Metallogenic Prediction of Metal Minerals Based on Remote Sensing Technology

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Abstract. Human beings have many indispensable material resources in the development of the earth, and mineral resources are an important part of them. In China, mineral resources are also one of the important products since ancient times. In today's era, China has entered an important period of building a well-off society in an all-round way. With the deepening of urbanization, social production and people's growing living needs, China's demand for mineral resources is also rising. However, due to endless mining and development, mineral resources in our country have become increasingly scarce, the reserve reserves are seriously insufficient, and the supply of mineral resources in the development and use is in short supply. In order to solve this difficult problem, this paper studies the metallogenic prediction of metal minerals by remote sensing technology, analyzes the relevant data, and provides a scientific basis for further resource exploration.

Keywords: Remote Sensing Technology, Mineral Resources, Non Renewable Resources, Resource Exploration

1. Introduction
Remote sensing is a subject or technology that does not directly contact objects, realizes the observation of the earth from a long distance in the air, obtains the information source of the ground features, realizes the interpretation of the ground features, and analyzes the properties of the relevant ground features through the measurement technology. Remote sensing technology has been widely used in many fields, and has been comprehensively applied in geological prospecting. The geological structural belt is favorable for the formation of the deposit, especially in the intersection of the structure caused by the fault and the line ring structure. And these structural features show line ring characteristics in remote sensing images, so we can get these key points by interpreting the remote sensing images [1].

The surrounding rock alteration is often found around the mineral resources, which delineates the favorable areas for prospecting, and provides a strong basis for geological prospecting personnel.
the same time, under the unfavorable factors such as rugged terrain, inconvenient transportation and bad environment, remote sensing technology can be used to delineate the mineralization anomaly area and prospecting target area, which not only shortens the geological exploration time and reduces the cost, but also gives full play to the advantages of remote sensing technology [2]. Geological prospecting is a relatively complex systematic work. It is an important premise to make comprehensive use of various means and scales to carry out geological prospecting. In this paper, modern remote sensing technology is used as the main means, and high-resolution, multispectral and other remote sensing data are used to carry out remote sensing interpretation of lithology and structure in Xiaogangou Nachitai area of East Kunlun metallogenic belt. Based on the results of field investigation, the remote sensing prospecting model of related minerals is established, and the remote sensing prospecting prediction is carried out to provide certain data and instructions for regional geological survey and comprehensive exploration of related minerals [3]. At present, the technical process and application have been basically mature. Using high-resolution remote sensing data, the lithology of the relevant work area has been divided and decomposed in detail, and the relevant lithology structure remote sensing interpretation map has been compiled [4]. Through two rounds of implementation, it has been provided to the relevant geological units to carry out the regional mineral survey work, and has obtained favorable comments. In addition, a number of influential mineralization clues have been found in the work, and some areas have been transferred to the mine survey work, which further illustrates the necessity and effectiveness of high-resolution remote sensing survey in important metallogenic zones.

This study plans to select a mineral spot in China to carry out the application research of high-resolution remote sensing data interpretation technology in prospecting work, obtain the corresponding data, and analyze the regional geological background, ore forming and ore controlling conditions, and study the reflection of ore-forming and controlling factors and mineralization belt on high-resolution remote sensing data, so as to provide basis and reference for related work in this area.

2. Research on the Related Concepts of Metal Mineral Resources Prediction Based on Remote Sensing

2.1. Theoretical Basis

The spectral characteristics of natural products in the visible short wave infrared spectrum (0.325um-2.5um) are not formed by their main chemical components, but by the reflection bands produced by iron ions (Fe3+, Fe2+), water, hydroxyl or carbonate groups existing in natural products in one form or another. These ion groups have the characteristics of electron transition or molecular vibration. Because of the complex composition of natural minerals and the influence of water content and transparency, the spectral characteristics of natural minerals are different from those of pure minerals containing ionic groups. In the spectral characteristics of minerals, some characteristics of pure minerals are still present [4-5].

In common minerals, there are metal ions, which have strong absorption band. Therefore, the spectral characteristics of iron bearing minerals mainly depend on the valence state of these iron ions and the water content of iron bearing minerals [6]. There are many hydroxyl and water bearing minerals in nature. Because hydroxyl always exists in the form of complex, such as clay, silicate minerals, etc., hydroxyl bearing minerals are more complex. However, the spectral characteristics of hydroxyl bearing minerals are still regular, such as kaolinite, montmorillonite, and silicon containing iron or magnesium Acid minerals such as chlorite, actinolite, serpentine, etc. There are also many carbonate bearing minerals in nature, such as calcite, siderite, gypsum, dolomite, etc. It is because of these ionic groups in minerals that the minerals have spectral characteristics of identification significance. According to the spectral characteristics of these minerals, the absorption and reflection characteristics of these minerals in the remote sensing image are analyzed, and then the appropriate
band combination is selected to extract the remote sensing information of mineralization and alteration [7].

Rock alteration is the result of the interaction between hydrothermal fluid and primary rock, and is the imprint of ore-forming material enrichment process. In this process, some useful elements are gradually enriched, and then transported and unloaded by the ore-forming hydrothermal solution. Remote sensing detection is the reflection spectrum information of ground objects. If there is a certain area of altered rock exposed on the ground, it may be detected by remote sensing, but it is also directly related to the strength of alteration information. Because different degrees of rock alteration, the generated altered rocks are not the same. If the rocks are not altered, there will be no altered rocks, so there is no alteration information. If the degree of alteration is very weak, the altered rocks generated are very few. In the complex geological background, the weak alteration information may not be detected by remote sensing, only if the moderate intensity alteration or strong alteration occurs It is conducive to the extraction of remote sensing alteration information [8].

2.2. Band Ratio Calculation

Band ratio operation is the division operation of the relative brightness value of the same pixel point between different wavebands. It is based on the different gray values of different ground objects in different wavebands. According to the spectral characteristics of a certain band of ground objects, the band ratio operation is used to suppress or enhance the ground object purposefully. In the application of remote sensing geology, etm3 / etm1 is often used to enhance iron oxide and hydroxide alteration, etm4 / etm3 is used to identify vegetation and distinguish limonitized rocks. After band ratio operation, the spectral meaning of the original image will not exist, but the useful information will be enhanced [9].

2.3. ASTER Data

Since the end of 1880's, the emergence of multispectral remote sensing technology has attracted extensive attention of the global geological research community. Because of its strong robustness and easy application, it is listed as the key promotion technology in the national mineral resources potential evaluation project. In the data processing of multispectral technology, ASTER data is a powerful supplement and enhancement to the previous data.

After years of preparation and Research on ASTER data, the multispectral detector was launched in the early 20th century. This technology is mainly used for the research and development of geological circles, and provides more scientific and objective satellite transmission data for improving the level of global geological exploration and the development of many related fields such as earth environment and science [10].

ASTER data is a powerful supplement to ETM data. Its infrared band increased from 2 ETM to 6, and thermal infrared band increased from 1 to 5. On this basis, it is possible to distinguish certain mineral materials and deposits in China. Through the development and research of this technical potential, the types of mineral resources and deposits can be distinguished to some extent. ASTER data in many convenient and advanced technology, there are corresponding deficiencies, such as its coverage area is very small, less than one ninth of ETM data, which is also the breakthrough direction of this technology in the future.

2.4. Image Density Segmentation

Select the appropriate threshold value (segmentation point) for the image, divide the gray value of the image into several regions, and then use different colors to represent these areas. The key of image density segmentation is to determine the threshold value, so it is necessary to fully analyze the histogram characteristics of the pixel gray value of the object of interest before image segmentation, so as to concentrate the interested object in one or a few segmentation regions. For example, "cloud" is separated from the background of sky and land. First, according to the bimodal characteristics of the
image gray value, a threshold value $t$ is determined. $T$ divides the gray value of the image into two parts A and B, and the target of "cloud" is in the gray value area a or B (assuming that "cloud" is in area a), then the density segmentation formula (4-1) is used to multiply the band of the original image, and the gray value of area a remains unchanged The value of "0" will be separated from "B".

$$g(x, y) = \begin{cases} 1, & f(x, y) \geq T \\ 0, & f(x, y) < T \end{cases}$$

(1)

Radiance:

$$L = \frac{d^2 \phi}{d\omega \cdot dA \cos \theta}$$

(2)

Surface emissivity:

$$\varepsilon(\lambda) = \frac{M_s(\lambda)}{M_b(\lambda)}$$

(3)

Planck formula:

$$M(\lambda, T_b) = \frac{2\pi h c^2 \lambda^5}{ch^2} \exp\left(\frac{ch}{\lambda k T_b}\right) - 1$$

(4)

3. Metallogenic Prediction Experiment of Metal Minerals Based on Remote Sensing Technology

Remote sensing exploration information refers to the geological background, ore controlling factors and rock alteration related to mineralization reflected in remote sensing images. The remote sensing information extracted from the research work generally refers to the abnormal information of rock alteration related to mineralization, such as limonite mineralization, carbonation, chlorination and silicification. Because of the interference of other factors and the mixture of pixels, the abnormal information of remote sensing will become complex. The spectral characteristics of remote sensing anomaly information will change with the change of composition, structure and weathering degree. Water content and surface roughness of surrounding rock minerals. In addition, in the remote sensing image, because of the ambiguous characteristics, the characteristics of geological bodies have many solutions, uncertainties and boundaries. Remote sensing anomaly information is the phenomenon of foreign bodies in the same ground object, different spectra or the same spectrum, which makes the remote sensing alteration information more complex. Compared with the surrounding soil, rock and other characteristics, it is always a small target. After the interference and mixing of large-scale surface features (such as complex rock and soil), the intensity of original "small-scale" mineralization change information becomes weaker. However, because the spectral characteristics of ground features are the basic attributes of ground features, with the continuous improvement of remote sensing image processing technology, these "weak" alteration information must be related to the surrounding features. Through the in-depth study on the spectrum characteristics of alteration information, we can enhance and extract these alteration information, and provide direct and powerful basis for geological exploration.

4. Analysis of Experimental Results of Metallogenic Prediction of Metal Minerals Based on Remote Sensing Technology

4.1. Mud Alteration Information Extraction
Table 1. Eigenvector Matrix of Principal Component Analysis

| principal component | ETM1  | ETM4  | ETM5  | ETM7  | characteristic value | variance |
|---------------------|-------|-------|-------|-------|----------------------|---------|
| PC1                 | 0.29742 | 0.41321 | 0.61474 | 0.51474 | 1192.7174             | 81.23   |
| PC2                 | 0.84125 | 0.25413 | -0.29324 | -0.35417 | 324.8141              | 13.00   |
| PC3                 | -0.35873 | 0.81424 | -0.34417 | -0.14812 | 43.2441              | 1.78    |
| PC4                 | 0.13454 | -0.0671 | 0.61741 | -0.72451 | 13.5713              | 0.47    |

It can be seen from Table 1 that after principal component transformation, the variance of PC1 is the largest, which is 81.23%, and the variance of other principal components decreases in sequence. The principal component PC1 contains most of the information of the four bands; in PC2, it mainly reflects the information in ETM1; in PC3, it mainly reflects the information in ETM4; in PC4, the coefficients of ETM5 and ETM7 are relatively large, indicating that PC4 reflects the spectral characteristics of off, cm and withered soil minerals; in ETM5 band, it is highly reflective. At the same time, the coefficient of PC4 also meets the criterion of representing the principal component of hydroxyl bearing minerals, that is, the coefficient of ETM5 is opposite to that of ETM7 and ETM3, and is generally the same as that of ETM1. Therefore, PC4 represents the principal component of hydroxyl bearing minerals.

4.2. Characteristic Analysis of Spectral Data

![Figure 1](simulated_aster_data_band_of_granodiorite.png)
The spectral curve of rocks and minerals is a continuous curve close to smooth. After simulating ASTER data, it becomes a broken line with only 9 turning points. In some practical researches, the main concern is the curve characteristics of the spectral curve of ground objects in the limited bands of remote sensing data, so the simulated curve is more intuitive.

4.3. Linear Structure Azimuth Histogram

From Figure 3, we can determine the azimuth characteristics of linear structures and understand the development status of each group of azimutual linear structures, which is consistent with the actual structural direction.

5. Conclusion
This study selected a mine in our province, according to the geographical environment characteristics of the study area and the requirements of remote sensing information extraction, the remote sensing data preprocessing was studied. The main contents of the study include: according to the requirements of remote sensing information extraction, the selection of suitable remote sensing data and color band combination; geometric correction, radiometric calibration and atmospheric correction of remote sensing data. In the selection and recommendation of alteration remote sensing anomaly information extraction, we usually remove the false anomaly. This paper mainly uses remote sensing technology to extract the mineralization and alteration information in the study area, and has achieved certain results.

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