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A Developed Spectral Identification Tree for Mineral Mapping using Hyperspectral Data

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The relationship between the spectral features and the composition of minerals are the basis of mineral identification using hyperspectral data. The reflectance spectrum of minerals results from the systematic combination of several modes of interaction between electromagnetic energy and mineral particles in the form of reflection and absorption. Minerals tend to have absorbing features at specific wavelengths with a characteristic shape, which can be used as diagnostic indicators for identification. The spectral identification tree (SIT) method for mineral identification is developed in our research to map minerals accurately and applied in some typical mineral deposits in China. The SIT method is based on the diagnostic absorption features of minerals through comparing and statistically analyzing characteristic spectral data of minerals. We establish several levels of identification rules for the type, group and species of minerals using IF-THEN rule according to the spectral identification criteria so that the developed SIT can be further used to map minerals at different levels of detail from mineral type to mineral species. Identifiable minerals can be grouped into six types: Fe2+-bearing, Fe3+-bearing, Mn2+-bearing, Al-OH-bearing, Mg-OH-bearing and carbonate minerals. Each type can be further divided into several mineral groups. Each group contains several mineral species or specific minerals. A mineral spectral series, therefore, can be constructed as "type-group-species-specific mineral (mineral variety)" for mineral spectral identification. It is noted that the mineral classification is based mainly on spectral reflectance characteristics of minerals which may not be consistent with the classification in mineralogy. We applied the developed SIT method to the datasets acquired at the Eastern Tianshan Mountains of Xinjiang (HyMap data) and the Qulong district of Xizang (Hyperion data). In Xinjiang, the two major classes of Al-OH and Mg-OH minerals were mapped firstly. Then montmorillonite, kaolinite and muscovite were identified in the area of the Al-OH bearing minerals, and chlorite and epidote were identified in the area of the Mg-OH bearing minerals. Muscovite of rich Al and poor Al were further identified in the area of muscovite. In Xizang, Al-rich and Al-poor muscovite, kaolinite, chlorite and malachite were identified using SIT method. In all, the developed SIT method can further reduce the effect of other materials and focus on targeted minerals. In particular, the discrimination accuracy will be improved when the most diagnostic absorption spectral features are used in the developed SIT method.