PS Depositional History and Shoreline Evolution of the Upper Wilcox Group and Lower Reklaw Formation, Northern Bee County, Texas*

William Ambrose[1], Hongliu Zeng[1], Mariana Olariu[1], and Jinyu Zhang[1]

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[1]Bureau of Economic Geology, Austin, Texas (william.ambrose@beg.utexas.edu)

Abstract

A detailed study of the upper Wilcox Group and lower Reklaw Formation, based on core, wireline-log, and 3-D seismic data in northern Bee County, Texas resolves this succession into 19 fourth-order sequences and demonstrates greater variability in depositional systems, facies, shoreline evolution, and reservoir sandstone-body geometry than previously documented. Earlier studies of the upper Wilcox Group in south Texas interpreted fluvial-dominated, wave-modified deltaic systems from thick (commonly > 400 ft [>122 m]), undivided stratigraphic intervals that encompass multiple depositional episodes. In contrast, mapping thinner, fourth-order sequences reveals a mosaic of wave-dominated shoreface, inner-shelf, lower-coastal-plain streamplain, and fluvial systems. A complex shoreline trajectory records numerous transgressive-regressive cycles representing multiple episodes of shoreline retreat and advance in south Texas.

The lower one-half of the upper Wilcox succession represents a major, 700 ft (213 m) retrogradational cycle capped by shelf deposits. It is overlain by a 300 ft (91.5 m) regressive cycle including a bedload fluvial system that truncates wave-dominated shoreline deposits. In turn, the overlying lower Reklaw stratigraphic succession represents a period of shoreline stabilization along the upper Wilcox/lower Reklaw shelf margin. Although upper Wilcox sedimentary delivery systems were continental in scale, most upper Wilcox sequences in northern Bee County are composed of small-scale depositional elements inferred to occur between regional, large-scale depocenters. Brazos Delta and other small-scale depositional features such as tidal inlets and lower-coastal-plain streamplain systems are appropriate analogs for upper Wilcox and Reklaw sequences at local scales in south Texas and should be considered in additional reservoir development.

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Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas at Austin

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ABSTRACT

A detailed study of the upper Wilcox Group and lower Reklaw Formation—based on core, wireline-log, and 3D seismic data in northern Bee County, Texas—resolves this succession into 19 fourth-order sequences and demonstrates greater variability in depositional systems, facies, shoreline evolution, and reservoir sandstone-body geometry than previously documented. Previous studies interpreted deltaic systems from thick (commonly >400-ft [>122-m]), undivided stratigraphic intervals that encompass multiple depositional episodes. In contrast, mapping thinner, fourth-order sequences reveals a mosaic of wave-dominated shoreface, inner-shelf, lower-coastal-plain streamplain, and fluvial systems. A complex shoreline trajectory records numerous transgressive–regressive cycles representing episodes of shoreline retreat and advance in South Texas. The lower half of the upper Wilcox succession is a major, 700-ft (213-m) retrogradational cycle capped by shelf deposits. It is overlain by a 300-ft (91.5-m) regressive cycle including a fluvial system that truncates wave-dominated shoreline deposits. In turn, the overlying lower Reklaw Formation represents a period of shoreline stabilization along the upper Wilcox shelf margin. Although upper Wilcox sedimentary delivery systems were continental in scale, most upper Wilcox sequences in northern Bee County are composed of small-scale depositional elements inferred to occur between regional, large-scale depocenters. Brazos Delta and other small-scale depositional features such as tidal inlets and lower-coastal-plain streamplain systems are appropriate analogs for upper Wilcox and Reklaw sequences at local scales in South Texas and should be considered in additional reservoir development.

OBJECTIVES

- Display fourth-order stratigraphic succession and shoreline trajectory
- Delineate sandstone geometry and interpret depositional systems
- Document evolution of shoreline and lower-coastal-plain systems
- Relate depositional systems and facies to oil and gas productivity

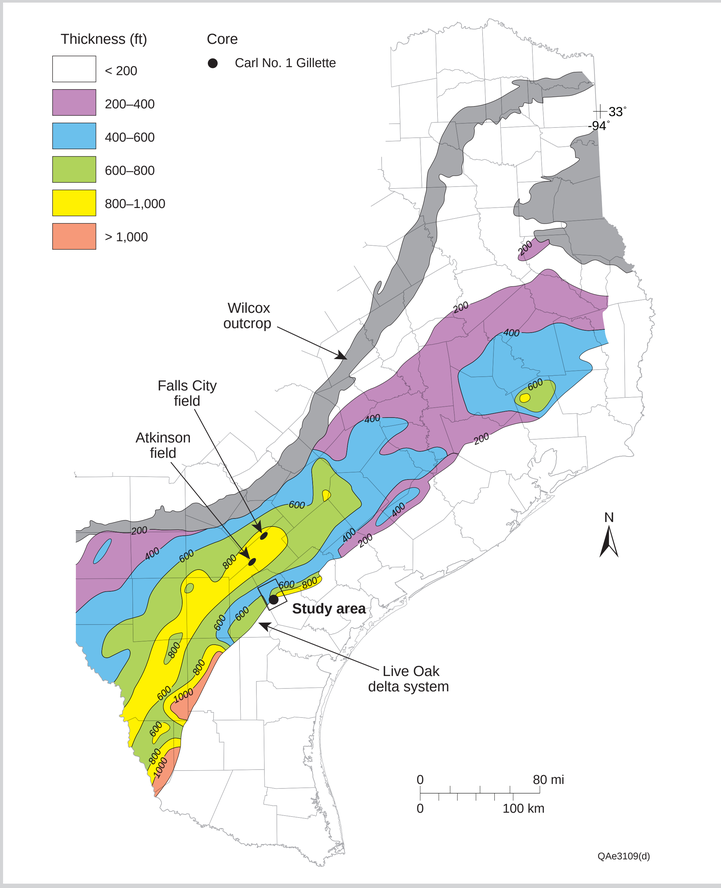

Fig. 1. Thickness of the upper Wilcox Group in Texas with location of study area. Modified from Bebout et al. (1982).

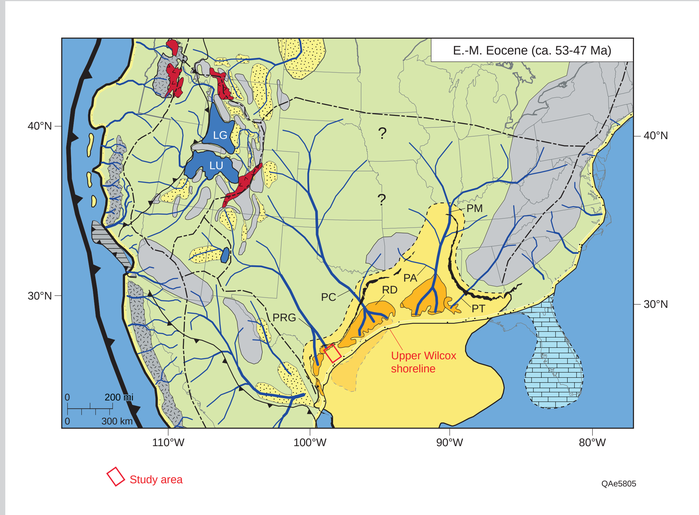

Fig. 2. Upper Wilcox paleogeography. Modified from Sharman et al. (2016).

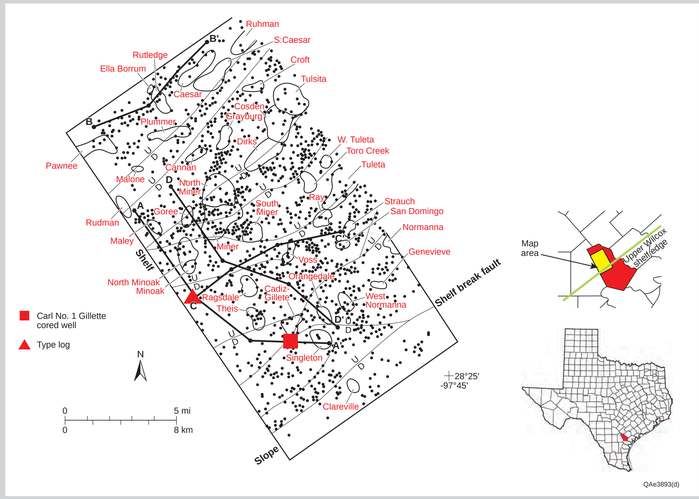

Fig. 3. Study area with well control. Also shown are location of type log (fig. 4), cored well (Carl No. 1 Gillette [description in fig. 13]), and wireline-log cross sections. Approximate location of upper Wilcox shelf edge is from Edwards (1981). Regional location of map area is shown in figs. 1 and 2.

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INTRODUCTION

The upper Wilcox Group comprises a major oil-and-gas trend in the south and south-central Texas Gulf Coast. It has been interpreted as a succession of primarily shelf-edge deltas in a wave-dominated coastal setting (Fisher and McGowen, 1967; Edwards, 1981). These deltas, based on trends in net-sandstone maps and observations from whole cores, were inferred as either lobate and wave-modified or dip-elongate digitate, and fluvial-dominated in origin (Edwards, 1981; Bebout et al., 1982). Depositional-systems interpretations of the upper Wilcox Group in South Texas were primarily based on correlation and mapping of thick (200- to 400-ft [61.5- to 122-m]) sections commonly combining several fourth-order sequences, resulting in mapping and interpreting composite depositional systems.

This study and companion studies by Zhang et al. (2016) and Zeng et al. (2016) resolve the upper Wilcox Group and Reklaw Formation into high-resolution, fourth-order regressive–transgressive sequences (Figs. 4 and 5). They also document evolution of depositional systems and chart the upper Wilcox and Reklaw shoreline trajectory in south-central Texas. This study complements and refines studies by Zhang et al. (2016) and Zeng et al. (2016) by focusing on a small area in northern Bee County, bounded on the southern margin by the upper Wilcox shelf edge (Fig. 3). It provides detailed net-sandstone maps of 19 regressive–transgressive, fourth-order sequences in the upper Wilcox and Reklaw stratigraphic succession, and documents its stratigraphic evolution. It also demonstrates variability in depositional styles and facies beyond that illustrated in previous studies, and delineates controls on sandstone-body architecture at the reservoir scale.

STRATIGRAPHY AND SHORELINE TRAJECTORY

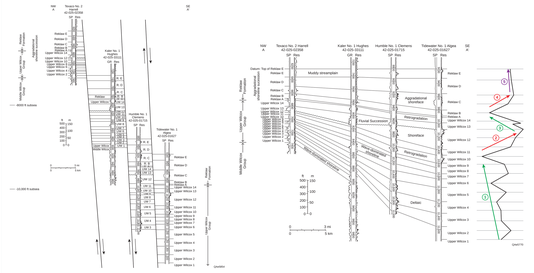

Fig. 4. Structural dip section A-A'. Section is located in figure 3. Same cross section with stratigraphic datum is shown in figure 5.

Fig. 5. Stratigraphic dip section A-A'. Datum is the top of the Reklaw E sequence. Section is located in figure 3. Same cross section with structural datum is shown in figure 4. Shoreline-trajectory chart is displayed on right margin.

DELTAIC SYSTEMS

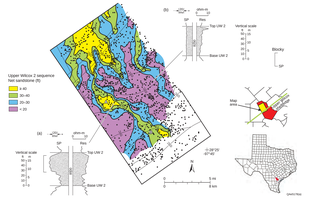

Fig. 6. Fluvial-dominated deltas in the upper Wilcox 2 sequence.

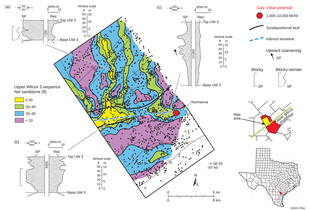

Fig. 7. Fluvial-dominated deltas in the upper Wilcox 6 sequence.

Fig. 8. Google Earth image of the Fraser River Delta, a depositional analog for the upper Wilcox 2 sequence (figs. 6 and 7).

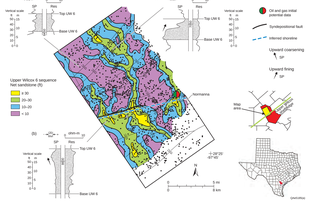

Fig. 9. Small, lobate deltas A and B in the upper Wilcox 3 sequence.

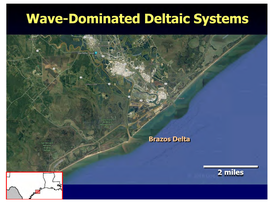

Fig. 10. Google Earth image of the Brazos Delta, a depositional analog for the upper Wilcox 3 sequence (Fig. 9).

WAVE-DOMINATED SHORELINE SYSTEMS

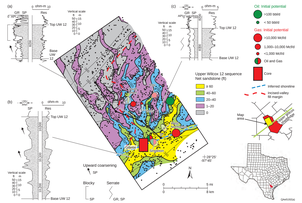

Fig. 11. Wave-dominated shoreline systems in the upper Wilcox 12 sequence. Core description is displayed in figure 13.

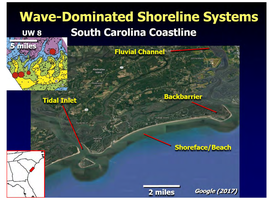

Fig. 12. Google-Earth image of part of the South Carolina coastline, a depositional analog for the upper Wilcox 12 sequence (fig. 11).

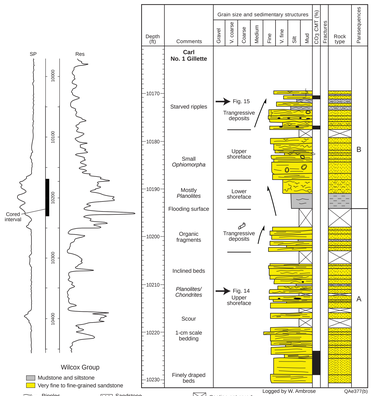

Fig 13. Core description of shoreface deposits in the Carl No. 1 Gillette well, located in fig. 11.

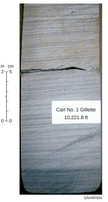

Fig 14. Upper shoreface facies at 10,211.2 ft. See figure 13 for stratigraphic occurrence.

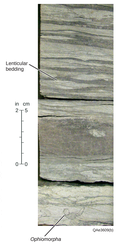

Fig 15. Transgressive facies at 10.173.0 ft. See figure 13 for stratigraphic occurrence.

SHELF SYSTEMS

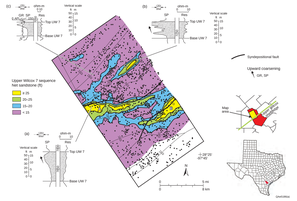

Fig. 16. Fault-bounded shelf-bar deposits in the upper Wilcox 7 sequence.

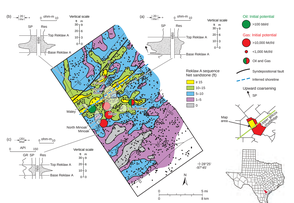

Fig. 17. Transgressive shelf deposits in the Reklaw A sequence.

LOWSTAND FLUVIAL SYSTEMS

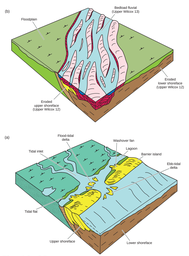

Fig. 18. 3D stratigraphic relationships between the highstand marine upper Wilcox 12 and lowstand fluvial upper Wilcox 13 sequences.

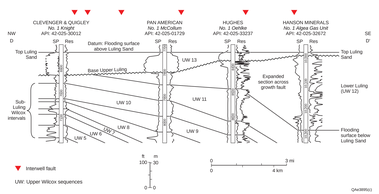

Fig. 19. Stratigraphic cross section D-D', displaying truncation of the Lower Luling Sand (UW 12) by the Upper Luling Sand (UW 13). Section located in figure 3.

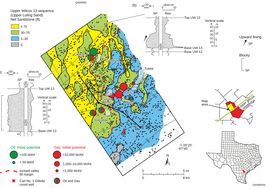

Fig. 20. Lowstand fluvial deposits in the upper Wilcox 13 sequence.

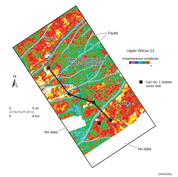

Fig. 21. Instantaneous-frequency map, combined UW 12 and UW 13 sequences.

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PRODUCTIVITY AND DEPOSITIONAL SYSTEMS

The upper Wilcox/Reklaw succession in northern Bee County produces oil and gas from a wide variety of depositional systems types. The greatest number of wells with production data are in wave-dominated shoreline systems (fig. 22). Most production data in fluvial-dominated deltaic reservoirs in the study area are from distributary-channel facies (fig. 23). However, production data exist for other deltaic facies, including delta-front, channel-mouth-bar, crevasse-splay, and interdistributary-bay. Both oil and gas productivity are greatest in sandy channel-axis deposits in fluvial systems (fig. 24). However, channel-margin and less-sandy interchannel facies are also productive. These facies are more heterogeneous than sandstone-rich, axial-fluvial-channel facies and are composed of overbank and crevasse-splay sandstones that pinch out into muddy floodplain deposits where potential stratigraphic traps may occur. Shelf and transgressive depositional systems in the upper Wilcox Group in northern Bee County display great variability, with some wells having limited volumes of oil (fig. 25).

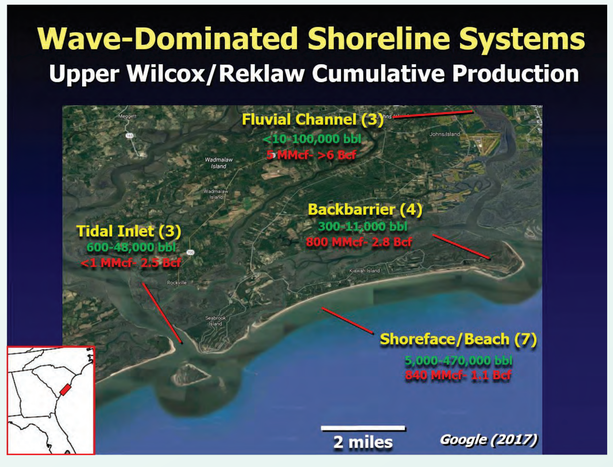

Fig. 22. Oil and gas production in upper Wilcox/ Reklaw wave-dominated shoreline systems, with South Carolina coastline as analog.

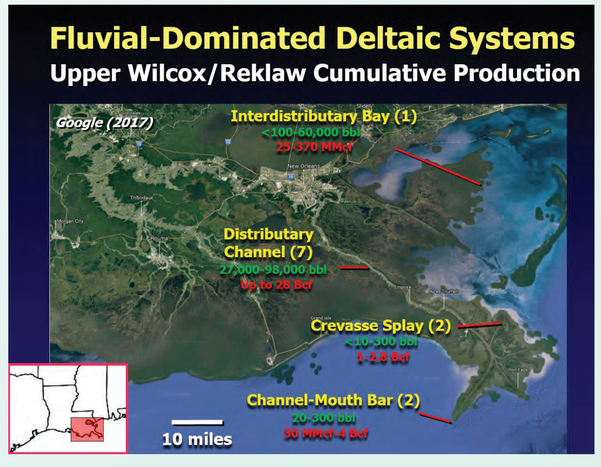

Fig. 23. Oil and gas production in upper Wilcox/ Reklaw fluvial-dominated deltaic systems, with greatly upscaled modern analog.

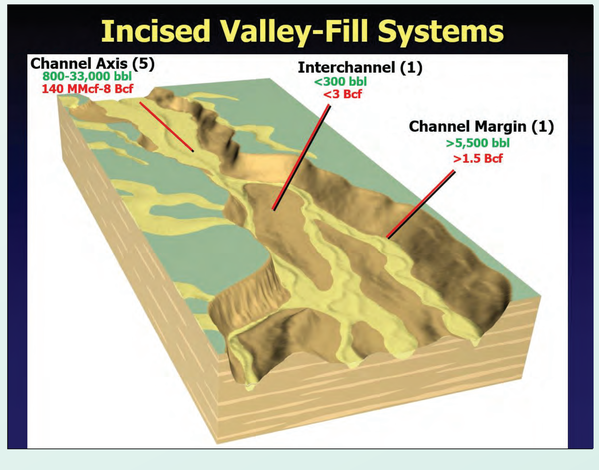

Fig. 24. Oil and gas production in upper Wilcox/ Reklaw incised-valley fluvial systems.

Fig. 25. Oil and gas production in upper Wilcox/ Reklaw transgressive-shoreline/shelf systems.

CONCLUSIONS

Sediment-delivery systems in the upper Wilcox Group in the Texas Gulf Coast were associated with continental-scale drainage patterns. However, net-sandstone maps of many upper Wilcox and Reklaw sequences in South Texas suggest small-scale depositional elements.

Structural controls on deposition for upper Wilcox and Reklaw sequences in northern Bee County are inferred from abrupt increases in isopach and net-sandstone values across faults, coinciding with facies changes. Reklaw sequences C to E are preferentially developed on the downthrown side of upper Wilcox shelf-edge faults, suggesting shoreline still stands and increased accommodation.

Trap styles for hydrocarbons include structural, stratigraphic, and combination structural/stratigraphic types. The most productive facies in wave-dominated shoreline and deltaic systems in the upper Wilcox and Reklaw Formations occur in shoreface/beach deposits, whereas distributary-channel facies are predominant in fluvial-dominated deltaic systems.

REFERENCES

Bebout, D. G., Weise, B. R., Gregory, A. R., and Edwards, M. B., 1982, Wilcox sandstone reservoirs in the deep subsurface along the Texas Gulf Coast: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 117, 125 p. plus plates, doi:10.23867/RI0117D.

Edwards, M. B., 1981, Upper Wilcox Rosita Delta System of south Texas: growth-faulted shelf-edge deltas: AAPG Bulletin, v. 65, no. 1, p. 54–73.

Fisher, W. L., and McGowen, J. H., 1967, Depositional systems in the Wilcox Group of Texas and their relationship to occurrence of oil and gas: The University of Texas at Austin, Bureau of Economic Geology Geologic Circular No. 67-4, 20 p.

Sharman, G. R., Covault, J. A., Stockli, D. F., Wroblewski, A. F.-J., and Bush, M. A., 2016, Early Cenozoic drainage reorganization of the United States Western Interior—Gulf of Mexico sediment routing system: Geology, v. 45, no. 2, p. 187–190, doi:10.1130/G38765.1.

Zeng, H., Ambrose, W. A., and Xu, W., 2016, Sediment dispersal patterns of the outer shelf to upper slope Paleocene-Eocene Wilcox Group, south-central Texas coast: Gulf Coast Association of Geological Societies Journal, v. 5, p. 215–237.

Zhang, J. Steel, R., and Ambrose, W., 2016, Greenhouse shoreline migration: Wilcox deltas: AAPG Bulletin, v. 100, p. 1803–1831, doi:10.1306/04151615190.

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