U.S. Gulf Coast Petroleum Systems Project

Assessment of Undiscovered Conventional Oil and Gas Resources in the Downdip Paleogene Formations, U.S. Gulf Coast, 2017

Using a geology-based assessment methodology, the U.S. Geological Survey estimated mean undiscovered, technically recoverable conventional resources of 100 million barrels of oil and 16.5 trillion cubic feet of gas in the downdip Paleogene formations in onshore lands and State waters of the U.S. Gulf Coast region.

Introduction

The U.S. Geological Survey (USGS) assessed undiscovered, technically recoverable oil and gas resources in the conventional sandstone reservoirs of downdip Paleogene formations deposited along an arcuate extent from south Texas through Louisiana (Salvador, 1991). The USGS conducts geology-based assessments of undiscovered petroleum resources by evaluating components of a total petroleum system (TPS), including source and reservoir rocks, seals and traps, and petroleum products geohistory. The interval assessed here is part of the Upper Jurassic–Cretaceous–Tertiary Composite TPS from Warwick and others (2007) in onshore lands and State waters of the U.S. Gulf Coast region (fig. 1). Within a TPS, strata in an assessment unit (AU) share similar stratigraphic, structural, and petroleum-charge histories. In this update of previous assessment work (Schenk and Viger, 1996; Dubiel and others, 2007), the USGS outlined 11 such AUs in the downdip Paleogene formations of the TPS (fig. 1). Eight AUs for conventional resources were quantitatively assessed, and three AUs for continuous (unconventional) resources were not quantitatively assessed.

Geologic Model for Assessment

Potential reservoirs in downdip Paleogene formations may exist as deep as 30,000 feet and may include paleoslope sandstones deposited as incised channel fills, slope fan channels, and ponded turbidites in intraslope minibasins. A paleoslope depositional environment was modeled for the AUs based on the stratigraphic interpretations of geophysical data, paleontologic picks, and combination of detrital zircon provenance studies with stratigraphic scaling relationships (Sømme and others, 2009). Potential seals consisting of fine-grained strata typical of continental slope deposits were interpreted as condensed sections on well logs and seismic lines. Trapping styles were interpreted to be both stratigraphic (for example, channel fill pinched out under distal overbank mudstones) and structural (for example, growth faulting in an expanded fault zone setting). AUs overlap with terrestrial source rocks interpreted in the west (Texas) of the TPS that transition to marine source rocks interpreted in the east (Lousiana), and thus, multiple Mesozoic–Paleogene source intervals are plausible (Hood and others, 2002), whereas thermal maturities are within the oil window or higher within the study area. Regardless, poor reservoir porosity, permeability, temperature, and pressure estimates may challenge further industry exploration.

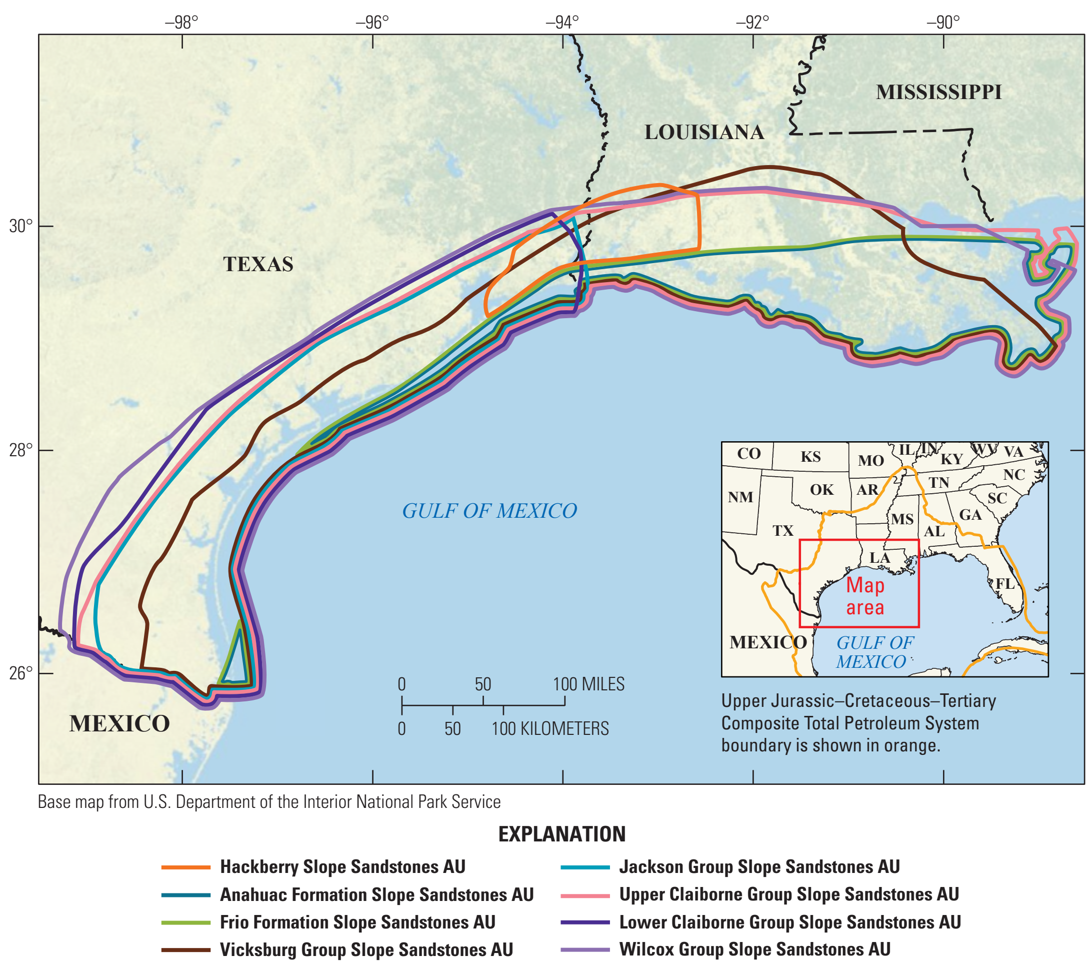

Figure 1. Map showing boundaries of the eight assessment units (AUs) in the downdip Paleogene formations along the U.S. Gulf Coast region. AU offshore boundary lines are shown side-by-side for illustration purposes.

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Assessment Units

Eight of 11 downdip Paleogene AUs were quantitatively assessed. These conventional AUs generally stack stratigraphically, and nearly all extend eastward from the United States-Mexico international border and northward from about the State-Federal waters limit. Table 1 lists input data used to calculate undiscovered resources in the eight conventional AUs.

The Hackberry Slope Sandstones AU incorporates upper Oligocene sandstone reservoirs of the middle part of the Frio Hackberry trend of eastern Texas and southwestern Louisiana (fig. 2). AU reservoirs comprise strata within rotated slide blocks and fill sequences in rotational fault accommodation spaces in updip areas and canyon and fan deposits farther downdip. Northern, western, and eastern AU boundaries are the limit of sand deposits in the Hackberry play, defined by Cossey and Jacobs (1992), and thus the limit of historical Hackberry production. The southern AU boundary is coincident with the northern boundary of the Frio Formation Slope Sandstones AU described below.

The Anahuac Formation Slope Sandstones AU comprises reservoirs in the downdip portion of the upper Oligocene Anahuac Formation. Paleodepositional systems of the reservoirs are sparse, shelf-fed channel, fan, and sheet sand deposits with the possibility of carbonate turbidites in eastern Louisiana. The updip AU boundary is the Frio paleoshelf margin, as interpreted by Galloway (2008), where transgressive facies of the Anahuac onlap the shelf.

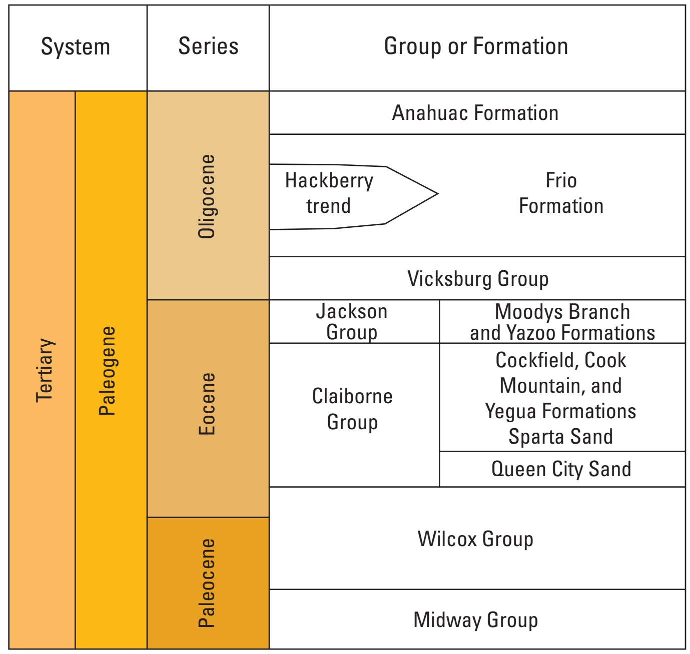


Figure 2. Generalized stratigraphic section of the northern Gulf of Mexico coastal plain downdip of the Paleogene shelf margins, modified from Schenk and Viger (1996).

Table 1. Key input data for eight conventional assessment units in the Tertiary slope sandstones of the downdip Paleogene formations, U.S. Gulf Coast region.

[AU, assessment unit; MMBO, million barrels of oil; BCFG, billion cubic feet of gas. Shading indicates not applicable]

Assessment input data—Conventional AUs	Hackberry Slope Sandstones AU				Anahuac Formation Slope Sandstones AU			
	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	3	6	3.1	1	6	30	6.8
Number of gas fields	5	12	30	12.6	1	25	125	28.5
Size of oil fields (MMBO)	0.5	0.7	20	1.1	0.5	1	100	2.5
Size of gas fields (BCFG)	3	7	300	13.1	3	10	1,000	26.7
AU probability	1.0				1.0			
Assessment input data—Conventional AUs	**Frio Formation Slope Sandstones AU**				**Vicksburg Group Slope Sandstones AU**			
	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	6	60	7.8	1	3	15	3.4
Number of gas fields	2	50	220	55.9	3	60	250	66.6
Size of oil fields (MMBO)	0.5	1	100	2.5	0.5	1	100	2.5
Size of gas fields (BCFG)	3	10	1,500	31.9	3	8	1,500	27.5
AU probability	1.0				1.0			
Assessment input data—Conventional AUs	**Jackson Group Slope Sandstones AU**				**Upper Claiborne Group Slope Sandstones AU**			
	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	3	15	3.4	1	7	50	8.5
Number of gas fields	1	30	200	36.0	8	80	500	94.9
Size of oil fields (MMBO)	0.5	1	100	2.5	0.5	1	100	2.5
Size of gas fields (BCFG)	3	10	1,000	26.7	3	10	1,000	26.7
AU probability	0.9				1.0			
Assessment input data—Conventional AUs	**Lower Claiborne Group Slope Sandstones AU**				**Wilcox Group Slope Sandstones AU**			
	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	3	20	3.6	1	5	30	5.9
Number of gas fields	1	50	250	57.0	2	120	1,000	150.7
Size of oil fields (MMBO)	0.5	1	100	2.5	0.5	1	100	2.5
Size of gas fields (BCFG)	3	10	1,000	26.7	3	12	2,500	45.4
AU probability	1.0				1.0			

The Frio Formation Slope Sandstones AU incorporates paleoslope sandstone reservoirs within lower to upper Oligocene Frio Formation strata. Paleodepositional systems of the reservoirs are both sand aprons in south Texas fed by the Norma and Norias Deltas and shelf-fed submarine channel and fan deposits throughout the AU. The updip AU boundary is the Frio shelf margin from Galloway (2008).

The Vicksburg Group Slope Sandstones AU consists of lower Oligocene Vicksburg Group sandstone reservoirs found downdip of the Vicksburg paleoshelf margin. Reservoirs are delta-fed aprons along the paleoshelf margin in Texas and sparsely distributed turbidite deposits throughout the AU, which therefore has a decreased probability. The updip AU boundary in south Texas is the Vicksburg shelf margin as defined by Coleman (1990), and the updip boundary in eastern Texas and southern Louisiana is the reinterpreted Vicksburg shelf margin and downdip limit of post-Vicksburg erosion.

The Jackson Group Slope Sandstones AU reservoirs comprise downdip equivalents of the upper Eocene and lower Oligocene Moodys Branch and Yazoo Formations. With a major paleodeposition center located downdip of the Rio Grande embayment, the AU only extends eastward to a facies change to primarily clay in the vicinity of the Texas-Louisiana State line. The Jackson paleoshelf margin from Galloway (2008) defines the northern AU limit.

The Upper Claiborne Group Slope Sandstones AU comprises downdip reservoirs of the middle Eocene Cockfield, Cook Mountain, and Yegua Formations and Sparta Sand (fig. 2). Paleodepositional systems included progradational shelf-fed and delta-fed aprons. The Yegua paleoshelf margin from Galloway (2008) defines the northern AU limit.

The Lower Claiborne Group Slope Sandstones AU comprises downdip reservoirs of the middle Eocene Queen City Sand. Sands of the Queen City were likely transported from the south Texas Rio Grande embayment to the paleoshelf edge and beyond, though they are not interpreted to extend east past the Texas-Louisiana State line. The Queen City paleoshelf margin from Galloway (2008) defined the northern AU limit.

The Wilcox Group Slope Sandstones AU comprises paleoslope sandstone reservoirs of the Paleocene–Eocene Wilcox Group strata. Paleodepositional systems of the reservoir strata are sandy delta-fed aprons and shelf-fed aprons in onshore Texas and Louisiana (McDonnell and others, 2008). The upper Wilcox Group shelf margin from Galloway (2008) defined the northern AU limit.

The continuous AUs reflect the extent of potentially self-sourcing shale oil and (or) gas resources. The Lower Claiborne Group Continuous AU, the Wilcox Group Continuous AU, and the Midway Group Continuous AU were defined where there is evidence of organic-rich, marine kerogen-rich mudstones in the oil-window or higher thermal maturity zone. There is no known development of continuous resources in this TPS from these three groups, and the source rock potential of these formations is not well known. Therefore, these three AUs were not quantitatively assessed.

Undiscovered Resources Summary

The USGS assessed undiscovered, technically recoverable resources for eight conventional oil and gas AUs in the downdip Paleogene formations (table 2). The estimated mean totals are 100 million barrels of oil (MMBO) with an F95–F5 range from 13 to 310 MMBO; 16,500 billion cubic feet of gas (BCFG), or 16.5 trillion cubic feet of gas, with an F95–F5 range from 4,033 to 38,851 BCFG; and 409 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 91 to 1,001 MMBNGL.

Table 2. Results for eight conventional assessment units in the Tertiary slope sandstones of the downdip Paleogene formations, U.S. Gulf Coast region.

[MMBO, million barrels of oil; BCFG, billion cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included in the NGL category. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. Fractiles are additive under the assumption of perfect positive correlation. Shading indicates not applicable]

Total petroleum system and assessment units (AUs)	AU probability	Accumulation type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Upper Jurassic–Cretaceous–Tertiary Composite Total Petroleum System														
Hackberry Slope Sandstones AU	1.0	Oil	1	3	7	3	3	8	25	10	0	0	1	0
		Gas					71	146	321	164	4	10	24	11
Anahuac Formation Slope Sandstones AU	1.0	Oil	3	12	50	17	3	16	85	30	0	1	3	1
		Gas					187	635	1,759	759	6	23	77	30
Frio Formation Slope Sandstones AU	1.0	Oil	2	12	62	19	2	17	104	30	0	1	5	2
		Gas					528	1,548	3,828	1,780	17	57	167	70
Vicksburg Group Slope Sandstones AU	1.0	Oil	1	5	27	8	1	7	45	13	0	0	2	1
		Gas					571	1,609	3,853	1,833	19	59	169	72
Jackson Group Slope Sandstones AU	0.9	Oil	0	4	26	8	0	10	70	20	0	1	3	1
		Gas					0	695	2,291	866	0	15	51	19
Upper Claiborne Group Slope Sandstones AU	1.0	Oil	3	14	64	21	7	35	170	55	0	2	9	3
		Gas					739	2,121	5,664	2,517	16	47	126	56
Lower Claiborne Group Slope Sandstones AU	1.0	Oil	1	5	29	9	2	12	79	23	0	1	4	1
		Gas					443	1,313	3,307	1,521	9	29	75	34
Wilcox Group Slope Sandstones AU	1.0	Oil	2	10	45	15	5	23	120	38	0	1	4	1
		Gas					1,471	5,420	17,130	6,841	20	82	281	107
Total undiscovered conventional resources			**13**	**65**	**310**	**100**	**4,033**	**13,615**	**38,851**	**16,500**	**91**	**329**	**1,001**	**409**

References Cited

Coleman, J.M.C., 1990, Depositional systems and tectonic/eustatic history of the Oligocene Vicksburg episode of the northern Gulf Coast: University of Texas at Austin, Ph.D. dissertation, 722 p.

Cossey, S.P.J., and Jacobs, R.E., 1992, Oligocene Hackberry formation of southwest Louisiana—Sequence stratigraphy, sedimentology, and hydrocarbon potential: American Association of Petroleum Geologists Bulletin, v. 76, no. 5, p. 589–606.

Dubiel, R.F., Pitman, J.K., Pearson, O.N., Warwick, P.D., Karlsen, A.W., Coleman, J.L., Hackley, P.C., Hayba, D.O., Swanson, S.M., Charpentier, R.R., Cook, T.A., Klett, T.R., Pollastro, R.M., and Schenk, C.J., 2007, Assessment of undiscovered oil and gas resources in Tertiary strata of the Gulf Coast, 2007: U.S. Geological Survey Fact Sheet 2007–3066, 4 p. [Also available at https://pubs.usgs.gov/fs/2007/3066/.]

Galloway, W.E., 2008, Depositional evolution of the Gulf of Mexico sedimentary basin, chap. 15 *of* Miall, A.D., ed., The sedimentary basins of the United States and Canada, volume 5: The Netherlands, Elsevier, Sedimentary Basins of the World, p. 505–549.

Hood, K.C., Wenger, L.M., Gross, O.P., and Harrison, S.C., 2002, Hydrocarbon systems analysis of the northern Gulf of Mexico—Delineation of hydrocarbon migration pathways using seeps and seismic imaging, *in* Schumacher, D., and LeShack, L.A., eds., Surface exploration case histories—Applications of geochemistry, magnetics, and remote sensing: American Association of Petroleum Geologists, Studies in Geology No. 48, and Society of Economic Geologists, Geophysical References Series No. 11, p. 25–40.

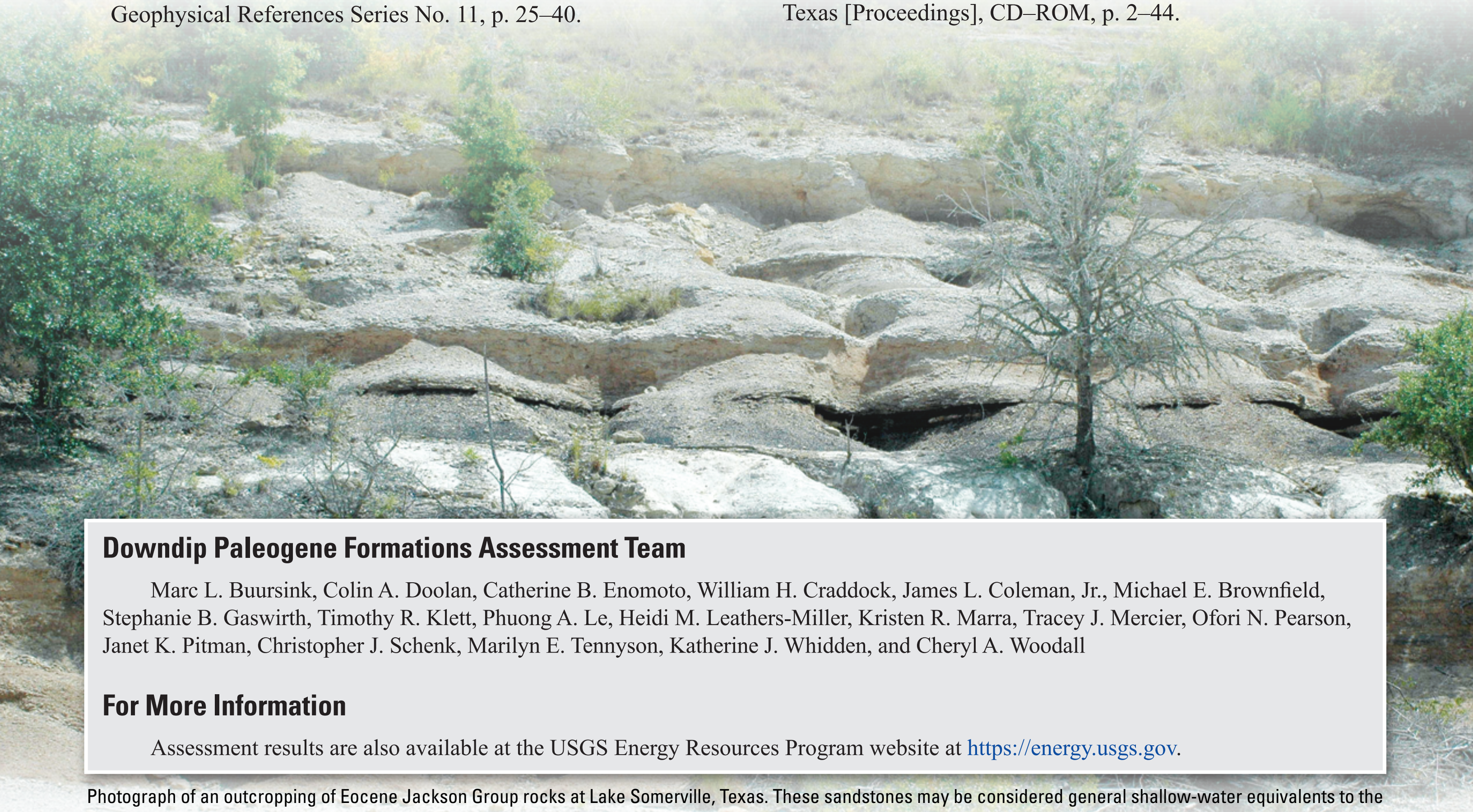
McDonnell, A., Loucks, R.G., and Galloway, W.E., 2008, Paleocene to Eocene deep-water slope canyons, western Gulf of Mexico—Further insights for the provenance of deep-water offshore Wilcox Group plays: American Association of Petroleum Geologists Bulletin, v. 92, no. 9, p. 1169–1189.

Salvador, A., ed., 1991, The Gulf of Mexico Basin: Boulder, Colo., Geological Society of America, Decade of North American Geology, v. J, 568 p.

Schenk, C.J., and Viger, R.J., 1996, Western Gulf Province (047), *in* Gautier, D.L., Dolton, G.L., Takahashi, K.I., and Varnes, K.I., eds., 1995 national assessment of United States oil and gas resources—Results, methodology, and supporting data [release 2]: U.S. Geological Survey Digital Data Series DDS–30, 44 p. [Also available at https://certmapper.cr.usgs.gov/data/noga95/prov47/text/prov47.pdf.]

Sømme, T.O., Helland-Hansen, W., Martinsen, O.J., and Thurmond, J.B., 2009, Relationships between morphological and sedimentological parameters in source-to-sink systems—A basis for predicting semi-quantitative characteristics in subsurface systems: Basin Research, v. 21, no. 4, p. 361–387.

Warwick, P.D., Coleman, J.L., Hackley, P.C., Hayba, D.O., Karlsen, A.W., Rowan, E.L., and Swanson, S.M., 2007, USGS assessment of undiscovered oil and gas resources in Paleogene strata of the U.S. Gulf of Mexico Coastal Plain and State waters, *in* Kennan, L., Pindell, J., and Rosen, N.C., The Paleogene of the Gulf of Mexico and Caribbean Basins—Processes, events, and petroleum systems: 27th Annual Gulf Coast Section Society for Sedimentary Geology (GCSSEPM) Bob F. Perkins Research Conference, December 2–5, 2007, Houston, Texas [Proceedings], CD–ROM, p. 2–44.



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For More Information

Assessment results are also available at the USGS Energy Resources Program website at https://energy.usgs.gov.

Photograph of an outcropping of Eocene Jackson Group rocks at Lake Somerville, Texas. These sandstones may be considered general shallow-water equivalents to the slope sandstones investigated in this Paleogene assessment. Photograph by James L. Coleman, Jr., is also used as banner image.

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