A Quantitative Paleo-Geomorphic Study of the Fluvio-Deltaic Reservoirs in the Atoka Interval, Fort Worth Basin, Texas, U.S.A*

Vishal Maharaj[1] and Lesli Wood[2]

Search and Discovery Article #10203 (2009)
Posted August 28, 2009

*Adapted from oral presentation at AAPG Annual Convention and Exhibition, Denver, Colorado, June 7-10, 2009

[1]Jackson School of Geosciences, University of Texas at Austin, Austin, TX (mailto:maharaj.vishal@gmail.com)
[2]Bureau of Economic Geology, University of Texas at Austin, Austin, TX

Abstract

The Atoka Group (Lower-Middle Pennsylvanian) of the Fort Worth Basin (FWB) forms a significant (~2-3 Tcf), and as yet underexploited, domestic gas resource that is often considered a secondary target for operators drilling the deeper Barnett Shale. Although thousands of wells penetrate the Atoka in the FWB, the origin and character of this unit are still debated. Current models for its deposition range from wave- to river-dominated, to fan deltas.

A 3-D survey covering 68 km^2 of the FWB has been integrated with wireline logs from 226 wells and core from 3 wells for detailed analysis of the Atoka. Well log mapping reveals that the Atoka can be subdivided into 12 parasequences that stack to form: (a) a lower, regressive; (b) a middle, transgressive; and (c) an upper, highstand parasequence set. Seven facies are identified in core, and include channel fill, proximal delta front, delta-plain, fluvio-estuarine, distal delta front, prodelta, and shelf carbonate facies. They are tied to log signatures as a template for interpreting facies using log motifs across the study area. Limited resolution of channelized reservoir elements in seismic necessitated implementing a process for defining channel dimensions using point bar measurements from well logs. Quantitative analysis of channel dimensions in cross-section was undertaken and results compared to sparse morphometric data observed in seismic. Results indicate that channel widths vary from 34 to 456 m. Channel sinuosities range from 1.09 to 1.32. Calculations of flow characteristics and channel slopes suggest that slope changed over time decreasing from lower to upper Atoka as the basin filled. A review and comparison of modern and ancient analogs to Atoka sediments support the interpretation of a river-dominated delta system. On the basis of the lack of mixed marine/non-marine influence, lack of mixed grain sizes and distance from the highland sources, the Atoka is not believed to represent a succession of fan delta deposits. Gamma-ray-log motifs, calculated flow characteristics, and channel morphology suggest the Atoka to represent a simple river-dominated delta system.

Quantitative Clastics Laboratory QCL

THE UNIVERSITY OF TEXAS AT AUSTIN
JACKSON
SCHOOL OF GEOSCIENCES

A Quantitative Paleo-Geomorphic Study of the Fluvio-Deltaic Reservoirs in the Atoka Interval, Fort Worth Basin, Texas, U.S.A.

Vishal Maharaj[1] and Lesli Wood[2]

1 Jackson School of Geosciences
2 Bureau of Economic Geology
University of Texas at Austin

Abstract

Quantitative Clastics Laboratory

The Atoka Group (Lower-Middle Pennsylvanian) of the Fort Worth Basin (FWB) forms a significant (~2–3 Tcf), and as yet underexploited, domestic gas resource that is often considered a secondary target for operators drilling the deeper Barnett Shale. Although thousands of wells penetrate the Atoka in the FWB, the origin and character of this unit are still debated. Current models for its deposition range from wave- to river-dominated, to fan deltas.

A 3-D survey covering 68 km^2 of the FWB has been integrated with wireline logs from 226 wells and core from 3 wells for detailed analysis of the Atoka. Well log mapping reveals that the Atoka can be subdivided into 12 parasequences that stack to form: (a) a lower, regressive; (b) a middle, transgressive; and (c) an upper, highstand parasequence set. Seven facies are identified in core, and include channel fill, proximal delta front, delta-plain, fluvio-estuarine, distal delta front, prodelta, and shelf carbonate facies. They are tied to log signatures as a template for interpreting facies using log motifs across the study area. Limited resolution of channelized reservoir elements in seismic necessitated implementing a process for defining channel dimensions using point bar measurements from well logs. Quantitative analysis of channel dimensions in cross-section was undertaken and results compared to sparse morphometric data observed in seismic. Results indicate that channel widths vary from 34 to 456 m. Channel sinuosities range from 1.09 to 1.32. Calculations of flow characteristics and channel slopes suggest that slope changed over time decreasing from lower to upper Atoka as the basin filled. A review and comparison of modern and ancient analogs to Atoka sediments support the interpretation of a river-dominated delta system. On the basis of the lack of mixed marine/non-marine influence, lack of mixed grain sizes and distance from the highland sources, the Atoka is not believed to represent a succession of fan delta deposits. Gamma-ray-log motifs, calculated flow characteristics, and channel morphology suggest the Atoka to represent a simple river-dominated delta system.

Acknowledgements

- *Member companies* of the BEG Quantitative Clastics Laboratory Industrial Associates program

- *BEG staff* – Dallas Dunlap, Tucker Hentz, Angela McDonnell, Bill Ambrose, Hongliu Zeng, Bob Hardage

- *Software support* – Landmark Graphics Corporation, IHS

Rationale

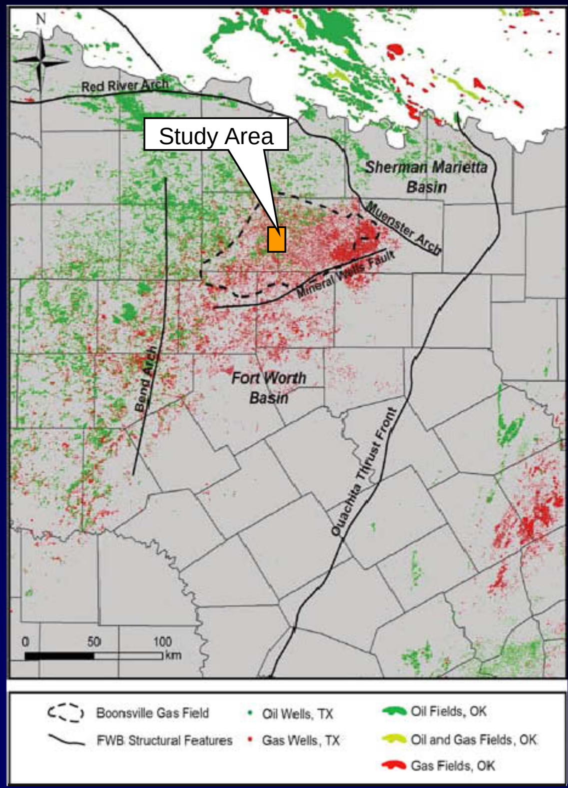
Quantitative Clastics Laboratory

What we know

- **The Atoka Group (E-M Pennsylvanian) of the Fort Worth Basin forms a significant (~3 TCF), and as yet under- exploited, domestic gas resource that is often seen as a secondary target as companies make their way to the deeper Barnett interval**

Problem

- **Although there are thousands of wells penetrating the Atoka in the FWB, the character of this unit is still debated among authors**
- **The actual influence of deeper Ellenburger karsting on depositional system orientations element character is widely debated**



Map of north-central Texas

Notes by Presenter: The Atoka is a significant hydrocarbon-producing interval. Although it is a mature reservoir interval in the Boonsville field, the nature of the deposits are still debated and the influence of karst collapse on sediment accumulation is poorly understood. The map of the FWB shows major structural features within the basin, the distribution of wells, the extent of the Boonsville field, and location of the study area.

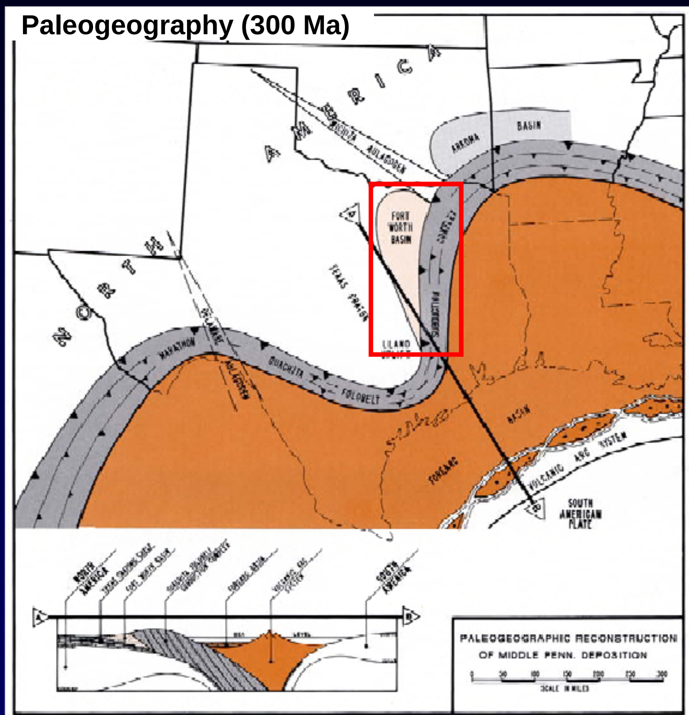
Key Summary Questions

For the Atoka Interval:

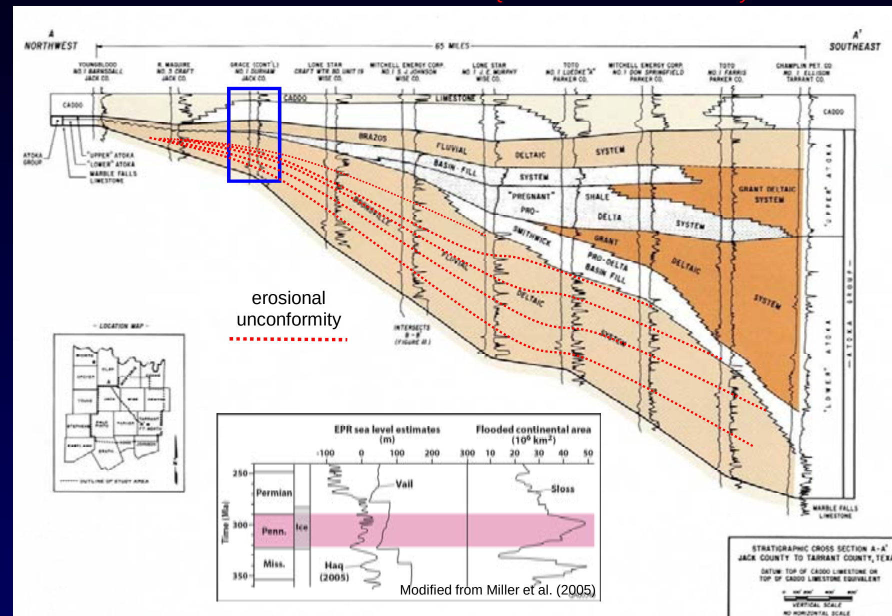
- What is the stratigraphic framework?
- What are the main facies and morphologic elements? Can we use existing data to better assess the environments of deposition for the Atoka?
- Can channel properties be quantified in cross-section and plan-view using core, well log and seismic data?
- What spatial and temporal observations regarding architectural variability can be made using these data?
- Do Atoka deposits represent fan delta sequences?

Regional Setting

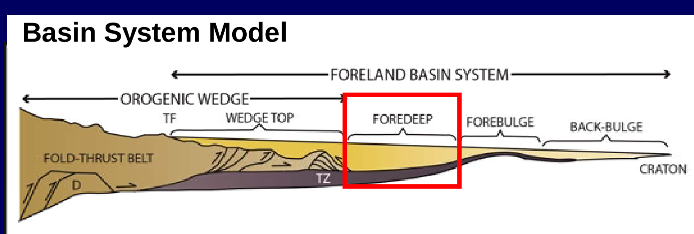
Quantitative Clastics Laboratory



Walper (1982)



Modified from Lahti and Huber (1982)



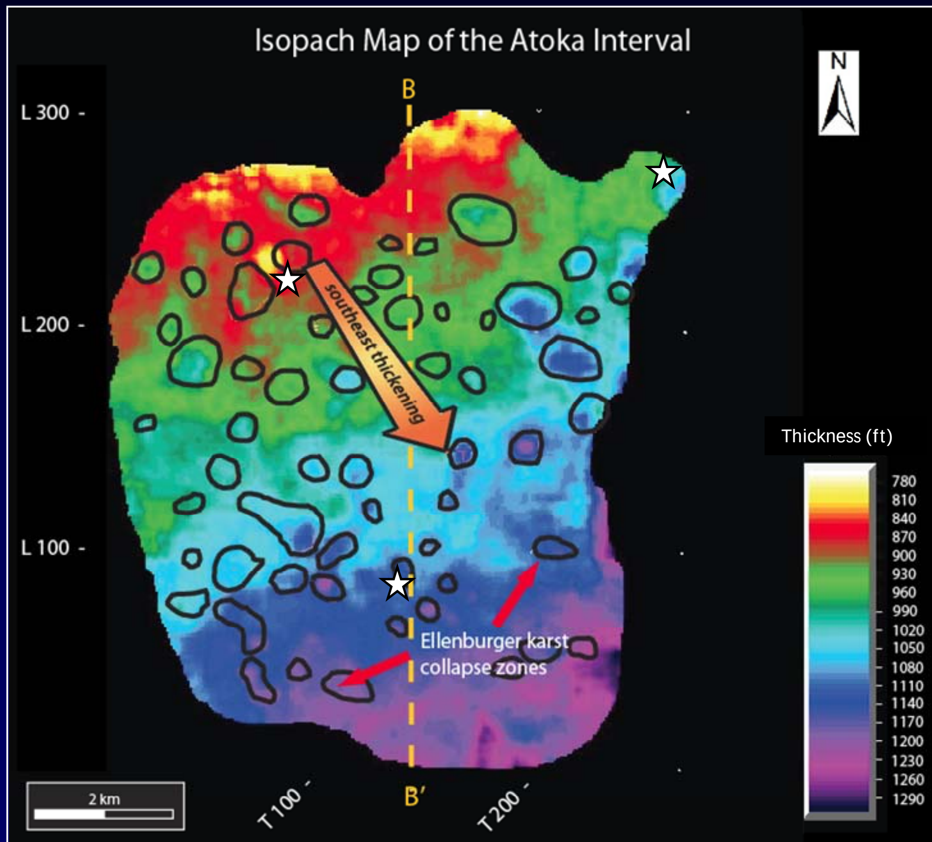
Modified from DeCelles and Giles (1996)

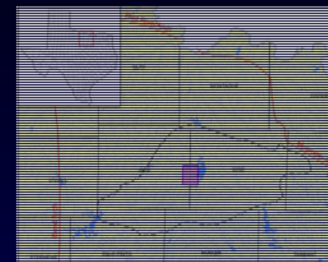
- **Early-Mid Penn. = high subsidence, Icehouse conditions**
- **Low preservability, sensitive to sea level fluctuations**
- **Relatively little accommodation space**

Notes by Presenter: The paleogeographic map shows the structural configuration of the FWB in the Pennsylvanian. The FWB is regarded as a foredeep basin within a foreland basin system as defined by DeCelles and Giles. The isopach map of the Atoka shows significant thickening toward the Ouacita Thrust front, which is a structural high and a major sediment contributor throughout Atoka time. Thickening is associated with downwarping of the basin and high subsidence during the Atoka.

Study Area and Dataset

Quantitative Clastics Laboratory



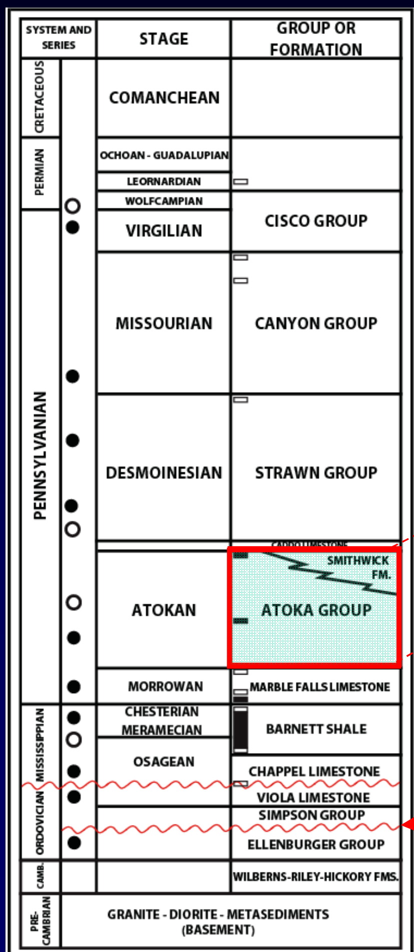


- Study area – 26 mi^2
- 226 Well logs, 108 w/GR
- Core from three well locations (★)
- Atoka interval thickens toward southeast (~800-1300ft)
- Sedimentation affected by syn-depositional karst collapse features

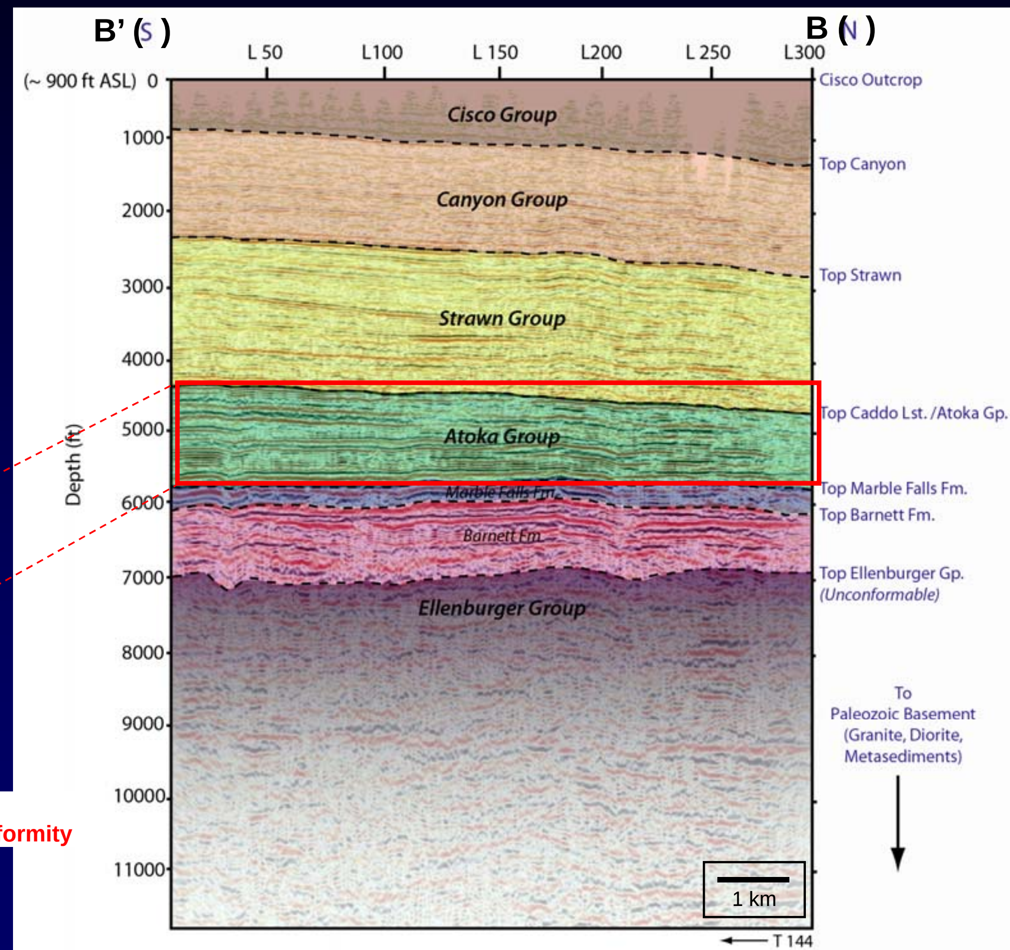
Notes by Presenter: This research is based on a dataset that comprises a 26 sq. mi. 3-D seismic dataset, 226 well logs and core from three locations shown by the stars.
The isopach map of the Atoka interval mapped in seismic shows that the interval thickens to the SE, but is affected by Ellenburger-induced karst collapse zones shown in black outline, where localized thickening relationships develop.

Stratigraphy

Quantitative Clastics Laboratory



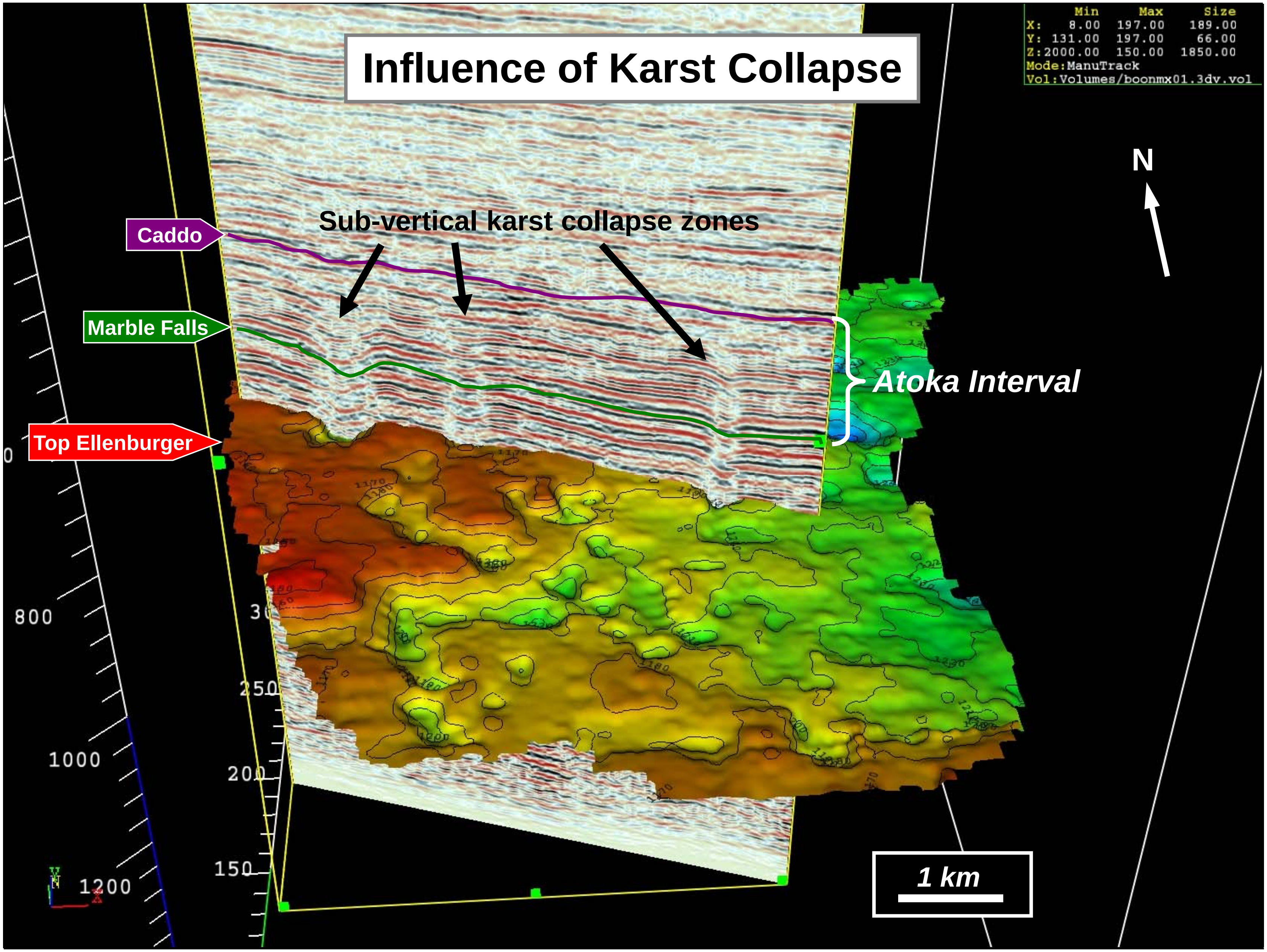
Modified from Pollastro (2007)



Seismic (T144) cross section from previous slide

Notes by Presenter: The stratigraphic chart shows the typical Paleozoic stratigraphy in the FWB, and the 3-D seismic line graphically illustrates this relationship within the study area.

The major feature to note is the unconformity at the top of the Ellenburger limestone, which created subaerial karst features during the Ordovician that collapsed under Mississippian and Pennsylvanian sediment overburden to form vertical structures which will be illustrated in the next slide.



Notes by Presenter: The mapped horizon is a structure map of the Ellenburger, from which vertical collapse structures originate. Their widths decrease up-section, and usually terminate within the upper portions of the Atoka. Their widths usually control the local accommodation space available that influence channel deposits

Previous Work

Quantitative Clastics Laboratory

Thompson (1982)

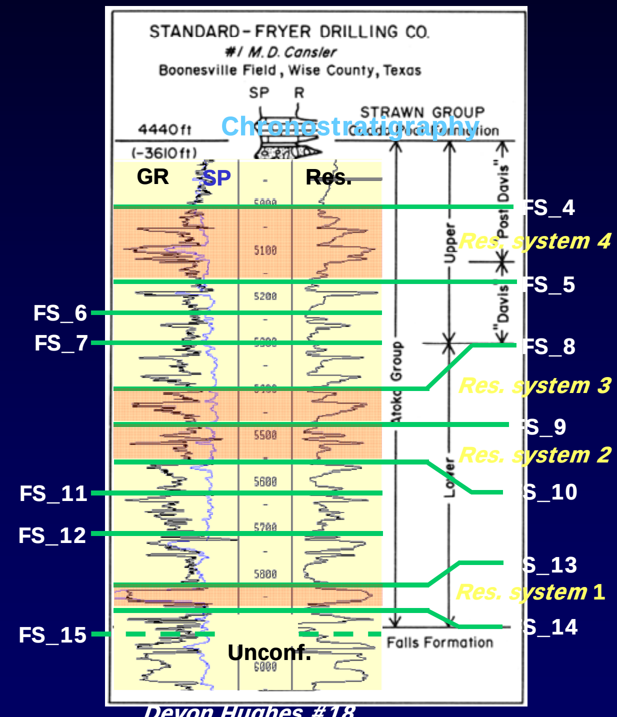
- Atoka comprised fan deltas and wave-dominated deltas
- No clear correlation between sand thickness and production trends

Hentz et al., (in press)

- Well log chronostratigraphic framework to build sandstone distribution, depositional facies and reservoir character
- Atoka comprised river-dominated deltas

Hardage et al., (1985)

- Focused on applications for infield reserve growth for the Boonsville field
- Primary trapping mechanisms are facies and permeability pinch-outs
- Thin and discontinuous sandstone reservoirs



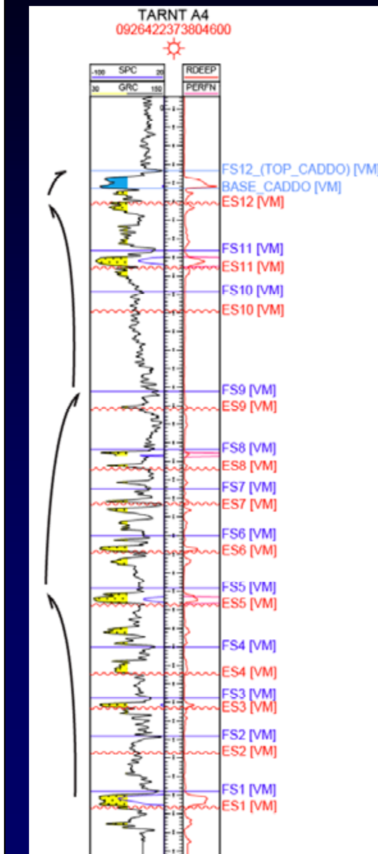
From Thompson (1982)

Modified from Hentz (2007)

Notes by Presenter: Regional well-log driven studies (based at the BEG) have been previously performed on the Atoka (shown in orange). Thompson divided the Atoka into three lithological units and claims that the Atoka comprised fan and wave-dominated deltas (shown in the model). Hentz adopted a chronostratigraphic approach, but heterogeneities within the Atoka deserved a more detailed look at depositional geometries. Hardage and others did a specific study, but their observations were not focused on characterizing depositional geometries and relationships with structure.

Atoka Stratigraphic Framework

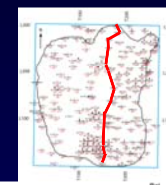
Quantitative Clastics Laboratory

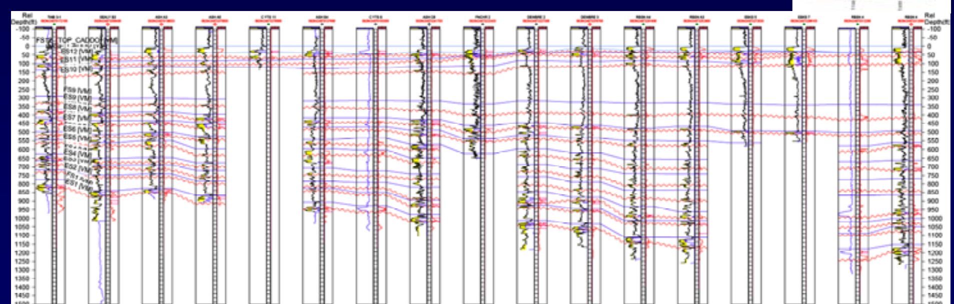


1. Stratigraphic framework built to systematically identify and compare temporal/spatial changes in architecture properties

Atoka Comprises

- **12 parasequences (single progradation/flood event)**
- **Stack into 3 parasequence sets (PS)**
  - **(a) *Lower/LAPS (FS1-5)* – regressive/aggradational**
  - **(b) *Middle/LAPS (FS5-9)* – transgressive**
  - **(c) *Upper/UAPS (FS9-12)* – highstand**





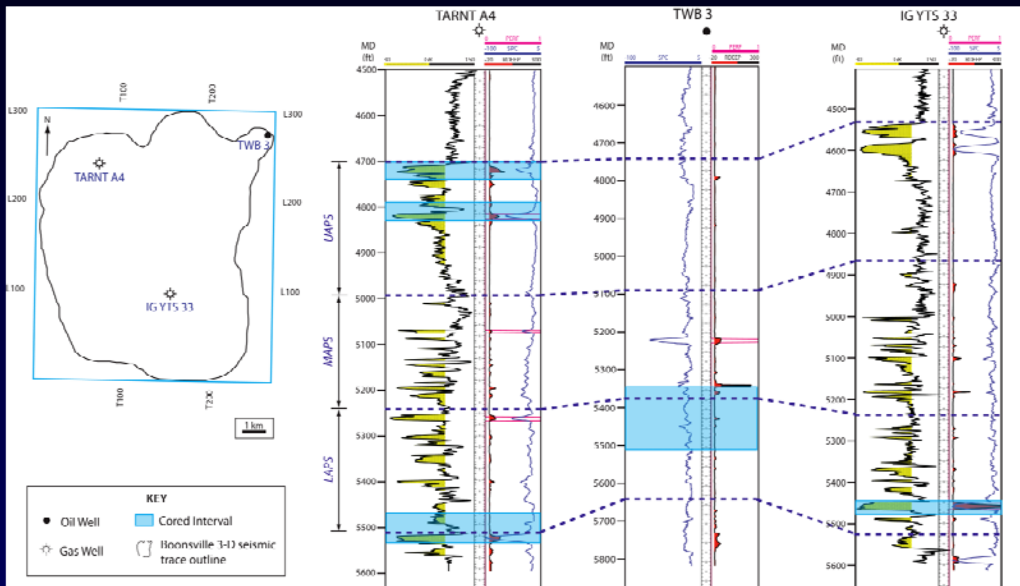
- **Use of this framework (with seismic and core data) can result in significant positive revisions of calculated gas volumes, reserve estimates, and development strategies in Atoka reservoirs**

Notes by Presenter: Well log mapping was done with the use of 3-D seismic data, while adopting a chronostratigraphic approach to correlations From this part of the study, it was concluded that the Atoka could be divided into twelve parasequences that stacked into three parasequence sets. The well log shows these intervals: 1. A lower, regressive/agg interval 2. A middle transgressive interval 3. An upper high-accommodation interval Despite this, it was noted that well log correlation was not sufficient to characterize the heterogeneity of Atoka deposits, because multiple erosion surfaces exist that create smaller depositional packages that were not easy to correlate.

It did, however allow to determine how sedimentary fairway patterns changed throughout Atoka time. These fairway patterns were found to be influenced more by regional-scale changes in accommodation, as opposed to the individual channel architectures, which were inherently influenced by karst-collapse-induced accommodation.

Core Analysis: Depositional Environments

Quantitative Clastics Laboratory



Core locations in study area

2(A). Core Description

- Core described for three wells and facies were identified based on lithologic relationships

2(B). Facies Identification

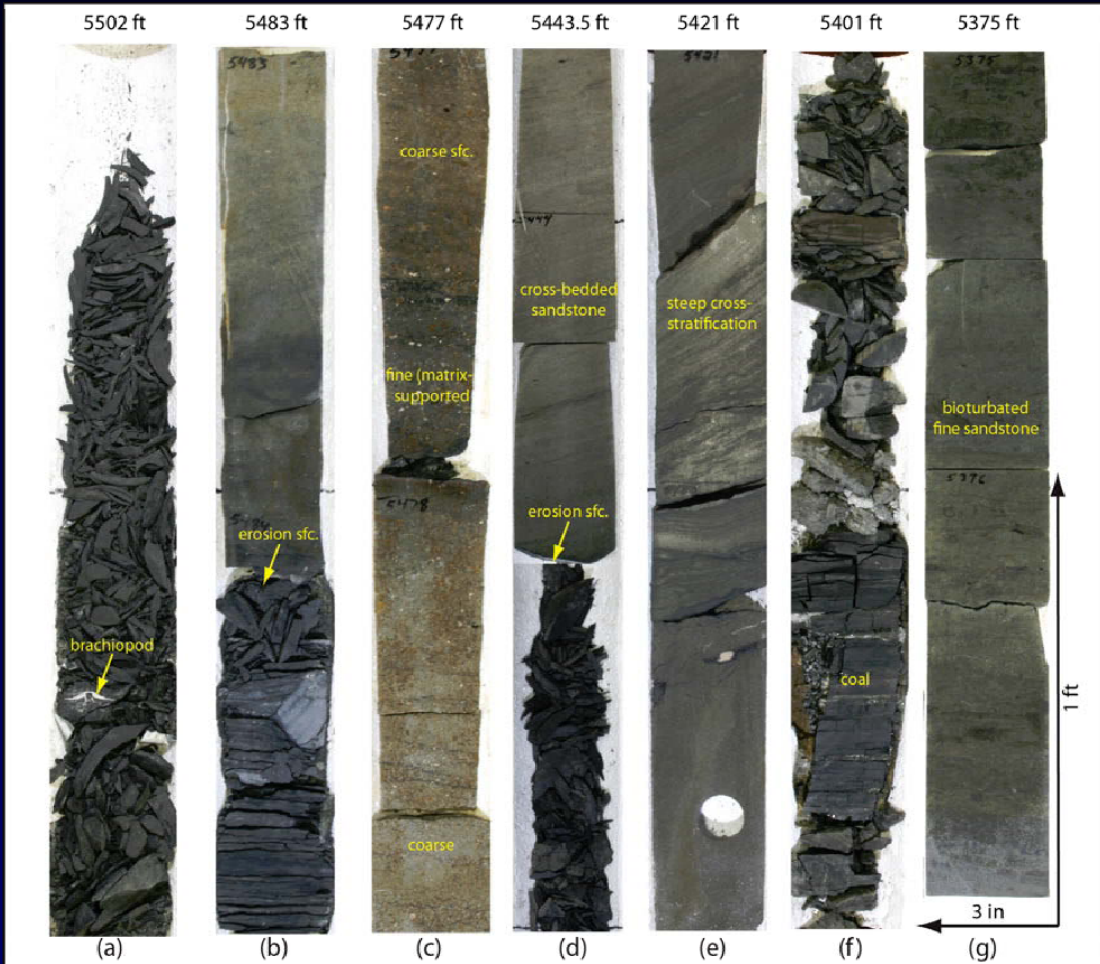
- 7 facies identified in core
- Mainly siliciclastic deposits that range from coarse-grained fluvio-deltaic to fine-grained shallow marine, reworking common in high-energy regimes

Facies No.	Facies Description	Paleoenvironment
1	conglomerates, coarse, well sorted sandstones and medium to fine-grained cross-bedded sandstone	point bar, channel fill; distributary mouth bar? (depends on internal structure)
2	wavy/flaser/lenticular bedding	intertidal flats
3	interbedded sandstone and siltstone, occasionally organic rich	delta plain, low energy overbank deposits
4	coal	swamp/marsh
5	bioturbated interbedded siltstone and sandstone	distal delta front; prodelta
6	dark, organic-rich shale with occasional shells and marine fossil fragments	marine
7	limestone	shelf carbonates

Notes by Presenter: This illustration shows the locations of the three cored intervals and the gamma ray expressions from wells. I shall show the core from the IGYTS33 well in the next slide.

Lithologic Character – E.P Operating Tarrant Co. W.B. #3 Core

Quantitative Clastics Laboratory

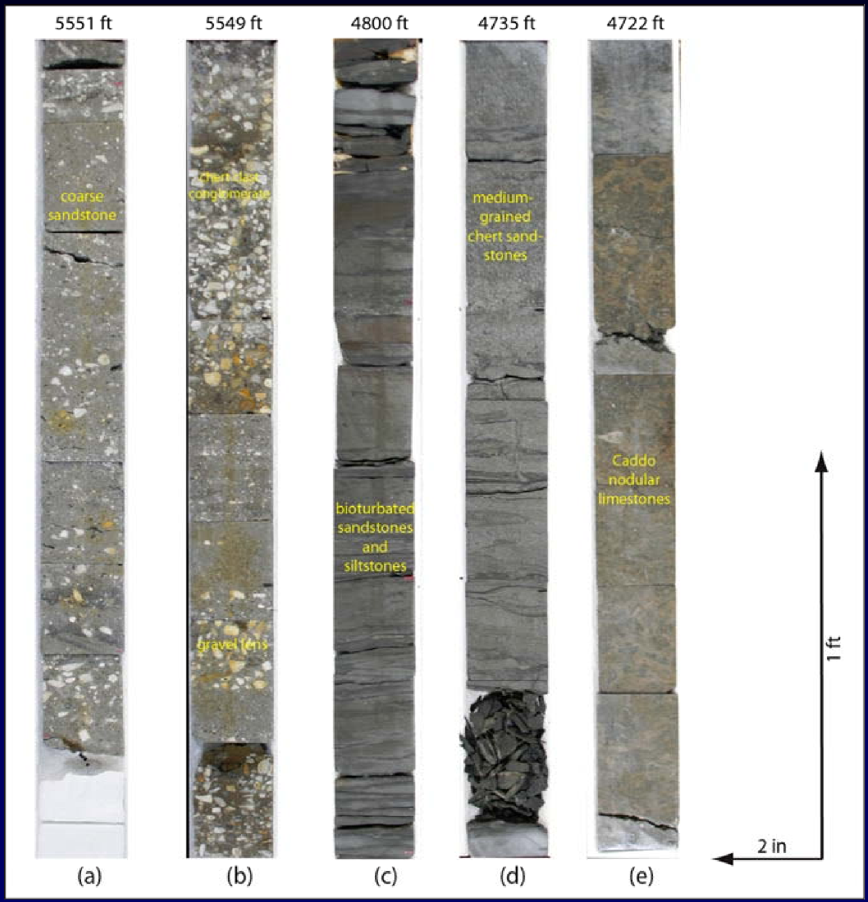


Core photographs of the E.P Operating Tarrant Co. W.B. #3 well: (a) shows a fissile, dark shale; (b) shows an erosional contact between siltstones (base) and fine to medium-grained, cross-bedded sandstones; (c) shows the variation between fine and coarse-grained sediment within successions; (d) shows another cross-bedded sandstone unconformably resting on dark shales; (e) shows high angle cross stratification in sandstones; (f) shows a coal bed overlying channel-fill sandstones and (g) shows bioturbated fine-grained sandstones

Notes by Presenter: What we see in most of the core is that the facies assemblages point to river-dominated delta systems, as illustrated in (what is interpreted to be) a fluvial point bar deposit. The coarse-grained components identified in core suggest multiple origins (one distantly-sourced, and another locally sourced). Eight facies were identified in all the core, and extend form channel fill deposits, to overbank/delta plain deposits to shallow marine deposits. Critical fan-delta facies e.g. beach, alluvial (gravity) facies were entirely absent from vertical successions.

Lithologic Character – Oxy Tarrant #A-4 Core

Quantitative Clastics Laboratory

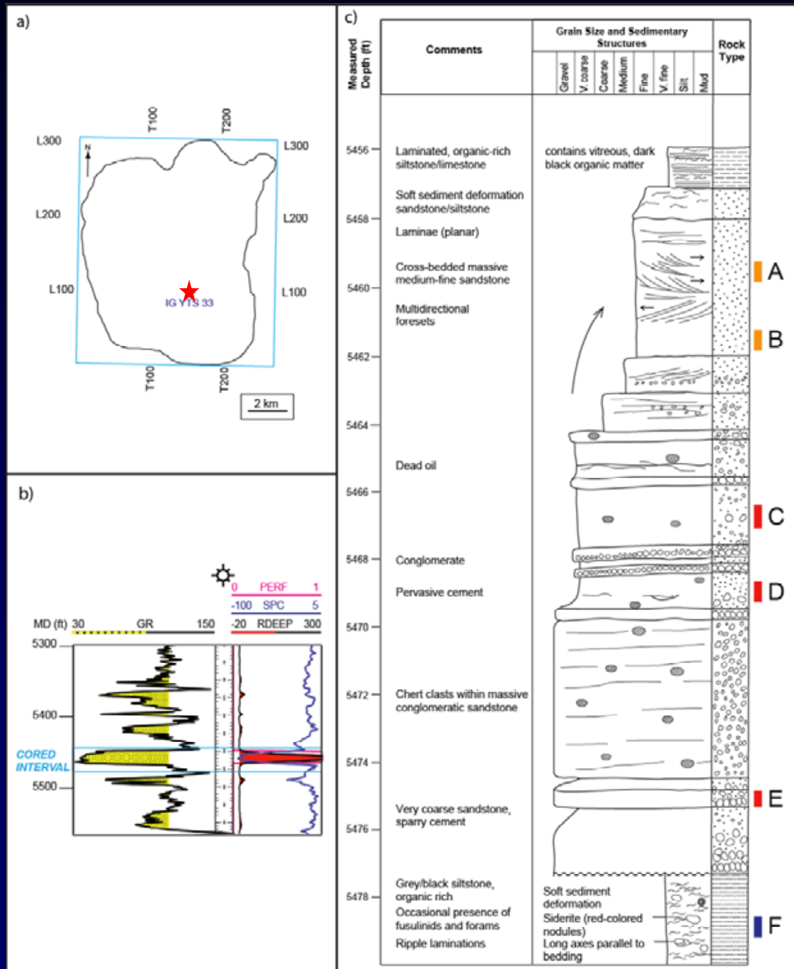


Core photographs of the Oxy Tarrant #A-4 well from deepest to shallowest: (a) shows coarse sandstones with chert pebbles; (b) shows gravel lenses at the base, grading into chert clast conglomerates; (c) shows the prodelta deposits of bioturbated sandstones and siltstones; (d) shows medium-grained sandstones of the Wizard Wells reservoir unit; and (e) shows nodular limestones of the Caddo Pool formation

Notes by Presenter: What we see in most of the core is that the facies assemblages point to river-dominated delta systems, as illustrated in (what is interpreted to be) a fluvial point bar deposit. The coarse-grained components identified in core suggest multiple origins (one distantly-sourced, and another locally sourced). Eight facies were identified in all the core, and extend form channel fill deposits, to overbank/delta plain deposits to shallow marine deposits. Critical fan-delta facies e.g. beach, alluvial (gravity) facies were entirely absent from vertical successions.

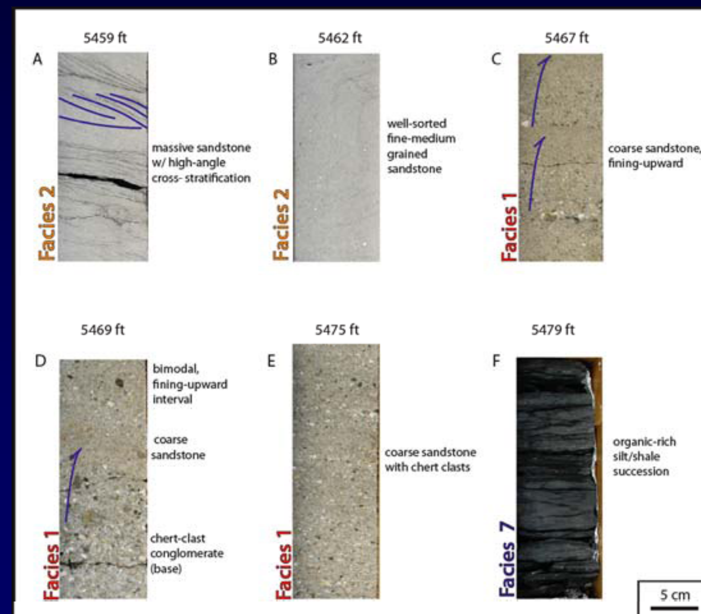
Core Analysis: Point Bar Identification

Quantitative Clastics Laboratory



3. Point bar identification in core

(a) Location, (b) gamma-ray motif, and (c) description of the IGYTS33 Core showing a typical Atoka point bar deposit



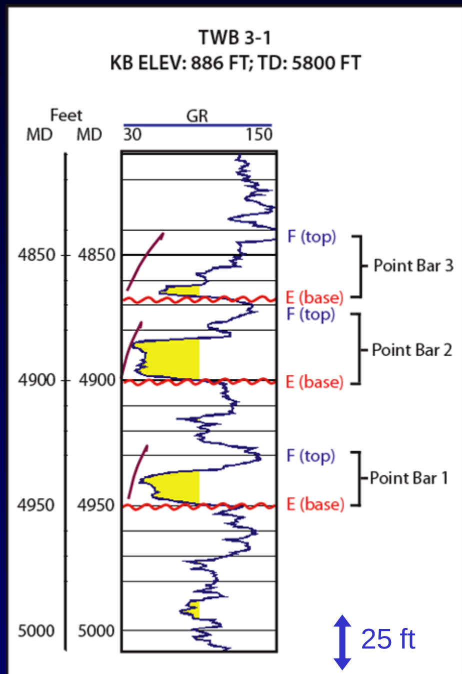
A, B, C, D, E and F from core description show lithologies and corresponding facies in more detail

Notes by Presenter: What we see in most of the core is that the facies assemblages point to river-dominated delta systems, as illustrated in (what is interpreted to be) a fluvial point bar deposit. The coarse-grained components identified in core suggest multiple origins (one distantly-sourced, and another locally sourced). Eight facies were identified in all the core, and extend form channel fill deposits, to overbank/delta plain deposits to shallow marine deposits. Critical fan-delta facies e.g. beach, alluvial (gravity) facies were entirely absent from vertical successions.

Channel Analysis and Point Bar Morphology

Quantitative Clastics Laboratory

4. Quantifying channel dimensions using point bar measurements from well logs



Point bar deposits determined from GR well log motif

- Methods based on Swanson (written comm.)
- Used core and well log motifs to determine point bar sizes
- Point bar heights used to calculate channel dimensions (width, depth, discharge) after Swanson (written comm.)
- Size of channels can be used to calculate slope using Manning's equation

  n = 0.030 for sand-rich fluvial systems

  n = 0.045 for gravel-rich fluvial systems

	LAPS	MAPS	UAPS
Average well log bar height, H_{av} (ft)	17.5	16.7	20.5
Standard deviation	9.60	7.52	7.87
Standard deviation (% H_{av})	54.9	44.9	38.4

Notes by Presenter: Since we were able to easily identify point bar deposits in well logs, I went through the literature to see if I could get some idea of the sizes of channel systems that probably existed in the Atoka. The procedures of Swanson (written comm.) was used to obtain channel dimensions, and includes widths, depths and discharge.

Manning's equation was used to calculate slope for both sandy and gravelly fluvial systems, because channel deposits of both types were encountered in core.

For each of the Atoka intervals, it was found that point bar height decreased up-section, with the exception of the Upper Atoka. This was because fluvial systems were confined to a single parasequence which was a short-lived regression event at the top of the Atoka. Channel dimensions varied according to point bar size.

Channel Morphology from Well Logs

Quantitative Clastics Laboratory

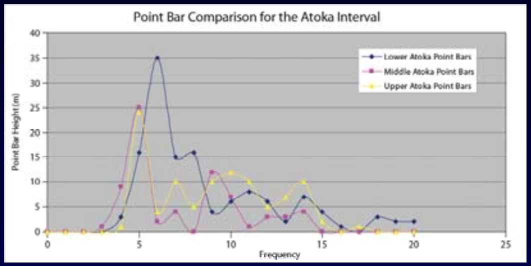
(a)

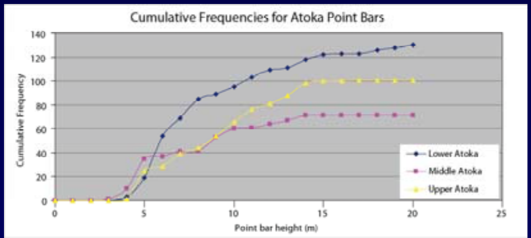
		From Well Log					From Swanson's Graph 1			
		Well Log Bar Height	Decompressed Point Bar Height	Decompressed Point Bar Height	Channel Depth	Channel Depth	Mean Annual Discharge	Mean Annual Discharge	Channel Width	Channel Width
		ft	ft	m	ft	m	cfs	m^3s^{-1}	ft	m
UAPS	MAX	40.0	61.5	18.76	20.51	6.25	71282	2018	1139	347
	AVG	20.5	31.6	9.63	10.53	3.21	16661	472	514	157
	MIN	8.0	12.3	3.75	4.10	1.25	1140	32	159	49
MAPS	MAX	34.0	52.3	15.95	17.44	5.31	46949	1329	934	285
	AVG	16.7	25.8	7.85	8.59	2.62	10819	306	403	123
	MIN	7.0	10.8	3.28	3.59	1.09	809	23	135	41
LAPS	MAX	50.0	76.9	23.45	25.64	7.82	126467	3581	1496	456
	AVG	17.5	26.9	8.20	8.96	2.73	14224	403	429	131
	MIN	6.0	9.2	2.81	3.08	0.94	545	15	112	34

(b)

			From Swanson's Graph 2		From Manning's Equation, *n=0.03*			From Manning's Equation, *n=0.045*		
		Channel W/D Ratio	Meander Length	Meander Length	Slope	Boundary Shear Stress	Shear Velocity	Slope	Boundary Shear Stress	Shear Velocity
		m/m	ft	m		Nm^{-2}	ms^{-1}		Nm^{-2}	ms^{-1}
UAPS	MAX	56	11389	3471	2.0E-04	1.1E-16	2.5E-10	2.9E-04	5.5E-16	5.7E-10
	AVG	47	5138	1566	2.7E-05	1.3E-18	7.5E-12	4.0E-05	6.6E-18	1.7E-11
	MIN	39	1592	485	1.1E-06	1.9E-28	3.3E-16	1.7E-06	9.4E-28	7.5E-16
MAPS	MAX	54	9337	2846	3.0E-04	1.0E-15	7.8E-10	4.5E-04	5.2E-15	1.8E-09
	AVG	45	4030	1228	5.5E-05	2.5E-17	4.2E-11	8.2E-05	1.2E-16	9.5E-11
	MIN	38	1352	412	1.9E-06	2.9E-27	1.3E-15	2.8E-06	1.5E-26	2.9E-15
LAPS	MAX	58	14961	4560	4.9E-04	1.4E-14	2.9E-09	7.4E-04	7.0E-14	6.4E-09
	AVG	45	4289	1307	6.0E-05	3.3E-16	9.4E-11	9.0E-05	1.6E-15	2.1E-10
	MIN	36	1120	341	5.5E-07	4.4E-30	5.1E-17	8.2E-07	2.2E-29	1.1E-16

KEY
***UAPS* = Upper Atoka Parasequence Set**
***MAPS* = Middle Atoka Parasequence Set**
***LAPS* = Lower Atoka Parasequence Set**





- **Point bars in LAPS are thick and abundant =** *regressive/ aggradational*
- **Point bars in MAPS are thin and few =** *transgressive*
- **Point bars in UAPS are restricted to specific interval =** *special case*

Notes by Presenter: Point bar analysis reveals a striking correlation between accommodation and the abundance of point bar deposits (degree of channelization).
Calculated dimensions were used to calculate slope, which was plotted against discharge.

Based on the relationships established by Lane (1957) it can be observed that Atoka channels tend to be meandering in character for both sandy and gravel-bed systems, although their limits also extend into braided streams.

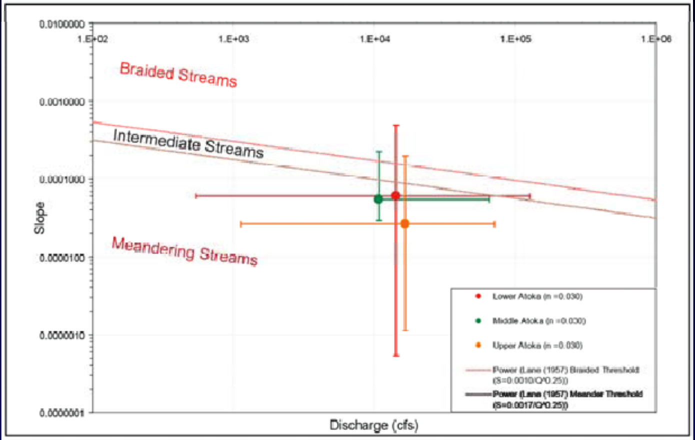
Point Bar Morphology and Channel Analysis

Quantitative Clastics Laboratory

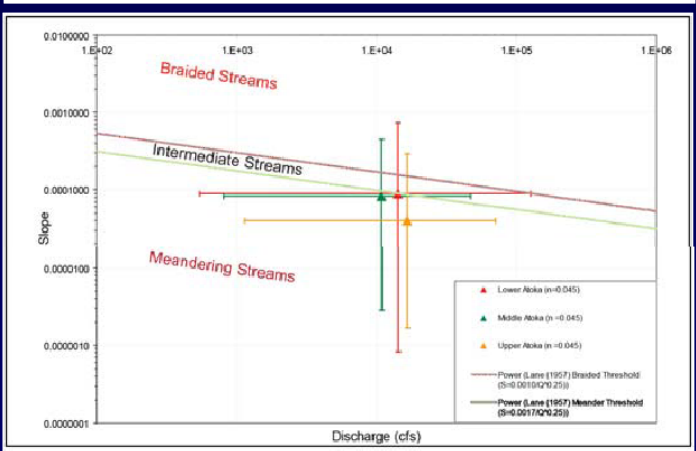
5. Classifying channels using calculated parameters

Equation	Comments	Author
$S = 0.0007\, Q_m^{-0.25}$ $S = 0.0041\, Q_m^{-0.25}$	Meandering sand-bed rivers Braided sand-bed rivers	Lane (1957)
$S = 0.0125\, Q_{bf}^{-0.44}$	Meandering to braided transition	Leopold and Wolman (1957)
$S = 0.000196\, Q_{bf}^{-0.44} D^{1.14}$	Meandering to braided transition	Henderson (1961, 1966)
$S = 0.0009\, Q_m^{-0.25}$ $S = 0.0041\, Q_m^{-0.25}$	Meandering sand bed rivers in Kansas Braided sand bed rivers in Kansas	Osterkamp (1978)
$S = 0.0016\, Q_m^{-0.33}$	Meandering to braided transition	Bengin (1981)
$S = 0.042\, Q^{-0.49} D_{50}^{0.09}$ $S = 0.042\, Q^{-0.49} D_{90}^{0.27}$	Meandering to braided transition for gravel-bed rivers	Ferguson (1984, 1987)
$S = aQ^{-0.5} D^{0.5}$	Meandering to braided transition	Chang (1985)

Well-documented methods for determining the morphological limits of meandering vs. braided sand and gravel-bed rivers in modern fluvial systems (modified from Bridge, 2003)



(a) n=0.030



(b) n=0.045

Relationships from Leopold and Wolman (1960)

Notes by Presenter: Point bar analysis reveals a striking correlation between accommodation and the abundance of point bar deposits (degree of channelization).

Calculated dimensions were used to calculate slope, which was plotted against discharge.

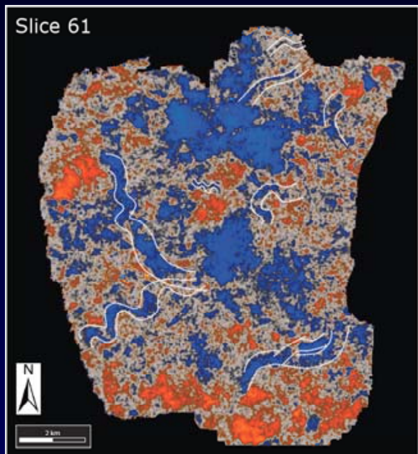
Based on the relationships established by Lane (1957) it can be observed that Atoka channels tend to be meandering in character for both sandy and gravel-bed systems, although their limits also extend into braided streams.

Seismic Geomorphology

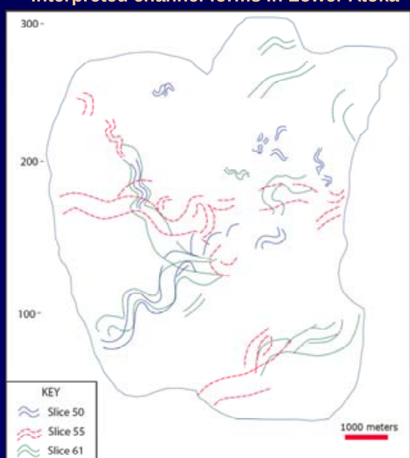
Quantitative Clastics Laboratory

6. Assessing seismic character of Lower Atoka channels

Amplitude slice on pseudo-volume (+-0ms)



Interpreted channel forms in Lower Atoka



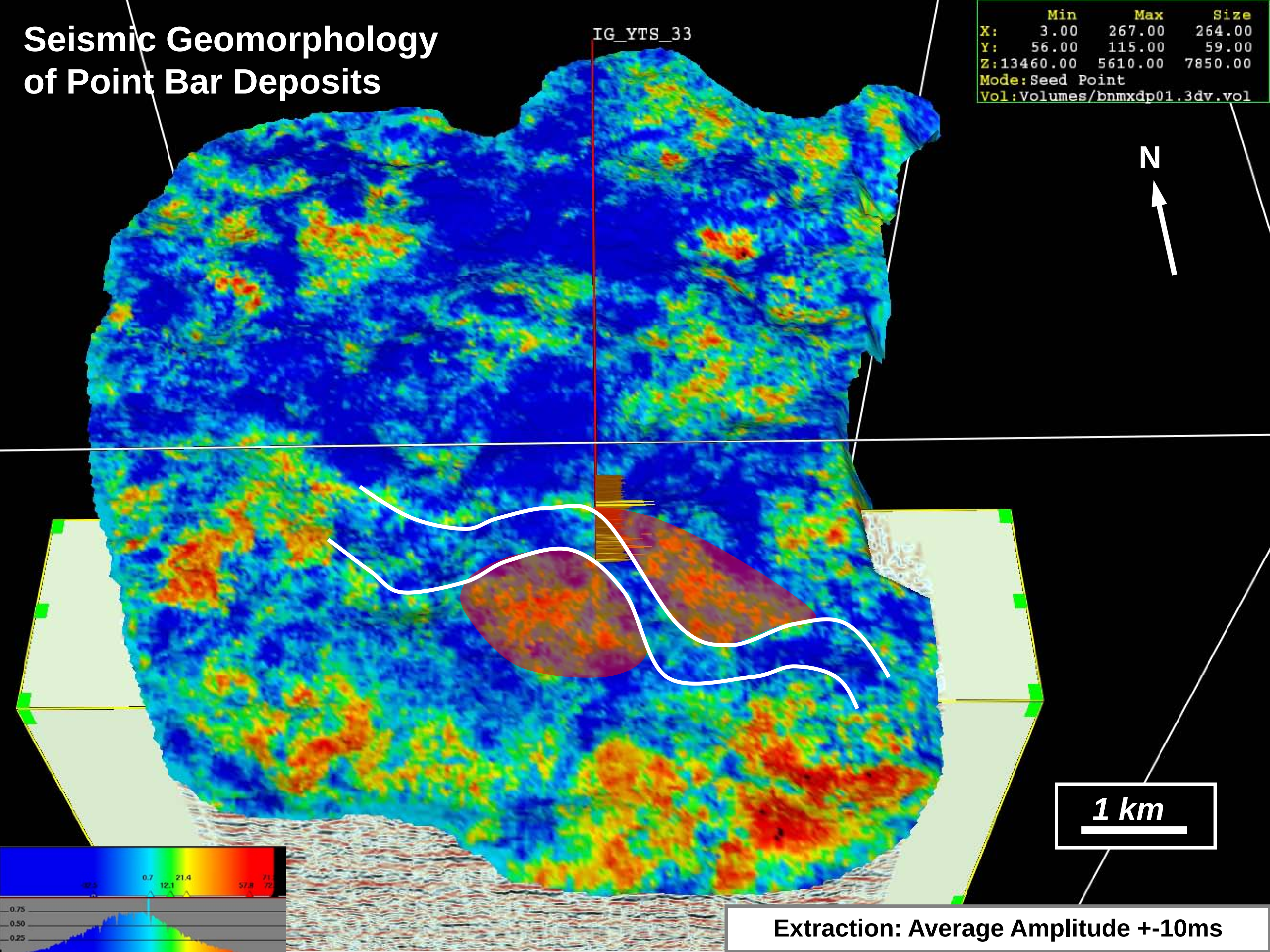
	From Slices			Back Calculated from Swanson's Graph 1					
	Sinuosity	Width	Width	Point Bar Height	Point Bar Height	Channel Depth	Channel Depth	Mean Annual Discharge	Mean Annual Discharge
		m	ft	m	ft	ft	m	cfs	m^3s^{-1}
MAX	1.32	583.00	1913	37	123	41	12	210000	5947
AVG	1.17	284.88	935	16	52	17	5	68258	1933
MIN	1.09	67.00	220	5	15	5	2	2500	71

		From Swanson's Graph 2		From Manning's Equation, n=0.03			From Manning's Equation, n=0.045		
	W/D Ratio	Meander Length	Meander Length	Slope (n=.03)	Boundary Shear Stress	Shear Velocity	Slope (n=.045)	Boundary Shear Stress	Shear Velocity
		ft	m		Nm^{-2}	ms^{-1}		Nm^{-2}	ms^{-1}
MAX	64	23855	7271	4.10E-03	9.63E-12	7.53E-08	6.15E-03	4.88E-11	1.69E-07
AVG	54	11655	3552	4.63E-04	8.03E-13	6.34E-09	6.95E-04	4.06E-12	1.43E-08
MIN	43	2743	836	3.70E-06	1.41E-27	9.12E-16	5.55E-06	7.16E-27	2.05E-15

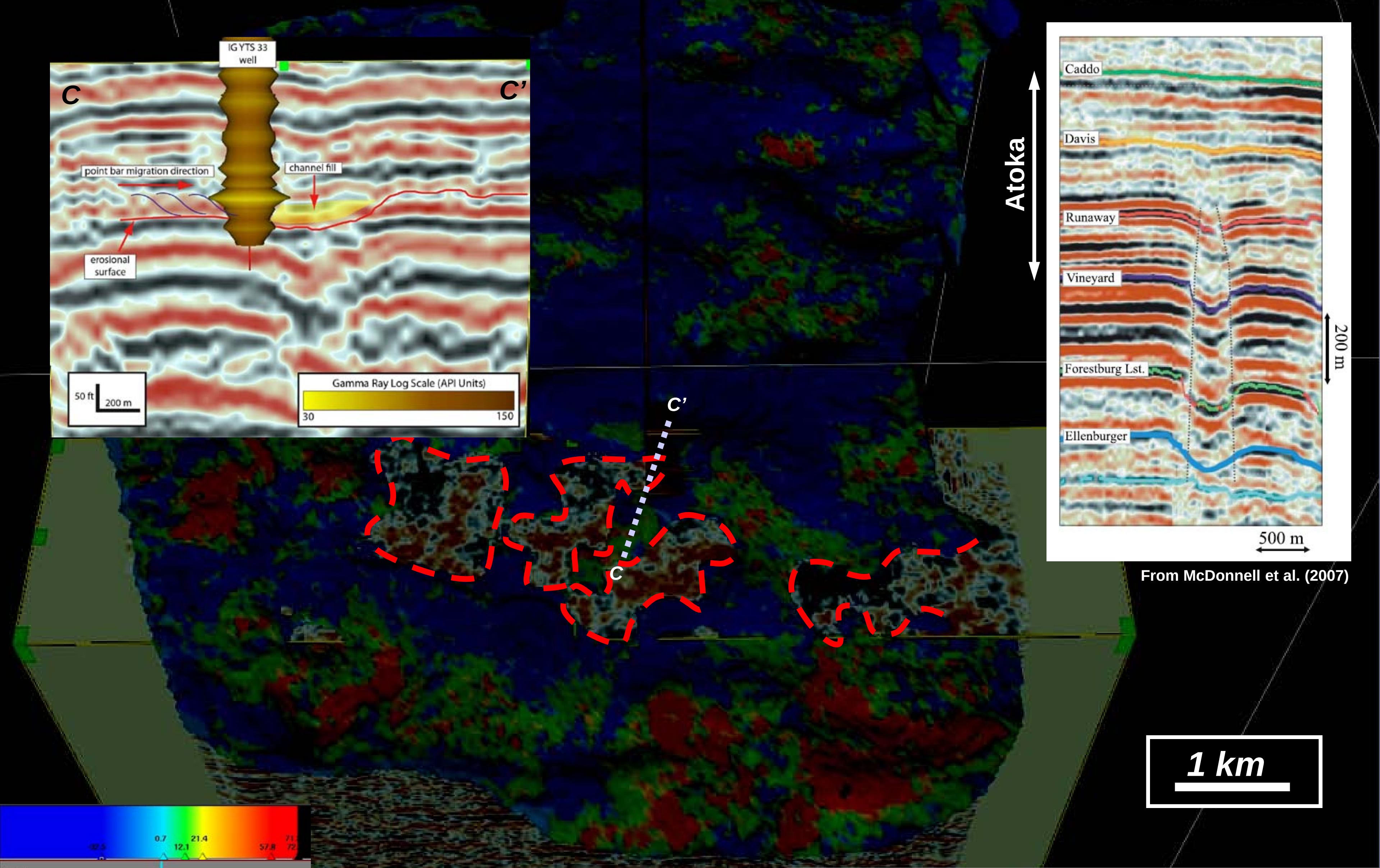
…calculated channel widths from well logs range from 34 to 456 meters

Notes by Presenter: Channels – Seismic cross-sections show channeling at numerous levels, while proportional slices show increased channeling deeper in the section. On seismic, channel forms appear moderately sinuous (1.09-1.32), with orientations varying temporally from N-S and SW-NE to E-W and back to SW-NE directions. Their widths range from 67-583 meters, and calculated flow parameters are illustrated in the table

Seismic Geomorphology of Point Bar Deposits

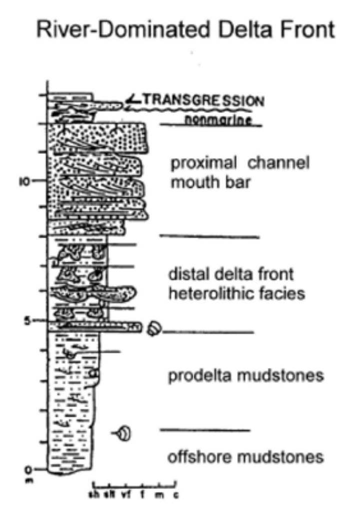


Seismic Geomorphology of Point Bar Deposits



Extraction: Average Amplitude +-10ms

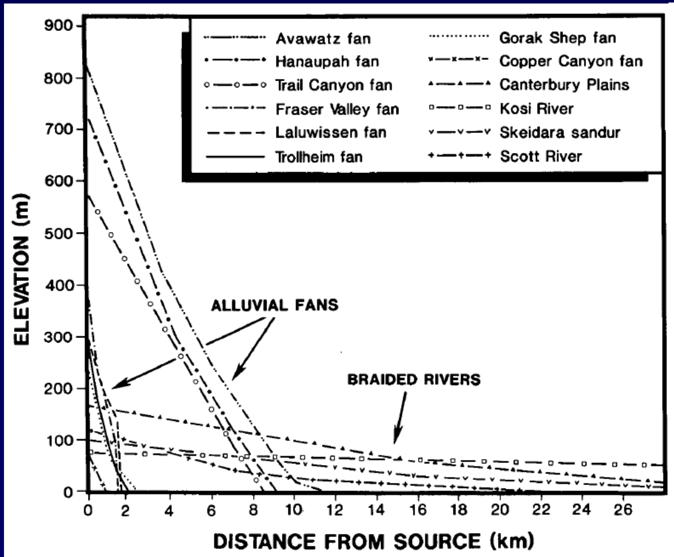
Comparative Analysis

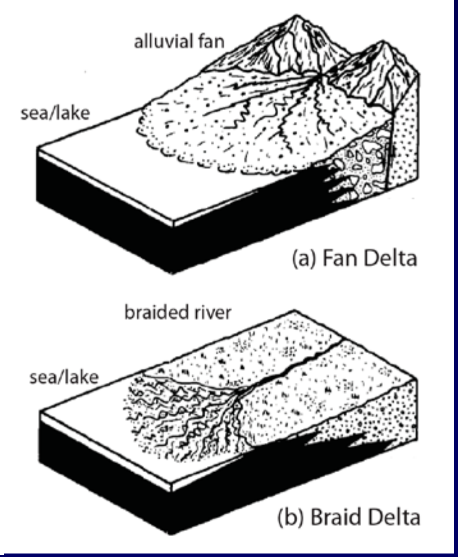


Modified from Bhattacharya and Walker (1992)

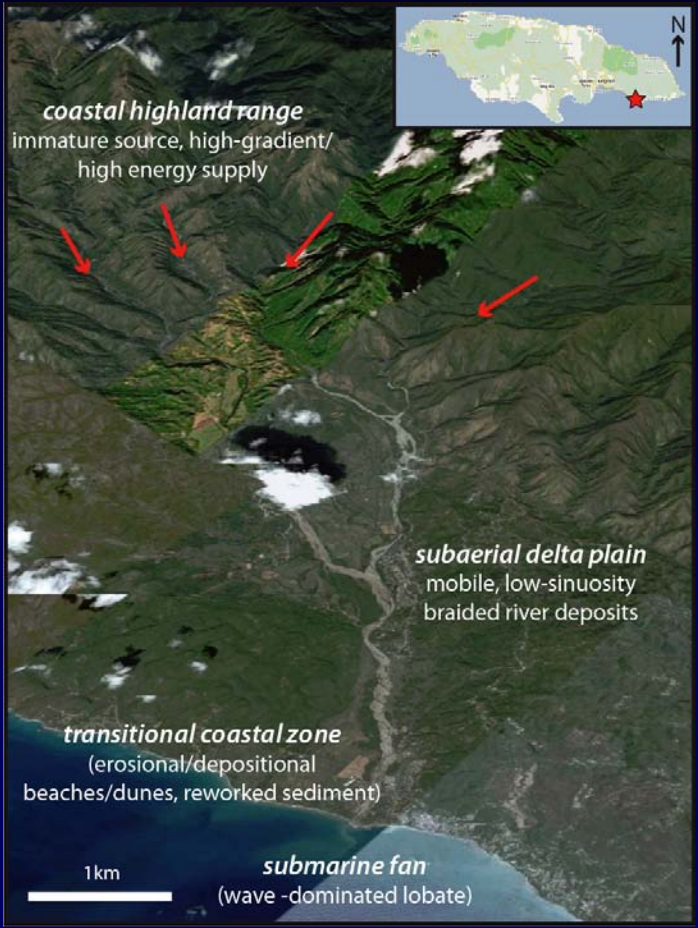
7. Under what depositional regime were Atoka sediments deposited?

- **Critical facies for fan delta deposition are absent**
- **Deposits located too far from source**
- **Well-log motif and core descriptions tend to match river-dominated delta profile**





McPherson et al. (1987)



Modified from Google Earth (2008)

Conclusions and Future Work

Quantitative Clastics Laboratory

- Integrating core, well log and 3D seismic data (when available) is critical for interpreting subsurface stratigraphy
- Well log correlation allows for defining temporal and spatial changes in depositional element architecture throughout Atoka time
- The distribution of Atoka channels controlled by a variety of factors, and emphasizes the complexity of the Atoka Gp.
- Quantitative analysis reveals that the size of Atoka channels can be predicted using well logs and seismic
- Comparative analysis shows that critical facies necessary for fan-delta deposition are absent, while those for fluvial-dominated deltas prevail
- A similar, regional scale study is needed to characterize thicker sections of the Atoka
- Petrographic analysis is needed to describe diagenetic processes and source area contributions

Notes by Presenter: Integrating core, well log and 3D seismic data (when available) is critical for interpreting subsurface stratigraphy
Well log correlation allows for defining temporal and spatial changes in depositional element architecture throughout Atoka time
The distribution of Atoka channels controlled by a variety of factors, and emphasizes the complexity of the Atoka Gp.
Quantitative analysis reveals that the size of Atoka channels can be predicted using well logs and seismic
Comparative analysis shows that critical facies necessary for fan-delta deposition are absent, while those for fluvial-dominated deltas prevail
A similar, regional scale study is needed to characterize thicker sections of the Atoka
Petrographic analysis is needed to describe diagenetic processes and source area contributions

Questions?

REFERENCES

Bhattacharya, J. P. and R. G. Walker (1992). Deltas. Canada, Geological Association of Canada : St. Johns, NL, Canada.

Bridge, J. S. (2003). Rivers and floodplains; forms, processes, and sedimentary record. United Kingdom, Blackwell Publishing : Oxford, United Kingdom.

DeCelles, P. G. (1996). Foreland basin systems. Basin Research. K. A. Giles. United Kingdom, Blackwell Science : Oxford, United Kingdom. 8: 105-123.

Hentz, T. F. (in press). Depositional facies, reservoir distribution, and infield potential of the lower Atoka Group (Bend Conglomerate) in Boonsville Field, Fort Worth Basin, Texas; new look at an old play. Abstracts: Annual Meeting - American Association of Petroleum Geologists. J. A. Kane, W. A. Ambrose and E. C. Potter.

Lahti, V. R. and W. F. Huber (1982). The Atoka Group (Pennsylvanian) of the Boonsville Field area, north-central Texas. United States, Dallas Geological Society : Dallas, TX, United States.

Leopold, L. B. (1957). U. S. Geological Survey Professional PaperRiver channel patterns; braided meandering, and straight. U. S. Geological Survey Professional Paper. M. G. Wolman. United States, U. S. Geological Survey : Reston, VA, United States: 39-85.

McPherson, J. G. (1987). Fan-deltas and braid deltas; varieties of coarse-grained deltas. Geological Society of America Bulletin. G. Shanmugam and R. J. Moiola. United States, Geological Society of America (GSA) : Boulder, CO, United States. 99: 331-340.

Pollastro, R. M. (2007). Geologic framework of the Mississippian Barnett Shale, Barnett-Paleozoic total petroleum system, Bend Arch-Fort Worth Basin, Texas. AAPG Bulletin. D. M. Jarvie, R. J. Hill and C. W. Adams. United States, American Association of Petroleum Geologists : Tulsa, OK, United States. 91: 405-436.

Thompson, D. M. (1982). Report of Investigations - Texas, University, Bureau of Economic GeologyAtoka Group (Lower to Middle Pennsylvanian), northern Fort Worth Basin, Texas; terrigenous depositional systems, diagenesis, and reservoir distribution and quality. Report of Investigations - Texas, University, Bureau of Economic Geology. United States, University of Texas at Austin, Bureau of Economic Geology : Austin, TX, United States.

Walper, J. L. (1982). Plate tectonic evolution of the Fort Worth Basin. United States, Dallas Geological Society : Dallas, TX, United States.

Selected References

Bhattacharya, J.P. and R.G. Walker, 1992, Deltas, *in* R.G. Walker and N.P. James (editors) Facies Models: Response to Sea Level Change: Geological Association of Canada, p. 157-177.

Bridge, J. S., 2003, Rivers and floodplains; forms, processes, and sedimentary record: Blackwell Publishing: Oxford, United Kingdom, 491 p.

Chang, H.K. and R.O. Kowsmann, 1985, Thermal Subsidence of Santos and Sergipe-Alagoas Basins, Brazil--Application to Hydrocarbon Exploration: AAPG Meeting Abstract, v. 69/2, 1 pg.

DeCelles, P. G., 1996, Foreland basin systems. Basin Research. K. A. Giles. United Kingdom, Blackwell Science : Oxford, United Kingdom. 8: 105-123.

DeCelles, P.G. and K.A. Giles, 1996, Foreland basin systems: Basin Research, v. 8/2, p. 105-123.
DOI: 10.1046/j.1365-2117.1996.01491.x

Ferguson, J.D., 1984, Jurassic Age Salt Tectonism Within the Mt. Enterprise Fault System, Rusk County, Texas, *in* The Jurassic of East Texas, edited by Mark W. Presley, East Texas Geological Society Publication, p. 157–161

Google Earth: Web Accessed 10 August 2009 http://earth.google.com/

Hardage, B.A., 1985, Vertical Seismic Profiling, Part A: Principles, 2nd enlarged ed. Seismic Exploration: Geophysical Press, London, v. 14A, 450 p.

Henderson G., 1966, Field mapping in the Egedesminde-Christianshab area: (sheets 68 v. 1 and 68 v. 2), p. 17-19.

Henderson, R.G., 1966, Field continuation and the step model in aeromagnetic interpretation: Geophysical Prospecting, v. 14/4, p. 528-546.

Henderson, F.M., 1961, Stability of alluvial channels: Proceedings of the American Society of Civil Engineers, Journal of the Hydraulics Division, v. 87, p. 109–138.

Hentz, T.F., E. Potter, and M.A. Adedeji, 2007, Reservoir-scale depositional facies, trends, and controls on sandstone distribution of the lower Atoka Group ("Bend Conglomerate"), Fort Worth Basin, Texas: AAPG Annual Convention Abstracts Volume, v. 16, p. 62.

Hentz, T. F., J. A. Kane, W. A. Ambrose and E. C. Potter (in press). Depositional facies, reservoir distribution, and infield potential of the lower Atoka Group (Bend Conglomerate) in Boonsville Field, Fort Worth Basin, Texas; new look at an old play. Abstracts: Annual Meeting - American Association of Petroleum Geologists

Lahti, V. R. and W. F. Huber, 1982, The Atoka Group (Pennsylvanian) of the Boonsville Field area, north-central Texas, *in* Petroleum geology of the Fort Worth Basin and Bend Arch Area: Dallas Geological Society: Dallas, Texas, p. 377-400.

Lane, E.W., 1957, A study of the shape of channels formed by natural streams flowing in erodible material: United States Army Corps of Engineers, Missouri River Division, Omaha, NB: Missouri River Division Sediment Series, v. 9, 106 p.

Leopold, L. B. and M. G. Wolman, 1957, River channel patterns; braided meandering, and straight. US Geological Survey Professional Paper, U. S. Geological Survey, Reston, VA, United States: 39-85.

Leopold, L.B. and M. G. Wolman, 1960, River Meanders: Geological Society of America Bulletin, v. 71/6, p. 769-793.

Manning, R., 1891, On the flow of water in open channels and pipes: Paper presented and published by Institute of Civil Engineers of Ireland.

McPherson, J. G., G. Shanmugam and R. J. Moiola, 1987, Fan-deltas and braid deltas; varieties of coarse-grained deltas: GSA Bulletin, Boulder, CO, United States. v. 99, p. 331-340.

Miller, K.G., M.A. Kominz, J.V. Browning, J.D. Wright, G.S. Mountain, M.E. Katz, P.J. Sugarman, B.S. Cramer, B.N. Christie, and S.F. Pekar, 2005, The Phanerozoic record of global sea-level change: Science, v. 310/5752, p. 1293-1298.

Osterkamp, W.R., 1978, Gradient, discharge, and particle-size relations of alluvial channels of Kansas, with observations on braiding: American Journal of Science, v. 278, p. 1253-1268.

Osterkamp, W.R., (investigator), 1978, Relationship between channel gradient and mean discharge: US Geological Survey Professional Paper, Report P1100, 212 p.

Pollastro, R. M., D. M. Jarvie, R. J. Hill and C. W. Adams, 2007, Geologic framework of the Mississippian Barnett Shale, Barnett-Paleozoic total petroleum system, Bend Arch-Fort Worth Basin, Texas: AAPG Bulletin v. 91, p. 405-436.

Thompson, D. M., 1982, Atoka Group (Lower to Middle Pennsylvanian), northern Fort Worth Basin, Texas; Terrigenous depositional systems, diagenesis, and reservoir distribution and quality: Report of Investigations, Bureau of Economic Geology, University of Texas at Austin, Austin, Texas, 125 p.

Walper, J. L. and C.L. Rowett, 1982, Plate tectonic evolution of the Fort Worth Basin, *in* C.A. Martin (editor), Petroleum geology of the Fort Worth Basin and Bend Arch area: Dallas Geological Society, Dallas, Texas, p. 237-251.