Stratigraphic Variability of the Marmaton Group Across the Lips Fault System in the Texas Panhandle Granite Wash, Southern Anadarko Basin*

Patrick D. Jordan¹ and Dr. Jesse J. Melick²

Abstract

The Desmoinesian Marmaton Group, located along the southern portion of the Anadarko Basin in the Granite Wash, contains over 2,000 feet of stacked tight-sand and conglomerate unconventional reservoirs. Facies variability and lateral continuity within reservoirs represent the biggest challenges to reservoir characterization due to laterally restricted alluvial fan systems. A high-resolution stratigraphic hierarchy mapped across fault blocks should identify previously undocumented syndepositional faults. These fine-scale time sequences should constrain reservoir thicknesses and frame facies changes near sub-seismic faults. Twenty-one stratigraphic surfaces were enveloped into a scalar stratigraphic hierarchy used for estimating fault timing and duration. Well log trends were calibrated to core descriptions, which enable interpreting depositional environments directly from well logs across the 810 square mile study area. The well log trends in non-cored wells were calibrated to cored wells to extrapolate depositional environments over the study area. This interrelationship between structure and stratigraphy provides tools to optimize the placement and design of lateral wells.

Selected References


Hypothesis

The Desmoinesian Marmaton Group, along the southern portion of the Anadarko Basin in the Granite Wash, comprises over 2,000 feet of stacked tight sandstones and conglomerates, containing unconventional reservoirs. Uncertainty around facies variability and lateral continuity of these reservoirs represents challenges to accurate reservoir characterization due to laterally restricted submarine fan systems, and mountain-front faulting. This study examines 206 wire-line well-log suites and nine icehouse flooding surfaces across an 810-square mile study area to frame fine-scale changes, track facies changes, and estimate fault timing and duration. This high resolution stratigraphic framework comprises a hierarchy of cycles: one third-order, three fourth-order, and eight fifth-order cycles; these were mapped across fault blocks. Mapping at the fifth-order scale documented previously un-published faults, and showed that movement occurred during the two separate fifth-order cycles. Within the stratigraphic framework, well log trends, calibrated to core descriptions, enabled prediction of depositional environments in uncored wells.

Introduction and Regional Setting

Abstract

The Desmoinesian Marmaton Group, along the southern portion of the Anadarko Basin in the Granite Wash, comprises over 2,000 feet of stacked tight sandstones and conglomerates, containing unconventional reservoirs. Uncertainty around facies variability and lateral continuity of these reservoirs represents challenges to accurate reservoir characterization due to laterally restricted submarine fan systems, and mountain-front faulting. This study examines 206 wire-line well-log suites and nine icehouse flooding surfaces across an 810-square mile study area to frame fine-scale changes, track facies changes, and estimate fault timing and duration. This high resolution stratigraphic framework comprises a hierarchy of cycles: one third-order, three fourth-order, and eight fifth-order cycles; these were mapped across fault blocks. Mapping at the fifth-order scale documented previously un-published faults, and showed that movement occurred during the two separate fifth-order cycles. Within the stratigraphic framework, well log trends, calibrated to core descriptions, enabled prediction of depositional environments in uncored wells.

1. Paleogeographic Setting and Present-Day Structure of the Southern Anadarko Basin

2. Depositional Model

3. Stratigraphic Framework

1. Paleogeographic Setting and Present-Day Structure of the Southern Anadarko Basin

What is the Granite Wash?

10,000 feet thick sedimentary column, which contains multiple stacked unconventional reservoirs (tight sands and conglomerates).

Comprised of Pennsylvanian age clastics eroded from uplifted Precambrian/Cambrian basement of the Amarillo-Wichita Uplift (Ball and others, 1991).

Reservoir characterization can be challenging due to lateral discontinuities of reservoirs, differentiation of reservoirs from non-reservoirs, and hydrocarbons are difficult to distinguish from water.

Hypothesis

Assuming faulting was active during deposition of the Marmaton Group, a high resolution stratigraphic framework constructed across documented fault blocks will highlight fault timing and duration.

Question

When did faulting occur and how did it impact facies distribution and sequence thickness?

Marmaton Group Study Area and Dataset

4. Regional Study Area

5. Focus Area: Data Map

6. Sedimentology: Process-Facies and Associations

7. Core B: Core Box Photographs

8. Core B: Core Box Photographs

9. Facies Associations

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Log-to-Core Calibration and Log Trends

10. Log Calibration - Fan Delta Cycle

Figure 10. Core “B” log-to-core calibration. The inset map shows wells with fan delta log trends in the vicinity of core “B.”

The well log shape calibrated to core “B” was compared with well log signatures of un-cored wells in the focus area. These well log shapes (e.g. blocky, deepening upward sand packages) appear to be laterally restricted to one area and are discontinuous along strike.

11. Log Calibration: Flooding Surface

Figure 11. Well log response of a Granite Wash flooding surface from the underlying Skinner Wash in the Cherokee Group calibrated to core photos from the well.

12. Extrapolation of Fan Delta Log Trends to Focus Area

Figure 12. Extrapolation of fan delta log trends from core “B” to un-cored wells in the focus area. These five depositional environments might be correlated with the log trend from core “B.”

Stratigraphic Framework

13. Type Well: Stratigraphic Hierarchy

Figure 13. Three-fold stratigraphic hierarchy of the Marmaton Group based on detailed correlations in 600 wells (sensu Mitchum and Van Waggoner, 1991).

Sand Thickness Across Faults

15. Gross Sand Isolith Maps

Figure 14. Cycle two and four isopach maps. Increased thickening of cycle four is expressed as channels and fan apron shaped depocenters on downdropped fault blocks, while upthrown fault blocks could have been eroded and are thinner.

In response to fault movement due to nearby tectonic uplift, sediments eroded and aggraded on the downdropped side of fault one. As a result of uplift and denudation, a large drop in base level occurred during cycle four.

Sequence Thickness Across Faults


Figure 15. Sand maps for cycles two and four. Cycle four contains twice as much sand on the down thrown fault side of fault one, where the upthrown side is thinner.

Faulting provided accommodation during deposition of cycle four, which allowed for sand to aggrade and stacked channels.

Un-Published Faults

16. Sequence 4 Structure Map

Figure 16. Structure map contoured on flooding surface four.

17. Sequence 4 Slope Angle Map

Figure 17. Dip angle curvature map calculated from flooding surface four structure map. Dip angle curvature calculations based on (Wood, 1996).

Structural Type Section

18. Structural Type Section Across Fault Blocks

Figure 18. Structural cross section (refer to Figure 5 on first poster for location of cross section) across fault blocks showing increased thickening of sequence four across fault one.

Conclusions

- A high-resolution chronostratigraphic framework was constructed in over 200 wells to delineate fault movement.
- Fault movement likely occurred episodically during two separate 5th-order cycles (Cycle 2, Cycle 4), which may be related to uplift during a 3rd-order cycle.
- Cycle 2 was thicker on upthrown fault blocks, whereas Cycle 4 was thicker on downthrown fault blocks.

References