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Early and Middle Atokan Lithostratigraphy and Reservoir Development, Northern Arkoma Basin, Northwestern Arkansas

A thesis submitted in partial fulfillment of
the requirements for the degree of
Master of Science in Geology

By

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University of Arkansas
Bachelor of Science in Geology, 2011

August 2016
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This thesis is approved for recommendation to the Graduate Council.

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ABSTRACT

The Arkoma Basin is a peripheral foreland arc basin associated with the Ouachita orogenic belt. In Arkansas, the basin is bounded by the Ouachita belt to the south and the Ozark Dome to the north. Sedimentary rocks of early to middle Atokan age are present in the shallow subsurface at the northern margin of the Arkoma Basin in northwestern Arkansas. Sedimentary units of this time interval reflect basinal subsidence, and the transition of the Arkoma Basin from a passive margin shelf to a rapidly evolving foreland arc basin. Sediment sources from the north and east produced a thickened Lower and Middle Atoka record across the basin.

Using PETRA, wireline logs were used to construct two sets of stratigraphic cross-sections that document the depositional changes that occurred during Arkoma Basin subsidence and associated structural events in northwestern Arkansas. Both sets of cross-sections extend west to east with one set in the north: cross-section North and the other set in the south: cross-section South. The Lower Atoka, Areci and Tackett were each deposited as a discrete interval, but the component sands of each unit are different reflecting different environment dynamics and sources. This explains why gas reservoir development in the Atoka Formation of the Arkoma Basin is so variable.
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# TABLE OF CONTENTS

INTRODUCTION .................................................................................................................. 1
  Purpose of Investigation .................................................................................................. 2
  Previous Investigations .................................................................................................. 2
  Methods .......................................................................................................................... 3

GEOLOGIC SETTING ........................................................................................................... 8

LITHOSTRATIGRAPHIC SUMMARY – NORTHERN CROSS-SECTION ....................... 12
  Lower Atoka ................................................................................................................. 12
  Casey .............................................................................................................................. 13
  Zamb .............................................................................................................................. 15
  Areci .............................................................................................................................. 16
  Tackett ............................................................................................................................ 16

LITHOSTRATIGRAPHIC SUMMARY – SOUTHERN CROSS-SECTION ..................... 20
  Lower Atoka ................................................................................................................. 20
  Areci .............................................................................................................................. 21
  Tackett ............................................................................................................................ 21

CONCLUSIONS ................................................................................................................. 22

REFERENCES .................................................................................................................. 27

ANALYSIS OF REGIONAL STRATIGRAPHIC CROSS-SECTIONS .......................... 29

APPENDIX A ..................................................................................................................... 29
  Lower Atoka A to A’ ...................................................................................................... 29
  Lower Atoka B to B’ ...................................................................................................... 32
  Lower Atoka C to C’ ...................................................................................................... 34
  Lower Atoka D to D’ ...................................................................................................... 36
  Lower Atoka E to E’ ...................................................................................................... 38
  Areci A to A’ ................................................................................................................ 40
  Areci B to B’ ................................................................................................................ 43
  Areci C to C’ ................................................................................................................ 46
  Areci D to D’ ................................................................................................................ 49
  Areci E to E’ ................................................................................................................ 51
LIST OF FIGURES

Figure 1. a map of Arkansas that displays the location of Johnson and Pope County. ............... 4

Figure 2. a geologic map of the study area in northwest Arkansas. ........................................ 4

Figure 3. A log that displays all units of interest ................................................................. 5

Figure 4. Map that displays the study area and locations of wells used in this study............... 6

Figure 5. A stratigraphic cross-section flattened on the Tackett formation top ..................... 7

Figure 6. Display of some of the more common gamma ray signatures (Pettijohn, 1987) ....... 8
Figure 7. A map of the geologic subprovinces (Manger, Zachry, and Garrigan, 1988)................. 9
Figure 8. Tectonic Evolution of the Arkoma Basin................................................................. 11
Figure 9. A well log displaying the formation tops of the Casey and Lower Atoka .................. 13
Figure 10. Well log that displays the Lower Atoka down to the Hale Formation ...................... 14
Figure 11. A well log from T9N R20W. This log displays both the Bynum and the Zamb........... 15
Figure 12. A well log from T9N R20W. The top of the Areci sand body is represented.......... 17
Figure 13. A well log from T9N R22W that displays the Areci with a serrated or ‘ratty’ pattern, and the thick shale interval that separates the Areci and Tackett. Well name: Patterson 2-19 .... 17
Figure 14. A well log from T9N R20W that displays the Tackett............................................ 18
Figure 15. A well log from T9N R22W that displays the Tackett with multiple gamma ray patterns.......................................................................................................................... 19
Figure 16. A well log from T9N R21W that displays the Tackett as a thin sand body in the ...... 20
Figure 17. northern stratigraphic cross-section A to A’ flattened on the Lower Atoka .......... 31
Figure 18. northern stratigraphic cross-section B to B’ flattened on the Lower Atoka .......... 33
Figure 19. northern stratigraphic cross-section C to C’ flattened on the Lower Atoka.......... 35
Figure 20. northern stratigraphic cross-section D to D’ flattened on the Lower Atoka. ........... 37
Figure 21. northern stratigraphic cross-section E to E’ flattened on the Lower Atoka.......... 39
Figure 22. northern stratigraphic cross-section A to A’ flattened on the Areci...................... 42
Figure 23. northern stratigraphic cross-section B to B’ flattened on the Areci ....................... 45
Figure 24. northern stratigraphic cross-section C to C’ flattened on the Areci ....................... 48
Figure 25. northern stratigraphic cross-section D to D’ flattened on the Areci....................... 50
Figure 26. northern stratigraphic cross-section E to E’ flattened on the Areci....................... 52
Figure 27. northern stratigraphic cross-section A to A’ flattened on the Tackett................. 54
Figure 28. northern stratigraphic cross-section B to B’ flattened on the Tackett............................ 56
Figure 29. northern stratigraphic cross-section C to C’ flattened on the Tackett......................... 58
Figure 30. northern stratigraphic cross-section D to D’ flattened on the Tackett......................... 60
Figure 31. northern stratigraphic cross-section E to E’ flattened on the Tackett......................... 62
Figure 32. southern stratigraphic cross-section F to F’ flattened on the Lower Atoka. ............... 65
Figure 33. southern stratigraphic cross-section G to G’ flattened on the Lower Atoka .............. 68
Figure 34. southern stratigraphic cross-section H to H’ flattened on the Lower Atoka .............. 71
Figure 35. southern stratigraphic cross-section I to I’ flattened on the Lower Atoka ............... 73
Figure 36. southern stratigraphic cross-section J to J’ flattened on the Lower Atoka .............. 75
Figure 37. southern stratigraphic cross-section F to F’ flattened on the Areci ......................... 77
Figure 38. southern stratigraphic cross-section G to G’ flattened on the Areci ...................... 80
Figure 39. southern stratigraphic cross-section H-H’ flattened on the Areci ......................... 83
Figure 40. southern stratigraphic cross-section I-I’ flattened on the Areci .......................... 86
Figure 41. southern stratigraphic cross-section J-J’ flattened on the Areci .......................... 88
Figure 42. southern stratigraphic cross-section F-F’ flattened on the Tackett ......................... 90
Figure 43. southern stratigraphic cross-section G-G’ flattened on the Tackett ......................... 92
Figure 44. southern stratigraphic cross-section H-H’ flattened on the Tackett ......................... 94
Figure 45. southern stratigraphic cross-section I-I’ flattened on the Tackett ......................... 96
Figure 46. southern stratigraphic cross-section J-J’ flattened on the Tackett ......................... 98
INTRODUCTION

Sedimentary rocks of early to middle Atokan age are present in the shallow subsurface at the northern margin of the Arkoma Basin in northwestern Arkansas. Sedimentary units of this time interval reflect basinal subsidence, and the transition of the Arkoma Basin from a passive margin shelf to a rapidly evolving foreland arc basin with the closing of the Ouachita trough. (Houseknecht, 1986) The Arkoma Basin is a peripheral foreland arc basin associated with the Ouachita orogenic belt. In Arkansas, the basin is bounded by the Ouachita belt to the south and the Ozark Dome to the north. Sediment sources from the north and east produced a thickened Lower and Middle Atoka record across the basin.

Sea level changes influenced early and middle Atokan deposition producing sedimentary sequences of alternating beds of sandstone and shale as well as deposition of thick shale intervals. There are multiple instances of sand bodies separated by thick shale units (Figure 1) implying that at least two, and probably more, maximum flooding events are present in the early and middle Atoka sequences.

The names of the early-middle Atokan units, i.e. Casey, Areci and Tackett, are informal applications by the petroleum industry to identify producing sandstones in the Arkoma Basin (Figure 3). The Zamb is an informal name used to designate the shale unit beneath the Bynum. Lower Atoka is a term used to designate the sand intervals that occur beneath the Casey. The name Morrowan is used to designate the sand and shale interval that occurs beneath the Lower Atoka (Figure 3). Unfortunately, there are multiple informal names for these intervals that have been, or are included in the petroleum industry nomenclature. To avoid confusion, for this study, only the names of the formations in Figure 3 were utilized for consistency, because they have been used in previous studies.
Purpose of Investigation
The objective of this study is to document the depositional changes that occurred during Arkoma Basin subsidence and associated structural events in northwestern Arkansas. Insight into these changes were documented by constructing detailed stratigraphic cross-sections that extend west and east through the entire area. Sets of cross-sections (Figure 4) extend west to east to provide detail about the northern part of the study area: cross-section North, while the other set describes the southern part: cross-section South. These two regional cross-sections were then divided into smaller segments in order to interpret them. The North divisions consist of cross-sections A-E, and the south divisions consist of cross-sections F-J (Appendices A and B).

Previous Investigations

Numerous theses produced by Geoscience students at the University of Arkansas have been devoted to studies of both the Morrowan and Atokan strata in the northwest and central portion of the Arkoma Basin in Arkansas. LaGrange (2002) studied the Lower Atoka Formation in surface exposures across the Arkoma Basin in central Arkansas. He described depositional characteristics of the Lower Atoka based on observations from multiple outcrops. Woolsey (2007) studied the basal Atoka Formation in central Arkansas. She created a depositional model for the basal units of the Atoka Formation to help improve the geologic understanding of those units for petroleum exploration. Houston (2007) described the depositional history of three
sandstone units in the Middle and Upper Atoka Formation. Bello (2012) studied the lithostratigraphic transition of the Middle Atoka Formation during Early and Middle Pennsylvanian time. He recognized a thickening in the Middle Atoka, as well as describing reservoir geometry and depositional environments. Studebaker (2014) studied the Morrowan interval and Lower Atoka Formation in the subsurface in Franklin and Johnson counties. She determined that the Bloyd Formation thickened across the northern part of the basin from west to east. Bahram (2015) studied the structural and stratigraphic aspects of the Middle Atoka Formation. He proposed an arch-and-trough setting that led to gas accumulation in his study area. His stratigraphic analysis confirmed a thickening to the south in Atoka Formation in the Arkoma Basin recognized in other studies (e.g. Bello, 2012).

**Methods**

The area of interest occupies Township 9 North and Ranges 22, 21 and 20 West in northwestern Arkansas with an inventory of 111 well logs with raster data (Figure 1). Using gamma ray, resistivity, and conductivity logs, formation tops for the sand units of interest were picked and correlated using PETRA. That software was also used to access and manipulate other stratigraphic and lithologic data taken from those gas exploration wells. Figure 1 shows a type log of all the units that are discussed herein. The nomenclature used to describe the gamma ray signatures follows previous studies listed above, and Pettijohn’s diagram (1987) (Figure 6). Wells that were either too shallow or lacked gamma ray signatures were not used for this study. Faults caused the omission of hundreds of feet of section, and wells with significant structural complications were not included in these cross-sections.
Figure 1. A map of Arkansas that displays the location of Johnson and Pope County.

Figure 2. A geologic map of the study area in northwest Arkansas (Haley et al., 1993).
Figure 3. A log that displays all units of interest. Well name: House of Prayer Chu 1.

The sedimentary units examined are Lower Atoka, and Zamb, Bynum, Areći and Tackett of the Middle Atoka. The earlier Casey and Morrowan are included to determine whether or not there are structural problems with a particular log. The designation of the Morrowan reflects
petroleum nomenclature to group the multiple sedimentary units that are members of the Hale and Bloyd Formations, rather than referring to each of the individual units.

Formation tops were picked at the top of the sand bodies of each interval, with the exception of the Zamb. Using a type log similar to Figure 3, those formation tops were correlated across the study area. This correlation provided the data to create both structural and stratigraphic cross-sections, such as Figure 5. Two west to east cross-sections that transect most of the study area were created. The cross-sections were then divided into smaller segments. The north contains cross-sections A-E, and the south contains cross-sections F-K. These cross-sections were interpreted to determine the depositional history of the study area (e.g. Figure 4).

Figure 4. Map that displays the study area and locations of wells used in this study. The red line represents the northern cross-section A to A’ and the blue line represents the southern cross-sections B to B.’
Figure 5. A stratigraphic cross-section flattened on the Tackett formation top. An example of the correlation procedure used herein.
Figure 6. Display of some of the more common gamma ray signatures, and the depositional environments assigned to them (Pettijohn, 1987).

**GEOLOGIC SETTING**

The focus of this study is the northern margin of the Arkoma Basin in northwestern Arkansas. The Arkoma Basin is bounded by the Ouachita Fold Belt to the south and the Ozark Dome to the north (Figure 7). The northern boundary is defined by the Mulberry Fault, while the southern boundary is defined by the Ouachita Mountains (Houston, 2007).
The Ozark Dome serves as the northern boundary of the Arkoma Basin. The dome is a large, elongated uplift that extends from south-eastern Missouri, through portions of northwestern Arkansas and northeast Oklahoma (Studebaker, 2014). It consists of an exposed core of Precambrian granite and rhyolite. Paleozoic strata dip gently away from the Precambrian core and form an asymmetrical concentric pattern of successively younger strata to the south and southwest (Handford and Manger, 1990). The dome is divided into three plateau surfaces that
dip away from the core: ascending Salem Plateau, the Springfield Plateau, and the Boston Mountain Plateau. The Salem Plateau is capped by lower Ordovician dolomite and limestone, the Springfield Plateau is capped by lower Mississippian limestone and chert, and the Boston Mountain Plateau is capped by Atoka terrigenous clastic strata (Woolsey, 2007).

The Ouachita Orogenic Belt is the southern boundary of the Arkoma basin. It was formed by the collision of North America and a southern terrain, during early Pennsylvanian time and Permian time (Houseknecht, 1986). Houseknecht’s model (Figure 8) explains the formation of the Ouachita Orogenic Belt and the Arkoma Basin. The basin is one of a series of foreland basins formed on the North American side of the Ouachita belt (Woolsey, 2007). The collision that created the Ouachita belt led to deformation of the strata that formed synclines and thrust sheets that now comprise most of the Ouachita Mountains (Studebaker, 2014).

The Arkoma Basin is a peripheral foreland basin associated with the Ouachita belt. It was originally a passive margin shelf until the closing of the Ouachita trough (Houseknecht, 1986). Houseknecht’s (1986) interpretation indicates that major rifting occurred during the Late Precambrian and through the Early Paleozoic (Figure 8A). Rifting resulted in the opening of a shallow ocean basin, where a shelf facies accumulated, dominated by carbonates, sandstones and shales. During the Early Mississippian, the Ouachita trough began to close as subduction began (Figure 8C). The closing of the trough led to the rapid transition of the passive margin shelf to a rapidly evolving foreland arc basin (Houseknecht, 1986). Along the southern margin of North America, an accretionary prism formed in the subduction zone that would later become the Ouachita orogenic belt (Studebaker, 2014). The ocean basin was completely subducted by early Atokan time (Figure 8D). Flexural deformation, ‘bending’, occurred on the southern margin due
to the weight of sediment from the vertical loading by the overriding plate. This flexural bending led to normal faulting as the crust was drawn into the subduction zone. Normal faulting

Figure 8. Tectonic Evolution of the Arkoma Basin in Response to Compressional Collisional Tectonics (Houseknecht and Kacena, 1983; Houseknecht, 1986).
occurred in the southern part of the basin as subsidence led to the breakdown of the passive margin shelf to the north. The Lower and Middle Atoka Formations were deposited at the breakdown. The breakdown of the shelf greatly influenced Atokan sedimentation, and is responsible for the thickening trend of Lower and Middle Atoka strata southward into the basin (Houseknecht, 1986). Normal faulting that occurred during basin subsidence provided accommodation space for the influx of sediment from multiple sources that created the Middle and Upper Atoka interval (Studebaker, 2014).

LITHOSTRATIGRAPHIC SUMMARY – NORTHERN CROSS-SECTION

The units examined in this study include; the Morrowan, Lower Atoka, Casey, Zamb, Bynum, Areci and Tackett. Due to the constraints on well log data, the Lower Atoka is used to designate all Pennsylvanian sandstone units beneath the Casey. The sand units of the Morrowan were not fully analyzed in this study due to constraints on well log depths, but they serve as a useful marker for the Morrowan-Lower Atokan boundary.

**Lower Atoka**

The formation top marked as the Lower Atoka includes the sandstones that occur beneath the Casey (Figure 9). The top of the Lower Atoka is also the top of the Dunn A, McGuire or in some usages the Dunn C. At the base of the Lower Atoka in Figure 7B, a thick shale unit separates the formation tops of the Lower Atoka and Morrowan. This thick shale interval is due to inundation that occurred following deposition of the thick sand bodies of the Morrowan. It also suggests a maximum flooding interval (MFI), where sea levels were at their highest level. The Lower Atoka’s gamma ray signature consists of alternating units of sandstones and shale. These alternating units suggest that deposition was intermittent across the area (Figure 10). In some instances, sand bodies were not deposited, and consequently, a thick interval of shale was produced. The number of sand bodies present in the Lower Atoka tends to vary from west to
east throughout the basin. This distribution implies that sediment supply, source, and delivery changed during that time interval.

Figure 9. A well log displaying the formation tops of the Casey and Lower Atoka. Well name: House of Prayer Chu 1.

**Casey**

The formation top marked as Casey is the top of the shale-sandstone interval that occurs beneath Bynum and above the Lower Atoka (Figure 3). The purpose of including the Casey is to provide a marker to measure the variations in thicknesses that occurred between the Zamb and the Lower Atoka, and thus isn’t thoroughly described in this study. It also serves the purpose of identifying structural complications that affect this interval across the basin. The Casey’s gamma
ray pattern (Figure 9) can be described as a shale with thin intermittent sand deposits. This pattern has been designated serrated (Houston, 2007).

Figure 10. Well log that displays the Lower Atoka down to the Hale Formation. The thick shale interval above the Morrowan suggests a maximum flooding interval (MFI). Top A is an example of serrated or ‘ratty’ pattern in the Casey. Top B is an example of a prograding pattern in the Lower Atoka. Top C is an example of a blocky pattern with some shale inclusion. Well name: House of Prayer Chu 1.
Zamb

The formation top marked as the Zamb is the shale body that occurs just below the Bynum (Figure 11). The thickness of the Zamb is a relatively constant few hundred feet. The gamma ray pattern varies from a typical shale to a sandy shale. This pattern suggests that there were weak, intermittent pulses of sand deposition. The Zamb differentiation in this study is to provide a basis to identify structural complications and regional thinning that may have occurred.

Bynum

The formation top marked as the Bynum defines the sandy shale body just below the Areci (Figure 11). The purpose of including the Bynum in this study is to help identify structural complications. The thickness of the Bynum ranges from a few feet to approximately 300ft. The
gamma ray pattern of the Bynum suggests shale with short intermittent pulses of sand deposition. The shale to sand ratio changes due to variations in the sediment supply. Even with some slight variations, the Bynum exhibits a very similar gamma ray pattern throughout the study area.

**Areci**

The formation top marked as the Areci is the top of the second unit of the Middle Atoka. The Areci refers to the sand-dominated portion of the formation. The thickness of the Areci ranges from 300ft to approximately 900ft. Major faults trend through the study area that resulted in the omission of hundreds of feet of the Middle Atokan section. There are also variations in the thickness of the shale both above and below the sand interval. The gamma ray pattern of the Areci varies throughout the basin. In the east and extending westward, the Areci’s gamma ray signature is a coarsening-upward expression that suggests a prograding sand as seen in Figure 12. In the west, the gamma ray pattern consists of sandstones with interbedded of shales at the top of the section. This pattern, as seen in Figure 13, can be described as serrated. An interval of sandy shale occurs above the base of the section with sand content increasing up-section. This pattern suggests that sea level was falling during Areci deposition. The base of the Areci consists of a thick shale interval, which suggests another high-order MFI.

**Tackett**

The Tackett Interval refers to the top of the uppermost sand down to the Areci sand (Figure 14). The formation top designated Tackett is the sand body that occurs just above the thick shale interval that separates it from the Areci sand below. There is also a higher, thick interval of shale (Figure 15) that separates the Tackett from the Upper Atoka (Houston, 2007). The Tackett thickness ranges from a few feet to more than a hundred feet, and tends to thicken to
Figure 12. A well log from T9N R20W. The top of the Areci sand body is represented by the purple line. The gamma ray pattern displays a prograding pattern that suggests coarsening upward. Well name: House of Prayer Chu 1.

Figure 13. A well log from T9N R22W that displays the Areci with a serrated or ‘ratty’ pattern, and the thick shale interval that separates the Areci and Tackett. Well name: Patterson 2-19.
the south, and thin to north. Thickness trends also show that the Tackett thins to the west and thickens in the east (Bahram, 2015). A thick shale interval separates the Areci from the Tackett. This shale interval is assigned in part to the Tackett, and its thickness varies in the northern margin due to missing section caused by normal faulting. The gamma ray signature of the Tackett ranges from a blocky sandstone to a very small body of sand (Figure 16). In the eastern portion of the northern margin of the basin, the Tackett’s gamma ray pattern is predominately a blocky sand body as seen in Figure 14. In the center of the study area, the Tackett’s gamma ray pattern indicates thinning and transition into a small sand body, but also has instances of a propagating pattern suggesting a coarsening upward in sequence in the same interval. The gamma ray patterns in the western portion of the northern basin margin are typically blocky sandstones with prograding patterns.

Figure 14. A well log from T9N R20W. The red line represents the top of the Tackett in the eastern area of the basin. The gamma ray pattern displays an example of a blocky sandstone unit. Well name: House of Prayer Chu 1.
Figure 15. A well log from T9N R22W that displays the Tackett with multiple gamma ray patterns. The bottom of the sand (C) can be described as a fining upward pattern, while the middle (B) can be described as blocky, and the top (A) is serrated or ‘ratty.’ Well name: Piney Flat “A.”
LITHOSTRATIGRAPHIC SUMMARY – SOUTHERN CROSS-SECTION

Lower Atoka

The Lower Atoka in the southern regional cross-section has a repeating pattern of alternating units of sandstone and shale in most of the wells. In some of the wells, such as well 3, in cross-section G to G’ (Figure 33), the alternating sandstone-shale pattern has been omitted by faulting. There are also wells, such as well 1 in cross-section I to I’ (Figure 35), in which the sand bodies of the Lower Atoka were not deposited. The variations in the gamma ray signature from well to well suggest that the Lower Atoka had multiple sediment sources throughout the Arkoma Basin. Sediment supply and rates of deposition variations are reflected in most wells. Variation of sediment supply can be seen in the sand bodies of cross-section F to F’ (Figure 32) and I to I’ (Figure 35). Even though they were deposited more or less simultaneously, the interval does not reflect the same sediment source. The sand bodies with coarsening-upward, blocky expressions had a better supply of sediment and better rate compared to the intervals with
thin, serrated sand signatures. Correlation of well logs using similar gamma ray signatures for the cross-sections suggests that most had relatively the same sediment supply. In contrast, logs, where there is more variation in the thickness and gamma ray signature, suggest a change in sediment source and rate from well to well.

**Arecci**

The Arecci in the southern cross-sections displays an overall pattern of coarsening-upward. The coarsening-upward signature suggests that a prograding sand was deposited over the basinal shale as sea level declined. The sandy-shale interval that is common in the Arecci suggests that sand was being deposited over shale for a period of time until sediment supply was great enough to form sand bodies. The Arecci was deposited at the same time throughout the southern area, but the sediment source and supply changes from west to east. In the western most cross-section F to F’ (Figure 37), the gamma ray signatures show that the Arecci had multiple, thick sand bodies above the sandy-shale, but the top of the section has a thin sand signature. In one of the eastern cross-sections H to H’ (Figure 39), the Arecci has two or less sand bodies. The top of the section in H to H’ displays a thick, coarsening-upward, sand signature rather than a thin one as seen in F to F.’ This variation suggests that sediment source and supply were not constant throughout the Arkoma Basin, but rather they change from west to east. Though the Arecci was deposited across this area at the same time, these component intervals are most likely not from the same source.

**Tackett**

The majority of the Tackett in the southern cross-sections has a blocky gamma ray signature that repeats throughout the basin. Nevertheless, there are variations in the thickness and signature of that pattern. In some areas, Tackett has a coarsening-upward signature, rather than the typical blocky one, such as well 3 in cross-section A to A’ (Figure 27). In some cases,
such as well 4, in cross-section B to B’ (Figure 28), very little sand was deposited over the basinal shale. The serrated pattern of that log suggests that sediment supply was lower, and the influx of sediment was intermittent. The Tackett is said to have a thickening trend to the east, but in cross-section B to B’, there are instances where it thins. In the easternmost cross-section E to E’, the Tackett does not thicken until the section in well 5, where the sand body begins to thin and shale content increases. The variations in the sand body thickness, as well as variations in the gamma ray patterns, suggests that sediment influx, supply and source varied across the basin. Although the sand intervals of the Tackett were deposited at the same time, they are not all from the same sediment source. The western wells in cross-section F to F’ (Figure 42) come from a different sediment source than that for the wells of cross-section J to J’ (Figure 46). The thinning and variation in the gamma ray signatures of wells 1-3 in cross-section G to G’ suggest that not only did sediment influx change, but the sediment source began to change as well. The Tackett then began to thicken to the east, which can be seen in well 4 of cross-section G to G’ and continues through to the eastern portions of the cross-sections. Overall, the Tackett in the Arkoma Basin was deposited in the same time interval, but the sediment source changed from west to east.

CONCLUSIONS

The closing of the Ouachita trough during Early Mississippian was the driving mechanism for the transition of a passive margin shelf to a rapidly evolving foreland arc basin associated with Ouachita Orogenic Belt. Early and Middle Atokan age units a present in the subsurface of the Arkoma Basin across northwestern Arkansas and were deposited during the destruction of the passive shelf.

During Atokan deposition in the northwestern Arkoma Basin, at least three 4th order cycles were developed. In the subsurface, thick intervals of shale associated with these 4th order
cycles represent intervals when sea level was at its highest, and constitute the maximum flooding interval (MFI), as used by Geosciences, University of Arkansas. There are three MFI’s present in the interval of study (ascending order): the basal shale of the Lower Atoka, the basal shale of the Areci, and the basal shale of the Tackett.

Formation tops were picked and correlated in Petra using gamma ray, resistivity and conductivity signatures. Through correlation, two regional cross-sections were constructed with the northern one designated A to A,’ and the southern one designated B to B’ (Figure 4). These two regional cross-sections were then divided into smaller segments for interpretational purposes. The north segments are designated A-A’ through E-E’ while those of the south are designated F-F’ through J-J’.

Analysis of these cross-sections indicates that the sediment source for the Lower and Middle Atoka units varies from west to east.

Lower Atoka Interval - Significant variation in the number of sand bodies present in each well log, as well as their thicknesses and gamma ray signatures of the Lower Atoka from west to east which suggests that sediment supply and influx varied throughout the Arkoma Basin. These changes are reflected in the subsurface. One of the segments from the north cross-section A-A’ (Figure 17) documents a pattern of alternating units of sandstone and shale with slight variation in the gamma ray signatures of the sand bodies. Sediment supply and influx begins to decrease in B-B,’ where the sand bodies of the Lower Atoka are either thin, or were not deposited at all. In that same region in the south, cross-section F-F’ exhibits a similar pattern to that of A-A’ until well 6, where there were only a few thin sand bodies deposited suggesting that sediment supply changed for that area. In cross-section G-G,’ faults trend through this area affecting the Lower Atoka after deposition. The thinning of the Lower Atoka that occurred in the north can be seen
in well 3 of cross-section G-G,’ where the alternating units of sandstone and shale are very thin. The number of sand bodies begin to increase as well as thicken to east as shown in both cross-sections B-B’ and G-G’. Sediment supply and influx increased in the western wells 1-3 of cross-section D-D,’ but decreased in the eastern wells 4-6. The decreases in sediment accumulation in cross-section D-D’ indicates a change in sediment source from west to east, since the alternating units of sandstone and shale were not deposited in the eastern wells. In the southern cross-section H-H,’ faulting omitted some of the Lower Atoka, but in the south, the alternating pattern is present in all of the wells. In cross-section I-I,’ the most western wells 1 and 2 are parallel to the most eastern wells 4-6 of cross-section D-D,’ and show the same decrease in sediment supply for that area. Sediment supply then increases from west to east in cross-section E-E’ and cross-section I-I.’ The increase in the thickness and number of sand bodies in cross-section E-E’ suggests that sediment supply and influx increased due to a different source for the sediment. The most eastern wells of cross-section I-I’ show thickening trend as well as an increase in the number of sand bodies present in the area, and share a source similar to that for the northern cross-section E-E’.

In cross-section J to J,’ the decrease of the thickness and number of sand bodies suggests that the sediment supply began to vary from the west or faulting may have omitted some of the sand bodies of the Lower Atoka. Overall the changes in the thickness, gamma ray signatures, and number of sand bodies suggests that the sediment source changed from west to east throughout the Arkoma Basin. The change in source sediment would suggest that natural gas will occur at different depths as well as in different sandstone units of the Lower Atokan interval.

_Areci Interval_ – A drop in sea level, and variations in the sediment supply are reflected in the subsurface Areci interval. The Areci has a gamma ray pattern that displays a coarsening-
upward signature throughout the study area. This overall coarsening-upward pattern suggests a prograding sandstone that was deposited over basinal shale as sea level were beginning to fall during the initial deposition of the Areci. The shale interval at the base of the Areci is a MFI. The drop in sea level over time produced a thick interval of sandy shale that coarsens upwards as sediment was deposited over shale. The upper section of the Areci consists of a number of sand bodies. The gamma ray signatures of these sand bodies varies from west to east as well as their thicknesses and number. The Areci in western most cross-sections A-A’ in the north and F-F’ in the south both display at least two or more sand bodies. The gamma ray signatures of these sand bodies begin to change in cross-sections C-C’ and H-H,’ where the top of section is a thick, prograding sand followed by another sand body that has either a blocky or coarsening-upward signature. The decrease in sand bodies, as well as the changes in the gamma ray signatures, suggest that sediment source and supply changed from west to east. The west, with thin sand bodies at the top followed by a sand with blocky signature with shale emplacement, differs from the east, where the top of the section is marked at a thick coarsening-upward interval followed by a sand with blocky or coarsening-upward signature.

*Tackett Interval* – Typically, the Tackett displays a blocky sandstone pattern throughout the basin, although the thickness and gamma ray signature varies from west to east. The western-most cross-section A-A’ in the north indicates a thinner sand body; the correlative sand body in the southern cross-section F-F’ is thicker. There is thickening trend in both the north and south cross-sections, B-B’ and G-G,’ where the Tackett thins and the gamma ray signature indicates a serrated sand body. This relationship suggests that the sediment supply and influx changed across this area. The Tackett thickens in the eastern portion of each cross-section. There are variations in the gamma ray signature of the sand bodies, where some of the blocky
signatures have a better defined coarsening-upward signature. The Tackett thickens and thins throughout the basin suggesting that there were variations in the supply of sediment at deposition which would suggest that the sediment source of the sand bodies changed from west to east.

Summary - Overall the changes in the gamma ray signatures, thicknesses and number of sand bodies present in the subsurface suggests that the sand units of the early to middle Atoka had multiple sources of sediment throughout the basin. The changes in the alternating units of sandstone and shale in the Lower Atoka show that sediment supply and influx changed, producing the variable number of sand bodies present. The Areci reflects a drop in sea level across the basin, and displays a general gamma ray signature of a prograding sandstone. That gamma ray signature changes from west to east suggesting that sediment supply changed throughout the basin. The variations in the thickness and gamma ray signature of the Tackett suggest that sediment influx and supply also varied throughout the basin. The Tackett has an overall blocky gamma ray pattern throughout the basin, but there are instances where the blocky signature has a coarsening-upward signature at the base of the sand body. The variation in the sediment supply and influx suggest that the sediment sources for the Tackett varied from west to east.

The Lower Atoka, Areci and Tackett were each deposited as a discrete interval, but the component sands of each unit are different reflecting different environment dynamics and sources. This explains why gas reservoir development in the Atoka Formation of the Arkoma Basin is so variable. Further research covering the sandstone units of the early to middle Atoka is required, and analysis of the structural components involved in their post-depositional history would be useful.
REFERENCES


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ANALYSIS OF REGIONAL STRATIGRAPHIC CROSS-SECTIONS

The following two appendices provide detailed descriptions of each of the well logs utilized for the construction of the northern and southern stratigraphic cross-sections discussed previously (pages 11-25). The northern cross-sections have been divided into sections A-A’ to E-E,’ while the southern cross-sections have been divided into sections F-F’ to K-K.’

APPENDIX A

DESCRIPTION OF LOGS COMPRISING NORTHERN CROSS-SECTIONS A-A’ TO E-E’

Lower Atoka A to A’
In the north cross-section A to A’ (Figure 17), the Lower Atoka consists of alternating units of sandstone and shale. From west to east, the well logs express similar gamma expressions. In well 1, there is a thick unit of shale that separates the Hale formation from the Lower Atoka. This shale was deposited by a transgression sometime after the deposition of the blocky sandstones of the Hale. The gamma ray signature of well log 1 is a mix of coarsening-upward, serrated, and thin signatures. At the base of well 1, a thick interval of shale occurs which suggests a MFI. Above that two coarsening-upward signatures occur separated by shale. Above that interval, a thin serrated signature with a shale interval separating it from a blocky sand body. The top of the section is marked at serrated signature. Wells 2 and 3 have a similar pattern of alternating units of sandstone and shale. The base of well 2 expresses a slightly blocky sand signature that is also present in well 3. Above that sand body in both wells a coarsening-upward sand occurs capped by an interval of shale. The next sand body displays a serrated pattern with a shale interval above that, and then a serrated sand signature is expressed above that. The top of the section in both wells is marked by a coarsening-upward sand. In well 4, an interval of shale occurs at the base of the section just above the Hale. The first sand body that is present
expresses a blocky sandstone signature with an interval of shale separating it from the next sand body. The next sand body displays a coarsening-upward signature with two more sand bodies separated by shale that express a slightly coarsening-upward expression. The top of the section is marked by a coarsening-upward signature with a slightly blocky serrated signature below. In well 5, the interval of the shale is absent by faulting at the base of the section. Well 4 and 5 have similar alternating units of sandstone and shale with the exception of the top of the section in well 5. The top of well 5 is marked at blocky serrated sand signature. In well 6, the interval of shale at the base of the section is present but has thinned. The first sand bodies above the sand interval express coarsening-upward signatures separated by shale. Above that interval, a diminished sand body occurs between two intervals of shale. The next sand body that occurs expresses a blocky serrated sandstone capped by an interval of shale. The top of the section is marked at a coarsening-upward signature with a thick blocky signature below. Overall, the Lower Atoka sand bodies change from west to east. The sand bodies have a thickening trend to the east in this area. This suggests that sediment influx began to increase and went from being intermittent, in well 1, to more abrupt influxes and deposition of sediments, well 6. This also indicates that sediment supply increases in the east.
Figure 17. Displays the northern stratigraphic cross-section A to A’ extended on the Lower Atoka.
Lower Atoka B to B’

In north cross-section B to B’ (Figure 18), the Lower Atoka was not penetrated. The gamma ray signatures that are present in wells 1 and 2 show the continuing pattern of alternating units of sandstone and shale, but are diminished. Well 1 displays alternating units of sandstone and shale with slightly serrated coarsening-upward signatures. The top of the section is marked at a sandy shale with a coarsening-upward signature. Well 2 displays a diminished sand body at the base of the section. The top of the section is marked at a serrated sand signature. The Lower Atoka in well 3 is not penetrated, but the sand bodies that are displayed are a blocky sand signature near the base and the top of the section is marked at a coarsening-upward sand. Well 4 lacks the alternating units of sandstone and shale. In their place, there is a thick shale interval that separates the Lower Atoka and the Hale. The thick interval of shale suggests that the lack of sand deposition is due to a lack of sediment, rather than a structural complication. In well 5 the only sand body visible displays a blocky serrated signature with an interval of shale at the base. Well 6 includes alternating units of sandstone and shale. At the base of the section, a thick interval of shale occurs. Above that interval, the first sand body occurs with a coarsening-upward signature capped by an interval of shale. The next sand body is thin interval of sand between shale. Above that a slightly blocky sand body with a serrated coarsening-upward signature occurs. The top of the section is marked at a coarsening-upward signature. Overall, the Lower Atoka in this area was not penetrated. Well 1 suggests that sediment supply and influx began to diminish in the western part of the area, but cannot be confirmed due to lack of drill depth. Well 4 suggests that sediment supply and source changed, and therefore, deposition of sand did not occur. In well 6, the alternating units of sandstone and shale occur, which suggests that sediment deposition resumed.
Figure 18 displays the northern stratigraphic cross-section B to B' flattened on the Lower Atoka.
**Lower Atoka C to C’**

In the north cross-section C to C’ (Figure 19), the Lower Atoka continues to show the alternating units of sandstone and shale. Well 1 does not exhibit the Lower Atoka well, but it displays coarsening-upward, serrated and small gamma ray with diminished signatures. The top of the Lower Atoka is marked by a serrated gamma ray signature. Sediment influx was gradual at the base and moving up section, became more intermittent. The Casey is omitted by faulting in well 1. In well 2, the Casey is present, and the Lower Atoka exhibits the alternating pattern, but the gamma ray signatures differ. The sands present have a lower gamma ray signature and a thicker basal shale interval. The top of the Lower Atoka is marked by a coarsening-upward signature followed by a serrated signature in the next sand. In well 3, the shale interval at the base thinned and multiple coarsening-upward signatures are present. The multiple coarsening-upward signatures suggest that sediment supply was more limited in the area of well 3. In well 4, the shale interval at the base of the Lower Atoka thickens. The shale intervals that separate the sandstones in well 4 are thinner. The gamma ray signatures of the sands suggest both intermittent and gradual sediment deposition over basinal shale. In well 5, the shale that divides the sandstones thickens. The gamma ray signatures are poor sands, coarsening-upward, serrated and blocky. These gamma ray signatures suggest increased sedimentation just above the thick shale interval and becoming less at the top of the interval. In well 6, the gamma ray signatures are similar to well 5. The similarity of well 5 and 6 implies that they share a similar depositional environment, where a slightly thicker interval is present above the thick shale interval and gives way to a more gradual rate of sedimentation at the top of the section.
Figure 19 displays the northern stratigraphic cross-section C to C' flattened on the Lower Atoka.
Lower Atoka D to D’

In the north cross-section D to D’ (Figure 20), the Lower Atoka contains alternating units of sandstone and shale in wells 1-3, but in wells 4-6 the succession changes. In wells 1-3, the gamma ray signature just above the thick shale interval suggests intermittent sediment deposition over the basinal shale. In well 1, a serrated signature is present just below the coarsening upward pattern that marks the top of the Lower Atoka. This change suggests that sediment supply was more intermittent in the area. In wells 2 and 3, the two coarsening-upward signatures towards the top of the Lower Atoka suggest that sediment supply became more limited. In well 4, the sandstones that divide the shale are thin, just above the thick shale interval. The gamma ray signature suggests very low, intermittent rate of sedimentation. Up-section there are two thicker intervals of sand. The lower has a blocky signature which suggests a sudden influx of sediment. The top of the Lower Atoka is marked by a prograding gamma ray signature. This suggests gradual sedimentation over a more basinal shale. Well 5 and 6 lack the alternating pattern of shale and sandstone that is more prevalent in well logs of the western area. Well 5 has two coarsening-upward patterns at the top of a large shale interval. This pattern suggests that sedimentation was gradual, then ceased abruptly at the base of the second sand. In well 6, the Lower Atoka is marked by a coarsening-upward gamma ray signature with a serrated signature just above a thick shale interval. As with similar patterns in well 5, sand units were not present below the interval of the top two. Above the thick shale interval, deposition was intermittent, and then gradual.
Figure 20. Displays the northern stratigraphic cross-section D to D' faulted on the Lower Atoka.
**Lower Atoka E to E’**

In the north cross-section E to E’ (Figure 21), the Lower Atoka contains alternating intervals of sandstone and shale. In well 1, sand bodies have multiple gamma ray signatures. Just above the thick shale interval thin, sand signatures are seen. Moving up section, there is a thin blocky section beneath an interval of shale. Above this interval, there is a serrated signature followed by a coarsening upward one. At the base of the section, deposition was low and intermittent. Moving up the section, there was an abrupt influx of sediment followed by intermittent deposition. At the top of the section, deposition became gradual as the basinal shale was covered. In well 2, sand bodies begin to thicken and the gamma ray signatures indicate progradation and finning. The thick sand body at the base of the section has a coarsening-upward expression. In the middle of the section, a coarsening-upward and finning signature are present with a thin shale dividing the two. The middle section suggests that there was gradual deposition followed an abrupt sediment influx that terminated gradually. The top of the section is marked by a coarsening-upward expression.
Figure 21 displays the northern stratigraphic cross-section E to E' flattened on the Lower Atoka.
**Areci A to A’**

In cross-section A to A’ (Figure 22), the Areci gamma ray signature shows a thick shale-sand at the base, and up-section, there are thick intervals of sand divided by shale. At the top the Areci’s signature is a thick sand or a shale-sand succession with either a blocky, coarsening-upwards, or serrated gamma ray signature. In well 1, the base of the log is a thick unit of shale until approximately 3880ft, then gives way to a thick sand interval with a coarsening-upward signature until approximately 3800ft, where the signature changes to a finning upwards sequence giving way to a shale interval. Above this shale interval, sand occurs with a blocky signature and coarsening-upward expression at the base becoming serrated at the top. The top of the Areci is marked by a shale-sand interval with a coarsening-upward signature. Well 2 records less sand content than well 1, and has a thick interval of shale beneath the coarsening-upward signature that marks the top of the formation. Wells 3 and 4 show more sand content just below the coarsening-upward signature. In well 4, the pattern at 3050ft changes to a blocky expression, and then farther down section, the signature indicates a sandy-shale giving way to a shale unit at the base of the Areci. The top of the formation has a blocky signature giving way to a coarsening upward with some serration. In the eastern most wells, 5 and 6, there is more sand content than the western most wells. The base of the Areci in well 5 has a shale interval that gives way to a sandy shale until about 3000ft, where a blocky signature begins, and ends with a finning upward sequence. At about 2900ft, a coarsening upward signature at the base gives way to a blocky signature up section. The top of the Areci is a small blocky sand body followed by a sandy shale interval. Well 6 is similar to wells with the exception of the top of the section. The top of the Areci in well 6 displays a small sand body followed by fining upward signature and changes to a coarsening upward signature down section. Well 6 has the same thick shale interval at the base until about 3400ft, where the gamma ray signature changes to a sandy shale. At
3150ft, the gamma ray signature changes to coarsening-upward that gives way to a thick blocky signature. Above the sandstone, a shale interval separates another blocky sand signature. The Areci in A to A’ shows that deposition at the base was low initially, but gradual to rapid influxes of sand moving up section. With the exception of well 2, the wells show a pattern of shale becoming sandier, and then giving way to sand bodies divided by shale or sandy-shale intervals. Well 2 shows a much lower sedimentation rate at the base until the top of the section, where a gradual sedimentation rate began.
Figure 22. Displays the northern stratigraphic cross-section A to A' flattened on the Areci.
**Areci B to B’**

In cross-section B to B’ (Figure 23), the Areci has both serrated and coarsening-upward signatures that mark the top of the formation. In well 1, the base of the Areci is shale and moving up section, it becomes a sandy-shale. The gamma ray signature then changes to two blocky sandstones divided by an interval of shale. At the top of the section, the Areci is marked by a serrated gamma ray signature. Similar to well 1, wells 2 and 3 have a shale interval at their base, followed by gamma ray signature changes to a sandy-shale. Near the top of the section, two coarsening-upward/blocky signatures are divided by a sandy-shale interval. The top of the formation is marked by serrated signatures in both wells. In well 4, the base of the section is shale. Moving up section, the interval remains shale, with occasional sandy-shale intervals. By 3000ft, there is a thin interval of sandy-shale with a finning upward signature. Moving up section, a serrated, coarsening upward succession occurs just below an interval of shale. Above the shale interval, a thin blocky sandstone occurs. At the top of the section, the Areci is marked at a sandy-shale interval with a thin coarsening upward signature. Well 5 has gamma ray signatures similar to wells 1-3. At 2450ft, a thick interval of sand occurs with a coarsening-upward signature with a serrated blocky signature farther up section. At the top of the section, the gamma ray signature has a coarsening-upward pattern. In well 6, faulting has omitted the Bynum and Zamb Formations and moved the Areci into contact with the Casey at its base. The base of the section consists of a thick shale/sandy-shale interval. Above the shale interval at 2600ft, an interval of sandy-shale occurs with a coarsening-upward signature succeeded by a blocky sandstone. Up-section, alternating units of sandstone and shale occur. The sand units have blocky and serrated signatures. At the top of the section, a thick sand interval occurs with a blocky coarsening-upward signature. The Areci in wells 1-3 is very similar. The only exception is that faulting omitted the Casey Formation in well 3. Overall the deposition in wells 1-3 was
initially low with a gradual increase of sediment over time giving way to a sudden influx of sediment. At the top of these wells, sediment flow slowed and became more intermittent. The tops also had higher gamma signatures that show sandy-shale rather than sandstone. Well 4 also lacks the Casey formation at its base like in well 3, but its gamma ray signature is higher at the base. Sediment flow was very low at the base of the section in well 4 and became intermittent up section. At the top, sediment flow was very low with the Areci being marked at a very thin interval sand. In well 5, sediment flow begins to increase again with a more gradual flow of sediment. In well 6, the Zamb and Bynum were omitted due to faulting, and sediment flow was more gradual with some intermittent pulses towards the top of the section.
Figure 23. Displays the northern stratigraphic cross-section B to B' flattened on the Areci.
Areci C to C’

The Areci in cross-section C to C’ (Figure 24) exhibits variations in the deposition rate moving from west to east. In well 1, the Casey and Zamb have been omitted by faulting. At the base of the well 1 log, an interval of shale separates the Areci and Bynum. Up-section, the gamma ray signature changes to a sandy shale until finally giving way to a sand body with a coarsening-upward signature. The sand interval is succeeded by a sandy-shale with a serrated signature divided by a high gamma ray shale. Further up-section, the signature changes to coarsening-upward and becomes a blocky sandstone. At the top of the section, the Areci is marked by a blocky, coarsening-upward sand. In well 2, the Areci is in contact with the Casey at its base. The base of the section is marked by a thick interval of shale. At 2400ft, a thin interval of sand occurs with a coarsening-upward signature overlain by a shale interval. Above that shale interval, another thin sand occurs with a fining-upward signature. The top of the section is marked by blocky sandstone. In well 3, the Zamb and Bynum have been omitted by faulting, and the Casey is juxtaposed with the base of the Areci. Unlike wells 1-2, well 3 has a thinner interval of shale and sandy shale at its base. Up-section, a serrated, coarsening-upward signature occurs with a succeeding interval of shale. A blocky, coarsening-upward sand body overlies the shale interval. At the top of the section, the Areci is marked by a thick blocky sandstone. In well 4, the Bynum is present at the base of the Areci. At the base of that well, there is shale interval succeeded by a thick interval of sandy-shale. Above the sandy shale interval, there is a thick, blocky sandstone. At the top of the section, the Areci is marked by a coarsening-upward sand with an interval of thick interval of sandy-shale. The logs of wells 5 and 6 are similar to well 4. In Well 5, the interval just above the sandy-shale at its base is a blocky sand, with a serrated sand signature. Above that sand, a prograding sandy-shale interval occurs toward the top of section, which is marked by a prograding sand. Well 6 is very similar to well 5, but has a
thin blocky sandstone at about 2370ft. Overall the Areci in C to C’ maintains a pattern of low depositional rate at the base giving way to large intermittent pulses of sedimentation, eventually becoming more gradual toward its top. Well 3 is an exception to this pattern and shows that a gradual depositional rate occurred in the two sand bodies above the thin sandy-shale interval. The top of well 3 shows that there was a higher rate of sedimentation followed by its termination.
Figure 24 displays the northern stratigraphic cross-section C to C’ flattened on the Areci.
**Areci D to D’**

The Areci in cross-section D to D’ (Figure 25) shows a pattern of low depositional rate at the base, and then, intervals of either gradual or rapid depositional rates to the top of the interval. In well 1, the base of is marked by a shale interval, and moving up section, the signature changes to a sandy-shale. Above the sandy-shale interval, a thick interval of sand occurs with a coarsening-upward signature. Above that sand body, a sandy-shale signature with a coarsening-upward pattern occurs until the top of section, which is marked by a coarsening-upward sand signature. Wells 2 and 3 are very similar to well 1, and each exhibits a blocky and coarsening-upward signature at the top of the section, and a shale at the base of the section. Wells 4-6 have similar Areci gamma ray signatures, but the blocky sand signature thins near the top of the section in wells 5 and 6. In well 4, the Bynum thins to a few feet, but is still present at the base of the Areci. In wells 5 and 6, the Bynum begins to thicken again. Overall, the Areci across cross-section D to D’ maintains a consistent pattern of deposition. There is some thinning of the sand bodies in wells 5 and 6, but they maintain the pattern of low rate of deposition at the base giving way to a higher rate towards the top, there is then a brief termination followed by gradual deposition.
Figure 25. Displays the northern stratigraphic cross-section D to D' flattened on the Areci.
Areci E to E’

The Areci in cross-section E to E’ (Figure 26) continues to show the same depositional pattern. At the base of well 1, a shale interval occurs above the Bynum. Moving up section, the gamma ray signature changes to sandy-shale. A serrated, prograding, blocky sandstone occurs above the sandy-shale interval. At the top of the section, the Areci is marked by a coarsening-upward signature. In well 2, the base and the top of the section have the same gamma ray signature as that of well 1. The blocky sand body just below the top of the Areci is thinner than that of well 1. Wells 3 and 4 maintain the same pattern as that of well 1, with some variation in the thickness of the blocky sand body just below the top of the section. The gamma ray signatures in well 5 differ from that of other wells in the cross-section. The base is a shale interval with a thick interval of sandy shale. At the top of sandy-shale interval, the pattern is blocky, and coarsening-upward. At the top of the section, the Areci is marked at a fining-upward signature. Overall, the Areci in cross-section D to D’ maintains the depositional pattern previously discussed with the exception of well 5. Well 5 exhibits a very low rate of deposition initially, and sand content was not very high. At the top of the section, there was a sudden influx of sediment followed by a gradual reduction.
Figure 26 displays the northern stratigraphic cross-section E to E' flattened on the arc.
Tackett A to A’

In the north cross-section A to A’ (Figure 27), the Tackett in the eastern portion of the cross-section displays a blocky gamma ray signature, whereas the western most portion of the cross-section displays a serrated gamma ray signature. In well log 1, the Tackett displays a serrated gamma ray signature, where sands were deposited by short, intermittent pulses. Moving from west to east, well log 2 shows signs of a rapid sand influx with its blocky signature. Well log 3 gamma ray signature displays a coarsening-upward signature indicating a gradual sand influx and abrupt termination. Well logs 4-6 display a blocky gamma signature. These wells show signs of rapid sand influx. The Tackett sands in these logs also begin to show a thickening trend to the east. These variations in the gamma ray signature suggest that sediment source and load varied. The Tackett does thicken going from west to east due to a larger influx of sediment. Well logs 1 suggests that the sediment load was smaller in this area and began to rapidly increase in well log 2. Well log 3 saw more of a gradual increase and an abrupt termination of sedimentation in the area. Beginning in well log 4, there is an increase and rapid influx of sediment, which led to a thickening in well log 5 and 6. Well log 5 gamma ray signature is blocky and slightly coarsening-upward. This suggests that the influx of sediment was gradual. The shale interval at the base of the Tackett is the maximum flooding interval (MFI), where sea level was at its highest.
Figure 27. Displays the northern stratigraphic cross-section A to A' flattened on the Tackett.
**Tackett B to B’**

The Tackett in cross-section B to B’ (Figure 28) shows variations in the rate of deposition. In well 1, the base of the section is a thick shale interval. At the top of the section, the Tackett is marked at a serrated, blocky sandstone. In well 2, the gamma ray signature changes. At the base of the section, the shale interval is much thinner. Above that interval, a thick blocky sandstone occurs. The top of section is marked by a sandy-shale with a prograding signature. The Tackett begins to thin in wells 3-5. In well 3, the shale at the base of the section thickened, while toward the top of the section, it thinned. The top of the section is marked by a serrated, sandy-shale with a blocky, coarsening-upward signature at its base. In well 4, the shale interval at the base continues to thicken and the top of the section thins. The top of the section is marked by a thin, prograding, sandy-shale interval followed by a serrated signature. In well 5, the Tackett begins to thicken. The top of the section is marked at a fining-upward signature followed by a serrated, coarsening-upward signature. In well 6, the top of the section continues to thicken. The top coarsening-upward signature is followed by a blocky sandstone interval.

Overall, depositional character of the Tackett varies. In well 1, sedimentation rate is high, but intermittent. Well 2 depositional rate is at its highest above the shale interval, where a large influx of sediment occurred followed by termination. At the top, deposition was lower, and more gradual. In wells 3 and 4, deposition is lower, and the sand bodies begin to thin. Well 3 shows a gradual depositional rate followed by a sudden influx of sediment, but then the rate of deposition is greatly reduced at the top of the section. Deposition is low and more intermittent in well 4, while in well 5, it is higher with a gradual termination. The Tackett also begins to thicken again in well 5. In well 6, depositional rate is high with a sudden termination followed by a more gradual rate.
Figure 28: Displays the northeastern stratigraphic cross-section B to B' Haltoned on the Tackett.
Tackett C to C’

The Tackett in cross-section C to C’ (Figure 29) has a pattern of high depositional rates and thickening of the sands. In well 1, the base of the section is marked by a thick interval of shale followed by a thick interval of sandstone. The top of the section displays a thick, blocky gamma ray signature. This pattern continues in wells 2, 3, 5 and 6. In well 4, the top of the section is a serrated, sandy-shale beginning with a blocky coarsening-upward signature at the base. Overall, the Tackett shows a thickening trend to the east with the exception of well 4. Sand units begin to thicken in the east due to the increase in sediment influx. The MFI at the base of the Tackett is also obvious across this cross-section. This suggests that sea level was at its highest during deposition, and followed by large influxes of sediment as sea level fell. The area around well 4 suggests that sedimentation was initially gradual, then gave way to multiple influxes of sand, but overall rate of sedimentation slowed toward the top of the section.
Figure 29 displays the northern stratigraphic cross-section C to C' flattened on the Tackett.
**Tackett D to D’**

The Tackett in cross-section D to D’ (Figure 30) maintains the blocky gamma ray signature at the top of the section. Well 1 has the thickest blocky sandstone at the top of the section in this cross-section. Beneath that, there is an interval of shale that is present at the base of the Tackett sandstone throughout the study area. Wells 2 and 3 have a blocky, slightly coarsening-upward, gamma ray signature. The base of the Tackett sand body in well 4 is blocky, but with a thin, fining-upward signature at the base that becomes coarsening-upward moving up section. The top is marked by a serrated signature of sandy-shale. Well 5 has a blocky signature with a fining-upward signature at the base of the sand body becoming coarsening-upward above. The top of the section is marked by a serrated, fining-upward signature. Well 6 is a blocky sandstone with a slight coarsening-upward signature, and a serrated one at the top of the section.

Overall, the Tackett maintains the blocky gamma ray signature. There are slight variations of the blocky signature, where coarsening-upward and fining-upward signatures occurred at the base and mid-section of the sand body. The rate of sedimentation in this area was high with large, but gradual influx of sediment. In well 5, there was a sudden influx of sediment, then gradual termination at the base of the sand body. Sedimentation became intermittent at the top of the wells with serrated gamma ray signatures. The MFI at the base of the Tackett sand body is present throughout this area.
Figure 30. displays the northern stratigraphic cross-section D to D’ flattened on the Tacket.
**Tackett E to E’**

The Tackett in cross-section E to E’ (Figure 31) continues to maintain the pattern of a blocky sandstone gamma ray signature. In wells 1-4, there is little variation in the gamma ray signatures. These signatures indicate a slightly coarsening-upward blocky sandstone. There is small variation in the thicknesses of the Tackett in this area, with Well 5 as an exception. Well 5 has a blocky signature, but has serrated, fining-upward, sandy shale signatures at the top of the section. Overall, the Tackett continues the pattern of large sediment load with high to gradual sedimentation rates at the base of the sand body in wells 1-4. The MFI is still present in this area at the base of wells 1-5. Well 5 displays a sudden influx of high sediment load followed by its gradual termination. The serrated-fining upward signature shows that the sedimentation rate was greatly reduced.
Figure 31. Displays the northern stratigraphic cross-section E to E' Halten on the Tacket.
APPENDIX B

DESCRIPTION OF LOGS COMPRISING SOUTHERN CROSS-SECTIONS F-F’ TO J-J’

Lower Atoka F to F’
In the southern cross-section F to F’ (Figure 32), the Lower Atokan interval consists of alternating units of sandstone and shale. In well 1, the base of the section consists of two intervals of sand with coarsening-upward gamma ray signatures, and a blocky expression at the top separated by shale. Moving up section, there are three blocky sandstones separated by shale intervals. The bottom sand body is a thin blocky sandstone signature with a thick shale interval just above it. The other two are slightly serrated blocky sandstones. The top of the section is marked by a serrated expression. In well 2, there are intervals of sandy-shale at the base of the section. Moving upward, a thin sand signature occurs with a slight coarsening-upward pattern succeeded by two sand bodies with coarsening-upward signatures separated by intervals of shale. The top of the section is marked by a serrated sand signature. In well 3, the base of the section has a blocky sandstone signature. Moving up section, a thick interval of shale occurs followed by a sand with a coarsening-upward signature. The top of the section is marked by a serrated sand body separated by intervals of shale. In well 4, there is a thick interval of shale and sandy shale at the base of the section. Moving up section, there are multiple intervals of sand separated by shale. The sand intervals have coarsening-upward gamma ray signatures. The top of the section is marked by a serrated sand signature. In well 5, the base of the section is marked by a thick interval of shale. Up-section, there are intervals of sandy-shale separated by shale with coarsening-upward signatures. Above that interval, alternating units of sandstone and shale occur. The first sand body has a thin blocky signature followed by a shale interval. The next sand body has a serrated, blocky signature that is slightly coarsening-upwards. The next sand has a coarsening-upward signature at the base with a serrated, blocky signature above that. The
top is marked by a serrated sand signature. In well 6, there are only a few thin intervals of sand with the top marked at a serrated sandy-shale signature. Overall, the Lower Atoka maintains a pattern of alternating units of sandstone and shale. There was little to no deposition of sand in well 6. In wells 1-5, sedimentation was gradual at the base becoming greater with larger sudden influxes of sand, followed by intermittent influxes until termination at the top.
Figure 32. Displays the southern stratigraphic cross-section F to F’ flattened on the Lower Atoka.
**Lower Atoka G to G’**

In cross-section G to G’ (Figure 33), there are variations in the pattern of alternating sandstone and shale units in the Lower Atoka. In well 2, the thick interval of shale typical of the base of the section has been omitted by faulting. The alternating units of sandstone and shale of the Lower Atoka are in contact with the blocky sandstones of the Morrowan Hale. Across the area, the top of the interval exhibits a coarsening-upward gamma ray signature that is also serrated and slightly blocky. At the base, there are some thin sand bodies just above the Hale contact. In well 3, there is an interval of shale at the base of the section. Moving up section, there are alternating packages of sandy-shale and shale. At the top of the section, the Lower Atoka is the typical serrated, blocky sandstone with a slight coarsening-upward expression at its base. Faulting omitted some of the Lower Atokan sand bodies after deposition, for example, in well 4, faulting has omitted most of the Lower Atoka leaving a thin sandy shale body at the top of the section with an interval of shale at the base. In well log 5, faulting omitted some of the Lower Atoka and the top of the section is marked by a blocky interval of sandy-shale. Well 6 returns to the more typical pattern of alternating units of sandstone and shale. The base of the section is marked by a thick interval of shale, while alternating units of sandstone and shale comprise the remainder of the section. The base of the alternating units has a thin blocky gamma ray signature. The next sand body is a sandy-shale with a slightly coarsening-upward blocky signature. The next sand is thin with a slightly blocky signature followed by a sandy-shale with a serrated, coarsening-upward pattern with a reduced gamma ray signature at its top. The top of the Lower Atoka is a serrated, blocky sandstone. Much of the Lower Atoka was affected by faulting in the area of this cross-section. In wells 2, 4 and 5, there is good evidence that faulting has omitted several of the alternating sandstone and shale intervals. During its early history, the
rate of deposition in wells 2 and 3 was low, while the top portion of these wells exhibit a higher rate and thicker interval, particularly in well 2, and even larger in well 3. The serrated log pattern in well 2 and 3 suggests that deposition was interrupted at the top of the section. Well 5 was affected by faulting, but the high gamma ray signature suggests a low depositional rate in the area. The top of well 5 suggests that deposition was low enough that the sands of the Lower Atoka were not deposited, and that faulting occurred after deposition. Well 6 records a return of the alternating units of sandstone and shale. Above the MFI is present at the base of well 6, the record indicates influxes of sediment that were deposited over the basinal shale as sea level began to fall.
Figure 33 displays the southern stratigraphic cross-section G to G' flattened on the Lower Atoka.
Lower Atoka H to H’
In cross-section H to H’ (Figure 34), the Lower Atoka maintains the typical pattern of alternating units of sandstone and shale. Faults trend through this area and some of the Lower Atoka has been omitted. Wells 1 and 2 have similar gamma rays signatures with a thick interval of shale at the bottom of the section. Up-section, alternating units of sandstone and shale occur. The gamma ray signatures of the sand are mixed between thin blocky signatures towards the middle of the section, and serrated blocky signatures towards the top with a coarsening-upward signature marking the top of the section. In well 3, faulting thinned the shale interval at the base of the section. Up-section alternating units of sandstone and shale occur. The first sand body at the base has a blocky, slightly coarsening-upward, gamma ray signature. The next sand has a slightly serrated, blocky expression that is also coarsening-upwards. Toward the top of the section, two thin gamma ray signatures occur. At the top of the section, the Lower Atoka is marked by a coarsening-upward sand. In well 4, faulting has omitted the shale interval at the base juxtaposing the alternating units of the Lower Atoka in contact with the Hale Formation. The sands at the base of the interval have thin, blocky signatures. Toward the top of the section, the gamma ray signatures changes to a coarsening-upward sand. The top of the section is marked by a coarsening-upward signature and a slightly higher gamma ray signature. In well 5, the shale interval is present at the base of the section. Up-section, two units of sand with blocky signatures occur that are divided by shale. Toward the top of the section, an interval of sand occurs with a coarsening-upward, gamma ray signature. The top of the section is marked by sandy-shale with a coarsening-upward signature. Overall, faults trend through the area of H to H’ removing intervals of sandstone and shale. Wells 1 and 2 continue to show the same depositional patterns. Sedimentation was sudden and high at the base of the section with immediate termination. Toward the top of the section, sedimentation increased, created thicker,
blocky signatures, and then was terminated. At the top of the section, deposition rates became more gradual. The same can be said about well 3, but faulting removed several feet shale at the base of the section. In well 4, faulting removed the MFI at the base of the section, but the succeeding alternating units of sandstone and shale are still present. The gamma ray signatures at the base are thin and blocky, suggesting that there were multiple influxes of sediment being deposited over basinal shale. Toward the top of the section, deposition rates became more gradual. Well 5 shows the same depositional patterns as wells 1 and 2.
Figure 3.4 displays the southern stratigraphic cross-section H to H' flattened on the Lower Atoka.
**Lower Atoka I to I’**

In cross-section I to I’ (Figure 35), the alternating units of sandstone and shale of Lower Atokan age are not present in the first two wells in the west. The pattern of alternating units resumes in wells 3-5. In well 1 and 2, the typical sands of the Lower Atoka were not deposited below the top of the section. The top of the section is marked by a coarsening-upward signature of sand. In well 3 and 4, alternating units of sandstone and shale occur. The gamma ray signatures of these sands of the two wells are a mix of thin and serrated signatures at the base. A serrated, blocky sandstone with a slightly coarsening-upward signatures occurs up-section. At the top of the section, the Lower Atoka is marked at a coarsening-upward signature. Well 5 and 6 have similar gamma ray patterns as wells 3 and 4, but have more blocky sand signatures toward the top of the section. The top of the section is marked at a coarsening-upward sand signature. Overall, sediment supply and rate varied in this area. In wells 1 and 2, sediment was not deposited over the basinal shale. In wells 3 and 4, rate of deposition was low at the base of the section with some thin pulses of sand between shale intervals. Toward the top of the section, deposition rate increased, but became more gradual at the top of the section. Sedimentation rate increased further in wells 5 and 6, where thicker blocky signatures can be found toward the top of the section.
Figure 35 displays the southern stratigraphic cross-section I to I' flattened on the Lower Atoka.
**Lower Atoka J to J’**

In cross-section J to J’ (Figure 36), the pattern of alternating units of sandstone and shale in the Lower Atoka continues into eastern most part of the study area. In well 1, a shale interval occurs at the base of the section, succeeded by a section with blocky sand signatures and some interbedded shale intervals. Toward the top of the section, a sand body with a blocky coarsening-upward signature is developed, while the top of the section is marked by a coarsening-upward signature. In well 2, there are few sand bodies present. An interval of shale occurs at the base of the section, succeeded by a serrated sand signature with some interbedded shale. The over-lying section is a serrated, coarsening-upward sandstone. The top of the section is marked by a blocky sand signature that is also slightly coarsening-upward. In well 3, an interval of shale occurs at the base of the section, and the overlying sand intervals are thinner. Toward the top of the section, a serrated, coarsening-upward signature occurs with associated shale. Above that interval, a thin, blocky, coarsening-upward signature returns, and the top of the section is a thin blocky sand signature. Overall sediment supply and rate of deposition varies across this area. The multiple intervals of blocky sand signatures suggest that there was a high rate of deposition, and a high sediment supply penetrated by well 1. Sediment was deposited over the basinal shale in pulses over time, until depositional rates became more gradual at the top of the section followed by a sudden termination. In well 2, sediment supply and rate decreased, with thin, intermittent influxes of sand that were deposited immediately above the shale interval. The blocky signature at the top of the section suggests that rate and supply increased with large influxes of sediment. In well 3, the serrated, coarsening-upward patterns suggest that deposition was intermittent and gradual. The blocky patterns at the top suggest that sediment supply increased up section.
Figure 36 displays the southern stratigraphic cross-section J to J' flattened on the Lower Atoka.
**Areci F to F’**

The Areci in cross-section F to F’ (Figure 37) displays a gamma ray pattern of a shale at the base of the section giving way to a sandy shale followed by blocky, coarsening-upward, signature, with interbedded shale. Wells 1 and 2 have similar gamma ray signatures. At the base of the section, a thick interval of shale occurs followed by a sandy-shale with a coarsening-upward signature that becomes an interval of sand. The sand interval has a blocky coarsening-upward signature at the base, and then gives way to a fining upward expression that terminates at a shale interval. Above the shale interval, another coarsening-upward blocky signature occurs. At the top of the section, the Areci is marked by a coarsening-upward, sandstone signature with a slightly serrated signature at its base. In wells 3 and 4, the top of the section is represented by a sandy-shale interval. The top of the section in well 3 has a serrated sandy-shale signature and well 4 has a coarsening-upward signature. In well 5, the first sand body also has a coarsening-upward signature below an interval of shale. The next sand body has a blocky signature. The top of the section is taken at a serrated, coarsening-upward sand. In well 6, a thick interval of shale occurs at the base of the section. The first sand body has a coarsening-upward signature at its base that gives way to a fining upward succession at the top. The next sand interval has a blocky signature. The top of the section is represented by a thin interval of sand. Overall, the Areci displays a pattern of coarsening-upward, gamma ray signatures at the base of the section that suggests a prograding sandstone. There were only slight variations in sediment supply in this area of deposition. The tops of wells 2, 3 and 6 show that sediment supply decreased at the top of section. The presence of shale with a thin sand interval at the top suggests that sediment supply was too low for thicker sands to be deposited. In wells 1, 4 and 5, the coarsening-upward signatures show that sediment influx was gradual and prograding sands were deposited over the basinal sands.
Figure 37 displays the southern stratigraphic cross-section F to F' flattened on the Areci.
Areci G to G'

The Areci in cross-section G to G’ (Figure 38) maintains a general pattern of coarsening-upwards with slight variations in the gamma ray signature. In well 1, a basal shale interval is overlain by a unit with a sandy-shale signature. The sand content increases moving up section with a coarsening-upward signature. Near the top of the section, a thick interval of blocky sand occurs with a slight coarsening-upward signature at the base of the interval, and a fining upward signature at the top of the interval. The top of the section is marked by a thin interval of sand. Wells 2 and 3 have a similar gamma ray signature, such as in well 1. There is some variation towards the top of the section, where the shale content increases. The top of the section is marked at a coarsening-upward sand signature in well 2. In well 3, the top of the section is marked by a blocky, coarsening-upward sand. In well 4, the sand content increases at the top of the section and is marked by a thick interval of sand with a serrated blocky signature. In well 5, the base of the section is shale becoming a sandy-shale up section. The first sand body has a coarsening-upward expression capped by an interval of shale that is succeeded by a thin interval of sand. The top of the section is placed at a blocky, coarsening-upward, sand signature. In well 6, the base of section consists of an interval of shale giving way to a sandy-shale until reaching the first sandy body with a coarsening-upward signature that is capped by an interval of shale. Above that interval, a thin sand occurs with a slight coarsening-upward signature. The top of the section is drawn at a blocky, coarsening-upward sand. Overall, the Areci has a coarsening-upward pattern in this area. The thicker sand bodies toward the top of wells 1-3 suggest that there was a large sediment influx followed by a rapid termination of deposition. The thin sand body at the top of that well suggests that sediment influx was lower at the top of the section in the west, but began to increase toward the east. In wells 5 and 6, the thinner sand bodies present just above the sandy-shale suggest that the sediment supply was lower in those intervals. At the
top of the section, the thicker, blocky, coarsening-upward sand signatures suggest that sediment influx was gradual, but that the supply had increased for those intervals.
Figure 38 displays the southern stratigraphic cross-section G to G' flattened on the Areci.
**Areci H to H’**

In cross-section H to H’ (Figure 39), the Areci maintains its pattern of coarsening-upwards across this area. There are faults that trend through this area that have omitted some of the section. In wells 1-3, the Areci’s gamma ray signature has few variations. At the base of the wells an interval of shale occurs that is succeeded by sandy shale until deposition of the first sand body. The first sand body has a coarsening-upward signature that is capped by an interval of shale; the thickness of that shale interval varies from well to well. The top of the section in wells 1-3 is marked by a coarsening-upward, sand signature. In well 4, the Areci section has been thinned due to faulting. At the base of the section, there is an interval of shale with the first sand body above that. The first sand body has a coarsening-upward signature, and is capped by an interval of shale. The top of the section is marked by a coarsening-upward sand signature. In well 6, the Areci thickens and the base of the section is marked by an interval of shale. Above that interval, a sandy-shale interval occurs until finally giving way to a coarsening-upward, sand signature with a slightly serrated signature at the top of the interval. The top of the section is marked by a coarsening-upward signature. Overall, the Areci in this section has very little variation in the gamma ray signature, which suggests that there was little variation in sediment supply, but there could still be variations in sediment source. The lack of variation suggests that the sediment supply in wells 1-3 remained relatively the same. The coarsening-upward patterns that occurred above the intervals of sandy-shale suggest a prograding sandstone with a gradual influx of sediment over time followed by rapid termination. The same signature at the top of the section indicates a sediment influx that was gradual with termination at the top of the section. The Areci in well 4 has the coarsening-upward signatures at the top of section, but most of the section has been omitted by faulting. There is some variation in the gamma ray signature in well 6 for the first sand body. The serrated pattern at the top of the sand body suggests that sediment
influx became more intermittent at the top of this interval. The top of section has the same coarsening-upward pattern as observed in the other wells.
Figure 39. Displays the southern stratigraphic cross-section H-H’ flattened on the Areci.
Areci I to I’

The Areci in cross-section I to I’ (Figure 40) continues to show the similar gamma ray pattern of a coarsening-upward succession developed throughout the study area. In well 1, an interval of shale occurs at the base of the section overlain by a sandy-shale. Above that interval, the first sand body has a blocky, coarsening-upward signature and is capped by an interval of shale. The top of the section is marked at a blocky sand with a coarsening-upward signature. In well 2, the Bynum and Zamb intervals have been omitted by faulting. At the base of the Areci, an interval of shale to sandy-shale is overlain by the first sand body, which has a serrated signature and is capped by a shale interval. The top of the section is marked by a coarsening-upward sand. In well 3, the base of the section is also an interval of shale that gives way to a sandy-shale. There, the first sand body also succeeds the sandy-shale. It has a blocky coarsening-upward signature and is capped by an interval of shale. The top of the section is marked by a coarsening-upward signature. In well 4, portions of the Areci have been omitted by faulting. An interval of shale occurs at the base of the section and is overlain by a sandy shale. The only sand body present in this well is at the top of the section and it has a coarsening-upward signature. In well 5, the Areci begins to thicken, but faulting appears to have omitted some of the section. The only sand body present in well 5 occurs at the top of the section with a coarsening-upward signature. In well 6, once again, the base of the section is marked by an interval shale that gives way to a sandy shale. The first sand body encountered has a blocky sand signature capped by an interval of shale. The top of the section is a coarsening-upward sand signature. Overall, the Areci experienced little variation in sediment supply and influx in this area. The variations in the sediment influx in this area are reflected by the changes in the gamma ray signatures. The first sand body in well 1 has a blocky, coarsening-upward signature that suggests that sediment influx was initially gradual, but became more rapid in the upper part of
the interval. Sediment influx was slightly lower in the first sandy body of well 2 based on the serrated pattern. Both have coarsening-upward patterns at the top of the section which suggests a prograding sandstone at the top of the section. Well 3 shows a pattern similar to well 1, and suggests that wells 1-3 had the same sediment supply with some variations in the sediment influx. Some of the lower sand bodies of the Areci in wells 4 and 5 appear to have been omitted due to faulting. This conclusion is supported by thinning of the Areci in these two wells. Well 6 had a slight increase of sediment influx in the first sand body encountered. The first sand body has a thick blocky signature, which suggests a larger influx of sediment. The top of the section suggests a decline in sediment influx, becoming more gradual and was slightly lower than observed in wells 1-3.
Figure 4.0 displays the southern stratigraphic cross-section I-I’ flattened on the Areci.
**Areci J to J’**

The Areci in cross-section J to J’ (Figure 41) continues the pattern of coarsening-upward gamma ray signatures typical of this area. In well 1, a thick interval of shale occurs at the base of the section succeeded by a sandy-shale. The first sand body above the thick sandy shale interval has a thick, blocky, signature capped by an interval of shale. The top of the section is occupied by a slightly blocky, coarsening-upward sand signature. Wells 2 and 3 have very similar gamma ray signatures. In both wells, the base of the section contains an interval of shale overlain by a thick interval of sandy-shale. The first sand body has a coarsening-upward signature capped by an interval of shale. The top of the section in both wells exhibits a coarsening-upward sand signature. Overall, there was very little variation in sediment supply and sediment influx in this area. The blocky signature of the first sand body in well 1 suggests that it had a larger influx of sediment than that of wells 2 and 3. The coarsening-upward patterns of the first sand body in wells 2 and 3 suggest that sediment influx was more gradual and slightly lower than found in well 1. The slightly blocky, coarsening-upward signature at the top of the section of well 1 also suggests that sedimentation was slightly higher in that area.
Figure 41. Displays the southern stratigraphic cross-section J-J’ flattened on the Areci.
**Tackett F to F’**

The Tackett in cross-section F to F’ (Figure 42) develops a general gamma ray pattern across this area that can be described as blocky. A thick interval of shale occurs in wells 1-6 beneath the blocky sand signatures, suggesting a maximum flooding interval. The sand body in both wells 1 and 5 has a blocky gamma ray signature. In well 2, the sand body has a blocky signature, but suggests a slight coarsening-upward. In well 3, the sand body has a sandy-shale signature at the base that is capped by a blocky sand. In well 4, the sand body has a blocky, coarsening-upward signature. In well 6, the overall signature is blocky, but it exhibits a fining upward pattern at its base. Overall, there are slight variations in the gamma ray signatures of this cross-section. The thick blocky signature in wells 1 and 5 suggests a large supply and influx of sediment deposited over the basinal shale followed by an abrupt termination. The sandy-shale signatures at the base of the sand body in wells 2 and 3 suggest that the sediment supply was lower in that area. The lower gamma ray signature in well 4 suggests an increasing sediment influx. The blocky, coarsening-upward signature suggests that sediment influx began to gradually increase in well 4 with a large influx toward the top of the section. At the base of the sand body in well 6, there was a large influx of sediment followed by a gradual termination. The blocky signature at the top of that section suggests that sediment influx resumed. These gamma ray signatures suggest that the sediment source for the Tackett in this area is the same for wells 1-4, but the changes in wells 5 and 6.
Figure 42. Displays the southern stratigraphic cross-section F-F’ flattened on the Tackett.
**Tackett G to G'**

The Tackett in cross-section G to G’ (Figure 43) shows variations in the gamma ray signatures for wells 1-3, while wells 4-6 have the blocky pattern that is commonly developed in this formation. All of the wells along this cross-section have a shale interval at the base of section that suggests the MFI. The Tackett in well 1 has a blocky signature with a shale emplacement towards the base of the section. Well 2 the top of the section is marked at a serrated, coarsening-upward sand signature. In well 3, the sand body has a serrated signature that is slightly coarsening-upward. In wells 4-6, the Tackett has a thick blocky sand signature with some shale toward the top of the section. Overall the gamma ray signatures in this section suggest a variation in the influx of sediment as well as the supply. The blocky sand signature over shale suggests that there was a large influx of sediment at the base of section followed by its immediate termination. The blocky signature at the top of section also suggests a large sediment influx. In well 2, the coarsening-upward signature at the base of the sand body suggests a gradual sand influx followed by termination. The thin sand signature at the top of the section suggests a small influx of sediment. The serrated pattern in well 3 suggests that sediment influx was intermittent, and the supply was lower than that of the other wells. The thick blocky sand signatures in wells 4-6 suggest that the Tackett had a different source of sediment in the eastern part of the area. Sediment supply and influx are much greater than the western wells based on the changes in the thickness of the sand bodies. The blocky signature in wells 4-6 also suggests a constant influx of sediment for that area.
Figure 43: displays the southern stratigraphic cross-section G-G’ flattened on the Tackett.
**Tackett H to H’**

The Tackett in cross-section H to H’ (Figure 44) has an overall pattern of blocky sand signatures with some variation in the thicknesses of the sand bodies. At the base of these wells, the thick interval of shale suggests the MFI. The sand bodies of wells 1-3 show very little variation in their blocky gamma ray signatures. The top of wells 1 and 2 are marked at a thin sand signature with a shale at their base. Well 3 is marked at a thin, sandy-shale signature. Wells 4 and 5 display a blocky sand signature with a slight coarsening-upward signature at the base of the sand body, and the top of the section develops a serrated signature. Overall, the Tackett has a blocky gamma ray signature in this area with very little variation in sediment influx and supply. The general blocky pattern in wells 1-3 suggests a large constant influx of sediment during deposition followed by termination. At the top of the section in wells 1 and 2, a small sediment influx occurred followed by termination. In well 3, the thin sandy-shale signature suggests that sediment supply decreased toward the top of the section. In wells 4 and 5, the slightly coarsening-upward signature at the base of the log suggests that sediment influx was initially lower and more gradual. Up-section, sediment supply increased and the influx became more constant followed by termination. The serrated pattern at the top of both wells suggests that sediment influx became more intermittent. The slight changes in the thickness and gamma ray signatures from west to east suggest that the sediment delivery changed, indicating that the source of sediment began to change.
Figure 44 displays the southern stratigraphic cross-section H-H’ flattened on the Tacket.
Tackett I to I’

The Tackett in cross-section I to I’ (Figure 45) displays the same blocky sand gamma ray signatures seen in previous cross-sections. The MFI, represented by the thick interval of shale at the base of these wells, is still developed. In well 1, the sand body has a thick blocky signature that is slightly coarsening-upward at the base, and a thin shale near its top. The top of the section is marked by a fining upward sand signature. In well 2, the gamma ray signatures displays a blocky, coarsening-upward sand signature becoming serrated at the top of the section. Wells 3 and 4 are similar to well 2 with a blocky, coarsening-upward signature toward the base and a serrated one at the top of the section. Well 5 displays a coarsening-upward signature with a very thin shale interval near the top of the section. The sand body in well 6 has a blocky signature that is slightly coarsening-upwards. The top of the section is marked at a serrated sandy-shale signature. Overall, the sediment supply and influx across this line of section exhibits very little variation. The thick, blocky, coarsening-upward signatures suggest that there was a large constant, buy gradual delivery of sediment to the area followed by termination. The thin fining upward signature at the top of the section in well 1 suggests that sediment influx had a gradual termination. The serrated patterns at the top of wells 2–4 suggest that sediment influx became more intermittent at the top of the section. The sandy-shale signature at the top of well 6 suggests that sediment supply had decreased by the top of the section.
Figure 45. Displays the southern stratigraphic cross-section I-I’ flattened on the Tackett.

Figure 45. Displays the southern stratigraphic cross-section I-I’ flattened on the Tackett.
Tackett J to J’

The Tackett in cross-section J to J’ (Figure 46) displays changes in the gamma ray signatures. The MFI, represented by the thick shale interval at the base of the section, is present in all these wells. In well 1, the gamma ray signature displays a sand body with a blocky pattern that is slightly coarsening-upwards. The top of the section is marked at a serrated signature. In well 2, the sand body displays a blocky, coarsening-upward pattern with a serrated, slightly coarsening-upward, sand-shale signature at the top of the section. In well 3, the sand body displays a coarsening-upward signature at the base of the interval giving way to a fining-upward signature toward the top of the section. The top of the section is drawn at a thin sandy-shale signature. Overall, the sand content of the Tackett begins to decrease from west to east. The blocky sand signature in well 1 suggests that sediment supply and influx were constant during deposition followed by termination. The serrated signature at the top of the section suggests that sediment influx became more intermittent. The blocky, coarsening-upward signature at the base of the sand body in well 2 suggests a constant, but gradual influx of sediment being deposited over the basinal shale followed by termination. The interval at the top of the section is a serrated, slightly coarsening-upward, sandy shale signature, which suggests that sediment influx became more intermittent at the top of the section. The increase in shale content at the top of the section suggests sediment supply also decreased in this area. The coarsening-upward pattern giving way to a fining upward one suggests that sediment influx was initially gradual, but instead of immediate termination, deposition tapered off toward the top of the section. The thin sand signature at the top of the section suggests that sediment supply and influx had decreased in this most eastern well.
Figure 46. Displays the southern stratigraphic cross-section J-J' flattened on the Tacket.