
Lithofacies, Depositional Systems, and Sequence Stratigraphy of the Fredericksburg Group (Cretaceous) in the Callahan Divide Region of West-Central Texas

Peter Holterhoff and A. Matthew Oyedeji

Department of Geosciences, Texas Tech University,
P.O. Box 41053, Lubbock, Texas 79409-1053

EXTENDED ABSTRACT

The Lower Cretaceous Fredericksburg Group in its type region of central Texas is composed of the Antlers Sand and overlying Walnut, Comanche Peak, and Edwards formations. Within these formal lithofacies divisions of the Fredericksburg Group, Moore (1996, 1997) recognized two depositional sequences in the Fredericksburg in the region around and north of Austin: the underlying Lower Cretaceous–Va (LK-Va) sequence and the overlying Lower Cretaceous–Vb (LK-Vb) sequence. Thus, a fairly robust framework and model for the Fredericksburg carbonate system has been constructed in this region of central Texas. However, in the Callahan Divide region of west-central Texas (i.e., Nolan County), the subdivisions above the Antlers Sand are not differentiated due to facies changes to the west of the central Texas outcrop belt. Published sections from the Callahan Divide region (i.e., Moore, 1967; Hoffman et al., 2003) and preliminary field work for this study in fact demonstrate important lateral and vertical lithofacies trends that allow subdivision of the Fredericksburg and characterization of this carbonate ramp system. Thus, the goal of this study is to describe the observed lithofacies and lithofacies associations, interpret the depositional systems, and construct a sequence stratigraphic framework of the Fredericksburg Group in the Callahan Divide region to determine the evolution of this carbonate ramp system.

The study area is centered in Nolan County, Texas, but also includes portions of Mitchell and Coke counties as well. This area is the western extent of the Callahan Divide, a Cretaceous outlier between the Brazos and Colorado River drainage basins. The west-central Texas outcrop area lies at the northern edge of the Cretaceous Central Texas Platform (Moore, 1996). This platform complex overlies the Llano Uplift and its western extension, the Concho Arch (Fig. 1). Shallow cratonic basins are developed to the north (North Texas Basin) and south (Maverick Basin) of the platform. The exposures examined for this study are aligned along a platform (south) to basin (north) dip transect (Fig. 2). The Gulf of Mexico passive margin and associated Lower Cretaceous carbonate platform system lies far to the east of the study area.

Two prominent sequence boundaries are developed across the entire study area. The lower sequence boundary is the onlap of the Antlers Sand onto the underlying Permian and Triassic units of the Permian Basin. The upper sequence boundary is expressed as an area-wide turn around in lithofacies stacking pattern from upward-shallowing (highstand systems tract, HST) to upward-deepening (transgressive systems tract, TST) and by the development of a complex brecciated and/or *Trypanites* surface at the top of the upward-shallowing package. The complex brecciated surface is associated

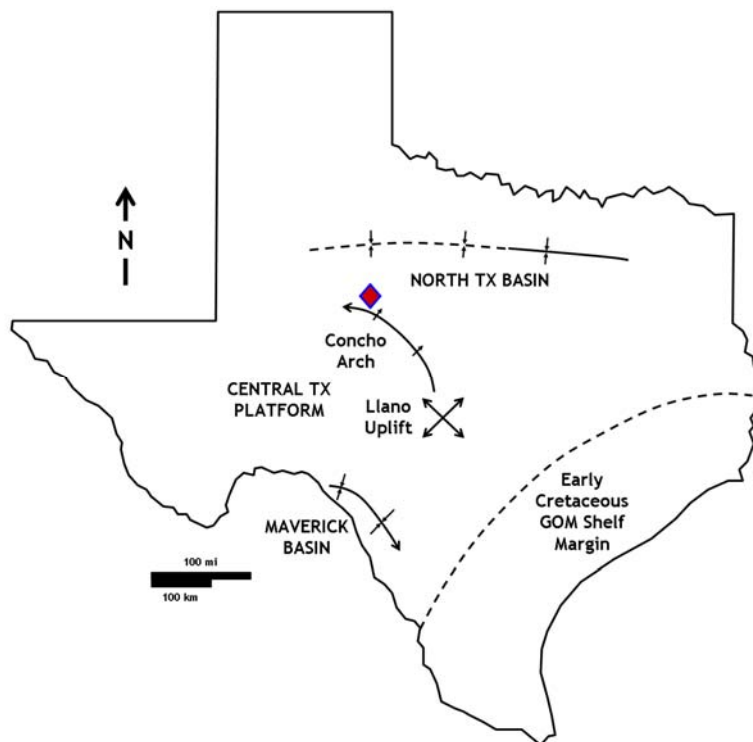


Figure 1. Early Cretaceous paleogeography of Texas. Nolan County study area indicated by diamond. The northern portion of the study area lies at the northern edge of the Cretaceous Central Texas Platform (Moore, 1996). This platform complex overlies the Llano Uplift and its western extension, the Concho Arch. Shallow cratonic basins are developed north and south of the platform.

with tidal flat lithofacies of the underlying HST and indicates prolonged subaerial exposure and associated karst and rhizolith development on the platform top. The encrusted *Trypanites* surface caps high-energy shoreface lithofacies. Based upon preliminary regional correlations, the lower sequence boundary and overlying succession are interpreted as the Lower Cretaceous Va sequence, and the upper sequence boundary and overlying strata are interpreted as the Lower Cretaceous Vb sequence of Moore (1996, 1997).

The TST of the Va sequence contains an onlapping terrestrial to shallow subtidal sandstone lithofacies association of the Antlers Sand overlain by, and grading northward down dip into, highly fossiliferous packstones and grainstones. These Va TST carbonates are characterized by sub-meter-scale cycles of glauconitic to clean limestones separated by firmgrounds with associated *Thalassinoides* burrows filled with coarser, glauconitic packstones. There appears to be little facies differentiation laterally along the dip transect, indicating that the overall geometry of the Va TST is a very low angle homoclinal ramp (Fig. 3). This TST package appears to be thicker to the north, thinning up-dip to the south (Fig. 3). Thus, sediment accumulation on the Va sequence boundary commenced earlier in the lower ramp position while the sequence boundary was still exposed to the south. Later retrogradation established shallow marine conditions on the sequence boundary to the south while open-marine carbonate sediments continued to accumulate downdip to the north.

The overlying Va highstand systems tract (HST) displays significant facies variation from south to north, indicating aggradation of a restricted inner ramp/platform interior

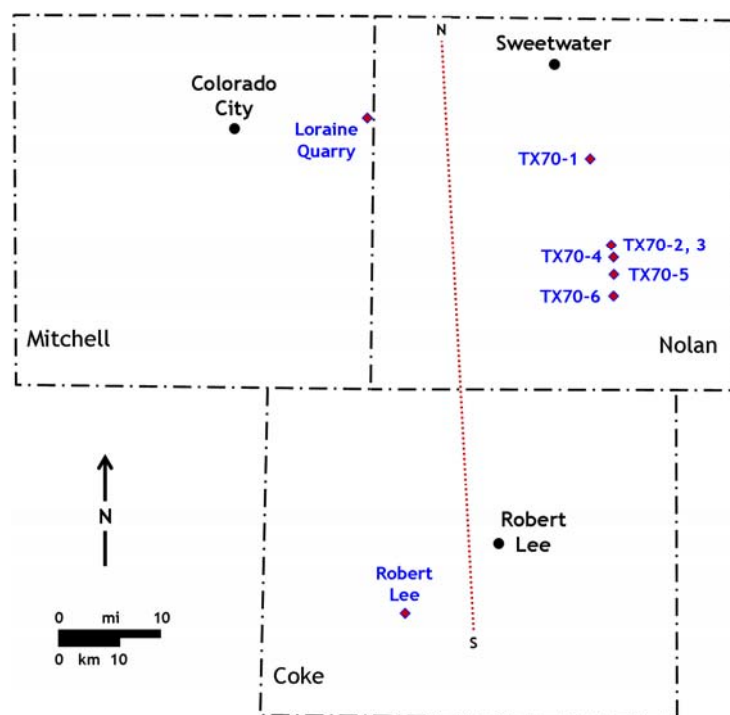


Figure 2. Base map of the Callahan Divide study area in Mitchell, Nolan, and Coke counties. Outcrops examined for this study are indicated by diamonds. The approximate location of the north-south schematic cross section of Figures 3-7 is indicated by the red dotted line.

to the south and progradation of a well-developed shoal margin to the north (Fig. 4). The southern inner-ramp succession is characterized by parasequences of bioturbated peloidal wackestones and laminated mudstones. Northern ramp crest/margin facies associations are dominated by bioturbated to small-scale trough- to ripple-stratified grainstones.

Everywhere this succession is overlain by a significant surface indicating cessation of carbonate sedimentation (Fig. 5). To the south tidal flat facies are associated with multiple generations of firmground *Glossifungites* surfaces and breccias that is overlain by gray marl. To the north, shoal grainstones are overlain by an encrusted *Trypanites* surface overlain by gray marl. Regionally this surface and marl correspond to the Vb sequence boundary and onlapping basal TST.

The basal gray marl bed is overlain to the south by bioturbated to laminated mudstone indicating establishment of a restricted and protected inner platform setting. However, to the north above the Va margin system, this marl is overlain by a southward-stepping, sheet-like rudist rudstone and ooid-lithoclast grainstone package that appears to be an aggradational transgressive buildup at the platform margin (Holterhoff and Oyedeji, 2009) (Fig. 6). This aggrading shoal system appears to have protected the southern interior of the platform, allowing accumulation of the mud-dominated inner-platform facies. This package potentially laps out onto the underlying Vb sequence boundary before reaching the southernmost field area.

Above the aggradational shoal complex of the northern field area, rudist patch reefs are regularly developed within cycles of platform peloidal-foram-mollusk wackestones and packstones (Fig. 7). South of this area, meter-scale rudist patches are interbedded with peloidal-foram wackestones. Many of these inner-platform lithofacies are exten-

South **LK-Va TST: Homoclinal Ramp** North

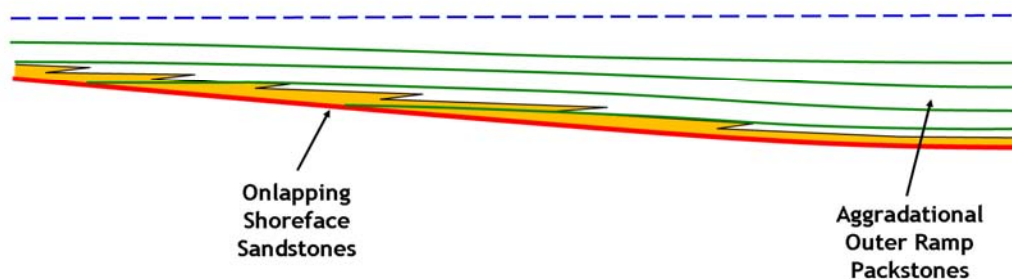


Figure 3. Stratigraphic geometry of the Fredericksburg Va transgressive systems tract. Permian and Triassic red beds underlie the Va sequence boundary and are onlapped by fluvial and shoreface lithofacies of the Antlers Sand. Skeletal packstones and grainstones are distributed regionally, indicating the development of a low-profile homoclinal ramp system.

South **LK-Va HST: Aggrading to Prograding Distal Steepened Ramp** North

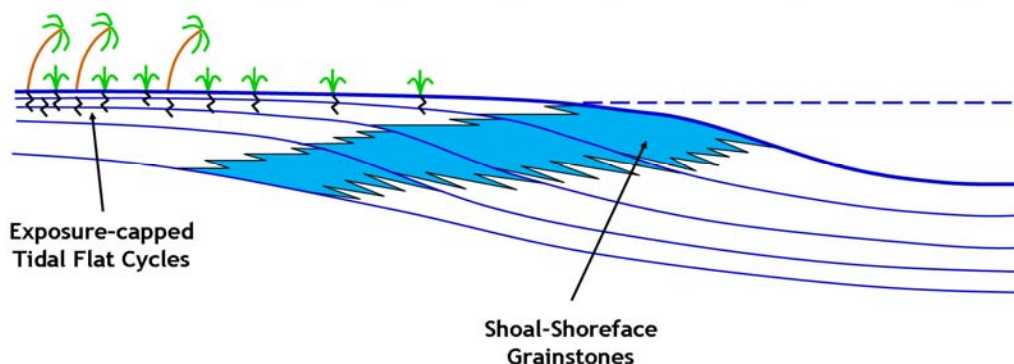


Figure 4. Stratigraphic geometry of the Fredericksburg Va highstand systems tract. Differential aggradation of the southern portion of the profile is indicated by development of tidal flat systems that pass northward into high-energy shoal/shoreface grainstones.

sively dolomitized. Far to the south bedsets of bioturbated dolomudstones and laminated dolopackstones to dolograinstones dominate the succession. These platform rudist and dolostone packages represent the Vb HST.

REFERENCES CITED

- Hoffman, C., C. Welch, G. Asquith, and E. Stouder, 2003, Cyclostratigraphic principles for reservoir characterization in carbonates: Examples from the Cretaceous of west-central Texas: Permian Basin Section of the Society of Economic Paleontologists and Mineralogists Field Trip Guidebook, Midland, Texas, 163 p.
- Holterhoff, P., and A. M. Oyedeji, 2009, Sequence stratigraphic control on middle Albian (Cretaceous) inner platform rudist mound geometries, west-central Texas: Insights from outcrops and implications for reservoir connectivity: American Association of Petroleum Geologists Search and Discovery Article #90090, <<http://www.searchanddiscovery.net/abstracts/html/2009/annual/abstracts/holterhoff.htm>> Last accessed September 4, 2010.

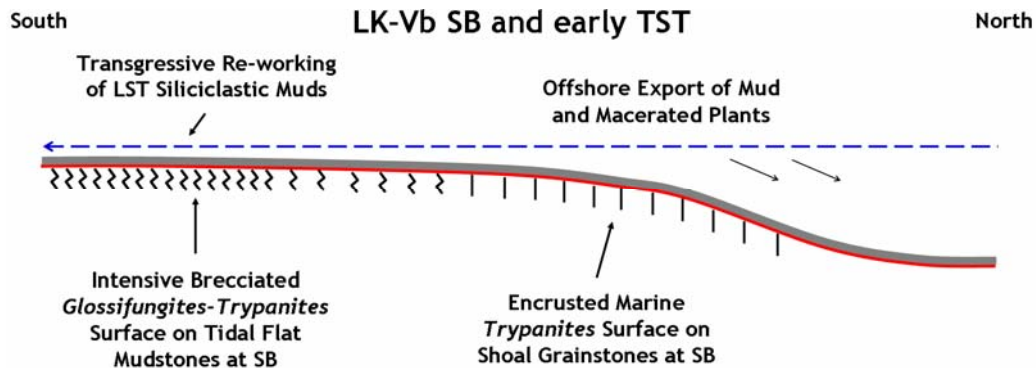


Figure 5. Diagnostic features of the Fredericksburg Vb sequence boundary and onlapping basal transgressive package. Regional development of a significant facies break and brecciated and bored surface onlapped by a meter-scale marl unit is interpreted as a significant unconformity. SB, sequence boundary.

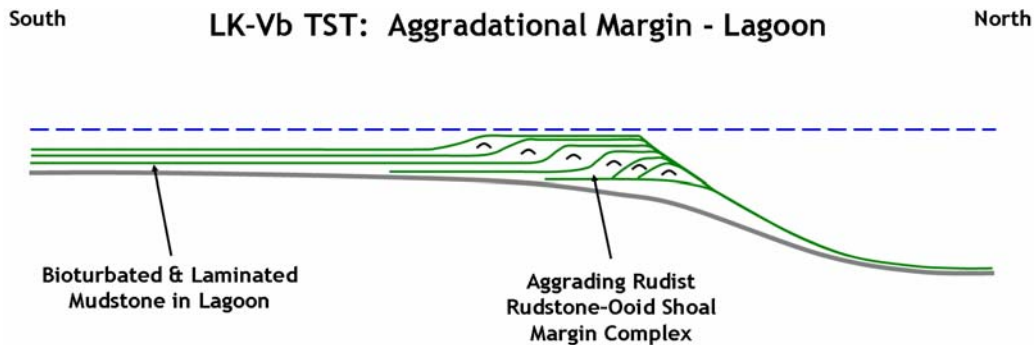


Figure 6. Stratigraphic geometry of the Fredericksburg Vb transgressive systems tract. A rudist rudstone-ooid shoal system is extensively developed as an aggrading, sheet-like complex hundreds of meters in dip extent at the northern margin of the platform. This shoal provided a barrier behind which restricted lagoonal mud-dominated lithofacies developed to the south.

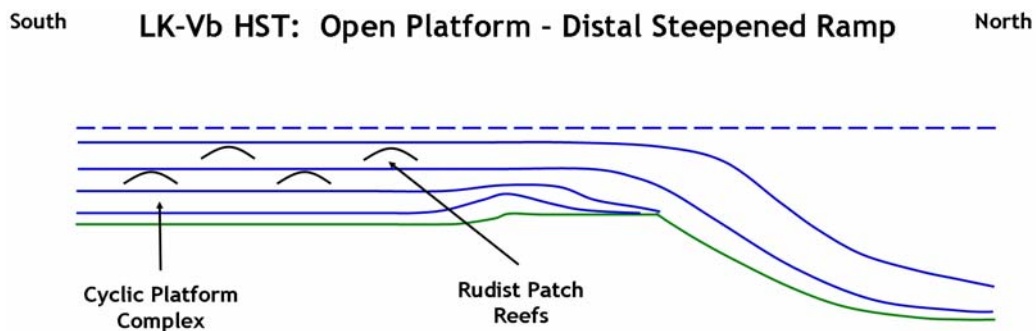


Figure 7. Stratigraphic geometry of the Fredericksburg Vb highstand systems tract. The platform is dominated by smaller patch reefs and less-restricted lagoonal lithofacies, indicating a more open platform system that allowed development of rudist build-ups and more diversely fossiliferous carbonates. However, periodic restriction and resulting concentration of brines is recorded by development of significant dolomitization across lithofacies types in the southern platform interior.

Moore, C., 1967, Stratigraphy of the Edwards and associated formations, west-central Texas: Gulf Coast Association of Geological Societies Transactions, v. 17, p. 61-75.

Moore, C., 1996, Anatomy of a sequence boundary—Lower Cretaceous Glen Rose/Fredericksburg, Central Texas Platform: Gulf Coast Association of Geological Societies Transactions, v. 46, p. 313-320.

Moore, C., 1997, A field guide to the sequence stratigraphic framework of Lower Cretaceous platform carbonates of central Texas: Self published, 79 p.