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The Sacatosa Coalbed Methane Field: A First for Texas

BARKER, CHARLES E., U.S. Geological Survey (USGS), Denver, CO; PETER D. WARWICK, USGS, Reston, VA.; MATT GOSE, The Exploration Co., San Antonio, TX; ROBERT J. SCOTT, The Exploration Co., San Antonio, TX; J.M. KLEIN, USGS, University of Kentucky, Lexington, KY; and R.W. HOOK, Consultant, Austin, TX.

INTRODUCTION

In 2001, The Exploration Company (TXCO), San Antonio, announced the Sacatosa Coalbed Methane (CBM) Field in Maverick County. This field is the first CBM field in Texas (Fig. 1). The field is producing from bituminous coal in the Cretaceous Olmos Formation that outcrops to the west and dips easterly towards the Gulf Coast. The CBM field was developed in coalbeds whose general structure was known from log top data in pre-existing oil and gas wells drilled throughout the basin (Fig. 2). These preliminary data showed a large area of coal above 2000 ft depth with net coal thicknesses in the 5 to 30 ft range. Subsequently, TXCO and the USGS formed a cooperative research effort to determine the gas in place, rank, quality, extent and thickness of the Olmos coal in order to understand the resource potential of this newly emerging field.

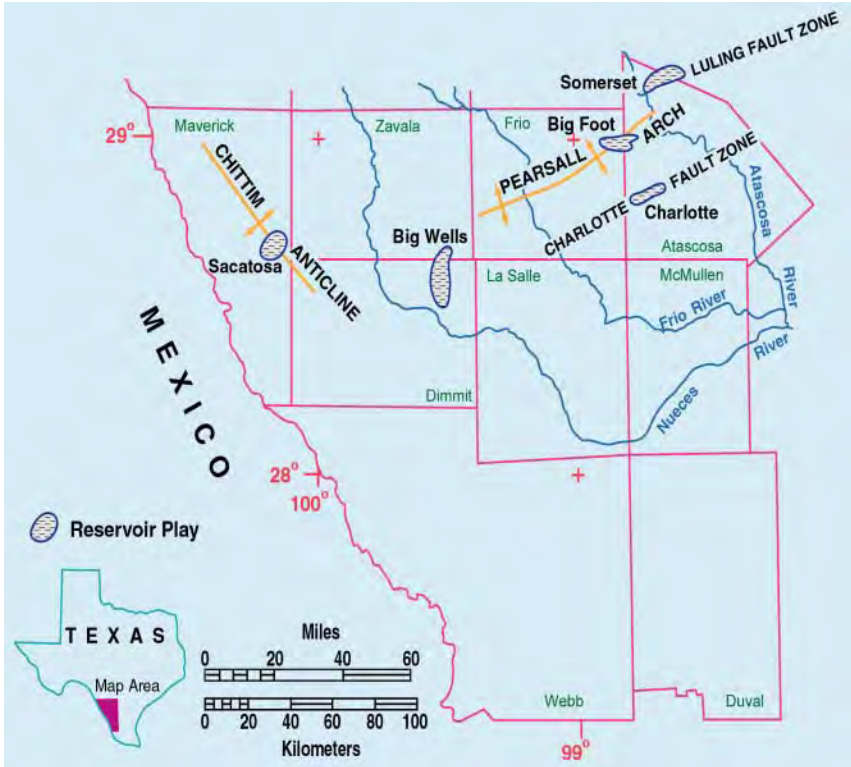

Figure. 1. The Sacatosa (San Miguel Sand) oil field and related fields. The Sacatosa (CBM Olmos) field is located two miles to the south. The Olmos coal zone lies 400 to 500 ft stratigraphically above the Sacatosa (San Miguel Sand) oil field shown. Laramide –age structural features, such as the Chittim anticline, in the Maverick Basin may serve to enhance permeability and therefore production. Map from Galloway et al. (1983).

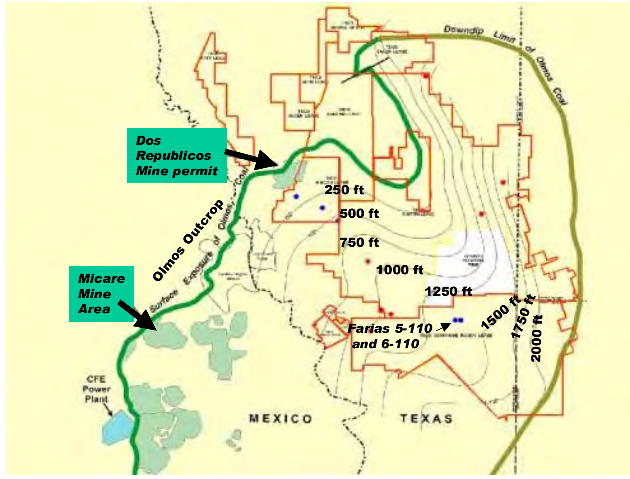

Figure 2. Depth to top of the Olmos coal zone, Maverick Basin, South Texas and Coahuila, Mexico. The Farias 5-110 and 6-110 discovery wells for the Sacatosa CBM field are shown on the map.

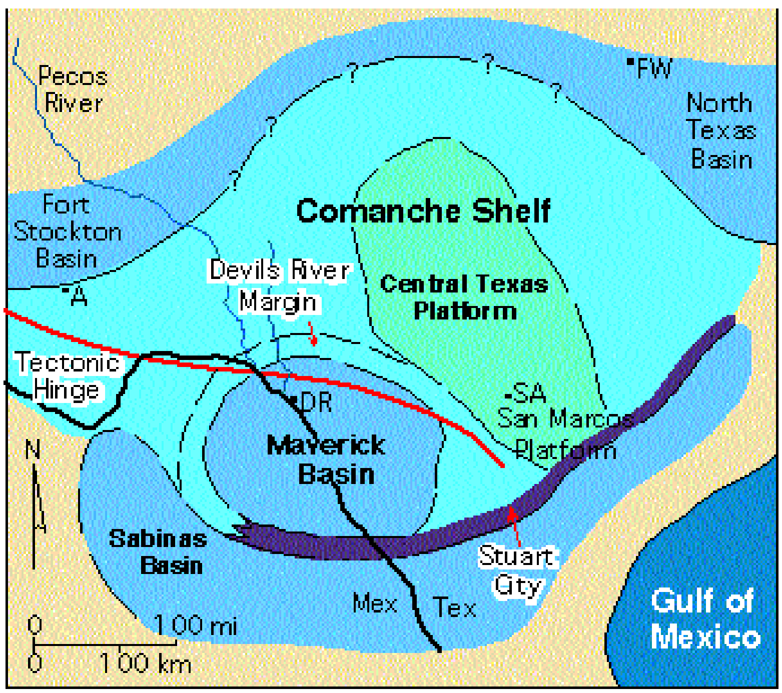

Figure 3. Paleogeography of the Maverick Basin (from Smith, 1984 and Web site of the Reservoir Characterization Research Laboratory, Texas Bureau of Economic Geology: http://www.beg.utexas.edu). The Maverick Basin and Devils River margin separate a generally shallow region of the Comanche shelf (Central Texas platform) from the deep water Sabinas trough to the south in Mexico. Abbreviations: Cities: A= Alpine; DR = Del Rio; FW = Fort Worth; SA = San Antonio. States: Tex = Texas. Countries: Mex = Mexico.

GEOLOGY

The Maverick basin center lies near the town of Eagle Pass, Texas at 28.7° north latitude and 100.5° west longitude. The Maverick Basin extends into Mexico where it is called the Rio Escondido Basin (Fig. 3). The Maverick Basin surface exhibits a level to slightly undulating terrain ranging in elevation from 540 feet in the southern part to 960 feet in the northern part of the Maverick County, the main area of CBM development. This terrain is ideal for the regularly spaced well field needed for CBM development. The field was developed by drilling basinward (to the southeast) from the Olmos coal zone outcrop exposed in a 4 mile wide outcrop belt centered about 6 miles northeast of Eagle Pass near the Dos Republicas Mine permit area (Ewing, 1989; Fig. 1 and 5). Coals at 220 ft depth contained 39 SCF/ton. Below this depth gas content increases to 72 SCF/ton at 480 ft and 100 SCF/ton at 600 ft depth to the 200 to 300 SCF/ton range at about 1500 ft in the central portion of the basin near the Maverick and Dimmit County line. Comparison of adsorption isotherm and corresponding canister desorption data with an assumed reasonable limit of analytical error suggest the coals are saturated (Fig. 4). Drilling has revealed that the coal zone pinches out to the northeast and east below about 1500 to 2000 ft. depth. However, these same coal zones extend south and southeast into Mexico where coals in the geologically equivalent Rio Escondido Basin reportedly contain an average about 200 SCF/ton and locally up to 300 SCF/ton of CBM.

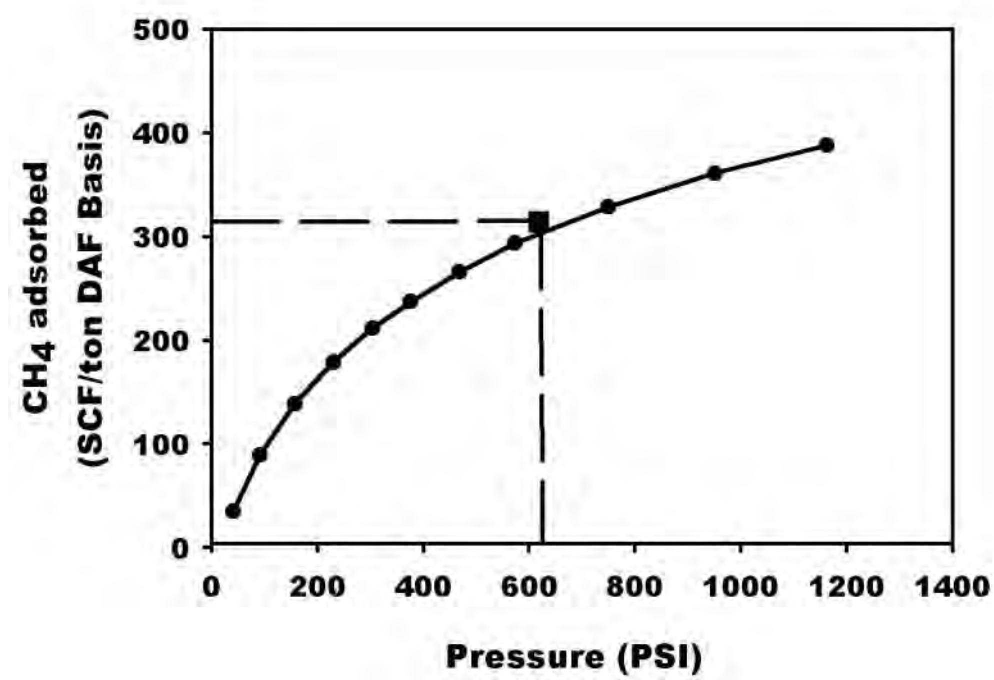

Figure 4. Methane adsorption isotherm for the Farias 5-110 well. Solid square shows the canister desorption gas content plotted at measured reservoir pressure. DAF = dry, ash-free.

Preliminary data show that the coals of the Olmos Formation are thin (< 6 ft), laterally discontinuous, and host to numerous rock and volcanic ash partings. The basal coal zone thickens from 20 ft at the outcrop to about 90 ft near the eastern boundary of Maverick County. Maximum net coal thickness within this coal zone is about 20 ft. Historic and modern coal mining data indicate that abrupt and repeated splitting, as well as minor faulting, account for most coal-seam discontinuities (Warwick et al., in press). Subsurface mapping and detailed correlation of the coal interval utilizing geophysical logs show good continuity of the coals locally. Regionally coal zones can be correlated 10 to 20 miles. The thickness, depth, and gas contents of the Olmos coal are similar to other gas-productive CBM basins such as Black Warrior, Cherokee and Raton Basins.

BURIAL HISTORY

The coal-bearing Olmos Formation was deposited in a easterly prograding delta that was subsequently buried by Late Cretaceous and Tertiary shelf sediments (Fig. 5). The Laramide Orogeny formed the southeast plunging Chittim Anticline, which is the dominant structural feature of Maverick Basin. Preliminary burial reconstructions suggests that post Laramide Tertiary age sediments buried the Olmos to a maximum of about 7000 ft depth and 100^{o}C. Late Tertiary erosion subsequently removed about 4000 ft of rock exhuming bituminous coal to less than 3000 ft present-day depth. The enhanced rank compared with other regions of the Gulf Coast which only attain subbituminous rank at similar maximum depth has been attributed to rifting, igneous activity and advection from the deeper portions of the Gulf Basin. The rift below the Maverick basin is Jurassic and appears too old to have much effect enhancing the heat flow or inducing convection in the younger Cretaceous Olmos coals. Cretaceous to Tertiary (?) age intrusions found in Mexico and north of the Maverick basin near Uvalde (Balcones Igneous province) are too limited in areal extent and likely too old to explain the observed regional increase in rank in rocks as young as Eocene (Fig. 5, SanFilipo, 1999) . However, these shallow intrusions maybe indicative of a hidden batholith-sized(?) magmatic body required to explain a regionally enhance heat flow. The simplest explanation may be forced advection out of the Early Tertiary age depocenter that developed to the east of the Maverick basin (Barker et al., 2001). Flow models suggest that during the Tertiary and continuing into the present, geo-pressuring developed in the easterly depocenter and likely caused warmer deep basin fluids to be expelled to the west unto the basin shelf region that includes the Maverick Basin (Written communication, Garvin, 1999). The northerly trend of the rank boundaries argues for regional heating related to burial in the northerly trending depocenter rather than point heating related to intrusions or heating from a Jurassic rift that trends southeasterly across the Maverick Basin.

Thermal Maturation

Published coal quality data show that these coals have high ash yields (about 20% as received basis), medium sulfur content (1.2%, as received basis) and average calorific values of about 12,000 BTU (moist mineral matter free basis), indicating an apparent rank of high-volatile C bituminous. Reflectance values (Ro) range as high as 0.58%.

Desorbed gas is dry (mean C_1/C_2+C_3 ratio = 1500) with average $\delta^{13}C_1$ of –51 per mil (range of –47 to –56) and δD of –192 per mil (range of –186 to –196). These values indicate a biogenic to mixed biogenic and thermogenic origin (Wiese and Kvenvolden, 1993) which is consistent with the regional bituminous coal rank in the Olmos coal that indicates a thermal maturity near the onset of thermogenic gas generation. The mixed gas found could be formed in several ways: preserved early biogenic methane could have been diluted with the thermogenic gas generated in-situ or at depth and migrated to the shelf region or biogenic gases also may have been generated as the rocks cooled during uplift and mixed with the thermogenic gases. Because uplift and cooling causes undersaturation as coal sorption capacity increases with decreasing temperature, additional late gas sources must have contributed to the Olmos coal to maintain the observed present-day methane saturation.

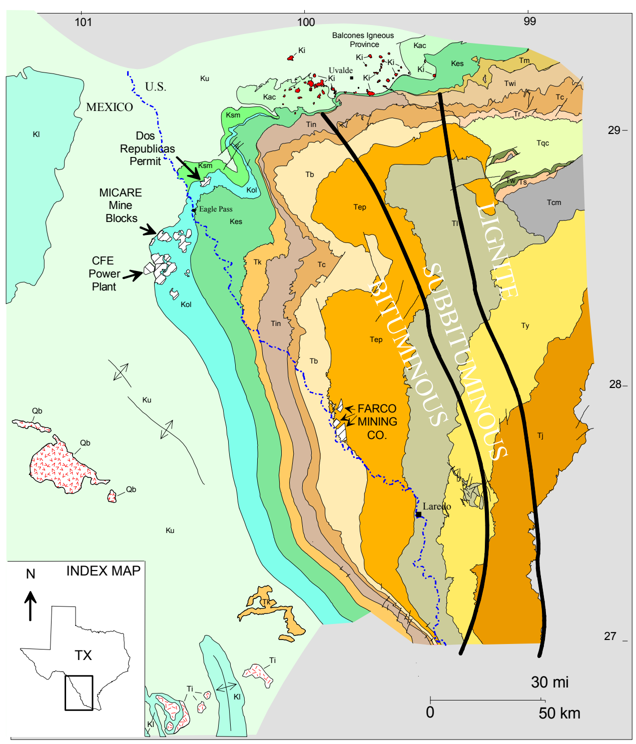

Figure 5. Surface Geology and Regional Rank Map, Maverick Basin Region, South Texas, USA and Coahuila, Mexico. From SanFilipo (1999).

FIELD HISTORY

The discovery well for the Sacatosa (CBM Olmos) gas field was The Exploration Company Farias 5-110, completed April 1, 2001, at a depth of 1392 ft to 1425 ft. Subsequent to this discovery, six additional wells in Section 110 (I&GN RR Company Survey) were completed in the coal reservoir, at an average depth of 1365 ft, on 80 acres per well spacing. The wells were cased through the coal interval, perforated, acidized and fracture stimulated. These wells constitute the initial pilot de-watering program in the coal reservoir. CBM production is from coal and carbonaceous shale near the base of the Upper Cretaceous Olmos Formation in the Maverick Basin.

Other Pilot Projects

Approximately one mile northwest of the Section 110 pilot, TXCO re-entered nine existing well bores in Section 92 to initiate a second de-watering pilot in the Olmos coal. These wells were previously drilled on 20 acres per well spacing for production in the Sacatosa (San Miguel-1 Sand) Field. The wells were plugged back, perforated and acidized in the coal. Because of close well spacing, only four wells were fracture stimulated. Eight wells were connected to production equipment and commenced the process of de-watering in the latter part of April 2001. One well was not conducive to be utilized as a producing well. Therefore, it was completed with a packer and Amerada quartz gauge to monitor pressure reduction within the coal reservoir.

In September of 2001, eight additional pre-existing well bores were reentered to initiate a third pilot, developed on 20 acres per well spacing. This pilot was located three miles northeast of Section 110. While one well bore was deemed unusable, seven were perforated and acidized with three of these undergoing additional fracturing treatments. These wells have been connected to production equipment and thus, have commenced the de-watering process.

Finally, in October of 2001, TXCO reentered fourteen inactive well bores in Sections 5, 6 and 91, located approximately one mile northeast of Section 110. These wells were previously drilled on 40 acres per well spacing. Of the fourteen wells, twelve were completed as CBM producers, while two wells were deemed unusable and subsequently plugged and abandoned. Eight of the producing wells were fracture stimulated.

Current Status

As of November 2001, the CBM pilot program consists of 34 wells de-watering in four separate production clusters. Though quantities of CBM gas have increased, the overall gas volumes currently produced are not yet at economic levels. The adsorption isotherm analysis indicates that the reservoir pressure has not decreased below the level necessary for the gas to desorb from the coal. The coalbed produced-water is injected into the San Miguel-1 sand 400 feet below the base of the Olmos coal. A proven San Miguel waterflood field offsets the TXCO Comanche lease to the north. In December 1956, the Sacatosa field was discovered by the Continental Oil Company. Conoco began water flooding the San Miguel-1 sand in 1966. As of August 31, 2001 the Sacatosa (San Miguel-1) Field has produced 40,478,394 BO and 19,668,021 MCFG. It is anticipated that additional secondary oil reserves will be recovered from the San Miguel-1 reservoir by coalbed produced water re-injection operations on the TXCO Comanche Lease.

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