

Mineralogy and Geometallurgy of Colorado Plateau U-V Deposits

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New research offers insights into the mineralogy and geometallurgy of the world-class U-V resource on the US Colorado Plateau. Mineralization occurs in all formations between Permian and Cretaceous ages, but the largest and highest-grade deposits are U-Cu(-V) breccia pipes in the Permian of northern Arizona, tabular U-V bodies in the lowermost Triassic Chinle of southeastern Utah, and tabular to rollfront V(-U) ores in the Jurassic Entrada and Salt Wash sandstones from southeastern Utah to southwestern Colorado.

Results from petrography and hyperspectral imaging, coupled with leaching experiments and TEM, indicate subtle variations in ore mineralogy and process behavior across deposit types. Pitchblende dominates all hypogene U assemblages, but V is diverse. In the Chinle and Salt Wash deposits V exists as trivalent to tetravalent V oxides (montroseite, duttonite) and a mix of V-illite, V-chlorite, and V-smectite. In breccia pipes and Entrada-hosted deposits V forms endmember roscoelite and V oxides are insignificant. Small amounts of V-bearing asphalt or other organic species have also been identified in the Salt Wash and Chinle ores, along with minor V-Ti oxides. Causes of the variation in hypogene V mineralogy remain unclear. Supergene alteration has produced carnotite and other uranyl vanadates across all deposit types.

Ore minerals in these deposit types are variably responsive to conventional extraction using sulfuric acid-sodium chlorate leaching. Pitchblende, V oxides, and uranyl vanadates leach well, but V-bearing phyllosilicates show a range of recoveries from 0% to around 40%. This reflects some phyllosilicate V existing as nanoscale V-oxide exsolutions that leach well when exposed, some as variably insoluble lattice V substitutions. Such V substitutions have unclear siting and average valence states of roughly 3.4 in chlorite, 3.6 in roscoelite, and 3.7-3.8 in illite, indicating high variations in bond strength that are expected to correlate with leachability.