserves replacement ratio being at the level of 0.3–0.4%) raise concerns in terms of maintaining the production growth and stabilization in the long-term perspective without start of hydrocarbon reserves reproduction on a simple or increasingly progressive scale. Moreover, the analysis of the hydrocarbon reserves increment structure for the recent years makes it possible to conclude that the reserves increment does not result from the discovery of new deposits, but stem from further exploration of the existing deposits, recalculation of conditions, oil production rates etc.

Changes in the existing legislation are required, and first of all, in those parts of the "Subsoil Law," which refer to reproduction of reserves. In this connection we highly appreciate the works started by "Gazpromtransgaz Ukhta" LLC on detection of large gas deposits in the Pre-Urals foredeep. The results of well-drilling in the Lemvin zone (Yunyaginskaya and Priural'skaya wells) can introduce significant corrections into the province gas reserves register.

(4) Taking into account that for the latest decades the global economic system has faced serious problems with conventional energy resources both in terms of a large-scale deficiency in certain industrial areas and entire countries, and in terms of avalanche-like price fluctuations, it is important to mention the importance of re-appraisal of oil shale reserves.

In the southern districts of the Komi Republic within the Vychegodskiy shale basin, there are two shale-bearing areas: the Sysol'skiy basin located on the territory of Sysol'skiy and Koygorodskiy administrative districts and the Yarengskiy basin located on the territory of Udorskiy district. The area of each of the shale-bearing districts is approximately 10 thousand km^2.

The shale presence here is associated with formations of the Upper Jurassic period, the Tithonian sub-stage (earlier Srednevolzhskiy), and its spacial extent covers the distribution area of the Upper Jurassic formations.

Formations of the Tithonian sub-stage with an average thickness of 25–30 m are ubiquitously saturated with organic substances of sapropel origin. Oil shale includes rocks with the calorific value exceeding 1800 kcal kg^{-1} (7.56 MJ kg^{-1}). The organic element in oil shale mostly consists of a combination of the two following micro-components: colloalginite and pseudovitrinite. Commercial interlayers of oil shale (usually 2–3) 0.5–6.0 m thick are deposited at depths varying from 5–10 to 150–200 m.

The most well-explored part in the Sysol'skiy shale basin is the Poingskaya prospective area (1800 km^2), where prospecting and appraisal works have been performed to preliminarily evaluate reserves under C_2 category.

The lower grey-colored rock mass in the Poingskaya prospective area has a low production capacity. Lenses and layers of minor thickness are distributed both along the strike and through the vertical section; and their integration into the plan is difficult, despite their thickness which is sufficient for cost-effective development. At the same time, the shale quality is high (the calorific value ranging from 1800 to 5690 kcal kg^{-1}).

The main shale content in the Poingskaya prospective area is associated with the dark-colored rock mass with two distinguishable oil shale strata. The lower stratum is confined to the bottom of the dark-colored rock mass. In most parts its thickness amounts to 2.5 m, increasing up to 5.7 m in the eastern

and south-eastern flanks of the area. The stratum weighted average indicators are as follows: calorific value of 1800–1958 kcal kg^{-1} (7.56–8.22 MJ kg^{-1}), resins output of 7.55–11.36%, and sulphur content of 1.07–3.25%.

The upper stratum is confined to the top of the dark-colored rock mass of the Srednevolzhskiy substage, and it is separated from the lower stratum by the layer of kerogen-containing clays of 1.2–6.9 m. The stratum thickness varies from 0.55 to 5.0 m with the average value of 1.2–2.6 m. The stratum weighted average indicators are as follows: calorific value of 1800–3610 kcal kg^{-1} with the prevailing value of 1.800–2.000 kcal kg^{-1}, resins output of 6.64–11.78%, and sulphur content of 1.72–3.30%. The shale-bearing formation depth varies from 10 to 154 m.

According to the preliminary appraisal of the Poingskaya area reserves, the amount of C_2 category reserves reaches 1617.49 mln tons and the amount of P_1 category reserves 44432.94 mln tons. A field with the productive formation depth below 50 m has been allocated for open works, the field C_2 category reserves amounting to 764.14 mln tons and P_1 category reserves, to 241.89 mln tons. The total forecast resources of the Sysol'skiy shale basin are estimated at 18.5 bln tons.

Production and laboratory studies that have been carried out have demonstrated that the shale is applicable for almost all existing spheres of shale use, both as a fuel and a process raw material, including energy-clinker production, resins production, conversion to liquid fuel, and production of medicines and fertilizers.

(5) To extract oil is the first step, and then it is necessary to transport oil and process it in the region. Several years ago the republic faced the problem of oil transportation. Taking into account the positive dynamics in the oil-extracting industry, "Transneft'" Company has performed modernization of the Usa-Ukhta pipeline, increasing the flow rate from 18.2 to 24.2 mln tons per year.

Modernization of a new remote terminal in Varandey, performed by "LUKOIL" OJSC, will make it possible to increase the shipment capacity of oil from the northern deposits of the Timan-Pechora province up to 12.5 mln tons per year. The railroad is another infrastructure element, which can also contribute to higher oil production rates at the oil deposits of the Timan-Pechora province. After modernization of the Usinsk-Synya road section it is possible to increase the oil loading rate at the Usinsk loading racks up to 5 mln tons per year. Implementation of all the abovementioned projects makes it possible to transport annually up to 40 mln tons of oil from the province and to close the issue of oil transportation facilities deficiency for a few years. However, in the long term the problem still remains. All the more so, as railroad transportation of oil is a temporary anti-crisis measure. Sooner or later the railroad transport will give place to the pipeline.

Our plans do not only include an increase in crude oil export, but also performance of works aimed at raising the oil processing volume and refinery level. "LUKOIL" OJSC has recently completed the Ukhta Oil Refinery fundamental modernization, resulting in the refinery level increase from 42 to 75.8%. The plant capacity is 3.8 mln tons per year. This oil refinery annually processes approximately 3.5 mln tons depending on the market situation, meeting the republic demands in full and supplying oil products to the neighboring regions. Moreover, there is active construction of the Usinsk Oil Refinery with the capacity of 1.3 mln tons of oil per year, which is performed by "Yenisey" Company.

Russia will not be able to maintain the existing gas production rates and meet its export commitments without exploration of the Yamal deposits. The design institute "VNIPIgazdobycha" under "Gazprom" OJSC is finalizing its study on the gas route defined as early as 1987 – via the Baidarata Bay, Vorkuta, Inta, and Ukhta. The project implementation has reached the practical stage. By 01.07.2011 it is planned to have the gas transmission system started, the system full capacity reaching 125 blm m^3/y. This value can be added to 95 bln m^3 currently transmitted via the territory of the Komi Republic.

For the republic it is a high-priority investment project, the implementation of which will provide up to 10000 jobs during the construction period, breathe new life into depressed districts of Vorkuta and Inta, bring about new highly-qualified job opportunities, and create an additional tax base in the field of gas transit.

The Mining Complex

The recent years have witnessed significant changes in the mining sector of the Komi republic. The republic mineral resource potential is one of the

highest in the Russian Federation. Occupying 2.4% of the total Russian territory with less than 1% of the total population, the republic plays a much more significant role in exploration and formation of the Russian mineral resource base. Our pool of mineral resources includes 30% of all discovered bauxite reserves, approximately 50% of titanic ore, 80% of piezooptic and quartz reserves, more than 50% of barytes etc. The gross value of the republic mineral resource base according to the estimates from different sources varies from 1 to 3 trln USD.

The Komi republic, which is geographically close to the industrially developed regions of the Urals, the central regions, and the North-West region, possesses great discovered reserves of bauxites (Middle Timan), titanic ore (Yaregskoye deposit), barytes (Khoylinskoye deposit among others), ferromanganese ores (Parnokskoye deposit), discovered deposits of placer gold and large deposits of vein gold under prospecting in the River Kozhim basin, and significant potential resources of chrome iron ore, copper ore, cobalt ore, rare-metal and rare-earth ores.

In compliance with the level of the deposits preparation for development, the degree of their integration in the national economy, and the expected time schedule of the projects implementation, there are three categories of mining objects: objects under development (bauxites, barytes, manganese, quartz, and construction materials); objects prepared for development (titanic ores, mineral salt, oil shale, placer and lode gold, and construction materials); prospective objects, requiring further geotechnical studies and economic assessment (chrome iron ore, copper ore, lode gold, and diamonds).

Therefore, the overall development of the mining sector suggest the development of operating enterprises in crude ore extraction and primary processsing; design and construction of large mining and metallurgical facilities on the basis of operating mining enterprises; fast-track appraisal, prospecting and start of development works at the Komi Republic prospective deposits of raw materials, highly deficient for the Russian industry.

Development of the Operating Mining Enterprises

Bauxites. One of the major problems of the Russian aluminum industry is provision of the commercial aluminum production with raw materials and detection and exploration of bauxite deposits. At present the Russian State Reserves Register includes approximately 60 bauxite deposits, 12 of them being under development and 4 being prepared for exploration. At the same time, 9 deposits have been discovered on the territory of the Komi Republic, including one deposit under development, three deposits prepared for exploration, three deposits at the stage of decision-making with regard to further prospecting works and final appraisal, and two deposits of balance reserves which have been considered economically ineffective to develop on the basis of their technical and economic indicators. The bauxite and alumina complex, which is being created on the basis of these deposits in the Komi Republic, is a unique example in today's Russia of efficient involvement of large mineral reserves into industrial use simultaneously with establishment of facilities for their advanced processing.

Prospecting of bauxites on the territory of the Komi Republic has a long history. In 1929 a geologist V.K. Likharev discovered outcrops of kaolinite clays in the upper course of the Cheri Vychegodskaya River, thus laying foundation to targeted prospecting of bauxites.

In 1969 in the upper course of the Vorykva River in Middle Timan, V.M. Pachukovskiy and A.A. Lutoev discovered pieces of bauxite rocks, containing 34.35% of alumina and having the silicon module of 2.01. In October 1970 at the same place lateritic bauxites were first opened in natural occurrence with a prospecting pit.

The Vezhayu-Vorykvinskaya group of deposits, including Vezhayu-Vorykvinskoye, Shchugorskoye, and Vostochnoye deposits of Middle Timan, forms the basis for the bauxite and alumina complex under establishment.

The largest Vezhayu-Vorykvinskoye deposit is located in the central part of the ore field. The deposit includes three formations, the largest of which is the Central. The form of the ore body is blanket-like, lens-shaped, complicated with pocket-like cavities. The thickness of the ore body varies from 0.6 to 32.5 m with an average value of 6.5 m. The average depth of bauxite formations in the deposit amounts to 27.6 m, varying from 0.5 to 75.5 m (for one of the bodies it reaches 123 m), which makes it possible to carry out open-pit mining works.

The major mineral types of bauxites are as follows: hematite-boehmite, kaolinite-hematite-boehmite, and

chamosite-boehmite. The bauxite ores of the deposit include aluminous and abrasive grades; and there are also high-aluminous (>60% Al_2O_3) and low-ferrous (below 2% Fe_2O_3) variations. The alumina content of the ore varies from 45 to 80% and the silica content – from 0.45 to 15.6%. The average silicon module value is within the range of 6.0–7.5. Low sulphur and calcium contents are beneficial for the ore processing properties. The specific characteristics of the bauxites is the presence of associated components (gallium, vanadium, scandium, rare earths, and in some cases) niobium (more common for the northern part of the Verkhne-Shchugorskoye deposit).

The Vostochnoye deposit is characterized with great depths (reaching 400 m, with the average depth of 210 m) and the presence of diaspore variations.

The deposits of bauxites discovered in South Timan include the Vol'sko-Kedvinskaya group of deposits (Verkhne-Vol'skoye and Verkhne-Ukhtinskoye deposits, Vapovskaya and Loimskaya occurrences) and the Timshersko-Puzlinskaya group of deposits (Timsherskoye and Puzlinskoye deposits). They possess balance reserves and forecast reserves of bauxites, comparable to their Middle Timan counterparts. However, South-Timan ores are inferior to Middle Timan ores in terms of significantly lower quality (lower silicon module), unfavorable development conditions (mostly shaft mining), and presence of harmful components (sulphur and organic substances).

As of 01.01.2008 the amount of commercial reserves under $A+B+C1_1$ categories in the Vezhayu-Vorykvinskoye deposit reaches 116.2 mln tons, the amount of C_2 category bauxites suitable for aluminum production 3.9 mln tons. Apart from that, there are reserves of C_1 category refractory bauxites amounting to 3.2 mln tons and C_2 category refractory bauxites – to 0.7 mln tons.

Bauxite reserves increment prospects in Middle Timan are associated with the Svetlinskoye deposit, located 15–20 km to the north-west from the Vorykvinskaya group. These bauxites are of high quality, and their low-ferrous variations significantly outmatch similar bauxites from the Vezhayu-Vorykvinskoye deposit in quality. The deposit is characterized with favorable mining conditions (formation depth varying from 30 to 60 m) and relatively high strata thickness (up to 8.5 m); its C_2 category reserves amount to 4.5 mln tons (including 0.8 mln tons of low-ferrous bauxites) and forecast reserves under P_1+P_2 categories reach 35.8 mln tons.

In addition to the abovementioned, the specified area possesses high-aluminous shale of the Paunskaya formation of the Upper Riphean, which can be considered as a promising non-conventional raw material for aluminum production, as Al_2O_3 content in the shale reaches 30–35% and SiO_2 content, approximately 7% (principal minerals represented by muscovite, chamosite, and kaolinite).

Commercial development of the Vezhayu-Vorykvinskaya group of bauxite deposits was started in 1998 by "Timan Bauxite" OJSC established for the purpose. The extracted ore is supplied to the following plants of the Urals: Urals Aluminum Smelter, Chelyabinsk Abrasive Plant etc. During a ten-year period more than 11 mln tons of ore have been extracted, including 190 thousand tons in 1998, 985 thousand tons in 2003, 2.39 mln tons in 2006, and 1.939 mln tons in 2008.

Within a short period the first line (design capacity of 2.0 mln tons) of a modern bauxite mine has been constructed, 156 km of the railroad line have been laid, and the construction of Sosnogorsk Aluminum Smelter has been started.

The construction of the aluminum smelter is an integral element of the bauxite and alumina complex under formation. The project objective is to establish a bauxite-processing production with an annual output of aluminum reaching 1.4 mln tons. The project design envisages application of the latest most advanced technologies. The project financing is performed by the newly-established "United Company "Russian Aluminum."

Implementation of the aluminum smelter construction plans will imply an increase in the bauxite mine production capacity to 6.5 mln t/y.

The investment project costs (without the aluminum component as the final third part) exceed 45 bln rubles (in prices of 2007).

Despite the existing conditions which are in general favorable for the implementation of the project on the bauxite and alumina complex establishment and development, there are a number of problems requiring urgent solutions.

The major deterrent in the construction of Sosnogorsk Aluminum Smelter is the issue of gas

Table 3. Content of accompanying components in quartz from different types of deposits (10^{-4} %)[a]

Country, continent	Fe	A1	Ti	Mg	Ca	Mn	Na	K	Cu	Cr
Pegmatitic quartz										
Brazil	2–5	2–80	1–3.5	1–10	1–10	0.5–3.5	1–10	1–10	0.1–0.3	0.5
Kola Peninsula	2–4	5–7	5–7	0.6–5	2–10	0.8–4	10–12	8–12	–	–
Urals	2–8	45–100	5–9	0.6–4	5–25	0.5–5	10–14	2–10	–	–
Kazakhstan	10–12	25–40	0.5–5	1.5–2.5	–	0.5–2	0.5–14	0.5–28	0.3	0.5
Hydrothermal quartz										
Brazil	0.1–4	4–6	1–2	0.1–3	0.2–9	0.1–5	0.1–9	0.1–1	0.1–0.3	0.01
Madagascar	0.5–5	3–18	1–1.5	0.1–1	0.2–6	0.1–0.5	0.1–4	0.2–1.5	0.1–0.3	0.01
Polar Urals	2–16	12–14	0.7	0.8	0.7–2	0.2–0.5	0.5–7	1–4	0.1–0.3	0.1
South Urals	10–15	12–20	104	1.5–5	8	1.4	4–5	8–9	1–2	0.1
Hydrothermal-metamorphogenic quartz										
Ufaley	86	25–240	9–17	3–40	2–15	0.4–1	5–70	4–10	0.1–1.5	0.5
Kyshtym	15–20	20–25	1–3.5	3–8	2–14	0.4	1–2	0.5–1	0.5	0.2

[a] "Quartzites and silica sands for silicon production" report, Institute of general physics, Russian Academy of Sciences.

supply, necessary both for the operation of the smelter CHPP and for the technological process. The required annual volume reaches 570 mln m^3. The specified issue was agreed upon by the Government of the Komi Republic and "Gazprom" OJSC only in December 2008 and the timeframe is confined to the completion of construction works at the first branch of Bovanenkovo–Ukhta gas-transmission line in the republic (2011).

Moreover, full-scale implementation of the aluminum project will as a result "present" the republic with more than 50 mln tons of red mud, buried in the plant red mud depository in perpetuity. However, this waste can be considered as an abundant long-term resource, homogeneous in composition and technologically processed (well-ground), which can be used for the development of a whole range of processing industry branches, including the construction sector (filling materials for concrete and construction mixtures, components for building blocks, road surfaces etc.).

Raw quartz. The Komi republic reserves register include 5 deposits of raw quartz, containing more than 70% of the Russian total reserves of vein quartz. The largest deposit, which is the only one under exploration, is the Zhelannoye deposit, located within the boundaries of the Central-Urals Uplift of Lyapinsk anticlinorium [3].

The deposit is localized in the Lower-Ordovician terrigenous masses (monomineral quartzitic sandstones of Tel'posskaya series); vein quartz bodies perform tectonic folds, formed under conditions of regional compression and local extension at the final stage of the Paleozoic tectonic activation.

The stratum rich in quartz veins can be traced stretching for 4 km according to the extension of the enclosing rocks; the vertical extent of mineralization exceeds 400 m. The quartz veins are of hydrothermal genesis, formed at approximately 400°C, and their age defined on the basis of the K-Ar dating method is 245 mln years. Crystal formation is of superimposed nature.

With regard to the majority of accompanying components, quartz of the Zhelannoye deposit has a higher content of accompanying components (ppm) than quartz from other deposits (Table 3).

The deposit is developed by "Kozhimskoye RDP" CJSC through underground mining. The annual production rate for the latest decade has been at the level of 800–1200 tons, which fully meets the demands of the Russian consumers (South-Ural plant "Kristall,"

Table 4. Characteristics of various brands of baryte concentrates from the Khoylinskoye deposit ore

Indicator	KE-3	KE-5	KE-6
Mass content of $BaSO_4$, %, minimum	90	85	80
Mass content of water-soluble salts, %, maximum	0.35	0.45	0.45
Moisture content, % , maximum	2.0	2.0	2.0
Density, g cm^{-3}, minimum	4.2	4.1	4.0
Mass content of 5 μm fraction, maximum	10		

VNIISIMS in Aleksandrov town etc.) in KZH-3 and KZH-6 concentrates. The deposit vein quartz and crystal quartz are in full compliance with the specifications for raw materials used in glass melting and single-crystal synthesis.

At present the production output can be increased 2–10-fold; however, the limited sales market does not allow the enterprise to reach its full capacity. Taking this circumstance into account, the enterprise is currently performing works on deep concentration of vein quartz of ordinary grades in order to obtain extra-pure quartz concentrates meeting international standards and raw materials for the production of extra-pure silicon.

Barytes. The Khoylinskoye baryte deposit was discovered and explored at the end of the last century by Vorkuta geologists. It is located in a zone of low mountain ridges of the Polar Urals western slope, 95 km to the south of Vorkuta. There are three commercial fields: Eastern, Western, and Central.

The deposit reserves prepared for open mining amount to 2.3 mln tons, which accounts for 30% of the total amount of discovered baryte reserves in the Russian Federation and 14% of the total amount of all Western European reserves. The deposit reserves under C_1+C_2 categories amount to 9 mln tons and the deposit resources to approximately 20 mln tons.

The ore composition of the Khoylinskoye deposit is simple, with baryte, quartz, and calcite as the major ore-forming minerals. For a number of properties this deposit has no counterparts in Russia or the neighboring countries. The average content of $BaSO_4$ in the ores is 85.4% in prevailing baryte natural type and 68% in silica-baryte and carbonate-baryte types [2].

Implementation of the investment project on the deposit development is carried out by "Khoylinskiy Concentration Plant" CJSC. The project detailed design embraces successive development of three quarries: Eastern, Western, and Central. The design capacity of the open mine amounts to 120 thousand tons of ore per year. The design capacity is to be reached a year after the start of the development. The mine operational life is 19 years. The total investment costs of the project implementation have amounted to approximately 10 mln USD. At present the works are performed in the Eastern quarry: in connection with delays in construction and installation works at the concentration plant, the production rate is limited to 50 thousand tons of ore per year.

Production of baryte concentrate from the Khoylinskoye deposit ore is based on the dry-grinding technology with parallel partial concentration of the product under the gravity scheme. The project envisages construction of a concentration plant consisting of two processing lines with the capacity of 60 thousand tons per year each (overall annual capacity of 120 thousand tons of concentrate) in the city of Vorkuta, Severny settlement.

Mono-baryte ore is the basis for production of concentrates in the percentage proportion of 40:50:10. In addition to the primary products, 15% of the output is taken by a product with barium sulfate content of 60–70%. The composition of concentrates is given in Table 4.

New Mining and Smelting Plants and Mining and Chemical Plants

Titanic ores. The Yaregskoye oil-titanium deposit located on the territory of the Komi Republic is the largest deposit in Russia with oil and titanium reserves concentrated at the same level.

The deposit is an ancient offshore placer of the Mid-Devonian age, saturated with oil. Titanium-bearing sandstones are located at a depth of 200–300 m, varying from 18 to 26 m in thickness. The

material composition of the ores is leucoxene-quartz and siderite-leucoxene-quartz. At average, TiO_2 content in the ore amounts to 10.5%, TiO_2 content in leucoxene to 64.3%, and oil content in sandstones varies from traces to 14.5%.Other components of the ore detected in commercial amounts include niobium, zirconium, tantalum, and rare earths.

The large Pizhemskoye deposit of titanic ores is similar to the Yaregskoye deposit in genesis. The average thickness of titanium-bearing layers is 62 m with the formation depth reaching 176 m. The major titanium-containing mineral is leucoxene (approximately 96%), while ilmenite content reaches 40%.

The reserves under $B+C_1$ categories are concentrated within the boundaries of the mining allotments of oil-extracting companies "Yaregskaya Oil-titanium company" OJSC and "Bitran" OJSC in the amount of 603 mln tons, and 37.6 mln tons more are located within the mining allotment of "YaregaRuda" OJSC, which has designed the titanium-processing plant. The remaining balance reserves of oil under $A + B + C_1$ categories amount to 163 mln tons.

The project on establishment of Yaregskiy mining and chemical complex, implemented by "YaregaRuda" OJSC is aimed at extracting and advanced processing of oil and titanium ore of the Yaregskoye deposit. In 2005 "Gipronikel' Institute" OJSC developed a feasibility study for the establishment of Yaregskiy mining and concentrating plant (object is titanium mine). The design plant capacity of 650 thousand tons of ore per year is to be reached in 4.5 years after the start of the construction. The total construction period is 6 years, the total costs of the mine construction amount to 3.7 bln rubles. The starting year of the construction is 2009. The payback period is 9.2 years. The technical solutions introduced in the feasibility study make it possible to later increase the mine production rate to 1.3 mln tons of ore per year. The main products are as follows: titanium dioxides of RKH-1, RKHO-1, and RKHO-2 brands, commercial slag, color pigments, concentrates for electrodes, and oil.

The mining and concentrating plant will create 1042 working places, including 750 positions for operating personnel and 292 for qualified specialists and management. The plant output parameters are as follows: titanium ore production of 650 thousand tons per year (with the potential to increase it later to 1.3 mln tons) and oil production of 175 thousand tons per year (with the potential to increase it later to 211 thousand tons). The total investment costs amount to 5.3 bln rubles.

The delays in exploration of this well-prospected deposit (discovered in 1939) are connected with searching for an economically effective processing pattern. Concentration of titanic ores makes it possible to produce leucoxene-quartz concentrate, containing 50–60% of TiO_2 and 35–45% of SiO_2. In order to obtain commercial titanium products, alongside with preliminary oil extraction and traditional concentrating methods, the project also applies technologies of autoclave leaching and pyro-metallurgical processing, which results in slag TiO_2 concentrations reaching 80%.

Manganese ores. The Parnokskoye ferromanganese deposit (in the south of the Polar Urals) is localized within the limits of the Lemvin structural and formational zone, concentrating along the junction line of Lemvin and Eletsk fractions. The primary mineralization dates back to the Mid- and Late-Ordovician age; it is associated with terrigenous-carbonate formations of Kachamyl'kskaya series and is considered to be of hydrothermal (volcanogenic)-sedimentary genesis.

The ore-bearing formation of Kachamyl'kskaya series is Parnokskaya rock mass, consisting of sandstones, silt sandstones, and argillaceous-carbonaceous shale. Among these formations there are layers and interlayers of manganese ores (mostly phodochrosite) and ferrous ores (magnetite), grouped in series of ore shoots. Each ore shoot is formed by a number of interstratified lens-shaped layers of manganese and ferrous ores ranging from 0.1–0.5 to 5.8 m in thickness, separated by sandstones interlayers. According to their inclination and strike, some strata can be traced for 0.8–1.2 km.

The following stages, metamorphogenic (Pz-Mz) and hypergenic (Mz_2), resulted in the formation of the deposit existing structure with the oxidation zone reaching 60–80 m in depth. Primary manganese ores are formed by carbonates, silicates, and manganese oxides. The main ore-forming mineral is phodochrosite, and managanocalcite in subordinate amounts. The content of manganese oxide varies from 37 to 53%. The amount of oxide ore reserves put on the reserves register is 0.8 mln tons.

Development of the Parnokskoye ferromanganese deposit is performed by Inta-based "Komi Manganese"

OJSC, a branch of "Chelyabinsk Electro-Metallurgical Company" OJSC. At present the deposit is not productive; various geological prospecting works are being performed, including drilling, sampling, and technological mining.

Rock salt. The Seregovskoye salt deposit is located near the village of Seregovo, on the right bank of the Vym' River. The deposit is confined to the roof part of the salt dome structure in the Central part of the Mezen Depression. Parent salt, thinned in a core, is assumed to be of the Archean-Early Proterozoic age.

The salt mass of the dome lies at depths varying from 229 m (in the centre) to 570 m (in the wings). The salt core area occupies approximately 5 km^2, the dome size at the top is 1.9×1.3 km. The cap rock is 230–400 m thick. The deepest wells (no. 35, 1125 m and no. 39, 1136 m) have gone down 804 and 827 m through the salt and have not reached the basement rocks.

Within the entire rock column, 77–98% of the rock salt is represented with halite. Potassium content varies from traces to 11.7%. The rock salt forecast reserves are estimated at 5 bln tons; explored reserves under A + B + C_1 categories amount to 690 mln tons and explored reserves under C_2 category to 2.061 mln tons.

The salt works existed from the middle of XVII till the end of XX, annually evaporating from 500 to 5000 tons of salt. At present the salt works are closed.

The plan to implement the project on alumina production at Sosnogorskiy Aluminum Smelter and titanium dioxide production at Yaregskiy mining and chemical complex on the territory of the republic can bring about a favorable situation for revival of the salt works at the Seregovskoye salt deposit. Production of titanium dioxide will require liquid chlorine supply in the amount of 2.5 thousand tons in 2012 and later 29.5 thousand tons annually; technical sodium supply in the amount of 1.8 thousand tons with a later increase up to 21 thousand tons annually; hydrochloric acid supply in the amount of 0.4 thousand tons with a later increase up to 4.8 thousand tons. Sosnogorskiy Aluminum Smelter even in the first year of operation will require 66 thousand tons of caustic soda, and later the annual consumption of this raw resource will increase up to 154 thousand tons. Apart from establishment of a chemical production, processing salts of the Seregovskoye salt deposit in order to produce chlorine and caustic soda, it is possible to produce "Extra" food salt as a by-product.

Performance of Fast-Track Geological Appraisal for Design and Construction of Mining Enterprises

At present the priority tasks are fast-track appraisal, prospecting and start of development works at the Komi Republic prospective deposits of raw materials, highly deficient for the Russian industry. The problem is that many mining objects have not been sufficiently explored, and to transfer them to the rank of commercial deposits it is necessary to bear significant costs for geological, geochemical, geophysical, drilling, mining and tunneling works, and for technological and economic appraisal of mineral raw materials. Compared to other directions, this type of activity is characterized with high investment risks. At the same time, a special feature of the Komi Republic in terms of ore prospecting is that – unlike the majority of other developed mineral-resource regions – the republic possesses the resource pool of poorly-explored but easily-detected, outcropping or near-surface deposits, which is far from being depleted.

Thus, the mineral-resource potential of the western slope of the Pre-Polar Urals and the North Urals, to the south of the Kozhim River basin, has been no more than touched by exploration and forecast appraisal at the level of prospecting works: almost no bore holes deeper than 100 m have been drilled here; the amount of mining and tunneling works have been minimal at local sites; geochemical and geophysical studies have also been performed only on a local scale.

The main exploration, appraisal and prospecting activities are planned to be focused on the following directions:

Chromite ores. The Komi Republic prospects for chromite ores are connected exclusively with the north-western part of Voykar-Syninskiy Massif, within the boundaries of the forming Eletsko-Khoylinskiy mining district [4]. It is possible to detect medium-scale deposits of metallurgical and refractory chromite ores within Khoylinskoye, Kechpel'skoye, and Kharotskoye ore fields. Ore resources in the Polar Urals on the territory of the Komi Republic amount to 58 mln tons.

Copper ores. A highly favorable demand-supply situation in Russia with regards to copper ores determines the need to renew additional geological appraisal and exploration of cupriferous sandstones of the Pre-Polar and Polar Urals. The Sauripeyskoye, Padyaginskoye, Moludvozhskoye, and Kosyunskoye

deposits form a kind of belt of cupriferous sandstones, stretching along the western slope of the Urals for more than 300 km. Mineralization in all the deposits is of stratiform nature (stratal, ribbon-like, and more rarely, pillarlike bodies) and is associated with formations of the terrigenous shelf of the Lower Ordovician.

Copper mineralization belongs to the porphyry and vein type, with copper content varying from tenths of % to 1.84% and more. Silver is registered in the ores in the amount varying from tens g/t to 340 g/t (Moludvozhskoye deposit), in individual samples gold is registered in the amount reaching 2.8 g/t for the formation thickness below 2 meters. The ore mineral type is bornite-chalcocite and chalcopyrite.

The resources of the specified objects under P_1 category amount to 3–4 mln tons of copper.

Gold. At present there are several gold-bearing areas detected on the western slope of the North Urals: Verkhnepechorskiy, Patoksko-Shchugorskiy, Kozhimskiy, Lemvinskiy, and Yenganopeysko-Manitynyrdskiy districts, within the boundaries of which the major deposits of placer and vein gold of various geological-mining types are concentrated. Apart from that there are crusts developed as a result of chemical weathering in various district of the Urals.

In Timan gold is encountered in sediments of a number of streams, rarely forming minor commercial placers. The distinctive feature of Timan gold mineralization is the presence of the Devonian polymineral placers.

The most original discovery is a gold deposit in Kozhimskiy district. The Chudnoye gold deposit of a non-conventional palladium-gold-fuchsite type has been recently discovered in the axial zone of the Maldynyrd Ridge in Al'kesvozhskiy section. It is interesting that earlier in alluvial sediments of the Al'kesvozh creek gold has been detected in aggregates with palladium minerals; however, ore bodies of gold-palladium mineralization have remained unclear. There are several ore zones oriented in the north-east direction within the boundaries of the deposit. These zones consist of numerous gold-bearing fuchsite veinlets below 2 cm in thickness, located in rhyolites. In fuchsite gold is found in association with allanite, palladium, and platinum minerals, in particular: mertieite, ateneite, sperrylite, stibiopalladinite etc. There are almost no sulfides. Gold is found in small amounts of imbricate, platy, irregular form. In composition of accompanying elements gold of the Chudnoye deposit differs significantly from the other ore occurrences discovered in the region. It contains silver, copper, mercury, and palladium. The gold fineness varies from 850 to 900%.

In the north-west of Kozhimskiy district there are occurrences associated with terrigenous formations of the Late Cambrian-Early Ordovician age (Nesterovskoye, Amfiteatr, Samshitovoye, Balbanty etc.). One of the largest is the Nesterovskoye deposit, located within the boundaries of Maldinskaya ore zone. The enclosing rocks are represented by quartz conglomerates, gritstones, and sandstones of Al'kesvozhskaya rock mass. Quartz veins, often containing hematite, chlorite, albite, chloritoid, and pyrophyllite occur in abundance.

The specified objects have been prepared for exploration, which is deterred by the fact that the deposits are located on the territory of the Yugydva National Park.

The total reserves of the area are estimated at 4.5 tons; the amount of resources exceeds 400 tons.

Finalizing the appraisal of the resource potential of the European Russia north-east (the Komi Republic, the Nenets Autonomous Area), it is necessary to note the following:

(1) The system of market relations requires referring to deposits of mineral raw materials as a geological and economic category, taking into account the current global prices for raw materials, technological and technical level of the concerned segment of the mining industry and modern science, and first of all, infrastructural characteristics of the region. Each of these elements can either facilitate or impede the exploration of a deposit, taking the object out of the category of economically viable objects and for many years leaving it outside the reserves register.

Often incorrect emphases in the resources exploration strategy act as deterrents. Thus, low gas prices have formed the balance in the Russian fuel and energy complex which is irrelevant to the global economy: in the coal–oil–gas triad the gas component reaches 62–64%, while coal accounts for not more than 18–20% (on the global scale the coal component varies from 40 to 60%). Despite all the efforts to shift to a more coal-oriented energy sector, the share of gas-based energy in recent years has increased by 3–4%.

(2) Introduction of modern technologies in the mining industry in principle should contribute to a more advanced extraction of mineral resources from the earth depths. In fact we often witness the opposite, selective development of deposits, resulting in a drastic increase in losses.

For the period of 1991–1998 process losses in the coal industry of the region and writing-off due to technical and economic terms amounted to 258 mln tons, which is 187% of the produced volume. As a comparison, 210 mln tons have been extracted during the previous 7-year period, with only 50 mln tons lost or written off, which does not exceed 23%.

In 2007 process losses accounted for 2.43 mln tons within the total produced amount of 12.8 mln tons. These facts require strengthening of the state position in the field of mineral resources.

(3) The main task for geologists is the issue of forming the mineral-resource base of the country. Let us not conceal that in many directions we are still "eating away" the Soviet heritage.

For the last fifteen years in many regions of the country the geological survey has been eliminated, geological traditions and the concept of "school" have been lost. It has been a strategic mistake of the state to withdraw the tasks on reproduction of the mineral-resource base, to delegate this matter of state importance to various companies. As a consequence, we have lost the increment as a multiplicative indicator of the geological activity as a whole. And restoration of the geological potential of the sector is the main strategic goal at the current stage of development of the Russian Federation.

REFERENCES

1. Gerasimov, N.N., *Gor. Zh*., 2007, no. 3, pp. 16–22.
2. Gerasimov, N.N., *Gor. Zh*., 2007, no. 3, pp. 75–80.
3. Kuznetsov, S.K., *Zhil'ny kvarts Pripolyarnogo Urala* (Vein Quartz of the Pre-Polar Urals), Leningrad: Nauka, 1998, p. 214.
4. Makeev, A.B., Perevozchikov, B.V., and Afanasyev, A.K., *Khromitonosnost' Polyarnogo Urala* (Chromite Mineralization of the Polar Urals), Syktyvkar, Komi Otd., Akad. Nauk SSSR, 1985, p. 152.