Paragenesis of Uranium Minerals in the Grants Mineral Belt, New México:Applied Geochemistry and the Development of Oxidized Uranium Mineralization

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Deposition of reduced uranium ores in the Grants Mineral Belt, was succeeded by locally well-developed oxidation and the generation of secondary or tertiary uranium (vanadium) minerals. Detailed study of these succeeding-generation minerals indicates that oxidation of reduced uranium mineralization was effected by carbonate-, sulfate-bearing meteoric waters that engendered a series of generally hydrated uranyl-carbonate (e.g., andersonite, $(Na_2Ca(UO_2)(CO_3)_3 \cdot 6H_2O$; Chávez, 1979)) and sulfate (e.g., zippeite-like minerals, Mt. Taylor mine, Chávez, 1988; $K_4(UO_2)_6(SO_4)_3(OH)_{10} \bullet 4H_2O$; see also Moench and Schlee, 1967, pp. 57-61)) minerals.

Initial X-ray diffraction (XRD) analyses of reduced uranium minerals from organic-rich arkosic sandstones of the Westwater Canyon Member of the Jurassic-age Morrison Formation from the Mt. Taylor mine show that various organic compounds are associated with the strongly-reducing environment characterizing primary uranium minerals and associated V, Se, Mo and Fe. Oxidation of these reduced, organic-rich host rocks (Squyres, 1980) apparently produced carbonic acid and generated weakly acidic solutions capable of continued oxidation of uranium. Deposition of native selenium (Poison Canyon Mine; Tessendorf, 1979) and weakly-crystallized MoS_2 as "jordisite" (Kao et al., 2001) suggests that the oxidation environment was variable immediately following uranium deposition and that weathering-derived supergene solutions served to modify both reduced and initially-oxidized uranium-vanadium ores. XRD analyses of green oxide coatings and black ores from Section 31 and yellow oxide coatings from the St. Anthony mine show that the ores host andersonite and gypsum, indicating that CO_3^{2-}(aq) and SO_4^{2-}(aq)-bearing, oxidizing groundwaters were responsible for developing a series of paragenetically-complex carbonate and sulfate minerals that reflect local groundwater compositions and composition changes through time.

Comparison of Grants Mineral Belt uranium mineralogy with the paragenesis of U-V minerals in other regions of the Colorado Plateau suggests that regional oxidation (Adams and Saucier, 1981) was likely responsible for uranium transport and later oxidative replacement of reduced uranium minerals (compare to Arizona Strip breccia pipe-hosted U-(Cu, Ag, Ni, Co) mineralization; e.g., see Van Gosen and Wenrich, 1989; Wenrich, et al., 1992). Latest oxidation is attributed to supergene processes coinciding with the onset of regional uplift and erosion in Laramide times of the southern portion of the Colorado Plateau.

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