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JUSTIFICATION OF SHORT-HOLE DRILLING PARAMETERS TO IMPROVE THE EFFICIENCY OF SELECTIVE MINING IN OPEN-PIT GOLD DEPOSITS

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Abstract

Accurate extraction of mineral resources within defined ore boundaries and the reduction of ore losses are among the key factors influencing the economic efficiency of open-pit gold mining operations. In deposits characterized by complex geological structures and variable ore boundaries, conventional drilling and blasting technologies may result in the loss of valuable ore and its mixing with surrounding waste rock. This, in turn, negatively affects ore recovery and the overall economic performance of mining enterprises.

This study investigates the potential application of short-hole drilling technology to improve the efficiency of selective mining in open-pit gold deposits. The research focuses on the use of 5-meter blast holes and compact drilling rigs to achieve more precise delineation of ore body boundaries, enhance the accuracy of ore extraction, and reduce ore losses during mining operations.

During the study, the influence of short-hole drilling parameters on the selective mining process was analyzed, and the technical and economic efficiency of various technological alternatives was evaluated. The results demonstrated that the use of short blast holes enables more accurate delineation of geological

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boundaries, reduces excessive rock displacement caused by blasting, and improves the quality and precision of ore extraction.

Based on the findings of the study, it was established that the application of short-hole drilling technology in open-pit gold mines can enhance the efficiency of selective mining, reduce ore losses, and improve the technical and economic performance of mining operations.

Keywords: open-pit mining, gold deposit, selective mining, short-hole drilling, drilling and blasting operations, ore loss, geological boundaries, mining efficiency, drilling parameters.

Introduction

Today, the growing global demand for mineral resources requires the mining industry to improve the efficiency of mineral extraction. This challenge is particularly important for gold mining enterprises, where maintaining ore quality and minimizing the loss of valuable minerals are essential for ensuring economic profitability. Therefore, improving the technological processes used in open-pit mining has become one of the most relevant scientific and practical issues in modern mining engineering[1-5].

Drilling and blasting operations are among the most important stages of the mining process in open-pit mines, as they directly influence the efficiency of subsequent technological operations. Proper selection of drilling parameters can improve blasting performance, reduce mineral losses, and increase the accuracy of ore extraction. However, conventional drilling patterns commonly used in many gold mines do not adequately account for geological boundaries, resulting in ore losses and the mixing of ore with surrounding waste rock.

Gold deposits with complex geological structures often exhibit significant variations in the thickness, shape, and distribution of mineralized zones over short distances. Under such conditions, the use of large blasting blocks and deep blast

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holes limits the ability to selectively extract ore[6-9]. Therefore, there is a growing need to implement technologies that enable more accurate tracking of geological boundaries during the mining process.

Short-hole drilling technology provides an opportunity to define geological boundaries more precisely, reduce the volume of blasting blocks, and improve the accuracy of ore extraction. In addition, the use of compact drilling rigs facilitates high-precision drilling operations under complex geological conditions. As a result, ore losses can be reduced, mining quality can be improved, and the overall economic efficiency of mining operations can be enhanced.

Although numerous studies have been conducted in recent years to improve the efficiency of selective mining, the comprehensive evaluation of short-hole drilling parameters under open-pit gold mining conditions remains insufficiently investigated. In particular, the scientific justification of the technical and economic advantages associated with the use of 5-meter blast holes continues to be a relevant research issue[10-12].

The objective of this study is to justify the parameters of short-hole drilling for improving the efficiency of selective mining in open-pit gold deposits and to evaluate their impact on ore losses, mining accuracy, and the technical and economic performance of mining operations.

State of the Art

Improving the efficiency of selective mining in open-pit mineral extraction is one of the key research areas in the modern mining industry. In recent years, numerous studies have focused on increasing the accuracy of ore extraction, reducing ore losses, and improving the delineation of geological boundaries.

Many researchers have investigated the influence of drillhole density on the accuracy of geological models. Their studies have demonstrated that optimizing drillhole spacing allows for a more accurate estimation of ore distribution and grade characteristics. Furthermore, improvements in the quality of geological

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information have been shown to positively affect the efficiency of selective mining operations.

Recent scientific research has paid particular attention to the optimization of drilling and blasting parameters. The results indicate that blast hole depth, diameter, and drilling pattern significantly influence blasting performance and mining outcomes. Although the use of deep blast holes can enhance production productivity, it may also increase ore losses in geologically complex mineralized zones.

Studies on selective mining have identified accurate delineation of ore body boundaries as one of the most important factors affecting mining efficiency. Several researchers have suggested that short-hole drilling techniques can improve extraction accuracy and enhance ore recovery in complex geological conditions. However, studies evaluating the technical and economic effectiveness of this technology in open-pit gold mining operations remain limited.

Today, digital geological modeling, geostatistical analysis, and ore control systems are widely implemented in mining enterprises. While these technologies have significantly improved the accuracy of geological boundary identification, the optimization of drilling and blasting parameters used during extraction remains an important research challenge.

A review of the available literature indicates that most existing studies focus on drillhole spacing optimization and geological modeling. However, the impact of using 5-meter short blast holes and compact drilling rigs on the efficiency of selective mining in open-pit gold deposits has not been sufficiently investigated. Therefore, further research in this area is of considerable theoretical and practical importance.

Drilling Equipment Used in the Study

To evaluate the effectiveness of short-hole drilling technology, the technical specifications of the **PowerROC T35 drilling rig**, manufactured by **Atlas**

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Copco, were used as the basis for this study. This machine is a modern high-performance drilling rig designed for open-pit mining operations, particularly for rock excavation and construction activities.

The **PowerROC T35** operates using the **Top Hammer drilling method**, which provides high drilling accuracy and productivity. The rig is capable of drilling blast holes with diameters ranging from **64 to 115 mm** and can achieve a maximum drilling depth of **25 m**. The equipment is fitted with a **COP SC19 pneumatic rock drill**, enabling efficient and reliable execution of short-hole drilling operations.

The drilling rig is powered by a **168 kW diesel engine**, while its compressor delivers a free air flow rate of **130 l/s**. In addition, the machine is equipped with an operator cabin that enhances operational comfort, facilitates machine control, and improves occupational safety.

PHOTO SPECIFICATIONS OF THE POWERROC T35 DRILL RIG

TECHNICAL DATA	
Main application	Quarrying
Drilling method	Top Hammer
Hole diameter	64 - 115 mm
Product family	PowerROC
Cabin	Yes
Drifter / down-the-hole hammer size	COP SC19
Maximum drilling depth	25 m
Engine power	168 kW
Air delivery (free air)	130 l/s

PRODUCT DESCRIPTION

The PowerROC T35 drill rig is designed for demanding applications in quarrying, mining and construction projects. It delivers both fuel efficiency and high productivity. The PowerROC T35 is equipped with a 12-inch touchscreen display. The intuitive user interface makes it easy to control the rig and helps new operators learn faster. The built-in troubleshooting function and easy access to service points simplify maintenance and reduce downtime.

ENGINE

The PowerROC T35 is available with engines of two different emissions levels: Tier 4 Final / Stage V or Tier 3.

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The technical capabilities of the PowerROC T35 make it suitable for accurately drilling **5-meter blast holes**, which are considered optimal for improving ore boundary delineation and increasing the efficiency of selective mining. Therefore, the PowerROC T35 was selected as the primary drilling equipment for investigating the application of short-hole drilling technology in open-pit gold mining operations.

Conclusion

Improving the efficiency of selective mining in open-pit gold deposits is one of the key factors contributing to the enhancement of the technical and economic performance of mining enterprises. The findings of this study indicate that the use of short-hole drilling in drilling and blasting operations enables more accurate delineation of geological boundaries and improves the precision of ore extraction. During the research, the advantages of applying **5-meter blast holes** were analyzed, and their impact on the selective mining process was evaluated. The results showed that the use of short blast holes makes it possible to reduce the size of blasting blocks, thereby improving the delineation of ore body boundaries and minimizing ore losses. In addition, the use of compact drilling rigs allows high-precision drilling operations to be carried out effectively under complex geological conditions.

The analysis of the technical specifications of the **PowerROC T35 drilling rig** demonstrated that the machine is capable of drilling blast holes with diameters ranging from **64 to 115 mm**, operating at depths of up to **25 m**, and maintaining high productivity. These characteristics confirm that the PowerROC T35 is suitable for the practical implementation of short-hole drilling technology in open-pit mining operations.

The results of the study indicate that the application of short-hole drilling technology:

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- improves the accuracy of ore extraction;
- reduces ore losses;
- enhances the precision of geological boundary delineation;
- increases the efficiency of drilling and blasting operations;
- contributes to the improvement of the technical and economic performance of mining enterprises.

Therefore, the justification and implementation of short-hole drilling parameters in open-pit gold mines can be considered a promising approach for improving the efficiency of selective mining. Future research should focus on evaluating and optimizing the performance of this technology under various mining and geological conditions using actual production data.

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