ous 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.

Proximal open-lacustrine deposition produced well-stratified marlstone and lean oil shale, and rare algal stromatolite. Detrital silicate minerals become less abundant and are volumetrically replaced by dolomite, Fe-dolomite, excess-Ca ankerite, analcime, and rare dawsonite. The $\delta^{34}S$ values of pyrite from this facies range from 22 to 54 per mill and average about 30 per mill. The distal open-lacustrine facies is represented by richer grades of oil shale (greater than 15 gal/ton) and saline minerals (nahcolite and halite). The oil shale contains abundant Ca-Fe-Mg-carbonate phases, authigenic quartz, K-feldspar, Na-plagioclase, and dawsonite. Analcime is rare. The $\delta^{34}S$ values of pyrite and marcasite range from 18 to 66 per mill and average 35 per mill.

Overall, the Parachute Creek Member shows that detrital silicate minerals and calcite are concentrated in the marginal-lacustrine facies but authigenic silicate minerals, complex Mg-Ca-Fe-carbonate minerals, and saline minerals are concentrated in the open-lacustrine facies. Sulfur-isotope data show that iron sulfide minerals become progressively enriched in ^{34}S toward the open-lacustrine environment of deposition.

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Tertiary Correlations in Bighorn and Uinta Basins, Wyoming and Utah

Electrical accessory curves have been used to map the Mesaverde, Lance-Meeteetse, Fort Union, and Willwood Formations in the Bighorn basin of Wyoming. These subsurface mapping units have been correlated to mapped outcrops on the flank of the basin. Recent authors have concluded that the basin started to subside during upper Lance deposition; however, I conclude that most subsidence along the axis of the basin was in late Paleocene and Eocene times (upper Fort Union and Willwood).

Electrical accessory curves also were used to map the Mesaverde, Wasatch, Green River, Uinta, and Duchesne River Formations in the Uinta basin of Utah. These subsurface formations have been correlated to mapped outcrops on the south flank of the basin. Thickening of the Uinta and Duchesne River Formations into the basin indicates that the main subsidence along the axis of the basin was in late Eocene time.

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Lineament Mapping with Orbiting Imaging Radar

The Seasat A Synthetic Aperture Radar (SAR) was designed primarily for oceanographic and polar studies. During its 150-day mission before equipment failure, the SAR imaged substantial areas of North America as well as parts of northern Africa, Europe, Central America, and South America. The Seasat SAR differs from most commercial SLAR systems in that it has long wavelength (λ = 25 cm) and a steep incidence angle (~20°). These factors make the system more sensitive to differences in surface materials.

In the Peninsula Ranges of southern California, some previously unmapped lineaments were seen on radar images but not on Landsat. Field work has revealed faults of unknown displacement. Similar findings in the Appalachians have been reported. Near Medicine Lake and Mount Shasta in northern California, scarps only a few meter high are detectable. In that these small scarps have eroded to near the angle of repose and are parallel with the flight path, the energy return is particularly strong.

In the course of this work we have developed a classification system for radar lineaments that includes physical models and predictions of effects of changing viewing geometry. Any attempt to analyze lineaments in smooth sedimentary basins should involve at least two viewing directions to minimize bias.

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Deposition and Diagenesis of Organic Matter and Calcium Carbonate in Modern North Temperate Lakes

The three most important components in the sediments of modern north temperate lakes are detrital material, organic matter, and calcium carbonate. The detrital material is derived from whatever materials are available in the drainage basin, with modifications by weathering and diagenesis. Organic matter is a mixture of both allochthonous material (pollen grains, seeds, needles, organic detritus, etc) from the drainage basin and autochthonous organic matter (largely debris from planktonic algae and aquatic macrophytes). Recent studies of sedimentary pigments in lake sediments indicate that most of the organic matter in sediments of productive (eutrophic) lakes is derived from algae. Sediments in these lakes usually are olive gray and contain more than 20% dry weight organic matter (10% organic carbon). High concentrations of organic matter also accumulate in meromictic lakes in which organic matter is protected from oxidation by permanently anoxic bottom waters.

Low-magnesian calcite is the most common carbonate mineral in those lakes that are saturated with respect to calcium and/or magnesium carbonates. Dolomite and high-magnesian calcite can form even under humid, temperate conditions if the Mg:Ca ratio in the water is greater than about 8. Aragonite is mostly derived from mollusk debris, but may form as a primary precipitate if the Mg:Ca ratio in the water is greater than about 12. Assimilation of carbon dioxide by phytoplankton photosynthesis is an important aspect of carbonate precipitation in hard-water lakes. In some lakes, the rate of precipitation of calcium carbonate from waters that are supersaturated with respect to calcium carbonate is directly proportional to rates of assimilation of calcium carbonate by plankton.

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Geologic Characteristics of Valles Caldera Geothermal System in New Mexico

The Valles Caldera is in north-central New Mexico,