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Remote Sensing Based Technology for the Evaluation of Hydrothermal Uranium Mineralization in South China

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1 Introduction

Hydrothermal uranium mineralization in South China often occurred in an area of multi periods magmatism and tectonic action, the deposit is mainly hosted by granite, acidic volcanic rocks and metamorphic rocks around the pluton and basement of the basin, and closely related to the fault. Due to the dense vegetation in this area, field geology mapping and uranium exploration is quite difficult and un-systematical in the South China. In this paper, three remote sensing methods were used to help the systematic exploration in South China with the combination geology and geophysical information.

2 Identification of Faults

2.1 Visual interpretation of RS image

Regional and local faults are easy to be interpreted in remote sensing image due to their outstanding line feature and distinct texture cutoff in rocks. To identify provincial scale frame fault, direction and shape change of mountain ridges, rivers, sedimentary basins are more helpful than the simple line feature. In South China, fault interpretation was performed at different scale and got different levels structure. Frame fault was first discovered with the whole area in one view field, then regional fault in several view fields and local fault in pixel-level view. We have discovered several new NWW and EW strike frame lime-structure.

2.2 Verification of geophysics

To verify the RS interpreted fault, we have to use magnetic, gravity and geologic information. Airborne magnetic ΔT contour map shows that there are bear-in-line anomaly distributed along the interpreted frame faults. Bouguer gravity anomaly map indicated that these frame faults constitute the boundary of different shapes gravity anomaly, and in geology, there do exist small NWW and WE strike faults and folds along the frame fault, and there are obvious forming temperature anomaly of the outcrop along these frame faults. In the field, we have discovered some new NWW, NW extending local faults in Xiangshan, Xizhuang, Dawan ore-fields.

2.3 Relation of faults to uranium ore-field

All above providence suggested the new discovered frame faults are related to deep and early geologic evolution and hence may affect the uranium mineralization in this area. In facts, we found that most known uranium deposits were controlled spatially by the intersection of new discovered frame structure and the mapped out NE, NNE faults. The intersection of NWW and NE(NNE) trending frame fractures control the distribution of granite type uranium ore-fields, while that of EW and NE(NNE) trending frame fractures control the location of volcanic ones.

3 Texture Feature and Structure Evaluation

3.1 Fractal feature of RS image of ore-fields

Fractal model in Matlab was used to calculate the box dimension and multifractal spectrum. We have studied the fractal box dimension and multifractal spectral of ETM image in 11 uranium ore-fields and their neighbor areas. Remote sensing image of ore-field is found to bear multi-direction texture at various scale in visual, larger fractal box dimension and more symmetrical spectrum than their neighbors in calculation, while the image of the neighbor usually has single texture direction or multi-direction texture only at certain scale in visual, less box fractal dimension and less symmetrical multifractal spectrum.

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3.2 Image texture and structure evolution

Texture of remote sensing image conclude the information of rock boundary and structures and mostly represent the fractures and gullies of rocks. If the rocks experienced structure deformation of multi-stage and/or multi-direction, more complex fracture will be developed, and hence have large box dimension and wider α span and more symmetric α-f(α) multi spectrum. Therefore, the three features of remote sensing image can be used as recognition criteria to evaluate regional condition for uranium ore-field.

4 Bright Temperature and Alteration

ASTER infrared data was used to retrieve the bright temperature and emissivity of the rock area. Bright temperature help us to find the thermal feature of fractures and siliceous vein. Because fracture with thermal liquid (underground water) and siliceous vein will have high bright temperature due to their larger emissivity than other rocks. Our study indicated that volcanic uranium deposit distributed in high bright temperature background while granite uranium deposit occurred middle-low background, but both type deposits are located at local higher temperature over the background.

5 Conclusion and Discussion

(1) Visual interpretation of remote sensing image can help us find the fault of different scale and level, with the comprehensive verification of geological and geophysical information, we have found new NWW trending frame, regional and ore-field scale fractures in South China.

(2) The intersection of NWW and NE(NNE) trending frame fractures control the distribution of granite type ore-fields while that of EW frame (regional) and NE(NNE) trending frame fractures control the location of volcanic type ore-fields. This can help the screen of strategic area in provincial prognostication.

(3) Through calculating the box dimension and α-f(α) multifractal spectrum of ETM image of the 11 uranium ore-fields and their neighbor areas, images of the ore-fields are found to have larger box fractal dimension, wider α span and more symmetric α-f(α) multi spectrum than that of the neighbor areas. These features can be used as the indicator in selecting favorable area in regional metallogenic forecasting.

(4) Deposit usually located in the local high bright temperature zone or sector over the background which can be used to predict the target in uranium exploration.

Although the three remote sensing methods have shown effective in the study, many questions need to be studied further, such as the forming tectonic mechanism and dynamics of NWW frame faults, the parameter selection in calculating fractal dimension and spectrum and the algorithm of bright temperature retrieving.

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