Prospects of Artificial Intelligence Application in the High-Quality Development of the Geological Exploration Industry

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Abstract. Artificial intelligence (AI) plays a pivotal role in facilitating the high-quality development of the geological exploration industry. Its applications span across diverse areas, including data analysis and interpretation, automated exploration processes, resource optimization management, risk assessment and management, intelligent resource development, and knowledge sharing and collaboration. By leveraging AI in these domains, the geological exploration industry can progress towards achieving high-quality outcomes. AI enables more accurate guidance for exploration activities, enhances efficiency, improves the quality of results, reduces costs, predicts risks, optimizes resource development, and accelerates knowledge dissemination and application. These crucial roles provided by AI contribute significantly to the sustainable development of the geological exploration industry.

Keywords: high-quality development, geological exploration industry, artificial intelligence, prospects analysis

1 Introduction

Artificial intelligence (AI) plays a pivotal role in driving the high-quality development of the geological exploration industry [1-5]. It effectively handles large-scale geological data using advanced machine learning and deep learning algorithms to extract crucial information, identify geological features, and predict underground structures and resource distribution [6-8]. In automating exploration processes, AI optimizes data processing, generates accurate geological models, and formulates efficient exploration strategies. It also enhances resource management by employing intelligent algorithms and optimization models to optimize resource allocation, including exploration areas, methods, and resource utilization efficiency [9-12]. AI facilitates risk assessment and management by analyzing historical and real-time data, enabling the prediction of geological hazards and evaluation of environmental risks, thereby providing timely warnings and emergency measures [13-15]. Furthermore, AI supports intelligent resource development through comprehensive analysis of geological data, engineering parame-

L. Moutinho et al. (eds.), *Proceedings of the 2023 International Conference on Management Innovation and Economy Development (MIED 2023)*, Advances in Economics, Business and Management Research 260,
https://doi.org/10.2991/978-94-6463-260-6_12

ters, and economic factors to guide decision-making and optimize resource exploitation. Lastly, AI promotes knowledge sharing and collaboration by establishing intelligent data platforms and communication mechanisms, facilitating the dissemination and application of research outcomes in the geological exploration domain [16]. Overall, AI's impact in the geological exploration industry drives high-quality development, sustainability, and optimized resource management.

2 Data Analysis and Interpretation:

Large-Scale Data Processing: Geological exploration involves a vast amount of geological data, including geological images, geophysical data, and geochemical data, among others. Artificial intelligence enables efficient processing of such large-scale data, extracting key information, and accelerating the speed and precision of data analysis.

Geological Feature Recognition: Through the utilization of machine learning and deep learning algorithms, artificial intelligence can learn and identify various geological features, such as lithology and structures. This capability aids in the accurate identification of potential mineral resource areas, providing better guidance for exploration targets.

Underground Structure Prediction: Artificial intelligence leverages historical geological data and geophysical data to establish predictive models, enabling accurate forecasting of underground structures and stratigraphic features. This aspect is particularly crucial for exploring underground resources and assessing geological risks.

Exploration Plan Optimization: By analyzing historical exploration data and geological information, artificial intelligence can provide optimization recommendations for exploration plans, including the planning of exploration paths and the selection of appropriate exploration methods. This helps improve exploration efficiency and the quality of outcomes.

Resource Distribution Prediction: By employing machine learning and deep learning algorithms, artificial intelligence can analyze geological data and environmental factors to predict the distribution and abundance of underground resources. This capability contributes to guiding resource exploration and development, enhancing the accuracy and efficiency of exploration activities.

Data Interpretation and Visualization: Artificial intelligence facilitates the interpretation and visualization of geological data through data analysis and model interpretation. Visualization techniques enable the intuitive presentation of geological features, underground structures, and resource distributions, thereby assisting decision-makers and researchers in better understanding and utilizing geological data.

3 Automation of Exploration Processes

Data Processing and Management: Geological exploration involves a vast amount of data, encompassing exploration data, geological images, geophysical data, and more.

Artificial intelligence (AI) can effectively process and manage this extensive data, extracting crucial information and accelerating data processing speed and accuracy. For instance, AI techniques can be employed to automatically cleanse, organize, and archive exploration data, reducing manual intervention and minimizing errors.

Geological Feature Recognition: Through the application of machine learning and deep learning algorithms, AI can learn and recognize geological features such as lithology and structures. This capability facilitates precise identification of potential mineral resource areas and provides enhanced exploration targets.

Subsurface Structure Prediction: AI can leverage historical geological data and geophysical data to establish prediction models for accurate forecasting of subsurface structures and stratigraphic features. This holds significant importance for exploring underground resources and assessing geological risks.

Optimization of Exploration Plans: By analyzing historical exploration data and geological information, AI can offer optimization suggestions for exploration plans, including optimal path planning, exploration methods selection, and sample collection strategies. This contributes to improved exploration efficiency and quality outcomes while reducing subjectivity and errors associated with human decision-making.

Data Analysis and Interpretation: AI can extract essential information from geological data and provide precise data analysis and interpretation. With the aid of machine learning and deep learning algorithms, AI can identify geological features, predict subsurface structures, and assess resource distribution, delivering more accurate guidance for geological exploration.

Automated Decision Support: Drawing upon abundant data and knowledge, AI can provide automated decision support to assist decision-makers. Through techniques such as data analysis, predictive modeling, and optimization algorithms, AI offers decision recommendations and optimization schemes, enabling decision-makers to make more informed choices throughout the exploration process.

4 Resource Optimization and Management

Optimization of Resource Allocation: Artificial intelligence (AI) plays a crucial role in analyzing geological exploration requirements and resource conditions to determine the optimal resource allocation strategy. By leveraging intelligent algorithms and optimization models, AI considers factors such as exploration area characteristics, effectiveness of exploration methods, and resource utilization efficiency to achieve optimal allocation. This enhances exploration efficiency and economic benefits.

Site Selection for Exploration Areas: AI employs machine learning and deep learning algorithms to utilize abundant geological data and relevant information, allowing for the identification of optimal exploration areas. Through the analysis of geological features, resource potential, and geological risks, AI accurately assesses the potential and feasibility of exploration areas, optimizing the selection of exploration targets.

Optimization of Exploration Methods: AI optimizes the selection and application of exploration methods by analyzing data and establishing models. Through the analysis

of historical exploration data and relevant parameters, AI determines the best exploration methods, thereby improving exploration effectiveness and the quality of outcomes.

Enhancement of Resource Utilization Efficiency: AI enhances resource utilization efficiency by leveraging intelligent algorithms and optimization models. By analyzing exploration data and relevant parameters, AI optimizes resource utilization during the exploration process, leading to increased resource utilization rates and reduced exploration costs.

Cost Control and Risk Management: AI provides effective resource management and risk management strategies through cost control models and risk assessment models. By predicting and evaluating costs and risks during the exploration process, AI enables the formulation of appropriate control and management measures, resulting in cost reduction and risk mitigation while improving resource management efficiency.

5 Risk Assessment and Management

Data Analysis and Pattern Recognition: Artificial intelligence (AI) plays a vital role in analyzing and recognizing patterns in vast amounts of historical geological data and real-time monitoring data. By leveraging advanced machine learning and deep learning algorithms, AI can establish predictive models to forecast the occurrence probability and spatial extent of geological hazards.

Environmental Risk Assessment: AI utilizes data analysis and modeling techniques to assess the environmental risks associated with geological exploration activities. Through comprehensive analysis of geological characteristics, environmental sensitivity, and monitoring data, AI enables accurate assessment of the severity and potential impacts of environmental risks, thereby providing a scientific basis for environmental protection and effective risk management.

Early Warning and Emergency Management: With the aid of predictive models and real-time monitoring data, AI facilitates early warning and effective management of geological hazards. By continuously monitoring and predicting geological events, AI can promptly detect abnormal conditions and trigger appropriate early warning systems and emergency response strategies, ensuring the safety and sustainability of exploration operations.

Decision Support and Optimization: AI offers valuable decision support for risk assessment and management. Through thorough analysis and simulation of different decision scenarios, AI provides decision-makers with crucial insights into risks and benefits, enabling them to optimize decisions and mitigate potential risks effectively.

Data Monitoring and Feedback: AI enables real-time monitoring and assessment of risks during exploration activities by integrating with sensors and monitoring devices. Through continuous data collection and analysis, AI can detect and interpret relevant geological parameters, facilitating timely feedback and management measures to ensure the safety and efficiency of exploration operations.

Note: Please note that the provided revision aims to enhance the academic language of the text, but it is always recommended to have the final version reviewed by a subject

matter expert for further refinement and suitability to specific academic or technical contexts.

6 Intelligent Resource Development

Integrated Data Analysis: Artificial intelligence (AI) plays a crucial role in providing comprehensive decision support for resource development through the integrated analysis of geological data, engineering parameters, and economic factors. Leveraging advanced machine learning and deep learning algorithms, AI can identify meaningful correlations and trends within the data, enabling decision-makers to gain insights into resource characteristics, distribution patterns, and potential.

Formulation of Optimal Development Strategies: AI aids in formulating optimal resource development strategies by considering multiple factors. By leveraging sophisticated optimization models and intelligent algorithms, AI takes into account geological conditions, engineering techniques, economic benefits, and other relevant factors to determine the most effective resource development path, extraction methods, and timing. This leads to enhanced resource development efficiency and improved economic outcomes.

Prediction and Simulation: AI utilizes prediction models and simulation techniques to forecast the outcomes and risks associated with resource development processes. By analyzing historical data and relevant parameters, coupled with AI's learning capabilities, accurate predictions can be made regarding resource yield, quality, and potential environmental impacts. This information serves as valuable guidance for resource development decision-making and strategic planning.

Enhancement of Resource Utilization Efficiency: AI plays a vital role in optimizing resource utilization efficiency through the application of intelligent algorithms and optimization models. By analyzing exploration data, geological characteristics, and economic factors, AI assists in optimizing resource development plans and processes. This includes minimizing resource waste, maximizing resource utilization efficiency, and ultimately reducing overall development costs.

Intelligent Decision Support: AI provides intelligent decision support for resource development, empowering decision-makers with critical information. By analyzing the benefits, risks, and feasibility of various decision scenarios, AI offers decision-makers the necessary insights and guidance to make informed decisions. This assists in the formulation of effective resource development strategies and ensures the utilization of resources in a sustainable and efficient manner.

7 Knowledge Sharing and Collaboration

Data Platform and Sharing: Artificial intelligence (AI) enables the establishment of intelligent data platforms that integrate geological exploration data and research findings from various regions and organizations. Through data sharing and open access, it facilitates the exchange and dissemination of diverse data sources, providing a comprehensive and enriched information resource for the field of geological exploration.

Knowledge Management and Intelligent Processing: AI can be applied in knowledge management and intelligent data processing to assist in organizing, analyzing, and promoting geological exploration knowledge and technologies. By establishing repositories of knowledge and expert systems, among other intelligent tools, it transforms professional geological exploration knowledge into actionable resources, accelerating the dissemination and application of scientific research outcomes.

Cross-Regional Cooperation and Communication: AI facilitates cross-regional cooperation and communication within the realm of geological exploration through intelligent data platforms and communication mechanisms. Different regions and organizations can strengthen collaboration and communication by sharing data, research findings, and experiences, collectively addressing challenges in geological exploration and driving industry development.

Experience Sharing and Collaborative Training: AI contributes to promoting experience sharing and collaborative training. Through the establishment of intelligent educational platforms and training mechanisms, it provides learning resources for relevant technologies and knowledge in geological exploration. Moreover, it facilitates talent collaboration and exchange among different regions and organizations, collectively enhancing professional skills and technical capabilities.

Innovation and Research Collaboration: AI fosters innovation and research collaboration in the field of geological exploration. Through intelligent data analysis and model building, AI expedites the research and application of innovative technologies and outcomes. Different regions and organizations can collaborate on research projects and engage in technical exchanges, jointly advancing the innovation and progress of geological exploration technologies.

8 Conclusion

In summary, this article elucidates the pivotal role of artificial intelligence (AI) in the high-quality development of the geological exploration industry. AI excels in efficiently analyzing and interpreting large-scale geological data, automating exploration processes, optimizing resource management, assessing and mitigating risks, enabling intelligent resource development, and facilitating knowledge sharing and collaboration. These multifaceted contributions of AI propel the industry towards enhanced efficiency, accuracy, and sustainability in geological exploration, while optimizing resource allocation, reducing costs, and promoting informed decision-making. Overall, AI revolutionizes the field of geological exploration, leading to significant advancements in resource identification, extraction, and environmental management.

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