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.