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The Relationship and Role of Remote Sensing in Geological Exploration

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Abstract. Geological exploration contributes to the development of resources, construction, and the prevention of disasters. The benefits of the remote sensing technology are extensive, effective, and non-contact, and they can swiftly and precisely offer information regarding geological exploration. The paper describes the relationship and role of remote sensing and geological exploration, considering three ways of geological exploration, namely, geological hazard prediction, regional geological mapping, and mineral resource prediction, and concludes. The studies have established that remote sensing technology has significant applications in predicting geological hazards, geological mapping of most of the regions, as well as predicting mineral resources. Regarding geological hazard prediction, remote sensing technology, which has its benefits, assists the researcher in detecting several geological hazards that are hidden. The information gathered using the remote sensing technology has a scientific ground through which the government can develop disaster prevention and reduction strategies. Remote sensing technology has also emerged as one of the most significant tools in the geological mapping of regions. The rich remote sensing information offers information to underpin the geological mapping study in the region, thereby rendering it accurate and precise. Remote sensing has recorded positive performance as an auxiliary tool in predicting mineral resources in this regard.

Keywords: geological exploration, remote sensing method, geological hazard monitoring, regional geological mapping, mineral resource prediction

1. Introduction

The history of geological exploration is long enough, and the remote sensing technology can record certain data of surface rock layers that are hundreds of kilometers above, which makes the technology very convenient in terms of conventional geological exploration. Geological exploration has been highly appreciated in recent years owing to its significant contribution in the area of construction engineering, including positioning and development of mineral resources, engineering, and environmental evaluation and protection of strategic resources. The remote sensing technology is a high-precision technology that is rapidly advancing, which employs non-contact processes to remotely identify the electromagnetic wave information of the objects targeted, to realize real-time control of the resources, the environment, and the disasters on earth.

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Remote sensing technology can also be applied in the geological exploration process in terms of efficiency, cost minimality, and ease of work, thereby making geological exploration quicker and more efficient, less expensive, and more productive when completing a geological exploration. Application: This technology has long been used in geological exploration through the use of remote sensing. In 1962, the United States performed airborne, infrared remote sensing experiments and then remote sensing geological exploration experiments of airborne infrared scanners, infrared cameras, sky laboratories, and others, being the first occasion of application of remote sensing to geological exploration. Experimental research on the patterns of distribution of basement fault systems, circular structures, and uranium deposits in southern China was done in the middle of the 1970s through the black and white images of land satellite MSS in Beijing Geological Research Institute of the Nuclear Industry in China. This was the start of the process of integrating geological exploration and remote sensing in China. Feng Bo and others searched uranium deposits in Longshoushan, Gansu, China, with the help of Gaofen-5 space hyperspectral remote sensing technology. They carried out an investigation on the abstraction of changing information of the GF-5 space hyperspectral data, as well as the extraction of altered minerals in the Longshoushan location, which was completed. Global LCR (GF-5 hyperspectral) data were successfully used to get good results. [1]. Sensors are more sophisticated and are able to acquire multispectral and high-resolution pictures with the rapid progress in technology in modern times. Consequently, remote sensing technology can become a more of an important factor in geological exploration. The efficiency of the remote sensing technology in retrieving multi-phase geological data across large scales is slowly addressing the pain points associated with traditional exploration, including a lack of efficiency, high cost, and the lack of blind spots.

This paper will examine the use of remote sensing technology in geological exploration (such as mineral resource prediction, geological hazard monitoring, regional geological mapping, etc.) over the past years, discuss the various applications of remote sensing technology in geological exploration, and attempt to enhance the level of intelligence of geological exploration and seek technical methods of minimizing the field operation risk and enhancement of reference.

2. Principles and benefits of remote sensing

2.1. Principle

The main idea of remote sensing is to obtain and record electromagnetic wave signals emitted or reflected by land objects with the help of sensors and deduce the state and characteristics of land objects based on the data obtained from data processing. It is possible to reduce a certain process to three steps. The signal source is the first stage because no object in nature does not portray spectral properties. This is to say that the electromagnetic waves are emitted by the sun or land objects themselves. Different land objects that have been shone on will have varying spectral properties after such, since the intensity and wavelength of reflected/emitted/absorbed electromagnetic waves differ (as an example, water bodies strongly absorb near-infrared radiation, whereas vegetation strongly reflects it). The second process is signal acquisition, in which the sensors (radar) on platforms like airplanes and satellites receive electromagnetic wave signals within the target area and convert them to digital information. The last processing stage is signal interpretation, and it consists of processing digital data acquired using specific software and analyzing the image using geological knowledge (wavelength reflection property) to interpret the information represented in the digital data in the image, e.g., lakes in dark regions and forests in green regions. Last, the acquisition of land cover information.

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2.2. Geological exploration: the benefits of remote sensing

In geological exploration, remote sensing has important benefits. Firstly, it is able to significantly decrease the use of human and material resources and decrease the expenditure on geological exploration. In comparison to the pre-integration of remote sensing technology with geological exploration, traditional geological exploration methods required several people taking several days, or even tens of days, to receive relevant data. Nevertheless, tens of thousands, or even hundreds of thousands of square kilometers could be observed within one remote sensing operation without necessarily installing the equipment on site, thereby minimizing the contribution of human and material resources. Furthermore, the geological exploration cycle is increased, and geological exploration is more efficient due to the application of remote sensing technology, decreasing the processing time of the data provided through geological exploration. Secondly, remote sensing has the potential of minimizing the safety risks of geological exploration. Through remote sensing technology, it is possible to overcome geographical constraints as per the demands of geological exploration exercises, make long-distance detection without disrupting the ore body or the surface rock layer, and gather information in rugged terrain. On the other hand, the conventional data gathering techniques involve the researcher visiting the research location to gather data, which puts personal harm to the researcher, and may cause disruption of the rock bed and ore bodies, the two layers of rock and ore, respectively. There are numerous blind spots and low efficiency in conventional ways of geological exploration in the Qinghai-Xizang Plateau, since most lands are obstructed by the severe environment. Yet, the issues of conventional geological exploration methods can be overcome with the help of remote sensing technology, which has a high level of spatial resolution and can be used in a non-contact mode [2]. Lastly, remote sensing technology can also be used to acquire more precise and detailed information by combining various sensors, such as hydrospectral and hyperspectral sensors. The image information can be taken at centimeter or even sub-centimeter level using high-resolution sensors, making observations and research conducted by researchers easier [3].

3. Other uses of remote sensing in geological exploration

3.1. Remote sensing methodologies for geohazard assessment

Over the last few years, there has been an increased emphasis on predicting the occurrence of geological disasters. The geological calamities like mudslides, landslides, and ground collapses have resulted in colossal economic losses and human loss to society because of their colossal destructive ability. The traditional geological hazard monitoring technique is restricted by the complexity of the terrain, small scale of monitoring, heavy load of human and material resources, and is hard to satisfy the integrated and precise requirements of geological hazard monitoring. With the benefits of high resolution, a wide range, and quick reaction to occurrences, remote sensing technology presents a new solution to the prediction of geological hazards. By using remote sensing systems like Aviator and Aerospace, scientists can easily have a consistent and dynamic evaluation of geological threat regions, therefore access vital data about the presence of surface features and geological arrangement, giving a scientific foundation to catastrophe forecasting. The use of remote sensing technology has been extensively used in Yanbian County, Sichuan Province, China, where geological disasters are common. This has seen researchers unsuccessfully point out numerous concealed hazards like mudslides and landslides among a significant portion of them, in mountainous regions where the terrain is complicated and heavily covered with vegetation, which is

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not easily identified under the normal methodology. Remote sensing technologies are based on the integration of geological, topographical, climatic, and other data, analyzing the process of geological disasters and forming a valuable foundation for disaster prevention and control work [4]. One such example is the possibility to learn more about the stability of the Earth's crust and predict the probability of occurrence of geological disasters through the use of optical remote sensing and radar. The most widespread type of geological hazard in Yanbian County is landslides. Geological structure Geologic structure maps have numerous characteristics in terms of landslides, including different color appearance compared to the surrounding surroundings and unique texture patterns. Through such characteristics of landslides, researchers can forecast the potential occurrence of landslides and be able to receive information pertaining to the landslides on time once they have taken place [5]. The information that is captured using the remote sensing technology helps the researchers to tag the risk level of the geological disaster, offering a scientific foundation on which the government develops disaster-prevention and mitigation strategies. In Yanbian County, the researchers examined the data of landslide areas obtained by the remote sensing technology with the help of artificial intelligence technology, identified the influencing factors and triggering mechanisms of landslides in Yanbian County, and offered a scientific basis for the work of government disaster prevention [6].

3.2. Remote sensing in regional geological mapping

With its low cost and capability to store the surface data within an extensive area and high speed, sensing technology has emerged as one of the most crucial technical resources in the regional geological mapping. The full procedure of regional geology mapping is inundated with remote sensing technology. It has many areas of use in the geological mapping of the region, including structure identification, mapping of hard-to-reach places, geomorphology, Quaternary mapping, and the mapping of mineral and mineral anomalies. Of these, the most significant one is remote sensing technology, which is useful in the coverage of hard-to-reach places. Remote sensing technology can also provide simple base geologists the information required by the scientific community, especially in areas inaccessible to the human species, like deserts, swamps, and mountains, making mapping very expensive. In the south-western regions of China, within the tropical rainforests, the geological mapping at a regional scale proves challenging to accomplish because of the thick vegetation cover and the absence of a profound bedrock. Through remote sensing technology coupled with the relationship between vegetation, soil, and underlying bedrock, the quality and accuracy of the geological mapping of the region in this area have been enhanced [7]. Another reason is the fast rise in the popularity of remote sensing technology in the geological mapping of the region, since the majority of geological studies learn more as the technology advances. The introduction of high-resolution satellites like SPOT in France, Rapid-Eye in Germany, and Chinese satellites like Gaofen-1 and Gaofen-2 has led to the application of the data to regional geological mapping, which has shown great success particularly in contributing greatly to the remote sensing geological mapping with 1: 50 and 000 scales in these regions that are exposed to bedrock [8]. Hyperspectral remote sensing has offered a new instrument for regional geological mapping. The Hyperspectral remote sensing or imaging spectroscopy technology is a recent technology that has been developed under the concept of multispectral remote sensing. Continuous narrow bands and ultra-multiband are important property of hyperspectral remote sensing that provides hyperspectral remote sensing data with special benefits in identification and classification, parameter inversion, and other functions [9]. The usage of remote sensing in regional geological mapping can be more accurate because hyperspectral remote sensing is able to consider both the information of components and hues of the

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objects on the ground, therefore characterizing the variation of a ground object more accurately [10]. Aerial hyperspectral remote sensing and combining optimal dynamic clustering with atlas-integrated recognition, optimal mapping of lithofacies-minerals with fine structure delineation, both of which have excellent engineering reproducibility in the Baigan Lake region, eastern Xinjiang [11]. As the number of satellites deployed to carry out remote sensing technology keeps on increasing, remote sensing data are getting richer and richer, and remote sensing data will be supportive of any future geological mapping work in the region, and more remote sensing will be applied in geological mapping of a region.

4. Remote sensing of mineral resources

Mineral resources play a critical role as a material base in human society's development. Remote sensing is commonly applied in predicting mineral resources, including the identification of rock minerals, mining of mineralization and alteration information, mining of geological structure information, dynamic monitoring and evaluation potential, etc. Currently, remote sensing as a mineral resources prediction auxiliary method has recorded a good performance in the prediction of different mineral resources, including metallic minerals, non-metallic minerals, and oil and gas minerals. Multi-band and rich information content of remote sensing technology can make the prediction of the mineral resources more efficient because of the advantages [12]. The advanced technology is the hyperspectral remote sensing technology, which continuously improves and enhances its application in the prediction of mineral resources. Lin Zhilei and Yan Luming suggested a better independent component analysis algorithm (M-ICA) on EO-1Hyperion hyperspectral image at different image frequencies. Based on their conclusion, one can observe that M-ICA is a rapid convergence algorithm of feature extraction of data of land cover images that is better at extracting the land cover information [13]. Hyperspectral remote sensing technology will be noted to be used more in the prediction of mineral resources. Remote sensing technology application in mineral resources has not only been used in geology and mineral resources, but is also an effective system in discovering minerals using the spectral features of vegetation. Plants absorb certain mineral elements in the nearby soil and rocks in the process of growth. These mineral ingredients have the potential to control the activities of life in plants, leading to physiological and ecological changes, and therefore are abnormal features in remote sensing images. Remote sensing technology can be used to identify these aberrant characteristics [14]. It can not only provide information about the predictability of mineral resources, but can also identify the presence of environmental pollution in the form of a large concentration of heavy metals in the region using the spectral characteristics of vegetation [15].

5. The problem of remote sensing technology use in geological exploration

Remote sensing has been extensively applied in geological exploration, to which it has had its fair share of challenges. This problem with surface interference factors is one of the challenges of the remote sensing technology in geological exploration, which can be largely separated into three aspects. To begin with, the spectral signal of soil cover will be smaller than that of the lithology itself and thus the ability of the spectral signal to identify the lithology will be lowered, and secondly, vegetation cover areas (like forests) may conceal underground lithology as well as geological structures beneath the waters and along coastlines, and Thirdly, manmade facilities may sometimes interfere with the application of remote sensing to geological exploration. The natural form of the surface can be modified by artificial structures like roads, buildings, etc, and result in

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incorrect structural orientation (like a road that cuts through rock layers may sometimes be confused with faults). The immense disparity in the quantity of data acquired by the remote sensing technology is also a challenge experienced in the practice of remote sensing technology in geological exploration. Searching for the large-scale anomalies in mineral exploration undertakings, such as linear and blocky shape has been the commonly used method of remote sensing. Through these abnormalities, scientists can be able to identify the geological control mechanism of mineral anomalies. These techniques are, however, challenging to employ in deriving spatial structural data on mineral anomalies at a narrow scale [16]. However, it is possible to combine hyperspectral remote sensing technology and multispectral remote sensing technology in the future, so that the application of remote sensing technology in geological exploration is more comprehensive.

6. Conclusion

The research paper is centered on the combined use of geological exploration and remote sensing technology, which is systematic in demonstrating the relevance of remote sensing technology in geological exploration. The central findings are as follows: Remote sensing technology is used in various areas of geological exploration (geological disaster prediction, regional geological mapping, mineral resource prediction, etc.). The adaptability and universality of remote sensing technology can be attested by the fact that it was successfully implemented in various ways in geological exploration. Hyperspectral is an accurate method and an exact combination of spatial location and spectral data of items; it has achieved the jump out of viewing pictures to name materials, and is thus applicable in numerous areas. Despite the late initiation of hyperspectral remote sensing technology, it has grown very fast and finds effective application during geological exploration. Remote sensing technology has been enormous in geological disaster prediction, hence researchers find it more convenient to detect and forecast possible safety scenarios. Remote sensing has been selected as one of the essential methods in the regional geological mapping, which offers data support to the regional geological mapping. Remote sensing technology has been critical in the field of mineral resource prediction, where it has contributed to the prediction of mineral resources in various respects, which has made it much more efficient. In a nutshell, the remote sensing technology has reached one of the fundamentaługs of geological searching, and the options of its signal permeation capability into tight realms and automatic efficiency of multi-source data integration are yet to be enhanced. Subsequently, through the presentation of learning algorithms to streamline the analysis model and through retrospective association of remote sensing with the ground geophysical exploration data, solitude geological exploration may be further directed towards the route of high precision, high efficiency, and low expenses.

References

[1] Feng, B., Duan, P., Cheng, X., et al. (2022). Application of Gaofen-5 aerospace hyperspectral remote sensing technology in uranium prospecting at Longshoushan, Gansu Province. Modern Geology, 36(06), 1594–1604.

[2] Zhang, X. (2025). Research on the application technology of geological survey for plateau railways based on multi-source remote sensing. Railway Survey and Prospecting, 51(04), 75–82.

[3] Wang, X., Yang, Z., Kang, G., et al. (2014). Application of WorldView-2 high-resolution satellite data in remote sensing geological survey of the Taxkorgan region in the West Kunlun Mountains. Geological Prospecting Review, 29(3), 428–432.

[4] Nie, S. (2023). Application and development of remote sensing technology in geological disaster prevention and mineral exploration. Inner Mongolia Coal Economy, (08), 166–168.

[5] Hu, H. (2023). Application of remote sensing technology in geological hazards in China. Geological Surveying and Mapping, 6(1), 1–3.

DOI: 10.54254/2753-8818/2026.BH32069

[6] Chen, L., Liang, S., Zhou, Y., et al. (2015). Analysis of the potential application of domestic high-resolution satellite data in geological surveys in high altitude areas. Remote Sensing of Land and Resources, 27(1), 140–145.
[7] Hu, G., Liu, F., Dang, W., et al. (2019). Application of remote sensing technology in geological mapping of vegetation-covered areas in southwest Yunnan. Remote Sensing of Land and Resources, 31(02), 224–230.
[8] Gan, F., & Wang, R. (2007). Application of hyperspectral remote sensing technology in the geological field. Remote Sensing of Land and Resources, (4), 57–60.
[9] Mu, X., Wu, B., Hu, D., et al. (2025). Research on application strategies of hyperspectral remote sensing in natural resource survey and monitoring. Science and Innovation, (16), 213–216.
[10] Li, N., Dong, X., Gan, F., et al. (2021). Application of hyperspectral remote sensing technology in regional geological survey mapping of bedrock areas. Geological Bulletin, 40(01), 13–21.
[11] Wang, G., Yin, Z., & Yu, X. (2025). Artificial intelligence, geological mapping and mineral prediction based on remote sensing hyperspectral data: Current status and challenges. Science, Technology and Engineering, 1–18.
[12] Liu, Y. (2011). Geological remote sensing and its application in ore prospecting. Western Exploration Engineering, (8), 105–109.
[13] Lin, Z., & Yan, L. (2011). M-ICA algorithm and application for ground object recognition in hyperspectral imaging. Journal of Geo-Information Science, 13(1), 126–131.
[14] Qian, J., Wu, G., & Chen, H. (2012). Application of modern remote sensing technology in geological prospecting. Geological Prospecting Review, 27(03), 355–360.
[15] Huang, W., & Gong, S. (2009). Application research of remote sensing technology in mineral resources development prediction. China High-tech Enterprises, (20), 45–46.
[16] Li, Z., Liu, D., Chen, S., et al. (2025). Remote sensing geological prospecting: Progress, challenges, and prospects. Satellite Applications, (06), 21–28.