Remote sensing image enhancement and structural interpretation based on OLI in the Karamay area，Xinjiang

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Abstract. The remote sensing technology has become the important tool for the basic geological study in the strongly dissected topography and high altitude mountain area. Based on analysis of OLI remote sensing data, the optimal band combination of R: G: B is Band 7: Band 5: Band 4 according to the analysis result of OIF index. Then the image fusion enhancement was conducted by Gram - Schmidt orthogonal algorithm. On the basis of existing geological data in the study area the interpretation criteria was established，finally the fracture interpretation in the Karamay area was completed. The study result provides valuable clues for the stage classification of tectonic activities as well as the next stage prospecting work．.

Introduction

The Operational Land Imager (OLI), will measure in the visible, near infrared, and short wave infrared portions of the spectrum. The images will have 15-meter panchromatic and 30-meter multi-spectral spatial resolutions along a 185 km wide swath, covering wide areas of the Earth's landscape while providing sufficient resolution to distinguish features like urban centers, farms, forests and other land uses (Irons et al., 2012, Su et al., 2012). The recently launched OLI sensor on board Landsat-8, with similar characteristics of a TM/ETM+ sensor, the capability of using bands based on Landsat imagery for evaluation of the faults.

Therefore, with the help of remote sensing image has a direct, macro, access to convenient, general characteristics, the use of ENVI 5.1 on Landsat 8 remote sensing data OLI for multiband fusion and Gram－Schmidt orthogonal algorithm method of image enhancement processing, establishment of remote sensing interpreting marks, analysis and screening, of faults in the area of interpretation.

Data and experimental approach

Geology of the area

The study area is located in the western Junggar Basin, approximately 330 km north-west of Urumqi, Xinjiang, China. Major plutonic rocks are represented by Miaoergou, Hatu, Akebasitao, Red Mountain and north Karamay granite batholiths in this area, with an age of 300 Ma from zircon LA–ICP–MS U–Pb (Liu et al. , 2014, Shen et al. , 2013). The distribution of intrusive rocks and ore deposits in this area are highly correlated with faults.

Hatu and Baogutu are two typical gold deposits in the study area. Hatu gold deposit is associated with magmatism and controlled by regional-scale faults; mineralization mainly occurs within hydrothermally altered felsic rocks and quartz veins (Wang et al. , 2014). Baogutu gold deposit is associated with the evolution of felsic magmas, and the porphyry copper-gold mineralisation and copper-gold ore body dominated by sulphide were formed in the rock or near the contract zone in the faults, respectively.

Data processing

Recent cloud free images from the OLI sensor, on board Landsat-8, date LC81450282014241 acquired in 29 April 2014, were downloaded from Earth Explorer website. Through the image data using a variety of image enhancement algorithm, can improve the visual effect of the image, to facilitate the manual visual interpretation, image classification, sample selection. The methods of image enhancement are mainly through the spectral enhancement, radiation enhancement and spatial domain enhancement method, which will be enhance the image of the linear object detail part or the main part by ENVI 5.1.

The optimum index factor (OIF index), Sm is the standard deviation of the first M band, Rmn is the correlation coefficient of M and n two bands, the higher the band combination of OIF value, the greater the amount of information contained in the band combination. For these combinations, lastly, the OIF has been calculated to get the best combination. The OIF can be calculated using the following formula:

$$\mathrm{OIF} = \sum_{m=1}^{3} Sm / \sum_{n=1}^{3} |Rmn| \tag{1}$$

Data analysis and discussion

OLI 7 is dedicated to the band additional geological industry, rich geological information, can reflect lithology and mineralization alteration characteristics and beneficial to construct the interpretation, so in color composite will OLI 7 as red; and OLI 9 for shortwave infrared band, has strong moisture absorbing characteristics, and the tectonic interpretation related degree is not high, does not participate in the band combination. First of remote sensing image preprocessing, image standard deviation and correlation coefficient data by ENVI 5.1 statistics, band data of standard deviation is greater, the amount of information contained more; inter band correlation coefficient is small, greater independence of the band, redundant information degree is smaller. Removal of high correlation data using statistical correlation coefficient data, combined standard deviation obtained band combination mainly 7: 5: 4, 7: 5: 3, 7: 5: 2, 7: 5: 1 (table 1), analysis of OIF index can be drawn optimum band combination for 7: 5: 4, roughly corresponding ETM+ data 7: 4: 3, the combination in the previous studies by application (Lobo et al. , 2015). Compared with 4: 2: 3 true color image, the spectral information is larger, and the difference of geological information is obvious.

Table1 statistics of band combination information of remote sensing image

Band combination （R：G：B）	**Sum of standard deviation**	**Sum of correlation coefficient**	**OIF index**
7：5：1	18503.75	2.91	6364.06
7：5：2	18366.65	2.91	6318.79
7：5：3	18446.12	2.90	6357.09
7：5：4	18786.46	2.89	6495.79

From the figure1 can be seen Gram - Schmidt orthogonal algorithm fusion image data accurately reveals the vegetation in the study area growth, faulted stream, ridge translation and other features.

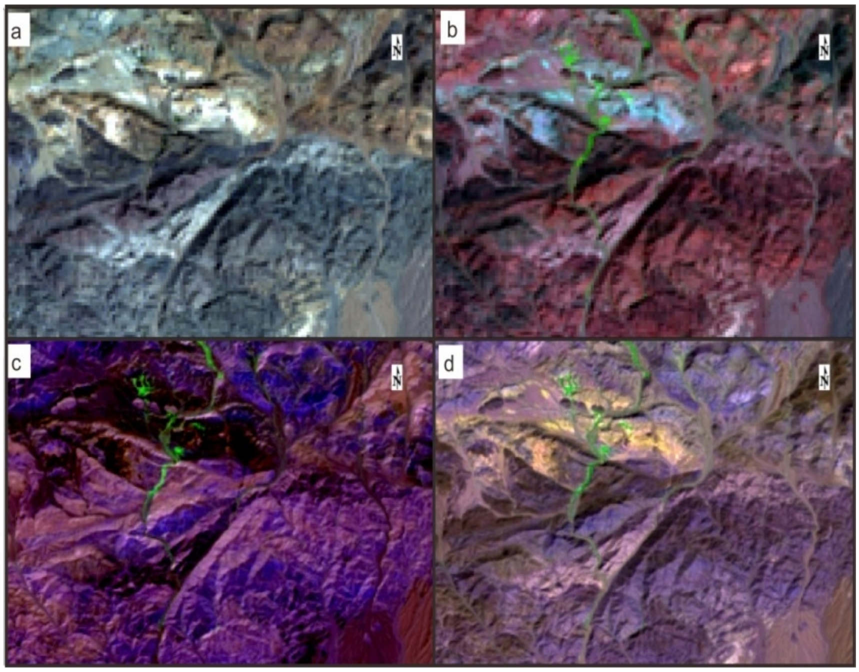

Fig1. contrast of image processing before and after image processing

A - R: G: B is 4: 3: 2 true color image; B - R: G: B 7: 5: 4 image; C - principal component analysis of image; D Gram - Schmidt orthogonal algorithm fusion image

The study area (Fig. 2) is located in the western Junggar Basin, approximately 330 km north-west of Urumqi, Xinjiang, China. This district is mainly controlled by NNE faults. Major faults in this area include, from north to south, the Hatu, Anqi, Darabut and Yijiaren faults. The Darabut ophiolitic melange belt, distributed as a band along Darabut fault, is approximately 50 km^2 in size which was tectonically disrupted, now forming the present imbricate structure that is mainly controlled by thrust faults. Materials from the oceanic crust often appear in terrigenous detrital sediment at old continental margins, and exhibit geochemical characteristics that are similar to the materials from the mantle (Shen et al. , 2009). The distribution of intrusive rocks and ore deposits in this area are highly correlated with faults.

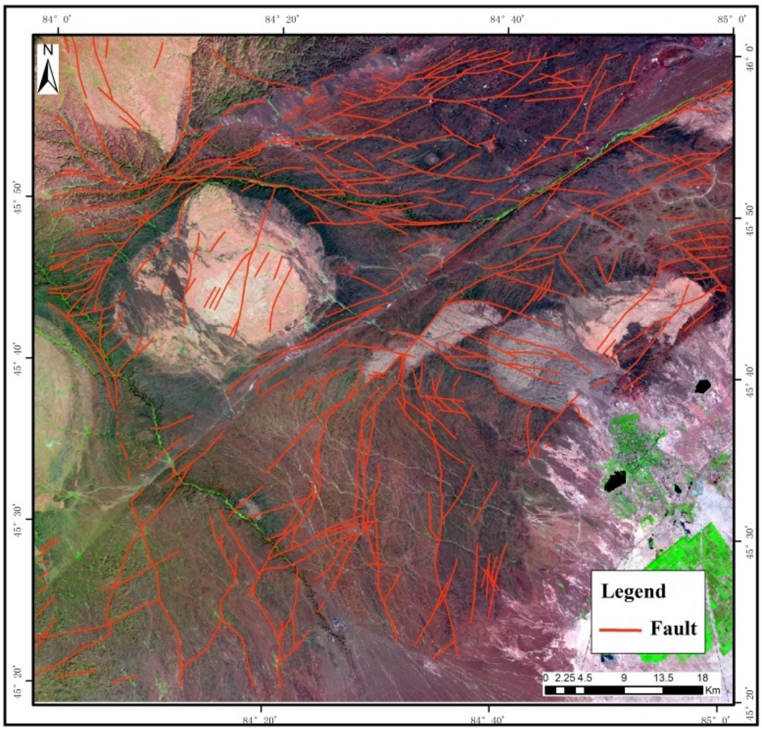

Fig.2 The faults of the Karamay area，Xinjiang

The Hatu gold deposit in the NW and the Baogutu gold deposit in the SE of the study area are two representative deposits of the regional mineralization geology. The Hatu gold deposit is controlled by two NE trending faults, namely, Anqi (extension fault) and Hatu (compression and scissor fault). Some NW, NE, and EW trending secondary faults are associated with ore formation and with the NE trending fault; the ore bodies occur in groups, an echelon, and end-to-end alignment.

Conclusions

Based on analysis of OLI remote sensing data, the optimal band combination of R:G: B is Band 7: Band 5: Band 4 according to the analysis result of OIF. Then the image fusion enhancement was conducted by Gram-Schmidt orthogonal algorithm. On the basis of existing geological data in the study area the interpretation criteria was established, finally the fracture interpretation in the Karamay area was completed. The study results provide valuable clues for the stage classification of tectonic activities as well as the next stage prospecting work. .

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References

[1]Irons JR, Dwyer JL, Barsi JA. The next Landsat satellite: The Landsat Data Continuity Mission. Remote Sensing of Environment. 2012,122:11-21.

[2]Lobo FL, Costa MPF, Novo EMLM. Time-series analysis of Landsat-MSS/TM/OLI images over Amazonian waters impacted by gold mining activities. Remote Sensing of Environment. 2015,157:170-84.

[3]Shen P, Shen Y, Liu T, Meng L, Dai H, Yang Y. Geochemical signature of porphyries in the Baogutu porphyry copper belt, western Junggar, NW China. Gondwana Research. 2009,16:227-42.

[4]Shen P, Shen Y, Pan H, Li XH, Dong L, Wang J, et al. Geochronology and isotope geochemistry of the Baogutu porphyry copper deposit in the West Junggar region,Xinjiang,China. 2013. p. 99 – 115.

[5]Liu D, Qiu J, Liu P, Tian F. Airborne Hyperspectral Remote Sensing Alteration Mapping for Uranium Exploration in Semistan, West Junggar, NW China. Acta Geologica Sinica. 2014,88:1373-4.

[6]Wang S, Zhou K, Zhang N, Wang J. Spectral Data Analysis of Rock and Mineral in Hatu Western Junggar Region, Xinjiang. Land Surface Remote Sensing Ii. 2014, 9260.

[7]Benxun Su, Kezhang Qin, He Sun, Dongmei Tang et al. Olivine Compositional Mapping of Mafic-Ultramafic Complexes in Eastern Xinjiang(NW China):Implications for Cu-Ni Mineralization and Tectonic Dynamics. Journal of Earth Science. 2012,v.23:41-53.