Barnett Shale and Other Fort Worth Basin Plays
Ellison Miles Memorial Symposium

June 22–23, 2004

Ellison Miles Geotechnology Institute

Brookhaven College, Farmers Branch, Texas

Presented by the Ellison Miles Geotechnology Institute

Brookhaven College, Farmers Branch, Texas

Co-sponsored by PTTC Texas Region; Dallas Geological Society; SIPES, Dallas Chapter; SIPES, Fort Worth Chapter; Dallas Geophysical Society; Fort Worth Geological Society; and SMU - Institute for the Study of Earth and Man

Table of Contents

Barnett Shale: A Significant Gas Resource in the Fort Worth Basin

Craig W. Adams, ADEXCO Production Company

ABSTRACT

The Mississippian Barnett Shale of the Fort Worth basin is an organic-rich shale that is the reservoir, source, trap and seal for a very large unconventional gas accumulation. The play has rapidly spread over a multi-county area.

The Barnett Shale is a spent oil-prone source rock. Porosity and permeability is developed upon thermal transformation from liquid to gas with resulting maturation-induced micro fractures. Gas is stored in these micro fractures, as well as being adsorbed in the solid organic matter (kerogen). The exploration fairway is defined by Barnett Shale isopachs, subcrop maps, source rock richness data (Total Organic Carbon), thermal maturity defined by vitrinite reflectance and the presence of reservoir quality Barnett Shale.

The Barnett Shale is one of the most active drilling targets of the past decade. Newark East Field is now the largest gas producing field (based on current production) in Texas. Drilling depths are less than 8,000 ft, and per well reserves in the expanding Newark East Field are 1-3 BCF. Gas-in-place is 150 BCF per square mile. The Barnett Play is estimated to have 26.2 TCF undiscovered gas resource (USGS, 2004).

As with most oil and gas plays the Barnett Shale has benefited from the application of new technology or the new application of established technology. The two main technological advances in the Barnett are water-fracs and horizontal drilling. While these technologies are not new their application to the Barnett Shale play resulted in significantly improved economics and opened up new areas previously thought to be uneconomic.

Low proppant hydraulic fracturing technology (“water-fracs”) has greatly improved play economics. This new technology has significantly reduced total well cost and has resulted in much improved rate and reserve profiles. Barnett Shale wells are typically re-fraced after several years resulting in producing rates comparable or even superior to initial production rates.

Prior to 2003 the Barnett Shale was drilled vertically, during 2003 198 horizontal well permits were filed and during the first six months of 2004 industry has filed 204 permits for horizontal wells. Horizontal drilling has opened up the “non frac barrier portion of the play and greatly enhanced the economics in the frac barrier play in Newark East Field proper. The non frac barrier portion of the play, west of the Viola subcrop, represents a significant emerging play covering an area three times the size of the frac barrier play.

Evaluation of Hydrocarbon Generation and Storage in the Barnett Shale, Ft. Worth Basin, Texas

Daniel M. Jarvie[1], **Ronald J. Hill**[2], **Richard M. Pollastro**[2], **Brenda L. Claxton**[3], **Kent A. Bowker**[4]

1 Humble Geochemical Services, Humble, Texas; 2 U. S. Geological Survey, Denver, Colorado; 3 Consultant, Sugar Land, Texas, 4 Star of Texas Energy Services, The Woodlands, Texas

As global demand for natural gas intensifies, identifying and producing reserves from unconventional (continuous) resources close to markets have gained considerable exploration interest and activity. Unconventional natural gas systems include fractured shale gas (FSG), tight gas sands (TGS), basin center gas (BCG), shallow basin methane (SBM), and coalbed methane (CBM). The origin of natural gas in these types of accumulations may be thermogenic sources, either from primary cracking of organic matter or secondary cracking of bitumen and oil, or mixed thermogenic-biogenic sources. Gas may be further categorized as in-situ generated-reservoired or as migrated gas. Fundamental geochemical characteristics of the petroleum system and type of gas must be determined to map favorable production fairways (sweet spots).

One such unconventional shale gas system is the Mississippian Barnett Shale, which is both source rock and reservoir rock for the largest gas field in Texas (Newark East field, Fort Worth Basin). Commercial gas accumulations are derived from secondary cracking of bitumen and oil. Gas production is from hydraulically-fractured black shales that yield gas with calorific values ranging from about 1050 to 1300 BTU. The economics of this gas play are enhanced by production of wet gas with higher BTU contents so areas with higher wet gas contents are preferred. Without stimulation, gas flow rates are non-commercial. Successful completion requires frac jobs (proppant-induced fracturing) and results in average commercial flow rates of about 150 to 555 MCF/day with a per well EUR of 1.0 BCF. While production decline curves show classical profiles over 10-20 years, re-fracturing of a well stimulates production to levels equivalent to initial flow rates. Recently, however, horizontal drilling has resulted in initial gas flow rates reported as high as 8 MMCFD.

The Barnett Shale is a very tight, over-pressured black shale with porosities averaging 6% and permeabilities in the 0.1 to 0.02 millidarcy range. It is organic-rich (4.5% average TOC at >1.1% Ro) and is very thick (450 ft. in Newark East field). Thermal maturity is greater than 1.1%Ro in Newark East field, but maturation varies across the basin and oil production occurs in the northern and western portions of the basin. Expulsion of hydrocarbons has been episodic as Barnett-sourced oil is found in both younger and older horizons as demonstrated by oil fingerprinting and biomarker analysis. Even at low maturity (ca. 0.6%Ro), it expels a high quality (low sulfur, high API gravity) oil, which appears to be a function of the organic matter type and mineralogy. Barnett lithofacies are primarily siliceous and calcareous shales with clay-rich intervals, but cherty and dolomitic units are also common. Regional uplift facilitated an erosional event that is at least partially responsible for a two-phase system when both oil and gas are present. However, a key question, is how the Barnett Shale stores so much gas? Figure 1 shows a typical methane adsorption isotherm for a Barnett Shale sample showing a very high total gas content with about 40-45% stored as adsorbed gas. This suggests that the remainder of the gas is stored in interstitial pores.

Hydrocarbon generation produces overpressuring and induces microfractures in the source-reservoir system. However, highly mature Barnett shale shows little evidence of fracturing because microfractures are subsequently annealed by residual oil and pyrobitumen through

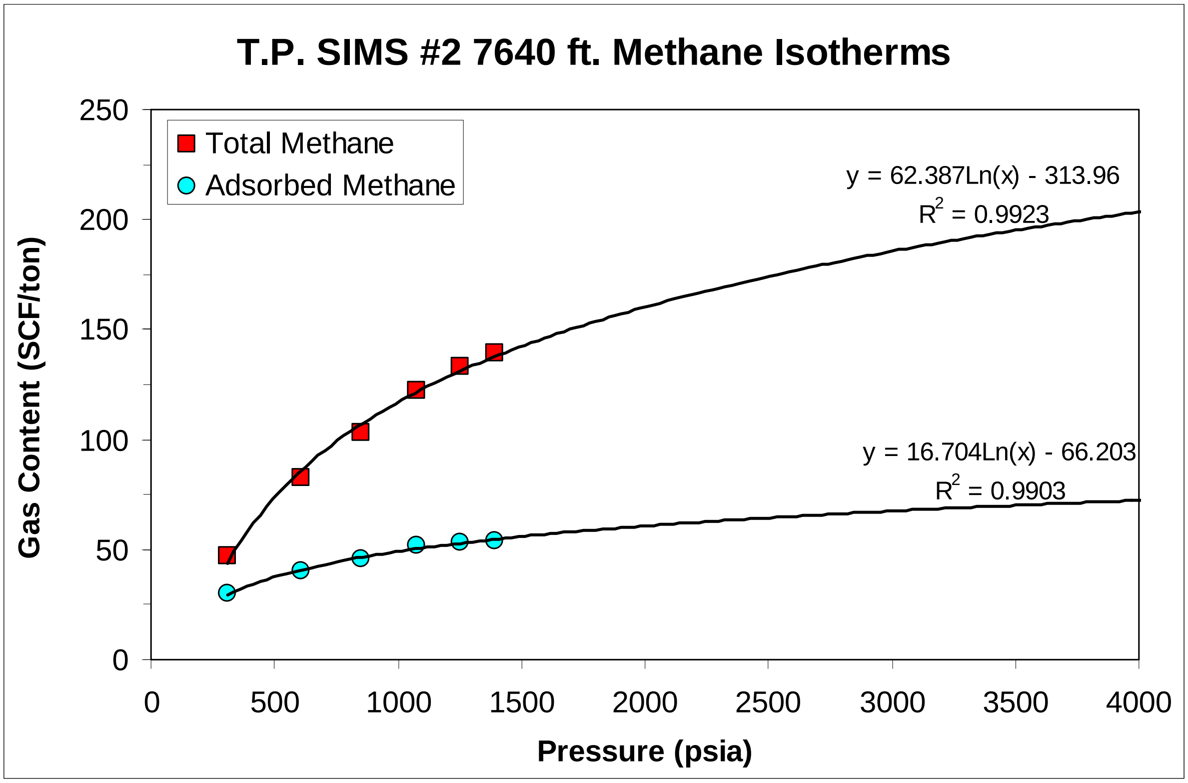

Figure 1. Methane adsorption isotherm for a Barnett Shale core from the MEC T.P. Sims #2 well at 7,640 ft.

time. Tectonic fracturing appears to be a negative function as some of the poorest flow rates are obtained in wells with the highest amount of such fractures (Bowker, 2002). Decreasing well spacing from 55 to 27 acres has had no apparent impact on production decline curves demonstrating the temporal integrity of this system.

Integrating extensive and diverse Barnett Shale data sets, from production data to geochemical measurements, predictive maps can be constructed to high-grade the best prospects for oil versus gas and the highest BTU gas prospects. In addition, because of the difficulties inherent in logging fractured shales, the use of basic geochemical measurements (TOC, Rock-Eval, Ro, TEGC) and gas analysis including gas flow line samples (free gas), desorbed gas from cuttings headspace analysis (desorb. gas), and gas released from maceration of cuttings (mac. gas), it is possible to predict sweet-spots within the well bore prior to completion.

A risking model showing minimum geochemical values applicable to discovery of gas in the Barnett fractured shale gas play. This does not include all risking components such as the timing of events and processes, the presence of seal(s), and other geological parameters or engineering functions particularly completion of the productive zones.

One goal of Barnett Shale work is to not only enhance the understanding of Barnett Shale unconventional gas yields and recovery factors, but to extend this knowledge to evaluation of other unconventional shale gas and other gas systems. A comparison of Barnett Shale gas storage to that shown for the Devonian Shale out of the Appalachian Basin illustrates storage differences (Fig. 2).

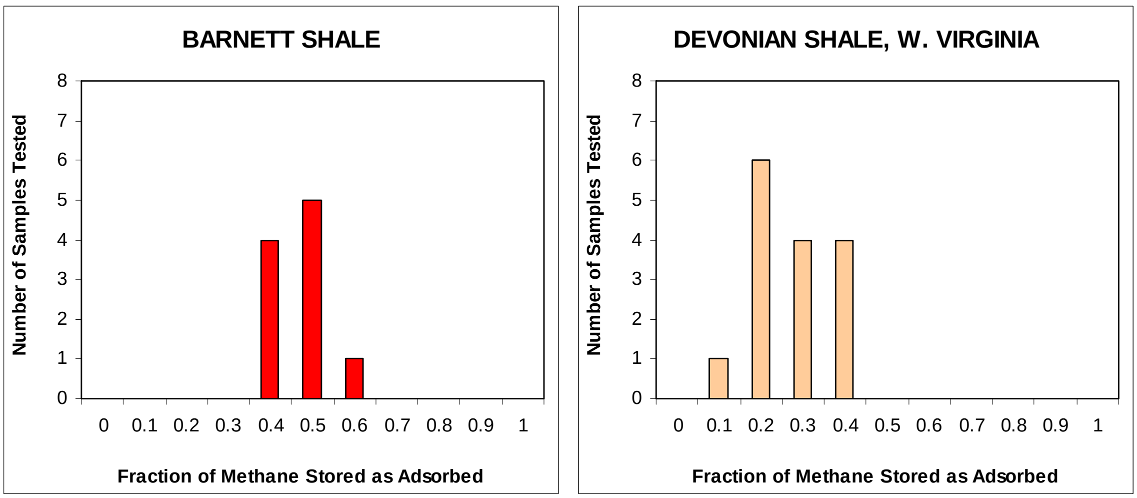

Figure 2. Comparison of gas storage in the Barnett Shale and the Devonian Shale in the Appalachian Basin (data derived from CER report dated 1992, GRI Contract No. 5091-212-2242).

References

Bowker, K. A., 2002, Recent Development of the Barnett Shale Play, Fort Worth Basin, Innovative Gas Exploration Concepts, Denver, CO, October 1, 2002, oral presentation.

CER Corporation, 1992, Geological, petrophysical and engineering analysis of theBarnett Shale in the Mitchell Energy Corporation T.P. Sims No. 2, Wise County, Texas: Topical Report prepared for Gas Research Institute, GRI Contract No. 5091-212-2242, 83 p.

Challenges of Urban Drilling

Glen Adams, ADEXCO Production Company

ABSTRACT

Urban drilling is not a new phenomenon. One merely has to examine the 80 year history of drilling in downtown Oklahoma City, or Longbeach California, or even the more recent drilling in the 1980’s under Bryan, Texas. One difference between these plays and the Barnett Shale is the ubiquitous nature of the Barnett. Only certain portions of Oklahoma City or Longbeach were affected because they are conventional trap plays, as opposed to the Barnett Shale, which has the potential to be productive under all of

Tarrant County and a portion of Dallas County. ADEXCO has leased in excess of 85,000 acres in the Barnett Shale trend, of which approximately 8,000 acres are affected by urban issues.

The rapid expansion of drilling into Tarrant County, combined with high rates of population growth, sets the stage for potential conflicts as to land usage, environmental stewardship, the rights of mineral owners and the exploiters of those minerals.

There are several significant challenges that face the expansion of the Barnett Shale play outside its core area, including bottom seal and gas pipeline/gathering infrastructure and gas marketing issues. Additional challenges faced in the urban portion of the play include onerous oil and gas lease provisions, air quality attainment issues, visual impact and noise standards, conflicting municipal and home owner association regulations and frac water cost and availability.

A lack of focus by the Lessee's team of landmen, geoscientists and engineers to identify and manage these issues can add up to (1) delays in drilling wells, completing wells and the laying of gathering lines/pipelines, (2) substantially increased costs not only in the area of drilling a well, but over the full cycle life of the project.

The independent operators active in the urban portion of the Barnett Shale play will drive the perception that the public has regarding the energy extraction business, for better or worse. The United States Geologic Survey recently released a report stating that the Barnett Shale may have 26+ TCF in recoverable reserves, which gives it the potential to become one of the largest onshore gas fields in the country. With 150 BCFG in place per square mile, there are potentially several TCF sitting under the city limits of the municipalities located in the fairway of the play. This could mean hundreds of millions of dollars injected into our economy, and as we have read in recent press reports, these municipalities see this as an opportunity to enhance revenue through both drilling on city owned lands and increasing the value of the tax base. The constituents with a stake in these enormous gas reserves, including the Operators, the Texas Railroad Commission, Environmental Protection Agency, Real Estate Developers, Municipal Governments, Lawyers, Pipelines, Homeowners and Mineral Owners all need to work together to extract this valuable resource for the benefit of our nation, without an unacceptable cost in terms of the lifestyle of surface owners, environmental quality and safety.

Mineral Scale in Barnett Shale Gas Production: Prediction and Inhibition

Glenn D. Fielder, Baker Petrolite, a division of Baker Hughes, Inc.

ABSTRACT

Mineral scale formation in producing wells can result in costly workovers and lost production. Effective mitigation of scale can reduce maintenance and improve well productivity. It has been found that the mineral scales, calcium carbonate (calcite) and barium sulfate (barite) are predicted and can occur during fracturing and flowback operations as well as subsequent production from Barnett Shale gas wells. Calcite can be the result of one or a combination of a temperature increase, a pressure decrease, or a

change in water chemistry. The potential for barite scale is due primarily to introduction of the sulfate ion during fracturing, but can also occur from commingling of incompatible waters from different formations. In some cases, this has resulted in NORM type scale. Depending upon the particular waters involved, and well conditions, one or both scales may be predicted to precipitate at some time during the life of a well, from fracturing through the production phase. Accurate predictions of potential scale formation are dependent upon reliable temperature, pressure, fluid ratio, CO2 content of the gas and water analysis data. Examples of prediction and correlation with observed scaling will be presented. The use of scale inhibitors, as a preventive tool, applied preemptively and in remedial applications, will be discussed.

Geophysical Needs for Barnett Exploitation

Tom Fulton, Seismic Solutions

ABSTRACT

Geophysical needs for Barnett exploitation are of imaging the sub-surface, particularly the zone produced. They include additional gravity data taken along the Muenster Arch where dense older sediments are thrust over the less dense Barnett and routine mapping of induced fractures. Gravity can assist in imaging the dense over thrust sheets, which increase drilling costs. While conventional 3-D data and fracture mapping are relatively expensive, techniques exist that allow the driller to look ahead as he drills so as to image the sub-surface. One may either use conventional sources on the drill string or use the bit as a seismic source. For the Barnett, the look a head drilling may give the operator his only 3-D at the very time he needs it most. Further, near surface geophones may be used to map induced fractures as well as monitor production. A test recording of near surface geophones by Pinnacle as they map induced fractures using a long array in a nearby well can confirm the premise that arrays of these geophones can be used to map fractures. Near surface geophone arrays would allow for cheaper mapping of the fractures to be available for subsequent fracs for same, and other wells, monitoring production (possibly to allay fears of environmental damage), and other research. Mapping fractures from the near surface rather than a nearby well would be both cheaper and simple in terms of equipment needed and because no additional well is necessary.

The Role of Gravity Data

Gravity data was initially used with success in the Ft. Worth Basin to define its northeast boundary along the Muenster Arch and to locate shallow oil and gas fields such as the current Lake Dallas gas storage field. Now, one can extract more information from the data with new algorithms to assist the driller to avoid drilling through the dense over thrust sheets and to model predictions of the extent of over thrust coverage of the Barnett. The older data is at a spatial sampling of perhaps a mile, yet allows one to resolve relative thickness of over thrust between known wells and to show the older fields up on the Arch. Additional gravity data will assist in the placement of wells in this zone as recent wells show significant density changes from well to well. These changes suggest that additional gravity data or denser spatial sampling is needed to resolve the complex thrust sheets above the Barnett. One may also desire the look a head capability of using the drill bit as a seismic source to image both the Barnett and faulting in this complex zone.

The use of gravity data away from the over thrust zone should be evaluated because of the thickness of the Barnett. If the zone above is relatively constant in terms of density, a density low may indicate thicker, more productive Barnett.

Gravity illustrations include an upward continuation showing the Muenster Arch, Lake Dallas field and location of a model fitting the gravity profile. The second illustration shows the model which matches the observed gravity and predicts as much as 5 miles of Barnett extension under the over thrust. The third shows an upward continuation enhancing the shallow zone with wells identified by letters. The last gravity display is of density log data for the wells identified in the previous display with densities of 2.55 and greater colored.

Induced Fracture Monitoring

Pinnacle has effectively shown how one can monitor and map induced fractures with a long geophone array in a near by well. Personal experience dating to at least 1960 suggests nearby well monitoring of horizontally traveling micro seismic events has some limitations not apparent for recording the same vertically traveling events near the surface. The differences are dependent on the direction of travel of the seismic event. The former is best when the layer of the zone to be fractured is thick such that seismic events traveling in nearby layers with faster velocities will not interfere with and attenuate the amplitude of the event. Such interference tends to limit the maximum offset of the monitor well as well as make interpretation difficult. Vertical travel lacks that limitation while requiring that the event travel further. The seismic array of the proposed near surface system compensates for the additional travel by the noise canceling capability of the array. Whereas it is not certain that we can record the low amplitude, high frequency events (500 – 2000Hz) our observations of the down traveling events on VSP surveys, over the years, gives us hope. These pulses are noted to change very little as a function of depth.

Potential benefits of near surface monitoring include better resolution of thin zones to be fractured, removing the need for the monitoring well with its loss of production, and seismic arrays left in place for monitoring subsequent wells or other research. Lastly, near surface monitoring can remove any possible ambiguity as to the fracture position and may give better information as to depth of fracture.

Both systems require calibration to measure velocity and to orient the geophones so that they can detect direction of travel. The calibration procedure is to record the seismic events associated with the perforation gun or other small seismic source near the zone to be perforated. Both systems depend on recording and measuring the velocity of compressional waves (P) and shear waves (S) hence the need to orient the three component phones used in each system. Individual detectors of the near surface arrays will be cemented in to reduce noise while those in well system may be noisy if the casing to which they are clamped is not cemented to the formation. The arrays will use expendable three component geophones designed to be left in place to be used to monitor additional fracs of the well in question, fracs of a nearby well or of enhanced recovery.

The near surface system may also require static corrections to compensate for detector depth error or slight velocity difference. The near surface array will use the power of direction dependent summation to both cancel noise and locate the direction to the S event. It's time and direction will indicate where to search for the weaker P event.

Three arrays, positioned for optimum resolution of the zone being fractured, are planned for each test. The depth for placement of the geophones is dependent on the depth of the weathered zone. This depth allows us to avoid the attenuation of the lower velocity near surface.

The number of geophones in each array is dependent, on the signal to noise ratio of the received compressional wave (P) determined from a test in the area.

The depth is generally the seismic shot depth for surveys in the area. The viability of this scheme can easily be determined by a test of geophones recorded in a piggyback mode by Pinnacle as they map the fracture pattern of a well in the area. The test using perhaps 3 geophones at different depths should allow confirmation that fracture signals can be recorded and allow estimation of the relative signal to noise as well as the needed depth.

Dependent on the above, perhaps as few as three or five detectors per array may be required. Shot hole drillers tell me that the cost for drilling in an array is a function of the cost to get there and the number of holes per array. This assumes that the contractor has the proper equipment (they would likely drill with air in the Ft. Worth Basin) such that the hole or geophone placement depth is not a consideration. It is too early to estimate potential saving using the suggested scheme. The use of simpler equipment (with the likelihood of more competition) and possible interruption of 300,000 cubic feet of production per day should be incentive to try the suggested system.

Look Ahead Drilling

3–D imaging ahead of a roller bit used as a seismic source can extend for upward of 5000 feet ahead of the bit according to technology enhanced by AGIP and offered by International Logging. Such technology is vital for the Barnett where little or no 3-D is available prior to drilling. Schemes by Klaveness, Noble, and others use a down hole source which may be pulsed every time a drill stem is added or at some other interval to provide the imaging to locate nearby faults, structure or casing point. These schemes are not new but as in all things, experience, proper tools and software make the difference, 3-D data can be used to avoid faults or to design the fracture job. This technology is also important because you have positive location of the bit with respect to the subsurface. Passive surface geophones used to record the data may not require the seismic cables usually required for seismic exploration and hence are "land owner friendly".

A look a head system by Weatherford is shown but less applicable for the Barnett at this time because it requires surface sources. It uses arrays of detectors clamped outside of the production string and fiber optic connections. Plans are for this system to be left in place.

Special Analysis of Existing 3-D

Technology exists which may make the production more efficient. An example of this is the patented Dynamic Fluid Method of Pisetski. It predicts relative fluid flow and has been tried on the Boonville field in this area. Examples from that work are shown with other examples of special processing expected from Marion Bone in an earlier paper of this Symposium.

Conclusions and Recommendations

Gravity data has a role to play in exploitation just as it did in early exploration. Although the need is greater in the over thrust zone where more data is needed, the thickness of the Barnett suggests that it may have value away from the thrust zone if the density of the overburden remains relatively constant.

Imaging of the zone produced is vital. It is good science, good geophysics, and good economics to map the fracture zone so that full potential of the resource will be realized. The use of near surface geophones in the fracture mapping process should be evaluated as it holds the hope of significant cost reduction. 3-D seismic acquisition while drilling is the key to efficient production around faults and over thrust. The use of passive surface seismometers during the drilling process may help to remove doubts regarding drilling activity causing environmental damage.

Should the cemented in, near surface geophone arrays be found suitable to map the fracture process, they will be a research resource for passive mapping of the reservoir and for enhanced recovery.

Acknowledgements

Gravity data was licensed from Gravity Map Service (who also lease gravity meters (281 342 2884) and interpreted by Bird Geophysical (281 463 3816). The author thanks Kenneth Couch of Multibrands, Dean Williams of Joint Resources and Bob Miller of Nations Gas for copies of Density logs. The talk would lack up-to date technology without the appreciated co-operation of Pinnacle, Weatherford, Klaveness, and Noble. Tom Guidish is thanked for examples of DFM technology and Power Point preparation.

Johnson County - Activity and Update

William Marble, Hallwood Energy Corp.

Welcome to Johnson County. Home to the shattered dreams and ideas reflected in 67 dry holes and two marginal producers. Where geologists and engineers squirm and struggle with no Viola or Forestburg frac barriers. But also home to gas bearing Barnett Shale.

Hallwood Energy Corporation began operations in Johnson County, Texas in January 2002 with the drilling of four Barnett Shale wells. Successful completions in three of these led to first gas sales in 2003. Today, Hallwood has 35 vertical wells and 6 horizontal completions. Gathering is being increased to handle over 100 MMCFD. Cumulative gas sales have passed 2.9 BCF as of June 1, 2004.

Drilling continues, with drilling times being cut from 18 days to 7 on vertical wells, and 30 days to 16 on horizontals. Frac design on horizontal wells has passed 6 million gallons in four stages. First 30 days of production on horizontal wells regularly range from 90 MMCF to over 140 MMCF.

No Viola, no disposals, no easy gas market. But shale. Shale with gas. The gas in place numbers can be staggering. A few TCF here, a few TCF there, pretty soon you're talking real gas reserves! The Ellenburger is still there, waiting to ruin every well with a torrent of water. But we have learned to respect it, not fear it, as we continue expanding the Barnett Shale play into this new territory.

Barnett Shale West of the Viola Pinchout

Successful Expansion of the Barnett Shale Play, Specifically Eastern Parker/Western Tarrant/Johnson Counties

Robert Miller, Harding Company

Overview

This play and expansion area was researched in depth for over a year before we purchased our first lease. After extensive and exhaustive research, it became evident that many early vertical wells in Eastern Parker County were located in poor areas around "known" faults and/or karsted areas, or located on or near Ellenburger structural highs that affect reservoir quality. Most of these early wells were poor wells, blamed by operators and the industry as a whole as, "...located west of the Viola Pinch-out and thus no lower frac barrier." Research revealed that much of Eastern Parker, Western Tarrant and Johnson Counties actually contain:

1. Tight Simpson Lime and/or underlying tight Ellenburger lower frac barriers;

2. Tight Marble Falls, upper frac barrier;

3. 250-350 feet of very good quality Barnett Shale (actually a consistently better section than seen elsewhere!);

4. Good BTU Gas;

5. More "geologically" favorable (significant faults, structures, shoaling areas, karsted areas are generally known);

6. Shallower depth;

7. Numerous up-hole shallow gas pays that are undrained and undepleted have been waiting for gas prices and pipeline infrastructure to be developed. This area is now being developed for Barnett Shale to exploit. Core area has depletion in these up-hole zones;

8. A prime area for creative and innovative technology for drilling and completion - unique for this expansion area.

In 2002, Harding Company began testing a unique drilling and completion technique, evaluation and leasing strategy for this area, based on this research. This has been very favorable and has been successfully copied by other operators from Weatherford to Fort Worth - definitely -extending the play for vertical Barnett Shale wells "west of the Viola Pinch-out" into Eastern Parker and Western Tarrant Counties. Recent studies, reports and well performances by numerous operators now show Parker, Tarrant and Johnson Counties as the Sweet Spots!! We are glad we figured this out early as it allowed us to develop a strong presence in the area. Horizontal drilling and various frac treatment completion designs are now being tested in this area with encouraging results.

Harding Company has drilled and/or caused to be drilled over a dozen or more successful vertical wells in this area, from Weatherford to Fort Worth. We have visited with numerous companies, resulting in many other companies entering the area.

Devon, Chief, Republic, Llano, Denbury, Joint Resources, Mid-Continent, PanAmerican, PLO, Carrizo, Grand, Premier, Tom Brown, EOG, Hollis Sullivan, Crown, Arrington, XTO, EOG. Quicksilver, Antero, and many others are now aggressively attempting to lease, or they have leased, in this area. They have begun an active drilling program for both vertical and horizontal wells, and are successfully experimenting with various techniques.

The Barnett Shale Play: A Time and Place for 3D

Marion R. Bone, President, TimeSlice Technology, Inc.

In 1975 the common size of a 3D survey was about the size of today's 3D surveys in the Barnett Shale area. In that time period, both cost and equipment availability were the restricting factors that governed the 3D project size. Today in the Barnett Shale areas costs still seems to be primary issue governing the size of a 3D project. The amount of lease acres acquired by an individual operator ranks as the number two issue controlling the size.

Advancement in equipment and associated technologies now makes 3D land projects, covering more than 100 square miles, common and actually allows the operator to see the results in less than one year lapsed time from the beginning of permitting to the time of the initial wells. With these type capabilities available, the 3D method has become cost effective and practical as a critical tool to guide the operator through the cycle of evaluating the lease potential, drilling and producing the well.

Seismic sampling of the subsurface can be achieved along a single line (2D), swath or from an aerial array of sources and receivers (commonly referred to as 3D). The 3D acquisition method gives a larger number of subsurface points in an aerial pattern than does 2D but does not yield true 3D results until the data are processed using an appropriate 3D migration algorithm. The practices that guide the appropriate collection method and the subsequent processing sequence will be explored.

The data volume derived from a 3D survey becomes the basic database from which the interpretations are conducted and its use continues throughout the drilling cycle. A 3D data volume, appropriately collected and processed, becomes a vital source for determination of both the drill site location of vertical wells and the trajectory of non-vertical wells. Some results from this type project will be shown and the resulting contributions discussed.

END