

# Statistical Analysis of Coal Mine Accidents of China in 2018

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**Abstract**—Coal mines constitute the basic industrial resource in China. China has a large number of coal mines, but insufficient safety measures cause frequent safety accidents, while the number of deaths per year in each mine has been ranked second, second only to traffic accidents. Firstly, in this paper, the 2018 mine accident data from the accident occurrence areas, the occurrence time, and the type of accidents were analyzed. Secondly, a detailed analysis was carried out regarding the large accidents from different provinces and cities. Finally, countermeasures and suggestions were proposed, based on the causes of the accidents. This data analysis could provide reference for future coal mine production safety, leading to the prevention and control emphasis of coal mine production safety.

**Keywords**—coal mine; data analysis; large accident; safe production

## I. INTRODUCTION

The natural conditions of coal mines in China are generally bad, the production environments are specific, while the geological conditions are complex. These factors cause numerous types of widely distributed disasters. The variation and unpredictability of mine conditions result in more severe production situations. Therefore, it is necessary for coal mine enterprises to take long term and arduous precautions of safe production.

By 2018, the total amount of measured reserves of coal resources in China has shown an increasing trend, reaching 1666.673 billion tons. The distribution of coal resources in

Inner Mongolia Autonomous Region is relatively concentrated and the resource potential is great. The advantages of coal-based energy are obvious. The total estimated resources of coal in the whole region is 851.18 billion tons, of which the recoverable deposits are 411.065 billion tons, ranking first in the China. Shanxi Province has formed three hundred million tons and four 50 million tons of large-scale coal groups. The recoverable deposits of coal resources have reached 270.9 billion tons. Guizhou Province is rich in coal resources and has its own distinctive features. The recoverable deposits of coal resources are 65.399 billion tons, ranking the fifth in the China. At the same time of resource growth, the workload of mining has increased correspondingly, and the costs for safe production has increased.

This paper analyzes the 2018 mine accident data from the accident occurrence areas, the occurrence time and the type of accidents. Secondly, a detailed analysis was carried out in conjunction with the large accidents from different provinces and cities. Finally, countermeasures and suggestions were proposed, based on the causes of the accidents. This data analysis could provide ideas for the safety improvement of coal mines in China.

## II. STATISTICAL ANALYSIS OF ACCIDENTS IN CHINA'S COAL MINES IN 2018

### A. Occurrence area of the accidents

According to incomplete statistics, coal mine accidents occurred in 23 provinces and cities nationwide in 2018, accounting for 79% of all statistical districts. A total of 198 accidents occurred and 303 people died. The number of provinces and cities with more than 20 deaths has reached four. Among them, there were 26 accidents in Guizhou Province, with 43 deaths; 28 accidents occurred in Shanxi Province, and 30 people died. Table I shows the number of accidents and deaths in coal mine accidents across the country.

TABLE I. CHINESE COAL MINE ACCIDENTS STATISTICS BY AREA IN 2018

Area	Number of accidents	Death toll	Area	Number of accidents	Death toll
Total	198	303	Hubei	5	8
Beijing			Huan	5	10
Tianjin			Guangdong		
Hebei	1	1	Guangxi	1	1
Shanxi	28	30	Hainan		
Inner Mongolia	14	17	Chongqing	8	14
Liaoning	6	6	Sichuan	3	8
Jilin	5	7	Guizhou	26	43
Heilongjiang	10	22	Yunnan	14	19
Jiangsu			Tibet		
Zhejiang			Shaanxi	14	18
Anhui	11	11	Gansu	9	10
Fujian	3	8	Qinghai	3	3
Jiangxi	7	11	Ningxia	7	9
Shandong	5	27	Xinjiang	7	8
Henan	6	12			

Fig.1 and Fig.2 show the number of coal mine accidents and deaths in various provinces across the country. The darker the color in the picture, the more accidents occur and the more deaths. It can be seen from the figure that Shanxi, Guizhou, Yunnan, Shaanxi, and Inner Mongolia are high-incidence areas for coal mine accidents, and the number of deaths is also high, which is inseparable from the distribution of coal resources and historical conditions. Except for Yunnan Province, the coal production of the other four provinces is located in the top five in the China. Regardless of the total number of accidents or the number of deaths, the coal mine safety production situation in the five provinces is very serious. A total of 96 accidents occurred and 127 people died, accounting for 48.5% and 41.9% of the total respectively. To do a good job in the management of coal safety production in the country, we must first implement the safety production of these major coal mines and accident-prone areas to decrease the death rate of 100 tons of coal production

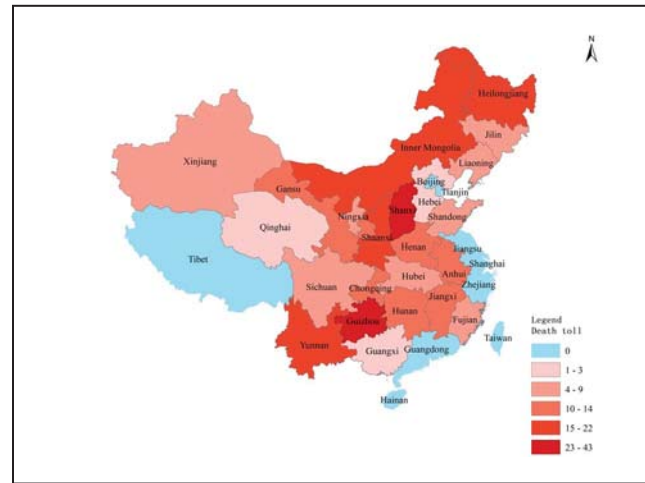


Figure 1. Number of accidents of different provinces

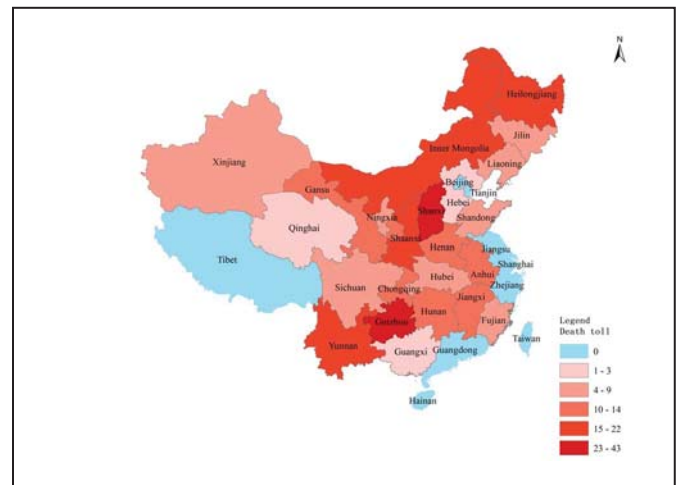


Figure 2. Number of deaths of different provinces

Shanxi's coal resources are widely distributed. The coal-bearing area is 62,000 square kilometers, accounting for 39.57% of the province's total area. In 2018, a total of 28 coal mine accidents occurred in Shanxi Province, killing 30 people. 10 electromechanical accidents occurred, resulting in 10 deaths; 9 transportation accidents occurred, resulting in 10 deaths; 4 roof accidents and 5 other accidents occurred. From the perspective of the causes of accidents, it was mainly electromechanical accidents and transportation accidents. The occurrence of these two types of accidents was not caused by objective reasons such as natural conditions. There were two main reasons for the occurrence of electromechanical accidents: equipment aging; improper operation of operators. Shanxi Province is a large coal mining province in China with a long history. Many coal mines had been in operation for many years, leading to aging of equipment. Timely repair and replace of equipment that poses a threat to safety production may avoid the occurrence of electromechanical accidents. At the same time, the safety training and education for operators should be strengthened. Most transportation accidents were also caused by subjective factors. In general, coal mine accidents in Shanxi Province can be controlled by the "human" factor.

In 2018, a total of 26 coal mine accidents occurred in Guizhou Province, killing 43 people. Regardless of the number of accidents or the number of deaths, the safety production situation was serious. Guizhou is the largest coal-producing province in the south of China. It is known as the “Southwest Coal Sea” and ranks fifth in the country in terms of coal reserves. Over the years, Guizhou Province has been a frequent occurrence of coal mine accidents. Roof accidents were the main cause of coal mine accidents in this region. The reason is that the geological conditions in Guizhou Province are complicated. The coal mines, especially the small and medium-sized coal mines, were lack of effective management. When mine pressure changed in the mining face, the roof support was not strengthened in time according to the actual situation [1]. Reducing the occurrence of roof accident is the top priority of coal mine safety production in Guizhou Province [2].

### B. Occurrence time of accidents

In 2018, the coal mine production safety accidents averaged 49.5 accidents and 76 deaths quarterly nationwide. The largest number of occurrences in a single quarter was the second quarter, with 50 occurrences and 74 deaths, accounting for 30.0% and 27.4% of the total. In the first quarter, there were 3 large accidents and 9 deaths; 6 and 24 respectively in the second quarter; 3 and 21 respectively in the third quarter; 7 and 48 respectively in the fourth quarter.

Spring Festival is located on the first quarter, which is a period of high attention to safety. All production enterprises were strictly engaged in safety production, so the accidents occurred relatively less in the first quarter. After a period of strict work on safety management, the safety production work had achieved some results, the second and third quarters were in such a slack period, so the possibility of accidents higher.

During the whole year, the number of accidents and deaths was the lowest in February, with the most accidents in May and the largest number of deaths in October (see Fig.3). China's Lunar New Year is located on February, the production activities of various coal mines are basically stopped, and the safety management of all aspects is very strict, so in this month the number of accidents and deaths decrease obviously. May and October are in the middle of the year, various safety management activities are weak, the emphasis on safety production is declining, and safety accidents are frequent.

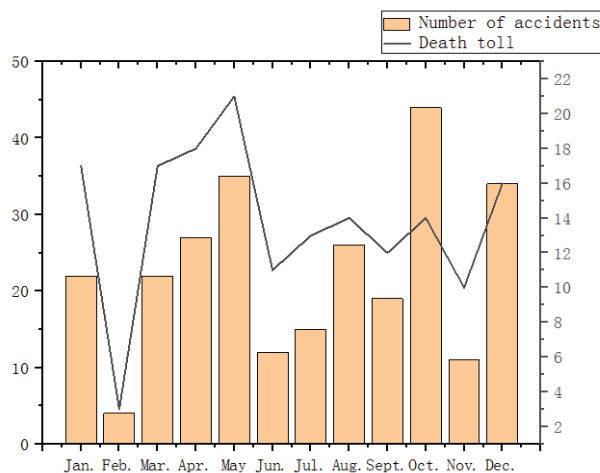


Figure 3. Analysis by month of accident occurrence

In 365 days of the year, coal mine accident occurred in 129 days, with average of 0.83 deaths per day, a maximum of 3 accidents in one day, and a maximum of 21 deaths a day (see Fig.4). In the years of improvement, China has achieved great results in the safety production management of coal mines. However, a coal mine accident occurred every three days in a year, and this data is still shocking. At the same time as production increasing, safety management measures should be taken to minimize the possibility of coal mine accidents.

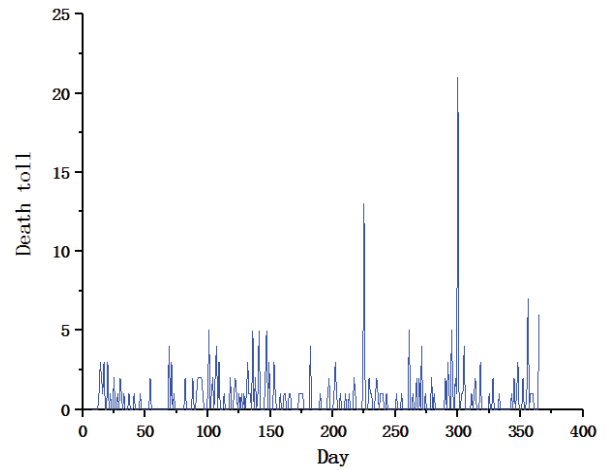


Figure 4. Analysis by day of death toll

### C. Analysis of different types of accidents

In 2018, there were 53 roof accidents and 86 deaths in coal mines nationwide. The number of accidents and deaths both ranked first, accounting for 26.8% and 28.4% of the total respectively; 44 transportation accidents and 58 deaths, accounting for 22.2% and 19.1% of the total respectively; 24 electromechanical accidents and 25 deaths, accounting for 12.1% and 18.5% of the total respectively; 24 electromechanical accidents and 25 deaths, accounting for 12.1% and 18.5% of the total respectively; 15 gas accidents and 56 deaths, accounting for 7.6% and 18.5% of the total respectively; 3 water hazard accidents and 10 deaths, accounting for 1.5% and 3.3% of the total respectively; 2 fire accidents and 3 deaths, accounting for 1.0% and 1.0% of the total respectively; 2 bombing accidents and 2 deaths, accounting for 1.0% and 0.7% of the total respectively; 20 other accidents and 21 deaths (see Fig.5).

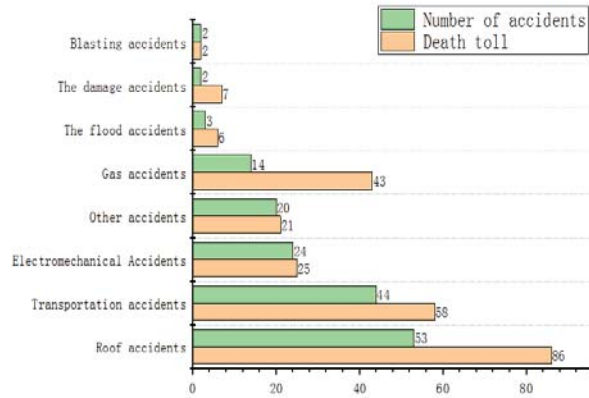


Figure 5. Analysis by type of accident

From the perspective of the cause of the accident, the number of occurrences of the roof accident and the number of deaths is the first, and accounted for 26.8% of the total number of the eight types of accidents. There are several main factors for this phenomenon: the first is the lack of understanding of complex geological conditions, and can't take effective measures in advance; the second is improper management of the support, in the management workers did not follow operating regulation of "the wall tapping and roof sounding" operating procedures, and the danger is not handled in time resulting in a bigger accident [3].

Secondly, the number of transportation accidents and the deaths caused were relatively high. Transportation accidents include accidents that occur during the operation of all transportation equipment [4]. Production practice shows that transportation accidents are mostly three violations of "zero-breaking and knocking", mainly in two aspects: first, the roadway transportation accident is like grabbing and jumping the conveyor in operation; the second is the oblique lane transportation accident, mainly for broken rope, sports car and other accidents.

Electromechanical accidents and gas accidents cannot be ignored. Electromechanical accidents refer to accidents caused by electromechanical equipment, including accidents that occur during maintenance and debugging [5]. The main cause of this type of accident was attribute to the operator whom did not follow the operating procedures during the operation; the second was the aging of the equipment, which posed a safety threat to the operators. There were more of subjective reasons for such accidents. Therefore, strengthening management in operations can greatly reduce the occurrence of various types of accidents.

Under today's technical conditions, it is not possible to accurately predict whether coal and gas outbursts occur, their strength and time. Accident investigation shows that many gas accidents are caused by imperfect ventilation system, wind stoppage, short circuit of air flow, breeze or windless operation. The main sources of gas ignition are electrical equipment explosion, illegal firing, and coal spontaneous combustion. Therefore, in the production process, ventilation and fire

prevention measures should be taken to avoid the occurrence of gas accidents to the greatest extent.

### III. STATISTICAL ANALYSIS OF LARGE ACCIDENTS IN COAL MINES IN CHINA FOR 2018

In 2018, there were 198 production safety accidents and 303 deaths in coal mines across China. There were 19 large accidents and 103 deaths in 15 districts, and no serious accidents occurred. There were 4 large accidents in Heilongjiang and 2 in Shandong. One large accident occurred in Inner Mongolia, Jilin, Fujian, Jiangxi, Henan, Hubei, Hunan, Chongqing, Sichuan, Yunnan, Shaanxi, Ningxia and Guizhou respectively (see Table II).

TABLE II. LARGE ACCIDENT STATISTICS OF CHINESE COAL MINE IN 2018

Area	Day	Type of accident	Death toll	economic loss (million yuan)
Jilin	1.7	Gas accident	3	3.74
Ningxia	1.10	Roof accident	3	3.12
Heilongjiang	3.3	Roof accident	3	2.33
Heilongjiang	4.4	Gas accident	5	4.30
Hubei	4.10	Gas accident	4	5.52
Hunan	5.9	Gas accident	5	
Henan	5.14	Gas accident	4	
Heilongjiang	5.20	Transportation accident	3	3.52
Heilongjiang	5.26	Water hazard	3	3.84
Guizhou	8.6	Gas accident	13	
Yunnan	9.11	Water hazard	4	9.19
Inner Mongolia	9.21	Transportation accident	4	4.99
Jiangxi	10.12	Water hazard	3	4.00
Shandong	10.20	Roof accident	21	
Sichuan	10.25	Gas accident	4	4.08
Shandong	12.7	Gas accident	3	4.76
Chongqing	12.15	Other types	7	
Shaanxi	12.24	Gas accident	5	
Fujian	12.29	Gas accident	6	

In large accidents, there were 9 gas accidents, resulting in 49 deaths, with an average of 5.44 deaths per accident; 4 roof accidents, resulting in 30 deaths, with an average of 7.50 deaths per accident; 3 water accidents, resulting in 10 deaths, average of 3.33 deaths per accident; 2 transportation accidents, resulting in 7 deaths, with an average of 3.50 deaths per accident; and 1 other accidents, resulting in 7 deaths (see Table III ).



TABLE III. STATISTICS OF LARGE COAL MINE ACCIDENTS BY TYPE IN 2018

accident type	Number of accidents	Death toll	A (%)	B (%)
Gas accident	9	49	60.0	87.5
Roof accident	4	30	7.5	34.9
water hazard accident	3	10	100.0	100.0
Transportation accidents	2	7	4.5	12.1
Other accidents	1	7	5.0	33.3

A= The number of large accidents / the total number of accidents of this type

B= The deaths of large accidents / the total deaths of accident of this type.

#### IV. SUGGESTIONS

##### A. Improvement in production safety awareness of personnel at all levels

Most causes of coal accidents were due to human factors. Therefore, it is necessary to improve the safety awareness of the administrator and production personnel at all levels [6]. The regulatory authorities should fulfill their supervisory responsibilities and must not allow mines with potential safety hazards to be operational. The regulatory authorities should strengthen the supervision and inspection of coal mine production safety, while obligating enterprises to investigate and manage potential safety hazards. The production safety education and training must increase; Safety knowledge education and training for manager must be carried out.

##### B. Enterprises fulfill responsibilities

Enterprises must fulfill the responsibility of safe production, strictly implementing production safety laws and regulations and technical safety standards, improving the internal safety management system, conscientiously organizing safety inspections, strengthening safety inspections, as well as conducting solid investigations of accidents to ensure work safety; the emergency rescue plan for enterprise production safety accidents must be improved; various types of accident scientific rescue activities must be regularly carried out; emergency rescue and disposal capacity must be improved.

##### C. Establishment and improvement of laws and regulations

Perfect production safety legislation is the basic work for scientific management along with production safety supervision guarantees. According to the current situation of coal mine production safety in China, legislation should start from the following aspects. First, establish a coal mine safety regulations system. The "Safe Production Law" to be taken as the parent law, fully drawing on the development experience of industrialized countries, formulate coal mine safety legislation. Second, the drafting of new regulations must be accelerated. On the basis of refurbishing existing regulations, the drafting of new regulations must be quickly prioritized [7].

#### V. CONCLUSIONS

In this paper, the numbers of accidents and deaths in 2018 from the perspectives of areas, time and type of accident were analyzed. From the perspective of district, Shanxi and Guizhou were the most frequent accident areas. The cause was that the coal resources in these areas were rich, while the geological conditions were complex, leading to difficult safe production control.

From the perspective of the time of occurrence, the accidents in the second quarters were more severe. This is because the stage of strict security of the Spring Festival has passed, and there was still a period of time from the end of the year. The production safety measures were relaxed during this period.

From the perspective of accident type, the roof accident was the most common type of accident. During coal mine resource exploitation, the original geological balance was broken and the new balance was required to be re-established. During the establishment of a new balance, if the external support, required for the establishment of a new balance was not fully predicted and the corresponding measures had been taken in advance, the possibility of a mine collapse accident would be higher.

In general, the safety control work of coal mines in 2018 was improved compared to the previous year, but the production safety management of coal mines is required to be further improved, to minimize the possibility of accident occurrence. Safe production must be governed by laws and regulations. It must also be strictly supervised by the regulatory authorities and the company policy on safe production. It also requires the cooperation of frontline workers.

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