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Hyperspectral image analysis for the determination of alteration minerals in geothermal fields: Çürüksu (Denizli) Graben, Turkey

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Çürüksu (Denizli) Graben hosts various geothermal fields such as Kızıldere, Yenice, Gerali, Karahayıt, and Tekkehamam. Neotectonic activities, which are caused by extensional tectonism, and deep circulation in sub-volcanic intrusions are heat sources of hydrothermal solutions. The temperature of hydrothermal solutions is between 53 and 260 degree Celsius. Phyllic, argillic, silicic, and carbonatization alterations and various hydrothermal minerals have been identified in various research studies of these areas. Surfaced hydrothermal alteration minerals are one set of potential indicators of geothermal resources. Developing the exploration tools to define the surface indicators of geothermal fields can assist in the recognition of geothermal resources. Thermal and hyperspectral imaging and analysis can be used for defining the surface indicators of geothermal fields. This study tests the hypothesis that hyperspectral image analysis based on EO-1 Hyperion images can be used for the delineation and definition of surfaced hydrothermal alteration in geothermal fields. Hyperspectral image analyses were applied to images covering the geothermal fields whose alteration characteristic are known. To reduce data dimensionality and identify spectral endmembers, Kruse's multi-step process was applied to atmospherically and geometrically-corrected hyperspectral images. Minimum Noise Fraction was used to reduce the spectral dimensions and isolate noise in the images. Extreme pixels were identified from high order MNF bands using the Pixel Purity Index. n-Dimensional Visualization was utilized for unique pixel identification. Spectral similarities between pixel spectral signatures and known endmember spectrum (USGS Spectral Library) were compared with Spectral Angle Mapper Classification. EO-1 Hyperion hyperspectral images and hyperspectral analysis are sensitive to hydrothermal alteration minerals, as their diagnostic spectral signatures span the visible and shortwave infrared seen in geothermal fields. Hyperspectral analysis results indicated that kaolinite, smectite, illite, montmorillonite, and sepiolite minerals were distributed in a wide area, which covered the hot spring outlet. Rectorite, lizardite, richterite, dumortierite, nontronite, erionite, and clinoptilolite were observed occasionally.