ern San Juan basin, northwestern New Mexico. Isopleth maps illustrate geometry of the major depositional units, distribution of sandstone depocenters, and large-scale lithofacies variations within the units. A reconstruction of topography at the base of the Westwater Canyon Member shows a series of subparallel paleotopographic lows and highs that trend east-southeast. The Westwater Canyon is thick and sandy along paleotopographic lows, but is thin and less sandy over the paleotopographic highs. These relationships suggest active structural control of sedimentary facies along east-southeast-oriented folds or faults by differential subsidence during deposition of the unit. Locally, east-southeast-oriented basement faults that were episodically reactivated since the Precambrian may be detected by detailed seismic reflection studies.

Depositional patterns and lithofacies distribution, in turn, appear to have controlled the location of uranium deposits. Primary and remnant uranium ore in the Westwater Canyon is restricted to east-southeast-trending depocenters defined by anomalously thick and sandy facies with relatively high sandstone:mudstone ratios. Redistributed ore is also localized in anomalously thick zones of the Westwater Canyon with relatively low sandstone:mudstone ratios.

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Plate Tectonics of Ancestral Rocky Mountains

The Ancestral Rocky Mountains were intracratonic block uplifts that formed in Colorado and the surrounding region during Pennsylvanian time. Their development related to the collision-suturing of North America with South America–Africa, which also resulted in the Ouachita-Marathon orogeny. During Early Pennsylvanian time, suturing was taking place only in the Ouachita region, and foreland deformation took place largely in the Mid-Continent. By Middle Pennsylvanian time, the length of the suture zone had increased, and it was active from the Ouachita to the Marathon region. At this same time, deformation of the craton also increased in intensity and in areal extent, culminating in the Ancestral Rocky Mountains. By Late Pennsylvanian time, suturing was taking place only in the Marathon region, and cratonic deformation decreased areally, spreading southward into New Mexico and west Texas and west into the Cordillera miogeocline. The Ancestral Rocky Mountains, and related features over a broad area of the western United States were formed while an irregularly bounded peninsula of the craton (including the transcontinental arch) was pushed northward and northwestward by the progressive collision-suturing of North America and South America–Africa. This intraplate deformation is, in some respects, similar to the deformation of Asia in response to the Cenozoic collision with India.

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Paleotectonic, Stratigraphic, and Diagenetic History of Weber Sandstone, Rangely Area, Colorado

Rangely field is in Rio Blanco County, Colorado, on a doubly plunging anticline of Laramide age. The Rangely structure is asymmetrical with the steepest flank to the southwest. The Permo-Pennsylvanian Weber Sandstone is the primary producing formation with cumulative production exceeding 670 million bbl of oil. The Weber is a subarkosic arenite deposited in an eolian regime. It interfingers with the alluvial Maroon Formation in the southern and southeastern portions of Rangely field. Isopach maps of the Pennsylvanian formations suggest a paleotectonic platform in the Rangely area and a Permo-Pennsylvanian north-south-trending arch west of the Laramide-age Douglas Creek arch. Hydrocarbons migrated into the Rangely area prior to the Laramide orogeny and were stratigraphically trapped at the Weber-Maroon transition zone. Subsequent Laramide structure localized and hydrocarbon accumulation.

Diagenetic history of the Weber Sandstone differs between the Uinta and Piceance basins. Weber diagenesis in the Uinta basin is dominated by silica precipitation and porosity appears to be residual primary. Weber diagenesis in the Piceance basin includes dissolution of detrital material and precipitation of a complex sequence of carbonate cements. Weber porosity in the Piceance basin appears to be both residual primary and secondary. The boundary between these two diagenetic regimes appears to coincide with the Pennsylvanian paleoarch.

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Potential Exploration Targets for Roxby Downs–Olympic Dam Type Mineral Deposits

The Olympic Dam deposit near Roxby Downs, central South Australia, appears to be another type of sediment-hosted stratabound ore deposit. It contains copper, gold, silver, uranium, and rare earths, and in terms of present market prices, is valued at over $100 billion, making it one of the world's most valuable deposits. When brought on line in 1988, the projected production of 4,000 tons/year of U_3O_8 as a by-product will have a significant impact on the world uranium market.

The deposit is hosted in middle Proterozoic rocks in a deep, small basin within the Gawler craton, and is overlain by 350 m (1,148 ft) of unmineralized late Proterozoic miogeoclinical Adelaidean sediments on the Stuart shelf. The nearest host rocks are no closer than 150 km (93 mi). According to Western Mining Corporation, the discovery resulted from regional considerations, with target selection being decided by nearly superimposed gravity and magnetic highs identified from detailed geophysical studies.

The present study is a synthesis and integration of large amounts of geological, geophysical, and geochemical data available from the South Australian Department of Mines and Energy, mining companies, and universities. The presence of a probable analog deposit at Mt. Painter, approximately 270 km (168 mi) east-northeast of Olympic Dam, available for field study and sampling, makes possible the testing of ideas and hypotheses. The exposed Gawler craton and surface and drill core samples from Mt. Painter have supplied materials for further study.

Plate tectonic reconstructions of the Gawler craton make it possible to apply Olympic Dam genetic models to other continents. The present study undertakes this application to the United States resulting in several areas being interesting targets.

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Fossil Basin and its Relationship to Absaroka Thrust System, Wyoming and Utah

The Fossil basin of southwestern Wyoming and adjacent north-central Utah is a Late Cretaceous–early Tertiary depositional basin formed largely on the hanging wall of the Absaroka thrust system. The basin is divided into the northern Fossil basin and the southern Fossil basin by the cross-basinal, northwest-southeast-trending Little Muddy Creek transverse ramp, which appears to be related to a lateral change in the stratigraphic position of the Absaroka thrust fault in both hanging wall and footwall rocks. The Absaroka thrust sheet is characterized by distinctly different structural styles north and south of this transverse ramp.

North of the ramp the Late Cretaceous–early Tertiary northern Fossil basin lies between the toe of the Absaroka thrust on the east and the Rock Creek anticline on the west. The basin was created by movement on, and erosion, of the Absaroka thrust sheet in pre-late Campanian-Maestrichtian time. Exploratory drilling has not as yet found significant oil and gas reserves in the northern Fossil basin even though Ordovician Bighorn Dolomite on the hanging wall of the Absaroka thrust has been juxtaposed with Cretaceous source beds in the footwall.

South of the transverse ramp the Late Cretaceous–early Tertiary southern Fossil basin lies between the toe of the Absaroka thrust system on the east and structure created on the hanging wall of the Medicine Butte thrust on the west. Within the southern Fossil basin, Cambrian through lower Upper Cretaceous rocks within the Absaroka thrust sheet are in fault contact with organic-rich Lower Cretaceous (on the west) and lower Upper Cretaceous (on the east) source rocks in the footwall. Essentially all oil and gas production established to date has been found in the southern Fossil basin in three lines of folding in the Absaroka thrust hanging wall. The westerly two lines of folding produce from Paleozoic and, locally, Mesozoic objectives, and the easterly folding produces from Mesozoic objectives. Exploratory and development drilling permits better interpretation of timing of thrust motion and subsurface structural geometry in the Fossil basin area.

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Parautochthonous Core-Thrusted Kink Folds and Chronologic Sequence of Thrusting, La Barge Platform, Sublette County, Wyoming

New information from deep Paleozoic wells on the La Barge platform has allowed explorationists to depict accurately the relationships between the Triassic Thaynes Limestone and structures with production from the Nugget Sandstone. The parautochthonous structures occur in the footwall of the La Barge, Prospect, and Darby thrusts.

The core-thrusted kink folds originated from a glide plane in the Thaynes Limestone. The glide plane can be easily identified on electric logs. The folds formed as one of the first structural events on the La Barge platform. Comparatively minor west to east movement of Thaynes and younger rocks produced a significant vertical deformation. As the core of Thaynes Limestone accumulated, it forced the younger more competent strata to form parautochthonous kink folds.

In the process of making this investigation, the chronologic sequence of thrusting has been worked out for the area. From oldest to youngest the thrusting sequence is: (1) Calpet, (2) La Barge, (3A) Tip Top, (3B) Dry Piney, (3C) Lake Ridge (proposed), (4) Prospect, (5) Darby (hogsback), (6) One Mile (proposed), and (7) Cretaceous Mountain. This interpretation varies substantially from the work of others.

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Fluvial Systems of Upper Cretaceous Mesaverde Group and Paleocene North Horn Formation, Central Utah: Record of Transition from Thin-Skinned Deformation in Foreland Region

Nonmarine strata of the upper part of the Mesaverde Group and North Horn Formation exposed between the Wasatch Plateau and the Green River in central Utah record a late Campanian tectonic transition from thrust-belt deformation to basement-cored uplift. Mesaverde Group sediments were deposited by synorogenic braided and meandering rivers. During most of Campanian time, sediment transport was east and northeast away from the thrust belt across a fluvial coastal plain. Subsequent development of the San Rafael swell, a basement uplift, between western and eastern localities caused erosional thinning of the section.

Sandstones within the upper part of the Mesaverde Group form two distinct compositional suites, a lower quartzose petrofacies and an upper lithic petrofacies. Lithic grain populations of the upper petrofacies are dominated by sedimentary rock fragments on the west and volcanic rock fragments on the east. Sedimentary lithic grains were derived from the thrust belt, whereas volcanic lithic grains were derived from a volcanic terrane to the southwest. Tributary streams carrying quartzose detritus from the thrust belt entered a northeast-flowing trunk system and caused a basinward dilution of volcanic detritus. Disappearance of volcanic grains and local changes in paleocurrent directions in latest Campanian time reflect initial growth of the San Rafael swell and development of an intermontane trunk-tributary fluvial system. Depositional onlap across the Mesaverde Group by the post-tectonic North Horn Formation indicates a minimum late Paleocene age for uplift of the San Rafael swell.

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Geohistorical Analysis of Paradox Basin

The Paradox basin is an elongate sedimentary basin, asymmetric in profile, extending across common corners of Utah, Colorado, Arizona, and New Mexico. Subsidence of the basin began in Desmoinesian time and was coincident with the development of the Ancestral Rocky Mountains. The Uncompahgre uplift formed the northeast boundary of the basin during Pennsylvanian and Permian times.

Formation thicknesses and lithologies were obtained from lithologic and radioactivity logs from various parts of the basin. The stratigraphic column at each well, restored through the Upper Cretaceous, was backstripped and decompacted to reconstruct its depositional history. Decompacted geohistory diagrams and residual (tectonic) subsidence curves were then generated for each well.

The Mobil 1 McCormick well, drilled in 1977, penetrates Pennsylvanian strata beneath reverse-faulted granitic basement; this indicates that the basin was flexed down in response to Pennsylvanian and Permian thrust faulting along the flank of the Uncompahgre uplift. However, close correspondence of the residual subsidence curves to theoretical thermal subsidence curves indicates that the basin formed by crustal extension. Consequently, development of the basin may have involved crustal stretching (transtensional?) beneath the basin floor, followed by thrusting (transpressional?) along the flank of the Uncompahgre uplift.

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Anatomy of a Dolomitized Carbonate Reservoir—Mission Canyon Formation at Little Knife Field, North Dakota

The Mission Canyon Formation is a regressive, shoaling-upward carbonate to anhydrite sequence deposited in a slowly shrinking epeiric sea. From its base upsection, the formation is mostly subtidal in origin and emergent at its top, and consists of (1) deeper water carbonates, (2) major cycles of open shallow-marine mudstones grading up into skeletal packstone or grainstone, (3) minor cycles of dolomitized transitional open to restricted marine mudstone grading up into skeletal wackestone, (4) dolomitized restricted marine pelletal wackestone or packstone, (5) partially dolomitized marginal marine skeletal wackestone, (6) slightly skeletal, oolitic-pisolitic wackestone or grainstone barrier-island buildups with storm washover aprons, (7) thin lagoonal limestones, (8) tidal-flat anhydrite, and (9) sabkha anhydrite. The oil is structurally trapped on the north, east, and west, within the northward plunging Little Knife anticline. Facies changes entrap the oil southward; the vertical seal is the overlying anhydrite beds. Closure is less than 100 ft (30 m). Porous, hydrocarbon-bearing beds were deposited as transitional open-to-restricted marine, restricted marine, and marginal marine lime muds. These became porous dolomitic reservoir rock by undergoing three diagenetic changes: (1) anhydrite replacement of skeletal fragments, (2) dolomitization of the muddy matrix, and (3) later, leaching of the anhydrite to create moldic porosity. The reservoir's pore system is composed of moldic pores and three types of dolomite intercrystalline pores—polyhedral, tetrahedral, and interboundary-sheet pores. Pore throats in productive beds are of two general sizes (1.2-1.6 μ and 5.2 μ).

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Minturn and Sangre de Cristo Formations of Southern Colorado—Prograding Fan-Delta and Alluvial-Fan Sequence Shed from Ancestral Rocky Mountains

The Middle Pennsylvanian Minturn Formation and the Pennsylvanian and Permian Sangre de Cristo Formation of the northern Sangre de Cristo Range form a 4,000-m (13,000-ft) thick, progradational sequence of fan-delta and alluvial-fan deposits. This sequence was deposited along the western margin of the central Colorado trough during faulting and uplift of the late Paleozoic Uncompahgre highland of the Ancestral Rocky Mountains.

The Minturn Formation is composed mostly of sandstone and shale deposited by fan deltas that prograded into the central Colorado trough. The Minturn of the northern Sangre de Cristo Range is divisible into (1) a turbidite-bearing facies, (2) a limestone-bearing facies, and (3) a red-bed facies. The turbidite-bearing facies is interpreted as deposits of fan deltas that prograded onto the sea bottom below wave base. The limestone-bearing facies is interpreted as deposits of fan deltas that prograded onto a shallow sea bottom above wave base. Turbidites and shallow-marine limestones, although they make up only a minor part of the Minturn Formation, are mutually exclusive deposits that serve to distinguish the two facies. In the limestone-bearing facies, sandstones containing deltaic foresets overlie thin shallow-marine limestones and are considered diagnostic of that facies. Both facies contain thick intervals of sandstone and shale interpreted as deltaic and alluvial deposits. Where it onlaps the Uncompahgre highland, the lower part of the Minturn Formation contains quartzose and arkosic red beds of probable alluvial origin.

The continental Sangre de Cristo Formation conformably overlies the Minturn Formation basinward, but it unconformably overlies Minturn Formation and Precambrian basement near the Uncompahgre highland. The Sangre de Cristo Formation contains (1) a sandstone facies deposited on the distal surfaces of alluvial fans, and (2) a conglomerate facies (Crestone Conglomerate Member) deposited on the proximal surfaces of alluvial fans. The sandstone facies consists of fining-upward cycles of red conglomeratic sandstone and siltstone interpreted as braided-stream deposits. The conglomerate facies consists of poorly sorted conglomerates interpreted as debris-flow and mudflow deposits, and sorted conglomerate and sandstone interpreted as streamflow and sheetflow deposits.