

## CATFISH BAYOU

ST. BERNARD PARISH, LOUISIANA

### EXPLORATION HISTORY AND RESULTS

ARCO's Exploration Group began initial discussions of the East Delacroix (Catfish Bayou) in 1978, with the idea of acquiring major regional blocks of seismic options in order to build a regional seismic grid across areas with Deeper Miocene (below pressure) objectives, where little deep drilling has been carried out by the industry. Some confidential knowledge of high quality Deeper Miocene sands in areas where most explorationists put small chance for sands enhanced the project. Also, being an area with very little regional high tech seismic control made the E. Delacroix (Catfish Bayou) Area a prime candidate for deep exploration. A small seismic purchase by ARCO of old Getty data in 1978 gave strong indications of a large, deep structure in the area, probably Cretaceous in age, at depths of about 20,000'. Originally, this deep structure was a secondary objective to Mid-Miocene sands, but with initial shooting of regional north-south seismic lines on the 1979 optioned lands the deep structure was observed to be much larger and more regional in nature and thus became the prime objective. The regional seismic option and grid, together with leasing, detailed seismic and drilling costs resulted in total exploration expenditures to ARCO of about \$150,000,000. Land acquisition was followed by major acquisition of state waterbottom leases across the area.

One major disappointment in mapping the regional seismic grid was the very small number of Mid-Miocene potential prospects in this large land holding. Several very experienced geophysicists reviewed the area after the initial mapping and they could not find any strong, economic Mid-Miocene opportunities in the area.

The large, deep regional structure became the main target and drilling locations were made after several reviews of the seismic data were carried out by District interpreters and followed by a management geophysicist review. In approximate numbers, the very large, deep regional uplift covers some 20 miles in east-west dimensions and about 7 miles in the north-south dimension. The highest portion of the structure centers around the State Lease 10707 No. 1, located in Section 15, 15S-16E. Numerous small and several large faults are scattered throughout the area. Record quality over most of the area is good, but at these depths involved there are some local areas where data are questionable and faulting could be moved around. These local problems do not detract from the overall major deep structural configuration - it is a very reliable, significant regional uplift.

The major geologic question was this initially: What age is the structure and what kind of reservoir rocks are we dealing with? Early ARCO thinking was that this was a major carbonate structure (limestones and dolomites) generated early in the formation of the Gulf of Mexico - Jurassic or early Cretaceous in age. Several models were presented, building a case for good porous and permeable carbonate rocks on the crest of this ancestral feature. Geologists postulated early migration of hydrocarbons into the favorable reservoir rocks and then sealing in the hydrocarbons as the feature was buried by following major sedimentation flow into the Gulf basin. The major questions were in the lithology and reservoir quality of the rocks and the only way to find out was to drill. Major northward expansion of the Upper Cretaceous Tuscaloosa section was indicated on the regional seis grid and this section was also a strong objective.

The Biloxi Marshlands P-2 was selected as the optimum initial location, not on the highest portion of the feature; in order to obtain a good first look at a more complete stratigraphic section in the area. The test was located in Section 7, 15S-17E and spudded in August, 1984. Total depth of 23,350' was reached on 5-20-85. While the well was in progress, velocity data began to suggest that the very anomalous, deep "carbonate reflections" were probably below 24,000', much deeper than original thinking in the project. These deep reflections have not been penetrated by any ARCO test well and remain a potential objective, as they were ARCO's original objective. The major zone of interest turned out to be the clastic (sand-shale) zones of Upper Cretaceous Tuscaloosa age. Depth to the Top of the Lower Tuscaloosa marker was at about 19,540'. This marker looks very equivalent to the Top of Lower Tuscaloosa "Bain" resistive marker found in the major Tuscaloosa sand fields at False River, Judge Digby, Irene, Port Hudson, etc.; far to the northwest in Central Louisiana. The Top of Tuscaloosa sand pay in the P-2 was at 21,200'-21,245', with about 20' of net pay indicated on the Dual Induction-SFL Sonic log. A second indicated pay was seen at 21,435'-21,475', with about 18' of pay indicated. The total net pay of about 38' was calculated by ARCO's Dallas log analysts, with a "possible" 25' additional in lower perm, higher water saturated zones. The well had been shut in at 21,000' on 3-4-85 with major gas indications on the mud log when drilling into the first sand. The well continued to total depth of 23,350' with only some very thin possible pays, nothing additional to be completed in at these tremendous depths and drilling-completion costs. Plans were made to complete this well, but mechanical problems as follows ended this completion attempt:

The P-2 was planned for completion and after delays required to obtain the correct types of equipment (ARCO had concerns about H<sub>2</sub>S and CO<sub>2</sub> gases), the well was perforated in the Top Tuscaloosa pay sand. Safety devices were installed to shut the well in if pressures were severe. The well flowed gas for a short time before the devices shut the well in; prematurely, according to some ARCO explorationists. Gas samples were collected and evaluated to show some small amount of H<sub>2</sub>S gas and about 6% CO<sub>2</sub> gas. CO<sub>2</sub> gas caused tubing-completion problems at fields in central Louisiana; False River, Judge Digby, etc. The well then had other mechanical problems and would not flow. ARCO went into the hole and found sand and other rock material as high as about 3000' and realized that sand from the Tuscaloosa reservoir had flowed uphole and plugged the tubing - probably when the sudden shut-in occurred. ARCO snubbed into tubing and got completely through tubing and then found more dense fill and could not get back down to the Tuscaloosa pay sand. Another concern of ARCO was the very thin, worn spots in the casing at different intervals, caused by excessive drilling-rotation time in certain parts of the hole. Engineers feared weak casing would not stand further workover attempts without risks of underground blowout. Also, there is a perforating gun in the hole which should have fallen to bottom, but that is not known after sand flow. The bore hole was plugged and top casing and equipment was shot off about 15' below the mud line. A diagram of casing in the hole and location of shot casing was provided by ARCO and transmitted to Rivers Lelong. The ARCO District drilling engineer, Doug Ruckels, feels that re-entry attempts in the P-2 would be very risky and an underground blowout with massive costs is possible. The worn casing is of major concern, with the deep high pressures involved. He feels that drilling a twin well, with all the drilling

experience gained to reduce costs, would end up being cheaper and have much less risk. Any completed well should be capable of producing 20-30 MMCF/D of gas if sand conditions in the twin well are like those in the P-2 well.

Although more pay than the  $\pm 38'$  in two prime zones was preferred, the overall major size of this regional structure gave indications of potential major reserves. From the initial regional structure of about 20 miles by 7 miles ( $\pm 90,000$  acres), if the reservoir rocks carried over the entire feature in somewhat uniform thickness, and if the feature had one-fourth ( $\frac{1}{4}$ ) fill-up (22,500 acres); reserves of major significance could be placed at about 1.0 trillion cubic feet of gas (50' pay avg. x 22,500 ac. x 900 MCF/AF). Other estimates ranged from 500 BCF to 1.25 TCF gas reserves. Thus, even considering the very high drilling and completion costs and very low gas prices, this was a very positive exploration target for ARCO if the sands were spread somewhat uniformly over the entire structure.

The near term expirations of major lease holdings throughout the prospect required rapid drilling of 4 wells to hold the leasehold together. In hindsight, if more time had been available for drilling the follow-up wells one at a time, with reviews of findings integrated into seismic data, then perhaps a better result could have been obtained. Also, if a suggestion by a high ARCO official to drill early and determine what kind of rocks were on the feature had been followed, probably a better job of spreading wells out would have resulted.

However, time pressures caused spudding of three wells in January, 1986 and the fourth well in March, 1986. The results of the follow-up wells were a major disappointment. Structurally, the wells fit seismic mapping quite well, no surprise as this large structure is well documented. Sand quality and

quantity was really the question from the beginning and the new well data plainly showed that there was no uniform, continuous sand deposition over the structure. This severely reduces reserve estimates in the prospect and together with poor gas prices makes the prospect uneconomic to complete. Following are brief comments about each of the ARCO follow-up wells:

1. ARCO-Biloxi Marshlands "O" No. 1

Spudded 1-20-86 and logged at total depth 21,889' on 6-1-86, the test is located in Section 31, 14S-17E. From the Dual Induction-Sonic Log, the Top Lower Tuscaloosa marker was found at 19,370', with the Tuscaloosa "P-2" pay equivalent at about 20,990'. Only 8' of very thin pay was found in the upper pay zone, not economic at these depths, pressures and well costs. The 2nd Tuscaloosa "P-2" sand equivalent was at 21,168' - 85', again thin and questionable pay. This test was set up to drill down structure from the P-2 discovery and determine if sand thickness and quality increased on north dip. A small fault between the two wells, down-to-the-south, caused the "O" No. 1 test to be structurally high on tops, but with all north dip and expansion shown on seismic between the wells, the test was very disappointing with much less sand than the P-2, reducing reserves.

2. ARCO State Lease 10680 No. 1

Spudded 1-3-86 and logged at T.D. of 22,147 on 8-23-86, the test is located in Section 35, 14S-17E. From the Dual Induction-SFL Sonic Log the Top of Lower Tuscaloosa marker is 19,415'. The Tuscaloosa "P-2" pay zone equivalent is at about 20,900', 300' high to the P-2 test, with very thin possible gas sands at 20,140' - 20,170' indicating about 10' of possible pay. Very tight sands are indicated with shows at ±20,800' and a possible thin pay at 21,440' - 48' (8'). The well, with several very thin pays, was not

considered for completion with the major costs involved. Again, the data says that there is no continuity and uniformity in sand quality through the prospect, severely cutting reserves. There was a mud log show at 11,900' in Mid-Miocene, with maximum gas of 1340 units. This show was not overly impressive on the electric logs, but with pay indicated in the same zone in the D-1 test immediately east, this zone should be carefully mapped and evaluated by your explorationists.

3. ARCO Lake Eugenie Land and Development No. D-1

Spudded in January, 1986 and logged at T.D. of 22,323 on 10-1-86, this test is located in Section 32, 14S-18E. From the Dual Induction SFL Sonic Log the Top of Lower Tuscaloosa marker is 19,450', some 35' low to the State Lease 10680 No. 1 located about 2½ miles west. The Tuscaloosa "P-2" pay zone equivalent is at about 21,030', about 130' low to the same zone in the S.L. 10680 No. 1. The D-1 is about 170' high to the initial P-2 test but the P-2 sand equivalent is broken up in the D-1. This test does have better sand quality and thickness than the 10680 No. 1, indicating again the variety of sand conditions in the area. There were thin zones of possible pays scattered at 20,200' - 20,300' and the zone from 20,950' - 21,160' is a zone of interest. With thin pays to the west limiting reserve size, the D-1 was plugged as non-economic because of the limited reserves, high costs to complete and very low gas prices.

The D-1 did find a very interesting "pay" in the Mid-Miocene at 11,920' - 35', with about 13' of net pay and a possible pay at 11,960' - 95'. These zones were good mud log shows No. 4 and No. 5 and are capable of production. The problem with the pay zone is the history of this part of the Mid Miocene section in this general area. There have been numerous wells drilled into

this section with very limited, small producing areas. The sands are generally discontinuous, quite variable in quality and quantity; and large reserves are difficult to demonstrate. ARCO mapped this area in detail and indicated to me that the area of closure is small, reducing reserve potential. Furthermore, the gas market at this time is poor and the cost of laying a pipeline to a nearby ( $\pm 6$  miles) gathering line makes the project uneconomic at this time. As industry conditions change this pay zone in Mid-Miocene could certainly become attractive to Independent Operators looking for smaller reserve targets than ARCO. This area should be remapped by your geophysicists when you receive the seismic data due you from ARCO, concentrating on this sand and how it relates to what appears to me to be the same sand in the State Lease 10680 No. 1 where ARCO had the good mud log show. The electric log has resistivity and perhaps this could enlarge the area of reserves. If the gas bubble bursts, this area would be your best chance to generate early revenues and could be somewhat larger than ARCO has mapped.

4. ARCO State Lease 10707 No. 1

Spudded on 3-10-86 and logged at T.D. of 22,000' on 9-21-86, the test is located in Section 15, 15S-16E. Top of Lower Tuscaloosa marker is 19,850'. The stratigraphic section thins rapidly with depth in this area, and the Tuscaloosa "P-2" pay sand equivalent is at about 20,910', some 290' high to the Biloxi Marshlands P-2; about  $3\frac{1}{2}$  miles to the northeast. The area around the S.L. 10707 No. 1 has always been the highest, thinnest portion of the large regional feature. Seismic shows dramatic thinning in the Lower Tuscaloosa and deeper into Lower Cretaceous reflections. Major concerns were given by previous ARCO exploration management as to potential sand quality on such a thin feature. A decision to drill this location was made by a

management group no longer with ARCO. The resulting P-2 sand equivalent zone had very thin, tight sands at 21,080' - 21,140' and there appears to be no exploration potential in the Tuscaloosa zone on this local uplift. Because this area has significant structure and thinning of sediments, it certainly could have controlled the distribution of Tuscaloosa sands in this area. Sands could have been diverted to the northwest, west, and southwest and this could be an area of future exploration if gas prices and total economics improve. The significant high area also indicates that this area remained high through a long period of geologic time. Remembering the original model of the area being a carbonate play with porosity maintained on the regional high, this area would be the prime candidate for carbonate porosity and hydrocarbon accumulation at some future date when drilling technology can reduce risks and costs, and when gas prices get back to the \$5.00 - \$7.00 per MCF like they were when False River and other Deep Cretaceous fields were initially discovered. Some place in the Gulf Coast Basin will ultimately find some major carbonate reserves, like have been found in Mexico's Golden Lane, and this large regional uplift could someday be the place. It certainly is the largest Louisiana Gulf Coast deep uplift mapped with confidence that was seen in my career of 34 years with ARCO, and it is very frustrating that the economic reserves have not been found on it to date.

In summary, ARCO embarked on a major regional exploration project in 1978 and 1979, put together one of the finest land positions ever built in South Louisiana; built the best regional seismic base possible; drilled 5 very deep, expensive wells from 1984 to 1986 to test their concepts; spent overall about \$150,000,000; and have found only small reserves - uneconomic under today's price conditions. There are certainly other opportunities in this large

leasehold area and when economic conditions improve, some exploration group will pursue them.

Yours truly,

A handwritten signature in cursive script that reads "Marc D. Roberts". The signature is written in black ink and is positioned above the typed name.

Marc D. Roberts

11-17-87

MDR:mma

ARCO-BILOXI P-2 WELL  
Spudded 8/84  
T.D. 5/20/85  
T.D. 23,350'  
Top-Lower Tuscaloosa  
19,540'

1st P-2 Pay  
21,200-245'  
20' net pay

2nd P-2 Pay  
21,435-470'  
(18' net pay w/25'  
possible pay)

ARCO-S.L. 10707 #1 WELL  
Spudded 3/10/86  
T.D. 9/21/86  
T.D. 22,000'  
Top-Lower Tuscaloosa  
19,850'

1st P-2 Pay  
20,910-990'

2nd P-2 Pay  
(no shows)

290' high to P-2 well

ARCO-BILOXI 0-1 WELL  
Spudded 1/20/86  
T.D. 6/1/86  
T.D. 21,889'  
Top-Lower Tuscaloosa  
19,370'

1st P-2 Pay  
20,990'-  
8 feet

2nd P-2 Pay  
21,168-85'  
(questionable pay)

210' high to P-2 well

ARCO-S.L. 10680 #1 WELL  
Spudded 1/3/86  
T.D. 8/23/86  
T.D. 22,147'  
Top-Lower Tuscaloosa  
19,415'  
20,140-170' (10 feet)

1st P-2 Pay  
20,900

2nd P-2 Pay  
21,440-448'  
(10' pay)

11,900'  
(Mud Logging Shows)

300' high to P-2 well

ARCO-LK. EUGENIED-1 WELL  
Spudded 1/86  
T.D. 10/1/86  
T.D. 22,323'  
Top-Lower Tuscaloosa  
19,450'  
20,200-300'  
(Possible Pays)

1st P-2 Pay  
21,030'  
(Thin Pays)

2nd P-2 Pay  
(no shows)

11,920-935'  
(35' w/13' net pay)

11,960-995'  
(Possible Pays)

170' high to P-2 well