

SALT ^{OF} THE EARTH

How Russia Supplies Its Military-Industrial Complex with Strategic Minerals Amid War and Sanctions



ECONOMIC
SECURITY COUNCIL
of UKRAINE



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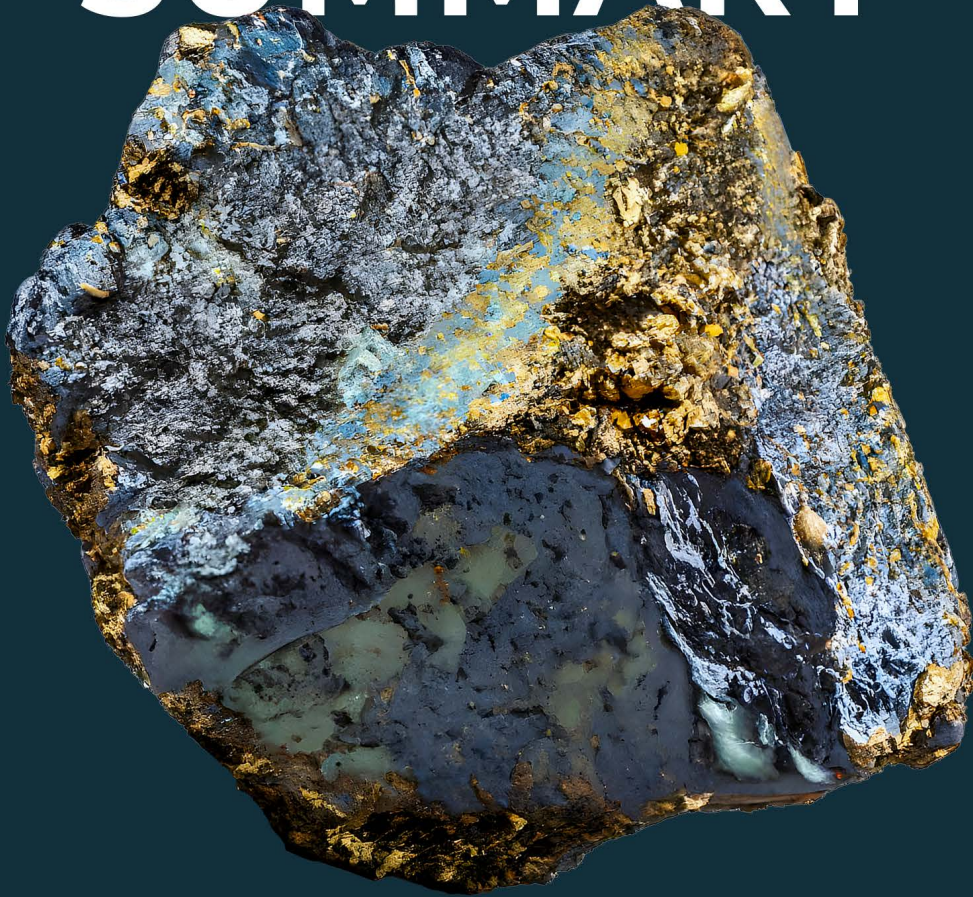
TABLE OF CONTENTS

Executive Summary.....	2
Introduction.....	5
Research Methodology and Caveats.....	8
Chapter I. How Did Russia Come to Recognize Its Strategic Minerals Problem?.....	11
Strategic Minerals as a (Non-)Priority Before 2022.....	11
Causes of Russia's Dependence on Strategic Mineral Imports.....	16
Imports as the Only Near-Term Way Out.....	22
Chapter II. How Does Russia Secure Strategic Minerals Under Sanctions?....	31
The Post-Soviet Space as Carrier of the Soviet Production Legacy.....	32
China as the Principal Compensator in Russia's Adaptation to Sanctions.....	41
Global South Countries as the Resource Base for Russia's Import Dependence.....	48
Sanctions-Coalition Jurisdictions as Visible but Non-Dominant Hubs.....	53
Chapter III. How Do Strategic Minerals End Up in the RMIC?.....	58
Aluminum: The Structural Backbone of Aviation, Missiles, and Explosives.....	58
Molybdenum: An Alloying Additive in Specialty Steels.....	65
Tantalum: Feedstock for Capacitors.....	70
Conclusions and Recommendations.....	75
Annexes.....	79



SALT OF THE EARTH

EXECUTIVE SUMMARY



EXECUTIVE SUMMARY

- **Russia is not a self-sufficient resource state in sectors outside its fuel and energy complex.** Its military-industrial complex (MIC) depends on imports of many strategic minerals — including aluminum (alumina and bauxite), beryllium, tungsten, manganese, molybdenum, niobium, rhenium, tantalum, and titanium — without which the production of aircraft, missiles, armor, engines, ammunition, air defense systems, military electronics, and specialty steels is impossible.
- **This dependency is the result of three decades of decline in Russia's non-energy mineral reserves.** For decades, Russia invested in oil and gas for the sake of export revenue, but not in strategic minerals for the high-tech industry and the MIC. The result has been declining output, the closure or degradation of Soviet-era mining and processing works (MPWs), the failure to bring new deposits into production, low levels of development even at large reserves, and the loss of full production chains after the collapse of the USSR.
- **Formal natural reserves do not give Russia genuine resource autonomy.** Its deposits are often remote, lack the necessary infrastructure, are technologically complex, and are economically unviable. In many segments, the Russian Federation has the raw materials for extraction and production but lacks the full cycle to manufacture the end product — concentrate, oxide, metal, or alloy of the required quality. This is precisely why imports serve as a systemic mechanism for compensating for Russia's industrial weakness.
- **After 2022, Moscow began administrative efforts to address this failure, but no rapid import substitution industrialization has occurred.** New state programs and strategies do not equate to new production. Most key extractive projects remain expensive, lack infrastructure, and have been pushed back to the late 2020s or the 2030s. In the short and medium term, Russia is unable to meet the needs of its economy and MIC for critical minerals on its own, cementing its dependence on imports.
- **In April 2024–March 2025, this dependency persisted or deepened.** The post-Soviet space filled the gaps in Soviet-era production chains that Russia was unable to reconstitute domestically — for beryllium, tantalum, and molybdenum. China became the principal compensator in Russia's adaptation to sanctions — both as a producer (of tungsten and titanium ore) and as a re-exporter (of ferroniobium). Global South countries supplied bulk raw materials — notably niobium, manganese, and alumina. Sanctions-coalition jurisdictions, although not dominant, remained important transit, corporate, and logistical hubs — especially for manganese and alumina.
- **Imported strategic minerals are used directly in military production.** An analysis of the financial operations of the 13 largest importers of alumina, tantalum, and molybdenum identified 102 Russian enterprises among their clients that either directly produce military goods or supply them to entities of the Russian military-industrial complex (RMIC). The aggregate volume of their purchases of these critical minerals amounted to RUB 86.7 billion, or approximately USD 1.1 billion.¹
- **Sanctions coverage of these chains is critically inadequate.** In Russia's supply chains for alumina, tantalum, and molybdenum, 278 unique companies were identified: 101 importers, 107 foreign shippers, and 70 foreign producers. Only 10 of them are under sanctions, of which 9 are Russian importers. Almost the entire international infrastructure that supplies strategic minerals to Russia —

¹ At the Central Bank of the Russian Federation exchange rate as of March 17, 2026 — RUB 81.05 per USD 1.

foreign producers, shippers, traders, intermediaries, and logistical hubs — remains outside the reach of individual sanctions pressure.

- **Strategic minerals must become a separate sanctions track.** Effective pressure should target specific forms of mineral products, importers, foreign producers, shippers, traders, re-exporters, logistical hubs, subsidiaries of Russian groups, and end industrial consumers. Russia cannot quickly rebuild its own raw-materials base, cannot fully replace critical imports, and cannot sustain its MIC without external supplies. This makes strategic minerals one of the most underestimated pressure points on the Russian war economy.

SALT OF THE EARTH

INTRODUCTION



INTRODUCTION

According to Russia's Strategy for the Development of the Mineral Resource Base to 2050, strategic types of mineral raw materials are those that "are of particular importance for the sustainable functioning and strategic development of the national economy, for ensuring national defense and security, for meeting the needs of high-technology industries, and for achieving international competitive advantage in the global trade of mineral raw materials and the products of their deep processing."²

Russia's list of strategic types of mineral resources defines 61 minerals of this kind, among which oil, natural gas, diamonds, gold, and silver play the leading roles.³ Undoubtedly, export and tax revenues from the extraction and sale of these resources make them critical to the Russian economy and to its capacity to wage war. Accordingly, it is logical that since February 24, 2022, international sanctions pressure has focused precisely on these minerals. After 2022, the G7, the EU, and other partners synchronized some of the key sanctions against Russian raw-materials exports: they introduced a price cap mechanism on seaborne shipments of Russian crude oil and petroleum products, restricting the provision of Western transportation, insurance, and other maritime services for shipments above the established price; subsequently, these same jurisdictions began to tighten enforcement against circumvention of this regime, including through sanctions against vessels, operators, and intermediaries linked to Russia's "shadow fleet."⁴ A separate coordinated track concerned diamonds: the G7 agreed to ban the import of Russian non-industrial diamonds from January 1, 2024, and to phase in restrictions on Russian diamonds processed in third countries from March 2024.⁵ In parallel, individual jurisdictions imposed their own broader energy embargoes: the EU banned imports of Russian coal, seaborne crude oil, and petroleum products, while the United States, as early as March 2022, banned imports of Russian oil, petroleum products, LNG, coal, and coal products.⁶

However, another segment of strategic raw materials long remained outside the focus of sanctions and diplomatic pressure on the Russian Federation — the minerals and metals without which a significant part of the RMIC cannot function.⁷ These are the strategic minerals critical to aviation manufacturing, the missile industry, specialty metallurgy, radio electronics, and the production of ammunition, engines, air defense systems, and other goods without which Russia is incapable of waging a prolonged war. Unlike energy resources and precious metals, this group of minerals was long not recognized as one of the material foundations of Russian military capability.

Yet it is here that one of Russia's most consequential structural vulnerabilities is concentrated. Viewed through the lens of potential external pressure, the list of strategic minerals for the Russian economy and the RMIC substantially overlaps with the list of resources Russia is forced to import. Specifically, in the Strategy approved in 2024, the Russian government openly admits that Russia depends on imports of uranium, manganese, chromium, titanium, bauxite, molybdenum, tungsten, lithium, beryllium, zirconium, niobium, tantalum, rhenium, rare-earth metals, graphite, fluorite,

² <http://static.government.ru/media/files/TNB3oQkPRJTmDE3AMaxuTn2KRSHG9X0S.pdf>

³ <https://www.garant.ru/products/ipo/prime/doc/405118925/>

⁴ <https://www.g7.utoronto.ca/summit/2022elmau/221212-statement.html>

⁵ <https://www.canada.ca/en/department-finance/news/2022/12/statement-of-the-g7-and-australia-on-a-price-cap-for-seaborne-russian-origin-crude-oil.html>

⁶ <https://www.gov.uk/government/news/joint-statement-on-g7-diamond-sanctions>

⁷ <https://www.consilium.europa.eu/en/policies/sanctions-against-russia/timeline-packages-sanctions-since-february-2022/>

<https://home.treasury.gov/news/press-releases/jy0608>

<https://www.gov.uk/government/news/uk-cracks-down-on-gold-and-oil-networks-propping-up-russias-war-economy>

⁷ <https://www.garant.ru/products/ipo/prime/doc/405118925/>

- The current geography of external supply — countries of origin, jurisdictions of shipping, and the re-exporting and logistical hubs through which strategic minerals and their processed products reach Russia;
- The specific supply chains linking foreign producers, exporters, and intermediaries with Russian importers and entities of the RMIC.

This study demonstrates that the problem of strategic minerals in Russia did not arise after the start of the full-scale invasion; it merely became more visible due of the war and sanctions. Despite the established perception of Russia as a resource state, its raw-materials model has for decades been focused primarily on oil, gas, certain precious metals, and the export revenue associated with them. By contrast, a significant share of other resources — including strategic minerals critical to military production, high-tech industry, and long-term economic security — has not become a full-fledged priority of state policy. As a result, Russia entered the phase of full-scale war as a state with large formal reserves of certain types of raw materials but without a properly developed non-energy mineral base, and with deep dependence on external supplies across a broad spectrum of minerals and their processed products.

Against this backdrop, the first chapter of the study focuses on the origins of this dependence and its persistence. It traces how strategic minerals long remained secondary against the backdrop of the oil and gas sector's dominance in Russia's budget, exports, and economic policy. Attention is paid to how this secondary status manifested in practice: in declining extraction and processing, the degradation of the Soviet production legacy, weak development even of substantial reserves, delays in sector-specific projects, insufficient funding of geological exploration, and the gradual formation of entrenched import dependence. The chapter also examines the geographical, infrastructural, technological, economic, and institutional factors that complicate efforts to overcome this dependence and demonstrates that the administrative measures adopted after 2022 are incapable of swiftly resolving the structural problem.

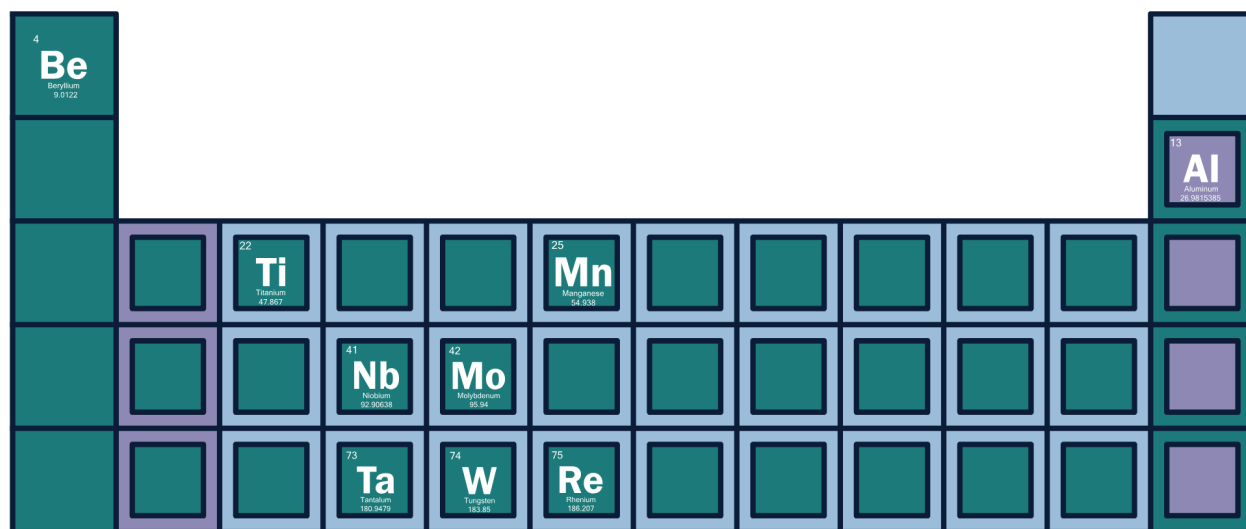
The second chapter is devoted to the external channels through which Russia obtains strategic minerals under conditions of war and sanctions. Its purpose is to show which countries, jurisdictions, and supply channels reproduce Russia's import dependence after 2022. To this end, the chapter analyzes the role of the post-Soviet space as an environment in which present-day dependence is often a continuation of older production ties; China as a key supplier of its own mineral output and as an agent of adaptation to sanctions, including through re-exports; Global South countries as sources of raw materials for certain positions, primarily bulk metals; and sanctions-coalition jurisdictions that, while not principal suppliers, can perform important logistical, transit, corporate, and re-export functions. This approach makes it possible to show that, after the start of the full-scale war, Russian dependence has not disappeared but has changed its geography and acquired more flexible forms.

The third chapter shifts the analysis to the level of specific production chains and addresses the question of how strategic minerals reach the RMIC. It is built around individual product case studies — imports of alumina, tantalum, and molybdenum — for which it was possible to trace the further movement of products to Russian enterprises engaged in the production of armaments and military equipment. This makes it possible to move from a general picture of trade to the reconstruction of specific supply chains — from a foreign producer or shipper to a Russian importer, a processing enterprise, and the end producer of goods for military use. It is in this part of the study that strategic minerals emerge as the material basis of specific segments of the Russian war machine.

The final part summarizes the main findings of the study and outlines their practical implications for sanctions policy. The principal point is that Russia's dependence on imports of strategic minerals is

Research Methodology and Caveats

The empirical core of the study consisted of detailed Russian import data, including supplies within the EAEU Customs Union, for the most recent available 12 months — from April 1, 2024, through March 31, 2025.¹³ An important supplementary source was the financial reporting of Russian importing enterprises for the same period, which enabled tracking of transaction amounts between Russian counterparties. To clarify the roles, specializations, and vulnerabilities of the companies appearing in such chains, an open-source analysis was conducted, drawing on court and arbitration cases, corporate reporting, historical public procurement records, sector-specific scientific publications, technical materials, and patents.



¹³ The EAEU Customs Union is a form of trade and economic integration within the Eurasian Economic Union (EAEU), providing for a single customs territory. Members (Russia, Belarus, Kazakhstan, Armenia, and Kyrgyzstan) have eliminated customs duties and economic restrictions in mutual trade and apply a unified Customs Code and common tariffs in dealings with third countries. Given this specific integration regime, customs data on trade between EAEU members are not included in the general structure of Russian imports, which is why — to ensure a complete picture — the study also uses transactions from a separate database on trade within the Customs Union.

The research proceeded iteratively. The first stage produced a list of minerals relevant to the study. The starting point was the Strategy for the Development of the Mineral Resource Base of the Russian Federation to 2050, which sets out the list of raw materials that the Russian state itself regards as strategically significant and import-dependent, together with the updated 2022 list of strategic types of mineral raw materials and the 2024 list of scarce raw materials and products.¹⁴ As a result, the analysis was focused on aluminum (bauxite and alumina), beryllium, tungsten, manganese, molybdenum, niobium, rhenium, tantalum, and titanium.¹⁵ At the same time, the analysis did not include minerals that had already been the subject of studies by the Economic Security Council of Ukraine (ESCU) — specifically chromium and antimony — or other minerals that have no direct or indirect military use.¹⁶

The next stage examined how Russia meets domestic demand for these minerals. This required an analysis of Russia's own raw materials base, the level of deposit development, extraction, and processing capacity, and external sources of supply. Attention was paid to the relationship between domestic production and imports, and to the stages — from ore and concentrate to oxides, alloys, metal, and semi-finished products — at which the most critical dependencies form. Open data from Russian government agencies, sectoral media, and the analytical work of other research organizations were used in this section.

A separate part of the study addressed the sanctions and regulatory environment. For each of the selected minerals and product forms, the study verified whether they were subject to international restrictions, which jurisdictions remained available for trade with Russia, and which, conversely, had restricted supplies due to sectoral sanctions. This stage analyzed the legal acts of the EU, the United States, the United Kingdom, Canada, and other states of the sanctions coalition. This made it possible to compare the actual structure of imports with the boundaries of existing prohibitions and to identify both gaps in the sanctions regime and potential routes for circumvention.

Based on customs data, HS codes, and financial transaction data, supply chains were reconstructed from foreign producers and shippers to Russian importers and downstream consumers within the country.¹⁷ This made it possible not only to identify the key supplying countries and companies, but also to trace the flow of products to enterprises connected with the MIC, aviation manufacturing, the missile industry, and other critical sectors. It was precisely this combination of customs data, financial transactions, and open sources that enabled a shift from describing the market to analyzing specific production and trade chains.

¹⁴ <https://www.interfax.ru/russia/860136>

<http://static.government.ru/media/files/TNB3oQkPRJTmDE3AMaxuTn2KRSHG9X0S.pdf>

<http://publication.pravo.gov.ru/document/0001202404190023?index=1>

¹⁵ <http://static.government.ru/media/files/TNB3oQkPRJTmDE3AMaxuTn2KRSHG9X0S.pdf>

¹⁶ For more details on the Economic Security Council of Ukraine's research on the role of antimony and chromium for the Russian MIC:

<https://www.rusi.org/explore-our-research/publications/external-publications/ore-ordnance-disrupting-russias-artillery-supply-chains>

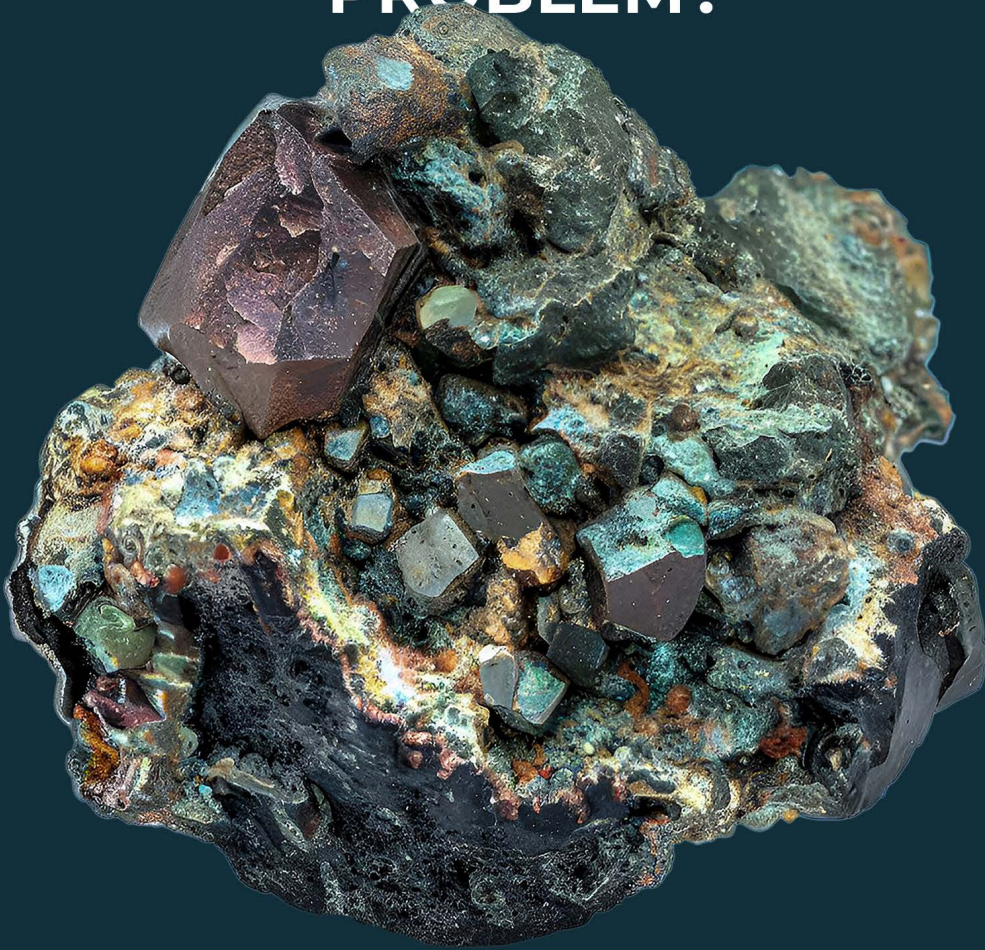
<https://www.demorgen.be/nieuws/kempens-bedrijf-groeide-uit-tot-wereldleider-maar-ligt-onder-vuur-voor-vermeende-omzeiling-van-sancties-tegen-rusland~b7b2154f>

¹⁷ The Harmonized System (HS) is a six-digit standard for classifying goods traded on the global market. HS codes are used by customs authorities worldwide to determine duty rates and taxes on specific types of products. HS codes consist of six digits and serve as a universal classification tool.

SALT OF THE EARTH

CHAPTER I

**HOW DID RUSSIA COME TO
RECOGNIZE ITS STRATEGIC MINERALS
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CHAPTER I.

HOW DID RUSSIA COME TO RECOGNIZE ITS STRATEGIC MINERALS PROBLEM?

This chapter is devoted to the preconditions that gave rise to Russia's dependence on imports of strategic minerals. Its starting thesis is that Russia's current vulnerability in this area cannot be reduced to the consequences of sanctions or wartime conditions but has considerably deeper, structural origins. Despite substantial domestic reserves and the established image of a "resource state," Russia entered the full-scale war with significant dependence on external supplies of a broad range of strategic mineral resources. This was largely the consequence of a long-standing development model in which state priority was systematically given to oil, gas, precious metals, and the export revenue associated with them, while other strategic resources — despite their importance for industry, the MIC, and technological security — never became a full-fledged object of consistent economic and industrial policy.

Against this backdrop, the chapter sequentially examines how this model manifested itself before 2022. Attention is paid to the factors that drove the reproduction of this dependence even in the presence of a domestic raw-materials base. The chapter concludes with an analysis of efforts undertaken after 2022 to accelerate the development of Russia's strategic mineral base.

Strategic Minerals as a (Non-)Priority Before 2022

In discussions of Russia's natural resources and the raw-materials model of its economy, the focus is most often on hydrocarbons, and that focus is justified. The mineral extraction tax, levied on all Russian subsoil users — but above all on the oil and gas sector — generates between a third and a half of the revenue side of the Russian budget.¹⁸ Energy resources also form the backbone of Russian exports: in 2025, oil and gas accounted for 54.9% of the country's total exports, bringing in revenue of USD 186.6 billion.¹⁹ In the same year, aggregate oil and gas revenues of the Russian budget amounted to RUB 8.47 trillion, or 22.7% of budget revenues — analytically comparable to military expenditures in 2025, which totaled RUB 15.96 trillion, or 38% of federal spending.²⁰ Given the importance of oil and gas to the Russian economy, the focus of the expert and policy community on sanctions pressure in this sector is justified.

However, this lens obscures an important reality: Russia's mineral resource base is considerably broader than oil and gas, encompassing a wide range of other resources, some of which are of strategic importance to the MIC, the high-tech industry, and long-term economic security. Russian officials and sectoral documents have consistently emphasized the country's wealth of various raw materials. According to Russia's Strategy for the Development of the Mineral Resource Base, "deposits of practically all known minerals have been identified on the territory of the Russian Federation and its continental shelf," and for a number of them — oil, natural gas, coal, iron ore,

¹⁸ <http://static.government.ru/media/files/TNB3oQkPRJtmDE3AMaxuTn2KRSHG9X0S.pdf>

The mineral extraction tax (NDPI) is a tax paid on the extraction of mineral resources as a form of state capture of resource rent from subsoil use. Rates depend on the type of resource: ad valorem rates set as a percentage of the value of the extracted resource, specific rates in rubles per ton, or a zero rate for certain preferential cases. Among others, rates are 4.8% for ferrous metal ores; 6% for gold-bearing concentrates and other concentrates and intermediate products containing precious metals; 6% for non-metallic raw materials; and 8% for non-ferrous and rare metal ores, diamonds, and semi-precious stones — while oil, gas, and gas condensate are subject to separate specific rates and adjustment coefficients.

¹⁹ <https://axillc.ru/news/novinki/vneshnyaya-torgovlya-rf-za-10-mesyatsev-2025-3-5-do-564-2-mlrd/>

²⁰ https://www.sipri.org/sites/default/files/2026-03/2026_01_russias_military_budget_for_2026.pdf

https://minfin.gov.ru/ru/press-center/?id_4=40166-predvaritelnaya_otseuka_ispolneniya_federalnogo_byudzheta_za_2025_god

diamonds, and others — Russia ranks among world leaders.²¹ The problem, however, is that over the past three decades, Russia has systematically developed primarily that part of its mineral resource base directly linked to oil, gas, precious metals, and the export revenue derived from them, while a significant share of other strategic resources remained outside the priorities of state policy — generating a large-scale structural vulnerability.²²

Specifically, with the collapse of the Soviet Union, the extraction and processing of strategic minerals fell steadily in physical volumes. For example, Russian production of tungsten concentrates — required for the manufacture of tank armor and armor-piercing projectile cores — fell from 20,000 tons in 1991 to roughly 2,000 tons in 2025.²³ Consumption of strategic minerals also fell: the USSR, for example, used roughly 10 tons of rhenium per year, with 70% going to the aviation industry, while current Russian consumption does not exceed 2 to 2.5 tons.²⁴ The extraction of other minerals also contracted sharply: in 2014, molybdenum extraction in Russia stood at 4,700 tons, falling to 1,700 tons in 2022.²⁵

Against the backdrop of declining or absent domestic demand, Soviet-era mining-and-processing and other processing combines began to close. The Tyrnauzsky mining and processing works (MPW) in Kabardino-Balkaria, which extracted tungsten and molybdenum ores, went bankrupt as early as 2001, and the MPW itself was later demolished.²⁶ The Zabaykalsky MPW, the sole producer of lithium concentrates in the RSFSR, was dismantled after 1991, with its equipment removed and sold off.²⁷ The Umbozerskoye lithium deposit and MPW, the Tatarskoye niobium deposit, and dozens of other extractive and processing enterprises ended up closed or bankrupt.²⁸

Even for strategic minerals, where demand has remained stable, extraction has been at minimal levels or not carried out at all. Titanium, for example, is indispensable in military and civil aviation, as well as in missile production, where it often accounts for more than 50% of the mass of the final product.²⁹ At the same time, in 2021, only 2.94% of Russia's 587.7 million tons of titanium dioxide reserves were being developed, while 68.86% remained in state reserves without allocation.³⁰ Bauxite — the key raw material for aluminum production and consequently important for metallurgy, machine building, and the aviation and defense industries — was likewise developed relatively weakly: of 1.366 billion tons of total reserves, only 33.38% had been allocated and were being developed, while the largest share — 53.15% — was not being developed at all.³¹

²¹ <http://static.government.ru/media/files/TNB3oQkPRJmDE3AMaxuTn2KRSHG9X0S.pdf>

²² <https://www.strausscenter.org/wp-content/uploads/Holland-Russias-Challenges-in-Mineral-Extraction.pdf>

²³ <https://cyberleninka.ru/article/n/problemy-mineralno-syrievoy-bazy-volframovoy-promyshlennosti-rossiyskogo-dalnego-vostoka/viewer>

<https://www.miningvisuals.com/post/charted-tungsten-production-2024>

<http://ru.tdmfginc.com/news/application-of-tungsten-alloy-in-military-weap-44498689.html>

<https://topwar.ru/257940-znachitelno-privoshodit-stal-o-stojkosti-volframa-k-kumuljativnym-boepripasam.html>

<https://www.forgedmoly.com/ru/news/why-is-tungsten-is-used-in-weapons/>

<https://www.cia.gov/readingroom/docs/CIA-RDP83T00853R000200070002-6.pdf>

²⁴ <https://iv-g.livejournal.com/1332422.html>

²⁵ <https://dprom.online/mining/dobycha-molibdena-v-rossii/>

²⁶ <https://urban3p.ru/object19405/>

²⁷ <https://bit.ly/3QbRWyU>

²⁸ <https://dprom.online/mining/lovozerskii-gok-12-tys-t-lopavitovogo-kontsentrata/>

https://www.prometall.info/novosti/razrabotka_tatarskogo_mestorozhdeniya_vozobnovyat_dlya_snizheniya_importa_niobiya

²⁹ <https://cyberleninka.ru/article/n/vysokoproduktivnye-titanovye-splavy-v-aviatsionnykh-konstruktsiyah>

<https://www1.ru/news/2024/07/11/kolossalnye-zapasy-titana-aluminia-bulgarian-military-obielasnilo-rost-proizvodstva-rossiiskix-rake.html>

<https://hvylyia.net/news/261919-brodskiy-poyasnil-kakaya-svyaz-mezhdu-prodannym-rossii-titanom-i-raketami-ubivayushimi-ukraincev>

<https://ren.tv/longread/1173436-supersovremennoe-oruzhie-rossii-unichtozhaet-bronepirog-tehniki-nato>

³⁰ https://rosnedra.gov.ru/activity/documents/gosudarstvennyy_doklad_2021/

Detailed information on the level of development of Russia's strategic mineral deposits in 2021 is provided in Annex 2.

³¹ https://rosnedra.gov.ru/activity/documents/gosudarstvennyy_doklad_2021/

The aluminum production cycle begins with the extraction of bauxite, from which — after crushing and chemical processing via the Bayer process — alumina (aluminum oxide, Al₂O₃) is obtained; the alumina is then dissolved in molten cryolite and subjected to electrolysis via the Hall-Héroult process, with liquid primary aluminum accumulating at the bottom of the electrolytic cell while gases are released at the carbon anodes. The metal is then tapped, refined as needed, alloyed to impart the required properties, and cast into ingots, slabs, billets, or other semi-finished products, from which sheet, profiles, wire, foil, or cast parts are subsequently manufactured.

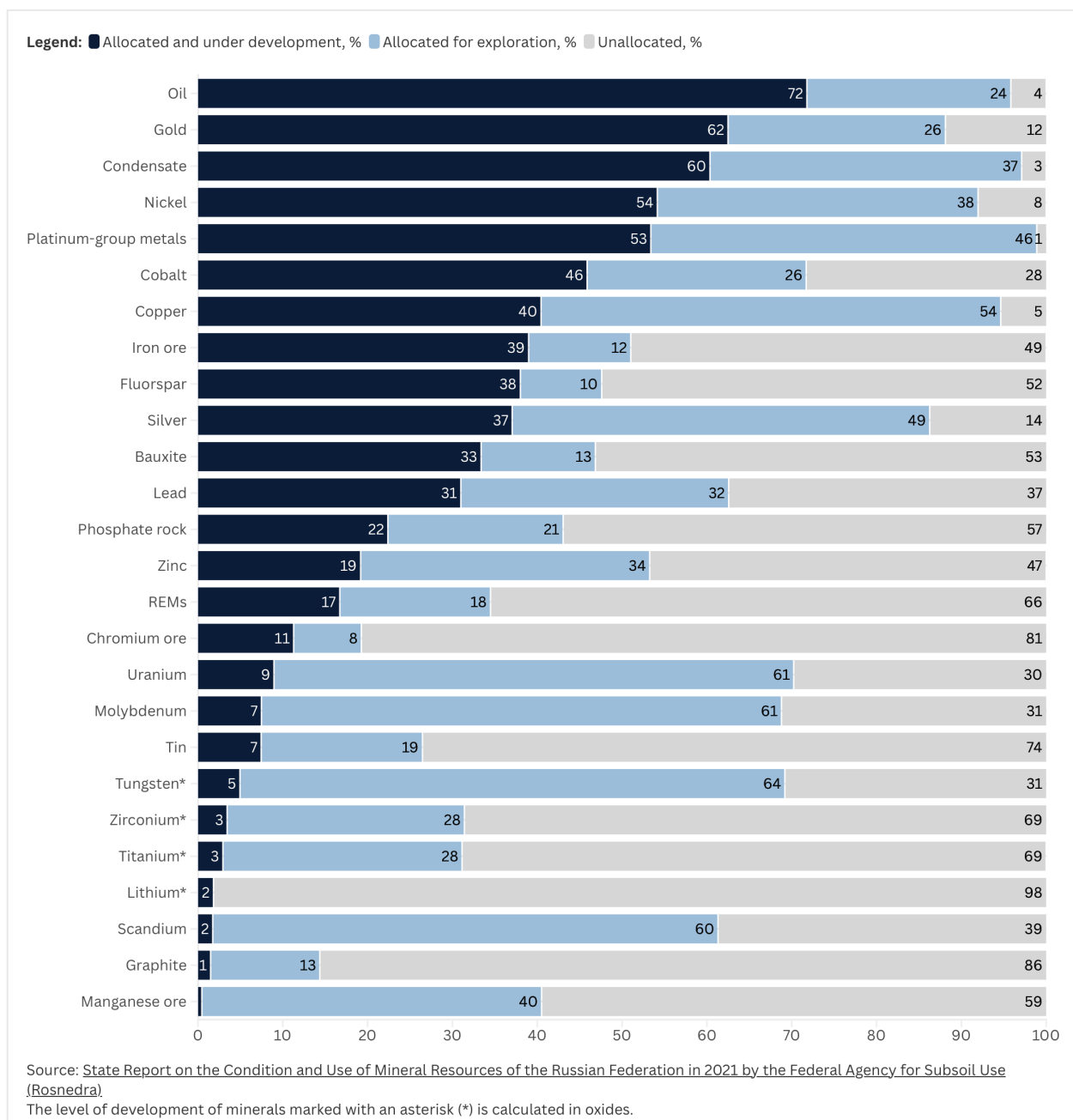


Fig. 3. Level of development of Russia's strategic mineral reserves in 2021. Made with Flourish

The situation was the same for strategic resources as well, where Russia held a global leadership position in reserves. Despite assertions by Russian commentators that the country's manganese reserves are theoretically sufficient to meet domestic needs for nearly a century without imports, the actual level of development remains extremely low. As of 2021, only 0.46% of deposits had been brought into production.³² This is particularly significant given that 85–90% of manganese is

³² <https://topwar.ru/251844-marganec-hrom-i-titan-starye-rychagi-vlijaniya-na-rossiju.html>
https://rosnedra.gov.ru/activity/documents/gosudarstvennyy_doklad_2021/

used in steelmaking, one of the foundational sectors of Russian industry.³³ This is not an isolated case: Russia ranks third in zirconium reserves (6%, or 16.6 million tons) — behind Australia (44% of world reserves) and South Africa (17%) — yet the share of development of this mineral, critical for the nuclear industry, stood at 3.44% as of 2021.³⁴ The level of development of tungsten ores — of which Russia's subsoil holds 1.3 million tons (12% of world reserves, third in the world after China and Kazakhstan) — was 4.95% in 2021.³⁵

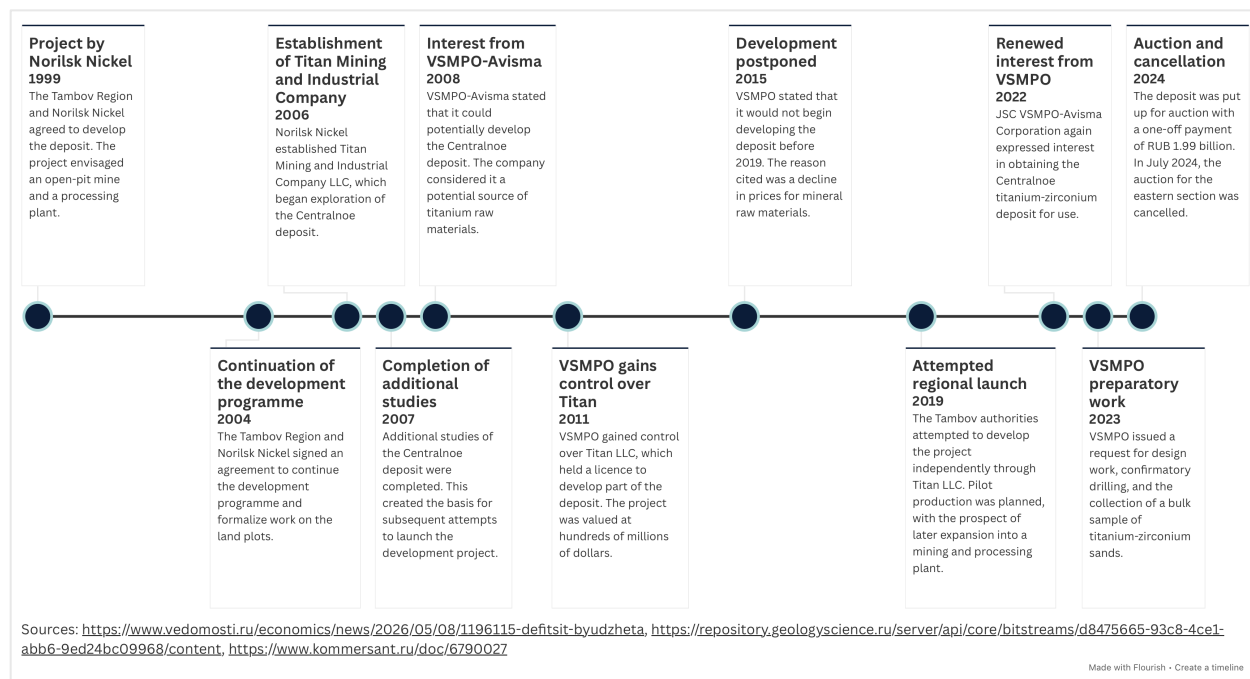


Fig. 4. Timeline of the development of the Centralnoe titanium-zirconium deposit after the collapse of the USSR. Made with Flourish

For deposits that had moved from the exploration stage to the extraction stage, the picture was equally unflattering: projects dragged on for various reasons, deadlines were pushed back, and license holders changed hands. For example, the Ozernoe Polymetallic Deposit in Buryatia, rich in zinc and lead, began development in 2004, yet construction of the MPW was completed only in September 2024.³⁶ The Zashykhinskoye niobium and tantalum deposit in Irkutsk oblast received a subsoil user in 2005, yet the development of reserves, construction of an MPW, and related infrastructure have not yet begun.³⁷ The Tsentralnoye titanium deposit in Tambov oblast went through three holders of extraction licenses between 2008 and 2019 — from Norilsk Nickel Company to GPK Titan LLC and then to VSMPO-AVISMA Corporation — and ultimately reverted to the state balance sheet.³⁸ The Karakulskoye cobalt deposit, where additional geological exploration and

³³ <https://www.britannica.com/technology/manganese-processing>

³⁴ https://rosnedra.gov.ru/activity/documents/gosudarstvennyy_doklad_2021/

The mass of zirconium-bearing mineral reserves encompasses not only baddeleyite (a mineral composed of zirconium oxide) but also zircon, which consists of zirconium silicate. The reserve figure is given specifically for the oxide in order to assess reserves in a single raw-material form of this metal.

³⁵ <https://tass.ru/ekonomika/22487817>

https://dzen.ru/a/Y2F9_U8BeS2sSvN?ysclid=m7boko2ray36129541

https://rosnedra.gov.ru/activity/documents/gosudarstvennyy_doklad_2021/

³⁶ <https://topcor.ru/64251-ozernyj-gok-novyj-gigant-rossijskoj-cvetnoj-metallurgii.html>

³⁷ https://www.prometall.info/analitika/gornodobicha/zashikhinskoe_v_ozhidanii_svoego_shansa

³⁸ <https://www.vedomosti.ru/business/news/2024/06/24/1045852-prinadlezhavshii-vsm-po-uchastok>

<https://www.kommersant.ru/doc/6790027>

extraction were to be conducted from 2007 onward, was never put into operation due to the bankruptcy of the subsoil user and the squeezing out of foreign investors from the project.³⁹

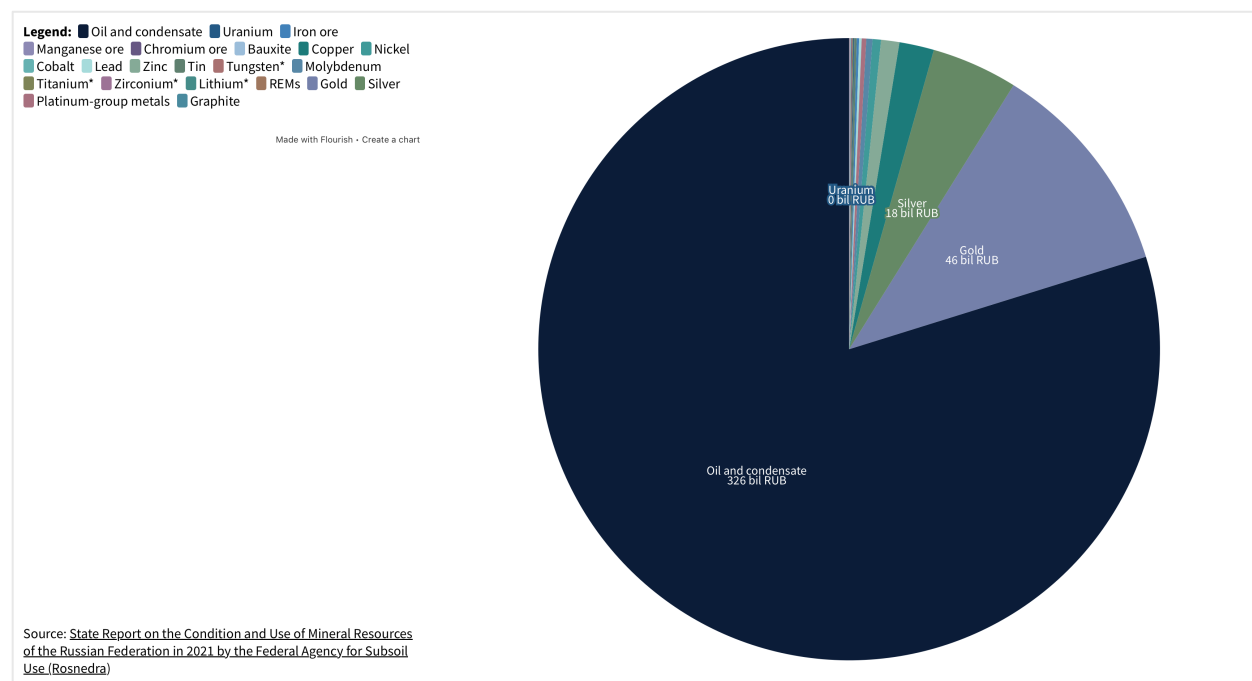


Fig. 5. Investment in geological exploration in the Russian Federation in 2021. Made with Flourish

The same logic could be traced in geological exploration. In 2021, total financing of geological exploration in Russia stood at RUB 408.6 billion, of which 79.79% went to oil and gas, another 11.32% to gold, and 4.47% to silver. Other strategic resources, even taken together, did not receive 1% of total funds, while exploration of some — such as scandium and graphite — was not financed at all.⁴⁰ State support for geological exploration was also minimal: 96.02% of all work was carried out at the expense of subsoil users, and for 13 of the 25 strategic resources, the state allocated zero rubles for exploration.⁴¹ In other words, for an extended period, the Russian state effectively maintained and reproduced not the "mineral resource base" in the broad sense, but above all its energy component.

As a result, over the past thirty years, Russia has developed an entrenched dependence on imports of strategic minerals that are of exceptional importance for the functioning of the economy as a whole and the MIC. According to the Accounts Chamber of Russia, in 2018–2020, Russia imported more than a third of strategic types of mineral raw materials and over 60% of scarce types of resources. For several commodities — including manganese, chromium, titanium, and lithium —

³⁹ <https://www.interfax-russia.ru/siberia/news/obankrotivshiysya-altayrudametall-realizuet-paket-akciy-dobyvayushchey-kompanii-kara-kulskoe-za-298-mln-py6>.
<https://altapress.ru/story/britanskaya-pressa-raskopala-altayskiy-sled-v-skandalnoy-otstavke-rossiyskogo-direktora-evropeyskogo-banka-rekonstruktsii-i-razvitiya-62822>

AltaiRudaMetall LLC was registered in 2005 in Moscow with its principal activity listed as "extraction and beneficiation of non-ferrous metal ores, except uranium and thorium ores." In late 2010, the Government Commission on Monitoring Foreign Investment in the Russian Federation authorized Canadian Puget Ventures Inc. to acquire AltaiRudaMetall LLC, which held the license for the Karakulskoye cobalt deposit. The company was controlled by Imperial Mining Holding Ltd. Following completion of the transaction — in which Puget and Imperial Mining exchanged shares — the merged company changed its name to Global Cobalt Corp. In October 2013, by a ruling of the Arbitration Court of the Republic of Altai, AltaiRudaMetall was declared bankrupt and bankruptcy liquidation proceedings were opened against it.

⁴⁰ https://rosnedra.gov.ru/activity/documents/gosudarstvennyy_doklad_2021/

Detailed information on the financing of geological exploration for Russia's strategic minerals in 2021 is provided in Annex 4.

⁴¹ https://rosnedra.gov.ru/activity/documents/gosudarstvennyy_doklad_2021/

imports covered 100% of Russia's domestic needs; for zirconium, the import-dependency rate was 87.2%. Russia also imported 100% of beryllium compounds and oxides of separated rare-earth metals. The situation was somewhat better for bauxite, copper, and molybdenum. However, the level of import dependence remained quite high: in 2018–2020, the share of imports was 68.6% for bauxite, 49.6% for copper, and 40.2% for molybdenum.⁴² By 2022, the situation regarding Russia's self-sufficiency in raw materials had hardly changed, while import dependence on manganese, lithium, and titanium had become even more acute.

A renewed focus on strategic minerals occurred only after the start of Russia's full-scale invasion of Ukraine. The intensive sanctions regime either directly banned the import and export of certain minerals or significantly complicated and raised the cost of meeting the domestic needs of the Russian economy and MIC. Beginning in 2022, the Kremlin enlisted the government, the Russian Academy of Sciences (RAS), and Rosatom State Nuclear Energy Corporation in developing the domestic mineral resource base. At the same time, a new, expanded list of strategic types of mineral raw materials and a list of scarce types of resources were approved.⁴³ Finally, in July 2024, the Russian government adopted a new Strategy for the Development of the Mineral Resource Base of the Russian Federation to 2050.⁴⁴ The very emergence of this strategy attests more to the scale of the prior failure than to a clear roadmap for overcoming Russia's dependence on imports in this sector.

Thus, before 2022, Russia systematically developed primarily that part of the mineral resource base directly tied to oil, gas, precious metals, and the export revenue derived from them, while a significant share of other strategic resources remained outside the real priorities of state policy. This manifested itself simultaneously in the physical decline of extraction and processing, the degradation of Soviet-era production capacity, low levels of development even at large reserves, delays or failures in deposit-development projects, and the almost complete absence of systemic financing for geological exploration across most strategic positions. As a result, Russia approached the full-scale war as a country with large formal reserves but without a well-developed non-energy mineral base — and therefore with deep structural dependence on imports.

Causes of Russia's Dependence on Strategic Mineral Imports

Russia's dependence on imports of strategic minerals is the result of a set of interconnected and mutually reinforcing problems that are structural in nature and admit no easy solutions. The cycle begins with the conditions in which Russia's subsoil resources lie: a significant share of deposits is in remote, climatically harsh, and sparsely populated regions, where even initiating extraction encounters substantial obstacles. For example, the Bolshetanginskoye niobium deposit lies in a zone of significant seismic activity (magnitude 7 on the Richter scale), which requires elevated design standards of MPW buildings and structures, thereby increasing capital expenditures.⁴⁵ The Karakulskoye tungsten deposit is located on the slope of a mountain range at elevations of 2,500 to 2,800 meters above sea level, which complicates its development due to limited access, the need to reinforce unstable terrain, more complex logistics, and elevated safety and environmental risks.⁴⁶ The Peschanka molybdenum deposit in the Chukotka Autonomous Region is 250 km from the nearest settlement, complicating the delivery of equipment and personnel.⁴⁷ The Tomtorskoye rare-earth

⁴² <https://journals.rcsi.science/0016-7770/article/view/134684/112618>

⁴³ <https://kremlin.ru/d/68775>

⁴⁴ <https://government.ru/docs/all/154492/>

⁴⁵ https://nedradv.ru/nedradv/ru/find_place?obj=282dc836d46f885f710db982b83f1e2d

⁴⁶ <https://webmineral.ru/deposits/item.php?id=1566>

⁴⁷ <https://webmineral.ru/deposits/item.php?id=4169>

metals deposit in the Republic of Sakha (Yakutia) operates under permafrost conditions, where extraction is possible only during the winter season and only through narrow open pits.⁴⁸



Fig. 6. Physical and geographical conditions for the development of Russian deposits of strategic minerals. Made with Felt

Geographical remoteness often gives rise to an infrastructure problem. The remoteness of deposits necessitates new roads, railways, energy supply, ports, power transmission lines, and logistical hubs. For example, the Chineyskoye titanium and magnetite deposit in Zabaykalsky Krai requires the construction of a new railway between Novaya Chara and China stations at a cost of RUB 15 billion.⁴⁹

⁴⁸ <https://nedradv.ru/nedradv/invetp?obj=345e642bddc6b9e33d15a47e5805daab#about>

⁴⁹ <https://varandej.livejournal.com/1117278.html>

<https://nedradv.ru/nedradv/invetp?obj=c1aa75568145898d9a4fe5dae70197b9>

In 2005, the East Siberian Railway (a division of OJSC Russian Railways) put into service the 42-km Novaya Chara–China access branch line to the Chineyskoye

The Pizhenskoye titanium deposit in the Komi Republic lacks the logistical infrastructure of the Indiga port and the Sosnogorsk–Indiga railway.⁵⁰ Due to the lack of infrastructure, the logistics of transporting ore from the Tomtorskoye deposit are complex: the radioactive ore must be carried by truck along a 600-kilometer seasonal winter road to the Khatanga commercial seaport.⁵¹ From Khatanga, the ore is then to be transported by sea to Arkhangelsk, and from there by rail to Zabaykalsky Krai, to the still-unbuilt Krasnokamensky leach plant, where a radioactive waste storage facility was previously established for the needs of the Priargunskoye Mining and Chemical Production Association PJSC, which extracts uranium.⁵²

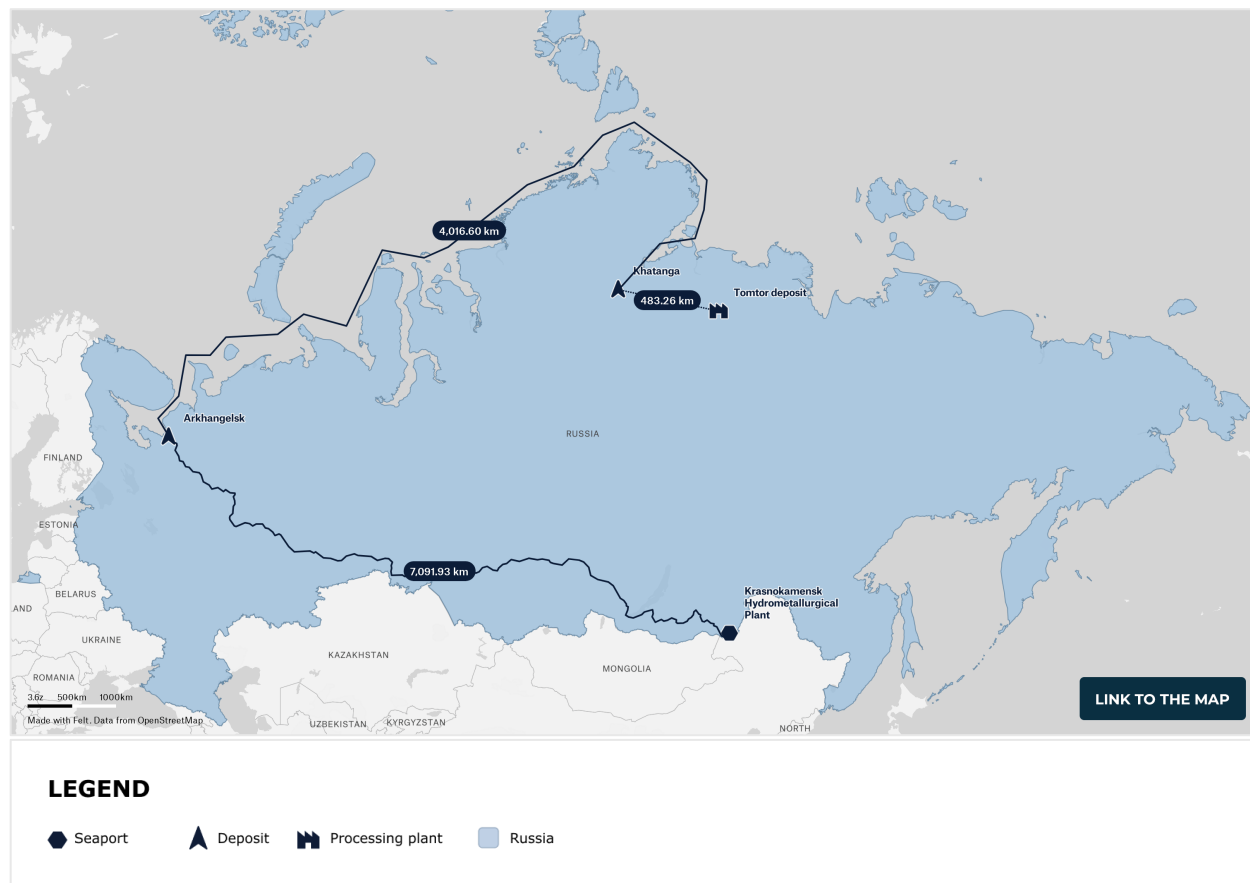


Fig. 7. Planned logistics for the delivery of ore from the Tomtor deposit to the processing plant. Made with Felt

deposit. The branch is currently operational only up to the 26th kilometer; the remaining section of track went out of operation back in 2008. To restore traffic on the destroyed portion, the damaged sections of track must be repaired, all engineering structures built, and the line extended from the "42-km mark" to China station. This project was included in the Strategy for the Development of Rail Transport in the Russian Federation through 2030.

⁵⁰ <https://dzen.ru/a/ZdN3UXYURDTgH4ES>
<https://www.interfax.ru/business/987435>

Construction of the Sosnogorsk–Indiga railway in the Nenets Autonomous Okrug (NAO) and the Komi Republic — part of an integrated infrastructure megaproject to create a national mining-and-industrial cluster in the Russian Arctic Zone — was suspended in 2024.

⁵¹ A winter road (zimnik) is a seasonal road that functions only at sub-zero temperatures, when marshes, soils, and rivers freeze.

⁵² <https://nedradv.ru/nedradv/investsp7obj=345e642bddc6b9e33d15a47e5805daab#about>

<https://rareearth.ru/ru/news/20170213/02963.html>

<https://www.interfax.ru/business/499852>

https://www.akm.ru/news/polimetall_kupil_proekt_po_stroitelstva_krasnokamenskogo_gidrometallurgicheskogo_kombinata_v_zabayka/
 Krasnokamensk Leach Plant LLC was registered in August 2015 with a charter capital of RUB 10 million. It was 100% owned by TriArk Mining LLC (TAM), in which 50% plus one share belonged to IST Company, 25% plus one share to Rostec's subsidiary RT-Global Resources Limited Liability Company, and 25% minus two shares to an investment fund. Actual construction began in 2023, with the facility scheduled for commissioning in 2028. However, as early as 2024 the project was sold to Polymetal JSC, and the plant's fate remains uncertain.

A separate problem is the technological complexity of the ores and concentrates themselves. Even when deposits are geologically accessible, they often fall short of imported equivalents in quality, content of the useful component, or mineralogical characteristics. For example, in most explored Russian manganese deposits, manganese content ranges roughly from 9% to 23%, whereas imported ores contain 30–43%.⁵³ This means that Russian ore has nearly half the concentration of the useful component and therefore requires significantly larger volumes of ore to be extracted, transported, and processed to obtain the same quantity of metal.⁵⁴ The situation is complicated by the fact that a significant share of Russian manganese deposits is of the carbonate type — such ores are technologically more difficult to beneficiate, and up to 50% of the manganese is lost in tailings.⁵⁵ A similar situation exists with bauxite: Russia's resource base consists predominantly of boehmite and diaspor-boehmite bauxites, which cannot be processed by the cheapest low-temperature method. Additional complexity arises from the co-occurrence of ores of varying quality within a single deposit, which forces the use of more expensive processing methods.⁵⁶

The complexity of the ores translates into a shortage of and high costs for technologies for processing and beneficiating concentrates. For example, although the Afrikandskoye deposit was discovered as far back as the 1950s and 1960s, the method for processing its complex perovskite-titanomagnetite ores was not developed until 2000.⁵⁷ A similar fate befell the niobium reserves at the Bolshetanginskoye deposit, where the method for processing complex ores with pyrochlore inclusions was found only in 2008–2012.⁵⁸ The Lovozersky MPW does not operate at full capacity due to the lack of technologies for extracting eudialyte ores containing samarium, terbium, and other rare-earth metals.⁵⁹ The radioactivity of ores at the Tomtorskoye deposit dictates the use of alkaline opening and autoclave acid decomposition for the extraction of uranium and thorium, which requires specialized infrastructure and technologies.⁶⁰

Another problem is the rupture or incompleteness of the production chain. Russia often lacks a full cycle for processing minerals from ore to finished product. In part, this is a legacy of Soviet-era inter-republican specialization, and in part the consequence of the degradation of processing capacities in the post-Soviet period. As a result, even with reserves and extraction in place, the country is not always able to obtain, on its own, a concentrate, oxide, metal, alloy, or semi-finished product of the required quality. While the main beryllium deposits were in the RSFSR, the center of Soviet beryllium metallurgy lay on the territory of present-day Kazakhstan.⁶¹ Or take titanium: VSMPO-AVISMA Corporation, the titanium company based in Verkhnyaya Salda, depended on

⁵³ <https://scispace.com/pdf/manganese-ferroalloys-of-russia-3rxunyavz.pdf> ;

<https://laprivate.com.au/an-overview-of-manganese/>

⁵⁴ <https://scispace.com/pdf/manganese-ferroalloys-of-russia-3rxunyavz.pdf>

⁵⁵ <https://scispace.com/pdf/manganese-ferroalloys-of-russia-3rxunyavz.pdf>

Due to their carbonate nature, the ores require an additional processing stage (calcination or special beneficiation) to convert manganese carbonates into oxides suitable for metallurgical production.

<https://insgeo.com.ua/manganese/>

<https://znp.nmu.org.ua/pdf/2018/55/8.pdf>

⁵⁶ https://dspace.znu.edu.ua/jspui/bitstream/12345/18031/1/Жмырков_ПВ.pdf

Ores with a high gibbsite content can be processed at 140°C, while boehmite bauxites require temperatures of 200 to 280°C.

<https://bit.ly/4dEqYK2>

<https://foundry.kpi.ua/wp-content/uploads/2020/03/tehnologiyi-oderzhannya-metaliv.pdf>

The Bayer process, used worldwide, cannot be applied to the processing of bauxite with high silica content. The presence of SiO₂ leads to its reaction with sodium hydroxide and the formation of silicate. Since Russian deposits contain ores of varying quality — including varying silica content — they cannot be processed by the standard method.

⁵⁷ https://ke-culture.gov-murman.ru/slovník/?ELEMENT_ID=92699

<https://arctic-russia.ru/project/osvoenie-afrikandskogo-mestorozhdeniya-rzm-belyy-poroshok-iz-redkikh-zemel/>

Perovskite concentrate contains 43–54% titanium dioxide, as well as niobium, tantalum, and other elements. Total ore mineral content is 70%. In the 1950s and 1960s, the Afrikandskoye Mining Administration conducted exploration and pilot work on extracting and beneficiating these ores, but operations were halted due to the absence of the necessary processing technologies.

⁵⁸ https://nedradv.ru/nedradv/ru/find_place?obj=282dc836d46f885f710db982b83f1e2d

Niobium mineralization in microclinites with extremely fine pyrochlore dissemination was considered unpromising until the early 1970s due to the lack of suitable beneficiation methods.

⁵⁹ <https://dprom.online/mining/lovozerskii-gok-12-tys-t-loparitovogo-kontsentrata/>

Eudialyte is a ring silicate of sodium, calcium, iron, and zirconium.

⁶⁰ <https://nedradv.ru/nedradv/ru/investsp?obj=345e642bddc6b9e33d15a47e5805daab#about>

The extraction of uranium and thorium — present in the ore in small quantities (0.005% and 0.13%, respectively) — is possible only through the use of acid at high temperatures and pressure.

⁶¹ <https://bit.ly/4mkqqlN>

Ukrainian titanium ores for more than 80% of its supply.⁶² A similar situation exists with rhenium: with the collapse of the USSR, Moscow lost both the relatively profitable molybdenum deposits with high rhenium content in Armenia and Uzbekistan, and the Jezkazgan mining-and-metallurgical integrated works in Kazakhstan, which processed copper ore and produced rhenium as a by-product.⁶³ At the same time, the value of any material rises at higher stages of processing, but the case of beryllium illustrates this especially vividly. The price of this metal in ore form is USD 5 per kilogram; in concentrate, USD 20; in hydroxide, USD 320; in pure metal form, USD 500; and in copper-beryllium alloys, USD 900 per kilogram — a 180-fold difference between the initial and final stages.⁶⁴

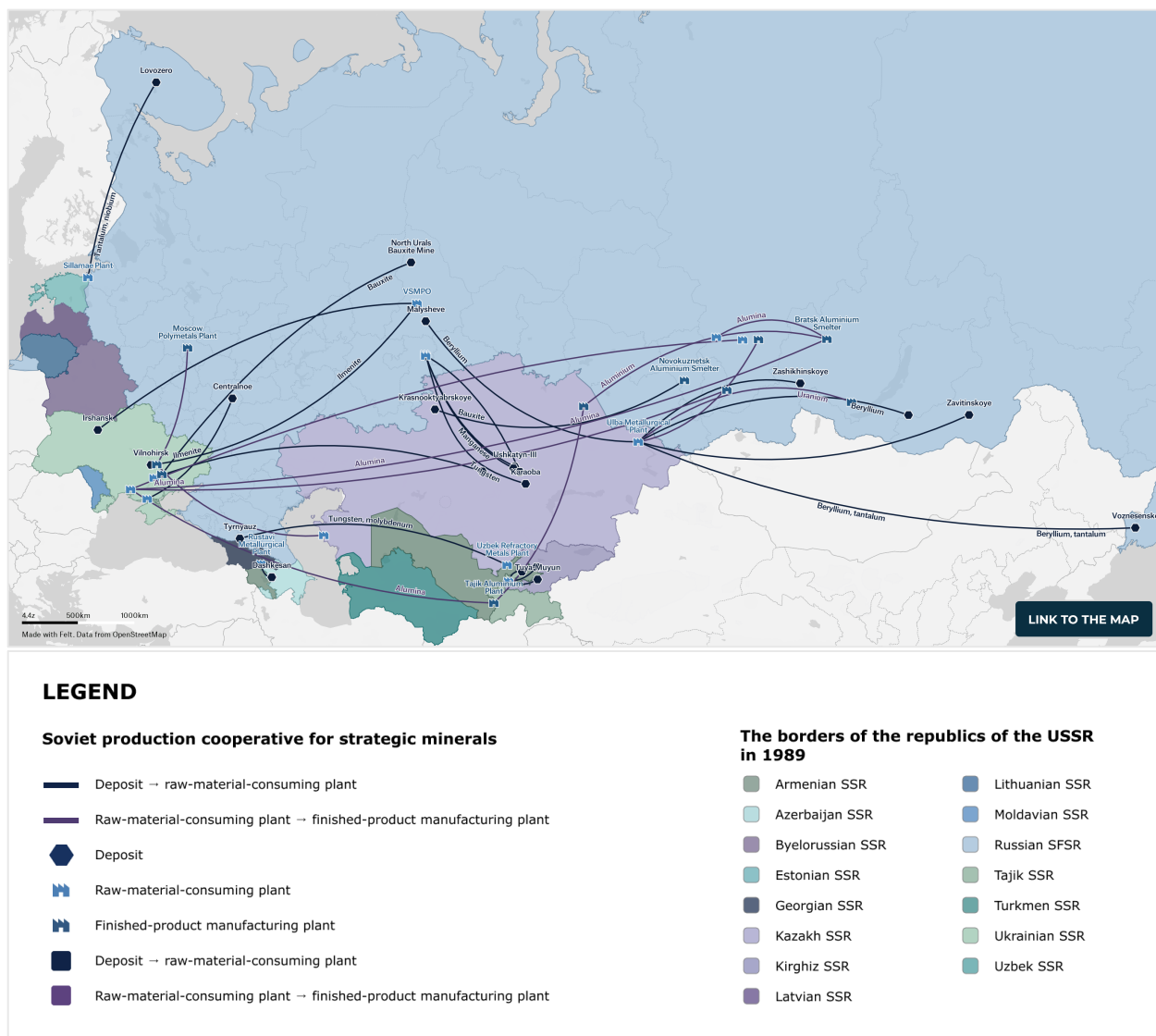


Fig. 8. Supply chains for the extraction, processing and manufacture of end products from strategic minerals in the USSR in 1989. Made with Felt

⁶² <https://vsmo.ru/en/https://trap.org.ua/en/publications/sanctioned-yet-supplied-us-and-eu-sold-russia-275m-in-titanium-later-used-for-weapons-during-three-years-of-invasion-into-ukraine/>

⁶³ https://zavtra.ru/blogs/russkij_renij_sdvinulsya_s_mesta_proekt_po_dobiche_na_ostrove_iturup

⁶⁴ https://www.prometall.info/analitika/rynok_berilliya_voprosov_bolshe_chem_otvetov

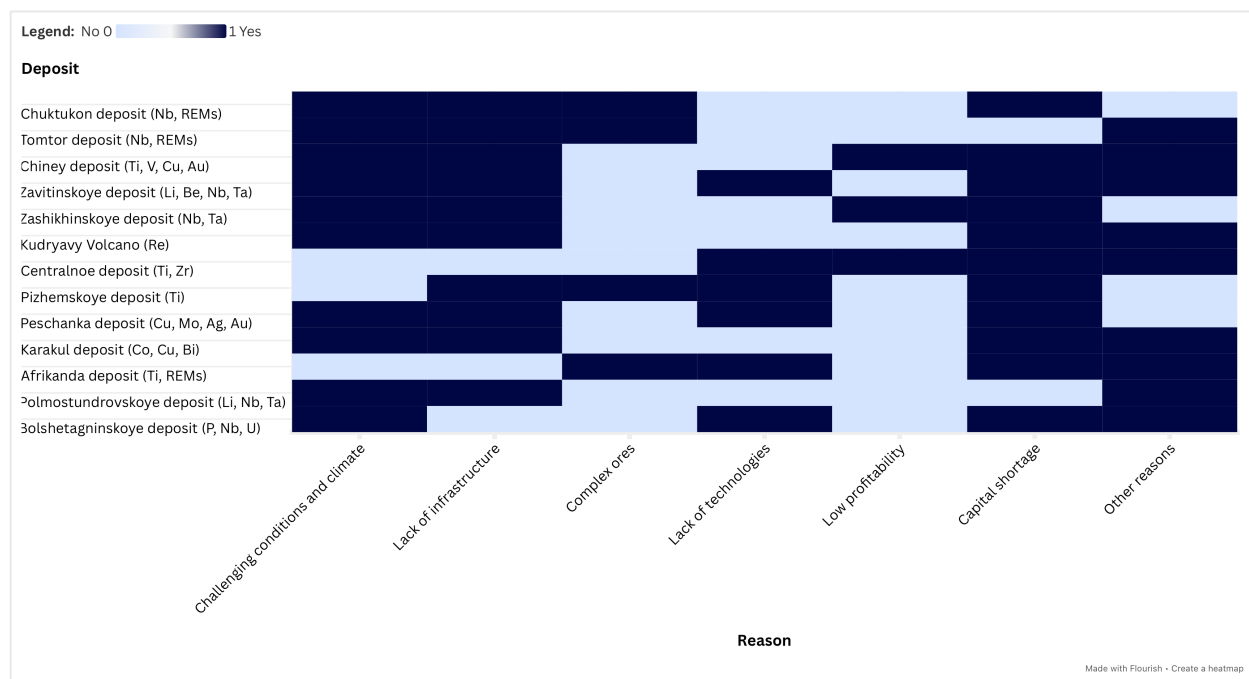


Fig. 9. Typology of Problems with Russian Strategic Mineral Deposits

A broken production chain leads to unprofitability and inflated budgets for extractive projects. When extraction is expensive, infrastructure is absent, the ore is complex, and processing is incomplete, capital expenditures rise sharply, and profitability falls. In the Soviet period, this criterion was ignored entirely because the extractive complex was under state control. The economy was of a command-administrative nature — many Soviet extraction and processing projects were expensive and largely insensitive to costs, prices were set administratively, and what mattered was not profit but the autarkic logic of the Soviet system in this sector.⁶⁵ With the collapse of the USSR, the bulk of extractive assets passed into private ownership and began to operate according to market logic.⁶⁶

Profitability, as the principal yardstick, began to filter out the bulk of extractive projects in the post-Soviet period. For example, by the criterion of economic efficiency, only two niobium deposits in Russia are competitive — Tomtorskoye and Chuktukonskoye: the value of the metals extracted from one ton of ore there is estimated at approximately RUB 60,000 and RUB 20,000–25,000, respectively. At other niobium and niobium-bearing deposits, this figure is only RUB 5,000–8,000 per ton of ore, which, against processing costs of RUB 6,000–10,000, does not even cover the standard profitability threshold.⁶⁷ On top of everything else, cheap imports also undermine the prospects for Russian extractive projects: cheaper Canadian and Brazilian ferroniobium, for example, made operations at the Tatarskoye deposit in Krasnoyarsk Krai unprofitable as early as 2010.⁶⁸

A significant factor is the low or specialized domestic demand for some strategic minerals. For some of them, the domestic market is too small or unstable to recoup the launch of a full production

⁶⁵ <https://www.jstor.org/stable/150642>

<https://www.daily.hse.ru/post/100-let-sssr-naskolko-effektivnoy-i-zhiznesposobnoy-byla-sovetskaya-ekonomika>

⁶⁶ <https://geonews.com.ua/mineralno-syrevye-resursy-rossii-i/>

⁶⁷ <https://cyberleninka.ru/article/n/chuktukonskoe-mestorozhdenie-niobiy-redkozemelnyh-rud-prioritetnyy-obekt-dlya-modernizatsii-redkometallnoy-promyshlennosti-rossii/viewer>

⁶⁸ https://www.prometall.info/novosti/razrabotku_tatarskogo_mestorozhdeniya_vozobnovyat_dlya_snizheniya_importa_niobiya

cycle. For example, as of 2021, Russia was importing roughly 30 tons of beryllium per year in addition to alloys, more than 70 tons in beryllium bronze, and another 30 tons or so as part of finished products.⁶⁹ The needs of the MIC, which account for only 10% of the total volume of beryllium on the Russian market, would be effectively limited to roughly 1,500 tons of ore per year — a scale that has not generated sufficient demand to support profitable deposit development. Opening a dedicated quarry to extract such volumes would look economically unjustified, given the negligible potential revenue of approximately USD 25,000 per year.⁷⁰ This means there is no sufficient commercial incentive either to begin extraction or to build new processing capacity. And in the absence of these, dependence persists either on imports of finished products or on the export of raw materials for processing abroad.

This is therefore not a set of isolated factors that separately impede the development of Russia's strategic mineral deposits, but a coherent cycle of interconnected constraints in which one problem sequentially produces another. Remoteness and difficult bedding conditions raise the need for expensive infrastructure; the infrastructure deficit complicates access to deposits, and increases costs; complex or low-grade ore requires more expensive beneficiation and processing technologies; and the open-endedness of the production chain further worsens project economics. As a result, capital expenditures rise, profitability falls, investors see insufficient incentive to participate in projects, and, under conditions of cheap imports and limited domestic demand, dependence on external supplies only grows. This is precisely why Russia's import dependence on strategic minerals is the consequence not of a single weak link but of a closed circle of problems that Russia manages to break only in isolated cases. And this is precisely why imports for Russia have been, are, and will remain not a temporary anomaly but a structurally embedded mechanism for compensating for the weakness of its own mineral resource base.

Imports as the Only Near-Term Way Out

After 2022, Russia did indeed intensify its focus on developing its own mineral resource base, primarily in the segment of scarce and strategic minerals. This is evident both in political statements and in new policy documents. In particular, the federal project "Development of the Rare and Rare-Earth Metals Industry" envisages increasing the monetary output of the relevant products to RUB 100 billion by 2030 and overcoming import dependency "with respect to most scarce metals."⁷¹ In tonnage terms, the extraction of critical minerals is expected to grow to 50,000 tons per year, although even Russian sources present this target as overly ambitious.⁷² Under the national project "New Materials and Chemistry," the Russian government announces the launch of approximately 30 technology chains and more than 700 types of high-value-added products. It intends to scale up the extraction of scarce raw materials—primarily niobium, tantalum, tungsten, and beryllium.⁷³

Since 2022, geological exploration activity in Russia has intensified, including in the strategic minerals sector. As of 2024, the program covered 23 key sites, including rare metals, gold, and copper. In 2024, more than RUB 450 billion was directed to geological exploration of all minerals, and by the end of 2025, private investment in this sector exceeded RUB 420 billion.⁷⁴ As a result,

⁶⁹ <https://dprom.online/metallurgy/redkij-metall-berillij-proizvodstvo-v-rossii-voznovlyaetsya/>

Addition alloys (Latin *ligatura*, from Latin *ligo* — "I bind") — auxiliary alloys used in metallurgy to introduce alloying elements into molten metal to impart specific properties either to the metal melt (e.g., fluidity) or to the solidified metal (increased mechanical strength, etc.).

⁷⁰ https://www.prometall.info/analitika/rynok_berilliya_voprosov_bolshe_chem_otvetov

⁷¹ <https://www.vedomosti.ru/business/articles/2025/09/08/1137412-minpromtorg-raskril-sroki-realizatsii-proektov>

⁷² <https://meobserver.org/mining/2025/08/24/russia-sets-2030-bar-for-critical-minerals-but-can-it-deliver/>

⁷³ <https://tass.ru/ekonomika/23801939>

⁷⁴ <https://tass.ru/ekonomika/23781661>

<https://rosnedra.gov.ru/press/nedropolzovanie-v-smi/obespechenie-resurnogo-suvereniteta-podvedeny-itogi-sfery-nedropolzovaniya-v-2025-godu/>
<https://ria.ru/20260406/minprirody-2085360690.html>

in 2025, 317 new solid-mineral deposits were added to the Russian state balance sheet. In addition, in 2025, the Ministry of Natural Resources and Environment of the Russian Federation publicly updated its estimate of reserves for 29 types of rare metals to 658 million tons, of which 28.5 million tons consist of REM.⁷⁵ The federal project "Geology: Revival of the Legend" is also currently underway, to accelerate geological study of prospective territories — particularly in Siberia and the Far East — raising the level of their study to 65%, and discovering no fewer than 1,000 new deposits.⁷⁶

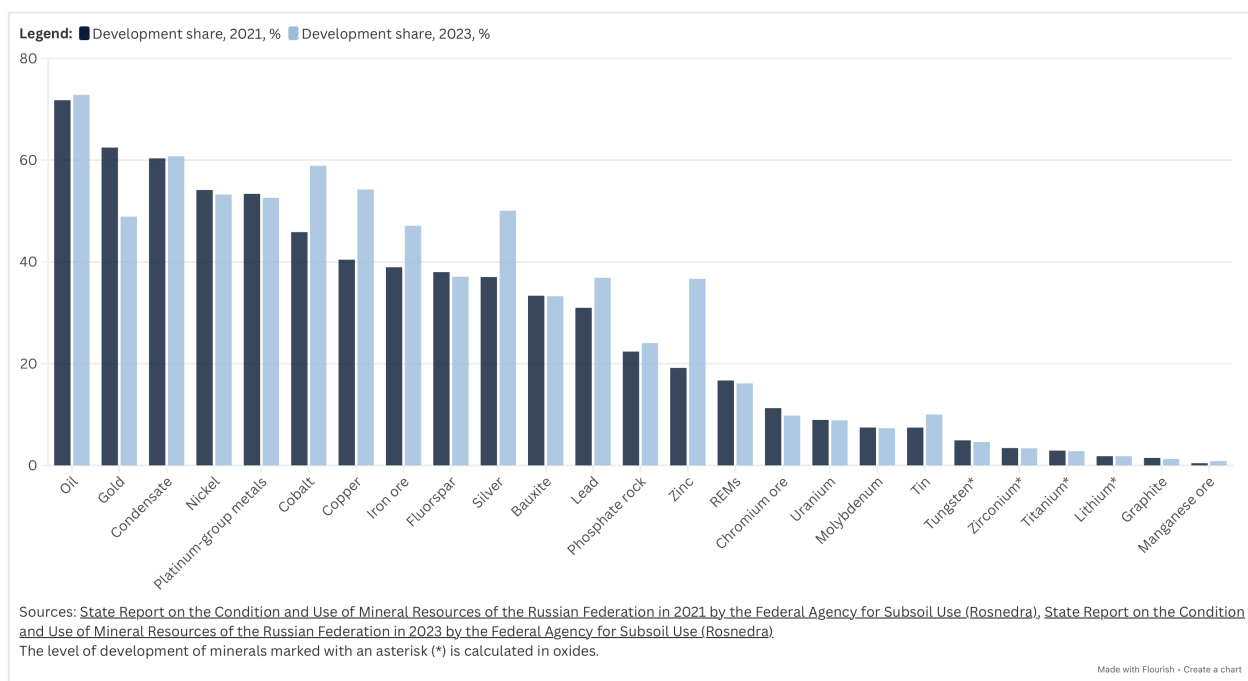


Fig. 10. Comparison of development shares of strategic minerals in the Russian Federation in 2021 and 2023. Made with Flourish

However, this is precisely where the gap between administrative activation and real production impact begins. Russian officials themselves acknowledge that a significant share of the growth in strategic mineral reserves is achieved not so much through fundamentally new discoveries as through additional geological study of already known or even operating deposits.⁷⁷ In other words, what is involved is more a matter of additional geological exploration, reassessment, and the formal expansion of the existing resource base than the rapid creation of new full-fledged production hubs.

The same limit is visible in licensing activity. Of the 309 auctions for subsoil-use licenses announced by the Federal Agency for Mineral Resources in 2024, 51.4% were held; 135 were canceled due to a lack of bids or rule violations.⁷⁸ Titanium deposits are especially illustrative here: in 2024, not a single subsoil user appeared at the state auctions for the Yugo-Vostochnaya Gremyakh, Beshpagirskoye, or Tsentralnoye (eastern section) deposits, as a result of which these auctions were

⁷⁵ <https://tass.ru/ekonomika/23239501>

Detailed data on geological exploration investments for 2024–2025 are not yet available; the most recent complete data dates from 2023.

⁷⁶ https://nedradv.ru/nedradv/ru/page_news?obj=6ebc7c3a96ae7e23895209c576faeb81

⁷⁷ <https://rosnedra.gov.ru/press/nedropolzovanie-v-smi/geologorazvedka-2025-plyus-317-otkrytykh-mestorozhdeniy-volframa-plavikovogo-shpata-zolota-medi-neft/>

⁷⁸ <https://neftegaz.ru/news/Geological-exploration/895070-titan-i-litii-ne-nuzhny-rosnedra-v-2024-g-proveli-chut-bolee-poloviny-zaplanirovannykh-auksionov/>

canceled, while the Steklyanka and Yaregskoye deposits returned to the state balance sheet after subsoil users relinquished their licenses.⁷⁹

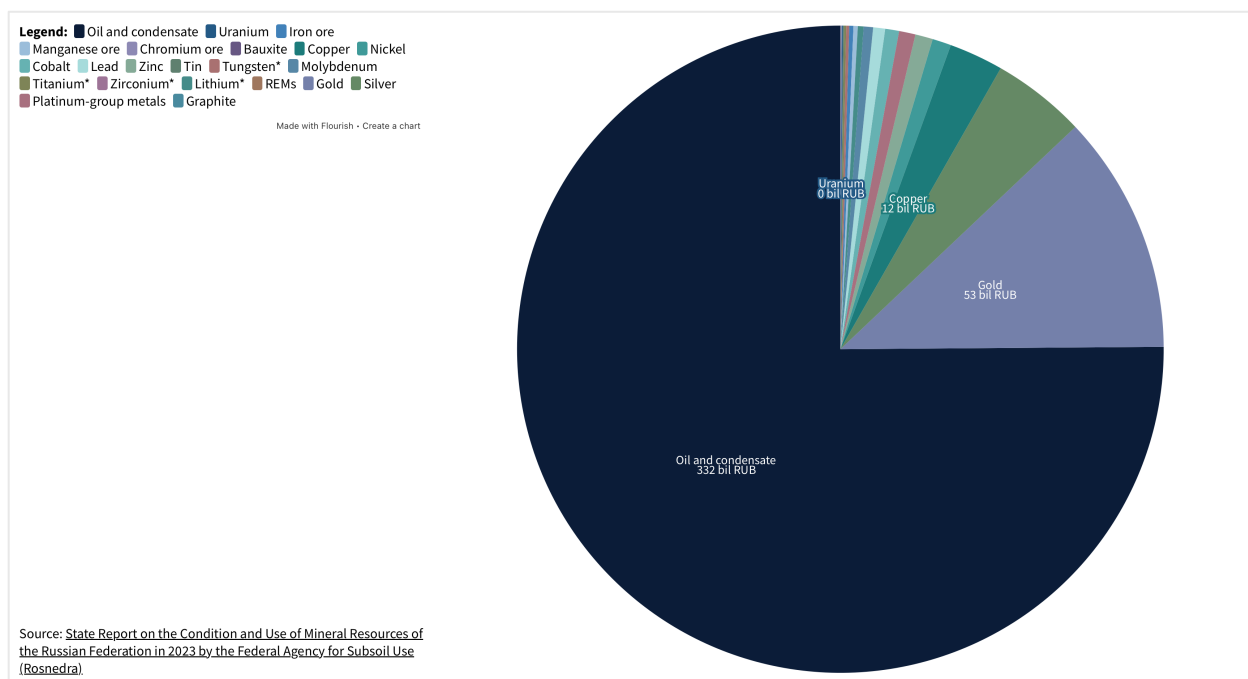


Fig. 11. Investment in geological exploration in the Russian Federation in 2023. Made with Flourish

The situation with geological exploration is also not entirely optimistic. Although exploration funding for some minerals classified as strategic has grown relative to 2021, by 7,833% for manganese ores, 10,408% for lithium, 328.9% for tungsten, 143.0% for titanium, and 58.4% for molybdenum, most of this growth is driven by the low base effect.⁸⁰ Moreover, oil, gas, and condensate remain the principal resources in geological exploration, accounting for 74.68% of total investments in 2023.⁸¹ Although the share of state financing of geological exploration has grown, it remains negligible — 4.21%. Moreover, no state financing was received for the exploration of 12 of the 27 strategic mineral resources.⁸²

Holding other variables equal, the shortage of risk capital and the overall expense of the projects themselves remain equally important factors. Even those deposits that Russian authorities and businesses regard as key to future import substitution require investments so large that realizing them without external financing or state support appears extremely difficult. Capital expenditures for developing the Kolmozerskoye deposit, for example, are estimated at RUB 91 billion; the first phase of the Pizhenskoye titanium project at approximately RUB 52 billion, and the second at RUB 120 billion.⁸³ The project at Tyrnauz, which is to cover gold, tungsten, and molybdenum ores, is

⁷⁹ https://www.prometall.info/analitika/gornodobicha/titan_pochti_ne_viden

⁸⁰ The low-base effect in economics, finance, demography, and statistics occurs when impressive growth rates for an indicator are explained by its extremely low starting value.

⁸¹ <https://rosnedra.gov.ru/activity/documents/gosudarstvennyy-doklad-2023/>
Detailed information on the financing of geological exploration for Russia's strategic minerals in 2023 is provided in Annex 5.

⁸² <https://rosnedra.gov.ru/activity/documents/gosudarstvennyy-doklad-2023/>

Detailed data on geological exploration investments by specific mineral resource for 2024–2025 have not yet been published.

⁸³ <https://www.interfax.ru/business/986137>

<https://tass.ru/ekonomika/19986127>

preliminarily estimated at RUB 50 billion.⁸⁴ Even relatively "smaller" projects in scale remain very expensive: the Afrikandskoye deposit requires approximately RUB 28 billion, and the Bolshetanginskoye deposit approximately RUB 29 billion.⁸⁵ In some cases, a colossal financial burden is created by the accompanying infrastructure. In the case of the Peschanka deposit, for example, more than RUB 90 billion has already been directed to its development alone.⁸⁶ This does not even consider the much more expensive rare-earth projects. According to a Reuters industry analysis, typical costs range from USD 550 million to USD 1.1 billion, with implementation periods of 10 to 17 years.⁸⁷

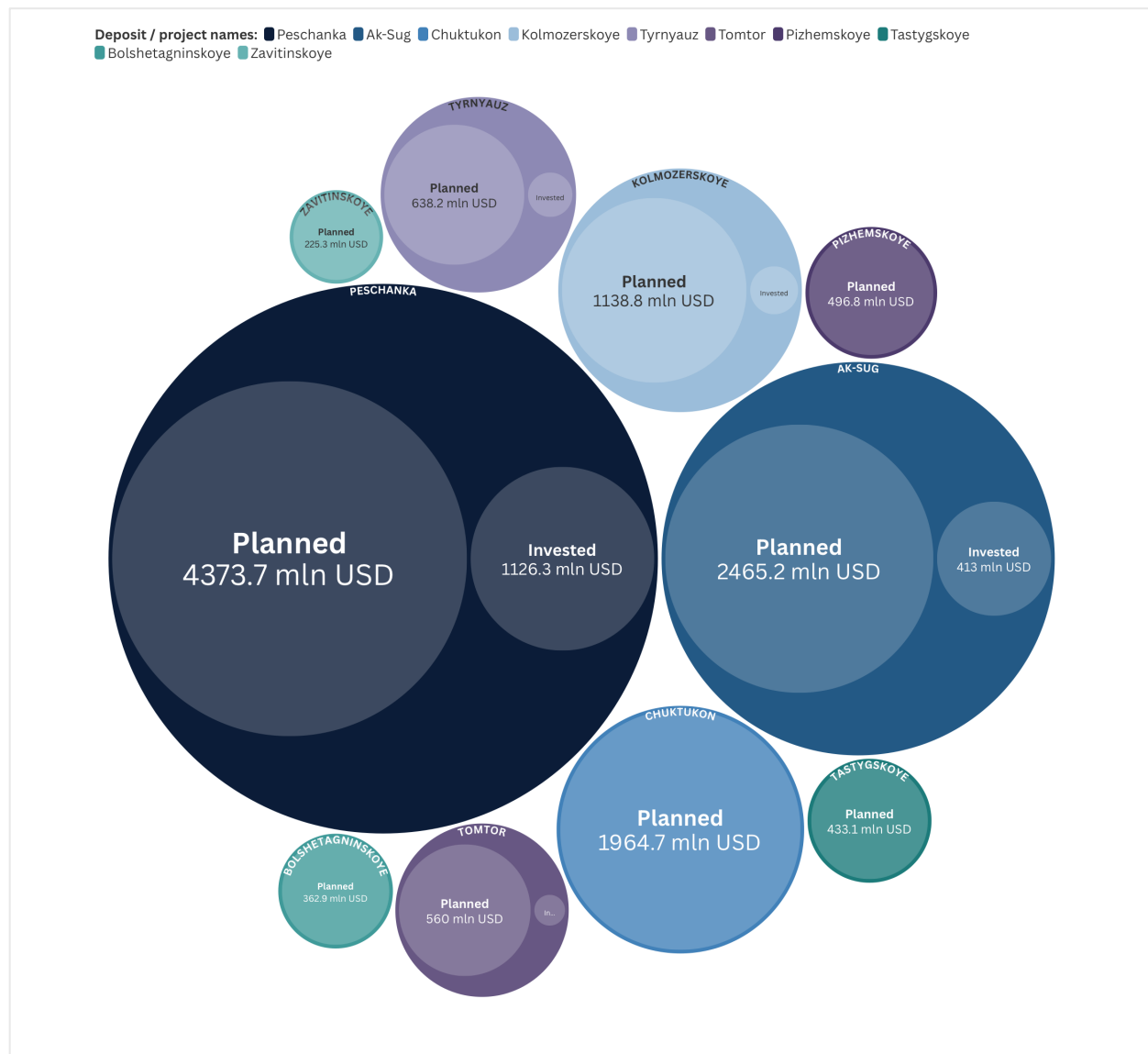


Fig. 12. Cost of Russia's strategic mineral-resource projects: invested and planned investment. Made with Flourish

⁸⁴ <https://tass.ru/ekonomika/26991789>

⁸⁵ https://nedradv.ru/nedradv/ru/page_news?obj=514af7cee60d2b21b946aca41d9662b5

⁸⁶ <https://zolotodb.ru/article/12271>

⁸⁷ <https://discoveryalert.com.au/russia-rare-earth-industry-bottlenecks-2025/>

There is little hope of large-scale state support. The Federal Agency for Mineral Resources itself is underperforming on its revenue plan and is trying to compensate for this through one-off payments for subsoil use. In particular, of several sites, starting payments are excessively high, ranging from RUB 747.5 million to RUB 2 billion.⁸⁸ This creates an additional deterrent effect: the state demands money up front at the project's entry stage, yet it is precisely this high financial threshold that further reduces the interest of potential investors in already expensive and risky deposits. Foreign investment could help, but Russia itself restricts the inflow: from 2025, the authorities are broadening the range of transactions that foreigners may carry out only after approval by a government commission, extending this control not only to assets in strategic sectors generally but also to companies operating with subsoil that contains reserves of rare metals.⁸⁹ The sole source of foreign capital for the Russian Federation remains Chinese investors, who are in no hurry to expand their presence on the Russian market and, in the extractive sector, focus mainly on gold mining and coal projects in Zabaykalsky Krai.⁹⁰ Moreover, Chinese investors show no enthusiasm for investing in the development of Russian processing and production facilities, instead concentrating on the already familiar cooperation model in which Russian raw materials are exported to the PRC for processing into higher-grade, more expensive products that are then sold back to Russia.⁹¹

In addition of financial constraints, there is a technological barrier stemming from sanctions. The Russian geological exploration sector — from the search and assessment of deposits to the extraction and beneficiation of minerals — still depends substantially on imported equipment, technologies, and software. This dependence is highest in drilling and laboratory analytical equipment, as well as in specialized software, where the import share exceeds 90%. At the same time, imports still account for about 50% of mining machinery, 30% of surface geophysical equipment, 20% of equipment for technological ore research, and 10% of geophysical equipment for borehole research.⁹² This means that even where the state is trying to accelerate the development of new deposits, it is compelled to do so under conditions of limited access to critical tools for exploration, beneficiation, and technological support.

Sanctions pressure reinforces these constraints, both through direct sectoral bans and through the "spillover effect" of bans from other areas, including logistics, finance, and investment.⁹³ Tellingly, even in the titanium industry — where sanctions pressure on Russian exports has long been limited or less stringent — Russian producers have nonetheless had to reorient their external sales and actively seek new markets. In 2025, Russia returned to the top ten suppliers of titanium to India, increasing exports nearly fivefold to USD 8.2 million, and also restored its presence among the leading titanium suppliers to Brazil.⁹⁴ Simultaneously, the Russian Federation increased titanium deliveries to China, where the physical volume of exports rose by 44% in 2024, and sought to develop new commercial ties with Saudi Arabia.⁹⁵ Even so, the contraction in exports has negatively affected VSMPO-AVISMA Corporation, the principal producer and exporter: revenue declined, and net profit fell by 32.2%.⁹⁶

This logic has manifested itself most acutely in the tungsten industry: after 2022, the United Kingdom imposed sanctions on imports of Russian tungsten, and some Western companies — such as Intel in August 2023 — abandoned Russian products even without sanctions, leading to a decline in exports and

⁸⁸ <https://neftegaz.ru/news/Geological-exploration/895070-titan-i-litij-ne-nuzhny-rosnedra-v-2024-g-proveli-chut-bolee-pолоviny-zaplanirovannykh-auksionov/>

⁸⁹ <https://iz.ru/1979987/taibat-agasieva-evgenij-grachev-yana-shturma/rf-uzhestochaet-usloviya-dlya-investicij-v-kriticheskie-aktivy>

⁹⁰ <https://dprom.online/mining/kitaiskii-investor-vykupil-zolotorudnoe-mestorozhdenie-v-zabaikale/>

<https://dprom.online/mining/keetayiskeeyi-eenvyestor-rassmatreevayet-uchasteeye-v-gornodobivayusheeh-proyektah-zabayikalya/>

⁹¹ <https://www.obozrevatel.com/novosti-mir/rossiya-pogruzhaetsya-v-ekonomicheskuyu-zavisimost-ot-kitaya-pekina-ispolzuet-sibir-kak-resursnyuyu-bazu-razvedka.htm>

⁹² <http://static.government.ru/media/files/TNB3oQkPRJmDE3AMaxuTn2KRSHG9X0S.pdf>

⁹³ The spillover effect occurs when an event, action, or policy in one context produces unintended side effects — positive or negative — for an entirely different, unrelated party.

⁹⁴ https://www.prometall.info/novosti/rossiya_vpervye_zachetyre_goda_voshla_v_desyatku_krupneyshikh_postavshchikov_titana_v_indiyu

⁹⁵ https://www.altai.ru/external_news/125557/

⁹⁶ https://www.prometall.info/intrigi/trendi/saudoyskaya_araviya_sobiraetsya_zayti_v_vsmo_avisma

<https://biz.nv.ua/markets/rossiya-rezko-uvelichila-vyvoz-titana-v-kitay-50488630.html>

⁹⁶ <https://www.interfax.ru/business/1023566>

a contraction in the profits of Russian producers.⁹⁷ At the same time, on the domestic market, competition from cheaper Chinese tungsten oxide intensified, further hitting Russian enterprises. The consequence was a wave of bankruptcies that swept not only individual enterprises but entire corporate groups. Since October 2022, Lermontovsky MPW LLC — one of the largest extractive enterprises in the industry — has been in bankruptcy proceedings.⁹⁸ In 2023, Kompaniya Wolfram JSC — the largest producer of tungsten products in Russia — was also declared bankrupt. Along with the parent entity, the crisis engulfed its subsidiaries: Gidrometallurg JSC, Unecha high-melting point metal LLC, and Primorskvolfram LLC ended up in bankruptcy.⁹⁹ Beyond this group, the financial collapse also affected other producers: Russkiy Wolfram LLC, through which the Lermontovskoye deposit was being developed, and Prospectors' crew Kvarts LLC, which operated at the Bom-Gorkhonskoye tungsten deposit and was finally liquidated in 2023.¹⁰⁰



Fig. 13. Infrastructure conditions for the development of Russian strategic mineral deposits. Made with Felt

⁹⁷ <https://www.gov.uk/government/publications/notice-to-importers-2953-russia-import-sanctions/russian-metals-sanctions-overview>

<https://www.clearytradewatch.com/2024/04/us-and-uk-tighten-restrictions-on-trade-and-use-of-russian-metals/>

<https://mashnews.ru/imushchestvo-krupnejshogo-proizvoditelya-volframa-v-rossii-arestovali.html>

⁹⁸ <https://drom.online/mtindustry/leekveedatseeiya-lyermontovskogo-goka/>

⁹⁹ <https://probankrotstvo.ru/news/aktivy-krupneisego-v-rf-proizvoditelya-volframa-vystaviat-na-torgi-za-15-mlrd-6294>

¹⁰⁰ <https://regnum.ru/article/3125398>

https://nedradv.ru/nedradv/ru/find_nduser?obj=06602d2688c55bb97f457a594592ae57

Another problem is that the bulk of the critically important industrial infrastructure, without which Russia's strategic mineral deposits cannot reach full-scale development, has still not been built, and deadlines for many facilities are systematically being pushed back. This is well illustrated by the Pizhenskoye titanium deposit, which is tied to the megaproject of the Indiga port and the Sosnogorsk–Indiga railway: in 2024, the development of this industrial cluster was once again postponed indefinitely, in part due to the astronomical cost — RUB 220 billion to develop the deposit itself, RUB 353.1 billion for the port, and RUB 371.2 billion for the railway.¹⁰¹ Even where construction has begun — as in the case of the Baimsky MPW based on Peschanka — a significant share of the accompanying infrastructure (the road, the modernization of the Pevek port, and four floating power units worth approximately RUB 190 billion) has not yet been put into operation and will require additional time.¹⁰²

A separately illustrative case is the Kyzyl-Kuragino Railway, critical for developing the Ulug-Tanzekskoye and Ayskanskoye tantalum and niobium deposits, the construction of which has been under discussion since 2008.¹⁰³ In 2024, the Ministry of Transport of the Russian Federation estimated the cost of routing this railway alone at approximately RUB 1 trillion. In 2025, the authorities of the Republic of Tyva spoke about attracting investors from China and Mongolia under an "infrastructure in exchange for resources" model.¹⁰⁴ That is, the discussion concerns the possibility of linking the railway's financing to access to metal deposits for Chinese investors — in effect, using the strategic mineral resource base as a form of compensation for capital investment in a long-running, unfinished construction project.¹⁰⁵

All this directly affects the timelines for putting new deposits into actual operation. Most of the projects that Russia has presented since 2022, as part of its import-substitution strategy, remain far from yielding any industrial results. Even the most advanced project — the Kolmozersky lithium project, where early pilot production began in 2026 — is to deliver its first industrial output only from 2028 and reach full capacity by 2030.¹⁰⁶ The launch of the Baimsky MPW in the Chukotka Autonomous Region was initially pushed back to 2027 and is now postponed to 2029.¹⁰⁷ Other projects are even further from this level of readiness: for the Zashykhinskoye niobium and tantalum deposit, launch is being discussed for the 2030s.¹⁰⁸ For the Tyrnauz tungsten and molybdenum deposit, the Russian authorities plan only to find, by 2028, an investor willing to take on the development of the deposit and the construction of the accompanying MPW infrastructure.¹⁰⁹

Deposit	Mineral reserves	Start of implementation	Planned date of completion/ commissioning	Investments (committed)	Investments (planned)
Tomtorskoye (Buranny section)	1,640,389 tons of REM ¹¹⁰ ; main components: niobium, tantalum, lithium, beryllium	2022	end of 2028 — commissioning	USD 20 million — investment by Polymetal International in TriArk Mining (9.1% stake)	USD 560 million

¹⁰¹ <https://www.vedomosti.ru/esg/ecology/articles/2022/04/13/917865-port-v-indige-i-zheleznyaya-doroga-k-nemu-budut-stoit-700-mlrd-py6.lei>

<https://www.interfax.ru/business/987435>

¹⁰² <https://www.interfax.ru/pressreleases/1059738>

<https://www.interfax.ru/russia/979632>

¹⁰³ https://inno-exp.ru/archive/20/innov_2017-2_89-100.pdf

<https://linkorr.com/rosia-budue-zaliznicu-za-kitajski-resursi-so-viddaut-natomist-285782>

¹⁰⁴ <https://www.vedomosti.ru/strana/siberian/news/2024/09/05/1060249-trassirovku-kizil-kuragino>

Route surveying is a form of engineering surveying aimed at determining the technically most favorable and economically advantageous alignment for a planned structure.

¹⁰⁵ <https://www.rbc.ru/business/24/11/2025/6921b9639a794714fd15ed6e>

<https://www.forbes.ru/biznes/550517-investory-iz-kitaa-i-mongolii-zainteresovali-zeleznoj-dorogoj-kyzyl-kuragino>

¹⁰⁶ <https://interfax.com/newsroom/top-stories/89726/>

¹⁰⁷ https://nedradv.ru/nedradv/ru/page_news?obj=f3d805e5ee17ab6def48bd6ab2ec725a

¹⁰⁸ <https://rostec.ru/en/media/news/confirmatory-drilling-was-started-at-the-Tyrnauz-mining-cluster-fields/>

<https://interfax.com/newsroom/top-stories/110614/>

¹⁰⁹ https://www.prometall.info/intrigi/trendi/Tyrnauzskoe_mestorozhdenie_otlozhili_na_potom

¹¹⁰ Rare earth metals

Kolmozerskoye	844 thousand tons of lithium dioxide; 6.6 thousand tons of tantalum pentoxide; 8.4 thousand tons of niobium pentoxide	February 2023 — license to Polar Lithium LLC	2026 — completion of design; 2029 — completion of MPW construction; 2030 — reaching 45,000 tons/year	RUB 4.8 billion — additional capitalization of Polar Lithium LLC	RUB 91 billion
Bolshetanginskoye	130,756 tons of niobium pentoxide; 964,762 tons of phosphorus pentoxide; 774.4 tons of uranium	August 2023 — license to ST-Element; July 2025 — start of development announced	no specific MPW commissioning date set; license valid until 2050	n/a	RUB 29 billion
Polmostundovskoye	351.7 thousand tons of lithium dioxide; 1,120 tons of tantalum pentoxide; 2,022 tons of niobium pentoxide	2024 — license to Arctic Lithium JSC	2030 — commissioning of MPW with capacity of 1 million tons of ore per year	private investments by Khalmek Trade House LLC and KhMZ JSC; share capital of Arctic Lithium JSC — RUB 1 million	n/a
Tastygskoye	596,266 tons of lithium dioxide; 3,949 tons of tantalum pentoxide; 7,824 tons of niobium pentoxide; 21,363 tons of tin	2023 — Elbrusmetall received the license and began geological exploration	2030	at least RUB 20 billion was planned to be invested by 2026	RUB 34,607 billion
Zavitinskoye (Pervomayskaya field)	153 thousand tons of lithium dioxide (balance reserves); 50.9 thousand tons of lithium oxide — off-balance; 348 tons of tantalum pentoxide; 45 tons of niobium pentoxide	2024 — license to Zabaykalsky lithium LLC; 2024 — auction for the main field did not take place	mid-2026 — start of MPW construction; end of 2028 — completion of transport and energy infrastructure; 2030 — commissioning of production	n/a	approximately RUB 18 billion

Table 1. Russian mineral and raw materials projects launched after 2022¹¹¹

Thus, after 2022, Russia did indeed attempt to accelerate the development of its own mineral resource base, but these efforts have not yet altered the main picture. Most new or relaunched projects remain expensive, slow-moving, technologically complex, infrastructurally underprepared, and dependent on external capital and imported equipment, all of which leads to lengthy implementation timelines. A significant share of the growth in reserves is linked to additional exploration of already known deposits rather than to the rapid launch of new production hubs. Under such conditions, the only realistic mechanism in the short and medium term for meeting the needs of Russian industry and the MIC for strategic minerals remains large-scale imports, both in the form of ore and concentrates and in the form of products of intermediate and deep processing.

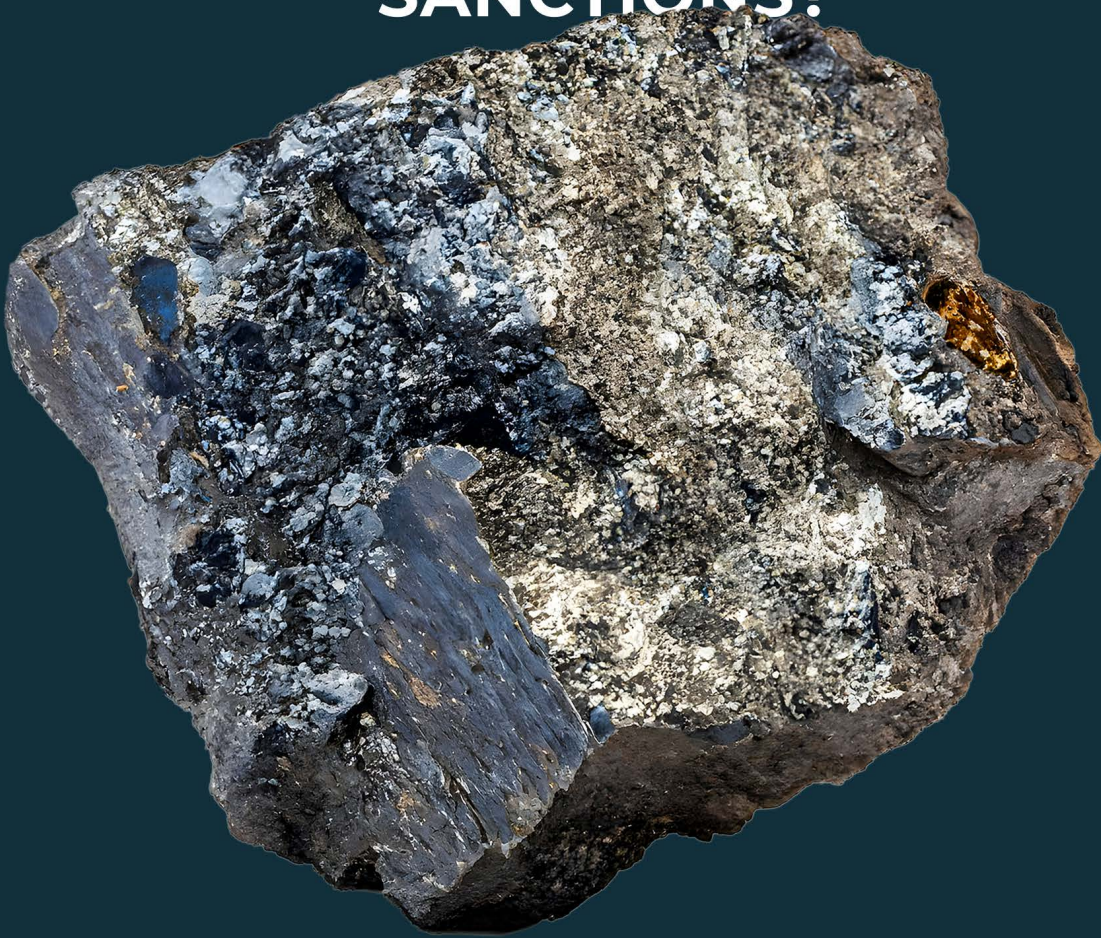
¹¹¹ All ruble amounts have been converted to USD at the Central Bank of the Russian Federation exchange rate as of March 17, 2026 — RUB 81.05 per USD 1. Accordingly:

RUB 4.8 billion — USD 59.2 million
RUB 91 billion — USD 1.1 billion
RUB 29 billion — USD 357 million
RUB 1 million — USD 12,300
RUB 20 billion — USD 246 million
RUB 34.607 billion — USD 426 million
RUB 18 billion — USD 222 million

SALT OF THE EARTH

CHAPTER II

**HOW DOES RUSSIA SECURE
STRATEGIC MINERALS UNDER
SANCTIONS?**



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HOW DOES RUSSIA SECURE STRATEGIC MINERALS UNDER SANCTIONS?

As shown in the first chapter, Russia's dependence on imports of strategic minerals is not temporary but persistent and is likely to continue. The reason is that it stems from a set of deeper structural constraints — from weak development of its own resource base and lack of infrastructure to technological gaps, capital shortages, and lengthy implementation timelines for new projects. Under these conditions, even after 2022, Russia has been unable to achieve self-sufficiency quickly and has continued to compensate for internal weaknesses by relying on external supplies.

This chapter, therefore, examines how this dependence has been transformed under sanctions and in what forms it has been reproduced during the period under review — from April 2024 through March 2025. Crucially, Russia depends not on minerals in general but on specific forms of raw materials and their processed products that have direct industrial and military significance. For some items, ores and concentrates are critical, as in the case of titanium or manganese; for others, oxides, salts, and other compounds, as in the case of rhenium, tungsten, or beryllium; for still others, alloys — particularly ferroalloys, as in the case of niobium and molybdenum — or pure metal, as in the case of tantalum.

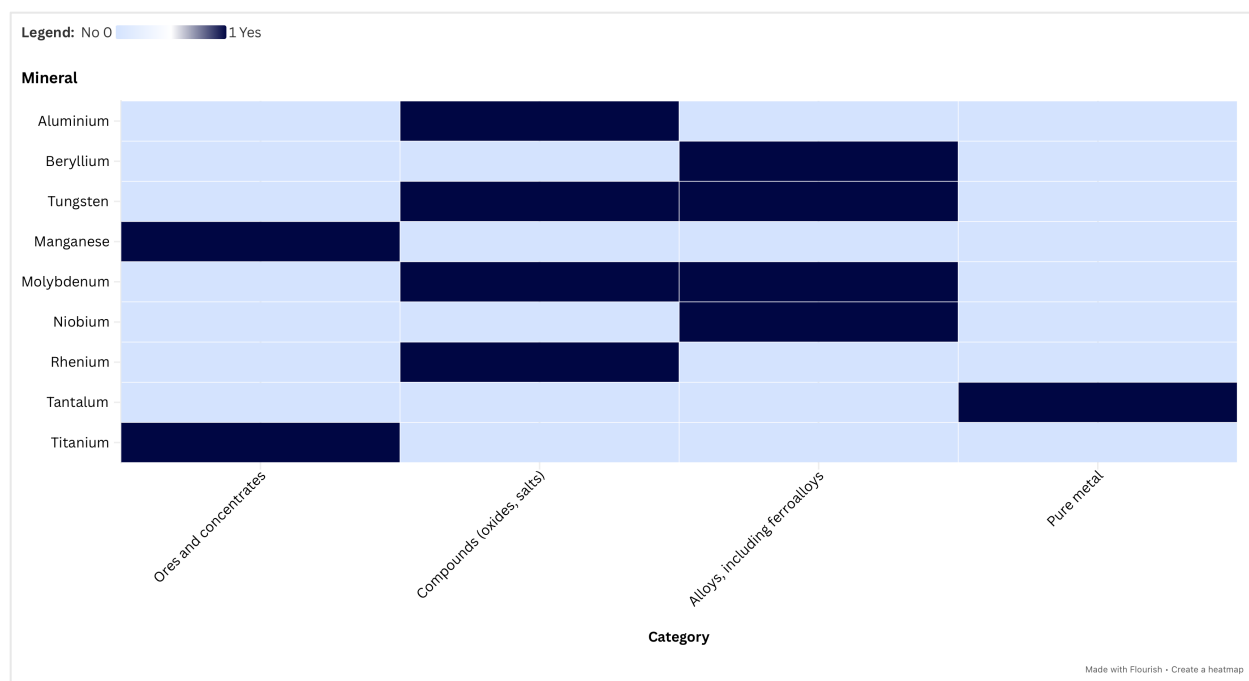


Fig. 14. Forms of the analysed strategic minerals whose shortages Russia compensates for through imports. Made with Flourish¹¹²

¹¹² Customs data analysis is conducted using four-digit or six-digit HS codes, since the last four digits of the ten-digit code may differ across jurisdictions. In cases where the search code covers compounds of multiple metals, the query was refined by filtering imported-goods descriptions. The following HS codes were used to analyze customs data for the relevant product forms (descriptions are given per UKTZED — Ukraine's Classification of Goods for Foreign Economic Activity):
281820 — Aluminum oxide, other than artificial corundum;
760120 — Aluminum alloys (filtered by goods description);

Accordingly, the discussion that follows examines the external channels through which this dependence was sustained and adapted during the period under review — the post-Soviet space, China, Global South countries, and individual sanctions-coalition jurisdictions. This chapter aims not only to show the geography of strategic mineral supply in 2024–2025 but also to explain why these minerals and their specific forms are important for the RMIC. For each case examined, therefore, the military application of the relevant mineral is briefly outlined — in armored vehicles, aviation, missile production, radio electronics, engine manufacturing, specialty alloys, or other critical segments. This makes it possible to understand which segments of the Russian war machine were sustained by external supplies during the period under review.

The Post-Soviet Space as Carrier of the Soviet Production Legacy

In the context of the Russian Federation's access to strategic minerals, the post-Soviet space remains key, particularly where current supplies effectively continue the Soviet model of cooperation, under which extraction, primary processing, or the production of specialized forms were dispersed across different union republics. After the collapse of the USSR, Russia did not reconstitute the full production cycle on its own territory, and this continues to manifest itself in current import dependence.

This logic is most clearly manifested in the case of beryllium. This metal is of critical importance to the military industry thanks to its combination of lightweight, high strength, thermal resistance, and stability under extreme loads.¹¹³ For this reason, it is used in structural elements of aviation, missile, and naval equipment, above all in systems where precision, thermal resistance, and weight reduction are decisive. The most illustrative examples are its applications in the guidance and orientation systems of aircraft, ballistic missiles, surface ships, and submarines — particularly in the inertial elements of gyroscopes — as well as in rocket engines, where beryllium is used in combustion chambers and engine bells.¹¹⁴ Equally important is the use of beryllium oxide in high-power radio frequency and microwave electronics — including in transistor backers and diodes, waveguide elements, and other components essential for radar systems, including those that form the basis of Russian air defense assets.¹¹⁵ A separate area is its role in nuclear technologies for military purposes: purified beryllium is used in nuclear weapons, in particular in external pulsed neutron sources, and in nuclear installations as a moderator, absorber, and reflector of neutrons.¹¹⁶

The main scarce forms for Russian industry are beryllium bronzes — products derived from the processing of ores and concentrates.¹¹⁷ In absolute terms, Russian demand for beryllium products

740990 — Plates, sheets, and strip of copper, of a thickness exceeding 0.15 mm: of other copper alloys (filtered by goods description);

740729 — Bars, rods, and profiles of copper, other (filtered by goods description);

811219 — Beryllium, chromium, hafnium, rhenium, thallium, cadmium, germanium, vanadium, gallium, indium, niobium (columbium), and articles of these metals, including waste and scrap (filtered by goods description);

284990 — Tungsten carbides (filtered by goods description);

282590 — Tungsten oxides and hydroxides (filtered by goods description);

810199 — Tungsten and articles of tungsten, including waste and scrap;

810110 — Tungsten powders;

260200 — Manganese ores and concentrates, including ferruginous manganese ores and concentrates with a manganese content of 20% or more by weight,

calculated on the dry weight;

720270 — Ferromolybdenum;

282570 — Molybdenum oxides and hydroxides;

720293 — Ferroniobium;

284190 — Salts of oxometallic or peroxometallic acids (filtered by goods description);

8103 — Tantalum and articles of tantalum, including waste and scrap;

2614 — Titanium ores and concentrates;

¹¹³ <https://habr.com/ru/articles/375877/>

¹¹⁴ <https://topwar.ru/18679-metally-v-voennoy-promyshlennosti.html>

https://bstudy.net/809998/tehnika/primenenie_berilliya_splavov?ysclid=mkqs5344s9251370372

¹¹⁵ <https://www.samaterials.com/content/what-are-the-uses-of-beryllium-oxide-ceramics.html>

¹¹⁶ <https://focus.ua/technologies/581069-opasnyy-element-v-sostave-atomnoy-bomby-chto-sdelaet-berillievaya-bolezn-s-vashim-organizmom>

¹¹⁷ <https://pravdaurfo.ru/polnotekst/394204-struktura-rosteha-otkladyvaet-dobychu-berilliya-v-sverdlovskoj-oblasti-milliardy-rosatoma-uhodyat-v-kazhstan/>
Beryllium bronzes are copper alloys containing 1–3% beryllium.

remains insignificant: annual consumption is approximately 30–40 tons of beryllium, of which only 1–3 tons go to the MIC. It is precisely this narrowness of the domestic market that makes the development of full domestic production and the creation of in-country processing capacity economically unattractive, and therefore objectively pushes Russia toward maintaining import dependency.¹¹⁸

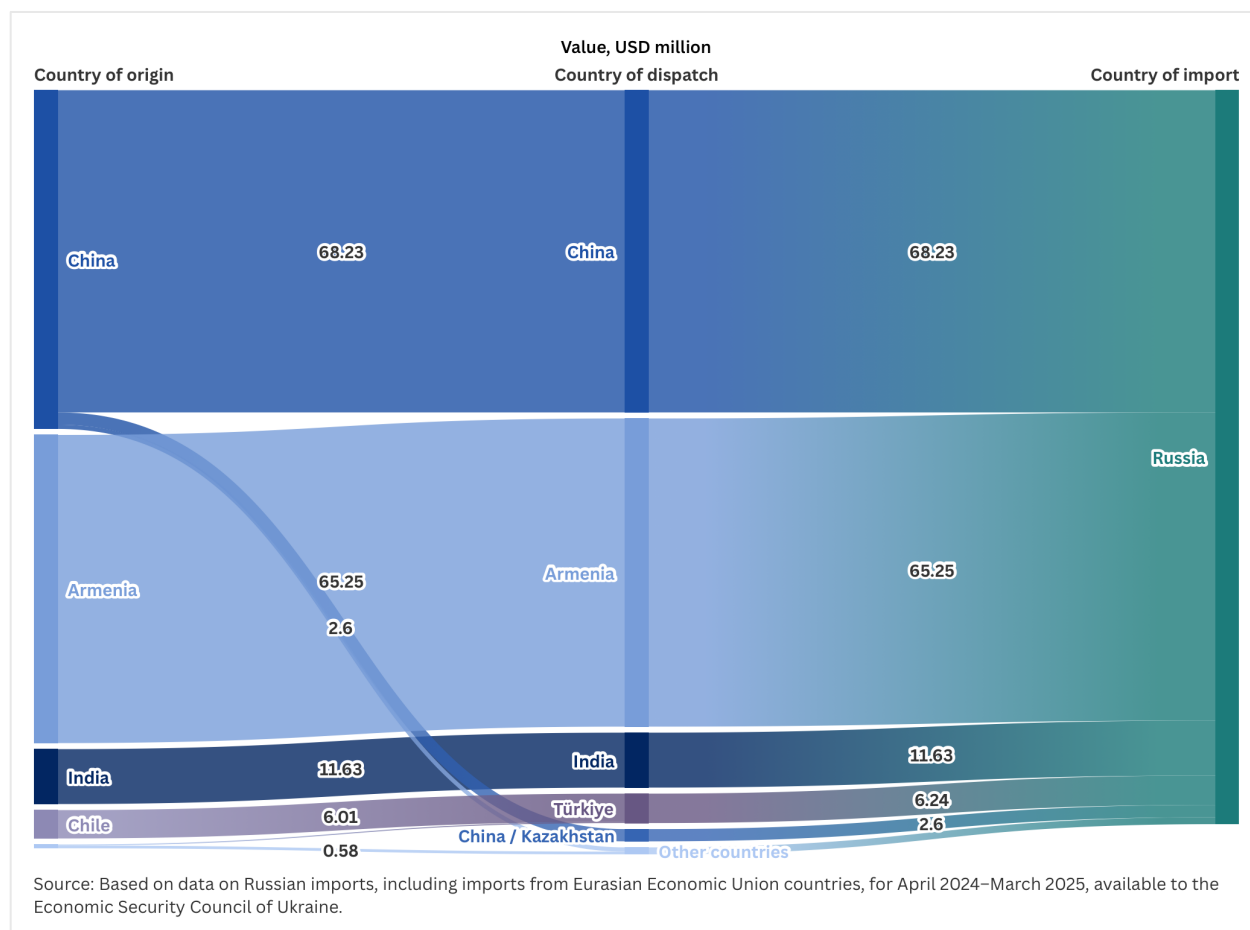


Fig. 15.1. Countries of origin and dispatch of beryllium imported by Russia from April 2024 to March 2025 (value). Made with Flourish

At the same time, this dependence is not critically vulnerable from the standpoint of sanctions or geopolitical risk, since it rests mainly on jurisdictions friendly to the Russian Federation. The main supplier of scarce forms of beryllium to Russia is Kazakhstan. During the period under review, it accounted for USD 11.03 million, or more than 76% of the value of such imports. China was the second-largest source — USD 3.31 million, or nearly 23% — while all other jurisdictions combined accounted for less than 1% of supply value. By physical volumes, the picture was somewhat different — China supplied 62.38 tons, or slightly more than 59% of import mass, while Kazakhstan supplied 35.08 tons, or about a third.¹¹⁹

¹¹⁸ <https://pravdaurfo.ru/polnotekst/394204-struktura-rosteha-otkladyvaet-dobychu-berilliya-v-sverdlovskoj-oblasti-milliardy-rosatoma-uhodyat-v-kazakhstan/>

¹¹⁹ Based on data on Russian imports of products under HS codes 811219, 760120, 740990, and 740729 for the period from April 1, 2024 through March 31, 2025, including transactions within the EAEU. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 12 and 13.

This configuration is a direct continuation of the Soviet legacy: the still-operating Kazakh Ulba Metallurgical Plant JSC processes beryllium-bearing ores sourced from the Russian Urals into beryllium alloys and compounds.¹²⁰ In turn, beryllium oxide was used at the Ust-Kamenogorsk plant in Kazakhstan, now known as Kaz Ceramics, to manufacture beryllium ceramics critical to radar systems, which Russia continues to procure today.¹²¹

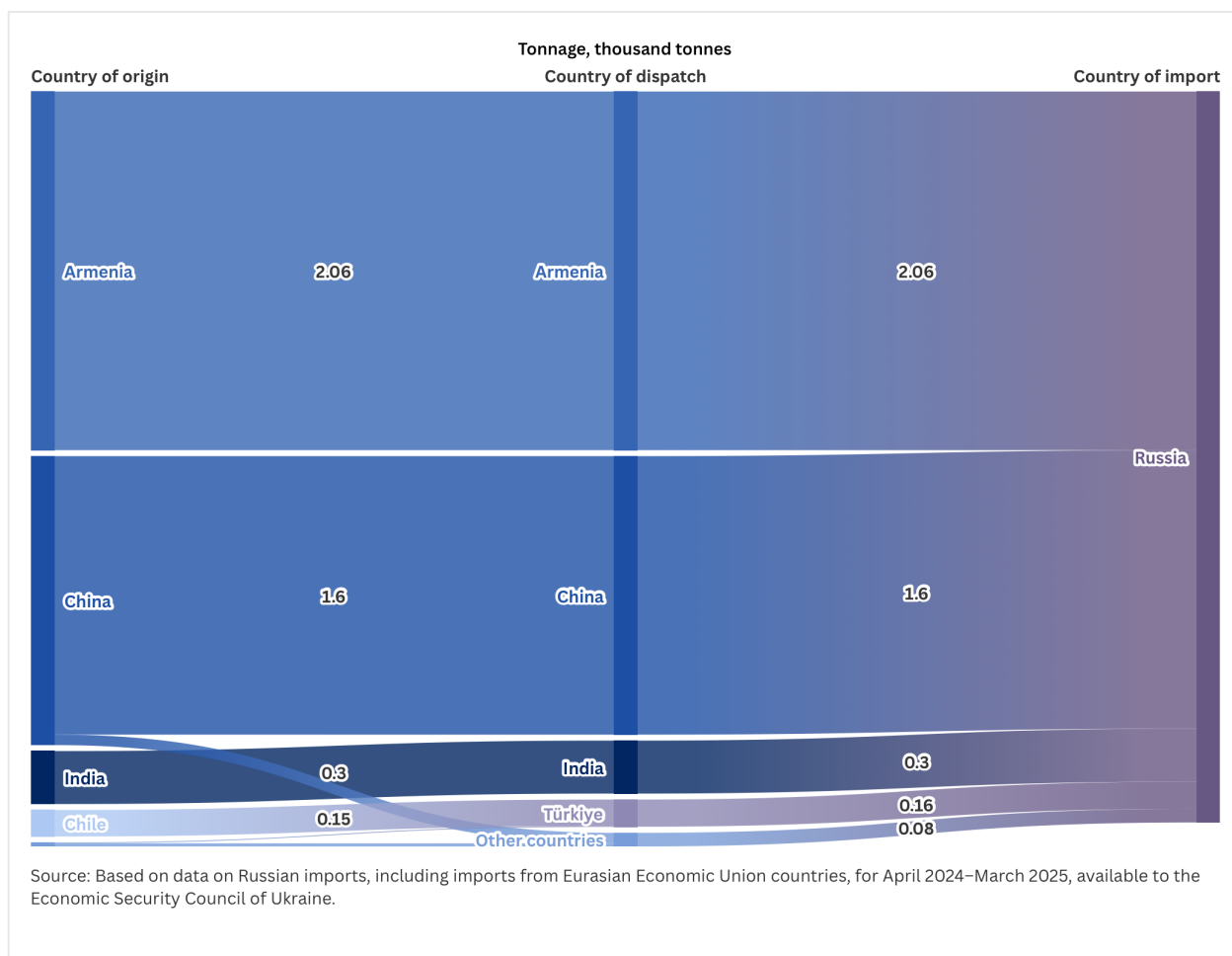


Fig. 15.2. Countries of origin and dispatch of beryllium imported by Russia from April 2024 to March 2025 (tonnage). Made with Flourish

¹²⁰ <https://bit.ly/41pxsoM>

https://www.prometall.info/analitika/rynok_berilliya_voprosov_bolshe_chem_otvetov

<https://link.springer.com/article/10.1134/S0036029523120261>

¹²¹ <https://www.rusi.org/explore-our-research/publications/research-papers/disrupting-russian-air-defence-production-reclaiming-sky>

As of 2025, Russia remained a key market for Kaz Ceramics. Zenit-K, registered at the same address in December 2014, used the plant's corporate identity, ran a Russian-language website, and regularly won Russian state tenders — including from NIIET and NPP Almaz, manufacturers of microwave electronics. According to commercial trade data, since 2024 Kaz Ceramics and Zenit-K have systematically supplied products under HS code 8547.10 to major manufacturers of radar-system components, including suppliers to the Almaz-Antey Concern — NPP Pulsar, NIIET, and NPP Istok — as well as Research Institute of Measuring Instruments-Novosibirsk Plant Named After Komintern JSC, the manufacturer of the 91N6 (Big Bird) radar. According to official Kazakhstan foreign trade statistics, since the start of the full-scale war, exports of these products to Russia have risen from USD 1.2 million in 2022 to USD 17.8 million in 2024.

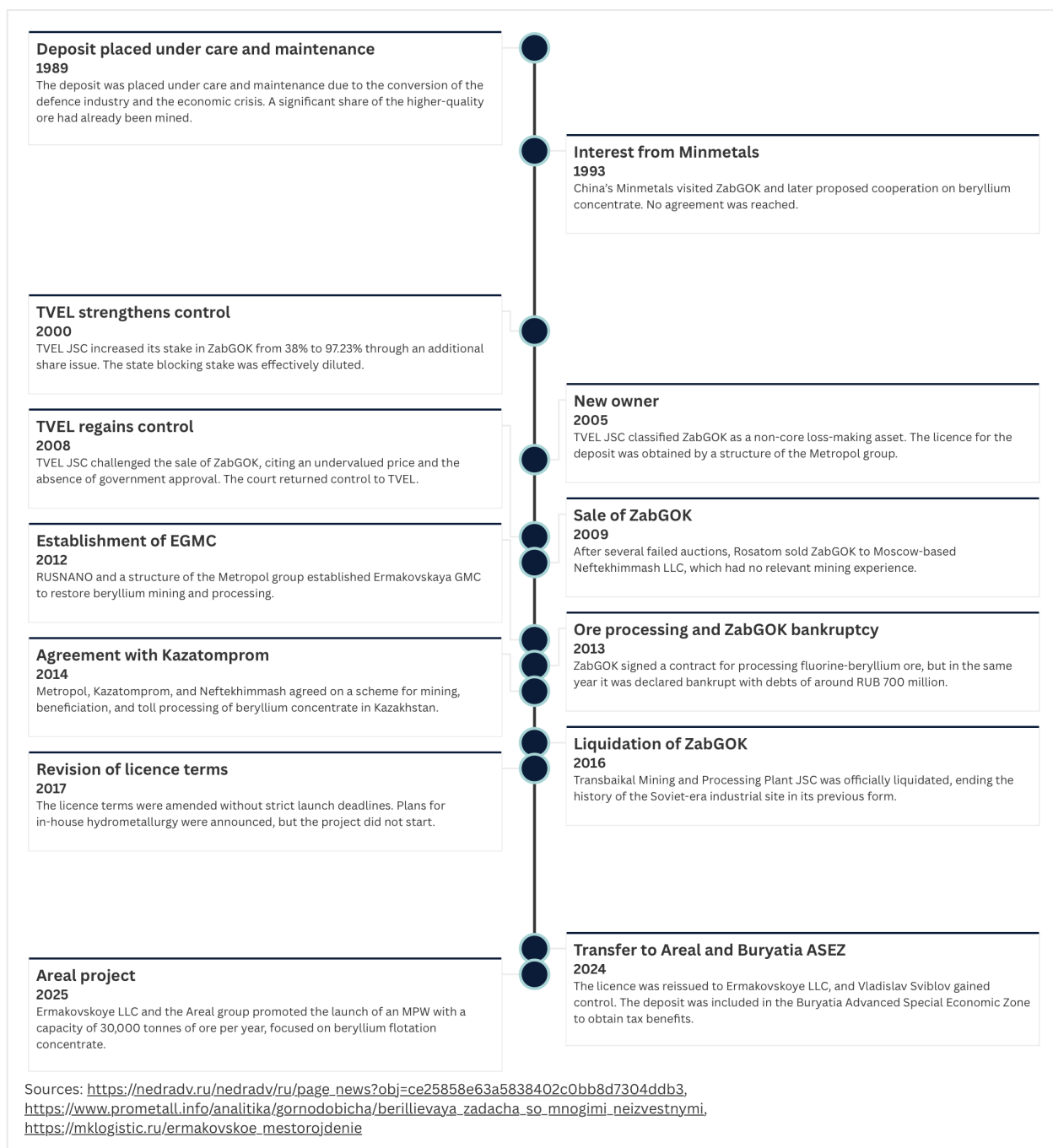


Fig. 16. Timeline of the development of the Ermakovskoye beryllium deposit after the collapse of the USSR. Made with Flourish

The Russian government currently intends to revive the extraction of beryllium concentrate production by launching operations at the Yermakovskoye deposit in Buryatia, which could yield 45 tons of beryllium per year.¹²² The Russian beryllium industry is expected to be export-ready as well — Russian deposits

¹²² <https://pravdaurfo.ru/polnotekst/394204-struktura-rosteha-otkladyvaet-dobychu-berilliya-v-sverdlovskoj-oblasti-milliardy-rosatoma-uhodyat-v-kazahstan/>
https://www.prometall.info/corp/drugie/vazhnyy_shag_v_reshenii_berillievoy_problemy

have the potential to capture up to 15% of the world market.¹²³ However, even if this scenario materializes, what is at stake for now is only the restoration of ore extraction. At the same time, the prospect of building hydrometallurgical works capable of producing beryllium oxide depends directly on a reassessment of reserves, which still relies solely on Soviet-era data. In other words, the creation of a complete production cycle is not currently on the agenda, even though it is precisely finished products that the Russian Federation needs.

Moreover, the project is only in its initial stage. The MPW launch is scheduled for 2027, with construction to be completed in 2034. This means at least seven years of guaranteed import dependence, even without accounting for possible delays, technical complications, financing problems, or difficulties in launching processing capacity. Accordingly, in the medium term, Russia is highly likely to remain dependent on imports for at least that part of the beryllium product range that has the greatest technological value for the MIC.¹²⁴

In the case of tantalum, the post-Soviet chain is also key. Its application is narrower but more familiar: about half of its consumption goes to the production of tantalum capacitors — compact, heat-resistant, and reliable components used in electronic circuits, particularly in high-frequency and high-voltage devices.¹²⁵ In the military sector, this directly links tantalum to the production of radio electronics, including elements of radar, navigation, and hydroacoustic systems, as well as vacuum-tube microwave devices.¹²⁶ Another quarter or so of tantalum is used in heat-treated alloys for aerospace equipment, particularly for critical jet engine components such as rotor disks and turbine blades.¹²⁷ Russian tantalum consumption, however, is almost entirely electronic: the bulk of tantalum (more than 80–90%) goes to capacitors for electronics, including military, while a smaller portion (around 10–20%) goes to alloys, primarily for high-temperature parts in the MIC.¹²⁸

Like beryllium, tantalum belongs to the small-tonnage metals.¹²⁹ Before 2022, Russia imported approximately 50 tons of tantalum per year.¹³⁰ The Russian Federation's key need concerns metallic tantalum, specifically in powder form, which is critical for capacitor production. Although Russia has several large tantalum deposits, its processing base remains limited. The only processing enterprise — Solikamsk Magnesium Plant OJSC — produces compounds, specifically tantalum oxides, from loparite concentrate from the Lovozerskoye deposit, with almost all of this output sold on external markets.¹³¹ At the same time, the technology for extracting metallic tantalum from ore is complex, and Russia still does not have it in an industrially mastered form.¹³² Tellingly, only in December 2023 did work begin on developing a technology to produce capacitor-grade tantalum powders — planned annual output is to be at least 10 tons, meaning that even if successful, only partial coverage of Russian needs would be achieved.¹³³ The first ingot of metallic tantalum in Russia was smelted in March 2024 — its weight was 8 kilograms, which was 0.016% of Russia's annual demand.¹³⁴

¹²³ https://www.prometall.info/corp/drugie/vazhnyy_shag_v_reshenii_berillievoy_problemy

¹²⁴ <https://www.metaltorg.ru/n/9b6677>

https://www.prometall.info/analitika/gornodobicha/berillievaya_zadacha_so_mnogimi_neizvestnyimi <https://www.metaltorg.ru/n/9b6677>

¹²⁵ <https://habr.com/ru/companies/onlinepatent/articles/781394/>

¹²⁶ https://www.metotech.ru/art_tantal_1.htm

Microwave electronics is the branch of electronics that studies processes and material properties in ultra-high-frequency electromagnetic fields.

¹²⁷ <https://habr.com/ru/companies/onlinepatent/articles/781394/>

https://www.prometall.info/analitika/skolko_tantala_nuzhno_rossii

https://www.prometall.info/eco/mirovaya-praktika/tantalovy_muki_xxi_veka?ysclid=mlru9trqij783590390

¹²⁸ https://www.prometall.info/analitika/skolko_tantala_nuzhno_rossii

¹²⁹ "Minor metals" are metals with relatively small global production volumes, often higher value, narrowly specialized applications, and frequently byproduct status from the mining or smelting of other metals.

"Base metals" are metals produced and consumed in very large volumes, typically in large-scale industry and infrastructure; common examples include iron/steel, aluminum, copper, and zinc.

¹³⁰ https://www.prometall.info/analitika/skolko_tantala_nuzhno_rossii

¹³¹ <https://rosnedra.gov.ru/activity/documents/gosudarstvennyy-doklad-2023/>

¹³² <https://hij.ru/read/21912/>

¹³³ <https://habr.com/ru/companies/onlinepatent/articles/781394/>

¹³⁴ <https://easaily.com/ru/news/2024/03/20/vazhno-rossiya-nachala-proizvodit-metallicheskiy-tantal-samostoyatelno>

Before the start of the full-scale invasion, Russia procured metallic tantalum mainly from Kazakhstan, which accounted for approximately 80% of supplies, as well as from China — about 15% — and from Germany and other Western countries — another 5% or so.¹³⁵ Among post-Soviet sources of tantalum powder, Estonia also played an important role with the Soviet-era plant in Sillamäe (now known as Silmet), but after 2022, these supplies ceased.¹³⁶ During the period under review, Kazakhstan retained its leading position: from April 2024 through March 2025, it accounted for USD 9.28 million, or nearly 69% of the value of all tantalum imports into the Russian Federation, as well as 12.08 tons, or about 75% of its physical volume. As in the case of beryllium, the key supplier remains Ulba Metallurgical Plant JSC, which was already in the Soviet period tightly integrated into the Russian industrial cycle.¹³⁷

At the same time, dependence on Kazakhstan is not fully monopolistic, as the remainder of the supply is provided mainly by China. From April 2024 through March 2025, the Chinese segment accounted for USD 4.08 million, or slightly more than 30% of import value, and 3.85 tons, or about a quarter of its mass. Some of these supplies already passed through third jurisdictions, primarily through the UAE, which served as a transit hub.¹³⁸ Yet the overall picture remained unchanged: Russia continued to receive the bulk of metallic tantalum specifically from Kazakhstan, attesting to the persistence of the old cooperative dependence inherited from the Soviet period.

Russian imports of rhenium-bearing compounds are exclusively of post-Soviet origin. The Russian Federation's demand for rhenium substantially exceeds domestic supply. It is covered mainly through external deliveries: as of 2019, total demand was estimated at 6.5–7 tons, of which approximately 4.5 tons were supplied by imports.¹³⁹ This metal is a strategically important material for the MIC, primarily because of its role in producing refractory superalloys for aviation and missile engines: more than 80% of global rhenium is used in this area.¹⁴⁰ It is added to nickel alloys for turbine blades, allowing the operating temperature of engines to be raised by approximately 50–80°C and therefore increasing their thrust, service life, and resistance to extreme loads.¹⁴¹ In addition to turbine blades, rhenium is used in molybdenum-rhenium and tungsten-rhenium alloys for engine bells, nozzle extensions, thermal protection shields, and high-temperature electronics components.¹⁴²

In the Soviet period, rhenium extraction and processing were concentrated mainly outside present-day Russia — in Kazakhstan, particularly at the Jezkazgan copper deposit; in Armenia (at molybdenum deposits, including Kajaran); and in Mongolia (at the Erdenet deposit) — although some processing plants also operated in the RSFSR. Following the collapse of the USSR, Russia retained part of these processing capacities but was left without an adequate base of high-quality raw materials.¹⁴³ The situation was complicated by the fact that rhenium is mainly obtained as a by-product of molybdenum and copper concentrates, which tied its extraction to molybdenum —

¹³⁵ <https://rareearth.ru/ru/pub/20220208/04243.html?ysclid=mknvzjp5dm81749141>

¹³⁶ <https://rareearth.ru/ru/pub/20220208/04243.html>

¹³⁷ <https://kaptechnology.kazatomprom.kz/ru/content/tantal-niobievoe-proizvodstva/>
<https://gravicon.biz/obzor-mirovogo-proizvodstva/>

¹³⁸ Based on data on Russian imports of products under HS code 8103 for the period from April 1, 2024 through March 31, 2025, including transactions within the EAEU. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 10 and 11.

¹³⁹ <https://tass.ru/ural-news/3734275>

¹⁴⁰ https://defensemirror.com/news/20491/Chinese_Fighter_Jet_Engines_Equipped_With_Home_Made_Single_Crystal_Turbine_Blades

<https://alloyindex.com/news/rhenium-the-jet-engine-metal-the-west-cant-afford-to-lose/>

<https://www.miningnewsnorth.com/page/rhenium-the-hot-superalloy-element/5748.html>

https://www.youtube.com/watch?v=wzK4Wc_ojs

¹⁴¹ <https://habr.com/ru/articles/534224/>

<https://markmet.ru/kniga-po-metallurgii/volfram-renievye-pokrytiya>

¹⁴² <https://rareearth.ru/ru/pub/20131111/00015.html?ysclid=mky6wqeli9604534911>

<https://ua.sscmaterials.com/non-ferrous-metals/molybdenum/molybdenum-rhenium-alloys.html>

<https://habr.com/ru/articles/534224/>

<https://markmet.ru/kniga-po-metallurgii/volfram-renievye-pokrytiya>

<https://dzen.ru/a/XKdiErvoKQC0X6w0?ysclid=mky6rkhjo122092515>

¹⁴³ <https://iv-g.livejournal.com/1332422.html>

<https://masterok.livejournal.com/2972154.html>

<https://tass.ru/ural-news/3734275>

another scarce mineral.¹⁴⁴ In addition, as with tantalum, there is a technological problem in Russia: on Iturup Island in 1992, rhenium disulfide was discovered — a unique mineral that forms a rare, renewable deposit, from which up to 10 tons of rhenium are released annually through fumaroles.¹⁴⁵ The problem, however, is that there are currently no technologies for "capturing" the volatile rhenium compounds (oxides), since, with insufficiently efficient organization of this process, metal losses can be significant.¹⁴⁶

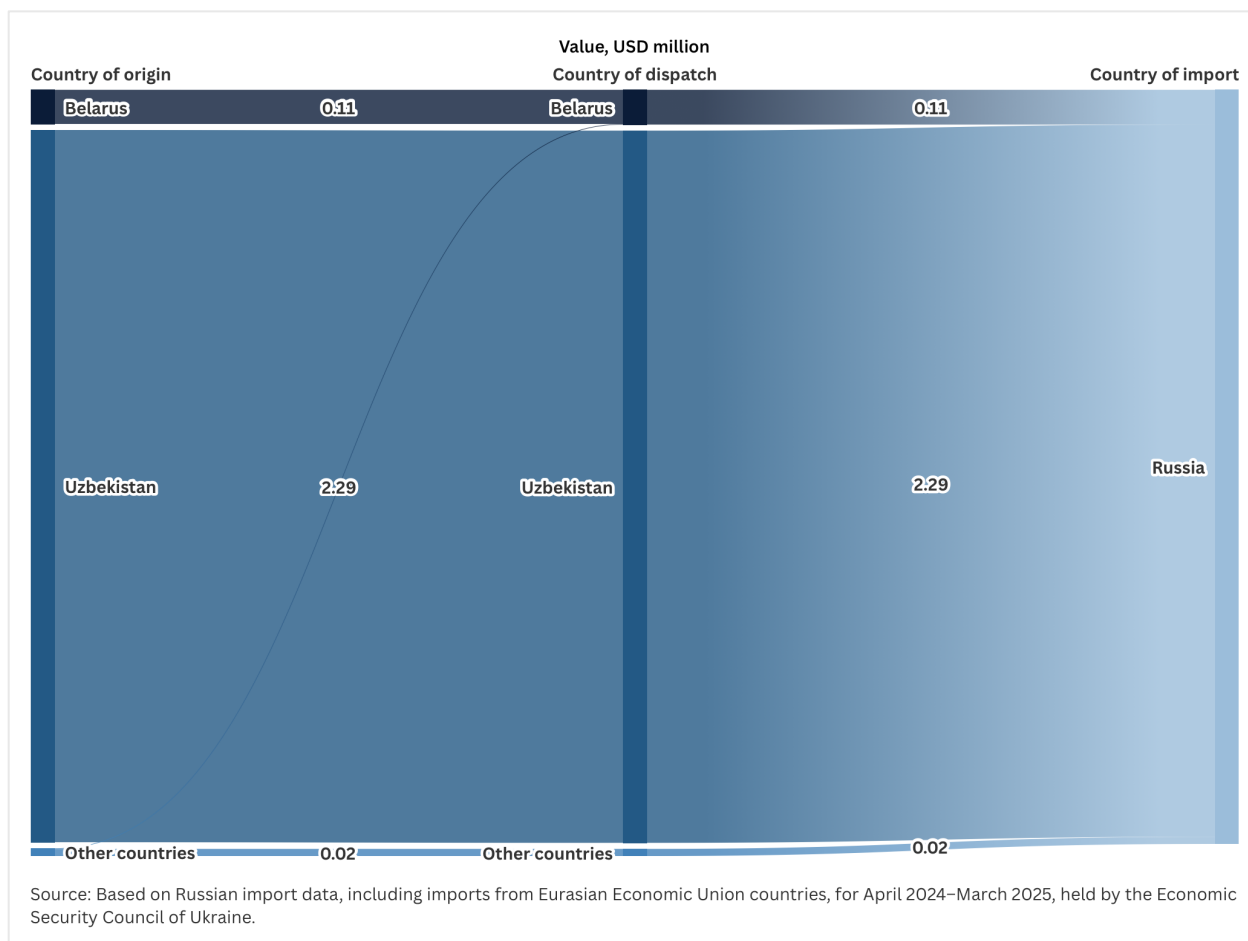


Fig. 17.1. Countries of origin and dispatch of rhenium imported by Russia from April 2024 to March 2025 (value). Made with Flourish

That is why Russian imports are oriented not toward pure rhenium or ready-made alloys, but toward rhenium feedstock in the form of ammonium perrhenate. Between April 2024 and March 2025, Uzbekistan unequivocally dominated the value structure of Russian rhenium imports: it accounted for USD 2.29 million, or over 94% of the value of all supplies. Belarus's share was substantially smaller — just USD 110,200, or about 4.5%. The physical-volume picture looked exactly the opposite. Almost all tonnage came from Belarus — 290.85 tons, or more than 98% of import mass — while Uzbekistan accounted for only 3.95 tons, or slightly more than 1%.¹⁴⁷ Such a sharp

¹⁴⁴ https://pdf.lib.vntu.edu.ua/books/2021/Chervonij_P1_2008_351.pdf

¹⁴⁵ A fumarole (from Italian Fumare, "to smoke") is a small opening or fissure in volcanic craters or in lava flows that are solidifying and forming a crust — a site for the emission of gaseous and vaporous products.

¹⁴⁶ <https://dzen.ru/a/ZGn8WfvvzHAGpTcV>

¹⁴⁷ Based on data on Russian imports of products under HS code 284190 for the period from April 1, 2024 through March 31, 2025, including transactions within the EAEU. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 20 and 21.

mismatch between the value and weight structures of supplies may indicate a distortion of customs statistics — in particular, the likely understatement of the actual value of imported products in internal EAEU databases, which investigative journalists have repeatedly highlighted. At the same time, Russian imports of ammonium perrhenate will continue — in March 2025, the principal investor in the project to extract rhenium from the gases of the Kudryavy volcano on Iturup Island withdrew from the project.¹⁴⁸

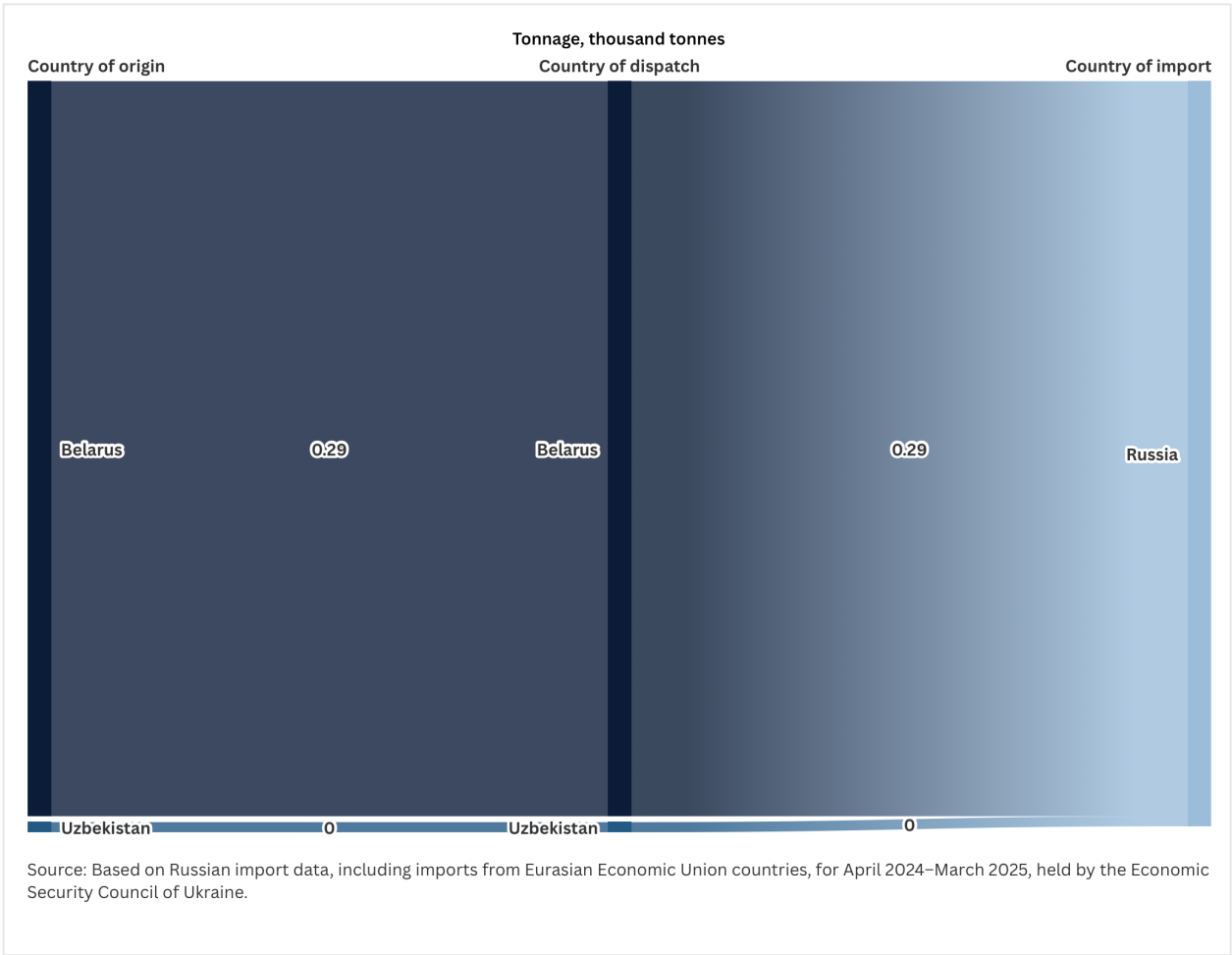


Fig. 17.2. Countries of origin and dispatch of rhenium imported by Russia from April 2024 to March 2025 (tonnage). Made with Flourish

Molybdenum belongs to this same group. Molybdenum is critically important for the MIC primarily as an alloying element in high-strength, wear-resistant, and heat-treated steels and superalloys.¹⁴⁹ Its military applications are concentrated primarily in the missile, aviation, and aerospace spheres, where molybdenum-containing materials are used in engines, engine bells, turbine parts, fuel systems, landing gear, and other components that operate under high temperatures and extreme mechanical loads.¹⁵⁰ Equally important is its use in armor protection, where molybdenum increases the hardness, strength, and durability of armor steels, as well as in the production of barrels and

¹⁴⁸ <https://www.interfax.ru/business/1015614>

¹⁴⁹ <https://www.imoa.info/molybdenum-uses/molybdenum-grade-stainless-steels/metallurgy-of-molybdenum-in-stainless-steel.php>

¹⁵⁰ <https://www.samaterials.com/content/molybdenum-alloys-in-the-aerospace-and-steel-industry.html> ;

<https://www.samaterials.com/content/how-molybdenum-is-used-in-alloying.html>

other load-bearing weapon components for which thermal resistance and wear resistance are critical.¹⁵¹

Despite the existence of its own extraction, Russia's molybdenum base remains limited in both scale and depth of processing. Russia conducts extraction at two deposits — Sorsk and Mikheevskoye — while other projects are in the preparatory stages, and ore processing occurs only to the level of concentrates at Sorsk MPW LLC.¹⁵² The Sorsk ferro-molybdenum plant — the only enterprise producing ferromolybdenum to cover part of domestic demand — also operates on Sorsk MPW concentrates, with over 40% of demand covered by imports.¹⁵³ In the coming years, Russia plans to begin molybdenum extraction at five deposits — Agaskyrskoye in Khakassia, Ak-Suzskoye in the Republic of Tyva, Yuzhno-Shameyskoye in Sverdlovsk oblast, Tyrnauz in Kabardino-Balkaria, and Peschanka in the Chukotka Autonomous Region.¹⁵⁴ However, even with the implementation of all prospective licenses or the revival of dormant ones, Russia will not reach full coverage of domestic demand by 2030, and a deficit is already anticipated by 2035.¹⁵⁵

It is precisely this shortfall that the external supply chain — combining post-Soviet and Chinese components — fills. The Soviet production cycle for molybdenum drew on the RSFSR (the Tyrnauz and Sorsk deposits), Kazakhstan (the Koktenklon deposit), and, above all, Armenia — particularly the Zangezur Copper and Molybdenum Combine, which still operates the Kajaran deposit and the Agarak deposit.¹⁵⁶ Current trade chains confirm that, of molybdenum, post-Soviet cooperation still carries significant weight. From April 2024 through March 2025, Armenia supplied USD 65.25 million, or about 42% of the value of Russian imports, as well as 2,058 tons — that is, nearly half of its physical volume.¹⁵⁷ Almost the entire segment consisted of ferromolybdenum, which is critical to metallurgy and the production of specialty steels.

At the same time, China stands almost on a par with the Armenian chain. Over the same period, China accounted for USD 71.72 million, or slightly more than 46% of the import value, and 1,657.64 tons, or nearly 40% of its mass. The Chinese segment was formed primarily from molybdenum compounds—oxides and hydroxides. If one looks at the jurisdictions of shipping, the ratio remained close: China provided nearly 45% of the value, Armenia about 42%, while other countries accounted for a substantially smaller share.¹⁵⁸ As a result, molybdenum best illustrates the transitional state of Russian dependency: the post-Soviet channel here remains very strong, but the Chinese channel has now effectively caught up with it in significance.

Thus, the post-Soviet space remains for Russia a direct continuation of the unfinished Soviet production architecture. It is precisely through Kazakhstan, Uzbekistan, Armenia, and, in part, other jurisdictions that Russia compensates for segments it was unable to reconstitute on its own territory after the collapse of the USSR. Beryllium, tantalum, rhenium, and a significant part of the molybdenum chain demonstrate the same pattern: Russia preserved or restored demand but did not create a full-fledged domestic base for meeting that demand. As a result, post-Soviet cooperation remains an operating mechanism for sustaining the RMIC and adjacent sectors.

¹⁵¹ <https://rtg-mps.ru/stati/molibden-cto-eto-za-metall>
<https://habr.com/ru/companies/onlinepatent/articles/796933/>

¹⁵² <https://www.rudmet.ru/news/14380/>

In 2023, Sorsk MPW extracted 1,360 tonnes of metal from ore and produced 1,251 tonnes of molybdenum in concentrate — effectively the entire volume of raw material processed in the country.

¹⁵³ <https://rosnedra.gov.ru/activity/documents/gosudarstvennyy-doklad-2023/>

¹⁵⁴ <https://dprom.online/mining/rossiya-zapustit-dobychu-molibdena-na-pyati-uchastkah/>

¹⁵⁵ <https://dprom.online/mining/dobycha-molibdena-v-rossii/>

¹⁵⁶ <https://www.infogeo.ru/metalls/news/?act=show&news=14896>

¹⁵⁷ Based on data on Russian imports of products under HS codes 720270 and 282570 for the period from April 1, 2024 through March 31, 2025, including transactions within the Eurasian Economic Union. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 8 and 9.

¹⁵⁸ Based on data on Russian imports of products under HS codes 720270 and 282570 for the period from April 1, 2024 through March 31, 2025, including transactions within the Eurasian Economic Union. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 8 and 9.

China as the Principal Compensator in Russia's Adaptation to Sanctions

In Russian supply chains, China simultaneously acts as the country of origin and shipping for Chinese products and as the country of shipping for minerals of non-Chinese origin. It is precisely this multifunctionality that makes it the systemic compensator for sanctions pressure after 2022.

China's role is most strikingly evident in the supply of tungsten and its products, particularly oxides and carbides. The main use of this metal is the manufacture of armor-piercing tank rounds with tungsten cores — including both modern Russian designs and modernized Soviet munitions, which still form the backbone of Russian arsenals.¹⁵⁹ Tungsten carbide is also used in armor-piercing ammunition for small arms, and since 2014, the Russian Federation has begun using it, in particular, in sniper and machine-gun ammunition.¹⁶⁰ Separately, with the development of combat UAVs, tungsten has begun to play an important role in drone warheads, where tungsten alloy pellets are used to enhance fragmentation effects and increase lethality.¹⁶¹ It is also used in certain elements of armor protection. However, in contemporary Russian armored vehicles, it is used much less often than in offensive weapons, where it is valued for its high density and hardness.¹⁶² In addition, tungsten is used in military aviation and missile equipment — to manufacture individual engine components, control systems, gyroscopic elements, and balancing weights — that is, wherever reliability and resistance to extreme loads are required.¹⁶³

Russia's need for tungsten and its processed products is growing. In 2024, consumption of tungsten concentrate stood at 4,100 tons per year, corresponding to approximately 2,000 tons of tungsten oxide; in 2025, the Russian Federation's tungsten demand was estimated at 3,000–3,300 tons.¹⁶⁴ However, despite having its own raw-materials base, the Russian tungsten sector remains vulnerable due to weak processing and a historically export-oriented model. As of 2023, deposits were being developed in Primorsky Krai, Khabarovsk Krai, Buryatia, and the Republic of Sakha (Yakutia), with ore extraction totaling 3,830 tons of tungsten oxide equivalent.¹⁶⁵ However, about 60% of extracted ore was previously exported, primarily to China, where it was beneficiated and processed into concentrates and oxides, which Russian metallurgists then purchased.¹⁶⁶ After the full-scale invasion, this model collapsed: exports contracted sharply, processing capacity began to go

¹⁵⁹ <https://www.forgedmoly.com/ru/news/why-is-tungsten-is-used-in-weapons/>
<https://www.cia.gov/readingroom/docs/CIA-RDP83T00853R000200070002-6.pdf>
https://www.researchgate.net/publication/362002011_Lethality_of_Russian_Contemporary_APFSDS_Tank_Rounds_Against_NATO%27s_MBTs
<https://lostarmour.info/articles/obednennuy-uran-v-snaryadah-detalnuy-razbor>
<https://tass.ru/armiya-i-opk/5934063>
<https://topwar.ru/151541-jekspert-t-80bvm-sposoben-streljat-snarjadami-s-obedennym-uranom.html?ysclid=izru65xz7840770522>
<https://topwar.ru/225489-v-zone-provedeniya-specoperacii-vs-rf-primenjajut-novejshe-rossijskie-bronebojnye-snarjady-3bm60-svinec-2.html>
<https://www.bvtv.narod.ru/4/bps.htm>
https://www.kotsch88.de/m_125_mm_d-81.htm
<https://anna-news.info/tankovye-lekalo-rossijskoj-armii/>
<https://rg.ru/2024/03/11/mwm-rossijskij-tank-armata-smozhet-primeniat-snariady-vakuum-1.html>
<https://sev.tv/news/64206.html>

¹⁶⁰ <https://www.yatechmaterials.com/ru/technology/tungsten-carbide-armor-piercing-core/> ;
<https://gunmag.com.ua/puli-iz-volchej-peny/>
<https://www.unian.net/army/991660-rossiya-na-vostoke-ukrainyi-ispyityivaet-puli-iz-karbida-volframa-geletey.html>

¹⁶¹ <https://www.nytimes.com/2025/06/25/magazine/ukraine-russia-war-drone-shahed-iran.html>
<https://isis-online.org/isis-reports/alabugas-shahed-136-geran-2-warheads-a-dangerous-escalation>

¹⁶² <https://www.twz.com/russias-shahed-136-drones-now-feature-tungsten-shrapnel>

¹⁶³ <https://cyberleninka.ru/article/n/v-glubokom-tylu-kovalas-pobeda-promyshlennost-buryatii-v-gody-velikoy-otechestvennoy-voyny-1941-1945-gg/viewer>

¹⁶⁴ <https://www.wolframet.com/applications/radiation-shielding-and-collimators/industrial/>

¹⁶⁵ <https://ua.yunchtitanium.com/news/properties-and-application-of-tungsten-79978417.html>

¹⁶⁶ <https://www.cia.gov/readingroom/docs/CIA-RDP83T00853R000200070002-6.pdf>

¹⁶⁷ <https://mashnews.ru/zhdut-tajnogo-investora.-odin-iz-krupnykh-proizvoditelej-volframa-mozhet-poluchit-novogo-vladelca.html>

¹⁶⁸ <https://expertsouth.ru/articles/iskal-volfram-a-nashel-zoloto-gornorudnoe-mestorozhdenie-v-Tyrnauze-zhdet-novaya-zhizn/>

¹⁶⁹ <https://web.archive.org/web/20251228173318/https://www.kommersant.ru/doc/8293479>

¹⁷⁰ <https://tass.ru/ekonomika/22487817>

¹⁷¹ https://dzen.ru/a/Y2F9_U8BeS2sSvN?ysclid=m7boko2ray36129541

¹⁷² <https://www.metaltorg.ru/analytics/color/?id=546>

bankrupt, and Russia was forced to import not the ore itself but the products of its primary processing — above all, tungsten oxides.¹⁶⁷

It is at this very point that China's decisive role in the current supply chain manifests itself. While in 2022, 80.5 tons of tungsten oxide were imported from China into Russia, in the first 11 months of 2023, the figure had already risen to 472.5 tons, valued of nearly USD 14 million.¹⁶⁸ From April 2024 through March 2025, Russia's dependence on China for tungsten supplies was almost total. By country of origin, the PRC provided USD 9.82 million, or more than 97% of the value of all imported tungsten, and by country of shipping, USD 9.77 million, or nearly 97%. By physical volume, this concentration was even higher: China accounted for 240.82 tons — more than 99% of total tonnage. The remainder consists of negligible residual flows through Kazakhstan or other countries that do not alter the overall picture.¹⁶⁹ This Chinese monopoly has a simple explanation: China occupies around 85% of the global tungsten market.¹⁷⁰

Russia's dependence on imports, given the crisis condition of the industry, will continue for decades. Only in September 2024 did a new owner emerge for the bankrupt Unecha high-melting-point metal LLC. In the summer of 2025, the Novoorlovsky MPW was relaunched, with operations slowly being restored at both facilities.¹⁷¹ In addition, the tax situation in the industry is difficult: Russian tungsten extractors pay the mineral extraction tax at a rate of 28%, with a preferential rate of 8% applied only to selected projects in Zabaykalsky Krai.¹⁷² Initiatives are currently under discussion to eliminate the tax for the next 15 years to support enterprises in the industry, but this conflicts with the broader strategic problem of the budget deficit, which is being covered in part by increased taxes.¹⁷³

On the other hand, the launch of the Tyrnauz deposit in Kabardino-Balkaria and the Agytki deposit in the Republic of Sakha (Yakutia) is planned, both after 2029.¹⁷⁴ A likely alternative supply channel also appears to be Kazakhstan, which began extracting at the Bogutinskoye deposit in 2025.¹⁷⁵ In any case, over the next 3 to 5 years, Russia will remain dependent on imports of tungsten oxides — both in light of the systemic problems of the extractive industry as a whole and in the context of the deep crisis in the tungsten industry in particular.

Supplies of titanium-bearing concentrates to the Russian Federation — in particular, ilmenite and rutile — originate from the PRC, accounting for nearly half. Titanium is critically important for contemporary Russian military production thanks to its combination of light weight, high strength, and corrosion resistance, and its key consumers are enterprises in the aviation and engine-building complex.¹⁷⁶ Titanium alloys make up approximately 35–50% of the mass of modern fighters, and in the design of the Su-35, their share exceeds 50%.¹⁷⁷ Titanium is used to manufacture the main load-bearing elements of combat aircraft — wing spars, beams, fuselage joints, landing gears, flap attachment fittings — as well as components of jet engines that operate under high-temperature

¹⁶⁷ <https://www.kommersant.ru/doc/5571897>

¹⁶⁸ <https://delprof.ru/press-center/experts-pubs/sostoyanie-rynka-volframa-v-rossii/> ;
<https://nedradv.ru/nedradv.ru/resources?obj=ca79a46078f5785d6a24f2c3830d3258>

¹⁶⁹ Based on data on Russian imports of products under HS codes 284990, 282590, 810199, and 810110 for the period from April 1, 2024 through March 31, 2025, including transactions within the Eurasian Economic Union. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 18 and 19.

¹⁷⁰ <https://delprof.ru/press-center/experts-pubs/sostoyanie-rynka-volframa-v-rossii/>

¹⁷¹ <https://vostok.today/53644-na-novo-orlovskom-goke-zabajkalja-perezapuskajetsja-proizvodstvo-deficitnogo-volframa.html>
https://www.prometall.info/corp/drugie/volframovyj_zavod_poluchil_novogo_sobstvennika

¹⁷² <https://www.zakonrf.info/nk/337/>

<https://www.zakonrf.info/nk/342/>

<https://www.zakonrf.info/nk/342.8/>

¹⁷³ <https://www.finam.ru/publications/item/sf-predlozhit-obnolit-ndpi-na-dobychu-rud-redkozemelnykh-metallov-20250320-1708/>

<https://dprom.online/metallurgy/volfram-i-molibden-obnulijsya-li-stavka-ndpi/>

¹⁷⁴ <https://myseldon.com/ru/news/index/338880581>

<https://www.kommersant.ru/doc/8554463>

¹⁷⁵ <https://kz.kursiv.media/2026-03-19/rmch-kazakhstan-vorvalsya-v-volframovuyu-trojku/>

¹⁷⁶ <https://www.kvartu.ru/kak-tsvetnye-metally-ispolzuyutsya-v-voennoj-tehnike/>

¹⁷⁷ <https://cyberleninka.ru/article/n/vysokoproduktivnye-titanovye-splavy-v-aviatsionnykh-konstruktsiyah>

<https://ritm-magazine.com/ru/public/shlifovanie-detaley-iz-titanovykh-splavov>

loads.¹⁷⁸ For this reason, titanium is used in the production of engines for the Su-27/30/34, Su-35, and MiG-31, as well as strategic aviation.¹⁷⁹ Equally important is the application of titanium in missile equipment, where it is used to manufacture missile bodies, tubular engine structures, monolithic, welded, and brazed fuel tanks, tanks for compressed gases, and the casings of compartments containing solid-propellant motors.¹⁸⁰ Titanium alloys are used in the designs of the Bulava submarine-launched ballistic missile, the Topol-M intercontinental ballistic missile, the Zircon hypersonic cruise missile, the Sarmat super-heavy intercontinental ballistic missile, and the Avangard hypersonic glide vehicle. New grades are being developed to withstand extreme heat at speeds above Mach 5.¹⁸¹ The share of titanium in cruise missiles is also high: in UEC NPO Saturn engines for the Kalibr cruise missile and the Kinzhal air-launched ballistic missile, it accounts for 50–60%; for the Kh-101 air-launched cruise missile, about 70%; and for the Kh-31 air-to-surface missile, about 30%.¹⁸²

Since the start of the full-scale aggression, Russia's domestic demand for metallic titanium has grown noticeably, increasingly concentrated in militarily significant segments.¹⁸³ By the end of 2023, the Russian industry already needed more than 18,000 tons of titanium, of which 40% went to engine manufacturing and another 19% to aircraft, helicopter, and space production combined.¹⁸⁴ At the same time, meeting demand specifically for metallic titanium is not the Russian Federation's main problem: in 2023, Russian producers — primarily VSMPO-AVISMA Corporation — produced over 63,000 tons of titanium ingots, 18% more than in 2022.¹⁸⁵ The key vulnerability of the Russian titanium industry lies in raw material supply, and it is at this level that import dependency takes shape.

In 2024, the Russian Federation's total need for titanium feedstock stood at approximately 450,000 tons in titanium dioxide equivalent, while domestic extraction provided only 27,000 tons — meaning that over 96% of demand was covered through imports.¹⁸⁶ Before the full-scale invasion, the principal external source of raw materials was Ukraine. In 2020, approximately 80% of the feedstock for VSMPO-AVISMA Corporation came from Ukraine, and in 2022, this share fell to nearly zero. Investigative journalism, however, suggests that Ukrainian titanium ore may continue to reach the

¹⁷⁸ <https://ru.wisdomtitanium.com/knowledge/what-parts-of-an-aircraft-are-titanium->

¹⁷⁹ <https://rostec.ru/media/news/prodolzhenie-dvadsat-sedмого-pyat-luchshikh-samoletov-na-osnove-su-27/#middle>

<https://bnpd.livejournal.com/1308781.html?es=1>

<https://engine.aviaport.ru/issues/08/page39.html>

<https://vpk.name/library/f/hk-32.html>

https://www.rusarmy.com/avia/tu_22m3.htm

<https://dzen.ru/a/Zb4LxuQP62g2bOLm>

¹⁸⁰ <https://wek.ru/giperzvuk-titan-i-prochee-kakim-budet-novejshee-oruzhie-rossii>

¹⁸¹ <https://topwar.ru/144488-giperzvukovoy-avangard-poluchit-titanovyy-korpus.html>

https://vpk.name/news/221547_istochnik_raketa_avangard_poluchit_zharoprochnyi_titanovyi_korpus.html

https://voenkhronika.ru/publ/vojna_na_ukraine/russkaja_raketa_kotoruju_otlivajut_iz_titana_super_oruzhie_sozdannoe_dlja_unichtozhenija_amerikanskogo_zrk_pehriot_2022/60-1-0-12116

https://www.metotech.ru/art_titan_2.htm

Mach number (M) is a dimensionless unit of speed measurement in aerodynamics, equal to the ratio of an object's speed to the local speed of sound.

¹⁸² <https://www1.ru/news/2024/07/11/kolossalnye-zapasy-titana-aliuminila-bulgarian-military-obielasnilo-rost-proizvodstva-rossiiskix-rake.html>

<https://hvylya.net/news/261919-brodschij-poyasnil-kakaya-svyaz-mezhdu-prodannym-rossii-titanom-i-raketami-ubivayushimi-ukraincev>

<https://ren.tv/longread/1173436-supersovremennoe-oruzhie-rossii-unichtozhaet-bronepirog-tehniki-nato>

<http://www.airwar.ru/weapon/avz/x31p.html>

¹⁸³ In nature, titanium occurs primarily in oxide ores and minerals — chiefly ilmenite and rutile; rutile is naturally occurring TiO₂, while ilmenite is an iron-titanium oxide (FeTiO₃). According to USGS data, over 95% of titanium mineral concentrates go toward the production of pigment-grade titanium dioxide, while only around 5% goes toward titanium metal and other specialty applications; the primary civilian uses of TiO₂ are paints, plastics, and paper.

<https://pubs.usgs.gov/periodicals/mcs2025/mcs2025-titanium-minerals.pdf>

¹⁸⁴ <https://www.metalinfo.ru/ru/news/161102>

<https://www.metal-expo.ru/ru/news/6693>

¹⁸⁵ <https://www.metal-expo.ru/ru/news/6693>

¹⁸⁶ <https://dprom.online/mtindustry/proizvodstvo-titana-v-rossii-kakovy-perspektivy/>

https://translated.turbopages.org/proxy_u/en-ru.ru.bbca4b6d-67cac387-cd5c0391-74722d776562/https/worldpopulationreview.com/country-rankings/titanium-production-by-country

<https://trap.org.ua/publications/tyanova-pastka-iaak-zakhid-i-rosiia-zalyshaiutsia-u-vzaimnii-zalezhnosti-popry-viynu/>

<https://zn.ua/ECONOMICS/titanovaja-vzaimozavisimost-rossii-i-zapada-ukrainskij-titan-mozhet-popadat-v-rf.html>

Russian Federation indirectly.¹⁸⁷ After the loss of this channel, Russian imports of titanium-bearing concentrates — primarily ilmenite and rutile — were reoriented to Asian suppliers.

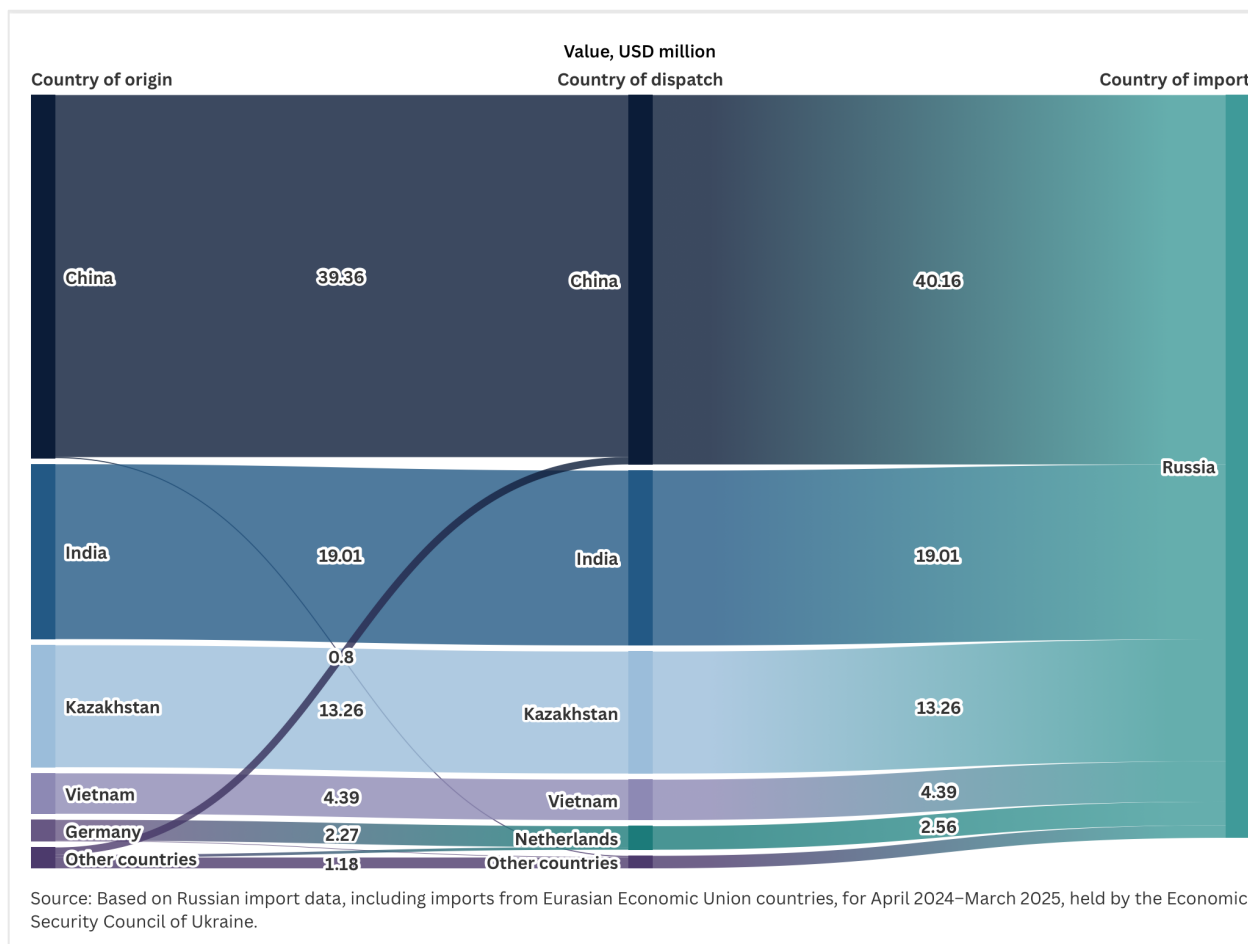


Fig. 18.1. Countries of origin and dispatch of titanium imported by Russia from April 2024 to March 2025 (value). Made with Flourish

China played the largest role in Russian imports of titanium-bearing concentrates during the period under review. From April 2024 through March 2025, it accounted for about half of the value of all supplies — USD 39.47 million by country of origin and USD 40.16 million by country of shipping. However, its share by physical volume was noticeably smaller — about 35%, or roughly 50,000 tons. Alongside China, India and Kazakhstan remained important suppliers. India accounted for nearly a quarter of the import value and nearly 30% of the mass, while Kazakhstan accounted for about 16% of the value and over a quarter of the physical volume. Vietnam played a significantly smaller role, providing about 5% of the value and slightly more than 7% of the mass of deliveries.¹⁸⁸ Thus, China is not an absolute monopolist by tonnage. Still, it has become the principal supplier by value and, accordingly, the key country in the renewed configuration of Russian titanium-feedstock imports.

¹⁸⁷ <https://www.nakanune.ru/articles/118381/>
<https://www.bfm.ru/news/531270>

¹⁸⁸ Based on data on Russian imports of products under HS code 2614 for the period from April 1, 2024 through March 31, 2025, including transactions within the Eurasian Economic Union. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 22 and 23.

Chinese participation will remain especially valuable, given the progress of Russian extractive projects: although Baikal-Amur Mining Corporation is increasing the extraction of titanium-magnetite concentrates at the Kuranakh deposit, the bulk will be exported, while other deposits remain undeveloped.¹⁸⁹ In some cases, the state returns titanium licenses to its own balance sheet. For example, in April 2026, the Bolshoy Seim deposit was left without an owner because the subsoil user failed to meet development deadlines.¹⁹⁰

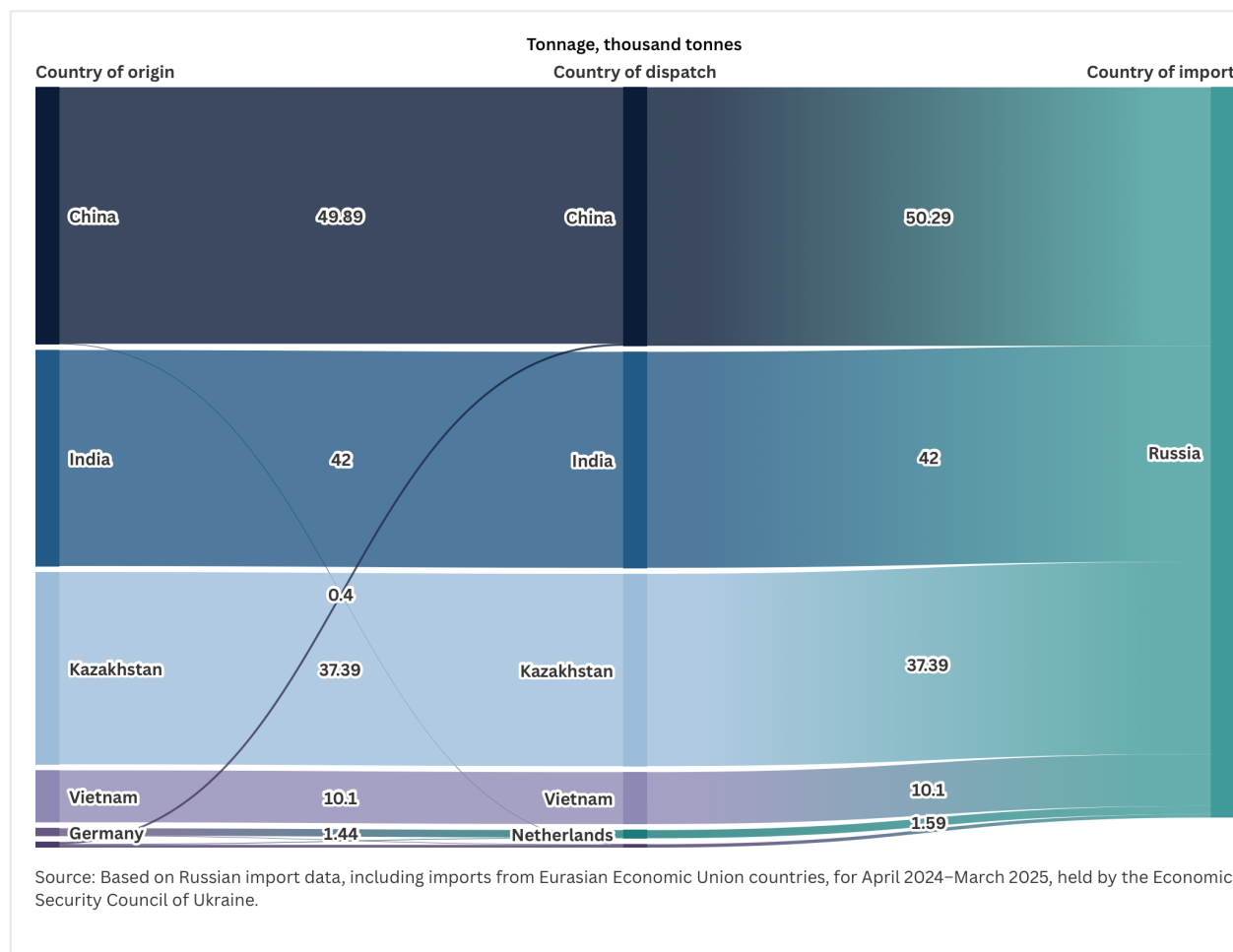


Fig. 18.2. Countries of origin and dispatch of titanium imported by Russia from April 2024 to March 2025 (tonnage). Made with Flourish

China's role with respect to niobium is especially telling, but no longer as the main source of the resource, but rather as a jurisdiction of shipping. Niobium, in its alloy with iron, is important for the RMIC primarily as an alloying additive in the production of high-strength, heat-treated, and corrosion-resistant steels used in missile bodies, engine components, and engine bells, armored vehicles, shipbuilding, and high-pressure pipelines.¹⁹¹ Even a small addition of niobium — about 0.03–0.05% — markedly increases the strength, impact toughness, and resistance of alloys, so its role in specialty steels is disproportionately large.¹⁹² Separately, niobium is used in specialized electronics, including niobium capacitors for military

¹⁸⁹ <https://vostok.today/54809-priamure-obespechivaet-syrem-titanovu-ju-promyshlennost-rossii-i-kitajskih-metallurgov.html>

¹⁹⁰ <https://www.kommersant.ru/doc/8624419>

¹⁹¹ <https://dzen.ru/a/Zy8wrhRy6FOSG79p?ysclid=mkv25ulth5585479077>

<https://xlom.ru/spravochnik/niobij-svoystva-primenenie-i-splavy-niobiya?ysclid=mkv7f4zw1l899493020>

¹⁹² <https://dzen.ru/a/ZSwf974F5kwVYpX>

and aviation equipment, as well as in heat-treated alloys and dual-use materials for the nuclear, aerospace, and high-temperature industries.¹⁹³

Russia's dependence on niobium imports, moreover, is distinctly structural. Despite Russia ranking second in the world in niobium reserves — approximately 20–25% of global reserves, or roughly 400,000 tons — its share of global extraction is only about 0.27%.¹⁹⁴ Actual industrial extraction is concentrated at the Lovozerskoye deposit in Murmansk oblast, and processing is carried out at the Solikamsk Magnesium Plant OJSC, which produces up to 500 tons of niobium pentoxide.¹⁹⁵ At the same time, actual niobium consumption in Russia stands at approximately 4,000 tons per year in metal-equivalent terms.¹⁹⁶ Thus, the gap between domestic demand and domestic production is multifold, and the deficit is covered through imports.

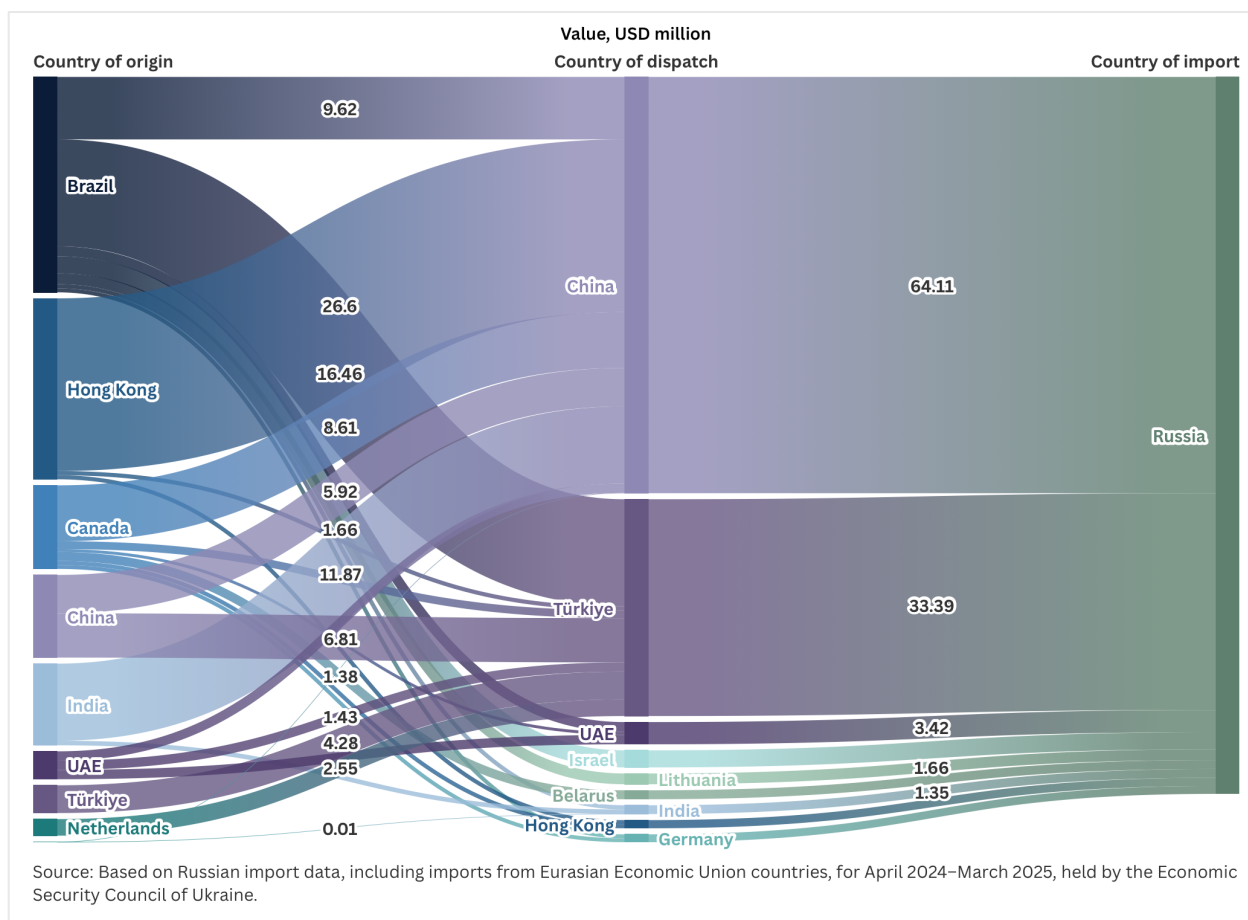


Fig. 19.1. Countries of origin and dispatch of niobium imported by Russia from April 2024 to March 2025 (value). Made with Flourish

¹⁹³ <https://dzen.ru/a/Zy8wrhRy6FO5G79p?ysclid=mkv25ulth5585479077>
<https://www.metotech.ru/niobi-y-opisanie.htm?ysclid=mkv5j3l7ma751814644>
<https://passive-components.eu/niobium-and-niobium-oxide-capacitors-overview/>
<https://elecond.ru/production/capacitors/niobium/>
<https://efind.ru/offer/%D0%9A53-19?ysclid=mlqnajikn4743730737>
<https://avia-solutions.ru/>
¹⁹⁴ <https://www.miningexpo.ru/articles/743>
<https://pubs.usgs.gov/periodicals/mcs2025/mcs2025-niobium.pdf>
¹⁹⁵ https://metallplace.ru/news180423_8/?ysclid=mko32olhnx160900185
¹⁹⁶ <https://habr.com/ru/companies/onlinepatent/articles/787064/>

Before 2022, Brazil remained Russia's key external source of ferroniobium, with total imports of approximately 3,280 tons. After 2022, this dependence did not disappear but merely changed form: supplies were partially restructured through parallel imports — Brazilian ferroniobium began to arrive through countries that do not themselves extract niobium, including via Lithuania, Turkey, Germany, Georgia, South Korea, and Ireland.¹⁹⁷ That is, Russia's adaptation to sanctions consisted not in creating a self-sufficient domestic cycle but in searching for new routes of access to the same external resource.

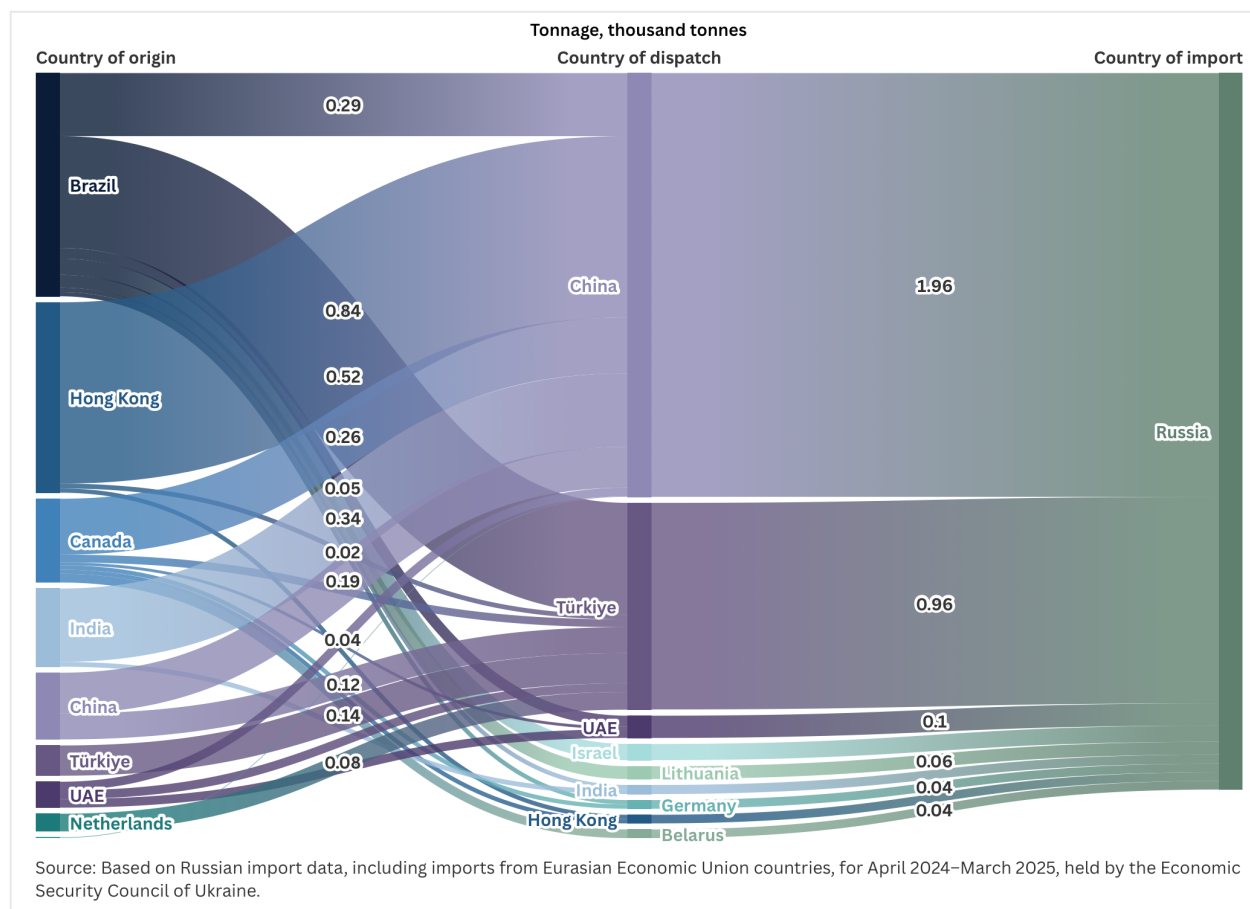


Fig. 19.2. Countries of origin and dispatch of niobium imported by Russia from April 2024 to March 2025 (tonnage). Made with Flourish

The most telling element in this restructuring is China's role specifically. In April 2024 – March 2025, by country of origin, niobium arriving in Russia originated from Brazil, Hong Kong, Canada, China, and India. By country of shipping, however, China accounted for USD 64.10 million, or 58.06% of the import value, and 1,732.79 tons — more than half of the physical volume.¹⁹⁸ Thus, China has become a central platform for Russia through which niobium products of various origins enter the country, and this role best illustrates the post-sanctions transformation of the import chain.

¹⁹⁷ https://metallplace.ru/news180423_8/?ysclid=mko32olhnx160900185

¹⁹⁸ Based on data on Russian imports of products under HS code 720293 for the period from April 1, 2024 through March 31, 2025, including transactions within the Eurasian Economic Union. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annex 16.

Despite declared plans to expand domestic production, no rapid overcoming of this dependence is in sight. The Strategy for the Development of the Metallurgical Industry to 2030 envisages preparing the Zashykhinskoye deposit in Irkutsk oblast and the Tomtorskoye deposit in the Republic of Sakha (Yakutia) for operation, but both projects face serious structural barriers.¹⁹⁹ Therefore, even given a substantial resource base, the expansion of domestic niobium production in Russia remains more a long-term declaration than a near-term industrial prospect.

Thus, China — already a critical supplier of several strategic minerals before the start of the full-scale invasion — has, after 2022, become the systemic compensator for sanctions pressure as well. Its role simultaneously encompasses both the supply of its own raw materials and products and the re-export of critical minerals extracted or produced in other countries. This is most clearly manifested in tungsten, titanium feedstock, and niobium, where China either directly fills critical shortfalls or provides the route through which products of other origin enter Russia. It is precisely this multifunctional role that makes the PRC the key element of Russia's contemporary model of adaptation to sanctions in the field of strategic minerals.

Global South Countries as the Resource Base for Russia's Import Dependence

The third major group consists of Global South countries. They provide Russia with a resource base wherever it needs large physical volumes of raw materials or products at the early and intermediate stages of processing. In this group, dispersion is most clear: for some minerals, Russia draws not on a single external center but on a broad belt of non-Western suppliers.

The most illustrative example is manganese. For the Russian Federation, what is scarce is specifically manganese ore and concentrates — the base raw material to produce ferromanganese, silicomanganese, and metallic manganese. Manganese is important for the MIC primarily as a critical alloying element in steel production: about 85–90% of its global consumption is used in metallurgy, where it increases the strength, hardness, wear resistance, and impact toughness of alloys and reduces the brittleness of steel.²⁰⁰ Manganese ores are not used directly in military equipment. Still, through their derivative products, they are the base raw material for armor, structural, weapons, spring, and heat-treated steels used in armored vehicles, small-arms and artillery barrels, landing gears, shafts, gears, bearings, tracks, equipment hulls, and other components that operate under high mechanical and thermal loads.²⁰¹ Manganese compounds also have separate significance: manganese dioxide is used in the production of batteries and certain catalysts, including for military power sources and, probably, in some components of missile production — but this is an auxiliary rather than the main military application.²⁰²

Despite large formal reserves, Russia remains deeply dependent on imports of manganese feedstock. According to the Ministry of Natural Resources and Environment of the Russian Federation and the Federal Agency for Mineral Resources, as of January 1, 2023, the country's balance reserves of manganese ore totaled 283.3 million tons.²⁰³ However, this resource base has limited practical

¹⁹⁹ https://metallplace.ru/news180423_8/?ysclid=mko32olhnx160900185

²⁰⁰ <https://www.nato.int/en/news-and-events/articles/news/2024/12/11/nato-releases-list-of-12-defence-critical-raw-materials>

²⁰¹ <https://esu.com.ua/article-63566>

<https://metalzenith.com/blogs/steel-properties/manganese-steel-properties-and-key-applications>

https://www.splav-kharkov.com/choose_mat.php?class_id=110 ;

<https://alsimag.ru/marganets/>

<https://www.splav-kharkov.com/main.php>

²⁰² <https://www.rboschco.com/uk/products/inorganic-compound-powder/oxide-powder/manganese-dioxide-mno2-cas-1313-13-9>

²⁰³ <https://dprom.online/metallurgy/dobicha-margantsa-v-rosseeee-pyerspektevi/> ;

value, since Russian manganese ores are mostly low-grade.²⁰⁴ According to the Ministry of Natural Resources, industrial extraction of manganese ores was not conducted in Russia from 2013 through 2020, while the country's production of manganese alloys grew by a factor of 2.1, reaching 742,000 tons in 2022.²⁰⁵ Imports sustained this growth: in 2020, Russia extracted only 188,000 tons of manganese ore but imported 1.189 million tons — that is, more than ten times what it extracted itself.²⁰⁶

After 2022, this dependence did not disappear but merely changed its geography. Before the full-scale invasion, Ukraine was the main supplier of manganese ore to Russia, with total imports reaching up to 1.5 million tons per year.²⁰⁷ After the loss of the Ukrainian channel, Global South countries became the primary sources of supply. As early as 2023, the leading producers of ore reaching Russia included Gabonese and South African companies. However, these supplies were carried out not directly but through a network of European traders and logistical companies, primarily in Estonia, Latvia, and the Netherlands.²⁰⁸

This same model persists today. By country of origin, Russian manganese imports during the period under review were sharply concentrated. South Africa remained the unequivocal leader, providing USD 179.38 million, or nearly 79% of supply value, and approximately 785,000 tons — over 73% of supply mass. A substantially smaller but still notable role was played by Côte d'Ivoire — slightly more than 9% of value and over 11% of mass — and Brazil, which accounted for about 8.5% of value and slightly more than 6% of physical volume. In other words, by origin, Russian manganese imports rested primarily on the African raw-materials base — above all, the South African one.

By country of shipping, however, the picture was significantly more ramified, which points directly to the importance of intermediary logistics. From April 2024 through March 2025, the largest shipping hub was Latvia, accounting for a third of supply value and about a quarter of supply mass. Next came South Africa and Turkey, each providing about a fifth of value, as well as China, which accounted for slightly more than 11%. Côte d'Ivoire and the UAE also played a notable, if smaller, role. Thus, while by origin, manganese for Russia arrived mainly from South Africa, in terms of logistics, its imports during the period under review rested on a broader network of transit and trade intermediaries.²⁰⁹

The Russian Federation now plans to meet its own manganese demand at the expense of Ukrainian subsoil in occupied territories. In April 2026, the Russian company Reale Engineering Invest LLC began geological exploration at the Velyko-Tokmak deposit in the Zaporizhzhia region. This deposit is among the five largest manganese deposits in the world, with a useful-component content of over 25%, making it far more promising than the deposits in the Urals. The project is to receive up to RUB 100 billion in investment.²¹⁰

Aluminum feedstock supply is even more polycentric. Aluminum alloys form the structural backbone of military aviation: they are used to manufacture skin, wing spars, beams, frames, landing-gear elements, rivets, and components of fuel, hydraulic, and oil systems, as well as individual engine

https://www.mnr.gov.ru/upload/iblock/42a/4xr9hgcas9sdixfirkes8pkrv9f3xmqv/%D0%9A%D0%BD%D0%B8%D0%B3%D0%B0_%D0%93%D0%94-2023_26.02.2025.pdf

²⁰⁴ <https://scispace.com/pdf/manganese-ferroalloys-of-russia-3rxunyavz.pdf>

See explanation in Chapter I.

²⁰⁵ <https://dprom.online/metallurgy/dobicha-margantsa-v-rosseeee-pyerspektevi/>

²⁰⁶ <https://theins.ru/en/inv/284017> ;

<https://link.springer.com/article/10.1134/S1075701523050069>

On the quality of Russian manganese ores, see Chapter I.

²⁰⁷ <https://theins.ru/en/inv/284017> ;

<https://topwar.ru/251844-marganec-hrom-i-titan-starye-rychagi-vlijaniya-na-rossiju.html>

²⁰⁸ <https://theins.ru/en/inv/284017>

²⁰⁹ Based on data on Russian imports of products under HS code 260200 for the period from April 1, 2024 through March 31, 2025, including transactions within the Eurasian Economic Union. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 14 and 15.

²¹⁰ <https://biz.liga.net/all/industry/novosti/rossiya-nachala-geologorazvedku-na-krupneishem-mestorozhdenii-margantsa-v-ukraine>

parts; in combat aircraft designs, their role is massive, as illustrated by hundreds of thousands of rivets on fighters and up to a million on bombers.²¹¹ Aluminum is also used in aircraft engines, particularly for aluminized protective coatings of turbine blades, and in missile equipment — in fuze and detonator casings, individual munitions components, thermobaric mixtures, solid rocket propellant, and explosives, where aluminum powder raises the reaction temperature and energy characteristics.²¹² Aluminum alloys are also of particular significance for armored vehicles and the navy: they are used to manufacture the hulls of amphibious combat vehicles and landing craft, ship superstructures, and elements of hovercraft and hydrofoils, thereby reducing weight without critical loss of protection or strength.²¹³

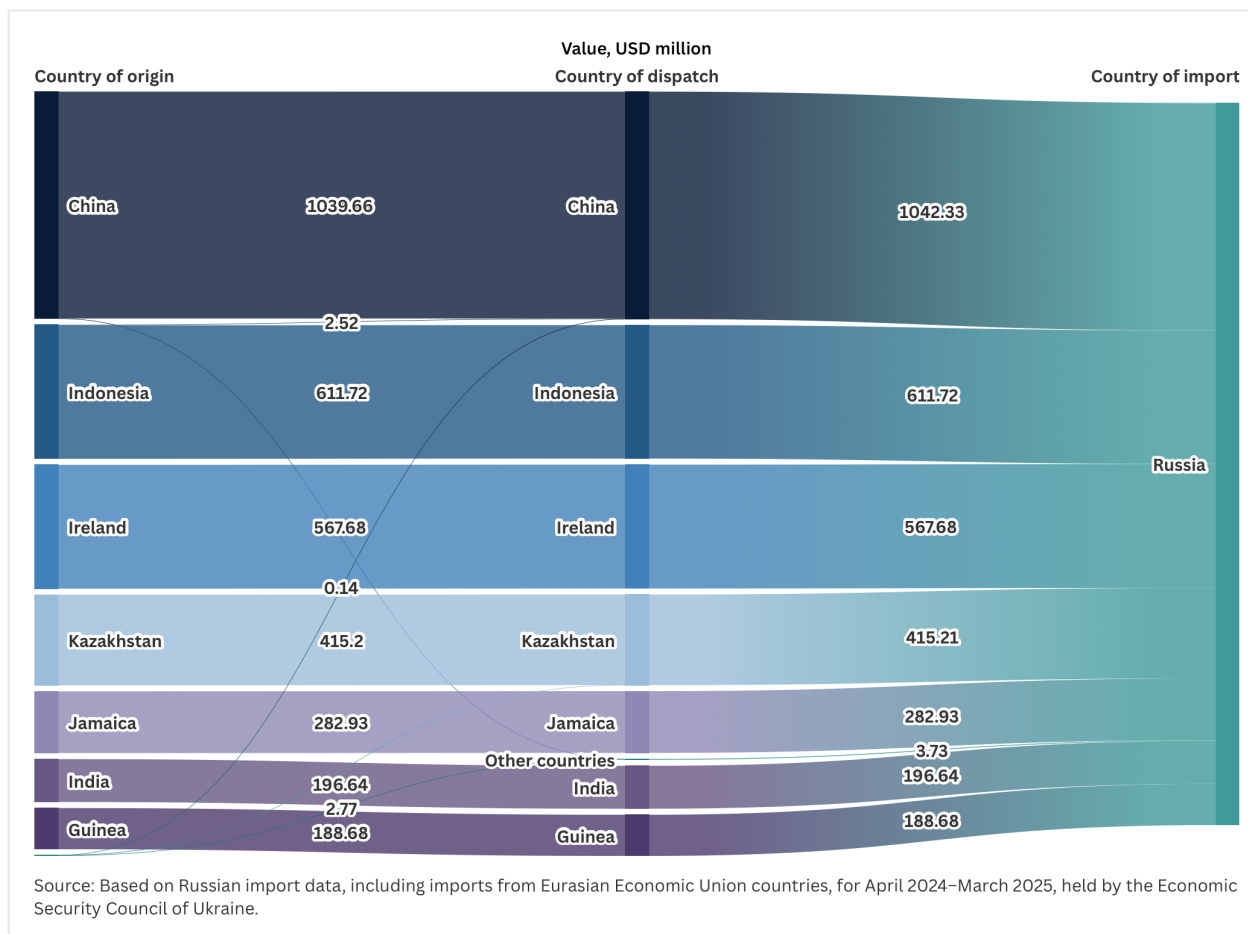


Fig. 20.1. Countries of origin and dispatch of alumina imported by Russia from April 2024 to March 2025 (value). Made with Flourish

²¹¹ <https://poisknews.ru/nauchnyj-likbez/boksity/>

<https://bit.ly/4t1NbGG>

²¹² <https://patents.google.com/patent/RU2107112C1/ru>

<https://avacs-avia.com/en/d-30kp-2>

<https://topwar.ru/205497-kitaj-razrabotal-sobstvennyj-dvigatel-dlja-istrebitelej-serii-chengdu-vzamen-rossijskogo-al-31f.html>

https://www.gichd.org/fileadmin/uploads/gichd/Publications/GICHU_Ukraine_Guide_2022_Second_Edition_in_Ukrainian.pdf
Alitizing (from German alitieren — to alitize, from Al — aluminum) is a diffusion coating of steel and cast-iron products with aluminum to prevent their oxidation at high temperatures; a variety of, and in many cases a synonym for, aluminizing.

²¹³ <https://www.chalcoaluminum.ru/application/aluminium-military/>

https://web.archive.org/web/20150418160327/http://www.znamia.ru/produkcija1/primenenie_agregatov_proizvodimyh_i_remontiruemyh_na_oao_mmz_znamya1/military/boevaya_mashina_pehoty_bmp_3/

Despite the considerable scale of the Russian aluminum industry, its key vulnerability lies not in metal output but in the supply of high-quality feedstock — alumina (aluminum oxides), which is extracted from bauxite. Russia ranks ninth in the world in bauxite reserves and seventh in bauxite extraction.²¹⁴ At the same time, Russian bauxites generally fall short of foreign equivalents in quality and often require more complex development conditions.²¹⁵ For this reason, even by drawing on nepheline ores as an alternative aluminum feedstock, Russia is unable to meet its own alumina needs fully.²¹⁶ Domestic Russian demand for alumina is estimated at approximately 8 million tons per year, while in 2023, production totaled only 2.78 million tons.²¹⁷

This shortage is long-term and has historically been offset by the external assets of United Company Rusal, which effectively controls nearly the entire production chain of Russia's aluminum industry.²¹⁸ As early as 2022, United Company Rusal had placed over 60% of its alumina capacity abroad. The company owned or controlled bauxite, alumina, and aluminum assets in Australia, Guyana, Guinea, Ireland, Italy, Nigeria, Romania, Ukraine, Sweden, and Jamaica.²¹⁹ Two hubs were especially important: the Mykolaiv Alumina Plant in Ukraine, which accounted for up to 20% of the company's alumina production, and Queensland Alumina in Australia, which accounted for another roughly 20%.²²⁰ After the start of the full-scale invasion in 2022, Russia lost both sources: the Mykolaiv plant was halted and subsequently nationalized, while Australia banned the export of alumina and bauxite to Russia. This created a deficit of 2 to 2.5 million tons of alumina annually.²²¹

Further adaptation occurred not through domestic import substitution but through a swift reorientation toward external sources of finished alumina. China increased supplies from a minimal 2,300 tons to 1.1 million tons; India scaled up exports to 2.6 million tons and became the key supplier; and another approximately 400,000 tons arrived via the Eurasian Resources Group plant from Pavlodar, Kazakhstan.²²² In parallel, United Company Rusal began consolidating control over external feedstock sources: it acquired a 30% stake of China's Hebei Wenfeng New Materials and a stake in India's Pioneer Aluminum Industries Limited. It continued to bet on the company's Guinean assets.²²³

For this reason, alumina supplies to Russia from April 2024 through March 2025 were distinctly polycentric. The single largest jurisdiction remained China: it accounted for USD 1.04 billion, or about 31.5% of import value, and 1.626 million tons, or nearly 30% of its mass. At the same time, a broad group of other large suppliers formed around it. During the period under review, Indonesia provided about 18.5% of both supply value and physical volume; Ireland, approximately 17%; Kazakhstan, 12.5–13%; Jamaica, around 9%; and India and Guinea, another 5–6% each.²²⁴ This structure shows that the feedstock, critical to the aluminum cycle, reached Russia not from a single

²¹⁴ <https://rosnedra.gov.ru/data/Files/File/8762.pdf> p.153

²¹⁵ <https://old.bigenc.ru/geology/text/3438740>

See explanation in Chapter I

²¹⁶ Russia has a model of alumina production from nepheline ores that is rare in the global aluminum industry, whereas globally alumina is produced almost entirely from bauxite, and nepheline and nepheline-syenite ores are used mainly as industrial mineral raw materials to produce glass, ceramics, fillers, coatings, and polymers. This technology is more complex, as it requires integrated ore processing to yield not only alumina but also by-products — soda, potash, cement raw materials, and others. Industrial alumina production from nepheline ores is carried out based on the Achinsk and associated nepheline deposits, while in other countries nepheline raw materials are regarded primarily as a feldspar substitute in the glass and ceramics industries.

²¹⁷ <https://bit.ly/4t602rw>

²¹⁸ <https://rusal.ru/en/about/>

²¹⁹ https://www.rudmet.ru/media/docs/3_08_al.pdf

²²⁰ <https://morvesti.ru/themes/1694/105992/>

²²¹ <https://morvesti.ru/themes/1694/105992/>

²²² <https://morvesti.ru/themes/1694/105992/>

²²³ In Guinea, RUSAL controls the Friguia bauxite and alumina refinery complex, Compagnie des Bauxites de Kindia, and the Dian-Dian deposit.

https://www.rusal.ru/en/press-center/press-releases/rusal_restarts_operation_of_the_friguia_alumina_refinery_in_guinea/

<https://rusal.ru/en/about/geography/kompaniya-boksitov-kindii/>

<https://www.rusal.ru/en/about/geography/dian-dian/>

<https://news.mondiaara.com/categories/7/posts/107559>

https://www.prometall.info/corp/rusal/rusal_nashye_sposob_kompensirovat_poteri_ot_sanktsiy

<https://bb.lv/statja/v-mire/2024/07/27/iz-chego-sdelany-samolety-i-rakety-putina-40-syrya-rusal-daet-gvineya-video>

²²⁴ Based on data on Russian imports of products under HS code 281820 for the period from April 1, 2024, through March 31, 2025, including transactions within the EAEU. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 6 and 7.

dominant donor but through a multipolar network that combined China, Global South countries, post-Soviet jurisdictions, and even individual sanctions-coalition countries.

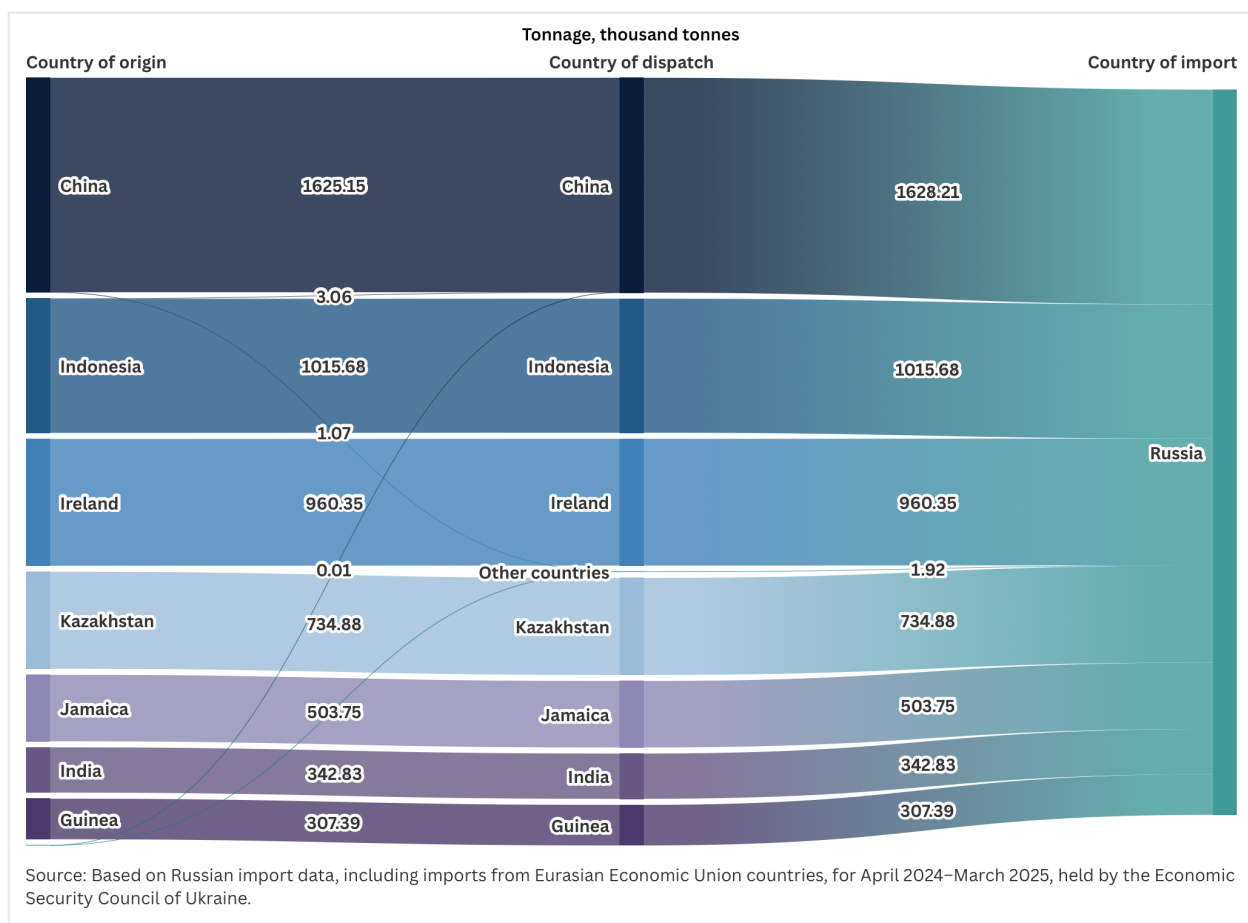


Fig. 20.2. Countries of origin and dispatch of alumina imported by Russia from April 2024 to March 2025 (tonnage). Made with Flourish

That said, sanctions pressure and the loss of some traditional sources have already noticeably worsened the industry's economics. In 2022, United Company Rusal's expenditures on alumina procurement grew by a factor of 1.5 to USD 1.8 billion, and the cost of producing one ton of aluminum rose by 31.8% in the second half of the year.²²⁵ Subsequently, the company faced declining profitability, rising logistics costs, a debt burden, and the gradual loss of Western markets, leading to a gradual reorientation of exports toward Asia, primarily China.²²⁶ The conflict in the Middle East, at first glance, ought to have played to the company's advantage by driving up primary aluminum prices, but in the long term, it poses more problems. The cost of dry-bulk transport by sea and rail has grown by 40 to 75%, primarily against the backdrop of a longer maritime "leg" around Africa, which will be reflected in the cost of feedstock procurement for United Company Rusal, while feedstock scarcity on the market due to the shutdown of Middle Eastern producers further drives costs upward.²²⁷

²²⁵ <https://morvesti.ru/themes/1694/105992/>

²²⁶ <https://www.rbc.ru/business/25/02/2025/67bcb2aa9a7947380253207e?ysclid=m7k0aq2tm3988553283>

https://www.prometall.info/novosti/rusal_obyavlyayet_finansovye_i_operatsionnye_rezultaty_za_2025_god

²²⁷ https://www.prometall.info/corp/rusal/importnyy_gliinozyem_i_logistika_protiv_otechestvennogo_alyuminiya

While China became the key shipper of ferroniobium during the period under review, Brazil remained the largest source of ferroniobium — accounting for USD 33.17 million, or about 30% of import value, and 983.31 tons, or nearly 30% of its mass.²²⁸ This corresponds to Brazil's global role: in 2024, Brazil accounted for about 93% of the world's niobium production.²²⁹

The remainder of the supplies had a substantially more intermediary nature. Hong Kong supplied USD 27.86 million, or slightly more than a quarter of the import value, and about 27.5% of the physical volume — though in this case, the matter is more of a trade and re-export hub than an independent raw-materials center.²³⁰ Canada provided another USD 12.87 million, or about 11.7%, remaining the second — though significantly smaller — center of primary niobium production.²³¹ China and India each accounted for approximately 11–12% of the value. Still, their role should also be understood primarily as participation in a broader trade-and-intermediation chain rather than as that of large primary niobium sources.

Thus, in those segments where Russia needs large physical volumes of raw materials or products of early and intermediate stages of processing, its dependency increasingly rests on Global South countries. Manganese, alumina, and part of the niobium chain exemplify a polycentric supply model in which the Russian Federation does not depend on a single supplier but works with a broad range of non-Western jurisdictions — from South Africa, Brazil, and Côte d'Ivoire to Indonesia, India, and Guinea. It is precisely this branching structure that makes this part of Russian imports more resilient to targeted restrictions, while simultaneously elevating the importance of the logistical, financial, and trading hubs through which these flows pass.

Sanctions-Coalition Jurisdictions as Visible but Non-Dominant Hubs

None of the minerals examined is predominantly coalitional in the sense of being dominated by sanctions-coalition jurisdictions. Still, in several cases, their role remains weighty and politically significant.

The most prominent example here is Ireland in the alumina case. From April 2024 through March 2025, Ireland accounted for USD 567.68 million, or slightly more than 17% of the value of Russian alumina imports, and 960,350 tons, or nearly 17.5% of its physical volume.²³² This makes Ireland one of the most visible individual hubs in this supply chain. The anomaly is explained above all by the role of Aughinish Alumina — Europe's largest alumina refinery, with a capacity of approximately 1.9–2.0 million tons per year, owned by United Company Rusal — which after 2022 acquired particular significance for the group as one of the few major Western assets that remained accessible following the shutdown of the Mykolaiv Alumina Plant and the loss of Queensland Alumina in Australia.²³³ Unlike primary aluminum from the Russian Federation, which the EU placed under separate import restrictions in 2025, the export of EU-produced alumina to Russia was not directly cut off, which allowed the Irish refinery to remain in operation.²³⁴

²²⁸ Based on data on Russian imports of products under HS code 720293 for the period from April 1, 2024, through March 31, 2025, including transactions within the Eurasian Economic Union. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 16 and 17.

²²⁹ <https://pubs.usgs.gov/periodicals/mcs2026/mcs2026-niobium.pdf>

²³⁰ <https://oec.world/en/profile/bilateral-product/ferro-niobium/reporter/hkg>

²³¹ <https://pubs.usgs.gov/periodicals/mcs2026/mcs2026-niobium.pdf>

²³² Based on data on Russian imports of products under HS code 281820 for the period from April 1, 2024, through March 31, 2025, including transactions within the EAEU. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 6 and 7.

²³³ <https://www.rte.ie/news/primetime/2022/0407/1291077-kremlin-linked-firms-banks-control-aughinish-owner/>

²³⁴ <https://www.occrp.org/en/investigation/inside-the-aluminum-supply-chain-linking-irish-industry-to-russian-rockets>

https://finance.ec.europa.eu/news/eu-adopts-16th-package-sanctions-against-russia-2025-02-24_en

For Ireland itself, Aughinish is too significant an industrial asset to be easily taken out of play: it is Europe's largest alumina refinery, and local and political assessments in 2026 described it as an entire local economic hub, with dependent contractors, transport, services, and households, and a thousand jobs.²³⁵ In addition, Aughinish has its own thermal power plant and sells surplus electricity back into the grid, which makes it an important player in the Irish energy market.²³⁶ Although debates over the refinery's operation have continued since at least March 2022, it marks the "red line" that European politicians are not prepared to cross in their sanctions pressure on the Russian Federation.

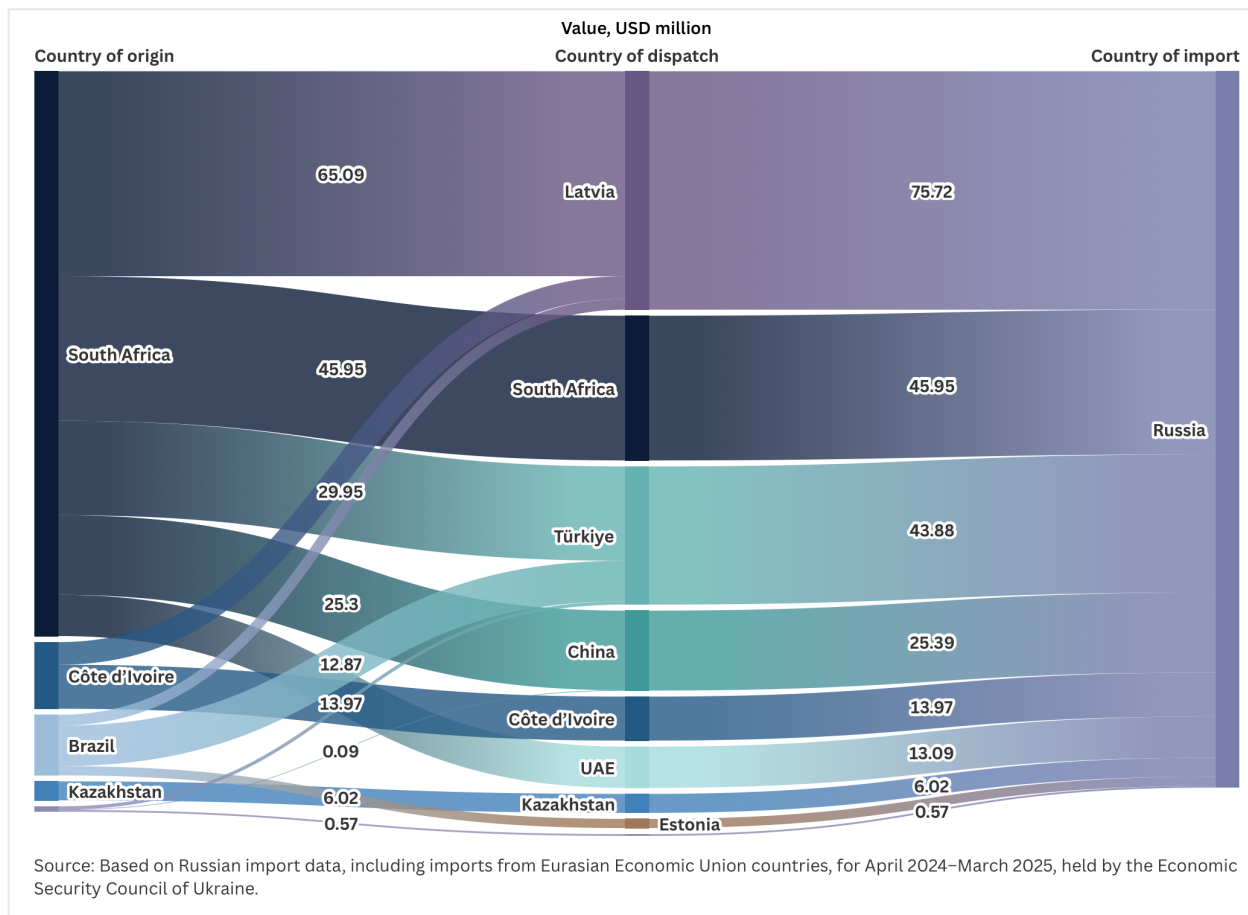


Fig. 21.1. Countries of origin and dispatch of manganese imported by Russia from April 2024 to March 2025 (value). Made with Flourish

In Russian niobium imports, Canada plays a notable role as a country of origin. During the period under review, it accounted for USD 12.87 million, or about 11.7% of the value of Russian imports.²³⁷ This broadly corresponds to Canada's place in the global supply chain: it accounts for about 5% of world niobium extraction, and in 2023 it supplied external markets with 9,540 tons of ferroniobium worth USD 279.2 million.²³⁸ Germany, by contrast, in the same chain, is better understood not as

²³⁵ <https://www.rte.ie/news/business/2024/1212/1486128-limerick-alumina-refining-ltd-results>

<https://www.thejournal.ie/aughinish-alumina-energy-market-6772808-Jul2025/>

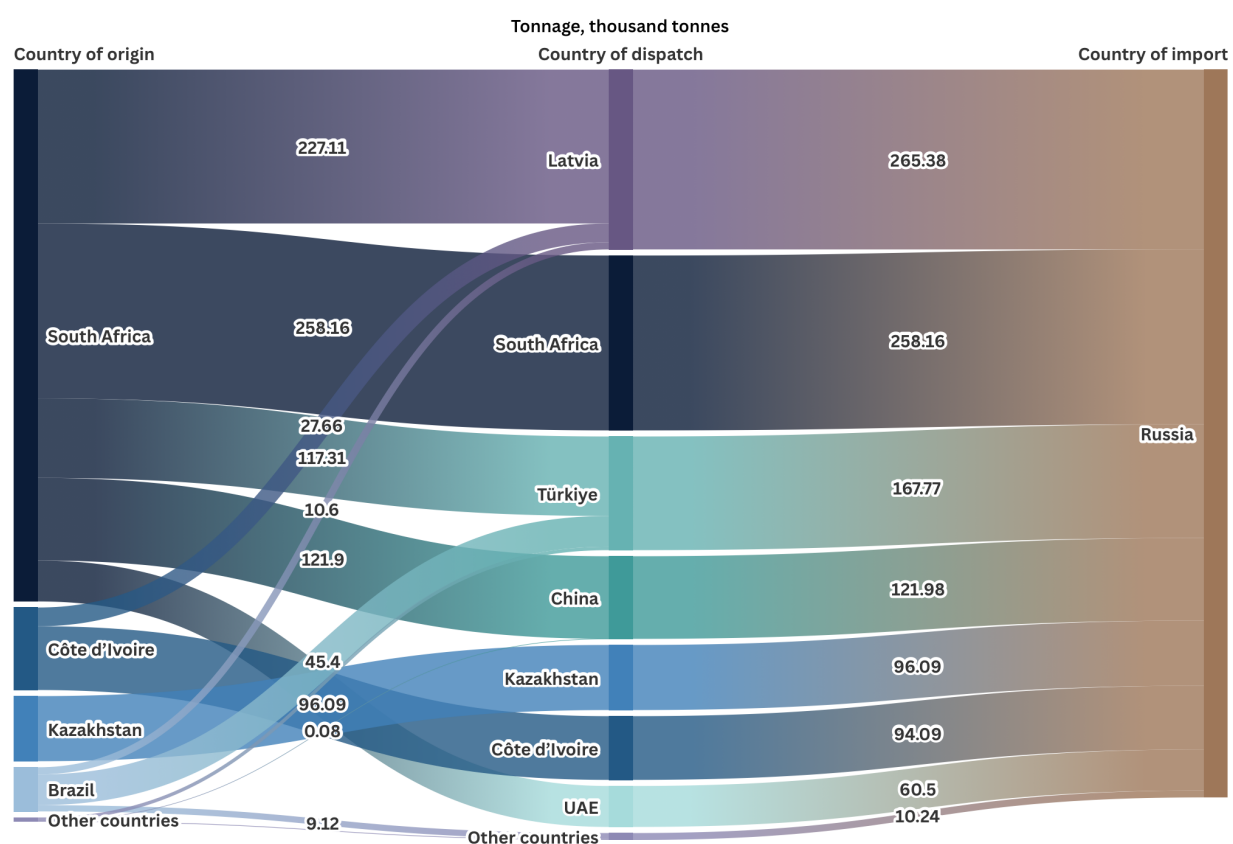
²³⁶ <https://www.rte.ie/news/business/2025/0724/1525210-government-working-very-closely-with-aughinish-alumina/>

²³⁷ Based on data on Russian imports of products under HS code 720293 for the period from April 1, 2024, through March 31, 2025, including transactions within the Eurasian Economic Union. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 16 and 17.

²³⁸ <https://pubs.usgs.gov/periodicals/mcs2026/mcs2026-niobium.pdf>

a source of raw materials but as a European hub for the redistribution and industrial circulation of ferroniobium.²³⁹

In the manganese chain, Latvia is especially important as a jurisdiction of shipping. From April 2024 through March 2025, USD 75.72 million passed through it, or about a third of the value of all Russian manganese supplies, as well as 265,380 tons, or nearly a quarter of their mass.²⁴⁰ This makes Latvia one of the key transit hubs in this chain, as previous investigative journalism has confirmed. Latvian public broadcasters LTV and Latvian Radio documented manganese ore transit to Russia through Latvia as early as March–April 2024: 1.2–1.3 million tons of manganese ore in 2022, 1.4 million tons in 2023, and another nearly 100,000 tons in the first months of 2024. The same investigations directly identified Latvian infrastructure — ports, railways, and traders — as one of the key transit channels for this commodity.²⁴¹



Source: Based on Russian import data, including imports from Eurasian Economic Union countries, for April 2024–March 2025, held by the Economic Security Council of Ukraine.

Fig. 21.2. Countries of origin and dispatch of manganese imported by Russia from April 2024 to March 2025 (tonnage). Made with Flourish

<https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2023/tradeflow/Exports/partner/WLD/product/720293>

<https://www.usgs.gov/centers/national-minerals-information-center/niobium-and-tantalum-statistics-and-information>

²³⁹ <https://pubs.usgs.gov/periodicals/mcs2026/mcs2026-niobium.pdf>

<https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2023/tradeflow/Exports/partner/WLD/product/720293>

<https://oec.world/en/profile/bilateral-product/ferro-niobium/reporter/rus>

²⁴⁰ Based on data on Russian imports of products under HS code 260200 for the period from April 1, 2024, through March 31, 2025, including transactions within the Eurasian Economic Union. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 14 and 15.

²⁴¹ <https://eng.ism.lv/article/economy/economy/21.03.2024-14-million-tonnes-of-manganese-ore-went-to-russia-through-latvia-in-2023.a547572/>

In the titanium case, the Netherlands remains a visible shipping hub: USD 2.56 million, or 3.17% of shipping value, and 1,590 tons, or 1.12% of mass.²⁴² These figures, although insignificant relative of total Russian imports, nonetheless confirm that the Netherlands is a pan-European routing point: the Port of Rotterdam remains Europe's largest seaport, and the Dutch trade model rests substantially on re-export.²⁴³ Accordingly, when the Netherlands appears in customs statistics as a country of origin or shipping for titanium or other mineral goods, this often reflects not its own raw-materials base but its systemic role as a logistical and trading hub through which goods are consolidated, reissued, and further redistributed across Europe and beyond — including to the Russian Federation.

Thus, although sanctions-coalition jurisdictions do not dominate Russia's supply of strategic minerals, their role remains politically and practically significant. Ireland in the alumina case, Canada and the Netherlands in niobium, Latvia in manganese logistics, and the Netherlands in titanium transit show that even a limited presence of coalition countries can carry disproportionate weight in the resilience of Russian supply chains. This means that the coalition's sanctions potential lies not only in directly banning supplies but also in shutting down transit, re-export, and redistribution hubs, without which a substantial part of Russian imports would become more expensive, slower, and less resilient.

²⁴² Based on data on Russian imports of products under HS code 2614 for the period from April 1, 2024, through March 31, 2025, including transactions within the Eurasian Economic Union. Detailed information on shares, tonnages, and values by jurisdiction is provided in Annexes 22 and 23.

²⁴³ <https://www.portofrotterdam.com/en/news-and-press-releases/cargo-throughput-port-rotterdam-slightly-decreased-2024>
<https://investinholland.com/doing-business-here/business-operations/smart-logistics/>
<https://www.cbs.nl/en-gb/news/2023/36/re-exports-higher-than-domestic-exports-in-2022>

SALT OF THE EARTH

CHAPTER III

HOW DO STRATEGIC MINERALS END
UP IN THE RMIC?



CHAPTER III. HOW DO STRATEGIC MINERALS END UP IN THE RMIC?

Whereas the previous chapter discussed the external channels through which Russia secures strategic minerals during the period under review, this chapter shifts attention to the next stage — how imported raw materials and their processed products are embedded into the production chains of the RMIC. The analysis is conducted based on three metals described in Chapter II: aluminum (specifically the feedstock for its production, alumina), molybdenum (particularly in alloy with iron and in compounds), and tantalum in the form of pure metal.

These metals were chosen for analysis because they represent three different levels of material dependence of the RMIC's material dependence. Aluminum represents the mass structural level — a large flow of raw materials and products by tonnage and value, used in casings, aircraft structures, missile components, armored vehicles, cable infrastructure, and certain components of explosives and solid rocket propellant. Molybdenum, in turn — though not a mass structural metal in the same sense as aluminum — is critical as an alloying additive for heat-treated steels and alloys that form the basis of engine manufacturing, providing strength, thermal resistance, and the operating life of components. Finally, tantalum represents the narrowest but technologically most sensitive segment — military electronics — because, despite substantially smaller import volumes, it is directly linked to tantalum capacitors, without which avionics, navigation, and control systems for air defense, missiles, and UAVs are impossible. Its criticality is determined not by the scale of supply but by the difficulty of substitution and its proximity to the final high-tech component.

Aluminum: The Structural Backbone of Aviation, Missiles, and Explosives

From April 1, 2024, through March 31, 2025, alumina imports to Russia were sharply concentrated in the hands of the Rusal group. Although the total number of importers was 37 companies, with aggregate imports of approximately 5.5 million tons worth USD 3.31 billion, five entities in the group — Bratsk Aluminum Smelter, Sayanogorsk Aluminum Smelter, Krasnoyarsk Aluminum Smelter, Taishet Aluminum Smelter, and United Company Rusal – Trade House JSC — imported 5.127 million tons of bauxite and alumina worth USD 3.094 billion. In other words, during the period under review, United Company Rusal alone accounted for over 93% of both the physical volume and the value of all such imports into the Russian Federation.²⁴⁴

At the same time, supplies largely flowed through United Company Rusal subsidiaries — primarily Beijing Rusal Trade Company Limited (PRC), Limerick Alumina Refining Limited (Ireland), and Uc Rusal Alumina Jamaica Ltd DbA Windalco (Jamaica).²⁴⁵ Other major suppliers included Alpia LLC and

²⁴⁴ ru: AT “Русал Братский Алюминиевый Завод”, TIN: 3803100054; Import value — USD 1,123,103,487.67.

ru: AT “Русал Саяногорский Алюминиевый Завод”, TIN: 1902014500; Import value — USD 973,782,830.46.

ru: AT “Русал Красноярский Алюминиевый Завод”, TIN: 2465000141; Import value — USD 424,084,295.59.

ru: AT “Объединенная Компания Русал - Торговый Дом”, TIN: 5519006211; Import value — USD 88,004,792.79.

ru: ТОВ “Русал Тайшетский Алюминиевый Завод”, TIN: 3815011264; Import value — USD 70,580,063.65.

²⁴⁵ <https://www.irishtimes.com/world/europe/2026/03/24/from-the-shannon-to-siberia-how-alumina-from-a-limerick-refinery-enters-russias-weapons-supply-chain/>;

<https://rusal.ru/en/about/geography/aughinish-alumina/> ;

<https://www.tendata.com/en/buyer/beijing-rusal-trade-company-ltd-CHNI8ed53f9c5ed53c0a54849cf887734034.html> ;

<https://rusal.ru/en/about/geography/windalco/> ;

<https://rusal.ru/en/about/geography/>

PT Bintan Alumina Indonesia, which are not subsidiaries of United Company Rusal but have a long history of business ties with the group.²⁴⁶ The largest role among suppliers was played by Beijing Rusal Trade Company Limited, which accounted for USD 965.2 million, or over a third of total supply value.²⁴⁷ Another roughly one-fifth was provided by PT Bintan Alumina Indonesia, and Alpia LLC supplied about 17%. Thus, alumina imports were, to a significant extent, organized as an intra-group or near-intra-group raw-materials supply chain serving the aluminum enterprises.

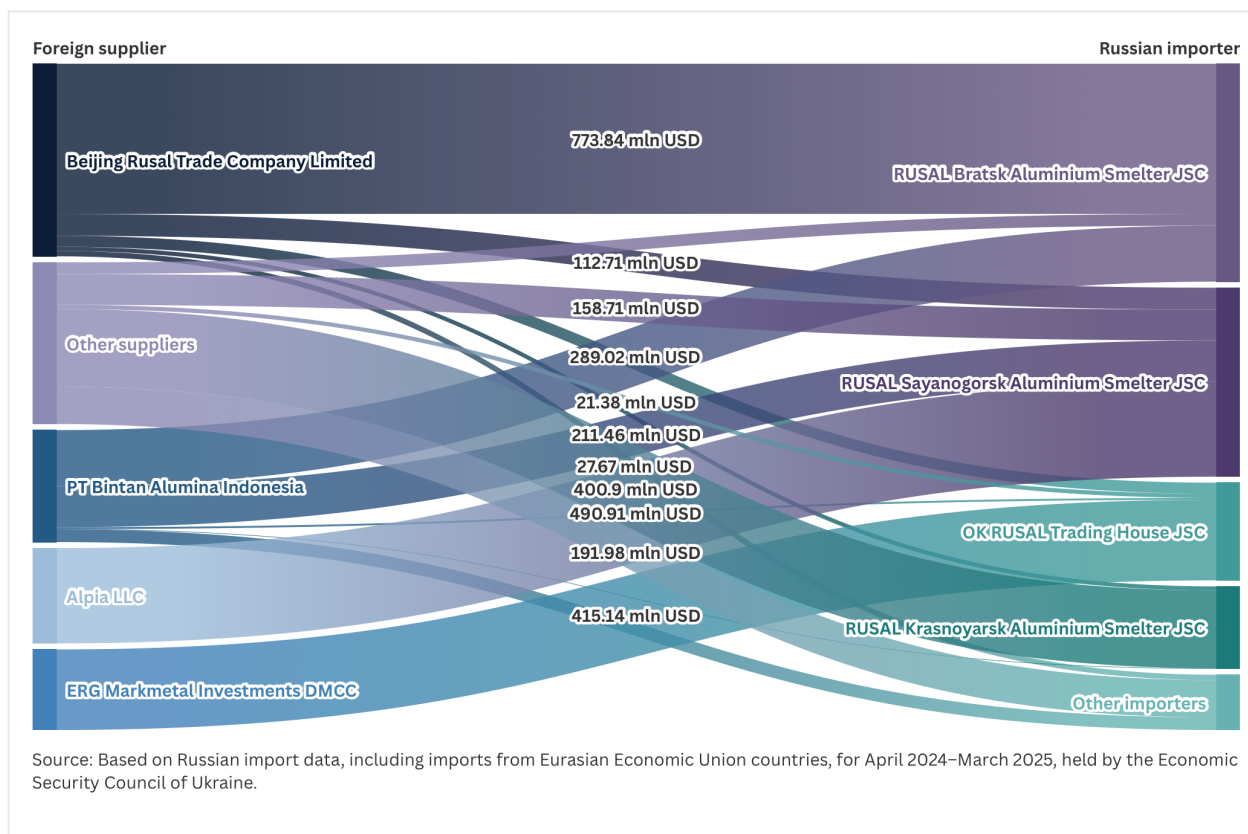


Fig. 22. List of the largest foreign suppliers and Russian importers of alumina from April 2024 to March 2025. Made with Flourish

According to financial data, the Rusal group's plants themselves do not display pronounced direct links with RMIC enterprises, which points to a predominantly indirect model of integration. Of all enterprises in the group, only United Company Rusal – Trade House JSC had historical contracts with RMIC enterprises: before 2022, it supplied products to Izhevsk Electromechanical Plant JSC (manufacturer of the 9K330 Tor and 9K33 Osa missile systems and UAVs); to Kamensk-Uralsk Foundry JSC (manufacturer of components for military aviation); and to Cheboksary Production

²⁴⁶ Beijing Rusal Trade Company Limited USCC: 91110105MA01QA7E6C;
Limerick Alumina Refining Limited LEI: 635400YOQLQP8GIOL317
Uc Rusal Alumina Jamaica Ltd Dbw Windalco e-mail: Elizabeth.McLaren@rusal.com;
Alpia LLC QFC Number: 02419;
PT Bintan Alumina Indonesia PermID: 5069468854

Detailed information on foreign alumina shippers is provided in Annex 24.

²⁴⁷ The value of deliveries from Limerick Alumina Refining Limited amounted to USD 307,857,174.46 (10.6%), from UC Rusal Alumina Jamaica Ltd dba Windalco — USD 205,812,603.01 (1.8%).

Association Named After V.I. Chapaev JSC (the successor to the Sergievsky Powder Plant, engaged in equipping munitions and producing TNT, tetryl, detonators, and primers).²⁴⁸

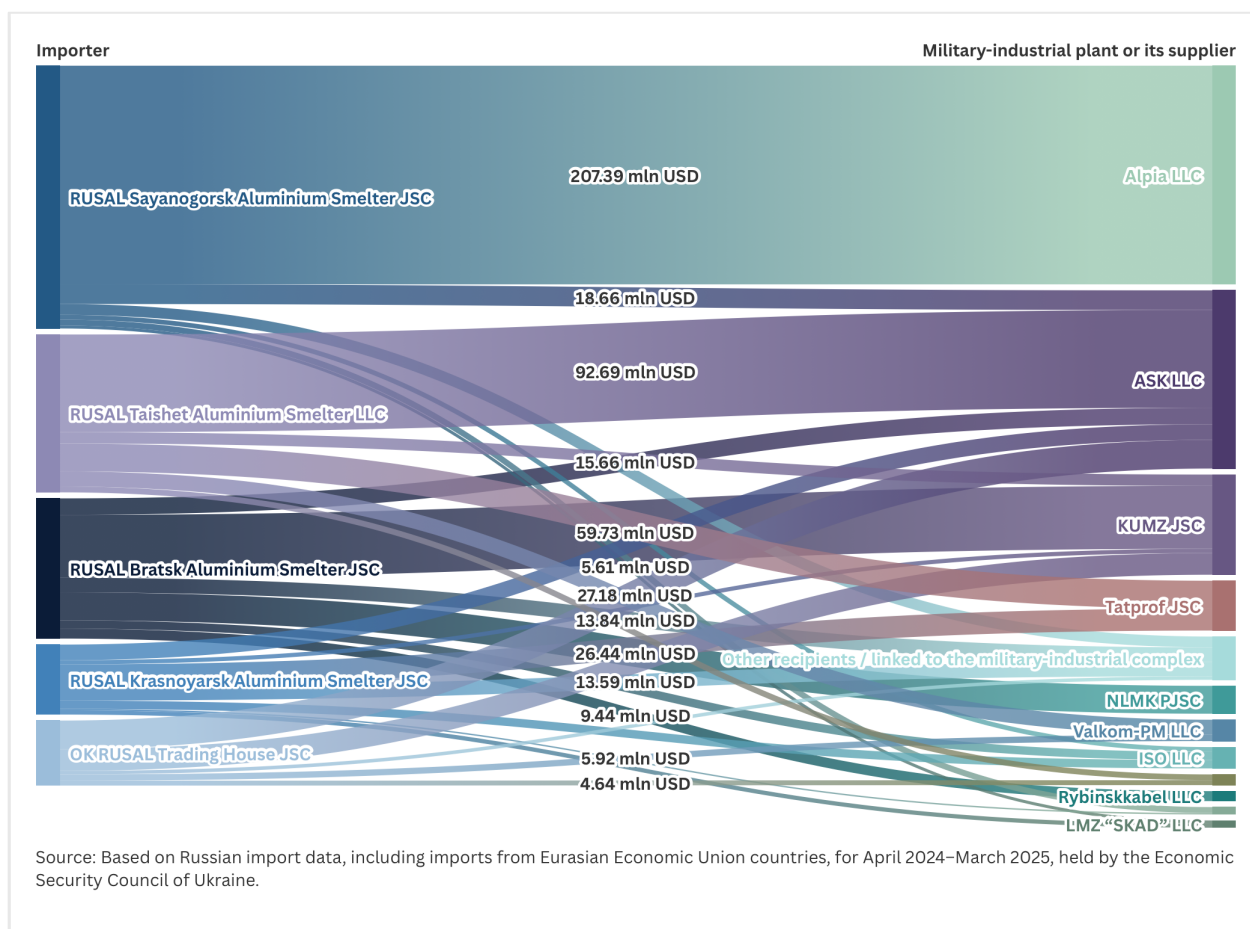


Fig. 23. Supplies by the largest alumina importers to Russian military-industrial enterprises or their suppliers from July 2024 to June 2025. Made with Flourish

Most likely, alumina imported by United Company Rusal — after being processed into primary aluminum or semi-finished products — is supplied to manufacturers or distributors that already work directly for the military sector. The most illustrative are Aluminum Sales Company LLC (ASC LLC), Kamensk-Uralsky Metallurgical Works JSC, Rybinsk Kable LLC, Ural-Siberian Specialized Company

²⁴⁸ (ru: AT "Объединенная Компания Русал - Торговый Дом", TIN: 5519006211);
 ru: AT "ИЭМЗ "Купол", TIN: 1831083343; the enterprise is subject to sanctions imposed by the United States from January 15, 2025, Canada from February 23, 2023, Switzerland from August 16, 2023, the EU from December 16, 2022, Australia from February 23, 2024, New Zealand from January 21, 2025, Japan from June 21, 2024, and Ukraine from October 19, 2022;
 ru: AT "КУЛЗ", TIN: 6666000100; the enterprise is subject to Ukrainian sanctions from October 8, 2024;
 ru: AT "Чебоксарское Производственное Объединение имени В.И.Чапая", TIN: 2130095159; The enterprise is subject to sanctions imposed by the United States (January 15, 2025), Canada (February 23, 2023), Switzerland (August 16, 2023), the EU (December 16, 2022), Australia (February 23, 2024), New Zealand (January 21, 2025), Japan (June 21, 2024), and Ukraine (October 19, 2022).
 According to internal reporting of the Russian companies Rusal Taishet LLC, Rusal Krasnoyarsk JSC, Rusal Bratsk JSC, Rusal Sayanogorsk JSC, and United Company Rusal - Trade House JSC, available to the Economic Security Council of Ukraine.
<https://www.rusprofile.ru/contractors/4274717/supplier>
<https://war-sanctions.gur.gov.ua/tools/company/3347>
<https://war-sanctions.gur.gov.ua/tools/company/1840>
<https://war-sanctions.gur.gov.ua/sanctions/companies/5135>
https://vpk.name/news/59489_vek_rossiiskogo_troila.html
<https://www.opensanctions.org/entities/NK-baGwnNbS5qPaifrTGBDwd4/>

LLC, and Orion – Spetsstavl – Gatchina LLC.²⁴⁹ In aggregate, these companies purchased products from United Company Rusal entities for at least USD 290.5 million, with the largest volumes going to ASC LLC (USD 169 million) and Kamensk-Uralsky Metallurgical Works JSC (USD 95 million). It is through these companies that aluminum raw materials and United Company Rusal's products enter the production chains of the military industry.

The most critical intermediary in this chain is ASC LLC, which works simultaneously with several United Company Rusal enterprises: the Bratsk, Sayanogorsk, Krasnoyarsk, and Taishet smelters, as well as United Company Rusal – Trade House JSC.²⁵⁰ ASC LLC, a large wholesale distributor of aluminum products, deals in casting alloys (AK12, AK7, AK9, AK5M2) and aluminum powders (ASD-1) directly relevant to the production of small arms, armored vehicles, aviation equipment, and warheads for the Kh-59M2/M2A missile.²⁵¹ During the period under review, ASC LLC's deliveries directly cover at least seven RMIC enterprises, spanning a fairly broad range of military production. On the one hand, the company works with manufacturers of munitions, explosives, and rocket propellant — particularly Federal State Enterprise "Plant Named After Y.M. Sverdlov" and Polymer JSC, which supply warheads for the UMPB D-30SN aerial munition and the FAB-500T and FAB-1500 high-explosive aerial bombs, and Federal State Enterprise Kamensky Combine, which produces solid propellant for munitions of the BM-27 Uragan, 9K58 Smerch, and 9K515 Tornado-S multiple rocket launchers. This broad list of explosives producers reflects the widespread use of aluminum in solid rocket propellant as an oxidizer that increases the heat-release temperature and the missile's specific impulse.²⁵² On the other hand, ASC's products also reach enterprises involved in producing finished platforms and weapons systems — including Concern Uralvagonzavod JSC (a tank and flame-thrower system manufacturer), Special Technological Centre LLC (STC LLC), which produces UAVs, and AAC Progress JSC, a helicopter manufacturer.²⁵³

Separately documented is the supply of ASD-1 aluminum powder to V.V. Bakhirev State Research Institute of Mechanical Engineering JSC, where it was used in the production of warheads for the Kh-59M2/M2A missile. In addition, two major contracts have been recorded — for approximately USD 1.95 million and USD 1.60 million — with enterprises operating in the rocket-propellant and engine-manufacturing segment.²⁵⁴ Finally, during the period under review, the company also

²⁴⁹ ru. ТОВ "Алюминиевая Сбытовая Компания", TIN: 7730236636
 ru. АТ "Каменск-Уральский Metallургический Завод", TIN: 6665002150
 ru. ТОВ "Урало-Сибирская Профильная Компания", TIN: 6678009883
 ru. ТОВ "Орион - Спецсплав - Гатчина", TIN: 4705020331
 ru. Rybinskable LLC, TIN: 7610093062

Detailed information on Russian alumina importers is provided in Annex 25.

²⁵⁰ ru. ТОВ "Алюминиевая Сбытовая Компания", TIN: 7730236636;

²⁵¹ <http://asc-trade.com/#prod>
<https://evек.org/reference/voennaya-promyshlennost-primenenie-alyuminiya.html>
<https://war-sanctions.gur.gov.ua/en/components/companies/11377>
<https://ntrs.nasa.gov/api/citations/20140002716/downloads/20140002716.pdf>

²⁵² Detailed information on Russian RMIC enterprises that were clients of alumina importers is provided in Annex 26.

ru. ФКП "Завод Имени Я.М. Свердлова", TIN: 5249002485; the enterprise is subject to sanctions imposed by the United States from January 15, 2025, Canada from February 21, 2024, Switzerland from June 27, 2023, the EU from June 23, 2023, the United Kingdom from February 22, 2024, Australia from February 23, 2024, Japan from December 15, 2023, and Ukraine from March 18, 2023;

ru. ФКП "Комбинат "Каменский", TIN: 6147025090; the enterprise is subject to sanctions imposed by the United States from December 12, 2023, Switzerland from December 24, 2024, the EU from December 16, 2024, the United Kingdom from June 13, 2024, and Ukraine from April 1, 2023;

ru. АТ "Концерн "Уралвагонзавод", TIN: 7706453206; the enterprise is subject to sanctions imposed by the United States from June 12, 2024, Switzerland from August 16, 2023, New Zealand from June 8, 2022, Japan from March 1, 2024, and Ukraine from December 7, 2023;

ru. ТОВ "СТЦ", TIN: 7802170553; the enterprise is subject to sanctions imposed by the United States from December 29, 2016, Canada from April 8, 2022, Switzerland from August 16, 2023, the EU from December 16, 2022, the United Kingdom from May 4, 2022, Japan from July 5, 2022, and Ukraine from March 18, 2023;

ru. АТ "ААК "Прогресс", TIN: 2501002394; the enterprise is subject to sanctions imposed by the United States from March 24, 2022, Switzerland from December 20, 2023, the EU from December 18, 2023, Japan from April 12, 2022, and Ukraine from October 19, 2022;

<https://checko.ru/company/ask-1177746542258#contracts>
<https://war-sanctions.gur.gov.ua/components/companies/8143>
<https://war-sanctions.gur.gov.ua/components/companies/8388>
<https://war-sanctions.gur.gov.ua/components/companies/9994>
<https://war-sanctions.gur.gov.ua/roster/11765>
<https://war-sanctions.gur.gov.ua/uav/companies/1693>
<https://war-sanctions.gur.gov.ua/tools/company/302>

²⁵⁴ ru. АТ "Госниимаш", TIN: 5249093130; the enterprise is subject to sanctions imposed by the United States from January 15, 2025, Canada from February 21, 2024, Switzerland from August 16, 2023, the EU from March 15, 2022, Australia from February 23, 2024, New Zealand from May 3, 2022, Japan from March 25, 2022, and Ukraine from October 19, 2022;

supplied products to VSMPO-AVISMA Corporation, which is indirectly linked to the RMIC — in the first quarter of 2024 alone, such deliveries exceeded USD 21 million.²⁵⁵

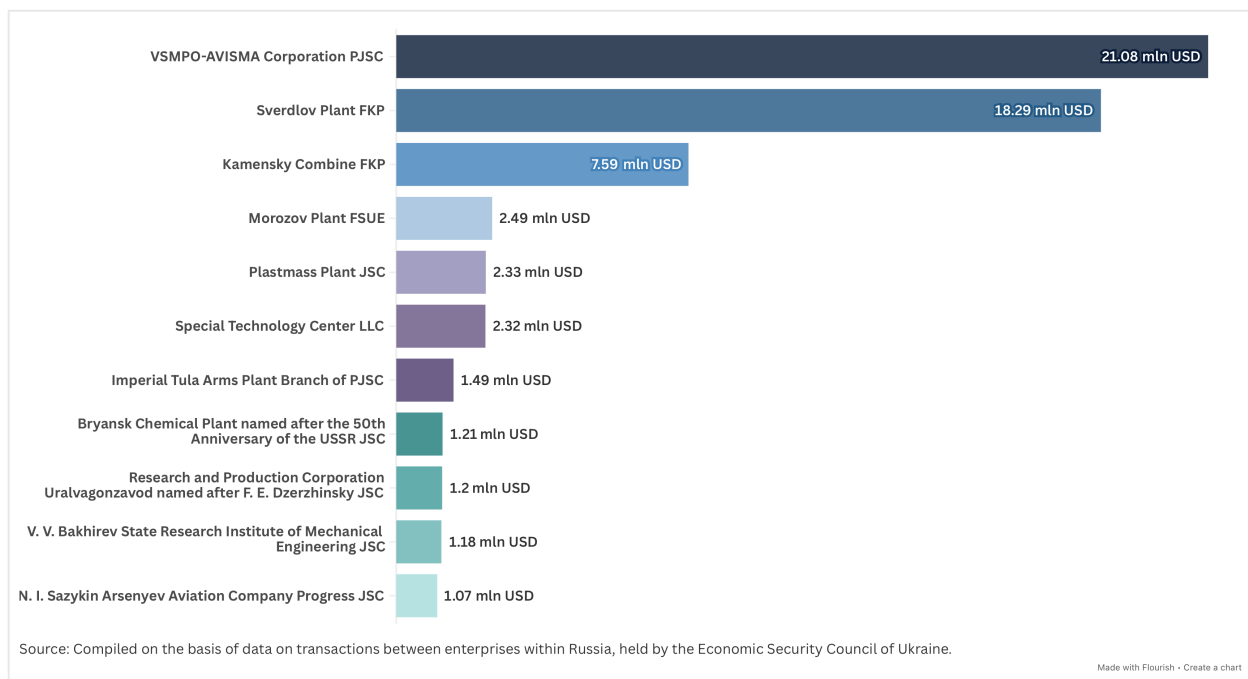


Fig. 24. Supplies by ASK LLC to Russian military-industrial enterprises from 2023 to 2025. Made with Flourish

The next major client of United Company Rusal — Kamensk-Uralsky Metallurgical Works JSC — is a major producer of high-tech aluminum alloys and semi-finished products for aviation, missile, and military equipment.²⁵⁶ The plant works with aluminum alloys 7075/V95, D16, 2219, 5083, and other grades used in structural elements of aircraft, missiles, warheads, armored vehicles, and naval platforms.²⁵⁷ Confirmed clients include:

- Yakovlev PJSC, manufacturer of the Su-30MS bomber, in which the center-wing surfaces (the main load-bearing assembly of the aircraft) are made from aluminum alloys, and of the Yak training-combat aircraft;
- Sukhoi Company JSC, manufacturer of military aircraft — in particular the Su-34, Su-35, and Su-30SM — in whose structure aluminum alloys are used in the fuselage, wings, and tail surfaces;
- Krasnoyarsk Machine-Building Plant JSC, which produces submarine-launched ballistic missiles R-29RMU2 Sineva and RSM-56 Bulava, in which aluminum alloys are used in casings and fuel tanks;

<https://war-sanctions.gur.gov.ua/ru/sanctions/companies/323>

²⁵⁵ ru: ПАТ"Корпорация ВСМПО-Ависма", TIN: 6607000556; the enterprise is subject to sanctions imposed by the United States from September 27, 2023, Canada from February 21, 2024, and New Zealand from June 8, 2022;

ru: АТ "Авиационная Холдинговая Компания "Сухой", TIN: 7740000090; the enterprise is subject to sanctions imposed by the United States from March 3, 2022, Canada from March 15, 2019, Switzerland from November 1, 2023, New Zealand from June 8, 2022, and Japan from March 1, 2022;

<https://war-sanctions.gur.gov.ua/sanctions/companies/1102>

<https://war-sanctions.gur.gov.ua/sanctions/companies/161>

²⁵⁶ ru. АТ"Каменск-Уральский Металлургический Завод", TIN: 6665002150)

²⁵⁷ <https://kumz.ru/products/>

<https://www.chalcoaluminum.com/uk/blog/differences-6061-7075-aluminum/>

<https://ekoproekt-kr.ru/articles/spravochnik-po-alyuminiyevim-splavam>

<https://firma-tera.com.ua/ua/a253906-harakteristiki-oblast-primeneniya.html>

<https://www.chalcoaluminum.com/uk/application/aluminium-military/>

- Votkinsk Plant JSC — manufacturer of the Oreshnik intermediate-range ballistic missile, the Iskander ballistic missiles (9M723 Iskander-M), and the RT-2PM2 Topol-M intercontinental ballistic missile, in which aluminum is used in stage casings, warhead components, and missile assembly structures.²⁵⁸

Other recipients of aluminum products demonstrate a more narrowly specialized but equally important role in the RMIC. During the period under review, Rybinskkable LLC — a manufacturer of cable products with military specialization — purchased over USD 9.4 million worth of products from the Bratsk Aluminum Smelter. These products were subsequently used in supplies to air defense, radar, radio electronics, and missile production enterprises. Rybinskkable's confirmed supply volume to RMIC enterprises exceeded USD 3.1 million.²⁵⁹ Its clients include air defense and radar enterprises — for example, Nizhny Novgorod Plant 70th Anniversary of Victory JSC (an Almaz-Antey structure and manufacturer of S-300 and S-400 air defense systems and antenna complexes); ballistic missile producers, including the 9M723 Iskander-M (Votkinsk Plant); and companies producing radio electronics and electronic warfare systems.²⁶⁰ In addition, the company supplied several enterprises engaged in the production of electronics and cables — Kovylkinskiy Electromechanical Plant PJSC and Mikran Research and Production Company JSC.²⁶¹

A similar role during the period under review was played by Kamskiy Kabel LLC, which produces wires and cables for the Russian Federation's aviation and shipbuilding industries. From April 2024 through March 2025, the company purchased over USD 5.5 million worth of aluminum wire and billets from the Bratsk Aluminum Smelter, and the confirmed volume of its subsequent supplies to RMIC enterprises was at least USD 3 million.²⁶² Among such recipients were enterprises connected with the production of UAVs and their control systems. In particular, Kamskiy Kabel supplied

²⁵⁸ The value of deliveries to Yakovlev PJSC — RUB 608 million; to Sukhoi — RUB 1.4 billion; Votkinsk Plant JSC — RUB 911 million; Krasnoyarsk Machine-Building Plant JSC — RUB 436 million;
ru: ПАТ “Яковлев”, TIN: 3807002509; the enterprise is subject to sanctions imposed by the United States from January 15, 2025, Canada from March 10, 2022, Switzerland from December 20, 2023, the EU from March 13, 2023, New Zealand from September 16, 2025, Japan from January 27, 2023, and Ukraine from October 19, 2022;
ru: АТ “Красмаш”, TIN: 2462206345; the enterprise is subject to sanctions imposed by Switzerland from December 13, 2025, the EU from October 23, 2025, and Ukraine from March 18, 2023;
ru: АТ “Воткинский Завод”, TIN: 1828020110; the enterprise is subject to sanctions imposed by the United States from June 2, 2022, Switzerland from August 16, 2023, the EU from December 16, 2022, the United Kingdom from December 6, 2023, Australia from February 24, 2025, Japan from May 26, 2023, and Ukraine from October 19, 2022;
<https://www.rusprofile.ru/contractors/2668666/supplier>
<https://dfnc.ru/arhiv-kataloga-predpriyatij/predpriyatiya/grc-makeeva/>
<https://www.dw.com/rv-udmurti-atakov-zavod-po-proizvodstvu-iskanderov-i-oresnika/a-76068545>
<https://checko.ru/company/1026600930707/contracts/data?role=supplier&law=223&year=&inn=>
<https://war-sanctions.gur.gov.ua/ru/sanctions/companies/131>
<https://war-sanctions.gur.gov.ua/sanctions/companies/260>
<https://vpk.name/library/f/suhoi.html>
<https://war-sanctions.gur.gov.ua/components/companies/3555>
<https://war-sanctions.gur.gov.ua/tools/company/5109>
<https://titus.kz/?previ=457>
<https://warbook.club/boepriyasy/rakety/raketa-sineva/>
<https://apni.ru/article/86-metalli-i-ikh-splavi-primenyaemie-v-aviastroeni>

²⁵⁹ <https://checko.ru/company/1117610006480/contracts/data>

²⁶⁰ The value of deliveries to Votkinsk Plant amounted to USD 106,930.00 in 2024; to Nizhny Novgorod Plant 70th Anniversary of Victory — USD 654,957.00 over 2024–2025;

ru: АТ “Нижегородский Завод 70-Летия Победы”, TIN: 5259113339; the enterprise is subject to sanctions imposed by the United States from December 12, 2023, Canada from August 22, 2023, Switzerland from August 16, 2023, the EU from December 16, 2022, Australia from February 23, 2024, and Japan from June 21, 2024;
<https://war-sanctions.gur.gov.ua/sanctions/companies/3557>
<https://checko.ru/company/rybinskkabel-1117610006480#contracts>
<https://checko.ru/company/rybinskkabel-1117610006480#contracts>
<https://flotprom.ru/%D0%A0%D1%8B%D0%B1%D0%B8%D0%BD%D1%81%D0%BA%D0%BA%D0%B0%D0%B1%D0%B5%D0%BB%D1%8C/>
<https://nevskii-bastion.ru/nmz/>
<https://war-sanctions.gur.gov.ua/components/companies/5109>

²⁶¹ The value of deliveries to Kovylkinskiy Electromechanical Plant PJSC amounted to 71,569.00; to Mikran Research and Production Company JSC — 93,058.00 over 2024–2025;

ru: “Ковылкинский электромеханический завод”, TIN: 1323010103; the enterprise is subject to Ukrainian sanctions from April 22, 2023;
ru: АТ “МПК “Микран”, TIN: 7017211757; the enterprise is subject to US sanctions from June 12, 2024;

<https://war-sanctions.gur.gov.ua/ru/tools/company/3626>
<https://war-sanctions.gur.gov.ua/sanctions/companies/9936>

²⁶² ru: ТОВ “Камский Кабель”, TIN: 5904184047, subject to US (OFAC) sanctions from October 30, 2024.

<https://kamkabel.ru/>
<https://checko.ru/company/kamsky-kabel-1085904004779>

products to Scientific and Production Corporation Systems of Precision Instrument Making JSC, which manufactures precision measurement equipment for unmanned aerial vehicles, including for the Kronshtadt Orion UAVs.²⁶³ In addition, deliveries to VNIIR-Progress JSC — a manufacturer of electronic components for UAVs and the 9M723 Iskander-M ballistic missile — were recorded for approximately USD 148,000.²⁶⁴ Overall, purchases by cable enterprises that received products from United Company Rusal and its subsidiaries amounted to nearly USD 18.8 million during the period under review.²⁶⁵

During the period under review, Ural-Siberian Specialized Company LLC purchased nearly USD 7 million worth of products from Sayanogorsk Aluminum Smelter and Krasnoyarsk Aluminum Smelter. The company produces aluminum alloys AD31, AD33, AD35, and AMts, which are used in the production of aviation structures, sighting systems, and combat UAVs.²⁶⁶ This is confirmed by the purchase, by the sanctioned Production Association Ural Optical-Mechanical Plant Named After E.S. Yalamov JSC, of AD31 aluminum profile from Ural-Siberian Specialized Company LLC, which can be used in the production of components for military products, including elements of thermal-imaging and optical-laser equipment for MiG, Su, and Tu aircraft and Ka and Mi helicopters.²⁶⁷ These aluminum products could subsequently be involved in the manufacture of Platan laser and television target stations and I-255B1/02 rev.3 optoelectronic sighting systems for Su-34 fighter-bombers.

From April 2024 through March 2025, Orion – Spetssplav – Gatchina LLC purchased over USD 10.1 million worth of products. The company produces alloys AK7, AK8, AK9, AK12, VAL, and other grades that may be used in the production of small arms, armored vehicles, aviation, and missile systems.²⁶⁸ The enterprise supplied products to the RMIC: VAL14P aluminum alloy, valued at over RUB 45 million, to Kamensk-Uralsk Foundry JSC, whose products are used in aviation equipment of PJSC United Aircraft Corporation and Russian Helicopters JSC, including components used in the Iskander-K cruise missile.²⁶⁹ In addition, Orion – Spetssplav – Gatchina LLC has historically supplied products to part of Il JSC — the aircraft plant of Voronezh Joint-Stock Aircraft Building Company, manufacturer of the Il-76MD-90A and Il-112V military aircraft — and to UEC-Perm Motors JSC, manufacturer of engines for military aviation, including the Mi-8 helicopter and Il-76MD military transport aircraft.²⁷⁰ Accordingly, the company's aluminum alloys support the production of military aviation, engines, and Iskander-K missile systems.

²⁶³ ru: AT «НПК»Системы Прецизионного Приборостроения», TIN: 7722698108; the enterprise is subject to sanctions imposed by the United States from July 20, 2023, Canada from February 21, 2024, Switzerland from December 24, 2024, the EU from December 16, 2024, and Ukraine from July 1, 2023; <https://war-sanctions.gur.gov.ua/components/companies/3593>

²⁶⁴ ru: AT «ВНИИР-Прогресс», TIN: 2130094170; subject to sanctions imposed by the United Kingdom (June 13, 2024), Switzerland (March 1, 2024), Australia (February 24, 2025), the EU (December 16, 2024).

<https://war-sanctions.gur.gov.ua/ru/components/companies/5930>

<https://war-sanctions.gur.gov.ua/uav/companies/5930>

²⁶⁵ Alyur Cable Plant LLC (ru: ТОВ «Кабельный Завод «АЛЮР», TIN: 6025013482; not subject to sanctions) — USD 2,039,302.78)

Rybinskkable LLC (ТОВ «Рыбинсккабель», TIN: 7610093062; not subject to sanctions) — USD 9,442,526.77

Kamskiy Kabel LLC (ru: ТОВ «Камский кабель», TIN: 5904184047; subject to US (OFAC) sanctions from October 30, 2024 — USD 5,502,062.57

Saranskakabel-Optika LLC (ru: ТОВ «Сарансккабель-Оптика», TIN: 1327153649; not subject to sanctions) — USD 1,826,051.94

²⁶⁶ ru: ТОВ «УСПК», ТОВ «Урало-Сибирская Профильная Компания», TIN: 6678009883; not subject to sanctions

<https://firma-tera.com.ua/ua/a253906-harakteristiki-oblast-primeneniya.html>

<https://cvetprokat.com.ua/alyuminiy/alyuminievyy-list-primenenie/>

<https://ekoproekt-kr.ru/articles/spravochnik-po-alyuminievym-splavam>

<https://war-sanctions.gur.gov.ua/en/roster/9339>

<https://war-sanctions.gur.gov.ua/en/components/companies/3367>

<https://war-sanctions.gur.gov.ua/en/components/companies/371>

²⁶⁷ ru: AT «Производственное объединение «Уральский оптико-механический завод» имени Э. С. Яламова», TIN: 6672315362; subject to sanctions imposed by Australia (July 20, 2023), the United States (June 28, 2022), New Zealand (August 2, 2022), Switzerland (March 29, 2023)

<https://www.opensanctions.org/entities/NK-k5ypJEASCL4DAYzbiQ2kM/>

<https://war-sanctions.gur.gov.ua/en/roster/9339>

<https://war-sanctions.gur.gov.ua/en/components/companies/3367>

²⁶⁸ ru: ТОВ «Орион - Спецсплав - Гатчина», TIN: 4705020331; not subject to sanctions

<https://evek.org/reference/voennaya-promyshlennost-primenenie-alyuminiya.html>

<https://extxe.com/14666/aljuminij-i-ego-splavy-2/>

²⁶⁹ ru: AT«Каменск-Уральский Литейный Завод», TIN: 6666000100; subject to Ukrainian sanctions

<https://war-sanctions.gur.gov.ua/ru/tools/company/1840>

²⁷⁰ ru: ПАТ«Авиационный Комплекс Им. С.В. Ильюшина», TIN: 7714027882; subject to sanctions imposed by the EU (from December 18, 2023), the United States, Switzerland (from January 25, 2023), Japan (from June 21, 2024)

Thus, the aluminum case shows that even where imported feedstock formally enters the civilian metallurgical cycle, its subsequent integration into military production is systemic and large-scale. Alumina, imported primarily by entities of the United Company Rusal group, after primary processing enters the production chain through downstream processing companies or wholesale distributors, above all, ASC LLC, Kamensk-Uralsky Metallurgical Works JSC, cable enterprises, and producers of profiles and specialty alloys. It is through these hubs that aluminum ends up in the production of combat aviation, missiles, armored vehicles, explosives, guidance systems, cable infrastructure, and other critical elements of the RMIC. This means that aluminum feedstock is a direct material foundation of the Russian war machine.

Molybdenum: An Alloying Additive in Specialty Steels

According to trade data, from April 2024 through March 2025, 35 Russian importer companies brought in slightly more than 4,190 tons of molybdenum products worth USD 155 million. The largest importers with confirmed RMIC ties were Semaks Metal LLC, Baltiyskaya Manufactura Scientific and Production Company LLC, and Unikhim LLC.²⁷¹ Together they accounted for USD 59.44 million in supplies and 1,778 tons in tonnage — nearly 40% of all molybdenum imports into the Russian Federation.²⁷² According to financial reporting, all three companies supplied products to Russian weapons producers or to enterprises deeply integrated into the RMIC.

Among the principal external sources of supply, Armenian, Chinese, and — in some cases — Indian companies stood out. Armenia's ARAMET played a notable role, supplying products to one of the largest importers, Semaks Metal LLC, among others. In some chains, Indian suppliers also appeared — notably Namoshree and Palvi Industries Ltd. At the same time, a significant share of imports was handled by several Chinese companies, further underscoring the importance of the Chinese channel in supplying Russia with molybdenum products during the period under review.²⁷³

From April 2024 through March 2025, Semaks Metal LLC was the largest importer of molybdenum products among companies linked to the RMIC, importing 1,272 tons of ferromolybdenum worth slightly more than USD 40 million. The company's products are used in segments related to aircraft engines, energy equipment, and precision equipment. This is confirmed, in particular, by historical supplies to the All-Russian Institute of Aviation Materials, which develops new materials and technologies primarily for aviation and other high-tech industries.²⁷⁴ As part of cooperation in the

ru: ПАТ «БАСО», TIN: 3650000959; subject to sanctions imposed by the EU (from December 18, 2023), the United States (June 6, 2022), Switzerland (from January 25, 2023), Ukraine

ru: АТ «ОДК-ПМ», TIN: 5904007312; subject to sanctions imposed by the United States, OFAC (from October 30, 2024), Switzerland (from January 25, 2023), Ukraine

<https://checko.ru/company/1024701246998/contracts/data?role=supplier>

<https://perm-motors.ru/production/avia/>

<https://war-sanctions.gur.gov.ua/ru/tools/company/1840>

<https://war-sanctions.gur.gov.ua/rostec/3353>

<https://www.opensanctions.org/entities/NK-jjC9JdkELnSRnJgBzUZUY/>

<https://www.opensanctions.org/entities/NK-jWLe9QJNGh37xgMmJwKHnp/>

²⁷¹ Detailed information on Russian molybdenum importers is provided in Annex 29.

²⁷² ru: ТОВ «Семакс Металл», TIN: 6168073560;

ru: ТОВ «НПФ «Балтийская Мануфактура»», TIN: 7801091980;

ru: ТОВ «Унихим», TIN: 7805755769;

The enterprises are not subject to sanctions.

²⁷³ Detailed information on foreign molybdenum shippers is provided in Annex 28.

Aramet N/A

Palvi Industries Ltd, info@palvichemical.com

Namoshree, office@namoshree.in

²⁷⁴ ru: НИЦ «Курчатовский Институт» - Виа, TIN: 7701024933. Subject to sanctions: Australia — from February 24, 2023; United States — from March 3, 2022; New Zealand — from August 2, 2022; Japan — from May 26, 2023; United Kingdom — from March 24, 2022.

production of the Kh-101 air-launched cruise missile, this institute develops and manufactures materials, composites, and thermal protection components.²⁷⁵

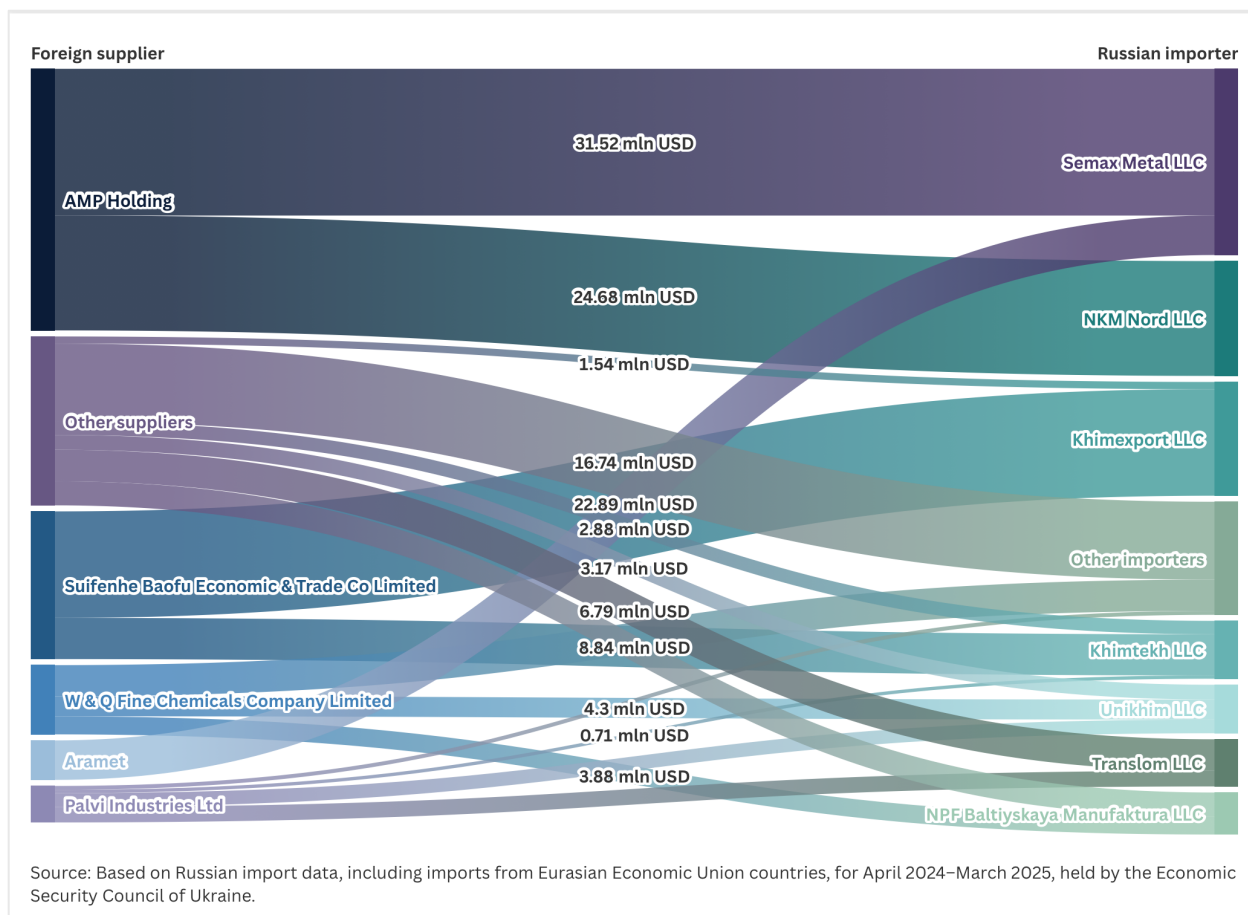


Fig. 25. List of the largest foreign suppliers and Russian importers of molybdenum from April 2024 to March 2025. Made with Flourish

Overall, during the period under review, the company had at least 10 major clients linked to the RMIC, with aggregate purchases of approximately USD 34.9 million.²⁷⁶ The most important channel is the supply of goods to the United Engine Corporation JSC (UEC JSC) holding and its subsidiaries — UEC JSC, UEC-Perm Motors JSC, UEC-UMPO PJSC, and UEC-Saturn PJSC.²⁷⁷ This holding is the core of Russian engine manufacturing. It covers the development, production, and servicing of engines for combat, military transport, and strategic aviation, as well as helicopters, missile systems, and several adjacent sectors.²⁷⁸ These enterprises accounted for at least USD 31.5 million

²⁷⁵ <https://war-sanctions.gur.gov.ua/ru/components/companies/246>

²⁷⁶ Detailed information on Russian RMIC enterprises that were clients of molybdenum importers is provided in Annex 30.

According to internal reporting of the Russian company Semaks Metal LLC, available to the Economic Security Council of Ukraine.

²⁷⁷ ru: ПАТ "ОДК", TIN: 7731644035. Subject to sanctions: United States — from December 22, 2015; Ukraine — from May 14, 2018 to May 14, 2021; Switzerland — from April 13, 2022; New Zealand — from June 8, 2022; Australia — from February 24, 2023; EU — from April 8, 2022.

ru: ПАТ "ОДК-Сатурн", TIN: 7610052644. Subject to sanctions: United States — from September 30, 2022; Switzerland — from March 4, 2022; Ukraine — from October 19, 2022 to October 19, 2027; Japan — from May 26, 2023; New Zealand — from June 8, 2022; EU — from December 18, 2023.

ru: ПАТ "ОДК-УМПО", TIN: 0273008320. Subject to sanctions: United States — from March 3, 2022; Ukraine — from October 19, 2022 to October 19, 2032; Japan — from May 26, 2023; New Zealand — from August 2, 2022; Switzerland — from January 25, 2023; EU — from October 23, 2025.

ru: ПАТ "ОДК-ПМ", TIN: 5904007312. Subject to sanctions: United States — from October 30, 2024; Ukraine — from October 19, 2022; Switzerland — from January 25, 2023.

²⁷⁸ <https://war-sanctions.gur.gov.ua/ru/components/companies/166>

in Semaks Metal sales, making the company one of the key suppliers of molybdenum products to the Russian engine-building segment of the RMIC.²⁷⁹

The UEC JSC holding develops and uses heat-treated alloys with molybdenum as an alloying element in the production of aircraft engines.²⁸⁰ Specifically, UEC-Perm Motors JSC uses molybdenum in the PS-90A and PD-14 engines that are used, among other things, on the Il-76MD military transport aircraft, where it increases thermal resistance and the operating life of components.²⁸¹ UEC-UMPO PJSC uses molybdenum in alloys for engine blades and disks of the AL-31F and AL-41F engines installed on Su-27, Su-34, and Su-35 fighters — underscoring the critical role of this metal in producing engines for combat aviation.²⁸²

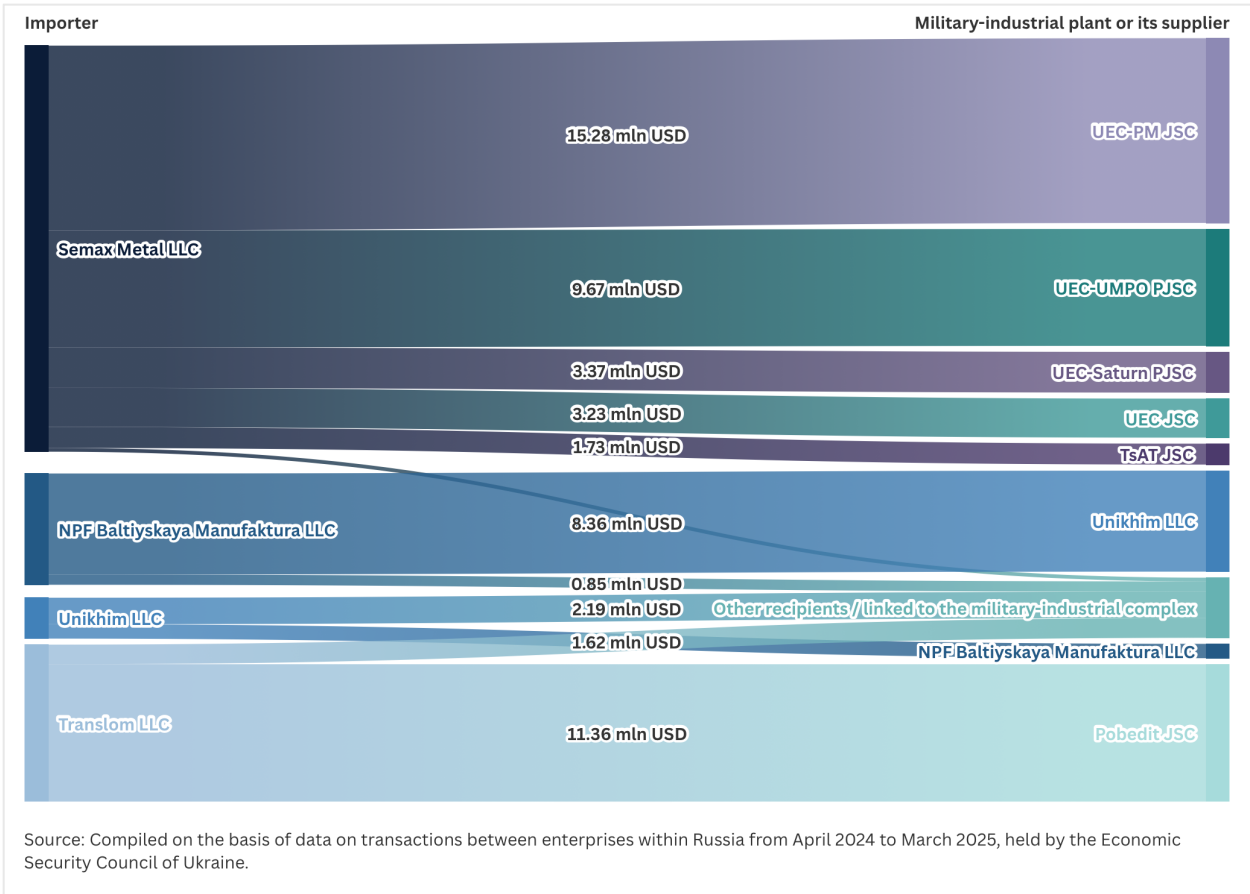


Fig. 26. Supplies by molybdenum importers to Russian military-industrial enterprises from July 2024 to June 2025. Made with Flourish

²⁷⁹ of which USD 3,229,871.10 fell to UEC JSC, USD 15,284,061.49 to UEC-Perm Motors JSC, USD 9,672,361.07 to UEC-UMPO PJSC, and USD 3,365,169.98 to UEC-Saturn PJSC.

²⁸⁰ Specifically, the patent "Heat-Resistant Nickel-Based Alloy and Article Made Therefrom" relates to materials for the manufacture of gas turbine engine blades; the alloy provides for a molybdenum content of 0.5–2.5%.

²⁸¹ <https://www.uecrus.com/upload/iblock/bc7/t6y20kumwr5hp2jzw5c91jpsr0igr9it/Spravochnik-kontrolyera.pdf>

²⁸² <https://war-sanctions.gur.gov.ua/ru/tools/company/3353>

<https://welder.stc-paton.com/pdf/welderua200304.pdf>

<https://paton.ua/ru/news/scho-take-naplavlennya-yakiy-zvaryvalniy-aparat-vibrati-i-yak-vikonuvati-naplavlennya/>

<https://nasplib.isoftware.kiev.ua/server/api/core/bitstreams/e2d8ddc1-073a-4bca-9e50-72e173bd9726/content>

<https://war-sanctions.gur.gov.ua/ru/roster/236>

<https://www.uecrus.com/about/structure/pao-odk-umpo/>

<https://dic.academic.ru/dic.nsf/ruwiki/100411>

http://viam-works.ru/en/articles?art_id=1232

https://www.splav-kharkov.com/mat_start.php?name_id=1297

Molybdenum plays a similar role in the production at UEC-Saturn PJSC, which manufactures the TRDD-50 engine for cruise missiles, the PD-8 and AL-41F1 engines, as well as engines and components for the Kh-59M2/M2A missile, the Izdeliye-30 missile, and the Su-34 aircraft. The company is also engaged in the repair and adaptation of missile engines, in which molybdenum is likely used as an alloying element for its ability to increase alloy strength and thermal resistance of alloys.²⁸³ Thus, in the Semaks Metal case, molybdenum is linked primarily to the engine-building segment of the RMIC, particularly to the production of fighter aircraft of various modifications.

The second major hub is formed by Baltiyskaya Manufactura Scientific and Production Company LLC, a producer of inorganic compounds, oxides, and catalyst materials, including molybdenum (VI) oxide and ammonium molybdate. Tellingly, during the period under review, the company not only imported molybdenum products but also resold them to another large importer, Unikhim LLC, which itself acted as an intermediate link in this chain. From April 2024 through March 2025, Baltiyskaya Manufactura imported approximately 230 tons of molybdenum products worth slightly more than USD 9 million. Subsequently, the company supplied products to at least nine enterprises linked to the RMIC, with the total volume of such deliveries exceeding USD 10.3 million. The most illustrative case here is Atlant Plant JSC, which operates in the segment of electrical connectors for aviation, space, and military equipment.²⁸⁴

During the period under review, Atlant Plant JSC purchased a comparatively small volume of products — about USD 89,000 — but the significance of this case lies not in the purchase volume but in the nature of the production. The enterprise produces hermetic electrical connectors of the 2RMG, 2RMGD, 2RMGP, 2RMGSPD, SNTs 30, and SNTs 31 series, as well as other product lines for aviation, space, and military equipment.²⁸⁵ In this case, molybdenum is important as a material used in glass-to-metal sealing technology in the production of connectors for avionics systems, sensors, control units, and on-board electronics.

Subsequent supply chains show that these products enter directly into militarily significant production cycles. Specifically, products from Atlant Plant JSC were supplied to:

- Smolensk Aviation Plant JSC, manufacturer of the Kh-101 air-launched cruise missile and the Kh-59 air-to-surface missile;
- Saratov Aggregate Plant JSC, which is part of NPO High-Precision Systems JSC under State Corporation "Rostec" and is involved in the production of the Khrizantema-S and Shturm-SM anti-tank guided missile systems, the Strela, Luchnik-E, and Gibka-S surface-to-air missile systems, and tank navigation equipment;²⁸⁶
- Electromashina Research and Production Association JSC, which produces starters for diesel engines of combat vehicles, BMP-3 electrical power systems, and Okhotnik and Narval combat modules;²⁸⁷
- Electroprivod JSC, which manufactures electric motors, control units, and automated electric drives for the Il-76MD-90A, MiG-29K, and Su-27;²⁸⁸

²⁸³ <https://war-sanctions.gur.gov.ua/ru/components/companies/165> ;
<https://www.uecrus.com/upload/iblock/bc7/t6y20kumwr5hp2jzw5c91jpsr0igr9it/Spravochnik-kontrolyera.pdf>

²⁸⁴ ru: AT "Завод Атлант", TIN: 2607000333. Subject to Ukrainian sanctions from July 1, 2023.

According to internal reporting of the Russian company Baltiyskaya Manufactura Scientific and Production Company LLC, available to the Economic Security Council of Ukraine.

²⁸⁵ <https://xn--26-6kcaakov4bvg4cd.xn--p1ai/about-us.html>

²⁸⁶ ru: AT "Саратовский агрегатный завод", TIN: 6455053670. Subject to Ukrainian sanctions from July 1, 2023.

ru: AT "Смоленский авиационный завод", TIN: 6729001476. Subject to sanctions: United States — from March 24, 2022; Ukraine — from October 19, 2022 to October 19, 2032; Switzerland — from June 10, 2022; Japan — from April 12, 2022; New Zealand — from March 18, 2022; EU — from December 18, 2023.

<https://war-sanctions.gur.gov.ua/ru/roster/3552>

²⁸⁷ ru: AT "НПО «Электромашина»", TIN: 7449044990. Subject to sanctions: Ukraine — from May 12, 2023 to May 12, 2033; United States — from December 22, 2015; New Zealand — from June 8, 2022; Switzerland — from March 1, 2024; EU — from February 23, 2024; Japan — from January 10, 2025.

²⁸⁸ ru: AT "Электропривод", TIN: 4345000922. Subject to Ukrainian sanctions from October 19, 2022.

- Kazan Instrument-Making Design Bureau, for the Kronshtadt Orion UAVs and Su-34 fighter-bombers.²⁸⁹

The third key importer is Unikhim LLC, which is simultaneously an independent importer of molybdenum products and a major domestic distributor of high-purity inorganic chemical reagents.²⁹⁰ From April 2024 through March 2025, the company imported 276 tons of such products, valued at slightly more than USD 10.4 million. At the same time, Unikhim itself produces molybdenum (VI) oxide of pure-grade quality, which has direct significance for military production: after further processing, it can be used in aircraft and missile parts as an alloy component, and as a modifier in high-energy solid-propellant composites based on ammonium nitrate, improving energy release, ignition, aluminum combustion, and combustion stability. In other words, in this case, the molybdenum product functions not only as a metallurgical additive but also as a component in the technologically sensitive segment of rocket propellant and special chemicals.²⁹¹

In addition to imports, Unikhim LLC purchased products from Baltiyskaya Manufatura Scientific and Production Company LLC for USD 8.35 million and further supplied them to producers of gunpowders, primers, explosives, rocket engines, and special chemicals. According to available financial data, at least 21 RMIC or adjacent-industry enterprises received the company's products, for a total of over USD 9.5 million. The most illustrative is Perm Powder Plant Federal State Enterprise, which received approximately USD 129,000 in products during the period under review.²⁹² This enterprise is one of the key Russian manufacturers of munitions for multiple rocket launchers, aircraft missile engines, booster rockets, gunpowder, and explosives. In such production cooperation, molybdenum and its oxides may be used both as components of alloyed materials for structural parts of jet systems and in auxiliary electrochemical or technological processes for producing specialty products.

Beyond this, Unikhim's deliveries also included Solikamsk Plant "Ural" JSC, which produces gunpowder for mortar rounds, solid-propellant charges for S-8 missiles, and the 9K121 Vikhr laser-beam-riding anti-tank missile, Mango armor-piercing projectiles, and fuzes for the BM-21 "Grad" multiple rocket launcher; as well as Scientific And Production Enterprise "Krasnoznamennets" JSC, a manufacturer of detonating, electric detonating, and percussion caps. This shows that in the Unikhim case, molybdenum and its oxides enter directly into the production cycle of munitions, rocket propellant, and military special compounds.²⁹³

Thus, the molybdenum case illustrates a different model of integration into the RMIC: not through mass structural metals but through specialty steels, alloys, and chemical compounds needed for engine manufacturing, special chemicals, gunpowders, microwave electronics, and military machine building. The key importers — Semaks Metal LLC, Baltiyskaya Manufatura Scientific and Production Company LLC, and Unikhim LLC — act as suppliers or producers of molybdenum products to

²⁸⁹ ru: ОАТ «Казанское приборостроительное конструкторское бюро», TIN: 1660151791. Subject to sanctions: Switzerland — from January 25, 2023; Ukraine — from October 19, 2022 to October 19, 2032; United States — from June 6, 2022.

https://clearspending.ru/contracts?page=6&sort=-sign_date&supplier_inn=2607000333

<https://war-sanctions.gur.gov.ua/roster/3552>

<https://clearspending.ru/contracts/223/54345000922170000500000>

<https://war-sanctions.gur.gov.ua/roster/3531>

<https://clearspending.ru/contracts/223/51660151791170000140000>

<https://war-sanctions.gur.gov.ua/components/companies/3512>

²⁹⁰ <https://unichim.su/>

²⁹¹ <https://promopt74.ru/catalog/dry-chemicals/molibden-vi-oksid>

<https://unichim.su/index.php/katalog>

<https://pubmed.ncbi.nlm.nih.gov/40500873/>

²⁹² ru: ФКП «Пермский пороховой завод», TIN: 5908006119. Subject to sanctions: United States — OFAC from December 12, 2023, BIS from August 27, 2024; United Kingdom — from February 22, 2024; EU — from May 23, 2023; Switzerland — from August 16, 2023; Australia — from February 24, 2025; Japan — from June 21, 2024; Ukraine — from March 18, 2023.

According to internal reporting of the Russian company Unikhim LLC, available to the Economic Security Council of Ukraine.

²⁹³ AT «НПП «Краснознамёнец», TIN: 7806469104. Subject to sanctions: Switzerland — from January 25, 2023; Ukraine — from March 18, 2023 to March 18, 2033.

AT «Соликамский З-д «Урал», TIN: 5919015877. Subject to sanctions: United States — from June 12, 2024; Ukraine — from November 6, 2025 to November 6, 2035; EU — from October 23, 2025; Switzerland — from December 13, 2025; Belgium — no date specified.

enterprises that manufacture jet engines, missile components, explosives, special-purpose electronics, and weapons components. In this sector, molybdenum is less visible than aluminum but no less important: it is through molybdenum that imported products provide the material resilience, thermal resistance, and durability of the components without which contemporary Russian weaponry cannot function.

Tantalum: Feedstock for Capacitors

Tantalum product imports into Russia during the period under review were significantly smaller in volume than, for example, alumina or molybdenum supplies, but technologically more sensitive. The reason is that tantalum is directly linked to the production of military electronics, capacitors, and components of precision weaponry. From April 2024 through March 2025, 34 Russian companies imported approximately 16 tons of tantalum products worth roughly USD 13 million.²⁹⁴

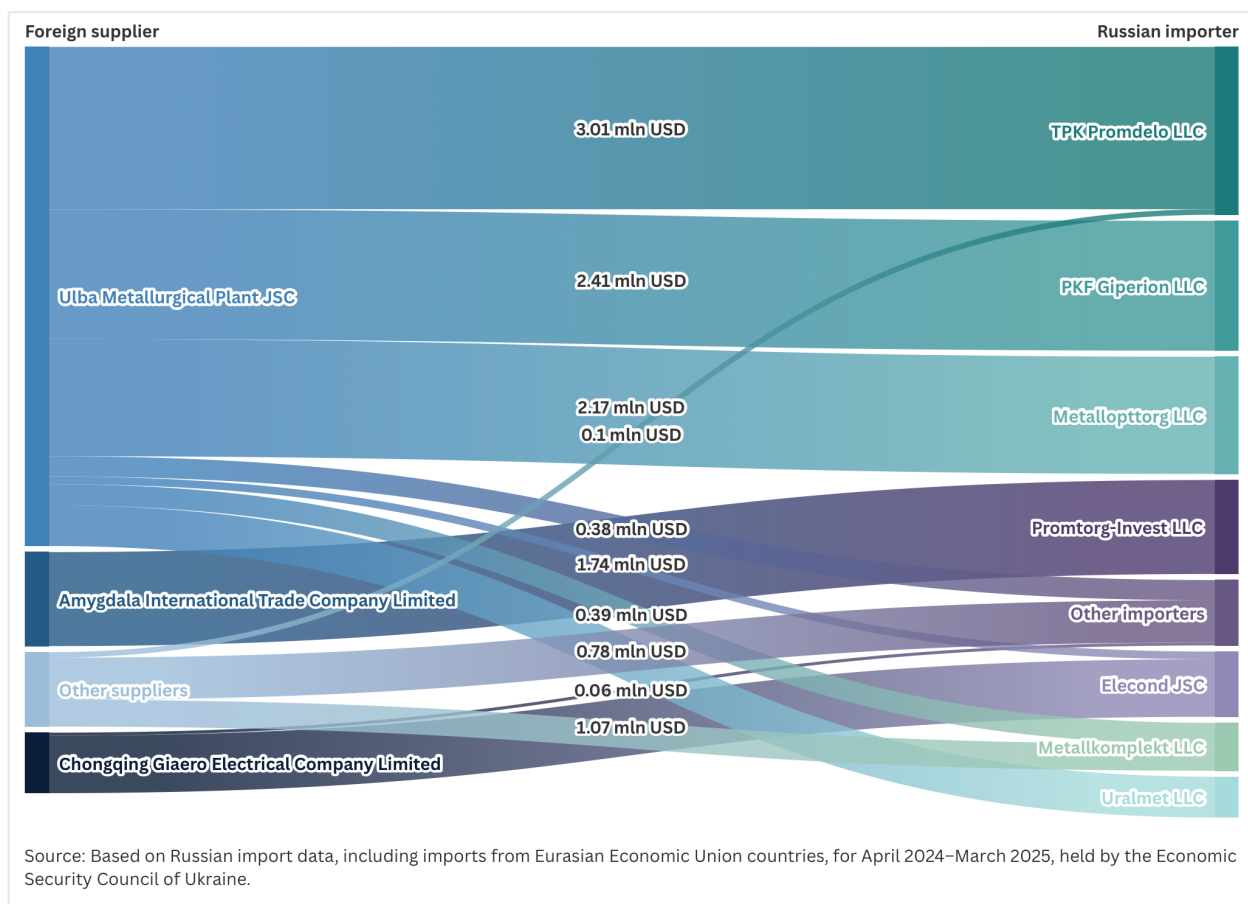


Fig. 27. List of the largest foreign suppliers and Russian importers of tantalum from April 2024 to March 2025. Made with Flourish

The market was rather concentrated. Three companies — Elecond JSC, Metallkomplekt LLC, and PKF Giperion LLC — together accounted for about USD 4.5 million in imports, or approximately 32%

²⁹⁴ Detailed information on Russian tantalum importers is provided in Annex 32.

of all supplies by both value and tonnage.²⁹⁵ These importers also have established ties with the RMIC. Unlike alumina, where intra-corporate channels predominated, tantalum imports rested primarily on Chinese and Kazakh suppliers — including Ulba Metallurgical Plant JSC.²⁹⁶

The most important case in this segment is Elecond JSC, which combines the functions of importer and manufacturer of tantalum capacitors and is itself an RMIC enterprise. From April 2024 through March 2025, Elecond imported tantalum primarily from China's Chongqing Giaero Electrical Company Limited — about 1.23 tons worth over USD 1 million — and from Kazakhstan's Ulba Metallurgical Plant JSC — another 0.17 tons or so worth USD 143,000.²⁹⁷ During the period under review, the enterprise used the imported tantalum in its own production of capacitors for avionics, control systems, and navigation. Specifically, these include K53-69/68 capacitors for the avionics of the S8000 Banderol small cruise missile, products of the BUB-30 combat-equipment control unit of the Izdeliye-30 missile, and tantalum capacitors for the S-400 air defense system.²⁹⁸

Overall, during the period under review, 25 RMIC enterprises were identified that made large purchases of Elecond products totaling approximately USD 46 million.²⁹⁹ The largest client of Elecond is NPK KBM JSC, developer of the 9M723 Iskander-M missile and the Kh-47M2 Kinzhal air-launched ballistic missile, the Strela, 9K38 Igla, and 9K333 Verba surface-to-air missile systems, the Khrizantema-S anti-tank guided missile system, the 9M120 Ataka anti-tank guided missile, the Arena active protection system, and the Izdeliye 305 missile.³⁰⁰ From the third quarter of 2024 through the first quarter of 2025 alone, KBM purchased USD 2.4 million worth of Elecond products.³⁰¹ Other buyers of this plant's products include Concern Sozvezdie JSC, which produces communications and electronic warfare systems — including those for the Pantsir-S1 missile system — and Detal Ural Design Bureau JSC, a manufacturer of radio altimeters for the Kh-59 air-to-surface cruise missile.³⁰²

The plant is most likely to remain a major importer of metallic tantalum. In 2023, Elecond began constructing a new shop to produce tantalum capacitors, for which of shortage emerged on the Russian market due of sanctions. Investment in the project amounts to RUB 400 million, and the shop itself will have an area of approximately 6,500 m². A key factor in implementing the project is

²⁹⁵ ELEKOND JSC (TIN: 1827003592) import tonnage of 1.40 tonnes valued at USD 1,208,337.96. Subject to sanctions: United States — from May 1, 2024; Ukraine — from April 15, 2023 to April 15, 2033; United Kingdom — from September 12, 2025.

Metallkomplekt LLC (TIN: 7702760164), import tonnage of 0.90 tonnes valued at USD 886,245.20. Not subject to sanctions.

PKF Giperion LLC (TIN: 5405065083), import tonnage of 2.90 tonnes valued at USD 3,009,146.40. Not subject to sanctions.

²⁹⁶ Chongqing Giaero Electrical Company Limited, Unified Social Credit Code:

91500107345943637F

Raytec Metal Company Limited, nfo@raytecmetal.com

+86-755-27810387

Luoyang Tongchang Tungsten & Molybdenum Material Co, Tel: +86- 379-63638318

Fax: +86-379-63638328

Changsha South Tantalum Niobium Co Limited, Smelter ID: CID000211

Ulba Metallurgical Plant JSC, BIN: 941040000097

²⁹⁷ Detailed information on foreign tantalum shippers is provided in Annex 31.

²⁹⁸ <https://elecond.ru/production/capacitors/tantalum-solid-electrolyte/>

<https://war-sanctions.gur.gov.ua/ru/components/companies/8> <https://checko.ru/company/ehlecond-1021800993752#contracts>

²⁹⁹ Detailed information on Russian RMIC enterprises that were clients of tantalum importers is provided in Annex 33.

According to internal reporting of the Russian company Elecond JSC, available to the Economic Security Council of Ukraine.

³⁰⁰ ru: AT «Научно-Производственная Корпорация «Конструкторское Бюро Машиностроения», TIN: 5022039177. Subject to sanctions: United States — from March 3, 2022 (OFAC) and from April 7, 2022 (BIS Entity List); Ukraine — from October 19, 2022; Switzerland — from June 10, 2022; New Zealand — from August 2, 2022; Japan — from May 26, 2023; Australia — from February 24, 2023.

<https://war-sanctions.gur.gov.ua/ru/tools/company/235>

³⁰¹ <https://war-sanctions.gur.gov.ua/ru/tools/company/235>

³⁰² <https://www.e-disclosure.ru/portal/files.aspx?id=8554&type=2>

AT «КОНЦЕРН «СОЗВЕЗДИЕ», TIN: 3666127502. Subject to sanctions: United States — from July 22, 2014 (BIS Entity List); Ukraine — from May 15, 2017; Japan — from October 7, 2022; EU — from April 8, 2022; Belgium — from April 8, 2022; Switzerland — from January 31, 2024; New Zealand — from July 21, 2023; Australia — from May 19, 2023.

AT «УПКБ «ДЕТАЛЬ»» (AT «УРАЛЬСКОЕ ПРОЕКТНО-КОНСТРУКТОРСКОЕ БЮРО «ДЕТАЛЬ»»), TIN: 6612011546. Subject to sanctions: United States — from March 24, 2022 (OFAC) and April 7, 2022 (BIS Entity List); Ukraine — from October 19, 2022; Switzerland — from March 25, 2022; New Zealand — from March 18, 2022; Australia — from February 24, 2025.

<https://war-sanctions.gur.gov.ua/ru/components/companies/312>

state support: the procurement of technological equipment was to be carried out through a federal subsidy for enterprises in the Russian Federation's radio electronics industry.³⁰³

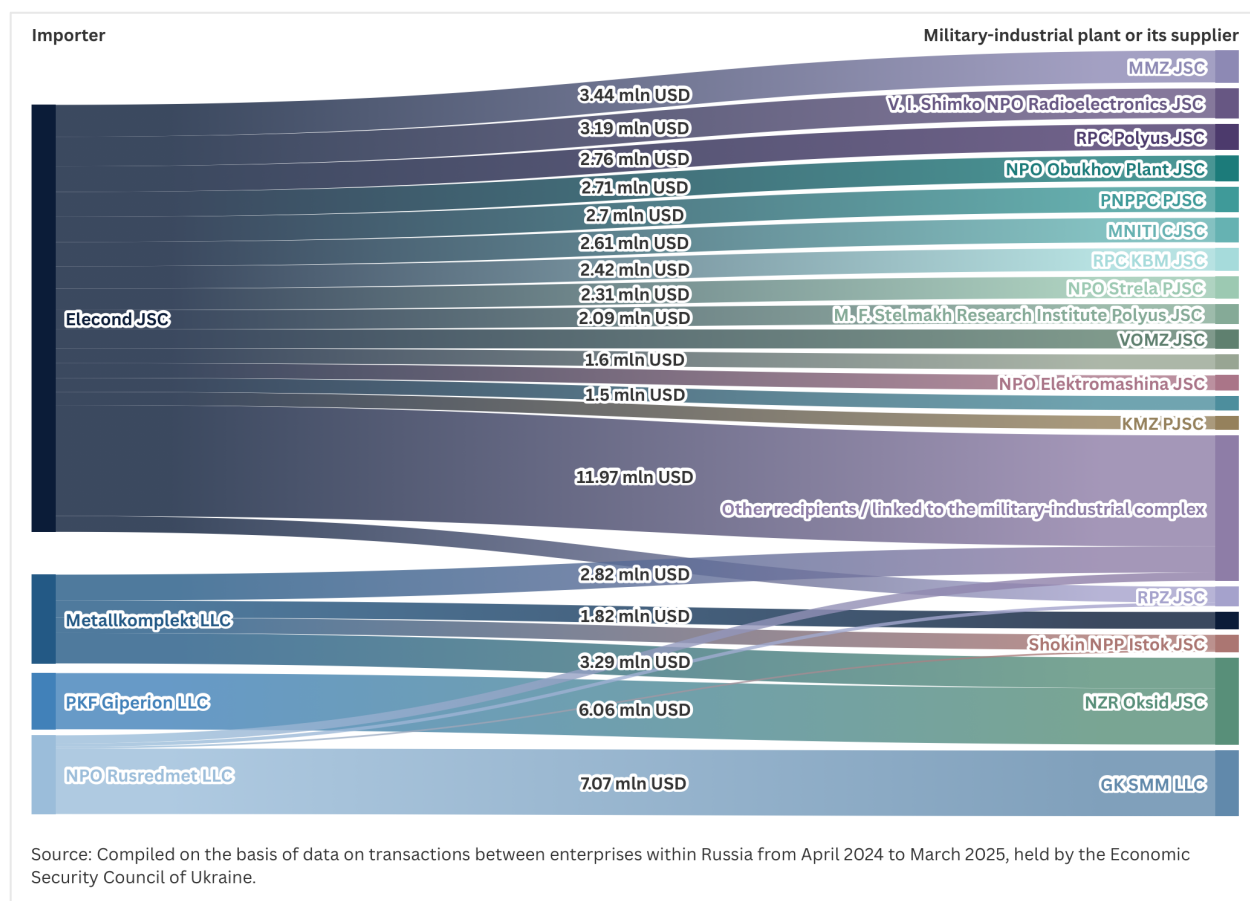


Fig. 28. Supplies by tantalum importers to Russian military-industrial enterprises from July 2024 to June 2025. Made with Flourish

The second-largest tantalum importer during the period under review was Metallkomplekt LLC, a wholesale distributor of tantalum, tungsten, molybdenum, niobium, and other specialty metals. From April 2024 through March 2025, the company imported tantalum from Chinese manufacturers and from Ulba Metallurgical Plant JSC. Subsequently, it supplied these products to at least nine RMIC-linked enterprises for approximately USD 7 million.

The most illustrative Metallkomplekt client is NPP Istok N.A. Shokin JSC, which purchased USD 1.6 million worth of products.³⁰⁴ Istok is one of the key Russian manufacturers of microwave electronics — diodes, transistors, monolithic integrated circuits, microwave modules, klystrons, traveling-wave tubes, and active homing heads — and accounts for approximately 30% of the Russian market for such products.³⁰⁵ Its products are used in radars, electronic warfare systems, targeting channels, and missile munitions electronic units, and according to historical public procurement, the plant has supplied its products to Izhevsk Electromechanical Plant JSC, Mariysky Machine-Building Plant JSC,

³⁰³ <https://susanin.news/udmurtia/other/20230511-302242/>

³⁰⁴ АТ «НПП «Исток» им. Шокина», TIN: 5050108496. Subject to sanctions: United States — from June 28, 2022 (OFAC), from March 9, 2022 (BIS Entity List); Ukraine — from October 19, 2022; Switzerland — from March 25, 2022; EU — from June 24, 2024; New Zealand — from August 2, 2022;

According to internal reporting of the Russian company Metallkomplekt LLC, available to the Economic Security Council of Ukraine.

³⁰⁵ https://vpk.name/news/108811_dmitrii_rogozin_posetil_podmoskovnyi_istok.html

Strela Research and Production Association PJSC, Avitek Vyatka Machine-Building Enterprise JSC, and other enterprises linked to surface-to-air missile systems and radio-electronic systems.³⁰⁶ Tellingly, Metalkomplekt's own clients also included Avitek Vyatka Machine-Building Enterprise JSC — a manufacturer of surface-to-air guided missiles, target missiles, and other products, involved in cooperation on the production of the 9K330 Tor missile system.³⁰⁷

The third major tantalum importer during the period under review was PKF Giperion LLC, which imported 2.9 tons of tantalum worth over USD 2.4 million from Ulba Metallurgical Plant JSC. According to financial transaction data, these products were further supplied to Novosibirsk Radio Components Plant Oksid JSC, which purchased them for approximately USD 6 million.³⁰⁸ Oksid, like Elekond, is a manufacturer of tantalum capacitors — including the K53-18-16V, K53-18-20V, and K53-18-32V series. Such capacitors are used in the television homing heads of the Kh-59M2 and Kh-59M2A guided air-to-surface missiles.³⁰⁹

Thus, tantalum is one of the most technologically sensitive import segments, since it is directly linked to the production of military electronics, guidance systems, on-board computing complexes, and radio-electronic components of precision weaponry. The cases of Elekond JSC, Metalkomplekt LLC, and PKF Giperion LLC show that imported tantalum not only enters the Russian industry but is also transformed into specific tantalum capacitors and electronic assemblies used in missiles, air defense systems, UAVs, microwave electronics, and other critical military equipment. This makes the tantalum chain one of the most susceptible to sanctions pressure, since its role in the RMIC is direct, and the capacity for rapid domestic substitution remains limited.

³⁰⁶ АТ «ИЖЕВСКИЙ ЭЛЕКТРОМЕХАНИЧЕСКИЙ ЗАВОД «КУПОЛ»», TIN: 1831083343. Subject to sanctions: United States — from December 12, 2023 (OFAC), from May 19, 2023 (BIS Entity List); Ukraine — from October 19, 2022; Japan — from June 21, 2024 (Ministry of Finance); Switzerland — from December 21, 2022; EU — from December 16, 2022; Australia — from February 23, 2024; New Zealand — from February 21, 2025;

АТ «МАРИЙСКИЙ МАШИНОСТРОИТЕЛЬНЫЙ ЗАВОД», TIN: 1200001885. Subject to sanctions: United States — from June 28, 2022, and from February 27, 2023; Ukraine — from October 19, 2022; EU — from February 23, 2024; Switzerland — from March 29, 2023, and from March 1, 2024; Australia — from July 20, 2023; New Zealand — from August 2, 2022; Japan — from January 10, 2025.

ПАТ «НАУЧНО-ПРОИЗВОДСТВЕННОЕ ОБЪЕДИНЕНИЕ «СТРЕЛА»», TIN: 7103028233. Subject to sanctions: United States — from June 12, 2024, and May 19, 2023; Switzerland — from December 21, 2022; EU — from December 16, 2022; Ukraine — from April 1, 2023; Australia — from July 20, 2023; Japan — from September 12, 2025.

АТ «ВЯТСКОЕ МАШИНОСТРОИТЕЛЬНОЕ ПРЕДПРИЯТИЕ «АВИТЕК»», TIN: 4345047310. Subject to sanctions: United States — from June 28, 2022; Japan — from January 10, 2025; EU — from February 23, 2024; Ukraine — from October 19, 2022; New Zealand — from August 2, 2022; Switzerland — from January 25, 2023, and March 1, 2024.

³⁰⁷ <https://war-sanctions.gur.gov.ua/ru/components/companies/3631>

³⁰⁸ ru: ООО «ПКФ «Гиперион», TIN: 5405065083. Not subject to sanctions.

According to the data available to the Economic Security Council of Ukraine.

³⁰⁹ <https://war-sanctions.gur.gov.ua/ru/components/companies/3631>

SALT OF THE EARTH

CONCLUSIONS AND RECOMMENDATIONS



CONCLUSIONS AND RECOMMENDATIONS

The analysis demonstrates that the Russian Federation's dependence on imports of strategic minerals is deep and systemic. It did not arise as a consequence of the 2022–2025 sanctions but considerably earlier, as the result of the prolonged underdevelopment of the non-energy part of the mineral resource base, the degradation of part of the Soviet production legacy, low levels of development of domestic reserves, the open-endedness of production chains, and the prioritization of oil, gas, and the export revenue associated with them. This is why Russia entered the full-scale war as a state with large formal reserves of strategic raw materials but without a sufficiently developed domestic base to supply its own MIC with a broad range of critical minerals and their processed products.

After 2022, Russia did not eliminate this dependence but merely began to respond to it administratively. Despite new strategies, the scaling-up of geological exploration, the reassessment of reserves, and the launch of several new or revived projects, most of these remain too expensive, technologically complex, infrastructurally underprepared, and financially vulnerable to substitute imports in the short term. As a result, in the short and medium term, large-scale imports remain the only realistic means for Russia to meet the needs of its MIC and adjacent high-tech industries.

The Russian Federation's import dependence is not an abstract trade characteristic. Analysis of the detailed supply chains for alumina, tantalum, and molybdenum in Russian imports during April 2024 – March 2025 identified 278 unique companies involved in deliveries — 101 importers, 107 shippers, and 70 producers. However, only 10 of all the identified companies are under sanctions, and 9 of them are Russian importers.³¹⁰ This means that the bulk of the foreign participants in these chains — including producers, shippers, traders, and intermediaries — effectively remains outside the reach of individual sanctions pressure.

Analysis of the financial transactions of the 13 largest importers of alumina, tantalum, and molybdenum identified 102 Russian enterprises among their clients that either directly produce military goods or supply them to RMIC enterprises. The aggregate volume of purchases by such enterprises from importer companies amounted to RUB 86.7 billion, or approximately USD 1.1 billion. Although the bulk went to aluminum feedstock and aluminum-based products — RUB 76 billion, or USD 937 million — purchases of tantalum (RUB 5.7 billion, or USD 70.9 million) and molybdenum (approximately RUB 5 billion, or USD 61.8 million) are also significant, both in absolute terms and given these metals' role in military production. This is the concrete material foundation to produce aircraft, missiles, air defense systems, munitions, military electronics, and other critical weapons components.

Against this backdrop, the incompleteness of the current sanctions regime stands out particularly clearly: strategic minerals as a distinct sector are still not covered by any coherent sanctions logic. For some critical items, restrictions appeared only with substantial delay — by the third or fourth year of the full-scale invasion. Thus, manganese ores were brought under EU restrictions only in June 2024; titanium oxides and molybdenum ores only in July 2025; and titanium ores and concentrates, bauxite, and tantalum in key subpositions only in October 2025.³¹¹

³¹⁰ Translom LLC, Top Alloy LLC, Polema JSC, Girmet LLC, Rusmedtorg LLC, Magnitogorsk Metallurgical Plant PJSC, Elekont JSC, Mezon Plant JSC, R-Stal JSC, and Belarusian Beltamozhservis Republican Unitary Enterprise.

³¹¹ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02014R0833-20240625>
<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02014R0833-20250720>
<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02014R0833-20251024>

Yet even where sanctions formally exist, they often do not cover all the critical forms of the same material. For tungsten, certain oxides and part of group 8101 fell under restrictions, while tungsten carbides remained outside EU sanctions; ferroniobium is banned for import from Russia, but not for supply to it; for alumina, there are no restrictions on supply to the Russian Federation at all.³¹² The effect of sanctions is further weakened by transitional periods, exceptions for the performance of old contracts, and the general fragmentation of enforcement.³¹³

Finally, no strategic mineral is included on the Common High Priority Items List, which is the key reference point for countries outside the sanctions coalition in enforcing anti-circumvention measures.³¹⁴ As a result, Russia retains access to a significant share of critical raw materials, even where the sector has already come partially under the sanctions spotlight.

It follows that one of the key tasks of sanctions policy should be to establish strategic minerals as a self-standing sanctions track. This is not merely about expanding lists of prohibited customs codes but about adopting a systemic approach to restricting the supply of raw materials that directly or indirectly support Russian military production. This means that the sanctions focus should fall not only on ores and concentrates but also on oxides, hydroxides, alloys, ferroalloys, powders, carbides, certain salts, and other intermediate forms that effectively serve as bottlenecks in Russian production chains. Otherwise, sanctions will continue to be belated, partial, and such as to allow Russia to switch imports from one form to another.

A separate emphasis must be placed on intermediaries in third countries. Analysis of import flows shows that for a significant share of strategic minerals, Russia relies on a ramified network of intermediaries, traders, re-exporters, and transshipment and logistical hubs through which products are consolidated, reissued, and routed onward to the Russian Federation. It is in these intermediate links that the real resilience of Russian supply chains often hides. Sanctions work; therefore, they must be reoriented toward the entire chain of goods movement. Attention should be paid to shipper companies, trading houses, brokers, port operators, and financial structures in third countries. These actors are often the most sensitive to secondary sanctions, compliance pressure, and reputational risks — and therefore may be more vulnerable than the final Russian importers.

In this context, the case of Novotroitsk Plant of Chromium Compounds JSC is particularly significant. It demonstrates that sectoral sanctions imposed by Western jurisdictions can be effective even when supplies are conducted not directly from the EU but from formally "friendly" or post-Soviet jurisdictions. After the EU, on February 24, 2025, imposed export restrictions on the Russian Federation of chromium ores and compounds as part of its 16th sanctions package, the plant's management announced on March 12, 2025, that operations were being suspended due to raw material supply problems.³¹⁵ It subsequently emerged that the Kazakh supplier — controlled, according to the plant's management, by Belgian and Turkish owners — had withdrawn from further cooperation.³¹⁶ This example is important because it refutes the widespread argument that sectoral sanctions do not work if minerals come from countries "friendly" to Russia. In fact, they can influence the behavior of such jurisdictions precisely through the broader corporate, financial, logistical, and compliance infrastructure in which these supplies are embedded. Sanctions policy, therefore, should be oriented not only toward direct export bans but also toward severing the accompanying ties through which a third country supports Russian production.

³¹² <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02014R0833-20260116>

³¹³ https://finance.ec.europa.eu/publications/list-common-high-priority-items_en

³¹⁴ https://finance.ec.europa.eu/system/files/2023-09/list-common-high-priority-items_en.pdf

³¹⁵ https://finance.ec.europa.eu/news/eu-adopts-16th-package-sanctions-against-russia-2025-02-24_en

<https://www.ural56.ru/news/741085/>

³¹⁶ <https://www.moscowtimes.ru/2025/03/13/v-rossii-iz-za-sanktsii-k-kotorim-prisoedinilsya-kazakhstan-reshili-zakrit-zavod-po-proizvodstvu-hroma-a157893>

<https://pda.orsk.ru/news/137701-prodoljit-li-rabotu-novotroitskiy-zavod-hromovyh-soedineniy>

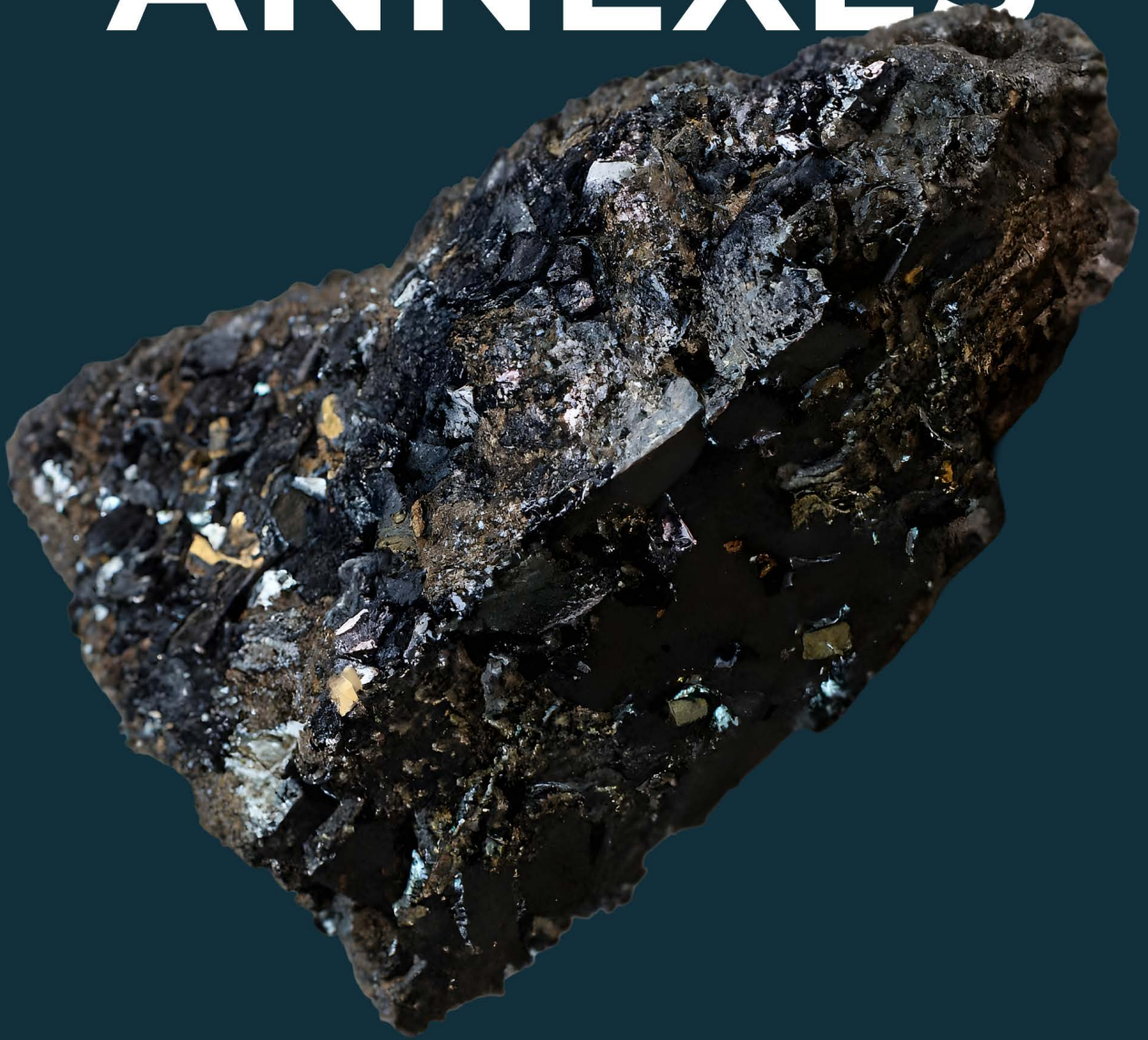
Accordingly, one of the priority directions should be targeted work with intermediary structures in countries that formally are not part of the sanctions coalition but serve as critical hubs for Russian imports. This concerns China, the UAE, Turkey, Hong Kong, certain post-Soviet jurisdictions, and trading and logistical platforms through which Russia obtains tantalum, niobium, molybdenum, alumina, manganese, tungsten, and other strategic minerals. In practice, this means that sanctions authorities should develop separate dossiers not only on Russian importers but also on companies in third countries: producers, shippers, intermediaries, beneficiaries, affiliated trading companies, and routes. Such an approach would make it possible to move from sanctioning the "end recipient" to dismantling the supply mechanism itself.

A separate priority should be strengthening the enforcement of sanctions restrictions already in place. Part of the problem now lies not so much in the absence of restrictions as in weak enforcement. Stricter tracking is needed for goods with dual classification, suspicious HS codes, non-standard routes, and recurring links between specific ports, traders, and Russian importers. This requires closer coordination among customs authorities, export-control agencies, port administrations, financial regulators, and the sanctions units of partner states. Ukraine, for its part, should promote not only new restrictions but also a separate line of work to identify routes for circumvention of strategic minerals, with a focus on transit, re-export, and intermediary jurisdictions.

In sum, strategic minerals should be conceived as a distinct and self-standing direction of sanctions policy. The analysis shows that it is precisely in this sector that Russian vulnerability is deep, long-standing, and insufficiently covered by existing restrictions. Russia has no real capacity to quickly replace imports across the broad spectrum of critical minerals and their processed products, so that sanctions pressure can be especially effective here. This, however, requires a transition from fragmentary and belated decisions to a systemic strategy that simultaneously addresses scarce mineral forms, intermediaries in third countries, logistical hubs, corporate chains, and end recipients in the RMIC.

SALT OF THE EARTH

ANNEXES



ANNEXES

Annex 1. Sanctions Status of Russian Extractors, Processors, Manufacturers, and Consumers of the Nine Strategic Minerals and Related Products Examined in This Study

Name	Sanctions status	Related strategic minerals
Magnitogorsk Metallurgical Plant Public Joint Stock Company, TIN: 7414003633	United States (OFAC) from August 2, 2022 United Kingdom from May 18, 2023 ³¹⁷	Manganese processing, ferroniobium consumer
Composite JSC, TIN: 5018078448	United States (OFAC) from November 2, 2023, Ukraine from May 12, 2023 ³¹⁸	Beryllium
Pravourmiyskoe LLC, TIN: 2717015290	United States (OFAC) from June 12, 2024 ³¹⁹	Tungsten
Tin Ore Company JSC, TIN: 2717017562	United States (OFAC) from June 12, 2024, Ukraine from October 19, 2022 ³²⁰	Tungsten
Territory LLC, TIN: 8706006954	United States (OFAC) from June 12, 2024 ³²¹	Tungsten processing
Polema JSC, TIN: 7105008070	United States (OFAC) from June 12, 2024, Ukraine from April 18, 2025 ³²²	Tungsten
SpetsMetalMaster Group of Companies LLC, TIN: 7722326685	United States (OFAC) from February 23, 2024 ³²³	Rhenium
VSMPO-AVISMA Corporation PJSC, TIN: 6607000556	United States (BIS) from September 27, 2023, Canada from February 21, 2024, Ukraine from June 24, 2021 ³²⁴	Titanium
Polar Lithium Limited Liability Company, TIN: 9709083109	United States (OFAC) from January 10, 2025 Ukraine from August 8, 2025 ³²⁵	Lithium
Stupinskaya Metallurgical Company JSC, TIN: 5045023416	United Kingdom from February 24, 2026, Ukraine from October 17, 2016 ³²⁶	Titanium, tantalum processor
Ruspolimet JSC, TIN: 5251008501	United Kingdom from September 12, 2025, Ukraine from April 18, 2025 ³²⁷	Titanium
Tugan Mining and Processing Plant "Ilmenite" Joint Stock Company, TIN: 7014038550	United States (OFAC) from January 15, 2025 Ukraine from October 19, 2022 ³²⁸	Zirconium and titanium extractor
Russian Titanium Resources Joint-Stock Company, TIN: 7702711230	United States (OFAC) from November 2, 2023 Ukraine from July 27, 2025 ³²⁹	Zirconium and titanium extractor
Severstal PJSC, TIN: 3528000597	United States (OFAC) from June 2, 2022 United Kingdom (IS) from April 9, 2025 and (FCDO) from May 18, 2023 New Zealand from November 22, 2022 Ukraine from October 19, 2022 Australia from May 19, 2023 ³³⁰	Manganese consumer
Magnitogorsk Electrode Plant LLC, TIN: 7456037049	United States (OFAC) from October 30, 2024 Ukraine from May 1, 2025 ³³¹	Manganese consumer

³¹⁷ <https://www.opensanctions.org/entities/NK-UwDN5nyVs4G3qsZVnCBscV/>

³¹⁸ <https://www.opensanctions.org/entities/NK-QmU7qgMAGeWK5aiKtncLVp/>

³¹⁹ <https://www.opensanctions.org/entities/NK-R3bjkd4jY3k9WjkawsSkfr/>

³²⁰ <https://www.opensanctions.org/entities/NK-U9vDHH2sLN5bBYiLxvPKHg/>

³²¹ <https://www.opensanctions.org/entities/NK-IQkWG6w22RV2aSoN6JwSaP/>

³²² <https://www.opensanctions.org/entities/NK-Mux7FjaCFE5YFKBbrX76dm/>

³²³ <https://www.opensanctions.org/entities/NK-QioR8caCSXWN2YWSUDJZC9/>

³²⁴ <https://www.opensanctions.org/entities/NK-VTijf9nC5ysEGRqS9pP/>

³²⁵ <https://www.opensanctions.org/entities/NK-DqxtXwJ9DNzssNiyZFzF4d/>

³²⁶ <https://www.opensanctions.org/entities/NK-QHcCmJyVqmHgAEajCpy5Ku/>

³²⁷ <https://www.opensanctions.org/entities/NK-jA5PUWpMcmETyXfWkc7ruc/>

³²⁸ <https://www.opensanctions.org/entities/NK-o9xaMhozYxk7SuZmkg4GZt/>

³²⁹ <https://www.opensanctions.org/entities/NK-fCth7v7qdPPusSki8KE6hf/>

³³⁰ <https://www.opensanctions.org/entities/NK-eYLn79IE9sQY8XHWYkwGSL/>

³³¹ <https://www.opensanctions.org/entities/NK-TadqeDdCDkpzXVjnj5ahUm/>

Chelyabinsk Metallurgical Plant PJSC, TIN: 7450001007	United Kingdom (FCDO) from May 18, 2023 ³³²	Manganese consumer
Kamensk-Uralsky Metallurgical Works JSC, TIN: 6665002150	United States (OFAC) from January 15, 2025 and (BIS) from March 3, 2022. EU from February 25, 2022. United Kingdom (FCDO) from February 22, 2024 and (IS) from April 9, 2025 ³³³	Manganese consumer
Litkarinsky Optical Glass Plant JSC, TIN: 5026000300	United States (OFAC) from January 15, 2025 Ukraine from June 24, 2024 ³³⁴	Tantalum consumer
Elekond JSC, TIN: 1827003592	United States (OFAC) from May 1, 2024 United Kingdom (IS and FCDO) from September 12, 2025 Ukraine from April 15, 2023 ³³⁵	Tantalum consumer
Mezon Plant Joint Stock Company, TIN: 7802044622	United Kingdom (IS and FCDO) from September 12, 2025 Ukraine from April 1, 2023 ³³⁶	Tantalum consumer
Girikond Research Institute JSC, TIN: 7802144144	Switzerland from March 29, 2023 New Zealand from November 1, 2022 United States (OFAC) from June 28, 2022 and (BIS) from February 27, 2023 Japan from May 26, 2023 Ukraine from October 19, 2022 ³³⁷	Tantalum consumer
Rekond Plant JSC, TIN: 7802005951	United Kingdom (IS and FCDO) from September 12, 2025 United States (OFAC) from August 23, 2024 Ukraine from April 1, 2023 ³³⁸	Tantalum
High-Tech Research Institute of Inorganic Materials named after Academician A.A. Bochvar JSC, TIN: 7734598490	United Kingdom from May 18, 2023 Ukraine from February 5, 2023 ³³⁹	Beryllium processor
Extractors, processors, manufacturers, and consumers of strategic minerals subject exclusively to Ukrainian sanctions		
United Company Rusal JSC, TIN: 7709329253	Ukraine from October 17, 2016 ³⁴⁰	Aluminum, manganese consumer
Solikamsk Magnesium Plant, Open Joint-Stock Company, TIN: 5919470019	Ukraine from May 9, 2025 ³⁴¹	Niobium, tantalum, titanium
Lovozerky Mining and Processing Works Limited Liability Company, TIN: 5106800454	Ukraine from May 9, 2025 ³⁴²	Niobium, tantalum, titanium
Yekaterinburg Non-Ferrous Metal Processing Plant JSC, TIN: 6661005707	Ukraine from July 27, 2025 ³⁴³	Tantalum processing
Timan Bauxite JSC, TIN: 1117000011	Ukraine from October 19, 2022 ³⁴⁴	Bauxite
Sevuralboxitruda JSC, TIN: 6631001159	Ukraine from October 19, 2022 ³⁴⁵	Bauxite

³³² <https://www.opensanctions.org/entities/NK-mdzJjnemRjDAjxobECxFTQ/>
³³³ <https://www.opensanctions.org/entities/NK-gGnFZ3e4MRCzJpDeVARzBD/>
³³⁴ <https://www.opensanctions.org/entities/NK-KoSeTVXoxYgthyGEW5MC/>
³³⁵ <https://www.opensanctions.org/entities/NK-QdXTbKFGHjzs4kvRsMj82r/>
³³⁶ <https://www.opensanctions.org/entities/NK-dAwQo7BcS2KPDfGjys87HA/>
³³⁷ <https://www.opensanctions.org/entities/NK-cxH6yqurS62EIBp4BGnfzq/>
³³⁸ <https://www.opensanctions.org/entities/NK-WHJhpdF54ehdHGuhXSMShN/>
³³⁹ <https://www.opensanctions.org/entities/NK-Au3hYy5Q4g5YPIVK7T9mC/>
³⁴⁰ <https://www.opensanctions.org/entities/NK-L94ShcQ7gpZpUrvFmreFcf/>
³⁴¹ <https://www.opensanctions.org/entities/NK-XNEshQzVvg48wiGNQjva3u/>
³⁴² <https://www.opensanctions.org/entities/NK-nfCZatWabR8g5iQawCvEGx/>
³⁴³ <https://www.opensanctions.org/entities/NK-XC3bxBZ7nDs7fjvjZtTCqw/>
³⁴⁴ <https://www.opensanctions.org/entities/NK-Zr4wXhJkVSeBxmWJcSr6Rs/>
³⁴⁵ <https://www.opensanctions.org/entities/NK-3YnSgC4sMTzPuRcVXM4cP/>



Primorskiy MPW JSC, TIN: 2517001325	Ukraine from October 19, 2022 ³⁴⁶	Tungsten
Sorsk Mining and Processing Works Limited Liability Company, TIN: 1910006486	Ukraine from October 19, 2022 ³⁴⁷	Molybdenum
GRK AIR JSC, TIN: 2517005270	Ukraine from October 19, 2022 ³⁴⁸	Tungsten processing
Priargunskoye Mining and Chemical Production Association PJSC, TIN: 7530000048	Ukraine from February 5, 2023 ³⁴⁹	Molybdenum
Mineral and Chemical Company EuroChem JSC, TIN: 7721230290	Ukraine from June 24, 2024 ³⁵⁰	Zirconium extractor
Atomredmetzoloto JSC, TIN: 7706016076	Ukraine from February 5, 2023 ³⁵¹	Zirconium extractor
Chepetsky Mechanical Plant JSC, TIN: 1829008035	Ukraine from February 5, 2023 ³⁵²	Zirconium, tantalum processor
Angarsk Electrolysis Chemical Plant JSC, TIN: 3801098402	Ukraine from February 5, 2023 ³⁵³	Zirconium processor
Lermontovsky MPW LLC, TIN: 2526011739	Ukraine from October 19, 2022 ³⁵⁴	Tungsten
Novolipetsk Metallurgical Plant PJSC, TIN: 4823006703	Ukraine from May 1, 2025 ³⁵⁵	Manganese consumer
Grankom LLC, TIN: 5251009791	Ukraine from May 9, 2025 ³⁵⁶	Manufacturers of ferroniobium, metallic niobium, and niobium-based addition alloys
Mariinsky Priisk JSC, TIN: 6683013677	Ukraine from October 19, 2022 ³⁵⁷	Beryllium extractor
Mayak Production Association Federal State Unitary Enterprise, TIN: 7422000795	Ukraine from February 5, 2023 ³⁵⁸	Beryllium processor
State Research and Design Institute of the Rare Metal Industry Giredmet JSC, TIN: 7706699062	Ukraine from February 5, 2023 ³⁵⁹	Beryllium processor
Apatit JSC, TIN: 5103070023	Ukraine from May 14, 2018 ³⁶⁰	Titanium
Research Institute of the Scientific and Production Association Luch JSC, TIN: 5074070474	Ukraine from February 5, 2023 ³⁶¹	Beryllium processor
Titanium Investments LLC, TIN: 7709956455	Ukraine from October 17, 2016 ³⁶²	Titanium
Novosibirsk Radio Components Plant Oksid JSC, TIN: 5405441299	Ukraine from July 1, 2023 ³⁶³	Tantalum consumer

³⁴⁶ <https://www.opensanctions.org/entities/NK-HWc4FZuWt6vTGbF8mLuZsy/>

³⁴⁷ <https://www.opensanctions.org/entities/NK-Fyxex3ohNR6zVC4h4Uqt5L/>

³⁴⁸ <https://www.opensanctions.org/entities/NK-JvKWZiYNstq8ZTExnBPWqs/>

³⁴⁹ <https://www.opensanctions.org/entities/NK-LzZagBQ5NnoUnHjxFbbQHs/>

³⁵⁰ <https://www.opensanctions.org/entities/NK-S3PqkFACzcpP7afWNuGiSH/>

³⁵¹ <https://www.opensanctions.org/entities/NK-gKV5Aa6GT45XvtPUn5xVdE/>

³⁵² <https://www.opensanctions.org/entities/NK-5SY2TV7a4zDFgPsiBdesfs/>

³⁵³ <https://www.opensanctions.org/entities/NK-aeNb3gHkUARfFenye8wB6g/>

³⁵⁴ <https://www.opensanctions.org/search/?q=2526011739>

³⁵⁵ <https://www.opensanctions.org/entities/NK-F3YMUXkYQawgWd5r8TkJV4/>

³⁵⁶ <https://www.opensanctions.org/entities/NK-6wXRXKDP3y7fs4gGDe9SdB/>

³⁵⁷ <https://www.opensanctions.org/entities/NK-SDcsERYy3CjMRamHGgusn5/>

³⁵⁸ <https://www.opensanctions.org/entities/NK-T7zBmbmpZmckxdNESUZHDe/>

³⁵⁹ <https://www.opensanctions.org/entities/NK-4XCufCbjo8uP8XbYuzgpcL/>

³⁶⁰ <https://www.opensanctions.org/entities/NK-53Bx2i9AkT2Smhq2SvTTuN/>

³⁶¹ <https://www.opensanctions.org/entities/NK-bVmkJwQ8BUaeQb6oj3gw9J/>

³⁶² <https://www.opensanctions.org/entities/NK-EK4k7emMMYX5zPiFTGxaRL/>

³⁶³ <https://www.opensanctions.org/entities/NK-kQfQ24MDkPtHpYxQ368XhP/>

Annex 2. Level of Strategic Mineral Reserve Development in the Russian Federation as of 2021, compiled by the authors based on ³⁶⁴

Mineral (* in oxides)	Allocated and in production		Allocated (exploration)		Unallocated		Total reserves
	thousand tonnes	%	thousand tonnes	%	thousand tonnes	%	thousand tonnes
Oil	22,400,000	71.79%	7,500,000	24.04%	1300000	4.17%	31,200,000
Condensate	2300000	60.37%	1400000	36.75%	110000	2.89%	3,810,000
Uranium	63,400	8.96%	433,600	61.27%	210,700	29.77%	707,700
Iron ores	43,700,000	38.98%	13,500,000	12.04%	54,900,000	48.97%	112,100,000
Manganese ores	1,300	0.46%	113,500	40.05%	168,600	59.49%	283400
Chromium ores	5,800	11.28%	4,100	7.98%	41,500	80.74%	51400
Bauxite	456,000	33.38%	184,000	13.47%	726,000	53.15%	1366000
Copper	41,500	40.45%	55,600	54.19%	5,500	5.36%	102600
Nickel	15449.4	54.15%	10787.1	37.81%	2291.7	8.03%	28528.2
Cobalt	722	45.88%	406	25.83%	445	28.29%	1572.9
Lead	5,300	30.99%	5,400	31.58%	6,400	37.43%	17100
Zinc	11,200	19.18%	19,900	34.08%	27,300	46.75%	58400
Tin	157.2	7.45%	401.3	19.02%	1551.8	73.53%	2110.3
Tungsten*	65.4	4.95%	848.7	64.24%	407	30.81%	1321.1
Molybdenum	165	7.48%	1352.2	61.31%	688.2	31.21%	2205.4
Titanium*	17,300	2.94%	165,700	28.19%	404,700	68.86%	587700
Zirconium*	428	3.44%	3481	27.97%	8536	68.59%	12445
Lithium*	64	1.83%	0	0.00%	3428	98.17%	3492
REM	4,800	16.72%	5,100	17.77%	18,800	65.51%	28700
Scandium	0.22	1.74%	7.522	59.57%	4.886	38.69%	12.628
Gold	9.656	62.49%	3.961	25.63%	1.835	11.88%	15.452
Silver	45.6	37.04%	60.6	49.23%	16.9	13.73%	123.1
Platinoids	8.557	53.39%	7.293	45.50%	0.178	1.11%	16.028
Graphite	1,500	1.49%	13,000	12.87%	86,500	85.64%	101000
Phosphate ores	272000	22.39%	251000	20.66%	692000	56.95%	1215000
Fluorite	111000	38.01%	28000	9.59%	153000	52.40%	292000

³⁶⁴ https://rosnedra.gov.ru/activity/documents/gosudarstvennyy_doklad_2021/

Annex 3. Level of Strategic Mineral Reserve Development in the Russian Federation as of 2023, compiled by the authors based on³⁶⁵

Mineral (* in oxides)	Allocated and in production		Allocated (exploration)		Unallocated		Total reserves
	thousand tonnes	%	thousand tonnes	%	thousand tonnes	%	thousand tonnes
Oil	22,800,000	72.84%	7300000	23.32%	1200000	3.83%	31,300,000
Condensate	2200000	60.77%	1300000	35.91%	120,000	3.31%	3,620,000
Uranium	62.2	8.87%	429.2	61.20%	209.9	29.93%	701
Iron ores	49800000	47.12%	1390000	1.32%	54500000	51.57%	105,690,000
Manganese ores	2,500	0.88%	112000	39.56%	168600	59.55%	283,100
Chromium ores	5000	9.82%	4100	8.06%	41800	82.12%	50,900
Bauxite	450000	33.26%	177000	13.08%	726000	53.66%	1,353,000
Nepheline ores	1,882,000	49.57%	1196000	31.50%	719000	18.94%	3,797,000
Copper	55,400	54.26%	42000	41.14%	4700	4.60%	102,100
Nickel	14,936	53.26%	10815.9	38.57%	2291.7	8.17%	28,044
Cobalt	694	58.91%	399.8	33.95%	84	7.13%	1,178
Lead	6,255	36.91%	4300	25.38%	6390	37.71%	16,945
Zinc	21,500	36.69%	9800	16.72%	27300	46.59%	58,600
Tin	210	10.03%	368.5	17.59%	1516.6	72.38%	2,095
Tungsten*	61	4.62%	950.3	72.23%	304.6	23.15%	1,316
Molybdenum	161	7.33%	1378.1	62.59%	662.4	30.08%	2,202
Titanium*	16,400	2.82%	153500	26.43%	410800	70.74%	580,700
Zirconium*	420	3.39%	3183	25.69%	8786.7	70.92%	12,389
Lithium*	64	1.83%	1196	34.25%	2232	63.92%	3,492
Niobium*	265	3.10%	1803.8	21.10%	6478.7	75.79%	8,548
Tantalum	14	3.33%	23.7	5.55%	389.1	91.12%	427
REM	4,600	16.14%	5100	17.89%	18800	65.96%	28,500
Gold	8	48.92%	7	42.07%	1.5	9.01%	17
Silver	62	50.08%	44.9	36.56%	16.4	13.36%	123
Platinoids	8	52.60%	7.3	46.26%	0.179	1.13%	16
Graphite	1,300	1.29%	13000	12.90%	86500	85.81%	100,800
Phosphate ores	288,200	24.05%	252400	21.06%	657800	54.89%	1,198,400
Fluorite	10,800	37.11%	2800	9.62%	15500	53.26%	29,100

³⁶⁵ <https://rosnedra.gov.ru/activity/documents/gosudarstvennyy-doklad-2023/>

Annex 4. Investment in Geological Exploration Work in the Russian Federation in 2021, compiled by the authors based on³⁶⁶

Mineral (* in oxides)	Exploration volume (RUB million)		Total value (RUB million)	Share of total exploration volume
	Subsoil users	State		
Oil and condensate	315,000	11000	326,000	79.79%
Uranium	9.5	197	207	0.05%
Iron ores	514.6	0	515	0.13%
Manganese ores	12	0	12	0.00%
Chromium ores	17	150	167	0.04%
Bauxite	118.3	0	118	0.03%
Copper	6500	871	7,371	1.80%
Nickel	1790	0	1,790	0.44%
Cobalt	120.7	0	121	0.03%
Lead	2.003	547.4	549	0.13%
Zinc	3200	687.4	3,887	0.95%
Tin	507.5	0	508	0.12%
Tungsten*	6.1	145.7	152	0.04%
Molybdenum	1200	117	1,317	0.32%
Titanium*	123.7	55	179	0.04%
Zirconium*	71.3	0	71	0.02%
Lithium*	11.6	0	12	0.00%
REM	34.4	0	34	0.01%
Scandium	0	0	0	0.00%
Gold	44500	1760	46,260	11.32%
Silver	17600	671	18,271	4.47%
Platinoids	959.4	0	959	0.23%
Graphite	0	0	0	0.00%
Phosphate ores	6.5	0	7	0.00%
Fluorite	13.6	66.9	81	0.02%
TOTAL	392,318	16268.4	408,587	100%

³⁶⁶ https://rosnedra.gov.ru/activity/documents/gosudarstvennyy_doklad_2021/

Annex 5. Investment in Geological Exploration Work in the Russian Federation in 2023, compiled by the authors based on³⁶⁷

Mineral (* in oxides)	Exploration volume (RUB million)		Total value (RUB million)	Share
	Subsoil users	State		
Oil and condensate	320000	12000	332000	74.68%
Uranium	8.9	243	251.9	0.06%
Iron ores	784	159	943	0.21%
Manganese ores	14.5	937.1	951.6	0.21%
Chromium ores	40.3	120	160.3	0.04%
Bauxite	46.2	0	46.2	0.01%
Nepheline ores	0	0	0	0.00%
Copper	11900	71	11971	2.69%
Nickel	4151	0	4151	0.93%
Cobalt	3063	0	3063	0.69%
Lead	2000	645	2645	0.59%
Zinc	3100	787	3887	0.87%
Tin	257.5	0	257.5	0.06%
Tungsten*	436.1	216.1	652.2	0.15%
Molybdenum	1900	185.9	2085.9	0.47%
Titanium*	107.6	327.1	434.7	0.10%
Zirconium*	58.7	0	58.7	0.01%
Lithium*	1261.1	0	1261.1	0.28%
Niobium*	1212	0	1212	0.27%
Tantalum	1209.6	0	1209.6	0.27%
REM	0	0	0	0.00%
Gold	50700	2040	52740	11.86%
Silver	19900	820	20720	4.66%
Platinoids	3629.6	0	3629.6	0.82%
Graphite	2.75	58.2	60.95	0.01%
Phosphate ores	72.4	0	72.4	0.02%
Fluorite	0	105	105	0.02%
TOTAL	425855.25	18714.4	444569.65	100.00%

³⁶⁷ <https://rosnedra.gov.ru/activity/documents/gosudarstvennyy-doklad-2023/>

Annex 6. Analysis of Alumina Imports to the Russian Federation. List of countries of origin of imported products, April 2024 – March 2025³⁶⁸

Alumina production jurisdiction	HS codes	Alumina shipping jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
PRC	281820	China	1,625,146.71	29.58%	1,039,660,231.07	31.42%
		Other countries	1,067.21	0.02%	959,266.37	0.03%
Total PRC			1,626,213.91	29.59%	1,040,619,497.44	31.45%
Indonesia	281820	Indonesia	1,015,681.27	18.48%	611,721,378.94	18.49%
		China	3,058.44	0.06%	2,521,505.22	0.08%
Total Indonesia			1,018,739.72	18.54%	614,242,884.16	18.56%
Ireland	281820	Ireland	960,346.40	17.48%	567,681,411.51	17.16%
Kazakhstan	281820	Kazakhstan	734,876.74	13.37%	415,198,743.67	12.55%
Jamaica	281820	Jamaica	503,745.01	9.17%	282,932,917.75	8.55%
India	281820	India	342,830.08	6.24%	196,638,890.76	5.94%
Guinea	281820	Guinea	307,387.45	5.59%	188,680,150.68	5.70%
Other countries	281820	Other countries	856.34	0.02%	2,924,345.71	0.09%

³⁶⁸ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 7. Analysis of Alumina Imports to the Russian Federation. List of countries from which imported products were shipped directly to the Russian Federation, April 2024 – March 2025³⁶⁹

Alumina shipping jurisdiction	HS codes	Alumina production jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
PRC	281820	PRC	1,625,146.71	29.58%	1,039,660,231.07	31.42%
		Other countries	3,063.79	0.06%	2,665,576.39	0.08%
Total PRC			1,628,210.50	29.63%	1,042,325,807.46	31.50%
Indonesia	281820	Indonesia	1,015,681.27	18.48%	611,721,378.94	18.49%
Ireland	281820	Ireland	960,346.40	17.48%	567,681,411.51	17.16%
Kazakhstan	281820	Kazakhstan	734,876.74	13.37%	415,198,743.67	12.55%
		Other countries	0.06	0.00%	12,594.76	0.00%
Total Kazakhstan			734,876.81	13.37%	415,211,338.43	12.55%
Jamaica	281820	Jamaica	503,745.01	9.17%	282,932,917.75	8.55%
India	281820	India	342,830.08	6.24%	196,638,890.76	5.94%
		Switzerland	0.00	0.00%	89.09	0.00%
Total India			342,830.08	6.24%	196,638,979.85	5.94%
Guinea	281820	Guinea	307,387.45	5.59%	188,680,150.68	5.70%
Other countries	281820	Other countries	1,918.14	0.03%	3,726,857.06	0.11%

³⁶⁹ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 8. Analysis of Molybdenum (Iron Alloys and Compounds) Imports to the Russian Federation. List of countries of origin of imported products, April 2024 – March 2025³⁷⁰

Molybdenum production jurisdiction	HS codes	Molybdenum shipping jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
Armenia	720270	Armenia	1,926.00	45.93%	61,965,040.79	39.87%
	282570	Armenia	132.00	3.15%	3,286,809.34	2.11%
Total Armenia			2,058.00	49.07%	65,251,850.13	41.99%
PRC	282570	PRC	1,617.54	38.57%	69,524,832.39	44.73%
		Other countries	20.00	0.48%	1,300,000.00	0.84%
Total PRC			1,637.54	39.05%	70,824,832.39	45.57%
India	282570	India	297.50	7.09%	11,261,621.52	7.25%
		Other countries	0.00	0.00%	65.78	0.00%
	282570 Total		297.50	7.09%	11,261,687.30	7.25%
	720270	India	6.00	0.14%	369,628.11	0.24%
Total India			303.50	7.24%	11,631,315.41	7.48%
Chile	282570	Turkey	151.68	3.62%	6,011,045.78	3.87%
Other countries		Other countries	22.91	0.55%	802,164.58	0.52%

³⁷⁰ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 9. Analysis of Molybdenum (Iron Alloys and Compounds) Imports to the Russian Federation. List of countries from which imported products were shipped directly to the Russian Federation, April 2024 – March 2025³⁷¹

Molybdenum shipping jurisdiction	HS codes	Molybdenum production jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
Armenia	720270	Armenia	1,926.00	45.93%	61,965,040.79	39.87%
	282570	Armenia	132.00	3.15%	3,286,809.34	2.11%
Total Armenia			2,058.00	49.07%	65,251,850.13	41.99%
PRC	282570	PRC	1,617.54	38.57%	69,524,832.39	44.73%
	720270		0.10	0.00%	4,847.91	0.00%
Total PRC			1,617.64	38.57%	69,529,680.30	44.74%
India	282570	India	297.50	7.09%	11,261,621.52	7.25%
	720270		6.00	0.14%	369,628.11	0.24%
Total India			303.50	7.24%	11,631,249.63	7.48%
Turkey	282570	Chile	151.68	3.62%	6,011,045.78	3.87%
		Other countries	4.56	0.11%	223,803.13	0.14%
Total Turkey			156.24	3.73%	6,234,848.91	4.01%
Kazakhstan	282570	Kazakhstan	13.65	0.33%	448,286.96	0.29%
		Other countries	3.00	0.07%	162,522.00	0.10%
	282570 Total		23.00	0.55%	1,051,335.50	0.68%
	720270	Kazakhstan	10.65	0.25%	285,764.96	0.18%
Total Kazakhstan			53.65	1.28%	2,637,100.46	1.70%
Other countries	720270	Kyrgyzstan	4.70	0.11%	130,140.27	0.08%

Annex 10. Analysis of Tantalum (Pure Metal) Imports to the Russian Federation. List of countries of origin of imported products, April 2024 – March 2025³⁷²

Tantalum production jurisdiction	HS codes	Tantalum shipping jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
Kazakhstan	8103	Kazakhstan	12.08	75.34	9,278,652.77	68.78
PRC	8103	PRC	2.85	17.77	2,340,867.35	17.35
		UAE	1.00	6.23	1,741,887.79	12.91
Total PRC	8103		3.85	24.00	4,082,755.14	30.26
Other countries	8103	Other countries	0.11	0.66	129,449.12	0.96

³⁷¹ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

³⁷² Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 11. Analysis of Tantalum (Pure Metal) Imports to the Russian Federation. List of countries from which imported products were shipped directly to the Russian Federation, April 2024 – March 2025 ³⁷³

Tantalum shipping jurisdiction	HS codes	Tantalum production jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
Kazakhstan	8103	Kazakhstan	12.08	75.34	9,278,652.77	68.78
PRC	8103	PRC	2.85	17.77	2,340,867.35	17.35
		Other countries	0.06	0.37	101,063.76	0.75
Total PRC	8103		2.91	18.14	2,441,931.11	18.10
UAE	8103	PRC	1.00	6.23	1,741,887.79	12.91
Other countries	8103	Other countries	0.05	0.29	28,385.36	0.21

Annex 12. Analysis of Beryllium (Alloys and Compounds) Imports to the Russian Federation. List of countries of origin of imported products, April 2024 – March 2025 ³⁷⁴

Beryllium production jurisdiction	HS codes	Beryllium shipping jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
PRC	760120	PRC	27.50	26.09	1,569,076.97	10.88
	740990		17.57	16.67	700,582.14	4.86
	740729		16.08	15.26	672,850.49	4.66
	848330		1.23	1.17	364,499.79	2.53
Total PRC			62.38	59.19	3,307,009.39	22.92
Kazakhstan	760120	Kazakhstan	17.19	16.31	1,196,527.81	8.29
	740729		10.76	10.21	534,792.07	3.71
	811219		7.13	6.77	9,295,641.14	64.43
Total Kazakhstan			35.08	33.29	11,026,961.02	76.43
Other countries		Other countries	7.92	7.52	93,277.05	0.65

³⁷³ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

³⁷⁴ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 13. Analysis of Beryllium (Alloys and Compounds) Imports to the Russian Federation. List of countries from which imported products were shipped directly to the Russian Federation, April 2024 – March 2025 ³⁷⁵

Beryllium shipping jurisdiction	HS codes	Beryllium production jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
PRC	760120	PRC	27.50	26.09	1,569,076.97	10.88
	740990		17.57	16.67	700,582.14	4.86
	740729		16.08	15.26	672,850.49	4.66
	848330		1.23	1.17	364,499.79	2.53
Total PRC			62.38	59.19	3,307,009.39	22.92
Kazakhstan	760120	Kazakhstan	17.19	16.31	1,196,527.81	8.29
	740729		10.76	10.21	534,792.07	3.71
	811219		7.13	6.77	9,295,641.14	64.43
Total Kazakhstan			35.08	33.29	11,026,961.02	76.43
Other countries		Other countries	7.92	7.52	93,277.05	0.65

Annex 14. Analysis of Manganese (Ore) Imports to the Russian Federation. List of countries of origin of imported products, April 2024 – March 2025 ³⁷⁶

Manganese production jurisdiction	HS codes	Manganese shipping jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
Republic of South Africa	260200	Latvia	227,112.00	21.14%	65,090,036.62	28.61%
		Republic of South Africa	258,163.68	24.03%	45,951,617.32	20.20%
		PRC	121,901.00	11.35%	25,296,029.16	11.12%
		Turkey	117,305.52	10.92%	29,951,437.23	13.16%
		UAE	60,500.00	5.63%	13,093,170.51	5.76%
Total Republic of South Africa			784,982.20	73.08%	179,382,290.84	78.85%
Côte d'Ivoire	260200	Côte d'Ivoire	94,086.24	8.76%	13,970,600.52	6.14%
		Latvia	27,663.80	2.58%	7,209,166.45	3.17%
Total Côte d'Ivoire			121,750.04	11.33%	21,179,766.97	9.31%
Brazil	260200	Turkey	45,397.22	4.23%	12,873,691.94	5.66%
		Latvia	10,604.40	0.99%	3,423,475.01	1.50%
		Estonia	9,120.70	0.85%	2,920,804.44	1.28%
Total Brazil			65,122.32	6.06%	19,217,971.39	8.45%
Kazakhstan	260200	Kazakhstan	96,092.97	8.95%	6,014,779.73	2.64%
Other countries	260200	Other countries	6,264.91	0.58%	1,713,714.27	0.75%

³⁷⁵ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

³⁷⁶ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 15. Analysis of Manganese (Ore) Imports to the Russian Federation. List of countries from which imported products were shipped directly to the Russian Federation, April 2024 – March 2025³⁷⁷

Manganese shipping jurisdiction	HS codes	Manganese production jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
Latvia	260200	Republic of South Africa	227,112.03	21.14%	65,090,036.62	28.61%
		Côte d'Ivoire	27,663.80	2.58%	7,209,166.45	3.17%
		Brazil	10,604.40	0.99%	3,423,475.01	1.50%
Total Latvia			265,380.23	24.70%	75,722,678.08	33.28%
Republic of South Africa	260200	Republic of South Africa	258,163.68	24.03%	45,951,617.32	20.20%
Turkey	260200	Republic of South Africa	117,305.52	10.92%	29,951,437.23	13.16%
		Brazil	45,397.22	4.23%	12,873,691.94	5.66%
		Other countries	5,065.23	0.47%	1,050,899.64	0.46%
Total Turkey			167,767.97	15.62%	43,876,028.81	19.29%
PRC	260200	Republic of South Africa	121,901.00	11.35%	25,296,029.16	11.12%
		Other countries	79.89	0.01%	90,842.42	0.04%
Total PRC			121,980.89	11.36%	25,386,871.58	11.16%
Côte d'Ivoire	260200	Côte d'Ivoire	94,086.24	8.76%	13,970,600.52	6.14%
UAE	260200	Republic of South Africa	60,500.00	5.63%	13,093,170.51	5.76%
Kazakhstan	260200	Kazakhstan	96,092.97	8.95%	6,014,779.73	2.64%
Estonia	260200	Brazil	9,120.70	0.85%	2,920,804.44	1.28%
Other countries	260200	Other countries	1,119.79	0.10%	571,972.21	0.25%

³⁷⁷ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 16. Analysis of Niobium (Iron Alloy) Imports to the Russian Federation. List of countries of origin of imported products, April 2024 – March 2025³⁷⁸

Niobium production jurisdiction	HS codes	Niobium shipping jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
Brazil	720293	Turkey	517.58	15.59%	16,464,023.08	14.91%
		PRC	291.92	8.80%	9,623,120.28	8.72%
		Israel	75.00	2.26%	2,631,071.98	2.38%
		Lithuania	58.80	1.77%	1,661,035.32	1.50%
		UAE	50.00	1.51%	1,538,412.88	1.39%
		Other countries	40.00	1.20%	1,254,803.67	1.14%
Total Brazil			1,033.30	31.13%	33,172,467.21	30.04%
Hong Kong	720293	PRC	840.40	25.32%	26,595,655.95	24.09%
		Other countries	41.60	1.25%	1,269,183.10	1.15%
Total Hong Kong			882.00	26.57%	27,864,839.05	25.24%
Canada	720293	PRC	259.47	7.82%	8,607,057.06	7.80%
		Belarus	40.00	1.21%	1,376,217.65	1.25%
		Turkey	36.00	1.08%	1,205,912.76	1.09%
		Other countries	53.00	1.59%	1,678,674.43	1.51%
Total Canada			388.47	11.70%	12867861.9	11.65%
India	720293	PRC	340.00	10.24%	11,873,148.99	10.75%
		India	22.00	0.66%	701,942.66	0.64%
Total India			362.00	10.91%	12,575,091.65	11.39%
PRC	720293	PRC	189.00	5.69%	5,915,478.58	5.36%
		Turkey	120.00	3.62%	6,812,863.02	6.17%
Total PRC			309.00	9.31%	12,728,341.60	11.53%
Turkey	720293	Turkey	139.98	4.22%	4,276,658.34	3.87%
UAE	720293	UAE	40.00	1.21%	1,438,268.18	1.30%
		Turkey	40.00	1.21%	1,432,000.00	1.30%
		PRC	40.00	1.21%	1,427,416.00	1.29%
Total UAE			120.00	3.62%	4,297,684.18	3.89%
Netherlands	720293	Turkey	82.00	2.47%	2,553,114.54	2.31%
Other countries	720293		2.25	0.07%	74,298.36	0.07%

³⁷⁸ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 17. Analysis of Niobium (Iron Alloy) Imports to the Russian Federation. List of countries from which imported products were shipped directly to the Russian Federation, April 2024 – March 2025³⁷⁹

Niobium shipping jurisdiction	HS codes	Niobium production jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
PRC	720293	Hong Kong	840.40	25.32	26,595,655.95	24.09
		India	340.00	10.24	11,873,148.99	10.75
		Brazil	291.92	8.80	9,623,120.28	8.72
		Canada	259.47	7.82	8,607,057.06	7.80
		PRC	189.00	5.69	5,915,478.58	5.36
		UAE	40.00	1.21	1,427,416.00	1.29
	720293	Other countries	2.00	0.06	65,407.84	0.06
Total PRC			1,962.79	59.14	64,107,284.70	58.06
Turkey	720293	Brazil	517.58	15.59	16,464,023.08	14.91
		PRC	120.00	3.62	6,812,863.02	6.17
		Turkey	139.98	4.22	4,276,658.34	3.87
		Netherlands	82.00	2.47	2,553,114.54	2.31
		UAE	40.00	1.21	1,432,000.00	1.30
		Canada	36.00	1.08	1,205,912.76	1.09
		Other countries	21.60	0.65	641,251.30	0.58
Total Turkey			957.16	28.84	33,385,823.04	30.24
UAE	720293	Brazil	50.00	1.51	1,538,412.88	1.39
		UAE	40.00	1.21	1,438,268.18	1.30
		Other countries	13.00	0.39	446,408.56	0.40
Total UAE			103.00	3.10	3,423,089.62	3.10
Israel	720293	Brazil	75.00	2.26	2,631,071.98	2.38
Lithuania	720293	Brazil	58.80	1.77	1,661,035.32	1.50
Belarus	720293	Canada	40.00	1.21	1,376,217.65	1.25
India	720293	India	22.00	0.66	701,942.66	0.64
		Brazil	20.00	0.60	639,857.77	0.58
		Unknown	0.25	0.01	8,890.52	0.01
Total India			42.25	1.27	1,350,690.95	1.22
Hong Kong	720293	Canada	20.00	0.60	632,149.50	0.57
		Hong Kong	20.00	0.60	627,931.80	0.57
Total Hong Kong			40.00	1.21	1,260,081.30	1.14
Germany	720293	Brazil	20.00	0.60	614,945.90	0.56
		Canada	20	0.60	600,116.37	0.54
Total Germany			40.00	1.21	1,215,062.27	1.10

³⁷⁹ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 18. Analysis of Tungsten (Compounds and Alloys) Imports to the Russian Federation. List of countries of origin of imported products, April 2024 – March 2025³⁸⁰

Tungsten production jurisdiction	HS codes	Tungsten shipping jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
PRC	282590	PRC	168.56	69.40%	3,917,988.92	38.83%
	810199	PRC	64.99	26.76%	5,431,668.40	53.83%
		Other countries	0.69	0.28%	78,583.55	0.78%
	284990	PRC	5.87	2.42%	346,071.58	3.43%
	Other codes	Other countries	0.10	0.04%	10,953.96	0.11%
Total PRC			240.82	98.9%	9,785,266.41	96.98%
USA			0.51	0.21%	80,820.35	0.80%
Israel			0.80	0.33%	47,398.75	0.47%
Other countries			0.75	0.31%	138,628.77	1.37%

Annex 19. Analysis of Tungsten (Compounds and Alloys) Imports to the Russian Federation. List of countries from which imported products were shipped directly to the Russian Federation, April 2024 – March 2025³⁸¹

Tungsten shipping jurisdiction	HS code	Tungsten production jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
PRC	282590	PRC	168.56	69.40	3,917,988.92	38.83
	810199	PRC	64.99	26.76	5,431,668.40	53.83
		Unknown	0.28	0.11	25,920.21	0.26
		Germany	0.03	0.01	11,835.30	0.12
		Czech Republic	0.00	0.00	52.21	0.00
		Australia	0.00	0.00	8,168.38	0.08
		USA	0.00	0.00	3,430.72	0.03
	Total for HS code 810199		65.30	26.88	5,481,075.22	54.32
	284990	PRC	5.87	2.42	346,071.58	3.43
	810110	PRC	0.62	0.26	37,899.78	0.38
Total PRC			240.35	98.96	9,783,035.50	96.96
Other countries			2.53	1.04	306,978.56	3.04

³⁸⁰ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

³⁸¹ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 20. Analysis of Rhenium (Ammonium Perrhenate) Imports to the Russian Federation. List of countries of origin of imported products, April 2024 – March 2025³⁸²

Rhenium production jurisdiction	HS codes	Rhenium shipping jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
Belarus	284190	Belarus	290.85	98.54%	110,202.48	4.53%
Uzbekistan	284190	Uzbekistan	3.95	1.34%	2,294,420.83	94.42%
Other countries	284190	Other countries	0.36	0.12%	25,448.03	1.04%

Annex 21. Analysis of Rhenium (Ammonium Perrhenate) Imports to the Russian Federation. List of countries from which imported products were shipped directly to the Russian Federation, April 2024 – March 2025³⁸³

Rhenium shipping jurisdiction	HS codes	Rhenium production jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
Uzbekistan	284190	Uzbekistan	3.95	1.34%	2,294,420.83	94.42%
Belarus	284190	Belarus	290.85	98.54%	110,202.48	4.53%
		Germany	0.32	0.11%	1,979.67	0.08%
Total Belarus			291.17	98.65%	112,182.15	4.62%
Other countries	284190	Other countries	0.04	0.01%	23,468.36	0.97%

Annex 22. Analysis of Titanium (Ores and Concentrates) Imports to the Russian Federation. List of countries of origin of imported products, April 2024 – March 2025³⁸⁴

Titanium production jurisdiction	HS codes	Titanium shipping jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
PRC	2614	PRC	49,888.414	35.13%	39,359,605.1	48.75%
		Hong Kong	54.00	0.04%	113,748.84	0.14%
Total PRC	2614		49,942.41	35.16%	39,473,353.94	48.89%
India	2614	India	42,000.00	29.57%	19,009,400.00	23.54%
Kazakhstan	2614	Kazakhstan	37,393.86	26.33%	13,261,782.44	16.42%
Vietnam	2614	Vietnam	10,100.68	7.11%	4,393,795.80	5.44%
Germany	2614	Netherlands	1,440.00	1.01%	2,266,152.09	2.81%
		Belgium	60.00	0.04%	68,872.42	0.09%
Total Germany	2614		1,500	1.06%	2,335,024.51	2.89%
Other countries	2614		1,086.84	0.77%	2,270,702.5	2.82

³⁸² Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.³⁸³ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.³⁸⁴ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 23. Analysis of Titanium (Ores and Concentrates) Imports to the Russian Federation. List of countries of origin of imported products, April 2024 – March 2025³⁸⁵

Titanium shipping jurisdiction	HS codes	Titanium production jurisdiction	Supply volume		Supply value	
			Tonnage (MT)	Share (%)	Value (USD)	Share (%)
PRC	2614	PRC	49,888.41	35.13%	39,359,605.10	48.75%
		South Africa	398.00	0.28%	801,088.75	0.99%
Total PRC	2614		50,286.41	35.41%	40,160,693.85	49.74%
India	2614	India	42,000.00	29.57%	19,009,400.00	23.54%
Kazakhstan	2614	Kazakhstan	37,393.86	26.33%	13,261,782.44	16.42%
Vietnam	2614	Vietnam	10,100.68	7.11%	4,393,795.80	5.44%
Netherlands	2614	Germany	1,440.00	1.01%	2,266,152.09	2.81%
		Netherlands	149.79	0.11%	290,518.46	0.36%
Total Netherlands	2614		1,589.76	1.12%	2,556,670.55	3.17%
Other countries	2614		653.05	0.46%	1,361,716.55	1.69%

Annex 24. Analysis of Alumina Imports to the Russian Federation. List of the largest suppliers of products imported to the Russian Federation, April 2024 – March 2025.³⁸⁶

Name	Home jurisdiction	Product origin jurisdiction	Import volume, USD	Sanctions status	Importer
Beijing Rusal Trade Company Limited	China	China	992,407,021.52	N/A	Boguchany Aluminum Smelter JSC; Rusal Krasnoyarsk Aluminum Smelter JSC, and others
Pt Bintan Alumina Indonesia	Indonesia	Indonesia	577,263,831.11	N/A	Boguchany Aluminum Smelter JSC; Rusal Krasnoyarsk Aluminum Smelter JSC, and others
Erg Markmetal Investments Dmcc	–	Kazakhstan	415,139,047.00	N/A	United Company Rusal – Trade House JSC
Alpia LLC	–	Ireland, Jamaica, India, Guinea	490,906,067.87	N/A	Rusal Sayanogorsk Aluminum Smelter JSC
Limerick Alumina Refining Limited	Ireland	Ireland	307,857,174.42	N/A	Rusal Krasnoyarsk Aluminum Smelter JSC; United Company Rusal – Trade House JSC; Rusal Bratsk Aluminum Smelter PJSC
Other suppliers			525,345,699.76		

³⁸⁵ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.³⁸⁶ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 25. Analysis of Alumina Imports to the Russian Federation. List of the Largest Product Importers, April 2024 – March 2025. ³⁸⁷

Importer name, TIN	Import volume, USD	Sanctions status	Supplier companies
Rusal Bratsk Aluminum Smelter JSC	1,123,103,487.67	N/A	Beijing Rusal Trade Company Limited (PRC) Limerick Alumina Refining Limited (Ireland)
Rusal Sayanogorsk Aluminum Smelter JSC	973,782,830.46	N/A	Alpia Llc (Ireland, Jamaica, India)
Rusal Krasnoyarsk Aluminum Smelter JSC	424,084,295.59	N/A	Limerick Alumina Refining Limited (Ireland) Uc Rusal Alumina Jamaica Limited Db Winalco (Jamaica) Friguia Sa (Guinea) Beijing Rusal Trade Company Limited (PRC)
United Company Rusal – Trade House JSC	503,143,839.79	N/A	Beijing Rusal Trade Company Limited (PRC)
Other importers	284,804,388.17		

Annex 26. Deliveries by alumina importers to Russian RMIC enterprises, July 2024 – June 2025. ³⁸⁸

Importer name, TIN	Client enterprises of the RMIC or suppliers to RMIC enterprises	
Name, TIN	Name, TIN	Value of deliveries, USD
Rusal Bratsk Aluminum Smelter JSC, TIN: 3803100054	Kamensk-Uralsky Metallurgical Works JSC, TIN: 6665002150	59,730,867.56
	Aluminum Sales Company LLC, TIN: 7730236636	15,658,012.39
	Rybinskable LLC, TIN: 7610093062	9,442,526.77
	Bratsk Ferroalloy Plant LLC, TIN: 3804028227	2,808,326.49
	Saranskabel-Optika LLC, TIN: 1327153649	1,826,051.94
	Novolipetsk Metallurgical Plant PJSC, TIN: 4823006703	26,437,403.33
	Engineering Construction Service LLC, TIN: 7730248021	7,874,337.72
	Kamskiy Kabel LLC, TIN: 5904184047	5,502,062.57
	Alyur Cable Plant LLC, TIN: 6025013482	2,039,302.78
	Kremny JSC, TIN: 3821008439	1,664,132.73
Rusal Sayanogorsk Aluminum Smelter JSC, TIN: 1902014500	Alpia LLC, TIN: 9909684153	207,389,271.50
	Ural-Siberian Specialized Company LLC, TIN: 6678009883	5,609,148.17
	BK-Alprof LLC, TIN: 6142017970	4,074,545.70
	SKAD Foundry and Machine Plant LLC, TIN: 2465072918	2,841,831.62

³⁸⁷ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

³⁸⁸ Based on data on transactions between enterprises within the Russian Federation, available to the Economic Security Council of Ukraine.

	R.O.S.Anticor Scientific and Production Association LLC, TIN: 7453205457	1,016,314.78
	Aluminum Sales Company LLC (ASC LLC), TIN: 7730236636	18,660,672.14
	Engineering Construction Service LLC (ISO LLC), TIN: 7730248021	4,450,307.25
	Ankor LLC, TIN: 6314018289	3,312,693.92
	Vikom-Vils LLC, TIN: 6612036371	1,886,566.31
Rusal Krasnoyarsk Aluminum Smelter JSC, TIN: 2465000141	Tatprof JSC, TIN: 1650089015	20,738,648.86
	Engineering Construction Service LLC, TIN: 7730248021	7,874,337.72
	SKAD Foundry and Machine Plant LLC, TIN: 2465072918	4,008,210.30
	Alpha-Metal Industrial Supply LLC, TIN: 5021011203	3,685,871.72
	Ural Foil JSC, TIN: 6646010043	1,947,957.76
	Elektrostal-Snab LLC, TIN: 5053055500	1,066,418.28
	Aluminum Sales Company LLC (ASC LLC), TIN: 7730236636	14,827,789.97
	Segal Foundry and Press Plant LLC, TIN: 2458008580	4,879,327.51
	Kamensk-Uralsky Metallurgical Works JSC, TIN: 6665002150	3,977,814.04
	Krasnoyarsk Metallurgical Plant LLC, TIN: 2465043748	2,010,065.99
	Ural-Siberian Specialized Company LLC, TIN: 6678009883	1,351,763.49
United Company Rusal – Trade House JSC, TIN: 5519006211	Aluminum Sales Company LLC, TIN: 7730236636	27,182,306.46
	Volgograd Aluminum Company – Powder Metallurgy LLC, TIN: 3435051260	5,921,452.82
	Novotroitsk Plant of Chromium Compounds JSC, TIN: 5607002135	1,862,667.13
	Kamensk-Uralsky Metallurgical Works JSC, TIN: 6665002150	20,594,913.11
	Orion – Spetssplav – Gatchina LLC, TIN: 4705020331	4,641,493.29
	Ankor LLC, TIN: 6314018289	1,455,927.72
Rusal Taishet Aluminum Smelter LLC, TIN: 3815011264	Aluminum Sales Company LLC (ASC LLC), TIN: 7730236636	92,684,926.48
	Volgograd Aluminum Company – Powder Metallurgy LLC, TIN: 3435051260	14,369,237.96
	ТОВ “Орион - Спецсплав - Гатчина”, TIN: 4705020331	5,503,085.65
	Tatprof JSC, TIN: 1650089015	26,492,483.01
	Kamensk-Uralsky Metallurgical Works JSC, TIN: 6665002150	10,707,505.10

Annex 27. Deliveries by Aluminum Sales Company LLC to Russian RMIC enterprises, 2023–2025 ³⁸⁹

Company name	TIN	Supply volume, USD
VSMPO-AVISMA Corporation Public Joint Stock Company	6607000556	21,076,319.00
Federal State Enterprise 'Plant Named After Y.M. Sverdlov'	5249002485	18,292,747.00
Federal State Enterprise Kamensky Combine	6147025090	7,588,430.00
Morozov Plant Federal State Unitary Enterprise	4703009607	2,493,686.00
Plastmass Plant JSC	7411009901	2,329,002.00
Special Technological Centre LLC	7802170553	2,319,464.00
Branch of PJSC "Imperial Tula Arms Plant"	7107003303	1,489,902.00
Bryansk Chemical Plant Named After the 50th Anniversary of the USSR JSC	3255517496	1,205,053.00
Scientific and Production Corporation 'Uralvagonzavod' Named After F.E. Dzerzhinsky JSC	6623029538	1,194,544.00
V.V. Bakhirev State Research Institute of Mechanical Engineering JSC	5249093130	1,175,290.00
N.I. Sazykina Arsenyev Aviation Company Progress JSC	2501002394	1,066,587.00
Novosibirsk Artificial Fiber Plant JSC	5446013327	555,598.00
Perm Powder Plant Federal State Enterprise	5908006119	470,507.00
Branch of PJSC "Yakovlev" – "Regional Aircraft"	3807002509	433,106.00
Kurgan Machine-Building Plant JSC	4501008142	432,581.00
ODK-Ufa Engine-Building Production Association PJSC	0273008320	378,971.00
Ruspolimet JSC	5251008501	299,489.00
Federal Center for Dual-Use Technologies Soyuz JSC	5027333849	297,550.00
Ralph Ringer Management LLC	7708619320	278,102.00
Arzamas Instrument-Making Plant Named After P.I. Plandin JSC	5243001742	208,011.00
Tupolev JSC	7705313252	107,804.00
Votkinsk Plant JSC	1828020110	103,113.00
Ural Transport Engineering Plant JSC	6659190900	47,969.00
Machinostroitel Perm Plant JSC	5906075029	44,946.00
M.I. Kalinin Machine-Building Plant PJSC	6663003800	42,818.00
Semiconductor Devices Plant JSC	1215085052	37,331.00
UEC NPO Saturn, PJSC	7610052644	28,027.00
Concern Sozvezdie JSC	3666127502	19,643.00
UEC Salyut Production Complex	7731644035	9,472.00
Production Association Ural Optical-Mechanical Plant Named After E.S. Yalamov JSC	6672315362	8,994.00
Mars Plant JSC	6915002325	7,557.00
Central Research Institute No. 18 Federal State Unitary Enterprise of the Ministry of Defense of the Russian Federation	7720090314	4,862.00
Bazalt Scientific and Production Association JSC	7719830028	4,466.00
Taganrog Scientific Research Institute of Communications JSC	6154573235	4,294.00
Bryansk Electromechanical Plant JSC	3255517577	2,949.00

³⁸⁹ The list includes only the largest enterprises by supply volume. Compiled based on data on transactions between enterprises within the Russian Federation for the period April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Radio Plant JSC	7452054678	1,467.00
Irkutsk Relay Plant JSC	3811016215	934.00
Novator Experimental Design Bureau JSC	6673092045	892.00
Avitek Vyatka Machine-Building Enterprise JSC	4345047310	534.00

Annex 28. Analysis of Molybdenum (Iron Alloys and Compounds) Imports to the Russian Federation. List of the largest suppliers of products imported to the Russian Federation, April 2024 – March 2025.³⁹⁰

Name	Home jurisdiction	Product origin jurisdiction	Import volume, USD	Sanctions status	Importer
AMP Holding	Armenia	Armenia	56,199,237.47	N/A	SEMAKS METAL LLC; NKM Nord LLC
Suifenhe Baofu Economic & Trade Co Limited	China	China	30,798,057.59	N/A	Khimeksport LLC; Khimtekh LLC
W & Q Fine Chemicals Company Limited (W&Q Group)	China	China	14,875,387.96	N/A	Unikhim LLC; Baltiyskaya Manufactura Scientific and Production Firm LLC; Industrial JSC Closed Joint-Stock Company; SKTB Katalizator JSC, and others
Other suppliers			53,689,976.68		

Annex 29. Analysis of Molybdenum (Iron Alloys and Compounds) Imports to the Russian Federation. List of the Largest Product Importers, April 2024 – March 2025.³⁹¹

Importer name, TIN	Import volume, USD	Sanctions status	Supplier companies
Semaks Metal LLC	40,004,528.92	N/A	AMP Holding (Armenia), ARAMET (Armenia)
NKM Nord LLC	24,675,085.51	N/A	AMP Holding LLC (Armenia)
Khimeksport LLC	24,435,877.73	N/A	Suifenhe Baofu Economic & Trade Co Limited (PRC) Anqing Yuetong Molybdenum Co., Ltd (PRC)
Other importers	66,299,377.54		

³⁹⁰ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

³⁹¹ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 30. Deliveries by molybdenum importers to Russian RMIC enterprises, July 2024 – June 2025 ³⁹²

Importer name, TIN	Client enterprises of the RMIC or suppliers to RMIC enterprises	
Name, TIN	Name, TIN	Value of deliveries, USD
Semaks Metal LLC, TIN: 6168073560	UEC-Perm Motors JSC, TIN: 5904007312	15,284,061.49
	UEC-Saturn PJSC, TIN: 7610052644	3,365,169.98
	Centre for Additive Technologies JSC, TIN: 7733325690	1,733,199.00
	Ural Forge PJSC, TIN: 7420000133	186,518.96
	UEC-UMPO PJSC, TIN: 0273008320	9,672,361.07
	UEC JSC, TIN: 7731644035	3,229,871.10
	Ufa Aggregate Enterprise Gidravlika JSC, TIN: 0278179819	122,342.39
Baltiyskaya Manufactura Scientific and Production Company LLC, TIN: 7801091980	Unikhim LLC, TIN: 7805755769	8,355,466.30
	Promelectronica JSC, TIN: 6454004102	261,024.06
	Federal Center for Dual-Use Technologies Soyuz JSC, TIN: 5027333849	61,351.02
	Research Institute of Chemical Current Sources JSC, TIN: 6451118983	302,790.87
	Elektrokeramika JSC, TIN: 5040005090	136,086.37
	Atlant Plant JSC, TIN: 2607000333	89,352.25
Unikhim LLC, TIN: 7805755769	Baltiyskaya Manufactura Scientific and Production Company LLC, TIN: 7801091980	1,187,895.15
	Magnetron Plant OJSC, TIN: 7802053803	482,032.08
	Spektr-Khim Trading Company LLC, TIN: 7707501100	243,666.26
	Khimpromkomplekt LLC, TIN: 5834033115	156,520.67
	Kurchatov Institute NRC – Prometey TsNIIKM (Federal State Unitary Enterprise "Prometey Central Research Institute of Structural Materials named after I.V. Gorynin of the Kurchatov Institute National Research Centre"), TIN: 7815021340	136,212.21
	Nevsky Khimik Scientific and Production Firm LLC, TIN: 7810079668	473,493.89
	Aloks LLC, TIN: 7802226090	347,600.25
	Khimreaktiv JSC, TIN: 5257000040	227,113.73
	Perm Powder Plant Federal State Enterprise, TIN: 5908006119	128,785.69
Translom LLC, TIN: 4345217731	Pobedit JSC, TIN: 1501000010	11,360,624.17
	Stupinskaya Metallurgical Company JSC, TIN: 5045023416	666,255.40
	Ural Forge PJSC, TIN: 7420000133	565,576.80
	Virial LLC, TIN: 7827000909	390,869.83

³⁹² The list includes only the largest enterprises by supply volume. Compiled based on data on transactions between enterprises within the Russian Federation for the period April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 31. Analysis of Tantalum (Pure Metal) Imports to the Russian Federation. List of the largest suppliers of products imported to the Russian Federation, April 2024 – March 2025.³⁹³

Name	Home jurisdiction	Product origin jurisdiction	Import volume, USD	Sanctions status	Importer
Ulba Metallurgical Plant JSC	Kazakhstan	Kazakhstan	9,249,284.54	N/A	Promdelo Trade and Production Company LLC PKF Giperion LLC Metallopttorg LLC, and others
Amygdala International Trade Company Limited	UAE	China	1,741,887.79	N/A	Promtorg-Invest LLC
Chongqing Giaero Electrical Company Limited	China	China	1,121,444.58	N/A	Elekond JSC, and others
Luoyang Tongchang Tungsten & Molybdenum Material Co., Ltd	China	China	331,602.42	N/A	Metallkomplekt LLC; Atomtekhkomplekt LLC; Metallurgiya Scientific and Production Enterprise LLC; Ergarda LLC; and others
Other suppliers			1,046,636.70		

³⁹³ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

Annex 32. Analysis of Tantalum (Pure Metal) Imports to the Russian Federation. List of the Largest Product Importers, April 2024 – March 2025.³⁹⁴

Importer name, TIN	Import volume, USD	Sanctions status	Supplier companies
Promdelo Trade and Production Company LLC, TIN: 1838027370	3,009,146.40	N/A	Ulba Metallurgical Plant JSC (Kazakhstan)
PKF Giperion LLC, TIN: 5405065083	2,405,716.86	N/A	Ulba Metallurgical Plant JSC (Kazakhstan)
Metallopttorg LLC, TIN: 5401958350	2,171,423.91	N/A	Ulba Metallurgical Plant JSC (Kazakhstan)
Promtorg-Invest LLC, TIN: 7703762774	1,741,887.79	N/A	Amygdala International Trade Company Limited (UAE)
Elekond JSC, TIN: 1827003592	1,208,337.96	The company is subject to Ukrainian sanctions from April 15, 2023. The company is subject to Ukrainian sanctions from May 1, 2024. The company is subject to United Kingdom sanctions from September 12, 2025. The company is subject to Canadian sanctions from June 12, 2024. ³⁹⁵	Chongqing Giaero Electrical Company Limited (PRC)
Metallkomplekt LLC, TIN: 7702760164	886,245.20	N/A	Luoyang Tongchang Tungsten & Molybdenum Material Co., Ltd (PRC)
Other importers	2,068,098.91		

³⁹⁴ Based on data on Russian imports (including transactions with Eurasian Economic Union countries) for April 2024 – March 2025, available to the Economic Security Council of Ukraine.

³⁹⁵ <https://sanctions.blackseanews.net/entry/5319>

Annex 33. Deliveries by tantalum importers to Russian RMIC enterprises, July 2024 – June 2025 ³⁹⁶

Importer name, TIN	Client enterprises of the RMIC or suppliers to RMIC enterprises	
Name, TIN	Name, TIN	Value of deliveries, USD
Elekond JSC, TIN: 1827003592	Mariyskiy Machine-Building Plant JSC, TIN: 1200001885	3,436,541.78
	Scientific and Production Association Radioelectronics Scientific and Production Association Named After V.I. Shimko JSC, TIN: 1660155764	3,192,898.15
	Polyus Scientific and Production Centre JSC, TIN: 7017171342	2,758,600.69
	Obukhovskiy Zavod Scientific and Production Association JSC (Northwestern Regional Centre of Concern VKO Almaz-Antey), TIN: 7811144648	2,706,033.33
	Perm Scientific and Production Instrument-Making Company PJSC, TIN: 5904000395	2,703,719.04
	Moscow Scientific Research Television Institute, CJSC, TIN: 7701024429	2,612,538.45
	KBM Scientific and Production Corporation JSC, TIN: 5022039177	2,418,589.53
	Strelna Research and Production Association PJSC, TIN 7103028233	2,312,789.84
	Polyus Research Institute named after M.F. Stelmakh JSC, TIN: 7728816598	2,085,167.55
	Vologda Optical and Mechanical Plant JSC, TIN: 3525023010	2,044,025.88
	Ramenskoye Instrument-Making Plant JSC, TIN: 5040001426	1,705,855.71
	Elektrosignal JSC, TIN: 3650001159	1,602,627.48
	Elektromashina Scientific and Production Association JSC, TIN: 7449044990	1,590,170.15
	Elektroavtomatika JSC, TIN: 2636008464	1,502,487.54
	Krasnogorsk Plant named after S.A. Zverev PJSC, TIN: 5024022965	1,425,276.50
	Concern Sozvezdie JSC, TIN: 3666127502	1,403,530.81
	Eltom Scientific and Production Enterprise JSC, TIN: 5027106028	1,362,902.36
	Dukhov All-Russian Research Institute of Automatics Federal State Unitary Enterprise, TIN: 7707074137	1,249,551.38
	Detal Ural Design Bureau JSC, TIN: 6612011546	1,217,495.16
	Research Institute of the Scientific and Production Association Luch JSC, TIN: 7610063043	1,193,512.25
	Poisk Scientific and Production Association named after V.I. Rdul'tovskiy JSC, TIN: 4703142849	1,164,658.76
	Polet Scientific and Production Enterprise JSC, TIN: 5258100129	1,143,100.45
	Concern Uralvagonzavod JSC, TIN: 7706453206	1,131,283.85
	Ulyanovsk Mechanical Plant JSC, TIN: 7303026762	1,055,738.68
	Radiopribor JSC, TIN: 1659034109	1,048,340.19
Metallkomplekt LLC, TIN: 7702760164	Novosibirsk Radio Components Plant Oksid JSC, TIN: 5405441299	3,293,705.74
	Istok Scientific and Production Enterprise named after Shokin JSC, TIN: 5050108496	1,651,691.72
	Almaz Scientific and Production Enterprise JSC, TIN: 6453119615	489,751.02

³⁹⁶ The list includes only the largest enterprises by supply volume. Compiled based on data on transactions between enterprises within the Russian Federation for the period April 2024 – March 2025, available to the Economic Security Council of Ukraine.

	Avitek Vyatka Machine-Building Enterprise JSC, TIN: 4345047310	348,504.96
	Tori Scientific and Production Enterprise JSC, TIN: 7728328640	248,329.26
	Federal State Unitary Enterprise K.A. Volodin Instrument-Making Plant, TIN: 7405000428	116,769.47
	State Research and Design Institute of the Rare Metal Industry Giredmet JSC, TIN: 7706699062	109,459.84
	Elekond JSC, TIN: 1827003592	1,815,746.96
	Elektropribor Central Research Institute Concern JSC, TIN: 7813438763	686,285.66
	Pulsar Scientific and Production Enterprise JSC, TIN: 7719846490	464,243.66
	Svetlana-Elektronpribor JSC, TIN: 7802070277	227,173.14
	S.E.D.-SPb JSC, TIN: 7802064996	132,460.63
PKF Giperion LLC, TIN: 5405065083	Novosibirsk Radio Components Plant Oksid JSC, TIN: 5405441299	6,062,889.82
Rusredmet Scientific and Production Association LLC, TIN: 9721045710	SpetsMetalMaster Group of Companies LLC, TIN: 7722326685	7,069,474.73
	Ramenskoye Instrument-Making Plant JSC, TIN: 5040001426	361,300.05
	UEC-Saturn PJSC, TIN: 7610052644	246,636.99
	Istok Scientific and Production Enterprise named after Shokin JSC, TIN: 5050108496	177,951.48
	UEC JSC, TIN: 7731644035	156859.86
	UEC-Perm Motors JSC, TIN: 5904007312	124,912.31
	V.V. Bakhirev State Research Institute of Mechanical Engineering JSC, TIN: 7743873015	75,609.95
	Orion Scientific and Production Enterprise LLC, TIN: 7724317301	73,937.48
	Composite JSC, TIN: 5018078448	72,653.36
	Research and Production Center for Automation and Instrumentation Named After Academic N.A. Pilyugin, TIN: 9728050571	47,520.67
	Fazotron-VMZ JSC, TIN: 7713297251	46,566.68
	Doza Scientific and Production Enterprise LLC, TIN: 7735542228	40,389.88

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