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_o 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