Identification of Alteration Minerals Using Airborne Hyperspectral Technique: A Case Study of Baiyanghe Uranium Deposit

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1 Introduction

Bayanghe uranium deposit was located in the west part of Xuemisitan volcanic matllogenetic belt, the North of Xingjiang province. There exist alteration minerals like hematite, limonite, muscovite, carbonate, and epidote among the deposit area. Hematite and muscovite were intimately related with uranium mineralization. Many researches were made in the genesis of Baiyanghe uranium deposit before, but the identification of alteration minerals and its macroscopic distribution characteristics were little made, which were very important for considering the genesis of uranium deposit and prospecting the regional favorable area.

Hyper-spectral remote sensing technology is an important new technique and method for geologic and mineral exploration. Last a few years, the airborne hyper-spectral technique had made great advance in geological prospecting application (Phil et al., 2002; Liu et al., 2006; Ye et al., 2011). For uranium prospecting application, the airborne hyper-spectral survey was made using the CASI (Compact Airborne Spectrographic Imager) /SASI (Shortwave infrared Airborne Spectrographic Imager) airborne hyper-spectral survey system in Xuemisitan area, Xingjiang, in 2011. A great deal of hyper-spectral data of CASI and SASI were acquired. CASI was in the spectrum width of 404–1047 nm, and it has 48 bands with 14nm spectral resolution and 0.8m spatial resolution. SASI was in the spectrum width of 950–2450 nm, and it has 101 bands with 15nm spectral resolution and 1.8m spatial resolution.

2 Methods

A standardized hourglass hyper-spectral data analysis methodology has been used to process CASI/SASI airborne hyper-spectral data in Baiyanghe uranium deposit district. This approach is implemented within the Environment for Visualizing Images (ENVI) software. The analysis approach consists of the following steps: (1) Correction for atmospheric effects using empirical line. (2) Spectral compression, noise suppression, and dimensionality reduction using the Minimum Noise Fraction (MNF) transformation. (3) Determination of endmembers using geometric methods (Pixel Purity Index-PPI). (4) Identification of endmember spectral using visual inspection, and spectral library comparisons. (5) Production of mineral maps using a variety of mapping methods Mixture Tuned Matched Filtering (MTMF) was used for this work.

3 Results

3.1 Regional distribution of alteration minerals

Through above processing, Al-rich muscovite, Al–median muscovite, Al-poor muscovite, epidote, carbonate, limonite, hematite were Identified and extracted. After some study ideas by others (Liu et al. 2006), in this paper, Al-rich muscovite, Al–median muscovite, Al-poor muscovite was characterized by the Al-OH absorption wavelength of 2195 nm, and 2210 nm, 2225 nm, separately. The alteration minerals in Baiyanghe uranium deposit distributed spatially as Fig. 1.

It can be find that an Al-rich muscovite expanded with a shape of small sheet uncontinuously and mainly distributed in the northern or southern fringe of the sub-volcanic body which is of wide in east part and narrow in west part. In the same time, in northwest of sub-volcanic rock body, mush Al-rich muscovite exists there. Some Al-middle muscovite distributed in the north and south fringe of the middle part of sub-volcanic rock body, and the
others distribute in the volcanic rock far from sub-volcanic rock body. Al-poor muscovite, epidote, carbonate were little, and mainly distributed in the northwest out of sub-volcanic rock body. The known uranium mineralization in Baiyanghe district were mainly located in the north fringe of sub-volcanic rock body (Fig. 1). By analysis, it was discovered that Al-rich muscovite was coincident with uranium mineralization in spatial distribution feature. This shows that Al-rich muscovite have some relationship with uranium mineralization in Baiyanghe area.

3.2 Characteristics of alteration zonation

In the north fringe of the uranium deposit, there exists the obvious characteristics of alteration zonation among limonite, Al-rich muscovite, and hematite (Fig. 2). Namely, from north to south, the limonite, Al-rich muscovite, and hematite occurred in turns. Limonite was mainly exhibited in the outer of the contract belt between the sub-volcanic rock body and the volcanic rock. The Al-rich muscovite was existed just in the contract belt, while the hematite was developed in the inner contract belt. Meanwhile, the hematite was also developed inside of sub-volcanic rock body. Moreover, the hematite inside the body was developed more strongly in west part than in the east, which was consistent with the fact that the main uranium mineralization bodies occurred inside the middle west of sub-volcanic rock body. Above analysis of the alteration characteristics in Baiyanghe uranium deposit was greatly contributed to understanding the evolution process of ore-forming fluids.

References


