characteristic marine structures.

An idealized vertical sequence within the veneer consists (in ascending order) of a laminated sandstone facies (in places containing chert pebbles), cross-stratified (0.3-m or 1-ft sets) sandstone facies, and an oscillation ripple sandstone facies. The upper part of the oscillation ripple sandstone facies may contain 6-sided polygonal structures filled with coarse-grained sandstone and chert pebbles, or it may be covered by a massive facies that contains abundant fluid-escape structures. Variations on the idealized veneer stratigraphy exist where some facies are absent, but the vertical sequence order is maintained.

Most of the formation is interpreted to be eolian in origin. Northerly winds deposited the large cross-bed sets in an extensive dune field. This event was followed by a period of marine transgression that reworked the uppermost part of the formation and formed the thin veneer. The abundance of fluid-escape structures and oscillation ripples in the veneer indicates rapid deposition by marine processes. The distinctive stratigraphy within the veneer reflects a deepening trend with the rising transgression.

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Hydrocarbon Potential Beneath Paris-Willard Thrust of Utah and Idaho

The Paris-Willard thrust trends in a north-south direction parallel with the eastern edge of the Bear Lake plateau of north-central Utah and southeastern Idaho. In places along the leading edge of the thrust, formations as old as the Cambrian Brigham Quartzite have overridden the Jurassic Nugget Sandstone and various Triassic formations. Movement on the Paris-Willard thrust began in latest Jurassic or earliest Cretaceous time, displacing rocks from the west to the east over 10 mi (16 km).

Seismic surveys indicate that from the leading edge to approximately 6 mi (10 km) west, the Paris-Willard thrust is relatively thin skinned. Detailed structural cross sections suggest that shales in the Triassic Woodside or Ankareh Formations, acted as "sled runners" for Cambrian quartzites moving on the overlying Paris-Willard plate. The thickness of this overlying thrust plate is believed to range between 3,000 and 8,000 ft (900 and 2,400 m), with a complete Paleozoic section present on the underlying Crawford thrust plate. With the exception of two wells drilled on the edge of the Paris-Willard thrust, 600 mi^2 (1,500 km^2) of potential Paleozoic reservoirs beneath the thrust have never been tested. Seismic interpretations indicate the presence of several large structures in the subthrust where formations such as the Phosphoria (which tested gas on the Crawford plate at Hogback Ridge field to the east), Weber, and Madison would be the primary objectives. Recent studies by several workers suggest units in the Phosphoria and other Paleozoic formations are excellent potential source rocks.

CLAYTON, JERRY L., U.S. Geol. Survey, Denver, CO, and ROBERT T. RYDER, U.S. Geol. Survey, Reston, VA

Petroleum Source-Rock Potential of Pennsylvanian Black Shales in Powder River Basin, Wyoming, and Northern Denver Basin, Nebraska

We analyzed 70 black shale samples from the middle member of the Minnelusa Formation (Pennsylvanian) in the Powder River basin of Wyoming and South Dakota, and from equivalent rocks of Desmoinesian age in the northern Denver basin of Nebraska. Organic-carbon content of these shales ranges from less than 1 to 26 wt. % (average = 5.4 wt. %). The shales contain predominantly type II organic matter and yield an average of 27,000 ppm hydrocarbons upon pyrolysis (S_2 yield, Rock-Eval). These data indicate that the shales are excellent potential source rocks. Thermal maturation data (vitrinite reflectance, pyrolysis, hydrocarbon geochemistry) indicate that some hydrocarbon generation has occurred, although complete generation of available hydrocarbons has not occurred for the samples analyzed in this study.

We analyzed 12 oil samples from fields producing from the Minnelusa Formation, for comparison with extracts from the black shales. Two, and possibly three, genetic oil types are produced from sandstone reservoirs in the Minnelusa Formation. One type is produced from sandstone reservoirs in the upper member (Permian), and a second type is produced from the middle member Leo sandstones (Pennsylvanian). This second oil type can be subdivided into two subgroups based on chemical composition, although we cannot determine from our data whether these are genetically distinct oils. Extracts from the black-shale samples correlate well with the two or three oil types based on stable carbon isotope composition and detailed molecular hydrocarbon composition determined by gas chromatography-mass spectrometry (C_{9+} alkanes and biomarkers). These results suggest that oil produced from the upper and middle members of the Minnelusa Formation in the Powder River basin is derived locally from the Pennsylvanian black shale and is not a product of long-range migration from the Phosphoria Formation in western Wyoming.

CLAYTON, JERRY, U.S. Geol. Survey, Denver, CO, ROBERT T. RYDER, U.S. Geol. Survey, Reston, VA, and FRED MEISSNER, U.S. Geol. Survey, Denver, CO

Geochemistry of Black Shales in Minnelusa Formation and Desmoinesian Age Rocks (Permian-Pennsylvanian), and Associated Oils, Powder River Basin and Northern DJ Basin, Wyoming and Colorado

No abstract available.

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Petroleum Geology of Greater Altamont Area, Uinta Basin, Utah

The Greater Altamont area consists of a group of major, naturally fractured, overpressured petroleum reservoirs situated on the gently northward-dipping flank of the asymmetric Uinta basin. This area produces approximately 17,000 BOPD and 29 MMCFGD—one-half the petroleum production in the Uinta basin. It presently consists of three contiguously producing designated fields: Altamont, Bluebell, and Cedar Rim.

The Tertiary Uinta, Green River, Wasatch, and North Horn Formations and the Tertiary-Cretaceous Flagstaff Limestone are the source and reservoir rocks. The low-porosity sandstones and siltstones form the stratigraphic traps within the interbedded shales. Vertical fractures provide the necessary permeability in these formations. Producing intervals occur at depths between 3,700 and 18,613 ft (1,128 and 5,673 m), each with an average thickness of 311 ft (95 m).

Average recovery is expected to be approximately 12%. Completion techniques play an important role in the primary production of oil from the area. Several extraction methods used in the area have resulted in variation of longevity of the wells. Secondary recovery is not deemed feasible owing to the type of reservoir; repressuring would result in channeling along fractures, bypassing most of the oil in place. In the near future, the Greater Altamont area is envisaged to extend farther south, as indicated by Sonat's recently completed producing wells in T3S, R1-2W.

DANA, GEORGE F., DONNA J. SINKS, and ROBERT OLIVER, Western Research Inst., Laramie, WY, and JAMES ELLIOTT, Independent, Laramie, WY

Tar Sand Triangle—Largest United States Tar Sand Deposit

Estimates of 4-8 billion bbl of oil in place make the Tar Sand Triangle the largest known deposit of tar sand in the United States. At present, 14 different companies or individuals hold leases in the area, most of which are for in-situ development of the tar sand resource.

In the summer of 1982, the DOE/LETC drilled four core holes, three of which penetrated the principal bitumen-bearing sequence—the White Rim Sandstone. The locations of the core holes were selected to fill obvious gaps in the data available from previous holes drilled into or through the deposit.

DEAN, JAMES S., RPI, Colorado, Boulder, CO

Seismic Facies and Reservoir Distribution in a Prograding Shelf-Slope-Basin Plain System: Chandler and Torok Formations, North Slope, Alaska

The Chandler-Torok sequence is one of several Cretaceous-Tertiary clastic wedges shed north and east from the ancestral Brooks Range hinterland into a rapidly subsiding foredeep trough. Each wedge consists of a

lower sequence of hemipelagic shales and submarine-fan deposits succeeded by slope-deposited silty shales and culminating in shelf and fluviodeltaic sandstones, shale, and coal. Basinal facies are expressed seismically as convergent bottomset reflectors of moderate to high amplitude and continuity, grading updip into mounded and channelized events of poor continuity and variable amplitude that onlap the base of the slope. This hummocky facies represents a combination of overlapping submarine fan lobes and gravity-failure deposits. The overlying slope sequences are expressed as complex sigmoid-oblique clinoform bundles of low amplitude bracketed by discrete continuous events of high amplitude. Clinoform bundles downlap over mounded facies onto bottomset events except where removed by deeply incised submarine canyons. Mounded submarine fans generally onlap the base of toplapped foresets, documenting their development during periods of low stand and shelf bypass. They were blanketed by high-amplitude foresets during transgressive periods of relative sea level rise. Shelf and nonmarine facies are seismically expressed as prograding and aggrading topset reflectors that respond to fluctuating sea level and sediment supply. Amplitude and continuity are high in the eastern wave-dominated shelf setting, low in the western river-dominated setting, and uniformly variable in the alluvial-plain setting owing to discontinuous channels and coal measures. Maximum reservoir development parallels the wave-dominated shelf setting.

DESMOND, ROBERT J., JR., and JAMES R. STEIDTMANN, Univ. Wyoming, Laramie, WY, and DONALD F. CARDINAL, Consulting Geologist, Casper, WY

Stratigraphy and Depositional Environment of Middle Member of Minnelusa Formation, Central Powder River Basin, Wyoming

Regional correlations of the middle member of the Minnelusa Formation (middle Upper Pennsylvanian) shed new light on the stratigraphic relationships of Pennsylvanian rocks in the central Powder River basin and serve as the basis for a regional depositional model.

The middle Minnelusa (Leo section) stratigraphy is best known in the southeastern part of the study area. To the north, the upper boundary (Red Marker shale) correlates with the base of the "B" dolomite interval, an upper Minnelusa marker. The underlying "C" sandstone of the upper Minnelusa is therefore Pennsylvanian in age. To the west the Red Marker becomes silty and disappears into the sand of the Tensleep Formation along the eastern Bighorn Mountains. There the middle Minnelusa is equivalent to the lower three-fourths of the Tensleep.

The two main factors influencing the depositional environments of the middle Minnelusa were paleogeography and sea level change. In the southeastern and south-central parts of the area, the proximity of the Lusk embayment and fluctuations in sea level caused frequent flooding of a broad, flat sabkha surface over which isolated dune complexes were migrating. The sediments deposited were subtidal carbonates and black shales interbedded with supratidal dolomites, evaporites, and eolian sandstones. Farther north, closer to the sand source, the dune complexes were larger, more continuous, and were affected only by major transgressive events. Laterally extensive eolian sands were also deposited to the west. The lack of black shales and presence of sandy dolomites with *Skolithus* burrows, however, suggests more normal marine conditions and deposition on a sand-dominated tidal flat.

DUBIEL, RUSSELL F., U.S. Geol. Survey, Denver, CO

Sedimentologic and Tectonic Control of Uranium Mineralization, Upper Triassic Chinle Formation, Southeastern Utah

Uranium deposits in the Upper Triassic Chinle Formation of the White Canyon, Capitol Reef, and Circle Cliffs areas occur in a succession of lithofacies that formed from sediments deposited under anoxic conditions. Anoxic conditions in the depositional environments of these lithofacies are indicated by the preservation of abundant organic matter and the drab (reduced) colors of the rocks. The coincidence of facies changes and the vertical sequence of rocks associated with isopach "thicks" suggests that certain depositional environments were localized by tectonic subsidence. Lake, marsh, and bog environments adjacent to anastomosing fluvial channel systems occur in synclinal areas that were actively subsiding during deposition. Deposition in these wetland environments, which had high organic productivity, high water tables, and minimal clastic input, resulted in organic-rich rocks. The vertical sequence of lithofacies indicates that initially the rate of tectonic subsidence was greater than the rate of clastic sediment influx. Subsequently, as the rate of clastic influx exceeded the rate of subsidence, sedimentation on prograding deltas buried the wetland deposits with clastic sediments that also contained abundant detrital plant debris. The subaqueous decomposition of this organic matter produced anoxic conditions in the overlying deltaic sediments that protected underlying marsh and bog deposits from oxidizing meteoric waters. Preservation of the organic material incorporated in the bog and marsh deposits established the reducing chemical environment necessary to precipitate uranium. Maintenance of this reducing environment also protected uranium deposits from later oxidation.

Subsidence, concomitant with sedimentation, produced the hydrologic conditions conducive to plant production, accumulation, and preservation and established the reducing chemical conditions necessary to precipitate and preserve uranium. Identification of wetland environment sediments that accumulated in structurally controlled areas of subsidence is a useful guide for uranium exploration in the Chinle Formation.

DUEY, HERBERT D., Northwest Exploration, Denver, CO

Oil Generation and Entrapment in Railroad Valley, Nye County, Nevada

Railroad Valley is a graben block in the Basin and Range structural province. Topographically, it is basically flat with recent playa deposits on the surface. Two structural deeps exist in the valley. Five oil fields are associated with the northern deep. All oil fields are related to faulting.

Oil has been generated from Tertiary Sheep Pass and Mississippian shales. This generation is probably due to recent local heating of the valley by intrusive rocks. Temperature gradients are as low as 0.9°F/100 ft (16°C/km) to as high as 7.3°F/100 ft (133°C/km).

Eight million barrels of oil, with no significant quantity of gas, have been produced from the fields. The seals on the fields are imperfect and any gas generated, and much oil, has probably leaked into the overlying valley fill. Trap Spring and Eagle Springs fields are hydrostatically pressured whereas Bacon Flat, Currant, and Grant Canyon fields are overpressured.

The concept of immature source rocks occurring near a valley with high heat flow may improve exploration success.

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Teton Pass—A Window on Structure of a Thrust Belt–Foreland Overlap Area

Detailed geologic mapping along Teton Pass, southwest of Jackson, Wyoming, has led to a reinterpretation of the spatial and sequential relations between the Paleocene-Eocene detached Jackson thrust and foreland Cache Creek thrust in that area. Structural evidence from both thrust sheets shows that where the two faults overlap, the Jackson thrust sheet was overridden by foreland rocks during southwestward movement along the Cache Creek thrust. Movement of the Cache Creek thrust sheet caused several anticlines along the leading edge of the Jackson thrust sheet to overturn to the southwest. Anomalous southwestward overturned folds elsewhere in the northern Snake River range may also be a result of this deformation. Continued movement of the Cache Creek thrust sheet sharply overturned the anticline on the leading edge of the Cache Creek thrust to the southwest and broke it along two major reverse faults that die out westward into an overturned anticline.

Cretaceous rocks form a common footwall of the Jackson and Cache Creek thrusts. On Teton Pass these rocks, squeezed up between the two faults, are nearly vertical and very broken. Seismic studies oriented at right angles to the apparent movement of the thrusts are necessary to determine the subsurface structure of the footwall, thrust belt, and foreland rocks in this overlap area from west of Teton basin, Idaho, to Hoback basin, Wyoming. Although the rocks on Teton Pass appear to be too deformed to produce oil and gas, suitable prospects may exist where the interaction of thrust belt and foreland deformation was less intense.