Longfellow Ranch Geological Report
West Texas Overthrust

Pecos County, Texas

Prepared by:
Chris Barden, Registered Petroleum Engineer
Wes Franklin, Certified Petroleum Geologist

For:
Longfellow Exploration Partners Limited
(Updated Edition)

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Note: This report was originally prepared in January of 2003. It has been partially updated to reflect more current events since its original production.

Introduction

The Marathon Overthrust (aka West Texas Overthrust/WTO) is a segment in far west Texas that runs from Canada, through the Appalachian and Ouachita Mountains of the United States, to Mexico. The complete thrust belt has been the site for oil and gas exploration for decades, for it has tectonically over-ridden a number of producing sedimentary basins. But until the last two decades, the complex geology of the thrusts obscured the hydrocarbon potential, and hampered development efforts. Recent discoveries in the Black Warrior Basin, the Arkoma Basin, the Ouachita Overthrust the Fort Worth Basin and the Marathon Overthrust have changed the way the industry views this trend. The WTO trend is characterized by stacked pay zones in multiple reservoirs and horizons. This trend, sourced by organically rich shale beds of Barnett and Woodford age with Total Organic Content/TOC ranging up to 13% is now considered one of the emerging pre-eminent resource plays in North America with larger conventional targets lying above and below it. The thrust belts of the world are undergoing a considerable degree of active exploration, and they are one of the highest potential frontiers for oil and gas discoveries in the future.

West Texas, is a dry, desert environment. Cattle ranches are large, because it takes a large number of acres per head to be economic. In southern Pecos County, Texas, three of these large ranches have been the site for gas exploration in the Marathon/Ouachita Overthrust, where geologic exposures at the surface can be correlated with subsurface well control. These three adjoining ranches from east to west are the Longfellow, West and Allison ranches. In 1981, Tenneco Oil Company discovered gas on the Allison Ranch, and the development of that field by other companies moved onto the West and Longfellow ranches. Tenneco, and its successor Fina Oil and Chemical Company, discovered the first commercial gas on the West Ranch in 1988, then Fina made the first discovery on the Longfellow Ranch in 1993. Since the initial discovery, production has been attributed to several fields comprising the Pinon Field network: Pinon, Bitterweed, South Bitterweed, Rio Caballos, Algerita, West Ranch, Sotol, South Sabino, Sabino and South Pinon. Over 500 completions have been made, daily production exceeds 250 MMCF/D, and over 300 BCF has been produced to date. Ultimate reserves from completed zones to date are estimated to exceed 4 TCFe and growing. Most WTO production is between 3,000 and 8,000 feet. The fact that WTO reservoirs are pressure depletion systems in that most wells produce water-free (without gas-water content) reduces the need for conventional structure mapping. The opportunity to extend production onto other areas of the Longfellow Ranch, and the potential to discover new reservoirs and traps, is outstanding.

One would think that the shallow depth of drilling, the number of wells drilled, the production rate and the cumulative production and compelling economics would have stimulated an earlier exploration boom by the industry. However, each step of development and exploitation was slow to come. This is due to several reasons: (1) The geology is complex (conventional exploration methods such as seismic was of low quality compared to conventional hydrocarbon basins); (2) Multiple partners have been involved at each step of exploration; (3)

The properties are distant from a market and the price for natural gas has experienced wild fluctuations since the discovery of the gas fields on the ranches; (4) Many of the early wells produced a high amount of CO_2 ("sour gas") that increased lease operating expenses and reduced profit; (5) The producers have not been located in Midland-Odessa, so the Permian Basin petroleum industry has largely ignored the exploration play; (6) The owners of the ranches' surface and minerals have historically proved difficult to take a lease from. This report will address the general geology, the history of exploration in the region, the production and reservoir complexity of the gas fields that have been discovered to date, the economic reality of the production, what potential opportunity exists on the ranches, what exploration techniques may prove valuable in leading to new discoveries, and where new prospects may occur.

General Geology

Before one can understand the nature of the economic potential of the region, one should first take a geologic tour of the region where the gas and oil are found. Geologically, the area is located on the leading edge of the Ouachita-Appalachian overthrust system, which runs from eastern Canada to Mexico. At the end of the Precambrian, continental rifting began on the eastern and southern margins of the ancestral North American (N.A.) continent. This rupture moved the European, African and South American continents away from the core of North America, providing a passive continental margin on the trailing edges of the bounding rifts and the transform faults which connected the spreading centers (Figure 1.)

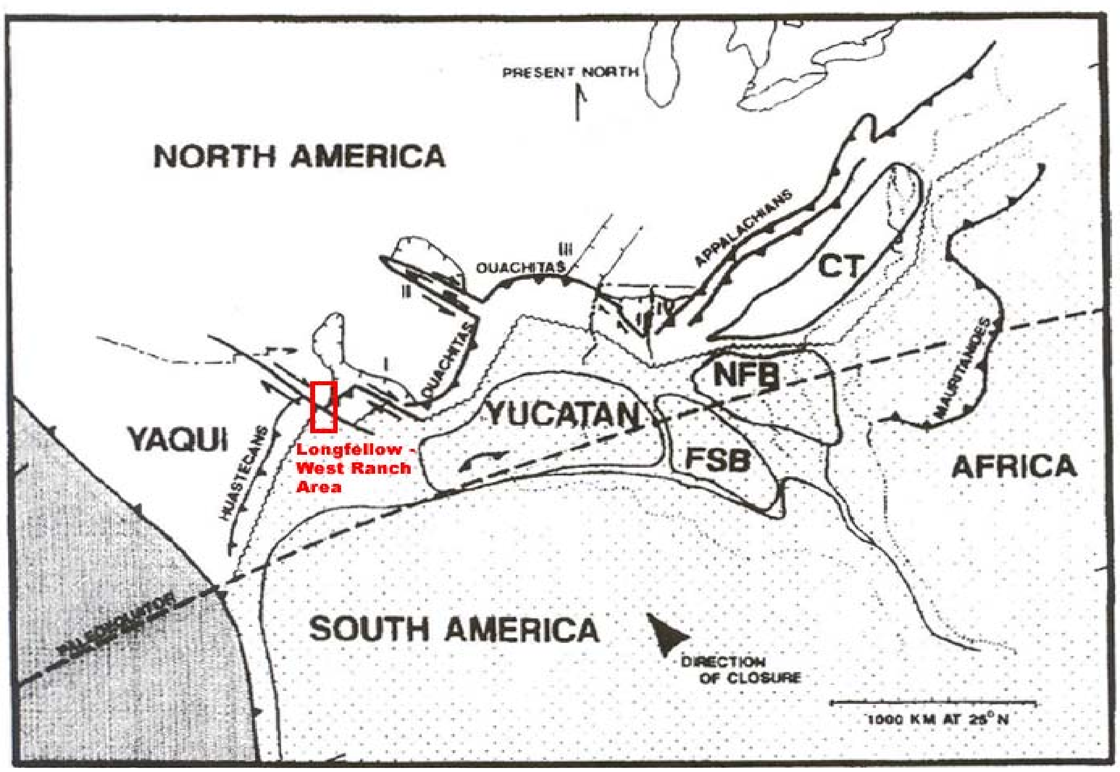

Figure 1.....Continental Plates: Appalachian-Ouachita Thrust Belts

During the early Paleozoic, shallow intra-cratonic carbonate basins developed along the edges of the N.A. continent. These basins were dominated by carbonate growth in very shallow water. In West Texas and New Mexico, the ancestral basin that developed was called the Tobosa Basin. While the shelf deposits of limestone, dolomite and shale were robust, the deep ocean basin, called the "Marathon Basin", that formed between the opening gulf between South America and N.A. was starved of sediment. The starved basin became increasingly distant from the northern and southern shelves and the slow deposition had approximately 1/3 of the sediment that was deposited at the same time within the Tobosa Basin. Currently, the most important unit, in economic terms, to the Longfellow-West Ranch area was deposited during the Siluro-Devonian time and is referred to as the Caballos Novaculite (Figure 2.) It is a complex formation of thin inter-bedded radiolarian chert deposits and basinal shales, with massively bedded white chert formed by sponge spicules swept from a distant shelf setting into deep water. This chert is referred to as a spiculitic chert, or novaculite.

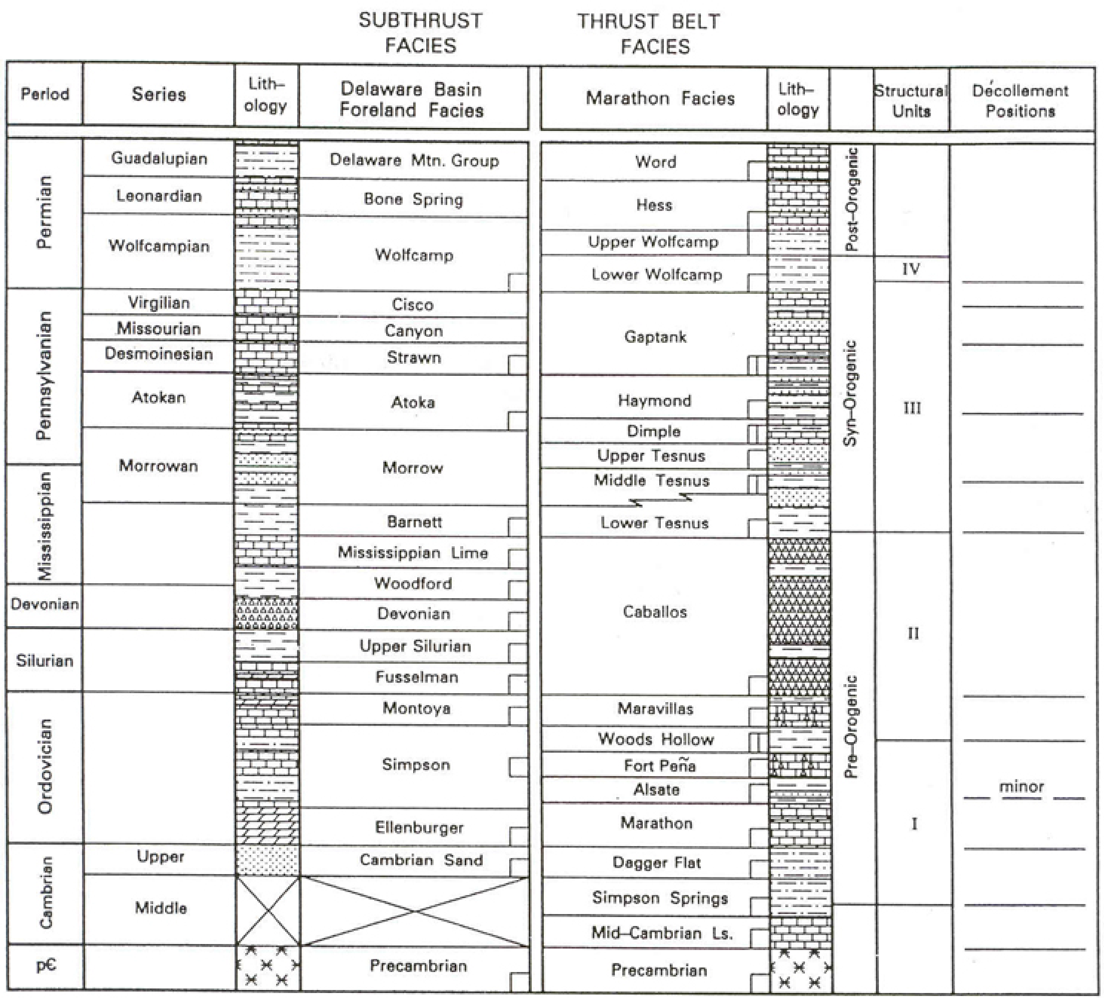

Figure 2.....Stratigraphic Correlation Chart Of Permian Basin and Marathon Overthrust

During the middle and late Paleozoic, the extensional, or spreading forces, that occurred during rifting were reversed, and the continents began to impinge on each other. Subduction zones surrounded the North American continent, which consumed oceanic crust and pulled the European, African and South American continental plates toward each other. The resulting collision of each of these continental masses occurred approximately 300 million years ago and formed the super-continent Pangea. This simultaneous collision of drifting continents produced complex thrust belt terrains at the sites of impact (Figure 1,3.) During the Mississippian and Pennsylvanian time, the Longfellow-West Ranch area experienced rapid deposition of Tesnus sands and shales by turbidity currents and gravity flow which had been shed from the highlands of the South American shield northward toward the edge of the North American continent. The leading edge of the Marathon/Ouachita thrust and fold belt covered the southern part the North American passive margin basins.

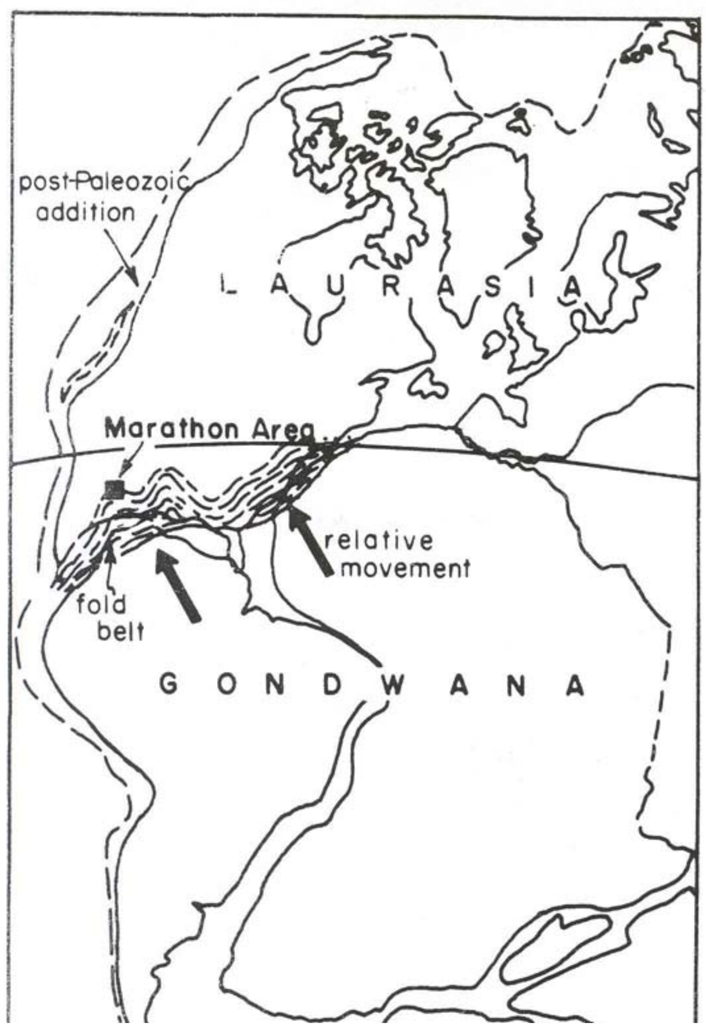

Figure3.....LatePaleozoic Thrust/Fold Belt Suture from Colliding Continents

During the early Paleozoic, the ancestral Tobosa Basin had been a broad, gentle depression on the southern shelf of the passive margin trailing edge of the diverging continents. Commencing in the middle Paleozoic, worldwide spreading from rifting ceased and continental convergence began. The compressional forces that would later produce the thrust and fold belts, segmented the Tobosa depression into smaller, deep sub-basins, known as the Delaware, Val Verde and Midland Basins. These down-dropped basins were bound by widespread uplifted shelves called the Central Basin Platform, the Northwest Shelf, and the Eastern Shelf. Together, the sub-basins formed what now has collectively been called the Permian Basin (Figure 5.) Large folds and faults further fragmented each of these uplifts and basins, thereby providing traps for world-class deposits of oil and gas. The southern edges of the continent were covered by large scale compressional folds and thrust faults of the Marathon/Ouachita Overthrust effectively "sealing" the Val Verde, Midland Basins (Figure 4).

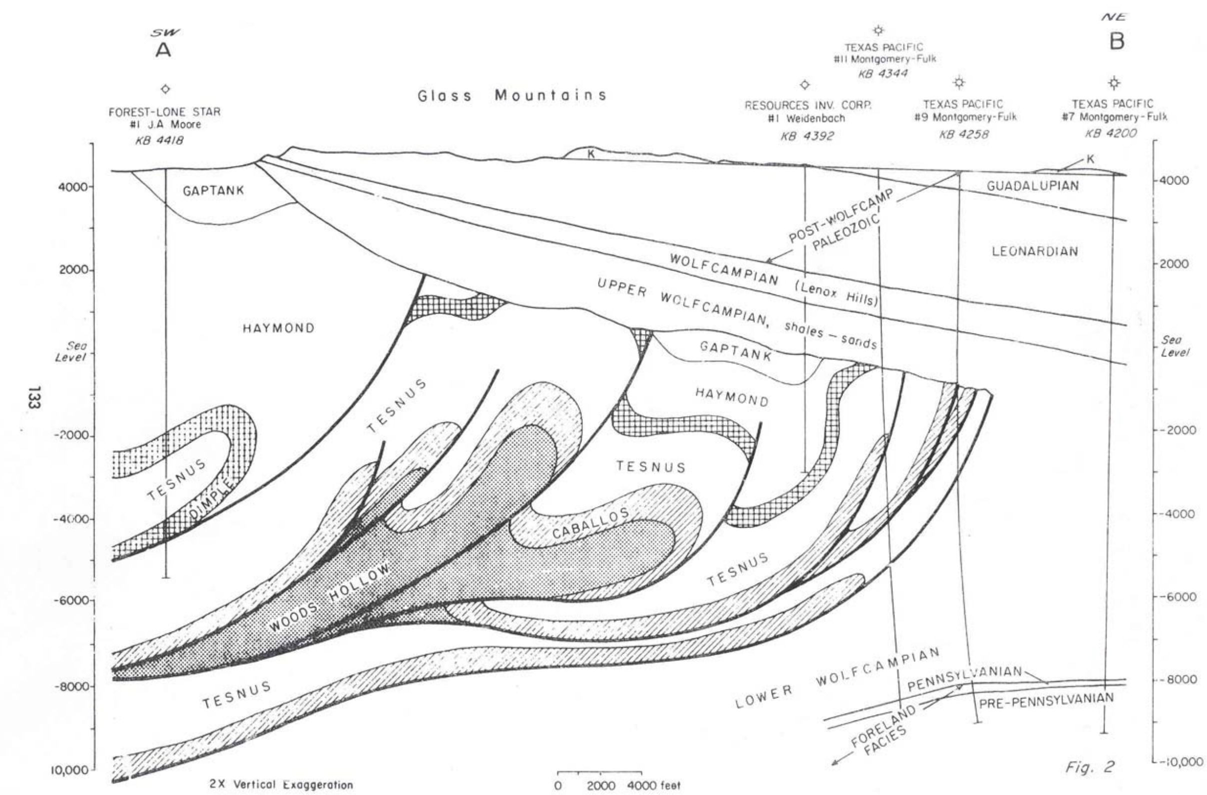

Figure 4.....Cross-section Showing Fold and Fault Relationship South end of Permian Basin

In the deep water Marathon Basin, which was positioned between the converging North and South American continents, deposition during the Pennsylvanian produced sandstones, basinal limestones and shales in the Dimple, Haymond, Gaptank formations. Even younger late Pennsylvanian and early Permian formations were produced by the erosion of all the older formations of the Marathon Overthrust as they were uplifted, re-folded and re-faulted. For this reason, these formations are a complex mixture of material and eroded blocks of the earlier Marathon formations. North of the overthrust, structural reactivation of the Mississippian faults and anticlines continued throughout the Pennsylvanian and Permian. The collisional forces reached their peak during the Permian Wolfcamp time, during which the uplifted Marathon thrust belt at the southern edge of the continent completely formed a sill, or barrier to open ocean conditions. From this point on, all sediment derived by the Marathon highlands was shed to the north into the Val Verde and Midland sub-basins. During the remainder of the Permian, thick wedges of carbonate platform sediments rimmed these basins. The basins were filled by thick accumulations of sands, which had their sources from the mountain ranges of the Marathons, the Sierra Diablo to the west, as well as highlands of the Wichita-Criner Uplift to the north and the Bend Arch to the east. At the end of the Permian, the basins became increasingly restricted, and shallow evaporite and salt deposits developed as regional seals for the Permian Basin.

Many geologists consider that the history of the Permian Basin stops at this point, but important geologic events later occurred that impacted the Permian Basin and the Marathon Overthrust. Beginning in the Triassic and Early Jurassic, worldwide extensional forces once again occurred which created continental rifting. The spreading centers were positioned near the seaward edges of the thrust belts and once again moved continents apart from each other. Relative to North America, the breakup of the Pangea super-continent formed the opening of the Atlantic Ocean and Gulf of Mexico. In West Texas, the sediments deposited on the Jurassic and Cretaceous shallow water shelves were predominantly limestones. These flat-lying limestone layers covered all the Paleozoic rocks of the Permian Basin. Although these sediments are not commonly productive in West Texas, they are extremely important reservoir targets in the sub-basins of South and East Texas, Northern Louisiana, Arkansas, Mississippi, Alabama and Florida. They are the most prolific reservoirs of the super-giant oil fields of the Golden Lane, Chiapas-Reforma-Tabasco-Campeche trends of Mexico.

Approximately 100 million years ago, during the late Cretaceous, an active subduction zone consumed oceanic crust at the western edge of North America. This process formed the volcanic and granite mountain ranges of the far western states, and the numerous uplifts and basins of the Rocky Mountains. This period is referred to as the Laramide, and the western overthrust of the Rocky Mountains was also initiated. During the Laramide uplift, large faults occurred in west Texas along the Rio Grande Rift, and the whole region, referred to as the Llano Estacado, or the high plateau, was uplifted approximately 3,000 feet above sea level. The Rocky Mountain uplifts provided the sediment sources for vast river and delta systems that crossed the high plateau of Texas and the Mid-Continent and drained into the coastal plain of the Gulf of Mexico. Deposition had changed from a predominant carbonate system to an exclusively clastic system. Throughout the Tertiary (65 million years to present), the southern edge of North

America successively overstepped itself as deltas continued to empty in to the Gulf. The earliest sediments were deposited just south of the Marathon-Ouachita Mountain Range, until at present, the edge of land is the present day Gulf Coast. Structural movements have continued from the Laramide orogeny throughout the Tertiary. They have had subtle, but important effects on the earlier formed Paleozoic structures and reservoirs of the Permian Basin.

The Permian Basin is one of the great oil and gas producing basins of the world (Figure 5.) Anticlinal structures were initiated by the Marathon orogeny and trapped gas and oil that

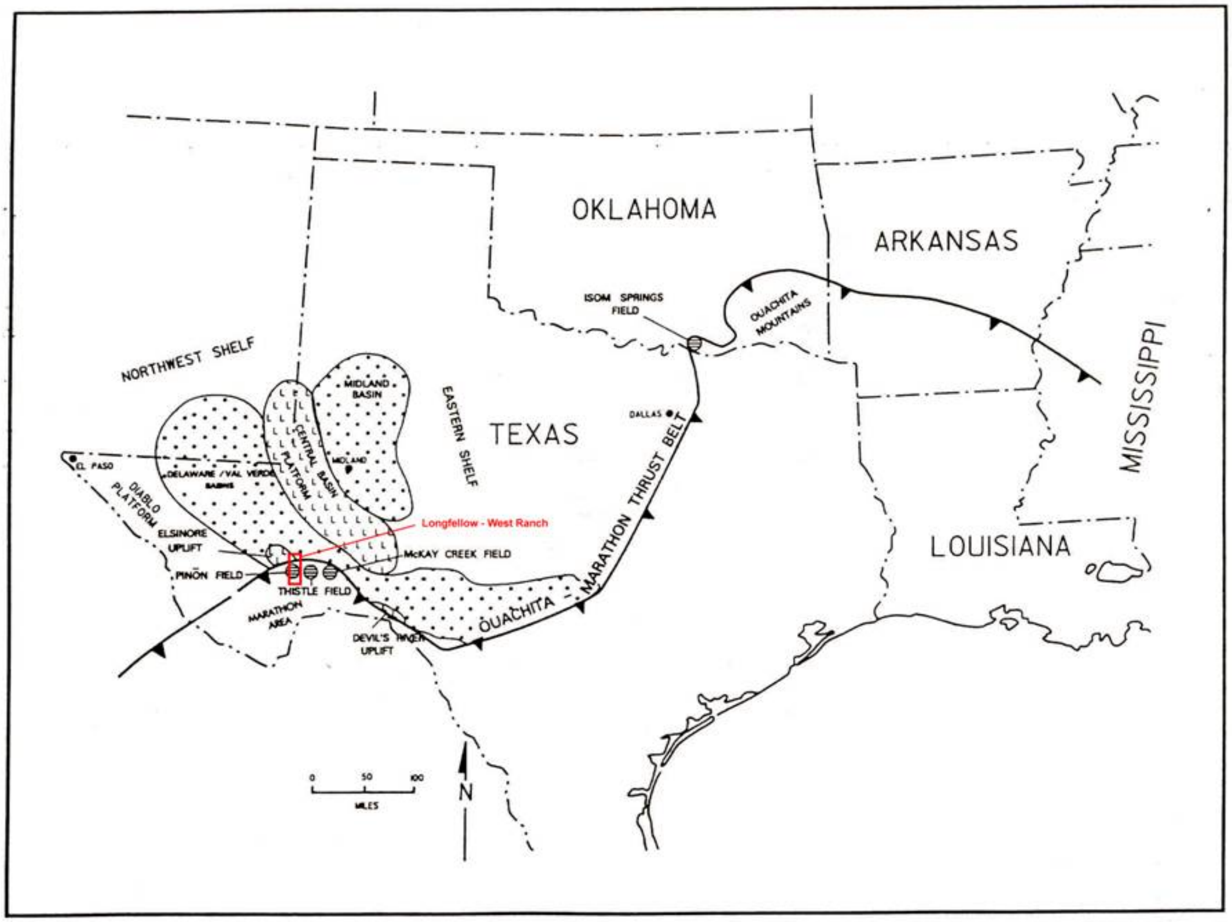

Figure 5....Map of Permian Basin and Marathon Overthrust

were generated from Mississippian, Pennsylvanian and Permian source rocks. The shallow Pennsylvanian and Permian carbonate platforms and shelf edges became the major oil reservoirs. Early Paleozoic sediments, by contrast, have been the major gas producers in the Delaware and Val Verde basins, and have produced from reservoirs that are at depths below 25,000 feet. The large gas discoveries were made during the hectic exploration drilling from the late 1950's through the 1970's. In contrast, though, the Marathon region has been ignored by the oil and gas industry. This began to change in the past 20 years, and the area that encompasses the Longfellow and West Ranches is developing into a prolific hydrocarbon producing area in its own right.

History of Oil and Gas Exploration in the Marathon Overthrust

Early exploration objectives in the Marathon Overthrust were for the deep Lower Paleozoic carbonate reservoirs of the Ellenburger formation and related anticlinal structures that were the important elements of the large gas fields in the Delaware and Val Verde Basins. To date, however, the shallow Marathon thrust faults and folds that were "jammed" on top of the Mississippian age foreland structures have proven to be some of the most productive reservoirs. The geometry of the thrusted structures is extremely complicated and serves as an extreme challenge for traditional seismic methods for several reasons: (1) The eroded, but flat-lying Cretaceous carbonate beds exposed at or near the surface reflect much of the seismic energy back to the surface and their high velocities distort the true position of the seismic reflections in time; (2) The steep dips and complex geometry of the folded beds scatter the seismic waves and they are difficult to image; (3) The complex thrust, wrench and shear faulting causes diffraction of the early seismic waves and caused false imaging.

The most important producing reservoirs in the Delaware and Val Verde basins are the Ellenburger dolomite and Siluro-Devonian limestones and cherts. To date, nearly 30 TCF has been produced from the Lower Paleozoic reservoirs from these sub-basins. Most of the gas fields are today undergoing in-fill and horizontal drilling that promise higher recoveries. During the Upper Paleozoic, the northern edge of the Marathon Overthrust lapped onto several large structural features that are large "Super Giant" gas fields: JM- Brown Bassett (2 TCF), Grey Ranch (2 TCF) and Elsinore (.8 TCF) (Figure 6.) Just to the north of the Marathon Thrust are the giant Puckett (7 TCF) Gomez fields (10 TCF) and others. All of these fields are Mississippian-Pennsylvanian aged anticlines and they are bound by large reverse (or high angle thrust) and strike-slip faults. The main producer in these fields is the Ordovician Ellenburger formation, although the primary producing interval at Elsinore is the Siluro-Devonian. The reservoir rocks have undergone repeated fracturing and diagenesis since their initial deposition. Cores in the Ellenburger show that fracturing occurred in at least four different periods of deformation. In some cases, fractures created more reservoir porosity, and in other cases porosity is occluded by fluids that moved through the fracture systems. JM-Brown Bassett produces up to 60% CO_2, while Elsinore produces more than 50% CO_2. Geochemical isotope analyses have shown that the origin of the CO_2 is from deep seated igneous intrusions underlying the basin sediments. Lesser production has also come from Pennsylvanian carbonates and Permian Wolfcamp sandstones. Mesozoic and Tertiary movements continued to affect the reservoirs during late stage tectonism.

Initial discoveries of the Delaware and Val Verde deep gas fields occurred in the 1950's and 1960's. Airborne and surface magnetic and gravity data were useful in delineating variations in basement composition and in estimating the approximate depth to the basement. Single fold seismic was helpful in detecting the large structures. The early explorers were Gulf, Shell,

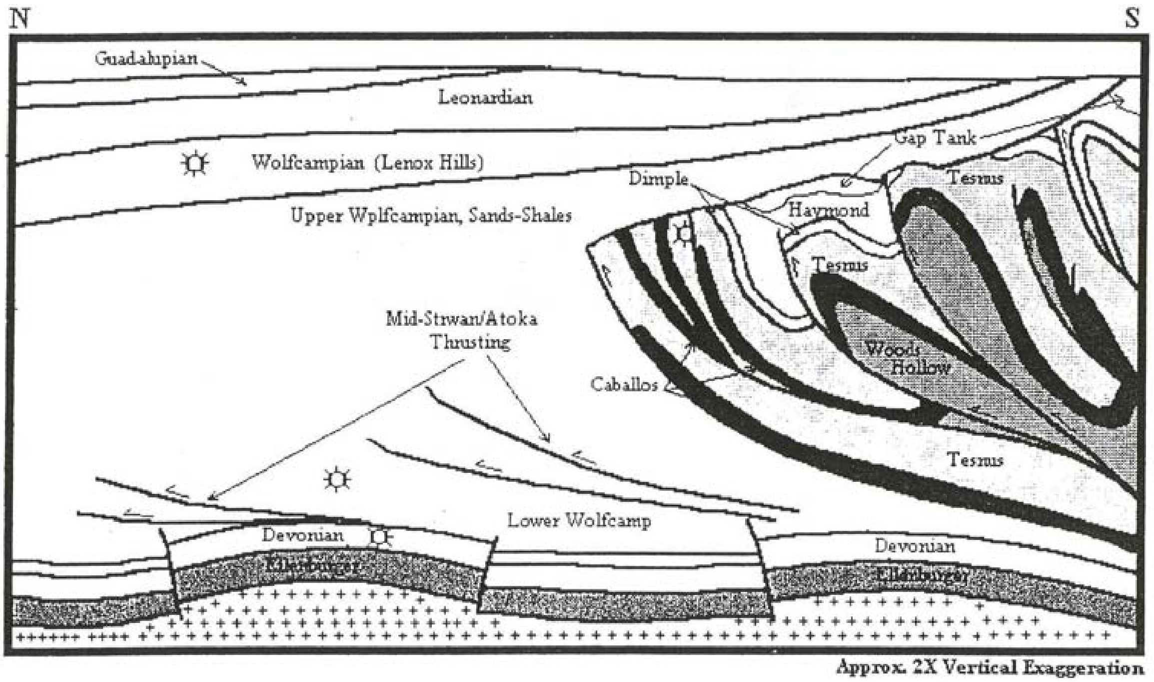

Figure 6.....Elsinore Beneath Marathon Overthrust; Pinon at Shallow Depths

Humble, Magnolia (Mobil), Pan American (Amoco), Texaco, Union, Chevron, Phillips, Superior, Amerada, Hunt, Getty, Texas Pacific and Conoco. A second wave of exploration and exploitation began in the late 1970's and 1980's when increased computer power permitted the stacking of seismic traces to improve the signal-to-noise ratio. Since the mid-90's, a third wave of deep gas exploration is the result of 3-D seismic data, and horizontal, or lateral, drilling.

Elsinore field was discovered in 1958 by Hunt Oil and is one of the oldest deep gas discoveries in the Val Verde Basin. It is immediately north of the Longfellow and West Ranches. One of the discovery wells, The Montgomery-Fulk #1, was the basin's highest flowing gas well at rates of 100 MMCF per day. The producing depth is approximately 12,000' and the production is from a north-south trending, asymetric anticline that has over 2,000' of closure. The Devonian chert is the major producer, but both the Devonian and the Silurian are missing on the south end of the structure. The Silurian Fusselman and Ordovician Montoya formations are also productive. The field has an average CO_2 content of 50%. The oldest producing formation is the Ellenburger, but it had a content that was 98% CO_2. Most of the wells are no longer productive.

The job of exploring for gas and oil in the Marathon Overthrust has been a more formidable task than that in the Delaware and Val Verde basins. Clues to the underlying structure and stratigraphy were studied at the surface for more than 60 years by such great names in geology as P.B. King, Peter Flawn, Robert Folk, Earl McBride, John Hills, James Wilson, Frank Kottlowski, to name just a few. Many of the operators that were successful in the Delaware and Val Verde basins were also pioneers in the Marathon Overthrust. Most noted of this group were Shell and Humble, but other explorers were Mobil, Conoco, Chevron, Forest, HNG and Gulf. Shell saw the entire Appalachian-Ouachita-Marathon thrust belt as an entire system and drilled a number of wells along the entire trend. In the Marathon area, Humble had long term leases on the Longfellow Ranch and concentrated its drilling efforts in the area east of Marathon. The first overthrust discovery, however, was made in 1979 by Texas Pacific in the Caballos Novaculite at McKay Creek (Figure 7.) The map shows the Caballos fields relative to a regional thrust systems; McKay Creek is trapped by one of the component systems referred to as the Warwick thrust fault. Wells in the field have penetrated as many as three different thrust sheets at 6500'. This field proved that the overthrust was capable of producing hydrocarbons at shallow depths.

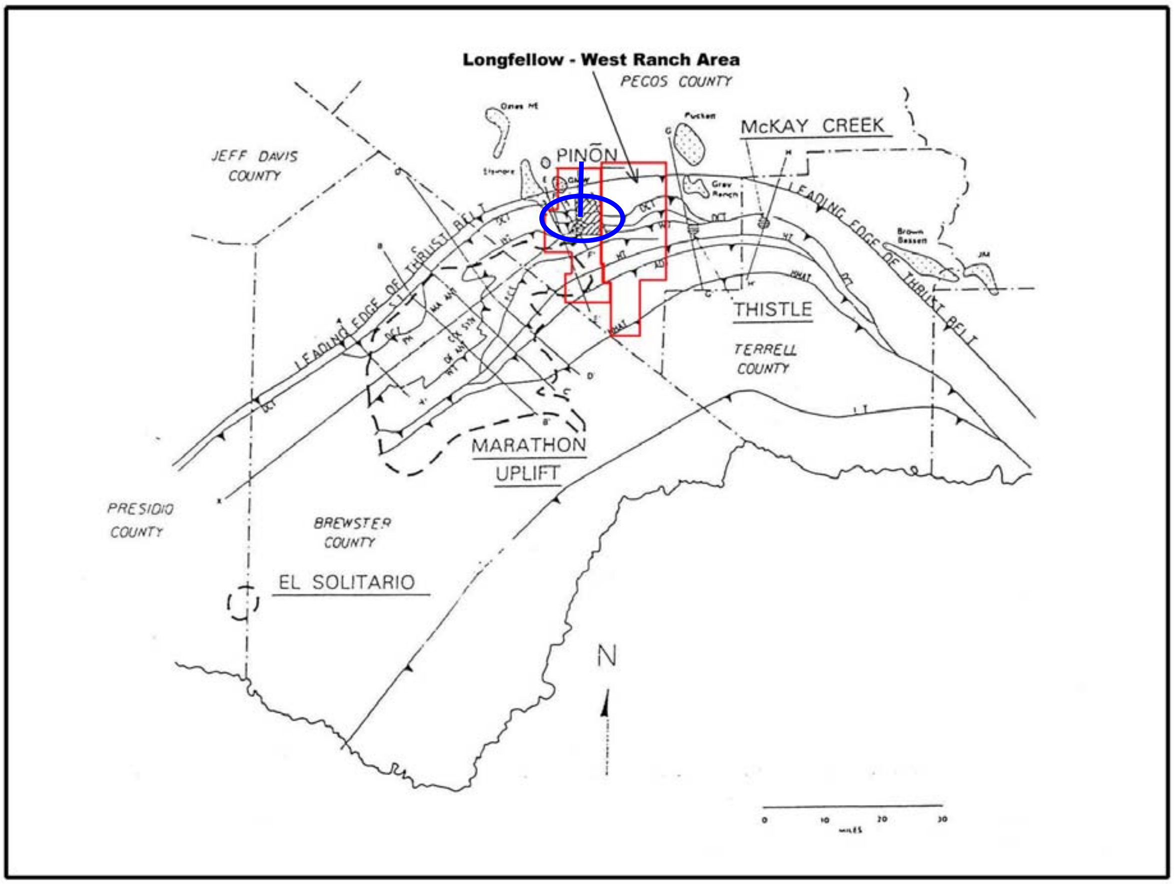

Figure 7....Map of Longfellow/West Ranches relative to Pinon, Elsinore, Puckett, Gray

Ranch, Thistle, McKay Creek, JM, Brown Bassett Fields showing major WTO thrust belts.

In 1980, Tenneco Oil Company began to explore the Marathon Overthrust and made a decision to look for prospects along the leading edge of the Dugout Creek thrust. This fault system was an older fault system than the Warwick thrust that trapped pay at McKay Creek. In 1981, the company took a farm-out on the J. A. Allison Ranch south of the Elsinore field from HNG, who had previously taken a farm-out on the same ranch from Conoco. The terms of the second farm-out required Tenneco to drill 2 wells to earn. The seismic was very poor so the first well was considered simply a strat test and was drilled in front of the leading edge of the overthrust. This well was a dry hole, but the second well, the J. A. Green 4-1, blew out in the Dimple limestone at approximately 3,700 feet. This discovery established a second front of exploration in the thrust belt. The well had an CAOF of over 9 MMCF/D and was the discovery for Pinon field (Figure 7.) The second well was drilled in 1982 and further changed the direction for development in the field and for the trend. The J. A. Green 4-2 was completed in the Caballos Novaculite at approximately 4,900 feet for a CAOF of over 18 MMCF/D. The well was notable for several anomalies. It had a high CO_2 content that was initially 50% (increasing over time to nearly 70%) and had a pressure gradient of .62 psi/ft. Previous production tests in the Caballos chert had "sweet" gas with no, or only small amounts, of CO_2, and had a normal pressure gradient. Cores taken in the 4-2 by Tenneco in the Caballos chert showed intense fracturing and brecciation. It was interpreted by Tenneco that the reservoir, itself, was part of a thrust fault, and that the gas was coming from a trap much deeper than the perforated interval. The formation pressure was extrapolated back to a "normal" gradient, and a 3000 foot gas column was estimated for the reservoir. This would place the depth for this reservoir at approximately 8500 feet. Carbon, oxygen and hydrogen isotopes of the produced gases indicated that most of the CO_2, and a lot of the methane, had the same composition as the gases from the Siluro-Devonian at Elsinore. Some of the methane had the same kerogen fingerprint as the Tesnus shales, and the produced oils that had recently been discovered at Thistle. So, some of the methane gas and the oil had a nearby source rock from a traditional Marathon facies (Tesnus), but the bulk of the produced gas (methane and CO_2) proved to be from deeper structures and reservoirs, from which a thrust plate acted as the pipeline to the Caballos reservoir. The #4-2 to date has produced 28 BCF and has remaining production estimated to be 20 BCF. (This was a difficult problem to unravel, for the Conoco J.A. Allison 20-1 had encountered four separate thrust sheets, with diminishing CO_2 levels in the lower Caballos thrust sheets. Unfortunately, these lower sheets did not test in commercial quantities, so the pattern of development at Pinon, and later Bitterweed, was that established by the shallow "sour" gas thrust plates. Only with deeper drilling in the past couple years has the importance of the deeper "sweet" gas Caballos thrust blocks been realized. They are apparently separate and isolated faults that are not in contact with, or are contaminated with, the deeper gas trap(s).) From this point forward, Tenneco used a variety of geochemical techniques to help detect patterns of near-surface leakage to be used with the seismic data in its development program. Unfortunately, this new discovery coincided with the largest single economic down-turn in the history of the oil business. Not only was capital hard to come by, but physically getting the wells on production was no easy chore. The Lonestar, or Pikes Peak, Plant is located a few miles north of Pinon field and was designed for processing high CO_2 gas from Elsinore, Perry Bass and Oates fields. This plant would take the Pinon gas, but only in volumes that wouldn't restrict the gas volumes sales being already being produced. And the high shrinkage for the CO_2 extraction reduced the profitability of the net gas. The Pinon field, therefore, was frequently curtailed in its early development.

In 1985 Shell discovered the Thistle oil field, which was situated immediately east of the Longfellow Ranch. The leading edge of the Dugout Creek thrust system was the trapping structure and the reservoir was the Caballos Novaculite (Figure 7.) Several thrust sheets were found to be productive at depths from 1,300 to 5,000 feet. Production to date has been 2.7 MMBO and 4.5 BCF from 6 wells. Superior obtained the right to shoot 2-D seismic on the West Ranch in 1984 and acquired approximately 25 lines. However, Mobil bought Superior in 1985 and was unable to obtain a lease from the landowner so no drilling followed the seismic program. In 1987, Citation and Columbia Gas leased the West Ranch, and drilled a discovery well to the south of Pinon in the Caballos chert. Unfortunately, the well's rate was insufficient to build a pipeline at that time. In 1988, Tenneco took a farm-out from Citation and Columbia Gas and drilled the hugely successful West Ranch 5-1 discovery for the Bitterweed field. This well had almost identical producing characteristics as the Green 4-2, with a .61 psi/ft. pressure gradient and a 65% CO_2 content. The well is expected to produce 24 BCF before depletion. In 1988, Fina Oil and Chemical Company purchased all of Tenneco's West Texas-New Mexico and Gulf Coast assets. Problems with the pipeline out of the West Ranch into the Lonestar plant again delayed production. Fina leased the Lonestar gas plant and became its operator. Additional seismic was acquired and seismic was reprocessed. Development of the field continued slowly.

In 1992, a group organized by Exploration Techniques, Inc. obtained a farm-out of the undeveloped acreage under the Citation-Columbia Gas lease at West Ranch. Fina joined ETI, and a discovery in the Caballos novaculite became the Rio Caballos field (Figure 8.) That well has made 6.5 BCF and has an additional 3.5 BCF remaining. Pinon, Bitterweed and Rio Caballos fields were being developed in the first and second Caballos thrust sheets (Figures 9, 10.) In 1994, Nuevo bought some of the working interest from ETI, et al, and in 1995, Riata Energy, Inc. bought Nuevo's interest. Additionally, Fina took a farm-out from Dolch Production and re-entered the Shell #9-1 on Longfellow Ranch.

In 1998, SandRidge Energy, Inc. (fka *****Riata Energy, Inc.) and Manti bought Fina's interest in the field at the same time Fina was selling all its production and assets in West Texas and New Mexico. Riata (SandRidge) became operator for the field, the Lonestar plant and the associated gathering pipeline systems. In 2002, they obtained all of the ETI interests and are attempting to acquire the remaining Citation interests at Pinon in Section 4.

Riata (SandRidge) has done an admirable job as both explorer and developer of the combined producing fields. They have their own equipment, drilling and completion rigs, and

*Note: Riata changed its name to SandRidge in Q3 of 2006.

they have tried to direct the drilling as a low-cost operator and producer. One of the most difficult control issues for drilling in the overthrust is the highly unstable Tesnus shale. Tenneco had discovered by drilling with oil based mud, stuck pipe and down-time could be virtually eliminated, and an in-gauge hole could be drilled. This also increased production rates. Riata began drilling with air utilizing customized drilling rigs, and this improved efficiency and costs. After taking over the fields in 1998, Riata (SandRidge) has drilled and completed numerous exploration and development wells with over a 95% success rate (failures have been mostly mechanical due to the steep dips of thrusted rock beds). A new "sweet" gas pipeline and compression system was added to transport the sweet gas production.

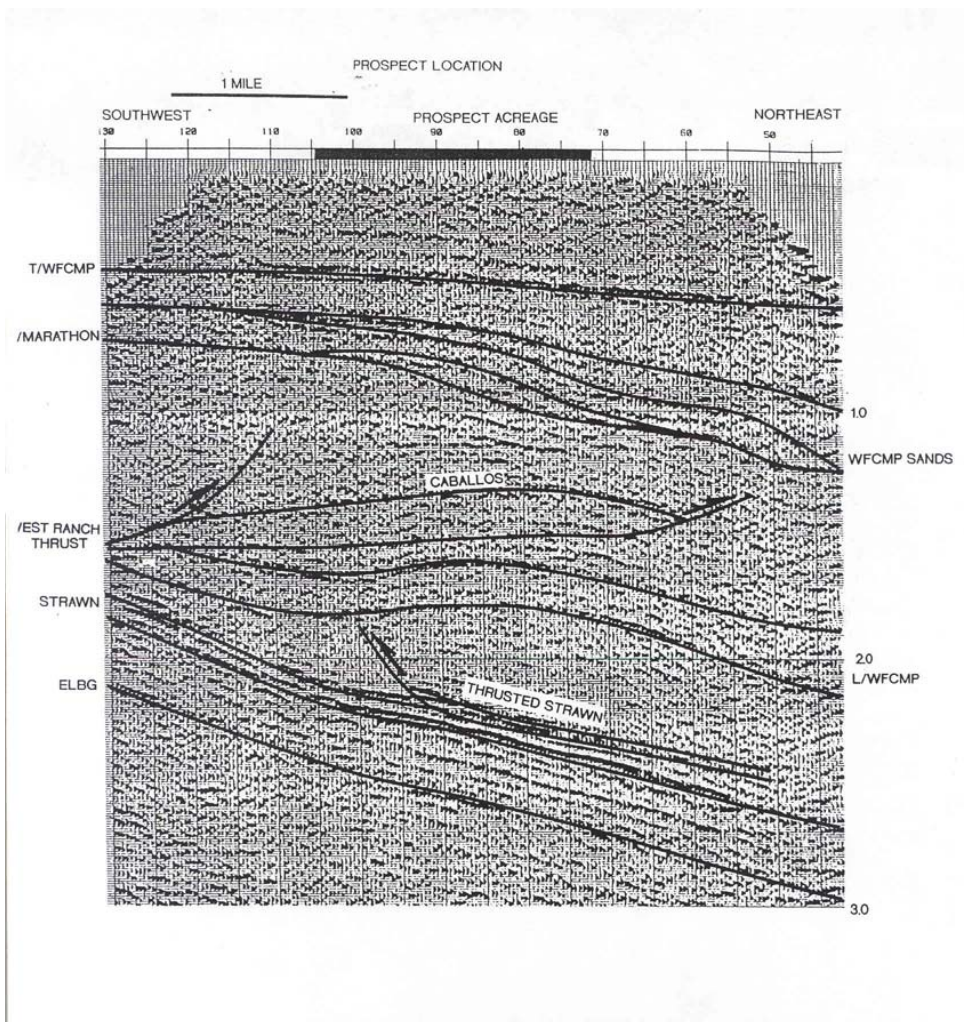

Figure 8....Line Showing Thrust Sheets at Pinon-Bitterweed and Rio Caballos

Active development has continued along the pattern established by the #4-2 and #5-1 wells, but in the process in 2002, high BTU gas from the 3rd and 4th thrust sheets (Figure 11) was tapped. These sheets are now undergoing active development as primary exploration and exploitation targets. These Caballos sheets are virtually free of CO_2, enjoy high producing rates and are highly profitable. These sheets are trending onto the southern part of the Longfellow North, Longfellow South and the Fairway Prospects and appear to be excellent candidates for field extensions. In fact, they will be the primary objectives of this exploration program, although the first and second thrust sheets will be evaluated on the way down.

In 2001 Longfellow Exploration Partners acquired long term development rights over the majority of the Ranch fee acreage. Since 2003 many prolific sweet gas Caballos wells have been drilled over the West and Longfellow Ranches' Caballos Zones. Needless to say the economics of these wells significantly boosted interest activity in the area. In 2003 LEP and Riata deepened the former Exxon #7 well on the East-Northeast part of Longfellow and encountered Wolfcamp pay at approximately flowing 1.4 mmcf/day of sweet gas. Moving eastward and across the Longfellow Ranch there are several wells drilled in the 70's and early 80's by Exxon and Shell which encountered positive shallow overthrust results; the remoteness of the wells from infrastructure at that time precluded their further development then. In late 2004 approximately 8 miles east of the Exxon-Longfellow #7 well the Sabino Field was discovered by Riata and producing sweet gas with condensate out of multiple shallow Caballos completions.

In 2007 LEP SandRidge drilled the discovery well for the South Sabino Field as an oil producer. The Longfellow SS-600-18-2 came on production at 288 BOPD with some gas out of a Caballos zone at just below 4,700',more wells are planned for this area.

More Recently in late 2007 LEP and SandRidge made several discoveries in a new Caballos trend on the Longfellow – West Ranch leasehold at East Pinon Field. These wells have three potential Caballos sweet gas targets in each well bore. Cab "A" with flow rates of 1.5 – 3 MMCF/day and 5 – 10 BCF of reserves, Cab "1" with flow rates of 6 – 10 MMCF/day and 15 – 25 BCF of reserves with an average 13.5% decline rate and Cab "2" with flow rates of 2 – 5 MMCF/day and 10 BCF of reserves (these wells have Tesnus, Upper Wolfcamp and some Dimple pay behind pipe). The Cab "A", Cab "1" and Cab "2" are situated at approximately 5,500', 7,500' and 10,000' respectively; this area is currently under intense development.

Since the 2003 version of this report much 2-D Swath and 3-D Seismic has been acquired over the entire area supporting significant structure development across the multiple thrust belt system Resource Play that traverses Longfellow Ranch. Many prolific wells have been drilled since then on the basis of these seismic interpretations. 3-D Seismic is currently being shot over a 1,400 square mile band of the WTO including all of the Longfellow Ranch. Sucessful downspacing of the Caballos, Tesnus, Dimple and Upper Wolfcamp has occurred in the WTO. Caballos wells are drilled on 40 acre spacing while Tesnus, Dimple and Upper Wolfcamp horizon are spaced at 20 acres or less.

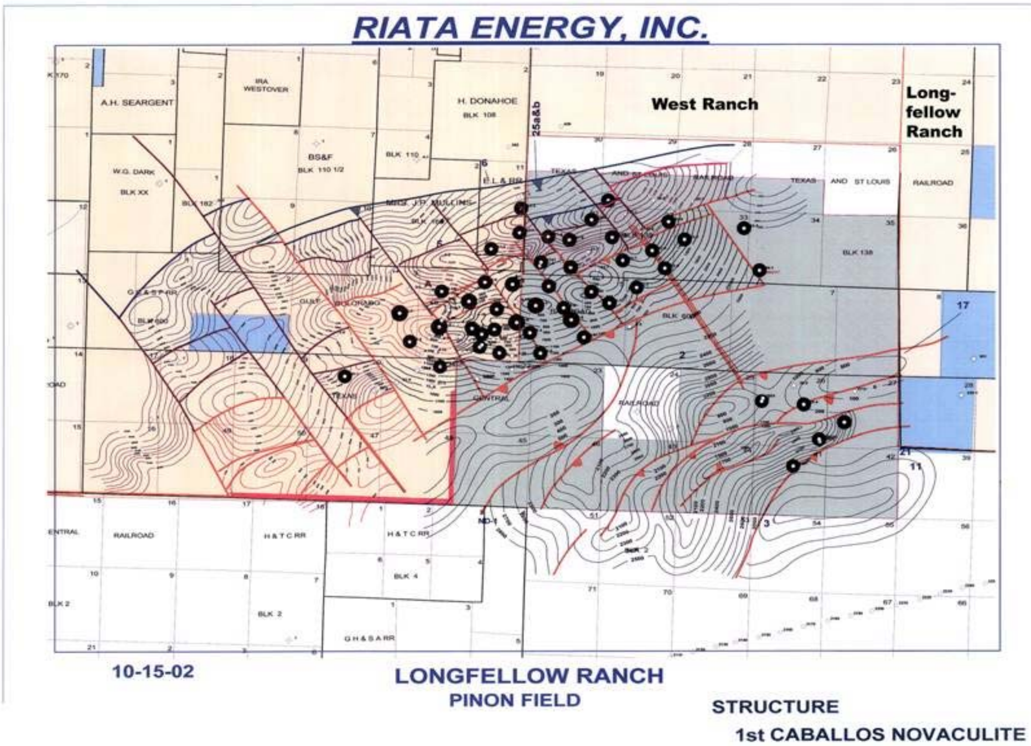

Figure 9....Structure Map: First Caballos Thrust Sheet (2002)

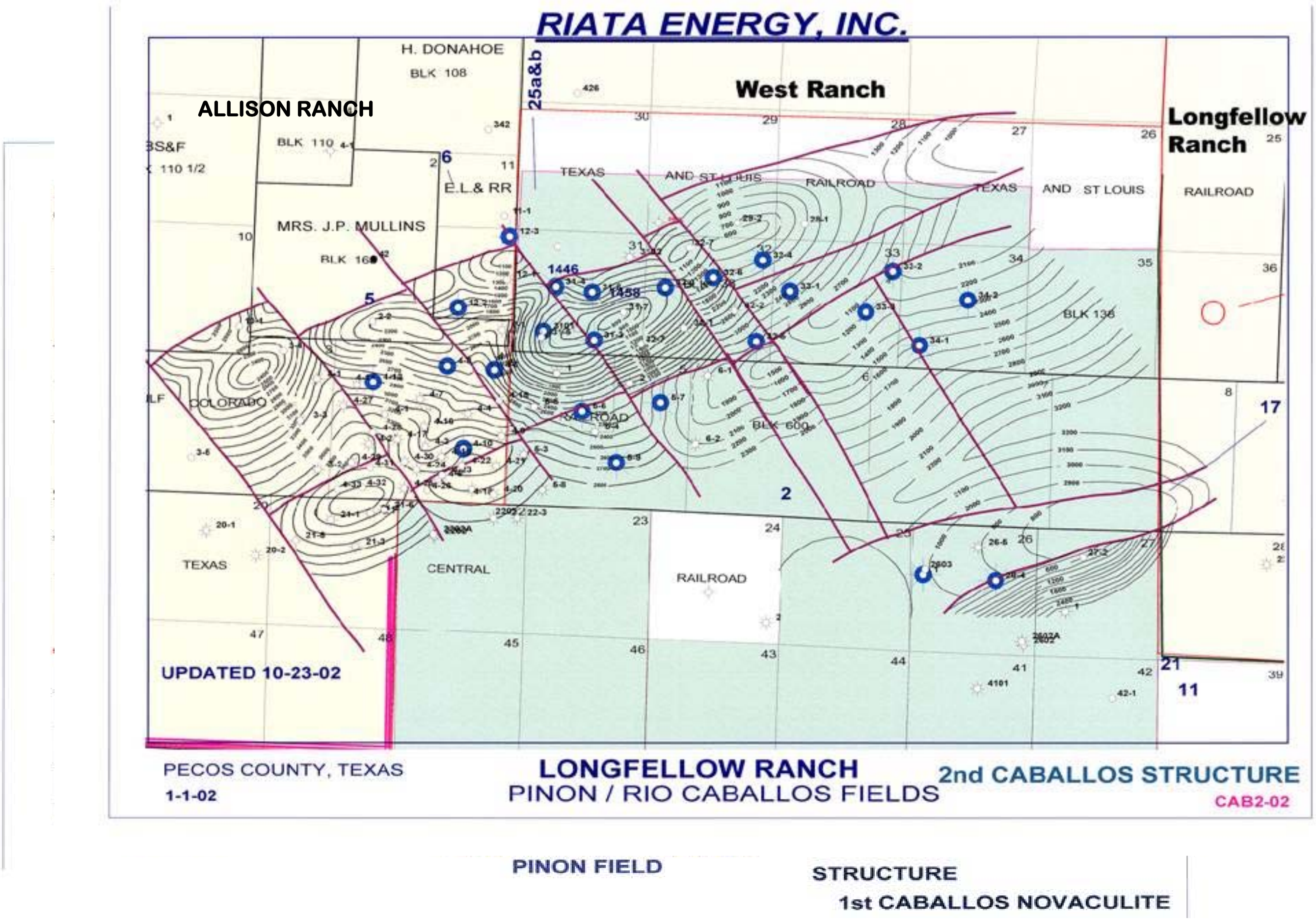

Figure 10...Structure Map: Second Caballos Thrust Sheet (2002)

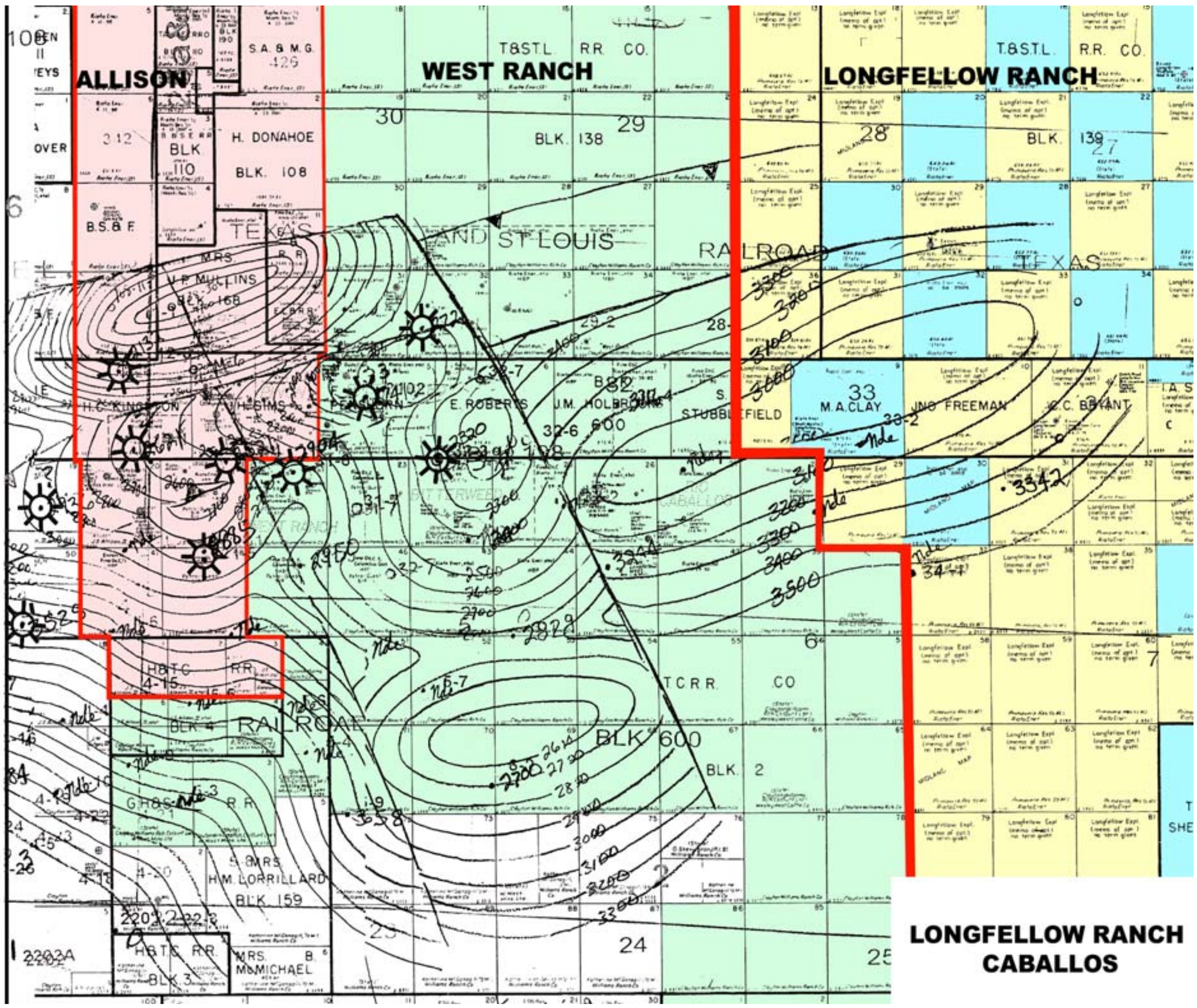

Figure 11....Structure Map: Third Caballos Thrust Sheet (2002)

Reservoirs and Gas Production Types

Caballos Novaculite

The main reservoir of the fields located on the Allison, Longfellow and West Ranches is the Caballos Novaculite. The reservoir is comprised of two lithologic types: (1) White novaculite, which is sometimes translucent, massively bedded, composed of almost pure silica, coarser crystalline, and which had a fauna that consisted almost entirely of sponge spicules; and (2) A gray, green and brown chert, which is thin-bedded, with abundant shale partings, considerable clay dispersed in the chert itself and a fauna that consists almost entirely of Radiolaria. As a whole, this formation is 90% chert. The remainder is mostly shale with small amounts of limestone and sand. In outcrop the formation ranges from 150 to 630 feet thick and is comprised of 5 members. The best surface exposures of the formation are 3 to 10 miles south of the town of Marathon on State Highway 385 on the way to the Big Bend National Park. It is best described there as consisting of 5 members, two of which are the massively bedded white novaculite, and three of which are thin-bedded interbeds of chert and shale. The following is a brief description of the Caballos members.

> The *upper chert and shale member* is 360 feet thick and is comprised of green and gray chert beds 1 to 10 inches thick. Radiolaria are common and red shale and jasper occur at the top.
>
> The *upper Novaculite* member is 0 to 360 feet thick. This white spiculitic chert has local breccia and fractures filled with black internal sediment.
>
> A *lower chert and shale member* is 180 feet thick, and is comprised of green and gray chert beds 1 to 10 inches thick, with shale partings. Radiolaria are common.
>
> The *lower Novaculite* member ranges from 0 to 135 feet in thickness. This white spiculitic chert is structureless and massive.
>
> The *lower chert member* is from 0 to 15 feet thick and is inter-bedded gray chert and quartz siltstone.

The novaculite is very brittle, and often crushes into small pieces by the thrusting and folding. What appear to be bedding planes are a surfaces of recrystallization, called styolites, that developed during lithification and diagenesis. In general, the subsurface description of the Caballos Novaculite by mud logs and electric logs is similar to its occurrence at the surface. Wells that have drilled near the frontal part of the overthrust have encountered thrust faults, and in many cases, an incomplete thickness of the Caballos is present. Either tops or bottoms may be faulted out. In some cases, part of the Caballos in one thrust plate may be rest on parts of other cherts in other thrust plates. This appears to be the case in the J.A. Green #4-2, the Caballos discovery well in the Pinon Field. Fortunately, part of the reservoir was cored by Tenneco, and the brecciated and tectonically-fractured nature of the chert is able to be observed. This well is the largest producer in the field and will eventually make 50 BCF. It is interpreted that the thrust plane which places chert against chert, is both the conduit and reservoir, and moves the gas from a deeper position to this level. Figures 12 and 13 illustrate how complex the faults are and how easily a well could have part of the Caballos faulted out.

Remnant ghost features of the needle-like spicules are evidence of the origin of the silica in the rocks. These sponge spicules were dumped by currents on the basin floor in a sub-equal trash deposit of siliceous spicules and carbonate mud. This deposit was susceptible to solution and the formation of styolites, solution pockets and some "karst" like development. It is likely that the spicules were deposited much like a sandstone in a series of sudden depositional events, and it is likely that the thin-bedded chert and shale were deposited slowly over a much greater period of time. During diagenesis, all novaculite bedding was destroyed by bioturbation and textural alteration during silica replacement. It is interpreted that the chemical reorganization of the silica in the novaculite is from skeletal opal to cristobalite and quartz in the pores. This happened rapidly after deposition. Near the top of each novaculite member, brecciation and fracture filling are common, and indicate the occurrence of an unconformity at that the cessation of spiculite deposition. This is not due to sub-aerial exposure. This is likely the result of submarine changes in the water depth or current circulation patterns that produced chemical replacement. The original natural fracturing of the novaculite during diagenesis produced "crackle breccias" and dissolution textures (called "birdseyes"), which became an important part of reservoir development. Locally, the chert sometimes developed a "karst", or cave-like porosity by dissolution of the silica in much the same way as in a carbonate. Any pre-existing porosity has been enhanced during folding and faulting. The combination of the novaculite hardness and it's brittle nature appear to make the rock a natural surface along which the thrust faults have moved.

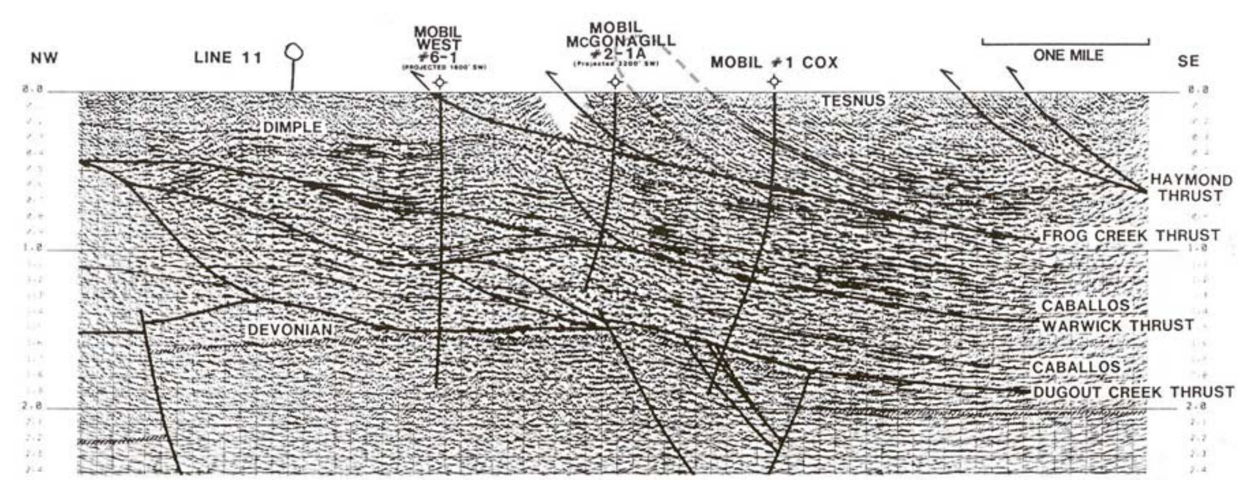

Figure 12.....Complex Thrust Fault Geometry

The chert and shale members are inter-bedded units of shales comprised of illite clay and units comprised of Radiolaria, spores, conodonts, quartz silt and "hemipelagic" deposits of micro-crystalline quartz. Radiolaria died and rained down on the basin floor. Thin silt and sand layers from land were deposited by turbidity currents into the deep basin position. Chert was formed by the diagenetic, or chemical reorganization of the silica sediments. Some conglomerate and carbonate sediments may have slumped off the shelf and they are deposited as unusual exotic blocks within the chert and shale.

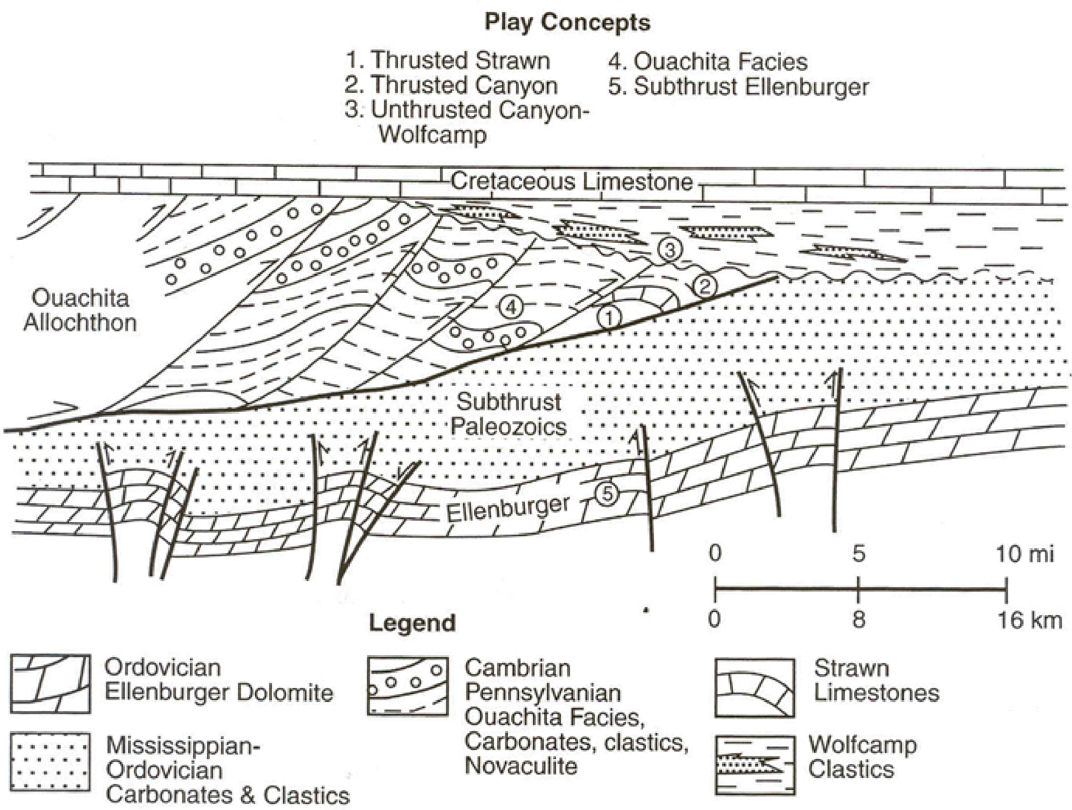

Figure 13....Thrust Fault Geometry; Underlying Structures; Overlying Unconformities

It is interpreted that the darker, more opaque chert of these members remained as a soft ooze for a long time, that it is richer in clay, organic matter and pyrite, and is so fine grained as to be referred as crypto-crystalline. The chert in this member lacks the brittle behavior of the pure novaculite chert, and can best be described as being soft-mud, or plastic, in its behavior, due to their mixed composition and the thinly bedded relationship with the shale. The rock may have acted like a gel, and this condition may have persisted after considerable burial and compaction. The distinction between the two fundamental types of chert formation is important, as the fractured, massively bedded novaculite is the preferred reservoir for gas production on the Longfellow, West and Allison Ranches, Thistle and McKay Creek. Perhaps some of the organic material deposited with the thin-bedded chert and shale has a partial role in sourcing hydrocarbons to the chert reservoir.

The thrust faults and folds are the trapping elements for the fields that have been discovered at the Longfellow-West-Allison ranches (Figure 4.) The seals are the overlying Tesnus shales. At Pinon and Bitterweed on the West Ranch, the gas and liquid compositions vary according to which thrust sheet they produce from. The lower two thrust sheets produce “sweet” gas from the fractured Caballos, and in most cases, less than 1% CO2. These reservoirs also tend to have a normal pressure gradient, some Longfellow shallow Caballos wells have pressure gradients exceeding 0.7 psi/ft. Their decline rates range from 20% to over 30%. The higher decline rates suggest that there is a limited drainage area for these particular reservoirs and that communication is limited with nearby wells. Recent exploration results in 2007 at East Pinon on the Longfellow Ranch and westernmost West Ranch have encountered three prolific Caballos sweet gas pay zones. The “Cab A”, “Cab 1”, and “Cab 2” zones are addressed on page 16 of this report. However, much of the gas produced to date at Western Pinon and Bitterweed from the upper two thrust sheets is “sour”, having a high CO_2 content ranging from 20% to over 80%. This reservoir is over-pressured (with a pressure gradient of .62 psi/ft.) The “sour” gas reservoirs generally have a higher initial producing rate and a low decline rate of less than 15%. This suggests that these reservoirs are in communication from well to well, that they are highly fractured, and are widespread (Figures 8, 9, 10.)

In the 1980's, Tenneco Oil attempted to better understand the differences of the reservoirs, the gases and their pressure environments. They fingerprinted the produced gases and oils from Elsinore, Pinon and Thistle and drill cuttings from the Pinon sour gas wells. One analysis was to examine the unique *spectral fluorescence* characteristics of the kerogen and the hydrocarbons. *Carbon, oxygen and hydrogen isotope* analyses were also run on the gases. These studies showed that the “sweet” gas is generated by a marine shale source rock within the younger, over-lying Tesnus formation. A small component of the “sour” gas comes from such a source. The liquid components at Pinon and Thistle correlated with the kerogen from the Tesnus shale. This is what one would expect if exploring for accumulations within the Caballos Novaculite. However, the major “sour” gas reserves produced to date at Pinon and Bitterweed fields correlate with the gases at Elsinore. The two gases have the same ratio of methane to CO_2. This isotopic match suggests that most of the methane, and virtually all of the CO_2, are from the Siluro-Devonian carbonates. Even though these “sour” gases come from the two highest thrust sheets, the thrust fault(s) associated with them has propagated from a deeper position at the Elsinore level. The depth at which the over-pressured gases is extrapolated to a normally pressured position is at a depth of 8,000-8,500 feet, or a 3,000' gas column. A seismic structure that fits this model below the thrust sheets. For the pressures to be the same over considerable area, the thrust fault "pipelines" must have been highly fractured. The fractured novaculite would also account for the higher producing rate, and the lower decline rate. The models for two types of reservoirs is probably too simple; they are likely end members. In these highly folded, faulted reservoirs, there are likely mixed reservoirs that have properties between the two types of gases. As drilling continues, other fault blocks may turn up different reservoirs and gases. When more pressure data becomes available, better geologic correlation between wells will allow more accurate structure and reservoir mapping, which, in turn, will enable more reliable reserve predictions.

Tesnus Sandstones and Dimple Limestone

The Tesnus formation is a series of deep water turbidite sandstones and shales whose source was from the impinging continent to the south during the Mississippian. The sands are imbricated in the same thrust sheets that involve the Caballos Novaculite. Although the Tesnus has not proven to be a primary objective, multiple Tesnus sands are frequently encountered in the wells and provide additional plug-back potential. The reservoir quality varies greatly, and it is difficult to predict from well to well how many, if any, good sands will be encountered in a given well bore. But a re-completion candidate of behind pipe reserves will almost always be present. The reservoir produces sweet gas with a higher decline rate, probably due to compartmentalization and the restricted size of the reservoirs. A good Tesnus completion can be expected to produce approximately 1 BCF or more. The Tesnus equivalent in the Ouachita/Arkoma region is the Stanley/Jackfork Sand. Many of these wells have been stimulated to produce 10 – 20 MMCF/D at lower depths. A number of zones that have been penetrated are behind pipe and won't be evaluated until the Caballos zones are abandoned or are found to be faulted out. The Tesnus formation thickens to the south, and it may be to the south that this objective has been trapped by some of the other thrust fault systems, other than the leading edge Dugout Creek thrust.

Stratigraphically overlying the Tesnus formation is the Dimple limestone. The Dimple is a basinal limestone, but near the northern part of the Marathon sequence close to the overthrust leading edge, the limestone appears to have shallow water characteristics. Like the Tesnus, the porosity within the Dimple is highly variable, and although it is difficult to predict prior to drilling how well developed the porosity is, or how many zones of porosity may be encountered, one can expect that the Dimple has a high probability of being a plug-back zone once the Caballos or Tesnus has been depleted. The older thrust features, themselves, may be capable of production for they are topographic highs on which shoaling sequences could have deposited. The J.A. Green #4-1 discovery well at Pinon blew-out in the Dimple limestone at approximately 3,700'. As of 2003 the well has produced 1.07 BCF since 1981. The Dimple is an accidental producing zone, and that is all it will likely be. It is a limited reservoir with inconsistent porosity development, but it may develop more favorably to the south and east of the West Ranch. The zone has plug-back potential on any Caballos tests.

Wolfcamp and Penn

The late Pennsylvanian Canyon and earliest Permian Wolfcamp consists of sandstones and shales shed from the overthrust highlands to the south into the Val Verde basin. The Canyon sands have been prolific producers in the area from Ozona to Sonora, and the Wolfcamp became a significant producer with the discovery by Riata of the Pakenham Wolfcamp field in front of the overthrust in 1989. That discovery later led to middle Pennsylvanian Strawn carbonate reservoirs trapped in imbricate thrust faults, not unlike those for the Caballos Novaculite (Figure 15.) The Wolfcamp produces up to several BCF from 4,000-10,000', while good wells in the Strawn have produced between 10 and 20 BCF and up to 500 MBO. New fields are Deer Park, South Park and South Branch. Similar discoveries may occur at North Longfellow. The Exxon-Longfellow #5-11 had very encouraging production tests of 1-2 MMCF/D at 2,000' and 7,680'. The latter appears to be trapped by a thrust, whereas the former appears to be stratigraphic, possibly a channel sand. Relative to the producing fields in the Pinon area, the Wolfcamp interval thickens off structure and north of the leading edge. This is an unconformable relationship, and it clearly indicates that the sediments were deposited after the Caballos aged thrusting was in place. Wells have not been drilled off-structure intentionally, so perhaps this may be the point at which the potential of the Wolfcamp will be fully recognized.

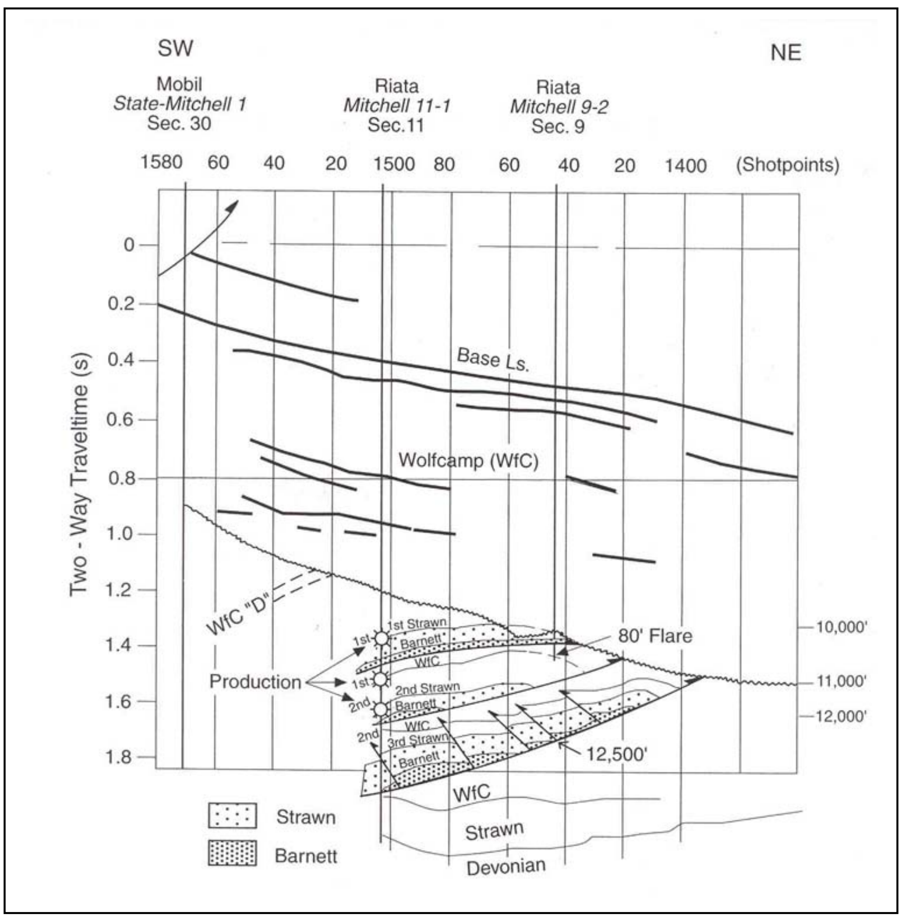

Figure 14...Structural Setting of Pakenham, Deer Park, South Park, South Branch Fields

Lower Penn and Siluro-Devonian

At Pinon, the third well in the field, the J.A. Green #4-3, was drilled to the Siluro-Devonian and where encouraging shows were encountered at a depth of 12,484'. Mechanical conditions prevented completion of the well, and was plugged back to a shallow depth. However, a 25-35 foot gas flare occurred through the fishing operation. In the early 90's Conoco recently tested a Devonian zone (later identified as Caballos) east of Longfellow at a rate of 9 MMCF/D, there was no pipeline in place to produce the gas. A lower Pennsylvanian Atoka carbonate zone is also a potential target of deep drilling. Exxon, Citation, Tenneco, Fina, Riata and others have seismically mapped deep Siluro-Devonian fault closures. Recently Riata (SandRidge) had exploration success with the 47-1 well drilled to 11,000' in the Fussleman. The well tested an AOF of ±150 MMCF/day of sour gas. SandRidge has estimated that this "Pinon Multi-Pay Field" has 1.5+ TCFe of reserves. These deeper objectives while holding large gas reserves that exhibit high flow rates generally contain variable levels of CO2. Recently Occidental (OXY) announced that it will build a $1.1B processing plant at Longfellow which will increase Longfellow Pinon area processing capacity to over 1 BCF/Day including 350 mmcf/day of methane from those fields. Deep foreland structures are potentially a large play beneath the entire overthrust especially with the addition of more processing capacity and the ability of enhanced 3-D seismic technology to image the deep structures.

Reserves, Economics and Financial Models

The production table in the Appendix details the production from Caballos Novaculite fields in the area. Several wells in the 3rd and 4th Caballos and more recently Cab "A", Cab"1" and Cab "2" have been completed with initial production (IP) rates much higher than the calculated average rates and will produce considerably more than the calculated average reserves. This is due to: 1) better drilling, completion and stimulation techniques, and 2) better understanding of the geology and therefore better well placement. Numerous additional locations remain to be drilled.

Any of the wells that are considered "sour" have a high CO_2 content that ranges from 10% to 80% and average 60%, whereas "sweet" wells range from less than 1% to 10% and average 2%. As development has moved from the west at Allison Ranch east through West Ranch to the Longfellow Ranch, the CO_2 content has decreased. The West Ranch wells average only 40% CO_2 with the eastern most wells being classified as "sweet", whereas, the CO_2 content of the Allison Ranch wells are quite high. The Longfellow wells have thus far produced 100% sweet gas and some oil. "Sour" wells have higher initial production rates and lower decline rates which yield slightly higher net methane ultimate recovery than the early "sweet" wells, but the recent Cab"1" discoveries also exhibit low decline rates similar to the "sour" wells. Close scrutiny of the production indicated that the initial production (IP) of the wells reported by PI-Dwights is overly optimistic. For this reason, an actual producing IP was obtained from the production data using the initial average monthly production. The IP's listed in the production data base reflect *actual* starting production rates which in some cases was restricted by the bottlenecked pipeline network. The decline rates of the production were calculated for each well, which normalize the production for any periods where the reservoirs were shut-in or worked over. While recent exploration efforts have been directed toward the prolific 3rd and 4th sweet Caballos horizons (and more recently the Cab "A", Cab "1" and Cab "2" horizons), the authors developed a model using historical production data from all wells drilled since 1988 in the area, to broaden the sample group.

Outlook for the Longfellow-West Ranch Area

Longfellow

The greatest known potential objective at Longfellow is the Caballos Novaculite. Recent discoveries by Riata of "sweet" production in the eastern Pinon Field in sections 6, 7, 8, 32,34 and 33 and have generated successful drilling for the extension of this Dugout Creek thrust plate eastward throughout Longfellow. The same potential may be true for the 4th thrust sheet. Moving southward more recent sweet discoveries in the Warwick thrust plate at Pinon/Longfellow as well as sweet Caballos discoveries at South Pinon along the Frog Creek and Haymond thrust systems show that these repeating thrust belts display similar characteristics and potential as the original Dugout Creek thrust discoveries. If just the average well for either "sweet" or "sour" gas is completed, the economic picture is excellent; outstanding potential for stacked pay exists.

The Tesnus formation that overlies the Caballos Novaculite stratigraphically has promise at Longfellow. A well drilled by Exxon in section 11 (#5) northeast of the Pinon Field is along the trace of the Dugout Creek thrust fault. This well drilled to a depth of 7,868 ft. and tested gas from a section of Tesnus sandstone at an unstimulated rate of over 2,000 MCF/D. In addition, a Wolfcamp sand at 2,300 ft tested at a unstimulated rate of over 2,000 MCF/D. Both wells were not stimulated.

The Pakenham Wolfcamp field was discovered by Riata in 1989 by farming in the shallow Wolfcamp rights at 4,000 feet +/- after Fina had drilled an 18,000 foot Ellenburger dry hole. Riata subsequently purchased the well bore and leasehold from Fina and fraced the Wolfcamp with great success. This completion set up the drilling of an additional 100 wells. By the end of the Pennsylvanian, the Marathon Overthrust had effectively formed a barrier, or sill, to the southern part of the Val Verde basin. Wolfcamp sands and shales were eroded from the highlands created by the thrusts and the colliding continents, and were shed south to north into the Val Verde Basin. The good wells in the Pakenham field lie in channels where the sands had better reservoir quality. The same geologic setting exists at Longfellow.

In 2006 LEP and Riata re-entered the 24,470 feet Exxon-Longfellow 11-1 wellbore, an Ellenburger test drilled in the seventies. The well has well developed Lower Wolfcamp (Subthrust) sands from 10,300' to below 13,000'. One of these zones was perforated (but not stimulated) and flowed gas at a rate of 650 mcf/day of high BTU methane with some water at 2,200 psi. Production logs were run and Schlumberger determined that a defective cement job allowed water to channel up the wellbore from below (the well was plugged back to produce at 6,000' in the Caballos). These Lower Wolfcamp sands thicken to the north and northeast and blanket the area.

Later in 2006 the Longfellow 600-8-2 drilled as a Tesnus producer was plugged back to test the Upper Wolfcamp at 2,830' – 2,920'. The well was put onto production at a rate of 1.4 mmcf/day with additional prospective UWC sands behind pipe. Shortly thereafter the 600-8-3 Upper Wolfcamp offset well was drilled and completed at 2,700'-2,800' and flowed 322 BOPD with gas demonstrating the oily potential of these upper sandstones. These Upper Wolfcamp zones along with Tesnus pay lie behind pipe in many of the deeper Caballos wells now being drilled. It is recommended that wells be designed to test additional Wolfcamp zones that tested gas. A Tesnus completion can be expected to produce approximately 1.0 BCF, and a single well bore may have several Tesnus pays. A shallow Wolfcamp well has the same reserve expectation. The Wolfcamp has produced from 12 wells on the south flank of Elsinore with several wells producing 1-2 BCF and has been a prolific Permian Basin producer as well.

Future Potential: Pinon to Thistle and southward

Moving southward the Longfellow Ranch has additional potential other than along the frontal portion of the overthrust as there are several similar thrust belts traversing the southern acreage. A list of potential producing reservoirs at Longfellow can be viewed at the end of the Appendix, where the production of the wells to date from the wells at the Allison and West Ranches has been ordered by their respective fields. This indicates the multipay potential that exists for all the greater Longfellow Ranch. The Ellenburger formation and the Siluro-Devonian formations are the largest gas producers in the Permian Basin. These reservoirs are prolific producers in a number of fields immediately north of the Longfellow Ranch. These Lower Paleozoic rocks were originally deposited in the ancestral Tobosa Basin. The objectives are predominantly shelf-platform carbonates. Seismically, they have dense, high velocity rock properties that provide strong acoustic characteristics, and are easily discernible from the sediments caught up in the overthrust. Their reflection characteristics are more well developed than those of the complexly faulted Marathon series of sands, shales, and cherts. The relatively thin, deep ocean basin Marathon sediments are time equivalent with the lower Paleozoic carbonates. The Marathon rocks have been brought great distances from the south, and have been emplaced up and over their basin equivalent foreland sediments by the overthrust (Figure 1, 6.) Therefore, the Ellenburger, Siluro-Devonian, Mississippian and Pennsylvanian shelf deposits are significant deep objectives beneath the structurally complex overthrust sheets. Nearly identical lower Paleozoic shelf carbonates also produce large gas volumes in the Anadarko, Ardmore and Arkoma Basins beneath the Ouachita Thrust Belt in Oklahoma and Arkansas in identical structural settings to the Marathon thrust-Val Verde Basin. The giant Wilburton field will produce over 1 TCF from Ellenburger-equivalent dolomites. On the Longfellow Ranch, these structures can be seen on seismic, and are very attractive targets in the future. To date, few wells have reached these formations, but beneath Pinon, Tenneco J.A. Green #4-3 encountered good shows in the top of the Devonian formation at 12,484 feet and continuously flared gas at 25-30 feet while fishing stuck drill pipe at total depth. Moving south Conoco in 1993 drilled the Conoco/Big Canyon well to 24,075 feet south of the leading edge of the overthrust that tested 9 MMCF/D from a foreland structure beneath the overthrust, mechanical problems prevented completion of the zone but the well was plugged back to the

Tesnus by Riata at 13,415’ and tested 2.6 MMCF/D. Several miles south of the Big Canyon well discovery Exxon had drilled the Exxon C.C. Mitchell well to 24,074’ in 1982 as an Ellenburger test and never came out of the overthrust sections. (This well lies on trend and just east of the southernmost portion of Longfellow Ranch.) Just west of the Longfellow Ranch SandRidge recently discovered the Pinon Multipay Field with EUR of 1.5TCF sour gas from a deeper Devonian horizon. On the south end of Longfellow Exxon drilled the Exxon-Longfellow #39-1 to 6,721’ in 1979 and in 1980 Exxon drilled the nearby Exxon-Longfellow #14-1 to 4,285’ both wells encountered multiple overthrust sections of Tesnus sandstones.

Seismic is now playing a bigger role in the WTO. Currently over 1,400 square miles of 3D Seismic data is being shot over the WTO including the Longfellow Ranch. This data will tie back into the field and should indicate how many thrust sheets are objectives. Abundant 2-D seismic data was shot by Superior, Exxon, Citation, Conoco, and Riata and will tie the new data. In light of the difficulty inherent in seismic acquisition and processing in these complex areas, it is recommended that non-seismic data be acquired. No geologic trap or seal is perfect. Minute amounts of hydrocarbon breach the seals above an accumulation via natural fractures in the seal (shales, evaporates or carbonates), or they episodically tend to breach as pressure builds up in the reservoir. It is recommended that several geochemical techniques be applied to the exploration along the overthrust front. *Airborne Micro-magnetic* surveys are excellent tools for detection of micro-seepage above an hydrocarbon accumulation where iron minerals near the surface have undergone ionic reduction from Fe+++ to Fe ++. This altered state produces minerals with high magnetic susceptibility, such as magnetite, maghemite and goethite. Removal of the regional magnetic effect results in micro-magnetic anomalies above an accumulation of gas or oil. *Ground based radar* actually detects gas in the air above an active microseepage. Oil has a tendency to “mushroom” more than the gas, but actual detection of hydrocarbons is possible. A technique that measures the electric potential (in millivolts) in the zone of ionic reduction frequently called the migration chimney is called a *telluric survey*. These measurements have the potential to detect hydrocarbon presence in approximate depths for potentially more than a single horizon.

It is recommended that gravity surveys be used in conjunction with photogeologic surveys and landsat imagery to look for evidence of thrust-offsetting vertical shears. It is possible that some of these may have been produced by the Sierra Madera meteorite impact (astrobleme) immediately north of the Pinon field at the end of the Cretaceous period. Riata has interpreted a number of lateral shear faults in the Pinon and the Thistle area, but these are very difficult to see on seismic. This would provide an inexpensive way to look for their presence.

It is believed that a landsat study will find some linear features that may represent deeper seated structures obscured by the overthrust structures. An airborne magnetic and gravity study should indicate the basement composition and structural setting beneath the overthrust. A micro-magnetic study of the residual features may provide an indication of micro-seepage above a deep structural trap. At that point, other geochemical techniques can be used to refine a deep prospect. It is believed that the likelihood for high reserve potential prospects is excellent on the remainder of the Longfellow Ranch.

Recommendations & Conclusions

The Longfellow area has great potential for the discovery and development of natural gas. SandRidge and LEP have considerable production and well data from the Pinon, Bitterweed, South Bitterweed, Algerita, Rio Caballos and Thistle fields. They also have the most complete seismic database and considerable experience integrating the different sets of data. They have been the lead generators in extending producing trends east of the West Ranch acreage onto Longfellow. However, additional mapping and modeling of production, pressures and gas content can be merged with the geological and geophysical data to provide a more accurate interpretation than now exists. It is important for the geologists and engineers to have as much production and subsurface data as possible to characterize the reservoirs and make the best estimates of reserves and future cash flows. Seismic data has come to be considered a first order tool in most of the world's producing basins, where great improvements in data acquisition and processing techniques have increased the interpreters' abilities to understand the subsurface geology. However, in complex terrains such as the thrust belts, other tools become powerful and can help make up for any potential geometric and imaging issues with seismic data in the overthrust. Use of unconventional exploration techniques, such as geochemistry, in conjunction with tools such as gravity, magnetics and landsat may help indicate where to drill exploratory wells or where production can be extended. Additional study of drilling, completion and fracing techniques may result in lower costs and better production. This is a long term project that will require substantial investment over time. Based on past performance, this WTO resource play with its conventional shallow and sub-thrust upside potential demonstrates repeatable results with statistical variance and promises excellent economic returns in the future.