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Russian Technological Transit Commodity Flows of Critical Minerals

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Abstract. The aim of the work is to analyze transit technological flows of critical mineral raw materials, which were formed in Russia by changing of the CIS economic relations in the 90s of the XX century.

The transit chain of alumina import and primary aluminum ingots export is the largest transit technological commodity flow and is the foundation of the stable operation of the Russian aluminum industry. Quite significant previously transit technological flow of chromite concentrate imports and exports of ferrochromium is gradually reducing its transit volumes due to changes in the logistics of supplying raw materials. The transit chain of imports of lithium carbonates and lithium oxides, and in the end most of the lithium hydroxides exports, is a perfect example in terms of a pure transit technological commodity flow that helped to maintain the Russian lithium industry working capacity during the economic transition.

Research results of transit technological flows of critical raw materials could be used to plan the import substitution of critical goods and risk reduction of production and sale of existing mineral product transit flows.

Due to the limited possibilities for import substitution of alumina, the transit flow of commercial aluminum products bears increased risks of its effectiveness. The transit technological flow of chromite concentrate imports and exports of ferrochromium is becoming uncritical due to the reduction in imports of chromium raw materials from Kazakhstan and the increase in chromite production in Russia. The transit chain of the total import of lithium carbonates and the export of produced lithium hydroxides may disappear (or be reduced) due to the planned development of the mining production of lithium raw materials in Russia.

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Российские технологические транзитные товарные потоки критического минерального сырья

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Аннотация. Целью работы стал анализ транзитных технологических потоков критического минерального сырья, которые сформировались в России в результате изменений экономических связей СНГ в 90-е годы XX века.

Транзитная цепочка импорта глинозема и экспорта алюминия первичного является самым крупным транзитным технологическим товарным потоком и служит основой стабильной работы российской алюминиевой промышленности. Бывший ранее весьма значительным транзитный технологический поток импорта хромитового концентрата и экспорта феррохрома постепенно сокращает свои объемы транзита ввиду изменения логистики поставок сырья. Транзитная цепочка импорта карбонатов и оксидов лития и в конечном счете большей части экспорта производимых гидроксидов лития является ярким примером чистого транзитного технологического товарного потока, который способствовал поддержанию работоспособности российской литиевой отрасли в переходный экономический период.

Результаты исследований транзитных технологических потоков критического минерального сырья могут быть использованы для планирования импортозамещения критических товаров и снижения рисков производства и реализации существующих транзитных потоков минеральных продуктов.

Ввиду ограниченности возможностей импортозамещения глинозема транзитный поток алюминиевых товарных продуктов несет повышенные риски своей результативности. Транзитный технологический поток импорта хромитового концентрата и экспорта феррохрома становится некритичным из-за сокращения импорта хромового сырья из Казахстана и наращивания добычи хромитов в России. Транзитная цепочка тотального импорта карбонатов лития и экспорта производимых гидроксидов лития может исчезнуть (или сократиться) ввиду планируемого развития добывающих производств литиевого сырья в России.

Ключевые слова: импортозависимость; экспорт; транзитные технологические потоки; алюминиевое сырье; хромовое сырье; литиевое сырье.

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Introduction

There are several schemes of international cooperation among the logistic flows of movement of mineral raw materials from their source to the final consumer, namely: direct flows of raw materials from source countries (Canada, Australia, South Africa, Brazil, etc.) to consumer countries (USA, Germany, Britain, France, etc.). etc.), self-sufficient countries with their own raw materials base, processing enterprises and consumers of final raw materials (China, Russia, India), as well as chains of movement of mineral raw materials with transit through some countries, such as trade points (Netherlands, Singapore, Hong Kong, etc.), and as technological centers for intermediate processing of mineral raw materials, considered in this article.

Russian critical imported mineral products include certain commercial products that form technological transit commodity flows (aluminum, chromium and lithium raw materials). These are large branches of Russian industry, dependent on imports to varying degrees. That is why consideration of peculiarities of existing transit technological flows of raw materials and final products is very critical.

Technological transit commodity flows of mineral raw materials occur under the following conditions:

- the existence in the transit country of the necessary energy resources for the processing of mineral raw materials and the limited national consumption of the final product: ferroalloy plants in Norway (Hunsbedt, Cowx, Flatabø, Johansen, Bustnes, 2007), alumina plants in Ireland (RUSAL, 2021);
- historically established centers for the processing of mineral raw materials becoming transit centers due to state changes: the Kadamzhai antimony plant in Kyrgyzstan (Usova, Butov, Ivanov, 1998), rare-earth chemical and metallurgical plants in Kazakhstan (Haritonov, Rachenkova, 2017) and Estonia (Lukason, Vissak, 2016), Johnson Matthey platinoids refineries in Britain (Johnson Matthey, 2020);
- excessive volume of operating production facilities for the processing of scarce (import-dependent) mineral raw materials when the markets for the sale of end products change – the aluminum industry in Russia (Radko, 1996; Odokij, Ostroumova, Menshenkin, 2001) and Italy (Ciacci, Chen, Passarini, Eckelman, Vassura, Morselli, 2013);
- reduction or cessation of mineral raw material supply from own sources and demand from national consumers while maintaining sustainable processing industries – lithium industry in Russia (Tolkushkina, Torikova, Komin, 2012).

Almost all of these above-mentioned types of mineral raw materials are critical in industrialized countries due to their apparent import dependence (Schulz, DeYoung, Seal, Bradley, 2017; Study on …, 2017; Zhu, Dong, Zhang, Suo, Liu, 2020). In Russia, the most problematic are transit technological flows: alumina → primary aluminum, chromium raw materials → ferrochromium, lithium raw materials → lithium hydroxides (Khatkov, Boyarko, 2018). The mere existence of import dependence of these large-tonnage commodity flows requires the risk assessment of their stability, factors of influence, especially external ones, and certainly the possibility of managing critical mineral resource chains (Zavertkin, Kusevich, Kiselev, 1996).

Methodology

With the aim of exploring the transit technological flows of critical Russian mineral raw materials, data on the movement of their commodity flows for 1996–2021, the dynamics of their world prices, and the prices of Russian imports and exports were processed. The primary sources of information for the research – the database of the Federal Customs Service of the Russian Federation[1], UN statistics on international trade[2], and reviews of the information center TrendEconomy[3]. The volumes of mineral raw material commodity flows are reported in metric tons, and prices – in US dollars per ton of goods. Subject to the availability of import and national sources of mineral raw materials (alumina, chromium raw materials), the volumes of the essentially transit end product (primary aluminum, ferrochromium) were determined as the indicator of the import content of raw materials in total national consumption. Available data gaps for individual periods that did not allow calculating derived values (prices, shares) were excluded from calculations and plotting.

Overview of critical commodity flows of mineral products

Aluminum raw material. The most significant in terms of volume and cost is the transit technological flow of aluminum raw materials. Huge volumes of alumina used in the production of aluminum are imported to Russia (3.6÷5.2 Mt/year or 53÷68 % of consumption), and 80÷90 % of the produced primary aluminum (up to 3.6 Mt/year) is exported (see Fig. 1) (Remizova, 2006; Petrov, 2020). However, such a scheme of importing raw materials (bauxite, alumina) and manufactured exports (primary aluminum, rolled aluminum, aluminum alloys) is typical for the old industrialized countries among the leaders in the production of aluminum products (USA and Canada) (Schulz, DeYoung, Seal, Bradley, 2017). In these countries, as well as in Russia, over a long period of the national mineral resource base usage, all the highest quality deposits of bauxite have been mined out. As a result, it has become a vital necessity to form import flows of raw materials, and not large-tonnage bauxite, but obtained by their processing 2÷3 times less volumetric industrial product – alumina. The import-export scheme is also used in the countries of new aluminum production, which have significant own sources of electricity (Norway, Iceland, UAE). Actually, in Russia, the economic results of the aluminum production of PJSC Russian Aluminum are ensured precisely by the availability of energy resources and their relatively low cost (RUSAL, 2021). The full cycle of processing “bauxite → alumina → aluminum” is carried out in raw material Australia and the new world leaders in the aluminum market, China and India (Sverdrup, Ragnarsdottir, Koca, 2015).

The import flow cost of alumina is the most significant among the import-dependent mineral products and amounts to 0.77÷2.1 billion USD/year, fully dependent on the dynamics of prices in the world market. Alumina import prices in dynamics for almost the entire period under study were at the world level (–17 … +17 %).

1.8÷3.9 Mt/year of primary aluminum is exported from Russia (81÷100 % of production in 1996–2017, 30÷32 % in 2018–2021) in the amount of USD 2.9 ÷7.3bn/year. The cost of a part of the primary aluminum export produced from imported alumina is USD 1.6÷4.7bn/year, 1.2÷4.7 times higher than the alumina import cost.

Price comparison of import alumina and primary aluminum produced from import alumina are intercorrelated in the first approximation (correlation coefficient +0.92). Such a significant difference in the prices of raw materials and the final product seriously affects the global aluminum market (Lowery, 2020).

[1] The Federal Customs Service of Russia. URL: http://stat.customs.gov.ru/analysis (access date: 18.04.2022).

[2] A world of information. UNdata. URL: UNdata (access date: 18.04.2022).

[3] International Commodity Trade. TrendEconomy. URL: TrendEconomy – Портал открытых данных (access date: 18.04.2022).

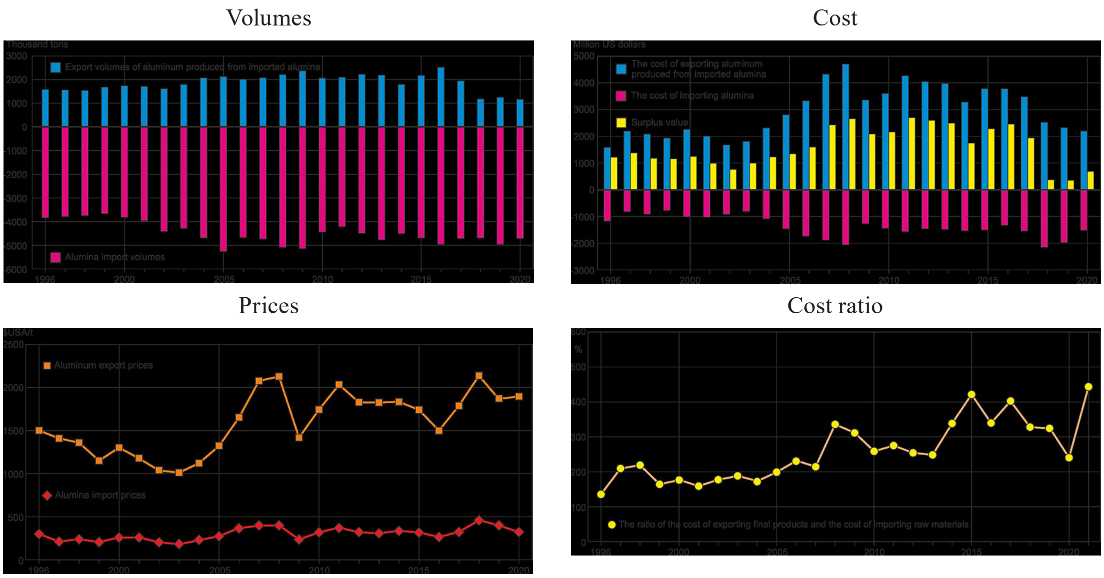

Fig. 1. Dynamics of indicators of imports of alumina and exports of primary aluminum for 1996–2021. Based on data provided by the Federal Customs Service of the Russian Federation, UN statistics on international trade, and TrendEconomy

The surplus value of the difference between aluminum export and alumina import in dynamics reflects external factors of the world economy:

- initially stable low level of USD 1.0÷1.4m/year in 1996–2001;
- growth from USD 0.8m in 2002 to USD 2.6m in 2008 within an overheated market;
- drawdown to USD 2.1m in 2009 due to the global crisis followed by a recession to USD 2.7m in 2011;
- drawdown to USD 1,7m during the political crisis, sanctions began in 2014, followed by a recession to USD 1.9÷2.5m/year;
- and the last sharp drawdown to USD 0.4÷0.7m/year in 2018–2021 after the introduction of US protective duties on aluminum imports and the loss of this market by Russia (at the same time, the level of profitability – the aluminum/alumina cost ratio – also decreased).

Magnitude of aluminum export value (produced from imported raw materials) relative to the cost of alumina imports in 1996–2017 fluctuates in the range of 184÷286 %, and in 2018–2021 it decreased to 117÷146 %. At the same time, the dynamics of this ratio correlates less than the ratio of export and import prices (correlation coefficient +0.62 %), indicating that the leading factor is the volume of commodity flows.

Chromium raw material. The only chromite mining plant in the USSR (Donskoy GOK) is located on the territory of Kazakhstan (Til, Bekeev, 2013). Therefore, since 1992, the needs of Russian ferroalloy plants for chromium raw materials began to be met through import. For a long time, exploration work for chromium raw materials was not carried out in Russia, and only in the 90s of the XX century, they were resumed. As from 2004, there has been a considerable increase of chromite national production share in the Perm Territory and in the Yamalo-Nenets Autonomous Okrug (Lapteva, Mitrofanov, Tigunov, 2017; Mashkovcev, Bakanova, Rudnev, 2019). Only by 2020, the delivery from the Russian sources has decreased to 28 % of the consumed chromium raw materials.

87÷95 % of consumed chromium raw materials are sent to Russian ferroalloy plants. In 1996–2019 there were imported 53÷89 % of consumed chromite concentrates, and the import of chromium ores increased significantly from 360 kt in 1998 to 1178 kt in 2012 (+12.3 %/year) (see Fig. 2). Starting from 2013,

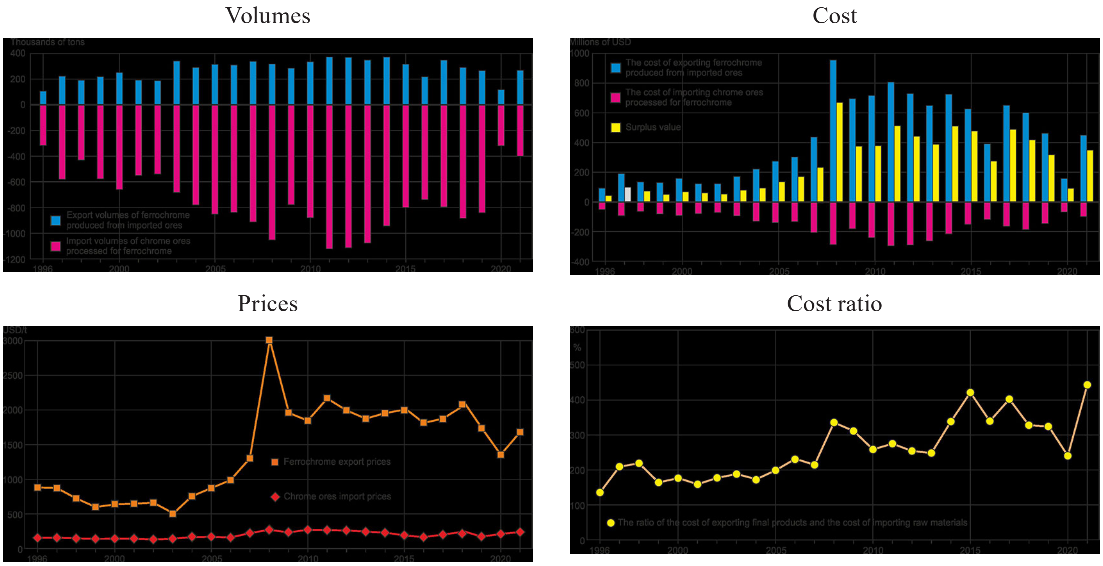

Fig. 2. Dynamics of indicators of import of chromite concentrates and ferrochrome export for 1996–2021. Based on data provided by the Federal Customs Service of the Russian Federation, UN statistics on international trade, and TrendEconomy

there has been a decrease in imports of chromium raw materials down to 349 kt in 2020 due to the reorientation of the Kazakh chromium industry to increase the volume of conversion of its raw materials into ferrochromium. The share of chromite concentrate import in Russian consumption fell to 29÷33 %.

In fact, the large-scale volumes of imported chromium raw materials directed to the production of export ferrochromium, as in the case of the aluminum industry, in dynamics reflect the external factors of the world economy with the addition of factors of reforming the national production of chromites and a decrease in the supply of raw materials from Kazakhstan – an increase from 315 kt to 1996 to 1048 kt decrease to 317 kt in 2020.

Import flow cost of chromium raw materials is very high and it has valued to USD 69÷291m/year in the study period, and import prices were on average 30 % lower than the world average. This was an additional factor in the profitability of transit for Russian technological imports of chromium raw materials and ferrochrome export.

Ferrochromium is one of the most expensive ferroalloys, which determines its high share in world trade turnover, 52÷77 % of production volumes (Pariser, Pariser, 2012). 77÷433 kt/year of ferrochrome produced by Russian ferroalloy plants (48÷89 % of production) worth up to USD 1.1bn/year is exported, including produced from imported raw materials 77÷370 kt worth USD 68÷947m/year, which is 1.3÷4.2 times higher than the cost of imported raw materials.

Price dynamics of imported chromium ores and ferrochromium produced from them correlate with each other (correlation coefficient +0.84), but for ferroalloy there is a large volatility, especially during the period of price growth in 2003–2008. (Jones, 2007).

The surplus value of the difference between ferrochromium export and chromium raw material import in dynamics reflect external factors of the world economy:

- initially low level of USD 19÷99m/year in 1996–2001;
- growth from USD 48m in 2001 to USD 665m in 2008 in an overheated market, a drawdown to USD 373m in 2009 due to the global economic crisis;
- subsequent recession to USD 509m in 2011;
- variable changes in the range of USD 274÷508m/year in 2012–2019;

• a sharp drawdown to USD 92m in 2020 due to the reduction of imports of chromium raw materials from Kazakhstan, increased its own consumption of chromites for the production of ferrochrome.

The export value of ferrochromium (produced from imported raw materials) relative to the import value of chromium raw materials fluctuates in the range of 138÷422 %. There is a distinct upward trend in the ratio of prices and the cost of raw material import and export of ferrochromium, which indicates an increase in the profitability of production of this ferroalloy.

Lithium products represent the basis of a rapidly growing global consumer market for the production of lithium battery cells based on lithium hydroxides (Martin, Rentsch, Höck, Bertau, 2017; Liu, Gao, An, Qi, Wang, Jia, Chen, 2019). In Russia, after the closure of the only lithium mining enterprise (Zabaikalsky GOK) in 1997, a transit technological import-export chain was formed, including the total import of lithium carbonates (0.5÷9.0 kt/year, 100 % of consumption), small in volume import of lithium oxides (0.1÷1.7 kt/year, 7÷70 % of national consumption), and ultimately also a significant export of lithium hydroxides (up to 8.5 kt/year, 8÷100 % from production), see Fig. 3.

Lithium carbonates are imported from the leading countries of their production: Chile, Argentina and China, while oxides with hydroxides are also imported from the USA and Belgium. The buyers of export lithium hydroxides were Belgium and Germany, and recently also India and South Korea. All this is happening against the backdrop of exponential growth in the volumes and imports of lithium carbonates and exports of lithium hydroxides (Liu, Gao, An, Qi, Wang, Jia, Chen, 2020; Lymar, Belousova, 2021). Under the political sanctions, Russian export of lithium oxides, which are in high demand in international trade, can be transformed with a reorientation towards deliveries to friendly countries.

There is a technological chain of buying cheap raw materials (lithium carbonates) with the release of a more expensive product (lithi-

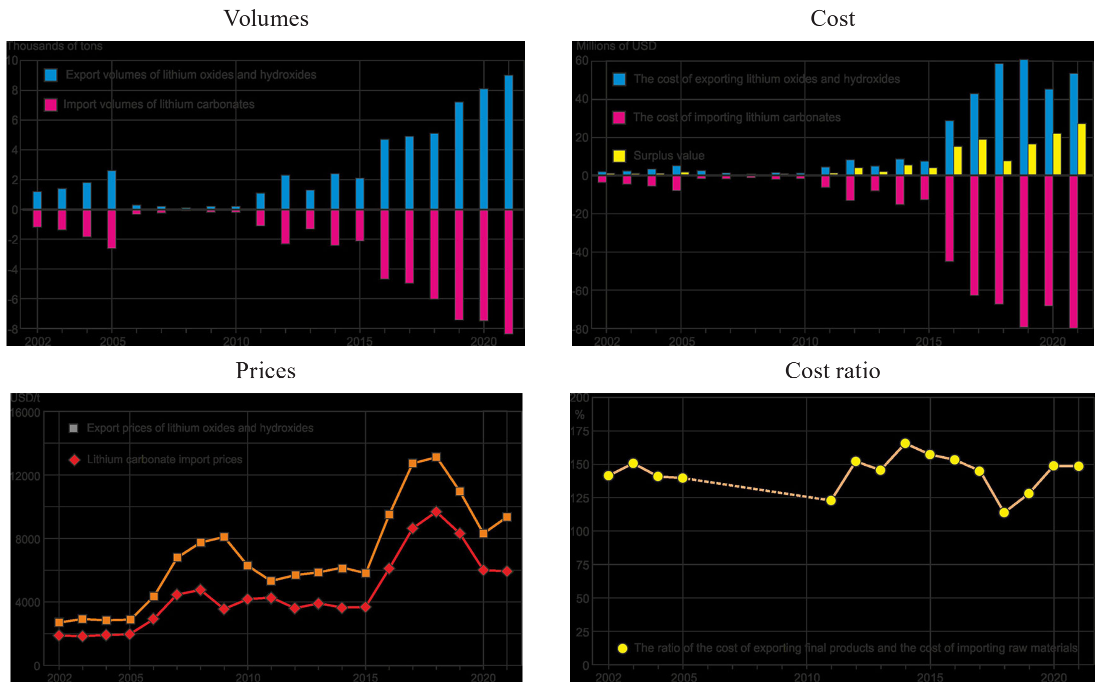

Fig. 3. Dynamics of lithium raw material import and export of final lithium products for 1996–2021. Based on data provided by the Federal Customs Service of the Russian Federation, UN statistics on international trade, and TrendEconomy

um hydroxides) and exporting it with additional surplus value.

The value of lithium carbonate import increased from USD 0.4m in 2008 to USD 61.2m in 2019. The value of exports of lithium oxides and hydroxides increased over the same period from USD 0.8m in 2008 to USD 79.4m in 2021.

The dynamics of prices for imported lithium raw materials (lithium carbonates) and the final product (lithium hydroxide oxides) is a completely conformal dependence (correlation coefficient +0.97). The ratio of prices for export of final lithium products and import of lithium raw materials fluctuates in the range of 122÷166 %.

The surplus value of the difference between exports of lithium raw materials and imports of lithium products, which in 2002–2011 amounted to USD 0.4÷1.7m/year since 2012 began to increase, up to USD 25.9m in 2021. The value of the export value of the final product relative to the import value of raw materials varies in the range of 114÷166 %.

The import-export chain of flow of almost all volumes of lithium raw materials through Russia is a clear example of a pure transit technological commodity flow.

Discussion

The considered transit technology flows of critical mineral raw materials are combined by a significant import dependence on raw materials – in 2020 100 % for lithium, 55 % for aluminum, 26 % for chromium. For all kinds of these mineral products, there are common foreign trade risks (intercountry relations, changes in market conditions, etc.) but for chromium there is also a factor in the reduction of Russian import due to the re-orientating use of chromium raw materials in Kazakhstan (the main chromite supplier to Russia) to the needs of its own ferroalloy production (to increase its own export of ferrochromium).

Concerning the export trend of final marketable mineral products, there is an increase in the attractiveness of ferrochrome export, the stable robust global demand for lithium hydroxides, and the sale of Russian aluminum on the world market due to the emergence of new US restrictive customs duties. In the immediate future, significant changes in the volume of import and export of critical mineral products are possible because of political sanctions.

During the study period, there was a systemic increase in the volumes of the transit technology flow of lithium raw materials, a decrease in the transit volumes of aluminum and chromium raw materials.

The study looked in depth transit technological commodity flows of large-tonnage types of mineral raw materials (Al, Cr and Li). There are other transit flows with low-volume and shares of import/export, for example, the supply chain of phosphorites from Kazakhstan → conversion into fertilizers in Russia → exports of phosphate and complex fertilizers. There are also temporary transit flows of mineral raw materials, as for the molybdenum industry, where significant imports of molybdenite concentrate periodically occurred, as well as an increase in ferromolybdenum exports. Other more complex and less noticeable transit schemes for the import of raw materials and middlings are also possible while exporting other middlings and the final commercial product.

Support from the state for critical mineral products is legitimate to ensure national consumption of the final marketable products produced from them. Similarly, state support for the production of export-oriented commercial products is justified, but only in the case of using predominantly domestic national resources (raw materials, labor, and logistics). The situation of transit technological commodity flows is more complex and their support can be perceived not as assistance to national enterprises, but as hidden subsidies for foreign consumers of final commodity products. Therefore, state regulation of transit import-export technological commodity flows should be considered from the standpoint of the national interests of the state, industrial production and society.

Aluminum raw material. In 2021, 4.75 Mt of alumina (63 % of consumption) were imported for USD 1.8bn and 2.03 Mt of primary aluminum (54 % of production) were exported, worth USD 4.0bn. Alternatives to imported sources of aluminum raw materials (high-quality bauxite and alumina) for the Russian aluminum industry are not yet available. The existing export strategy of the aluminum industry has always been risky in terms of sales stability, which has happened recently because of political sanctions. According to the ratio of price dynamics and the cost of import of aluminum raw materials and export of aluminum, there is a relative stability of these indicators, which indicates the stability of the world market for aluminum products, despite the external restrictions on Russian exports of primary aluminum.

The possibility of transforming the aluminum industry in Russia are limited. For the stable supply of raw materials, PJSC Russian Aluminum has formed a foreign division of enterprises for the extraction of bauxite in Guinea, Guyana and Jamaica, alumina refineries in Ireland, Italy, Guinea, Australia and Ukraine. However, in 2022, the supply of alumina from Australia (political sanctions) and Ukraine (stop production) was stopped, which amounts to a loss of up to 68 % of its import flow or 43 % of national consumption. It is possible to reorient the import flow of alumina to other sources, but this requires time to form a new logistics for the movement of alumina raw materials, including the transit schemes of parallel import. Therefore, in the conditions of the need to maximize the load of Russian aluminum smelters, the scheme for the technological transit of aluminum raw materials through Russia remains in demand.

However, the Russian aluminum industry has a new challenge – as a result of political sanctions, the possibility of selling primary aluminum for export has decreased (from 3 Mt in 2017 to 1.8÷2.0 Mt/year in 2018–2021 It is necessary to solve this problem of excess production by increasing the national volumes of primary aluminum conversion into demanded products (powders, rods, profiles, wire, plates, sheets, and strips) and increasing their domestic consumption. On the part of the state, assistance to the aluminum industry is in the support of foreign raw materials projects of PJSC Russian Aluminum in friendly countries, at the interstate level, participation in the negotiation process with the governments of the countries of the project sites, as well as support for new domestic projects (Boguchanskoye Energy and Metallurgical Association and the Taishet Aluminum Plant), accompanied by the creation of new jobs (RUSAL, 2021).

Chrome raw material. In 2021, 442 kt of chromite concentrate were imported (39 % of consumption) for USD 111m and 266 kt of ferrochromium were exported (76 % of production) for USD 361m. Russian ferrochromium production capacities were initially surplus for national consumption and were export oriented. At the same time, initially they were completely import-dependent in terms of chromium raw materials, and only as a result of the development of national chromite mining with the direct assistance of the state in organizing targeted geological exploration by 2020, import dependence was significantly reduced. It is worth noting that the ferroalloy plants of Kazakhstan are increasing the production of ferrochromium from 415 kt in 1996 to 1.8 Mt in 2021, which, accordingly, affects the decrease in the volume of Russian imports of chromium raw materials from this country.

According to the ratio of the price dynamics and the cost of import of chromium raw materials and exports of ferrochrome, there is a trend of increasing profitability of the production of this ferroalloy. At the same time, the share of Russian ferrochromium export produced from raw materials of national production remains quite high, so a possible reduction in the transit technological chromium commodity flow will not affect the stability of the work of Russian ferroalloy production.

Lithium raw material. In 2021, 7.5 kt of lithium carbonates (100 % of consumption) were imported to the value of USD 45m and 8.5 kt of lithium hydroxides were exported (83 % of production) worth USD 79m. Actually, the volumes of the transit technological flow of lithium products are small and the surplus value of the redistribution (only 14÷65 %) is not impressive, i.e. economic factors in the lithium industry are not the main ones.

One good thing with the situation of through Russian import-export flow of lithium raw materials is that at present, small domestic national needs for lithium products (1.5÷2.0 kt/year) are fully met. In case of the emergence of national enterprises for lithium raw material extraction and an increase in domestic consumption of lithium products, the processing capacities of existing industries (Krasnoyarsk Chemical and Metallurgical Plant, Novosibirsk Plant of Chemical Concentrates, Siberian Chemical Plant, Tula plant of the company "TD" Khalmek") are enough to close all probable changes in the demand for lithium materials in Russia (in the nuclear industry, the production of lithium lubricants and lithium electric batteries).

In 1997–2012 the State supported the development of technologies for the processing of lithium raw materials within the Federal Target Program "Libton" to ensure the independent functioning of the nuclear complex of Russia[4]. It is possible to provide state support for the creation of production facilities producing lithium raw materials under the projects of overhead water intakes at hydromineral deposits at existing oil and salt fields in Eastern Siberia with the extraction of bromine and iodine from brines in addition to lithium (Vakhromeev, 2014).

Results

Transit technological flows of critical mineral raw materials in Russia were formed as a result of changes in the economic relations of the CIS in the 1990s.

The transit chain of alumina import (up to 5.2 Mt/year, up to 68 % of consumption) and primary aluminum export (up to 3.6 Mt/year) is the largest transit technological commodity flow. Due to the limited possibilities for import substitution of alumina, the transit flow of commercial aluminum products bears increased risks of its effectiveness. The problem of reducing sales of primary aluminum volume can be solved by increasing its redistribution in Russia into demanded products (powder, rolled products) for domestic consumption and export of products.

A former very significant transit technological flow of chromite concentrate import (up to 1.2 Mt/year, up to 95 % of consumption) and exports of ferrochrome (up to 433 kt/year) is declining due to a decrease in the supply of chromium raw materials from Kazakhstan with an increase in export volumes of the final product produced during the processing of Russian raw materials.

The transit chain of lithium carbonate import (up to 9.0 kt/year, up to 100 % of consumption) and lithium oxides (up to 1.7 kt/year, up to 70 %), and at the end of lithium hydroxide export (up to 8.5 kt/year, up to 100 % of production) is a clear example of a pure transit technological commodity flow that maintains the continuity of the work of processing facilities in the lithium industry. Nevertheless, it is possible to eliminate the existing total import dependence and, accordingly, the transit flow of lithium raw materials by organizing national lithium production at the at the spodumene deposits of the Kola Peninsula and hydromineral deposits of Eastern Siberia. After the establishment of its own lithium mining production in Russia, it is also possible to resume the export of lithium hydroxide due to a fivefold increase in prices for it and the growing need for global production of lithium electric batteries.

[4] Federal'naya celevaya programma «Dobycha, proizvodstvo i potreblenie litiya i berilliya. Razvitie proizvodstva tantala, niobiya i olova na predpriyatiyah Ministerstva Rossijskoj Federacii po atomnoj energii» [Federal target program "Extraction, production and consumption of lithium and beryllium. Development of tantalum, niobium and tin production at the enterprises of the Ministry of Atomic Energy of the Russian Federation"]. Resolution of the Government of the Russian Federation dated November 10, 1996, no 1345.

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