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 southern half of the zone is down on the northwest side.

Another conspicuous feature related to the wrench-fault system is the Ash Creek oil field on a small faulted anticline. Isopach mapping of the producing Upper Cretaceous Shannon Sandstone Member of the Steele Shale shows that folding and faulting were initiated prior to deposition, thus providing optimum conditions for early migration of hydrocarbons into the structural trap.

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Hot-Spring-Generated Karst Features Near Salida, Colorado

Several types of karst features related to hot springs are developed in the Ordovician to Mississippian carbonate rocks exposed along both banks of the Arkansas River east of Salida, Colorado. The area is also one of current hot-spring activity. The karst features show a degree of development and morphology which separates them from karst features formed solely by cold groundwater. Part of the difference reflects the solutional agents, H_2S and H_2SO_4, the latter forming where the hydrogen sulfide-bearing hot-spring waters mix with oxygenated groundwater.

The karst features occur in both dolomite and limestone but are much better developed in the latter. The best developed small- and moderate-scale features are present in the Mississippian Leadville Formation.

Individual solution features include shelter caves up to 40 ft (12 m) high and 30 ft (9 m) wide, spongework-type cave development, and ascending water chimneys. Multiple "spongework" caves up to 3 ft (1 m) high occur within a zone 12 ft (3.6 m) thick in one exposure.

The hot-spring solution activity is localized by structure occurring along fractures and bedding planes, and in one place is channeled along a tight syncline. Similarly, it may also produce structure. At one exposure the removal of tens of feet of carbonate rock across an area a few hundred feet wide has produced a synclinal sag and local anticlinal closure at one edge of the syncline.

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Importance of Secondary Porosity in Sandstones to Hydrocarbon Exploration

Terrigenous sandstones in many basins owe their reservoir quality to secondary porosity that developed by the dissolution of detrital framework grains (chiefly plagioclase, carbonate rock fragments, and unstable heavy minerals), carbonate fossil fragments, and cement minerals (chiefly calcite and evaporite minerals). This dissolution event is responsible for changing tight sandstones to porous and permeable sandstones slightly prior to the major episode of hydrocarbon migration. Dissolution of most non-evaporite minerals is accomplished by formation water containing carbon dioxide generated during the thermal or bacterial breakdown of hydrocarbons. Dissolution porosity is commonly well developed at 6,000 to 9,000 ft (1,828 to 2,743 m), but gradually is lost during deeper burial stages by recementation (chiefly by ferroan calcite, ferroan dolomite, and kaolinite). Variations in the simple scheme during sandstone burial of cementation→decementation→recementation is complicated in basins with complex "plumbing" systems and those that experience uplift. For example, dissolution porosity in some uplifted sandstones develops during invasion by meteoric water flowing downdip.

Dissolution porosity in sandstones can be suspected from certain log responses and water saturation characteristics, but is best identified from clues visible in thin sections made of dyed epoxy-impregnated perm plugs. Clues to secondary porosity in thin section include: (1) oversize pores formed where framework grains have been dissolved, (2) patchy distribution of carbonate or evaporite cement, (3) honeycombed feldspar grains, (4) fossil molds, (5) corroded grains whose margins were etched by previous cement, (6) broken silicate framework grains that formed when rapid compaction followed removal of cement minerals, and (7) quartz grains that have been reduced to a pile of shards when calcite, which invaded quartz along hairline fractures during cementation, was dissolved.

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Pennsylvanian Coarse-Grained Meandering Fluvial Deposits, Taos Trough, North-Central New Mexico

Rocks of middle Desmoinesian age are well exposed in the Sangre de Cristo Mountains of northern New Mexico. In the Tres Ritos area, Taos County, these rocks consist of several laterally persistent sandstone units 6 to 50 m thick, interbedded with thick sequences of siltstone and shale. The sandstone units were deposited by eastward-flowing, low-sinuosity, bed-load rivers which fed lobate deltaic systems associated with an extensive platform along the western margin of the Taos trough.

The dominant sedimentary structures of the fluvial sandstone units are large-scale (2 to 10 m) sigmoidal cross-beds (epsilon cross-stratification) formed by lateral accretion of point bars. The cross-strata dip 4 to 24° and show a gradual rotation of dip direction moving up through a single point-bar deposit. Individual accretionary beds range from 10 to 150 cm in thickness, with an average thickness of 40 cm. Internal bedding is generally parallel with the accretionary bed sets, with some low-angle cross-bedding (particularly at the base of a point bar). The accretionary beds commonly have a gravel veneer on their upper surfaces and are usually separated by micaceous, carbonaceous silt to fine-sand drapes. Average grain size of point-bar sediments is conglomeratic, very coarse sand with a slight fining-upward trend within individual point-bar deposits. Locally the point-bar sands grade into overbank siltstone and sandstone. These coarse fluvial sandstone units overlie deltaic or marine sediments.

Lateral accretion occurred on coarse-grained point bars during flood discharge when sand and gravel were transported across the bars. During the waning stage of floods, organic-rich fine sediment was deposited from suspension and formed mud drapes on the bar surfaces. Lateral migration of these rivers coupled with rapid