

Hyperspectral Insights Into Vanadium-bearing Phyllosilicates From the Paradox Basin V-U Ore Deposits (USA)

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In this study, we provide a detailed hyperspectral analysis of uranium and vanadium deposits in the Paradox Basin, USA. The basin hosts numerous U-V mineralization systems, all containing some V in spectrally active phyllosilicates. The objective is to evaluate the potential of hyperspectral techniques in exploring for U-V mineralization and to characterize the hyperspectral response of V-bearing phyllosilicates in the Paradox Basin.

This study focuses on visible–shortwave infrared (VSWIR) hyperspectral analysis of representative samples from three sandstone-hosted U-V districts: (1) the La Sal district, hosted in the quartzarenitic Salt Wash Member of the Morrison Formation, (2) the Placerville district, hosted in the quartzarenitic Entrada Formation, and (3) the Big Indian district, hosted in arkosic sandstones and conglomerates of the lowermost Chinle Formation. Vanadian illite, chlorite, and smectite are reported from La Sal and Big Indian; V at Placerville occurs in roscoelites. Laboratory-based hyperspectral imaging was integrated with mineralogical and geochemical analyses to identify diagnostic absorption features associated with these vanadium-bearing minerals and to validate the new spectral interpretations.

The results indicate distinct spectral patterns related to vanadium-bearing phyllosilicates across the examined deposits. V-illite and roscoelite display a characteristic absorption feature at 2238–2249 nm, interpreted as a V–OH bond. Variations in the position of the Al–OH absorption feature allow discrimination between V-illite and roscoelite. In some samples, spectral evidence also suggests the presence of V-bearing chlorite. Additional features commonly observed at around 1750 and 1783 nm may reflect the presence of sulfates, plant residues, or hydrocarbons in the samples. VNIR spectra typically distinguish electronic transitions associated with transition metal ions and are most often used for characterizing Fe, but potentially also usable for fingerprinting V.

Vanadium features identified in hand samples can be used to aid mineral exploration using hyperspectral imaging in outcrops, airborne, or satellite data.