were previously estimated at 113 billion short tons. This deposit is in the Paleocene Tongue River Member of the Fort Union Formation; overburden ranges from 700 to 2,400 ft (213 to 732 m).

The "Big George" bed was initially outlined using geophysical logs from nearly 300 oil and gas drill holes. More logs were studied in the northern portion of "Big George" and as far north as the Montana state line to examine the entire system of coal beds that includes this thick bed. We interpreted geophysical logs primarily for coal and sandstone, digitized lithologic intervals, and generated strip logs of lithologic sequences using a microcomputer. These computer-generated logs were generated in lines of sections, on matching elevations, to reconstruct the stratigraphic framework of subsurface coal in this part of the Powder River basin.

The framework was used to trace the interval containing the Anderson deposit into the Decker, Montana, and Recluse, Wyoming, areas. This interval appears to be confined by the Smith coal bed above; the bottom of the interval is less well defined. Lithologic patterns of the framework suggest that a major fluvial channel system defined part of the northwestern boundary of the "Big George" coal bed. The locations of these channels may have been controlled primarily by Laramide deformation in the Powder River basin.

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Stratigraphic Controls on Duperow Production in Williston Basin, Montana and North Dakota

There are presently over 200 wells in Montana and North Dakota that produce from, or have indicated pay, behind pipe in the Duperow Formation. Production is primarily confined to the basin center, decreasing greatly as the shallower rim of the basin is approached. There is no production from the Duperow Formation in the Canadian portion of the Williston basin.

Production in the Duperow Formation is primarily from dolomitized stromatoporoid-assemblage patch reefs that occur in the lower unit of the formation. Published work by others concisely defines the stratigraphy, paleontology, and facies subdivisions within the Duperow Formation. The formation consists of series of distinctive shoaling-upward carbonate sequences, and contains cyclic or repetitious bedding characteristic of the formation.

There appear to be three types of traps in the Duperow Formation reservoirs in the Williston basin. The structural type is most common on the Nesson anticline. The structural-stratigraphic type is the most common trap found in the Billings nose area. The unconformity-stratigraphic type is uncommon and found only at Seven Mile and Ollie fields in Montana.

The growth of stromatoporoid bioherms appears to have been influenced by tectonic activity. Many structurally positive areas, such as the Billings nose and the Nesson anticline in North Dakota and the Poplar dome and Sweetgrass arch in Montana, have stromatoporoid biohermal accumulations. These areas, probably slight topographic expressions during Duperow deposition, apparently offered optimum growth position for framework builders.

A stromatoporoid bioherm is interpreted to be the reservoir at Ridgelawn field, Montana. Eight wells appear to be capable of production from the basal portion of cycle 3. The wells appear to define a patch reef that is oriented northwest-southeast and is perhaps 1-1.5 mi (1.6-2.4 km) in its longest dimension.

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Source-Potential Rating Index—Evaluation of Bakken Formation

The Bakken Formation, an organic-rich, oil-prone unit, is the source of the crude oils found in the middle Bakken and overlying Madison Group. Thickness, organic carbon, and vitrinite reflectance data for the Bakken were gathered from 101 wells within the Williston basin and evaluated in terms of source potential.

An index exists that combines sediment thickness, organic carbon content, and thermal maturity data into a single mappable parameter that indicates areas of potential hydrocarbon generation. Multiplying the average percent organic carbon by the effective source rock thickness of a formation yields a richness factor that is then multiplied by maturity scaling factors to give source potential ratings for oil and/or gas generation. By using burial-history curves and thermal-maturation modeling, the rating index can be used to look at source potential through geologic time. The Bakken Formation has been evaluated with the aid of the rating index.

The source-potential rating index provides objective semiquantitative measures by which the source potential of a single formation can be compared within an area or the source potential of two or more formations can be compared within the same or different basins. The Bakken did not begin to reach high source potential until toward the end of the Late Cretaceous. This contrasts with previous authorities who believed the Bakken was at peak generation and expelling hydrocarbons throughout the Cretaceous.

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Depositional Environments, Diagenesis, and Hydrocarbon Potential of Nonmarine Upper Cretaceous and Lower Tertiary rocks, Eastern Uinta Basin, Utah

Core studies of nonmarine rocks from the Natural Buttes field, Utah, indicate that depositional environment and diagenetic alteration control the geometry and quality of low-permeability gas reservoirs in the eastern part of the Uinta basin. The Tuscher Formation (Upper Cretaceous) is composed of fine to medium-grained, moderately to well-sorted sandstones and less abundant carbonaceous and coaly shale that formed on the lower part of an alluvial braidplain. The Wasatch Formation (Paleocene and Eocene) unconformably overlies Cretaceous rocks and consists of fine-grained lenticular cross-bedded sandstones, argillaceous siltstones, and variegated mudstones, which were deposited in lower deltaplain settings along the margin of Lake Uinta. Cretaceous and Tertiary sandstones have been modified by minor quartz overgrowths, by the precipitation and subsequent dissolution of ferroan and nonferroan calcite, by poikilotopic anhydrite, and by the formation of authigenic illite, mixed-layer illite-smectite, kaolinite, chlorite, and corrensite. Most authigenic carbonate and anhydrite formed during early burial, before significant compaction. During later stages of diagenesis, precipitation of authigenic clay in secondary pores created by carbonate dissolution reduced porosity and permeability. Large amounts of natural gas generated in situ are stratigraphically trapped in these lenticular, diagenetically modified sandstones. Source rocks in the Tuscher Formation have reached the advanced stages of thermogenic gas generation (0.7% R_0) but are only moderately mature with respect to liquid hydrocarbon generation. Interbeds of lacustrine Green River shale are in the early stages of gas generation (0.5% R_0) and are source rocks for gas produced from the Wasatch Formation.

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Origin and Distribution of Fractures in Tertiary and Cretaceous Rocks, Piceance Basin, Colorado, and Their Relation to Hydrocarbon Occurrence

Gas production in the lower Tertiary Wasatch Formation and Upper Cretaceous Mesaverde Group, Piceance basin, Colorado, is controlled by a network of open and partly mineralized natural fractures. These fractures formed in response to high pore-fluid pressures that developed during hydrocarbon generation, and to widespread tectonic stress associated with periods of uplift and erosion that occurred during the late Tertiary. Sandstone beds commonly contain vertical extension fractures that are cemented with fine to coarsely crystalline calcite and locally with quartz, barite, and dickite. These minerals cut detrital grains, authigenic cements, and secondary pores, indicating that fracture mineralization occurred during later stages of diagenesis. Isotopic compositions for fracture-fill calcite in the Wasatch vary from -5.0 ‰ to -11.6 ‰ for $\delta^{13}C$ and from -9.5 ‰ to -14.9 ‰ for $\delta^{18}O$. In the Mesaverde, calcite ranges from -0.7 ‰ to -10.4 ‰ for $\delta^{13}C$ and from -13.3 ‰ to -17.7 ‰ for $\delta^{18}O$. These isotopic data indicate that fractures were mineralized during burial by fluids of meteoric origin, with temperatures that remained fairly constant, or by fluids that circulated at a rate that