Key Technological Focus Areas for Geological Exploration Enterprises in the New Round of Mineral Exploration Breakthrough Strategy

Yao XIA*

China Institute of Geo-Environment Monitoring, Beijing 100081, China

*Corresponding author: 693719349@qq.com

Abstract. In the context of the new mineral exploration breakthrough strategy, geological exploration enterprises have identified key areas of technological focus, including high-precision exploration techniques, multi-source data integration and interpretation, deep-seated resource exploration technology, environmentally friendly exploration methods, and unmanned exploration technology. These domains of scientific and technological advancement aim to enhance the accuracy, efficiency, and reliability of exploration endeavors while minimizing environmental impact and ensuring safety. Through innovation and the application of cutting-edge exploration instruments, techniques, and technologies such as big data analytics, artificial intelligence, deep electromagnetic exploration, remote sensing technology, environmentally sustainable equipment, and unmanned systems, geological exploration enterprises can achieve more precise, efficient, and sustainable resource exploration practices. These advancements make significant contributions to the successful implementation of the mineral exploration breakthrough strategy.

Keywords: mineral exploration breakthrough, strategic action, geological exploration, technological advancement

1 Introduction

In the new round of mineral exploration breakthrough strategy, geological survey companies are prioritizing key technological areas, including high-precision exploration, multi-source data integration, deep resource exploration, environmentally friendly techniques, and unmanned exploration [1-6]. These advancements aim to improve the accuracy, efficiency, and outcomes of mineral exploration while minimizing environmental impact and risks [7-11]. Through innovative technologies such as high-resolution seismic surveys, electromagnetic exploration, data integration algorithms, and unmanned systems, geological survey companies can achieve precise and sustainable resource exploration, contributing to the successful implementation of breakthrough strategies [12-14].

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_15

2 High-Precision Exploration Techniques

Innovations in Geophysical Exploration Technology: Geophysical exploration entails the measurement and interpretation of Earth's physical fields to infer the existence and distribution of subsurface resources. The focus of technological advancements can encompass the development of advanced geophysical exploration instruments and techniques to enhance the accuracy and depth of underground resource detection. For instance, progress can be made in refining high-resolution seismic exploration techniques, electromagnetic surveying methods, and gravity surveying techniques to acquire more precise information regarding subsurface conditions.

Advancements in Geochemical Exploration Technology: Geochemical exploration unveils the potential presence of subsurface resources by analyzing the chemical elements and mineral compositions in samples such as rocks, soils, and water. Technological endeavors in this domain may entail the refinement of more sensitive and rapid geochemical analysis techniques, such as mass spectrometers, spectrometers, and ion chromatographs, to heighten the precision and efficiency of exploration endeavors.

Application of Remote Sensing Technology: Remote sensing technology utilizes sensors deployed on satellites, aircraft, drones, and other remote platforms to capture surface and subsurface imagery and data. Within the realm of geological exploration, remote sensing can be harnessed to identify distinctive features like topography, lithology, mineral alteration, and vegetation indices, thereby aiding in the identification of potential mineral resources. Noteworthy areas of technological advancement can involve the development of high-resolution, multispectral, and high-frequency remote sensing sensors, alongside the utilization of artificial intelligence and machine learning techniques to facilitate effective data processing and interpretation [15-24].

3 Integration and Interpretation of Multi-Source Data

Data Acquisition and Integration: Exploration data of different types often originate from diverse sources and instruments, necessitating efficient data collection and integration. Key areas of technological focus may involve the development of effective methods and equipment for data acquisition, as well as the establishment of data standards and protocols to enable seamless integration of diverse data sources.

Data Quality Control and Processing: The quality and accuracy of multi-source exploration data are paramount for data fusion and interpretation. Technological endeavors in this domain may encompass the development of methods and algorithms for data quality control, addressing issues such as noise reduction, calibration, and correction. These efforts aim to enhance the accuracy and reliability of the data.

Big Data Analysis and Mining: Given the substantial volume of multi-source exploration data, leveraging advanced techniques in big data analysis and mining becomes imperative for extracting valuable information and identifying patterns. Prominent areas of technological focus include the development of methodologies based on machine learning, deep learning, and data mining to unveil potential correlations, trends, and prospective areas for mineral resource exploration [25-30].

Data Interpretation and Simulation: By employing data interpretation and simulation techniques, multi-source exploration data can be integrated with geological models and theories to provide explanations and predictions regarding the distribution and characteristics of subsurface resources. Technological advancements may involve research in geological modeling, physical modeling, and numerical simulation to enhance the precision and dependability of resource exploration.

4 Deep Resource Exploration Technologies

Deep Electromagnetic Survey: Deep electromagnetic survey technology involves measuring electromagnetic responses underground to infer subsurface geological structures and resource distribution. Technological advancements in this field aim to develop more advanced instruments and techniques, improving exploration depth and resolution. For instance, research focuses on high-power and wide-bandwidth electromagnetic signal sources, sensitive and high-resolution receiver systems, and innovative data processing and interpretation methods tailored to diverse geological conditions.

Seismic Inversion: Seismic exploration utilizes the analysis of seismic wave propagation and reflection to understand subsurface geological structures and resources. In deep resource exploration, seismic inversion technology provides valuable information about underground geological interfaces and structures. Technological developments include high-resolution seismic survey instruments and techniques, enhancing the quality and resolution of seismic data. Advanced seismic inversion algorithms and models are also being pursued to achieve more accurate subsurface information.

Geophysical Imaging: Geophysical imaging technology reveals subsurface geological and resource information by monitoring changes in physical fields below the surface. In deep resource exploration, geophysical imaging techniques contribute to understanding underground geological structures, lithology, and mineralization. Research efforts focus on developing high-resolution instruments and techniques for geophysical imaging, such as seismic imaging, electromagnetic imaging, gravity imaging, and magnetic imaging. Additionally, the integration of big data analysis and machine learning techniques supports the processing and interpretation of geophysical data.

5 Environmental-Friendly Exploration Technologies

Low-Noise Survey Techniques: Geophysical exploration often involves the use of noise-generating sources such as seismic excitations and vibration equipment. The technological focus in this area revolves around the development of low-noise survey equipment and methods, aiming to minimize disturbances to the surrounding environment and wildlife.

Low-Emission Survey Equipment: The utilization of survey equipment typically entails the operation of combustion engines or power devices, which can contribute to air pollution and the emission of greenhouse gases. The key technological pursuit lies in the development of low-emission survey equipment that adopts clean energy sources

or high-efficiency energy technologies, thereby mitigating atmospheric pollution and minimizing adverse environmental impacts.

Drone Remote Sensing Surveys: Drone remote sensing technology finds extensive applications in exploration, enabling the efficient acquisition of surface and subsurface imagery and data. Technological advancements in this realm involve the development and application of drone remote sensing surveys to minimize disruption to surface ecosystems and the environment. For instance, drones can be utilized for terrain mapping, lithology classification, mineralization detection, and other purposes, avoiding or reducing direct contact with ecologically sensitive areas.

Data Processing and Simulation: Another focus area involves the development of environmentally friendly data processing and simulation methods. By employing efficient data processing algorithms and models, there is potential to reduce the need for extensive data acquisition, thereby minimizing the environmental impact.

6 Conclusion

Within the context of the new round of mineral exploration breakthrough strategy, geological exploration enterprises have prioritized their technological efforts on high-precision exploration techniques, multi-source data fusion and interpretation, deep-seated resource exploration technology, environmentally friendly exploration practices, and unmanned exploration technology. Research and innovation in these domains hold paramount importance in providing crucial technical support to exploration endeavors. By enhancing exploration accuracy and efficiency, high-precision exploration technology plays a vital role in locating and characterizing mineral resources, thereby facilitating effective resource development. The application of multi-source data fusion and interpretation techniques amplifies data analysis capabilities, enabling comprehensive geological information and bolstering the scientific underpinnings of exploration decision-making. The advancement of deep-seated resource exploration technology propels exploration activities towards probing the depths of geological structures and resource distributions, offering novel perspectives for shaping exploration strategies. Research and development efforts in environmentally friendly exploration technologies aim to curtail the environmental impact of exploration activities, achieving a mutually beneficial scenario where resource exploration aligns harmoniously with environmental preservation. The deployment of unmanned exploration technology enhances exploration efficiency and safety, concurrently reducing labor costs and mitigating exploration-related risks. The outcomes derived from these technological pursuits will furnish indispensable technical support for the successful execution of the new round of mineral exploration breakthrough strategy, thus fostering sustainable development within the realm of resource exploration.

References

[1] Gao Mengmeng. (2023). Analysis of the spatiotemporal variation of vegetation in the Yellow River Basin and its correlation with soil moisture. Hydrogeology, Engineering Geology, 03, 172-181. https://doi:10.16030/j.cnki.issn.1000-3665.202108051.
[2] Qiu Shuilin. (2023). Exploration of reform paths for the ecological compensation mechanism in nature reserves. China Land and Resources Economics, 04, 44-50. https://doi:10.19676/j.cnki.1672-6995.000873.
[3] Bao Xiaobin. (2023). Dilemmas and countermeasures for water ecological environment governance in China. China Land and Resources Economics, 04, 23-29. https://doi:10.19676/j.cnki.1672-6995.000872.
[4] Jun Liu. (2023). Research hotspots and trends of groundwater and ecology studies: Based on a bibliometric approach. Journal of Groundwater Science and Engineering, 01, 20-36.
[5] Li Xueliang. (2023). Theoretical analysis and engineering practice of dynamic pre-reclamation in coal mining subsidence areas. Mining Safety & Environmental Protection, 01, 86-91. https://doi:10.19835/j.issn.1008-4495.2023.01.015.
[6] Wu Lianbei. (2022). Research trajectory and prospects of forest ecological compensation in China: A visualization analysis based on CiteSpace. China Land and Resources Economics, 11, 25-34. https://doi:10.19676/j.cnki.1672-6995.000814.
[7] Zhang Yan. (2022). Pioneer plant selection for the restoration of steep limestone slopes in North China. Journal of Geological Hazards and Environment Preservation, 05, 109-118. https://doi:10.16031/j.cnki.issn.1003-8035.202110012.
[8] Liu Tianke. (2022). Village planning strategies from the perspective of urban-rural integration: Village classification and development directions. China Land and Resources Economics, 11, 35-40, 47. https://doi:10.19676/j.cnki.1672-6995.000802.
[9] Wang Chunguang. (2022). Analysis and evaluation of heavy metal characteristics in soil from important coal mines in the middle reaches of the Yellow River. Mining Safety & Environmental Protection, 05, 124-130. https://doi:10.19835/j.issn.1008-4495.2022.05.021.
[10] Min Wang. (2023). Opportunities and challenges for geological work in China in the new era. Journal of Groundwater Science and Engineering, 01, 1-3.
[11] Wang Yufei. (2022). Experience and reference of conservation easements in the United States. China Land and Resources Economics, 10, 52-59. https://doi:10.19676/j.cnki.1672-6995.000795.
[12] Jing Dingqian. (2023). Exploration of pathways for realizing the value of abandoned cultivated land as ecological products in mountainous areas. China Land and Resources Economics, 01, 53-59. https://doi:10.19676/j.cnki.1672-6995.000788.
[13] Yang Shicheng. (2022). Realizing the value of rural ecological products: Positioning, dilemmas, and path research. China Land and Resources Economics, 11, 48-55, 65. https://doi:10.19676/j.cnki.1672-6995.000774.
[14] Yu Yang. (2022). Application of three-dimensional laser scanning measurement in vegetation parameter extraction. Journal of Henan Polytechnic University (Natural Science), 04, 51-57. https://doi:10.16186/j.cnki.1673-9787.2020090105.
[15] Yin Yan. (2022). Quantitative study on ecological compensation for arable land based on ecological value accounting: A case study of Shenyang City. China Land and Resources Economics, 11, 18-24. https://doi:10.19676/j.cnki.1672-6995.000750.
[16] Mao Zhihong. (2022). Exploring ecological protection diversification compensation based on market mechanisms: An investigation and reflection on ecological protection compensation in the natural resources field of Minqing, Qiong, and Su. China Land and Resources Economics, 06, 56-62. https://doi:10.19676/j.cnki.1672-6995.000743.

[17] Liu Bo'en. (2022). Basic framework and value realization of carbon sequestration ecological products. China Land and Resources Economics, 04, 4-11. https://doi:10.19676/j.cnki.1672-6995.000744.
[18] Yu Yang. (2018). Comprehensive review of land consolidation research progress. Land and Resources Science and Technology Management, 05, 34-48.
[19] Li Senrong. (2022). Dilemmas and ways out of the legal remedy mechanism for marine ecological environmental damage: A research perspective on ecological civilization. China Land and Resources Economics, 06, 10-18. https://doi:10.19676/j.cnki.1672-6995.000722.
[20] Shi Shuaihang. (2022). Migration law of heavy metals in soil and ecological risk assessment in a mineral exploitation area in Southwest China. Metal Mine, 02, 194-200. https://doi:10.19614/j.cnki.jsks.202202026.
[21] Liu Ruilin. (2022). Enlightenment of the Yingde ecological compensation mechanism to ecological compensation work in China. China Land and Resources Economics, 07, 48-56. https://doi:10.19676/j.cnki.1672-6995.000697.
[22] Chun-lei Liu. (2021). Analysis on the situation and countermeasures of water resources supply and demand in the cities of small and medium-sized river basins along the southeast coast of China—taking Xiamen City as an example. Journal of Groundwater Science and Engineering, 04, 350-358. https://doi:10.19637/j.cnki.2305-7068.2021.04.008.
[23] Fan Yumin. (2022). Research on the zoning of ecological environment carrying capacity of mines in Sanmenxia City, the middle reaches of the Yellow River. Natural Resource Information, 01, 30-36, 29.
[24] Wang Na. (2021). Investigation and research on ecological restoration of mines based on remote sensing technology—taking the Jidong iron mine as an example. Metal Mine, 10, 192-198. https://doi:10.19614/j.cnki.jsks.202110026.
[25] LI Yue-peng. (2017). Research review on the treatment of urban landscape lakes. Journal of Groundwater Science and Engineering, 02, 152-161. https://doi:10.19637/j.cnki.2305-7068.2017.02.007.
[26] Yu Yang. (2016). Optimization of land use structure in Hefei City based on the coupling relationship between urbanization and cultivated land. https://kns.cnki.net/kcms2/article/abstract?v=Wz7QSVtT7FZfT2eII7rEKAb6PKMyu7K4USPMVmqAPsDLRt1Ppy-BVTC_NKNppDlArPFHSwkM8y_h79vOP-ST0v4l3_q9FojXD9IB5G816asSiwVDEERK4jIERS_oPok6aAp2qp3er548=&uniplatform=NZKPT&language=CHS
[27] Zhu Xiaokang. (2021). Research progress on ecological compensation mechanism for hydropower development in China. China Land and Resources Economics, 09, 47-54. https://doi:10.19676/j.cnki.1672-6995.000609.
[28] Zhou Wei. (2021). International experience and inspiration of ecological protection and compensation for arable land—based on the Common Agricultural Policy of the European Union. China Land and Resources Economics, 08, 37-43. https://doi:10.19676/j.cnki.1672-6995.000607.
[29] Fan Zhenlin. (2021). Development of blue carbon sinks to help achieve carbon neutrality. China Land and Resources Economics, 04, 12-18. https://doi:10.19676/j.cnki.1672-6995.000597.
[30] Zhang Zhimin. (2021). Implications of ecological unequal exchange for horizontal ecological compensation. China Land and Resources Economics, 07, 26-31. https://doi:10.19676/j.cnki.1672-6995.000596.