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Study on the Geochemical Anomaly of Copper Element Based on Hyperspectral Indices

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Geochemical anomalies are an important indicator in prospecting. In particular, geochemical anomalies of Cu play a very important role in geological prospecting of minerals. Geochemical anomalies of Cu are mainly related to mafic-ultramafic rocks and porphyry bodies, which are also associated with ore-forming elements of the Co-Zn-Cr-Ni-Cu combination. The conventional technique of geochemical prospecting involves superimposition of element symbols (Au, Fe, Cu, Al, Ca, etc.) on the geological map of an area by analysing geochemical anomalies using geochemical data. However, this technique is not suitable for regions where geochemical anomaly data are limited. The development of hyperspectral remote sensing has enabled the mapping of spectral features related to characteristic absorption bands of elements in minerals at high spatial resolution, providing a means for precise and detailed reconstructions of geochemical anomalies facies (surface). Compared to conventional techniques for identifying elements, reflectance spectroscopy offers a rapid, inexpensive, and non-destructive tool for determining the mineralogy of rock and soil samples. Hyperspectral remote sensing also provides data for prospecting in areas without sufficient geochemical data, and thus is of vital significance in prospecting for ores in such regions. However, approaches for remotely sensing elements are still lacking, particularly for element content. In this study, a level analysis of Cu content via spectral indices in the northwestern Junggar region, Xinjiang, was conducted. Based on four levels (0–100 ppm, 100–1000 ppm, 1000–10000 ppm, and >10000 ppm) of Cu content and corresponding spectral reflectance, simple and useful spectral indices for estimating Cu content at different levels were explored. The best wavelength domains for a given type of index were determined from four types of spectral indices by screening all combinations using correlation analysis. The coefficient of determination (R2) for Cu was calculated for all indices derived from the spectra of rock samples and was found to range from 0.02–0.75. With sensitive wavelengths and a significant correlation coefficient ($R2 = 0.63$, $P < 0.005$), the Normalized Difference (ND)-type index was the most sensitive to Cu content exceeding 10000 ppm. Although the ND-type index has a few limitations, it is a useful, simple, and robust indicator for determining Cu at high concentrations. With the advent of new platforms and satellites in the future, such relationships with other elements are required to enable the widespread use of this index in broad-scale surveys of mineral elements in the field.