[PS]Lowstand Deltas and Incised Valleys of the Tannehill Sandstone (Cisco Group) of the Southern Eastern Shelf of the Permian Basin, West Texas*

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Abstract

Depositional cycles of Permo-Pennsylvanian (Virgilian and Wolfcampian) Cisco Group strata of the Eastern Shelf of the Permian Basin are dominantly transgressive limestones interstratified with highstand fluvial-deltaic and lowstand incised-valley-fill sandstones and mudrocks. Alternating thickened transgressive shelf-edge limestone systems and lowstand shelf-edge deltaic deposits, equivalent to the valley-fill systems, were also deposited along the margin of the deepening basin. This study focuses on the lower Wolfcampian Tannehill Sandstone as an example of the areal and shelf-to-basin stratigraphic expression of one of these valley-fill/lowstand delta systems.

In Nolan, Taylor, Coke, and Runnels counties, the Tannehill Sandstone occurs in two areal configurations: (1) narrow, slightly curvilinear belts that extend southwestward and due east-west across this study area and (2) local, digitate depositional trends. The first configuration represents lowstand valley-fill systems that locally incise the underlying Saddle Creek Limestone. These facies are 20-50 ft thick, blocky to upward coarsening, characterized by consistently low resistivity values and high SP/low GR values, and are restricted to on-shelf areas. Down-dip equivalents of these sandstones with digitate areal configurations are marked by similar well-log values but in contrast are 60-100 ft thick, upward-coarsening, blocky, and digitate. Moreover, they partially overlap and extend about 8-12 mi basinward of the Saddle Creek shelf edge and record deposition of lowstand shelf-edge deltas fed by the incised-valley systems. Digitate areal facies were also deposited in the on-shelf area and are primarily upward coarsening and represent thinner (10-30 ft thick) highstand deltas. Incised-valley-fill, lowstand-delta, and highstand-delta sandstone facies are significant hydrocarbon producers in the Eastern Shelf.

Mapping of shelf-edge lowstand deltas of the Tannehill and other Cisco Group sandstones record an aspect of the self-edge evolution in the Eastern Shelf. These deltas formed depositional platforms over which the next younger limestone (in this case, the Stockwether Limestone) transgressed across the shelf. As a result, the western (basinward) limit of the lowstand-delta platforms marks the shelf edge of these overlying limestones.

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Abilene Geological Society, 1992, The Stratigraphic Distribution of Hydrocarbon Production from 19 Counties in the Abilene Area: Abilene Geological Society, unpaginated.

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Bureau of Economic Geology

Project STARR — State of Texas Advanced Resource Recovery

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Jackson School of Geosciences
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INTRODUCTION

Figure 1. Study area of Nolan, Taylor, Coke, and Runnels Counties in the central part of the Eastern Shelf of the Midland Basin. Cross section A-A' shown in Figure 5.

Depositional cycles of Permo-Pennsylvanian (Virgilian and Wolfcampian) Cisco Group strata of the Eastern Shelf of the Permian Basin are dominantly transgressive limestones interstratified with highstand fluvial-deltaic and lowstand incised-valley-fill sandstones and mudrocks. Alternating thickened transgressive shelf-edge limestone systems and lowstand shelf-edge deltaic deposits, equivalent to the valley-fill systems, were also deposited along the margin of the deepening basin. This study focuses on the lower Wolfcampian Tannehill Sandstone as an example of the areal and shelf-to-basin stratigraphic expression of one of these valley-fill/lowstand delta systems.

In Nolan, Taylor, Coke, and Runnels counties, the Tannehill Sandstone occurs in two areal configurations: (1) narrow, slightly curvilinear belts that extend southwestward and due east-west across this study area and (2) local, digitate depositional trends. The first configuration represents lowstand valley-fill systems that locally incise the underlying Saddle Creek Limestone. These facies are 20–50 ft thick, blocky to upward coarsening, characterized by consistently low resistivity values and high SP/low GR values, and are restricted to on-shelf areas. Down-dip equivalents of these sandstones with digitate areal configurations are marked by similar well-log values but in contrast are 60–100 ft thick,

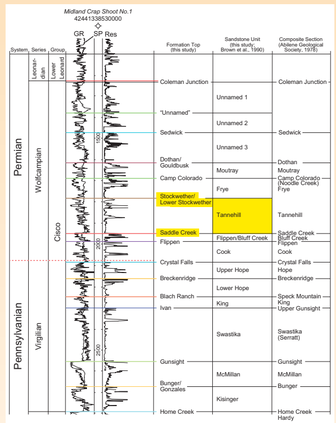

Figure 2. Type stratigraphic column from the Midland Crap Shoot No. 1 well in southeastern Taylor County depicting the Stockwether Limestone, Tannehill Sandstone, and Saddle Creek Limestone (all highlighted) correlated in this study. This section represents the shelf succession—the shelf-edge and slope systems to the west vary markedly in thickness and abundance of limestone and mudrock.

upward-coarsening, blocky, and digitate. Moreover, they partially overlap and extend about 8–12 mi basinward of the Saddle Creek shelf edge and record deposition of lowstand shelf-edge deltas fed by the incised-valley systems. Digitate areal facies were also deposited in the on-shelf area and are primarily upward coarsening and represent thinner (10–30 ft thick) highstand deltas. Incised-valley-fill, lowstand-delta, and highstand-delta sandstone facies are significant hydrocarbon producers in the Eastern Shelf.

Mapping of shelf-edge lowstand deltas of the Tannehill and other Cisco Group sandstones record an aspect of the self-edge evolution in the Eastern Shelf. These deltas formed depositional platforms over which the next younger limestone (in this case, the Stockwether Limestone) transgressed across the shelf. As a result, the western (basinward) limit of the lowstand-delta platforms marks the shelf edge of these overlying limestones.

GROSS-SANDSTONE MAP

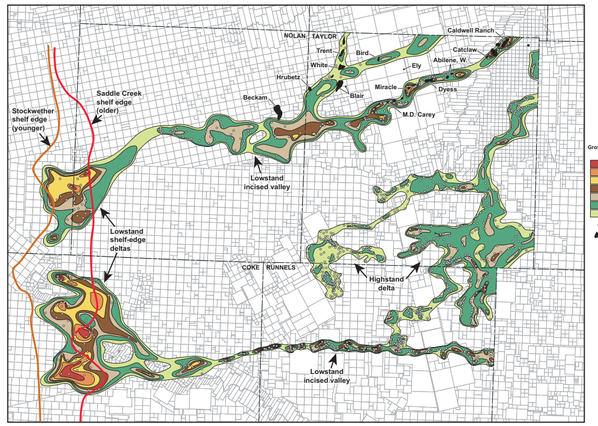

Figure 3. Gross-sandstone map of the Tannehill Sandstone of the upper Cisco Group. The map depicts two primary lowstand incised-valley systems originating in the east and northeast and their two genetically associated lowstand shelf-edge deltas. The Tannehill lowstand deltas prograded across the underlying Saddle Creek Limestone shelf edge, extending westward above slope facies and forming a depositional platform over which the overlying Stockwether Limestone transgressed. The Stockwether Limestone shelf edge marks the progradational limit of the Tannehill Sandstone. An inferred Tannehill highstand fluvial–deltaic system occurs in the far east-central part of the map area. Although occurring at a slightly higher stratigraphic level, this highstand sandstone is designated by industry to be part of the Tannehill stratigraphic zone. Tannehill field locations from Abilene Geological Society (1992).

LOCATION MAP CROSS SECTIONS

Figure 4. Index map of cross sections B-B', C-C', and D-D'. Cross sections shown in Figures 6-8.

REGIONAL DIP CROSS SECTION

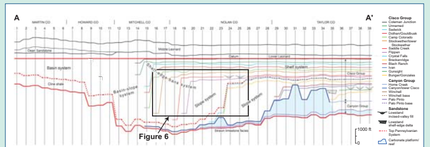

Figure 5. Cross section A-A' depicting the location of the Tannehill Sandstone, Saddle Creek Limestone, and Stockwether Limestone and associated shelf-edge bank and slope systems within a basin-scale context. The Cisco Group is a regionally progradational succession, unlike the underlying aggradational Canyon Group. From Hentz et al. (2017). Line of section shown in Figure 1.

CROSS SECTIONS

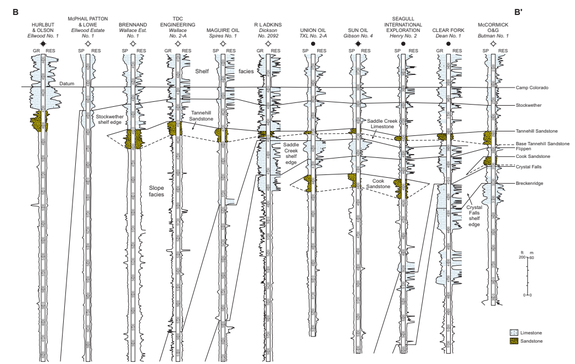

Figure 6. Cross section B-B' illustrating in dip profile the stratigraphic relations among the Tannehill Sandstone, Saddle Creek Limestone, and Stockwether Limestone. Blocky to upward-fining (aggradational) log facies of the Tannehill incised-valley fill transition downdip (westward) to thicker upward-coarsening (progradational) log profiles of the associated shelf-edge delta. The Tannehill Sandstone pinches out just updip of the Stockwether shelf-edge limestone, which transgressed across the depositional platform formed by the Tannehill shelf-edge delta. The same relation exists between the Cook Sandstone and the overlying Flippen Limestone. This record of large-scale shelf-edge progradation is collectively represented by all lowstand sandstones in the Cisco Group. Line of section shown in Figure 4.

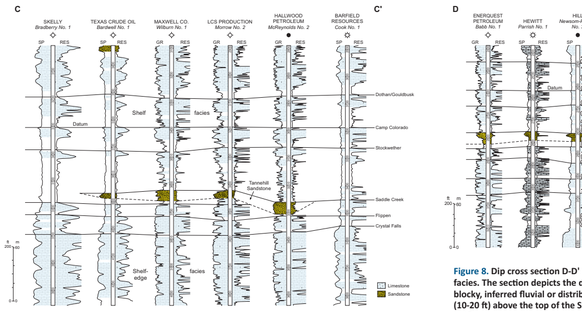

Figure 7. Cross section C-C' illustrating Tannehill incised-valley-fill facies across the axis of the valley fill. Note complete erosion of the Saddle Creek Limestone in the Hallwood Petroleum McReynolds No. 2 well. Line of section shown in Figure 4.

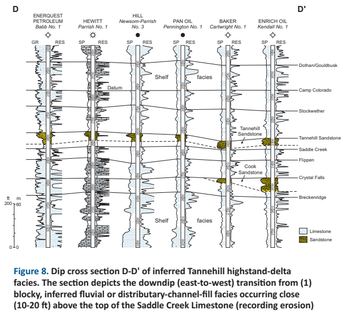

Figure 8. Dip cross section D-D' of inferred Tannehill highstand-delta facies. The section depicts the downdip (east-to-west) transition from (1) blocky, inferred fluvial or distributary-channel-fill facies occurring close (10-20 ft) above the top of the Saddle Creek Limestone (recording erosion) to (2) upward-coarsening prodelta-to-channel-mouth-bar facies occurring as much as 50 ft above the Saddle Creek internal. The progradational log profile in the west is best displayed on gamma-ray logs (for example, see the Enerequest Babb No. 1 well). Incised-valley-fill facies occur in the underlying Cook Sandstone.

CORED SECTION

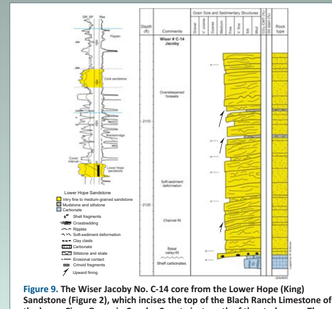

Figure 9. The Wiser Jacoby No. C-14 core from the Lower Hope (King) Sandstone (Figure 2), which incises the top of the Blach Ranch Limestone of the lower Cisco Group in Concho County just south of the study area. The core records coarse-grained fluvial channel-fill facies of a lowstand incised-valley fill. Although the core is not of the Tannehill Sandstone, it is representative of that and other incised-valley units within the Cisco Group of the southern Eastern Shelf.

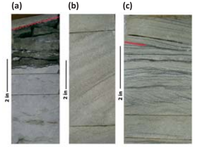

Figure 10. Core photographs of the Wiser Jacoby No. C-14 well. (a) Basal incised-valley fill deposits in the Lower Hope sandstone, showing erosional contact with carbonate mudstone of the lower Blach Ranch Limestone at 2,126.5 ft. (b) Oversteepened foresets in bedload-channel-fill facies in medium-grained sandstone at 2,107.1 ft. (c). Ripple-stratified and mud-draped, fine-to-medium-grained sandstone in upper-channel-fill facies, truncated by planar-stratified, medium-grained sandstone in lower-channel-fill facies at 2,119.4 ft.

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