PBS-SEPM NEWSLETTER

November

November—December 2011

PBS-SEPM 2011-2012

Nov 8,-WTGS Luncheon Mtg, 11:30 am, Midland Center.
Speaker: Richard Bishop, PhD. Consultant, Houston
Topic: "What is the Current Shale Oil and Gas Production in the US?"

Nov 10 ,WTGS Evening Social, 6 pm—
Kessler's 3204 West Wall St, Heavy hors d'oeuvres and live music by Murph
RSVP by Nov 8

Nov 15, PBS-SEPM Luncheon Mtg, 11:30 am, Midland Center.
Speaker Tucker Hentz, PhD Bureau of Economic Geology, University of Texas, Austin, TX 78713-8924
Topic: "Cleveland & Marmaton Tight-Gas Ss; Sequence Framework, Depositional Facies and Production Trends, Northwestern Anadarko Basin"

Dec 6, PBS-SEPM Luncheon Mtg, 11:30 am. Midland Center,
Speaker: Ronald Broadhead, New Mexico Bureau of Geology and Mineral Resources, New Mexico Tech.
Topic: "Helium in New Mexico: Geologic Distribution and Exploration Possibilities"

Jan 17, PBS-SEPM Luncheon Mtg, 11:30 am. Midland Center,
Speaker: Dr. Steven Sonnenberg, Colorado School of Mines — The Niobrara Petroleum System, a Major Tight Resource Play in the Rocky Mountain Region.

Tucker Hentz and William A. Ambrose
Tues., November 15, 2011

Biography on page 2—

—11:30 am, Midland Center, Midland, TX—

" Cleveland & Marmaton Tight-Gas Ss: Sequence Framework, Depositional Facies and Production Trends, Northwest Anadarko Basin"

Abstract:

Although natural-gas and oil production from the low-permeability (tight) Desmoinesian Marmaton and overlying Missourian Cleveland Formations in the northwest Anadarko Basin started in the mid-1950's, the sequence-stratigraphic and depositional settings of reservoir sandstones in the primary producing area are not well known. Regional sequence framework and paleoenvironmental aspects of the two units have been previously described. However, newly acquired well and core data in the main play area of Ochiltree and Lipscomb Counties, Texas, and adjacent Ellis County, Oklahoma, have yielded additional details on sequence stratigraphy, shelf configuration, depositional origins, and controls on hydrocarbon production. These refinements of the 1994 study were afforded by the use of (1) denser well log control; (2) abundant post-1994 well data, including production statistics; and (3) additional whole cores to complement those used in the earlier study. Unlike the first regional study, we can now better resolve specific geologic attributes of the Marmaton and Cleveland reservoir sandstones locally in the play area.

The western Anadarko Basin is bordered on the south by the Amarillo and Wichita Uplifts and on the west by the Cimarron Arch, all source areas of Marmaton and Cleveland sediments. Farther east, the Apishapa Uplift of the Ancestral Rocky Mountains in southeast Colorado and northeast New Mexico was a prominent highland region throughout the Pennsylvanian Period and composed another source area for the northwest part of the basin.

Analysis of closely spaced well log sections of approximately 800 wells and about 250 ft (~75 m) of five whole cores in the Marmaton and Cleveland Formations indicates that they compose a succession of highstand deltaic and lowstand incised-valley-fill estuarine deposits that accumulated on a topographically irregular shelf or ramp influenced by strong tidal currents.

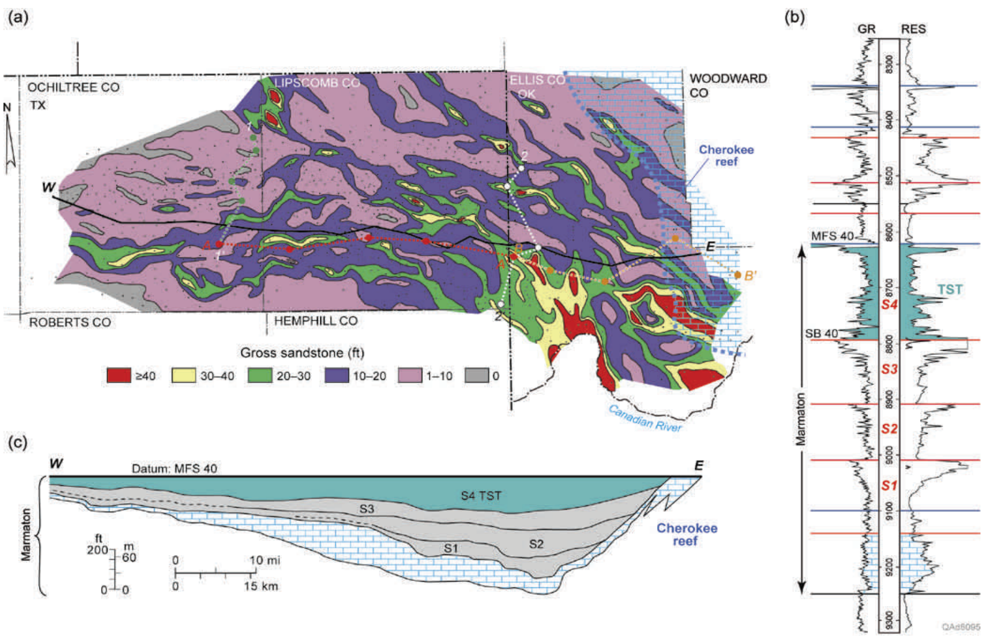
The Marmaton succession (80–600 ft [24–183 m] thick) comprises three southeasterly sourced, highstand-dominated sequences showing no evidence of lowstand incision in the study area and an unusually sandy and thick (140 ft [43 m]), southeast- and westerly sourced transgressive systems tract in the upper part of the interval. The top of the Marmaton Formation coincides with a regional marine condensed section bearing latest (terminal) Desmoinesian fauna. Marmaton cores record upward-coarsening highstand successions of muddy inner shelf to proximal delta front (or upper shoreface) overlain by upward-fining, retrogradational intervals of mudrock containing silty, starved ripples (transgressive systems tracts). Wave and minor mud-draped ripple beds suggest a wave- and/or tide-dominated depositional setting. However, occurrence of elongate, dip-parallel sandstone bodies on gross-sandstone maps of systems tracts reveals evidence of a strong tidal influence on sedimentation. Such elongate tidal bars are akin to those seen in the modern tide-influenced Fly River delta of the Gulf of Papua and in modern estuarine deposits of the Gulf of Cambay on the west coast of India. The primary Marmaton reservoir zone, the Hepler sandstone, consists of topset beds of the uppermost sequence and overlying beds of an unusually sandy and thick (140 ft [43 m]) transgressive systems tract.

The Cleveland section in the producing area, 100 to 325 ft (30–100 m) thick, contains three sequences: two westerly sourced highstand-dominated systems and a prominent, 40- to 80-ft-thick (12- to 24-m) lowstand incised-valley system that has eroded lower sequences in the middle Cleveland. The valley-fill section consists of dominantly fine grained estuarine sandstones exhibiting tidally modified, bidirectional-ripple (flaser) and double-draped-ripple bedding and sandy upper-flow-regime rhythmites. Thin fluvial sandstones bearing abundant mudrock clasts occur locally at the base. Gross-sandstone mapping reveals that the valley-fill section occurs in two segments: (1) a well-defined, west- to east-southeast-oriented system in the north-central part of the study area and (2) the margin of a poorly defined system at the south margin of the study area. Modern estuarine valley-fill analogs include the Gironde

estuary of coastal France. The valley-fill sandstones and the underlying highstand deltaic topset beds into which the valley system locally incises compose the primary reservoir zone in the Cleveland, the unit's so-called *Main sand*.

The Marmaton and Cleveland Formations were deposited on either a shelf or ramp setting in the western Anadarko Basin. Whereas a shelf occurs in a basin with a discrete shelf/slope break, a ramp is characteristic of basins having no distinct shelf/slope break and a coinciding absence of deep-water deposits equivalent to the more shoreward successions. Correlations of the Cleveland Formation east of the study area into central Oklahoma and the central Anadarko Basin reveal no clear evidence of a shelf/slope break in the succession, such as pronounced eastward stratal thickening at the margin of a progradational wedge. The issue of where the Cleveland shelf break and basinal facies occur is currently unresolved. Correlation and seismic analysis of the unit farther east in the Anadarko Basin are needed. Deposition of Marmaton siliciclastics does not appear to have been associated with a shelf/slope break within the study area.

Preexisting topography of the Marmaton and Cleveland shelf or ramp had a significant influence on depositional patterns of the two units. Sediments accumulated on a topographically irregular surface influenced by west-northwest-trending faults and flexures that formed during culmination of basin subsidence induced by regional Early and Middle Pennsylvanian compressional deformation. Isopach maps of these units indicate that they accumulated in two structural "swales" on the shelf/ramp, the northernmost swale occurring in the study area. A shift in source area from primarily the southeast to the west coincided with a decrease in subsidence and sediment input that occurred near the end of Marmaton sedimentation. The mechanism of these changes involves differential uplift just east and west of the area of sedimentation.



Attributes of the upper Marmaton transgressive systems tract, the lower part of which partly composes the productive Hepler sandstone. (a) Gross-sandstone map illustrating multiple transport directions of deltaic and tide-influenced shelf sandstone bodies. (b) Log expression of the mapped interval. (c) Regional west-east cross section of the structurally complex shelf/ramp swale in which the Marmaton and Cleveland sequences accumulated.

Hydrocarbon production from the Cleveland Formation, the primary producer of the two units (1.1 Tcf and 37.3 MMbbl as of June 2010), is controlled mostly by the occurrence of the sandstone-rich, west- to east-southeast-trending incised-valley system close to the structural updip limit of the unit's sandstone facies. Small southeast-plunging anticlines, such as the Perryton anticline in central Ochiltree County, are also sites of hydrocarbon accumulation, but they are developed only locally. Marmaton production (14.0 MMcf and 1.5 MMbbl as of June 2010) also appears to be controlled largely by sandstone distribution, most likely at the updip limits of elongate tidal sandstone bodies.

Sources

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Hentz, T. F., 1994a, Sequence stratigraphy of the Upper Pennsylvanian Cleveland Formation: A major tight-gas sandstone, Western Anadarko Basin, Texas Panhandle: AAPG Bulletin, v. 78, no. 4, p. 569–595.

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Bio—PBS-SEPM Speaker—Nov. 15, 2011

Tucker F. Hentz is a research geologist with the Bureau of Economic Geology of The University of Texas at Austin specializing in sequence stratigraphy and basin analysis. He received his M.S. degree in geology in 1982 from The University of Kansas. Prior to joining the Bureau, he worked for Exxon Co., USA, in its New Orleans office. Tucker has been involved in, and published on, a variety of research topics during his 29 years at the Bureau, including depositional, sequence-stratigraphic, and production analysis of Cleveland tight-gas sandstones in the Anadarko Basin, basin analysis using a 3D-seismic and well-log data-set from the offshore Louisiana Miocene succession, evaluation of hydrocarbon plays in the Burgos Basin of offshore northeast Mexico, characterization of reservoir facies of lower Atoka siliciclastics of the Fort Worth Basin, sequence-stratigraphic and depositional analysis of Upper Cretaceous Woodbine Group sandstones in the East Texas Basin, and regional stratigraphy of the Eagle Ford and Pearsall shale-gas plays.

His contact information is: email – tucker.hentz@beg.utexas.edu, telephone – (512) 471-7281, address – Bureau of Economic Geology, The University of Texas at Austin, University Station, Box X, Austin, TX, 78713-8924.

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"The intuitive mind is a sacred gift and the rational mind is a faithful servant; we have created a society that honours the servant and has forgotten the gift."
Albert Einstein

President's Column

David Thomas III

What a difference a few years can make in the oil and gas arena.

We doubted the repeatability of the success in the Barnett Shale outside of Tarrant County, Texas, then moved to Johnston County where horizontals are not only utilized to stay out of the water below but are determined as a significant enhancement to production. We then doubt the repeatability of shale gas outside the Fort Worth Basin, then move to the Fayetteville in Arkoma Basin but justify that success as it was the age equivalent to Barnett. If that was the case it should certainly work in the Barnett in the Permian Basin.

These two plays enabled the return of solid science to the industry as we tried to determine the key factors to the deliverability of gas in commercial quantities in the shale's. Acquiring core, working on the geochemistry and rock mechanics were back in vogue. Micro seismic was becoming an accepted technology and enhancing our knowledge in fracture stimulation. The geochemical labs were working old samples for data at an unprecedented pace. The parameters to make a shale play had been determined, published and the race was on to new areas.

Our own Permian Basin was at the top of the list for the next big shale play as it had all the prescribed parameters. Hundreds of thousands of acres were leased and millions of dollars spent. The very minor success certainly did not qualify our old, worn out basin commercial shale status. We were locked out of the unconventional horizontal game.

The key to unlocking the knowledge continued to evolve as plays were successfully being made in the Woodford (Arkoma Basin), Haynesville (Arkla Tex) and Marcellus (Appalachian Basin). There was a tight market for natural gas and in 2008 prices reached a peak of over $10/MCF. Technology was advancing and efficiencies improving to the point we drilled ourselves right into a surplus gas market and prices that touched below $3.00/MCF in 2009 rendering most, if not all shale gas plays uneconomic. Unconventional shale gas currently contributes over 20% of our daily volumes but most of the plays are delivering a very low rate of return.

On the other hand, crude oil suffered the same precipitous decline but rapidly recovered to over $100/BBL this year and is hanging in above $80/BBL. Too bad we couldn't apply the technology used in the unconventional gas and start making unconventional oil plays. But wait, some were willing to try in the "oil" window. First in a tight siltstone in the Bakken (Williston Basin), the Eagleford Shale (South Texas), and also in the Avalon/Bone Spring in our old tired and worn out Permian Basin.

With a large area to play in with both the Avalon and Bone Spring wells coming in at 600-1,200 BOPD, with estimated ultimate recovery of 300K-700K barrels per well and hundreds of thousands of acres to develop, the future looks bright.

What a difference a few years can make in the oil and gas arena.

President, PBS-SEPM 2011-2012

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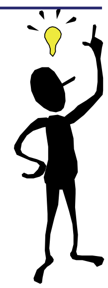

"An education isn't how much you have committed to memory, or even how much you know. It's being able to differentiate between what you do know and what you don't ."

Antole France

(1844—1924)

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PBS-SEPM Speaker : Ronald F. Broadhead
December 6, 2011

Helium's unique physical and chemical properties lend it to many uses for which there is no substitute. In addition to its well-known property of being a low-density ("lighter-than-air") gas, its boiling point is –269°C, the lowest of any substance; it therefore has invaluable uses as a coolant. It is also inert and nonreactive with other substances in all but the most extreme conditions, so it has application as a nonreactive atmosphere. Its main uses are as a coolant in magnetic resonance imaging (MRI) instruments and an inert atmosphere in semiconductor manufacturing. Its use as a lifting gas is relatively minor.

The U.S. does not import helium but instead exports it, providing 85 percent of the world's helium production. Helium sales in the U.S. increased from 4 to 4.5 BCF from 1998 to 2010. During this same time period, domestic production of helium decreased from 4 BCF to 2.8 BCF. The shortfall in production has been filled by withdrawing helium from storage. As demand has exceeded production prices have risen from $42/MCF in 2000 to $75/MCF in 2010. The trends of increasing demand and decreasing production indicate a need to identify and develop new sources of helium.

Helium gas has been produced from eight oil and gas fields located on the Four Corners Platform of northwestern New Mexico since 1943. Almost 950 MMCF helium have been produced from reservoirs of Permian, Pennsylvanian, Mississippian, and Devonian age on the Four Corners Platform in San Juan County. Concentration of helium in gases produced from these reservoirs ranges from 3 to 7.5 percent.

In northwest New Mexico, elevated levels of helium in natural gases occur not only in Paleozoic reservoirs on the Four Corners Platform but also in Paleozoic reservoirs in the deeper parts of the San Juan Basin located east of the Four Corners Platform. The regional set of orthogonal faults that offset Precambrian basement throughout the deeper parts of the San Juan Basin may have acted as migration pathways that transmitted helium from its basement source into overlying Paleozoic reservoirs.

Helium has not been extracted from produced gases in the New Mexico part of the Permian Basin where the concentration of helium in most reservoir gases is significantly less than 0.1 percent. However, gases with helium contents ranging from 0.3 to almost 1.0 percent occur in Pennsylvanian and Permian reservoirs along the northwest flank of the basin. The helium originated by radiogenic decay of Precambrian granitic rocks and migrated vertically into Pennsylvanian and Permian reservoirs through regional, high-angle, strike-slip faults. Known accumulations of helium-rich gases are located near these faults. In this area, lower and middle Paleozoic strata are only a few hundred feet thick, resulting in short vertical migration distances between the Precambrian source and helium-bearing reservoirs.

Other basins and areas in New Mexico are characterized by helium-rich gases and are of significant exploratory interest. These areas include the Chupadera Mesa region of eastern Socorro and western Lincoln Counties in the central part of the state, the Tucumcari Basin in the east-central part of the state, and a wide region across Catron and southern Cibola Counties in the west-central part of the state. Elevated levels of helium are found in Pennsylvanian and Permian gases in these areas; gases with 3.5 percent helium have recently been discovered in Permian reservoirs on Chupadera Mesa. This is the highest known concentration of helium in any New Mexico gases outside of the Four Corners Platform.

Bio—Ron Broadhead—Dec. 6, 2011

New Mexico Bureau of Geology and Mineral Resources, a Division of New Mexico Tech,
Socorro, NM 87801

Ron Broadhead received his B.S. in Geology from New Mexico Tech and his M.S. in Geology from the University of Cincinnati. He worked for Cities Service Oil Company in Tulsa and Oklahoma City and has been with the New Mexico Bureau of Geology (formerly Mines) and Mineral Resources (a Division of New Mexico Tech) since 1981 where he is presently Principal Petroleum Geologist. He has taught subsurface and petroleum geology at New Mexico Tech since 1981. He is Editor of Search and Discovery, the online journal of AAPG.

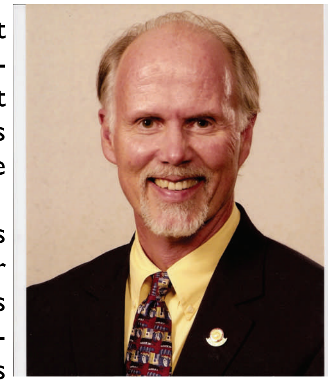
Stephen A Sonnenberg, Ph.D.

Dept of Geology and Geological Engineering

Colorado School of Mines

January 17, 2012

Abstract



The Niobrara Petroleum System of the U.S. Rocky Mountain Region is a major tight petroleum resource play. The Niobrara is self-sourced and reservoirs are low permeability chalks, shales, and sandstones. Source beds have total organic carbon contents that range from 2 to 8 weight percent. Source beds are thermally mature in the deeper parts of many of the Laramide basins in the Rocky Mountain region. Continuous or pervasive accumulations occur in thermally mature areas.

The Niobrara source rocks are dominantly Type II (sapropelic). Oil accumulations occur where source beds are still in the thermogenic oil window (e.g., Denver Basin). Thermogenic gas accumulations occur where the source beds have entered the gas generating window in deeper parts of basins (e.g., Piceance Basin). Biogenic methane occurs in shallow chalk reservoirs on the east flank of the Western Interior Cretaceous Basin. In addition shallow gas fields are found in northern Montana.

Natural fractures are important in controlling sweet spots in the play and form for several causes. Several models create fractures in the Niobrara and include Laramide tectonics, Neogene extensional tectonics, solution of evaporates, hydrocarbon generation, and regional stress patterns.

The Niobrara is a technology reservoir that requires horizontal drilling and multi-stage hydraulic fracturing. The Niobrara petroleum system is present over most of the Rocky Mountain Region and is prospective in many areas.

Bio—Stephen A. Sonnenberg

Dr. Stephen A. Sonnenberg is a Professor of Geology and holds the Charles Boettcher Distinguished Chair in Petroleum Geology at the Colorado School of Mines. He specializes in unconventional reservoirs, sequence stratigraphy, tectonic influence on sedimentation, and petroleum geology. A native of Billings, Montana, Sonnenberg received BS and MS degrees in geology from Texas A&M University and a Ph.D. degree in geology from the Colorado School of Mines. Steve began teaching at Colorado School of Mines in 2007 after working in the petroleum industry for over 25 years.

Steve has served as President of several organizations including the American Association of Petroleum Geologists, Rocky Mountain Association of Geologists, and Colorado Scientific Society.

"Engineering is the practice of safe and economic application of the scientific laws governing the forces and materials of nature by means of organization, design and construction, for the benefit of mankind."

S.E. Lindsay, 1920

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P.O. Box 1595
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"When truth is evident, it is impossible for parties and factions to rise. There never has been a dispute as to whether there is daylight at noon. "

Francis Marie Arouet
de Voltaire,
(1694-1778)
French Writer 1764

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Winter 'tis upon us, 'tis time to look at the rocks!