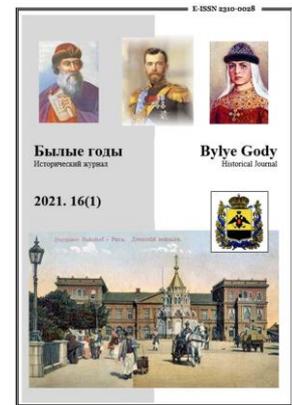


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The Development of the Mineral and Raw Materials Base of Russia in the Works of Scientists of the Mining Institute (second half of the 19th and early 20th centuries)

Igor A. Tropov ^{a,*}, Sergey I. Podolskiy ^a, Sergey V. Lyubichankovskiy ^{b,c}

^a Saint Petersburg Mining University, Russian Federation

^b Orenburg State Pedagogical University, Orenburg, Russian Federation

^c Samara Federal Research Center Russian Academy of Sciences, Samara, Russian Federation

Abstract

The article examines the contribution of the scientists of the Mining Institute to the study of the mineral resources of the Russian Empire in the second half of the 19th century to the early XXth century. For the first time, we present the results of a comprehensive analysis of the scientific, theoretical and practical activities of such prominent representatives of mining in post-reform Russia as K.I. Lisenko, I.F. Schroeder, L.I. Lutugin, N.S. Kurnakov and others. On the basis of published materials and using archival sources, it is shown that scientists of the Mining Institute were at the forefront of scientific developments in the fields of exploration, production and use of mineral resources (oil and coal mining, potassium salt production, etc.). Their high scientific potential was in demand by the state, which often acted as the initiator of scientific research on the mineral resource base of the Russian Empire. Scientists of the Mining Institute, being experts in mining, acted at the same time as popularizers of science, undertaking this work both through the meetings of various public organizations and through publishing in periodicals. A high level of scientific training, ensuring continuity in the development of scientific schools, exceptional diligence, and striving for a combination of scientific achievements and production practices have all determined the significance of the results obtained by the scientists of the Mining Institute, which became an important basis for further study of the mineral resource base of Russia and, in general, for the development of the Russian economy.

Keywords: mineral resource base, economic modernization, Mining Institute, scientific research, mining, mining industry.

1. Introduction

The rapid process of bourgeois modernization that unfolded in the post-reform Russian Empire, primarily in the fields of industry and transport, was accompanied by active scientific, theoretical and practical work in the fields of exploration, extraction and use of mineral resources. This term is defined as the entire “totality of reserves of various minerals suitable for using in various sectors of the economy, both in modern conditions and in the future” (TSB, 1974: 282).

Those mineral resources that are directly discovered in the bowels of the earth as a result of geological exploration are denoted by the term “mineral-resource base” (Mineral'no-syr'evaya baza, 2020). This concept is historical, since the composition of the mineral-resource base, methods of extraction and processing of mineral raw materials (oil, gas, rare earth metals, etc.) change over time under the influence of various objective and anthropogenic factors (Gladkova et al., 2018: 8-12; Zuev et al., 2019: 8-12; Cheremisina et al., 2019: 1-16; Cheremisina et al., 2020: 1-15).

* Corresponding author

E-mail addresses: tropov_ia@pers.spmi.ru (I.A. Tropov), podolskiy_si@pers.spmi.ru (S.I. Podolskiy), svlubich@yandex.ru (S.V. Lyubichankovskiy)

The relevance of examining the role of scientists of the Mining Institute in studying the mineral-resource base of the Russian Empire is due, first of all, to the role that representatives of the scientific community played in ensuring scientific, technical and economic progress in the country in the post-reform decades.

In addition, this research is relevant to the modern realities in which the development of science, technics and technology is taking place. Their ever-increasing roles in ensuring the sustainable socio-economic development of the country encourages the most attentive attitude to the historical experience in studying and using the resources of the mineral-resource base of Russia, which has a significant impact on the formation of the sectoral and territorial structure of the economy, as well as on the development of specialized sectors of the economy.

2. Materials and methods

The most important sources on the history of the development of knowledge about the mineral-resource base of Russia for us are the works of the scientists of the second half of the 19th and early 20th centuries. First of all, these are the works of Professor K.I. Lisenko on oil production and oil pipeline construction (Lisenko, 1868; Lisenko, 1878; Lisenko, 1886). No less important are the scientific works of his student I.F. Schroeder. He wrote the most important works on the state of Donetsk coal and salt production (Schroeder, 1909; Schroeder, 1911). The report of the prominent geologist F.N. Chernyshev on the results of the Pechora expedition is of great interest (Chernyshev, 1889). We find fundamental works on geology in the scientific heritage of L.I. Lutugin and P.I. Stepanov (Stepanov, 1909; Lutugin, Stepanov, 1913).

The archival materials contained in the fund of the Mining Institute, kept in the Central State Historical Archive of St. Petersburg (TsGIA SPb. F. 963), were also of great importance for the study.

Memories of the personal qualities of scientists are found in I.F. Schroeder's memoirs about K.I. Lisenko (Schroeder, 1904) and in the necrologue dedicated to the memory of L.I. Lutugin (Stepanov, 1916: 240).

Some useful facts were gleaned from the regional press, in particular, the newspapers Yuzhny Krai and Zabaikalskaya Nov'.

The research methodology is based on the basic principles of historicism, objectivity and consistency. In the process of the research, we tried to base it not on the biographies of scientists, but on the evolution of their scientific concepts and views regarding the development and use of mineral resources. At the same time, based on an understanding of the commonality of objective and subjective factors, we widely used the biographical method, which made it possible to focus on the unique aspects of the work of scientists of the Mining Institute, and to assess the personal contributions of individual scientists to the study of the mineral-resource base of Russia. The diachronic method was used to study the main stages in the development of scientific thought in the field of mining. Finally, the method of comparative analysis allowed us to identify common features and peculiarities in the activities of the scientists of the Mining Institute in the study of the mineral-resource base of the Russian Empire.

3. Discussion

In the pre-revolutionary period, generalizing works on the mineral resources of Russia were very rare. One of the typical works of this kind was the composition of V.I. Islavin on the role of the Donetsk basin in the Russian economy (Islavin, 1875). Yet, during this period, there was an accumulation of practical knowledge about the state of oil production, coal basins and salt sources.

In Soviet times, detailed biographies of scientists who made an outstanding contribution to the development of the mineral-resource base of Russia began to appear or were republished (Gapeev, 1951: 59; Lipin, 1951: 98). Interest in the biographical genre with detailed scientific calculations continued in the following decades (Soloviev, Zvyagintsev, 1960).

In the post-Soviet period, new biographical works about K.I. Lisenko, I.F. Schroeder, D.I. Mushketov and other prominent scientists were published (Matveichuk, 2002; Morachevsky, 2009; Afanasyev et al., 2010; Bazhin et al., 2018). The problems of institutional history in the field of mining began to be developed more actively (Mokeyev, 2015; Valieev, Shorin, 2017; Voloshinova et al., 2018). We separately highlight the collective monograph on the economic and industrial potential of Russia before the revolution (Lomkin et al., 2016).

4. Results

One of the most important minerals extracted in Russia since the beginning of the 18th century, and occupying a significant place in the country's raw material balance, was oil. Its production significantly increased when it began to be extracted by industrial methods in the late 1870s-1880s (Matveychuk, 2020). At that time, a prominent Russian chemist and professor of the Mining Institute, Konon Ivanovich Lisenko (1836–1903), was at the forefront of oil research. Lisenko combined the qualities of a theoretical chemist, a practical scientist and an industrial expert (TsGIA SPb. F. 963. Op. 1. D. 5440. Sheet 1). He advocated that scientific developments find wide application in practice, in particular, in the field of industrial production (Schroeder, 1904: 3).

Since 1876, on the instructions of the Imperial Russian Technical Society (IRTS), Lisenko was based in the Caucasus, where he studied the methods of oil production and processing. It was then that he met Ludwig Nobel, one of the founders of the Nobel Brothers Oil Production Partnership in Baku in 1879. This meeting determined Lisenko's interest in the problems of oil production and transportation (Lisenko, 1878; Lisenko, 1886). In particular, his work "Oil Production", which was published in 1878 in three issues of the IRTO Notes, became the first Russian manual on the technology of oil production and refining.

Lisenko cited the results of studying oil from domestic deposits and turned to the peculiarities of kerosene made from it, which was actively used to illuminate houses, streets and various structures. The technological peculiarity of lighting in Russia was that kerosene lamps worked only on American kerosene, and it was impossible to burn a domestic product in them. A chemist from the Mining Institute identified differences in the hydrocarbon composition of Russian and American oil (Schroeder, 1904: 2), which was later confirmed in the studies of F.F. Beilstein and V.V. Markovnikov (Morachevsky, 2009: 74).

Among Lisenko's students who contributed to the study of the properties of regional oil fields, Ivan Fedorovich Schroeder stands out. Following the advice of his scientific advisor, he developed both theoretical issues and problems of a purely practical nature (TsGIA St. Petersburg, F. 963. Op. 1. D. 5478. Sheet 1). He also trained talented chemists, among whom a special mention is due to one graduate of the Mining Institute who graduated in 1918, Pyotr Petrovich von Weimarn (1879–1935), known as the creator of a new direction – colloidal chemistry (Valiev, 2017: 617).

The career of Schroeder, one of the prominent industrial experts in Russia, began in 1889 with the study of oil samples obtained during an expedition to the Ukhta oil basin under the leadership of F.N. Chernyshev (Matveychuk, 2002: 174-175). For the entire space explored by the expedition, which is over 150 thousand square versts, adjacent to the Arctic Ocean, "a new topographic map was developed, on the basis of which F.N. Chernyshev compiled a geological map that greatly changes the previous ideas about the geological structure of this region" (Afanasyev, 2014: 121). In the report on the results of the expedition it was emphasized that "only a comprehensive scientific study of the northern regions can clarify their industrial significance and give a solid foundation for practical work" (Chernyshev, 1889). I.F. Schroeder highly appreciated the samples brought by Chernyshev, and on the basis of these he predicted the glory of the famous oil field (Matveichuk, 2002: 174-175).

Yet coal has long been the king of fuel. Like iron ores, nickel, cobalt and potash salts, it belongs to the group of so-called non-scarce minerals, the exhaustion of which is not expected in the foreseeable future. Although the demand for coal in the 21st century in a number of countries has fallen, interest in it as a fuel still persists, which forces scientists to improve the methods of its extraction.

The fuel base of the country in the period under research was very narrow, the fuel balance of Russia was reduced to a deficit, and the country was experiencing fuel difficulties even before the First World War (Voloshinova et al., 2018: 15). In this regard, the interest of scientists of that time in the problems of the development of the country's coal base, first of all, in Donbass, is understandable. "If to the natural wealth of the region", wrote V.A. Islavin, ethnographer and member of the Council of the Ministry of State Property, in the mid-1870s – "labor, knowledge and capital will be applied, in less than ten years our Donetsk steppes will be covered with a forest of chimneys and Russia will have a manufacturing district, which in its favorable conditions is not inferior to the well-known manufacturing districts of Western Europe" (Islavin, 1875: 59).

The study of the properties of Donetsk coal was productively carried out at the end of the 19th century by K.I. Lisenko, who was the first to characterize the coals of the Donetsk basin and carried out a number of successful experiments on the coking of coal hydrates (Schroeder, 1904: 1). At the beginning of the 20th century, I.F. Schroeder was engaged in this activity (Schroeder, 1909). He proposed to use furnaces more extensively for pulverized fuel in order to stimulate the process of utilization of Donetsk coal (Schroeder, 1909: 89, 96).

Schroeder was a supporter of a protectionist policy, dreamed of "exporting the southern metal made on Donetsk coal" and added that "if the people should make sacrifices in the form of additional payments for the development of industry, then it would be more right to do this in the form of a premium for the export of metals, than to bear these sacrifices for the rise in fuel prices" (Schroeder, 1909: 29). The works of I.F. Schroeder were aimed at finding ways to make the most rational use of the rich resources of the Donbass.

Another scientist of the Mining Institute, who became famous for the study of coal, was Professor Nikolai Semenovich Kurnakov. He carried out work in the mines of the Donetsk Basin, studying the properties of detonating gas and explosions, as well as the explosive properties of coal dust. In 1912–1914, Kurnakov analyzed the toxic properties of ferrosilicon – an alloy of silicon and iron (Nemilov, 1951: 52). His student, a prominent specialist in alloys and solutes, Nikolai Ivanovich Stepanov (1879–1938), continued to study the explosive properties of coal dust from the mines of the Donetsk basin in 1913 (Lipin, 1951: 98).

The talented scientist Leonid Ivanovich Lutugin (1865–1915) devoted more than 20 years to studying the Donetsk and Kuznetsk coal basins. He made a huge personal contribution to the compilation of the geological map of Donbass. He managed not only to identify the mines, but also to trace and depict their areas. The map was able to solve the problem of accurately parallelizing the coal seams of the entire basin. In addition, as a result of painstaking surveys completed by 1914, Lutugin proved that the reserves of Kuzbass are 20 times greater than previously thought (Romanovsky, 1997: 133-144, 154).

Lutugin was a convinced and passionate popularizer of geology and repeatedly explained its practical benefits to entrepreneurs: "... In simple phrases that are understandable to everyone, often in a humorous tone, he gave valuable advice for industrialists. Yet under this playfulness there was always a strict scientific consistency, which industrialists gradually sensed and began to appreciate" (Romanovsky, 1997: 154). Contemporaries recalled how, in a dispute with businessmen at one of the congresses of miners in the South of Russia, Leonid Ilyich won an unconditional victory "over the conviction of industrialists about the needlessness and uselessness of "scientific lectures" about some kind of geology" (Stepanov, 1916: 241).

L.I. Lutugin was a great authority abroad. When the XII International Geological Congress was preparing a monograph on world coal reserves for publication, Lutugin provided a map and calculations of Donbass coal reserves. In 1911, when an international exhibition took place in Turin, the geologist provided a map of the Donetsk basin with a scale of one inch to three versts. The map received the Great Gold Medal of the exhibition (Stepanov, 1916: 240-241).

One of the outstanding students of Lutugin was Pavel Ivanovich Stepanov – the best expert on the country's coal deposits. He devoted most of his life to studying and identifying new industrial areas in the Donetsk coal basin. In 1903 he participated in the development of a new survey technique based on lithological analysis of sediments. This technique is the basis of modern lithological survey work. The maps compiled using this technique have received the highest praise and widespread popularity. A detailed geological survey carried out directly by Pavel Ivanovich, or with his participation, in the period from 1903 to 1917, covered the eastern anthracite regions of Donbass (Dolzhanovsky, Gukovsky, Likhovsky, Sulinsky, Shakhtinsky). These works, in addition to their deep scientific significance, were distinguished by the thoroughness of their execution (Stepanov, 1909: 395-413).

In 1913, together with L.I. Lutugin, Stepanov published a complete calculation of coal reserves in the basin, which for the first time gave a clear understanding of the industrial significance of the region (Lutugin, Stepanov, 1913).

Under the guidance of L.I. Lutugin, geologist Dmitry Ivanovich Mushketov began his activities. In particular, he was the author of a geological and geomorphological description of the area of the Suchansky railway region, which was detailed and thorough in many respects. It was here, in the Far East, in 1908, that Mushketov discovered and explored previously unknown coal-bearing areas. A little later, in 1909–1916, fulfilling the assignments of the Geolkom, D.I. Mushketov went to Eastern Fergana to make up a geological map of Central Asia. There, in the course of long-term field observations, Dmitry Ivanovich systematized the richest factual material on stratigraphy, seismicity, tectonics, geomorphology and minerals. In May 1915, D.I. Mushketov successfully defended his thesis for a Master's degree in geology on the geological structure, tectonics and geomorphology of the area between the Altai and Fergana mountain ranges. At the end of 1915, Mushketov was elected to the post of professor of the Department of General Geology (Voloshinova et al., 2018: 16-17).

With the outbreak of the World War I, the demand for fuel increased greatly in connection with the needs of the defense industry and the needs of military transport by rail. The war and the emergency conditions generated by this war clearly showed that the fuel industry did not have the potential that, even in the conditions of mobilization measures, could help in solving fuel problems. The loss of front-line industrial areas, primarily the Dombrovsky coal basin and a number of other economically important territories, also played a negative role (Lomkin et al., 2016: 26, 29). Under these conditions, the search for coal deposits in the Kuznetsk Basin and in other less-studied areas became especially valuable.

One of the most important parts of the mineral-resource base of the Russian Empire, in addition to oil and coal, were potash (potassium) salts. They found wide application in electrometallurgy, medicine and photography, as well as in the production of glass, soap, paints and leather dressing, and in the chemical industry. The production of potassium salts began in Germany in the middle of the 19th century and spread rather quickly, in particular in Russia. The most famous salt deposits are still found in Siberia.

When I.F. Schroeder was already an ordinary professor at the Mining Institute, D.P. Konovalov, on behalf of the Ministry of Trade and Industry, invited him to write a paper on salt mining in Siberia. In the summer of 1910, Schroeder visited Irkutsk, Tomsk and other large centers. He was interested, in particular, in the state of salt production on Lake Koryak (not far from the modern Kazakh city of Pavlodar) and Lake Iletsk, located 70 km from Orenburg (Schroeder, 1911: 3-4, 13-15). Schroeder gave practical advice on the development of salt production. He believed that the owner of the Ilimovsk salt plant, merchant S.I. Serebrennikov, had to conduct exploration by drilling several new salt wells, since the old ones used by the previous owners had already been depleted. He also recommended organizing the sale of Ilimovsk salt to the Turukhansk region, rich in fish, and to the Bratsk and Namyr volosts (Schroeder, 1911: 14).

At approximately the same time, several studies of salts were carried out by Professor N.S. Kurnakov (1860–1941), who was interested in salt water and waterless systems, and natural salt brines. Together with his closest student, a graduate of the Mining Institute in 1900, Sergei Fedorovich Zhemchuzhny (1873–1929), he studied the exchange between magnesium chloride and sodium sulfate. This reaction is extremely important in the life of natural salt lakes. In 1909, Nikolai Semenovich organized an expedition to survey the Kara-Bogaz Bay in the Caspian Sea and obtained rich data used to create the so-called equilibrium diagram. It contains a picture of salt transformations, conditions for the crystallization of various salts, and the

boundaries of their stable existence. All this was necessary for the development and use of Lake Kara-Bogaz-Gola and is applicable to other sulfate lakes. In particular, the method of isolating individual substances in a pure form became known due to this research (Nemilov, 1951: 53).

In 1912, based on the study of brines and salts of Solikamsk and other salt-making plants, N.S. Kurnakov predicted the existence in Solikamsk's vicinity of the richest deposits containing potassium chloride and magnesium, sodium and bromine, and rare elements – such as rubidium and cesium (Nemilov, 1951: 53-54). The construction of the Solikamsk potash plant later was of strategic importance for a manufacturer of products made of rare earth metals – carbonates and oxides of europium, promethium, cerium, samarium, etc. (Lobacheva, Dzhevaga, 2017).

One of the most important groups of metals mined in Russia is the so-called “non-scarce minerals”: gold, platinum group metals, silver and diamonds. The study of the properties of these substances has been carried out at the Mining Institute for a long time. Back in 1826, a joint laboratory of the Department of Mining and Salt Affairs and the Mining Cadet Corps was created. Peter Georgievich Sobolevsky became its headmaster (Nemilov, 1951: 55). In the period of 1828–1834, in the laboratory of the Mining Corps, 476 poods of pure platinum were obtained. Sobolevsky established the minting of platinum coins at the St. Petersburg Mint (Bazhin et al., 2018). In our time, the tradition of the deep scientific research of platinum continues at the Mining University in full (Stepanov et al., 2019; Stepanov et al., 2020).

During World War I, the use of non-scarce metals in defense technologies became especially important. In January 1915 at the Academy of Sciences, V.I. Vernadsky, A.E. Fersman and N.S. Kurnakov created the Commission for the Study of Natural Productive Forces. The commission, in turn, organized the Institute for Physical and Chemical Analysis under the leadership of Kurnakov and the Institute for the Study of Platinum and Other Noble Metals. Its director, Professor L.A. Chuguev, invited Kurnakov to work on the study of alloys of platinum metals (Koltsov, 2015: 29-30).

At that time, global platinum mining was concentrated in Russia, but crude platinum was exported abroad – to Britain, France and Germany, where it was subjected to refining, i.e. the removal of impurities. In 1910, on the initiative of N.S. Kurnakov at the Mining Department of the Ministry of Trade and Industry, a meeting on the organization of crude platinum refining directly in Russia was established (Soloviev, Zvyagintsev, 1960: 90). At a special meeting of the Commission for the Study of Natural Productive Forces held in April 1916, Kurnakov spoke in favor of “the possible widespread use of platinum in Russia, the organization of the production of pure metals – platinum, iridium, rhodium”, which was of particular importance for the manufacture of platinum-rhodium thermoelements that were used in furnaces, boilers, water heaters and – most importantly – in aircraft engines (Soloviev, Zvyagintsev, 1960: 90).

5. Conclusion

The scientists of the Mining Institute in the second half of the 19th and early 20th centuries made a significant contribution to the study of the mineral-resource base of the Russian Empire. Responding to the objective needs of the country's modernizing economy, they launched serious, large-scale work to study the problems of the extraction of oil, coal, potassium salts and other mineral resources necessary for the progressive development of industry and transport, and also the household sphere.

The scientists of the Mining Institute for the most part were not only prominent theoreticians, well known abroad, but also active popularizers of science, and supporters of the practical implementation of scientific achievements in the field of mining. To this end, they made extensive use of the tribunes of the congresses of miners, other public organizations, periodicals and other opportunities available at that time for communication with interested organizations and with entrepreneurs.

An important factor that favored the success of the scientific endeavors of the representatives of the Mining Institute was the support of expeditions and other forms of scientific activity from the state, in particular, the Ministry of Trade and Industry. Such cooperation not only ensured the concentration of scientists' efforts in the most important, breakthrough areas, but also clearly demonstrated the state's interest in the development of scientific research in mining in the country.

Throughout the period under review, the scientists of the Mining Institute managed to ensure continuity in the organization and conducting of scientific research, both in the study of the fuel base of the Russian Empire, and in other studies of the country's mineral resources. As a result, whole scientific schools were formed and successfully functioned, the results of which enriched the national mining science, and in many respects have not lost their relevance to this day.

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