petroleum source beds. The present-day Coast Range basalts, which were probably an oceanic (spreading?) ridge, apparently were in place to provide the western barrier for a sediment trap and may also have encouraged an anoxic environment. A suite of coarse-grained, nonmarine to deltaic arkoses (the Puget Group of Washington) was available to be dumped into the trench as fan-type reservoirs. Thermal maturity may have been achieved by heat flow from the ridge and/or the Cascades, and depth of burial. Numerous, apparently large, structures have been mapped and several unconformities have been defined on the surface and in the subsurface.

The area of greatest potential poses some problems, such as glacial and volcanic cover and very sparse subsurface control, but there are enough oil and gas shows to suggest that a focused program, emphasizing the search for reservoir facies, may well prove successful in this classic frontier province.

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Largest Exposed Anticline in Denver Basin Area: Model for Mountain-Front Subthrust Structures

More than 1,000 ft (305 m) of four-way closure exists on the doubly plunging Red anticline, which is exposed at the eastern front of the Wet Mountains, Colorado. This anticline is the only one with large closure exposed in the Denver basin area. The Precambrian basement, intermittently exposed through the overlying Pennsylvanian Fountain Formation, is folded concentrically with the overlying Paleozoic and Mesozoic section, as shown by structure contours and cross sections. The anticline is steeply asymmetric to the west, toward the mountains, and the east flank dips 10° eastward toward the Denver basin. The anticline is exposed in an 18-mi-long (29-km-long) window in the Wet Mountains thrust, and it plunges northwest and southeast under the window's edges.

Recent seismic work on the Rampart Range thrust along the southeastern flank of the Front Range, north of the Wet Mountain, permits about 6 mi (10 km) of overhang and allows an underlying structure similar to the 5 mi wide (8 km) Red anticline. The trace of the Rampart Range thrust plunges north and south from its midpoint at Monument, Colorado, and may reflect the double plunge of such a subthrust anticline.

In both the Wet Mountains and the southeastern Front Range, a system of normal faults is present about 6 mi (10 km) west of the mountain front. These faults probably are listric, and their downthrown west blocks probably collapsed down the west side of an anticline below the thrust.

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Depositional Environments and Diagenesis of Mississippian Midale Beds, Midale Field Area, Williston Basin, Southeastern Saskatchewan

The Midale oil field in southeastern Saskatchewan lies on the northeastern flank of the Williston basin. Oil occurs mainly in Mississippian strata that dip south-southwestward and are truncated progressively northward by a Late Mississippian–Early Jurassic erosion surface.

The reservoir is in the Midale beds, a suite of carbonates and evaporites that was deposited during several transgressive-regressive episodes in a shallow shelf environment.

The Midale beds produce predominately from the Midale carbonate, which is divided into three zones. The lower zone represents a restricted, possibly lagoonal environment in which moderate energy conditions occurred intermittently; the middle zone formed in a transgressive, moderate to high-energy shoal environment; and the upper zone carbonate originated in restricted subtidal conditions. Oil reservoirs are coarsely crystalline vuggy dolomite and fractured, bioturbated calcareous dolomite of the middle and upper zones, respectively.

Diagenesis resulted in the formation of various stratigraphic traps. Early syntaxially cemented crinoid banks form local reservoirs. Fieldwide leached intercrystalline porosity and microfractures are the economically most significant porosity types. Based on the knowledge of local depositional environments, diagenesis, structural contours, and isopach maps, it is possible to high grade reservoir predictability.

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Seismic Evaluation of Hanna Basin and Implications for Regional Structure

The Hanna basin is a deep, nearly circular, intermontane basin covering 2,600 km^2 (1,000 mi^2) in Carbon and Albany Counties in south-central Wyoming. The average elevation of the basin floor is 2,150 m (7,000 ft) above mean sea level. The Hanna basin is one of the deepest structural basins in the Rocky Mountains. It contains as much as 10,800 m (35,000 ft) of sediments beginning with the Cambrian Flathead Sandstone, but the majority of the rocks are Cretaceous and Tertiary in age. The Hanna basin is surrounded by Laramide mountain ranges or uplifts: the Sweetwater arch (Seminoe and Shirley Mountains and Bennet and Freezeout Hills) on the north, the Rawlins uplift on the west, and the Medicine Bow Mountains on the south. The eastern boundary is more poorly delineated—Simpson Ridge, a small northeast-southwest-trending anticline, separates the Hanna basin from the smaller Carbon basin, which in turn is separated from the Laramie basin by the Medicine Bow anticline. The Hanna basin provides an uplift-basin couplet in which both overthrusting, at the northwest end, and largely vertical uplift at the northeast end exist almost side by side. It is proposed that, with Hanna basin is a pivot point, the extent of overhang for Rocky Mountain foreland uplifts generally increases to the north and west whereas more vertical movement dominates to the south and east. The change in structural style may be due to the rotation of the Colorado Plateau block and a thickening of the crust toward the craton. Many different types of structures are to be encountered and expected around the Hanna basin owing to the anisotropy of the basement, the sedimentary cover, and the structural forces responsible for their deformation.

The Hanna basins full hydrocarbon potential has not been realized. Several small fields are present around the basin, but deep tests are rare, especially toward the center of the basin.

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Facies Control on Oil Production From Upper Member of Permo-Pennsylvanian Minnelusa Formation, Powder River Basin, Wyoming

Lateral and vertical facies variations within the predominantly eolian upper member of the Minnelusa Formation control both the regional reservoir distribution and the localization of oil-producing trends.

Sands sourced by northeasterly trade winds were deposited in a land area bounded on the west by the Lusk embayment, which was a shallow, restricted extension of the Permo-Pennsylvanian sea. This embayment was present throughout Minnelusa deposition, and was located in the western portion of the present-day Powder River basin. Another extension of the epeiric sea, located in western South Dakota, formed the eastern boundary of the land area. In the northern part of this area, an inland sand-sea developed; in the southern part, the sand supply was less and isolated barchan dunes migrated over a coastal sabkha. Dune sandstones are bounded laterally by predominantly sandy interdune deposits in the north and by coastal interdune deposits, including sandstone, dolomite, and anhydrite, in the south. Major marine transgressions deposited laterally extensive dolomites that separate the dune sandstones.

Interdune deposits constitute permeability barriers adjacent to dune sandstones. The dune sandstones, which can be of excellent reservoir quality, were subjected to early cementation by anhydrite. Later dissolution of the anhydrite cement, facilitated by good to excellent sorting and possibly enhanced by hydrocarbon migration, led to development of significant secondary porosity. Interdune sandstones are less well sorted and so did not develop good secondary porosity. Interdune carbonates and evaporites have virtually no permeability. The coastal interdune deposits in the southern part of the region, therefore, form more effective lateral permeability barriers than do the sand-dominated interdune deposits in the north.

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Structurally Controlled Sediment Distribution Patterns and Their Relationship to Uranium Deposits in Jurassic Morrison Formation, Northwestern New Mexico

Structures that were active in the Jurassic, inferred from isopleth and structure contour maps, significantly affected depositional patterns in the Westwater Canyon Member of the Morrison Formation in the south-