type sandstone deposits. The Wyoming type of roll deposit though in similar environments is unique, having mineralogic and compositional zoning, a feature of epigenetic deposits of other minerals and one which may be indicative of truly epigenetic origin.

The hypothesis of near-surface, quasisyngenetic origin presumes that formations are unique at their time of formation, which explains the ubiquitous stratigraphic control. Objections to this hypothesis are based largely on the high temperatures and salinities indicated by fluid inclusions and the late dates given by Pb-U dating methods. However, these are the results of diagenesis which recrystallized the quasisyngenetic deposits at high temperature and produced discordant dates. In contrast, hypotheses that postulate ore formation long after deposition and burial of the sediments fail to account for the stratigraphic control. Unique features such as the presence of volcanic debris acting as an intrasediment source of uranium are commonly cited as ore controls, but only a very small proportion of sediments with such features has uranium deposits in spite of an apparent consistency of diagenetic processes.

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Organic Geochemistry and Uranium in Grants Mineral Belt

Organic material is closely associated with the primary uranium deposits of the Grants mineral belt. This organic material is now insoluble and nonvolatile, and most of it is lacking in physical structure. The mixture of organic matter and uranium coats sand grains and fills interstices, which seems to indicate that both the organic matter and uranium were introduced as soluble materials after sedimentation. The relation of organic matter and uranium can be shown physically, chemically, and statistically.

Pyrolysis–gas chromatography, mass spectrometry, and elemental analysis have been used to examine the organic matter from several ore deposits. The results show carbon-rich materials which have been severely degraded by radiation from uranium and daughter products. The organic material now resembles amorphous carbon, having lost most of its hydrogen and oxygen. From the uranium content and approximate age, the radiation dose is calculated to be 10^{11} rads. The radiation damage has also produced an interesting new carbon-isotope fractionation effect, by which the carbon associated with ore is enriched in carbon-13 relative to the non-ore carbon.

Laboratory model experiments using freshly extracted soluble organic material from recent sediments and uranium—as $UO_2(CO_3)_2^{-2}$—show large enrichment of uranium by chelation and ion exchange, which are pH dependent. The greatest concentration factor for uranium is at slightly acid pH values.

From model experiments and laboratory work on samples from the Grants district, the following hypotheses are made: first, the soluble organic matter (of unknown origin) coated or precipitated on the mineral grains; subsequently, the uranium—probably as UO_2^{+2} or $UO_2(CO_3)_2^{-2}$—concentrated in and on this organic matter by ion exchange and chelation with functional groups. This cycle of organic coating and uranium concentration could have been episodic or continuous, but must have lasted at least 10^6 years based on calculations using assumed porosity, permeability, hydraulic gradient, uranium content of water, and organic concentration factors. Finally, after 10^8 years, the radiation damage has created an amorphous carbon material which is deficient in hydrogen and oxygen but which helps protect the ore from mobilization owing to its chemical inertness.

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Geology and Development of Marquez, New Mexico, Uranium Deposit

Uranium deposition in the Marquez, New Mexico, area occurs almost exclusively in the lower Westwater Canyon Member of the Morrison Formation of Jurassic age. The average aggregate thickness of the Westwater is 90 m but ranges from a minimum of 73 m to a maximum of 100 m. A "K" shale separates the upper and lower Westwater sandstone boundaries. The lower Westwater sandstone development is more pronounced in an east-southeast direction parallel with strike of the orebody(ies). Three distinct ore zones were deposited in peneconcordant elongate patterns. The upper zone occupies a stratigraphic interval just below the "K" shale and two lower zones lie above and below the "K_1" shale. Coffinite and uraninite predominate as the stable uranium species; other extrinsic elements were added during the mineralization process. Humates undoubtedly exerted major control on formation of the uranium. Ferrous iron pervades both within and outside the deposit whereas ferric iron, though limited in quantity, is confined principally to the orebody(ies). The lower "K_1" shale, parameters of permeability, and recurrence of meanders along the paleochannels also seem to influence enrichment.

Surface drilling is continuing, a vertical mine shaft to approximately 2,100 ft (630 m) is nearing completion, and a mill is being constructed on the property.

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Magnitude and Variability of Disequilibrium in San Antonio Valley Uranium Deposit, Valencia County, New Mexico

The San Antonio Valley deposit is a flat-lying tabular body of uranium mineralization in the Westwater Canyon Member of the Morrison Formation. The deposit is elongate northwest-southeast, is approximately 1.6 km long and 0.3 km wide, and averages from 2 to 4 m in thickness. The "trend-type" deposit has a chemically reduced mineralogy and occurs below the water table.

The average disequilibrium factor for the deposit shows a 4% enrichment in chemical uranium. Variations occur throughout the deposit, however, with the northeastern edge being chemically excessive by 11% and the southwestern edge being chemically deficient. Three