

2020

China Mineral Resources

**Prepared by
Ministry of Natural Resources, PRC**

**GEOLOGICAL PUBLISHING HOUSE
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Foreword

Under the guidance of Xi Jinping Thought on Ecological Civilization, China continuously promoted the reform of mineral resources management and green development in mining sector. In order to make people at home and abroad who care about and support natural resources conditions understand Chinese policies and reform progress of mineral resources management, the Ministry of Natural Resources (MNR) organized the compilation of the *China Mineral Resources* (hereinafter referred to as the Report).

This year's report focuses on the information since 2019 as the new progress made in China's exploration, exploitation and utilization of mineral resources, green geological survey, construction of green mines, survey and evaluation of mineral resources; the new changes in policies and regulations related to mineral resources; the new measures taken in management of mineral resources and protection of ecological environment; the new scientific and technological innovation in mineral resources exploration; the new development made in geoscience theoretical studies as well as the new achievements obtained in the international geological and mineral resources cooperation with countries participating in the "Belt and Road Initiative". Meanwhile, the implementation of "Six Stability and Six Guarantees" and some measures to help enterprises to resume production by the MNR since the outbreak of COVID-19 are also introduced in this report.

In 2019, the investment in oil & gas was increased by 29.0%. A large shale gas field of which the reserves have reached 1 trillion m³ was found in southern Sichuan Province. New progress has been realized in the exploration of shale gas in deep depth, and that under common stata pressure. A total of 79 new deposits were discovered throughout the country. The identified resources & reserves of major minerals, such as coal, natural gas, shale gas, manganese, lead, zinc, bauxite, tungsten, molybdenum, antimony, gold, magnesite, graphite, etc. increased.

The investment in the fixed assets of China's mining industry was increased by 24.1%. The output and consumption of primary energy, crude steel, 10 kinds of non-ferrous metals, gold and cement continued to rank first in the world. The level of comprehensive saving and efficient use of mineral resources were further enhanced.

The ecological restoration of mines was continuously improved. Policies and measures to encourage and guide the social capital in the ecological restoration of mines were studied and formulated. Major strategic decisions of China were implemented to carry out the ecological restoration of historical mines in key areas like the Yangtze River Economic Belt, the Yellow River Valley, surrounding areas of Beijing-Tianjin-Hebei Region and Fenhe Plain and Weihe Plain. Active efforts were made to promote the revision and perfection of green exploration standards. The exemplary work of green exploration was carried out energetically. Local authorities comprehensively promoted the green mine construction through formulation and implementation of various plans, standards and policies.

Based on the duty of "two unifications", the *Opinions on Promoting the Reform of Mineral Resources Management (Trial)* was issued. A series of major institutional innovations were achieved in the establishment and implementation of mining right transfer, optimization of mining right management of oil and gas, reform of classification and management approaches of mineral resources & reserves, etc. The revised *Geological Environment Protection Provisions of Mines, Measures for the Implementation of the Regulation on Land Reclamation* and a series of normative files were published.

A new round of mineral resources planning and preparation were fully launched, corresponding methods of supervision and management of geological exploration were studied and drafted, new classification standards of mineral resources & reserves were implemented, the transfer of mining rights was optimized, and the supervision and management system of ancient fossils was improved, which further enhanced the management level of the mineral resources.

The basic geological survey was further enhanced. New breakthrough was realized in the non-profit survey of oil and gas. New progress was realized in the mineral survey and evaluation of China's major metallogenic belts, packaged exploration areas, important mineral-concentrated areas and large-scale resource bases. New accomplishments were achieved in the survey and evaluation of geothermal resources and groundwater. A geological survey in China's jurisdictional seas was continued. The construction of the Pilot Testing Area for exploration and exploitation of gas hydrate in the Shenhu Sea Area in the northern South China Sea was

promoted unceasingly. The second round of production test has been implemented successfully. The collection of the Library of NGAC was further enriched. The service of geological materials was more precise, convenient and efficient.

Significant achievements were realized in the study on mineral resources. New breakthroughs were realized in the metallogenic theories and key technologies. The construction of the science and technology innovation platforms for mineral resources was accelerated. Multiple key laboratories and engineering innovation centers have been established. The standardization of geology and mineral resources was promoted to provide technical support for the high quality development of geological and mineral industries.

Active efforts were made to implement the results of the 2nd Belt and Road Forum for International Cooperation. The bilateral and multilateral cooperation in the field of geology and mineral resources was comprehensively promoted. Through international exchange platforms such as China Mining and China-ASEAN Mining Cooperation Forum, the exchanges and cooperation with relevant countries were further solidified and improved.

Statistics in the Report are mainly from the Ministry of Natural Resources and the National Bureau of Statistics of the People's Republic of China. Statistics from the Hong Kong Special Administration Region, the Macao Special Administrative Region and Taiwan Province are not included in the Report.

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Chapter I

Mineral Resources

Till the end of 2019, a total of 173 kinds of minerals have been discovered in China, including 13 kinds of energy materials, 59 kinds of metals, 95 kinds of nonmetallic minerals and 6 kinds of water and gases. The resources & reserves of minerals such as natural gas, shale gas, lead, zinc, bauxite, molybdenum, silver, magnesite, graphite, etc. increased substantially.

I. Mineral Resources Identified

By the end of 2019, 162 kinds of mineral's resources & reserves were identified in the whole country. Compared with the previous year, 106 of 215 sub-types increased, 47 sub-types decreased and 62 sub-types unchanged, accounting for 49%, 22% and 29% respectively.

Among the major minerals, the remaining resources & reserves of 34 kinds of minerals increased, 13 kinds decreased and 1 kind stayed the same. In particular, coal increased by 0.6%; the remaining technically recoverable reserves of oil decreased by 0.5%; and that of natural gas increased by 3.0%; shale gas increased by 77.8%. The reserves of non-oil and gas mineral resources increased: manganese increased by 5.6%; lead 6.7%; zinc 6.8%; bauxite 5.7%; tungsten 4.6%; molybdenum 5.4%; antimony 4.8%; gold 3.6%; magnesite 12.9%; graphite 21.4%; while that of nickel (-9.4%), fluorite (-6.3%) and boron (-4.3%) decreased notably.

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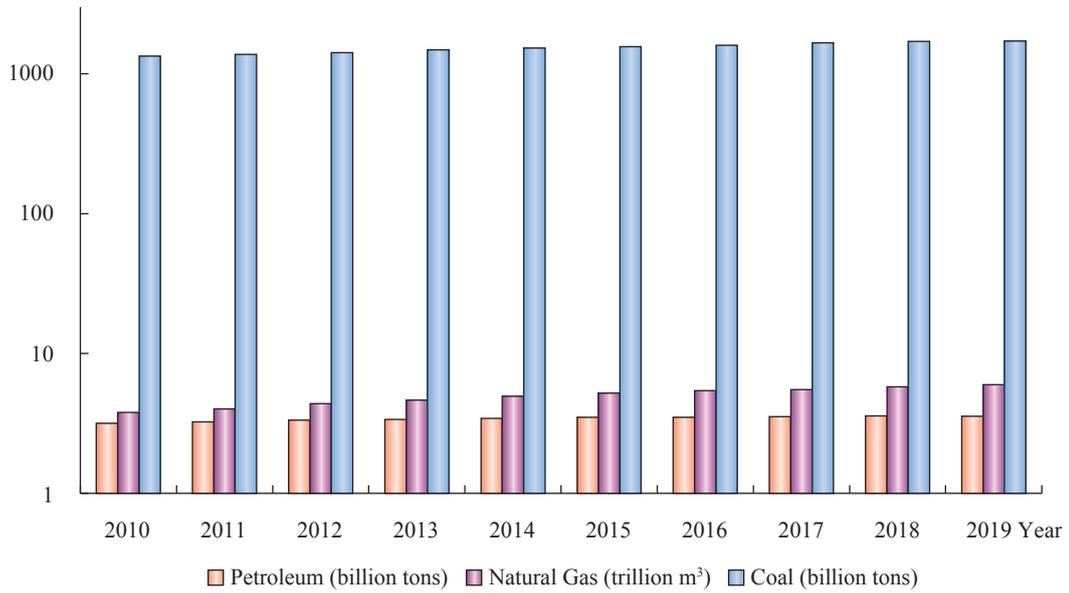


Fig. 1-1 Changes in Resources & Reserves of Coal, Petroleum and Natural Gas
(For oil and natural gas, remaining proved technical reserves are indicated)

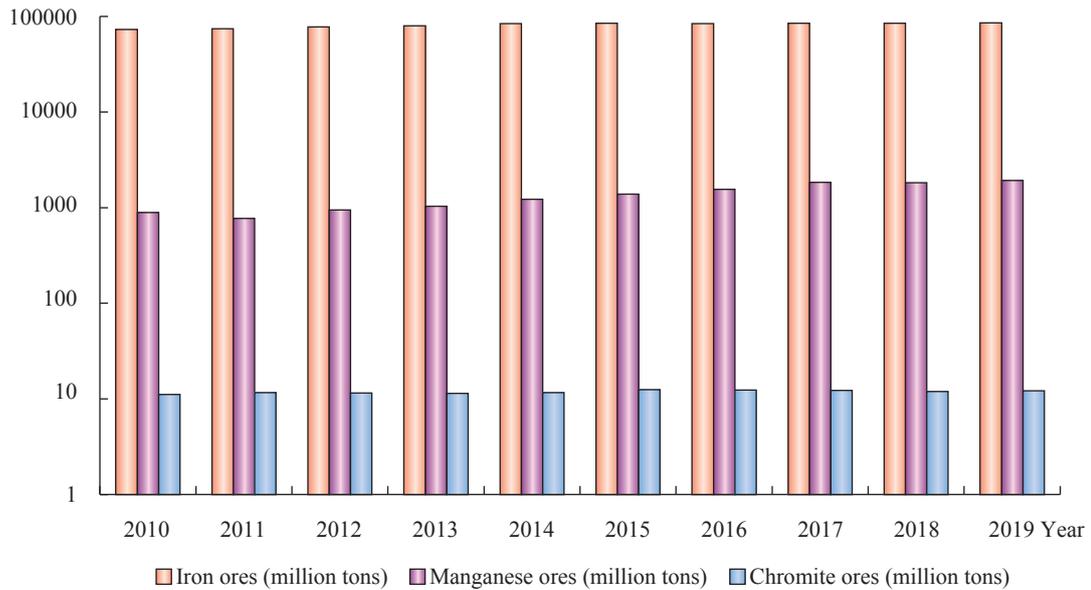


Fig. 1-2 Changes in Resources & Reserves of Iron, Manganese and Chromite

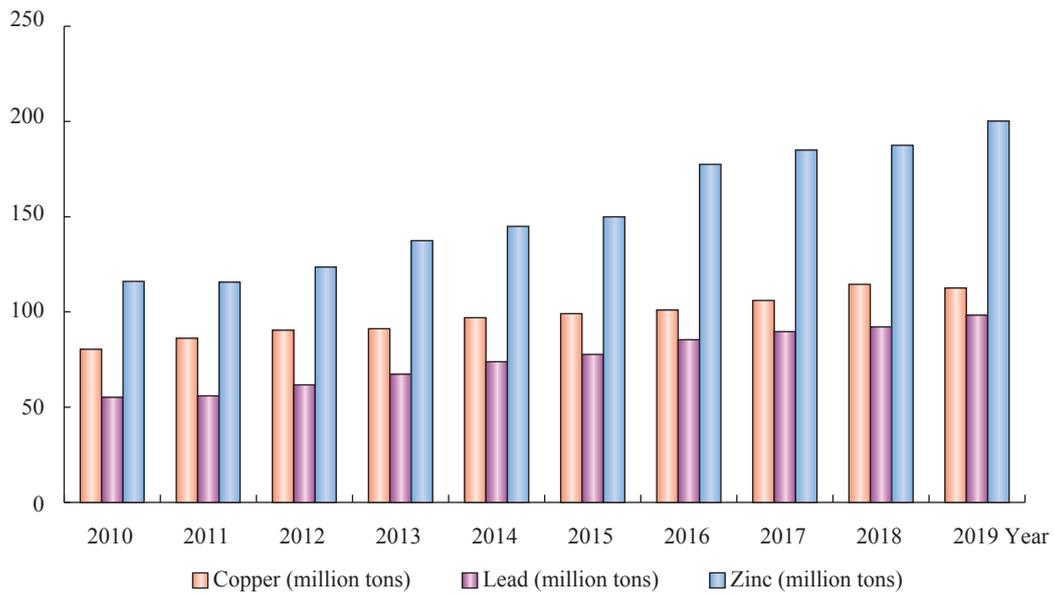


Fig. 1-3 Changes in Resources & Reserves of Copper, Lead and Zinc

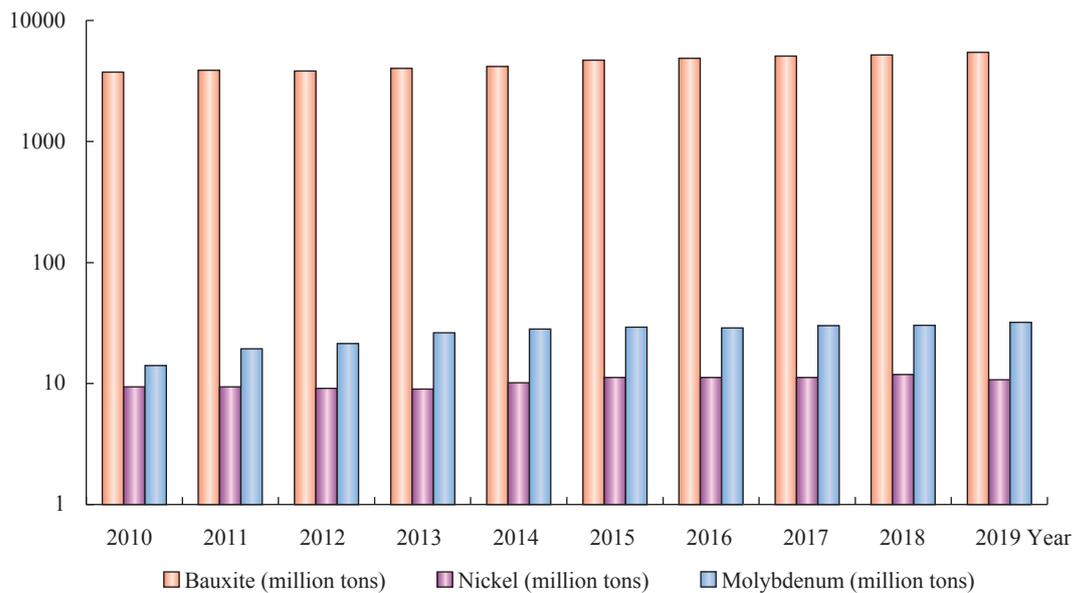


Fig. 1-4 Changes in Resources & Reserves of Bauxite, Nickel and Molybdenum

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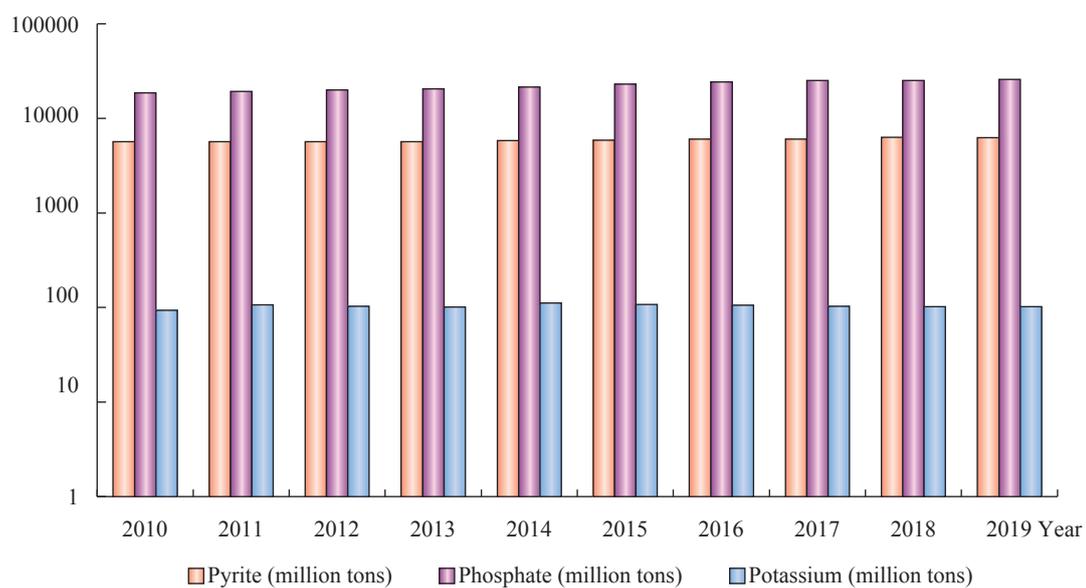


Fig. 1-5 Changes in Resources & Reserves of Pyrite, Phosphate and Potassium

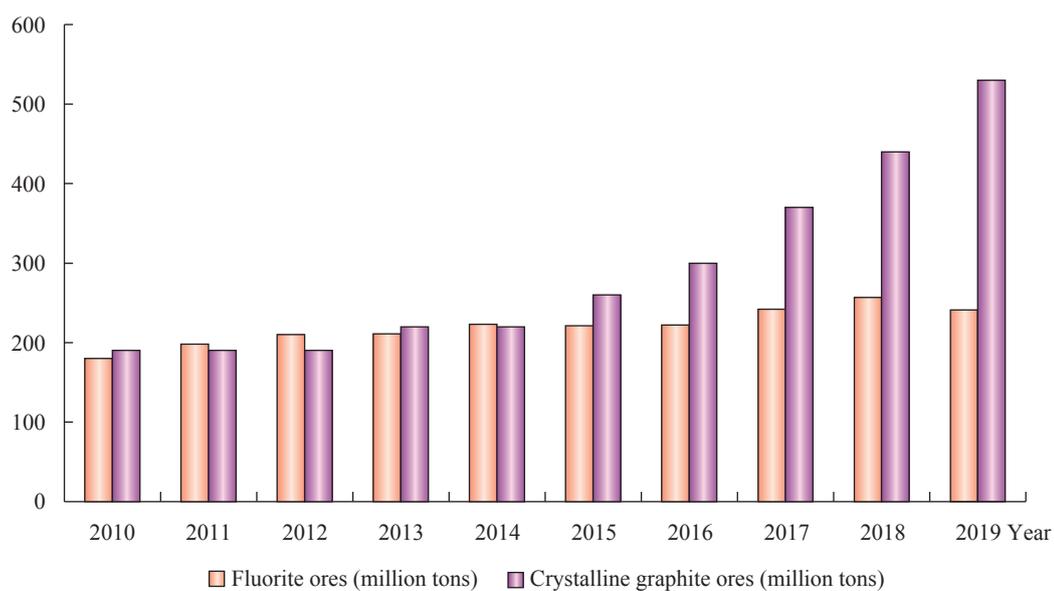


Fig. 1-6 Changes in Resources & Reserves of Fluorite and Crystalline Graphite

II. New Mineral Resources Discovered

In 2019, the newly-discovered geological reserves of oil was 1.12 billion tons, of which, the newly increased proven technical recoverable reserves was 160 million tons. The newly discovered geological reserves of shale gas were 764.42 billion m³, of which, the newly increased proven technical recoverable reserves were 183.84 billion m³. The newly discovered resources of coal was 30.01 billion tons, which was a dramatic decline compared to that of the previous year. Among major metal minerals, the newly discovered resources of manganese, copper, lead, zinc, tungsten, molybdenum and silver increased remarkably, while that of iron ore, nickel, tin and gold decreased substantially. Among nonmetallic minerals, the newly discovered resources of phosphate and graphite increased remarkably (Table 1-1).

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Table 1-1 Newly-Discovered Reserves & Resources of Major Minerals

No.	Mineral	Unit	2018	2019	Growth rate /%
1	Coal	Billion tons	55.61	30.01	-46.0
2	Oil	Million tons	960	1120	16.7
3	Natural gas	Billion m ³	831.16	809.09	-2.7
4	Coalbed methane	Billion m ³	14.71	6.41	-56.4
5	Shale gas	Billion m ³	124.68	764.42	513.1
6	Iron ore	Million tons of ore	993	530	-46.5
7	Manganese ore	Million tons of ore	68	100	42.9
8	Copper	Million tons of metal	2.25	3.64	61.6
9	Lead	Million tons of metal	3.72	6.05	62.9
10	Zinc	Million tons of metal	5.76	14.80	156.9
11	Bauxite	Million tons of ore	116	280	133.3
12	Nickel	Thousand tons of metal	472	65	-86.2
13	Tungsten	Thousand tons of WO ₃	278	481	73.0
14	Tin	Thousand tons of metal	167	39	-76.6
15	Molybdenum	Thousand tons of metal	282	1564	454.6
16	Antimony	Thousand tons of metal	187	193	3.2
17	Gold	Tons of metal	719.8	487.7	-32.2
18	Silver	Thousand tons of metal	12	22	83.3
19	Pyrite	Million tons of ore	144.50	68.62	-52.5
20	Phosphate rock	Million tons of ore	225	880	282.6
21	Potash	Thousand tons of KCl	-1867	14522	—
22	Fluorite	Million tons of mineral	11.58	14.63	26.3
23	Graphite	Million tons of mineral	54.97	92.17	67.7

Note: The coal, natural gas, coalbed methane and shale gas here are newly discovered geological reserves.

Chapter II

Exploration

In 2019, investments in geological exploration generally rebounded, of which, the investment in geological exploration of oil and gas increased, while investment in geological exploration of solid mineral decreased. New breakthroughs were made in oil and gas exploration, and proven shale gas resources increased substantially. New progress was made in the exploration of manganese ore, lead-zinc and graphite.

I. Investments in Geological Exploration

In 2019, the investment in geological exploration reached RMB 99.34 billion in China, which realized an increase of 22.6% compared to the value of 2018. Among them, the investment in geological exploration of oil and gas was RMB 82.13 billion, increased by 29.0%. The investment in geological exploration of non-oil and gas mineral resources was RMB 17.21 billion yuan, decreased by 0.9% (Figure 2-1).

2919 wells were drilled for oil and gas exploration and the drilling footage reached 8.09 million meters, which decreased for 1.2% and 0.1% respectively. A total of 51,400 km² 2D seismic data was acquired, increased by 17.9%; and a total of 47,100 km² 3D seismic data was acquired, increased by 40.2%.

Among the investments in the non-oil and gas geological exploration, the investment in mineral exploration was RMB 8.08 billion and decreased by 5.1%; the investment in basic geological survey was RMB 2.57 billion and decreased by 21.8%; the investment in hydrogeology, environmental geology and geological disaster survey and evaluation was RMB 3.46 billion and increased by 18.8%; the investment in geological science and technology and comprehensive research was RMB 1.97 billion and increased by 25.1%; investment in geological data service and digitalization was RMB 0.41 billion and increased by 27.1%. See Figure 2-2 for the proportion of each investment.

Among the investments in non-oil and gas geological exploration, China's nationwide investment reached RMB 11.63 billion; including RMB 6.32 billion that was financed by the central government and increased by 8.4%; RMB 5.31 billion that was financed by local governments and decreased by 1.3%. RMB 5.59 billion was from social investment and decreased by 9.4%. The national geological exploration funds were coordinated and linked, and 2.37 billion yuan from provincial geological exploration funds was invested, which continued to play an important role in geological prospecting. See Figure 2-3 for the proportion of the investment sources.

In 2019, the investments of non-oil and gas mineral exploration were dominated by minerals like gold, lead-zinc, coal, uranium and copper, totally accounting for 54.2% of total investment in non-oil and gas exploration in China. Compared to the value of 2018, the investment in tungsten, tin, molybdenum and graphite increased; the investment in coal, iron ore, manganese, copper, nickel, gold, potassium salt, phosphate etc. has dropped significantly (Table 2-1).

II. Progress in Oil and Gas Exploration

1. Conventional oil and gas exploration

In 2019, over 100 million tons of geological reserves were newly discovered in the Mahu Oilfield in Junggar Basin and Qingcheng oilfield in Ordos Basin respectively. The newly-discovered geological reserves of natural gas of Jingbian Gas Field and Sulige Gas Field in Ordos Basin and the Anyue Gas Field in the Sichuan Basin have exceeded 100 billion m³ respectively.

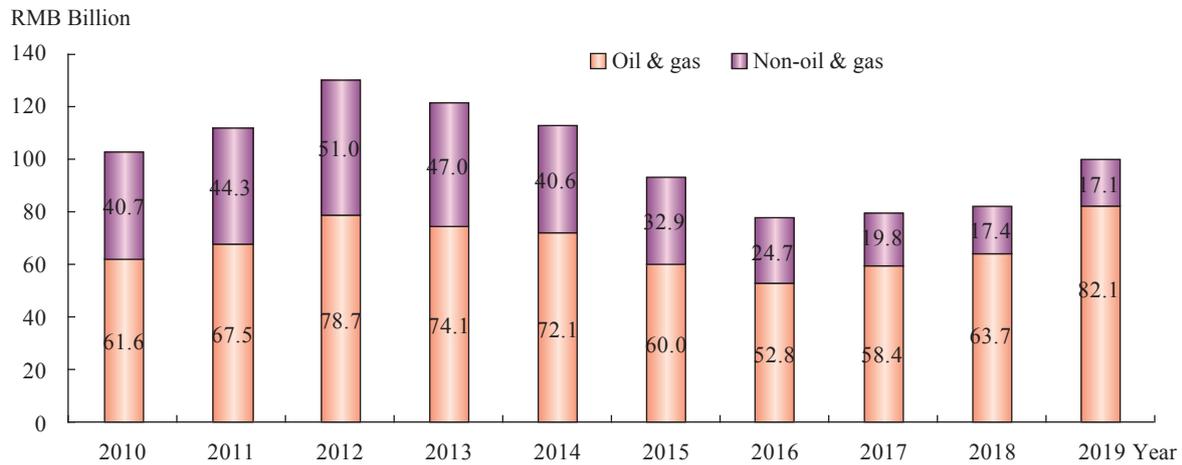


Fig. 2-1 Investment in Geological Exploration in China from 2010 to 2019

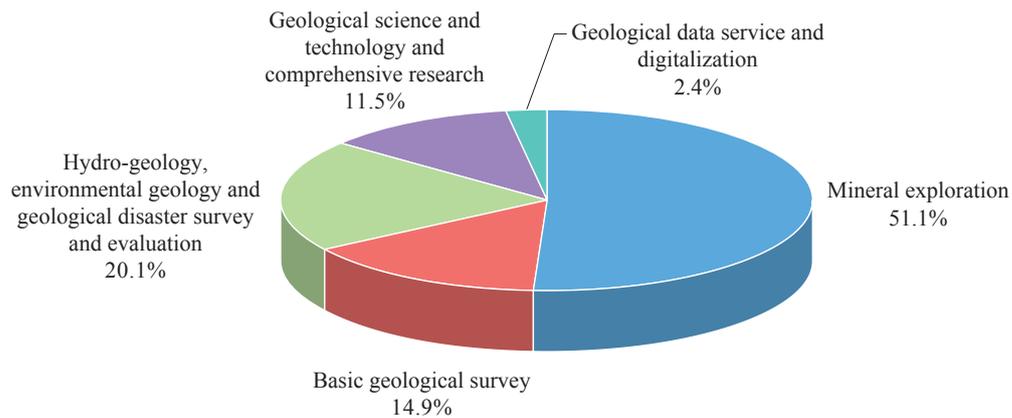


Fig. 2-2 Investment Structure of Non-Oil and Gas Geological Exploration (by Category)

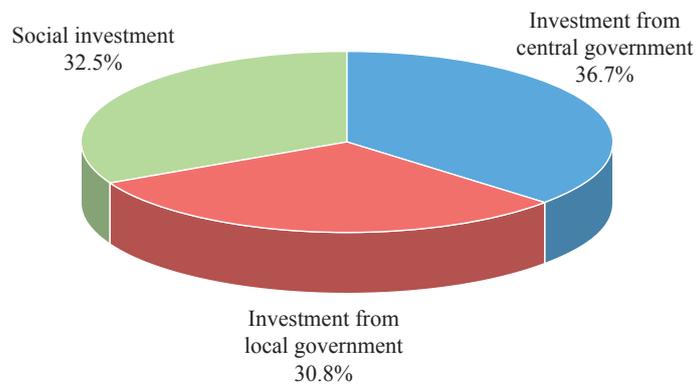


Fig. 2-3 Investment Structure of Non-Oil and Gas Geological Exploration (by Fund)

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Table 2-1 Major Mineral Exploration Investments and Quantity Drilled in 2019

Mineral	Capital investment billion yuan	Year-on-year growth/%	Meters drilled thousand meters	Year-on-year growth/%
Coal	1.00	-21.1	770	-18.1
Iron ore	0.22	-21.1	170	-29.2
Manganese ore	0.11	-28.7	50	-28.6
Copper	0.63	-32.9	490	-21.0
Lead-zinc	1.07	12.4	860	2.4
Bauxite	0.15	4.1	150	-16.7
Nickel	0.07	-40.2	30	-50.0
Tungsten	0.20	220.6	190	137.5
Tin	0.04	84.2	30	50.0
Molybdenum	0.07	25.0	60	500.0
Gold	1.17	-24.6	770	-34.2
Silver	0.29	-18.0	260	23.8
Phosphate rock	0.06	-28.6	50	-64.3
Potash	0.09	-37.1	20	-60.0
Graphite	0.21	20.2	180	63.6

358 million tons of shale oil geological reserves were newly discovered in the Chang 7₁₊₂ section, Mesozoic Yanchang Formation, Ordos Basin. The reserves of Qingcheng Oilfield exceeded 1 billion tons. The Cretaceous Qingshuihe Formation of Gaotan 1[#] Well, Junggar Basin, has a production rate of 1213 m³ of oil per day and 321,800 m³ of natural gas per day, which ranks the top among clastic rock wells in China. The Bozi 9[#] Well, Tarim Basin, has a tested production rate of 418,000 m³ of natural gas and 115.2 m³ of condensate oil per day. The Shunbei 53X Well in the Shunbei area realized a production rate of 125 tons of oil and 75,000 m³ of natural per day in the Yingshan Formation (7,750 meters - 8,341 meters hole section). The Moxi 129H Well in the Longnü Temple area, Central Sichuan Oilfield, Sichuan Basin, has a tested production rate of 1.41 million m³ of natural gas per day in the Dengsi Section. The Qietan 2[#] Gusher Well in Qiekelike Depression, Qaidam Basin, has a production rate of 54.9 m³ of oil and 6,899 m³ of natural gas per day at the depth of 4700 meters.

The breakthrough was realized in Caofeidian 2-2, Paleozoic limestone buried hill, west section of the Shaleitian Uplifting, Bohai Sea. The newly-discovered geological reserves of CFD2-2-2 Well exceeded 10 million tons. The Mesozoic granite buried hill, Songnan Low Uplifting, Qiongdongnan Basin, South China Sea, has a high tested production rate. YL8-3-1 Well has a tested production rate of 1.29 million m³ of natural gas per day.

2. Unconventional oil and gas exploration

In 2019, the newly-discovered geological reserves of coalbed methane were 6.408 billion m³, mainly from the Wenjiaba Coalbed Methane area of Guizhou Shuicheng Coal Mining (Group) Co., Ltd.

Newly-discovered geological reserves of Changning Shale Gas Field, Weiyuan Shale Gas Field and Taiyang Shale Gas Field in Sichuan Basin exceed 100 billion m³ respectively. The newly-discovered geological reserves of shale gas in Ning 216[#] - Ning 209[#], Wei 208[#] and Tai Yang - Da Zhai area were 740.97 billion m³. The technically recoverable reserves were 178.45 billion m³. The accumulative newly-discovered geological reserves were 1.06 trillion m³. A large-scale shale gas area with over 1 trillion m³ reserves was formed in South Sichuan.

New progress was realized again in the deep shale gas production. The drilled depth of Shen 1 HF Well in the east section of Dongxi Structure, Qijiang, South Sichuan, is 6,062 meters and has a tested production rate of 312,000 m³ per day. Shengye 2HF Well in the southern Sichuan has a tested production rate of 328,000 m³ per day.

Lu 203[#] Well in Luzhou area has a tested production rate of 1.379 million m³ of shale gas per day, which made it the first shale gas well in China of which the daily output exceeds 1 million m³.

III. Progress in Non-Oil and Gas Exploration

In 2019, a total of 79 new deposits were discovered throughout the country, including 23 large-scale, 32 medium-scale and 24 small-scale deposits. Fluorite (10 places), graphite (7 places), gold (5 places), copper (5 places) and tungsten (4 places) ranked the top among the newly discovered deposits.

Periodic exploration has been finished in 418 deposits in China, among which, 169 deposits were generally surveyed, 181 deposits were closely surveyed and 68 deposits were explored. Lead-zinc (44 places), gold (31 places), copper (30 places), silver (28 places) and tungsten (21 places) ranked the top among the deposits of which the periodic exploration was finished.

New progresses were made in the packaged exploration areas and important mineral-concentrated areas. An industrial uranium deposit was newly discovered in the packaged exploration areas of Tongliao Basin; independent cobalt deposit was discovered in Shanggao-Pingxiang key exploration area of Jiangxi Province, and a large rare earth mineral deposit was discovered in Ninghua, Fujian Province. Newly increased resources by exploration include Chengkou manganese mine in Chongqing, Zunyi manganese mine in Guizhou, Huoshaoyun lead-zinc mine in Xinjiang, Huayuan-Fenghuang lead-zinc mine in Hunan, Huogeqi graphite mine in Inner Mongolia and Huangyang mountain graphite mine in Qitai, Xinjiang.

Chapter III

Development and Utilization

In 2019, the fixed assets investment in China's mining industry was increased substantially. The supply capacity of major minerals was strengthened unceasingly. The production and consumption of primary energy, crude steel, ten kinds of non-ferrous metals, gold, cement and etc. continued to rank first in the world. The level of comprehensive conservation and efficient utilization of mineral resources were further enhanced.

I. Mining Fixed Assets Investments

In 2019, the fixed assets investment in the mining industry experienced a remarkable increase of 24.1% year-on-year, 20 percentage points higher than the previous year and 19 percentage points higher than the average of all industries in the country. Among them, the fixed assets investment in the coal mining and washing, oil & gas extraction and non-metals mining and processing increased by 29.6%, 25.7% and 30.9% respectively. The growth in these three sectors account for over 90% of the mining industry; the fixed assets investment in ferrous metals mining and processing increased by 2.5%; the fixed assets investment in the non-ferrous metals mining and processing reversed the descending situation in the previous two years by 6.8% of growth (Figure 3-1).

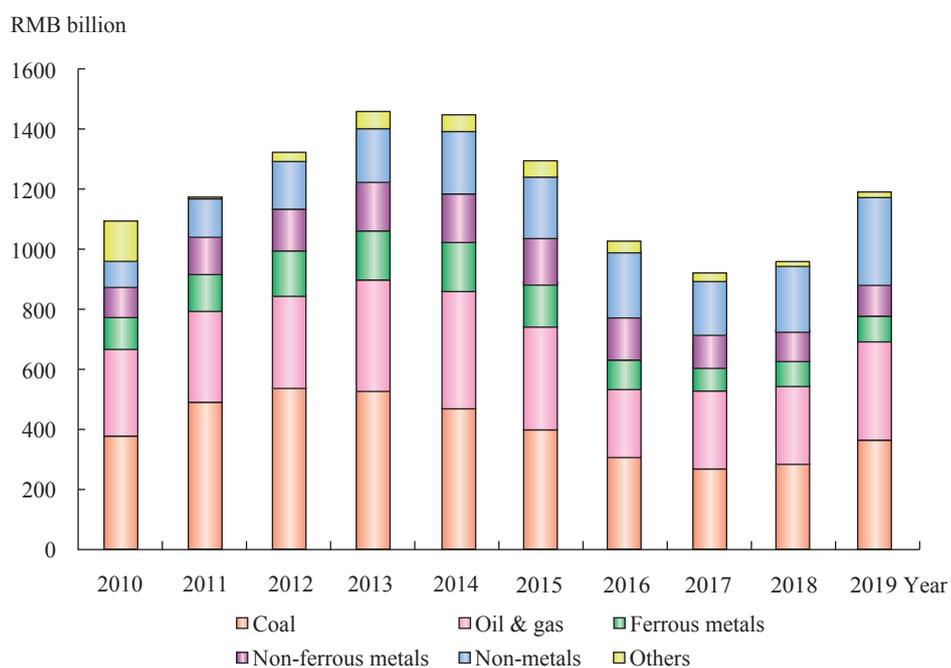


Fig. 3-1 Mining Fixed Assets Investments

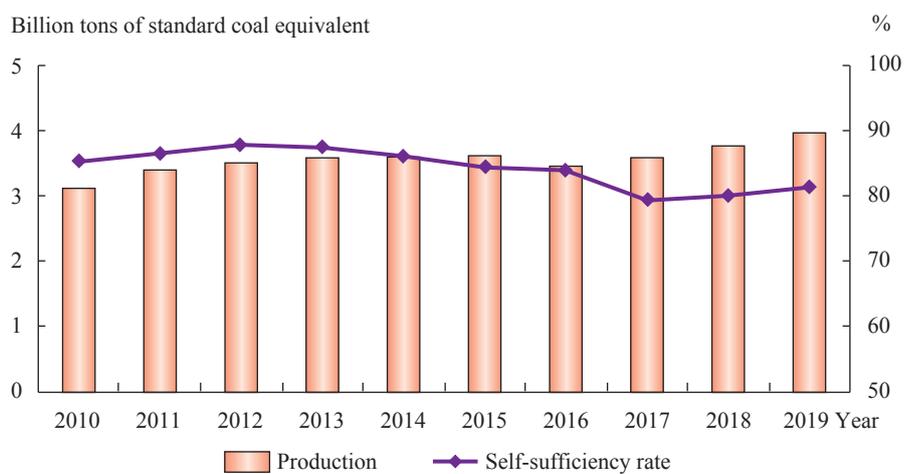


Fig. 3-2 Production of Primary Energy

II. Production and Consumption

1. Energy

In 2019, China has a total primary energy production of 3.97 billion tons of standard coal equivalents, increased by 5.1% year-on-year (Figure 3-2). The total consumption in this country was 4.86 billion tons of standard coal equivalents, increased by 3.3%; the energy self-sufficiency rate was 81.7%.

The energy consumption structure was continuously improved. The proportion of coal was declining, accounting for 57.7% of the energy consumption structure in 2019, down 1.3 percentage points from the previous year and 11.5 percentage points from 2010 (Figure 3-3). Oil accounts for 18.9%, natural gas accounts for 8.1%, and other energy sources such as hydropower, nuclear power and wind power account for 15.3%.

In 2019, 3.85 billion tons of coal was produced, increased by 4.0% year-on-year; the coal consumption was 3.93 billion tons, increased by 1.0%. China's oil production in 2019 was 191 million tons, increased by 0.9% (Figure 3-4); apparent consumption of oil (domestic output + net import volume) was 650 million tons, increased by 4.8%. China's natural gas (including shale gas and coalbed methane) production in 2019 was 176.17 billion m³, increased by 10.0%; apparent consumption of natural gas was 305.8 billion m³, increased by 7.3%.

2. Metals

In 2019, the production of iron ore was 840 million tons, increased by 4.9% year-on-year; apparent consumption was 1.41 billion tons (standard); the production of crude steel was 1 billion tons, increased by 7.2% (Figure 3-5). The production of ten kinds of non-ferrous metals was 58.42 million tons, increased by 3.1%. Among them, the production of refined copper was 9.78 million tons, increased by 10.2%; the production of electrolytic aluminum

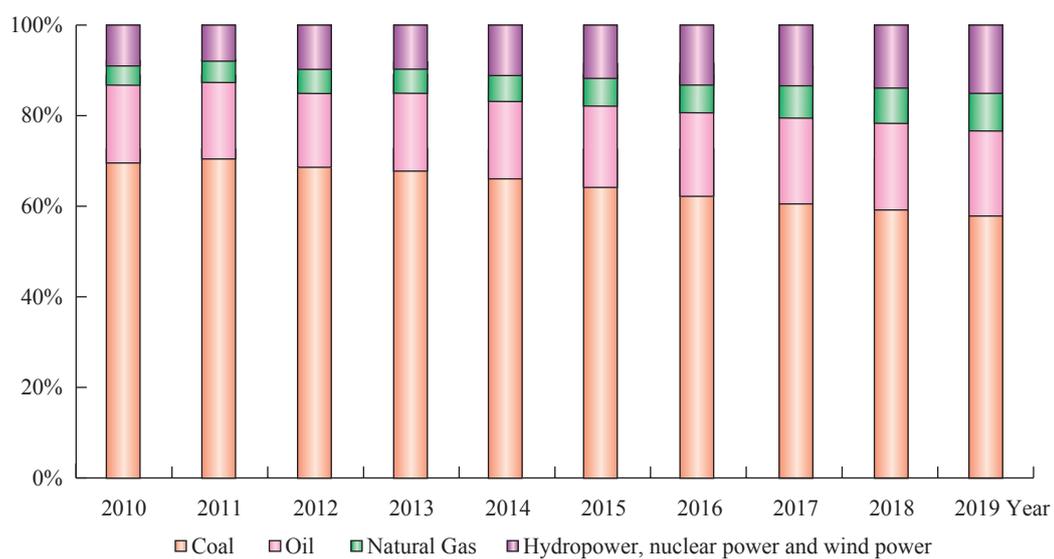


Fig. 3-3 Primary Energy Consumption Structure

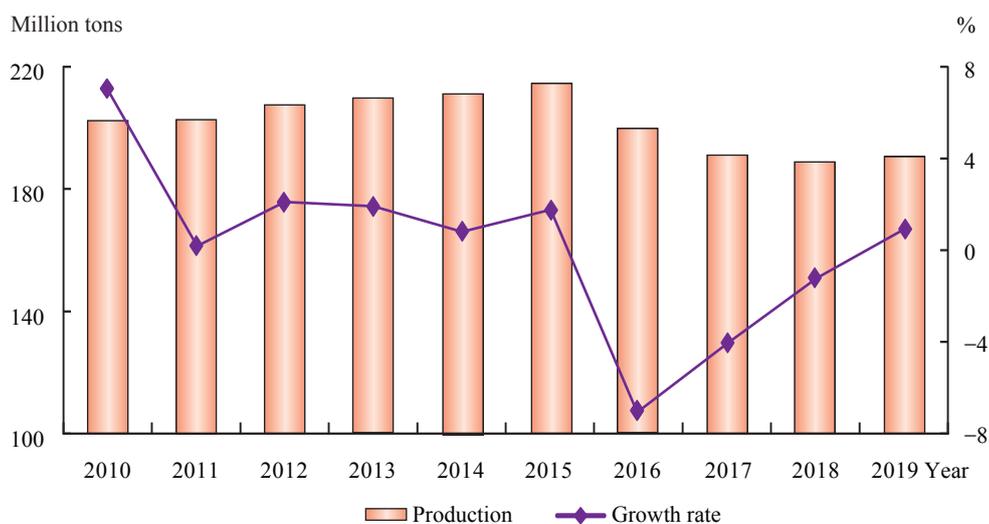


Fig. 3-4 Crude oil production

was 35.04 million tons, decreased by 0.9%. Among the main non-ferrous metal mineral products, the output of copper concentrate was 1.63 million tons, an increase of 4.1%; the output of lead concentrate was 1.23 million tons, down 7.5%; the output of zinc concentrate was 2.81 million tons, decreased by 1.0%. Gold output was 500.4 tons (including mine gold output of 380.2 tons), decreased by 2.6%; the national gold consumption was 1002.8 tons, increased by 12.9%.

3. Non-Metals

In 2019, production of phosphate rock (containing 30% P₂O₅) was 93.32 million tons, decreased by 3.1% year-on-year; production of plate glass was 930 million weight cases, increased by 6.6%; production of cement was 2.35 billion tons, increased by 4.9% (Figure 3-6).

III. Conservation and Comprehensive Utilization

1. Minimum requirements of “three rates” index were optimized

In order to promote the saving and comprehensive utilization of mineral resources by mining enterprises, in January of 2020, *The Ministry of Natural Resources’ Announcement of the Minimum Requirements of “Three Rates” for Reasonable Development and Utilization of Mineral Resources like Potassium Bearing Rocks (for trial implementation)* was issued. Till the first half of 2020, the Ministry of Natural Resources had formulated and issued the minimum requirements of the “three rates” index of 77 (types of) minerals (8 batches) for rational development and utilization, which have been used as the main basis for preparation and reviewing mineral resources’ development and utilization plan and mine design.

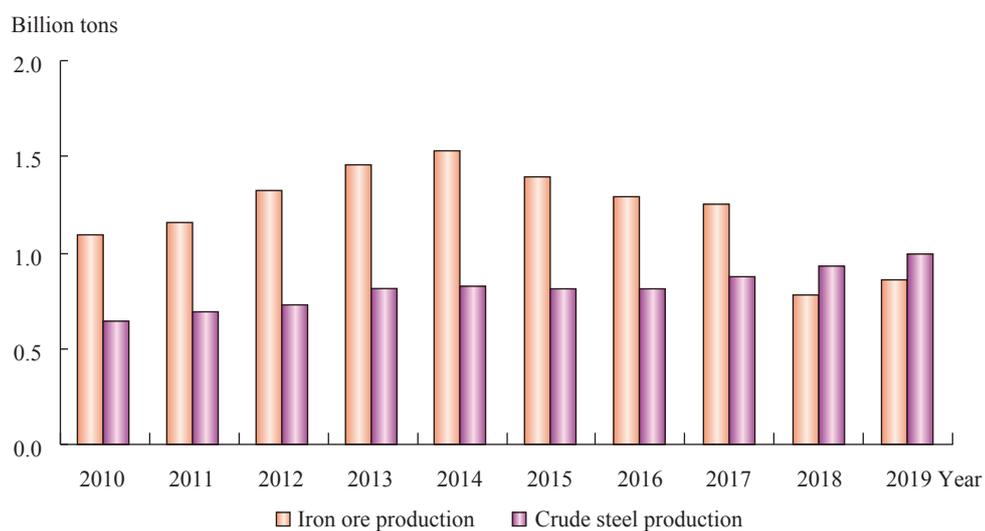


Fig. 3-5 Iron Ore and Crude Steel Production

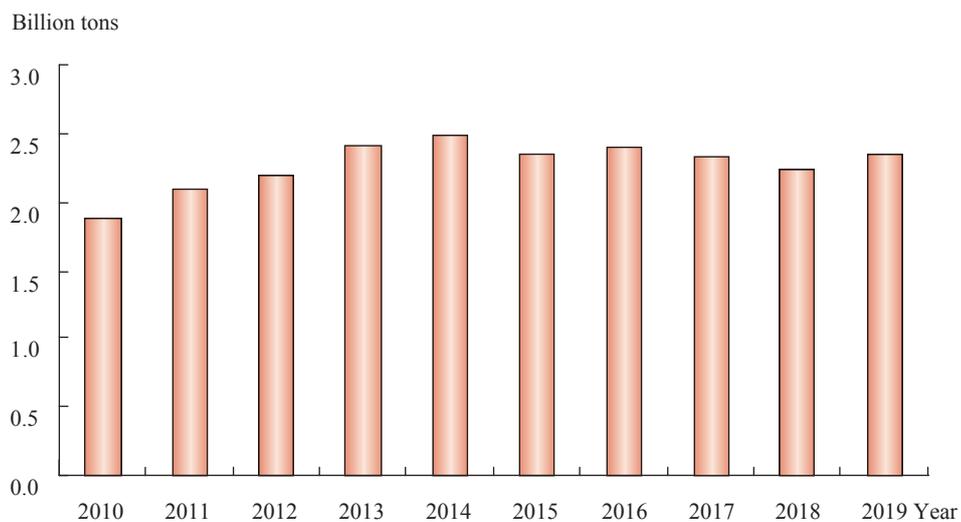


Fig. 3-6 Cement Production

2. Investigation and evaluation system on the development and utilization level of mineral resources were established

On the basis of summarizing the achievements of pilot projects, the *Methods of Investigation and Evaluation on the Development and Utilization Level of Mineral Resources* (draft for comment) and the *Technical Guideline of Investigation and Evaluation on the Development and Utilization Level of Mineral Resources* (draft for comment) were drafted to further specify scope and indexes of investigation, and evaluation criteria, etc. The index system, work processes, technical methods and operational mechanism of the investigation and evaluation of mineral resources' development and utilization level, which are based on the "three rates", were established.

3. Catalog of advanced and applicable technologies for mineral resources' conservation and utilization was updated

In June 2019, the *Ministry of Natural Resources' Notice on the Update of the Catalog of Advanced and Applicable Technologies for Mineral Resources' Conservation and Utilization* was announced to deploy the implementation of the update of advanced and applicable technologies for mineral resources' conservation and utilization. In December of 2019, after the comprehensive analysis and selection in the 334 technologies in the first batch, 360 advanced and applicable technologies were selected at last to form the *Catalog of Advanced and Applicable Technologies for Mineral Resources' Conservation and Utilization (2019)*. Among these technologies, there are 17 exploration technologies, 125 mining technologies, 76 mineral processing technologies, 106 comprehensive utilization technologies and 36 automation and information technologies.

Chapter IV

Restoration of Mine Geological Environment and Green Development

The restoration of mine geological environment was carried out, relative management systems were improved, policies and measures were studied and formulated for encouraging and guiding social capital to invest in geological restoration of key mining areas left over the history. The exemplary work of green exploration was carried out. Local authorities planned the promotion of the green mines construction through formulation and implementation of various plans, standards and policies to comprehensively promote the construction of green mines.

I. Ecological Rehabilitation in Mines

1. Ecological Rehabilitation in mines supported by the central financial funds

In 2019-2020, the central government allocated RMB 3.7 billion of award funds to support the ecological restoration of abandoned open-pit mines in key river basins and areas such as the Yangtze River Economic Belt, the Yellow River Drainage, the surrounding areas of Beijing-

Tianjin-Hebei and Fen River-Wei River Plain, and it was expected that the treatment task of 25,000 hectares had been completed.

2. Efforts were made to explore the utilization of market mechanism in promoting the ecological restoration of mines

Opinions of the Ministry of Natural Resources on Exploring and Using Market-oriented Methods to Promote Ecological Rehabilitation of Mines was issued to coordinate the consideration of ecological restoration of mines, the subsequent development and utilization of resources and industrial development, etc. Corresponding incentive policies were established to encourage and attract the social investment and promote the unification of ecological benefits, social benefits and economic benefits.

3. Regulations on Ecological Rehabilitation in Mines

Regulations on *the Protection of Geological Environment in Mines, Measures for the Implementation of Land Reclamation Regulations* etc. were revised. According to the requirements on replacing the security deposit for the rehabilitation and restoration of the geological environment in mines with funds, urging different provincial competent departments in charge of natural resource management to work with financial departments and other relevant department for the accomplishment of security deposit repayment, and speed up the establishment and improvement of the fund system for the rehabilitation and restoration of the geological environment in mines.

4. The progress of ecological restoration in mines

Based on remote sensing monitoring, statistical data shows that areas of approximately 48,000 hectares newly rehabilitated nationwide in 2019, in which 19,200 hectares was part of the mines under construction or in operation, accounting for 40.05% of the total, and the land of 28,800 hectares is part of abandoned mines, accounting for 59.95% of the total.

II. Green Exploration

1. Green exploration specifications were prepared and revised

According to experimental verification carried out in mountainous areas in Guizhou and Jiangxi provinces, desert areas in Inner Mongolia, forest areas in Heilongjiang Province, hilly areas in Shandong Province and ecologically fragile areas at high altitude in Qinghai Oilfield, the standards and regulations like *Green Ecological Exploration Specification and Quality Management Regulations of Geological Exploration Activities* were revised and improved.

2. Demonstration work of green exploration

The General Office of the Ministry of Natural Resources issued the Notice on the Demonstration of Green Exploration Projects, selecting the first batch of 18 green exploration demonstration projects to promote the typical experience of green geological exploration.

III. Construction of Green Mines

1. The annual selection and evaluation of mines carried out

In January of 2020, *the Announcement of the Ministry of Natural Resources on Including the Dagang Oilfield of PetroChina, etc. in National List of Green Mines* was issued. On the basis of the original national-level pilot green mines, 953 mines were included in the national list of green mines through prudent selection. Among them, there were 573 large mines, accounting for 60.2%; 292 medium-sized mines, accounting for 30.7%.

the Notice on Selection of Green Mines in 2020 was issued and the selection of green mines in 2020 was carried out in May 2020. The normalization and standardization of the third party evaluation of green mines were advanced. *Green Mine Evaluation Indexes and Requirements of Green Mine Selection by Third Party* were issued to unify the indexes and standards of green mine evaluation.

2. Green mine construction promoted locally

Local governments promulgated relevant laws, regulations, policies and measures to actively promote the construction of green mines. Shaanxi included the green mine construction in *Ecological Environment Protection Regulations of Qinling Mountains in Shaanxi Province (Revised Draft)*; Guangxi and Heilongjiang published the local standards on green mine construction; Zhejiang and Shandong issued documents related to third party evaluation management; Qinghai and Jiangxi stipulated tasks and responsibilities of green mine construction in mining right transfer agreements. Hainan regards the construction of green mines as a requirement for the continuation of mining rights.

In accordance with the principles of organizing by government, cooperating with departments, enterprise acting as the main body, participating by the public and jointly promoting by all parties, the full play was given to the enthusiasm of local governments to implement corporate responsibilities, select areas with rich resources and strong management and innovation ability, and the construction of more than 50 green mining development demonstration zones was actively promoted.

Chapter V

Policies and Regulations on Mineral Resources

Since 2019, the *Resource Tax Law of the People's Republic of China* was promulgated and implemented, and the *Mineral Resources Law (Revised Draft) (Draft Submitted for Approval)* was drafted. The *Opinions on Promoting the Reform of Mineral Resources Management (Trial)* was issued, a series of major institutional innovations were achieved in the establishment and implementation of mining right transfer, optimization of mining right management of oil and gas, reform of classification and management approaches of mineral resources & reserves, etc.

I. Laws and Regulations

1. Laws

(1) *Resource tax law of the People's Republic of China* promulgated

Resource tax law of the People's Republic of China came into effect on September 1st, 2020. Meanwhile, the *Provisional Regulations on Resource Tax of the People's Republic of China* was abolished. The resource tax is levied according to sales or quantities in accordance with the *List of Tax Items and Tax Rates*. The payable taxes levied according to sales shall be calculated by multiplying the sales of taxable resource products (hereinafter “taxable products”) with

applicable tax rates. The payable taxes levied according to quantity shall be calculated by multiplying the sales volume of taxable products with applicable tax rates. The Resource Tax Law has clear stipulations on circumstances of exemption, abatement and no-tax-relief of the resource tax. Also, detailed stipulations and definition explanations are provided for the taxation of water resources tax and tax payment of Sino-foreign cooperative enterprises which engage in extraction of oil onshore and offshore.

(2) Revision of *Mineral Resources Law* promoted

Based on the practice in mineral resource management, as well as the opinions solicited extensively in recent years, the Ministry of Natural Resources drafted the *Mineral Resources Law (revised draft) (draft for approval)* and submitted to the State Council in February of 2020 according to the legislative procedure. New arrangements were brought forth for the comprehensive promotion of the competitive assignment of mining right, the promotion of the ecological restoration mechanism of mining area, optimization of mining industry's business environment, establishment of a management system which conforms to the technical characteristics of mineral resource exploration and exploitation and the clarification of mineral resources' tax system.

2. Regulations

Since 2019, comprehensive sorting work has been carried out specifically to currently effective rules, regulations and normative documents on natural resource management, three batches of resolutions on the termination and modification of departmental rules and regulations issued and the directories of three batches of terminated or invalid normative documents published. The sorting work has resulted in the termination of 13 departmental rules and regulations and the modification of 19 departmental rules and regulations in total, and the termination or invalidity of 170 normative documents in total.

On May 27, 2020, the *Announcement of the Ministry of Natural Resources on the Directory of the 3rd Batch of Terminated or Invalid Normative Documents* was issued, and the directory of 18 terminated or invalid normative documents concerning mineral resource management were published.

II. Reform on Mineral Resources System

The Ministry of Natural Resources successively issued the *Opinions on Promoting the Reform of Mineral Resources Management (Trial)* (hereinafter “the Opinions”) and the *Notice of Transfer of Sea Sand Mining Right and Sea Area Usage Right which are unified through Bidding, Auction and Listing* (hereinafter “the Notice”).

1. Reform of Mining Right Transfer System

The *Opinions* realized a series of major institutional innovations in the establishment and implementation of mining right transfer system. (1) Comprehensive implementation of competitive transfer of mining rights. It is clearly specified that all mining rights shall be transferred by the way of bidding, auction and listing except for agreement transfer. (2) Strict limitation of agreement transfer. The exploration and exploitation of rare earth or radioactive mineral resources or key projects approved by the State Council could be transferred to specific entities through agreement. Mining right of same minerals(except the minerals for building materials, i.e. sand, gravel and clay) below or above the mining section under the current concession, in which the existing production facilities were needed, could be transferred to the same entity through agreement. (3) Promotion of “Net Mining Right” transfer. The Net Mining Right transfer of sand, gravel and clay will be implemented, and the others actively advanced. (4) Peer management on the transfer & registrations of exploration right and mining right of the same mineral. The Ministry of Natural Resources is responsible for the transfer and registration of the mining rights of 14 kinds of strategic mineral resources, including oil and hydrocarbon natural gas, etc. (5) Regulations on the geological explorations funded by the governments. (6) Adjustment of the term of exploration right. The term of the granted exploration right, which was registered for the first time, was extended to 5 years. The duration of each extension is 5 years. 25% of the initial area will be deducted when extension registration of exploration right is applied for.

2. Reform of oil and gas exploration and production management

The *Opinions* realized a series of major institutional innovations in the optimization of oil

and gas mining right management. (1) Market-oriented exploration and extraction of oil and gas. Domestic and foreign enterprises, which are registered in China and have a minimum net asset of RMB 300 million, are entitled to obtain mining rights of oil and gas. (2) Unification of exploration right and mining right of oil and gas. After reporting to the natural resource authorities in charge of permissions and registration, the oil and gas exploration right owners who make recoverable discovery can extract the resources, and the owners extracting oil and gas resources should sign the mining right transfer contract within 5 years and perform mining right registration according to corresponding laws and regulations.

3. Implementation of the grant system through bidding, auction and listing of unified right of sea sand mining and sea area usage.

The *Notice* stipulated simplification and optimization of the links and procedures in the grant of sea sand mining right and sea area usage right. The unified sea sand mining right and sea area usage right are transferred through bidding, auction and listing. The “Net Mining Right” transfer system was implemented strictly. The bidding, auction and listing of the two rights’ transfer shall be performed in governmental trading platform of public resources. The winning bidder shall perform registration of the two rights at the provincial natural resources authorities.

III. Taxes on Mineral Resources

1. Resources tax

In 2019, the national resources tax revenue totaled RMB 182.2 billion, showing an increase of 11.8% year on year, and accounting for 1.2% of the national tax revenue.

2. Special income

The year of 2019 saw a special revenue of RMB 97.75 billion from national mineral resources, in which the revenue of RMB 94.15 billion was attributed to the transfer of exploration rights and mining rights; and the revenue of RMB 3.61 billion was attributed to the usage fees (occupancy fees) of exploration rights and mining rights.

Chapter VI

Mineral Resources Management

The *Opinions on Promoting the Reform of Mineral Resources Management (Trial)* was fully implemented, and the reform of “streamlining administration, delegating power, strengthening regulation and optimizing service” was deepened, which further improved the management of mineral resources. A new round of mineral resources planning compilation and deployment work was started, corresponding supervision and management methods of geological exploration sector were studied and drafted, new classification standards of mineral resources & reserves were implemented, the declaration of mining rights was optimized, the supervision and management system of ancient fossils was improved, and the mineral resources management level further enhanced.

I. Mineral Resources Planning

1. The assessment of mineral resource planning implementation completed

The Ministry of Natural Resources performed evaluation on the implementation of *National Mineral Resources Plan (2016-2020)* together with the National Development and Reform Commission, the Ministry of Industry and Information Technology, the Ministry of Finance, the Ministry of Ecology and Environment and the Ministry of Commerce. The evaluation

result indicated that new progress has been made in the geology survey, the domestic mineral supply relatively stable, the level of resource conservation and intensive utilization improved continuously, the international cooperation in mining industry has achieved initial success and important progress has been made in mineral resource management reform since the implementation of the plan.

2. A new round of planning work initiated

In July 2019, the General Office of the Ministry of Natural Resources issued the *Notice on the Preparation of Mineral Resources Planning (2021-2025)*. In March 2020, the Ministry of Natural Resources, together with the National Development and Reform Commission, the Ministry of Industry and Information Technology, the Ministry of Finance, the Ministry of Ecological Environment and the Ministry of Commerce, established a coordination mechanism for the preparation of *National Mineral Resources Plan (2021-2025)*, comprehensively arranged and started the preparation.

3. Guidance of local mineral resources planning strengthened

In April 2020, the Ministry of Natural Resources formulated the *Technical Specification for the Preparation of the Provincial Mineral Resources Overall Planning and the principals for the Preparation of Mineral Resources Overall Planning at the City and County Level* to clarify the technical requirements for the preparation of local plans at all levels. In July 2020, a training video conference on the preparation of mineral resources planning was held. It was required to comprehensively implement the national resource security strategy, accurately grasp the principals of the new round of mineral resources planning, and strengthen the secure guarantee and support role of resources.

II. Geological Exploration Management

1. Statistical on the geological exploration sector carried out

The statistical survey indicators of the geological exploration industry were revised, the data collection, verification, summary and report compilation completed timely. The 2019 report on *National Geological Exploration sector* was published.

In 2019, there are 2397 geological exploration entities in China. Among them, 225 geological exploration entities belong to the central management, including 138 institutions and 87 enterprises; 1062 geological exploration entities localized, including 698 institutions and 364 enterprises; 1110 others, including 110 institutions and 1000 enterprises. The basic information is as follows:

In 2019, there are 414,300 employees in geological exploration entities nationwide, an increase of 5.37% over the previous year. Among them, 74,600 were engineering exploration and construction personnel, an increase of 17.67% over the previous year; 164,200 geological exploration personnel, a decrease of 16.27% over the previous year; and 16,100 mineral exploitation personnel, a decrease of 12.97% over the previous year.

In 2008, the revenue of geological exploration industry was RMB 42.06 billion, which reached RMB 80.70 billion in 2011, and then showed a downward trend, which was RMB 47.16 billion in 2019. Geological exploration sector overcame the pressure of continuous drop in investment, actively explored industrial transformation, expanded service areas, and achieved positive results in safeguarding national resources security, serving ecological civilization construction and supporting natural resource management.

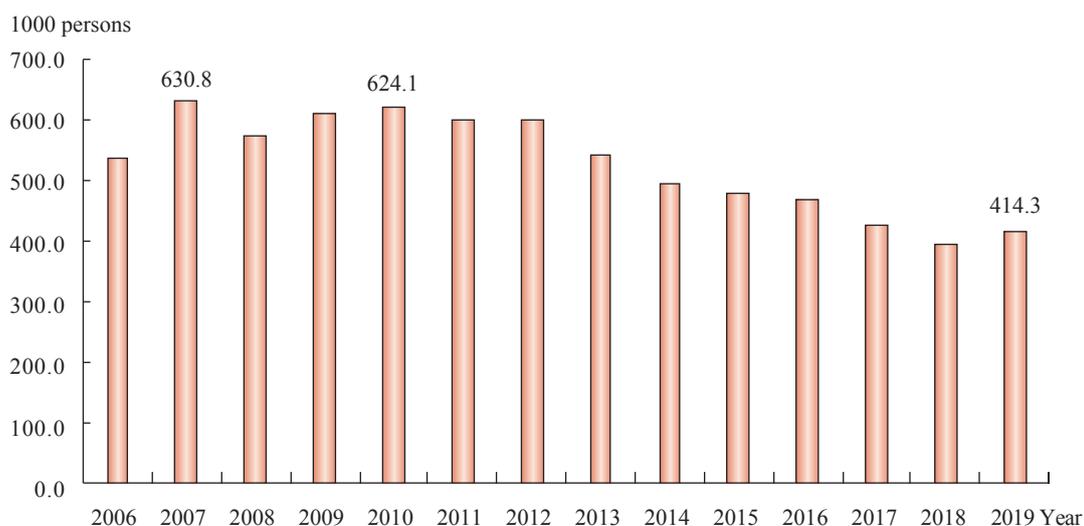


Fig. 6-1 Number of In-Service Employees in Geological Exploration Units in China

2. Supervision strengthened and the market environment optimized

The supervision system of geological exploration industry has been constantly improved and the fair competition environment of geological exploration market has been optimized. The national supervision and service platform for geological exploration sector was established, studying and drafting the *Measures for Supervision and Management of Geological Exploration Activities during and after the Event* to explore a new supervision system based on credit. Through the publicity of geological exploration activities and credit information of geological exploration entities, a joint disciplinary mechanism was established to build the multi-governance pattern of self-government, industry self-discipline, social supervision and government supervision.

III. Mineral Resources Reserves Management

1. New classification of mineral resources & reserves promulgated

On May 1, 2020, new classification standards for solid mineral resources & reserves (GB/T 17766-2020) and for oil and gas (GB/T 19492-2020) were officially implemented. Solid minerals are divided into resources and reserves. Resources are divided into inferred resources, indicated resources and measured resources. Reserves are divided into probable reserves and proved reserves. Oil and gas are divided into resources and geological reserves. Geological reserves include possible, probable and proved geological reserves (or 3P petroleum initially-in-place).

2. Review and record of mineral resources & reserves

In 2019, 3,063 reports on mineral resources & reserves were reviewed and filed nationwide, up 24.9% over the previous year; among them, 194 reports were on oil and gas, up 40.6%; 2869 reports non-oil and gas minerals, up 24%. 243 reports were reviewed and filed by the Ministry of Natural Resources, up 7%; 2820 reports were reviewed and filed by provincial departments in charge of natural resources, up 26.7%. Among the minerals reviewed and filed in 2019, the top five reported minerals were coal (798, accounting for 26.1%), iron ore

(347, 11.3%), gold (275, 9%), oil (147, 4.8%), geothermal (141, 4.1%). Among the reviewed and filed reports of non-oil and gas mineral resources & reserves, there were 866 exploration reports, accounting for 30.2%; 1,570 reserves verification reports, accounting for 54.7%; 204 covered resource reports, accounting for 7.1%; 138 reports of pit closure, accounting for 4.8%; 51 production geological reports, accounting for 1.85%; 40 reports of other types, accounting for 1.4%.

3. Assessment and filing of mineral resources & reserves strengthened

On May 19, 2020, *Notice on Several Matters Concerning the Assessment and Filing Management of Mineral Resources & Reserves* was issued by the General Office of the Ministry of Natural Resources to standardize the assessment and filing scope of mineral resources reserves. The Notice requires that reports on mineral resources & reserves should be prepared in accordance with relevant standards and regulations to apply for assessment and filing if one of the following cases occurs: exploration rights are converted into mining rights; mineral types or mining scope of mining right are renewed; geological reserves of oil and gas are proved during the prospecting and mining periods, or major changes occur in the amount of accumulated proved resources & reserves of other minerals during mining periods (the amount of change exceeds 30% or reaches a medium scale or above); and projects are constructed overlying important minerals.

On June 2, *Notice on Further Regulating the Assessment and Filing of Mineral Resources & Reserves* was issued by the General Office of the Ministry of Natural Resources to further clarify the responsibilities and work scope of assessment authorities, assessment experts and filing authorities.

The assessment process of reserves was simplified. During the COVID-19 outbreak, the assessment and filling materials can be submitted by post mails, express delivery or emails; and the assessment methods are adjusted from meeting-based assessment to examination by letter and meeting-based review to review in writing. When the application materials or the supplementary materials for assessment expired, the time limit could be reasonably prolonged to minimize personnel contact and help enterprises resume work and production during the COVID-19 outbreak.

4. Approval for important minerals overlaid by construction projects optimized

On April 28, 2020, the *Notice of the General Office of the Ministry of Natural Resources on Effectively Regulating the Examination and Approval for Covered Important Mineral Resources of Construction Projects* was issued, which requires that the examination and approval service for covered important mineral resources of construction projects shall be optimized from four aspects: comprehensively carrying out investigation and evaluation in specific areas, effectively conducting connecting work after canceling the registration of covered mineral resources reserves, building an inquiry service system, and opening the Internet remote approval channel.

5. Statistics of reserves under new classification standards promoted

The *Measures for the Administration of Mineral Resources Statistics* was revised. In the meanwhile, in order to promote the implementation of the new classification standards, effectively linking up the data of mineral resources & reserves under the old and new classification standards, and consolidate the foundation of the mineral resources, the *Notice of the General Office of the Ministry of Natural Resources on Effectively Conduct the Data Conversion between the New and Old Classification Standards of Mineral Resources & Reserves* was issued, and the data conversion between the old and new classification standards was arranged.

IV. Mining Rights Management

1. Setting of mining rights

At the end of 2019, there were 12,294 exploration rights nationwide with area of 3.152 million km², a year-on-year decrease of 26.1% and 6.4% respectively; there were 39,799 mining rights with area of 255,000 km², a year-on-year decrease of 18.9% and 1.1% respectively.

In 2019, there were 527 new prospecting rights nationwide with area of 14,429 km²; 1,649 new mining rights with area of 5,235.48 km².

2. Optimization of mining rights declaration

In April 2020, the revised *Service Guide for Mining Rights Approval and Registration* was released. The new guide simplified application materials in eight aspects, including the submission certificate for geological data, project approval by relevant competent authorities, assessment reports on environmental impact and approval documents from environmental protection departments.

Mining right application is subject to remote declaration. Since March 1, 2020, the applicant should submit the electronic document of application material (including the correction material) through the remote declaration system for the mining right registered by Ministry of Natural Resources and the paper document should be submitted at the time of obtaining approval results.

3. Enhancement of management and service of mining right registration information

In June 16, 2020, the General Office of the Ministry of Natural Resources issued the *Measures for Mining Right Registration Information Management* to standardize mineral exploration license and mining license code and the digital certificate management of mining right registration information system and make clear that the mineral exploration license number and mining right license number nationwide are subject to unified coding system. In 2019, a total 35,567 of public information including mining right transfer registration has been publicized. Among them, there were 1298 notices concerning transfer by tender, auction and listing, 1139 publicities of results of transfer by tender, auction and listing, 166 publicities of agreement-based transfer, 856 publicities of transfer, 788 publicities of newly-established mining right handling and 31,320 publicities of mining right approval results.

V. Ancient Fossils Protection Management

The *Announcement of the Ministry of Natural Resources on Online Handling of Key Protected Paleontological Fossils Examination and Verification* was issued, Since December 30, 2019, online declaration and online handling started for key protected paleontological fossils excavation and entry and exit examination and verification. In order to implement the decision of the State Council to cancel the examination and approval of transferring, exchanging and donating key protected fossils among institution collectors, the *Regulations on the Protection of Paleontological Fossils* and the *Measures for the Implementation of the Regulations on the Protection of Paleontological Fossils* were revised, and the preliminary study on the revision of the *Regulations on the Protection of Paleontological Fossils* had been organized. In addition, China's paleontological fossil management policy research was continued with the revision requirements of the *Regulations on the Protection of Paleontological Fossils*, the reform ideas of the entry and exit management system of paleontological fossils were initially formed. The excavation and entry and exit approval of paleontological fossils were strictly regulated. There were totally one approval of fossil excavation, four approvals of entry and exit of fossils and 325 identifications of fossils; there were 10 times participating in the identification of involved fossils seized by public security and customs departments and there were 249 samples identified; there was one time carrying out identification of rock sample suspected to contain fossil collected by foreign scientists in our country and there were nine samples identified; there were two times carrying out reviews on protection and planning of the origin of ancient fossils.

Chapter VII

Geological and Mineral Resources Surveys and Evaluations

The level of basic geological survey was further improved. A new breakthrough was realized in the non-profit oil and gas resources survey. New progress was realized in the mineral survey and evaluation of China's major metallogenic belts, packaged exploration areas, important mineral-concentrated areas and large-scale resource bases.

I. Basic Geological Survey

In 2019, the financial fund of the central government was used to complete the survey of an area of 45,600 km², with an accumulated completed area of 4,292,200 km², occupying 44.63% of the land area of China. The geochemistry investigation in an area of 22,100 km² with a scale 1:50,000 has completed, with an accumulated completed area of 2,790,500 km², occupying 28.93% of the land area of China. The gravity measurement in an area of 8,400 km² with a scale of 1:50,000 has completed, with an accumulated completed area of 321,200 km², occupying 3.29% of the land area of China. The ground high-precision magnetic survey in an

area of 1,500 km² with a scale of 1:50,000 has completed, with an accumulated completed area of 1,149,700 km², occupying 11.92% of the land area of China. A survey line-based aeromagnetic survey of 163,000 km was accomplished.

II. Mineral Resources Surveys and Evaluations

1. Oil and gas survey and evaluation

In 2019, non-profit surveys of oil and gas resources were carried out, including 2,181 km of 2D seismic lines, 3,632 km non-seismic geophysical prospecting, 48 surveying wells and 11 parameter wells were drilled.

Survey and evaluation of conventional oil and gas resources: For Xinji-1 parameter well in southern Jungles, Xinjiang, the industrial gas flow of 18,000 m³ and 10,800 m³ were daily acquired by hydrofracture in Lucaogou group and Karamay group respectively. Xinji-1 well in Tarim Basin was indicated to have multi-bed series of oil and gas, and gas testing by hydrofracture succeeded in Kalpintag Formation of the Silurian system. Three sets of oil and gas intervals were found in the Carboniferous - Permian and Cambrian systems of Yujidi-1 well in southern North China.

Survey and evaluation of unconventional oil and gas: In the survey of shale oil in continental facies of Songliao Basin, Each of the three parameter wells generates over 10 m³ of daily industrial oil flow after the hydrofracture of the shale in the section of Qingshankou Formation. New progress was also seen in the geological survey of shale gas in the Anhui region along the downstream of the Yangtze River Economic Zone, the middle Hunan region along the midstream of the zone, and Ninglang, Duguan and other areas in Yunnan along the upstream of the zone. The Chuangao-2 parameter well for the survey of coalbed methane demonstrates in the Yibin region, southern Sichuan, has a maximum gas capacity of 3,787 m³ per day.

The national oil and gas resource evaluation of the 13th Five-Year Plan was completed to systematically evaluated 10 resource types such as conventional oil and gas, tight oil and gas,

shale oil and gas, and potential oil and gas resources in 129 basins/regions such as Bohai Bay, Ordos and Tarim.

2. Geothermal resources survey and evaluation

Nine wells were drilled for the utilization of deep geothermy in the area, the prospecting and appraisal of the geothermal resources in Rongdong District were finished, and the estimation of the quantity of geothermal resources and the potential for development and utilization under equilibrium conditions of exploitation and filling across the whole Xiong'an New Area was carried out. In Gong-he Basin, Qinghai, the first domestic development well of 4,000 m deep for hot dry rock testing was successfully completed.

3. Investigation, evaluation and monitoring of groundwater

In Wumeng Mountains, Luoxiao Mountains, southwest karst mountain areas and northwest ecological fragile areas, 1:50,000 hydrogeology survey of 26,000 km² and 1:250,000 that of 126,000 km² were carried out. A total of 236 exploration-mining-combined wells have been completed in poverty alleviation. Among them, 146 wells were built in southern Jiangxi, with a total water inflow exceeding 21,000 tons per day, which directly solved the drinking water difficulty of 71,000 people in 103 water-deficient villages and provided supplementary water sources for 10 centralized water supply points, benefiting 121,000 people.

The unified measurement of groundwater in the main plain basins in China was carried out by basin characteristics, covering 3.7 million km², with 56,000 logging points, including 36,000 civil pumped wells, which effectively improve the monitoring accuracy of groundwater exploitation areas such as Sanjiang Plain and North China Plain.

The whole national groundwater monitoring project was completed. 10171 monitoring stations have been built in 4 years. More than 89 million pieces of water level and temperature data were generated every year, and the water quality test indexes were expanded from 35 items to 97 items. The overall operation of the project is stable.

4. Other minerals geological survey and evaluation

In 2019, the 1:50,000 mineral geological survey of 35,000 km² were completed, with more than 100 prospecting targets delineated. For the first time, a thick marine potassium-bearing halite layer of primitive sedimentary origin was drilled in Lanping-Simao Basin, southwest Yunnan, which expanded the prospecting direction and space of potassium salt in this area. During the copper prospecting in the deep-cover area in the south of Hongnipo, Huili-Huidong ore concentration area, Sichuan Province, three layers of copper ore bodies and eight layers of copper-mineralized bodies have been drilled, with a cumulative thickness of 41 meters. The large spodumene deposit in Jiada mining area on the periphery of Ma'erkang in western Sichuan was newly found. 2 pegmatite vein groups containing lithium (Beryllium) and 3 fluorite belts have been generally delineated in the western section of Altun metallogenic belt.

By the end of 2019, China had carried out the potential evaluations of 32 kinds of non-oil and gas solid mineral resources, among which the potential evaluations of beryllium, titanium, cobalt and zirconium were newly completed.

III. Marine Geological Survey

1. Basic marine geological survey

The 1:250,000 and 1:50,000 marine regional geological surveys in the sea areas under Chinese jurisdiction were continued. The 1:250,000 marine regional geological survey and aerogeophysical survey were carried out in three key sea areas of the East China Sea and the South China Sea, which obtained important measured geological data and formed new understandings. The 1:50,000 marine regional geological surveys in two key sea areas of the Yellow Sea and the South China Sea were carried out, serving major construction projects. Surveys of offshore sea sand resources in Guangdong, Hainan and Fujian were carried out.

2. Progress in exploration and trial production of natural gas hydrate in sea areas

We continuously advanced the construction of the pilot test areas for exploration and exploitation of natural gas hydrate in the Shenhu sea area in the northern South China Sea, depicted the spatial distribution characteristics of the ore body of the natural gas hydrate, preferentially determined the trial production target ore body and well site of the second round and formed key trial production technology equipment with the horizontal well as the core. In March 2020, the second round of trial production was successful and new breakthroughs were made. In key sea areas in the northern South China Sea, 5 key target areas have been delineated. Through drilling, a sandy natural gas hydrate reservoir with an accumulated thickness of about 10 m has been found, enriching the natural gas hydrate reservoir type of our country. 5 favorable zones for mineralization has been delineated in key sea areas such as the eastern Pearl River Mouth Basin, which further expanded the ore exploration space for natural gas hydrate.

Feature 7-1 New Breakthroughs have been made in Terms of the Second Round of Trial Production of Natural Gas Hydrate in Sea Areas of Our Country

From February 17 to March 30, 2020, horizontal well drilling technology was first used to explore the natural gas hydrate in the 1225-meter-deep Shenhu sea area in South China Sea, producing gas for 42 days in a row, with accumulated total gas production of 1,498,600 m³ and daily average gas production of 35,700 m³, which set a new world record in both total gas production and daily average gas production and realized a momentous leap from "exploratory trial production" to "experimental trial production".

3. Survey on oil and gas resources in sea areas

We continued to carry out oil and gas resources survey in new sea areas under the jurisdiction of our country and in new formations. We have further evaluated the potentiality of the oil and gas resources in Mesozoic of key areas in the northeastern South China Sea, achieved 3 exploration goals and proposed and demonstrated the suggested 3 well sites. We have constructed 3 important structures in the Mesozoic of the southern East China Sea and preliminarily proposed the suggested 2 well sites. We have preliminarily constructed 20 local structures in key basins of South China Sea and delineated 2 oil and gas prospects. We have delineated 2 favorable structure belts featuring NW trending in the western Gaoshi stabilized zone in Laoshan Uplift.

4. Geological survey in oceans

Rare earth mineralization enrichment region and Cobalt-rich polymetallic nodule enrichment region in key survey areas have been delineated. Sino-Pakistan joint marine geologic survey has been successfully completed, obtaining valuable geologic and geophysical data, and significant progress has been made in aspects such as oil and gas, natural gas hydrate, basic geology, etc. The first large-scale deep sea exploration voyage sharing has been implemented. more than 20 tasks such as cold spring system survey and study, sea trial for domestic large equipment standardization, experimental application of independently developed deep sea detection instrument, etc. have been completed. 55 voyages of expedition task in ocean have been completed, smart splicing of underwater images achieved for the first time, and in situ acoustic thickness measurement system, deep sea shallow drilling and other key equipment performance optimized. Study on selection of sites for deep sea scientific drilling and pilot geochemical mapping at the sea floor have seen achievements for this stage, making an early preparation for the proposing of the international big science plan.

Chapter VIII

Geological Data Management and Services

567,900 accumulated geological data achievements and 38,900 kinds of original geological data were collected by the geological data archives at all levels in China. The service website of geological data gets 5,432,300 visits. A total of 23,400 customers visited the data archives, provided with 4,955,600 services. Geological Cloud 2019 Edition was put into use, with 36,000 registered users, 3.85 million visits and 1.10 million downloads of data products. During the COVID-19 pandemic, the data service is uninterrupted.

I. Geological Data Management System

In 2019, the *Notice of Ministry of Natural Resources on Supplementing Oil and Gas Geological Data and the Notice of the General Office of Ministry of Natural Resources on Printing and Distributing 'Technical Requirements for Supplementing Oil and Gas Geological Data'* were issued. According to the requirements of the documents, the National Geological Archives of China, the Natural Resources Physical Geological Data Center and various oil and gas companies jointly compiled the working rules for receiving and accepting the supplementary oil and gas geological data, reviewing catalogues, issuing certificates, etc., completed the upgrading and improvement of the entrusted management system of oil and gas geological data, established a consultation working mechanism, and promoted the smooth implementation of supplementing oil and gas geological data.

In 2020, the *Notice of the General Office of the Ministry of Natural Resources on Further Improving the Management of Geological Data Collection* was issued to further improve the management system of geological data collection and promote the establishment of a credit system for geological data collection. The *Notice of the General Office of the Ministry of Natural Resources on Fully Enabling the Geological Data Information Management Service System* was issued to accelerate the government service of “Internet + Geological Data”.

The management efficiency and service level of geological data were improved. *The Notice of the General Office of the Ministry of Natural Resources on Core Digitalization and Information Sharing* was issued to improve the level of core digitization and information sharing, and strive to build a big-data sharing pattern for cores with characters of overall planning, effective collection and high sharing throughout the country.

II. Geological Data Collection

1. Achievements and original geological data

Geological data collection archives at all levels in China have received 27,600 kinds of geological data achievements and 8,600 kinds of original geological data. By the end of 2019, there were 567,900 kinds of accumulated geological data and 38,900 kinds of original geological data. The entrusted unit received a total of 368,200 copies of original geological data and kept 1,265,900 copies of original geological data.

2. Physical geological data

Geological data archives at all levels in China newly accepted and kept 472,600 meters of cores, 28,700 rock specimens, 41,700 bags of cuttings, 47,800 pieces of polished section and thin section and 1,715,100 bags/bottles of samples. By the end of 2019, a total of 2,025,300 meters of cores, 118,900 rock specimens, 181,900 bags of cuttings, 224,900 pieces of polished section and thin section and 4,095,800 bags/bottles of samples were kept. The entrusted units received much physical geological data including totally 92,600 meters of cores and 3,335,500 bags of cuttings, and accumulative entrusted custody of 335,100 meters of cores and 8,743,000 bags of cuttings.

III. Geological Data Services

1. Collection service

The National Geological Archives of China, the Natural Resources Physical Geological Data Center and the geological data collection institutions of provinces (autonomous regions and municipalities) actively carried out special services, archive services and network services. The service volume of geological data network of geological data collection institutions at all levels in China remained stable, and the service page views of geological data website reached 5,432,300 person-time. A total of 23,400 customers visited the data archives, provided with 4,955,600 items of service.

In 2019, the National Geological Archives of China provided geological data services for 338 units, with a total of 36,700 copies of geological data and 749,100 service cases of geological data (reading and processing). 16,900 copies of data were copied or processed 119,700 times, including 2,240,000 pages of written reports and 87,000 geological maps (calculated by converting into 200,000 standard maps), with a data service volume of 1.36TB; the official website of the National Geological Archives of China got 23.99 million hits (including 12.12 million times of data search) and 4.10 million visits (including 863,000 times of data research); the website visits by API calls were 8 million. 13,300 items of service for customers were provided by telephone, email and online service. 12 batches of domestic and foreign on-site visiting and technical exchange groups were received, totaling 227 person-times.

The natural resources physical geological data center provided 3666 person-times of reception service such as visit, investigation, practice, observation and sampling. It provides sampling services for scientific research in many fields, such as conventional - unconventional oil and gas resources, deep geotherm, paleontology, paleoenvironment and geochemical analysis, etc. 2248 samples were sampled by using 30058.66 meters of rock cores. There were 132,000 visits to the website of China Geological Sample Information. Popular science products such as *Core Cognition Tour (VR Video) of Songliao Scientific Drilling Well-2* have been made to provide popular science study and dissemination services for the public.

After the outbreak of pandemic of COVID-19, the National Geological Data Center and the Material Geological Data Center of Natural Resources have provided users with accurate,

convenient and efficient services to the maximum extent. During the epidemic period, users can log on to the website of the National Geological Data Center (www.ngac.cn) to submit an application for obtaining geological data. The National Geological Data Center provides consulting services to readers by telephone, mail, WeChat, etc., and provides data contact-free services by filling in processing forms, mailing and online transmission and other ways. On the basis of strictly examining and approving the application for observation and sampling, the Material Geological Data Center of Natural Resources uses remote video to connect with the sampling applicant online, and it takes only a few hours to complete the whole process of sampling.

2. Geological cloud online service

“Geological Cloud 2019 Edition” was officially released to provide online services. The “geological cloud” node system has been further improved, including 29 units directly under the China Geological Survey and 11 industrial units including Geological Cloud-Shandong, and Geological Cloud-Shaanxi, etc. All 464 geological survey projects have achieved the “on-line” mode of geological survey, and the “intelligent” application demonstrations such as intelligent survey, intelligent identification and intelligent search have achieved initial results; 96 national core geological databases have been updated and maintained, and more than 7,000 authoritative information products on resources and environment, 900,000 pieces of achievement geological data, 100,000 important borehole data, 80,000 meters of important rock core image data, 15,000 volumes of geoscience literature, etc. have been added; more than ten important geological survey application systems and special services have been launched. 1264 complete national 1 : 200,000 and 1 : 250,000 geological maps were firstly published online; authoritative geological information series products such as geological records, mineral records and basic geological maps have been developed.

In 2019, the number of registered users of “Geological Cloud” reached 36,000, with 3.85 million visits and 1.10 million downloads of data products. Compared with the same period of last year, the number of page views increased by 9.4 times and the number of downloads increased by 12.9 times.

Chapter IX

Scientific and Technological Innovations in Mineral Resources

In 2019, remarkable achievements have been made in the research of mineral resources, with two State Science and Technology Awards granted to two research outcomes. Many invention patents were applied to further strengthen the protection of the intellectual properties of mineral resources. The science and technology innovation for mineral resources were promoted. Multiple key laboratories and engineering innovation centers were established. The standardization of geology and mineral resources was promoted to provide technical support for the high-quality development of geological and mining industries.

I. Major Technical Improvements and Achievements in Mineral Resources

1. Major improvements

Major progress has been made in gas hydrate exploration and test mining, which has made theoretical and technical preparations for the implementation of the second round of test mining. A new understanding was gained to the enrichment law of shale oil in Songliao Basin, and a comprehensive evaluation system of target optimization was established. The evaluation

of shale gas resources potential in the Yangtze River Economic Belt has been basically completed. The oil and gas survey of new strata in Bogurda piedmont zone in Xinjiang expanded the prospect of natural gas exploration and development in Junggar Basin.

A new model of “tectonics, oil-water interface, paleovalley ore control” was put forward in the investigation of sandstone-type uranium deposits in the continental-marine facies formation of Erlian Basin. The new metallogenic mechanism and breakthrough in prospecting of large-scale lithium deposits in China created new ideas for prospecting pegmatite-type spodumene deposits, rare metals and rare earth metals.

The first deep-sea wellhead suction anchor with completely independent intellectual property rights of China was successfully applied. The first miniaturized high-precision ZAG-E cold-atom absolute gravimeter of China was applied in earthquake monitoring and prediction, crustal movement research, geophysical survey and other fields.

2. Major achievements

The integrated systematic achievements of 1:1 million regional geological surveys in China's sea area and the innovation of geological theory in the oceanic and continental convergence belts promoted the research of major basic scientific problems in the western Pacific rim.

The newly discovered seven new minerals gained international recognition, which has enhanced China's influence in the international mineralogy field. “Metallogenic Theory of Collisional Porphyry Copper Mine” won the second prize of the National Natural Science Award in 2019. “Key Technology Innovation in Discovery and Detection of Hydrothermal Sulfide in Ultra-Slow Expanding Mid-Ocean Ridge” won the second prize of the National Science and Technology Progress Award in 2019.

3. Major Projects

Adhering to the circular released by the General Office of the State Council on the “Thirteenth Five-year Plan” for Scientific and Technological Innovation, we will actively promote the establishment and implementation of the major project of scientific and technological innovation facing 2030 --Deep Earth Exploration Project. We will propel the construction of technology and equipment systems of deep earth exploration, carry out the exploration of

the deep earth structure and material composition of our country in a systematical way, and strengthen the ability to identify geological bodies of deep earth. By innovating deep earth science and deep earth dynamics, and making breakthroughs in geothermal power generation technology, we are to find out the reserves of deep-earth resources, and sketch prospecting target of energy and minerals in 10000 meters depth.

II. Technical Standards in the Field of Mineral Resources

With a focus on the reform on classifications of mineral resources reserves, the national standards such as the *Classification of Solid Mineral Resources Reserves*, and the industrial standards such as *Overview of Solid Mineral Resources Investigation*. In addition, in other fields of geology and mineral resources, the national standards such as *Methods for Chemical Analysis of Copper, Lead and Zinc* and the industrial standards such as *Technical Specification for Marine Geological Sampling* were issued.

Among the national standards, *Classifications of Solid Mineral Resources Reserves* and *Classifications of Oil and Gas Mineral Resources Reserves* are the fundamental and programmatic technical standards for the mineral resources management of China. The General Requirements for Solid Mineral Exploration stipulates the basic principles, requirements on exploration objectives and exploration stages, exploration research contents, exploration work level, green exploration, exploration work and its quality, feasibility evaluation, resource & reserve type and conditions, resource reserve estimation etc., which are used to guide the preparation of exploration specification, technical requirements and relevant specification and procedures for solid mineral resources, providing the technical support for exploration and development of mineral resources.

III. Scientific and Technological Innovation Platform for Mineral Resources

In 2019, the original 97 key laboratories and 39 engineering technology innovation centers were evaluated and optimized by experts in three batches according to different disciplines,

and 77 key laboratories and 36 engineering technology innovation centers were included in the innovation institution list. A total of 22 scientific and technological innovation platforms in the field of mineral resources were listed, among which 16 are key laboratories and 6 are engineering technology innovation centers. The existing innovation platforms in the field of mineral resources focus on the main responsibilities and main tasks of mineral resources, to refine key scientific theories and core technologies in related disciplines, and focus on major scientific problems and major engineering and technical problems in mineral resources. In the aspect of basic research, theoretical research on mineralization and resource evaluation, salt lake resources and environment, natural gas hydrate, seabed mineral resources, magmatism and mineral prospecting was strengthened; in the aspect of application basis research and technology research and development, innovation and application in shale gas exploration, resource exploration and comprehensive utilization, “rare, rare earth and scarce metals”, natural gas hydrate exploration and development, and aerogeophysical survey technology were emphasized.

IV. Intellectual Property Rights in Mineral Resources

In 2019, there were 236 registered patents and 144 computer software copyrights in the field of mineral resources.

The limited sand control mining technology for multilateral wells with large-size main borehole of marine gas hydrate overcomes the “congenital” weakness that shallow hydrate reservoir is not suitable for fracturing, and solves the contradiction between the extremely low permeability of natural gas hydrate reservoir in the South China Sea, the low comprehensive strength of formation and the serious sand production trend. This technology obtained the international PCT patent.

An environment simulation device for natural gas hydrate patented in China has been invented, which can simulate the exploitation of natural gas hydrate in an all-round way, and be used to study the water-gas migration in hydrate formation and gas production rate of hydrate reservoir under decompression and thermal recovery conditions.

Chapter X

International Cooperation

The bilateral and multilateral cooperation in the field of geology and mineral resources was comprehensively promoted. The exchanges and cooperation with relevant countries were further solidified and improved through international exchange platforms such as China Mining and China-ASEAN Mining Cooperation Forum.

I. Bilateral and Multilateral Cooperation Mechanisms

1. Bilateral cooperation

The outcomes of the second belt and road forum for international cooperation were implemented, the practical cooperation in geology and mineral resources with Argentina, Uruguay, Brazil, Chile, Surinam, Kazakhstan, Mongolia, Cambodia, Laos, Myanmar, Philippines, Malaysia, Mozambique, Tanzania, Mali, Sudan, Ethiopia and other countries was actively propelled, and the cooperative relationship in the fields such as geoscience research, geological survey, mineral resource management, mine environment protection and mining investment, was further promoted.

A number of cooperation agreements have been reached with foreign geological survey institutions. Memorandums of understanding on inter-ministerial cooperation with Argentina

and Uruguay were signed. Cooperation agreements and action plans with geological survey institutions in Tanzania, Poland, Norway, Mongolia, Serbia, Eritrea, Cote d'Ivoire, Peru, Myanmar, Turkey and Saudi Arabia were signed, and project cooperation agreements with relevant institutions in Russia, Poland and Thailand were signed. Technological exchanges and cooperation researches were conducted with developed countries in such fields as basic geological survey, strategic mineral resources survey, deep exploration, marine geology, natural gas hydrate, shale gas, hot dry rock, geological disasters, karst environment, and underground water.

2. Multilateral cooperation

In the coordination with the “Lancang-Mekong Week” activity in 2019, the second Geosciences Forum for Lancang- Mekong Cooperation Countries was hold, demonstrating the achievements of the geoscience cooperation between China and Lancang-Mekong countries and condensing the cooperation agreement. The MNR delegation went to Chile to participate in activities during the APEC Mining Week and were deeply involved in mining cooperation under the APEC mechanism. The Ministry of Natural Resources attended the 12th ASEAN +3 Senior Mining Officials Meeting to plan and deploy the cooperation between China and the ASEAN in the fields of geology and mineral resources.

The MNR delegation attended the 55th Annual Meeting and the 72nd and 73rd Committee Meetings of the Coordinating Committee for Geo-science Programmes in East and Southeast Asia (CCOP) and participated in the formulation of the CCOP work plans. The MNR delegation also attended the 8th Expert Committee Meeting of the United Nations-Global Geographic Information Management and proposed the initiative of Global Geoscience Big Data Working Group with China taking the lead, to attended the 2019 Conference Week of the Group on Earth Observations (GEO) to participate in the formulation of the GEO 2020-2022 work plans and clarify the various strategic implementation plans for China as the rotating chairman of GEO in 2020, and attended the 73rd Executive Committee Meeting of the International Union of Geological Sciences (IUGS) to promote international large-scale scientific plans such as Deep-time Digital Earth and play a leading role in solving major global geoscience issues.

II. Opening-up and Cooperation

1. New progress in resources cooperation with countries participating in the “Belt and Road” Initiative

To implement the expected outcomes of the Second Belt and Road Forum for International Cooperation, technical aids in geological survey were delivered to Rwanda, Nepal, Zambia and Liberia.

International geoscience cooperation and international mining investment with countries and regions participating in the “Belt and Road” Initiative were promoted. Medium-to-large-scale geological and geochemical surveys have been conducted with the geological survey agencies in the 7 countries participating in the “Belt and Road” Initiative, including Mongolia, Myanmar and Laos, covering an area of 55,000 km² and comprehensively delineating 124 prospect targets for buried mineral deposits; 42 mining investment programs were promoted at the International Geological Cooperation and Mining Investment Forum jointly with the geological and mineral authorities of 4 countries, including Uzbekistan.

2. International mining cooperation

The Ministry brought the platform functions of the UNESCO International Center on Karst and UNESCO International Center on Global-Scale Geochemistry into full play and further implemented international large-scale scientific plans, such as “Chemical Earth”. Newly added global geochemical baseline networks covered an area of 3.34 million km²; global geochemical reference values were established for 29% of the Earth’s land area. *Technical Guideline for International Geochemical Mapping* was formulated and then adopted as an international standard by the Global Geochemical Baseline Committee. International standards for karst, including *Technical Specifications for Monitoring Key Karst Zones*, *Terminologies of Karst and Caves*, *Investigation Regulations on Karst Collapse (1:50000)* and *Database Standard for Hydrogeological Environment Survey in Karst Areas (1:50000)*, were established to support the construction of international standardization of karst. A series of thematic maps of the geological environment of karst over the world were compiled to master the geological types, distribution and environmental characteristics of the karst along countries and regions participating in the “Belt and Road Initiative”

3. Training sessions on geology and mineral resources for foreign trainees

A total of 8 domestic and 4 overseas training sessions were organized. Totally 417 geological and mineral officials and technicians from more than 23 countries and regions in Asia, Africa, Latin America and Central and Eastern Europe participated in the training courses, which shows our technology and level in geological survey and minerals management, establishing a wide range of cooperative relations and laying a solid foundation for future bilateral and multilateral cooperation.

III. International Platforms for Mining Cooperation

1. China Mining 2019

(21st) China Mining 2019 was held. A total of 54 countries and regions sent delegations to China to participate in the China Mining 2019. Representatives from more than 1,000 mining enterprises, financial institutions and industry associations at home and abroad attended the conference, with a total of more than 8,500 participants. The theme of the China Mining 2019 was “High-quality Development for the Shared Future of Global Mining Industry”. The international mining capacity cooperation of the “Belt and Road” Initiative was used as the pointcut, so as to enhance the exchange and cooperation with other countries in the mining industry. During the conference, the Ministry of Natural Resources held productive bilateral talks with mining competent authorities of Argentina, Mongolia, Sudan, Mali and other countries, and exchanged in-depth opinions on further enhancing information sharing, talent cultivation, scientific research, and policy guidance and support for mining enterprises.

2. China-ASEAN Mining Cooperation Forum 2019

2019 (10th) China-ASEAN Mining Cooperation Forum & Promotional Exhibition was held. The leaders of the Ministry of Natural Resources and Guangxi Zhuang Autonomous Region as well as the mining competent authorities of Cambodia, Laos, Myanmar, Philippines and Ethiopia attended the opening ceremony and delivered speeches. With the theme of “Deepening Mutual Beneficial Cooperation in Mining Industry and Promoting Win-Win

Economic Development”, the forum held more than 20 activities such as the China-ASEAN geological survey directors’ round table conference, the signing-promotion-negotiation meeting of mining projects, and the exhibition of new mining technologies and mining machinery, etc. A total of 12 mining cooperation projects were signed with a contract value of RMB 52.9 billion.

3. The 2nd “Lancang–Mekong Week” Geoscience Series Activities

The 2nd Geoscience Forum for Lancang-Mekong Cooperation Countries was held. With the theme of “Strengthening Geoscience Cooperation and Promoting Green Development”, the current situation and future requirements of geoscience development in various countries were fully exchanged, the *Memorandum of Understanding on China-Myanmar Geoscience Cooperation* was signed, and the two project cooperation agreements of “Cooperation and Mapping of Environmental Geological Survey” and “Cooperative Research on Comparison between Sylvine Sedimentology and Geochemistry” were signed. At the same time, seminars on information sharing of natural resources and sustainable development of water resources, as well as sub-forums on geoscience information and water resources were held.

4. “Belt and Road” International Geoscience Cooperation and Mining Investment Forum

The “Belt and Road” International Geoscience Cooperation and Mining Investment Forum was held. The leaders and researchers from 23 national geological and mineral institutions attended the forum. Focusing on the theme of “Promoting High-level Cooperation in Geoscience and Helping High-quality Development of Mining Industry”, in-depth discussions were made and relevant initiatives were put forward. During the forum, the unveiling ceremony of “Wuhan Institute of China-SCO Geoscience Cooperation Research Center” and the activity of “SCO Geological Youth Practice Exchange Camp” were held.