Research on the Safety Analysis and Risk Management of China's Lithium Mine Supply Chain Under the Background of "Lithium Peck"

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Abstract: In recent years, strategic mineral resources have played an important role in ensuring China's economic security and the development of strategic emerging industries. Especially with the accelerated transformation of energy structure and the rapid growth of new energy vehicles, energy storage batteries have become the key to ensure the stable development of new energy vehicles. Lithium, as the core raw material for manufacturing lithium batteries, is used in electric vehicles, industrial energy storage and other applications to build a bridge between traditional and emerging energy sources. This paper analyzes the current situation of lithium ore quantity, market demand and lithium ore type at home and abroad, and analyzes the development support conditions of "lithium pec". On this basis, suggestions are made to consider the security of lithium supply in China: (1) to establish a new era of resource security; (2) to strengthen the strategic scientific and technological forces in the field of lithium; (3) to build a modern lithium service system; (4) to create a policy environment conducive to the development of lithium.

Keywords: "lithium pec"; lithium mine; security of supply; suggestions for reflection

1. INTRODUCTION

Lithium is a mineral resource essential for strategic, consumer and commercial applications and is traded in three main forms: mineral concentrates, mineral compounds and refined metals, the main uses being batteries, ceramics, glass, metallurgy, pharmaceuticals and polymers, with excellent electrical conductivity and low density making it an ideal component for battery manufacturing (HSAT 2021). Lithium mineralogy is diverse and it is found in various pegmatite minerals such as lithium pyroxene, lithium mica, weakly crystalline and the clay mineral lithium montmorillonite. Global lithium production is currently dominated by pegmatite and closed-basin brine deposits, but lithium-bearing clay minerals, oilfield brines and geothermal brines are abundant.

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Recently, the Argentine national news agency reported that three major lithium producing countries in South America-Argentina, Bolivia, and Chile-are in talks to create an export price alliance for lithium, much like the Arab oil-producing countries created the oil alliance "OPEC "(Feng 2021). Therefore, this lithium price alliance is also known as "lithium pec" by the media.

China is the world's largest importer, largest refiner, and largest consumer of lithium ore, and in 2021, China's lithium battery production accounted for 60% of the total global production. Many people worry that the establishment of "lithium pec" will not further shift the global bargaining power of lithium to South America, which will further push up our import prices and be detrimental to the development of domestic new energy industry (Chen 2021).

At present, about half of the strategic minerals in China have a reserve-to-mining ratio below 25, including lithium ore, and the new resources cannot keep up with the growth rate of reserve consumption, so the resource supply situation is worrying. In this paper, we analyze the current situation of lithium ore at home and abroad in the context of "lithium pec", and put forward suggestions for the security of lithium supply in China, in order to provide guidance and reference for ensuring the security of China's lithium industry chain, supply chain and consumption.

2. Analysis of the current situation of foreign lithium mines

2.1 Lithium mine quantity status

Regardless of the global lithium resources or reserves, lithium is an abundant resource, according to the "Global Lithium, Cobalt, Nickel, Tin, Potash Mineral Resources Assessment Report (2021)" released by the Global Mineral Resources Strategy Research Center of the China Geological Survey, as of the end of 2020, there are 376 global lithium projects on record, 110 with resource data, distributed in 20 countries, assessing the global lithium resources of 349.43 million tons. Among them, in terms of resources, the global lithium resources in 2020 is about 65.69 million tons, of which Bolivia 21.01 million tons (31.98%), Argentina 14.92 million tons (22.71%),the United States 10.32 million tons (15.72%), Australia 3.88 million tons (5.90%), the above four countries together account for 81.55% of the world, Figure 1 for details; For reserves, In 2020, the global lithium reserves of about 24.12 million tons, of which 52.67 million tons in Chile (41.06%), Australia 18.39 million tons (14.34%), Argentina 16.93 million tons (13.20%), the United States 570,000 tons (4.44%), Figure 2 and Table 1 for details; production, in 2021, the total amount of global lithium minerals 104,100 tons. In terms of consumption, the global consumption of lithium in 2021 is 103,200 tons (Liu 2021, Song 2022).

Figure 1: Global lithium resources distribution ratio

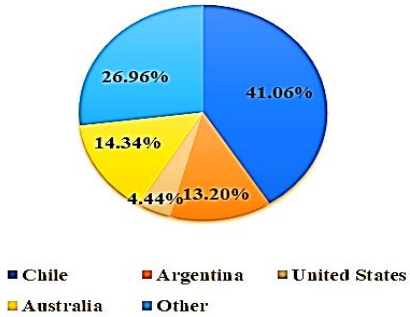

Figure 2: Global lithium reserves distribution share map

Table 1 The world's lithium ore (lithium carbonate) reserves are mainly distributed in countries

Ranking	Country	Reserves (million tons)	Global share（%）
1	Chile	5267	41.06
2	Australia	1839	14.34
3	Argentina	1693	13.20
4	China	810	6.31
5	United States	57	4.44
6	Canada	369	2.88
7	Congo (DRC)	363	2.83
8	Zimbabwe	243	1.89
9	Mexico	173	1.35
10	Spain	79	0.62
11	Other	1422	11.09

2.2 Current market demand

According to a recent report published by the USGS, the end-consumer market for lithium is estimated to be 74% for batteries; 14% for ceramics and glass; 3% for greases; 2% for

continuous casting flux powders; 2% for polymer products; 1% for air treatment; and 4% for other applications, Figure 3 for details. In recent years, lithium consumption in batteries has increased significantly due to the widespread use of rechargeable lithium batteries in the growing electric vehicle and portable markets (Wang 2022).

A comprehensive industry association and brokerage analysis shows that the total demand rises to about 2,080,700 tons LCE in 2025. according to Arbor forecast, the global demand for lithium will reach 2.5 million tons of lithium carbonate equivalent/year by 2030 (Ma 2022, Dong 2022), as shown in Table 2.

Table 2 Forecast Information of Global Lithium Resource Demand

Category	Item	2020	2021	2022	2023E	2024E	2025E
Power Battery	Installed volume /GWh	145	303	496	721	1015	1395
	Lithium Demand /LCEmillion tons	14.46	30.22	49.46	71.90	101.22	139.12
	Growth Rate /yoy	41.50%	109.00%	64.00%	45.00%	41.00%	37.00%
Energy Storage Battery	Installed volume /GWh	29	57	120	203	315	426
	Lithium Demand /LCEmillion tons	2.89	5.68	11.96	20.23	31.39	42.45
	Growth Rate /yoy	36.00%	97.00%	111.00%	69.00%	55.00%	35.00%
Consumer Batteries	Installed volume /GWh	108	119	131	144	158	174
	Lithium Demand /LCEmillion tons	10.77	11.87	13.06	14.36	15.76	17.35
	Growth Rate /yoy10	22.73%	10.00%	10.00%	10.00%	10.00%	10.00%
Traditional Industries	Lithium Demand /LCEmillion tons	5.18	5.28	5.34	5.34	5.34	5.34
	Growth Rate /yoy12		2.00%	1.00%	0.00%	0.00%	0.00%

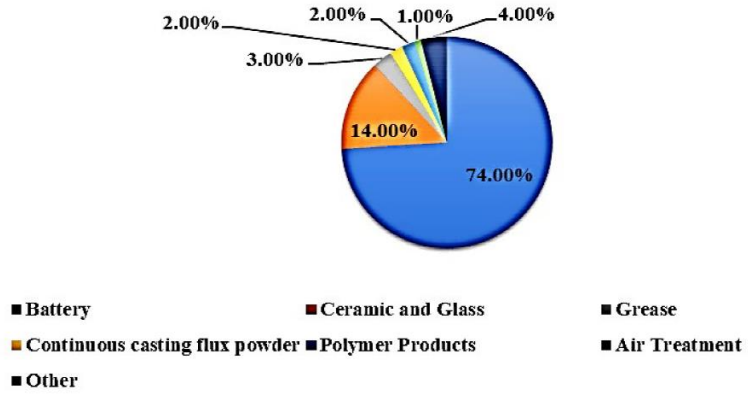

Figure 3: Estimated distribution share of the end-consumer market for lithium

2.3 Status of lithium ore types

The lithium genesis types are mainly salt-lake brine type (about 66% of the total reserves), granite-pegmatite type (23%), sedimentary clay type (5%), and a small amount of oil field brine type and geothermal brine type, Figure 4 for details. The main production types are granite-pegmatite type (59%) and salt-lake brine type (41%). The granite-pegmatite-type lithium ore is mainly produced in Australia, and the saline brine type lithium ore is mainly produced in Argentina, Chile, and China (Zha 2022, Li 2022, Bao 2022).

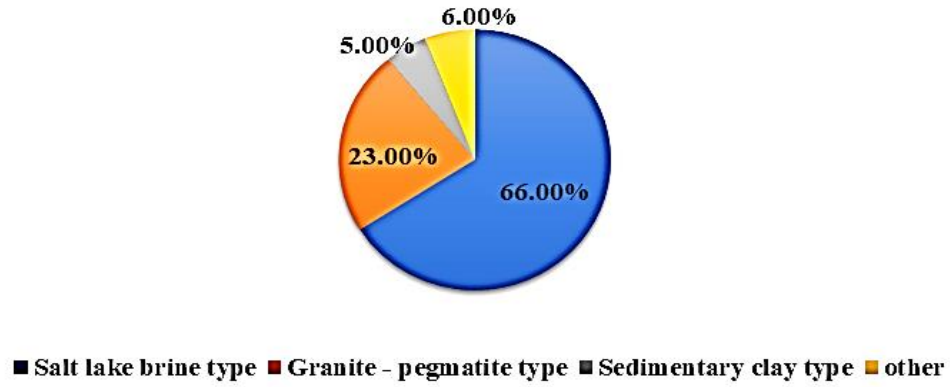

Figure 4: Lithium ore genesis come type share

3. Analysis of the current situation of domestic lithium mine

China is the world's largest importer, largest refiner and largest consumer of lithium ore, and will account for 60% of global lithium battery production in 2021.

3.1 Lithium mine quantity status

China's lithium ore resources and production growth is slow, the supply capacity is weak, with lithium compound production and consumption increasing year by year, the raw material gap is gradually increasing and heavily dependent on imports (Table 3), the industry chain has the characteristics of "weak development capacity, strong lithium compound processing capacity, strong consumption", the development of each link is unbalanced, the development of lithium ore resources to a certain extent restrict the high-quality development of lithium ore resources industry (Dong 2021). According to the data of the Ministry of Natural Resources, as of 2020, China's lithium resources are 3.598 million tons, accounting for 5.48% of the world, mainly in Sichuan, Jiangxi, Hubei, Qinghai, etc. lithium reserves are 1.52 million tons, accounting for 6.31% of the world; lithium minerals are 24,400 tons, accounting for 25.4% of the world; consumption of lithium ore is 73,800 tons, accounting for about 71.51% of the world, the largest consumer. In 2021, China imported 51,800 tons of lithium resources, from Australia 39,000 tons. The external dependence is as high as 67% (Yin 2021).

Table 3 China's lithium "five volumes" statistics over the years

Resource type (million tons)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Resources	215.2	226.6	228.5	228.3	235.8	234.4	238.5	289.5	359.8	-
Reserves	239.1	233.5	222.0	218.4	214.7	211.7	210.4	217.2	152.3	-
Capacity	0.37	0.39	0.45	0.52	0.63	0.69	0.71	0.72	1.50	2.44
Consumption	1.03	1.18	1.24	1.48	1.74	2.34	2.70	3.49	4.31	7.38
External Dependence	64%	67%	64%	65%	64%	71%	74%	79%	65%	67%
Import volume	0.66	0.59	0.78	0.85	1.06	2.64	3.89	4.04	3.36	5.18

3.2 Current market demand

According to the company of ANTEC, China will consume 73,800 tons of lithium in 2021. Among them, batteries account for 84.6%, glass ceramics 4.7% and lubricants 4.4%. The demand for lithium in new energy vehicles, computers, digital cameras, cell phones and other fields will continue to grow. It is expected that by 2025, China's new energy vehicle sales will reach more than 11.81 million units, combined with glass ceramics, grease and other traditional lithium consumption areas to maintain a stable upward trend. The preliminary judgment is that China's lithium demand will be 198,000 tons/year in 2025 and 1,124,000 tons/year in 2035, and the total lithium ore demand will reach 6.34 million tons from 2022-2035 (Liu 2015, Peng 2019). Figure 5 is the diagram of lithium industry chain.

3.3 Status of lithium ore types

The genesis of lithium ore in China is mainly salt-lake brine type, granite-pegmatite type and a small amount of sedimentary clay type. Among them, closed basin brines account for 58% and pegmatite for 26%. By type, salt- lake is the main reserve and ore is the main supply (Xu 2021).

4. Analysis of the development of "Lithium Pec"

Some scholars have shown that three conditions are needed to support the smooth operation of “Lippec”: first, from the perspective of supply and demand, only a few countries can supply this commodity, while most countries need it; second, from the perspective of production control, the cartel organization must be able to fully control the production of this commodity and can decide to increase or decrease production at any time (Wang 2022); third, from the perspective of commodity characteristics, the weak substitutability of this commodity and low price elasticity, which means that price fluctuations will not significantly cause demand fluctuations.

4.1 Supply and Demand

On the supply side, although the lithium reserves in the "lithium triangle" account for 65% of the total global reserves, such reserves have not been directly converted into production (Zhou 2022). Currently, the three South American countries account for only 30% of global lithium production. The largest lithium producer is actually Australia, which accounts for 55% of the total global production in 2021 alone. Therefore, if the three South American countries leave

Australia behind, "lithium pec" can’t be carried out, and need to cooperate with Australia. On the demand side, the global buyers of lithium ore are only a few industrial countries, of which China accounts for the absolute majority. Therefore, in the lithium ore market, the demand side is more concentrated than the supply side, and the bargaining power of the demand side is stronger.

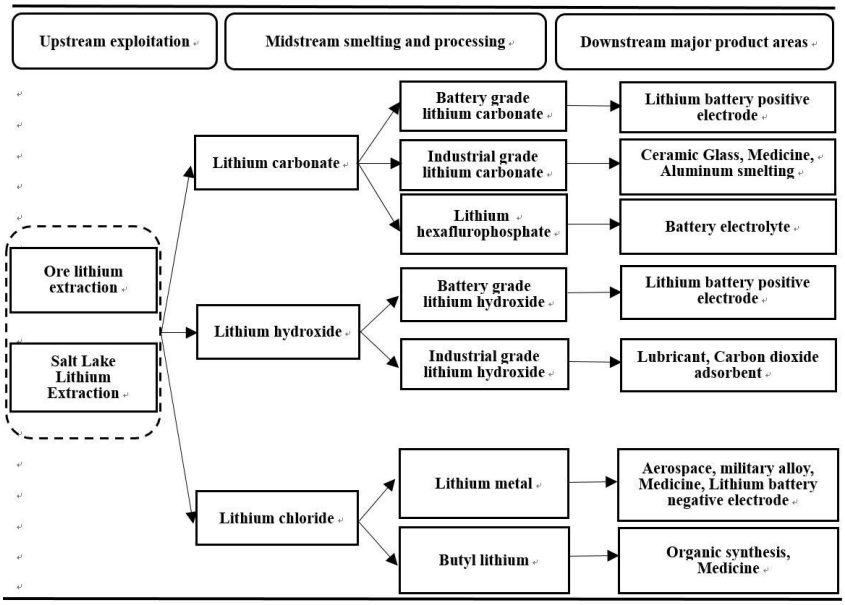

Figure 5: Diagram of the lithium industry chain

4.2 Yield control

At present, the lithium mine ownership situation in the three South American countries is very different. For example, in Bolivia, the lithium mines are state-owned, and the state-owned enterprises are responsible for mining and production, and private capital and foreign investors are not allowed to intervene; in Chile, the lithium mines are state-owned, but the mining rights are open to private capital and foreign investors; in Argentina, the mineral ownership and mining rights are basically in the hands of foreign investors and are not controlled by the government. In this case, it is difficult for "Lithium Pec" to control the amount of lithium minerals, and it cannot increase or decrease the production uniformly(Wang 2022, Tian 2022).

4.3 Price Elasticity

In the short term, the power battery is still dominated by lithium batteries, so the price elasticity of lithium ore is low, and the price spike is still in short supply. But in the long term, the irreplaceability of lithium is declining. At present, the power battery manufacturers are exploring a variety of battery methods, in addition to lithium batteries, there are sodium batteries, antimony batteries, vanadium batteries, all-solid-state batteries, no rare metal batteries, etc.. If multiple technology routes for power batteries go hand in hand in the future, the importance of lithium for the new energy industry will decline relatively, and its price elasticity will rise and

no longer meet the conditions for achieving a price cartel (Mei 2022, Pei 2022, Wei 2022, USDC 2019).

To sum up, from the analysis of supply and demand, production control and price elasticity, even if "Lippec" can be established, it is impossible to reach a high price alliance like "OPEC". However, it may become a low version of "OPEC", not to pursue absolute price control, but mainly to achieve regional information sharing, policy coordination, industrial cooperation.

5. Based on the "lithium pec" background of China's lithium supply security thinking suggestions

5.1 Establishing a new era of resource security

Integrate development and security, establish a resource security concept that meets the requirements of changing times and development, fully respect geological and economic laws, coordinate domestic and foreign resource supply according to the comparative advantage of lithium resources, establish an autonomous and controllable, economically reasonable and resilient global resource supply chain, and realize the security, stability and sustainability of resource supply under open conditions(USDS 2019). Following the basic geological law of uneven distribution of lithium ore, we will coordinate the use of domestic and foreign resources on the basis of domestic bottom line preservation; optimize the use of foreign resources, not focusing on simple market purchase, but through direct investment and development, and cooperate in the development of mineral resources and processing industries globally, to establish a stable production supply chain dominated by us and realize the globalization of China's resource supply; at the same time, actively participate in At the same time, take the initiative to participate in multilateral and bilateral lithium resources cooperation rule-making, strengthen the docking with countries in the fields of mining market, policies and standards, and enhance the shaping power of lithium trade, prices, mechanisms and rules, industrial standards, etc.

5.2 Strengthen the strategic science and technology force in the field of lithium mining

Improve the science and technology level of the whole chain and links of lithium ore exploration, mining, beneficiation, smelting, material preparation and recycling, focusing on solving the key technologies of lithium ore resource exploration, deep development (detection, development and utilization capacity), difficult-to-use resource selection, high-purity metal smelting, and efficient separation and recovery of secondary resources, and greatly improve the efficiency of lithium ore resource production, use and recycling of all links. Vigorously develop the green and intelligent mining industry, accelerate the transformation of the mining industry development mode, and promote the whole process of lithium ore resource conservation and management (NASDAQ 2020).

5.3 Build a modern lithium mining service system

Build a modern lithium mining service system in terms of strategy, planning, market, information, finance and science and technology, and provide comprehensive support services for Chinese mining enterprises to participate deeply in international cooperation in the mining

industry. The domestic public welfare institutions can fully utilize their professional and technical strengths to provide public service products such as basic geology, supply and demand situation, market analysis and investment evaluation for Chinese enterprises going abroad, and provide information and technical services for market players. Construct the policy system and path of financial support for the mining industry under the new situation, support and encourage financial institutions to innovate financial products that adapt to the development of lithium mining in accordance with the law and under the premise of risk control, and improve the quality and efficiency of services.

5.4 Create a policy environment conducive to the development of lithium mining

Improve lithium mine development expectations, increase financial support, play the respective advantages of developmental financial institutions, policy banks and commercial financial institutions, coordinate the Silk Road Fund, China-Africa Fund, China-Latin America Fund, ASEAN Fund and other types of funds, build investment and financing platforms, enrich investment and financing products, innovate investment and financing models, and attract social capital investment to stabilize the trend of lithium mine investment(USDE 2021). Correctly handle the relationship between lithium mine resource development and environmental and ecological protection, do not engage in one-size-fits-all, explore the implementation of differentiated and positive list management of lithium mines within the ecological protection red line, and focus on opening up the policy chain, innovation chain, capital chain, and service chain of lithium mine development.

6. Conclusions

Once the "Lithium Peck" is established, China should establish a lithium resource security concept of internal and external coordination, independent control and green economy, further deepen reform and opening up, improve the international mining cooperation support and service system from the management system, decision-making mechanism, financial support, policy guidance and information services, give full play to the market mechanism and the role of the main body of enterprises, strengthen the strategic scientific and technological forces in the field of lithium, and ensure the safety of China's lithium resources industry chain, supply chain and consumption.

National energy resources security, industrial security, strategic emerging industries leapfrogging development and other major strategies have put forward new demand for lithium resources. According to statistics, China's external dependence on imported lithium resources will be as high as 67% in 2021. According to the latest list of 50 critical minerals published by the USGS, lithium is still an "old member" of the "critical minerals list" (TUSCS 2021). It is obvious that lithium, as the energy metal of the 21st century, is a key mineral and strategic resource to ensure the security of energy resources in China. With the accelerated evolution of the unprecedented changes in the century and the continued geopolitical turmoil, the strategic significance of lithium will be further enhanced. Therefore, in the follow-up study, we should make full use of the existing achievements and data, increase the application and development of new theories, new technologies and new methods, promote the global and diversified layout of lithium resources development in China, ensure the scale and quality of lithium reserves in

China, and then support and guarantee the safety of national energy resources.

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