floor thrust of this imbricate stack appears to lie within the Upper Devonian Three Forks Formation; the roof thrust lies within the middle Meramecian Kibbey Sandstone. The upper duplex involves Upper Mississippian rocks above the Kibbey Sandstone. Its roof thrust closely follows bedding near the top of the Mississippian sequence. The geometry of imbricate stacks within the McKenzie plate demands shortening of greater than 100%, resulting in at least 2 mi (3 km) additional eastward displacement of its trailing edge.

Recognition of the Blacktail salient with its complex structural patterns and unusual platform to basinal carbonate sequence provides new exploration targets in the southwestern part of the Montana thrust belt.

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Jurassic Crustal Deformation in West-Central Part of Colorado Plateau

Although the Jurassic Period is commonly thought of as a time of tectonic quiescence, updated isopach maps and new sedimentologic information indicate that it was a time of notable crustal deformation on the Colorado Plateau. A significant change in structural style occurred in Middle Jurassic time, especially during the erosion interval that produced the J-3 unconformity.

Prior to late Middle Jurassic time, the region had been tilted westward and structural troughs formed in the area of the present-day Circle Cliffs uplift and in the vicinity of the the Circle Cliffs and Black Mesa regions were uplifted and the nearby Henry and Kaiparowits regions began to be downwarped as troughs or basins. It cannot be determined if or how the present-day monoclines flexed during the Jurassic. However, the direction of structural tilt across these areas changed from west side down to east side down during the late Middle and early Late Jurassic. The Monument region, the largest and most persistent structural element in the region, changed from a structural bench to a positive structure in the early Late Jurassic.

In most cases the positive structures subsided more slowly than adjacent downwarps. Two exceptions during the Late Jurassic are the Black Mesa and Emery uplifts. These are the only uplifts that actually rose above the level of sediment accumulation.

Jurassic rocks are not known to contain significant hydrocarbon resources in this region, but their tectonic history may offer clues to the structural history of underlying Paleozoic strata, which are the primary hydrocarbon exploration targets.

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Subsurface Stratigraphy and Depositional History of Madison Limestone (Mississippian), Williston Basin

Cyclic carbonate-evaporite deposits of the Madison Limestone (Mississippian) in the Williston basin are made up of four main facies. From basin to shelf, the normal facies transition is from offshore deeper water (Lodgepole) facies to crinoidal-bioclastic banks at the basin to shelf transition, to oolite-algal banks and back-bank fine carbonate, evaporite, and minor terrigenous clastic beds on the shallow shelf. Five major depositional cycles are correlated and mapped on the basis of shaly marker beds identified on gamma-ray-neutron or gamma-ray-sonic logs. The marker beds are interpreted as reworked and redistributed silt and clay-size sediments originally deposited, possibly by eolian processes, on the emergent shelf during low sea level phases of cycle development. From oldest to youngest, the first two cycles are characterized by increasing amounts of crinoidal-bioclastic and oolite-algal carbonates, culminating in the Mission Canyon facies of the middle cycle. The upper two cycles are characterized by increasing amounts of evaporite deposits, culminating in the Charles salt facies of the youngest cycle.

Much of the Madison section on the south and east flanks of the basin consists of dolomite. Dolomite content decreased toward the basin center, where a major share of Madison petroleum production is located. Reservoir beds in the oil fields are primarily partially dolomitized oolite-algal or crinoidal-bioclastic bank carbonates. Most of the productive petroleum reservoirs are located in the middle cycles of the Madison.

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Regional Stratigraphy and General Petroleum Geology, Williston Basin

Paleozoic sedimentary rocks in the Northern Great Plains and northern Rocky Mountain region include a sequence of dominantly shallow-water marine carbonate, clastic, and evaporite deposits of Middle Cambrian through Early Permian age. The lower part of the Paleozoic section is a sequence of marine sandstone, shale, and minor limestone, ranging in age from Middle Cambrian through Middle Ordovician. Some porous sandstone beds occur in this section, mainly in the eastern and southern bordering areas of the Williston basin and Central Montana trough. Upper Ordovician through middle Upper Mississippian rocks are primarily carbonate beds, which contain numerous widespread cyclic interbeds of evaporite and fine-grained clastic deposits. Carbonate mounds or banks were deposited through most of this time in the shallow-water areas of the Williston basin and northern Rocky Mountains. Porous units, mainly dolomite or dolomitic limestone, are common but discontinuous in most of this sequence, and are more widespread in the eastern and southern margins of the Williston basin.

The upper Paleozoic beds are dominated by clastic rocks, beginning with the green and gray marine shales, marine carbonates, red beds, and some evaporites of the Upper Mississippian Big Snowy Group, and terminating with relatively thick marine and eolian sandstones and widespread red bed and evaporite facies of Pennsylvanian and Permian age. The Big Snowy Group is present only in the Central Montana trough and the central part of the Williston basin. Pennsylvanian and Permian beds, where present, unconformably overlie the Big Snowy Group, and overlie Mississippian or Devonian rocks in most of the remainder of the Northern Great Plains and northern Rocky Mountains, pinching out the Upper Pennsylvanian and Lower Permian section in Wyoming, southeastern Montana, northwestern South Dakota, and southwestern North Dakota.

Cumulative petroleum production (January 1982) in the United States part of the Williston basin was about 1.1 billion bbl of oil and 1.6 tcf gas. Estimated remaining recoverable reserves are about 400 million bbl of oil and 0.8 tcf gas. U.S. Geological Survey 1980 estimates of undiscovered recoverable oil and gas resources are about 900 million bbl of oil and 3.5 tcf gas.

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Influence of Preexisting Tectonic Trends on Geometries of Sevier Orogenic Belt and Its Foreland in Utah

The tectonic style of the late Mesozoic Sevier orogenic belt in Utah was greatly affected by preexisting structural trends that date from the late Precambrian rifting and fragmentation of the North American continent.

The late Precambrian cratonic margin (Cordilleran hinge line) was marked by a system of prominent faults including the north-south-trending ancestral Wasatch and ancient Ephraim faults and the southwest-northeast-trending Leamington, Scipio, Cove Fort, and Paragonah faults.

During the Paleozoic and Mesozoic, renewed activity on these faults affected the geometries of the late Paleozoic Paradox and Oquirrh basins, the boundaries of the Jurassic Arapien Formation, and the sedimentary pattern of the Cretaceous foreland basin.

Many of these fault zones were reactivated as tectonic ramps (e.g., the ancient Ephraim fault) and tear faults (e.g., the Leamington fault) during the compressional Sevier tectonism. The Fillmore arch and some other structural highs situated along the edge of the late Precambrian craton caused ramping of the inner Keystone-Pavant-Canyon thrust sheets and telescoping of the frontal thrust sheets.

Post-thrust uplift of basement highs led to tectonic denudation and to the development of low-angle, extensional faults, such as the Sevier detachment. Northeast-trending lineaments, such as the Cove Fort and Paragonah lineaments, were reactivated as right-lateral strike-slip faults. They also affected the extent of the Marysvale volcanic field.

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Computer-Assisted Reconstruction of Stratigraphic Framework of an Anderson Coal Deposit, Powder River Basin, Wyoming

The "Big George" coal bed, 30 mi (48 km) west of Gillette, Wyoming, is the thickest part of a large Anderson coal deposit. The coal resources of this central core, essentially a single bed of coal up to 202 ft (62 m) thick,