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Discovery of Upper Cretaceous "Parkman Sandstone" Production, Denver Basin, Colorado

During August 1983, Golden Buckeye Petroleum completed the Dinner 15-1 well, 4 mi (6.4 km) northeast of Greeley, Colorado, pumping 107 BOPD and 30 BWPD through untreated perforations in the "Parkman sandstone" at a depth of approximately 3,650 ft (1,112 m). This completion established the first reported "Parkman" production in Colorado. The Dinner 15-1 has produced over 13,000 bbl of oil and 9,500 bbl of water in 16 months, and has ultimate oil reserves estimated to be 60,000 bbl. Since August 1983, six more "Parkman" wells have been completed by St. Michael Exploration, Coors Energy, and Golden Buckeye.

The productive facies is a permeable, highly glauconitic, shaly, fine to medium-grained quartz sandstone. "Parkman" is the drillers' informal name for the Larimer and Rocky Ridge Sandstone Members of the Pierre Shale. The Larimer and Rocky Ridge Members correlate to younger rocks than the Parkman Sandstone of the Powder River basin. Environments of deposition are being studied at an outcrop area approximately 25 mi (40 km) northwest of the Larimer and Rocky Ridge productive area.

Hydrocarbon trapping in the fields discovered to date is due to a combination of structural and stratigraphic factors. The permeable "Parkman" facies must be present and the permeable sand must be sealed by structural closure, fault closure and/or updip pinch-out. High-angle listric normal faults, which create local horst and graben systems, account for the "Parkman" structural traps. Relief on these faults is on the order of 20-60 ft (6-18 m). Productive areas probably average 80-160 ac per field.

Well-cost payout can be achieved within 1 year and undiscounted returns in excess of five to one are forecast for many completions.

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Stratigraphy, Depositional History, and Trapping Mechanisms of Lone Tree Creek and Lodgepole Creek Oil Fields, Lower Cretaceous Fall River Formation, Powder River Basin, Wyoming

Stratigraphically trapped accumulations of oil in the Lone Tree Creek and Lodgepole Creek fields occur within and just updip from a fluvial meander belt within the Fall River Formation. The meander belt can be mapped north-to-south over a distance of at least 100 mi (161 km) in the eastern part of the Powder River basin. The northern part of the meander belt contains the oil fields of the Coyote Creek–Miller Creek trend; the southern part contains only the relatively small Lone Tree Creek and Lodgepole Creek fields. These small fields are of considerable interest, as they display a style of stratigraphic trapping of hydrocarbons not observed in the prolific Coyote Creek–Miller Creek trend. The stratigraphic traps of the Coyote Creek–Miller Creek trend occur at updip-facing convexities along the eastern edge of the meander belt, with abandonment clay plugs serving as lateral permeability barriers to hydrocarbon migration. Oil has been produced in part of the Lone Tree Creek field from a similar trap. The remaining part of Lone Tree Creek field and Lodgepole Creek field produce from stratigraphic traps formed by lateral pinch-outs of delta-front sandstone bodies. These traps are situated updip from and apparently in continuity with the meander-belt deposits,indicating that they may have been charged with hydrocarbons that found their way through the clay-plug barriers along the margin of the meander belt. Similar, undiscovered traps may exist updip from Fall River meander belts elsewhere in the basin.

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Stratigraphy and Depositional History of Lakota and Cloverly Formations, Powder River Basin, Wyoming

The partially equivalent Lakota and Cloverly Formations comprise the basal Cretaceous strata in outcrop exposures along the eastern and western margins, respectively, of the Powder River basin. They unconformably blanket a subaerial erosional surface that developed during Early Cretaceous time. Paleocurrent analysis of outcrops surrounding the Powder River basin, together with petrographic data, demonstrates that the formations had different source areas: sediments of the Cloverly were derived from the Sevier orogenic belt, whereas those of the Lakota were derived primarily from areas east and southeast of the present-day Powder River basin. The formations also display different facies: conglomeratic sandstones of the Cloverly appear to have been deposited by braided streams, whereas the well-sorted, fine to medium-grained sandstones of the Lakota were deposited by meandering fluvial systems. Although confirming biostratigraphic data are lacking, stratigraphic relationships strongly suggest that initiation of Lakota deposition preceded that of the Cloverly. The upper parts of both formations include red, green, and beige mudstones and appear to be correlative. They record a period of slow sedimentation immediately prior to transgression of the sea. They also record a change in paleoslope over much of the Powder River basin, the original northeastward-sloping surface having been tilted northwestward in response to subsidence within the foreland basin. Cloverly deposition was terminated by rapid transgression of the Thermopolis sea. Basal beds of the Thermopolis interfinger southeastward with deltaic deposits at the top of the Lakota. Lakota deposition was terminated somewhat later, the youngest Lakota strata being overlain by the Fuson tongue of the Thermopolis.

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Stratigraphy and Depositional Environment of Upper Mississippian Big Snowy Group, Bridger Range, Montana

Isopachs and lithofacies of the Big Snowy Group in the Bridger Range of southwestern Montana reflect subtle shifting of tectonic elements along an ancient structural lineament. The group comprises a transgressive series informally divided into the Kibbey Formation (with two members) and the Lombard facies, which is equivalent to Otter and Heath Formations of the Big Snowy Group farther east in central Montana.

The lower Kibbey member was deposited in a sabkha environment and is composed of algal laminated dolostone with desiccation features and evaporite solution breccias deposited at the leading edge of the transgressing sea. Siliciclastic intertidal channels that developed on the sabkha were restricted to a low-lying area that developed in the central part of the range. The upper Kibbey includes a regressive shoreface deposit composed of sandstone at the northern and southern ends of the range in contrast to mudstone and siltstone that dominate in the center of the range where deeper water and lower energy conditions prevailed. Ultimately, the Kibbey sabkha and shoreface transgressed out of the area leaving a partially restricted shelf lagoon. Shale and lime mudstone of the Lombard facies were deposited in quiet water at the center of the range. To the north and south, bioclastic wackestone, packstone, and grainstone were deposited under shoaling, higher energy conditions within the lagoon.

All three units of the Big Snowy are thickest where deeper water lithofacies occur, indicating that subsidence was greatest in the central part of the Bridger Range and that this subsidence was an important factor on the control of lithofacies distribution. Similar tectonic influence on sedimentation in this area is evident in other Paleozoic formations. The depositional changes in the central part of the range are coincident with the southern margin of the Precambrian Belt embayment along the Ross Pass fault zone, and seem to indicate a zone of deep crustal weakness along the transition from the fold and thrust belt to the Wyoming foreland deformation province.

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Libby Thrust Belt and Adjacent Structures—New Factors to Consider in Thrust Tectonics of Northwestern Montana

About 40 mi (65 km) west of the Rocky Mountain trench and at least 9 mi (15 km) above the sole detachment of the Rocky Mountain thrust belt is a zone of Cretaceous-Tertiary thrust faults up to 25 mi (40 km) wide in middle Proterozoic and Cambrian rocks. This zone (the Libby thrust belt) extends northward from the Lewis and Clark line to the northwest corner of Montana. Within the Libby thrust belt is a series of complex ramps, horsts, splays, and folds that accommodate a tectonic shortening of about 6.2 mi (10 km). Backsliding has occurred on some listric thrust faults, and middle Tertiary(?) extensional horst-and-graben faults offset or join most thrust faults. On the east, the lead thrust ramps up onto the broad open Purcell anticlinorium. On the west, the Libby thrust belt is overridden in the north by the lead thrust of the Yaak plate (whose central part is the broad, open Sylvanite anticline), and in the south, it is overridden by the Moyie thrust (which trends northwest and also overrides the west edge of the Yaak plate).

An essentially continuous section, 46,000 ft (14,021 m) thick, of Belt rocks is displayed on the south-plunging Sylvanite anticline. The base is not exposed, and the top is eroded. A section of similar thickness exists on the west flank of the Purcell anticlinorium, where the Belt Supergroup is overlain by about 3,000 ft (914 m) of Cambrian rock. The Cambrian occurs in the broad synclinal Libby trough that is paired with the Purcell anticlinorium, and these Cambrian strata are also caught up in the Libby thrust belt.

Geologic cross sections suggest that the Belt rocks have overridden the Cambrian at shallow depths only and that Cambrian and younger Phanerozoic strata probably do not occur at greater depths beneath and west of the Purcell anticlinorium. This interpretation differs significantly from interpretations that suggest intercalation of major wedges of Paleozoic and Belt rocks at depth in this same area.

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Carbon Isotope Variation in Mid-Continent "Ordovician-Type" Oils: Relationship to a Major Middle Ordovician Carbon Isotope Shift

"Ordovician-type" oils are found throughout the Mid-Continent and are characterized by strong odd-carbon predominance in the n-C_{11} to n-C_{19} alkanes, and relatively small amounts of branched and cyclic, and higher molecular weight normal ($>$ n-C_{19}) alkanes. Detailed organic geochemical comparisons of these oils with extracts of potential source rocks show that in the Forest City basin of northeastern Kansas and southeastern Nebraska, oil source rocks are Middle Ordovician shales of the Simpson Group. For the Keota Dome field, Washington County, Iowa, the oil source rock is the Middle Ordovician Glenwood Shale Member of the Platteville Formation.

Analyses of saturated and aromatic hydrocarbon fractions of "Ordovician-type" oils from the Forest City basin, Keota Dome field, and the Michigan basin show that $\delta^{13}C$ of the two fractions are similar and that δ^{13} varies over a considerable range, from -32.5 per mil to -25.5 per mil (PDB). This large range in $\delta^{13}C$ reflects a major shift in the carbon isotope composition of organic matter during the Middle Ordovician. This shift is shown in a 62.5-ft (19 m) interval of core from the Decorah and Platteville Formations in the E. M. Greene 1 well in Washington County, Iowa, where organic carbon $\delta^{13}C$ changes regularly upward from -32.2 per mil to -22.7 per mil (PDB). The change in organic carbon $\delta^{13}C$ in this core is not related to variations in amount (0.13-41.4% TOC) or type (hydrogen index = 69 to 1,000 mg HC/g TOC) of the marginally mature (T_{max} = 440 ± 5°C) organic matter. "Ordovician-type" oils in both the Forest City and Michigan basins show variable $\delta^{13}C$, suggesting that the $\delta^{13}C$ shift displayed in the Middle Ordovician rocks of southeastern Iowa is a regional and possibly a global effect, related to changes in the $\delta^{13}C$ of the ocean-atmosphere carbon reservoir. Isotopic analyses of coexisting carbonate minerals support this interpretation.

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Source of Triassic Thaynes Hydrocarbons in Idaho-Wyoming-Utah Thrust Belt

Hydrocarbons have been tested or produced from the Triassic Thaynes Formation in at least four fields in the Overthrust belt. The source of these hydrocarbons has been a subject of speculation and research. Gas chromatographic analyses of Thaynes Formation hydrocarbons and pyrolitic analyses of rocks of the Thaynes Formation were done in an attempt to establish the source of hydrocarbon liquids produced from the formation in the Overthrust belt.

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Regional Trends in Porosity and Permeability of J Sandstone in Denver Basin—Controls of Burial History

The Lower Cretaceous J sandstone is the principal reservoir for oil and gas in the Denver basin of Colorado, Wyoming, and Nebraska. Net pay of the J sandstone depends strongly on sandstone depositional environments, but other important aspects of reservoir quality reflect the burial history. Most notable of these are porosity, permeability, depth, and degree of thermal maturation (as indicated by vitrinite reflectance). An understanding of the regional interrelationships between these variables is important in predicting reservoir quality and in estimating undiscovered petroleum resources in the Denver basin.

Statistical treatment of the core analysis and well-log data from 134 widespread boreholes across the basin, for which the U.S. Geological Survey has core, reveal the following. (1) Thermal maturity increases exponentially with depth, indicating increased temperature with burial. (2) Porosity decreases linearly with increasing R_0 and depth. The presence of authigenic clays and carbonate cements are important to porosity reduction. In many examples across the basin, however, quartz pressure solution and precipitation processes are the main causes of porosity reduction, and these phenomena may be temperature-limited. (3) Permeability decreases exponentially with increasing depth. The permeability data exhibit more scatter than porosity, indicating a less direct relationship to depth and reflecting the effects of both porosity loss and increased surface area of the pore network. Authigenic clays, especially ordered illite-smectite, control the specific surface area of the pore network in the J sandstone.

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Development of Structure and Porosity at Medicine Lake Field, Northeastern Montana, Williston Basin

Medicine Lake field produces oil from the Mississippian Charles, Devonian Winnipegosis, Silurian Interlake, and Ordovician Stony Mountain and Red River Formations. Drill-stem tests also show a potential for production from the Devonian Birdbear and Duperow Formations. Noncommercial quantities of oil were recovered from the Mississippian Mission Canyon Limestone and Ordovician Winnipeg Formation. Different combinations of bioclastic bank development, dolomitization, solution, and fracturing have contributed to the porosity of each of the producing formations. Porosity development in the Winnipegosis and Red River Formations may have been influenced by the Medicine Lake paleostructure.

The Medicine Lake structure is slightly elliptical, 1 mi (1.6 km) in diameter, and has 125 ft (38 m) of structural closure at the top of the Red River Formation. Growth of the structure was essentially complete by the end of Devonian time. On another structure at nearby Outlook field, structural movement can be shown to have continued into the Cenozoic.

The configuration of Cambrian and Precambrian rocks at Medicine Lake suggests that the structure there formed by the compaction of Cambrian sediments deposited around a hill on the Precambrian land surface. Regional-scale southeast-plunging anticlines in the eastern Montana Williston basin may also have formed by compaction of Cambrian sediments on a differentially eroded Precambrian land surface.

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Petroleum Potential of Western Washington and Oregon

An interpretive geologic history for western Washington and Oregon based on recent plate-tectonic theories suggests that there is a significant potential for large petroleum accumulations in an area that is very sparsely drilled.

If, as many workers think, the early Tertiary edge of the continent was marked by a subduction zone in the vicinity of the present-day Cascade Mountains, then the trench associated with that subduction zone could have been the site of deposition of reservoir-quality turbidites as well as