WESTERN GULF PROVINCE (047)

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INTRODUCTION

Province 47 encompasses the area known as the Western Gulf, which includes the portion of Louisiana south of the Lower Cretaceous shelf edge, and Texas south and east of the Ouachita Fold Belt. The Western Gulf includes Texas Railroad Districts 1 through 4. The boundaries include the Ouachita Fold Belt, the southern boundary of East Texas Basin Province (048), the southern boundary of the Mississippi-Louisiana Salt Basins Province (049), the offshore 3-league (10.36-mile) limit in Texas, and the offshore 3-mile limit in Louisiana. The southwest boundary is the Texas-Mexico border. The area of the Western Gulf is 116,599 sq mi.

The Western Gulf is one of the most heavily explored provinces in the country. Data from approximately 227,000 dry holes, 235,000 oil wells, and 105,000 gas wells are available to us. Exploration has led to the discovery of 2,518 significant oil and gas fields, comprising 3,883 significant oil and gas reservoirs.

The Western Gulf Province has been divided into 48 hydrocarbon plays, with 3 plays in the Jurassic, 15 plays in the Cretaceous, and 30 plays in Tertiary rocks; all but 3 plays are conventional. The Austin Mid-Dip Oil play, was removed from the conventional list and divided into three plays (4747, 4748, 4749), and the oil was assessed as an unconventional resource. Many of the plays in the Tertiary continue offshore into Federal waters, and several Cretaceous and Tertiary plays extend into northeastern Mexico. The following is a list of plays.

CONVENTIONAL PLAYS

4701	Houston Salt Dome Flank Oil and Gas
4702	Norphlet South Texas Deep Gas
4703	Smackover South Texas Gas
4704	Cotton Valley Western Gulf Gas and Oil
4705	Lower Cretaceous Carbonate Shelf/Shelf Edge Gas and Oil
4706	Lower Cretaceous Shelf Carbonate Fault Zone Oil
4707	Buda Fault Zone Oil
4708	Buda Downdip Oil
4709	Tuscaloosa Deep Sandstone Gas
4710	Woodbine South Angelina Flexure Oil and Gas
4711	Austin Shelf Edge Gas and Oil
4713	Austin Updip Oil
4714	Upper Cretaceous Volcanic Mound Oil and Gas
4715	Upper Cretaceous Sandstones Fault Zone Oil
4716	Upper Cretaceous Sandstones Maverick Basin Oil
4717	Upper Cretaceous Sandstones Downdip Gas
4718	Lower Wilcox Lobo Gas
4719	Lower Wilcox Fluvial Oil and Gas
4720	Lower Wilcox Downdip Overpressured Gas

4721 Upper Wilcox Updip Fluvial Gas
4722 Upper Wilcox Shelf-Edge Gas and Oil
4723 Upper Wilcox Downdip Overpressured Gas
4724 Middle Eocene Sandstones Downdip Gas
4725 Middle Eocene Sandstones Updip Fluvial Oil and Gas
4726 Yegua Updip Fluvial-Deltaic Oil and Gas
4727 Yegua Downdip Gas
4728 Jackson Updip Gas and Oil
4729 Jackson Downdip Gas
4730 Vicksburg Updip Gas
4731 Vicksburg Downdip Gas
4732 Frio South Texas Downdip Gas
4733 Frio South Texas Mid-Dip Oil and Gas
4734 Frio Updip Fluvial Gas and Oil
4735 Frio SE Texas/S. Louisiana Mid-Dip Gas and Oil
4736 Frio SE Texas/S. Louisiana Downdip Gas
4737 Hackberry Sandstone Gas and Oil
4738 Anahuac Sandstone Gas and Oil
4739 Lower Miocene Fluvial Sandstone Oil and Gas
4740 Lower Miocene Deltaic Sandstone Gas and Oil
4741 Lower Miocene Slope and Fan Sandstone Gas
4742 Middle Miocene Fluvial Sandstone Gas and Oil
4743 Middle Miocene Deltaic Sandstone Gas and Oil
4744 Upper Miocene Fluvial Sandstone Gas and Oil
4745 Upper Miocene Deltaic Sandstone Gas and Oil
4746 Plio-Pleistocene Fluvial Sandstone Oil

UNCONVENTIONAL PLAYS

4747 Austin Chalk–Pearsall area
4748 Austin Chalk–Giddings area
4749 Austin Chalk–Outlying areas

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CONVENTIONAL PLAYS

4701. HOUSTON SALT DOME FLANK OIL AND GAS PLAY

The Houston Salt Dome Flank Oil and Gas Play is defined by sandstone reservoirs that produce oil and gas from structural traps along the flanks of piercement salt domes in the Houston Salt Basin. The boundaries of the play are defined by the limits of the Houston Salt Basin, and the downdip boundary is the State-Federal water boundary.

The piercement salt dome play is the oldest in Texas. The caprock reservoir on Spindletop (1901) was the first major oil discovery in Texas, and it ushered in the Gulf Coast oil boom. Spindletop was quickly followed by other caprock discoveries, such as Saratoga Dome (1901) and Sour Lake Dome (1902), and finally the flanks of the shallow domes were drilled. Many of the shallow oil reservoirs along the flanks of the domes in this play were discovered prior to 1940.

Reservoirs: Reservoirs in this play include sandstones of the Paleocene to Eocene Wilcox Group, the Eocene Yegua and Jackson Formations, the Oligocene Vicksburg, Frio, and Anahuac Formations, and lower and middle Miocene units. The so-called *Heterostegina* limestones of Anahuac age are minor reservoirs in this play. Caprock reservoirs, although not technically part of the flank area, were also included, as these were the first reservoirs discovered in this play. Depths of undiscovered reservoirs range from 250 to 16,000 ft.

Source rocks: Source rocks for the accumulations along the flanks of the piercement salt domes have not been identified, but many possible source rocks are associated with the play. The Tertiary section downdip from this play contains many organic-bearing mudstones, from the Wilcox through the Miocene. Hydrocarbons generated in deep mudstones migrated updip and up faults to accumulate along the flanks of the piercement salt structures.

Traps: The growth of piercement salt domes leads to the formation of complex structures. Sedimentary units around the domes are complexly faulted and are upturned against the edges of the domes. Mushroom-shaped domes create excellent traps under the overhanging salt. The intense faulting around many of the domes causes compartmentalization of the numerous reservoirs, and one stratigraphic horizon can be broken into many reservoirs not in pressure communication.

Exploration status and resource potential: Exploration in the shallow part of this play has been extensive. Significant potential exists for undiscovered gas resources in the deeper, downdip parts of the play, particularly in deep Frio and Yegua reservoirs. The intensity of exploration in the shallower part of the play indicates that the potential for undiscovered oil resources is moderate, but the potential for undiscovered gas remains high in the deeper part of the play, as eight significant gas discoveries have been made since 1975.

4702. NORPHLET SOUTH TEXAS DEEP GAS PLAY (HYPOTHETICAL)

This hypothetical play was developed for deep gas potential in the Upper Jurassic Norphlet Formation in south Texas. At present there is no production from Norphlet or Norphlet-equivalent rocks in south Texas. The analog for this play is the deep Norphlet Mobile Bay Deep Gas Play (4903) of southern and offshore Alabama described in Province (049).

Reservoirs: Where productive in the eastern Gulf Coast, the Norphlet Formation comprises eolian sandstones formed in dune, interdune, and clastic sabkha environments. The distribution of the productive eolian dune facies in the eastern Gulf is well known, but the Norphlet facies distribution in south Texas is unknown. Using the eastern Gulf as an analog for reservoirs, the deep Norphlet of the western Gulf, having had a similar diagenetic history, would be expected to have porosity as high as 15-20 percent. Depths of undiscovered reservoirs are estimated to range from 14,000 to 25,000 ft. However, the major risk associated with this play is the presence of eolian dune sandstones.

Source rocks: As in the analog Norphlet play in the eastern Gulf, the source rock for the deep Norphlet gas in this play is postulated to be the lower, organic-bearing mudstones of the Upper Jurassic Smackover Formation. The postulated depths of both the source rock and the Norphlet suggest that this play would be gas-prone, as is the deep Norphlet play in southern Alabama.

Traps: Traps for Norphlet accumulations are postulated to be faulted salt structures similar to those in the eastern Gulf Coast. The Middle Jurassic Louann Salt is present in south Texas, and faulted salt structures such as those in southern Alabama may also be present in south Texas.

Exploration status and resource potential: At present the Norphlet interval has not been tested in south Texas. The main issue in this play is whether or not the eolian dune facies of the Norphlet is present in south Texas. Eolian dune sand may have accumulated in the shadow of the Llano Uplift, if this tectonic element had sufficient paleotopography to cause sands to accumulate, as the eolian sediments did along the Appalachian Front in the eastern Gulf. At this point in our understanding of eolian sandstone distribution, the chance of eolian dune sandstone being present in south Texas was considered to be less than 10 percent, so the play was not assessed for gas.

4703. SMACKOVER SOUTH TEXAS GAS PLAY

The hypothetical Smackover South Texas Gas Play was developed for the gas potential of the Upper Jurassic Smackover Formation in the Western Gulf Province. The play is defined by Smackover grainstones known to exist in a band that extends from the Mexican border across the Western Gulf northeast to the East Texas Province boundary. The Smackover is a prolific gas-producing interval in East Texas.

Reservoirs: Reservoirs in the Smackover Formation in the Western Gulf, as in East Texas and throughout the eastern Gulf, are postulated to be oolite grainstones and packstones formed in high-energy intertidal environments. Much of the porosity in the Smackover reservoirs is secondary, having resulted from dolomitization or other diagenetic processes. Depths of undiscovered reservoirs range from 10,000 to 22,000 ft.

Source rocks: The source of the gas is postulated to be the lower organic-bearing facies of the Smackover, similar to the Smackover in the eastern Gulf region. The depth of the Smackover in the Western Gulf province implies that gas would be the principal hydrocarbon type. Migration of the gas would be from the lower to the upper Smackover, possibly through vertical migration, into the overlying grainstones.

Traps: Traps in this play are similar to those of the Smackover in East Texas, where traps have formed on the regional peripheral fault zones and on deep-seated salt structures in the more basinal positions. Seals would be provided by anhydrite in the overlying Upper Jurassic Buckner Formation.

Exploration status and resource potential: A total of 26 wells have penetrated the Smackover in the Western Gulf province, suggesting that the Smackover is virtually untested in south Texas. The Smackover is a prolific oil and gas producer in East Texas and the eastern Gulf, and the potential for undiscovered gas resources in the Smackover in south Texas is considered high.

4704. COTTON VALLEY WESTERN GULF GAS AND OIL PLAY

Description: The Cotton Valley Group produces gas and oil from sandstone reservoirs in the East Texas province, and this play is defined as a natural extension of Cotton Valley production into the Western Gulf province. There is at present no Cotton Valley production in the Western Gulf. The Cotton Valley Salt Basins Gas Play (4922) was used as a partial analog for this play.

Reservoirs: Reservoirs in this play are deltaic and shallow-marine sandstones of the Upper Jurassic Cotton Valley Group. The Gilmer Limestone, which is the basal unit of the Cotton Valley in East Texas, may be present as a reservoir unit in the updip portion of this play in the Western Gulf, near the East Texas boundary. This play also includes potential in Hosston Formation sandstones. Depths of undiscovered reservoirs are estimated to range from 3,000 to 20,000 ft.

Source rocks: The most likely source rocks for the Cotton Valley, using East Texas as an analog, are organic-bearing mudstones of the lower part of the Smackover Formation. Other potential source rocks include the downdip organic-bearing mudstones within the Cotton Valley Group. Migration of hydrocarbons was most likely up faults into Cotton Valley reservoirs.

Traps: Traps for Cotton Valley accumulations are present in the peripheral fault zones, faulted salt structures, and stratigraphic updip pinchouts of Cotton Valley reservoir sandstones. The updip area of

the Western Gulf is the area where traps will be found in the peripheral fault zones, whereas the larger salt structures are downdip in the salt basins. Stratigraphic traps may be found in the area south of the Angelina Flexure.

Exploration status and resource potential: Exploration for Cotton Valley reservoirs in the Western Gulf province has been light, and the wells to date that have tested the Cotton Valley are concentrated near the East Texas boundary. This Cotton Valley play in the Western Gulf is considered to be oil prone in the updip area, but most of the undiscovered resource will be gas in the deeper downdip area of the play. The analog Cotton Valley Salt Basins Gas Play (4922) in East Texas contains 29 significant gas reservoirs. One well drilled in McMullen County, Tex., tested over 1.0 MMCFGPD, which was noncommercial, but this well indicates the high potential for gas in the Cotton Valley in the Western Gulf.

4705. LOWER CRETACEOUS CARBONATE SHELF/SHELF EDGE GAS AND OIL PLAY

The Lower Cretaceous Carbonate Shelf/Shelf Edge Gas and Oil Play is defined by carbonate reservoirs that produce oil and gas along the Lower Cretaceous shelf edge and along the carbonate shelf area behind the shelf edge, but downdip from the peripheral fault zones (play 4706). This play extends across the Western Gulf--from the Mexican border, along the Lower Cretaceous shelf edge through Texas and Louisiana, to the State-Federal water boundary in southern Louisiana. The play continues into the Federal waters offshore. In south Texas the shelf edge splits, and the Edwards (Stuart City) and Sligo shelf margins are separate.

Reservoirs: Reservoirs in this play are shelf and shelf edge carbonates of the Lower Cretaceous Edwards, Stuart City, Sligo, and Pearsall Formations, formed in shelf-margin reefs, banks, channel fills, shelf reefs and mounds, and tidal bars. Shelf-edge reservoirs include boundstones, grainstones, and packstones. Porosity in these units is largely due to interparticle dissolution, but some interparticle and fracture porosity is present. The complex interfingering of reef and adjacent facies and diagenetic modification lead to significant heterogeneity in shelf-edge reservoirs. Shelf carbonate reservoirs are mainly dolomitized mudstones, but some shelf grainstones and wackestone reservoirs are present. Depths of undiscovered reservoirs range from 6,000 to 20,000 ft. The main limitation to resource potential in this play is reservoir quality.

Source rocks: Most of the shelf-edge reservoirs contain gas, whereas the shelf reservoirs are oil bearing. Source rocks for both oil and gas are considered to be organic-bearing Lower Cretaceous shelf and slope mudstones.

Traps: Traps in the shelf-edge reservoirs result from a combination of reef-related facies changes, faults, and diagenetic alterations. Faults and facies changes account for most of the trapping, but hydrocarbons in several of the reservoirs are stratigraphically trapped.

Exploration status and resource potential: The predominant hydrocarbon in this play is gas, which has been found mainly in the shelf-edge reservoirs (36 reservoirs with a median size of 34 BCFG discovered between 1929 and 1989), but 10 oil reservoirs have been discovered in the play (median size of 3.7 MMBO discovered between 1942 and 1983). Most of the discoveries in the play are in south Texas, southwest of Colorado County. This play has the potential for significant oil and gas discoveries all along the remainder of the shelf edge and adjoining shelf northeast across the remainder of Texas, across southern Louisiana, and into Federal waters. One field, Main Pass 253, produces oil from a shelf-edge reservoir in Federal waters off Louisiana, suggesting that the shelf edge onshore in this are has untapped potential. Exploration of the shelf edge has been light to nonexistent along this extension into Louisiana. The undiscovered resource potential for this play is considered to be high for oil and gas. This play, although a carbonate play, includes potential undiscovered resource in sandstones within the Lower Cretaceous Hosston and Travis Peak Formations.

4706. LOWER CRETACEOUS SHELF CARBONATE FAULT ZONE OIL PLAY

The Lower Cretaceous Carbonate Fault Zone Oil Play is defined by carbonate reservoirs of the Lower Cretaceous Edwards, Georgetown, and Glen Rose Formations that produce oil from structural traps along the regional peripheral fault zones in the Western Gulf. The downdip boundary of the play follows the for edges of the Luling, Charlotte, and Mexia fault zones, and the updip boundary is the Balcones Fault Zone. The play extends from the Mexican border across the province to the boundary with East Texas.

Reservoirs: Reservoirs in this play are extensively dolomitized restricted-platform and tidal-flat carbonates. Reservoir porosity has been created by dolomitization, by collapse breccias formed by removal of tidal-flat evaporites, and as moldic porosity after leaching of bioclastic fragments. Depths of undiscovered reservoirs range from 1,000 to 5,000 ft.

Source rocks: Source rocks for the oil in these reservoirs are the Lower Cretaceous marine shelf and slope organic-bearing mudstones. The oil migrated up faults into the carbonate reservoirs.

Traps: Traps in this play are structural and occur along faults of the peripheral fault zones. The Lower Cretaceous reservoirs are sealed by down-faulted, less permeable Upper Cretaceous carbonates and mudstones. Many of the reservoirs are focused on paleo-highs along the San Marcos Arch.

Exploration status and resource potential: The reservoirs in this play are the Luling-Branyon, Darst Creek, and Salt Flat, and all were discovered between 1922 and 1929. Given the lack of oil reservoirs discovered in the next 65 years, the chance of discovering another oil reservoir of minimum size (1 MMBO) was considered to be less that 10 percent, and the play was not quantitatively assessed for oil.

4707. BUDA FAULT ZONE OIL PLAY

The Buda Fault Zone Oil Play is defined by Upper Cretaceous Buda Formation chalk reservoirs that produce oil from structural traps along the peripheral fault zones in the Western Gulf province. The updip boundary of the play is the Balcones Fault Zone, and the downdip boundary is the Luling and Charlotte Fault Zones; the play extends from the Mexican border to the boundary of the East Texas province.

Reservoirs: Reservoirs in this play are coccolith- and foraminifera-bearing micrites. Fracturing is required in the chalk for the rock to be a reservoir, and fracturing is present in the Buda in the fault zones. Depths of undiscovered reservoirs range from 1,000 to 6,000 ft.

Source rocks: Source rocks for the Buda in this play are considered to be mudstones within the Buda or in the overlying Eagleford Formation, which, by faulting, can be juxtaposed with fractured Buda in the fault zone traps.

Traps: Traps for this play were formed in the Buda along the peripheral fault zones, which may have also produced the fracturing locally within the Buda. The Buda produces from structurally high positions along the fault zones.

Exploration status and resource potential: Buda production in this play consists of two fields discovered in 1929 and 1938. Given the lack of other significant discoveries for over 50 years within this play, the chance of another discovery of the minimum size was determined to be less than 10 percent, and the play was not quantitatively assessed for oil.

4708. BUDA DOWNDIP OIL PLAY

The Buda Downdip Oil Play is defined by fractured chalk reservoirs in the Upper Cretaceous Buda Formation that produce oil along a trend that crosses the Western Gulf downdip from the regional peripheral fault zones. The trend of production from fractured Buda chalk is similar to the trend of production from fractured chalk of the Upper Cretaceous Austin Group (unconventional continuous-type plays 4747, 4748, 4749). As defined here, this Buda play extends from the Mexican border across the Western Gulf to the Angelina-Caldwell Flexure in East Texas and ends just after passing into Louisiana. Stratigraphically the Buda is separated from the Austin chalk by mudstones of the Upper Cretaceous Eagleford Formation.

Reservoirs: Reservoirs in the Buda, like those in the Austin, consist of fractured coccolith- and foraminifera-bearing micrites or chalk. The Buda must be fractured to produce, and exploration for the reservoir intervals in the Buda centers on determining the areas that have the greatest density of natural fractures. Depths of undiscovered reservoirs range from 5,000 to 10,000 ft.

Source rocks: Source rocks for the oil in the Buda are generally considered to be mudstones of the overlying Eagleford or mudstone intervals within the Buda Formation.

Traps: Oil in the Buda has not been trapped in well-defined structures, but rather in natural fracture systems which may be irregularly distributed throughout the entire play. Areas of Buda production, such as the Giddings area, are virtually devoid of significant structure. However, the areas of greatest fracture density may overlie subtle basement structures.

Exploration potential: The Buda Downdip Oil Play consists of nine reservoirs with a median size of 6.7 MMBO, seven of which were discovered between 1973 and 1981. Two were discovered in the early 1950's. Four of the nine reservoirs coincide with producing Austin reservoirs. The drop in discoveries since 1981 may be due in part to the shift to horizontal wells in the Austin play; wells that in former years would have been drilled as potential dual completions in the Buda and Austin are now targeted for the Austin only as horizontal wells.

The potential for undiscovered resources of oil in the Buda is considered to be high. Buda reservoirs remain exploration objectives in their own right, given the high average well productivities and the fact that several of the reservoirs also produce from the Austin.

4709. TUSCALOOSA DEEP SANDSTONE GAS PLAY

The Tuscaloosa Deep Sandstone Gas Play is defined by sandstones of the Upper Cretaceous Tuscaloosa Group that produce gas from structural and stratigraphic traps downdip from the Lower Cretaceous shelf margin in southern Louisiana. The play is bounded on the updip side by the shelf edge, and a downdip limit was arbitrarily chosen at a depth of 25,000 ft. To the east the play follows the shelf edge into Federal waters of southeastern Louisiana; to the west the sandstones thin into Texas, and the play ends in the vicinity of Colorado County, Texas, where Tuscaloosa sandstones pinch out.

Reservoirs: Reservoirs in this play are downdip from the shelf edge and include shelf-edge deltaic sandstones formed in the expanding sections downdip from growth faults. In more distal areas of the play the reservoirs are interpreted to be slope sandstones, and finally fan sandstones are present in the deepest portions of the play, as sea-level fluctuations during Tuscaloosa deposition would have resulted in fans being deposited along the shelf edge. Porosities in the sandstones at about 20,000 ft are up to 25 percent, and permeabilities are as high as 100 mD. The preservation of such high porosities may be attributed in part to early chloritic clay coatings on framework grains. Depths of undiscovered reservoirs range from 12,000 to 25,000 ft.

Source rocks: Source rocks for the Tuscaloosa gas are considered to be mudstones of the Lower and Upper Cretaceous downdip from the shelf edge. The reservoirs more than about 19,000 ft deep are overpressured. Migration would have been local, from mudstones nearby the sandstones.

Traps: Many of the traps in the deltaic sandstones have formed where anticlines have rolled over against growth faults. Traps in the fan and slope sandstones are dominantly stratigraphic, forming where the sandstones are covered by mudstones. Seals are provided mainly be enclosing mudstones in this play.

Exploration status and resource potential: The Tuscaloosa Deep Sandstone Play consists of 18 reservoirs with a median size of 80 BCFG, and most reservoirs were discovered since 1974. The slowdown in discoveries in the late 1980's is attributed to gas prices, and to the depths to sandstone targets and overpressuring. Exploration in this play varies from moderate in the updip areas to light in the deeper part of the play. The potential for undiscovered gas resources in this play is estimated to be very high.

4710. WOODBINE SOUTH ANGELINA FLEXURE OIL AND GAS PLAY

The Woodbine South Angelina Flexure Oil and Gas Play is defined by sandstone reservoirs of the Upper Cretaceous Woodbine Formation that produce oil and gas and from stratigraphic-diagenetic traps on the southern margin of the Angelina-Caldwell Flexure. The play is bounded to the north in East Texas and Louisiana by the Angelina Flexure, and to the south by the Lower Cretaceous shelf edge; the sandstones thin to the southwest in the vicinity of Colorado County, Texas, which was chosen as the play limit, and the sandstones extend slightly to the east into Mississippi.

Reservoirs: Reservoirs of the Woodbine in this play are predominantly deltaic and shelf sandstones downdip from fluvial-deltaic sandstones north of the Angelina Flexure in East Texas. The reservoir sandstones have porosities as high as 20 percent and permeabilities ranging up to 500 mD. Much of the porosity in the Woodbine sandstones in these reservoirs is interpreted as secondary porosity after the dissolution of feldspars and rock fragments. Depths of undiscovered reservoirs range from 7,000 to 20,000 ft.

Source rocks: Source rocks for the oil and gas in this play are considered to be mudstones of the contemporaneous Eagleford Formation south of the Angelina flexure. The Woodbine sandstones pinch out downdip into the fine-grained sediments of the Eagleford. Migration would have been updip from the mudstones into the Woodbine reservoirs.

Traps: Trapping of the oil and gas in the Woodbine sandstones is predominantly stratigraphic, as the Woodbine sandstones were partially truncated along the Angelina Flexure and covered by the fine-grained carbonates of the Austin Group. The Austin forms an excellent seal for the Woodbine in this play, as it does for the Woodbine accumulations in East Texas.

Exploration potential: Exploration in this play has resulted in the discovery of 16 oil reservoirs with a median size of 6 MMBO, and 9 gas reservoirs with a median size of 30 BCFG. The oil reservoirs were discovered between 1949 and 1989, but 12 of the 16 were discovered since 1970. The Kurten field is an excellent example of the Woodbine reservoirs in this play. The gas reservoirs were discovered between

1949 and 1987, but seven of the nine were discovered since 1975. The stratigraphic aspect of the trapping in this play cannot be resolved satisfactorily in seismic data, so exploration for these subtle Woodbine reservoirs is difficult. The potential for undiscovered oil and gas resources in this play is estimated to be high.

4711. AUSTIN SHELF EDGE GAS AND OIL PLAY

The Austin Shelf Edge Gas and Oil Play is defined by the potential for gas and oil reservoirs in the Upper Cretaceous Austin Group along the Lower Cretaceous shelf edge. The play is a narrow band of Austin that coincides with the Lower Cretaceous shelf edge across the Western Gulf province from the Mexican border across Texas and Louisiana to the State-Federal water boundary. The play area is downdip from the Austin unconventional continuous-type plays 4747, 4748, and 4749.

Reservoirs: Reservoirs in this play are fractured coccolith- and foraminifera-bearing micrites that require fractures for sufficient reservoir quality. The Austin is not well known in this shelf-edge area, and neither is the regional distribution of fracture systems that could create reservoirs within the chalk. Depths of undiscovered reservoirs range from 4,000 to 14,000 ft.

Source rocks: Source rocks for the Austin shelf-edge play include organic-bearing micrites within the Austin and Lower Cretaceous organic-bearing mudstones downdip from the shelf edge. Most of this play is within the gas and gas-condensate maturation zone of the Austin.

Traps: Traps in the Austin are related to fracture systems within the chalk, thus the traps and reservoirs are closely related. The extent of fracturing within the Austin in this narrow zone along the shelf edge is unknown, as is the thickness of the potential reservoirs.

Exploration status and resource potential: This play consists of one reservoir to date, discovered in 1960. The degree of exploration in this narrow trend has been light to nonexistent for the past thirty years, and potential may exist if fracturing is present. However, the chance of locating another reservoir of the minimum size is considered to be less than ten percent, thus the play was not quantitatively assessed.

4713. AUSTIN UPDIP OIL PLAY

The Austin Updip Oil Play is defined by Upper Cretaceous Austin carbonate reservoirs that produce oil from structural traps along the peripheral fault zones updip from the Austin unconventional continuous-type plays (4747, 4748, 4749). The boundaries of the play are the limits of the Balcones, Mexia, Luling, and Charlotte fault zones in the Western Gulf; the play extends from the Mexican border across the Western Gulf to the boundary with East Texas.

Reservoirs: Reservoirs in this play are coccolith- and foraminifera-bearing micrites or chalks of the Austin. The chalk needs to be fractured for it to be a reservoir. Minor reservoirs in this play are

limestones of the Upper Cretaceous Dale and Anacacho Formations. Depths of undiscovered reservoirs range from 1,000 to 4,000 ft.

Source rocks: Source rocks for the Austin and other reservoirs in this play are considered to be organic-bearing micrites within the Austin and mudstones of the underlying Eagleford Formation. The Austin and Eagleford in this play are within the oil maturation zone.

Traps: Traps in this play are related to the peripheral fault zones, including the Mexia, Luling, Charlotte, and Balcones segments. The faulting has brought fractured Austin, Dale, or Anacacho limestone into a structurally high position relative to less porous Upper Cretaceous carbonate.

Exploration potential: This play consists of nine oil reservoirs with a median size of 4 MMBO, seven of which were discovered between 1922 and 1963; two were discovered in 1980. Exploration along the fault zones is moderate to heavy, yet only two discoveries have been made in the past 30 years. The record of discoveries indicates that the chance of finding another reservoir of the minimum size (1 MMBO) is less than 10 percent; thus this play was not quantitatively assessed for oil.

4714. UPPER CRETACEOUS VOLCANIC MOUND OIL AND GAS PLAY

This unique play is defined by Upper Cretaceous sandstone and limestone reservoirs that produce oil and gas from the margins of volcanic plugs in part of the Maverick Basin of south Texas. The play boundary is the outline of the area in the Maverick Basin where the volcanic structures occur. Most of these volcanic structures were emplaced prior to Olmos sandstone deposition.

Reservoirs: Reservoirs in this play are mainly sandstones of the Upper Cretaceous San Miguel Formation, but reservoirs are also found in sandstones of the Upper Cretaceous Olmos Formation, and minor reservoirs are found in sandstones of the Upper Cretaceous Escondido Formation and in limestones of the Upper Cretaceous Anacacho Formation. The San Miguel Formation consists of wave-dominated sandstones that were deposited throughout the play area, and the Olmos sandstones are deltaic sandstones in this area of the Maverick Basin. Porosities of the San Miguel and Olmos range up to 25 percent, and permeabilities range up to 500 mD. Depths of undiscovered reservoirs range from 2,000 to 8,000 ft.

Source rocks: Source rocks for the oil and gas in this play are not known, but possible sources include organic-bearing mudstones of the Eagleford, or possibly mudstones downdip in the San Miguel and Olmos. Migration was local, from mature mudstones updip into reservoirs flanking the volcanic plugs.

Traps: Traps developed as a result of the interplay between the preexisting volcanic structures and the processes that deposited the sediments around them. the Anacacho limestones are thickest around many of the volcanic plugs, whereas the sandstones of the San Miguel, Olmos, and Escondido become thinner,

merge, or truncate near the plugs. Many of the traps developed within the thinning, merging, truncating parts of these sandstones. Also, mudstones deposited around the plugs compacted more than the volcanic rock did, and this differential compaction led to the formation of many faults in the sandstones radiating from the plugs, creating many segmented reservoirs.

Exploration status and resource potential: The San Miguel reservoirs produce mainly oil, and the Olmos reservoirs produce mainly gas. This play at present contains 6 oil reservoirs with a median size 2.9 MMBO and 10 gas reservoirs with a median size of 11 BCFG. Given the sizes of the oil reservoirs, and the fact that only 2 oil reservoirs have been discovered since 1960, the chance of finding another oil reservoir of the minimum size was considered to be less than 10 percent, and the play was not assessed for oil. However, the discovery of gas has been more vigorous, with six reservoirs having been discovered since 1960. The potential for additional gas reservoirs of minimum size in this play is considered to be low.

4715. UPPER CRETACEOUS SANDSTONES FAULT ZONE OIL PLAY

This play is defined by Upper Cretaceous sandstones of the Taylor, Navarro, Olmos, and Escondido Formations that produce oil from structural traps along the regional peripheral fault zones in the Western Gulf. The play is bounded on the southwest by plays 4714 and 4716, to the southeast by the Lower Cretaceous shelf edge, and the fault zones to the northwest. The play extends to the East Texas boundary.

Reservoirs: Reservoirs in this play are sandstones of the Upper Cretaceous Taylor, Navarro, Olmos, and Escondido Formations. The reservoirs are mainly deltaic sandstones of the Olmos and Taylor Formations. Porosities range up to 30 percent, and permeabilities range up to 500 mD. The Taylor Formation consists of limestones in the extreme updip part of this play, but a limestone reservoir of minimum size has not been discovered in over 50 years in this play. Depths of undiscovered reservoirs range from 250 to 6,000 ft.

Source rocks: Source rocks for this play have not been identified. Possible source rocks include organic-bearing mudstones of the Eagleford and Austin, from which hydrocarbons may have migrated up faults into existing traps along the peripheral fault trends.

Traps: Traps in this play are in anticlinal structures along the regional fault trends, and beneath unconformities in the updip Olmos reservoirs. Post-Olmos erosion partially truncated the Olmos sands, which were then covered by Escondido mudstones. Big Foot field in Frio County is a classic example of this trapping mechanism. Seals in these cases are the overlying mudstones.

Exploration status and resource potential: This play contains 36 oil reservoirs with a median size of 4.4 MMBO discovered between 1915 and 1985. Seven of these reservoirs discovered prior to 1933 were in limestones of the Taylor, but no Taylor limestone reservoirs have been found since that date. Taylor

reservoirs, of which two have been discovered since 1985, are all sandstones. This play has a moderate level of exploration, but, because many of the traps are stratigraphic, a moderate potential remains for oil in Taylor and Olmos sandstones.

4716. UPPER CRETACEOUS SANDSTONES MAVERICK BASIN OIL PLAY

This play is defined by Upper Cretaceous sandstone reservoirs that produce oil and gas from structural traps in part of the Maverick Basin along the Lower Cretaceous shelf edge. The play extends from the Lower Cretaceous shelf edge in La Salle and McMullen counties westward through the Maverick basin to the Mexican border. This play is situated between the Upper Cretaceous Sandstones Downdip Gas Play (4717), the Upper Cretaceous Volcanic Mound Oil and Gas Play (4714), and Upper Cretaceous Sandstones Fault Zone Oil Play (4715).

Reservoirs: Reservoirs in this play are mainly in the Olmos and San Miguel Formations, although minor production is also reported from the Navarro and Escondido Formations. The sandstones are mainly deltaic, but strandplain and barrier sandstones are also productive. The porosities of the sandstones range up to 26 percent, and permeabilities range up to 150 mD. In the area of the shelf edge, both porosity and permeability are lower; permeabilities are as low as 1 mD. Depths of undiscovered reservoirs range from 1,000 to 12,000 ft.

Source rocks: Source rocks have not been identified for this play, but possible sources of the oil and gas include the underlying Eagleford and Austin Formations and deep Upper Cretaceous organic-bearing mudstones downdip from the reservoirs.

Traps: Traps are predominantly structural in this play, in the form of low-relief anticlinal structures in which the reservoirs have been gently folded. Some of the trapping is also due to updip sandstone pinch-outs. The traps along the shelf edge result from differential compaction of the Upper Cretaceous sediments over the Lower Cretaceous shelf edge carbonates. The best example of a shelf-edge field is the AWP field, where compaction has caused the sandstones to tilt to the southeast. Other traps of this type may be present along the remainder of the shelf edge.

Exploration status and resource potential: This play consists of eight oil reservoirs with a median size of 10 MMBO, and one gas reservoir containing 8 BCFG. The oil was discovered between 1949 and 1983; four of the eight oil reservoirs were discovered since 1970. The one gas reservoir dates to 1967. Exploration effort has been moderate in the Maverick Basin area of the play, but less so along the shelf edge area of the play. This play is considered to have high potential for undiscovered resources of oil and condensate.

4717. UPPER CRETACEOUS SANDSTONES DOWNDIP GAS PLAY

This play is defined by Upper Cretaceous sandstone reservoirs that produce gas from structural and stratigraphic traps downdip from the oil play in the Maverick Basin. The play extends from the Upper Cretaceous Sandstones Maverick Basin Oil Play (4716) southwest to the Mexican border and straddles the Lower Cretaceous shelf edge.

Reservoirs: Reservoirs in this play are mainly sandstones of the Olmos and Navarro Formations, but minor production has been recorded from the Escondido and San Miguel Formations. The reservoir sandstones are deltaic and shelf in origin. Porosities range up to 20 percent, but permeabilities are generally less than 10 mD. Water saturations can be as high as 60 percent. Much of the Olmos in this play was formerly designated as tight gas sandstone. Depths of undiscovered reservoirs range from 2,000 to 12,000 ft.

Source rocks: Source rocks for the gas in this play have not been identified, but possible sources include downdip organic-bearing mudstones of the Lower and Upper Cretaceous. Other possible sources include the Austin and Eagleford Formations. Migration from these sources would have been updip or up faults into the reservoir sandstones.

Traps: Traps in this play are stratigraphic and structural. Stratigraphic traps occur at the updip pinchout of reservoir sandstones. Structural traps are the result of faulting along the Lower Cretaceous shelf edge. Seals are generally provided by mudstones within the Upper Cretaceous interval.

Exploration status and resource potential: This play contains 17 gas reservoirs with a median size of 25 BCFG, which were discovered between 1959 and 1988. Nearly half of the discoveries were made since 1975. The level of exploration in this play has been moderate, and the potential for undiscovered resources is high.

4718. LOWER WILCOX LOBO GAS PLAY

The Lower Wilcox Lobo Gas Play is defined by complexly faulted lower Wilcox deltaic sandstones that produce gas from structural traps developed by gravity sliding and extensional faulting of deltaic sandstones over mudstones of the Paleocene Midway Formation. The Lobo Gas Play is located in Webb and Zapata Counties, Texas, and the play extends into Mexico. The boundaries of the play are defined by the downdip limits of the most extensive deltaic sandstones. This play also includes minor Midway gas production.

Reservoirs: Reservoirs in this play are Paleocene-Eocene deltaic sandstones in the lower part of the Wilcox Group. These units are known locally as the Walker, Hirsch, O'Keefe, Clark, and Lobo sandstones. The sandstones average less than 10 mD permeability, and porosities are less than 19 percent. The permeabilities indicate that some of the reservoirs are tight-gas sandstones. Depths of undiscovered reservoirs range from 5,000 to 14,000 ft.

Source rocks: Source rocks for the gas are not known for certain, but a most likely source is organic-bearing mudstones of the Midway and the lower Wilcox. Migration would have been local and was updip and up faults into the reservoir sandstones.

Traps: Trapping is complex and is a result of extensional faulting and gravity sliding of sandstones deposited over shelf mudstones of the Midway. The gas is pervasive in the sandstones, however, and is not restricted to particular structural positions indicating that the gas may be a continuous-type accumulation. Seals are provided by the extensive lower Wilcox mudstones.

Exploration status and resource potential: Exploration remains active in this play. To date 81 fields have been developed with a median size of 25 BCFG, and 70 of these were discovered since 1975. Given the complexity of the geology, the pervasive gas saturation, and the extent of the sandstones, the potential for additional significant discoveries is estimated to be very high.

4719. LOWER WILCOX FLUVIAL OIL AND GAS PLAY

This play is defined by lower Wilcox fluvial-deltaic reservoirs that produce oil and gas from structural-stratigraphic traps updip from the Wilcox Fault Zone. The updip boundary of the play is the Wilcox outcrop belt, the downdip limit is placed at the beginning of overpressuring in the lower Wilcox and the eastern boundary is the Federal waters of eastern Louisiana and the boundary with Louisiana–Mississippi Salt Basins Province (049). To the southwest, the play extends into Mexico.

Reservoirs: Reservoirs in this play are Paleocene-Eocene fluvial and deltaic sandstones in the lower part of the Wilcox Group and deltaic sandstones of the Poth Formation. The lower Wilcox sandstones are predominantly fluvial and deltaic in origin, but some valley-fill sandstones may be present in this play. Porosity of the sandstones ranges up to 25 percent, and permeability of the sandstones ranges up to 1,000 mD. Depths to undiscovered reservoirs range from 2,000 to 12,000 ft.

Source rocks: Source rocks for this play have not been identified, but possible source rocks include the Paleocene Midway organic-bearing mudstones that underlie the lower Wilcox. Another potential source is the Upper Cretaceous, from which hydrocarbons would have had to migrate up faults to enter lower Wilcox reservoirs.

Traps: Traps in this play are structural and stratigraphic. The structural traps occur along the peripheral fault zones and along growth faults in the downdip area of the play. Stratigraphic traps are present updip in the fluvial sandstones, and these traps are postulated to be where much of the remaining oil is to be found. Seals are provided by mudstones of the lower Wilcox.

Exploration status and resource potential: This play contains 43 gas reservoirs with a median size of 16 BCFG, and 25 oil reservoirs with a median size of 2.4 MMBO. The gas reservoirs were discovered

between 1942 and 1988; 10 of the gas discoveries were made since 1975. The potential for undiscovered gas in this play is considered to be high, particularly in the downdip area of the play in deltaic and shelf-edge deltaic reservoirs. The potential for undiscovered oil in this play is considered to be moderate, given the intensive exploration in the shallow area of the play.

4720. LOWER WILCOX DOWNDIP OVERPRESSURED GAS PLAY

The Lower Wilcox Overpressured Gas Play is present downdip from the Lower Wilcox Fluvial Oil and Gas Play (4719) all along the margin of the Western Gulf province. The play is bounded updip by Play 4719, and the downdip limit was placed at a depth of about 25,000 ft. From the west the play begins at the edge of the Lower Wilcox Lobo Gas Play (4718), and extends across the province to the State-Federal water boundary in southern Louisiana.

Reservoirs: Reservoirs in this play are lower Wilcox shelf, slope, and fan sandstones downdip from the Wilcox Fault Zone. These reservoirs are overpressured in the Houston salt basin area, and the overpressuring may extend laterally along strike far beyond this area. The porosity of the sandstones ranges up to 25 percent, and permeabilities range up to 250 mD but decrease downdip. Depths to undiscovered reservoirs range from 9,000 to 25,000 ft.

Source rocks: The most likely source rocks for the gas in this play are downdip organic-bearing mudstones of the Wilcox and Midway intervals. The hydrocarbons migrated updip into the lower Wilcox sandstones.

Traps: Traps are predominantly structural in this play and are found along the numerous growth faults and other faults downdip from the Wilcox fault zone. The gas migrated up faults to the reservoirs. Seals are formed by mudstones of the middle interval of the Wilcox.

Exploration status and resource potential: This play contains 40 gas reservoirs with a median size of 22 BCFG, and nearly half of the reservoirs were discovered since 1975. The potential for undiscovered gas resources in this play is very high. Exploration for deep lower Wilcox reservoirs has been light, given the play area, and much of the play area remains to be tested.

4721. UPPER WILCOX UPDIP FLUVIAL GAS PLAY

The Upper Wilcox Updip Fluvial Gas Play extends from the Wilcox outcrop belt downdip to the boundary of the Upper Wilcox Shelf Edge Gas and Oil Play (4722). The play extends from the Mexican border across the Western Gulf into southern Louisiana.

Reservoirs: Reservoirs in this play are predominantly upper Wilcox coastal plain fluvial sandstones. The sandstone porosity ranges up to 25 percent, and permeabilities range up to 1,000 mD. Depths to undiscovered reservoirs range from 2,000 to 8,000 ft.

Source rocks: Source rocks for this play have not been identified, but possible sources include downdip organic-bearing mudstones of the Wilcox and Midway. These units are known to be thermally mature downdip. Migration was updip or up faults into the upper Wilcox reservoirs.

Traps: Traps for the gas in this play are structural and occur along the peripheral faults zones and associated fault systems. Seals for the hydrocarbons in this play are mudstones within the Wilcox.

Exploration status and resource potential: This play contains 11 oil reservoirs with a median size of 3 MMBO and 4 gas reservoirs with a median size of 9 BCFG. The oil reservoirs were discovered between 1943 and 1958. Given the level of exploration in this shallow play since 1958, the chance of finding another oil reservoir of minimum size is considered to be less than 10 percent; thus this play was not assessed for oil. The four gas reservoirs were discovered between 1942 and 1982. The potential for undiscovered gas in this play is considered to be moderate, and the gas is postulated to be mainly in the downdip and south Texas portions of the play.

4722. UPPER WILCOX SHELF-EDGE GAS AND OIL PLAY

The Upper Wilcox Shelf-Edge Gas and Oil Play is defined by shelf-edge deltaic sandstone reservoirs that produce oil and gas from structural traps along the Wilcox shelf edges. The play is a narrow trend that begins at the Mexican border, runs across the Western Gulf through southern Louisiana, and ends at the State-Federal waters boundary in southern Louisiana.

Reservoirs: Reservoirs in this play are predominantly upper Wilcox shelf-edge deltaic sandstones cut by Wilcox growth faults. The porosity of the sandstones ranges to 26 percent, and permeabilities range to 600 mD. Depths to undiscovered reservoirs range from 5,000 to 14,000 ft.

Source rocks: Source rocks for the gas and oil in this play have not been identified, but possible source rocks would be the downdip organic-bearing Wilcox and Midway mudstones. The hydrocarbons primarily migrated up faults and into upper Wilcox sandstone reservoirs.

Traps: Traps in this play occur on the numerous growth faults and growth fault segments, and include fault traps, facies changes along the growth faults, and anticlinal structures in the growth faults. Seals for many of the reservoirs are mudstones juxtaposed with the sandstones along the faults.

Exploration status and resource potential: This play contains 232 gas reservoirs with a median size of 22 BCFG and 56 oil reservoirs with a median size of 2.6 MMBO. The gas reservoirs were discovered between 1937 and the present, and 67 of these discoveries have been made since 1975. The recent history of discoveries indicates that the potential for undiscovered accumulations of gas in this play is high. The oil reservoirs were discovered between 1937 and 1987, with nine being discovered since 1975. The potential for undiscovered oil reservoirs of minimum size in this play is estimated to be moderate.

4723. UPPER WILCOX DOWNDIP OVERPRESSURED GAS PLAY

The Upper Wilcox Downdip Overpressured Gas Play is defined by overpressured upper Wilcox sandstone reservoirs that produce gas from structural traps across the Western Gulf. The play extends from the Mexican border in the west across the province into southern Louisiana, where it crosses the State-Federal water boundary.

Reservoirs: Reservoirs in this play are Upper Wilcox slope and fan sandstones downdip from the shelf-edge deltas of the previous play. Porosity of the sandstones ranges up to 15 percent, and permeabilities range to 50 mD. Slope and fan sandstones are known to be heterogeneous with respect to sandstone body continuity and recovery efficiency. Depths to undiscovered reservoirs range from 8,000 to 25,000 ft.

Source rocks: Source rocks for this play have not been identified, but possible source rocks are the downdip Wilcox organic-bearing mudstones. Migration would have been local, as the reservoirs are not far from the source.

Traps: Traps in this play are predominantly structural and occur on growth faults and shale ridges. Seals are provided by Wilcox shales juxtaposed with reservoir sandstones either along faults or at the margins of the shale ridges.

Exploration status and resource potential: This play contains 82 gas reservoirs with a median size of 24.5 BCFG discovered between 1942 and 1989, with half of the 82 discoveries made since 1975. The potential for undiscovered resources of gas in this play is considered to be very high. The level of exploration throughout this play has been low.

4724. MIDDLE EOCENE SANDSTONES DOWNDIP GAS PLAY

The Middle Eocene Sandstones Downdip Gas Play is defined by some Middle Eocene sandstone reservoirs that produce gas from structural traps across the Western Gulf. This play is downdip from the Middle Eocene Sandstones Updip Fluvial Oil and Gas Play (4725). The play extends from the Mexican border across the province into southern Louisiana, and to the State-Federal water boundary.

Reservoirs: Reservoirs in this play are sandstones in the Eocene Queen City and Cook Mountain Formations. The Queen City sandstones are located predominantly in south Texas and consist of shelf and possibly slope sandstones. The Cook Mountain reservoirs are thicker and more extensive in southeast Texas and are deltaic and shelf sandstones. The Queen City and some of the Cook Mountain gas reservoir sandstones in this play are overpressured. Porosity in the Queen City reservoirs ranges up to 20 percent, and permeabilities are unknown. Porosity in the Cook Mountain sandstones ranges up to 30 percent, and permeabilities range to 350 mD. Depths to undiscovered reservoirs range from 3,000 to 18,000 ft.

Source rocks: Source rocks in this play are unknown, but potential source rocks are the organic-bearing mudstones of the Eocene, including the Wilcox, Queen City, and Sparta. Migration of hydrocarbons in this downdip play is local, from Eocene mudstones updip and up faults into Queen City and Cook Mountain sandstones.

Traps: Traps in this play are predominantly structural and occur on reactivated Wilcox growth faults and faulted anticlines. Some traps also occur along deep shale ridges.

Exploration potential: This play contains eight oil reservoirs with a median size of 3 MMBO, and 27 gas reservoirs with a median size of 18 BCFG. Exploration in this play has been moderate. Given the depths and the overpressured conditions in the deep reservoirs, the level of exploration, and the fact that more sandstone may be present downdip in these units, the potential for undiscovered gas resources is considered high, and the potential for undiscovered oil resources is estimated to be low.

4725. MIDDLE EOCENE SANDSTONES UPDIP FLUVIAL OIL AND GAS PLAY

The Middle Eocene Sandstones Updip Fluvial Oil and Gas Play is defined by Middle Eocene sandstone reservoirs that produce oil and gas from structural and stratigraphic traps in a band across the Western Gulf. The play begins at the Mexican border, extends across the Western Gulf to the borders of the East Texas and Mississippi Salt Basin Provinces, and ends at the State-Federal water boundary in southern Louisiana. The updip boundary of the play is the updip extent of the sandstones, and the downdip boundary is the Middle Eocene Sandstones Downdip Gas Play (4724).

Reservoirs: Reservoir sandstones in this play include the Eocene Reklaw, Queen City, and Sparta Formations. The Reklaw reservoirs are two types: transgressive sandstone reservoirs and deltaic reservoirs. The Reklaw transgressive sandstones are located primarily in Live Oak, Karnes, Bee, and Goliad Counties. Reservoir porosity ranges up to 30 percent, and permeabilities range up to 300 mD. The Reklaw deltaic sandstone porosity ranges up to 30 percent, and permeability ranges up to 1300 mD. The Queen City consists of deltaic sandstones in which porosities range up to 35 percent, and permeabilities range up to 600 mD. The Sparta formation consists of deltaic and shoreline sandstones in which the porosity ranges to 30 percent, and permeability ranges up to 1500 mD. The Sparta is thicker and more widespread in southeast Texas and southern Louisiana, whereas the Queen City is thicker and more widespread in south Texas. Depths to undiscovered reservoirs range from 250 to 12,000 ft.

Source rocks: Source rocks for this play have not been positively identified, but likely source rocks are the downdip organic-bearing Eocene mudstones of the Wilcox Group and of the Queen City and Sparta Formations and other middle Eocene units. Migration was primarily up faults into sandstone reservoirs.

Traps: Traps for the oil and gas accumulations in this play are predominantly structural, and most are reactivated Wilcox-age growth faults and faulted anticlines. The trapping in the Reklaw transgressive sandstones is stratigraphic. Seals are provided by the middle Eocene mudstones.

Exploration status and resource potential: Exploration in this play has resulted in 17 oil reservoirs with a median size of 2.1 MMBO, and 10 gas reservoirs with a median size of 17 BCFG. The level of exploration in this play is extensive, and given the fact that these middle Eocene clastic units are not as extensive or as thick as the Wilcox Group or the Oligocene Frio Formation, the potential for undiscovered oil and gas resources is low to moderate.

4726. YEGUA UPDIP FLUVIAL-DELTAIC OIL AND GAS PLAY

This play is defined by Eocene Yegua sandstone reservoirs that produce oil and gas from sandstones in a band across the Western Gulf. The play is bounded updip by the limit of Yegua sediments and downdip by the boundary of the Yegua Downdip Gas Play (4727). The play extends from the Mexican border across the province to the State-Federal water boundary in southern Louisiana.

Reservoirs: Reservoirs in this play are fluvial, deltaic, and shelf sandstones of the Eocene Yegua Formation. Sandstone porosity ranges up to 37 percent, and permeability ranges up to 2,000 mD. The complexity of facies in the sandstones of the fluvial-deltaic reservoirs indicates that reservoir heterogeneity and hydrocarbon recovery is complex. Depths to undiscovered reservoirs range from 1,000 to 10,000 ft.

Source rocks: Source rocks for the oil and gas in this play have not been identified, but potential source rocks are the organic-bearing Eocene mudstones downdip from the reservoirs in this play. Migration would have been updip and/or up growth faults and other faults into Yegua sandstone reservoirs.

Traps: Traps are predominantly structural in this play and have formed along reactivated Wilcox growth faults, faulted anticlines, and Yegua growth faults. Yegua oil and gas accumulations trapped above or marginal to piercement salt domes are included in the Houston Salt Dome Flank Oil and Gas Play 4701. Seals are provided by mudstones juxtaposed with reservoir sandstones in the structural traps.

Exploration status and resource potential: This Yegua play contains 96 oil reservoirs with a median size of 2.2 MMBO and 74 gas reservoirs with a median size of 16 BCFG. Of the 96 oil reservoirs discovered between 1932 and 1988, only 8 were discovered since 1975. Of the 74 gas reservoirs discovered between 1932 and 1988, only 7 were discovered since 1975. Given the intense level of exploration in this play in the past several decades, the potential for undiscovered oil and gas resources in this play is considered to be moderate.

4727. YEGUA DOWNDIP GAS PLAY

The Yegua Downdip Gas Play is defined by Eocene Yegua sandstone reservoirs that produce gas from deep overpressured reservoirs across the Western Gulf. The play is bounded updip by the boundary of the Yegua Updip Fluvial Deltaic Oil and Gas Play (4726), and the downdip limit is placed at a depth to Yegua reservoirs of 25,000 ft. The play begins at the Mexican border and crosses the province to intersect the State-Federal water boundary in southern Louisiana.

Reservoirs: Reservoirs in this play are Eocene Yegua slope and submarine fan sandstones. Porosity in the reservoir sandstones ranges up to 25 percent, and permeabilities range up to 100 mD. Slope and fan sandstones are known to exhibit a high degree of reservoir heterogeneity, which seriously affects recovery efficiency. Depths to undiscovered reservoirs range from 8,000 to 25,000 ft.

Source rocks: Source rocks for the deep overpressured gas have not been positively identified, but potential source rocks include organic-bearing mudstones of the deep downdip Eocene, including mudstones of the Wilcox, Queen City, Sparta, and Yegua. Migration of hydrocarbons into reservoirs of this play would have been local, either updip or locally up faults.

Traps: Traps for the gas in this play are predominantly structural and are on Yegua growth faults and possibly on to shale ridges. Gas in fan sandstones in the extreme downdip part of the play may be stratigraphically trapped. Seals are provided by Yegua mudstones that in many cases enclose reservoir sandstones.

Exploration status and resource potential: This play contains 39 gas reservoirs with a median size of 26.3 BCFG discovered between 1948 and 1989. Of the 39 reservoirs, 35 were discovered since 1975, indicating that this is an emerging play. Given the level of exploration and the mapped area of the play, the potential for undiscovered resources of gas is estimated to be very high.

4728. JACKSON UPDIP GAS AND OIL PLAY

This play is defined by sandstones of the Eocene Jackson Formation that produce oil and gas in the Western Gulf. The play is bounded updip by the limit of Jackson sandstones and downdip by the Jackson Downdip Gas Play (4729) boundary. The play extends from the Mexican border across coastal Texas to approximately the Louisiana border, where Jackson facies are known to pinch out.

Reservoirs: Reservoirs in this play are Eocene Jackson deltaic and strandplain sandstones. Porosity ranges up to 30 percent and permeabilities range up to 800 mD. Depths of undiscovered reservoirs range from 500 to 6,000 ft.

Source rocks: Source rocks for the Jackson hydrocarbons have not been identified, but possible source rocks include Eocene organic-bearing mudstones. Migration was updip and up faults into Jackson sandstone reservoirs.

Traps: Traps in this play are structural and stratigraphic and occur in salt structures, along growth faults, in anticlinal structures along the growth faults, and at facies changes. Seals are provided by mudstones of the Jackson, by juxtaposition of facies along faults, and by salt structures.

Exploration status and resource potential: This play contains 100 oil reservoirs with a median size of 3.2 MMBO and 22 gas reservoirs with a median size of 14.2 BCFG. The oil reservoirs were discovered between 1914 and 1980, and the gas reservoirs were discovered between 1924 and 1966. Given the exploration and discovery history in this play, the potential for undiscovered oil reservoirs is considered to be moderate. However, the chance of finding another gas reservoir was considered to be less than 10 percent, and the play was not quantitatively assessed for undiscovered gas.

4729. JACKSON DOWNDIP GAS PLAY (HYPOTHETICAL)

This hypothetical play was developed for the potential for deep gas in the Eocene Jackson Formation in the Western Gulf. The play is bounded updip by the Jackson Updip Gas and Oil Play (4728), and the downdip limit is placed at a Jackson reservoir depth of 25,000 ft. The plays extends from the Mexican border across coastal Texas to approximately the Louisiana border, where Jackson facies are known to pinch out.

Reservoirs: Reservoirs in this play are hypothesized to be Jackson slope and fan sandstones, using many of the other Tertiary clastic units in the Western Gulf as analogs. Sandstone porosities are estimated to range up to 25 percent, and permeabilities are estimated to range up to 100 mD. Slope and fan sandstones are well known to be heterogeneous reservoirs with respect to hydrocarbon recovery. Depths of undiscovered reservoirs range from 6,000 to 25,000 ft.

Source rocks: Source rocks for this play have not been identified, but potential source rocks include the downdip and lateral organic-bearing mudstones of the Eocene, from Wilcox to Jackson age. Migration is estimated to have been local, from local source rocks into updip reservoir sandstones or by short distance vertical migration up growth faults.

Traps: Traps are postulated to be structural and to occur on growth faults and on faulted anticlines along the growth faults. The fan sandstones could also contain stratigraphic traps, which would occur at facies changes and where the fan sandstones are encased by mudstones.

Exploration status and resource potential: This play is hypothetical, meaning that no gas reservoirs of the minimum size have been discovered to date. If slope and fan reservoir sandstones are present as described, the low level of exploration indicates that the potential for undiscovered gas resources in this play is very high.

4730. VICKSBURG UPDIP GAS PLAY

The Vicksburg Updip Gas Play is defined by fluvial sandstones in the Oligocene Vicksburg Formation that produce gas from structural traps. The play extends from the updip limit of all Vicksburg sandstones to the downdip limit of the fluvial-deltaic sandstones, and from the Mexican border across the Western Gulf, through southern Louisiana, to the State-Federal water boundary.

Reservoirs: Reservoirs in the Vicksburg are fluvial sandstones with porosities ranging up to 30 percent, and permeabilities ranging up to 1,000 mD. Depths of undiscovered reservoirs range from 4,000 to 11,000 ft.

Source rocks: The source for Vicksburg gas is not known with certainty, but possible sources include the downdip and underlying Eocene organic-bearing mudstones. Migration was either up faults within the growth-fault zones or updip from the deeper part of the Western Gulf.

Traps: Traps in the Vicksburg are predominantly structural and occur along the numerous growth faults and salt structures in this updip area. Seals are provided mainly by mudstones both where they encase the reservoir sandstones and where they are juxtaposed against the sandstones in structural traps.

Exploration status and resource potential: The Vicksburg Updip Gas Play contains 17 gas reservoirs with a median size of 12.4 BCFG discovered between 1936 and 1980, and 15 oil reservoirs with a median size of 3.4 MMBO discovered between 1936 and 1970. The lack of significant oil discoveries in the past 23 years led to the conclusion that the chance of finding another oil reservoir greater than minimum size was less than 10 percent, and the play was not assessed for oil. The potential for additional gas discoveries greater than minimum size is considered to be low to moderate in this play.

4731. VICKSBURG DOWNDIP GAS PLAY

The Vicksburg Downdip Gas Play is defined by Oligocene Vicksburg shelf-edge delta, shelf, and slope sandstone reservoirs that produce gas downdip from the Vicksburg fluvial sandstones. The updip boundary of the play is the Vicksburg Updip Gas Play (4730), and the downdip limit is placed at a depth of 25,000 ft. The play extends from the Mexican border across the Western Gulf and southern Louisiana to the State-Federal water boundary.

Reservoirs: Reservoirs in this play range from shelf-edge deltas, to shelf-depression deposits, to possible slope and fan sandstones. Most of the reservoirs in the south Texas part of this play are in the shelf-edge deltas. Porosity in these sandstones ranges up to 30 percent in the shallow area and up to about 15 percent in the downdip overpressured section. Permeability ranges up to 2,000 mD in the shallow part of the play and up to 10 mD in the deep overpressured section. Depths of undiscovered reservoirs range from 7,000 to 25,000 ft.

Source rocks: The source for Vicksburg gas is not known with certainty, but possible source rocks include organic-bearing mudstones of the Eocene that occur beneath and downdip from the Vicksburg. The downdip Vicksburg may also be a source of gas. The deep, downdip part of this play is overpressured.

Traps: Traps in this play are structural and stratigraphic. Structural traps occur on the faults, the growth faults, faulted anticlines in the growth faults, and shale structures. Stratigraphic traps occur at facies changes in the deeper water sandstones, and at facies changes in the shelf-edge deltas. Seals are provided by juxtaposition of facies along faults and shale structures, and by mudstones enclosing the sandstones.

Exploration status and resource potential: The Vicksburg Downdip Gas Play contains 88 gas reservoirs with a median size of 22 BCFG discovered between 1941 and 1989, and 8 oil reservoirs with a median size of 4 MMBO discovered between 1947 and 1965. The lack of oil discoveries since 1965 indicates that there is a less than 10 percent chance for reservoirs of the minimum size to be discovered, and the oil was not assessed in this play. Of the 88 significant gas reservoirs in this play, 32 were discovered since 1975, and the potential for additional gas discoveries is considered to be very high.

4732. FRIO SOUTH TEXAS DOWNDIP GAS PLAY

This play is defined by shelf sandstone reservoirs that produce gas from structural traps in the downdip part of the Oligocene Frio Formation in south Texas. The play is bounded downdip by the State-Federal water boundary and updip by the Frio South Texas Mid-Dip Oil and Gas Play (7433), and the play extends from the Mexican border to the western boundary of the Houston Salt Basin.

Reservoirs: Reservoir rocks in this play are shelf, slope, and possibly fan sandstones of the Frio. The porosity of the sandstones ranges up to 30 percent, and permeability ranges up to 1,000 mD. Both porosity and permeability decrease into the deeper parts of this play. Depths of undiscovered reservoirs range from 6,000 to 18,000 ft.

Source rocks: Source rocks for the Frio gas are not known for certain, but possible sources include organic-bearing mudstones of the Eocene and Oligocene downdip from this play. The hydrocarbons migrated updip or up faults into the Frio reservoirs. The deeper Frio reservoirs in this play are overpressured.

Traps: Trapping in this play is structural and stratigraphic. Structural traps occur along faults and growth faults, and include faulted anticlines, shale structures, and anticlines. Stratigraphic traps are at facies changes in the shelf, slope, and fan environments. Seals are provided by mudstones of the Frio and the Anahuac that enclose the sandstones, and by the juxtaposition of mudstones against sandstones in the growth faults and other structures.

Exploration status and resource potential: This play contains 62 gas reservoirs with a median size of 30 BCFG and 4 oil reservoirs with a median size of 2.2 MMBO. The oil reservoirs were discovered between 1938 and 1977. The lack of discoveries since that date indicates that there is less than a 10 percent chance of finding an oil reservoir of minimum size, so oil was not assessed. Of the 62 gas reservoirs in this play, 20 were discovered since 1975, and the potential for undiscovered gas resources in this play is estimated to be high.

4733. FRIO SOUTH TEXAS MID-DIP OIL AND GAS PLAY

This play is defined by Frio coastal plain, deltaic, barrier, and strandplain sandstones that produce oil and gas in a broad band across south Texas. The play is bounded by the Frio Updip Fluvial Gas and Oil Play (4734), and the Frio South Texas Downdip Gas Play (4732); the play extends from the Mexican border to the western boundary of the Houston Salt Basin.

Reservoirs: Frio reservoirs in this mid-dip play are deltaic, barrier, and strandplain sandstones. The porosity of the sandstones ranges up to 34 percent, and permeability ranges up to 2,000 mD. Both porosity and permeability decrease toward the deeper parts of this play. Depths of undiscovered reservoirs range from 8000 to 14,000 ft.

Source rocks: Source rocks in this play are not known for certain, but possible source rocks include Eocene and Oligocene organic-bearing mudstones beneath and within the reservoir intervals. Migration of the hydrocarbons was mainly up faults into the Frio reservoirs.

Traps: Traps in this play are mainly structural and occur along growth faults, faults, and shale structures. Structures along the faults include faulted anticlines and anticlines. Seals are provided by the juxtaposition of mudstones against reservoir sandstones in the structures.

Exploration status and resource potential: This Frio play is one of the most productive plays in the Gulf Coast, and it contains 304 gas reservoirs with a median size of 21 BCFG discovered between 1930 and 1989, and 159 oil reservoirs with a median size of 3.7 MMBO discovered between 1925 and 1989. Of the 159 oil reservoirs, 11 were discovered since 1975; of the 304 gas reservoirs, 31 were discovered since 1975. Given the discovery history and the level of exploration in this play, the potential for undiscovered oil and gas accumulations of the minimum size is estimated to be moderate.

4734. FRIO UPDIP FLUVIAL GAS AND OIL PLAY

Description: This play is defined by Frio fluvial-coastal plain sandstone reservoirs that produce oil and gas in the updip area. The play is bounded updip by the Frio outcrop belt and downdip by the Frio mid-dip plays; the play extends from the Mexican border across Texas and Louisiana, to the State-Federal water boundary in southern Louisiana.

Reservoirs: Reservoirs in this play are predominantly fluvial sandstones. Porosity of the sandstones ranges up to 35 percent, and permeability ranges up to 1500 mD. Depths of undiscovered accumulations in this play range from 1,000 to 9,000 ft.

Source rocks: Source rocks for this play are not known for certain, but possible source rocks include Eocene and Oligocene organic-bearing mudstones both downdip and underlying the Frio. Migration of hydrocarbons was mainly up faults from deeper sources into Frio fluvial reservoirs.

Traps: Traps in this updip part of the Frio are structural and stratigraphic. Structural traps are on faults, faulted anticlines, and anticlines. The stratigraphic traps are within the fluvial parts of the sandstones, where channel sandstones are enclosed in floodplain mudstones. The stratigraphic traps are the ones in which future exploration may focus. Seals for the hydrocarbons are provided by Frio mudstones enclosing sandstones, or by juxtaposition of mudstones and sandstones along faults.

Exploration potential: This Frio play contains 60 gas reservoirs with a median size of 11 BCFG discovered between 1937 and 1985, and 32 oil reservoirs with a median size of 3 MMBO discovered between 1936 and 1983. The discovery history and level of exploration in this play indicate that the potential for additional discoveries of gas and oil reservoirs is moderate, given that exploration for stratigraphic traps can be difficult.

4735. FRIO SOUTHEAST TEXAS/SOUTH LOUISIANA MID-DIP GAS AND OIL PLAY

This Frio play is defined by deltaic, barrier, and strandplain sandstone reservoirs that produce gas and oil from salt-related structures. The play is bounded on the updip side by the Frio Updip Fluvial Gas and Oil Play (4734), and downdip by the Frio Southeast Texas/South Louisiana Downdip Gas Play (4736). This play begins at the western edge of the Houston Salt Basin and extends to the northeast into Louisiana, and ends at the State-Federal water boundary in southern Louisiana.

Reservoirs: Reservoirs in this play are Frio deltaic, barrier, and strandplain sandstones. The porosity of the sandstones ranges up to 35 percent, and permeabilities range up to 3,500 mD. Depths of undiscovered accumulations in this play range from 6,000 to 16,000 ft.

Source rocks: Source rocks for the Frio in this play are not known for certain, but possible sources include Eocene and Oligocene organic-bearing mudstones. Considering the number of structures in the salt dome province, sources may also include deeper mudstones of the Wilcox. Migration of hydrocarbons was predominantly up faults into the Frio reservoirs.

Traps: Traps in this mid-dip play are predominantly structural and occur on salt structures and faults. Traps include faulted anticlines, anticlines, and the margins of the various types of salt structures. Seals

are provided by mudstones within the Frio and by the juxtaposition of sandstone reservoirs with salt and mudstones in the structural traps.

Exploration status and resource potential: This Frio play contains 149 gas reservoirs with a median size of 23.5 BCFG discovered between 1924 and 1989, and 141 oil reservoirs with a median size of 4.8 MMBO discovered between 1902 and 1986. The discovery history and level of exploration in this play indicates that the potential for additional discoveries of gas and oil of minimum reservoir size is high and moderate, respectively.

4736. FRIO SOUTHEAST TEXAS/SOUTH LOUISIANA DOWNDIP GAS PLAY

This play is defined by Frio shelf, slope, and possibly fan sandstone reservoirs that produce oil and gas from salt structures and stratigraphic traps. The play is bounded updip by the Frio Southeast Texas/South Louisiana Mid-Dip Gas and Oil Play (4735), and downdip by the State-Federal water boundary, or by a depth of approximately 25,000 ft. The play extends from the western edge of the Houston Salt Basin northeast into Louisiana and ends at the State-Federal water boundary in southern Louisiana.

Reservoirs: Reservoirs in this play are Frio shelf, slope and possibly fan sandstones. The porosity of the sandstones ranges up to 30 percent, and permeabilities range up to 1,500 mD. Both porosity and permeability decrease with depth in this play. Depths of undiscovered accumulations in this play range from 8,000 to 25,000 ft.

Source rocks: Source rocks for this Frio play are not known for certain, but possible sources include Eocene and Oligocene organic-bearing mudstones. Migration of the gas was updip and up faults into Frio sandstones. The deeper sandstones in this play are overpressured.

Traps: Traps are structural and stratigraphic. Structural traps are on salt structures and faults, and stratigraphic traps are at facies changes in the slope-fan environments, where sandstones are encased in mudstones. Seals are provided by these enclosing mudstones in the stratigraphic accumulations and by Frio mudstones in the structural traps.

Exploration status and resource potential: This Frio play contains 68 gas reservoirs with a median size of 25 BCFG discovered between 1939 and 1988, and 17 oil reservoirs with a median size of 2.2 MMBO discovered between 1939 and 1980. The small size and the drop in discovery rate of oil indicates that the chance of finding additional oil reservoirs in this play is less than 10 percent; thus the play was not assessed for oil. However, 19 of the 68 gas reservoirs were discovered since 1975. This discovery rate, combined with the low level of exploration in this deeper part of the Frio, indicates that the potential for additional Frio gas reservoirs in this play is high.

4737. HACKBERRY SANDSTONE GAS AND OIL PLAY

This play is defined by Hackberry slope and fan sandstones that produce oil and gas in the Hackberry embayment, which is a re-entrant into the middle Frio shelf possibly caused by a middle Frio sea-level fall. The northern, eastern, and western play boundaries are the edges of the re-entrant. To the south this play extends to the State-Federal water boundary.

Reservoirs: Reservoirs are thick, submarine channel sandstones and fan sandstones of the Oligocene Hackberry Formation. Porosities range up to 30 percent, and permeabilities range up to 2,000 mD. Slope and fan reservoirs are characterized by significant compartmentalization, which affects hydrocarbon recovery. The slope sandstones are channel sandstone reservoirs, and the fan sandstones could include reservoirs in any or all of the several subfacies of the submarine fan systems. Depths of undiscovered reservoirs range from 7,000 to 14,000 ft.

Source rocks: Source rocks for the oil and gas in this play have not been positively identified, but most likely source rocks are the downdip organic-bearing mudstones of the Eocene-Oligocene section, including the Frio and Vicksburg. Migration is postulated to be local, from downdip mudstones into Hackberry reservoirs or up faults into the sandstones.

Traps: Traps in the Hackberry are structural and stratigraphic. Structural traps occur in salt structures, in faulted anticlines in growth faults, and in slide blocks within the Hackberry embayment. Stratigraphic trapping occurs where reservoir sandstones in the slope-channel systems pinch out, and where sandstones within the fan systems are encased in mudstones. Seals are provided by the mudstones enclosing most of the reservoirs.

Exploration status and resource potential: The Hackberry Sandstone Gas and Oil Play contains 16 oil reservoirs with a median size of 5 MMBO discovered between 1939 and 1985, and 18 gas reservoirs with a median size of 40 BCFG discovered between 1946 and 1986. Exploration in this play has been intensive, but because of the complex geologic setting, the potential for undiscovered gas resources is high, and the potential for undiscovered oil resources is moderate.

4738. ANAHUAC SANDSTONE GAS AND OIL PLAY

This play is defined by fluvial-deltaic sandstones of the Oligocene Anahuac Formation that produce oil and gas from structural traps in southern Louisiana and southeast Texas. The play extends from the Mexican border across the Western Gulf into southern Louisiana. This play also includes the *Heterostegina* limestones, which may be a future subplay in southeastern Louisiana. Most Anahuac production occurs in southern Louisiana.

Reservoirs: Reservoirs are deltaic and slope sandstones of the Oligocene Anahuac. Sandstone porosity ranges up to 31 percent, and permeabilities range up to 3000 mD. The productive Anahuac sandstones

are mostly in southern Louisiana. The *Heterostegina* limestones are mainly in southeast Louisiana. Depths of undiscovered reservoirs range from 6,000 to 20,000 ft.

Source rocks: Source rocks for the oil and gas in the Anahuac have not been positively identified, but possible source rocks include the downdip Eocene and Oligocene organic-bearing mudstones. Migration from the sources to the traps was up existing structures, including the margins of salt structures and faults.

Traps: Traps in the Anahuac are predominantly structural and are in salt structures, on growth faults, and in rollover anticlines along faults. Seals are provided by the shales within the Anahuac interval, and by juxtaposition of facies along faults.

Exploration status and resource potential: This play contains 25 oil reservoirs with a median size of 5.3 MMBO, and 49 gas reservoirs with a median size of 43 BCFG. The oil reservoirs were discovered between 1926 and 1974. The gas reservoirs were discovered between 1912 and 1982. Given the level of exploration in the Anahuac and the area of the play, the potential for undiscovered resources of both oil and gas of minimum size is estimated to be moderate.

4739. LOWER MIOCENE FLUVIAL SANDSTONE OIL AND GAS PLAY

Description: This play is defined by lower Miocene fluvial coastal-plain sandstones that produce oil and gas from structural traps in the Western Gulf. The play is bounded updip by the Miocene outcrop and downdip by the gradational change to deltaic sandstones. The lower Miocene as used here is the interval between the *Crisellaria "R"* and the *Discorbis "B"* benthic foraminifera zones. This interval corresponds in general to the Oakville Formation of coastal Texas.

Reservoirs: Reservoirs are fluvial coastal-plain sandstones of lower Miocene age. Porosity ranges to 36 percent, and permeabilities range up to 1,800 mD. Depths of undiscovered reservoirs range from 1,000 to 12,000 ft.

Source rocks: Source rocks for the lower Miocene have not been identified, but potential source rocks include downdip Eocene and Oligocene organic-bearing mudstones. The hydrocarbons migrated up faults and salt structures into lower Miocene traps.

Traps: Traps in the lower Miocene are structural and occur in salt structures, along growth faults, in shale structures, and in faulted anticlines along growth faults. Seals in this play are provided by mudstones of the lower Miocene, by the juxtaposition of mudstones and sandstones along faults, and by the margins of salt structures.

Exploration status and resource potential: The Lower Miocene Fluvial Sandstone Oil and Gas Play contains 34 oil reservoirs with a median size of 2.6 MMBO and 69 gas reservoirs with a median size of 16

BCFG. The oil reservoirs were discovered between 1901 and 1978, and the gas reservoirs were discovered between 1921 and 1983. The potential for undiscovered resources of oil and gas in this play is estimated to be low and moderate, respectively.

4740. LOWER MIOCENE DELTAIC SANDSTONE GAS AND OIL PLAY

This play is defined by lower Miocene deltaic and shelf sandstone reservoirs that produce gas and oil from structural traps in the Western Gulf province. The updip boundary is the general limit of the fluvial sandstones, and the downdip boundary is the State-Federal water boundary. Much of this play exists in Federal offshore waters of Texas. The downdip boundary in southern Louisiana is the limit of the deltaic sandstones. The lower Miocene as used in this play is defined as the interval between the *Crisellaria "R"* and the *Discorbis "B"* benthic foraminifera zones. This interval corresponds in general to the Oakville Formation of coastal Texas.

Reservoirs: Reservoirs are deltaic and shelf sandstones of lower Miocene age. Porosity ranges up to 35 percent, and permeabilities range up to 5,000 mD. Depths of undiscovered reservoirs range from 3,000 to 16,000 ft.

Source rocks: Source rocks for the lower Miocene have not been identified, but possible source rocks include the organic-bearing mudstones of the Eocene and Oligocene. Migration was up faults from the mudstones into the traps containing the lower Miocene sandstones.

Traps: Traps in this play are structural and occur on salt structures, along growth faults, shale structures, and faults related to growth faults. Seals are provided by lower Miocene mudstones along growth and shale structures, and by the margins of salt structures.

Exploration status and resource potential: The lower Miocene in this play contains 31 oil reservoirs with a median size of 4.8 MMBO, and 100 gas reservoirs with a median size of 32.5 BCFG. The oil reservoirs were discovered between 1910 and 1987, and the gas reservoirs were discovered between 1936 and 1989. The level of exploration in this play and the discovery history indicate that the potential for undiscovered oil and gas resources in this play is moderate and high, respectively.

4741. LOWER MIOCENE SLOPE AND FAN SANDSTONE GAS PLAY

This play is defined by lower Miocene slope and fan sandstones that produce gas from structural traps in southern Louisiana. This play does not exist onshore in Texas. The updip boundary in Louisiana is the limit of deltaic sandstones, and the play extends downdip to the Federal water boundary. The lower Miocene as used in this play is the interval between the *Crisellaria "R"* and the *Discorbis "B"* benthic foraminifera zones. This interval corresponds in general to the Oakville Formation. Much of this play exists in the Federal waters offshore.

Reservoirs: Reservoirs are slope and fan sandstones downdip from the deltaic and shelf sandstones. Porosity of the sandstones ranges up to 25 percent, and permeabilites range to 300 mD. Slope and fan sandstones are known to exhibit a high degree of heterogeneity with respect to hydrocarbon recovery. Depths of undiscovered reservoirs range from 8,000 to 20,000 ft.

Source rocks: Source rocks for the lower Miocene have not been identified, but potential source rocks for this play include the Eocene, Oligocene, and lower Miocene organic-bearing mudstones downdip and from adjacent to the sandstones. Migration was local, from the underlying and enclosing mudstones into the lower Miocene sandstones. The deeper, downdip part of this play is overpressured.

Traps: Traps in this play are structural and stratigraphic and occur in salt structures, in shale structures, along growth faults, and at facies changes within the fan sandstones. Seals are provided by the enclosing mudstones, by salt structures, and by the juxtaposition of mudstones and sandstones along faults.

Exploration status and resource potential: The lower Miocene in this play contains 8 oil reservoirs with a median size of 5.6 MMBO and 55 gas reservoirs with a median size of 87 BCFG. The oil reservoirs were discovered between 1939 and 1970. The chance of finding another oil reservoir of minimum size in this play is considered to be less than 10 percent, so the play was not assessed for oil. The gas reservoirs were discovered between 1931 and 1982, and the potential for undiscovered gas resources, given the exploration and discovery history, is estimated to be high.

4742. MIDDLE MIOCENE FLUVIAL SANDSTONE GAS AND OIL PLAY

This play is defined by Middle Miocene fluvial coastal plain sandstones that produce oil and gas from structural traps in the Western Gulf Province. The updip boundary is the depositional limit of middle Miocene sediment, and the downdip limit is the change to deltaic sandstones, but across much of the play the downdip limit is the State-Federal water boundary. The middle Miocene as used in this play is the interval between the *Robulus* "*L*" and the *Textularia* "*W*" benthic foraminifera zones. This interval corresponds in general to the Lagarto Formation of coastal Texas.

Reservoirs: Reservoirs are middle Miocene fluvial coastal-plain sandstones. Porosity ranges up to 36 percent, and permeabilities range up to 4,000 mD. Depths of undiscovered reservoirs range from 1,000 to 17,000 ft.

Source rocks: Source rocks for middle Miocene hydrocarbons have not been identified, but possible source rocks include the organic-bearing mudstones of the Eocene and Oligocene. The hydrocarbons migrated up faults and into existing traps containing middle Miocene sandstones.

Traps: Traps are predominantly structural in this play, and are in salt structures, on growth faults, in structures such as anticlines along growth faults, and in shale structures. Seals are provided by

mudstones within the middle Miocene, by salt and shale structures, and by the juxtaposition of facies along growth faults.

Exploration status and resource potential: The middle Miocene in this play contains 44 oil reservoirs with a median size of 4.9 MMBO, and 82 gas reservoirs with a median size of 24.5 BCFG. The oil reservoirs were discovered between 1901 and 1984. The gas reservoirs were discovered between 1907 and 1990, and 17 of these have been discovered since 1975. Given the exploration and discovery history in this play, the potential for undiscovered resources is estimated to be moderate for oil and high for gas.

4743. MIDDLE MIOCENE DELTAIC SANDSTONE GAS AND OIL PLAY

This play is defined by middle Miocene deltaic sandstones that produce gas and oil from structural traps downdip from middle Miocene fluvial sandstones. Much of this play exists in the Federal offshore, but onshore areas include part of southernmost Louisiana and a small area of extreme south Texas. The middle Miocene as used in this play is the interval between the *Robulus "L"* and the *Textularia "W"* benthic foraminifera zones. This interval corresponds in general to the Lagarto Formation of coastal Texas.

Reservoirs: Reservoirs are middle Miocene deltaic and shelf sandstones that exist mainly in the Federal offshore. Porosity ranges up to 32 percent, and permeabilities range up to 2,000 mD. Depths of undiscovered reservoirs range from 4,000 to 20,000 ft.

Source rocks: Source rocks for the middle Miocene have not been identified, but possible source rocks included organic-bearing mudstones of the Eocene and Oligocene. The hydrocarbons migrated up faults into the middle Miocene sandstones.

Traps: Traps in this play are structural and are in salt structures, along growth faults, and in anticlinal structures along the growth faults. Seals are provided by enclosing middle Miocene mudstones, by the juxtaposition of facies along faults, and by salt structures.

Exploration potential: This play contains 42 oil reservoirs with a median size of 24 MMBO, and 56 gas reservoirs with a median size of 103 BCFG. The 42 oil reservoirs were discovered between 1929 and 1987, and the 56 gas reservoirs were discovered between 1938 and 1988. Given the exploration and discovery history in this play, the potential for undiscovered reservoirs is estimated to be low for oil and moderate for gas.

4744. UPPER MIOCENE FLUVIAL SANDSTONE GAS AND OIL PLAY

This play is defined by upper Miocene fluvial coastal-plain sandstone reservoirs that produce oil from structural traps in southern Louisiana and southeast Texas. The updip limit is placed at the limit of upper Miocene sediments, and the downdip limit, except in a small area of southern Louisiana, is the Federal water boundary. Production in this play is largely restricted to southern Louisiana. Most of this play exists in Federal offshore waters. The upper Miocene as used in this play is the interval between the *Textularia* "*W*" and the *Robulus* "*E*" benthic foraminifera zones. This interval corresponds in general to the Goliad Formation of coastal Texas.

Reservoirs: Reservoirs are upper Miocene fluvial coastal-plain sandstones. Porosity ranges up to 30 percent, and permeability ranges up to 1,700 mD. Depths of undiscovered reservoirs range from 1,000 to 16,000 ft.

Source rocks: Source rocks for the upper Miocene have not been identified, but possible source rocks include organic-bearing mudstones of the Eocene and Oligocene downdip from this play. Migration was up faults and updip into fluvial sandstones of the upper Miocene.

Traps: Traps in this play are predominantly structural and occur in salt structures, on faults, along growth faults, and in anticlinal structures along growth faults. Seals are provided by mudstones of the upper Miocene, by the juxtaposition of facies along faults, and by the margins of salt structures.

Exploration status and resource potential: This play contains 29 oil reservoirs with a median size of 13.2 MMBO and 38 gas reservoirs with a median size of 31 BCFG. The oil reservoirs were discovered between 1901 and 1975, and the gas reservoirs were discovered between 1916 and 1981. Given the exploration and discovery history of the upper Miocene in this play, the potential for undiscovered oil and gas reservoirs of the minimum size is estimated to be low.

4745. UPPER MIOCENE DELTAIC SANDSTONE GAS AND OIL PLAY

This play is defined by upper Miocene deltaic sandstone reservoirs that produce oil from structural traps in southern Louisiana. The play does not exist onshore in Texas, and most of this play exists in the Federal offshore waters. The updip limit is placed at the limit of upper Miocene sediments. The upper Miocene as used in this play is the interval between the *Textularia* "*W*" and the *Robulus* "*E*" benthic foraminifera zones. This interval corresponds in general to the Goliad Formation of coastal Texas.

Reservoirs: Reservoirs are upper Miocene deltaic sandstones. Porosity ranges up to 35 percent, and permeability ranges up to 1,600 mD. Depths of undiscovered reservoirs range from 4,000 to 20,000 ft.

Source rocks: Source rocks for the upper Miocene have not been identified, but potential source rocks include the Eocene, Oligocene, and Miocene organic-bearing mudstones downdip from the play. Migration was updip and up faults into the upper Miocene deltaic sandstones.

Traps: Traps are predominantly structural and are in salt structures, along growth faults, and in structures along the growth faults. Seals are provided by Miocene mudstones, by salt structures, and by the juxtaposition of facies in faults.

Exploration status and resource potential: This play contains 34 oil reservoirs with a median size of 36.8 MMBO, and 25 gas reservoirs with a median size of 28 BCFG. The oil was discovered between 1929 and 1985, and the gas reservoirs were discovered between 1938 and 1987. Given the exploration and discovery history in this play, the potential for both undiscovered oil and gas resources is estimated to be moderate.

4746. PLIO–PLEISTOCENE FLUVIAL SANDSTONE OIL PLAY

This play is defined by Pliocene and Pleistocene fluvial sandstone reservoirs that produce oil from structural traps that resulted from salt movement and from movement along growth faults in southern Louisiana. The northern boundary of the play is defined by the updip limit of Pliocene-Pleistocene age sandstone, and the play extends into the Federal waters offshore, where this interval is a major oil and gas producer.

Reservoirs: Reservoirs are Pliocene and Pleistocene fluvial coastal-plain sandstones. Porosity ranges up to 35 percent, and permeability ranges up to 1,200 mD. Depths of undiscovered reservoirs range from 500 to 4,000 ft.

Source rocks: Source rocks for this Pliocene-Pleistocene play have not been identified, but potential source rocks include the Eocene and Oligocene organic-bearing mudstones. The hydrocarbons migrated up faults into the Pliocene and Pleistocene sandstones.

Traps: Traps in this play are structural, and are mainly on salt structures and along growth faults. Seals are provided by Pliocene-Pleistocene mudstones, by salt structures, and by the juxtaposition of facies along faults.

Exploration status and resource potential: This play contains seven oil reservoirs with a median size of 39 MMBO and one gas reservoir containing 10 BCFG. The oil was discovered between 1918 and 1950, and the gas in 1962. Given the many years since the last discoveries of both oil and gas and the tremendous exploration effort since that time, the chance of finding another reservoir of minimum size for either oil or gas is considered to be less than 10 percent, and the play was not assessed for oil or gas.

UNCONVENTIONAL PLAYS

Continuous-Type

4747. AUSTIN CHALK–PEARSALL PLAY

This unconventional continuous-type play was developed to estimate the undiscovered oil resources in a section of the mid-dip Upper Cretaceous Austin Chalk trend in the Western Gulf centered around the Pearsall area. The play is bounded updip by the Austin Updip Oil Play (4713), and by the Austin Shelf/Edge Gas and Oil Play (4711). The Austin Chalk–Pearsall Play is located in parts of Dimmit, Zavala, Frio, La Salle, Atacosa, Wilson, Karnes, Gonzales, and Lavaca counties, Texas.

Reservoirs: The reservoir rock in this play is coccolith- and foraminifera-bearing fractured chalk. Reservoir quality is dependent upon the intensity of fracturing in the chalk. Depths of untested reservoir cells range from 5,000 to 11,000 feet.

Source rocks: The sources for the oil and gas in the Austin Chalk are interpreted to be organic-bearing micrites within the Austin, particularly in the deeper parts of the play, and organic-bearing mudstones of the Upper Cretaceous Eagleford Formation.

Traps: The mid-dip area of the Austin Chalk does not contain the large structures associated with fault zones such as in the Austin Updip Oil Play (4713). The greater Pearsall area does have a large, subtle domal structure that may have served to focus fracturing. Fractured chalk reservoir rock appears to the intercalated with shales and marls that did not fracture like the chalk; trapping may be related in part to the fact that fractured chalk is sealed by non-fractured shale and marl.

Exploration status and resource potential: Given the cell size, mean numbers of cells, the mean EUR, and the success ratio, the Austin Chalk in the greater Pearsall area is estimated to contain approximately twice the undiscovered resource as what has already been produced within the play area. Although not assessed using fields, the Pearsall, Horn, Pilgrim, Sutil, Mag, Cost, Marcelina Creek, Peach Creek, Cindy Ann, Pandora Northwest, and First Shot fields are included in the play area.

4748. AUSTIN CHALK–GIDDINGS PLAY

This unconventional continuous-type play was developed to assess the undiscovered oil resources in a section of the mid-dip Austin Chalk trend centered on the Giddings area. The play is bounded updip by the Austin Updip Oil Play (4713), and by the Austin Shelf Edge Gas and Oil Play (4711). This play is located in parts of Fayette, Bastrop, Lee, Washington, Burleson, Brazos. and Grimes counties, Texas.

Reservoirs: The reservoir rock in this play is coccolith- and foraminifera-bearing fractured chalk. Reservoir quality is dependent upon the intensity of fracturing in the chalk. Depths of untested reservoir cells range from 6,000 to 12,000 feet.

Source rocks: The sources for the oil and gas in the Austin Chalk are interpreted to be organic-bearing micrites within the Austin, particularly in the deeper parts of the play, and organic-bearing mudstones of the Upper Cretaceous Eagleford Formation.

Traps: The mid-dip area of the Austin Chalk does not contain the large structures associated with fault zones such as in the Austin Updip Oil Play (4713). Unlike the greater Pearsall area, the Giddings area may not have the large, subtle domal structure that may have served to focus fracturing. Fractured chalk reservoir rock appears to the intercalated with shales and marls that did not fracture like the chalk; trapping may be related in part to the fact that fractured chalk is sealed by non-fractured shale and marl.

Exploration status and resource potential: Given the cell size, mean numbers of cells, the mean EUR, and the success ratio, the Austin Chalk in this play area is estimated to contain a mean undiscovered oil resource in the range of resource that has already been produced from this area. Although this play was not assessed using fields, the Giddings, Clay Northeast, Kurten: Woodbine, Caldwell, Stone City, Big-A-Taylor, and Jerry's Quarter's fields are included in the play area.

4749. AUSTIN CHALK–OUTLYING PLAY (HYPOTHETICAL)

This unconventional continuous-type play was developed to assess the two outlying areas of the mid-dip Austin Chalk trend in the Western Gulf. The play is bounded updip by the Austin Updip Oil Play (4713), and by the Austin Shelf Edge Gas and Oil Play (4711). This play is separated into two parts by the Austin Chalk–Pearsall and Austin Chalk–Giddings Plays (4747 and 4748); the Austin Chalk–Outlying Play is located in parts of Webb, Dimmit, Maverick, Zavala counties in the southwest area; Angelina, Trinity, Polk, Jasper, Newton, Tyler, Walker, Houston, Leon, Madison, Robertson, Milam, Burleson, Lee, and Bastrop counties, Texas, and Sabine, Vernon, Rapides, and Avoyelles counties, Louisiana, in the northeast area.

Reservoirs: The reservoir rock in this play is coccolith- and foraminifera-bearing fractured chalk. Reservoir quality is dependent upon the intensity of fracturing in the chalk. Depths of untested reservoir cells range from 7,000 to 12,000 feet.

Source rocks: The sources for the oil and gas in the Austin Chalk are interpreted to be organic-bearing micrites within the Austin, particularly in the deeper parts of the play, and organic-bearing mudstones of the Eagleford Formation.

Traps: The mid-dip area of the Austin Chalk does not contain the large structures associated with fault zones such as in the Austin Updip Oil Play (4713). Unlike the greater Pearsall area, these outlying areas may not have the large, subtle domal structure that may have served to focus fracturing. Fractured chalk reservoir rock appears to be intercalated with shales and marls that did not fracture like the chalk; trapping may be related in part to the fact that fractured chalk is sealed by non-fractured shale and marl.

Exploration status and resource potential: Given the cell size, mean numbers of cells, the mean EUR, and the success ratio, the Austin Chalk in the Outlying Areas Play is estimated to contain a mean of about 200 MMBO. Although this play was not assessed using fields, Elaine, Cherokee , and Brookeland fields are included in the play area.

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SYSTEM	SERIES	RIO GRANDE EMBAYMENT	S. LOUISIANA, HOUSTON EMBAYMENT, SAN MARCOS ARCH
QUAT.		Pleistocene	Pleistocene
TERTIARY	Plio.	Pliocene	Pliocene
	Miocene	Upper Miocene	Upper Miocene
		Middle Miocene	Middle Miocene
		Lower Miocene	Lower Miocene
	Oligocene	Anahuac / Frio	Anahuac / Frio / Hackberry
		Vicksburg	Vicksburg
	Eocene	Jackson	Jackson
		Yegua	Yegua
		Cook Mountain	Cook Mountain
		Sparta	Sparta
		Weches	Weches
		Queen City	Queen City
		Reklaw	Reklaw
		Carrizo	Carrizo
	Paleocene	Wilcox	Wilcox
		Midway	Midway
CRETACEOUS	Gulfian	Escondido	Navarro
		Olmos	Taylor
		San Miguel	
		Anacacho	"Serpentine" and Dale Lime
		Austin	Austin
		Eagle Ford	Eagle Ford / Woodbine
	Comanchean	Buda	Buda
		Del Rio	Del Rio
		Georgetown	Georgetown
		Edwards / Stuart City	Edwards / Stuart City
		Glen Rose	Glen Rose
		Pearsall	Pearsall
	Coahuilan	Sligo	Sligo
		Hosston	Hosston
JURASSIC	Upper	Cotton Valley	Cotton Valley
		Gilmer	Gilmer
		Buckner / Smackover	Buckner / Smackover
		Norphlet	Norphlet
	Mid.	Louann Salt / Eagle Mills	Louann Salt / Eagle Mills
Pz		Ouachita Facies	Ouachita Facies