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YUN YU[1]

Assessing the criticality of minerals used in emerging technologies in China

Introduction

Emerging technologies represent the direction of the new industrial revolution of promoting sustainable economic and social development, and strategic emerging industries have developed rapidly in China. In 2015, the added value of strategic emerging industries accounted for approximately 8% of the country's GDP. In 2016, the Chinese government released *the 13th Five-Year Plan Dedicated to Strategic Emerging Industries*, which is the clearest indication of China's blueprint for industrial upgrading and technological development for 2016–2021 (Kenderdine 2017). According to this plan, the added value of strategic emerging industries will account for approximately 15% of the GDP by 2020, and there will be five new pillars with a total output value of CNY 10 trillion: next-generation information technology, advanced manufacturing, biotechnology, low-carbon industries, and digital creative industries.

The development of these emerging technology industries requires more mineral resources as raw materials, especially nonfuel minerals such as the source of following

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✉ Corresponding Author: Yun Yu; e-mail: yuyun@mail.cgs.gov.cn

[1] China Geological Survey Development and Research Center; China; ORCID iD: 0000-0002-9030-0503; e-mail: yuyun@mail.cgs.gov.cn

elements Cu, Cr, Ni, Zn, which is used in wind turbine manufacturing, Pb, Cd, Ga, In, Ag, Te which is used in solar photovoltaic goods (Hodgkinson and Smith 2018), Li, Co, REEs which are used in electric vehicles (Nicholas LePan 2018), Ta, Be, and Nb which is used in the aerospace industry (Silveira and Resende 2017). These minerals have smarter and faster features for use in manufactured goods, and in the future, the growth rate of the demand for these resources will accelerate with the development of globally emerging technologies, which will lead to the reshaping of the global supply and demand pattern, thus affecting the industrial chain.

Globally, there has been a rapid growth demand of minerals needed for emerging technologies, However, supply development has been slower, so the demand-supply gap of these minerals is large. China is no exception; the supply and demand of the mineral commodities needed for emerging technologies is unbalanced. In 2017, the country was the largest consumer of Ni, Cu, and Co in the world, and Chinese reserves accounted for 3.9, 3.4 and 1.1% of the global supply, respectively (USGS 2018). China has been dependent on imports to meet its demand, but the supply sources are relatively concentrated. More than 60% of the total imports of Ni, Co, and Li is coming from the Philippines, the Democratic Republic of the Congo (DRC) and Chile.

The unsatisfied growing demand for minerals used in emerging technologies or an unexpected supply disruption in major producing countries could have an impact on national security and economic development. There are growing concerns over a number of issues regarding supply risk and supply chain disruption, including a lack of domestic resources, external supply concentration, a highly import-reliant sector, volatile prices, and geopolitics. In terms of resource endowment, no country can supply all the resources it needs; for example, Co in China mainly comes from the DRC, and Cu comes from Chile and Peru. South African Pt miners went on strike in 2014; Indonesia banned exports of Bauxite, Ni and Sn in 2014; and the DRC raised the taxes on Co exports in 2017.

Recently, the minerals needed by emerging industries have received more attention. We find that there are no studies that extensively assess the mineral commodities used for emerging technologies in China in terms of supply risk and supply chain disruption, so this paper attempts to evaluate the criticality of 34 mineral commodities in the country using three indicators: import concentration, volatility of prices and the application requirements.

1. Reviews of critical assessment

Our research focuses on two key terms, the assessment of Chinese mineral commodities and critical minerals for emerging technologies, so we review the literature from these two perspectives. Various countries have actively researched both the assessment methods suited to their own countries and the demand for critical minerals for special emerging technologies.

Since the publication of the NRC report (NRC 2008), some efforts have aimed at assessing material criticality. For the European Union, some reviews discuss the criticality methodology in use (Bedder 2015; Blengini et al. 2017), the minerals needed for wind energy systems (Kim et al.2015), and the EU manufacturing companies that need critical materials (Lapko et al. 2016); the availability of critical minerals has been quantitatively examined and compared at the country level in Germany (Erdmann and Graedel 2011), Poland (Radwanek-Bąk 2011) and France (Beylot and Villeneuve 2015). Brown (Brown 2018) discusses the trends in supply diversity for five mineral raw materials (Fluorspar, Li, Coal, Cu and Ni) at decadal intervals over the past century to determine whether supply concentration is a cause for concern. The second important area of research is the United States, whose government agencies and associations conduct extensive research (DOE 2011; Parthemore 2011; DOD 2013; Fortier et al. 2018). McCullough and Nassar update an early-warning screening methodology for critical minerals for the US (Mccullough and Nassar 2017). Goe and Gaustad identified the most critical materials used for photovoltaics are Ge, Pt, As, In, Sn and Ag in US (Goe and Gaustad 2014). Some research concerns Japan (Hatayama and Tahara 2015).

In addition to conducting research at national scales, some studies of critical minerals are conducted from the perspective of the demand for specific emerging technologies which included solar panels (Fizaine 2013), Ni for low-C electricity (Roelich et al. 2014; Miyamoto and Hashimoto 2019), PGMs for smart cars (Zhang et al. 2016), clean energy (BP 2014), Nd, Co, and Pt for Li-ion batteries (Helbig et al. 2017).

This section reviews some previous Chinese research, the first category of which includes minerals for which China is considered a global supplier (Graedel et al. 2012; Riddleet al. 2015) and are concentrated in REEs, Sb, and W ore. The other category assesses the minerals needed for emerging technologies in China. Gulley et al. (Gulley et al. 2018) use the net import reliance of the US and China for 42 nonfuel minerals to assess the foreign supply risk related to emerging technologies, and He et al. (He et al. 2018) evaluate the minerals contained in waste from the emerging technologies of smartphones in China. However, while there has been active research from a national perspective in China, there are few studies on the supply of mineral resources from the perspective of mineral resources needed by the development of China's emerging industries.

2. Methodology

2.1. Assessment overview

Based on internationally accepted indicators and methods, this research initially designs the overall framework used to assess the criticality of mineral commodities used for emerging technologies in China based on the reality of the mining industry, and it explores the criticality of the mineral resources for the country. This paper adopts three factors to assess the criticality of minerals used for emerging technologies in China – the supply, risk and volatile market, all which serve an essential function in the emerging technologies of a product. Based on an analysis using the definition and multiple criteria, our criticality analysis uses three indicators: import concentration, volatile prices and the application requirements. Supply risk may be caused by many reasons, high country concentration, trade disputes or natural disasters for disruption. We choose the import concentration that is calculated as the percentage of imports from the top three countries. The volatile prices index is calculated by the price change rate for the past five years. The application requirements come from a literature review, and eight strategic emerging industries are highlighted in China's *13th Five-Year Plan Dedicated to Strategic Emerging Industries*: energy-saving environmental protection, next-generation IT, biotechnology, advanced manufacturing, new materials, new energy vehicles, digital creative industries and emerging technologies services.

2.2. Indicators and Data Points

We conducted a review, comparison, and analysis of the past literature (Erdmann and Graedel 2011; Graedel and Reck 2016; Dewulf et al. 2016). Some scholars use two primary indicators for critical mineral assessment: supply risk (Gloeser et al. 2015; Achzet and Helbig 2013) and supply vulnerability (Helbig et al. 2016) (as indicated by a review of comparative research). Considering that our research focuses on two key terms, the assessment of Chinese metals, minerals and mineral raw materials for emerging technologies, we focus on assessment methods suited to China and assess that the indicator for minerals used in this paper is a three-dimensional group of indexes. Considering the resource situation in China, the percentage of imports for the top three countries indicates supply issues. The application requirements are demand indicators for emerging technologies, and the market response reflects the market, which can express a short-term consumer response more intuitively. The price change rate uses five years of data to calculate the change rate for every year, thereby avoiding statistical errors.

In this research, three indicators are calculated from the data, and the specific scores range from 1–3. The weighting is based on an equal weighting method. For each indicator, the higher the score, the stronger the crisis, and scores of 3, 2, 1 represent high, medium and low, respectively. The indicator used for "volatile prices" is based on the methods (Mccullough and Nassar 2017). Price data came from the US Geological Survey , and import price data from the General Administration of Customs of China.

The "price change rate" is obtained by the following calculation.

Price change rate (M):

$$M_{m,t}^{r} = \frac{\sqrt{\dfrac{\sum_{t'}^{t}\left(P_{m,t} - \overline{P}_{m,t:t'}\right)^{2}}{t - t'}}}{\overline{P}_{m,t:t'}}$$

M – price change rate (%),
m – mineral,
t' – the initial year,
t – the current year,
$\overline{P}$ – the annual average price the current year,
P – the annual average price over the past five years.

After observing the market response for the past five years, the larger the value of M, the higher the criticality. When the price change rate account for >66% is high, 0.33~0.66 is medium, less than 0.33 is low.

The classification standard of the “the percentage of imports for the top three countries” indicator was obtained from literature published by BP (BP 2014) and the British Geological Survey (2015). For example, “high” means that the total imports of the top three importing countries account for >66% of the total import volume. Trade data was obtained from the General Administration of Customs of China.

The scoring standard used for the “emerging technologies requirements” indicator also comes from the literature and *the 13th Five-Year Plan Dedicated to Strategic Emerging Industries*. The minerals for which data is lacking are defined as “medium” (score of 2) according to the BP (BP 2014).

3. Results and discussion

3.1. Overall analysis

We assess the criticality of 34 metals, minerals and mineral raw materials as: Li, Ni, Co, PGMs, Cr, Nb, Be, Ta, Ce, Bauxite, Potash, Cu, Mn, B, Zr, Hf, W, In, Magnesite, Natural Graphite, REEs, V, Ti, Nb, Ga, Talc, Fluorite, Bi, Sn, Sb, Diatomite, Te, and Cd.

Understanding the methods used to assess critical minerals through a theoretical analysis has placed a particular emphasis on conducting measurable and assessable practical research that must incorporate internationally accepted assessment methods while considering the reality of the Chinese mining industry. For critical minerals, there are many reasons that obstacles and supply risks exist, and any aspect of these factors can affect the security, stability, diversity, and economy of the supply. From a resource perspective, the results of this research indicate that China needs to focus on the degree of the crisis for emerging technologies, as shown as follows.

The first indicator is import concentration, which implies that there is an insufficient reserve in China. From the perspective of resource endowments, no country in the world has all the resources it needs within its own borders, but if the supply is risky or unable to meet the growing demand, especially for mineral resources used for economic development and emerging technologies, international trade may bring global competition for these resources. China's critical minerals may be facing the same issues as other insufficient resource countries. For example, China is heavily dependent on the import of Zr and Co resources, the reserves of which accounted for only 1% of the global total, but it is the largest consumer of these minerals in the world, accounting for 53 and 32%, respectively, of the total global consumption.

The second indicator is the price change rate, which aims to capture dynamic changes in supply markets. Excessive or sudden price volatility and changes in market expectations can be caused by a number of different factors, including supply and demand and low inventories. The inelastic supply may indicate that the supplier is unable or unwilling to change the quantity produced when the price changes rapidly, and by-products from mineral production may fall into this category because they are relatively low in yield and economic value compared to the major minerals that are recovered. Inelastic demand indicates that the consumers of the mineral are unwilling or unable to change their purchasing habits, even when changes in the prices of by-products are fast and dramatic, so it may indicate a lack of adequate substitutes.

In addition, there is a need to consider the application requirements for the minerals in accordance with the Chinese *13th Five-Year Plan Dedicated to Strategic Emerging Industries* in 2016 as well as the classification of strategic emerging industries issued by the National Bureau of Statistics of China in 2018. This study considers the structure of mineral products used in nine fields including the next-generation information technology industry, high-tech equipment manufacturing industry, new material industry, biological industry, electrical vehicle industry, new energy industry, energy-saving and environmental protection industry, digital creative industry, and related service industry.

Table 1. Selected minerals and elements used in emerging industries

Tabela 1. Wybrane surowce mineralne i pierwiastki stosowane w nowo powstających branżach przemysłu

Field	Minerals and elements used for emerging technologies
Next-generation information technology industry	REEs, In, Ga, silicon, Sb, Ta, Bi
high-tech equipment manufacturing industry	Rb, Cs, Mn, Ni, Cr, V, Ti, W, Cu, Al, Zr, Nb, Ta, Co, Be, Fluorite
New material industry	Sn, In, Cr, Ti, Sb, Hf, Talc
Biological industry	Zr, Ti, B, Al, Mg, REEs, Nb, Potash
Electrical vehicle industry	Co, Cu, Li, Mn, Ni, REEs, Natural Graphite
New energy industry	In, Ga, Silicon, Al, Li, Co, Ni, Mn, Natural Graphite, REEs, Te
Energy-saving and environmental protection industry	V, Mo, W, Co, Cr, PGMs, Zr, Ge
Digital creative industry	Cu, Al, Sn, In
Related service industry	Cu, Al, Co, Li, Ni, Magnesite, Cd

Data source from: Cui et al. 2017.

This research divides minerals into three levels according to the degree of the supply crisis, and each level is subdivided into different types.

Table 2. Three categories of minerals used for emerging technologies

Tabela 2. Trzy kategorie surowców mineralnych stosowanych w nowo powstających technologiach

Category of criticality	Sub-category	Minerals and elements
Level-I		Li, Ni, Co, PGMs, Cr, Nb, Be, Ta
Level-II	II-a	Rb, Cs
	II-b	Bauxite, Potash, Cu, Mn, B, Ze, Hf
	II-c	W, In, Magnesite, Natural Graphite, REEs
Level-III	III-a	V,Ti, Ge, Ga, Talc, Fluorite
	III-b	Bi, Sn, Sb, Diatomite, Te, Cd

3.2. Level-I critical

There are 8 critical minerals with serious supply risks, broad application in emerging technologies, and substantial market fluctuations. The three indicators are subject to crises that also affect Level-I critical minerals, including Li, Ni, Co, PGMs, Cr, Nb, Be, and Ta, that can be subdivided into three cases.

In the first case, Li, Ni, and Co are critical mineral resources that are used for the electrical vehicle industry, the new energy industry, new material industry, and new environmental protection industry. However, China's Li, Ni and Co resources cannot meet the rapid growth in demand, so there will be a severe shortage in the supply of these minerals because there is only one source for imports. Firstly, Li, Ni, and Co are critical mineral resources used for the new energy industry, the new material industry, and the new environmental protection technology industry. Li is used for electric vehicles and energy storage. Co is used for C capture and storage, nuclear power generation, electric vehicles, and energy storage. Ni is used for wind power, solar photovoltaic products, C capture and storage, nuclear power generation, LEDs, electric vehicles and energy storage. Secondly, China is the world's largest consumer of Li, Ni, and Co. China is phasing in quotas for electric vehicles in 2019, and most multi-national automotive companies will be manufacturing electric vehicles by 2020 (World Economic Forum 2017). In 2016, China's Li output was 2,000 tons, and its consumption was 13,230 tons. According to the (World Bureau of Metal Statistics 2017), China's refined Ni accounted for 46.8% of the global consumption in 2016, and China is the world's largest importer of Ni. Thirdly, the global market demand for Li, Ni and Co resources will be very high in the future; the demand for Li is expected to grow 2–7 times by 2030 and ten times by 2050. Fourth, there is generally a high import concentration of Li, Co, and Ni in China. The data obtained from the China Customs Information Network shows that Ni, Co and Li mine imports to China in 2016 depended on several countries, and the top three importers accounted for 98.0, 98.0 and 97.2% of the total imports of Ni, Co, and Li, respectively. Fifth, prices fluctuate greatly. In 2017, the Co price on the London Metal Exchange had a year-on-year increase of 76.2% in 3 months, which was three times the lowest price in 2016.

The second case is of PGMs and Cr, of which there has been a severe shortage since the first round of identification meant to guarantee the extent of China's mineral resources. At present, the degrees of dependence of the country on the import of PGMs and Cr, are all higher than 85% while the reserves of both are deficient around the world, and there is only one deposit for each of these minerals in China. The global reserves of PGMs and Cr are highly concentrated and mainly in South Africa, Russia and Turkey, so the crises related to these two types of minerals are less important than those related to Li, Ni, and Co.

In the third case, Nb, Ta, and Be are three rare metals, all of which have promising prospects for application in the fields of high-tech and new technologies, especially aeronautics. China's reserves and outputs of Nb and Ta account for approximately 5% of the global output, and the degree of import dependency is higher than 90%. Beryllium mines are mainly found in the US, which produces approximately 74% of the global supply. China produces less than 9% of Beryllium mined worldwide. The supply security of Nb, Ta, and Be will become an important factor restricting the development of fields that use these minerals in China.

3.3. Level-II critical

In the primary assessment results for China's critical minerals, serious criticality is indicated for 14 minerals according to two of three indicators. The minerals belonging to Level-II crises include: Rb, Ce, Bauxite, Potash, Cu, Mn, B, Ze, Hf, W, In, Magnesite, Natural Graphite, and REEs, which can be divided into three cases.

The first Sub-category is II-a and includes two minerals, Rb and Ce. At present, the market capacity of Rb and Ce is small, but they are widely used in emerging technology industries, and the prospect for development is promising. Global Rb and Ce mineral deposits are mainly concentrated in Namibia and Zimbabwe, and the US was the world's first producer of refined Rb, accounting for 48.1% of the total global output. In recent years, the output of Rb concentrate by China has been less than 4,000 tons, accounting for only 3.3% of the global output. Due to their unique characteristics, including strong chemical reactivity and excellent photoelectric performance, these minerals have important and unique applications in many fields, especially in space monitoring and control, satellite navigation, medical testing, optoelectronic equipment, organic catalysts, and light guide fiber. At the same time, China's degree of foreign dependence on Rb and Ce is very high as is the concentration of imports.

The second Sub-category is II-b, which includes seven minerals: bauxite, potash, Cu, Mn, B, Zr, and Hf. The supply risk for these minerals is high and the market is fluctuating, but their application in emerging technology industries is not particularly prominent. Of these, four relatively large-scale minerals deserve considerable attention. In the 21st century, high demand for Cu and Al will continue. These were two large-scale metals in the 20th century whose demand was mainly driven by the development of the energy industry, especially in the fields of electric vehicles, power transmission and distribution, and cables. With the development of the global economy and technological progress, economic restructuring and industrial structure upgrading, the types of required minerals are changing. Comparing the production of a Chevrolet Bolt electric car and that of a Volkswagen Golf car, the usage of Cu and Al for the former has increased by 80% and 70%, respectively (UBS 2017). In 2035, the global demand for Cu and Al will still be high. Additionally, China's current potash and Mn account for 9% and 6% of the global reserves, respectively, but the output accounts for 16% and 19% and the development and utilization intensities are, on average, two to three times that of the world. There has been a high concentration of imports for these four types of large-scale critical minerals in recent years.

The third Sub-category is II-c, which includes five minerals, W, In, magnesite, natural graphite, and REEs, for which the global production of these resources is concentrated in China. They are widely used in emerging-tech industries, and the market is highly fluctuating. For example, W ore is mainly scheelite and wolframite, and the W resources in China are characterized by less-rich, poorer and low-grade ore. Although scheelite reserves are rich, smelting is difficult and expensive, so W smelting in China currently mainly involves wolframite, resulting in greater wolframite consumption, a gradual increase in the proportion of low-grade scheelite, and a decline in the resource grade. Furthermore, China's crystalline graphite reserves are overmined, and the mining and processing enterprises are mainly small and medium-sized with a small and scattered scale of production characterized by outdated technology and equipment. China produces and exports primary graphite products but imports high-tech graphite products for technical reasons. Additionally, the use of graphite in electric vehicle batteries is expected to promote increases in the global graphite demand by several times.

3.4. Level-III critical

The results of the primary assessment of China's critical minerals indicate a serious crisis for 12 minerals, as noted by the Level-II indicator. Among these, there are 6 critical minerals for emerging technologies of III-a: V,Ti, Ge, Ga, Talc, Fluorite, there are 6 type of III-b critical minerals with high critical market fluctuation index values: Bi, Sn, Sb, Diatomite, Te, Cd. These are rare metals that are mainly produced as co-associated elements of primary minerals (Cu, Pb and Zn). The management and regulation of these minerals must be strengthened.

4. Comparison with other research

This section analyzes and compares the results of other reports with the results of this study. The EU's 2017 critical minerals catalog includes 61 items, of which 54 were included in 2014, and 40 were included in 2011 (EC 2011; EC 2014; EC 2017). In addition, 32 were included in the US (NSTC 2016) critical minerals catalog; 40 were included in the critical minerals catalog of the British Geological Survey (BGS 2015); 26 were included in the critical minerals catalog of the European Commission (EC 2017); and 22 were included in the Australian (Skirrow 2013) critical minerals catalog.

We find that different research reports analyze critical minerals from different angles: some are based on supply; some are based on demand; some are based on trade and markets; and some are based on applications. Therefore, the assessment results of different research reports must be analyzed in-depth, especially the development trend of the industry under economic structural adjustment. A comprehensive comparison of the critical minerals catalogs studied and listed by prestigious institutions in major countries provides the following preliminary insights.

1. Regarding the types of minerals listed in the critical mineral catalogs of most countries, most of the large-scale minerals are not included. Among the widespread minerals, those in the critical mineral catalogs are mainly Cu and Al, two kinds of large-scale metals in the 20th century for which there will still be significant demand in the 21st century. The main reason for this demand is the drive for the development of the energy industry, especially in the fields of electric vehicles, power transmission and distribution, and cables. To a certain extent, this result also indicates that the types of minerals required for the advancement of technology, the adjustment of the global economy and the upgrading of the industrial structure, are changing with the development of the global economy.
2. For the types of minerals in the critical mineral catalogs of various countries, the number of non-metallic minerals is small and relatively concentrated and mainly includes natural crystalline Graphite, Fluorite, Barite, Diatomite, Talc, and a few other special non-metals. Compared with that of metallic minerals, the development and utilization of non-metallic minerals still experiences significant deficiencies and thus requires significant innovations and breakthroughs in material technologies.
3. In terms of the minerals in the critical mineral catalogs of various countries, the most similar are REEs, PGMs, and In; most studies also identify W, Ge, Co, Nb, Ta, Ga, and Sn as critical (Hayes and McCullough 2018). These are essential minerals for future international competition and the development of emerging technologies. The changing markets, the progress in the technology to develop and utilize these minerals and the application of new technologies deserve the attention of researchers.
4. Some countries have listed many special metal alloys in their critical minerals catalogs. Alloying elements refer to the addition of a certain amount of one or more metal or non-metal elements in the process of smelting metal to obtain special material

properties, such as increased strength, improved oxidation resistance, increased plasticity and improved process performance. These added auxiliary elemental materials are called alloying elements.

5. The critical mineral catalogs of many countries are dynamic, and there are active crises related to different critical minerals. These catalogs mainly depend on technological advancement and industrial adjustment. For example, the European Commission's catalog of critical minerals must, in principle, be adjusted every three years, and each time it is modified, some types of critical minerals may be added or deleted, Additionally, the degree of the crisis related to some critical minerals may be altered. For example, in some early research reports on critical minerals, either Li was excluded or its degree of critically assessed to be low. However, with the development of electric vehicles, some recent studies of critical minerals have included Li in the catalogs, and this mineral is heavily analyzed and studied.

Conclusions

Several assessments of China's critical minerals have been made, most of which analyze and assess the mineral resources of China as a resource supplier. Our research divides 34 minerals into three levels. Level-I critical consists of 8 minerals which need special policies support. Level-II critical includes 14 which need different policy combination measures. Level-III critical contains 12 minerals also need attention, all of which were analyzed. Then, three important issues related to the mineral resources needed for emerging industries are highlighted. Firstly, the Chinese research institutions should continuously, dynamically, and systematically assess of minerals for emerging industries. Secondly, the market development for each mineral, especially related to its specific characteristics should correspond to the development policies for each mineral. Thirdly, the policies corresponding to critical minerals for industry should be developed or revised in a timely manner.

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ASSESSING THE CRITICALITY OF MINERALS USED IN EMERGING TECHNOLOGIES IN CHINA

Keywords

criticality, minerals, China, strategic emerging industries

Abstract

Emerging technologies represent the direction of the new industrial revolution of promoting sustainable economic and social development, and strategic emerging industries have developed rapidly in China. The development of these emerging technology industries requires more mineral resources as raw materials, especially the need for specific minerals, has increased. The unsatisfied growing demand for minerals used in emerging technologies or an unexpected supply disruption in major producing countries could have an impact on economic development. There are only several studies on the supply of mineral resources from the perspective of mineral resources needed by the development of China's emerging industries. To assess the criticality of the minerals needed by the strategic emerging industries in China, this paper adopts three indicators: import concentration, the volatility of prices and the application requirements by the Chinese 13th five-year plan dedicated to strategic emerging industries in 2016. Furthermore, 34 types of nonfuel minerals and mineral raw materials are separated into three categories. Finally, this paper indicates that the three indexes are all high for 8 minerals with supply risks, application in emerging technologies, and substantial market fluctuations which need the support of special policies. Two indexes of three Level-II indicators are high for 14 minerals which need different policy combination measures, and one index is high for 12 minerals which also needs attention, all of which were analyzed.

OCENA KRYTYCZNYCH SUROWCÓW MINERALNYCH WYKORZYSTYWANYCH W NOWO POWSTAJĄCYCH TECHNOLOGIACH W CHINACH

Słowa kluczowe

krytyczność, surowce mineralne, Chiny, strategiczne wschodzące branże

Streszczenie

Nowo powstające technologie stanowią kierunek nowej rewolucji przemysłowej promującej zrównoważony rozwój gospodarczy i społeczny, a strategiczne wschodzące branże przemysłu szybko rozwinęły się w Chinach. Rozwój tych nowo powstających branż technologicznych wymaga wykorzystania znacznej ilości zasobów surowców mineralnych, a zwłaszcza ściśle określonych surowców mineralnych. Niezaspokojony rosnący popyt na surowce mineralne (pierwiastki, minerały, surowce mineralne metaliczne) wykorzystywane w nowo powstających technologiach lub nieoczekiwane zakłócenie dostaw z produkujących je krajów może mieć wpływ na rozwój gospodarczy. Występują nieliczne badania dotyczące podaży zasobów surowców mineralnych z punktu widzenia zasobów surowców mineralnych potrzebnych do rozwoju wschodzących branż przemysłu w Chinach. Aby ocenić krytyczność surowców mineralnych potrzebnych strategicznym wschodzącym branżom przemysłu w Chinach, w artykule przyjęto trzy wskaźniki: koncentrację importu, zmienność cen i wymogi dotyczące zastosowania zawarte w trzynastym chińskim planie pięcioletnim poświęconym strategicznym wschodzącym przemysłom w 2016 roku. Ponadto 34 rodzaje surowców mineralnych (pierwiastki, metale, surowce mineralne niepaliwowe) podzielono na trzy kategorie. Ostatecznie, w artykule pokazano, że wszystkie trzy indeksy są wysokie dla 8 surowców mineralnych z ryzykiem ich dostaw, zastosowaniem w nowych technologiach i znacznymi wahaniami rynku, które wymagają specjalnej polityki wsparcia. Dwa wskaźniki z trzech wskaźników poziomu II są wysokie dla 14 surowców mineralnych, które wymagają kombinacji różnej polityki wsparcia, a jeden wskaźnik jest wysoki dla 12 surowców mineralnych, które również wymagają uwagi spośród wszystkich, które zostały przeanalizowane.