Geophysical Research Abstracts
Vol. 20, EGU2018-6965, 2018
EGU General Assembly 2018

Identification and Extraction of Mineralization alteration information with multi-fractal filters

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Identifying and extracting information related to mineralization alteration by remote sensing technique is a significant progress in mineral exploration. The altered rocks can be distinguished from the unaltered rocks by their prominent differences in reflectance spectra. Eastern Tianshan district is a famous mineralization belt in China. Long-term tectono-magmatism had produced complicated geological background, as well as high potentials of polymetallic mineralization, such as Fe, Cu, Au, etc. The extremely dry climate causes very few distributions of vegetation, which makes this district an ideal place for extraction of mineralization alteration by remote sensing technique. For the extraction method, many of previous researches employed principal component analysis (Crosta method, Crosta et al., 2003) and band ratio analysis to identify the altered areas. After that, median filtering and support vector machine (SVM) are commonly used methods to delete fake anomalies and enhance the target information or real alteration anomalies. From the viewpoint of non-linear theory, mineralization is a complicated, cascade, non-linear processes, spatial distribution of which is fractal/multi-fractal.
Considering of this characteristics, spatial distribution of alterations related to mineralization can be analyzed by fractal/multi-fractal theories and methods. Proposed by Qiuming Cheng, a Spectrum-Area (S-A) model can help with measuring the generalized self-similarities in alteration field. With different filters describing different generalized self-similarities, anomalies and background of alteration field can be therefore separated in spatial scenario by inverse Fourier transformation. The anomalies delineated with this method can be diverse in different ways, for example, the strength of the alteration anomalies. Based on commonly used Crosta and S-A models, this research proposed a workflow to delineate altered regions in eastern Tianshan mineral district with both Landsat 8 OLI and ASTER remote sensing data. Choosing suitable thresholds, several filters with different characteristics of generalized self-similarities will be built in frequency domain and applied to the principal component analysis results. Real anomalies with different grades can therefore be recognized from the fake ones in the spatial domain via inverse Fourier transformation. The analytical results will be verified with existing mineral deposits. The current research is beneficial to the methodologies of alteration extraction with remote sensing imageries.