2018

China Mineral Resources

Prepared by
Ministry of Natural Resources, PRC

GEOLOGICAL PUBLISHING HOUSE
BEIJING

Editorial Committee

Foreword

Since 2011, the Ministry of Land and Resources has started to organize the preparation of the annual *China Mineral Resources* (CMR) to effectively improve the public service capacity of mineral resources management departments and promote the disclosure of government information so that the public can better know about China's exploration, exploitation and utilization of mineral resources and the latest policies and regulations.

In 2018, the Ministry of Natural Resources was established to integrate the responsibilities of the former Ministry of Land and Resources and other departments to uniformly exercise the responsibilities of the owners of natural resources assets owned by the whole people, and to uniformly exercise all the responsibilities of national land space use regulations and ecological protection & restoration. The continuous compilation of *CMR* will enable the relevant departments and agencies at home and abroad, as well as people who care about and support China's natural resources undertakings, to better know about the relevant information.

The *CMR* 2018 focuses on such information since 2017 as the new progress in China's exploration, exploitation and utilization of mineral resources, mine geological environment protection, and geological and mineral surveys and evaluations; the new measures in policies and regulations related to mineral resources planning, supervision and management, mining tax and fee system reforms and ecological environment protection; the new developments in scientific and technological innovation in mineral resources exploration, exploitation and utilization, as well as geoscience theory research; and the new achievements in international geological and mineral resources cooperation with countries participating in the "Belt and Road" Initiative.

In 2017, the reserves & resources of coal, oil, natural gas, shale gas, manganese, gold, graphite and so on in China increased. Several giant deposits were discovered, in which of, three new

coal fields with resources more than 5 billion tons, two gold deposits more than 1 hundred tons, two oil fields with geological reserves more than 100 million tons, and three gas fields more than 50 billion m^3. By the end of April 2018, accumulative geological reserves of shale gas has been more than 1 trillion cubic meters.

The investment in oil and gas exploration rebounded to some extent, whilst the investment in non-oil and gas exploration continued to decline. Guided by the strategic thought of ecological civilization, green exploration was advocated, and the use of green environmentally-friendly exploration and exploitation techniques was promoted. Four support policies (i.e. mining right policy, land use policy, fiscal policy, and financial policy) were clearly defined, and the construction of green mines was comprehensively promoted. The mine geological environment management and ecological restoration were actively implemented. The availability of mineral commodities has been continuously strengthened, the demand has kept growing, and the energy consumption structure has been continuously optimized.

Policies and regulations on mineral resources have been constantly revised and improved. Some of the administrative approvals were further canceled and decentralized clean-up of land and resources laws, regulations, rules and normative documents involved in the construction of ecological civilization and fair competition review was carried out, so as to further promote the reform of "decentralization, supervision and service optimization". The royalty system for mineral resources was established and improved, and the competitive transfer of mineral rights in six pilot provinces was comprehensively promoted.

The State Council's approval opinion of the National Mineral Resources Plan was fully implemented, and the mid-term evaluation of the implementation of the plan was conducted. The supervision and management of geological exploration was improved, and the layout of mineral exploration was further optimized. The approval and registration system of mineral rights was improved, and the clean-up and classified disposal of mining rights were accelerated. Moreover, a pilot project for unified mining rights registration of mineral resources and reserves was initiated, the mineral resources reserve system was established and improved, the protection and supervision of mineral resources were strengthened, and the ability of mineral resources protection was further improved.

The level of basic geological survey was further improved. Important discoveries of oil and gas were made in new areas, new series of strata, new fields and new depths. Geological survey and evaluation of non-oil and gas minerals were mainly carried out in the key metallogenic belts, packaged exploration areas, important ore deposit-concentrated areas and large resource

bases, new prospecting targets were delineated and new mineral deposits were discovered. The geological data management system was further improved, and the service capacity and level were continuously promoted.

The strategy of scientific and technological innovation of mineral resources was fully implemented to meet national development. Moreover, innovations were continuously made in metallogenic theory, prospecting model and exploration approach, and R&D or integration of a number of geological prospecting instruments and equipment was also carried out. The technology for comprehensive utilization of mineral resources was widely applied. A recommended national standard and 35 recommended geological and mineral industry standards were released and implemented.

The bilateral and multilateral cooperation in the field of geology and mineral resources was comprehensively promoted to actively respond to the "Belt and Road" Initiative. Through international exchange platforms such as China Mining and China - ASEAN Mining Cooperation Forum, mining exchanges and cooperation with relevant countries were further expanded.

Statistics in the *CMR* 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 Administrative Region, Macao Special Administrative Region and Taiwan Province of the People's Republic of China are not included in this report.

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Chapter I
Mineral Resources

By the end of 2017, a total of 173 kinds of minerals were discovered in China, of which natural gas hydrate was a new one in that year. The identified reserves & resources of major minerals, such as coal, oil, natural gas, manganese, gold and graphite demonstrated an evident growth. The reviewed and filed reports on mineral resources and reserves increased slightly over the previous year, and new progress was made in the evaluation of the potential of mineral resources such as oil, natural gas, manganese, lead, zinc, lithium and graphite.

I. Reserves & Resources

1. Newly-discovered mineral — natural gas hydrate

According to the relevant provisions of the *Detailed Rules for the Implementation of the Mineral Resources Law of the People's Republic of China*, the Ministry of Land and Resources announced the discovery of a new kind of mineral resources on November 15, 2017, with the approval of the State Council. The newly-discovered mineral is natural gas hydrate, and its discovery time and place of origin are as the follows: the natural gas hydrate in China's sea area was discovered in June 2007 for the first time in Shenhu Area of the South China Sea, whilst the natural gas hydrate in China's land area was discovered in November 2008 for the first time in Qilian Mountain of Qinghai Province.

2. Growth in remaining reserves & resources

In 2017, among the major minerals, there was an increase in 42 kinds of remaining reserves & resources and a decrease in 6 kinds. Among them, the remaining technologically recoverable reserves of oil, natural gas and shale gas increased by 1.2%, 1.6% and 62.0% respectively, whilst that of the coalbed methane decreased by 9.5%. The remaining reserves & resources of coal increased by 4.3%, manganese 19.1%, copper 4.9%, bauxite 4.9%, molybdenum 4.3%, antimony 4.1%, gold 8.5%, phosphate rock 3.6%, fluorite 8.9% and crystalline graphite 22.6%, whilst potash decreased by 2.8% (Table 1-1).

Table 1-1 Remaining Reserves & Resources of Major Minerals

No.	Mineral	Unit	2016	2017	Growth rate/%
1	Coal	Billion tons	1598.00	1666.67	4.3
2	Oil	Billion tons	3.50	3.54	1.2
3	Natural gas	Billion cubic meters	5436.55	5522.10	1.6
4	Coalbed methane	Billion cubic meters	334.40	302.54	-9.5
5	Shale gas	Billion cubic meters	122.41	198.29	62.0
6	Iron ore	Billion tons of ores	84.06	84.89	1.0
7	Manganese ore	Billion tons of ores	1.55	1.85	19.1
8	Chromite	Thousand tons of ores	12331.9	12202.4	-1.1
9	Vanadium	Thousand tons of V_2O_5	64017.7	64281.6	0.4
10	Titanium	Million tons of TiO_2	786	819	4.2
11	Copper	Million tons of metal	101.11	106.08	4.9
12	Lead	Million tons of metal	85.47	89.67	4.9
13	Zinc	Million tons of metal	177.53	184.94	4.2
14	Bauxite	Million tons of ores	4852	5089	4.9
15	Nickel	Thousand tons of metal	11183.7	11180.7	0.0
16	Cobalt	Thousand tons of metal	672.5	687.8	2.3
17	Tungsten	Thousand tons of WO_3	10159.5	10304.2	1.4
18	Tin	Thousand tons of metal	4453.2	4500.4	1.1
19	Molybdenum	Thousand tons of metal	28824.1	30067.8	4.3
20	Antimony	Thousand tons of metal	3072.4	3197.6	4.1
21	Gold	Tons of metal	12167.0	13195.6	8.5
22	Silver	Thousand tons of metal	275.2	316.0	14.8
23	Platinum group metal	Tons of metal	365.5	365.3	-0.1
24	Strontium ore	Thousand tons of celestite	55156.4	56440.5	2.3
25	Lithium	Thousand tons of oxides	9614.6	9673.8	0.6
26	Magnesite	Million tons of ores	3086	3115	0.9

Continued

No.	Mineral	Unit	2016	2017	Growth rate/%
27	Fluorite	Million tons of minerals	222	242	8.9
28	Refractory clay	Million tons of ores	2581	2592	0.4
29	Pyrite	Million tons of ores	6037	6060	0.4
30	Phosphate rock	Million tons of ores	24408	25284	3.6
31	Potash	Million tons of KCl	1057	1027	−2.8
32	Boron	Thousand tons of B_2O_3	76476.1	78172.6	2.2
33	Sodium salt	Billion tons of NaCl	1412.86	1422.49	0.7
34	Mirabilite	Billion tons of Na_2SO_4	117.11	117.12	0.0
35	Barite	Million tons of ores	351	362	3.1
36	Cement limestone	Billion tons of ores	134.33	137.01	2.0
37	Glass-making siliceous rock	Million tons of ores	8321	8875	6.6
38	Gypsum	Million tons of ores	97262	98472	1.2
39	Kaolin	Million tons of ores	3395	3474	2.3
40	Bentonite	Million tons of ores	2966	3062	3.2
41	Diatomite	Million tons of ores	494	513	3.9
42	Veneer granite	Million cubic meters	4637	5057	9.1
43	Veneer marble	Million cubic meters	1631	1675	2.7
44	Diamond	kg of minerals	3124.64	3124.62	0.0
45	Crystalline graphite	Million tons of minerals	300	367	22.6
46	Asbestos	Million tons of minerals	95.66	95.46	−0.2
47	Talc	Million tons of ores	286	289	1.1
48	Wollastonite	Million tons of ores	166	170	2.1

Note: 1. The oil, natural gas, coalbed methane and shale gas here are the remaining technically recoverable reserves. See GB/T 19492-2004 for classification criteria.

2. The non-oil and gas minerals here are the remaining reserves & resources. See GB/T 13908-2002 for classification criteria.

3. Newly-discovered reserves & resources

In 2017, the new discovered geological reserves of oil amounted to 877 million tons, natural gas 555.38 billion m^3, and shale gas 376.76 billion m^3. The newly-discovered reserves & resources of coal amounted to 81.556 billion tons, manganese ore 282 million tons, copper 4.18 million tons, bauxite 292 million tons, molybdenum 1.07 million tons, gold 1104.35 tons, phosphate rock 992 million tons, fluorite 14.392 million tons and crystalline graphite 61.48 million tons (Table 1-2).

II. Review and Filing of Reports on Mineral Resources & Reserves

In 2017, 2,604 reports on mineral resources and reserves were reviewed and filed in China (by the Ministry of Land and Resources and provincial departments of land and resources, the same below), showing an increase of 1.0% over 2016. Among them, 203 reports were about oil and gas and 2,401 reports were about non-oil and gas minerals (Table 1-3). The Ministry of Land and Resources reviewed and filed 286 reports, increased by 40.0%. Provincial departments of land and resources reviewed and filed 2,318 reports, decreased by 2.0%. Of the 103 minerals reviewed and filed in 2017, the top five minerals reported are coal (618 reports, accounting for 24%), gold (293, 11%), iron ore (217, 8%), oil (143, 5%) and cement limestone (118, 5%).

In 2017, 2,401 reports on non-oil and gas mineral resources and reserves were reviewed and filed, including 838 exploration reports, accounting for 34.9%, 1,138 reserves verification reports, accounting for 47.4%, 183 reports on overlaid minerals, accounting for 7.6%, 146 reports on mine production and geology, accounting for 6.1%, 67 reports on mine closure, accounting for 2.8%, and 29 reports on other types, accounting for 1.2% (Table 1-4).

III. Potential of Mineral Resources

1. Oil and gas

In 2017, the Ministry of Land and Resources organized the "13th Five-Year Plan" national evaluation of oil and gas. In the evaluation of the quantity and quality of oil and gas, economic

Table 1-2 Newly-discovered Reserves & Resources of Major Minerals

No.	Mineral	Unit	2016	2017
1	Coal	Million tons	60680	81556
2	Oil	Million tons	914	877
3	Natural gas	Billion cubic meters	726.56	555.38
4	Coalbed methane	Million cubic meters	57610	10480
5	Shale gas	Billion cubic meters	0.00	376.76
6	Iron ore	Million tons of ores	518	1451
7	Manganese ore	Million tons of ores	172	282
8	Copper	Million tons of metal	3.63	4.18
9	Lead	Million tons of metal	6.31	6.12
10	Zinc	Million tons of metal	22.40	10.87
11	Bauxite	Million tons of ores	156	292
12	Nickel	Thousand tons of nickel	127.5	38.8
13	Tungsten	Thousand tons of WO_3	603.1	160.1
14	Tin	Thousand tons of metal	41.0	86.0
15	Molybdenum	Thousand tons of metal	225.6	1070.0
16	Antimony	Thousand tons of metal	51.5	140.4
17	Gold	Tons of metal	824.50	1104.35
18	Silver	Thousand tons of metal	16.2	51.6
19	Pyrite	Million tons of ores	189.76	105.95
20	Phosphate rock	Million tons of ores	1341	992
21	Potash	Million tons of KCl	-6.92	10.75
22	Cystalline graphite	Million tons of minerals	36.66	61.48
23	Fluorite	Thousand tons of minerals	6390.1	14391.7

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

Table 1-3 Review and Filing of Reports on Mineral Resources and Reserves in China

Reviewed and filed by		2016		2017	
		Number of reports	Proportion %	Number of reports	Proportion /%
Ministry of Land and Resources	Solid minerals	96	4	83	3
	Oil and gas	108	4	203	8
	Total	204	8	286	11
Provincial departments of land and resources		2364	92	2318	89
Total		2568	100	2604	100

Table 1-4 Review and Filing of Reports on Non-oil and Gas Mineral Reserves

Report type	2016		2017	
	Number of reports	Proportion %	Number of reports	Proportion %
Verification	1167	47.5	1138	47.4
Exploration	947	38.5	838	34.9
Overlaid minerals	180	7.3	183	7.6
Production	84	3.4	146	6.1
Mine closure	71	2.9	67	2.8
Others	11	0.4	29	1.2
Total	2460	100.0	2401	100.0

and ecological environment risk assessments were carried out to comprehensively, scientifically and objectively evaluate the potential of various oil and gas in China and predict the growth trends of reserves and productivity. In 2017, the evaluation of oil and gas potential in deep waters (≥300m) and Yin-E Basin was preliminarily completed.

There were 125.7 billion tons of potential resources and 30.1 billion tons of recoverable resources of oil, 90 trillion m^3 of geological resources and 50 trillion m^3 of recoverable resources of gas in China. Moreover, the geological resources of shale gas amounted to 122 trillion m^3, while the recoverable resources of shale gas amounted to 22 trillion m^3, which was buried at 4,500m or below. The geological resources of coalbed methane amounted to 30 trillion m^3, while the recoverable resources of coalbed methane amounted to 12.5 trillion m^3, which was buried at 2,000m or below.

According to the type and occurrence of natural gas hydrate resources, combined with geological conditions, the natural gas hydrate resources in China's sea area were preliminarily estimated to be about 80 billion tons of oil equivalent.

2. Non-oil and gas minerals

The potential of non-oil and gas mineral resources in China is huge, with less than 1/3 of an average discovery rate of resources buried at 2,000m or above. The evaluation results of the potential of important minerals in 2017 indicated that the lead and zinc resources are estimated to be 849.00 million tons, of which the lead resource amounts to 256.00 million tons and the zinc resource amounts to 593.00 million. These lead and zinc resources are mainly distributed in Xinjiang, Yunnan, Tibet, Gansu, Qinghai, Shaanxi, etc. The manganese resource is estimated to be 4.8 billion tons, and is mainly distributed in Hunan, Guangxi, Guizhou, Sichuan, Chongqing, etc. The lithium chloride (LiCl) resource is estimated to be 92.48 million tons, and the lithium oxide (Li_2O) resource is estimated to be 8.01 million tons, which is equivalent to 18.86 million tons of metallic lithium. Lithium chloride is mainly distributed in Qinghai and Tibet, and lithium oxide is mainly distributed in Sichuan, Xinjiang, Jiangxi, Hunan, etc. The graphite resource buried at 500m or above is estimated to be 2.014 billion tons, and is mainly distributed in Heilongjiang, Inner Mongolia, Xinjiang, Sichuan, Shandong, etc. The bauxite-associated gallium resource in China is estimated to be 1.318 million tons, and is mainly distributed in Guangxi, Henan, Guizhou, Shaanxi, etc. The indium resource associated with lead-zinc-tin is estimated to be 21,600 tons and is mainly distributed in Guangxi, Yunnan, Inner Mongolia, Guangdong, etc.

Chapter II Exploration

In 2017, the investment in geological exploration rebounded after falling for four consecutive years in China. The exploration spending of oil and gas increased, but that of non-oil and gas mineral continued to decline. New breakthroughs were made in shale gas and natural gas hydrate exploration, and new progress was made in exploration of some minerals, such as oil, natural gas, manganese, copper, tungsten, tin, gold, silver, lithium and graphite.

I. Geological Exploration Spending

1. Investments in geological exploration

In 2017, the investment in geological exploration totaled RMB 78.285 billion in China, increased by 1.0% compared with the previous year, and rebounded for the first time after falling for four consecutive years. Among them, the investment in geological exploration of oil and gas minerals was RMB 58.449 billion, increased by 10.8%. The investment in geological exploration of non-oil and gas minerals was RMB 19.836 billion, decreased by 19.8% (Fig. 2-1).

2. Proportion of investments in geological exploration

Among the investments in geological exploration of non-oil and gas minerals in 2017, 5.866 billion yuan was financed by the central government, accounting for 29.6% of the total amount, and increasing by 16.2% over 2016; 6.746 billion yuan was financed by the local governments, accounting for 34.0% and increasing by 2.8%; and 7.224 billion yuan was from the social funds, accounting for 36.4% and decreasing by 19.0%.

Among the investments in geological exploration of non-oil and gas minerals in 2017, the investment in mineral exploration amounted to 12.061 billion yuan and decreased by 29.0% year on year, accounting for 60.8% of the total amount ; basic geological survey amounted to 3.446 billion yuan and decreased by 1.2%,accounting for 17.4%; hydrogeological, environmental geological and geological disaster investigations and assessments amounted to 2.463 billion yuan and decreased by 2.1%, accounting for 12.4%; geological science and technology amounted to 1.547 billion yuan and increased by 9.0%, accounting for 7.8%; and data services and informatization amounted to 0.319 billion yuan and decreased by 0.9%,accounting for 1.6%.

3. Spending in geological exploration of major minerals

In 2017, the investment in geological exploration of oil and gas minerals (including oil, natural gas, shale gas, coalbed methane and natural gas hydrate) amounted to 58.449 billion yuan, increased by 10.8% year on year. A total of 38 thousand km 2D seismic data was acquired, decreased by 27.4%, and 33 thousand km^2 3D seismic data was acquired, increased by 23.1%. A total of 2,727 exploratory wells and 20,696 development wells were drilled, increased by 0.44% and 31.1% respectively.

In 2017, the investments in geological exploration of gold, copper, coal and lead-zinc were the main part of the investment in non-oil and gas mineral exploration, accounting for 34.0% of the total investment in non-oil and gas mineral exploration in China. Compared with the previous year, the investments in gold, copper, coal, lead-zinc, molybdenum, iron ore, phosphate rock, manganese, graphite, etc. decreased significantly, in which the degrees of decline for iron ore, molybdenum and phosphate rock investments ranked the front (Table 2-1).

II. Progress in Oil and Gas Exploration

In 2017, the newly-discovered geological reserves of oil and gas fell to the lowest levels in nearly 10 years. Oil and gas exploration activities were mainly conducted in Ordos, Tarim, Sichuan, etc., and sea areas. Ordos Basin continued to maintain a high growth of discovered geological reserves, and two oil fields (i.e. Huaqing and Jiyuan oil fields) more than one hundred million tons were discovered. Important discoveries were made in exploration of Chang 8 and Chang 9 oil reservoirs in Zhidan district of northern Shaanxi Province. Three gas-bearing structures have been discovered in Kelasu - Dabei structural belt in Kuche Depression

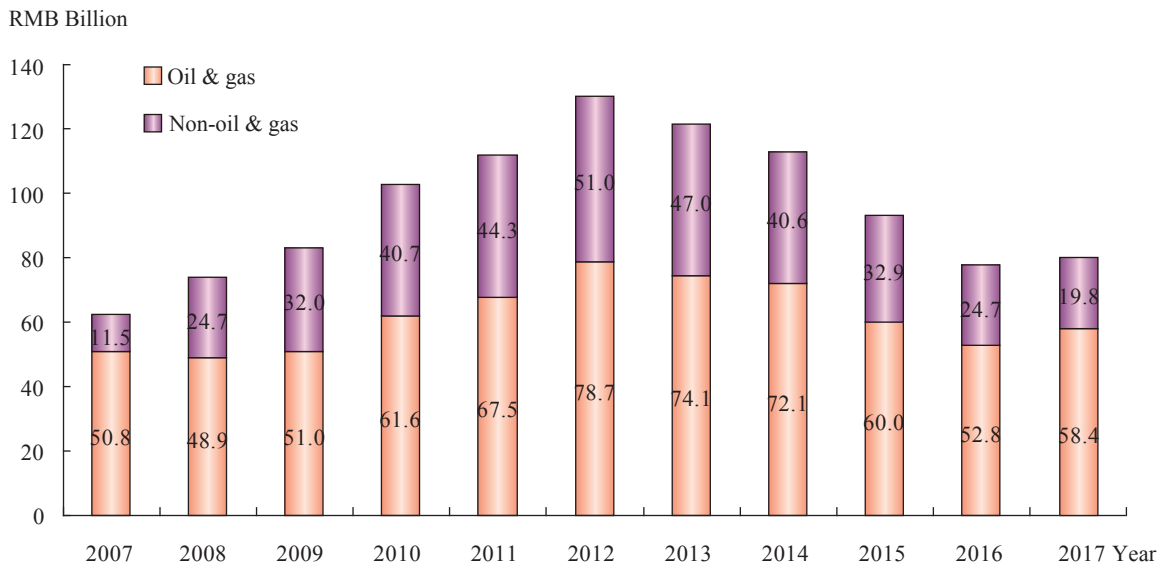

Fig. 2-1 Investments in Geological Exploration in China

Table 2-1 Spending in Geological Exploration of Major Non-oil and Gas Minerals in 2017

Mineral	Capital investment million yuan	Year-on-year growth/%	Drilling workload million meters	Year-on-year growth/%
Coal	1621	-7.2	0.96	-3.1
Iron ore	451	-56.1	0.30	-49.2
Manganese ore	141	-47.2	0.07	-30.0
Copper	1623	-48.1	0.81	-46.0
Lead-zinc	1355	-22.5	0.93	-16.2
Bauxite	274	-14.4	0.29	-12.1
Nickel	64	-19.0	0.03	50.0
Tungsten	116	-9.4	0.08	-11.1
Tin	78	-21.2	0.03	-57.1
Molybdenum	94	-56.5	0.06	-40.0
Gold	2174	-35.9	1.39	-32.9
Silver	248	-34.4	0.23	43.8
Phosphate rock	99	-54.6	0.10	-23.1
Graphite	209	-36.7	0.15	36.4
Potash	120	-4.0	0.02	-33.3

in Tarim Basin. Important new discoveries have been made in oil exploration in Shunbei area. On the north slope of Zhongguai in the northwestern margin of Junggar Basin, wells Mahu 8, Mahu 013 and Ke 017 in upper Wuerhe Formation produced more than 100 tons of oil per day, and new areas with reserves of more than 100 million tons were discovered. A new gas-bearing zone has been discovered in the risk exploration of the northern tip of Altun Mountain in Qaidam Basin. Important breakthroughs have been made in deep natural gas exploration in the Bohai Sea area, with capacity tested to be 135 tons of oil and 180 thousand m^3 of gas per day in well BZ19-6-2Sa in Bozhong Sag. The single well for Paleogene exploration in Lufeng Sag of Pearl River Mouth Basin produced 404 tons of naturally flowing oil per day.

The newly-discovered geological reserves of shale gas in Weiyuan County of Sichuan Basin amounted to 156.5 billion m^3. That of shale gas in Jiangdong and Pingqiao blocks of Fuling Gas Field amounted to 220.2 billion m^3, laying a solid resource foundation for the establishment of Fuling's 10 billion m^3 production capacity.

The quantitative evaluation of natural gas hydrate and the detailed description of reservoirs in Shenhu sea area in the northern South China Sea were systematically carried out, and the spatial distribution, characteristics and reserves potential of the reservoir were identified. Drilling targets were delineated and prioritized in natural gas hydrate plays in key sea areas. At present, two deposits with more than 100 billion m^3 of resources have been discovered in the South China Sea, and 11 prospective areas and 25 favorable blocks were delineated.

III. Progress in Non-oil and Gas Mineral Exploration

In 2017, a total of 109 new mineral deposits (37 large-, 29 medium- and 43 small-sized deposits) were discovered in China. The top 5 minerals present in the newly discovered mineral deposits are gold (17), graphite (11), coal (8), lead-zinc (5), iron ore (4), silver (4) and phosphate rock (4).

New developments were continuously made in integrated exploration. A large uranium deposit named Dalin was discovered in Tongliao integrated exploration area in Inner Mongolia. The deep prospecting discovery of gold was remarkable. Thick, large and high-grade gold ore bodies were discovered at the depth of 2,800 m in Jiaojia Fault Belt on Jiaodong Peninsula. A total of 1.32 million tons of lead-zinc were newly discovered in Sachakou deposit in Huoshaoyun lead-zinc integrated exploration area in West Kunlun, Xinjiang . The Pb-Zn

resources newly discovered in Fankou lead-zinc integrated exploration area of in Guangdong Province totaled 1.05 million tons. A total of 15 thousand tons of silver resources were newly discovered in the silver-polymetallic deposit situated at Shuangjianzi Mountain in the integrated exploration area at the southern foot of Greater Khingan Mountains in Inner Mongolia. A large deposit at Wanlong Mountain was discovered in Dulong integrated exploration area in Maguan County, Yunnan Province, and 77 thousand tons of tin resources were newly discovered. The deep prospecting results of manganese in the integrated exploration area in Chengkou, Chongqing were remarkable, and the new manganese resources amounted to about 110 million tons. More than 70 million tons of crystalline graphite were newly discovered in Huangyangshan integrated exploration area of in Qitai, Xinjiang. A total of 427 thousand tons of quartz-vein type lithium were newly discovered in Shaotangou deposit in Kangding-Daofu-Yajiang rare metal integrated exploration area in Sichuan Province. The beryllium-tungsten-tin polymetallic ore body with further prospecting potential was discovered for the first time in the Zhaxikang integrated exploration area, in Cuonadong region, Tibet.

Feature 2–1 New Progress in Mineral Exploration with Geological Exploration Fund

In 2017, the National Geological Exploration Fund effectively coordinated financial funds to make them continue to play their important role in mineral exploration. The Central Geological Exploration Fund is still in the process of reform and is carrying out follow-up management and maintenance of two projects at home and abroad.

Provincial geological exploration funds invested RMB 3.362 billion, of which RMB 2.582 billion was invested in mineral exploration, accounting for 21.4% of the total investment in non-oil and gas mineral exploration and 45.9% of the government-financed investment in non-oil and gas mineral exploration in that year in China. Of the 780 mineral exploration projects implemented, the investments in gold, copper, coalbed methane, geothermal water and lead-zinc ranked the top five, and the coal was not in the top five. The number of non-ferrous metal mineral projects and the amount of funds surpassed that of energy minerals for the first time.

Among the 80 newly discovered large- and medium-sized mineral deposits, 105 tons of gold resources were newly discovered during the prospecting of gold in Zhaoxian District, Laizhou City, Shandong Province. A total of 38.92 million tons of resources were newly discovered during the prospecting of graphite in the northwestern Linkou County, Heilongjiang Province. A total of 190 million tons of iron ore resources and 239.09 million tons of gypsum resources were discovered during general exploration of Dadaliangou iron ore-gypsum deposits in Dengta City, Liaoning Province.

Chapter III
Development and Utilization

In 2017, China's demand for mineral commodities remained growing and the energy consumption structure was continuously optimized. The fixed assets investment of the oil and gas extraction industry began to rebound, and the supply capacity of major mineral commodities was continuously strengthened. The outputs of primary energy, crude steel, ten kinds of non-ferrous metals, gold, cement and etc. continued to rank first in the world. The construction of demonstration bases for comprehensive utilization of mineral resources was completed fully, the requirements for three indicators - mining recovery rate, dressing recovery rate and comprehensive utilization rate of six minerals such as magnesium and niobium were issued, and the sixth promotion list of 62 advanced and applicable technologies was published.

I. Mining Fixed Assets Investments

In 2017, the mining fixed assets investments in China totaled 920.9 billion yuan, decreased by 10.0% year-on-year, and fell for the fourth consecutive year. Among them, the investment in coal mining, washing and dressing industry totaled 264.8 billion yuan and decreased by 12.3%. The investment in oil and gas extraction industry totaled 264.9 billion yuan and increased by 13.9%. The investment in ferrous metal mining and dressing industry totaled 75.1 billion yuan and decreased by 22.8%. The investment in non-ferrous metal mining and dressing industry totaled 110.9 billion yuan and decreased by 21.3%. The investment in non-metal mining and dressing industry totaled 175.5 billion yuan and decreased by 16.3% (Fig. 3-1).

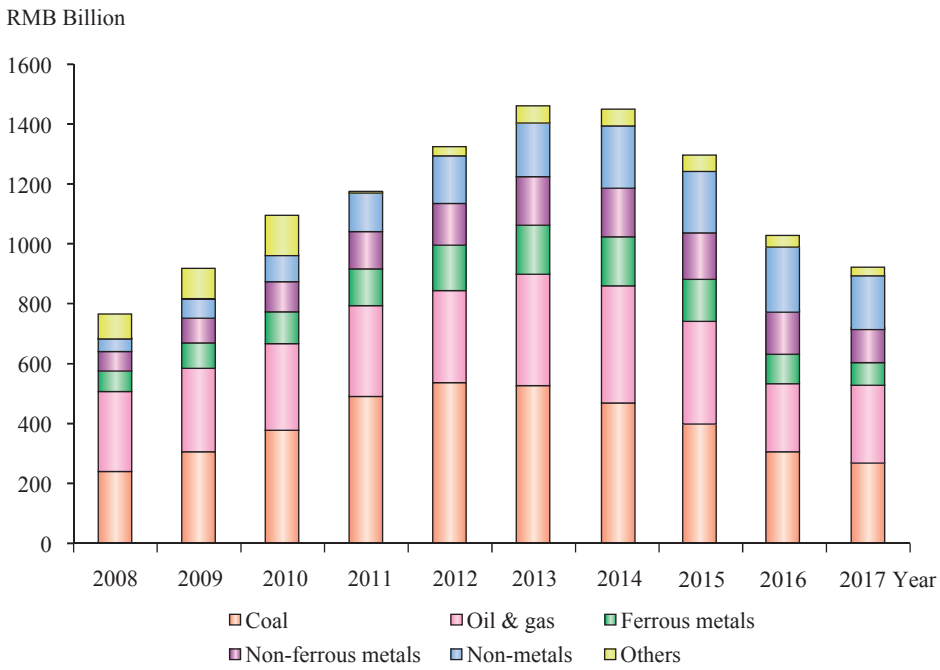

Fig. 3-1 Mining Fixed Assets Investments

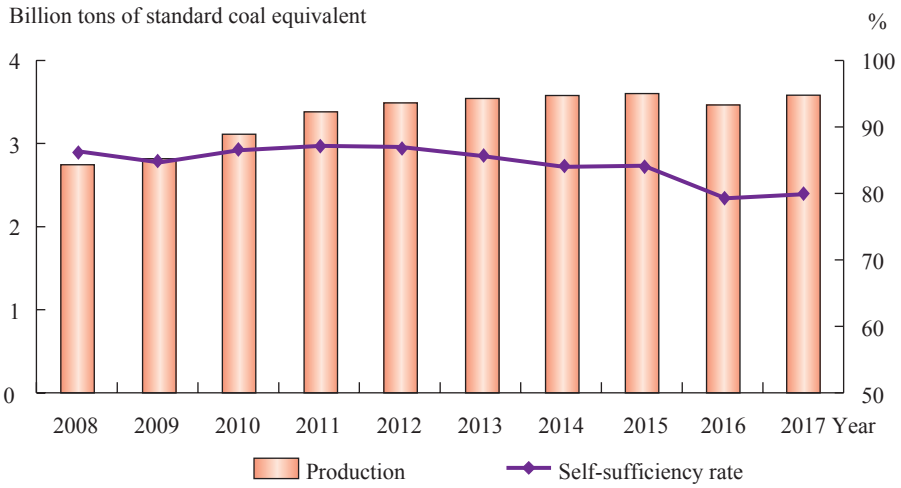

Fig. 3-2 Production of Primary Energy

II. Production and Consumption

1. Energy

China is the world's largest energy producer and consumer. The total primary energy production in 2017 was 3.59 billion tons of standard coal equivalents, showing an increase of 3.6% over the previous year (Fig. 3-2). The total consumption was 4.49 billion tons of standard coal equivalents, showing an increase of 2.9%, and the energy self-sufficiency rate was 80.0%. In 2017 energy consumption, coal accounted for 60.4%, oil 18.8%, and natural gas and other energy 20.8%.

China's energy consumption structure has been continuously improved and the proportion of coal continues to decline. In 2017, the proportion of coal consumption decreased by 1.6% over the previous year and by 11.1% over 2008 (Fig. 3-3).

Coal production ranked first in the world for many years, reaching 3.45 billion tons in 2017 and increasing by 3.2% year-on-year. The coal consumption was 3.80 billion tons, increased by 0.4%. Oil production ranked the seventh in the world, and was 192 million tons, decreased by 4.0% (Fig. 3-4). The oil consumption was 596 million tons, increased by 5.2%. Natural gas production ranked the sixth in the world, and was 147.42 billion m^3, increased by 8.5%. The natural gas consumption was 240.44 billion m^3, increased by 14.8%.

2. Metals

In 2017, the production and consumption of crude steel, ten kinds of non-ferrous metals and gold ranked first in the world. Among them, the production of iron ore was 1.23 billion tons, increased by 7.1% over the previous year, and the iron ore consumption was 1.57 billion tons (standard ore). The production of crude steel was 830 million tons, increased by 5.7% (Fig. 3-5). The production of ten kinds of non-ferrous metals was 53.778 million tons, increased by 3.0%. Among them, the production of refined copper was 8.889 million tons, increased by 7.7%; and the production of electrolytic aluminum was 32.273 million tons, increased by 1.6%. The production of gold was 426.1 tons, decreased by 6.0%. The consumption of gold was 1,089.0 tons, increased by 9.4%.

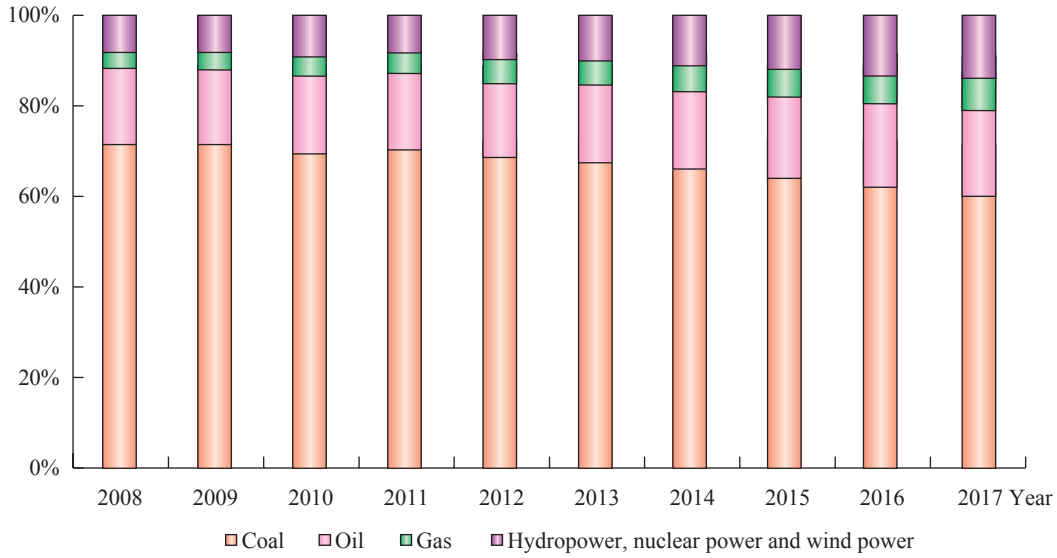

Fig. 3-3 Primary Energy Consumption Structure

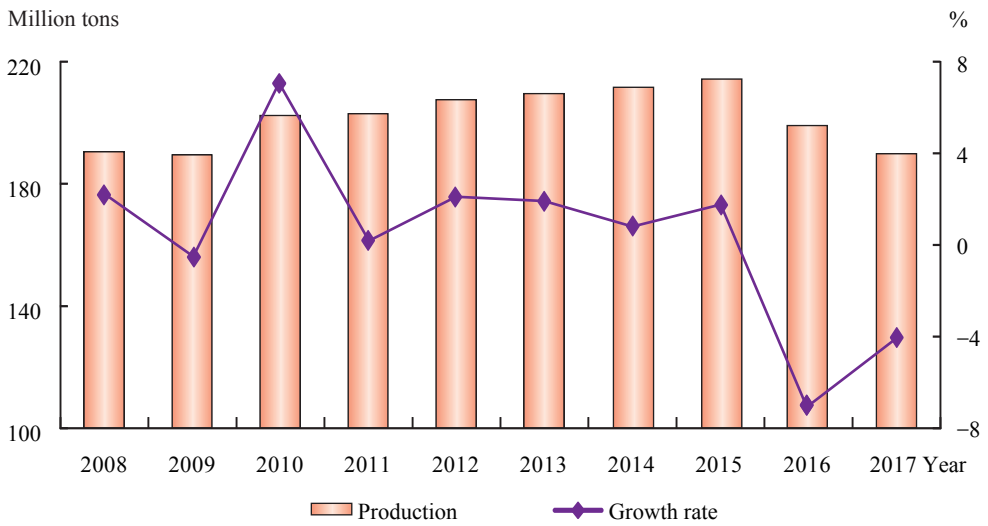

Fig. 3-4 Crude Oil Production

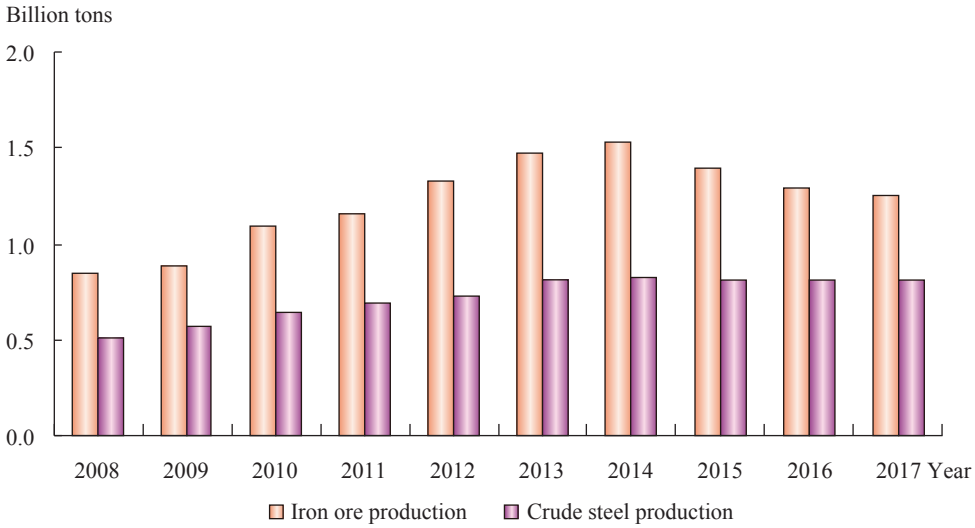

Fig. 3-5 Production of Iron Ore and Crude Steel

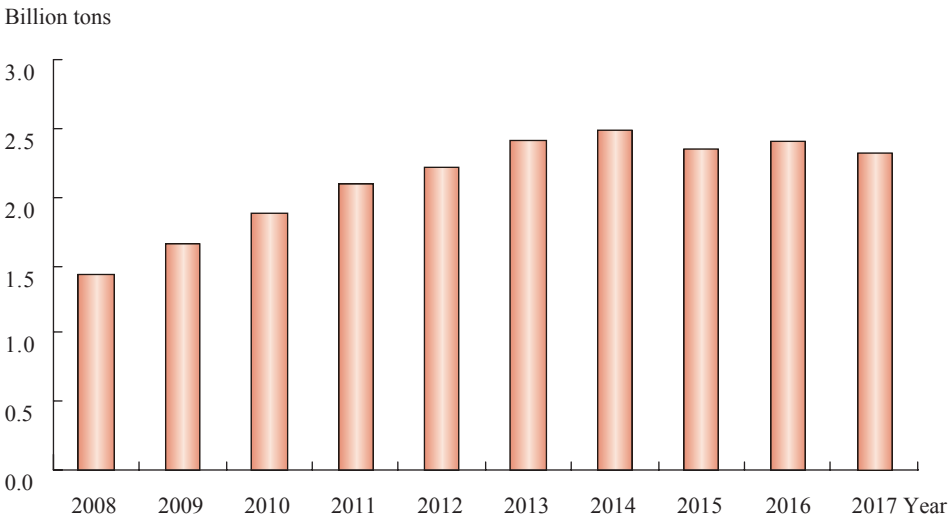

Fig. 3-6 Cement Production

3. Non-metals

In 2017, the production of phosphate rock was 120 million tons (containing 30% P_2O_5), increased by 0.6% over the previous year. The output of plate glass was 790 million weight cases, increased by 3.5%. The production of cement was 2.32 billion tons, decreased by 0.2% (Fig. 3-6).

III. Conservation and Comprehensive Utilization

1. Minimum requirements of "three rates" index

In 2017, the minimum requirements for mining recovery rate, dressing recovery rate and comprehensive utilization rate of six minerals, i.e. magnesium, niobium, tantalum, siliceous raw material, bentonite and mirabilite, were issued for rational exploitation and utilization of these mineral resources. So far, the minimum requirements for mining recovery rate (recovery factor), dressing recovery rate and comprehensive utilization rate of 39 minerals were issued, and the evaluation system for conservation and comprehensive utilization of major minerals was further improved.

2. Advanced and applicable technologies

In 2017, the sixth promotion list of 62 advanced and applicable technologies was published. There are 7 technologies for coal, 3 for oil and gas, 32 for metals and 20 for non-metals (Table 3-1). At present, the promotion list of 334 advanced and applicable technologies has been released.

3. Construction of demonstration bases for comprehensive utilization of mineral resources

In 2017, the Ministry of Land and Resources and the Ministry of Finance approved 40 demonstration bases for comprehensive utilization of mineral resources. Over the past five years, the central government has invested 19.3 billion yuan and enterprises has invested more than 400 billion yuan. The planning and construction goals are well accomplished (Table 3-2).

Table 3-1 Promotion list of Advanced and Applicable Technologies for Comprehensive Utilization of Mineral Resources (The Sixth Group)

Coal (7)	1	Digitalized process for high-efficiency extraction of coalbed methane
	2	Technology for ballasted flocculation magnetic separation of wastewater in underground coal mine
	3	Technology for high-efficiency detection and treatment of hidden dangers caused by water disasters in coal mine
	4	Packaged technology for down-hole deep drilling rig in coal mine
	5	Technology for optimization of complete equipment for safe and efficient mining of coal in fully mechanized caving face
	6	Key technology of soft rock support and coal pillar-free mining in the Southwestern
	7	Surface water recharge technology
Oil and gas (3)	1	Enhanced oil recovery technology of heterogeneous composite driving in reservoir after polymer driving
	2	IWD integrated intelligent decision-making technology in drilling
	3	Deep fixed-location displacement control technology by oil field waste
metals (32)	1	Technology for high-efficiency fine grinding and cleaning of magnetite difficult to grind and beneficiate
	2	Technology for comprehensive utilization of magnetite tailings and reuse of tailings pond
	3	Technology of comprehensive recovery, energy-saving and consumption-reducing for phosphorus and copper resources associated with ultra-poor iron ore
	4	Key technologies for large-scale mining of super-large underground metal mines
	5	A new integrated process for tailings disposal
	6	Construction system and key technologies of smart ferrous mine
	7	Digitalized management system of underground mining based on GIS and space object-oriented approach
	8	Large-scale upward waste-free mining technology for deep low grade ore deposit
	9	Modular portable core drill
	10	Safe and efficient mining technology for inclined thin ore body
	11	Key technology for grinding classification-based expert control system

Continued

metals (32)	12	Environmentally-friendly technology for high-efficiency dry-wet dust removal and desulfurization for titanium concentrate drying
	13	Technology integration and engineering transformation of complex polymetallic beneficiation at high altitude
	14	Technology for clean, high-efficiency and comprehensive utilization of complex polymetallic ores associated with low-grade copper, lead, zinc and iron
	15	A new technology for high-efficiency, quality-based separation and fully reuse of beneficiation wastewater from lead-zinc polymetallic ores
	16	Technology for recovery of associated low-grade scheelite from tailings
	17	Key technology for synthesis of allyl isobutyl sulfur polyurethane
	18	Mining technology for delivery of yellow mud and gravel by high-pressure pump and cemented filling
	19	Green beneficiation process and technology for integration of super-large beneficiation equipment for molybdenum ore
	20	Technology for gold extraction from gold concentrate by biological oxidation in alpine region
	21	Technology for mining of residual ores at top and bottom pillars and corners
	22	Technology for comprehensive recovery of ultra-low grade copper associated with molybdenum ore
	23	Technology for integration of automatic control information processing system for lead-zinc ore beneficiation process
	24	Key technology for pressurized pre-oxidation of refractory gold ore containing arsenic
	25	A new integrated technology for green and efficient leaching and extraction of ion-adsorbed rare earth ores
	26	Technology for utilization of copper-bearing low-grade gold ore
	27	Mining technology of low-grade ore bodies in high-stress mined-out area
	28	Key technology for combined beneficiation and smelting of refractory polymetallic oxidized ores bearing fine-grained gold, silver and iron
	29	Optimization of business performance evaluation system in mining workshop
	30	Technology for recovery of rhenium from the tail gas in molybdenum concentrate roasting

Continued

metals (32)	31	Harmless treatment and comprehensive recovery of high-sulfur gold and copper tailings
	32	Technology for prioritized extraction of concentrate from strontium ore by color sorting and high-efficiency separation and beneficiation of celestite and pyrite
non-metals (20)	1	Technology for dry purification of low-grade bentonite
	2	Technology for high-efficiency flotation of complex associated fluorite at low temperature
	3	Intelligent supervision system for mobile equipment in mining area
	4	Technology for digital monitoring and comprehensive utilization of "three wastes" emissions from building aggregate mines
	5	Technology for neutral flotation of feldspar
	6	Technology for industrialized production of high-efficiency water purifying agent and dehydrating agent from diatomite
	7	Technology for iron removal and high-efficiency utilization of nepheline ores
	8	Technology for high-efficiency dust suppression in sand and gravel aggregate mines
	9	Technology for heavy medium separation and recycling of industrial silicon slag
	10	Technology for digital mining of flux limestone ores
	11	Energy-saving technology of power generation by potential energy of downward belt conveyor with four-quadrant medium voltage frequency convertor
	12	Technology for harmless treatment and comprehensive utilization of water in phosphate rock mine
	13	Technology for production of potassium sulfate from sulfuric acid subtype salt lake brine
	14	Safe and efficient mining technology for thick and gently-inclined phosphate rock
	15	Technology for production of magnesium by electrolysis of residual brine
	16	Technology for production of soda ash from by-products in salt lakes
	17	Key technology for resource utilization of lean and fine refractory collophanite
	18	Technology for combined support of portable single props and flexible net
	19	Compartment-typed cut-and-fill mining technology
	20	Integrated intelligent control technology for mining, beneficiation and backfilling of phosphate rock

Table 3-2 Overview of Some Construction Achievements in Demonstration Bases for Comprehensive Utilization of Mineral Resources

Minerals	Oil and gas	Coal	Iron ore	Non-ferrous metals	Rare and precious metals	Non-metals
Number of bases	6	5	4	14	4	6
Exploitation and utilization level	Recovery rate increased by 6%	Mining recovery rate increased by 6.5%	Mining recovery rate increased by 8% and dressing recovery rate increased by 6.2%	Mining recovery rate and dressing recovery rate generally increased by 1%~6%	Gold mining recovery rate increased by more than 5% and dressing & smelting recovery increased by 3%	Generally increased by about 5%
Revitalized resources	Revitalized oil 1.8 billion tons, output value increasing by 200 billion yuan	3.9 billion tons, output value increasing by 130 billion yuan	1.56 billion tons, output value increasing by 2.04 billion yuan	480 million tons of copper ore	4.1 tons of gold	110 million tons of phosphate rock and 200 million tons of potash, realizing the industrial utilization of lithium resources in salt lakes
Technological innovations	During the construction period, 72 national science and technology awards, 354 provincial and ministerial awards and 1,362 authorized patents were obtained. 120 scientific research and innovation platforms such as national key laboratories were established. 700 standards (136 national standards) were formulated (revised).					
Resources Saving	The arable land occupation decreased by 29 thousand mu, green land increased by 43 thousand mu, and reclaimed land was up to 47 thousand mu. 5.745 million tons of standard coal equivalent and 1.18 billion tons of water were saved.					

Note: One demonstration base for comprehensive utilization of radioactive minerals such as uranium is not included.

Chapter IV
Rehabilitation and Restoration of Mine Geological Environment and Green Development

The rehabilitation and restoration of mine geological environment was actively implemented, the green exploration advocated, and the construction of green mines comprehensively advanced. Four support policies - mining right policy, land use policy, fiscal policy and financial policy were clearly defined, and a series of typical models of green mine construction were established.

I. Rehabilitation and Restoration of Mine Geological Environment

1. Rehabilitation and restoration of mine geological environment

In 2017, there are about 44.3 thousand hectares of newly increased recovery area of mines in China, of which 28.2 thousand hectares of production and construction mines were restored, accounting for 63.7%, and about 16.1 thousand hectares of abandoned mines were restored. A total of 6,268 mines were restored, mainly located in Inner Mongolia, Ningxia, Shandong, Anhui, Xinjiang, Shaanxi, Shanxi, Jiangsu, Qinghai ,etc.

2. Construction of geology parks and mine parks

From 2017 to 2018, 31 new agencies with national geopark qualification were listed, 9 new national geoparks were entitled, and 4 new UNESCO world geoparks were approved.

Up to now, 270 national geoparks have been approved, of which 209 have been named, 61 have been granted with construction qualification for national geopark. There are 343 provincial geoparks, distributed in 31 provinces and cities and the Hong Kong Special Administrative Region, of which, 37 world geoparks were named by UNESCO, ranking first in the world. There are 88 mine parks granted with national construction qualifications, which planning construction area is more than 10,000 km^2, and 33 mine parks have already been opened.

II. Green Exploration

1. Idea of green exploration

Green exploration, a practice of the green development idea, minimizes the negative impact on the ecological environment by using advanced new methods, equipment and technology. The geological prospecting in the New Era should not only explore mineral resources, but also protect ecological environment. In 2017, guided by the green development idea, based on the sustainable development of mineral exploration and the breakthrough in mineral prospecting, trainings were actively carried out and advanced experience was greatly promoted.

2. Technology for green exploration

Efforts were made in the research, compilation and implementation of green exploration standards. The *Green exploration guidelines* (Standard of China Mining Association) were issued in accordance with the *Implementation Opinions on Accelerating the Construction of Green Mines*. Techniques like drilling-instead-of-trenching, multi-hole drilling in a platform and multi drilling branches in a drilling hole and portable modular prospecting equipments were promoted.

III. Green Mines

1. Industry standards for construction of green mines

Industry standards for non-metals, chemicals, gold, coal, sandstone, onshore oil and gas, cement limestone, metallurgy, non-ferrous metals, etc. have been formulated in terms of six factors-mine environment, resource development methods, comprehensive utilization of resources, energy-saving & emission-reduction, scientific & technological innovation and digitalized mine, as well as enterprise management and image. The standards were put forward for the construction of green mines.

2. Pilot regions for the development of green mining industry

In September 2017, the *Announcement on Construction of Pilot regions for Green Mining Development* was issued by the Office of Ministry of Land and Resources. Pilot regions were selected in cities or counties with relatively abundant resources, relatively concentrated mines, favourable mining order, urgent needs for transformation and upgrading, and high enthusiasm of local governments in terms of the principles of policy guidance, local government as the main participant, one scheme for one region, characteristics highlighting, innovation driving, and demonstration guiding, aimed at the optimization of the layout of mines, the adjustment of the mining industry structure, the promotion of the construction of green mines , and the innovation of green development management.

3. Construction of green mines

Green mines have made remarkable achievements in high-efficiency and comprehensive utilization of resources, energy saving and emission reduction, ecological protection, etc. which reflect the high level of green development of the mining industry. A number of typical models have been established and have played a leading role in the efficient exploitation of oil and gas resources, green mining of coal resources, high-efficiency and comprehensive utilization of associated resources of metals minerals, chemical industry, environment protection of non-metals mines, modernized mine operation,harmonious relations with community and the sharing of the benefit of resources development.

Chapter V
Policies and Regulations on Mineral Resources

Since 2017, China has continued to promote the reform of the administrative approval system on mineral resources, canceled numbers of administrative approval items, revised the *Regulations on the Administration of Geological Data* and abolished the *Regulations on the Administration of Geological Exploration Qualification*. The real property rights system of mineral resources has been continuously improved and the reforms of the mineral resources management system and taxes & fees have been pushed forward.

I. Policies and Regulations on Mineral Resources

1. Administrative regulations

The *Regulations on the Administration of Geological Data* has been amended. On March 1, 2017, according to the *State Council's Decision on Amending and Abolishing Some Administrative Regulations*, (State Council Decree No. 676) the second paragraph of Article 15 of the *Regulations on the Administration of Geological Data* has been amended as follows: "Geological data other than those specified in the preceding paragraph should be made public by geological archives or agencies within 90 days from the date of submission. If those data can not be made public, the agencies receiving such data should protect them in accordance with the regulations of the competent department of geology and mineral resources under the State Council."

The *Regulations on the Administration of Geological Exploration Qualification* has been abolished. On March 19, 2018, the State Council issued the *Decision of the State Council on Amending and Abolishing Some Administrative Regulations* (State Council Decree No. 698) and abolished the *Regulations on the Administration of Geological Exploration Qualification* (State Council Decree No. 520, promulgated by the State Council on March 3, 2008) for the cancelation items of geological exploration qualification administration approval.

2. Policies

Innovating resources allocation by government. On January 11, 2017, the General Office of the CPC Central Committee and the General Office of the State Council issued the *Guiding Opinions on innovating resources allocation by government*, calling for the establishment and improvement of the natural resources property rights system, the improvement of national natural resources assets management system, the improvement of the system of paid use of natural resources, and the guidance and restraint of spatial planning on natural resources allocation.

Adjusting the market supply and demand. In April 2018, the *Notice on Adjusting the Relevant Provisions of "Opinions on Supporting the Steel and Coal Industry to Resolve Over-Capacity and Realize Development from Difficulties"* was issued by the Ministry of Natural Resources which supported for the coal industry to release high-quality capacity and promoted the dynamic balance of supply and demand.

Improving urban geological work. On September 1, 2017, the Ministry of Land and Resources issued *the Guiding Opinions on Improving Urban Geological Work*, and proposed to achieve the following three major goals by 2020. Firstly, basically established the modern geological work system compatible with new urbanization development. Secondly, basically established the system of environmental planning, management, protection and rational utilization of urban geological resources. Thirdly, explored and formed a systematic, industrialized and green exploitation and utilization model of urban underground space resources.

II. Reforms of Mineral Resources System

1. "Two unifications" of natural resources management

After the establishment of the Ministry of Natural Resources, we will establish regulatory

agencies to manage state-owned natural resource assets and monitor natural ecosystems, and improve environmental management systems. In terms of mineral resources management, it will be responsible for the investigation, monitoring & evaluation, unified "mineral rights" registration, paid use, rational exploitation and utilization of mineral resources, as well as the management of geological exploration industry and the national geological work.

2. Transfer income and occupancy fee systems of mineral rights

Establishing the mineral rights transfer income system. The distribution coefficient was 4:6 between the central government and the local governments in the transfer of mineral rights. At the same time, the reform of the mineral rights transfer system was accelerated, the competitive transfer of mineral rights was fully realized, and the agreement transfer was strictly limited. In June 2017, the Ministry of Finance and the Ministry of Land and Resources jointly issued the *Interim Procedures for the Collection and Management of Mineral Rights Transfer Income*, which was implemented on July 1, 2017.

By June 2018, Henan, Tianjin, Inner Mongolia, Chongqing, Guangxi, Shanxi, Hainan, Gansu, Qinghai, Yunnan, etc. had successively released local market benchmark prices for mineral rights, whilst Zhejiang, Hubei, Hunan, Liaoning, Jilin, Jiangxi, Heilongjiang, Guizhou, Xinjiang, Hebei, etc. had released the exposure drafts on market benchmark prices of mineral rights transfer income. Besides the above regions, Sichuan, Guangdong, etc. are also carrying out relevant work.

Establishing the mineral rights occupancy fee system. The existing mineral exploration rights fee and mining rights fee were integrated into the mineral rights occupancy fee which was dynamically adjusted according to the price fluctuation of mineral products and the needs of economic development, and the distribution coefficient between the central government and the local governments was 2:8.

3. Reform pilots of mineral rights transfer system

In 2017, the reform of the mineral rights transfer system, which took the provinces Shanxi, Fujian, Jiangxi, Hubei, Guizhou and Xinjiang as pilots, was carried out in an orderly manner, and a number of good experiences and practices were explored. The proportion of competitive transfer of mineral rights in the pilot provinces continuously increased, sustained efforts were put into decentralization, and the registration management of mineral rights became more

standardized, which accumulated useful experience for the promotion and implementation of the reform of the mineral rights transfer system nationwide in 2019.

On June 7, 2017, the Ministry of Land and Resources announced the implementation of the *Decision on Entrusting Six Provincial (e.g. Shanxi Province) Land and Resources Authorities to Implement the Approval and Registration of Some Mineral Resources Exploration and Exploitation Previously Implemented by the Ministry of Land and Resources* (Decree No. 75 of the Ministry of Land and Resources), and decided to entrust Shanxi, Fujian, Jiangxi, Hubei, Guizhou and Xinjiang provincial land and resources departments to implement the approval and registration of some mineral resources exploration and exploitation previously implemented by the Ministry of Land and Resources within their respective administrative areas.

4. Mineral rights approval and registration system

In order to implement the State Council's reform requirements of "decentralization, supervision and service optimization" and further improve the mineral rights approval management system, the Ministry of Land and Resources issued four normative documents in 2017, namely *Mineral Rights Transfer Rules, Notice on Further Standardizing Approval, Registration and Management of Mineral Resources Exploration, Notice on Further Standardizing Mineral Rights Application Materials and the Notice on Improving Issues Related to Approval, Registration and Management of Mineral Resources Exploitation* to further standardize mineral rights transfer, standardize and improve the approval, registration and management of mineral exploration rights and mining rights, streamline and merge mineral rights application materials, and continuously improve the business environment in mineral exploration and development.

5. Mine geological environmental rehabilitation and restoration fund system

The mine geological environmental rehabilitation and restoration deposit was adjusted to the mine environmental management and restoration fund with standardized management, unification of duties & rights and convenient use. In November 2017, the Ministry of Finance, the Ministry of Land and Resources and the Ministry of Environmental Protection jointly issued the *Guiding Opinions on Canceling the Mine Geological Environmental Management and Restoration Deposit and Establishing the Mine Geological Environmental Rehabilitation and Restoration Fund*, which came into effect on the date of issuance. At

the same time, the *Guiding Opinions of the Ministry of Finance, Ministry of Land and Resources and State Environmental Protection Administration on Gradually Establishing a Responsibility Mechanism for Mine Environmental Rehabilitation and Ecological Restoration* was abolished.

III. Taxes on mineral resources

1. Resources tax

On November 20, 2017, the Ministry of Finance and the State Administration of Taxation issued the *Resource Tax Law of the People's Republic of China (Exposure Draft)*. There were 19 articles in the *Exposure Draft*, which specified that resource taxpayers were the enterprises and individuals that explored mineral resources or produced salt in the territory of the People's Republic of China and other sea areas under the jurisdiction of the People's Republic of China, and the objects of taxation were mineral products and salt.

On December 1, 2017, the pilot range of water resources tax was first expanded to nine provinces (autonomous regions and municipalities) including Beijing, Tianjin, Shanxi, Inner Mongolia, Henan, Shandong, Sichuan, Ningxia and Shaanxi.

In 2017, the national resources tax revenue totaled 135.3 billion yuan, showing an increase of 42.3% over the same period last year, and accounting for 0.94% of the total tax revenue in China. From January to June 2018, the resources tax was 84 billion yuan, increased by 20.2%.

2. Environmental protection tax

On December 25, 2016, the *Environmental Protection Tax Law of the People's Republic of China* was released as Presidential Decree No. 61 and operated on January 1, 2018. On December 25, 2017, the State Council promulgated the *Regulations on the Implementation of the Environmental Protection Tax Law of the People's Republic of China*, which was implemented simultaneously with the *Environmental Protection Tax Law* from January 1, 2018. This was considered to be the first special tax law in China to embody the "green tax system" and promote the ecological civilization construction. China levied the environmental tax and ceased the sewage charges from January 1, 2018.

Table 5-1 Items and Amounts of Environmental Protection Tax Related to Mineral Resources

Item		Unit	Amount
Atmospheric pollutants		Per pollution equivalent	1.2 yuan to 12 yuan
Water pollutants		Per pollution equivalent	1.4 yuan to 14 yuan
Solid wastes	Coal gangue	Per ton	5 yuan
	Tailings	Per ton	15 yuan
	Hazardous wastes	Per ton	1000 yuan
	Smelting slag, fly ash, slag and other solid wastes (including semi-solid and liquid wastes)	Per ton	25 yuan
Noise	Industrial noise	Exceeding the standard by 1~3 decibels	350 yuan per month
		Exceeding the standard by 4~6 decibels	700 yuan per month
		Exceeding the standard by 7~9 decibels	1,400 yuan per month
		Exceeding the standard by 10~12 decibels	2,800 yuan per month
		Exceeding the standard by 13~15 decibels	5,600 yuan per month
		Exceeding the standard by 16 decibels or more	11,200 yuan per month

Chapter VI
Mineral Resources Management

Since 2017, the mineral resources management departments in China continuously innovated and improved management methods, actively carried out the mid-term evaluation of the implementation of the third round of the national mineral resources plan, strengthened the supervision and management of geological exploration and further optimized the pattern of mineral exploration. The departments carried out a pilot of unified "mineral rights" registration of mineral resources and reserves, established and improved the mineral resource reserve system, and optimized the approval procedure for overlaid important mineral resources. The departments improved the "mineral rights" approval registration system, upgrade the management level of mineral rights, strengthened the protection and supervision of mineral resources, and further improved the support capability of mineral resources .

I. Mineral Resources Planning and Management

1. The third round of mineral resources planning

The spirit of the State Council for approval of the national mineral resources plan (2016 - 2020) was fully implemented, 31 provincial general mineral resources plans were approved and implemented, and various departments in different regions were guided in preparation of more than 300 municipal general mineral resources plans, more than 1600 county-level mineral resources general plans, Shanxi coalbed methane resources exploration and

exploitation plans and other special plans. A national unified mineral resources planning database platform was established, basically created a mineral resources planning system compatible with the transformation of government functions and classification and graded classification management of mineral resources.

2. Mid-term evaluation of national mineral resources plan

On May 29, 2018, the Ministry of Natural Resources issued the *Scheme for Mid-term Evaluation of the Implementation of the National Mineral Resources Plan* (2016 - 2020).

The preliminary evaluation showed that nearly 70% of the 45 indicators in the 3 categories identified in the plan were well completed or completed ahead of schedule with obvious effect. First, a pattern of mineral resources development with 103 energy resource bases and 267 national planned mining areas as the main part was formed, and the development of resource industry agglomeration was accelerated, with 14 coal resource bases producing more than 94% of the total coal in China. Second, the exploitation and utilization structure was further optimized, and the number and scale of mines showed a "rise and fall" trend. The number of mines decreased by 19% compared with that in the planned base period, the average production capacity increased by 34%, and the proportion of the large- and medium-sized mines increased to 16%. The pattern of coordinated development of large-, medium- and small-sized mines with large groups as the main participant was basically taken shape. Third, the level of exploitation and utilization of mineral resources was further raised, and the yield of major mineral resources in the country increased by about 12% over the planned base period. Fourth, the allocation of mineral resources became more reasonable, more efforts were made to implement the zoning system for mineral rights, and more than 12,000 exploration and mining blocks were designated in local plans. The reasonable setting of mineral rights was implemented in accordance with the principle of one planned block and one main participant. Fifth, the layout of exploitation and utilization became more reasonable, the exploitation of resources in the Beijing-Tianjin-Hebei area was strictly controlled, the orderly development of advantageous resources along the "Belt and Road" Initiative in China was guided, and the interactive cooperation and green transformation and upgrading of mineral resources development in the upper, middle and lower reaches of the Yangtze River economic belt were promoted.

II. Geological Exploration Management

1. Basic situation of geological exploration industry

In 2017, a total of 428,300 employees were employed in entities engaged in non-oil and gas geological exploration (hereinafter referred to as "geological exploration entities"), decreased by 8.21% year-over-year. Among them, there were 212,000 geological exploration personnel, decreased by 8.15% over the same period last year. Of the geological exploration personnel, 154,500 were technicians, decreased by 6.76%. Of these technicians, 49,800 were senior technicians, decreased by 5.50%, and 78,900 were intermediate technicians, decreased by 5.96%. The per capita remuneration of workers in geological exploration entities nationwide was 76,100 yuan, increased by 12.08%.

The total income and expenditure of geological exploration entities in China decreased slightly. The total income of geological exploration entities nationwide was 160.905 billion yuan, decreased by 6.24%. Among them, the revenue of geological exploration industry was 60.087 billion yuan, decreased by 9.30%. The total expenditure of geological exploration entities nationwide was 129.637 billion yuan, decreased by 8.24% over the previous year, of which 53.422 billion yuan was spent on geological work, falling by 0.28% over the previous year.

The assets of geological exploration entities nationwide totaled 584.981 billion yuan, increased by 0.13%. Total liabilities amounted to 322 billion yuan, decreased by 2.64%.

2. Promotion of the management reform of oil & gas exploration and exploitation

The spirit of the CPC Central Committee and the State Council for deepening the reform of the oil and gas system was implemented. The transfer of shale gas blocks was proactively carried out and the Guizhou provincial government was entrusted to auction off Zhengan shale gas exploration block. More efforts were made to push ahead the pilot reform of oil and gas exploration and exploitation in Xinjiang, and the Xinjiang Uygur Autonomous Region government was entrusted to list and sell the Keping South, Wensu and Wensu West oil and gas exploration blocks. The pilot reform of coalbed methane mineral rights approvals was implemented, and the coalbed methane authorization and approval pilot range was expanded from Shanxi to six provinces (regions) like Xinjiang and Guizhou, etc., in which Shanxi

Provincial Department of Land and Resources completed the transfer of 10 coalbed methane exploration blocks by public bidding.

3. Supervision and management

We proactively studied and developed procedures for supervision and management of geological exploration entities during and after exploration to meet the new requirements of the new situation, carried out the clean-up of administrative regulations and normative documents involved in the cancellation of approval items, formulated and issued standards and norms for carrying out geological exploration activities, promoted the spot checks based on "random selection of objects and inspectors, and exposure of results to the public", strengthened supervision over the performance of geological exploration entities, and promptly investigated violations of laws and regulations. We also established the national geological exploration information publicity platform, and implemented the abnormalities list and blacklist system.

III. Management of Mineral Resources and Reserves

1. Unified "mineral rights" registration pilot

A solid progress was made in the pilot work of unified "mineral rights" registration of mineral resources with proved reserves, and the main task of "knowing the background of resources, setting up accounts, and building platforms" was established. A smooth progress was made in two pilot areas in Fujian and Guizhou, special investigations were conducted in 16 provinces and 5 oil and gas companies, expanding the coverage and finding out basic rules. We actively and steadily promoted the unified "mineral rights" registration of mineral resources, laying the foundation for the establishment of a natural resource asset management system.

2. Publicity of exploration and exploitation information of mineral rights holders

In 2017, there were 26,100 publicized exploration projects nationwide, with a publicity rate of 94.0%, and 64,000 publicized mines with a publicity rate of more than 91%. In addition, there were more than 8,600 exploration and exploitation projects identified according to

the spot checks based on "random selection of objects and inspectors, and exposure of results to the public", with a spot check rate of 9%. The on-site verification was completed. The mineral rights holders who failed to publicize information according to regulations, concealed the real situation, resorted to deceit, or failed to fulfill their legal obligations were included in the abnormalities list publicized according to procedures to receive social supervision.

3. Reserves standardization system establishment

A solid progress was made in the establishment of the reserves standardization system. The international exchanges and cooperation were continuously deepened, and the English version of the Chinese Standard for Classification of Solid Mineral Resources and Oil & Gas Reserves (draft) was finished. China's document corresponding to UNFC classification framework was jointly released. The study of the rules for disclosure of information on solid mineral resources and reserves in the capital market and the application of the international classification standards for mine cases were organized, the cooperation with CRIRSCO (Committee for Mineral Reserves International Reporting Standards) was strengthened, and a foundation was laid for the implementation of the "Belt and Road" Initiative and for mining enterprises to go global.

4. Mineral land reserve

Researches on the mineral land reserve management system and operation mechanism were organized, and the reserve mechanism of important mineral deposits in nature reserve was explored. We made investigations and statistical analyses of the delimitation of nature reserve, mineral rights in nature reserve and mineral rights exploration investment, and conducted field researches in Xinjiang, Qinghai and other places. We also promoted the incorporation of mineral deposit reserve into the national reserve system, and accelerated the progress in overall promotion of mineral deposits, products and production capacity.

5. "Decentralization, supervision and service optimization" measures

The approval of important mineral resources overlaid by construction projects was strictly controlled, and mineral resources were effectively protected. The *Compilation of Practical Documents on Administrative Review of Mineral Resources and Reserves Management,*

Service Guide to Administrative Review of Mineral Resources and Reserves Management and Detailed Rules for Administrative Review of Mineral Resources and Reserves Management were compiled and released, standardizing the procedures for approval, review and filing, and registration review of overlaid minerals, improving the efficiency of handling affairs, and optimizing service.

IV. Mineral Rights Management

1. Basic information about mineral rights

By the end of 2017, there were 941 exploration rights of oil, natural gas, coalbed methane and shale gas in China, covering an area of 3284.6 thousand km^2, and 762 mining rights covering an area of 160.3 thousand km^2. In 2017, there were 16 new oil and gas exploration rights covering an area of 3165.68 km^2, 285 renewed exploration rights covering an area of 1154 thousand km^2, 97 changed and narrowed exploration rights covering an area of 134.7 thousand km^2, and 58 canceled exploration rights covering an area of 124.1 thousand km^2.

The total registered area of oil and gas exploration rights in China decreased from 3539.9 thousand km^2 in 2016 to 3284.6 thousand km^2, showing a decrease of 255.3 thousand km^2 and 7.2% decrease year-on-year. The total registered area of oil and gas mining rights in China increased from 154.2 thousand km^2 in 2016 to 160.3 thousand km^2, showing an increase of 6,100 km^2 and 4.0% increase year-on-year. In 2017, there were 17 new oil and gas mining rights covering an area of 6165.47 km^2, and 32 renewed mining rights covering an area of 1512.76 km^2.

There were 21,200 non-oil and gas mineral exploration rights covering a registered area of 363.3 thousand km^2 in China, decreasing by 16.9% and 20.8% respectively year-on-year. In 2017, there were 737 new non-oil and gas mineral exploration rights covering a registered area of 17.4 thousand km^2 in China, decreasing by 36.7% and 36.6% respectively.

There were 56.6 thousand non-oil and gas mineral mining rights covering a registered area of 95.9 thousand km^2 in China, decreasing by 13.6% and 4.7% respectively. The designed production capacity was 15.146 billion tons per year, increasing by 1.2%. In 2017, there were 1,559 new non-oil and gas mineral mining rights in China, decreasing by 14.3%. The registered

area was 1,785 km^2 and the designed production capacity was 833 million tons per year, increasing by 66.4% and 40.2% respectively.

2. Clean-up and classified disposal of mineral rights

The mineral rights in national nature reserves, national parks, national scenic spots and other protected areas were deployed and verified, laying a foundation for the classified disposal of mineral rights in protected areas. Focusing on national nature reserves, the mineral rights within the forbidden mineral resources exploration and exploitation areas in various protected areas within the administrative area were comprehensively investigated, sorted out and systematically analyzed. Investigation and research was actively carried out. The implementation of the rectification requirements of central environmental inspectors was guided in provinces, especially in the west, and work plans were studied and formulated, and the withdrawal and classified disposal of mineral rights in protected areas were carried out.

V. Management of Paleontological Fossils

1. Paleontological fossil monitoring system

A relatively complete fossil supervision and management system, standard system and expert team have been preliminarily established. By the end of 2017, a new management system and standard system involving all aspects of the supervision and management of paleontological fossils based on the *Regulations on the Protection of Paleontological Fossils and Procedures for the Implementation of the Regulations on the Protection of Paleontological Fossils* had been established, including the fossil excavation and entry/exit approval system, the circulation system, the identification system and identification standards of the centralized origin of fossils for key protection, the classification system and classification standards of collectors, the classification standards of fossils, the list of the first batch of key protected fossils, and the data storage requirements for fossil specimens, etc. In 2017, the composition of the third National Committee of Paleontological Fossil Experts was announced, and a national paleontological experts database including 152 specialists was established. Another 21 provinces established provincial committees of paleontological fossil experts.

After canceling the approvals of transfer, exchange and bestowal of key protected fossils among the fossil collectors, three measures were adopted to strengthen supervision of fossils during and after the event. The first was to clearly define the standard norms and conditions for transferring, exchanging and bestowing fossils among the collectors. The second was to establish management procedures for the record keeping to trace key protected fossils in time through the record keeping, and update the archives and databases of the key protected fossils. The third was to carry out spot checks based on "random selection of objects and inspectors, and exposure of results to the public" and other means to supervise and examine the collectors to ensure the proper protection of fossils under special protection.

2. Fossil excavation and entry/exit approval and management

By the end of 2017, a total of 41 fossil excavation applications had been approved, with excavation sites covering more than 20 provinces such as Jilin, Liaoning and Xinjiang. Through the approval of the excavations, the fossil excavation activities were gradually standardized, escorting the paleontological research, providing institutional guarantee to combat poaching, and rescuing fossils facing the risk of natural and man-made destruction in time. The approval of fossils involving the entry and exit and the identification of fossils illegally traded and seized by public security and other departments amounted to 64 times. Fossil specimens such as dinosaur egg nests were recovered from overseas in cooperation with customs.

3. Locality and specimen management of paleontological fossils

By the end of 2017, 481 localities of important paleontological fossils were discovered. There were 53 localities (e.g. Chaoyang City in Liaoning Province) included in the national list of places of origin of fossils under special protection. A total of 20 fossil villages were named to protect fossils in the fields and progress was made in the economic development of local fossils. Six fossil conservation and research centers were set up to continuously improve the scientific value of important fossil localities. The grading of collectors was carried out, and 20 collectors including China Geological Museum became the first group of top-level collectors of fossils. A total of 82 thousand specimens were registered for storage.

Chapter VII
Geological and Mineral Resources Surveys and Evaluations

In 2017, regional geological surveys (scale 1:50,000) covering an area of about 159 thousand km^2 were completed. In total, regional geological surveys (scale 1:50000) covering an area of 4.01 million km^2 were completed up to the end of 2017, accounting for 41.6% of the land area of China. In addition, mineral resource surveys (scale 1:50,000) covering an area of about 117 thousand km^2 were completed, 450 prospecting targets were identified, and 60 new mineral deposits were discovered. Geological surveys at the scale of 1:1,000,000 of marine areas under the jurisdiction of China have been completed, and 13 types of marine geological maps were compiled as well.

I. Basic Geological Surveys

In 2017, regional geological surveys (scale 1:50,000) covering an area of 159 thousand km^2 were completed with financial funds from the central government of China. Regional geological surveys (scale 1:50,000) covering a total area of 4.01 million km^2 have been completed at the end of 2017, accounting for 41.6% of the land area of China. In addition, regional geological surveys (scale 1:250,000) covering an area of 5 thousand km^2 were completed In 2017.

Gravity surveys (scale 1:50,000) covering an area of 4 thousand km^2 were conducted, geochemical surveys of soil quality at scale of 1:50,000, covering an area of 11 thousand km^2

were completed, and at scale of 1:250,000 covering an area of 186 thousand km^2 were also completed.

Aeromagnetic survey, airborne gravity survey and avionic survey or integrated surveys composed of multiple survey methods were carried out in 12 survey areas such as Qiangtang and Huayangchuan, together with aerogeophysical surveys covering about 390 thousand km completed (mainly at the scales of 1:50,000 and 1:100,000).

II. Mineral Resources Surveys and Evaluations

1. Oil and gas surveys and evaluations

Conventional oil and gas surveys and evaluations. Eighteen oil and gas target area were delineated in the Tarim Basin, Yin-E Basin, Wuwei Basin, Qaidam Basin, and the periphery of Junggar and Songliao Basins. High-yield commercial oil flows were found in Wensu County of Xinjiang autonomous region (i.e. daily production exceeding 40 m^3) and Fuxin City of Liaoning Province (i.e. daily production exceeding 15 m^3). The breakthrough of discovery of oil and gas was made in Carboniferous strata in Qaidam and Yin-E Basins.

Unconventional oil and gas surveys and evaluations. A total of 15 shale gas target area such as Changyang in western Hubei, Tongzi in northern Guizhou and Xuancheng in southern Anhui has been identified as favorable exploration regions. A major breakthrough was made in the survey of shale gas in Yichang area near to the middle regions of Yangtze River as highly-productive shale gas flow was obtained in the Sinian, Cambrian and Silurian strata. High-yield oil and gas were encountered in Wanxuanye Well 1$^{\#}$ in Xuancheng, Anhui, realizing the strategic expansion of shale gas exploration from the upper reaches to the middle and lower reaches of the Yangtze River. The surveys of coalbed methane in Liupanshui, Guizhou province, and Yibin, Sichuan province, etc. showed high-yield gas flows.

2. Non-oil & gas geological surveys and evaluations

In 2017, geological surveys of mineral resources were carried out around the key metallogenic belts, integrated exploration areas, major ore districts and large-scale resource bases. Mineral resource surveys (scale 1:50,000) covering an area of 117 thousand km^2 were completed, and a

total of mineral geological surveys (scale 1: 50,000) covering an area of 3.23 million km^2 were completed by the end of 2017, accounting for 33.5% of the land area of China. Moreover, 450 prospecting targets were identified, and 60 mineral deposits were discovered.

Fifty million tons of crystalline graphite ores were newly discovered in Huangyangshan graphite deposit in Xinjiang, with a total of 72.64 million tons of crystalline graphite minerals discovered. Four prospecting targets were identified in Cuonadong super-large beryllium deposit (located in Shannan region, Tibet), with predicted beryllium resource of 159 thousand tons, tin 190 thousand tons and tungsten (WO_3) 275 thousand tons. The Sizemuzu super-large lithium deposit in Ke'eryin ore district cluster in western Sichuan Province has discovered additional Li_2O 520 thousand tons. A total of 547 thousand tons of Li_2O and 1.45 million tons of brine type lithium ore were discovered in Dahongliutan, Xinjiang. Four rock series were identified as manganese-bearing rocks and two new concealed manganese-rich ore bodies were discovered in Ma'erkansu, West Kunlun, and the volume of manganese-rich ore resources increased to 45 million tons in this region. The largest carboniferous manganese ore deposit in China was discovered in central Guangxi, including four ore-prospecting targets, and the manganese ore resource was estimated at 83 million tons. The new potash salt (KCl) resource discovered in Qaidam Basin was 20 million tons, with a cumulative volume of over 371 million tons explored. An additional mineral resources of gold, estimated to be 100 tons, has been identified in the periphery of Jiangshan gold deposit in the eastern part of Anhui province.

3. Groundwater surveys and evaluations

Hydrogeological surveys (scale 1:50,000) covering an area of 55 thousand km^2 were carried out in Wumeng Mountain Area, Yimeng Mountain Area, Dabie Mountain Area, Southwest Karst Mountain Area and Northwest Ecological Fragile Area. For the purpose of lifting people our of poverty, 38 thousand m hydrogeological drilling was completed, and more than 140 wells were drilled, providing a stable drinking water source for people in poverty and water-deficient areas. In Wumeng Mountain, Dabie Mountain and Qaidam Basin, a total of 102 water-rich sections covering an area of 10 thousand km^2 were identified. Additionally high-quality mineral water resources were discovered in Dabie Mountain and Yimeng Mountain, with strontium content of 0.24~1.24 mg/L, and the recoverable resources were preliminarily estimated to be more than 12 million m^3/year.

A total of 9,883 groundwater monitoring stations were built by the national groundwater

monitoring project, of which 7,306 were newly built stations and the rest were upgraded stations. A total of more than 8,000 integrated automatic groundwater monitoring instruments were installed, which initiated the automatic collection and transmission of data of water level and corresponding temperature. Provincial information nodes were set up geological and environmental monitoring institutions and connected with national center information nodes using 10M dedicated network in 31 provinces.

4. Geothermal resource surveys and evaluations

Surveys of shallow-level geothermal energy in Xiong'an New Area were completed, and proving exploitation and utilization of shallow-level geothermal energy in this area were possible, which could meet the needs of heating and cooling of about 100 million m^2 of buildings, and geothermal energy in the core area could support 30 million m^2 of buildings, thus providing a basis for future energy utilization planning in Xiong'an New Area.

Geothermal resources were investigated and assessed in the Beijing-Tianjin-Hebei region. The available amount of shallow geothermal energy in the south of Beijing and central Hebei was equivalent to 119.9 thousand tons of standard coal, the annual recoverable amount of geothermal resources in the Guantao Formation in the Beijing-Tianjin-Hebei region was equivalent to 50 million tons of standard coal.

A major breakthrough was made in the exploration of hot dry rocks in Qinghai, and hot dry rocks at 236°C were encountered at 3,705 m in depth in Gonghe Basin. Eighteen hot dry rock bodies covering a total area of 3,092 km^2 were delineated in this basin and its periphery.

A survey of hot dry rock resources from large concealed rock bodies in the southeast coast was carried out. Consequently, the spatial distribution and occurrence characteristics of hot dry rock resources in Conghua Fogang, Guangzhou, as well as the thermal control characteristics of faults in Huangshadong geothermal field in Huizhou were primarily identified.

III. Marine Geological Surveys

1. Marine basic geological survey

Geological surveys of the marine areas (scale 1:1,000,000) under the jurisdiction of China have

been completed, and 13 types of maps such as structural map, geological map and mineral resource map were compiled. Regional geological surveys at the scale of 1:250,000 have been completed in seven map sheets such as Jinxi and Ledong. Comprehensive geological surveys of the coastal zones were carried out, China's coastal zone geological survey reports, specialized survey report on the coastal zone, major engineering geological survey reports on the coastal zone and atlas of resources and environment were completed, providing important basic data support for major engineering construction, marine economic development and theoretical findings of marine geology.

2. Oil & Gas surveys in sea area

Investigation of new areas, new series of strata, new formation and oil and gas resources in deep key sea areas such as the Yellow Sea and the northern South China Sea was continued. Favorable trap structures were identified from the 16 traps in the key target area of Yellow Sea, and well drilling positions were proposed accordingly. A well position for Mesozoic oil and gas drilling was proposed in the prospective hydrocarbon play of Chaoshan Depression in the northern South China Sea.

IV. Urban Geological Surveys

In 2017, environment geological surveys (scale 1:50,000) covering an area of 43 thousand km^2 were completed for cities at prefecture-level and above, and laid an important foundation for urban geological surveys conducted in Xiong'an New Area. The *Guiding Opinions on More Efforts Put into Urban Geological Work* and the *Specifications for Urban Geological Survey*, and published the *Overall Plan for Urban Geological Survey* (2017-2025). The urban geological surveys of Xiong'an New Area and Beijing sub-center showed a remarkable effect in supporting and serving the planning and construction of the above mentioned areas. The geological environment atlas that served Chengdu urban underground space exploitation and utilization, as well as the resource and environment atlas that served Guangzhou city planning and construction and green development of resources were compiled.

Chapter VIII
Geological Data Management and Services

In 2017, the number of archived geological data amounted to 504.5 thousand while the products of geological data collected by the National Geological Archives (NGA) to 144.6 thousand, with the digitalization rate of archived paper-based data up to 99.9%. The NGA has totally provided nearly 20 thousand kinds, more than 40 thousand sets and nearly 900 thousand pieces of geological data. The "GeoCloud 1.0" was officially released and served online in November, 2017. The total visits of users exceeded 560 thousand, and the downloads of Internet data and products reached to 7,285 times.

I. Geological Data Management

In 2017, some regulative documents were reviewed and systematically integrated. The *Notice of the Ministry of Land and Resources on Strengthening Geological Data Management* was issued to further strengthen the management of the final geological data, original geological data and physical geological data collected, standardize the collection procedures, simplify the work-flow, and improve service and supervision.

The *Notice on Five Implementation Rules Including the rule of Geological Survey Project Initiation and Renewal Evaluation* was issued to further standardize the procedures for the data collection and documentation of geological survey projects of the China Geological Survey.

II. Archived Geological Data

1. Final and original geological data

By the end of 2017, the number of final geological data at ministerial and provincial levels had grown up to 504.5 thousand, increasing by 2.4% over last year. The original geological data increased to 775.2 thousand by 10.98%. Among them, there have been 144.6 thousand archived final geological data, 7 thousand original geological data and 143.9 thousand archived electronic documents managed by the NGA, with the size up to 139 TB.

In 2017, the final geological data collected by geological agencies at all levels in China amounted to 15.2 thousand, whilst the original geological data to 7.6 thousand. Among them, the final geological data within National Geological Archives newly increased to 4.9 thousand, whilst new original geological data amounted to 2.6 thousand.

2. Physical geological data

In 2017, the Cores and Samples Center of Land & Resources (CSCLR) and 26 provincial geological data archives received a total of 351.8 thousand meters of cores, 8.3 thousand pieces of specimens, 11.2 thousand bags of cuttings, 50 thousand pieces of optic slices and 125.5 thousand bag/bottle of samples.

By the end of 2017, the geological data agencies at the provincial and ministerial levels had kept a total of 1.05 million meters of cores, 120.6 thousand pieces of specimens, 115.5 thousand bags of cuttings, 189.2 thousand pieces of optic slices and 1.83 million bag/bottle of samples.

3. Geological data digitalization

By the end of 2017, geological data agencies at all levels in China had completed the digitalization of 347 thousand files with more than ten millions of geological data. A national key geological borehole database of 0.9 million boreholes (with a cumulative footage of 240 million meters) was established, which included 0.93 million digital borehole histograms, 0.37 million profiles of exploration, 60 thousand engineering layout maps and 1.44 million sample analysis results tables.

The “GeoCloud 1.0” was officially released and served online in November 2017. The national-level inter-link and sharing of 75 geological survey databases in 10 categories and 2,382 geological information products in 8 categories, as well as some software systems and

information-based foundamental resources was complished, providing "one-stop" inquiry, browsing and download services to the community.

III. Geological Data Services

1. Geological data social service

In 2017, geological data agencies at all levels in China served 38.6 thousand visitors and provided 4.38 million pieces of geological data. Among them, the NGA served 5 thousand visitors and provided 898.2 thousand pieces of geological data. The CSCLR received 4,121 visitors from 191 groups, and a total of 54.4 thousand meters cores, 60 pieces of specimens and 121 thousand samples was utilized.

The number of geological data network services provided by geological data agencies at all levels in China increased rapidly, with 6.07 million visits to geological data websites, increasing two times over the previous year. Among them, the number of visits to the website of the NGA was 4.14 million, showing an increase of nearly 10 times.

2. Special geological data achievement service

In 2017, the NGA, Sichuan and Gansu geological agencies actively responded and provided special services in earthquake relief and geological disaster prevention. The cooperation between ministries and provinces was carried out, with special geological data services for the construction of Xiong'an New Area. Shanghai, Shandong and other provinces (autonomous regions and municipalities) supplied special geological data services for major project construction and urban planning. Archival agencies at all levels carried out publicity and service theme of activities on the World Earth Day, the National Land Day, etc.

3. Geological data service products

By the end of 2017, *China Geological Survey Annual Report* (2017) was released. The NGA and its all level agencies had released 820 thousand pieces of important geological borehole data, and published 2,381 regional geological maps (scale 1:50,000) nationwide. A total of 16 types of marine geological survey data were published, including 12 thousand geological samples, 73,905 km shallow profiles, 64,783 km single-channel seismic, 19,686 km of multi-channel seismic, 202 final maps (marine regional geological survey, coastal zone environmental geological survey), and 67 final reports.

Chapter IX
Scientific and Technological Innovations

The strategy of scientific and technological innovations in mineral resources was fully implemented, the metallogenic theories, prospecting models and exploration methods were innovatively created, a number of geological prospecting instruments and equipment were developed or integrated, and applications of comprehensive utilization technology of mineral resources were deepened. A great progress was made in the establishment of relevant standards in the mining industry to meet the needs of national standardization reform.

I. Research on Basic Geology and Mineral Theories

1. Research on basic geology

"Well Songke-2" (SK-2) recorded the most complete Cretaceous continental strata in the world. New evidences were found for the lithosphere structure and differential subduction of plates, material composition and growth transformation of the huge thick crust, and mantle channel flow in the collision zone of the Qinghai-Tibet Plateau. A digital map of granite and related rocks in the northern Xinjiang and its adjacent areas was compiled, and geological evidences of prominent differences in the compositions of the deep crust between the northern and central orogenic belts were found. The evolution process of the North China Craton was realized, in which a back-arc basin at 2.2~2.1 billion years became to a foreland basin at 1.85 billion years

ago, and three giant high-pressure granulite facies metamorphic belts were discovered, proving that the unification of the North China Craton at 1.9~1.85 billion years was related to Columbia supercontinent aggregation.

2. Metallogenic theories

The shale gas "four-control" accumulation mechanism, i.e. structural-controlled deposition, sediment-controlled lithofacies, lithofacies-controlled enrichment-preservation controlled gas reservoir, the shale gas's trinity-accumulation theory integrating "deep amphibious shale, stable structural preservation and formation overpressure" in complex structural areas was put forward. Five kind of shale gas accumulation models were established, i.e. simple anticline, reverse faulted anticline, residual syncline, reverse faulted syncline and basement uplift. The constraints of red-black rock series in continental basins on the sandstone-type uranium deposits were understood, a theoretical framework for large-scale uranium mineralization of epigenetic fluids in continental basins in northern China was created, and a speculative system of prospecting was established. In addition, the dome-controlled mineralization model was established, the formation mechanism of porphyry copper deposit in the collision system was clearly defined, the porphyry copper deposit theory was further developed, and the breakthroughs in the Be-W-Sn rare metal prospecting was guided. The preliminary virtualization of Zhaxikang lead-zinc deposit revealed the source of lead-zinc ore-forming fluids in the late collision stage. The gold mineralization model of Ailaoshan gold belt was established. The new understanding that the main collision lead-zinc mineralization in Himalayan-Zagros orogenic system occurred in the thrust fold belt rather than the continental basin was put forward, and a new model of MVT lead-zinc mineralization was established. It is confirmed that the Tianshan orogenic belt had tectonic deformation events in the late Mesozoic era, the Cenozoic uplift-disintegration process of southwestern Tianshan was reconstructed, and a new mineralization model of leakage recharge was put forward.

3. Metallogenic theory of natural gas hydrate

The reservoir-accumulation theory of natural gas hydrate system according to the geological characteristics of China's sea area has been established and laid a geological theoretical foundation for the determination of the marine pilot production target. The "two phases and three types" metallogenic theory has been established, the prospecting target has been accurately delineated in the South China Sea, and the pilot production target has been precisely

determined. The theory and method of "three-phase control" mining have been established to maintain the stability of the test production formation and ensure the continuity of gas production and environmental safety during the production test.

II. Exploration Technologies

1. Instrument and equipment

The vessel Ocean 6 completed its 33rd voyage of Antarctic and Oceanic scientific investigations, and the self-developed deep-sea submersible "Haima", which is remote controlled and unmanned, was successfully put into use. The development of three optical satellite prototype products was completed and the application of domestic satellite remote sensing data was promoted. Aviation geophysical exploration technology and equipment achieved a great leap forward, and six sets of exploration system equipment were developed, including the aeromagnetic three-component, the new high-precision aviation gravity, the fixed-wing time domain aviation electromagnetism and the helicopter podded time domain. A special unmanned helicopter for heavy-load intelligent geophysical prospecting was developed. The survey line of the pilot application of the developed aerial exploration equipment reached 54 thousand km. A number of urgently needed exploration devices such as distributed high-density multi-parameter electromagnetic detection system, borehole multi-channel induced polarization logger, cross-hole electromagnetic wave tomographic imaging system and *small-caliber intelligent core drilling rig* with drilling depth of 4000m were successfully developed. Moreover, a new X-ray fluorescence spectrometer with high power (4kW), optical-energy spectrum combination and multi-functions (overall analysis and element distribution analysis) was successfully developed to provide technical support for analysis and testing. The ultra-high temperature borehole trajectory measuring instrument was successfully developed to provide technical support for borehole trajectory measurement in high temperature environment (270°C and 120MPa). A large-scale TOF-SIMS scientific instrument dedicated to advanced application in isotope geology was successfully developed, and its performance reached the international advanced level, filling the domestic gap.

2. Methods and techniques

The large-scale software for processing and interpreting airborne geophysical data was developed and improved, and thus fast processing and interpreting of gravity, magnetic

force, electromagnetism, energy spectrum and other whole parameters were realized in the whole process on the same platform. The 3D measurement technology of surface electromagnetic method and the corresponding multi-functional interactive interpretation software system for 3D electromagnetic forward and backward modeling and visualization were studied and improved, realizing the leaping development of surface electromagnetic method from 2D to 3D exploration. The data processing and interpreting system for large penetration distance & high-resolution underground electromagnetic wave imaging technology and borehole IP measurement technology was developed and improved. The deep-penetrating geochemical exploration technology was developed and improved, and nano-copper crystals were synthesized for the first time in the laboratory. The intelligent drilling monitoring software for core drilling and the 4 thousand m-depth core drilling control software system were developed. Analysis and testing methods such as chemical tracer analysis for evaluation of fracturing effect, in shale reservoir, and investigation of water and soil quality and detection of organic pollution were studied and established, which greatly improved the analysis and testing ability and support service ability. The three-dimensional geological exploration technique and method system that mainly included exploration geophysics, exploration geochemistry, drilling, analysis and testing techniques from the air to the ground and underground and adapted to complex geological conditions was further improved.

3. Deep scientific drilling technology

The Continental Scientific Drilling Project in Songliao Basin (Well SK-2) has set a world record of the continuous coring of 311mm large-caliber (1650m) and *single coring* (30m, 41m, 33m) of three different calibers (311mm, 216mm, 152mm), innovated large-caliber coring technology system, of ultra-deep well, solved the problems of ultra-high temperature drilling technology and cementing technology, successfully implemented the 7018m Well SK-2 drilling project, becoming the deepest continental scientific drilling organized by Asian countries and the deepest drilling implemented in the past 22 years since the establishment of the International Continental Scientific Drilling Program (ICDP).

4. Natural gas hydrate exploration and exploitation technology

Independent innovations were made in six major technical systems, such as sand control, reservoir reconstruction, exploration, drilling and completion, testing and simulation experiments, environmental monitoring, and 20 key technologies such as deep sea access,

survey, and exploitation, providing a powerful method and technical support for natural gas hydrate exploration and production test.

III. Development and Utilization Technologies

For rhenium associated with molybdenum and copper, a new ion exchange process for rhenium was developed. The molybdenum (or copper) smelting eluent containing rhenium 3～70 mg/L had an adsorption rate of more than 97% and recovery rate of more than 95%. A new flotation agent was developed for the lead-zinc-copper polymetallic ores in southern Jiangxi Province, making the recovery rate of lead increased from 76% to 83%, the grade of lead concentrates increased from 44.38% to 51.98%, and the recovery rate of silver increased by 10.83 percentage points. In view of the lithium resources in western Sichuan, a new process of "Li-Nb-Ta mixed flotation - mixed flotation of concentrates and weak magnetic removal of iron - strong magnetic, heavy medium separation of Nb-Ta" was developed. The concentrate Li_2O had a grade of 6.13% and a recovery rate of 88.07%. Nb_2O_5 and Ta_2O_5 grade of niobium and tantalum concentrate were 36.14% and 32.74%, and the recovery rates of niobium and tantalum were 46.97% and 60.22%, respectively.

The technology of "laminated crushing – grading and classification – selective regrinding and reseperation" was developed for Alashan graphite deposit. The fixed carbon content of the concentrate was up to 96.39%, and the recovery rate of graphite concentrate of different particle size was up to 88.22%. For Hainan seashore quartz sand, mineral cleaning agent and process "scrubbing – grading – heavy medium seperation – magnetic separation" were developed, with $SiO_2 > 99.7\%$, $Fe_2O_3 < 80 \times 10^{-6}$ and $TiO_2 < 450 \times 10^{-6}$, in the product. The fluorite beneficiation technology of "pre-enrichment physical separation process" achieved a 50% waste removal rate through "concentrating by ore pre-separation – using waste to make sand", reducing the production of tailings and realizing recycling of wastewater in beneficiation process.

IV. Scientific and Technological Innovation Plans

In June 2018, Ministry of Natural Resources organized the selection of high-level innovative scientific and technological talents training project. The main research directions in the field

of geology and mineral resources were mineral prospecting and exploration, metallogenic theory, mineral resources evaluation and prediction, geochemical survey, drilling technology, aerogeophysical prospecting, geophysical exploration and other fields.

The overall layout of scientific and technological innovation and development of natural resources focused on promoting scientific and technological innovations in the field of geology and mineral resources in the following aspects:

Promote the implementation of major projects for deep earth detection. Focus on the advanced scientific and technological issues in deep earth, move forward to the deep earth, "perspect into the earth, explore resources deeply and utilize resources safely", and innovate deep earth science and dynamic theories.

Strengthen the research and development of key technologies for the exploration and evaluation of marine oil and gas. Innovate key technologies for investigation and evaluation of oil and gas in sea areas, independently innovate deep-sea drilling systems and key technologies, integrate the use of large-scale equipment and supporting technologies for production processes, and construct natural gas hydrate drilling and production vessels.

Overcome the major issues of green utilization of mineral resources. Develop technologies for utilization of refractory mineral resources and comprehensive utilization of tailings resources, accelerate the research and development of clean energy development and efficient utilization technology, and strengthen the research and development of new resources exploration and exploitation technology and equipment system.

V. Technical Standards of Geology and Mineral Resources

A recommended national standard (*Quality Standard for Ground Water*) and 35 recommended geological and mineral industry standards were issued and implemented, including the *Criterions for Urban Geological Survey, the Criterions for Geological Exploration of Graphite and Mica Minerals*, the *Design Criterions for Regional Ground Water Quality Monitoring Network*, the *Procedures for Construction of Ground Water Nesting Monitoring Well*, the *Geological Environment Monitoring Marks*, the *Procedures for Soil Geochemical Survey*, the *Technical Procedures for Multi-process Air Drilling*, the *Criterions for Large-scale Gravity Exploration*, and the *Criterions for Construction of Green Mines in Non-metallic Mineral Industry*.

Chapter X International Cooperation

With the implementation of China's overall diplomatic strategy, active response was made to the "Belt and Road" Initiative, and the bilateral and multilateral cooperation in the fields of geology and mineral resources was comprehensively promoted. Through international exchange platforms such as China Mining and China - ASEAN Mining Cooperation Forum, geological survey cooperation projects were actively carried out, and mining exchanges and cooperation with relevant countries were further expanded.

I. Bilateral and Multilateral Cooperation Mechanisms

1. Bilateral cooperation

Four cooperation agreements and action plans were signed with the Ministry of Mines of Chile, Ministry of Natural Resources of Canada, Ministry of Mines of Sudan, and Queen's University of Canada, etc.

More cooperation was explored with developed countries such as Britain and the Netherlands in the fields of oil and gas resource management, shale gas exploration and exploitation, and geological environment protection. Close cooperation was carried out with Laos, Cambodia, Papua New Guinea, Ethiopia, Namibia, Nigeria, Argentina, Peru, Mexico and other resource-rich countries in Asia, Africa and Latin America in the fields of geosciences research, geological survey and mining administration.

Under the framework of bilateral intergovernmental cooperation, high-level coordination mechanisms with Canada, Australia, South Africa, Mongolia, Kazakhstan, Argentina, Chile, Mexico and other countries in the mining industry were continuously consolidated. Through bilateral cooperation, it provided reference for geological survey, unconventional oil and gas development, mineral resource management and geological environment protection.

Twenty-eight cooperation agreements were signed with foreign geological survey agencies, and there were five new cooperation partners - Mali, Niger, Morocco, Montenegro and Bangladesh. More efforts were made to promote key bilateral cooperation projects between China and the United States, Germany, Canada, Italy and South Korea. The cooperation covered basic geological survey, deep earth exploration, marine geology, natural gas hydrate, shale gas, geological disasters, karst environment, groundwater and other fields. At present, 229 Memorandums of Understanding and project cooperation agreements have been signed with geological survey agencies, institutes and universities in 63 countries.

2. Multilateral cooperation platforms

With actively participating in multilateral meetings in the field of mineral resources, President Xi Jinping's initiative at the 24th and 25th APEC Economic Leaders' Meetings was implemented and promoted. The follow-ups to the Johannesburg Summit of the Forum on China-Africa Cooperation were put into practice, and the relevant expressions on energy and resources cooperation were included in China's *Africa Policy Paper*. Contributions were made to the preparations for the Sixth Ministerial Conference of the Forum on China - Africa Cooperation, and the 2018 Shanghai Cooperation Organization (SCO) Summit. The 2030 Agenda for United Nations Sustainable Development was implemented, and the revisions of the World Bank *Systematic Country Diagnostic* document and the formulation of the International Seabed Authority's regulations on seabed resources development were actively engaged. Relevant commitments on the *Minamata Convention on Mercury* were performed, and the image of a responsible power was established. More efforts were put into the communication and exchanges with UNESCO, the International Union of Geosciences, the International Institute of Mathematical Geology, CCOP and other institutions in terms of personnel recruitment and business cooperation. the 10th ASEAN + 3 Mining Senior Officials Consultation was attended, the mining cooperation issues with ASEAN countries in 2018 were planned and deployed, the 68th CCOP Steering Committee Meeting and the 53rd

CCOP Annual Session were participated in, and the formulation of CCOP 2018 Work Plan were engaged.

II. Opening-up and Cooperation

1. Resources Cooperation with countries participating in the "Belt and Road" Initiative

An action plan to promote the "Belt and Road" Initiative was developed, and an active response was made to the "Belt and Road" Initiative by promoting opening-up and cooperation in the field of resources, strengthening policy communication and information sharing. The outcomes of President Xi Jinping's meeting with the president of Rwanda were proactively put into practice, and the organization and implementation of Rwanda national mineral resources potential evaluation projects were promoted. Assistance was provided to Laos in carrying out geological and geochemical mapping in blank areas. New progress was made in satellite remote sensing interpretation with countries participating in the "Belt and Road" Initiative. The compilation of hydrogeological maps, groundwater resource maps and groundwater quality maps of adjacent areas between China and five Central Asian countries provided a geological basis for solving the problems of water shortage and ecological environment protection in the study areas. The China Geological Survey - Eastern and Southern Africa geoscience cooperation research center and the China-Arab geoscience cooperation research center were established. The China- SCO Geoscience Cooperation Research Center successfully held the "Belt and Road" Initiative International Geoscience Cooperation and Mining Investment Forum for the first time within the framework of the Eurasian Economic Forum.

China's advantages in geochemistry, satellite remote sensing and aero-geophysical participating in were taken, and substantive geological survey cooperation with 23 countries participating in the "Belt and Road" Initiative was carried out, mainly involving in geological mapping, geochemical mapping, technical training, technical cooperation and research, metallogenic regularity research and cooperative mapping. In 2017, a total of 40 international cooperation projects on geological survey were carried out, with a total annual spending of 178 million yuan, and the global geological and mineral resources information system was further improved.

2. Opening-up on geology and mineral resources

The revision of the *Catalogue for the Guidance of Industries for Foreign Investment* further expanded the opening up of the mining industry, and removed the entry restrictions on foreign investments in unconventional oil and gas, precious metals, lithium, etc. Multilateral and bilateral negotiations on the revision of minerals trade and investment rules were engaged, and the formulation of negative lists of trade in services was assisted, the degree of openness to mining investment and services in relevant countries (regions) was expanded, China-Russia bilateral agreements, China-Australia FTA evaluation, China-Peru FTA upgrade negotiations were assisted. WTO's trade policy reviews on Nigeria, EU, Brazil, West Africa and Cambodia, and seventh Trade Policy Review of China were coordinated,

3. International mining cooperation

The roles of platforms, such as the International Research Centre on Karst of UNESCO and the International Center on Global-Scale Geochemistry, were brought into full play, and the implementation of international scientific programs such as "EarthChem" was promoted. The International Geoscience Contrast Program (IGCP), International Continental Scientific Drilling Program (ICDP) and Coordinating Committee for Geoscience Programmes in East and Southeast Asia (CCOP) were actively participated in, and relevant international geoscience cooperation projects were implemented.

Special international science and technology cooperation projects were carried out to promote international cooperation in research, transformation and application of advanced and applicable technologies. More efforts were made to construct the International Joint Center on Global-scale Geochemistry and the International Scientific and Technological Cooperation Base for Deep-sea Geological Exploration.

4. Training course on geology and mineral resources for foreign trainees

A total of 16 training courses on geological survey for foreign geological and mineral officials and technicians were organized, and more than 400 geological and mineral officials and technicians from more than 50 countries and regions in Asia, Africa, Latin America and Central and Eastern Europe participated in the training courses, which established extensive cooperative relations, and laid a solid foundation for expanding bilateral and multilateral cooperation.

III. International Mining Cooperation Platforms

1. China Mining 2017

More than 10 thousand representatives from 54 countries and regions attended the China Mining 2017. The conference focused on promoting the Silk Road spirit and put forward the initiative of building a global community of mining destinies, which received a positive response. During the conference, the Ministry of Land and Resources conducted mining management and policy dialogues and exchanges with the mineral resources management departments of more than 10 resource-rich countries, strengthened policy guidance and support for mining investment, and achieved fruitful cooperation across the mining industry chain.

2. Mining cooperation forums

Under the overall framework of China - ASEAN Expo, China- Russia Expo and China-Mongolia Expo, China - ASEAN Mining Cooperation Forum, Northeast Asia Mining Cooperation Forum and China-Mongolia Mineral Resources Exploitation Conference were held to establish a cooperation platform for mining enterprises. Overseas investment forums for Chinese enterprises and explorers and developers were held to exchange experiences on overseas mining investment.

3. China Mining International Capacity Cooperation Enterprise Alliance

Efforts were made to promote the “Belt and Road” Initiative, actively create mining exchange and cooperation platforms at home and abroad, and further promote international mining capacity cooperation. China Mining International Capacity Cooperation Enterprise Alliance was established in September 2017. Based on the principle of “service, coordination, honesty, self-discipline, cooperation and win-win”, it played integrated advantages, set up an all-round service platform for mining international capacity cooperation, and promoted the policy communication, information communication and inter-industry cooperation.