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Discussion on the working criteria of remote sensing geological prospecting based on multi-source data

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Abstract: *In geological prospecting, the further implementation of remote sensing technology has improved the accuracy of prospecting and promoted the development of geological prospecting. In order to do a good job in mining mineral resources, it is necessary to improve geological prospecting and prospecting technology. Only by constantly innovating and discovering new technologies can we ensure the discovery and development of new resources and new mineral sources and promote the development of China's economy and society. In this paper, the geological exploration in the new period and the remote sensing geological prospecting criteria based on multi-source data are taken as the research objects, and the current situation and specific development prospects of technological innovation are discussed and analyzed.*

Keywords: *Multisource data; Remote sensing geological prospecting; Working criteria*

1. Introduction

Mineral resources play an important role in the process of economic construction and social development. However, with the rapid development of social economy, the national economy requires higher and higher detection level of mineral resources [1]. The western metallogenic belt in China is rich in mineral resources, but it is difficult to carry out conventional mineral resources exploration due to the low access rate, poor physical and geographical conditions and harsh conditions in no man's land. Compared with conventional geological prospecting methods, remote sensing prospecting has the advantages of faster speed, lower cost, time saving and labor saving [2]. In addition, with the development of remote sensing technology, the technology of Earth observation sensors has been continuously improved and improved, and the available remote sensing data sources are increasingly abundant. Multi-platform and multi-type remote sensing data are widely used in various fields, and remote sensing technology has become an indispensable high-tech means for prospecting in western metallogenic areas.

2. Principles of geological exploration technology

2.1. Overall planning principle

In order to fully implement the scientific concept of development, it is necessary to make overall plans for commercial and public geological exploration, and make overall investigations on mining geology and mineral exploration. Coordinate local and central geological exploration work and geological exploration work in other planning areas; Coordinate the opening up of geological exploration field and the development of domestic geological exploration, deploy and plan the geological exploration work for 10 ~ 15 years in advance, and give play to the leading role of the basic work of geological exploration.

2.2. Principles of geophysical and geochemical exploration

Geophysical exploration is called geophysical exploration, which mainly includes six methods: gravity, electrical method, earthquake, magnetism, radioactivity and ground temperature. The application of geophysical prospecting technology in geological prospecting can improve the efficiency and determine the area where minerals are located more accurately. It is mainly used to find and expand energy minerals, non-ferrous metal minerals, ferrous metal minerals and non-metallic minerals, and has obvious advantages compared with geochemical exploration [3].

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At present, the present situation of China's mineral development is that there are fewer and fewer open-pit mines and easily found mineral resources, and the search and exploration of hidden mines has become the focus of our current geologists. The application of geochemical exploration technology in geological prospecting can improve people's understanding of the special existing forms of earth materials and promote geologists' research on geochemical exploration methods.

2.3. Cooperative principle

There are two trends in the application of geological prospecting and exploration technology [4]:

First, the trend of integration of geological prospecting and exploration technology with other technologies. This requires us to actively integrate the technology of other specialties or disciplines on the basis of geological prospecting and exploration, and accelerate the integration and cooperation between geological prospecting and exploration technology and other modern science and technology with the help of computer, network and automatic control.

Second. The integration of geological prospecting and exploration technology with similar technology in international market should cooperate and compete with international advanced technology in geological prospecting and exploration. Make the geological prospecting and exploration technology get new development.

2.4. Innovation principle

In the geological survey work. Implement the requirements of scientific and technological development, mainly discuss major geological theories and related issues, speed up geological survey, keep pace with modernization, gradually transform the original geological location advantages into technological innovation advantages, vigorously promote the development of geological survey technology and metallogenic theory, promote the organic combination of survey and scientific research, and improve the technological innovation system of the whole geological activity.

3. Working criteria of remote sensing geological prospecting based on multi-source data

3.1. Rock spectrum collection

Since the application of remote sensing technology in geology, the study of rock spectral characteristics has been the research foundation of remote sensing technology in geology, the basis of alteration information extraction and lithology identification using multi-spectral and hyperspectral data, and one of the important research contents of remote sensing geology.

Rock and mineral spectrum test can obtain rock and mineral spectrum data and related data, and provide important data support for remote sensing geological application and mechanism research, such as rock and mineral spectrum characteristic analysis, remote sensing data processing, information extraction, geological interpretation, parameter inversion, authenticity inspection, etc. In the choice of measuring weather, the weather conditions with good visibility on the ground, clear weather, good and stable illumination and no more than 4 winds should be selected for testing. In addition, during the measuring process, the measurers should wear dark clothes, which are more than 0. 5m away from the test target, and ensure good visibility conditions around the measuring points [5].

In the process of indoor spectrum testing, there is no requirement for testing time. However, in the test environment, it is required to minimize the influence of all light sources except the test light sources, and keep away from the influence of windows and walls on light. Testers should wear dark clothes, and ensure that the distance from the test target is more than 0.5m, and the incident direction of light is unobstructed.

3.2. Establishment of interpretation sign of remote sensing geological structure

Remote sensing structure interpretation is one of the most successful applications of remote sensing in geology, which can be used to predict the depth of structures. Using remote sensing to interpret structures has achieved good results in geological survey, prospecting and earthquake research [6].

Linear construction. Linear structure refers to the linear image features of straight line, arc line and broken line related to geological processes on the image map.

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Ring structure. Ring image features related to geological processes or controlled by geological structures on remote sensing images are called ring structures. The ring structure is round, oval, round, semi-circular, arc and polygon in remote sensing image through color tone, topography and water system, etc. The color tone is color spot or ring, while the landform is radial or ring water system [7].

Classification of ring-shaped structural markers: it is represented by ring-shaped features of hue ring, landform change, water system ring, vegetation ring, shadow ring or composite type on the image [8]. As the basis of prospecting, ring structure has special and important significance for mineralization.

Filtering is a method of signal processing, including spatial domain and frequency domain. The former is realized by convolution with the original image with a certain operator or template, while the latter looks at the problem from another angle, that is, the spatial difference and change of pixel gray value in an image is regarded as a complex waveform formed by superimposing many sine waves or cosine waves with different amplitudes, frequencies and phases, and artificial images and amplitude images are generated by forward and inverse Fourier transform and special filtering functions (high-pass or low-pass, etc.) Spatial domain filtering is simple and feasible, which can flexibly adjust the operator content to obtain various filtering effects to meet geological needs, and can further highlight linear structures by appropriately adding shadows. It is a widely used linear structure extraction method [9].

3.3. Data fusion of remote sensing and geochemical exploration and comprehensive analysis of multiple information

Under the guidance of modern metallogenic theory, it is an inevitable trend of modern geological prospecting to use comprehensive analysis of multiple information for metallogenic prediction, and it is usually effective to search for prospective prospecting areas. There are many methods of data fusion between remote sensing and geochemical exploration, including overlay analysis and buffer analysis using GIS, false color synthesis method after blending with remote sensing images, false color synthesis method directly with remote sensing data after rasterization of geochemical exploration data, data fusion based on HIS transform, two-dimensional correlation coding data fusion, geometric average method, etc.

Weighted image fusion based on pixel;

The expression of weighted fusion is:

$$Y(i,j)=a(p_1X_1(i,j)+p_2X_2(i,j))+b \quad (1)$$

In which $X_1(i,j)$ and $X_2(i,j)$ are two original images; p_1, p_2 ($p_2=1-p_1$) is the weight of two images, which can be determined according to the analysis of application purpose, and can also be determined by the correlation coefficient of two images a is the image scale parameter; b is a given constant; $Y(i,j)$ is the result image.

When considering the difference between two images, the difference method is used to fuse, namely

$$Y(i,j)=a(p_1X_1(i,j)-p_2X_2(i,j))+b \quad (2)$$

Image linear model fusion;

There are m variables $X_1\cdots X_m$ (including remote sensing band and geochemical element data), and the following linear relationship is given:

$$Y=a_1X_1+a_2X_2+\cdots+a_mX_m+b \quad (3)$$

Type, $a_i(i=1,2,\cdots,m)$ variable weight; b is a constant. The larger a_i is, the more important X_i is. Variable weight a_i and constant b can be estimated by many methods, such as multiple linear regression, principal component analysis or characteristic variable selection. The physical meanings of the estimated values of a_i, b obtained by different methods are different, and then fusion images Y

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with different geological meanings can be obtained.

Nonlinear models can be converted into linear models to solve the problem. The nonlinear models are mainly regression models, including polynomial regression models, power functions and exponential models.

The spectral characteristics of rocks mainly depend on the amount of these special ions (clusters) contained in various minerals (including cements) that make up rocks. This shows the response of remote sensing to geochemical information, which must be included in their data. Through the enhancement and extraction of remote sensing prospecting information and the fusion processing with geochemical data, we can correctly identify and judge its correlation and obtain richer prospecting information.

4. Specific development prospect of remote sensing geological prospecting based on multi-source data

4.1. Application of hyperspectral data and microwave remote sensing

Hyperspectrum is a comprehensive technology integrating detector technology, precision optical machinery, weak signal detection, computer technology and information processing technology. It uses imaging spectrometer to record hundreds of spectral channel data at the same time with nanoscale spectral resolution, and can extract a continuous spectral curve from each pixel, thus realizing the synchronous acquisition of spatial information, radiation information and spectral information of ground objects, thus having great application value and broad development prospects.

Make full use of the advantages of hyperspectral narrow band and hyperspectral resolution, combine with remote sensing thematic maps and make use of abundant texture information, and strengthen the processing and application ability of hyperspectral data. The imaging principle of microwave remote sensing is different from optical remote sensing, which uses infrared beam to project on the object surface, and the antenna receiving end receives the weak echo returned by the target and generates a monitorable voltage signal, so that the physical structure and other characteristics of the object surface can be determined.

4.2. Combination of 3S

3S is short for remote sensing (RS), geographic information system (GIS) and global positioning system (GPS). Using GPS can quickly locate, determine the position coordinates of points and scientifically manage the coordinates of spatial points. Massive remote sensing data needs a huge space, so it needs a powerful management system. With the rising price of human resources, remote sensing shows the advantage of getting the maximum return with the minimum investment when prospecting in a region, so the combination of RS and GIS is imperative, because GIS is more conducive to image management and browsing in a region.

With the development of 3S technology, the interpretable degree and speed of remote sensing data have been further improved. At present, geologists have tried to apply 3S, VS (Visualization System), CS (Satellite Communication System) and other technologies comprehensively, and achieved good results.

4.3. Fusion of data

Any single-source information can only reflect one or several features of ground objects. In order to identify targets more accurately, it is necessary to extract more abundant and useful information from multi-source data than single-source data. Comprehensive analysis and mutual supplement of multi-source data promote the continuous development of data fusion technology. Through data fusion, on the one hand, useless information can be removed and the amount of data processing can be reduced; on the other hand, useful information can be collected to facilitate the complementary advantages of various information features. Data fusion includes the fusion of remote sensing data, remote sensing data and non-remote sensing data.

There are many ways to realize the fusion technology. It is easy to carry out four operations or HIS transformation on geometrically registered pixels point by point, and some methods are to preprocess multi-source data (feature extraction, discriminant analysis) before information fusion. The main

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methods are algebraic operation fusion, wavelet transform fusion and so on. In the future research, we should deeply analyze the imaging mechanism of various images and the correlation, complementarity and redundancy among data, so as to solve the problem of radiometric precision correction of multi-source data and develop spatial registration technology.

5. Conclusions

With the rapid development of space remote sensing technology and information processing technology, the multi-information comprehensive prospecting method combining remote sensing with conventional geology, geophysics and geochemistry is gradually becoming the mainstream of modern prospecting technology. The application of remote sensing technology based on multi-source data in geological prospecting has irreplaceable advantages of conventional geological methods in alpine areas with low geological work, poor topographic conditions and inconvenient transportation. Therefore, comprehensive analysis and research should be carried out by using various means to fully exploit the advantages of remote sensing technology and achieve better prospecting results. Be good at using new technology and new methods to carry out exploration, and sum up more relevant information beneficial to prospecting in the process of application, effectively carry out mineral exploration, and bring higher economic benefits to production units.

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