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Strategic Research on Nonmetallic Mineral Resources for Building Materials in China

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Abstract: This study presents strategic research on five nonmetallic mineral resources for building materials, namely limestone for cement, silica raw material for glass, clay mineral raw material for sanitary ceramics (kaolin clay), high-purity quartz, and graphite. To develop nonmetallic mineral resources for building materials, this study first presents the roadmap and objectives, and subsequently proposes several key tasks, which are strengthening the planning and protection of the mining area, constructing demonstration bases for supply and standard raw material bases, and promoting the strategic resource reserve system. To support the development of a leading country with regard to nonmetallic mineral resources for building materials, a steering group should be set up, the standards system for raw materials and products of mineral resources should be improved, a personnel training system should be established, and laws and regulations on mineral resources should be formulated and implemented.
Keywords: building materials; power nation strategy; limestone for cement; silica raw materials for glass; clay mineral raw materials for building sanitary ceramics (kaolin clay); high-purity quartz; graphite

1 Introduction

Since the reform and opening-up policy was initiated in 1978, especially in the first decade of the 21st century, China's building materials and nonmetallic mining industry has maintained rapid growth, while the industrial structure has undergone continuous and profound changes.

In 1978, there were 69 000 enterprises in China manufacturing building materials, with 3.7 million employees and annual sales of 16.2 billion yuan. In 2015, this number rose to 200 000 manufacturing enterprises and 8.61 million employees, with annual sales of 5.9 trillion yuan, and in 2017, the annual sales reached 61 trillion yuan [1].

Annual sales of the building materials industry increased by 12.6% on average from 1981 to 1990. In the next ten years, the average growth rate rose to 19.6%, whereas from 2000 to 2017, the average growth rate decreased to 16% [1]. The industrial structure of the building materials industry remains subject to change and continues its rapid growth in the 21st century. Traditional basic material industries such as cement, plate glass, and building

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sanitary ceramics tend to saturate in the "12th five-year plan" period, and their growth rates have been declining (as shown in Table 1). Meanwhile, the demand for high-purity quartz, graphite, and their products is on the rise.

Table 1. Sales of building materials and nonmetallic mines in China from 2000 to 2017.

Time	Sales ($\times 10^8$ yuan)	Annual growth rate (%)
2000	5293	−3.9
2001	5199	−0.8
2002	5529	7.0
2003	6535	18.7
2004	8481	25.5
2005	10 387	21.7
2006	12 960	21.4
2007	16 551	24.0
2008	21 686	21.4
2009	25 542	16.3
2010	32 490	24.0
2011	41 310	21.3
2012	46 630	13.6
2013	52 916	14.4
2014	58 019	9.5
2015	58 702	4.2
2016	61 689	5.1
2017	61 353	−0.6

The nonmetallic mineral resources of building materials in this study refer to five materials: cement limestone, siliceous raw materials for glass, clay mineral raw materials for building sanitary ceramics (kaolin clay), high-purity quartz, and graphite.

Cement limestone, siliceous raw materials for glass, and clay minerals raw materials for building sanitary ceramics (kaolin clay) are the main materials used in the manufacture of cement, glass, and ceramics, respectively, and they play an important role in the national economy. They are characterized by abundant resources, wide distribution, easy access, huge demand, and low value. They are not suitable for long-distance transportation, which makes it impossible to rely on their import, and there are no alternative resources available in the foreseeable future. The reserves and potential reserves of siliceous raw materials for cement limestone and glass are vast, and the total supply exceeds the demand. These reserves are capable of meeting the needs of China's national economic development in the coming decades. The supply and demand of clay mineral raw materials (kaolin) for building sanitary ceramics are generally balanced, however the resources of high-grade and high-plastic clay are in short supply.

High-purity quartz refers to quartz products or raw materials with SiO_2 content greater than 99.9%. High-purity quartz mineral resources refer to the natural silica mineral resources that are used to produce high-purity quartz after ore dressing, purification, and processing. High-purity quartz raw materials in China were mainly collected from natural crystals in the early stage, and have been basically exhausted. At present, the raw materials of high-purity quartz are mainly extracted from vein quartz, and there are numerous problems such as small scale, underdeveloped processing technology and equipment, overcapacity of low-end products, and large annual import of high-end products.

China is a country with great graphite utilization, and its reserves, output, consumption, and export consistently occupied the first place in the world, which can meet the needs of the following decades. The graphene production technology in China is similar to that employed in the advanced countries of the world. However, China does not

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own a competitive graphite technology. The low-grade output and high-grade input problem persists, as there is still an import demand of 5×10^4–1.3×10^5 t high-grade graphite each year.

2 Current situation of cement limestone resources

The overall level of China's cement industry has experienced marked improvements, which is reflected in the slowing of output growth, significant improvement of production concentration, enhancement of the independent innovation ability of the enterprise, elimination of backward production capacity, energy saving and emission reduction, and further emergence of international construction market competitiveness. From 2000 to 2017, the annual output of cement in China increased by a factor of 3.94 [1], as shown in Fig. 1.

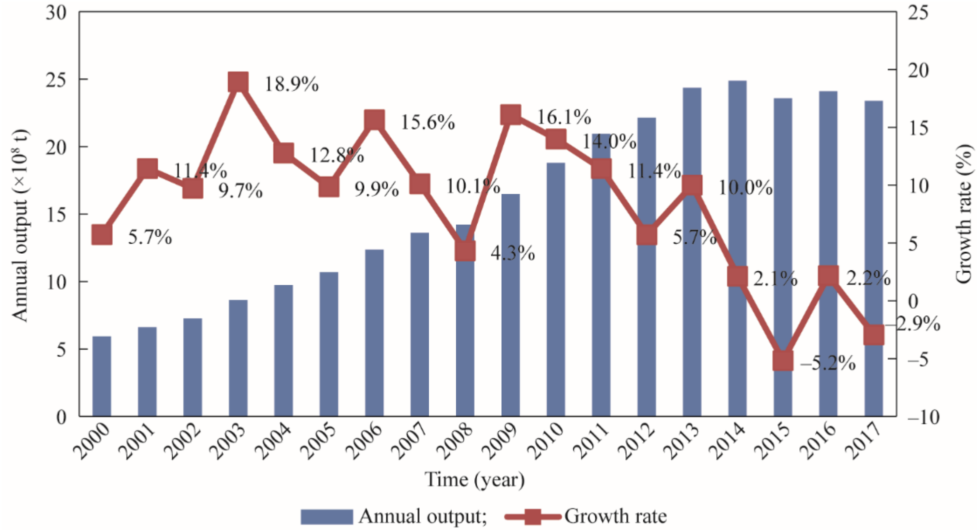

Fig. 1. Annual output and growth rate of cement in China from 2000 to 2017.

Since 1985, China was the world's largest cement producer and consumer. In 2015, cement consumption fell for the first time, by 5%. Cement consumption has reached a plateau, with a consumption of 1.7 t/person, exceeding the international average of 0.3 t/person by far. The market share of the top ten cement enterprises is 62% with respect to production capacity, and that of the top three cement enterprises is 34%. The eastern China cement output was 8.464×10^8 t, accounting for 36.79% of the total national output. The middle part was 7.239×10^8 t, accounting for 31.46%. In western China, the output was 7.306×10^8 t, accounting for 31.75%. Moreover, the output proportion in western China is increasing annually.

In terms of the use of alternative fuels, China has spent almost 30 years to meet foreign countries, including 20 years of promotion and more than 10 years to explore and practice. The annual replacement amount is less than 5×10^4 t of standard coal, and the overall replacement rate is less than 1%. Since the start of the 21st century, the proportion of new dry process cement in the total cement production has increased rapidly. Cement enterprises have started to globalize, and major cement enterprises have invested and built factories abroad [2]. Table 2 and Table 3 list the predictions of China's future cement demand and cement limestone consumption.

Table 2. Forecast data of China's cement demand.

Time	Cement output ($\times 10^4$ t)	Population (ten thousand)	Per capita consumption (kg/person·a)	Per capita cumulant (kg/person)
2020	210 000–250 000	142 849.7	1 470–1 750	30 874–32 436
2025	145 122	146 750.6	989	37 602
2030	93 867	148 805.1	631	41 334

China is one of the richest countries with regard to mineral resources of cement limestone in the world, distributed across all the provinces except Shanghai. In 2015, 2391 cement limestone mining areas were discovered in China, and the predicted resource amount was ~3–4×10^{12} t with 2391 mines of proved reserves. The cumulative confirmed basic reserves of the cement limestone ore amounted to 4.234×10^{10} t; confirmed resources were 8.589×10^{10} t, and resource reserves were 1.282×10^{11} t. Among these, the reserves of retained resources in Anhui Province were 1.222×10^{10} t, which represents the largest in quantity in China [3].

Table 3. Forecast data of cement limestone consumption in China. $\times 10^4$ t

Time	Cement output	Cement clinker output	Consumption of cement limestone
2020	210 000–250 000	126 000–150 000	176 400–210 000
2025	145 122	87 073	121 902
2030	93 867	56 320	78 848

The characteristics of China's cement limestone resources are as follows. Primarily, China ranks first in the world with respect to its amount of cement limestone resources. Second, the ore quality is excellent, and the average grade can reach first grade requirements. Third, most deposits are single deposits. Chemical or biochemical sedimentary deposits account for more than 90% of the confirmed deposits. Fourth, most of the ore bodies are located above the local erosion datum, which easily lends itself to open-pit-mining. However, the local distribution of resources is not balanced, especially in the eastern coastal areas, where resources are possibly in short supply.

3 Current situation of silica raw material resources for glass

In 1981, China's Luoyang float glass technology was introduced, becoming one of the world's three float technologies. The technology obtained a level of internationally advanced technologies; nevertheless, a gap remains between China's special glass technology and the international advanced level.

Since 1989, the flat glass output in China has been ranked first in the world. In 2017, China produced 890 million weight boxes of plate glass, including more than 90 float glass manufacturers, 325 float glass production lines, and 1.187 billion weight boxes of float glass in production capacity. From 2000 to 2017, the annual output of plate glass increased by a factor of 4.57 [1], as shown in Fig. 2.

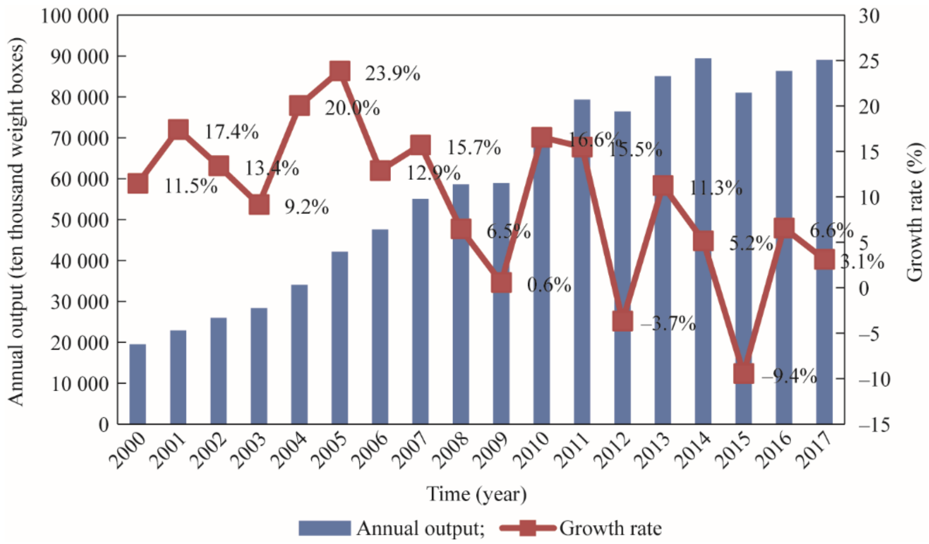

Fig. 2. Annual output and growth rate of flat glass in China from 2000 to 2017.

The second generation of China's float glass technology integration has been carried out, and thus the deep processing products rate of plate glass increased from 25% to more than 45%. In 2015, the production capacity of the top ten enterprises accounted for about 48.92% of the national production capacity, the comprehensive energy consumption of flat glass was 13.20 kgce/ weight box, and the comprehensive energy consumption of float glass was 12.11 kgce/ weight box [1].

The main problems faced by China's plate glass industry are as follows. First, the production capacity of flat glass is excessive and its utilization ratio is 63.81%. Second, the high-quality float glass only accounts for 31.03% of the plate glass output in a year. Third, the productivity concentration ratio of the top ten enterprises is less than 50% [2].

China has developed ultra-thin glass (0.15−1.1 mm), super-thick glass (15−25 mm), low-E glass, TCO glass, super white rolled glass, ultra-white float glass, energy-saving glass, TFT-LCD glass substrates, and other new varieties of special glass. China has realized the wide application of waste heat power generation, flue gas treatment, and oxy-fuel combustion technology. There is an increasing amount of enterprises expanding globally.

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Table 4 and Table 5 list the prediction results of the demand for plate glass and the consumption of silicon raw materials for glass in China.

Table 4. Forecast of China's flat glass demand. × 10^4 weight box

Time	Float glass	Rolled glass	Other	Total
2020	69 210	7 724	1 577	78 533
2025	62 994	11 472	1 741	74 466
2030	56 573	14 554	1 922	71 126

Table 5. Prediction of silica material consumption for flat glass in China.

Time	Demand for flat glass (Ten thousand weight box)	Consumption of silica raw material reserve for glass (× 10^4 t)
2020	78 533	3 926.65
2025	74 466	3 723.3
2030	71 126	3 556.3

Siliceous raw materials for glass are abundant in China, including quartzite, quartz sandstone, quartz sand, and vein quartz. At the end of 2015, there were 648 siliceous raw material mining areas with reserves of 1.299 × 10^9 t, basic reserves of 1.99 × 10^9 t, resources of 5.908 × 10^9 t, and confirmed reserves of 7.897 × 10^9 t. Among these, there are 203 quartzite mining areas, 116 quartzite sand mining areas, 147 quartz sandstone mining areas, and 182 vein quartz mining areas [3].

The characteristics of siliceous raw material resources for glass in China are as follows. First, the resources are abundant, but the distribution is not balanced. The total resources of Eastern and Northern China, where the plate glass industry is relatively developed, are not large. Second, the resources are mainly quartz (3.147 × 10^9 t, accounting for 53.27%), quartz sand (2.147 × 10^9 t, accounting for 36.35%), and quartz sandstone (5.48 × 10^8 t, accounting for 9.28%). The amount of vein quartz (6.524 × 10^7 t, accounting for 1.10%) is lower, and the crystal resources have been basically exhausted. Third, minerals of different origins have different grades: the quality of rock ore is better than that of placer deposit; the northern rock ore quality is better than that of the south; the southern placer is better than that of the north; marine sand is better than terrestrial sand. Fourth, the associated siliceous resource was developed and utilized. In recent years, with the discovery and exploitation of nepheline syenite, granite, and shallow granulite, they have become another source of siliceous raw materials for glass [3].

The main problems arising in the exploitation of siliceous raw materials for glass in China are as follows. First, the degree of development and utilization is not balanced, as both are higher in East China than in the west. Second, the utilization efficiency of some mining resources is low. Third, the construction of "green mining" has just begun, and there is no national green mine pilot unit. Fourth, the layout is scattered, and the scale is small. Generally, with one plant for a single ore, there is lack of large-scale siliceous raw material dressing enterprises with competition at the international scale.

4 Current situation of clay mine raw material (kaolin) resources for building sanitary ceramics

From 2000 to 2017, the average annual growth rate of China's production of building ceramic tiles and sanitary ceramics was 11.54% and 9.61%, respectively. In recent years, output has been growing, whereas the growth slowed down gradually. Since 1995, China has been the world's largest producer and consumer of building sanitary ceramics. From 2000 to 2017, the annual production of building ceramic tiles increased by a factor of 6.40, and the annual production of sanitary ceramics increased by a factor of 4.76 [1], as shown in Fig. 3 and Fig. 4.

China's building sanitary ceramics products are increasingly rich in their specifications and color patterns, which have reached more than 2000 varieties, while their overall performance is at the international advanced level.

The industrial concentration rate of the building sanitary ceramics industry improved further. In 2015, the output of the top ten enterprises of building sanitary ceramics accounted for 15% of the total output of ceramics, which was 5% higher than that of 2010. The ceramic industrial parks and industrial agglomeration zone are developing rapidly and becoming increasingly sustainable. Green development has become the consensus of the industry. The extensive mode of development has been curbed. The energy consumption per unit product and energy consumption per 10 000 yuan added value were reduced. During the 12th five-year plan period, the total energy consumption of building sanitary ceramics industry increased by 8.2% annually, which is lower than the growth rate of 10.2% during the 11th five-year plan period. The energy consumption per unit product of building ceramic tile decreased by 0.80% annually, while the fully energy consumption per unit product of sanitary ceramic decreased by 0.91% annually. The export trade of building sanitary ceramic products continues its growth. From 2010 to 2015, the annual growth rates of export volume and export value were 8.1% and 41.98%, respectively, and the respective average unit price increased by 10.5% and 31.4% [2]. Table 6 shows the forecast results of demand for building sanitary ceramics and clay mineral raw materials for ceramics in China.

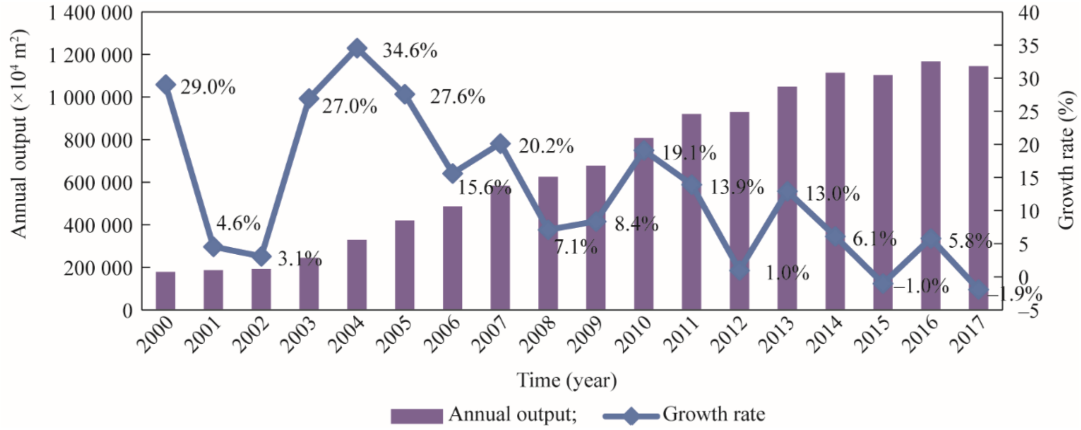

Fig. 3. Annual output and growth rate of building ceramic tiles in China from 2000 to 2017.

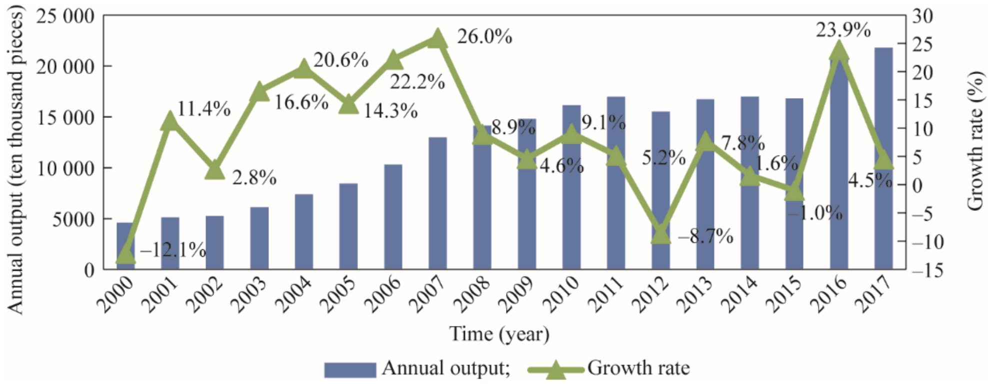

Fig. 4. Annual output and growth rate of building sanitary ceramics in China from 2000 to 2017.

Table 6. Demand forecast of building sanitary ceramics and clay mineral raw materials for ceramics in China.

Type	2020		2025		2030	
	Demand	Raw material quantity (× 10^8 t)	Demand	Raw material quantity (× 10^8 t)	Demand	Raw material quantity (×10^8 t)
Building ceramic bricks	1.158×10^{10} m^2	2.4411	114.8×10^8 m^2	2.3933	106.8×10^8 m^2	2.2274
Sanitary ceramics	2.4×10^8 pieces	0.0365	2.6×10^8 pieces	0.0393	2.8×10^8 pieces	0.0423
Sum		2.4775		2.4326		2.2697
Kaolin		0.8763		0.8612		0.8050
Feldspar		0.7378		0.7239		0.3532
Quartz sand		0.7396		0.7258		0.8419
Wollastonite ore		0.1246		0.1216		0.0579

Kaolin is a type of clay and clay mineral raw material mainly composed of kaolinite clay minerals, which can be generally divided into three types: hard (coal) kaolinite, soft kaolinite, and sandy kaolinite. In 2015, 481 kaolin mining areas were discovered in China, and the confirmed reserves were 2.708×10^9 t, including 5.74×10^8 t basic reserves and 2.134×10^9 t resources. The kaolin used in building sanitary ceramics is usually soft kaolin. The

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characteristics of kaolin resources for building sanitary ceramics in China are as follows. First, kaolin resources are mainly distributed in central south and east of China, accounting for 60.2% and 19.1% of the total national resources, respectively. Second, the discovered deposits are mainly small and medium-sized, and there are only a few large deposits with resource reserves exceeding 2×10^6 t. Third, most of them are kaolin for ceramics, accounting for 49.9% of the total reserves. Fourth, there are more soft kaolin reserves in the south with the characteristics of a thin ceramic body, high transmittance, and blue color. In the north, there is sedimentary mineral-type secondary migration clay, which contains more impurities of titanium, iron ore, and organic associated organisms. The product is white yellow [3].

5 Current situation of high-purity quartz resources

High-purity quartz has become a key strategic mineral resource in the world. China has listed high-purity quartz as a national strategic mineral. At present, there is no national standard for high-purity quartz products in China. Quartz with a mass fraction of SiO_2 at 99.9−99.999 wt% and Fe_2O_3 < 10 μg /g is usually referred to as high-purity quartz. Quartz products with a SiO_2 mass fraction higher than 99.9991 wt% are called ultra-high-purity quartz. High-purity quartz can be divided into 40−70 mesh, 70−140 mesh, and < 140 mesh, according to its granularity, among which the 40−70 mesh and 70−140 mesh products are most widely used.

China's quartz products industry developed relatively late. Since the 1970s, China has employed advanced technology and equipment from developed countries, and the quartz products industry has made great progress. China's high-purity quartz products are mainly used in semiconductor photovoltaic and electric light source industries, however most enterprises do not master the core technology of fine processing of high-purity quartz products. The products of most enterprises are of the middle and low level, and it is difficult for them to meet the quality requirements from high-end industries such as electric light source, semiconductor, and photovoltaic industries.

Crystal is the main raw material used in the production of high-purity quartz products in China. With the depletion of crystal resources in China, studies have been carried out on the replacement of natural crystal with other quartz mineral raw materials containing about 2N SiO_2 for the processing of high-purity quartz. The main mineral raw materials include vein quartz, pegmatite, quartzite, quartz sandstone, etc.

A large gap remains between China's high-purity quartz processing technology and the international advanced level, and most of the quartz products produced in China are middle and low-end products. At present, China still needs to import high-grade and high-purity quartz from abroad at a high price to meet the production needs of the industry, such as photovoltaic and electronic information industries. Otherwise, China can directly import quartz bars and ingots made with high-grade high-purity quartz products to meet the needs of high-grade quartz glass products and devices.

The reserves and resources of siliceous raw materials in China are 1.302×10^9 t and 5.959×10^9 t, respectively. At present, the annual consumption of high-purity quartz (including for electric light sources) in China is less than 3×10^5 t. Assuming that 10% of the reserves of siliceous raw materials are used as raw materials for processing high-purity quartz, the predicted service life of retained reserves of high-purity quartz in China is 434 years, and the service life of resource reserves is 1986 years. Table 7 shows the prediction of China's demands for high-purity quartz resources. The demand for quartz products in 2020 and 2030 is 4.13×10^5 t and 7.35×10^5 t respectively [3].

Table 7. Demand forecast of high-purity quartz products in China.

Quartz consumption structure	Consumption proportion (%)	Growth in 2015−2020 (%)	Growth in 2021−2030 (%)
Electric light source	11	6	3
Semiconductor	48	8	5
Photovoltaic	15	15	10
Optical communication	22	8	5
Other fields	4	5	3
Predicted growth		6.7	

The main problems faced by China's high-purity quartz industry are as follows. First, a large gap remains between China's current processing technology and the international advanced level. Most quartz products in China are low-end products, and high-end products are heavily dependent on imports. Second, the protection of high-quality resources in China is not sufficient. High-purity quartz is mainly processed with raw materials such as quartz and other high-quality vein quartz. However, the crystal resources in the East China Sea have been exhausted. Third, China's mineral products reserve facilities construction lags behind, and relevant reserve measures for high-purity quartz have not yet been implemented.

6 Current situation of graphite resources

Graphite is an important nonmetallic mineral resource that is widely used in new energy, aerospace, steel, refractory materials, and other fields. Graphite has been attracting increasing attention all over the world. Many countries have listed it as an important strategic resource and established a stable strategic reserve system for graphite resources.

Graphite is divided into natural and synthetic graphite, and this study mainly addresses the former. There are two main types of graphite ore in China: crystalline graphite and cryptocrystalline graphite. One-hundred-seventy-two graphite mineral sites have been identified, and the resource reserves have been found to be 3×10^8 t. Among these, 140 mineral sites are crystalline graphite ores, whose resource reserves have been estimated at 2.65×10^8 t, accounting for 88.33% of the total graphite mineral resources; the other 32 are cryptocrystalline graphite ores, whose resource reserves have been estimated at 3.5×10^7 t, accounting for 11.67%. Crystalline graphite ore is mainly distributed in 20 provinces including Heilongjiang, Shanxi, and Sichuan, and cryptocrystalline graphite is mainly distributed in 10 provinces including Inner Mongolia, Hunan, and Guangdong. China's graphite reserves have always been the highest in the world, accounting for more than 70% of the world's total graphite reserves. Moreover, China has consistently been the largest producer, consumer, and exporter of graphite in the world. With the recent rapid increase of graphite reserves in Brazil, India, and other countries, the proportion of China's graphite reserves in the world has decreased, and now ranks third in the world [3].

There are nearly one thousand graphite mining and processing enterprises in China, and their output of graphite increased from 1.65×10^6 t in 2000 to 1.92×10^6 t in 2006, after which it decreased year by year. In 2015, the annual output was 7.8×10^5 t, among which crystalline graphite was $5 \text{ x } 10^5$ t and cryptocrystalline graphite was 2.8×10^5 t. From 2002 to 2015, the graphite usage increased from 4.33×10^5 t to 6.34×10^5 t, exhibiting overall growth. The amount of graphite used in 2015 was 6.34×10^5 t, comprising 40% for iron and steel metallurgy and refractory materials, 20% for casting industry, and 40% for other materials (pencils, conductive materials, sealing materials, batteries, etc.). According to the 2015 statistical data, the service life of China's graphite reserves is 19.76 years, and the service life of resource reserves is 303.55 years [3]. Tables 8 and Table 9 list the predictions of the growth rate of graphite demand and the graphite demand in China.

Table 8. Forecast of the growth rate of graphite demand in China.

Graphite consumption structure	Consumption proportion (%)	Growth in 2016−2020 (%)	Growth in 2021−2030 (%)
Refractory materials (magnesia carbon brick) and steelmaking (recarburizer)	42	–3	–1
Cast	12	3	2
Lithium ion battery, fuel cell and more	15	20	10
Friction materials and lubricating material	10	3	1
Sealing material and heat conduction material	5	2	1
Pencil and printing ink	6	1	0
Other graphene, military project, new materials	10	5	5
Predicted growth（2016—2030）		4.6	

The development of China's graphite industry is faced with the following problems. First, the phenomenon of disordered mining is severe. Second, there are problems such as low abundance of industry, inefficient industrial structure, low technology, and weak ability of independent innovation. Third, the Chinese graphite industry is lagging behind international competitiveness and has no price leadership.

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Table 9. Forecast of graphite demand in China.

Time	Demand ($\times 10^4$ t)
2019	75.9
2020	79.4
2025	99.4
2030	124.5

7 Problems, strategic ideas, and objectives of the development of nonmetallic mineral resources of building materials

7.1 Problems in the development of nonmetallic mineral resources of building materials

Main problems include shortening of the guaranteed life of major mineral resources, poor balance of reserve structure, disequilibrium of resource development and low technical equipment level in exploration, mining, development, and utilization. The development pattern of high resource consumption, severe environmental pollution, and disordered mining remains fundamentally changed. The comprehensive utilization of resources is inefficient, and the mine environment is significantly damaged. Industry concentration and labor productivity are low, and industrial structure is inefficient. Moreover, the competitiveness within the industry is weak. The protection of high-quality resources is inadequate, and no strategic resource reserve system has been established.

7.2 Strategic thinking and goal of the development of nonmetallic mineral resources of building materials

Our strategy and goals include focusing on the major needs of national economic and social development, aiming at building a powerful country in nonmetallic mineral resources, taking innovation as the driving force, improving quality and efficiency as the central factors, realizing sustainable development as the main line, accelerating the transformation and upgrading of the nonmetallic mineral industry as the main direction of approach, and developing limestone, siliceous raw materials, kaolin, high-purity quartz, graphite ore, and its deep-processing products.

Emphasis should be placed on strengthening the resources guarantee, improving innovation, improving the mining capital market, and establishing a multi-level talent training system to provide raw material support and guarantee for the realization of a strong manufacturing system in China.

By 2020, a nonmetallic mineral resource industrial system with a strong independent innovation capability and sustainable development will be established, and a number of multinational companies and industrial clusters with strong international competitiveness will be formed. Their status in the global industrial division and value chain will be significantly enhanced. Major mineral varieties can meet the needs of the national economy and national defense construction. Some fields involving mineral resources are at the world's leading level; the mining capital market will have been formed; the strategic mineral resource reserve system will have been constructed; the transformation and upgrading of non-metallic mining industry has achieved remarkable results, and the strategic transformation from a big mining country to a strong mining country will be preliminarily realized.

By 2030, the overall mining power of China will reach the medium level of an international great power in the mineral industry. The global resources control capacity will be greatly enhanced, major breakthroughs will be made in key areas of development, and the overall competitiveness will be significantly increased. An innovative leadership will be formed in the field of nonmetallic mining, and global influence will increase significantly.

By 2050, China will lead the development of global building materials and the nonmetallic mining industry, and will become a powerful country in the relevant fields.

8 Key tasks and guarantees in the development of nonmetallic mineral resources for building materials

8.1 Key tasks in the development of nonmetallic mineral resources for building materials

We aim to carry out geological survey and exploration in key areas, strengthen the planning and protection of mining areas, strengthen the integration of mines, build green mines, improve the security of mineral resources, and improve the overall competitiveness of the mining industry. We will also build demonstration bases for mining, processing, and a specialized supply of mineral resources, and bases for standard raw materials. Furthermore, we will build international enterprises with core competitiveness, and thus improve global economic capabilities. Hence, we should accelerate the strategic resource reserve system, implement the global distribution of strategic resources, and improve the control and resource security of China's global mining resources.

8.2 Guarantee measures for the development of nonmetallic mineral resources for building materials

Steering groups should be set up, along with strategic advisory committees and technological innovation alliances to strengthen industry management. The standard system should be improved, as well as technical specifications, testing methods, and certification mechanism of raw material products of mineral resources. Moreover, personnel training should be strengthened, and the system of training highly skilled personnel should be improved, based on enterprises, colleges and universities, and link school education with enterprise training. The government should promote a system of training highly skilled personnel that combines government support with social support, setting up research and development centers and high-tech enterprises. Finally, we should strengthen the formulation and implementation of laws and regulations on mineral resources, development strategies, plans and policies, and increase support for enterprises of strategic raw materials to explore, develop, and acquire resources overseas.

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