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# An Improved Crosta Technique for Alteration Information Extraction Based on Local Variable Window

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With the advancement of remote sensing technology, the mineralization-related alteration anomalies can be used as independent indicators during mineral exploration activities as geochemical and geophysical anomalies. Crosta and Moore (1989) developed a methodology called Feature Oriented Principal Components Selection (FPCS) based on principal component analysis (PCA). Loughlin (1991) modified the FPCS technique by selecting specific remote sensing band sets and applying PCA separately to them, then developed a methodology called Crosta technique. Crosta technique has been successfully used for mineral exploration purposes due to its ease of use and robustness. This technique has become a standard operational tool for alteration mapping using Landsat TM and ASTER. However, traditional Crosta technique calculates the eigenvectors of each component based on the statistical analysis of the entire image. It will produce a lot of noise in the abnormal component and reduce the accuracy of alteration information extracted. This paper presents an improved method to solve the above problems based on local variable window. For the improved method, the entire image is divided into a number of independent statistical analysis units by the local variable window. In each local variable window, principal component analysis and judgment of the abnormal component will comply after the elimination of interference information such as water, clouds, snow and so on.

Crosta et al (2003), Zhang and Yao (2009) described TM and ASTER band sets of Crosta technique for typical alteration minerals as table 1. According to Crosta criterion can identify which principal component (PC) contained the alteration mineral information: the PC that contains the target spectral information shows the highest eigenvector loadings from the ASTER (or TM) bands, coinciding with the target's most diagnostic features, but with opposite signs (+ or -).In the alteration PC, if the eigenvector loading of high reflectance band is positive, the alteration mineral will be distinguished by bright pixels. Otherwise the alteration mineral will be distinguished by dark pixels. To enhance alteration mineral as bright pixels, those PC images with negative loadings should be negated.

**Tabel 1. TM and ASTER band sets of Crosta technique for typical alteration minerals**

| Sensor | Alteration minerals | band sets | | | |
|---|---|---|---|---|---|
| TM | Ferric oxide | 1-- | 3++ | 4 | 5 |
| | Hydroxides | 1 | 4 | 5++ | 7-- |
| ASTER | Iron-oxide | 1-- | 2++ | 3 | 4 |
| | Al-Hydroxides | 1 | 3 | 4++ | 5-- |
| | Mg-Hydroxides | 1 | 3 | 4++ | 8-- |
| | Kaolinitez | 1 | 4 | 6-- | 7++ |
| | Illite | 1 | 3 | 5++ | 6-- |
| | Alunite | 1 | 3 | 5-- | 7++ |
| | Kaolinitez +smectite | 1 | 4 | 6-- | 9++ |

Note: ++ and – represent high reflectance and strongly absorption respectively

The improved Crosta algorithm is as following.

Step1: Input an ASTER (or TM) image.

Step2: Identification of valid background pixel.

Invalid background pixels include vegetation, water, clouds, snow, ice and bad pixels, which can be identified by remote sensing feature index, such as normalized

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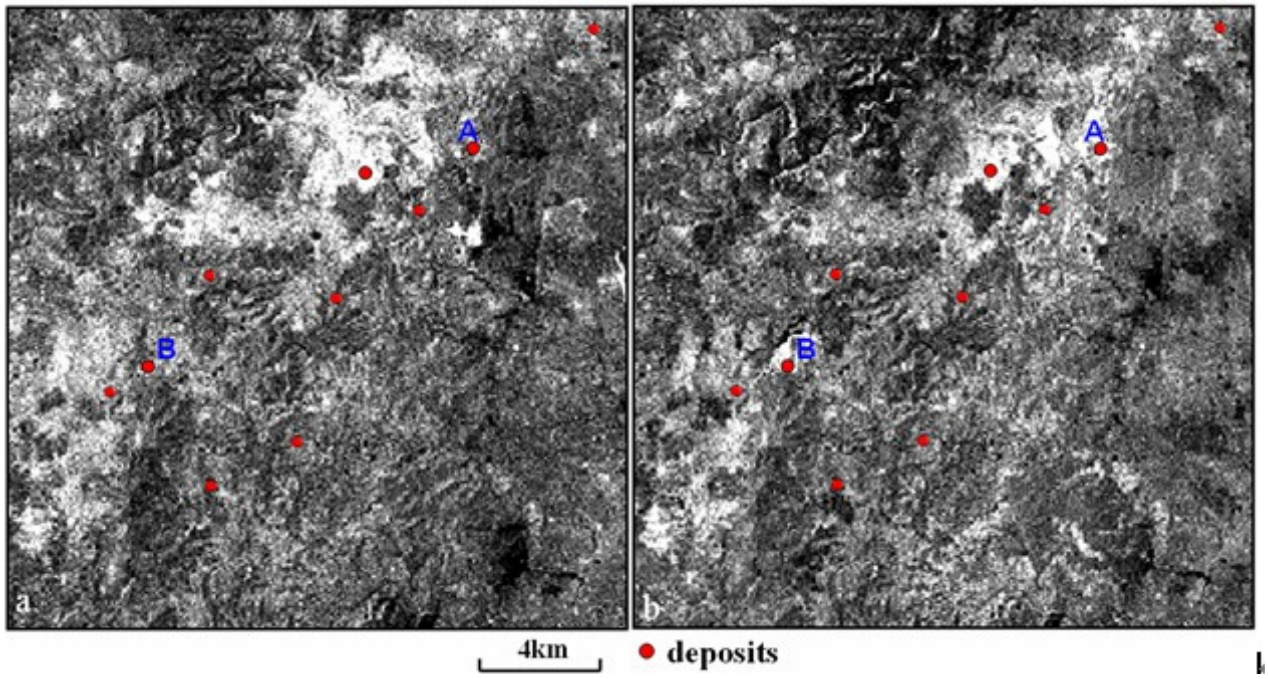


Fig.1. The ferritization anomaly extracted from traditional (a) and improved (b) Crosta technique

difference vegetation index (NDVI). Removal of invalid background pixels, valid background pixels can be obtained.

Step3: Selection of local variable window.

The local variable window starts as an 11×11 pixel square ring around every valid background pixel. The ring is increased to a maximum of 31×31 pixels, as necessary, until at least 51% of the pixels within the window have been deemed as valid background pixels, and the number of valid background pixels is at least 62.

Step4: Crosta analysis in local variable window.

Analyze the valid background pixels in local variable window with Crosta technique. It includes three aspects: the choice of characteristic band sets, the judgment of abnormal component, and the discrimination and conversion of bright (or dark) pixels for abnormal component.

Step5: Output the abnormal image

The computer program of improved Crosta technique has been developed with interactive data language (IDL) in ENVI4.5 environment. Domozhazhua is an important Pb-Zn deposit located in the north segment of sanjiang metallogenic belt. Gossan mineralization and ferritization are the important prospecting criteria for hydrothermal Pb-Zn deposits in this area. Figure1 show the iron-oxide abnormal derived from ASTER band sets comprising bands 1, 2, 3 and 4 using traditional and improved Crosta technique. Statistical results show that the mean and standard deviation of abnormal derived from traditional Crosta technique are 0.0476 and 3.6237, while that of improved Crosta technique are 0.1252 and 3.0795 respectively. The mean of improved method is more than that of traditional method, while the standard deviations of them are opposite. It indicates that the iron-oxide abnormal derived from improved method is stronger and more centralized than that of traditional method. Figure 1 also confirms this conclusion. In addition, A and B deposits in figure-1a are located in the weak abnormal area, while them are all located in the intense abnormal area in figure-1b.All the above results indicate that the improved method can reduce the background noise, filter interference information, and identify weak alteration information effectively. Based on the grid of 1km×1km, comprehensive geochemical anomalies are used to evaluate the effectiveness of the iron-oxide abnormal derived from traditional and improved method. The number of grid located in abnormal derived form traditional method is 579, and 207 of them also have geochemical anomalies. The effective rate of traditional method is 35.8%. The number of grid located in abnormal derived form improved method is 5562, and 245 of them also have geochemical anomalies. The effective rate of improved method is 43.6% and more than that of traditional method. The verification results also show that improved Crosta technique is more effective than traditional Crosta technique.

The superiority of improved Crosta technique based on local variable window has been reflected in Dongmozhazhua area preliminarily. For different regions and deposit types, the validation and evaluation of this

improved method should be studied in further work.

**Key words**: Alteration, Crosta technique, Remote sensing anomaly, Local variable window, Dongmozhazhua

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