

Ages and Geochemical Character of Sandstone-hosted U-V Ores Indicate Long Term Topographic Stability is Key for Colorado Plateau Mineral System

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A novel combination of geochronology and geochemical analysis of the Colorado Plateau's sandstone-hosted uranium deposits in the Late Jurassic Morrison Formation point to an important role of a stable surface that drove mineralization during the Early Cretaceous. U-Pb dating of calcite intergrown with primary/reduced U-minerals from six districts in the region indicates that mineralization spanned 144-105 Ma. Primary uranium mineralization therefore began shortly after Morrison deposition and continued, perhaps intermittently, for tens of millions of years prior to deeper burial in the Late Cretaceous. This regime is consistent with stratigraphic evidence of minimal deposition based on recurrent unconformity development including pedogenic features in an attenuated section of Late Jurassic through Early Cretaceous sedimentary units. Carbon, oxygen, and strontium isotopes of these carbonate-rich paleosols of the same age as mineralization also resemble the isotopic compositions of the dated calcites. Furthermore, ore-stage calcite isotopes are distinct from those of carbonate cements that formed after mineralization. Finally, heavy rare earth element enrichment relative to the North American Shale Composite in sandstone uranium ores is analogous to the enrichment observed in modern oxidized and bicarbonate-bearing surface waters, a plausible transport agent for uranium. These results suggest that uranium mineralization occurred throughout much of the Early Cretaceous due to topographic-driven flow of oxidized surface waters infiltrating into the shallow Morrison aquifer where metals could be trapped by local or deeper-derived reductants. This implies that long-term relative stability of the hydrologic system was key instead of specialized sources or traps.