The Great Divide basin of central Wyoming has been the focus of intense uranium exploration for a decade. Over 10 million lb (4.5 million kg) of uranium oxide has been produced since 1957 from the Crooks Gap mining district in the northern part of the basin. This geologic province is estimated to contain at least 270 million lb (122 million kg) of uranium resources and is the least exploited of Wyoming basins known to contain significant deposits of uranium.

The Great Divide basin has the most complex structural, stratigraphic, and sedimentologic history of any Wyoming uranium-producing basin. These complexities have exerted significant controls on the ore-forming processes which have resulted in many variations in the characteristics of alteration features and the geometry of the uranium deposits.

The massive thickness of the Eocene Battle Springs Formation provides a host unit of up to 4,000 ft (1,200 m) at a maximum in the northern part of the basin and generally does not contain continuous shale breaks to allow for stratigraphic correlations or for the primary focusing of the ore-forming fluids. The result is a massive roll-front system which may be several thousand feet (1,000+ m) in vertical extent, a few miles wide, and tens of miles long exhibiting extreme irregularities caused by variations in both vertical and horizontal porosity and permeability as well as the structural complexities of the basin itself. Farther west and southwest, where the Battle Springs Formation intertongues with the Wasatch and Green River Formations, continuous shale beds are common, allowing for easier stratigraphic correlations, good focusing of the ore-forming fluids, and the development of roll-front features similar to those in other Wyoming basins.

Gross roll-front features indicate pervasive alteration through most of the basin leaving scattered areas of reduced ground as islands. The roll-front trends which outline these reduced islands display a significant influence by faulting and folding in the basins and contain deposits of uranium of variable tenor scattered along the trends at various lateral and vertical positions. The gross outlines of the redox interfaces outlining the reduced islands are very complex in detail and may represent multiple individual roll fronts, each of which must be mapped separately to insure a complete understanding of the frontal development and to result in the discovery of the greatest amount of uranium possible.

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Mineral Evaluation of Oil-Shale Land Exchanges

Oil shale is a potential energy resource of the future, but full realization of this potential requires the development of technology and land-ownership patterns that permit efficient mining operations. Therefore, the policy of the Department of Interior has been to encourage oil-shale development through a program of land exchanges designed to consolidate land-ownership patterns. The first such proposals for exchange were submitted by the Colony Development Operation and the Superior Oil Co. and are now being considered. The U.S. Geological Survey and the Bureau of Land Management procedures to evaluate exchange proposals include a mineral and mining evaluation by the U.S. Geological Survey.

The oil-shale mineral and mining evaluation includes a determination of the total in-place resource, definition of minable intervals, and calculation of the in-place and recoverable mining interval resources for both the offered and selected lands involved in a proposed exchange. The evaluation is tailored to the geology and hydrology of each site, as illustrated by a description of the land-exchange evaluations for Colony Development Operation and Superior Oil Co.

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Stratigraphic and Sedimentologic Relations Among Three Frontier-Turner Depocenters in Wyoming Portion of Powder River Basin

During Turonian time, the western North American Cretaceous seaway covered a shallow shelf upon which sediments were deposited predominantly from western sources. Pulsating rates of sediment supply resulted in local regressions and transgressions along the seaway margins. The last three of these regressive-transgressive sequences affecting the Powder River basin are recorded by two sandstone complexes with western sources: the Torchlight and First Frontier sandstones, and the Turner sandstone, a shale-sandstone complex which prograded westward from the craton.

The Torchlight and First Frontier sandstones represent deltaic depocenters which consisted of distributary-channel and delta-front sand complexes, capped by well-sorted transgressive, reworked sands. The Turner sandstone represents isolated individual bars, channels, and splays within a mud-rich deltaic complex.

Stratigraphic analyses show that the Torchlight sandstone is slightly older than the First Frontier, and that the Turner complex is somewhat younger than the First Frontier. An isopach map of the lower, calcareous part of the overlying Niobrara Formation shows that calcareous shales are thickest over the western deltaic complexes, decreasing to zero along the seaward edges of the Turner lobes. Interpretation of the calcareous shales as representing periods of slow siliciclastic sediment influx indicates that the western complexes were inactive as depocenters for a significant period of time whereas the Turner distributaries were still supplying significant siliciclastic sediments from the craton to the eastern parts of the Powder River basin.

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Less Common Trace Elements in Sandstone-Type Uranium Deposits—Theory and Application

Trace elements commonly associated with sandstone-type uranium deposits include V, Mo, Se, and some As, Cu, and Pb. Because V, Mo, and Se are usually included in separate phases, all uranium-free, their use as pathfinders for uranium deposits is straightforward but often hindered by high background from the non-ore country rocks or other non-ore phases. Data for numerous other trace elements have been gathered, but many are of limited use owing to low precision and accuracy of analytical methods or failure to separate authigenic from detrital minerals. It is essential to separate the <2-μ fraction from barren oxidized, barren reduced, and mineralized rocks from sandstone-type uranium deposits to address quantitatively the problems of paragenesis. Elements now considered important which are commonly enriched in the authigenic fraction include the rare earth elements (REE), Sb, Ta, Ba, Cs, Rb, Sr, Co, Ni, and others. The chalcophile elements allow definition and tracing of redox fronts, Rb/Sr systematics, and Rb/Cs ratio aspects of primary versus remobilized mineralization. Tantalum and antimony for primary reduced from re-reduced ground and the REE distribution patterns for rocks penetrated by uraniferous solutions are different from those of barren rocks.

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Stratigraphy and Coal Deposits of Upper Cretaceous Mesaverde Group in Southern Wasatch Plateau, Utah

The Wasatch Plateau of central Utah contains large coal reserves. Rocks in the southern part of the Wasatch Plateau coalfield are early Late Cretaceous (lower Coloradoan) to late Paleocene in age. Major stratigraphic units, from oldest to youngest, are: the Mancos Shale, Mesaverde Group, North Horn Formation, and Flagstaff Limestone. The Mesaverde is divided, in ascending order, into the Star Point Sandstone, Blackhawk Formation, Castlegate Sandstone, and Price River Formation. The Blackhawk is divided into the transitional marine facies, which contains important coal beds, and the fluvial facies.

The Mancos was deposited as offshore, marine claystone and marine shoreface sandstone. Formations of the Mesaverde Group were deposited shoreward of the Mancos Shale and intertongue with it. The Star Point was deposited as littoral marine sandstone and the Blackhawk, Castlegate, and Price River were deposited as restricted marine and continental beds as the sea retreated. Coal beds probably were deposited on the delta-plain facies of actively prograding delta lobes.

The Hiawatha and Upper Hiawatha coal seams of the Blackhawk Formation are thick and extensive. The Hiawatha is about 1.8 m (6 ft) thick whereas the Upper Hiawatha averages 4.2 m (14 ft) thick and is probably minable throughout the study area except south of Convulsion Canyon. The coal is high-volatile C bituminous of noncoking quality. It has low sulfur and low ash content, and contains abundant resin. Mining in the Wasatch Plateau has been continuous since 1875 and over 112 million tons of coal have been produced.

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Basin Evolution of Late Paleozoic Taos Trough, Northern New Mexico

The Taos trough (Rowe-Mora basin of earlier workers) of northern New Mexico was one of several tectonically active cratonic basins associated with the late Paleozoic Ancestral Rockies. The basin was an asymmetric, fault-bounded feature flanking the Uncompahgre uplift. The basin fill was controlled primarily by local tectonics. As the basin and adjacent uplift evolved structurally, the depositional systems likewise evolved in conjunction with changing tectonic stability, fluctuating sediment input, evolution and integration of sediment dispersal systems, and varying water depth.

The onset of the first mild structural deformation and encroachment of the sea during Morrowan time was marked by deposition of a complex sequence of fine-grained sandstone, shale, coal, and limestone. These sediments were deposited in a variety of environments including mud flats, marshes, strand plains, and shallow-water carbonate banks. During Atokan time, tectonic activity of the Uncompahgre uplift increased, and subsidence of the basin accelerated. During this time, coarse alluvial-fan, braided-stream, and fan-delta complexes began to fill the basin along its western margin. By middle Desmoinesian time, an extensive coastal plain and a more continuous sediment supply had developed. Meandering rivers with coarse-grained bedloads fed lobate and wave-dominated deltas. Associated with this delta platform were local algal-mound and cross-bedded shelf-edge carbonate accumulations. Basinward, a mixed carbonate and terrigenous slope system developed in conjunction with continued subsidence of the basin.

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Definition of Depositional Facies of Parachute Creek Member of Green River Formation, Colorado—Evidence from Sulfur Isotopes and Whole-Rock Mineralogic Data

The Parachute Creek Member of the Green River Formation in the southern Piceance Creek basin displays four major lacustrine and marginal-lacustrine facies: deltaic-interdeltaic mudflat, carbonate mudflat, proximal open lacustrine, and distal open lacustrine. These facies are strongly gradational across the basin and their definition is not clearly evident from study of the physical characteristics of each facies. Additional evidence from whole-rock mineralogy (defined by X-ray diffraction) and sulfur isotopes, however, help to clarify each facies.

The deltaic-interdeltaic mudflat facies contains channel-form cross-stratified sandstone intercalated with pyritic mudrock and marlstone. Detrital quartz, K-feldspar, Na-plagioclase, and rock fragments characterize the sandstone. The mudrock and marlstone contain both calcite and dolomite plus detrital silicate minerals; $\delta^{34}S$ values of pyrite from this facies range from 2 to 26 per mill and average 12 per mill. The carbonate mudflat facies is dominated by dolomitic algal stromatolite, oolite, pisolite, and interclastic carbonate rock, and interbedded green to gray pyritic marlstone. The marlstone contains both calcite and dolomite and considerable authigenic analcime; $\delta^{34}S$ values range from 5 to 40 per mill and average 16 per mill.