



# Stratigraphic Evolution of Fluvial-Dominated Deltaic and Wave-Modified Shoreline Systems in the Eocene Yegua Formation in Northern Jim Wells County, South Texas

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## ABSTRACT

The late middle Eocene Yegua Formation in northern Jim Wells County in South Texas is a stratigraphic succession of fifteen fourth-order depositional units composed of fluvial-dominated delta, wave-dominated delta, and shoreface deposits. These depositional units collectively compose an offlapping, progradational clastic wedge punctuated by two major retrogradational cycles. During periods of coastal offlap, a succession of fluvial-dominated deltas prograded eastward and southeastward across northern Jim Wells County. In contrast, retrogradational cycles are marked by strike-elongate, northeast-trending net-sandstone trends that record wave-reworked deltaic headlands and continuous (>25 mi [>40 km]) sandy belts composed of wave-dominated shoreline deposits.

Distributary-channel deposits in the Yegua Formation are defined by narrow (<2 mi [<3.2 km]), dip-elongate and southeast-bifurcating net-sandstone trends with  $\geq 30$  ft ( $\geq 9$  m) of net sandstone. The transition from prodelta to proximal-delta-front and channel-mouth-bar facies, interpreted from whole-core data, consists of 40 to 50 ft (12 to 15 m), upward-coarsening sections of burrowed, silty mudstones interbedded with thin (<1 ft [<0.3 m]), very fine-grained sandstone beds, in turn overlain by 10 to 12 ft (3 to 6 m) sections of very fine- and fine-grained sandstone with plane beds and ripple cross-stratification.

Oil and gas production in the Yegua Formation in northern Jim Wells County is primarily related to fault-bounded, sandy distributary-channel, delta-front, and upper-shoreface deposits. Major Yegua oil and gas fields include Alice, Amargosa, Ben Bolt, Braman, Muerto Creek, Orange Grove, and San Diego East fields. Primary producing facies in Yegua fluvial-dominated deltaic systems include distributary-channel margin, distributary-channel, and channel-mouth-bar/proximal-delta front, with production in individual gas wells ranging from <100 MMcf (million cubic feet) to >1 Bcf (billion cubic feet). Oil production in the Yegua Formation in northern Jim Wells County is comparatively minor compared to gas production, with the greatest cumulative production in many individual wells <20,000 bbl (barrels). However, oil production in some wells exceeds 100,000 bbl. Oil and gas production in Yegua wave-dominated shoreline systems is less than in fluvial-dominated deltaic systems, with cumulative oil production in most individual wells <5000 bbl. There are numerous areas in northern Jim Wells County where potential reservoir facies in the Yegua Formation could be tested for additional oil and gas production. These areas occur where regional faults transect narrow and sandy distributary-channel deposits and where sandy, wave-reworked deltaic headland deposits pinch out into delta-fringe mudstones.

## INTRODUCTION AND SIGNIFICANCE OF THIS STUDY

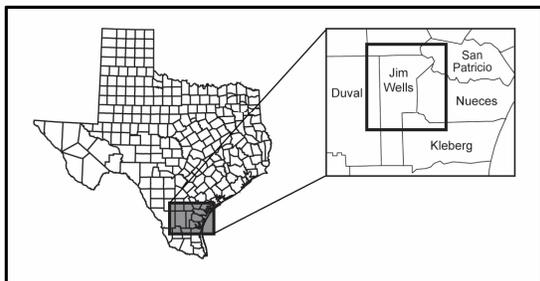
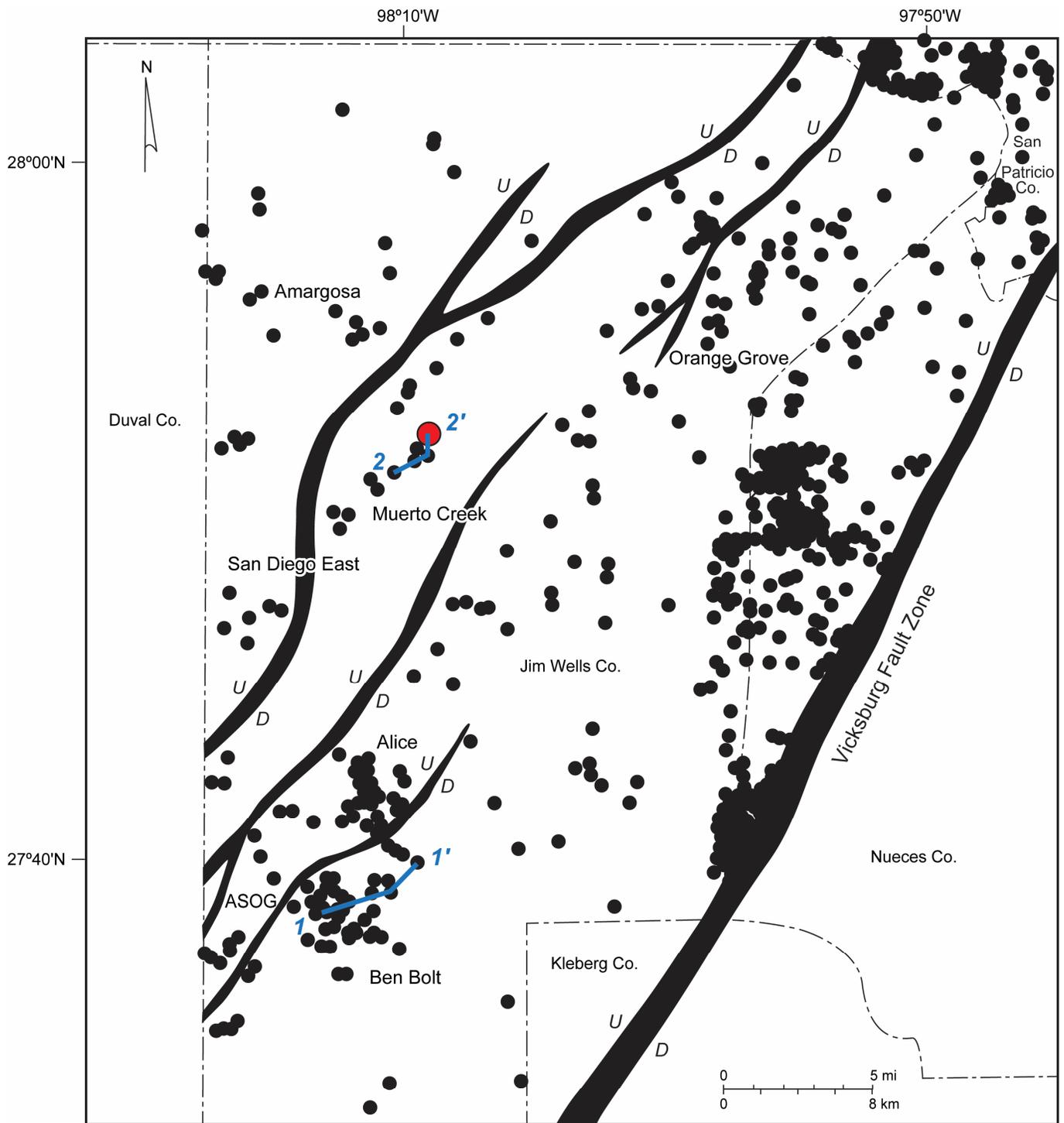
The late middle Eocene Yegua Formation in northern Jim Wells County in South Texas (Fig. 1) is a clastic stratigraphic

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succession bounded below by the Cook Mountain Formation and above by the Jackson Group (Fig. 2). The upper and middle Yegua Formation in eastern Duval and Jim Wells counties is overpressured and produces oil and gas in growth-fault trends (Ewing, 2007). Previous studies interpreted the Yegua Formation in South Texas as composed of strandplain and barrier-bar deposits fed by wave-reworked deltaic headlands (Van Dalen, 1981; Yuliantoro, 1995). In contrast, this study demonstrates that the Yegua Formation in northern Jim Wells County records a succession of fluvial-dominated deltas, with wave-modified deltaic and shoreline systems deposited during episodes of shoreline retrogradation.



Explanation

- Well control
- Cored well

QAf160(a)

Figure 1. Study area in northern Jim Wells County, major faults, well control, major oil and gas fields, location of cored well (TXO No. B-1 Gomez, API 42-249-31674), and location of stratigraphic cross sections 1-1' and 2-2', shown in Figures 2 and 7, respectively. Core descriptions are shown in Figures 5 and 6. Faults adopted from Ewing (2007).



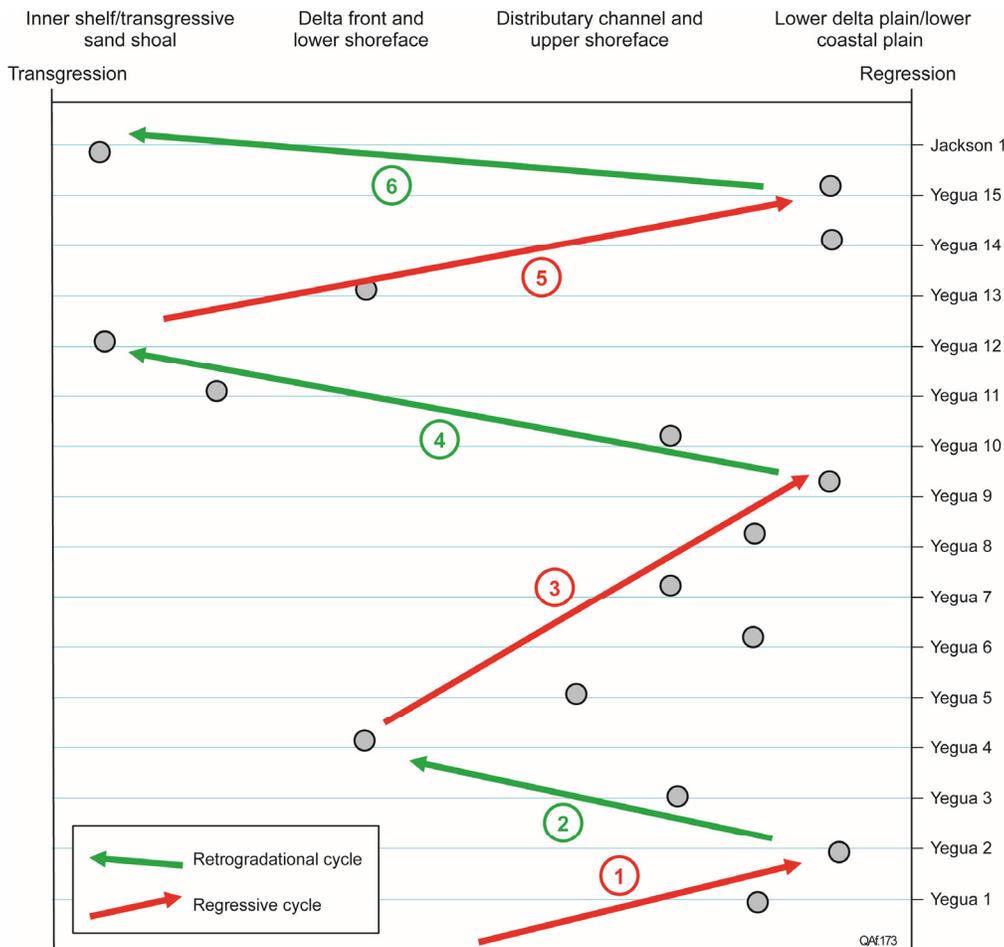
A shoreline trajectory chart of the Yegua Formation in northern Jim Wells County is based on relative positions of paleogeographic elements in fluvial-dominated deltaic and wave-dominated shoreline systems interpreted from net-sandstone maps of 15 Yegua depositional episodes. This shoreline trajectory chart shows that the Yegua Formation in northern Jim Wells County is net-regressive although punctuated by two major retrogradational episodes (Figs. 3 and 4A). The chart displays similarities to those of a chart of Yegua regressive and transgressive depositional episodes in Ewing (2007) although that study documents more high-frequency transgressive-regressive episodes (Fig. 4B). The regressive clastic wedge encompassed by the Y-25 to Y-50 sequence boundaries in Ewing (2007) (Fig. 4B) is approximately equivalent to the net-offlapping clastic wedge between the Yegua 5 and Yegua 10 depositional units in this study (Fig. 4A). This study recognizes an uppermost Yegua regressive cycle, in contrast to Ewing (2007), in which the uppermost Yegua succession is interpreted to be retrogradational.

The significance and value of this study is twofold: (1) it demonstrates that a high-resolution stratigraphic framework depicting net-sandstone trends of fourth-order depositional cycles is critical in accurately reconstructing the shoreline trajectory and the paleogeographic evolution of clastic depositional systems such as the Yegua Formation, and (2) documenting spatial relationships between net-sandstone and facies distribution and oil

and gas production to serve as a predictive model for hydrocarbon exploration.

### OBJECTIVES

This study had two (2) objectives: (1) To depict the shoreline trajectory of the Yegua Formation and the basal depositional unit in the Jackson Group (Jackson 1), interpreting major regressive and transgressive depositional cycles, and (2) to identify areas in northern Jim Wells County where sandstone-rich facies are near major faults or where stratigraphic traps may exist in sandstone-body pinchouts. Five (5) tasks were undertaken to meet these objectives. They were (1) to divide the Yegua Formation and the basal depositional unit in the Jackson Group (Jackson 1) in northern Jim Wells County into high-frequency, regressive-transgressive episodes, named informally the Yegua 1 to Yegua 15 and Jackson 1 depositional units (Figs. 2, 3, and 4A); (2) to describe lithology and sedimentary features from slabbed core (Figs. 5 and 6); (3) to construct net-sandstone maps of these depositional units to depict sandstone-body geometry; (4) to integrate core data with net-sandstone maps and cross sections from wireline logs to infer depositional systems and facies, thereby reconstructing the paleogeography of each depositional unit; and (5) annotate net-sandstone maps with oil- and gas-production data to document structural and facies controls on hydrocarbon production.



**Figure 3. Shoreline trajectory chart for the Yegua 1 to Jackson 1 depositional units in northern Jim Wells County, displaying regressive and retrogradational cycles 1 to 6. These depositional units are shown in stratigraphic cross section 1-1' (Fig. 2). Net-sandstone maps of these depositional units are shown in Figures 8, 9, and 13-17.**

**DATABASE AND METHODS**

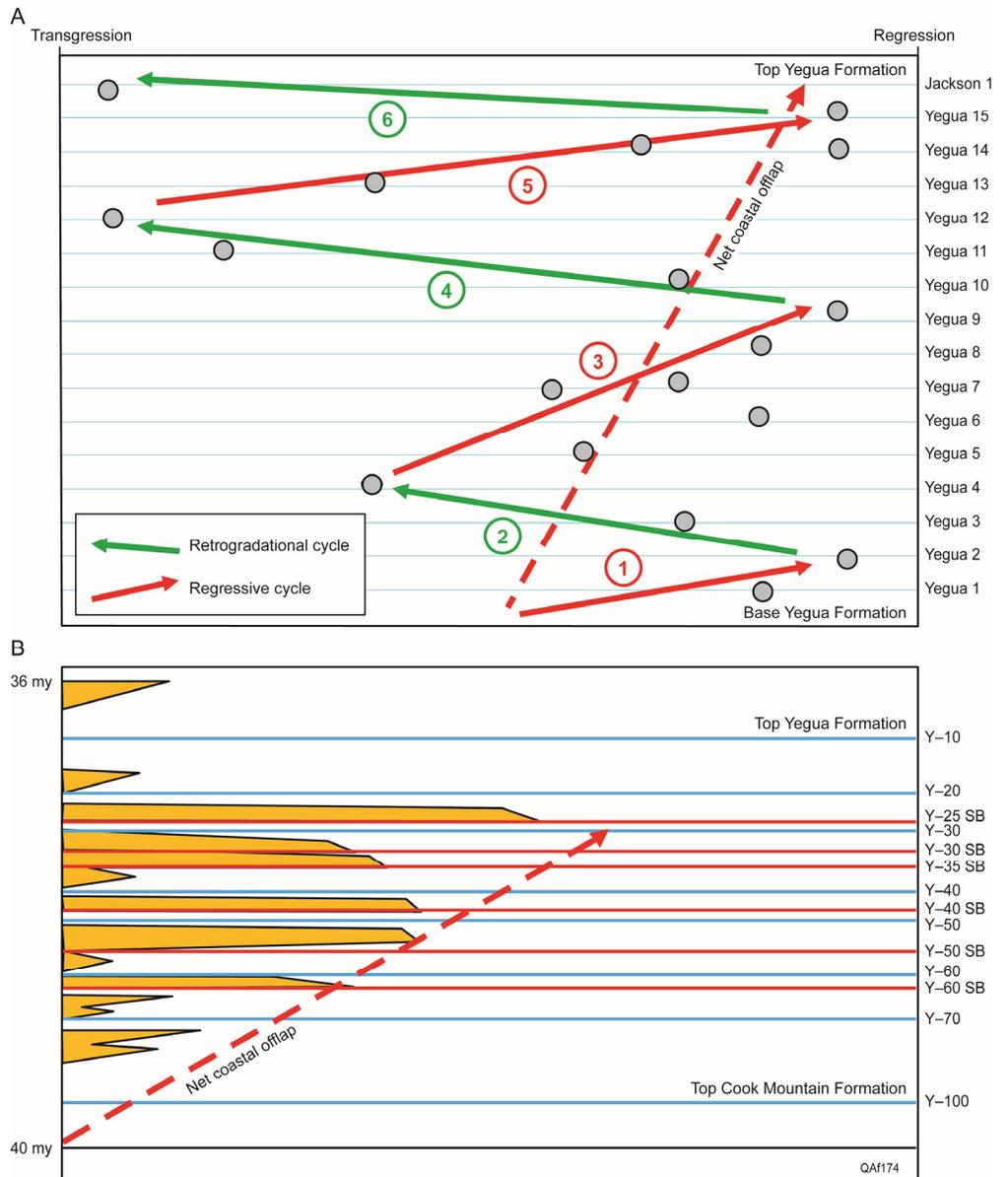
**Wireline Logs, Core Data, and Biostratigraphic Data**

This study used wireline-log data from ~210 wells in an ~770 mi<sup>2</sup> (~1990 km<sup>2</sup>) area in Jim Wells County in South Texas (Fig. 1). Biostratigraphic data from operator tops were included where available. Data from two cored intervals in the TXO Production Company No. B-1 Gomez well (API 42-249-31674) (Figs. 5 and 6) in Muerto Creek Field, located in figure 1 and shown in cross-section 2-2' (Fig. 7), were used to describe and interpret facies and to calibrate net-sandstone values from wireline logs. Cores were described at a 1 in per 10 ft (3 m) scale to depict the entire stratigraphic succession of individual cored intervals, thereby documenting changes in vertical grain-size trends and sandstone-body stacking patterns between different Yegua depositional units in a single illustration. These core descriptions were supplemented with detailed photographs to document bed boundaries, stratification types, and diagnostic features such as trace fossils to support facies interpretations.

**Stratigraphic Surfaces and Depositional Units**

This study recognized flooding surfaces that bound 15 Yegua depositional units and the Jackson 1 depositional unit (Fig. 2). Flooding surfaces were interpreted from both core and wireline log data. In cores, they are silty, dark-gray mudstone beds that cap upward-coarsening and upward-coarsening/serrate sections representing progradational parasequences (Figs. 2, 6, and 7). These flooding surfaces occur within continuous, low-resistivity zones in wireline logs that vertically bound parasequences (transgressive-regressive cycles) of the type defined by Van Wagoner et al. (1990). Depositional units in the Yegua Formation and the basal depositional unit in the Jackson Group in northern Jim Wells County represent individual episodes of coastal offlap and progradation. They are typically upward-shoaling and upward-coarsening, bound at the top by flooding surfaces that record episodes of coastal inundation by marine waters (Vail et al. 1977; Van Wagoner, 1985; Van Wagoner et al., 1990). They are in contrast to sequences that are either bounded by unconformities (Vail et al., 1977) or the tops of sand-

**Figure 4. (A) Shoreline trajectory chart of the Yegua Formation and basal Jackson depositional unit (Jackson 1) in northern Jim Wells County, displaying regressive and retrogradational cycles, compared to (B) chart displaying regional regressive and transgressive depositional episodes in the Yegua Formation (modified after Ewing [2007]).**



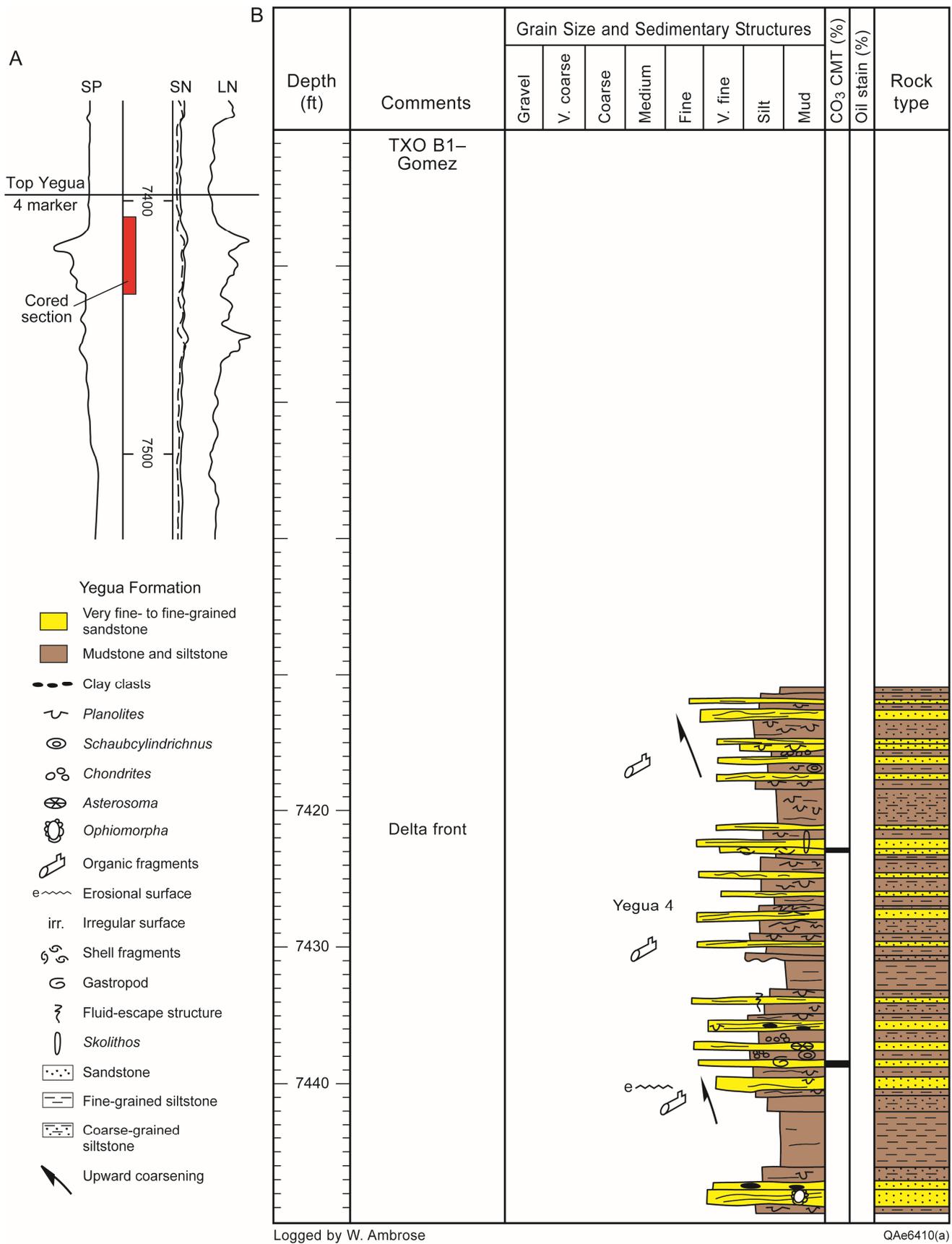


Figure 5. (A) Wireline log and stratigraphic occurrence of cored section in the Yegua 4 depositional unit in the TXO No. B-1 Gomez well. (B) Core description. Stratigraphic occurrence of cored interval is shown in wireline-log cross section 2-2' (Fig. 7). Net-sandstone map of the Yegua 4 depositional unit is shown in Figure 9B. Core photographs are shown in Figure 10.

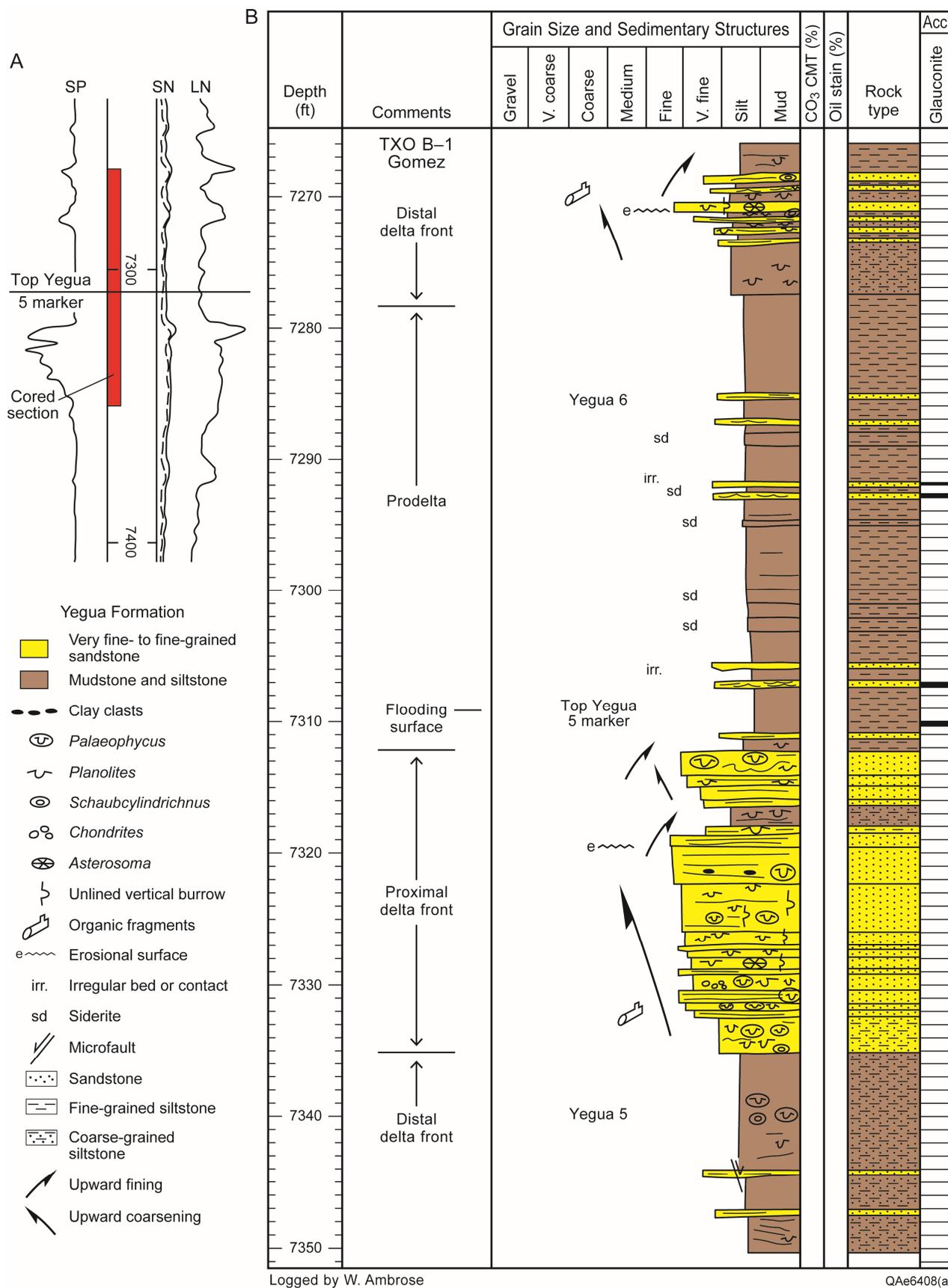


Figure 6. (A) Wireline log and stratigraphic occurrence of cored section in the Yegua 5 and Yegua 6 depositional units in the TXO No. B-1 Gomez well. (B) Core description. Stratigraphic occurrence of cored interval is shown in wireline-log cross section 2-2' (Fig. 7). Core photographs of the Yegua 5 and Yegua 6 depositional units are shown in Figures 11 and 12, respectively. Net-sandstone maps of the Yegua 5 and Yegua 6 depositional units are shown in Figures 13A and 13B, respectively.

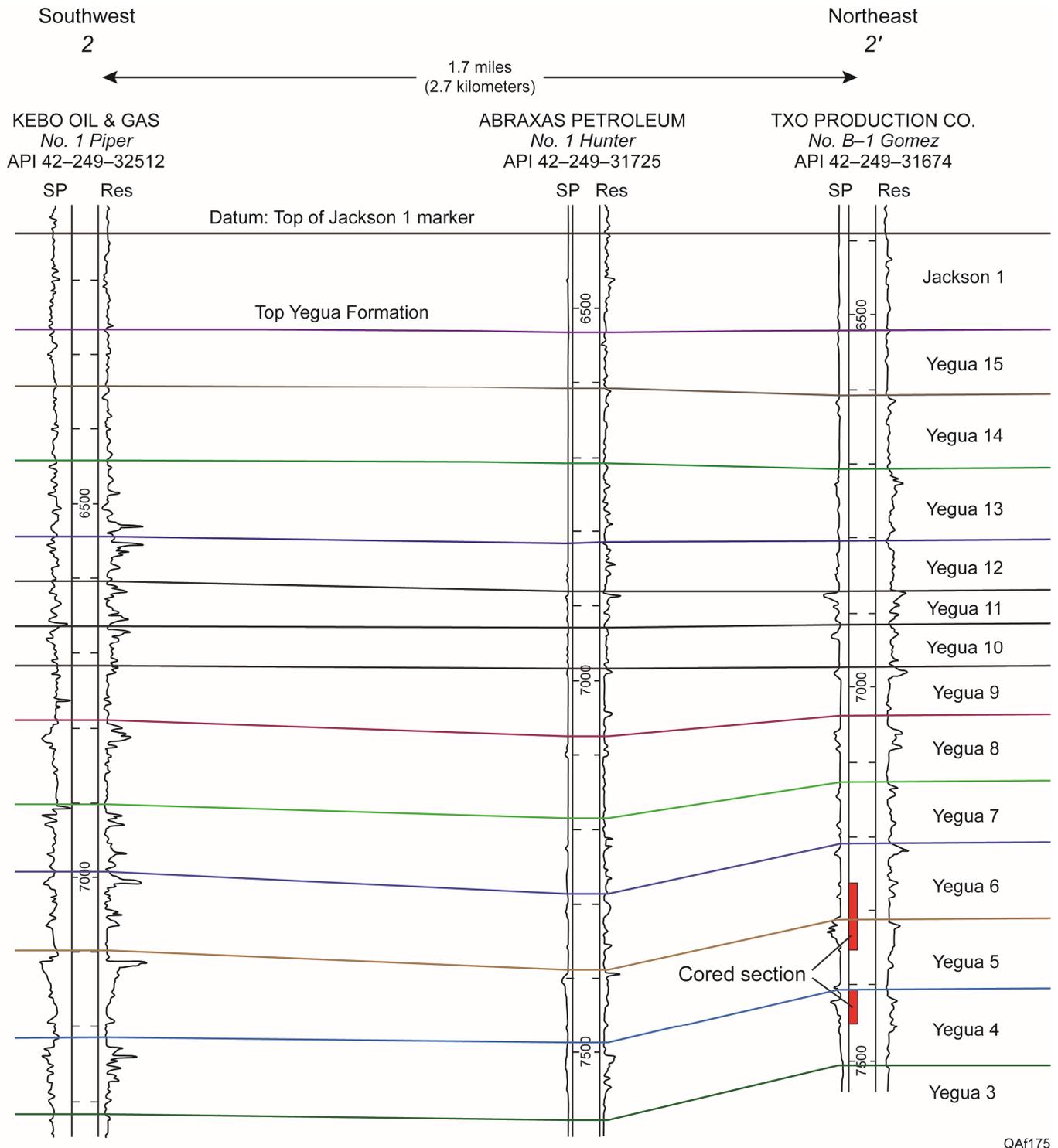


Figure 7. Stratigraphic cross section 2-2', displaying the stratigraphic occurrence of two cored intervals in the Yegua 4, Yegua 5, and Yegua 6 depositional units. The location of the section is shown in Figure 1. Core descriptions are shown in Figures 5 and 6. Datum is the top of the Jackson 1 depositional unit.

stone beds that are less continuous than overlying flooding surfaces. An array of studies of other Tertiary stratigraphic units in the Texas Gulf Coast have demonstrated the utility of flooding surfaces in defining and mapping regionally extensive depositional cycles, including the Miocene section (Doyle, 1979; Morton et al., 1988), the Frio Formation (Galloway et al., 1982), and the Wilcox Group (Edwards, 1981).

Yegua depositional units in this study are composed of a lower progradational section and a relatively thin, upper transgressive section, as for example the 10 ft (3 m), erosionally based interval from 7309 to 7319 ft (~2229 to 2231.4 m) at the top of the Yegua 5 depositional unit in the TXO B-1 Gomez core (Fig. 6). These thin, transgressive sections that cap Yegua depositional units are overlain by muddy flooding surfaces that commonly

correspond to reservoir seals and which are operationally defined as tops of reservoirs in fields in northern Jim Wells County.

Thin (50 to 100 ft [15.2 to 30.5 m]) Yegua and Jackson depositional units, bounded by continuous flooding surfaces, were correlated and mapped rather than thicker (150 to 400 ft [46 to 122 m]) sections that consist of a composite of multiple depositional cycles. Individual depositional units, based on ages from approximately 36 to 40 Ma spanning the Yegua Formation (Ewing, 2007), were interpreted to each be ~250,000 yr in duration, slightly more than that of fourth-order sequences (Van Wagner et al., 1990). However, based on comparison with age data in Brown and Loucks (2009), given as 40.0 to 41.3 Ma for the Yegua Formation, depositional units in this study are only ~100,000 yr in duration, more consistent with fourth-order cycles. This study more accurately portrayed the sandstone-body geometry and facies architecture at reservoir scales by dividing the Yegua and the basal Jackson stratigraphic successions into high-frequency, fourth-order parasequences.

### Net-Sandstone Maps

Net sandstone from wireline logs in this study was defined from a cutoff value of ~25% from the rightward baseline of SP (spontaneous potential) to the SSP (static self-potential), defined as the consistent and maximum, leftward deflection indicating the theoretical maximum SP current that can be measured in a non-shaly sandstone (Serra, 1984). The GR (gamma-ray) and resistivity (Res) curves were also used in zones with indistinct SP responses. In this study, the net-sandstone maps were hand-contoured, with wireline-log responses used to guide contours.

### Facies and Scales of Depositional Systems

Facies interpretations in this study were based on integrating wireline-log responses, net-sandstone maps, and core data. Distal-delta-front and lower-shoreface facies in the Yegua Formation in northern Jim Wells County have predominantly upward-left, serrate, and spiky SP and GR responses. Channel-mouth-bar and upper-shoreface facies have relatively greater percent-sandstone values than distal-delta-front and lower-shoreface facies. They have upward-coarsening (upward-left deflections) and upward-coarsening/blocky wireline-log responses. Distributary-channel and tidal-inlet facies have upward-fining and blocky wireline-log responses. Interdistributary and lower-delta-plain facies are characterized by low net-sandstone content and baseline and serrate wireline-log responses. The use of wireline-log responses for facies interpretation in Tertiary stratigraphic units in the Gulf Coast Basin is established in numerous subsurface studies of the Texas Gulf Coast, including the Wilcox Group (Fisher and McGowen, 1967; Edwards, 1981; Hamlin, 1983; Zhang et al., 2016; Ambrose et al., 2018), Frio Formation (Galloway and Cheng, 1985; Galloway, 1986; Tyler and Ambrose, 1986), and the Miocene stratigraphic succession (Doyle, 1979).

### Relative Shoreline Positions and Shoreline Trajectory

Average shoreline positions for Yegua and lower Jackson depositional units in northern Jim Wells County were inferred from facies associations interpreted on net-sandstone maps. These average shoreline positions were the basis for constructing a shoreline-trajectory chart that depicts an overall regressive interpretation for the Yegua Formation (Figs. 3 and 4A).

Four (4) types of facies associations, both in fluvial-dominated deltaic and wave-dominated shore zone systems, were included in the interpretation of average-shoreline positions: (1) lower-delta-plain/lower-coastal-plain, (2) distributary-channel

and upper-shoreface, (3) delta-front and lower-shoreface, and (4) inner-shelf/transgressive-sand-shoal (Fig. 3).

For lower-delta-plain/lower-coastal-plain facies associations, average-shoreline positions were inferred from the landward (northwestern) margin of the intersection of dip-elongate (southeast-trending) and strike-elongate (northeast-trending) net-sandstone trends.

For distributary-channel and upper-shoreface facies associations, average-shoreline positions in fluvial-dominated deltaic systems were interpreted from the most downdip (southeastward) point of bifurcation of distributary-channel facies or the most downdip occurrence of lobate net-sandstone patterns adjacent to distributary-channel facies, interpreted as crevasse-splay/sub-delta facies. In wave-dominated shorezone systems, average shoreline positions were inferred from positions of sandy, northeast-trending depositional axes.

For delta-front and lower-shoreface facies associations, average-shoreline positions in fluvial-dominated deltaic systems were interpreted from the downdip (southeastern and eastern) termini of dip-elongate net-sandstone trends inferred to be distributary-channel deposits. In wave-dominated shore zone systems, average-shoreline positions of lower-shoreface facies were inferred from sandstone-poor areas on the downdip (southeastern and eastern) margins of sandy, northeast-trending depositional axes.

For inner-shelf/transgressive-sand-shoal facies associations, average-shoreline positions were inferred from the most-updip (northwestward), strike-elongate, sandy trend of depositional units that contain overall low net-sandstone values and which are dominated by strike-elongate (northeast-oriented) trends.

### Oil and Gas Production Data

Cumulative oil- and gas-production data from the Railroad Commission of Texas are depicted on net-sandstone maps of Yegua depositional units and the Jackson 1 depositional unit to document spatial relationships between productivity, net-sandstone, and facies trends. Circular symbols representing relative oil and gas production volumes, specific to each depositional unit, are depicted on net-sandstone maps. By comparing the distribution of oil- and gas-producing wells with net-sandstone trends and facies, this study documents producing facies as well as identifying sparsely drilled areas or areas with wells having potential for recompletions.

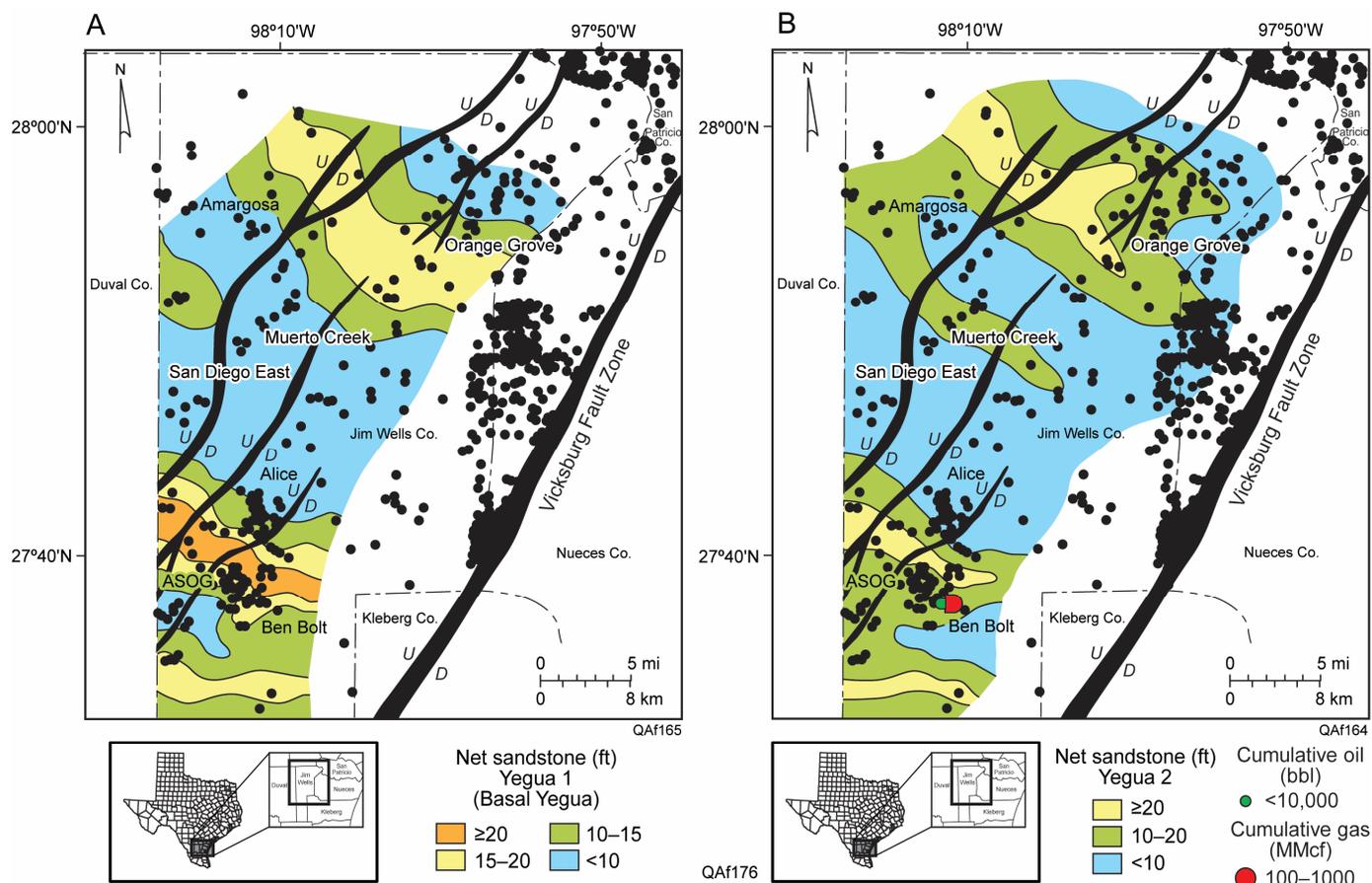
## YEGUA AND BASAL JACKSON STRATIGRAPHIC SUCCESSION

### Yegua 1 and Yegua 2 Depositional Units: Regressive Cycle 1

The Yegua 1 and Yegua 2 depositional units mark the onset of coastal offlap and deltaic progradation over muddy, inner-shelf deposits in the Cook Mountain Formation (Figs. 2–4). The Yegua 1 depositional unit varies in thickness from 150 to 200 ft (46 to 61 m) (Fig. 2). Wireline-log responses in the Yegua 1 depositional unit are serrate and upward-coarsening (middle well in stratigraphic cross section 1–1' [Fig. 2]). Wireline-log responses in the Yegua 2 depositional unit are serrate overall, although they include multiple 20 to 40 ft (6 to 12 m) cycles with upward-coarsening wireline-log responses.

### Net Sandstone

Sandstone-body geometry in the Yegua 1 depositional unit consists of multiple, dip-elongate, east-southeast-oriented trends of  $\geq 15$  ft ( $\geq 4.6$  m) of net sandstone that varies in width from 1 to 4 mi (1.6 to 6.4 km). These depositional axes are projected eastward toward Kleberg and Nueces counties (Fig. 8A).



The Yegua 2 depositional unit contains four sandy depocenters defined by lobate-shaped net sandstone areas of  $\geq 20$  ft ( $\geq 6$  m). The northern sandy depocenter in Orange Grove Field contains a southeast-bifurcating trend, with trends of  $\geq 10$  ft ( $\geq 3$  m) of net sandstone extending toward northwestern Nueces County (Fig. 8B).

### Facies Interpretation

The Yegua 1 and 2 depositional units were deposited as a series of small-scale, fluvial-dominated deltas. Continued deltaic progradation in the Yegua 2 depositional unit is recorded in four dip-elongate depocenters with  $\geq 20$  ft ( $\geq 6$  m) of net sandstone (Fig. 8B). Net-sandstone geometry and scales of depocenters in the Yegua 1 and Yegua 2 depositional units, defined by net-sandstone trends of  $\geq 15$  ft ( $\geq 4.6$  m), are comparable to those of the Holocene Wax Lake Delta in the Atchafalaya Basin (Tye and Coleman, 1988; Neill and Allison, 2005; Wellner et al., 2005; Shaw et al., 2013).

### Oil and Gas Production

No oil and gas production has occurred in the Yegua 1 depositional unit although two sandy distributary-channel trends are intersected by major faults (Fig. 8A). Limited oil and gas production has occurred in distributary-channel-margin facies in the Yegua 2 depositional unit in Ben Bolt Field (Fig. 8B). Similar fault-bounded, distributary-channel and channel-margin facies in

the Yegua 3 depositional unit are present in Muerto Creek and Orange Grove fields, where they could be tested for oil and gas production.

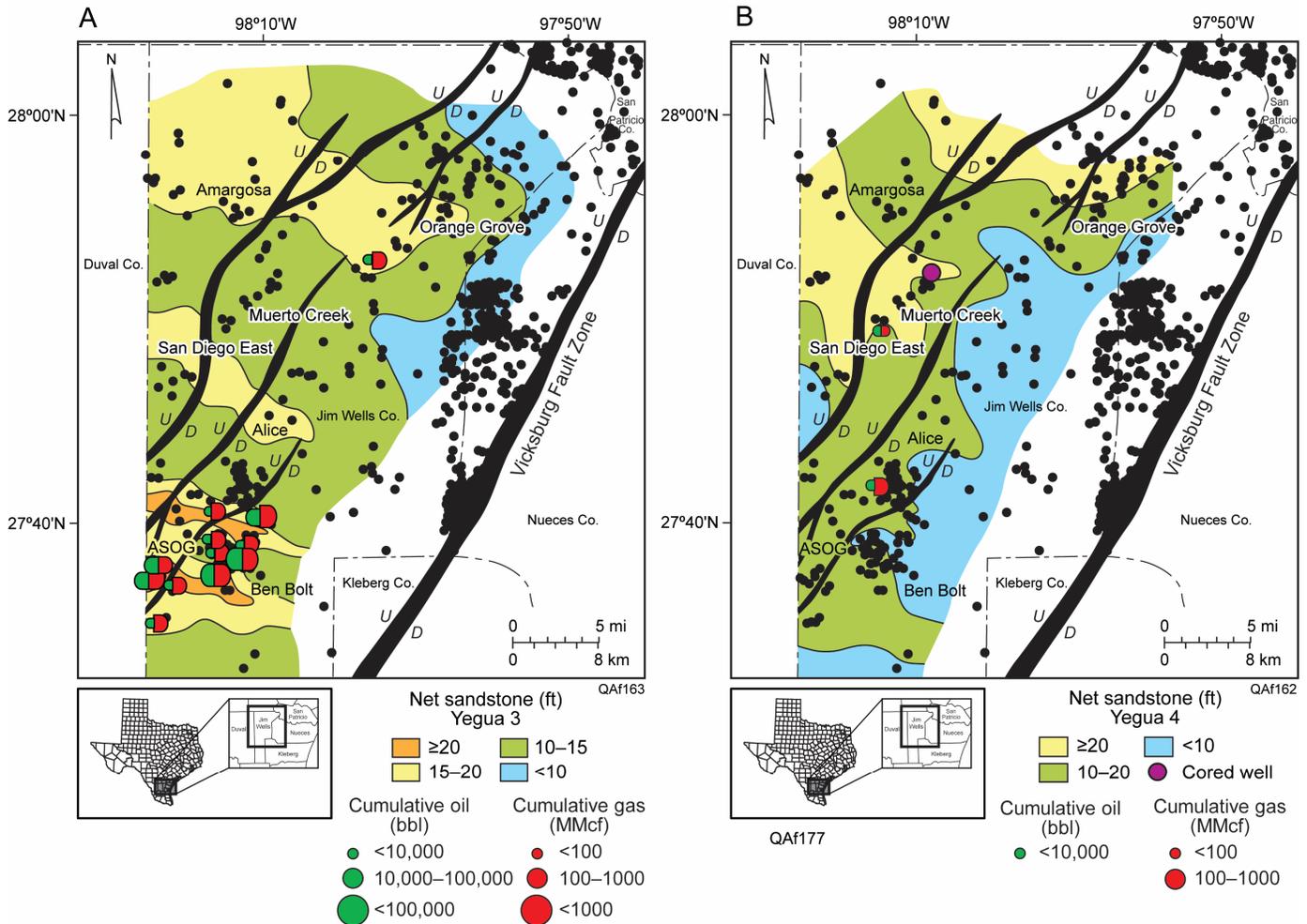
### Yegua Depositional Units 3 and 4: Retrogradational Cycle 2

#### Net Sandstone

The section including the Yegua 3 to Yegua 4 depositional units marks a net-retrogradational cycle (Figs. 3 and 4A). Net-sandstone geometry in the Yegua 3 depositional unit is dominantly dip-elongate (Fig. 9A). Depositional axes in the Yegua 3 depositional unit are defined by east- and southeast-trending trends of  $\geq 20$  ft ( $\geq 6$  m) of net sandstone in Orange Grove Field that extend almost to the Jim Wells–Nueces county line. In contrast, net-sandstone trends in Yegua depositional unit 4 are of two types: (1) a dip-elongate, downdip-bifurcating trend of  $\geq 20$  ft ( $\geq 6$  m) of net sandstone in northwestern Jim Wells County that extends southeastward to Muerto Creek Field and (2) an extensive, north-northwest-oriented, strike-elongate trend of 10 to 20 ft (3 to 6 m) of net sandstone that links Ben Bolt, Alice, Muerto Creek, and Orange Grove fields (Fig. 9B).

#### Yegua 4 Lithology

The upper part of the Yegua 4 depositional unit in the Muerto Creek Field is cored in a 39 ft (12 m) section, where it consists



**Figure 9.** Net-sandstone maps of Yegua depositional units in retrogradational cycle 2. (A) Net sandstone and producing wells, Yegua 3 depositional unit. (B) Net sandstone, producing wells, and location of cored well, Yegua 4 depositional unit. Core description of the Yegua 4 depositional unit is shown in Figure 5. Stratigraphic occurrence of the Yegua 3 and Yegua 4 depositional units are shown in cross sections 1–1' and 2–2' (Figs. 2 and 7). Relative positions of these depositional units in the shoreline-trajectory chart of the Yegua Formation are shown in Figures 3 and 4A.

of thin (1 to 2 ft [0.3 to 0.6 m]) beds of very fine- and fine-grained sandstone interbedded with muddy siltstone (Fig. 5). These sandstone and siltstone beds occur in three, slightly upward-coarsening cycles, extending from 7411 to 7420 ft (~2256 to ~2262 m), 7420 to 7434 (~2256 to ~2266 m), and 7434 to 7442 ft (~2266 to ~2269 m) (Fig. 5). Trace fossils in the Yegua 4 depositional unit include *Asterosoma*, *Chondrites*, *Schaubcylindrichnus*, *Palaeophycus*, and *Planolites* (Figs. 10A and 10B), consistent with a shallow-marine, *Cruziana* ichnofacies (Pemberton et al., 1992). Bedforms consist of low-angle planar stratification and mudstone-draped ripples (Figs. 10B and 10C), respectively.

**Facies Interpretation**

The Yegua 3 depositional unit was deposited in a fluvial-dominated deltaic setting. Deltaic depocenters in the Yegua 3 depositional unit are defined by distributary-channel deposits with  $\geq 20$  ft ( $\geq 6$  m) of net sandstone (Fig. 9A). Sandiest distributary-channel deposits are in Ben Bolt and Alice fields, with narrow ( $< 1500$  ft [ $< 460$  m]) trends of  $\geq 30$  ft ( $\geq 9$  m) net sandstone.

The Yegua 4 depositional unit was deposited in a wave-dominated deltaic setting at the culmination of retrogradational

cycle 2 (Figs. 3 and 4A). The eastern and southeastern termini of distributary-channel deposits in the Yegua 3 depositional unit that flank Muerto Creek Field north and south occur 1 to 4 mi (1.6 to 6.4 km) west of the Jim Wells–Nueces county line (Fig. 9A). In contrast, the southeastern end of distributary-channel deposits in the Yegua 4 depositional unit in the area of Muerto Creek field, where they merge with the extensive, strike-elongate (northeast-trending) trend of 10 to 20 ft (3 to 6 m) of net sandstone, is 10 to 12 mi (16 to 19 km) west of the Jim Wells–Nueces county line (Fig. 9B), representing a northwestward shoreline retreat of 6 to 10 mi (10 to 16 km).

The scale of the deltaic depocenter in the Yegua 4 depositional unit in northwestern Jim Wells County in Muerto Creek field is comparable to that of the modern Brazos Delta on the wave-dominated Texas Gulf Coast. This Yegua 4 depocenter encompasses  $\sim 16$  mi<sup>2</sup> ( $\sim 41$  km<sup>2</sup>) [Fig. 9B] and the Brazos Delta is 13.5 mi<sup>2</sup> ( $\sim 35$  km<sup>2</sup>) in areal extent (Bernard et al., 1970; Rodriguez et al., 2000). Other analogs of similar size and morphology for this Yegua 4 deltaic depocenter include the Holocene Santee Delta on the wave-modified South Carolina shoreline (Stephens et al., 1976), lobate depocenters in the Oligocene Frio Formation in Julian Field in South Texas (Jackson and Ambrose, 1989), and deltas within wave-dominated shoreline trends in the Upper Cre-

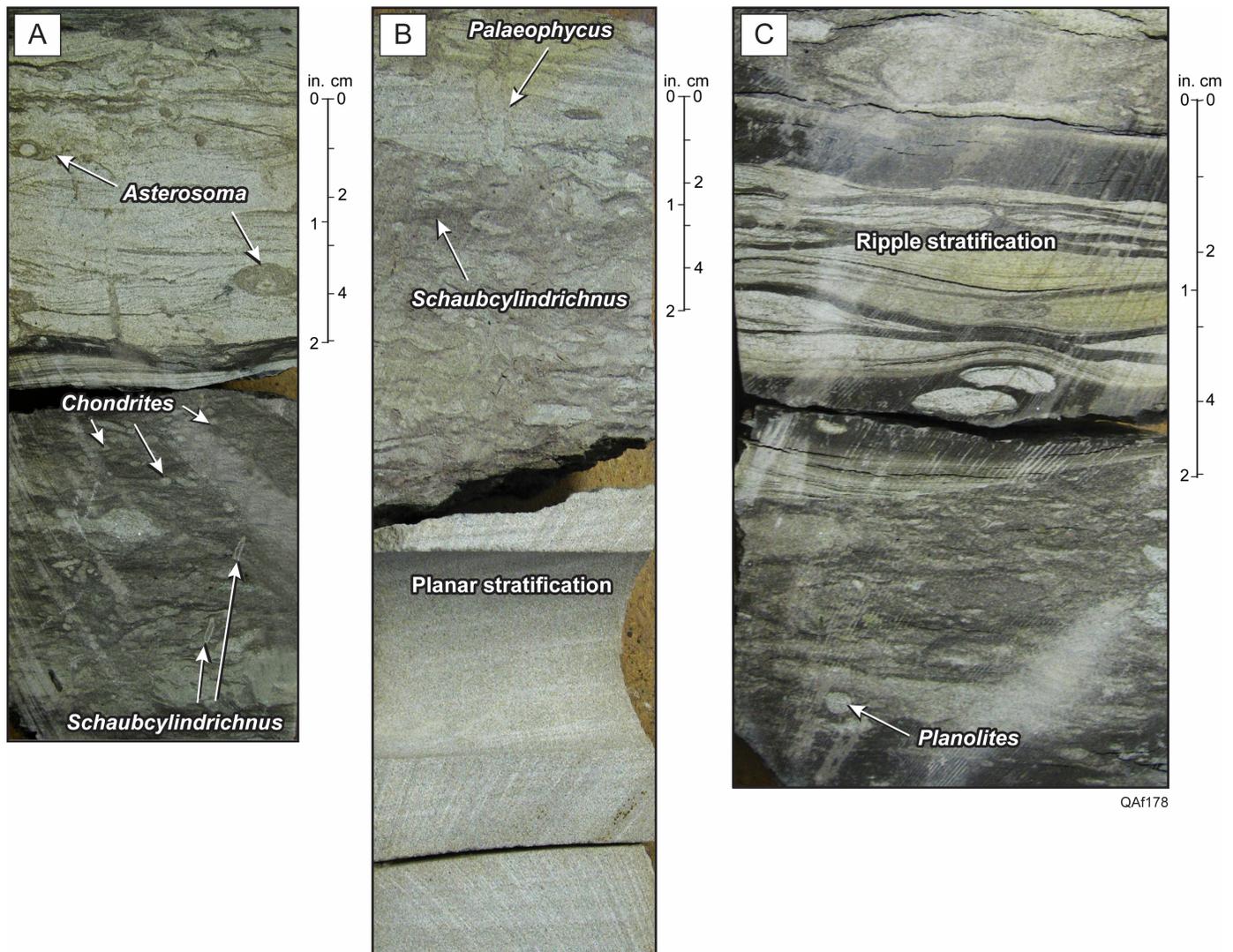


Figure 10. Core photographs of delta-front deposits in the TXO No. B-1 Gomez well in the Yegua 4 depositional unit. (A) Fine-grained sandstone with ripple cross-stratification and *Asterosoma* overlying silty mudstone with *Chondrites* and *Schaubcylichnus* at 7437.3 ft (2267.4 m). (B) Fine-grained, planar-stratified sandstone overlain by burrowed siltstone and very fine-grained sandstone at 7430.0 ft (2265.2 m). Trace fossils include *Palaeophycus* and minor *Schaubcylichnus*. (C) Very fine-grained sandstone with mudstone drapes overlying silty mudstone with *Planolites* at 7417.0 ft (2261.3 m). Core description is shown in Figure 5. The location of the cored well is shown in Figures 1 and 9B.

taceous Pictured Cliffs Sandstone in the San Juan Basin in northwestern New Mexico and southwestern Colorado (Ayers et al., 1994).

### Oil and Gas Production

Oil and gas have been produced from ~10 wells in the Yegua 3 depositional unit in a deltaic depocenter spanning Ben Bolt and Alice fields, as well as from one well in distributary-channel facies southwest of Orange Grove Field (Fig. 9A). Wells in these fields produce from distributary-channel and channel-margin deposits. Almost all Yegua 3 producing wells in Ben Bolt and Alice fields are near major faults. In contrast, the Yegua 4 depositional unit has produced gas and minor oil from only one well in Alice Field in wave-reworked, deltaic headland facies and three wells in channel-mouth-bar and delta-front facies in Muerto Creek Field (Fig. 9B).

## Yegua Depositional Units 5 to 9: Regressive Cycle 3

### Yegua 5, Yegua 6, and Yegua 7 Depositional Units

The Yegua 5, Yegua 6, and Yegua 7 depositional units compose the oldest three stratigraphic units of Yegua regressive cycle 3 (Figs. 3 and 4A). Wireline-log responses for these depositional units vary. In the Muerto Creek Field, the dominant wireline-log response of the Yegua 5 depositional unit is upward-coarsening. In contrast, wireline-log responses of the Yegua 6 and Yegua 7 depositional units are mainly serrate (Fig. 7).

**Lithology.** The upper part of the Yegua 5 depositional unit and the lower part of the Yegua 6 depositional unit are cored in the TXO No. B-1 Gomez well in Muerto Creek Field (Fig. 6). The Yegua 5 depositional unit consists of a lower, 16 ft (5 m) section of burrowed, muddy siltstone with thin (<1 ft [ $<0.3$  m]) beds of very fine-grained sandstone, abruptly overlain at 7335 ft

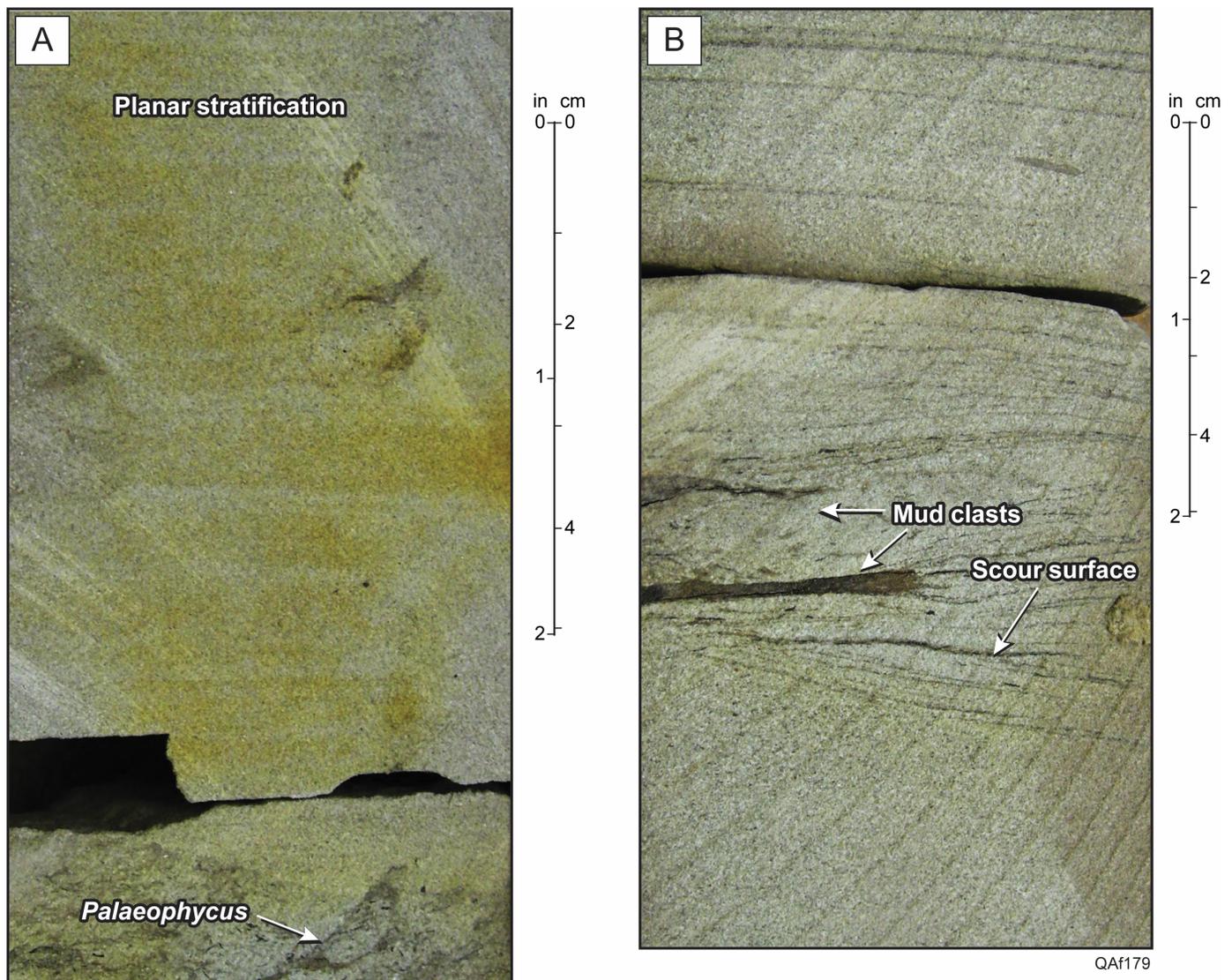


Figure 11. Core photographs of proximal-delta-front deposits in the TXO No. B-1 Gomez well in the Yegua 5 depositional unit. (A) Very fine- to fine-grained, planar-stratified sandstone overlying burrowed, sandy siltstone with *Palaeophycus* at 7331.3 ft (2235.2 m). (B) Fine-grained sandstone with low-angle, planar, and curvilinear stratification with mud clasts and scour surface at 7319.3 ft (2231.5 m). Core description is shown in Figure 6. The location of the cored well is shown in Figures 1 and 13A.

(~2236 m) by an upward-coarsening, sandy section that grades upward from very fine to fine-grained sandstone (Fig. 6). The lower part of this upward-coarsening section is composed of beds of silty sandstone with *Palaeophycus*, interbedded with planar-stratified, fine-grained sandstone beds (Fig. 11A). The upper part of this sandy section contains fine-grained sandstone with low-angle plane beds, crossbeds, and scour surfaces (Fig. 11B).

The cored section in the lower half of the Yegua 6 depositional unit is composed of muddy siltstone with thin (<1 ft [ $<0.3$  m]) beds of very fine-grained sandstone with ripple cross-stratification (Figs. 6 and 12A). The core's top 7 ft (~2 m) contains a slightly upward-coarsening section of very fine- to fine-grained, burrowed sandstone and mudstone beds. Sandstone beds in this uppermost section of the core display convolute bedding with abundant sediment clasts (Fig. 12B).

**Net Sandstone.** Net-sandstone maps of the Yegua 5, 6, and Yegua 7 depositional units illustrate a system of multiple, dip-elongate, and east- to southeast-trending sandstone bodies with

$\geq 20$  ft ( $\geq 6$  m) of net sandstone (Fig. 13). Sandstone-body geometry in the Yegua 5 depositional unit is dominated by dip-elongate trends (Fig. 13A). In contrast, dip-elongate net-sandstone trends in the Yegua 6 depositional unit merge into a broad, northeast-oriented trend of intermediate (10 to 20 ft [3 to 6 m]) net-sandstone values (Fig. 13B). Dip-elongate net-sandstone trends in the Yegua 7 depositional unit extend farther southeastward than those in the Yegua 6 depositional unit by 4 to 5 mi (6.4 to 8 km) (Fig. 13C).

**Facies Interpretation.** The Yegua 5, Yegua 6, and Yegua 7 depositional units constitute the lower half of a regressive cycle in which deltas prograded slightly eastward and southeastward beyond the Yegua 4 paleo-shoreline (Figs. 3 and 4A). Dip-elongate sandstone bodies in the Yegua 5 depositional unit extend ~4 mi (~6.4 km) further downdip (southeastward) of Muerto Creek Field than those in the underlying Yegua 4 depositional unit (Figs. 13A and 9B, respectively). In contrast, the Yegua 6 depositional unit (Fig. 13B) represents a minor phase of shoreline

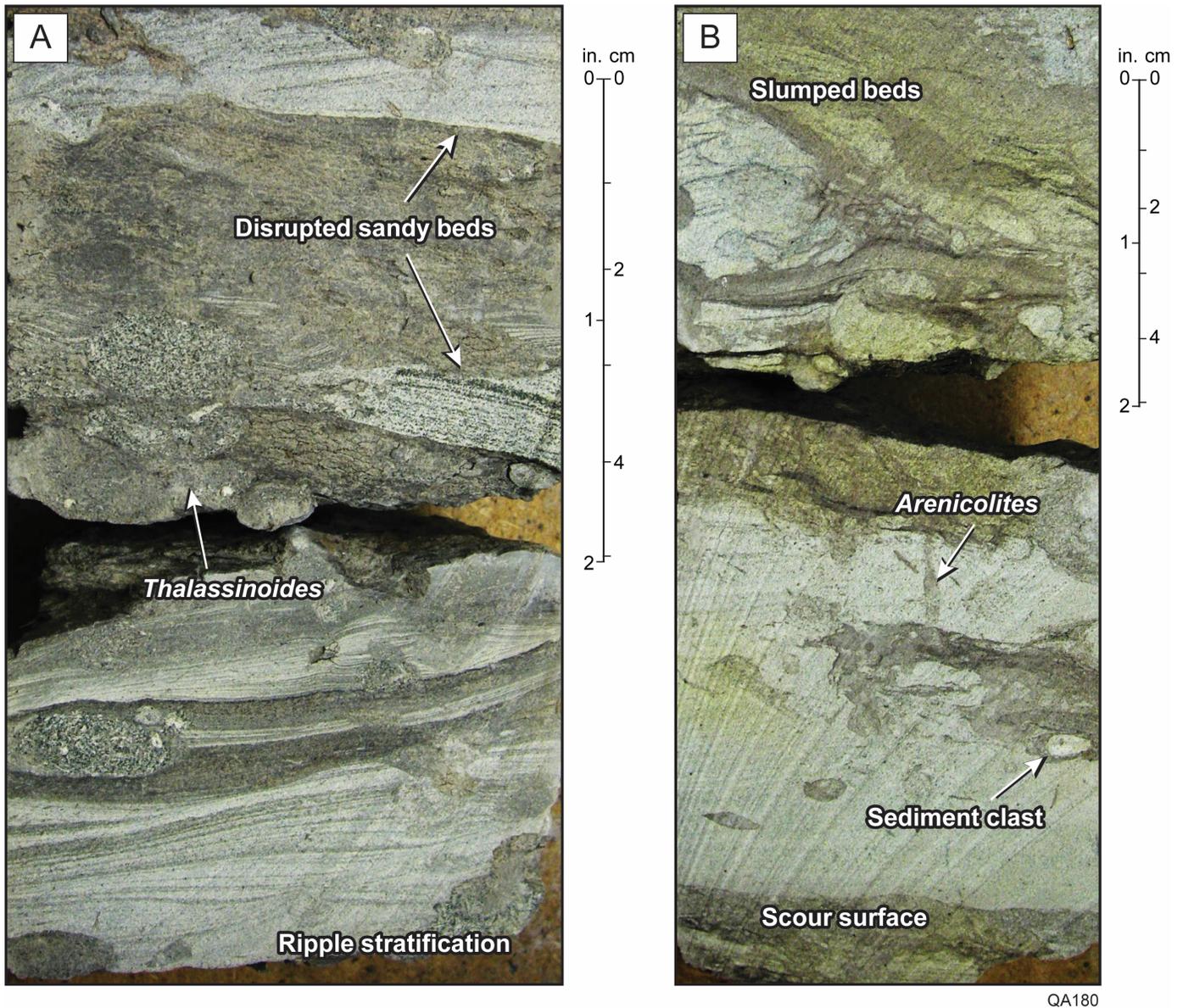


Figure 12. Core photographs of distal-delta-front deposits in the TXO No. B-1 Gomez well in the Yegua 6 depositional unit. (A) Very fine-grained sandstone beds with ripple cross-stratification and sandy siltstone with *Thalassinoides* at 7292.7 ft (2223.4 m). (B) Fine-grained sandstone beds with slumps and sediment clasts at 7271.0 ft (2216.8 m). Core description is shown in Figure 6. The location of the cored well is shown in Figures 1 and 13B.

retrogradation, with delta-front facies occurring in a similar position in the Muerto Creek Field relative to those in the Yegua 4 depositional unit. Net offlap in a subsequent phase of deltaic deposition is recorded in the Yegua 7 depositional unit, with deltas having advanced ~4 mi (~6.4 km) southeastward of the Muerto Creek Field. A sandy deltaic depocenter in the Ben Bolt Field in the Yegua 7 depositional unit (Fig. 13C) records auto-cyclic lobe switching following the deposition of the Yegua 6 depositional unit.

**Oil and Gas Production.** Oil and gas production in the Yegua 5 depositional unit is from deltaic depocenters in Ben Bolt, San Diego East, and Muerto Creek fields (Fig. 13A). No oil nor gas production has been recorded in the Yegua 6 depositional unit. However, three trends of sandy distributary-channel deposits are intersected by faults in San Diego East, Muerto Creek, and Amargosa fields (Fig. 13B). The Yegua 7 depositional unit has

produced both oil and gas in the Muerto Creek Field. Similar delta-front facies occur in Alice Field, although no production has been documented (Fig. 13C).

#### Yegua 8 and Yegua 9 Depositional Units

The Yegua 8 and Yegua 9 depositional units are the youngest two stratigraphic units in Yegua regressive cycle 3 (Figs. 3 and 4A). They compose upward-coarsening cycles interpreted from wireline-log responses (Yegua depositional 8 unit in cross sections 1-1' and 2-2' [Figs. 2 and 7], respectively). Serrate wireline-log responses are also in these depositional units (Yegua 9 depositional unit in cross-section 2-2' [Fig. 7]).

**Net Sandstone.** Net sandstone geometry in the Yegua 8 and Yegua 9 depositional units is dip-elongate and lobate, with net-sandstone trends in both stratigraphic units projected toward the

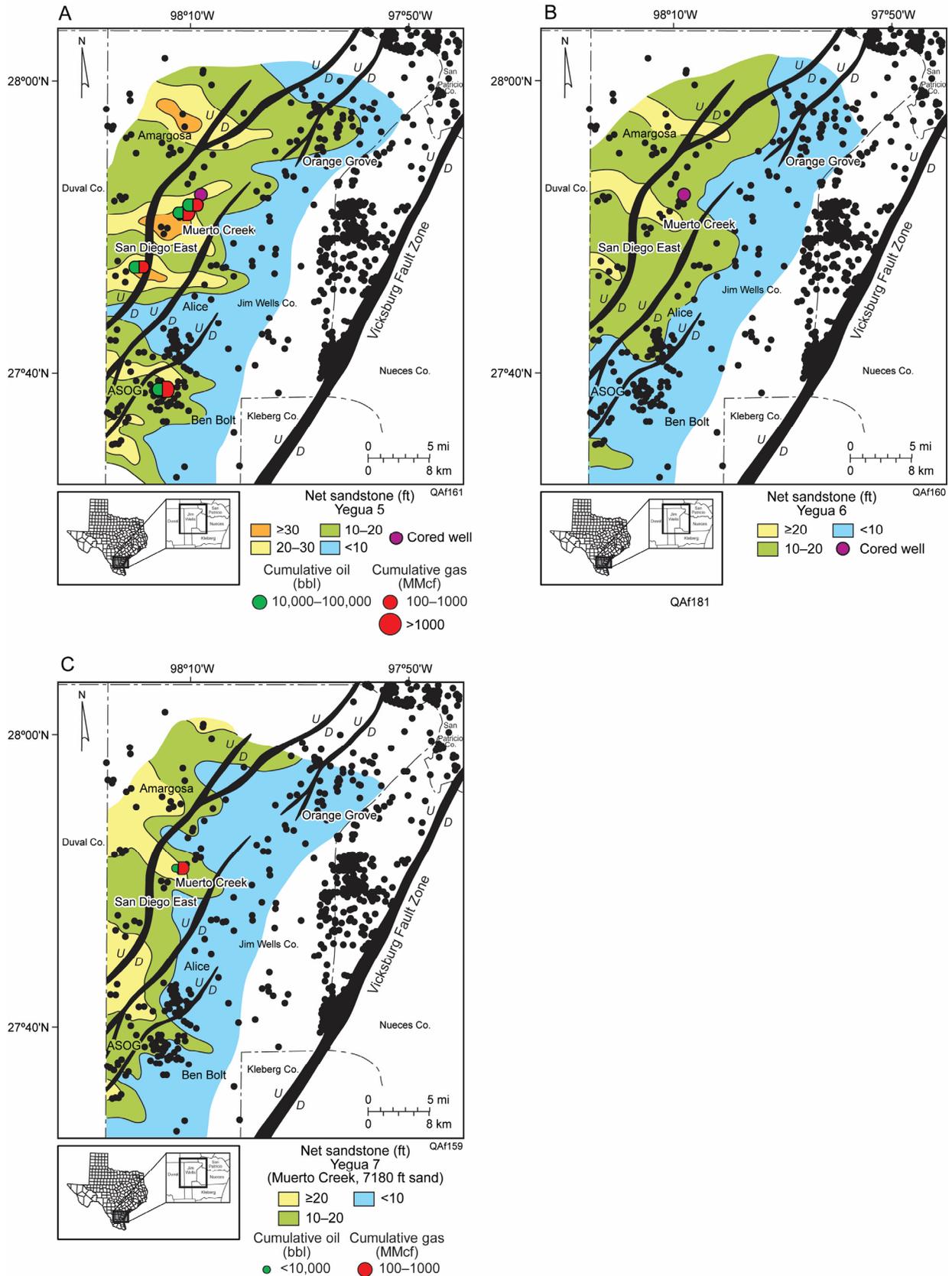


Figure 13. Net-sandstone maps of Yegua depositional units in the lower part of regressive cycle 3. (A) Net-sandstone, producing wells, and location of cored well, Yegua 5 depositional unit. (B) Net-sandstone and location of the cored well, Yegua 6 depositional unit. (C) Net-sandstone and producing well, Yegua 7 depositional unit. Core description of the Yegua 5 and 6 depositional units is shown in Figure 6. Stratigraphic occurrence of the Yegua 5, Yegua 6, and Yegua 7 depositional units are shown in cross sections 1–1' and 2–2' (Figs. 2 and 7). Relative positions of these depositional units in the shoreline-trajectory chart of the Yegua Formation are shown in Figures 3 and 4A.

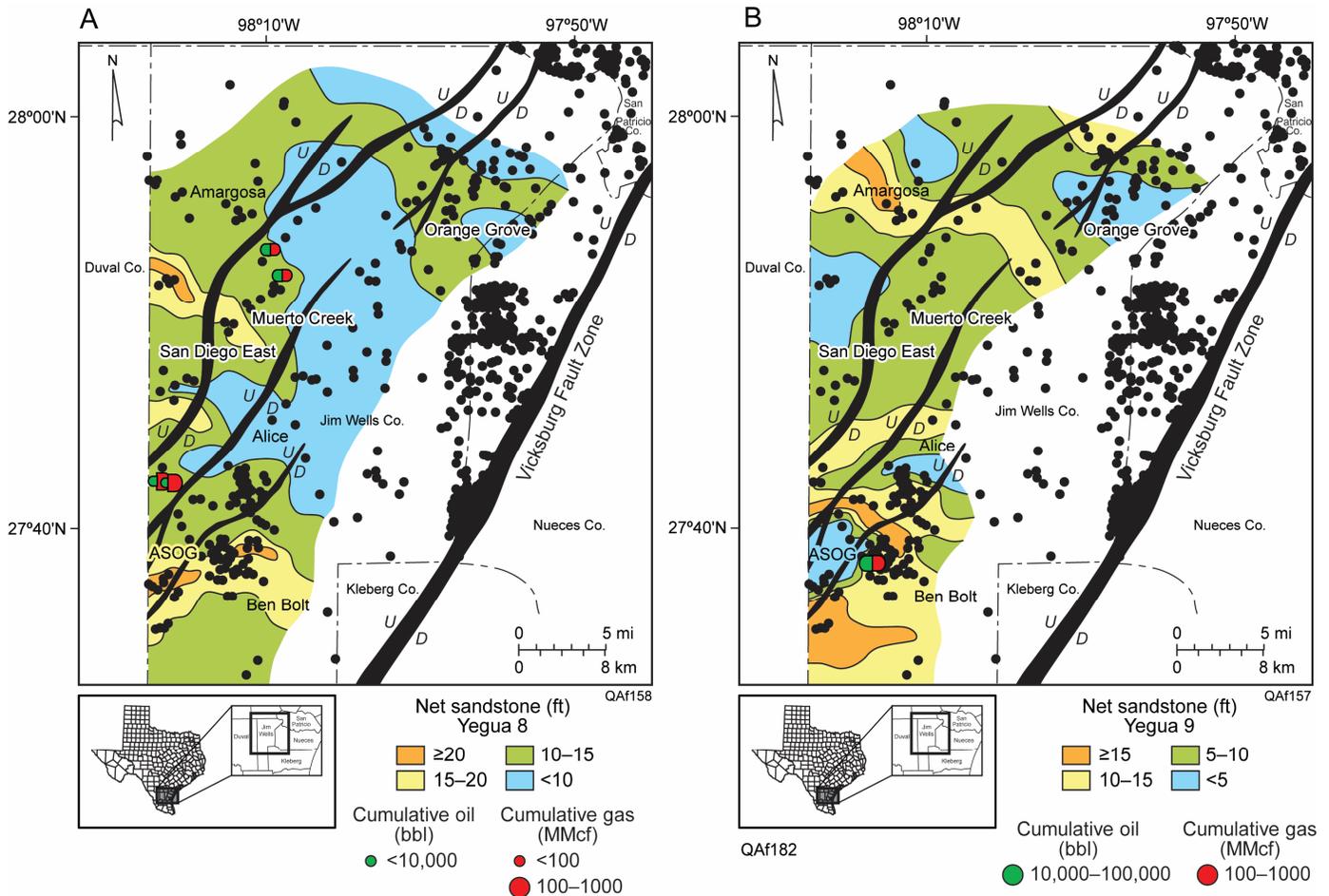


Figure 14. Net-sandstone maps of Yegua depositional units in the upper part of regressive cycle 3. (A) Net-sandstone and producing wells, Yegua 8 depositional unit. (B) Net-sandstone and producing well, Yegua 9 depositional unit. Stratigraphic occurrence of the Yegua 8 and Yegua 9 depositional units are shown in cross sections 1–1' and 2–2' (Figs. 2 and 7). Relative positions of these depositional units in the shoreline-trajectory chart of the Yegua Formation are shown in Figures 3 and 4A.

eastern edge of Jim Wells County (Fig. 14). The Yegua 8 depositional unit contains three depocenters with  $\geq 20$  ft ( $\geq 6$  m) of net sandstone in Ben Bolt, San Diego East, and Muerto Creek fields and a depocenter in Orange Grove Field with a southeast-bifurcating trend of 10 to 20 ft (3 to 6 m) of net sandstone (Fig. 14A). Net-sandstone distribution in the Yegua 9 depositional unit is similar to that of the Yegua 8 depositional unit (Fig. 14B), although it is sandstone poor in Muerto Creek Field.

**Facies Interpretation.** The Yegua 8 and Yegua 9 depositional units were deposited as a series of fluvial-dominated deltas at the end of a middle Yegua regressive cycle (Figs. 3 and 14). Distributary-channel deposits in the Yegua 8 depositional unit are projected to the Jim Wells–Nueces county line, southeast of the Orange Grove Field (Fig. 14A). Distributary-channel trends in the Yegua 9 depositional unit occur both north and south of the Orange Grove Field. They are projected southeastward toward the Jim Wells–Nueces county line (Fig. 14B).

**Oil and Gas Production.** The Yegua 8 depositional unit has produced minor volumes of oil and gas in Muerto Creek and San Diego East Field. Gas has also been produced in two closely spaced wells in a fault-bounded area west of Alice Field (Fig. 14A). Oil and gas production in the Yegua 9 depositional unit is from Ben Bolt Field in only one well (Fig. 14B). Numerous areas of sandy, distributary-channel deposits transected by faults occur throughout northern Jim Wells County where both the Yegua 8

and Yegua 9 depositional units could be tested for oil and gas production.

**Yegua 10, Yegua 11, and Yegua 12 Depositional Units**

The Yegua 10, Yegua 11, and Yegua 12 depositional units compose a retrogradational cycle in the upper part of the Yegua Formation (Figs. 3 and 4A). The Yegua 10 depositional unit has an upward-coarsening wireline-log response in the Ben Bolt Field. In contrast, the Yegua 11 and Yegua 12 depositional units have spiky and muddy-serrate wireline-log responses (Fig. 2). In the Muerto Creek Field, wireline-log responses for these depositional units are upward-coarsening to serrate from northwest to southeast (Fig. 7).

**Net Sandstone.** Net-sandstone trends in the Yegua 10, Yegua 11, and Yegua 12 depositional units are strike-elongate (Fig. 15). Overall net-sandstone values decrease upward from the Yegua 10 depositional unit to the Yegua 12 depositional unit. Greatest net-sandstone values in the Yegua 10 depositional unit are  $\geq 30$  ft ( $\geq 9$  m) north of Amargosa Field (Fig. 15A). Although both the Yegua 11 and Yegua 12 depositional units have greatest net-sandstone values of  $\geq 15$  ft ( $\geq 4.5$  m), there are more trends of net sandstone  $\geq 15$  ft ( $\geq 4.5$  m) in the Yegua 11 depositional unit (Fig. 15B) than in the Yegua 12 depositional unit (Fig. 15C).

**Facies Interpretation.** The Yegua 10, Yegua 11, and Yegua 12 depositional units were deposited in a series of retrogradational-

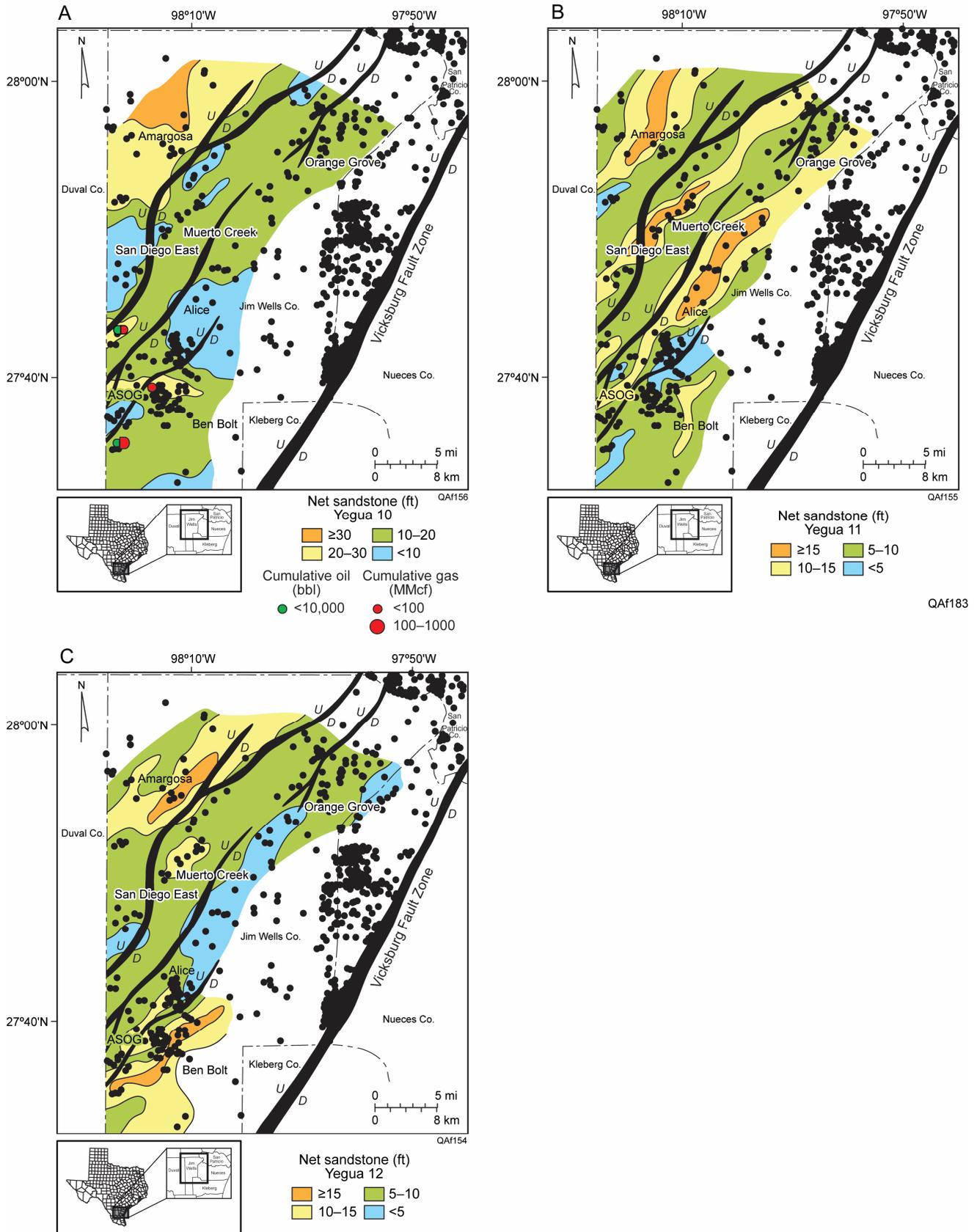


Figure 15. Net-sandstone maps of Yegua depositional units in retrogradational cycle 4. (A) Net sandstone and producing wells, Yegua 10 depositional unit (B) Net-sandstone, Yegua 11 depositional unit. (C) Net-sandstone, Yegua 12 depositional unit. Stratigraphic occurrence of the Yegua 10, Yegua 11, and Yegua 12 depositional units are shown in cross sections 1–1' and 2–2' (Figs. 2 and 7). Relative positions of these depositional units in the shoreline-trajectory chart of the Yegua Formation are shown in Figures 3 and 4A.

al, wave-dominated shoreline systems (Fig. 15). The Yegua 10 depositional unit, being the most sandstone-rich depositional unit in retrogradational cycle 4 (Figs. 3 and 15A), was deposited in a wave-dominated shoreline setting. The areal extent and net sandstone of these sandstone bodies in the Yegua 10 depositional unit ( $\geq 25$  ft [ $\geq 7.6$  m]) is consistent with lower-to-upper-shoreface successions in the Gulf of Mexico (Galloway and Hobday, 1996).

In contrast, the Yegua 11 and Yegua 12 depositional units (Figs. 15B and 15C), composed of multiple strike-oriented sandstone bodies, are transgressive deposits that record marine inundation of shoreline systems in the Yegua 10 depositional unit. Sandstone bodies in the Yegua 11 and Yegua 12 depositional units are narrow (0.5 mi [0.8 km]) and discontinuous, strike-elongate sandstone bodies that pinch out into extensive, muddy areas of  $<15$  ft ( $<4.5$  m) of net sandstone. Sandstone bodies in the Yegua 11 and Yegua 12 depositional units are transgressive deposits of the type in the Chandeleur Islands (Penland et al., 1988; Suter et al., 1988; Otvos and Giardino, 2004). Sandstone bodies in these transgressive deposits pinch out updip and downdip (northwest and southeast) into muddy deposits and are not associated with updip feeder systems.

**Oil and Gas Production.** The Yegua 10 depositional unit is the only producing stratigraphic unit in Yegua retrogradational cycle 4 (Figs. 3, 4A, and 15A). Oil and gas production in the Yegua 10 depositional unit is limited, with wells in the Braman and Ben Bolt fields and another well south of the San Diego East Field. All three producing wells are near major faults, suggesting structural controls on production.

#### Yegua 13, Yegua 14, and Yegua 15 Depositional Units

The Yegua 13, Yegua 14, and Yegua 15 depositional units represent the last phase of Yegua deposition in regressive cycle 5 (Figs. 3 and 4A). These depositional units together represent an advance of the Yegua shoreline through deltaic progradation into Nueces County (Fig. 16).

**Net Sandstone.** Sandstone-body geometry in all three Yegua depositional units in regressive cycle 5 is dominated by dip-elongate, east- and southeast-oriented net-sandstone trends (Fig. 16). Depositional axes, defined by net-sandstone values  $\geq 15$  ft ( $\geq 4.5$  m) in the Yegua 13 and 14 depositional units, are narrow ( $\sim 3000$  ft [ $\sim 915$  m]) (Figs. 16A and 16B). Trends of 10 to 15 ft (3 to 4.5 m) of net sandstone in the Yegua 13 and Yegua 14 depositional units exhibit downdip-bifurcating patterns in Muerto Creek and Alice/Ben Bolt fields. Similar, downdip-bifurcating sandstone-body trends with 10 to 15 ft (3 to 4.5 m) of net sandstone occur in the Yegua 15 depositional unit in Ben Bolt Field (Fig. 16C).

**Facies Interpretation and Oil and Gas Production.** Net-sandstone trends in the Yegua 13, Yegua 14, and Yegua 15 depositional units illustrate a series of small-scale, fluvial-dominated deltas that prograded from northwest to southeast (Fig. 16). Delta-lobe switching occurred in Alice Field between deposition of the Yegua 13 and Yegua 14 depositional units (Figs. 16A and 16B), as well as in Amargosa Field between deposition of the Yegua 14 and Yegua 15 depositional units (Figs. 16B and 16C). In contrast, the area of Muerto Creek Field continued to feature sandy, deltaic depocenters throughout regressive cycle 5 and is the only area of oil and gas production in regressive cycle 5 (Figs. 16A and 16B).

#### Jackson 1 Depositional Unit: Retrogradational Cycle 6

The Jackson 1 depositional unit marks a backstepping, retrogradation cycle following the deposition of the Yegua Formation (Figs. 3 and 4A). Wireline-log responses of the Jackson 1 depositional unit are dominantly serrate, with minor upward-coarsening and spiky responses (Figs. 2 and 7).

#### Net Sandstone

Net-sandstone trends in the Jackson 1 depositional unit are strike-elongate (northeast-oriented), with major sandstone bodies defined by trends of  $\geq 10$  ft ( $\geq 3$  m) of net sandstone (Fig. 17). These sandstone bodies occur as a set of four en echelon trends, with the sandiest trend in far northwestern Jim Wells County, where net-sandstone values are  $\geq 20$  ft ( $\geq 6$  m).

#### Facies Interpretation and Oil and Gas Production

The Jackson 1 depositional unit records transgressive reworking of older deltaic deposits in the Yegua 15 depositional unit. The northwestward sandstone body in the Jackson 1 depositional unit represents upper-shoreface facies. In contrast, similarly aligned net-sandstone trends constitute a series of offshore transgressive-sand-shoal deposits (Fig. 17). Oil and gas production in the Jackson 1 depositional unit is limited to the relatively sandy trend of upper-shoreface facies in the Amargosa Field. Two other net-sandstone trends that have not yet produced oil and gas are intersected by major faults in Ben Bolt, Alice, and San Diego East fields (Fig. 17).

#### FACIES CONTROLS ON OIL AND GAS PRODUCTION

Oil and gas production in the Yegua Formation in northern Jim Wells County is controlled by a combination of structure and facies variability. Production occurs mainly in sandy distributary channel, delta-front, and upper-shoreface facies. Leading Yegua oil and gas fields in northern Jim Wells County include Muerto Creek, San Diego East, Alice, Ben Bolt, and Braman fields, with minor production in Orange Grove and Amargosa fields (Fig. 1).

#### Fluvial-Dominated Deltaic Depositional Systems

Primary producing facies in Yegua fluvial-dominated deltaic systems include distributary-channel margin, distributary-channel, channel-mouth-bar/proximal-delta front, and interdistributary-bay, with gas production in individual gas wells ranging from  $<100$  MMcf (million cubic feet) to  $>1$  Bcf (billion cubic feet). The greatest cumulative gas production occurs in distributary-channel-margin and distributary-channel facies, which account for  $\sim 14.4$  Bcf (Table 1). Most of this gas production is in the Yegua 3 depositional unit in Ben Bolt and Alice fields (Fig. 9A). Cumulative gas production in channel-mouth-bar facies in all Yegua depositional units is only  $\sim 2.4$  Bcf (Table 1).

Oil production in Yegua fluvial-dominated deltaic systems is minor compared to that of gas production, with greatest cumulative production in most individual wells  $<20,000$  bbl (barrels), although one well in the Yegua 3 depositional unit exceeds 130,000 bbl (Fig. 9A and Table 1). As with gas production, the greatest cumulative oil production is in distributary-channel-margin and distributary-channel facies, accounting for slightly more than 410,000 bbl, mostly in Ben Bolt and Alice fields (Table 1). Oil production also occurs in channel-mouth-bar facies, mainly in the Yegua 3, Yegua, 4, and Yegua 5 depositional units (Figs. 9A, 9B, and 13A, respectively). Cumulative oil production in channel-mouth-bar facies is slightly more than 35,000 bbl (Table 1).

Net-sandstone maps of fluvial-dominated depositional units in the Yegua Formation illustrate several areas and fields with sandy facies that could be tested for additional oil and gas production (Table 2). Many of these areas that have not yet been proven for oil and gas production are transected by faults. The most sandstone-rich facies in Yegua fluvial-dominated deltaic systems where additional oil and gas could be tested are distributary-channel and distributary-channel-margin. Examples include the Yegua 1 depositional unit in the Ben Bolt Field and areas south and southwest of the Orange Grove Field (Fig. 8A) and the

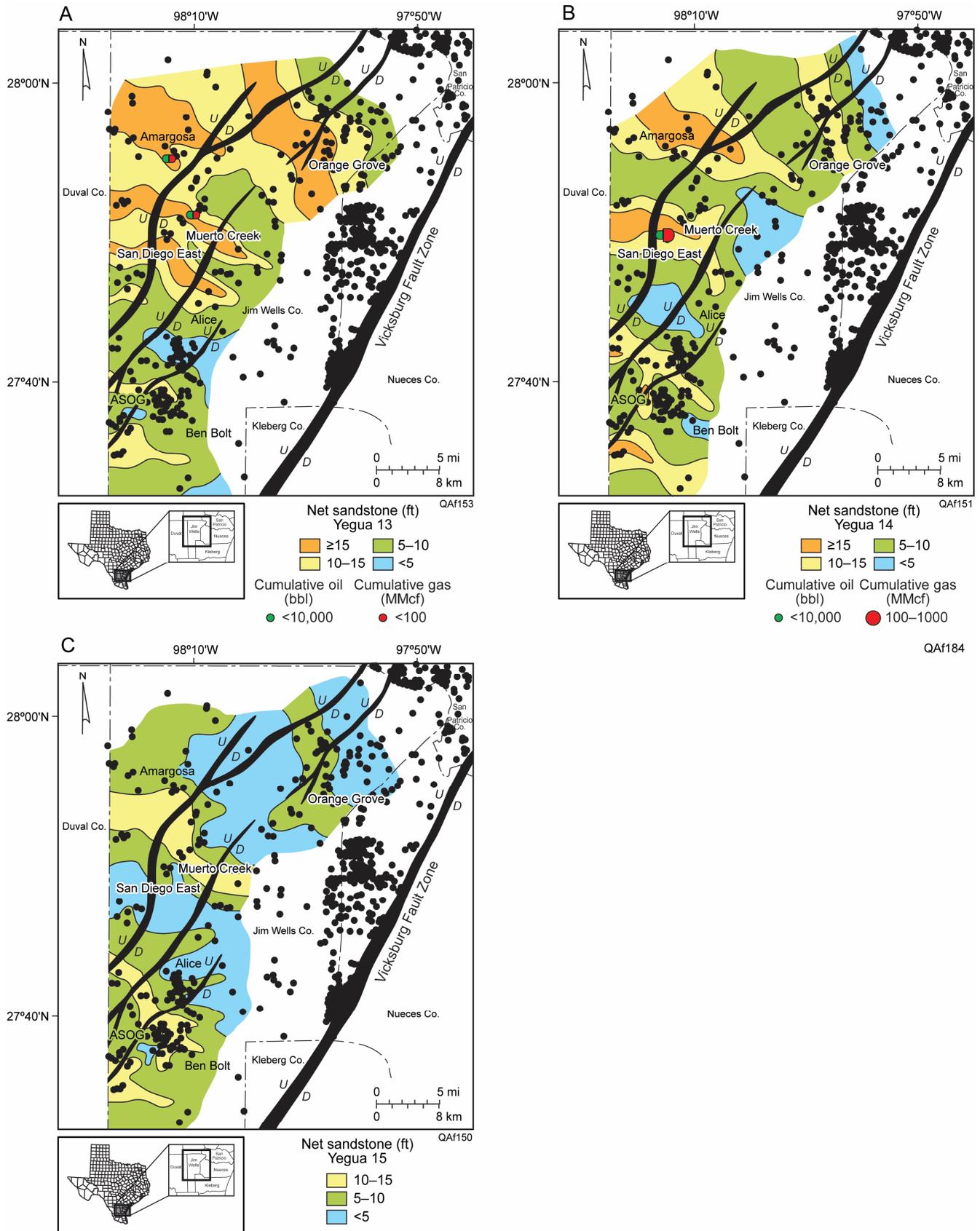
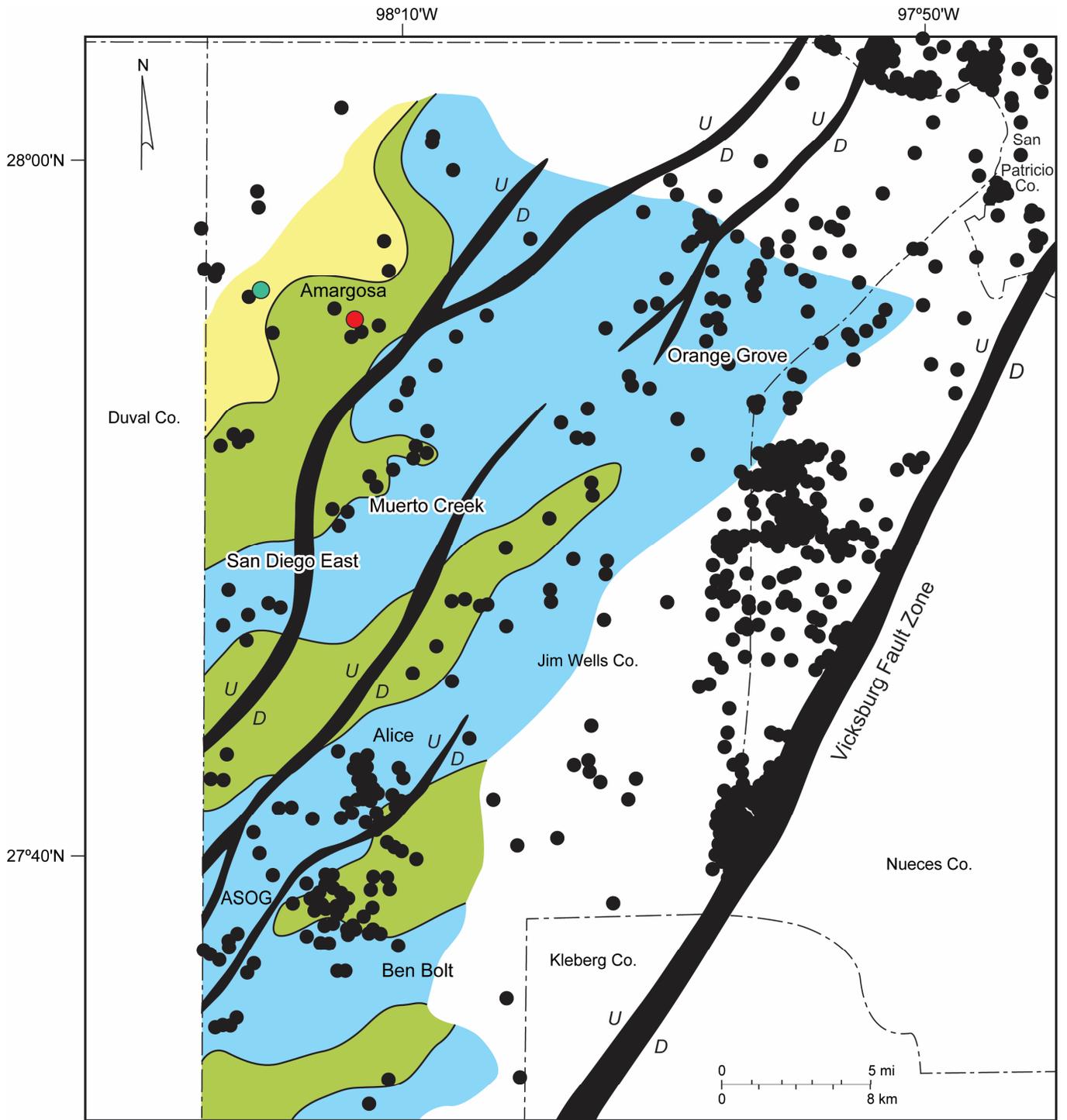
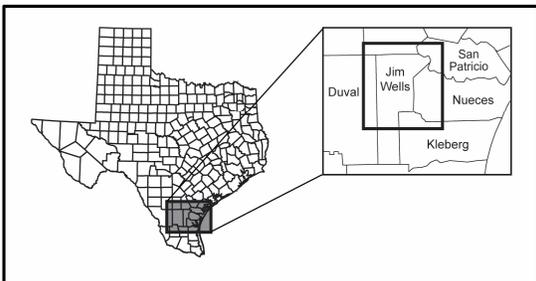


Figure 16. Net-sandstone maps of Yegua depositional units in regressive cycle 5. (A) Net-sandstone and producing wells, Yegua 13 depositional unit. (B) Net-sandstone and producing wells, Yegua 14 depositional unit. (C) Net-sandstone, Yegua 15 depositional unit. Stratigraphic occurrence of the Yegua 13, Yegua 14, and Yegua 15 depositional units are shown in cross sections 1-1' and 2-2' (Figs. 2 and 7). Relative positions of these depositional units in the shoreline-trajectory chart of the Yegua Formation are shown in Figures 3 and 4A.



QAf149(a)



Net sandstone (ft) Jackson 1	Cumulative oil (bbl)	Cumulative gas (MMcf)
≥20	<10,000	
10-20		100-1000
<10		

Figure 17. Net-sandstone and producing wells, Jackson 1 depositional unit. Stratigraphic occurrence of the Jackson 1 depositional unit is shown in cross sections 1-1' and 2-2' (Figs. 2 and 7). The relative position of the Jackson 1 depositional unit in the shoreline-trajectory chart of the Yegua Formation and Jackson Group is shown in Figure 3.

**Table 1. Cumulative oil and gas production in the Yegua 1 to Yegua 15 depositional units and the Jackson depositional unit 1 versus facies in northern Jim Wells County. Format: number of wells (cumulative oil in barrels; cumulative gas in MMcf [million cubic feet]).**

Stratigraphic Unit	Distributary Channel	Distributary Channel Margin	Channel Mouth Bar/ Proximal Delta Front	Interdistributary Bay	Upper Shoreface/ Beach	Tidal Inlet	Wave-Reworked Deltaic Headland	Totals
Jackson 1					2 (284–60,729 oil; 31–155 gas)			61,013 oil; 186 gas
Yegua 15								
Yegua 14	1 (918 oil; 105 gas)							918 oil; 105 gas
Yegua 13		1 (568 oil; 29 gas)	1 (25 oil; <1 gas)					593 oil; 30 gas
Yegua 12								
Yegua 11								
Yegua 10					1 (361 oil; 27 gas)		2 (4850 oil; 1–203 gas)	5211 oil; 231 gas
Yegua 9		1 (19,620 oil; 999 gas)						19,620 oil; 999 gas
Yegua 8		1 (23 oil; 3 gas)		4 (180–9297 oil; 13–322 gas)				12,930 oil; 610 gas
Yegua 7						1 (3654 oil; 285 gas)		3654 oil; 285 gas
Yegua 6								
Yegua 5	1 (18,700 oil; 906 gas)	1 (12,645 oil; 542 gas)	2 (10,041–18,355 oil; 452–1565 gas)					59,741 oil; 3465 gas
Yegua 4			2 (597–700 oil; 26 gas)				1 (1797 oil; 135 gas)	3094 oil; 186 gas
Yegua 3	5 (5143–117,951 oil; 323–1626 gas)	6 (4313–135,092 oil; 115–4213 gas)	1 (5,402 oil; 364 gas)					354,993 oil; 12,008 gas
Yegua 2		1 (8377 oil; 143 gas)						8377 oil; 143 gas
Yegua 1								
Totals	7 (192,650 oil; 5963 gas)	11 (217,792 oil; 8408 gas)	6 (35,096 oil; 2432 gas)	4 (12,907 oil; 607 gas)	3 (61,398 oil; 214 gas)	1 (3654 oil; 285 gas)	3 (6647 oil; 339 gas)	530,144 oil; 18,248 gas

Yegua 8 depositional unit in the Ben Bolt, Alice, and Orange Grove fields (Fig. 14A).

### Wave-Dominated Shoreline Depositional Systems

Oil and gas production in wave-dominated shoreline systems in the Yegua Formation in northern Jim Wells County is less than in fluvial-dominated deltaic systems, with cumulative oil production in individual wells commonly <5000 bbl (Table 1). Cumulative gas production in individual wells in these wave-dominated shoreline systems ranges from 27 to 285 MMcf. In contrast to the 28 Yegua-producing wells in fluvial-dominated deltaic systems, only five Yegua-producing wells occur in wave-dominated shoreline systems, with three in wave-reworked deltaic headland facies, one in tidal-inlet facies, and one in upper-shoreface/beach facies.

In contrast, the Jackson 1 depositional unit, deposited in a major retrogradational cycle (Figs. 3 and 4A), has produced >61,000 bbl of oil and 186 MMcf of gas from two wells in upper-shoreface/beach facies (Fig. 17 and Table 1). These two wells are in the Amargosa Field, where net-sandstone values range from 15 to >25 ft (4.5 to >7 m) (Fig. 17).

Although Yegua wave-dominated shoreline systems are not as productive as fluvial-dominated deltaic systems in northern Jim Wells County (Table 1), several areas exist where wells with sandy facies in these shoreline systems could be tested for recompletions (Table 2). Examples include the Yegua 4 and Yegua 7 depositional units with wave-reworked, deltaic headland facies in Braman and Ben Bolt fields (Figs. 9B and 13C, respectively), the Yegua 6 depositional unit in tidal-inlet facies in Muerto Creek Field (Fig. 13B), the Yegua 10 depositional unit in upper-shoreface facies north of Amargosa Field (Fig. 15A), and the

**Table 2.** Fields and areas in the Yegua Formation and the basal depositional unit in the Jackson Group (Jackson depositional unit 1) with sandy, potential reservoir facies that could be tested for additional oil and gas production. Facies abbreviations: CMB/PDF (Channel mouth bar/proximal delta front); DC (distributary channel); DCM (distributary channel margin); ETD (ebb-tidal delta); IB (interdistributary bay); TI (tidal inlet); TSS (transgressive sand shoal); US/B (upper shoreface/beach); and WRDH (wave-reworked deltaic headland).

Stratigraphic Unit	Alice	Amargosa	ASOG	Ben Bolt	Braman	Muerto Creek	Orange Grove	San Diego East
Jackson 1				TSS		WRDH		TSS
Yegua 15	DCM		DCM	DC	DC	DC	DC	DCM
Yegua 14	DCM	DC			DC		DC	
Yegua 13				CMB/PDF	DC	CMB/PDF: southeast	DC	DCM
Yegua 12	TSS	TSS			TSS	TSS		
Yegua 11		TSS		TSS: northwest		TSS	TSS: north	
Yegua 10		US/B		WRDH		WRDH		
Yegua 9	DCM	DC			DC			
Yegua 8	DCM			DC		DC: northwest	CMB/PDF	
Yegua 7	ETD	TI		ETD	ETD			TI
Yegua 6	WRDH	TI			ETD	TI		
Yegua 5		DC			DC		CMB/PDF	
Yegua 4				DCM	DC		DC	CMB/PDF
Yegua 3		DC				IB	DCM	DC: north
Yegua 2			DCM: north		DCM	DC	CMB/PDF	
Yegua 1				DC			DC: south	

Yegua 11 depositional unit in transgressive-sand-shoal facies in Muerto Creek and Amargosa fields (Fig. 15B).

**CONCLUSIONS**

The Yegua Formation in northern Jim Wells County in South Texas is a succession of high-frequency depositional units (transgressive-regressive episodes) composed individually of small-scale fluvial-dominated deltaic, wave-dominated deltaic, and shoreface deposits. These transgressive-regressive episodes display more variability in depositional style than has been interpreted in previous studies as dominantly barrier-strandplain and wave-dominated shoreline systems.

Yegua depositional units in northern Jim Wells County collectively compose an offlapping, progradational clastic wedge punctuated by two major retrogradational cycles. During periods of coastal offlap, a succession of fluvial-dominated deltas prograded eastward and southeastward across northern Jim Wells County. In contrast, retrogradational cycles are marked by strike-elongate, northeast-oriented net-sandstone trends that record wave-reworked deltaic headlands and continuous (>25 mi [ $>40$  km]) sandy belts representing wave-dominated shoreline systems.

Primary producing facies in Yegua fluvial-dominated deltaic systems include distributary-channel margin, distributary-channel, and channel-mouth-bar/proximal-delta front, with individual gas wells having produced <100 MMcf to >1 Bcf. Oil production is minor, with greatest cumulative production in many individual wells <20,000 bbl. Oil and gas production in Yegua wave-dominated shoreline systems is less than in fluvial-dominated deltaic systems, with cumulative oil production in individual wells in wave-dominated shoreline systems commonly <5000 bbl.

Numerous areas in northern Jim Wells County exist where potential reservoir facies could be tested for additional oil and gas production. These areas are defined where regional faults transect narrow and sandy distributary-channel trends and where muddy delta-fringe facies flank sandy, wave-reworked deltaic headland facies.

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