

is based in part on comparison with criteria developed for Holocene sequences of the Atchafalaya flood plain.

Lacustrine deposits consist of highly organic, parallel-laminated clay with some silty laminations. Burrow structures are quite common and nodules of pyrite are present. Calcium carbonate is common along bedding planes. Lacustrine delta fills form coarsening-upward sequences which grade upward from lake deposits into interlaminated silts, clays, and sands with abundant ripple laminations, steeply dipping spill-over foresets, and loading features. Burrowing and pyrite nodules are present in the lower part and coarse organic debris and roots are common in the uppermost part. Poorly drained swamps are best recognized by their high content of organic fragments and root bioturbation that destroys most depositional structures. Pyrite and siderite are common as nodules. Well-drained swamps, in contrast, are relatively high in silt content and contain few organic fragments. Roots and root bioturbation structures are well preserved and stratification is only vaguely discernible. Iron oxide nodules are common, especially as crusts surrounding roots. Calcium carbonate nodules also are present in these deposits. Crevasse-splay deposits are similar to those of well-drained swamps except that stratification is better preserved and thin (less than 1 m) coarsening-upward sequences are common. These sequences contain ripple laminations, shallow scour-and-fill structures, and may be capped by rooted beds of sand. Natural levees are recognizable as fining-upward sequences with a well-stratified, burrowed, sandy lower part grading upward into a finer grained, root-bioturbated upper part with iron oxide and calcium carbonate nodules. Finally, abandoned channel-fill sequences consist of a complex interlayering of swamp, lacustrine, lacustrine-fill, and crevasse-splay deposits lying on, and often below, point-bar sequences.

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Painter Reservoir—Clear Creek—Ryckman Creek Nugget Sandstone Trend in Absaroka Thrust Plate, Uinta County, Wyoming

Nugget Sandstone reserves in the southwestern Wyoming part of the Thrust Belt province are rapidly being developed in the Painter Reservoir field, Ryckman Creek field, and the Clear Creek area. This series of northeast-trending fields is situated on the hanging wall of the Absaroka thrust.

Painter Reservoir field, discovered in 1977, is located 5 mi (8 km) northeast of Evanston, and is the most southerly of the three areas. Ryckman Creek field, discovered in 1976, lies 10 mi (16 km) farther northeast. Between the two fields, the most recent discovery on the trend is the Clear Creek area where Chevron tested 25 MMCFGD from the Nugget Sandstone in September 1978.

Each area is a separate, structurally controlled Nugget Sandstone reservoir. Field limits and structural details are not yet firmly established, but seismic and drilling data outline similar structure forms, each area appearing as an asymmetric overturned fold. The hy-

drocarbon columns range from an estimated 500 ft (150 m) in the Clear Creek area to over 1,000 ft (300 m) in the Painter Reservoir field. The column at Ryckman Creek is approximately 575 ft (175 m). A significant gas column is present in each area.

The Nugget Sandstone reservoir rock is cross-bedded and cross-laminated. This cross-stratification creates local variation in porosity and permeability. Along the trend, average Nugget Sandstone porosity and permeability appear to decrease somewhat from north to south. At Ryckman Creek field the Nugget Sandstone is more porous and homogeneous than in Painter Reservoir field. The Clear Creek area porosity and permeability data are limited with the field in an early stage of development.

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Whitney Canyon Field—Potential Gas Giant in Wyoming Thrust Belt

Recent drilling in the Absaroka plate of the thrust belt has confirmed the presence of a major gas-condensate accumulation in the Whitney Canyon area of Uinta County, Wyoming. Reserves are primarily in porous and/or fractured Paleozoic carbonate formations. Triassic carbonate rocks also appear to be commercially productive.

The discovery well, which was scheduled as a 13,400-ft (4,020 m) test, was spudded in October 1976. Mechanical problems were encountered at a depth of 10,691 ft (3,027 m) in the Permian Phosphoria Formation and the well was subsequently completed in the Triassic Thaynes Formation. Paleozoic gas production was established in 1978 by the Amoco-Chevron-Gulf 2. This well drilled a nearly normal stratigraphic section of Jurassic Twin Creek Limestone through Ordovician Big Horn Dolomite before crossing the Absaroka thrust at a true vertical depth of 15,516 ft (4,655 m). Cretaceous sandstones and shales were drilled to a total depth of 16,224 ft (4,867 m) or 15,894 ft (4,768 m) true vertical depth. A development well approximately 1 mi (1.6 km) north of the Amoco-Chevron-Gulf 2 drilled a similar stratigraphic sequence.

The Whitney Canyon structure is a north-south-trending geophysical anomaly with little or no surface expression; its general shape can be defined quite well with reflection seismic. At the Phosphoria level, the structure is approximately 10 mi (16 km) long and 2 mi (3.2 km) wide with 2,500 ft (750 m) of structural closure.

Gas tested from the Triassic Thaynes Formation is sweet, whereas the Paleozoic gas is sour with a hydrogen sulfide content of 18% or less. Environmental considerations and construction of a gas treatment plant probably will delay Paleozoic gas production until 1982.

Although reserve estimates are quite speculative, the Whitney Canyon structure appears to be in the giant field category.

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Influence of Diagenetic Reactions on Nonmarine Up-

per Cretaceous Rocks of Southman Canyon Gas Field, Uinta Basin, Utah

Natural gas is produced from sandstone in the Upper Cretaceous Neslen, Farrer, and Tuscher Formations in the southeastern Uinta basin. Examination of these sandstone units along the eastern Book Cliffs indicates that most of the reservoir units are part of alluvial channels. Sandstone beds in the Neslen represent relatively small and isolated meandering channels in swampy coastal plains. Sandstone beds in the Farrer were deposited by somewhat larger and more numerous meandering streams depositionally upslope from the Neslen setting. The Tuscher Formation represents the most landward facies and was deposited principally by meandering, laterally migrating, large streams with local braided courses.

Core samples from the Southman Canyon gas field studied with the scanning electron microscope (SEM) indicate that extensive diagenetic modifications of the reservoir rocks have occurred and have strongly influenced reservoir characteristics.

Authigenic overgrowths on detrital quartz are common, but secondary silica is not a significant cementing agent. Feldspars are not abundant and are commonly altered to illitic clay. Carbonate minerals—dolomite, ankerite, calcite, and minor siderite—account for up to 20% of the rock. They are generally interstitial and have replaced some detrital quartz and rock fragments. Chert and other rock fragments account for more than 20% of the volume of many sandstones. Some rock fragments are extensively altered by mechanical deformation, dissolution, and clay-mineral formation. Dissolution and leaching, primarily of rock fragments, have improved the reservoir storage capacity of the sandstone units by producing a significant amount of intergranular and intragranular secondary porosity. The dissolution and leaching appear to have exerted a greater influence on reservoir characteristics than did mechanical deformation and growth of authigenic minerals. Most porosity in the units is of secondary origin.

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Structural Geology of Northern Salt River Range, Idaho-Wyoming Thrust Belt—Preliminary Report

The northern Salt River Range is the structural culmination of the Absaroka-St. Johns thrust complex. The Stewart Peak quadrangle, located on the culmination, has been mapped to gain an understanding of the nature of the thrusts and folds in this part of the Idaho-Wyoming thrust belt. Rocks ranging in age from Middle Cambrian through Late Cretaceous are interleaved in a complex array of imbricate thrust faults and asymmetric folds.

Major thrust faults in the Stewart Peak quadrangle include the Absaroka, Murphy, and Firetrail. Imbricate thrusts in the hanging wall of the Absaroka include the Star, Stewart, and four imbricate slices at the north-central margin of the quadrangle which may correlate with the St. Johns complex in the Snake River Range. The Grand Valley fault bounds the range near the west

margin of the quadrangle where fanglomerates of probable Tertiary age (Pliocene?) are offset against Middle and Upper Cambrian strata.

Several conclusions may be proposed regarding the northern Salt River Range. (1) Cataclasis occurs on a scale much greater than previously reported because deeper and more intensely deformed levels of the thrust belt are exposed relative to thrusts cropping out east and south in the Idaho-Wyoming salient. (2) Deformational intensity increases downward through the Paleozoic succession as the basal Absaroka decollement in the Cambrian Wolsey Shale is approached. (3) Stratigraphic thicknesses for units below the Mississippian Madison Group are tectonically thickened by ubiquitous small-scale thrust slivers (each with a few centimeters or more offset), stylolites, and small-scale folds. Stratigraphic correlations and isopach studies based on the present distribution of tectonically thickened Paleozoic units should not be made in this part of the thrust belt. (4) The Stewart Peak area represents a structural culmination in which the roots of the Absaroka thrust have been exposed, possibly from thrusting over a basement arch. In this regard, isopach trends of Cretaceous rocks east of the Darby-Hogsback thrust suggest that the Moxa arch may continue northwestward beneath the thrust belt in alignment with the Stewart Peak culmination. In addition, several structural discontinuities within the thrust belt northwest of LaBarge suggest the influence of a basement upwarp. The Stewart Peak culmination may therefore reflect a deeper structural level of exposure owing to thrusting over a basement arch above the regional level of decollement. This interpretation has important ramifications regarding the structural control of potential oil and gas reservoirs beneath the Absaroka thrust.

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Wrench Faulting and Hydrocarbon Occurrence in Northwestern Powder River Basin, Montana and Wyoming

Detailed geologic mapping in the northwestern Powder River basin of Montana and Wyoming has delineated a west-northwest-trending structurally deformed zone that is related to a primary, left-wrench fault. The southeast end of the zone is located on the west side of the Badger Hills in Wyoming and trends N75°W for about 70 km to the east side of the Big Horn Mountains in Montana. Published aeromagnetic and gravity maps indicate that this structural zone extends across the northern Big Horn and Pryor Mountains and may represent a southeast extension of the Nye-Bowler lineament.

The most prominent structural elements within the zone are en echelon normal faults with surface traces trending N50°E in Paleocene and Eocene rocks. These high-angle tension faults commonly show reverse drag, with the downthrown sides rotated into the fault planes. Some of these faults have a small component of left-lateral strike-slip movement in Upper Cretaceous rocks. Fault displacement in the northern half of the zone is generally down on the southeast side and in the south-