Analysis on the Causes of Coal Mine Accidents and Research on Prevention Countermeasures

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Abstract: In order to explore coal mine accident prevention and control countermeasures, the coal mines in Jiangxi Province were taken as representatives to analyze the causes of coal mine accidents in Jiangxi Province from 2000 to 2013 and put forward targeted prevention and control countermeasures. It is of great significance to the prevention and control of similar coal mine accidents.

1. Introduction
Coal mine disasters in Jiangxi Province are very serious, with disasters such as water, fire, gas, and roof all available \cite{1-5}. The death rate per million tons of coal from 2011 to 2013 was 1.28, 1.23 and 1.58, respectively, which were 2.27 times the national average, 3.29 times and 5.39 times. The province has a large number of small coal mines. There are 532 coal mines with an annual output of less than 90,000 tons, accounting for 93.5% of the total number of coal mines in the province. These coal mines have poor mining conditions, low management level, weak technical force, low level of mechanization, and disasters serious. Therefore, the analysis of the causes of coal mine accidents in Jiangxi Province and the prevention and control countermeasures are of great significance to coal mine disaster prevention and safety production.

2. Overview of coal mines in Jiangxi Province
The coal resources in Jiangxi Province are widely distributed and relatively concentrated. According to coal-bearing characteristics and structural characteristics, they are divided into five coal fields, namely, North Jiangxi Coal Field, Pingxiang-Leping Coal Field, Shangrao Coal Field, Ji’an-Luoshi Coal Field, and Gannan Coal Field, among which Pingxiang-Leping Coal Field Coal field reserves are the largest, accounting for 79.4%. The main coal-bearing strata are the Leping Coal Measures and Anyuan Coal Measures, accounting for 98.3% of the proven reserves. The main coal seams are the single B4 coal seam of the Laoshanxia sub-segment of the Leping coal measure and the Anyuan coal measures coal seam group. The thickness of the B4 coal seam is generally 1~3m, the structure is simple to relatively simple, the distribution range is wide, and the stability is good; the Anyuan coal measures coal seam group can be mined or locally mined 5~15 layers, and the single layer thickness is 0.5~20m. Most of them are thin coal seams, and a few are thick or extra-thick coal seams, with large thickness variations and complex to extremely complex structures. The geological structure of the coal fields in the province is generally more complex, with folds and faults relatively developed, and there are igneous rock intrusions in some areas, but the impact on the coal seams is relatively small.
3. Analysis of the cause of the accident
From 2000 to 2013, a total of 843 coal mine accidents occurred in Jiangxi Province, as shown in Figure 1.

![Figure 1. Basic situation of accidents from 2000 to 2013](image)

Gas accidents: ① Gas explosion accidents: a. Single well bore, poor ventilation results in gas accumulation, blasting or electric sparks cause gas explosion. b. The team leader conducts illegally, personally works illegally, and violates labor discipline. c. The blasting operation detonates the gas accumulated in the goaf. d. The backwardness of safety management and safety technology has led to the expansion of accidents. ② Gas outburst accident: a. The two-level “four in one” measures for coal and gas outburst are not in place. b. The blasting or mining operation induces outstanding. ③ Gas suffocation accident: The mining operation mistakenly exposes the goaf and causes the gas to gush out and become poisoned.

Roof accident: empty roof operation in mining face and disrepair of the main roadway of the mine.

Fire accident: a. The underground electromechanical chamber caught fire and ignited combustible supporting materials. b. Fire is caused by equipment operation, friction and heat generation.

Water hazard accidents: a. No water detection and release measures have been formulated for mining operations. b. The mining operation mistakenly exposes the old empty water. c. Failed to keep water-proof coal pillars as required.

Mechanical and electrical accidents: a. Insufficient equipment investment, imperfect supporting facilities, and relatively aging equipment. b. Irregular operation and inadequate maintenance.

Transportation accidents: a. Insufficient investment in safety and slow upgrading of new technologies and equipment. b. There are few technicians and even faults occur.

4. Countermeasures

4.1. Strict security access
Strict access conditions for coal mines. Coal mines must strictly abide by regulations and meet the safety conditions for issuing certificates before allowing them to apply for coal mine safety production licenses.

Strict certification standards. The following situations will not be accepted: cross-border mining, informal mining, unreasonable ventilation system, use of wood support on the working face, high gas mine without drainage system, failure to provide the mine manager and technical personnel according to the regulations, and outstanding mine integration Outbreak prevention measures are not in place, accidents occurred in the original pre-approved coal mines, etc.

Strict license conditions. For those who do not meet the safety production conditions, the safety
production license shall be temporarily suspended and the safety production license shall be ordered to be rectified within a time limit. For those who fail to make the rectification on time or fail to pass the time limit, the safety production license shall be revoked.

4.2. Improve safety technology
Introduce advanced technology and equipment. ① Apply national advanced and applicable technologies and equipment to Jiangxi coal mines to provide technical support for coal mine safety. ② Improve the coal mine's ventilation system, outburst prevention, fire prevention, dust prevention, and safety monitoring system, and improve the level of coal mine safety equipment.

Increase investment in safety technology. Improve coal mine productivity and safety assurance capabilities, so that coal mine enterprises rely on technological progress to ensure safe production.

4.3. Strengthen emergency management
Carry out emergency drills. Carry out normalized emergency drills, strengthen the popularization of emergency knowledge, and strengthen emergency skills training for underground employees.

Guarantee the rescue team and rescue materials. Strengthen the quality standardization of rescue teams and establish a scientific rescue command system. Reserve the necessary relief supplies to ensure that they are effective during the rescue.

Strengthen safety production risk analysis. Coal mining companies must conduct a head-to-face safety production risk analysis once a month, and immediately issue early warning information when they find signs of an accident. The coal mine must give the production site leaders, team leaders, and dispatchers the direct decision-making power and command power to suspend production and remove personnel as soon as they encounter a dangerous situation. In the event of casualties caused by untimely evacuation, the relevant personnel shall be investigated for legal responsibility.

4.4. Deepen the investigation of hidden dangers
Carry out a good investigation and management action for hidden dangers. In accordance with the principle of "no blind spots, full coverage, and zero tolerance", implement the requirements of "one mine for one group, one mine for one strategy, and mines to be effective", insist on investigating large systems, curing large hidden dangers, preventing large accidents, and treating hidden dangers as accidents To carry out investigation and treatment of hidden dangers.

Establish and improve the management and supervision system for major hidden dangers. Supervise and urge coal mining enterprises to establish and improve a system for investigating and managing hidden dangers and form a long-term mechanism. Implement listing supervision and increase penalties for major hidden dangers, and resolutely order the suspension of production for rectification if there are hidden dangers that cannot guarantee safe production, so as to ensure that the hidden danger investigation and treatment achieve effective results.

Carry out key inspections and standardize the rule of law in coal mines. Focus on cracking down on problems such as cross-border mining behaviors of coal mines, adopt the “four no two straight" approach to carry out law enforcement, and carry out key inspections on accidental mines and technologically modified mines; prohibit coal mines with super-capacity, super-strength, and super-fixed personnel to organize production, and prohibit illegal construction produce.

4.5. Implement supervision and supervision
(1) Strictly supervise and supervise law enforcement. ① Vigorously contain the "first killer" of gas. ② Strengthen the prevention and control of water. ③ Pay attention to the prevention of roof accidents. Strengthen the on-site management of coal mine enterprises, do not allow empty roof operations, and resolutely cancel wood supports. ④ Strengthen the testing and inspection of lifting equipment, and stop using it if it does not meet the requirements.

Implement key supervision and supervision. ① Adopt methods such as joint departmental law
enforcement, cross law enforcement in different places, heart-to-heart dialogue with mine managers, and strengthening of safety training to promote the implementation of various work measures. ② Focus on the implementation of measures in key counties and promote the fundamental improvement of coal mine safety. ③ Strengthen the key supervision work of the group company and the Mining Bureau, and regard the prevention of accidents as a hard task.

4.6. Strictly investigate and punish education
Strictly investigate and deal with accidents. Increase the intensity of accident investigation, strictly deal with the person responsible for the accident, and disclose the accident investigation report to the public in a timely manner and accept social supervision.

Strictly implement the rectification of accidental mine shutdown. For general accidents in mines with an annual output of less than 90,000 tons, the mining area or mine where the accident occurred must be stopped for rectification, and production can be resumed after acceptance.

Continue to carry out accident warning education. Select the typical accident cases of coal mines in the country or in Jiangxi Province to carry out warning education in various mining bureaus and provincial energy group companies to promote safe production.

5. Conclusion
It analyzed the causes of various coal mine accidents, providing a certain reference for the prevention and control of coal mine disasters.

Proposed prevention and control countermeasures such as strict safety access, improvement of safety technology, strengthening of emergency management, deepening of hidden danger investigation, implementation of supervision and supervision, and strict investigation and education.

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