M E M O R A N D U M
R E P O R T

TO: Robert Bradley, Texas Water Development Board

FROM: Neil Blandford and Stephanie Moore, Daniel B. Stephens & Associates, Inc.

DATE: August 19, 2020

SUBJECT: AUGUST 14, 2020 STAKEHOLDER ADVISORY FORUM

The team of Daniel B. Stephens & Associates, Inc. (DBS&A), Allan R. Standen LLC, and Blanton & Associates, Inc. (B&A) (collectively referred to as the DBS&A Team) held the second Stakeholder Advisory Forum (SAF) for the Cross Timbers Aquifer Conceptual Model Project on Friday, August 14, 2020.

1.0 Stakeholder Advisory Forum Background

By statute, the Texas Water Development Board (TWDB) is required to develop numerical groundwater flow models for the major and minor aquifers in Texas. The Cross Timbers Aquifer was designated as a new minor aquifer in December 2017. As a precursor to developing the Groundwater Availability Model (GAM), the DBS&A Team is developing the Conceptual Model for the Cross Timbers Aquifer to describe the best understanding of how groundwater moves through this system. Stakeholder participation is critical to the success of the TWDB GAM Program and development of these models. Section 2.0, Stakeholder Participation, of the TWDB GAM standards specify the TWDB's requirements for stakeholder participation.

The SAFs are designed to encourage participation in the project, and to provide an understandable and convenient means to comment and ask questions. The SAF held on August 14, 2020 was the second of three meetings scheduled for the project; a summary of the meeting is provided below..

2.0 Stakeholder Advisory Forum Overview

SAF Date: Friday, August 14, 2020

SAF Location: To comply with best practices and directions provided by the State of Texas for the COVID-19 pandemic situation, this SAF was held online or by phone. A total of twenty-five stakeholders attended the meeting using the using following link: https://blantonassociatesinc.webex.com/blantonassociatesinc/onstage/g.php?MTID=e5f38eaeec6a61d9fdb244e19fe259306.

SAF Notices: The TWDB preferred method of SAF notification is by email.[1] The DBS&A Team prepared email notices to announce the August 14, 2020 SAF. Using stakeholder contact information lists provided by TWDB staff, the team distributed notices by email on July 22, 2020 (23 days before the meeting) and sent a reminder email on August 6, 2020 (8 days before the meeting). Each email notice included information about the SAF and a project summary sheet.

SAF Purpose: The DBS&A Team held this second SAF to inform and update stakeholders on the Cross Timbers Aquifer conceptual model mid-way through the project. The purpose of this meeting was for the DBS&A Team to discuss the status of the project, obtain input, and answer questions regarding portions of the project completed to date.

SAF Attendance: The table below lists 35 attendees (25 stakeholders including TWDB staff and ten members of the DBS&A Team including B&A Information Technology Team) that attended the second SAF:

Name	Affiliation
Jilane Carper	Texas Soil and Water Conservation Districts
Chase Brooke	Texas A&M AgriLife Extension Service
Doug Shaw	Upper Trinity Groundwater Conservation District (GCD)
Mike McGuire	Rolling Plains GCD
Tracy Homfeld	Collin County
Simone Kiel	Freese and Nichols, Inc.
Honorable Brian Keith Umphress	Jack County
Tracy Mesler	Nocona News
Kristal Williams	Freese and Nichols, Inc.
Carmelia Baluta	University of Texas at Austin
Honorable John Bullock	Young County
Luci Dunn	Consultant
Ray Brady	RMBJ Geo, Inc.
Michael Berry	Texas A&M AgriLife Extension Service/Comanche County
Todd Thomas	RWPGB
David Villarreal	Texas Department of Agriculture
Peter Schulmeyer	Collier Consulting
Spencer Schuler	Freese and Nichols, Inc.
James Beach	WSP
Shirley Wade	TWDB
Cindy Ridgeway	TWDB
Natalie Ballew	TWDB
Robert Bradley	TWDB
Ki Cha	TWDB
Sarah Backhouse	TWDB
Neil Blandford	DBS&A, Inc.
Stephanie Moore	DBS&A, Inc.
Farag Bostos	DBS&A, Inc.
Kenneth Calhoun	DBS&A, Inc.
Allan Standen	Allan R. Standen LLC
Vince Clause	Allan R. Standen LLC
Velma Danielson	B&A
Alicia Reinmund-Martinez	B&A
Ray Green	B&A
Robert Ryan	B&A

Appendix A has the list of attendees in the order that they signed in to the webex online meeting.

[1] Two letters were sent by U.S. mail on July 22, 2020, to stakeholders that did not have a valid email account.

SAF Format: The SAF commenced at approximately 10:10 AM with Robert Ryan of B&A, informing attendees about when and how they would be able to ask questions of the panelists. Neil Blandford, Project Manager, DBS&A Team, officially opened the meeting by first welcoming everyone to the virtual meeting and introducing the elected officials and TWDB staff in attendance.

Robert Bradley, Project Manager, TWDB, provided a brief overview of the GAM Program including the purpose and importance of the SAFs. He concluded his presentation with his and Cindy Ridgeway's, Manager, TWDB, contact information.

Neil Blandford provided an overview of the project background and the agenda for the meeting. He noted that an audio and video recording of the meeting, presentation, and the report summarizing the meeting would be provided on the TWDB website. He then presented the 11 components of the conceptual model and identified that the presentation would focus on the geology, hydrostratigraphy, and hydrostratigraphic framework of the Cross Timbers Aquifer.

DBS&A Team members Allan Standen (Professional Geologist), Farag Bostros (Professional Engineer), and Vince Clause then presented comprehensive summaries of these components of the conceptual model. Allan Standen provided an overview of the geology, hydrostratigraphy and hydrostratigraphic framework. Farag Botros provided an overview of the three-dimensional geologic model developed within the Leapfrog software package. Vince Clause provided an overview of the Team's net sand thickness analysis.

Neil Blandford finished the presentation with an overview of the project schedule, next steps, and the contact information for the DBS&A Team. He noted again that the TWDB website for Cross Timbers Aquifer Conceptual Model Project would have a posted a copy of the presentation, a copy of the memorandum report for the SAF, and other information regarding the project.

Appendix B contains a copy of the presentation and **Appendix C** includes a revised handout prepared by the DBS&A Team that was made available during the meeting through the webex chat box.

SAF Questions & Answers, and Comments & Observations:

After the presentation concluded, a few questions were asked via the chat box and one attendee provided a verbal comment. The responses to these questions and comments from the DBS&A Team and the TWDB are as follows:

Question 1. Is the Leapfrog viewer that was presented available from the TWDB website?

Response: No, it is not. Please contact the DBS&A Team or go to the following address: https://www.seequent.com/products-solutions/leapfrog-viewer/

Question 2. Why were the sandstone layers designated as the more productive layers of the aquifer versus the limestone layers?

Response: The limestone layers are thin. There is no evidence that these layers exhibit karst features. Also, when the Cross Timbers Aquifer was first framed, it was generally characterized as a sandstone formation.

Question 3. Where and when will the recording of the meeting be available?

Response: The recording will be available on the TWDB website (https://www.twdb.texas.gov/groundwater/models/gam/cstb/cstb.asp) but TWDB will need about one to two weeks to add captions to the video before they will be able to post it.

Question 4. When does the TWDB plan to develop the numerical model for the Cross Timbers Aquifer?

Response: There is not a schedule currently. Right now, the TWDB has a priority to update the 23 existing models with new code and will fit in the Cross Timbers Aquifer numerical model as resources allow.

Comment 1. A meeting attendee commended the presenters for their excellent presentations and work on the project. This project is very important to his GCD because 70-80% of his district's water comes from the Cross Timbers Aquifer. Also, the geologists at his GCD will be able to use this model. He further expressed his appreciation to the TWDB for their support of the development of this model.

Response: Thank you. Also recognized comments that the GCD had provided on the interim deliverable, and stated that the comments would be addressed to the extent feasible within the existing scope of work.

Appendix A

List of Attendees

List of Attendees

First Name	Last Name	Affiliation
Ray	Green	Blanton & Associates, Inc.
Farag	Botros	Daniel B. Stephens & Assoc., Inc.
Jilane	Carper	SWCD
Velma	Danielson	Blanton & Associates, Inc.
Chase	Brooke	Texas A&M AgriLife Extension Service
Doug	Shaw	UTGCD
Mike	McGuire	Rolling Plains GCD
Shirley	Wade	TWDB
Alicia	Reinmund-Martinez	Blanton & Associates, Inc.
Tracy	Homfeld	Collin County
simone	kiel	Freese and Nichols
Brian	Keith Umphress	County of Jack
Tracy	Mesler	Nocona News
Kristal	Williams	Freese and Nichols, Inc.
Camelia	Baluta	UT Austin
John	Bullock	Young County
Vince	Clause	Allan R. Standen, LLC
Luci	Dunn	consultant
Ray	Brady	RMBJ Geo inc
Stephanie	Moore	Daniel B. Stephens & Assoc., Inc.
Michael	Berry	Comanche County Agent Office
Natalie	Ballew	TWDB
Todd	Thomas	RWPG B
Sarah	Backhouse	TWDB
Neil	Blandford	Daniel B. Stephens & Assoc., Inc.
Robert	Bradley	TWDB
Cindy	Ridgeway	TWDB
Kenneth	Calhoun	Daniel B. Stephens & Assoc., Inc.
David	Villarreal	Texas Department of Agriculture
Peter	Schulmeyer	Collier Consulting
Allan	Standen	Allan R Standen LLC
Spencer	Schnier	Freese and Nichols, Inc.
Ki	Cha	TWDB
James	Beach	WSP
Robert	Ryan	Blanton & Associates, Inc.

Appendix B

Presentation Slides

Texas Water Development Board

Cross Timbers Aquifer Conceptual Model

Stakeholder Advisory Forum #2

August 14, 2020

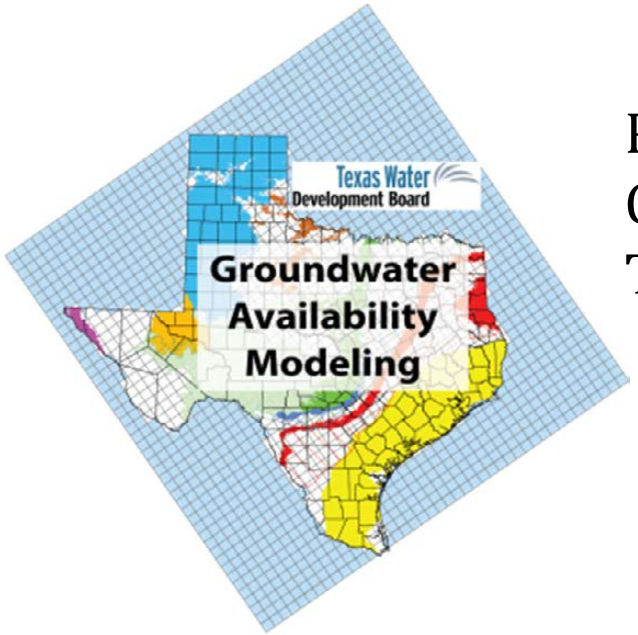
Remote Meeting

DBS&A Daniel B. Stephens & Associates, Inc. a Geo-Logic Company

Allan R. Standen LLC Groundwater & Natural Resource Consulting

Blanton & Associates, Inc.
Environmental Consulting • Planning • Project Management

Texas Water Development Board (TWDB) Groundwater Availability Modeling (GAM) Program



Robert Bradley (Contract Manager)
Groundwater Availability Modeling Program
Texas Water Development Board

GAM Program

- **Aim**: Develop groundwater flow models for the major and minor aquifers of Texas.
- **Purpose**: Tools that can be used to aid in groundwater resources management by stakeholders.
- **Public process**: Stakeholder involvement during model development process.
- **Models**: Freely available, standardized, thoroughly documented. Reports, data, models are available for download from TWDB download page for models.
- **Living tools**: Periodically updated.

Why Stakeholder Advisory Forums?

- Keep stakeholders updated about progress of the model
- Inform how the groundwater model can, should, and should not be used
- Provide stakeholders with the opportunity to provide input and data to assist with model development

Contact Information

Robert Bradley, P.G, CTCM
TWDB Contract Manager
512-936-0870
Robert.bradley@twdb.texas.gov

Cindy Ridgeway, P.G.
Manager of Groundwater Availability Modeling Section
512-936-2386
Cindy.ridgeway@twdb.texas.gov

Texas Water Development Board
P.O. Box 13231
Austin, Texas 78711-3231

Web information:
https://www.twdb.texas.gov/groundwater/models/gam/cstb/cstb.asp

Overview

- Past: Cross Timbers Aquifer designated as minor aquifer in December 2017
- Current: Develop Conceptual Model
  - June 1, 2019 - Start date
  - June 1, 2020 - Interim Deliverable
  - March 31, 2021 - Study Completion Date
- Future: Groundwater Availability Model

Agenda

1. Interim Deliverable
   - Geologic structure/stratigraphy
   - Hydrostratigraphic framework
   - Data sets
   - Leapfrog 3-D geologic model
   - Net sand analysis
2. Next steps
3. Questions

Meeting Documentation

An audio and video recording of the meeting, presentation, and the report summarizing the meeting will be made available on the project's TWDB website

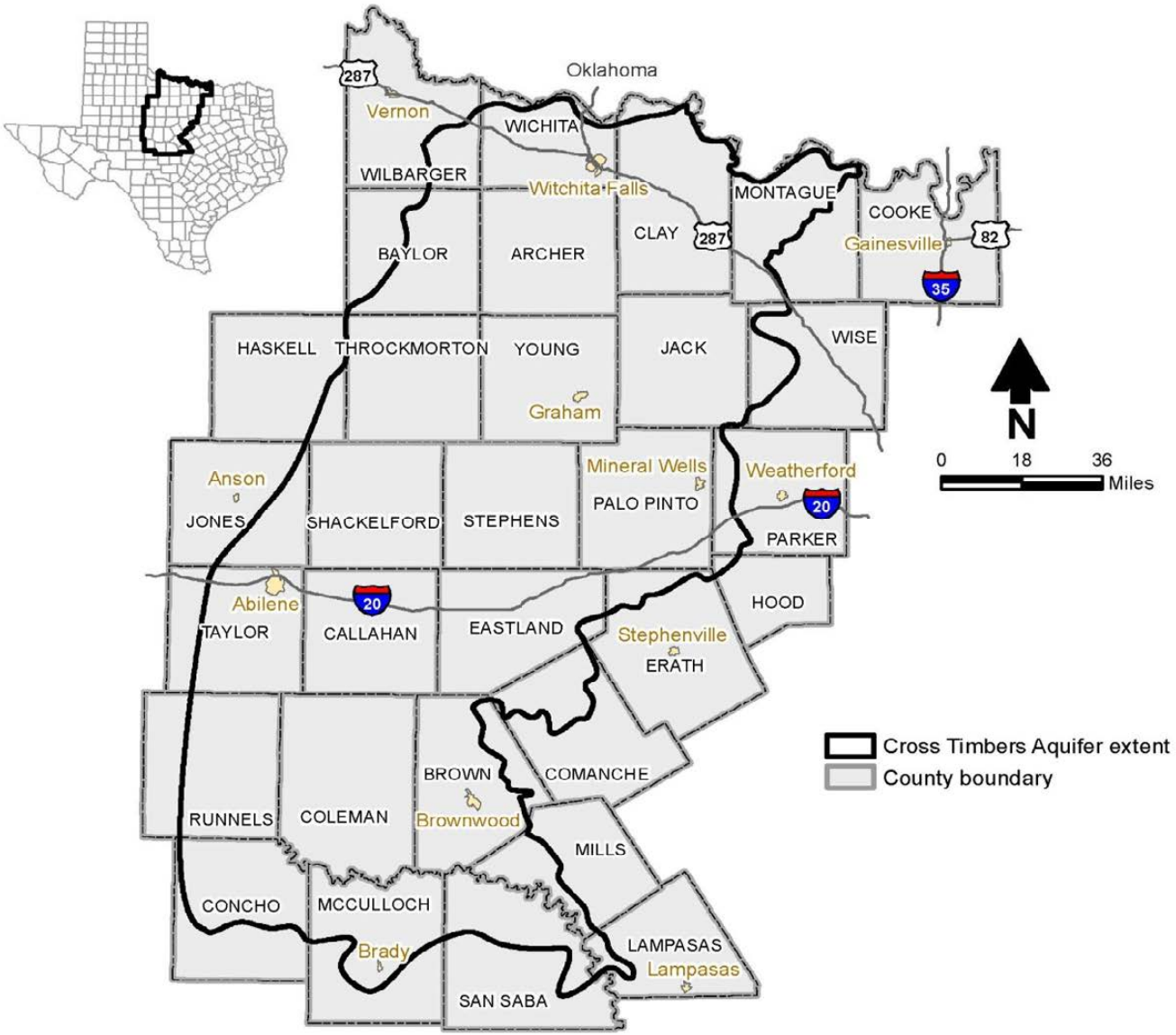
https://www.twdb.texas.gov/groundwater/models/gam/cstb/cstb.asp

Components of Conceptual Model

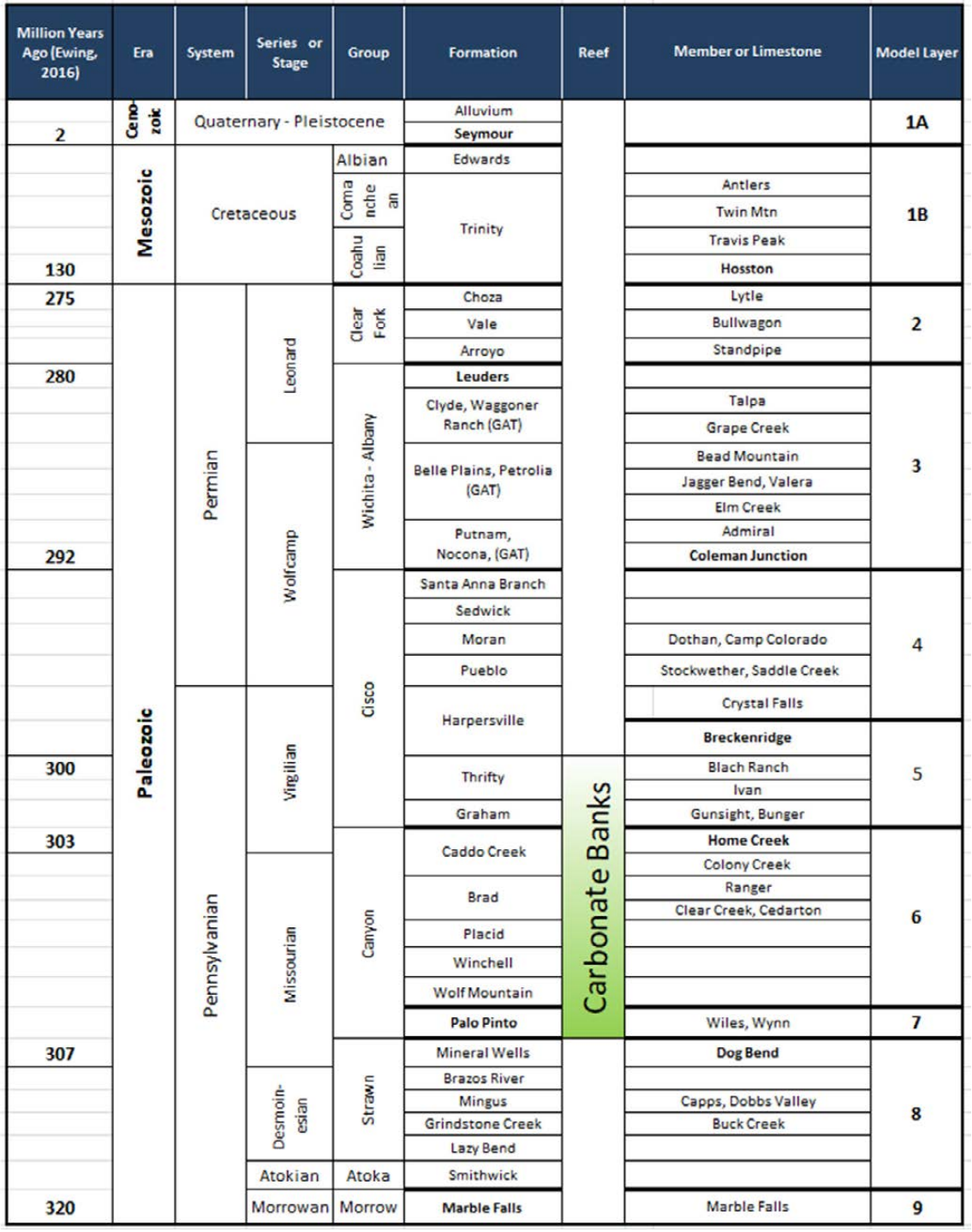
1. Physiography and climate
2. Geology
3. Hydrostratigraphy
4. Hydrostratigraphic framework
5. Water levels and regional groundwater flow
6. Recharge
7. Rivers, streams, reservoirs, springs and other surface water features
8. Hydraulic properties
9. Subsidence
10. Discharge
11. Water quality

Study Area

~17,800 square miles covering all or portions of 31 counties

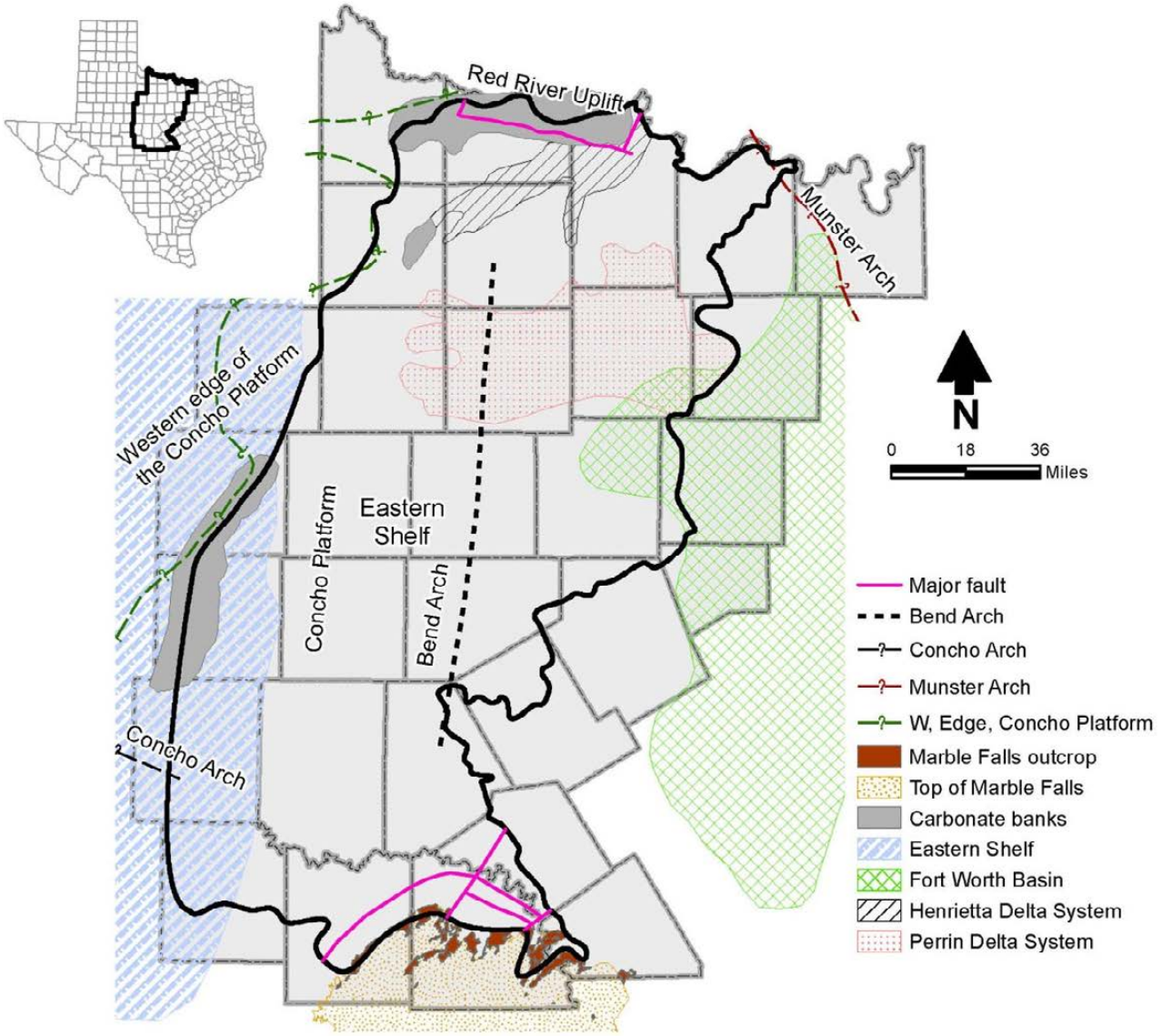


Stratigraphic Column and Model Layers

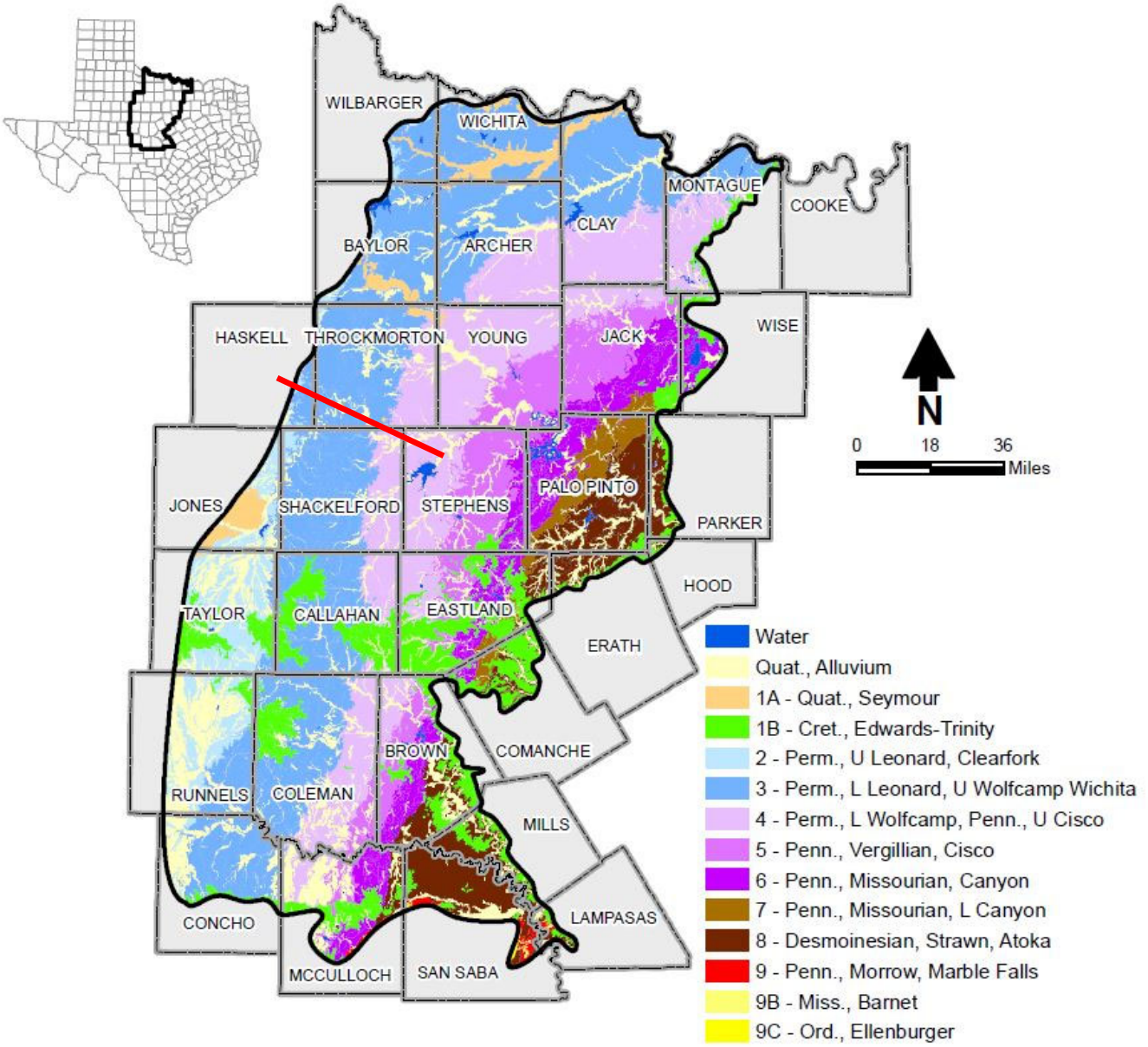


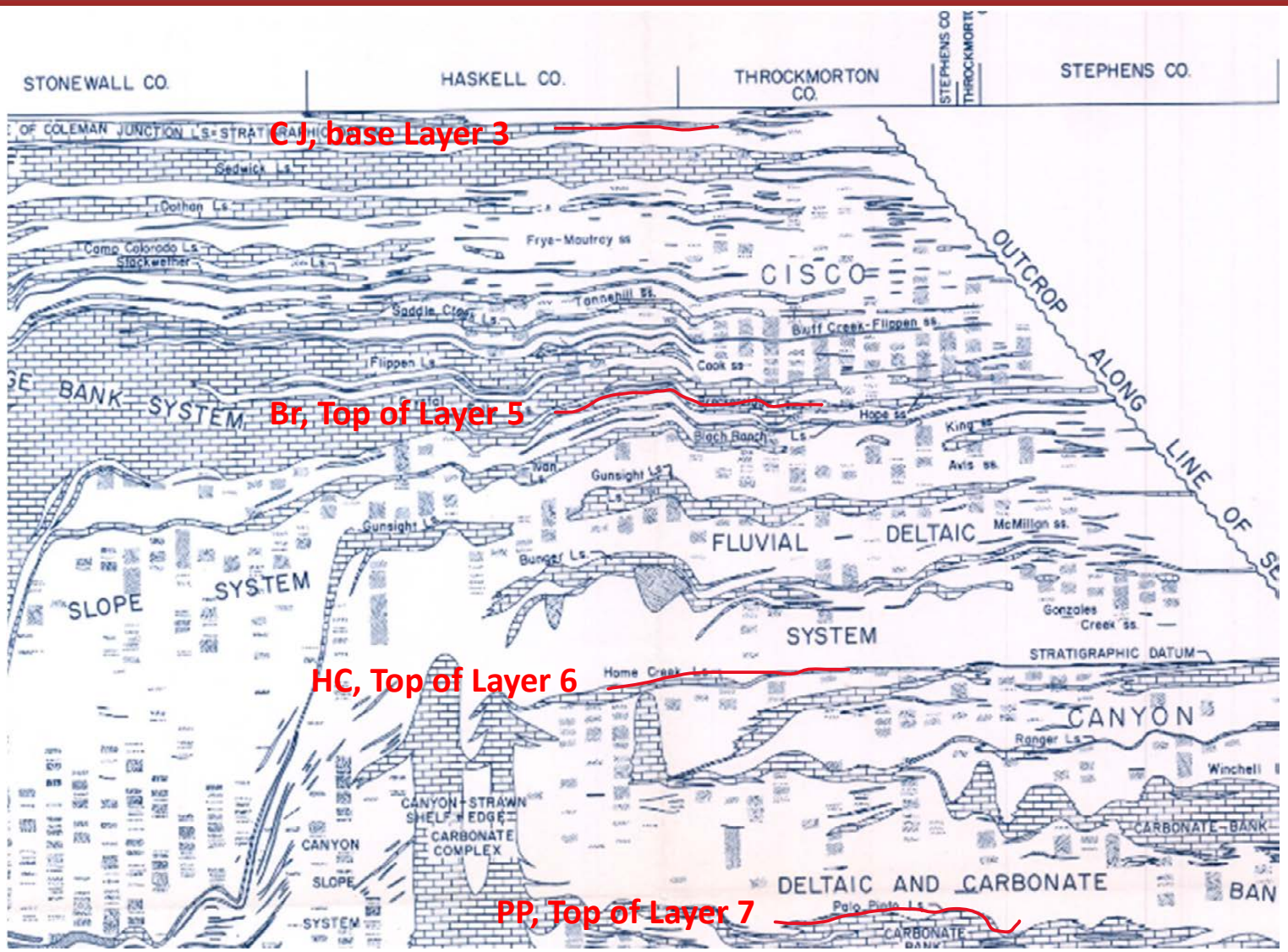
Million Years Ago (Ewing, 2016)	Era	System	Series or Stage	Group	Formation	Reef	Member or Limestone	Model Layer
2	Cenozoic	Quaternary - Pleistocene			Alluvium			1A
					Seymour			
	Mesozoic	Cretaceous		Albian	Edwards			1B
				Comanchean	Trinity		Antlers	
							Twin Mtn	
				Coahulian			Travis Peak	
130							**Hosston**	
275	Paleozoic	Permian	Leonard	Clear Fork	Choza		Lytle	2
					Vale		Bullwagon	
					Arroyo		Standpipe	
280				Wichita - Albany	**Leuders**			3
					Clyde, Waggoner Ranch (GAT)		Talpa	
							Grape Creek	
			Wolfcamp		Belle Plains, Petrolia (GAT)		Bead Mountain	
							Jagger Bend, Valera	
							Elm Creek	
					Putnam, Nocona, (GAT)		Admiral	
292							**Coleman Junction**	
		Pennsylvanian	Virgilian	Cisco	Santa Anna Branch			4
					Sedwick			
					Moran		Dothan, Camp Colorado	
					Pueblo		Stockwether, Saddle Creek	
					Harpersville		Crystal Falls	
							Breckenridge	5
300					Thrifty	Carbonate Banks	Blach Ranch	
							Ivan	
					Graham		Gunsight, Bunger	
303			Missourian	Canyon	Caddo Creek		**Home Creek**	6
							Colony Creek	
					Brad		Ranger	
							Clear Creek, Cedarton	
					Placid			
					Winchell			
					Wolf Mountain			
					Palo Pinto		Wiles, Wynn	7
307				Strawn	Mineral Wells		**Dog Bend**	8
			Desmoinesian		Brazos River			
					Mingus		Capps, Dobbs Valley	
					Grindstone Creek		Buck Creek	
					Lazy Bend			
			Atokian	Atoka	Smithwick			
320			Morrowan	Morrow	**Marble Falls**		Marble Falls	9

Geologic Structure



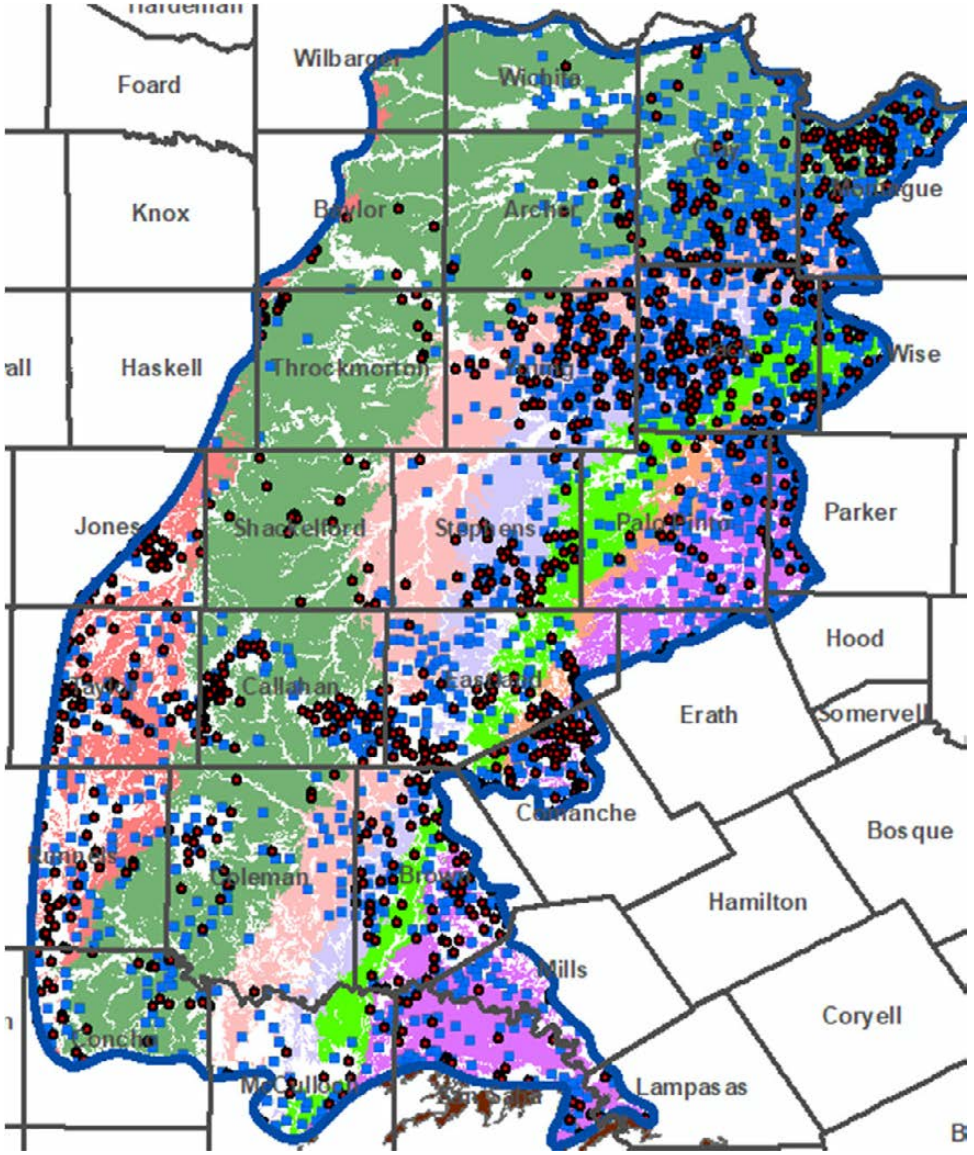
Surface Geology





Cleaves, 1975, Figure 18, NW-SE cross-section, Stonewall to Stephens counties

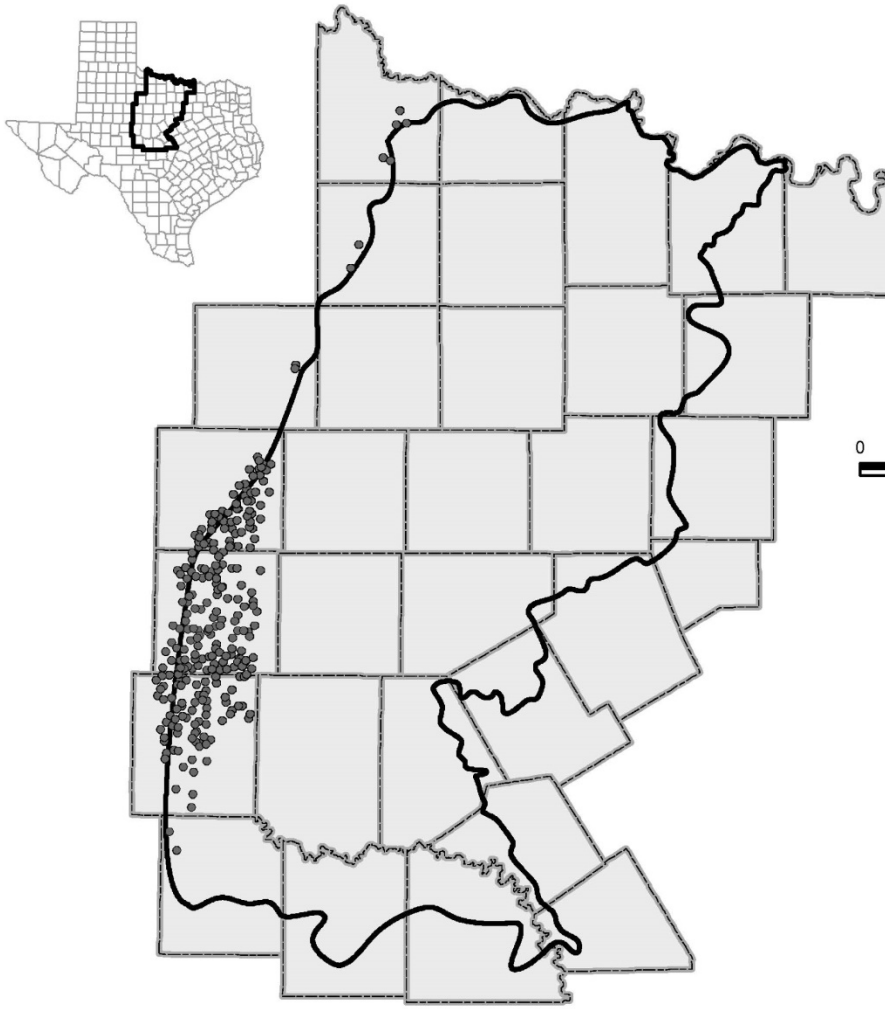
Selected wells from the TWDB and TDLR databases; most wells have production interval information



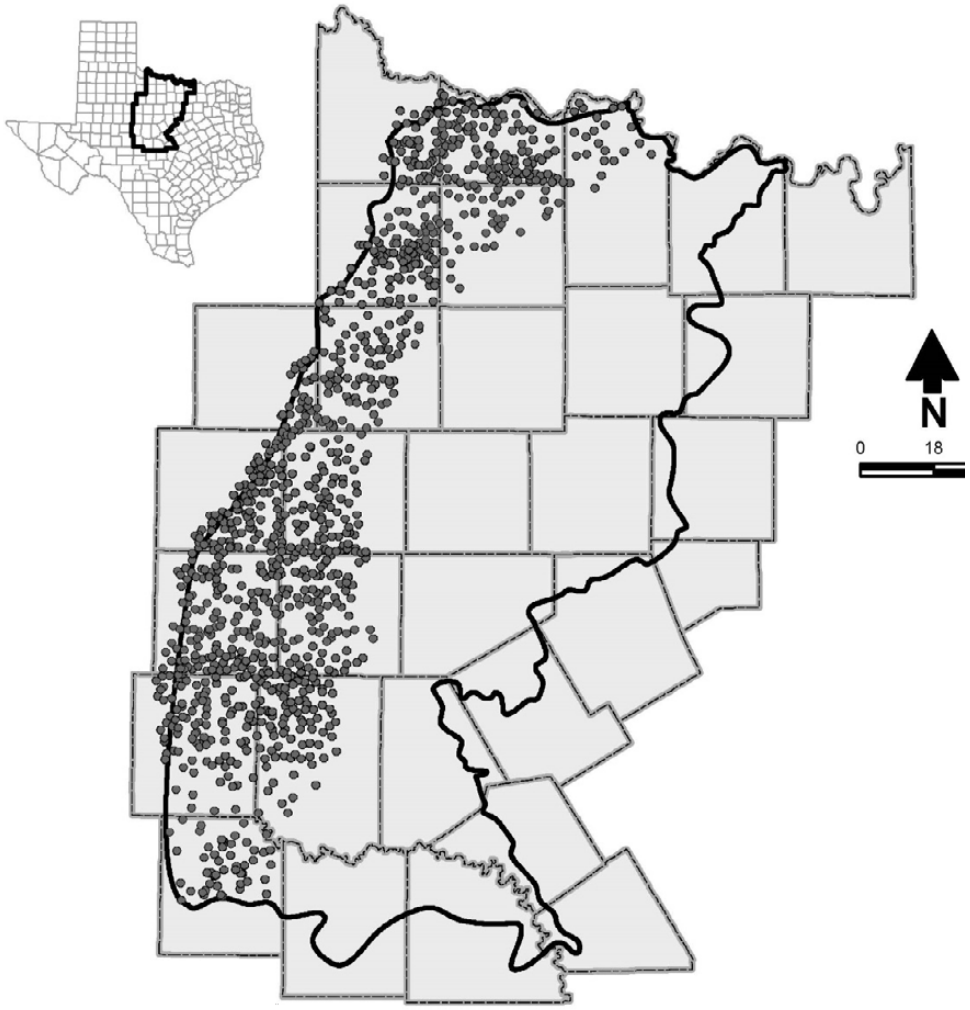
Datasets Used for Hydrostratigraphic Analysis

Source	Collection	Count
TWDB	BRACS geophysical well logs	682
TWDB	BRACS unprocessed	1
BEG	Dr. Frank Brown collection – geophysical well logs	1,530
BEG	Well records and scout tickets	81
BEG	IGOR - geophysical well logs	79
	Total	2,373

Well Control Points

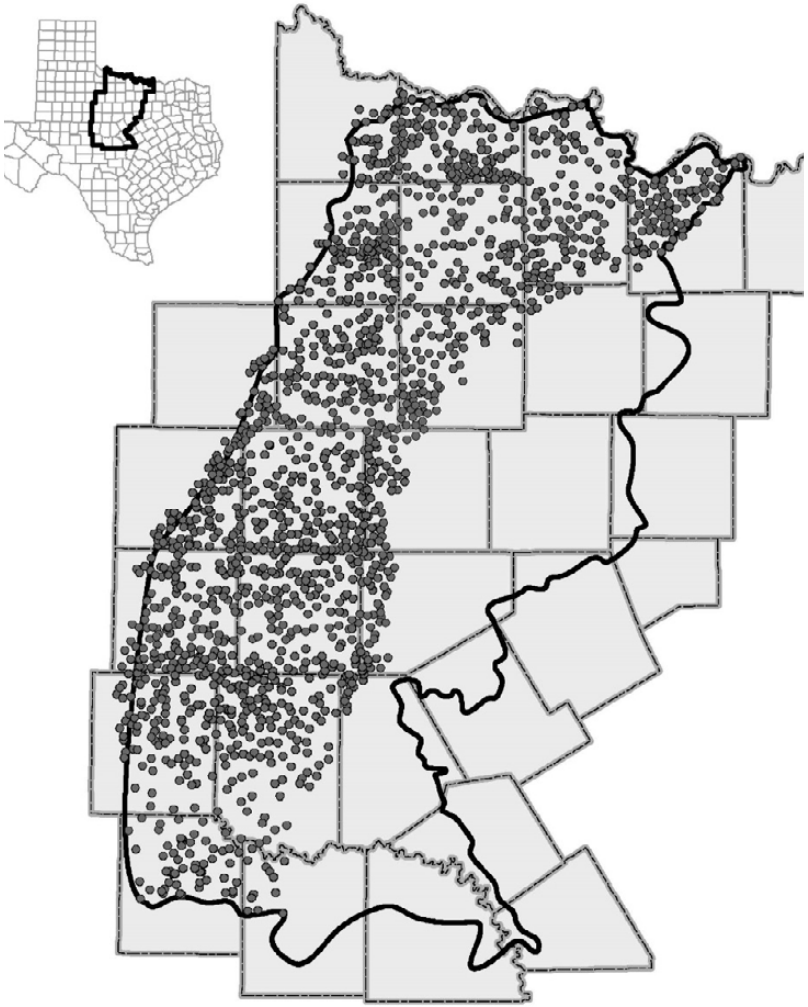


Layer 3

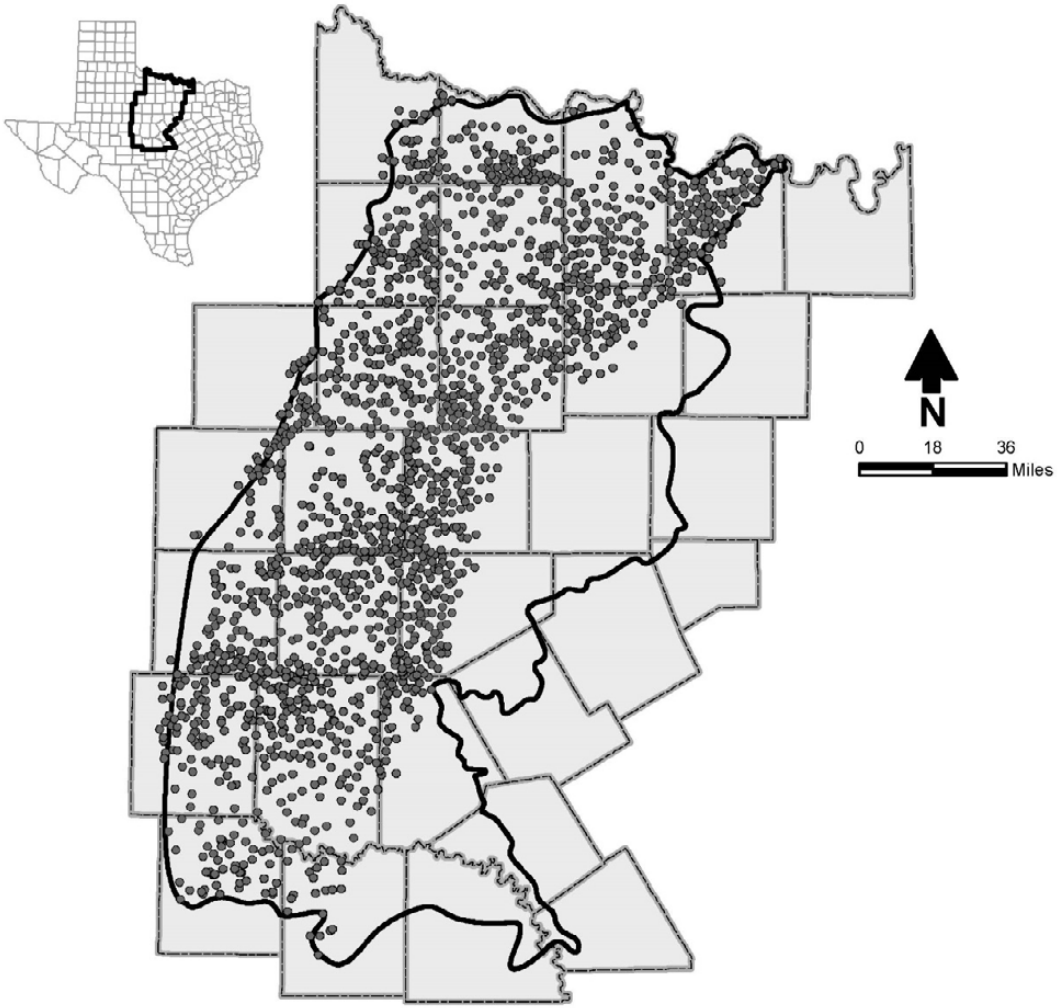


Layer 4

Well Control Points

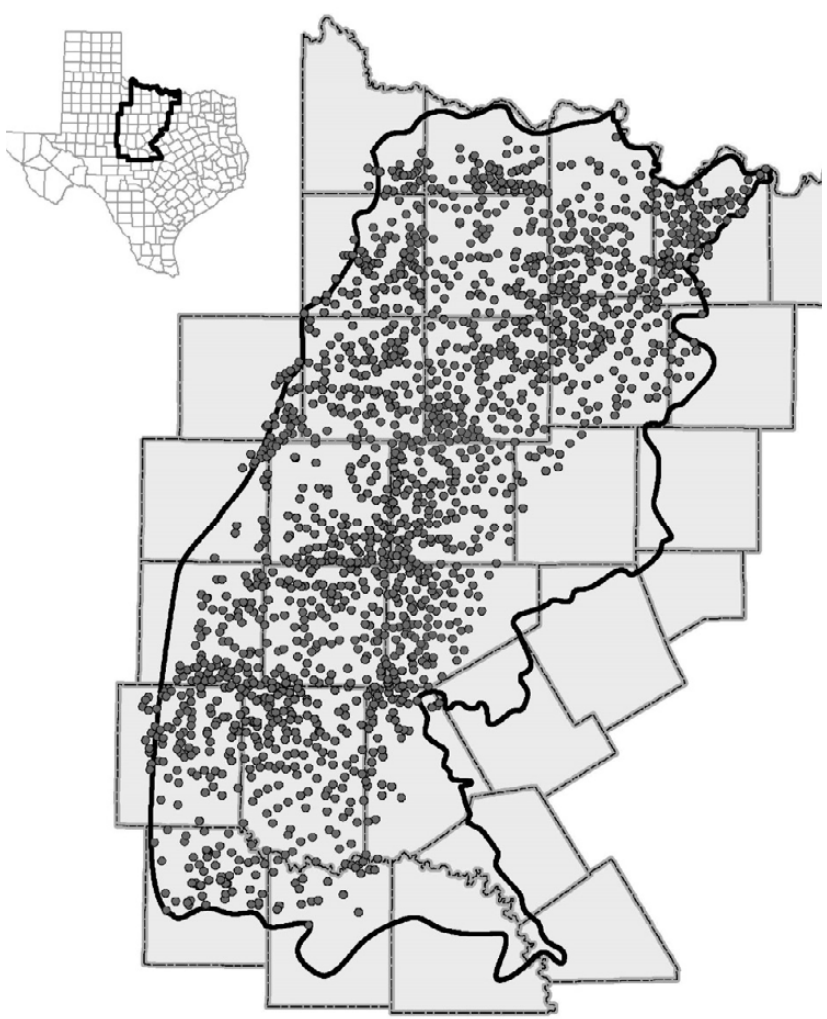


Layer 5

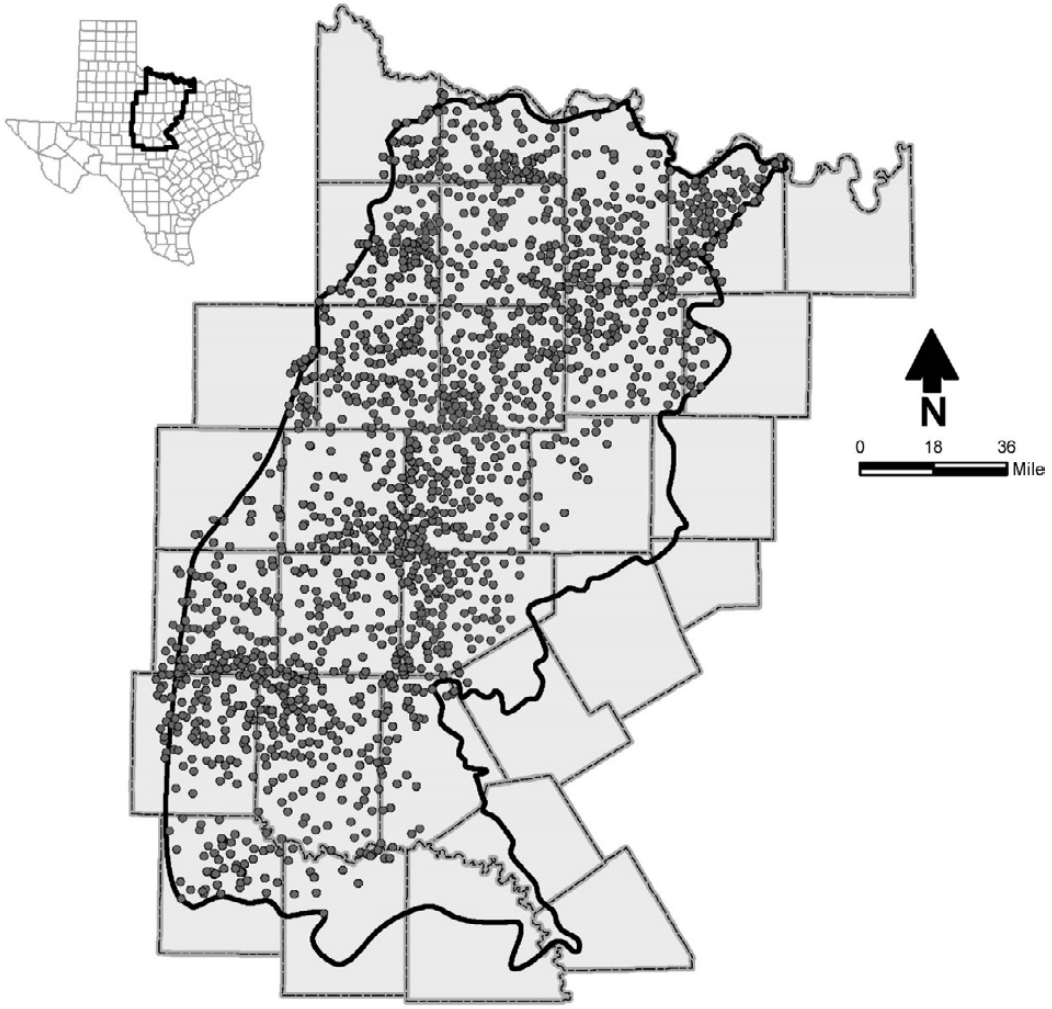


Layer 6

Well Control Points

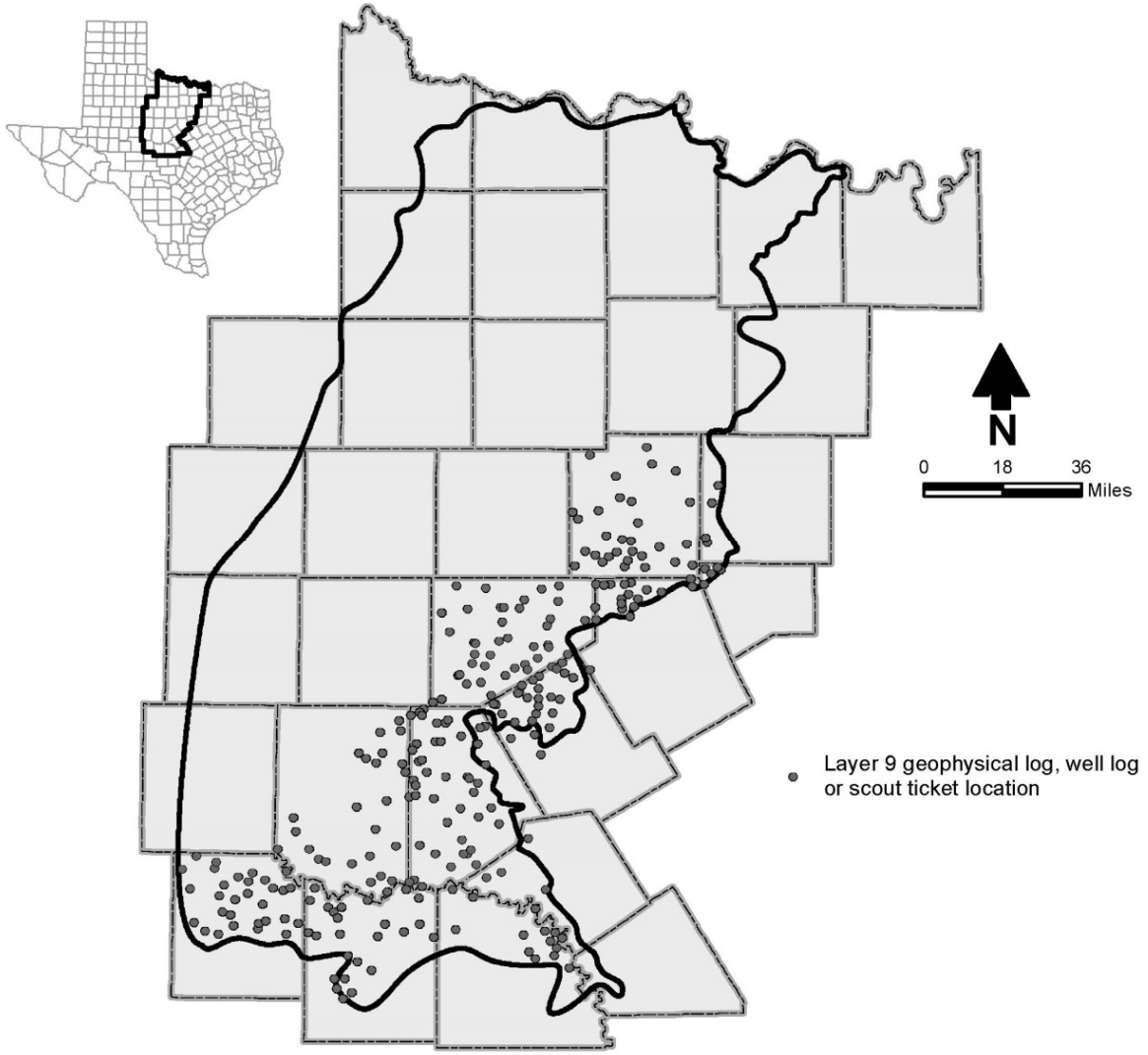


Layer 7



Layer 8

Well Control Points

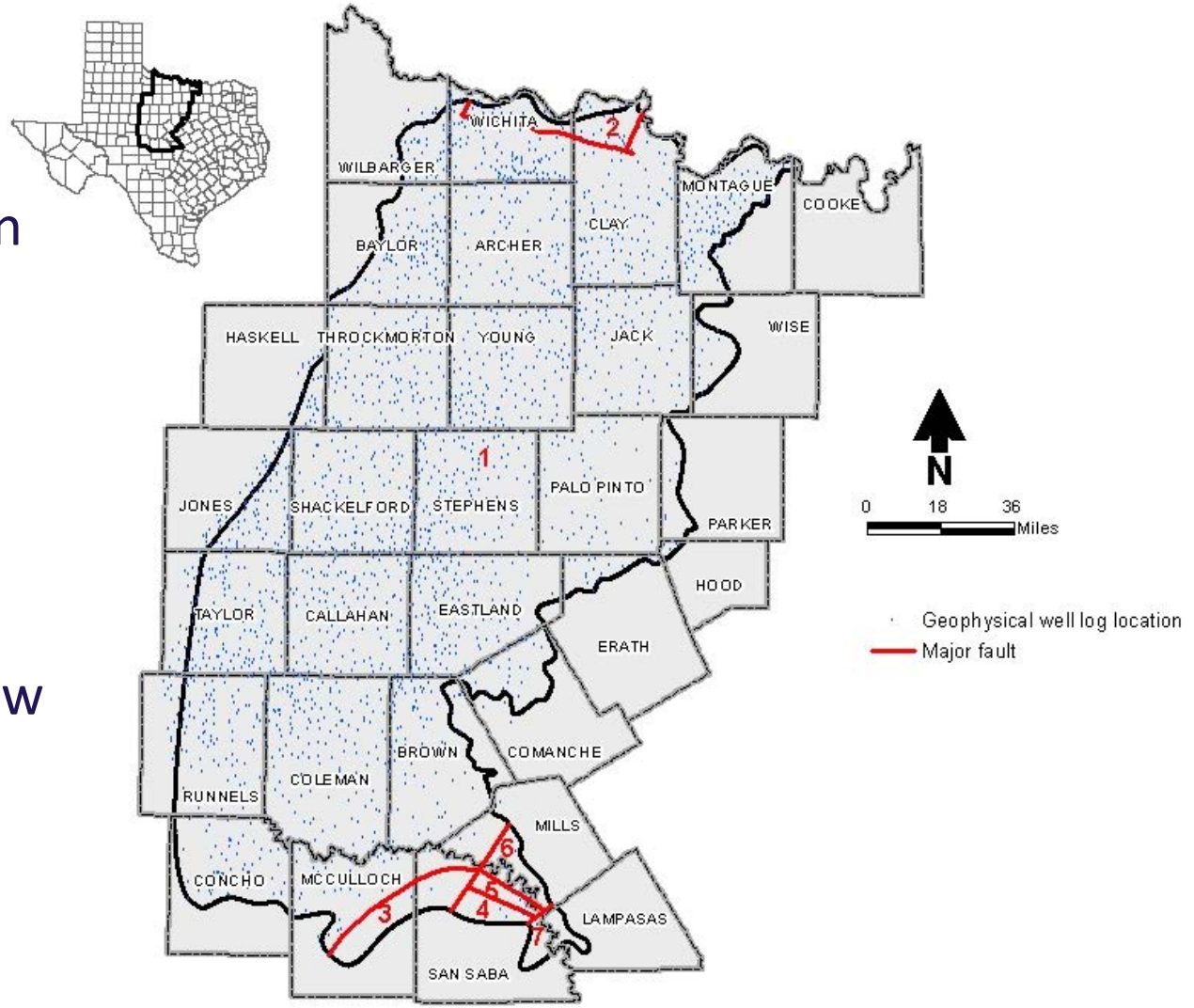


Layer 9

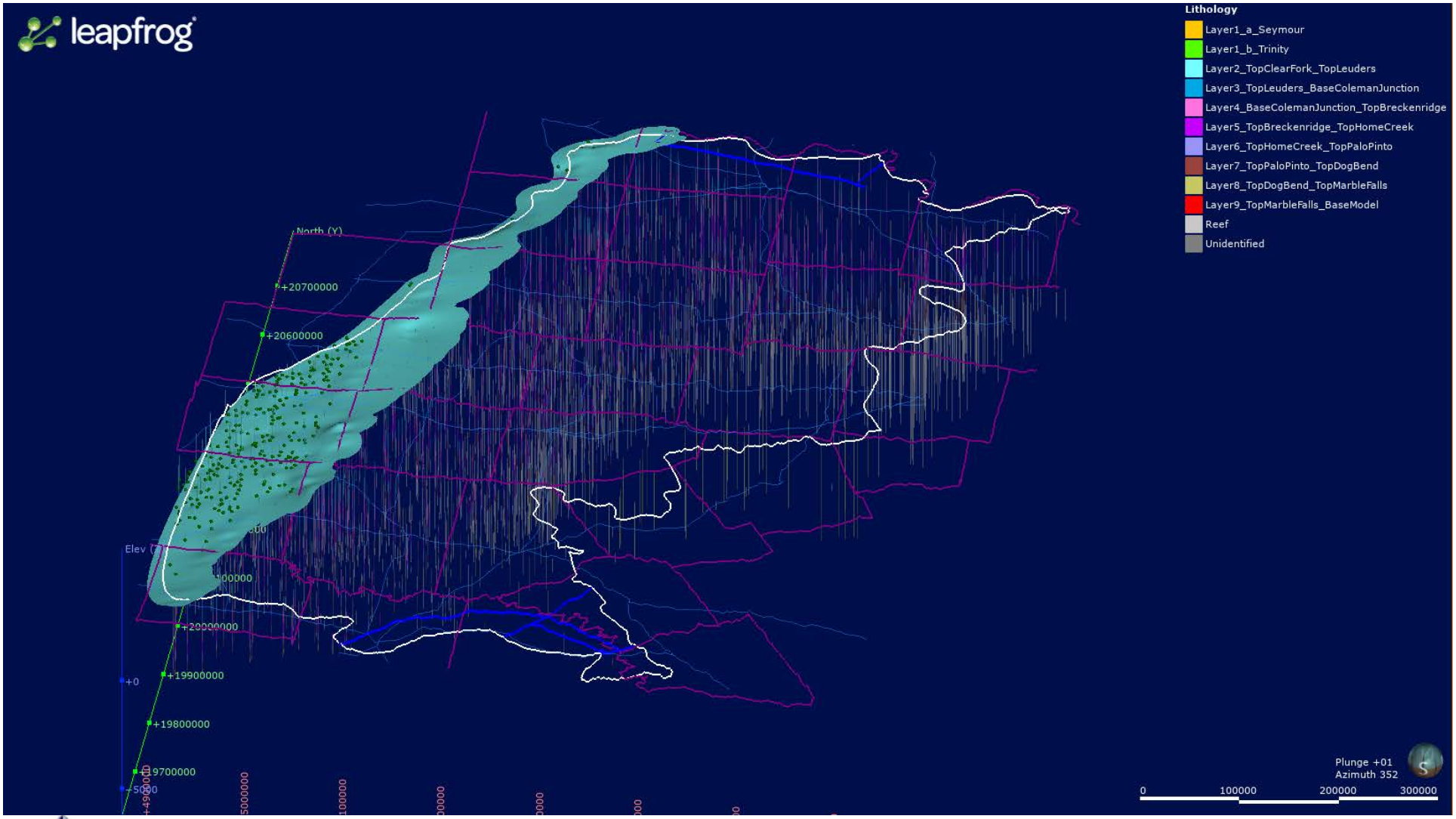
Fault Blocks in Leapfrog Model

Red River and Llano Uplift faults were considered, resulting in seven “fault blocks” considered in model.

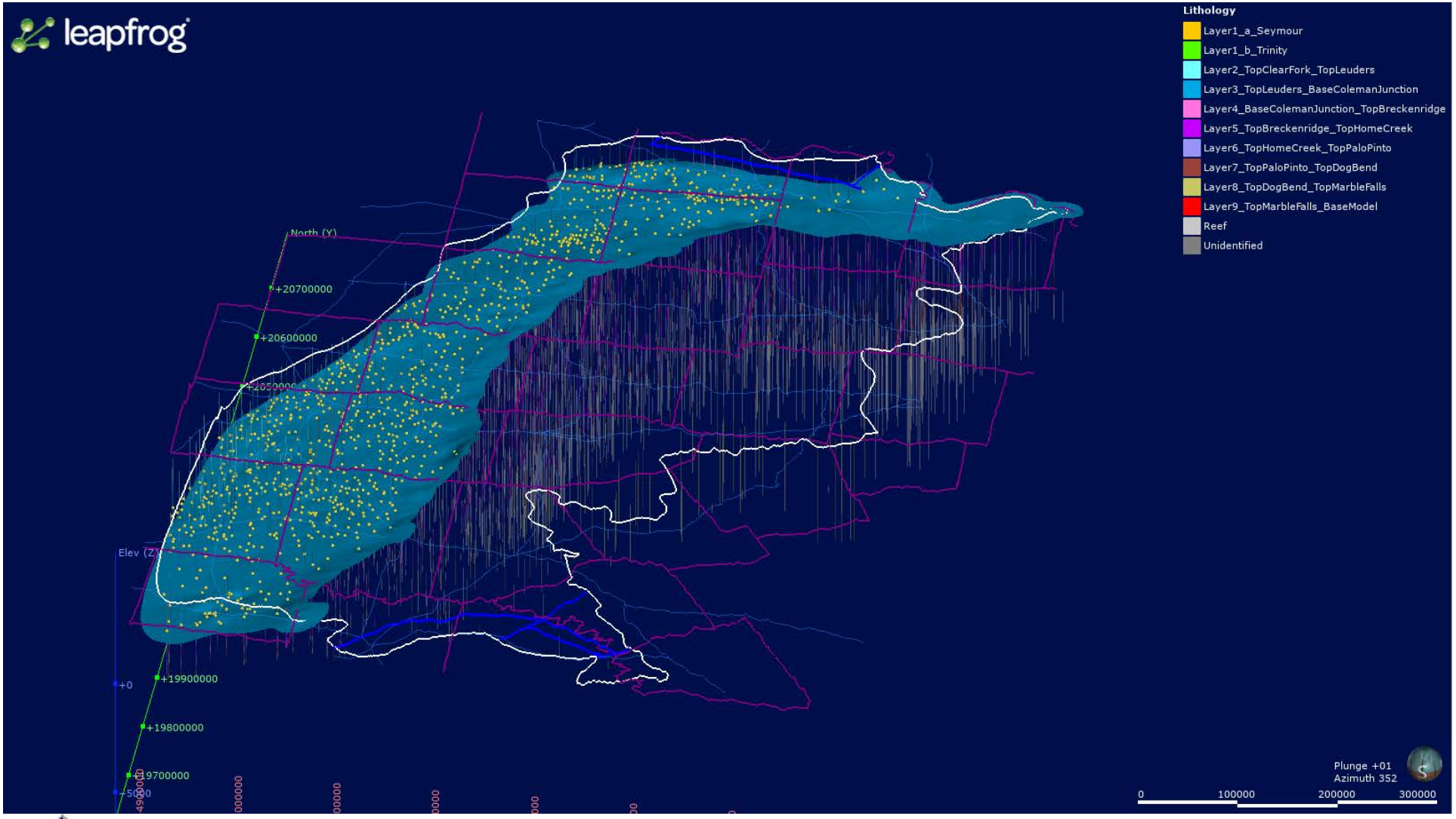
Base of the model is 100 ft below top of Marble Falls, or elevation 3,850 ft below sea level, whichever higher



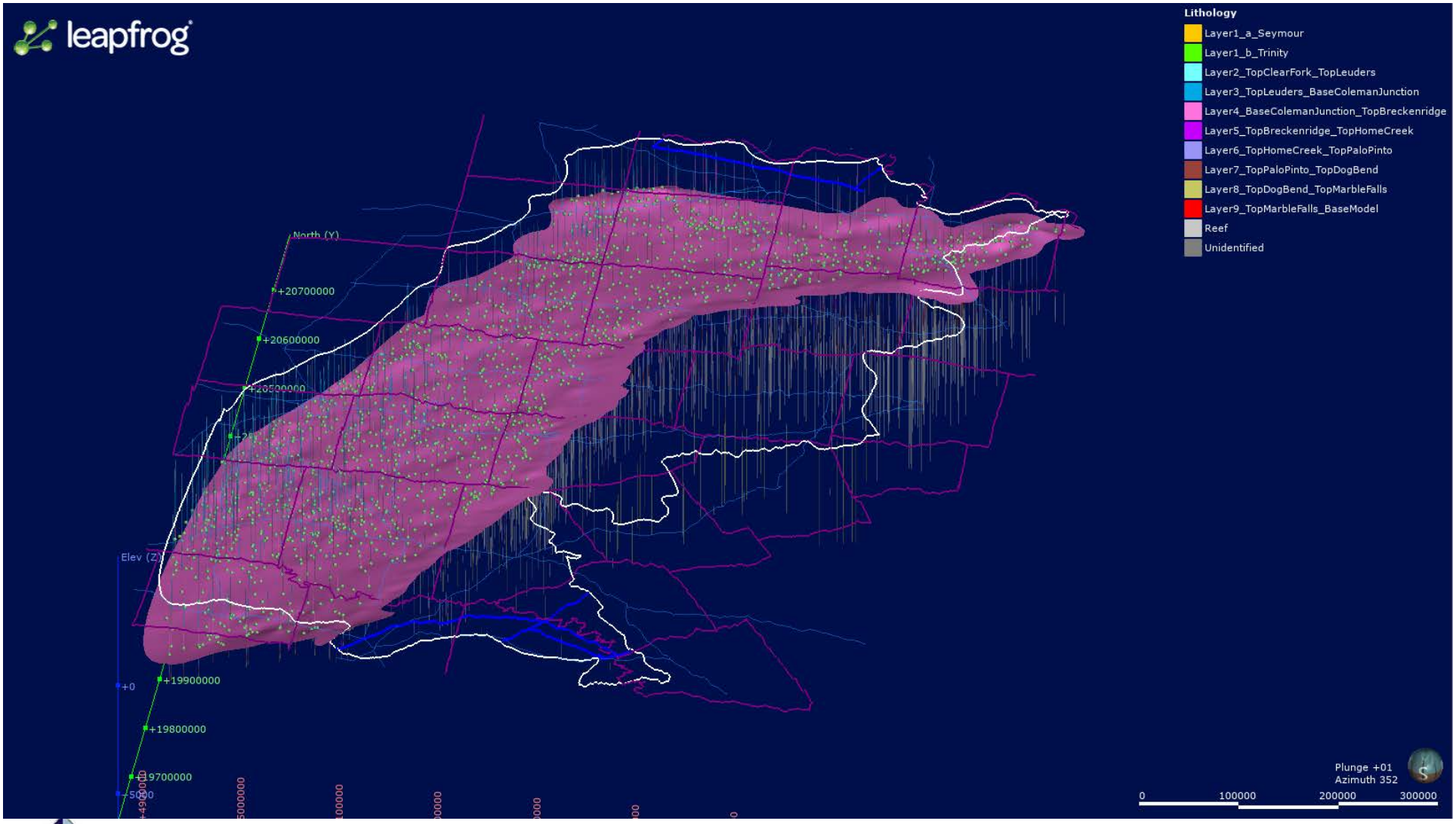
Top of Leuders Surface



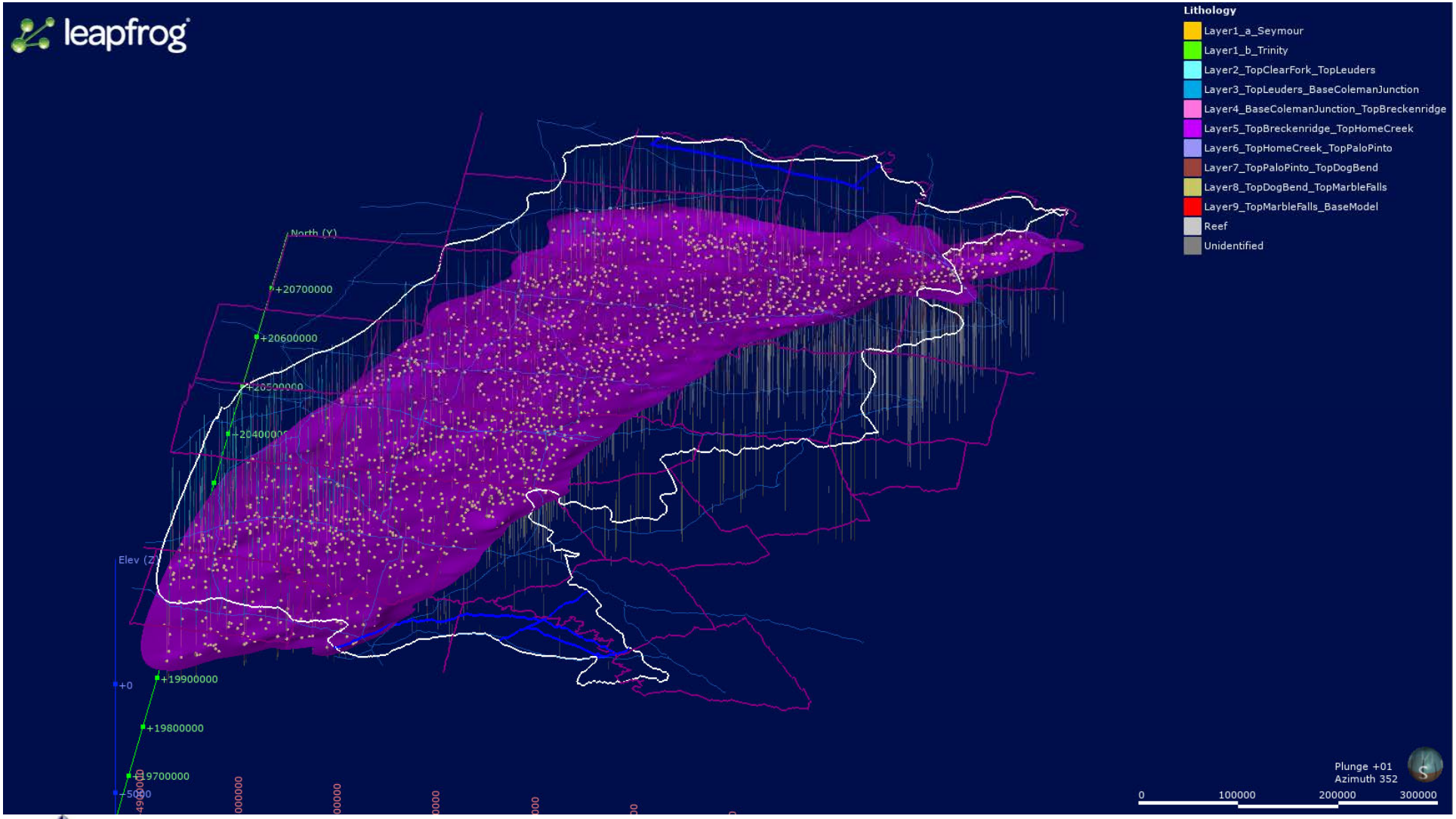
Base of Coleman Junction Surface



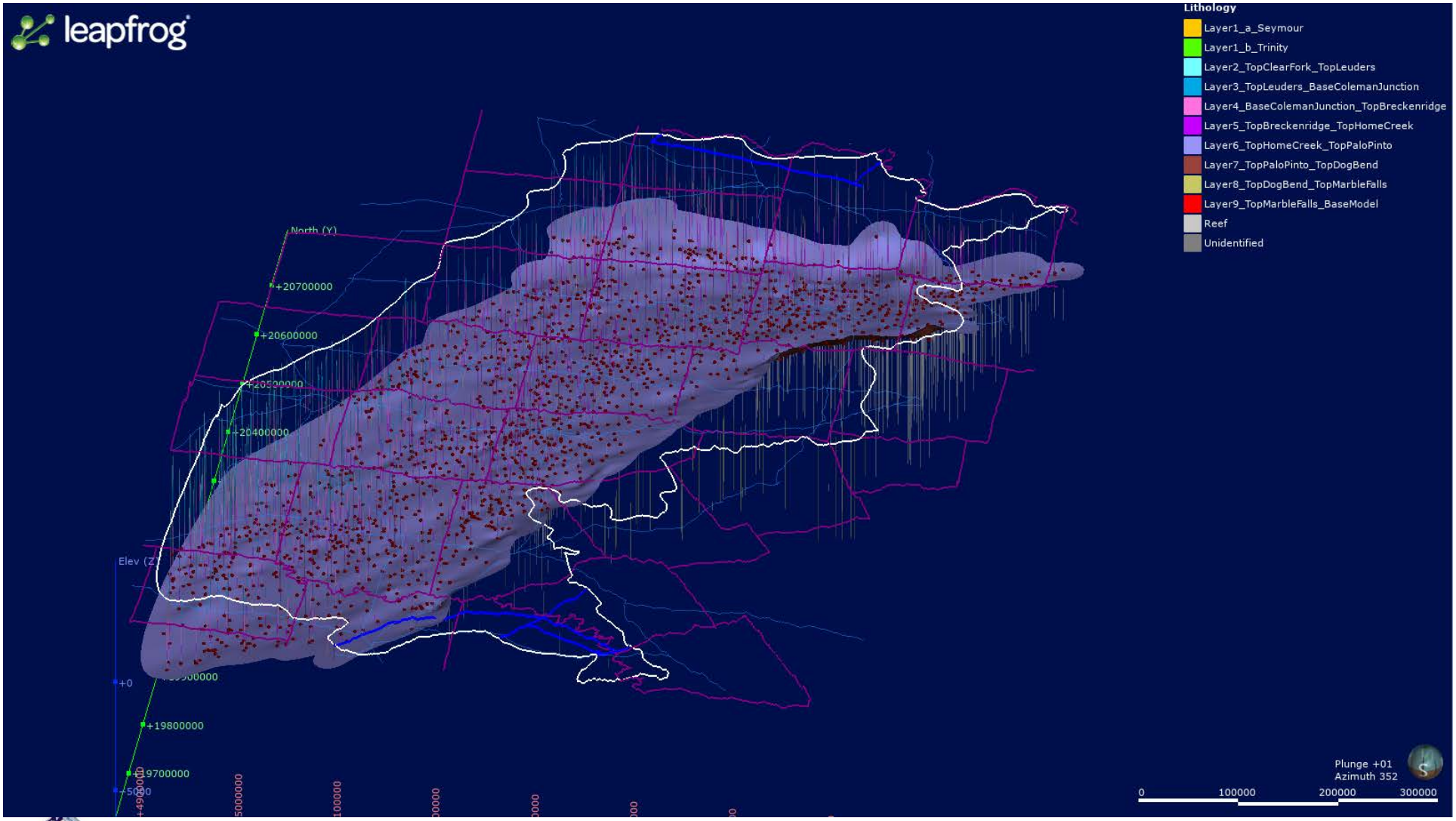
Top of Breckenridge Surface



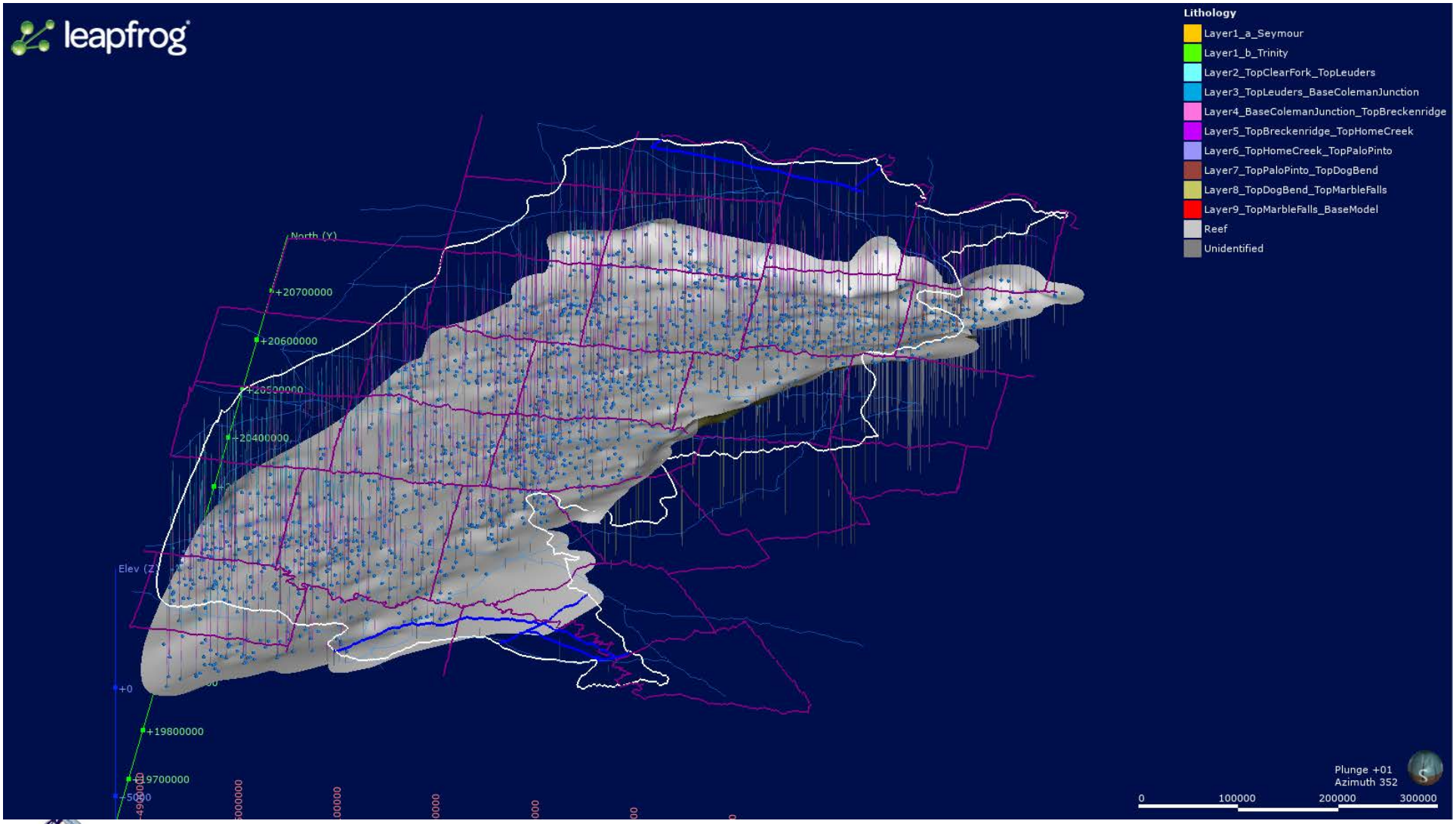
Top of Home Creek Surface



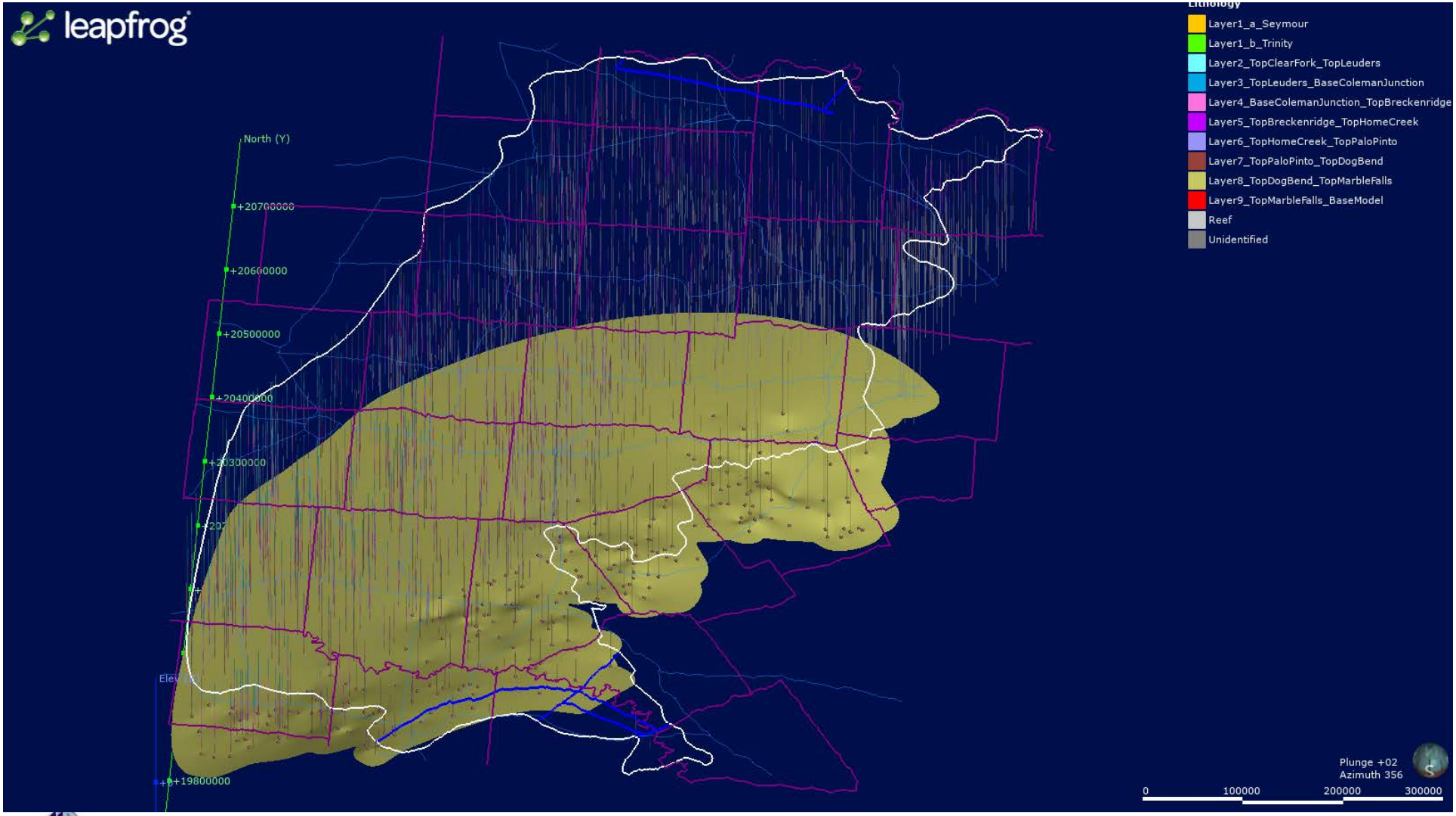
Top of Palo Pinto Surface



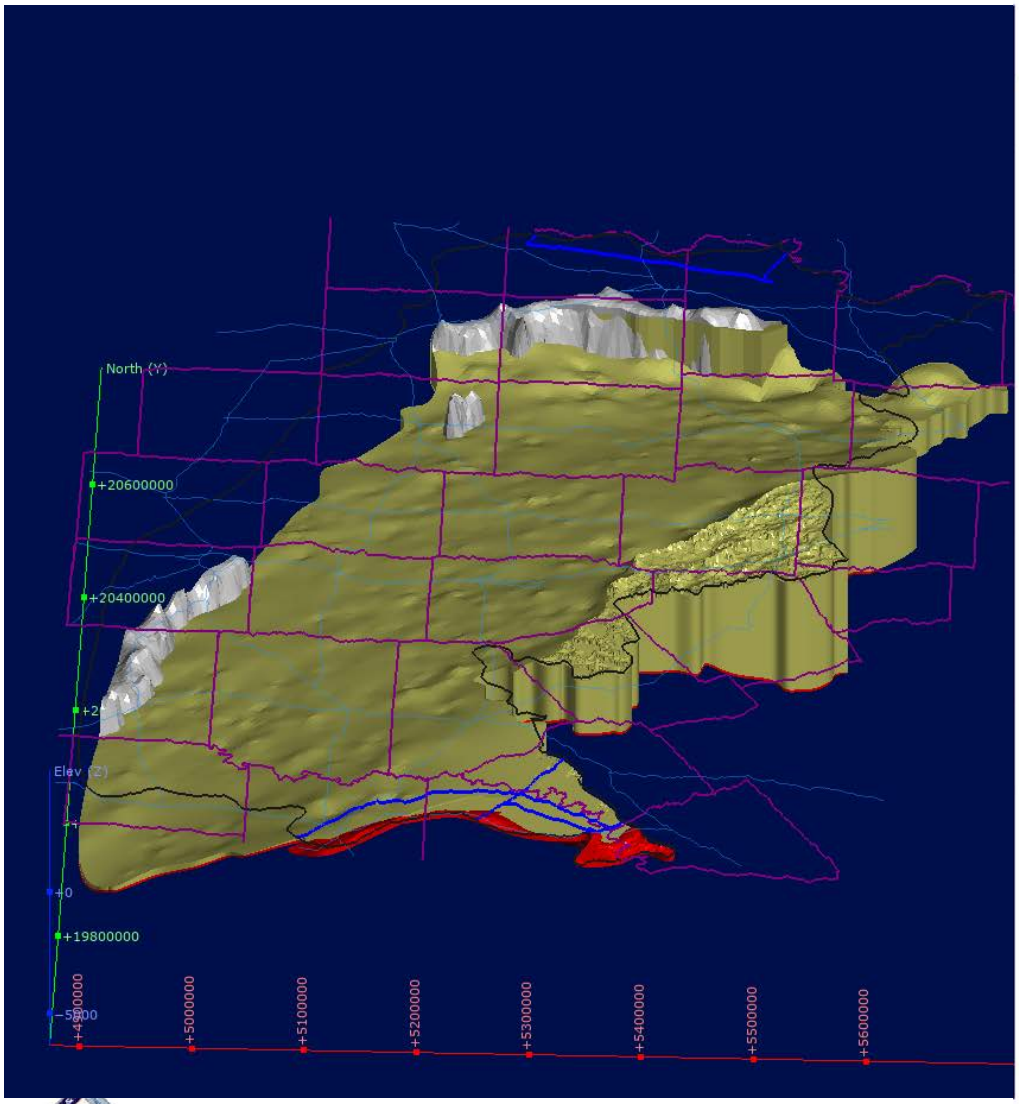
Top of Dog Bend Surface



Top of Marble Falls Surface

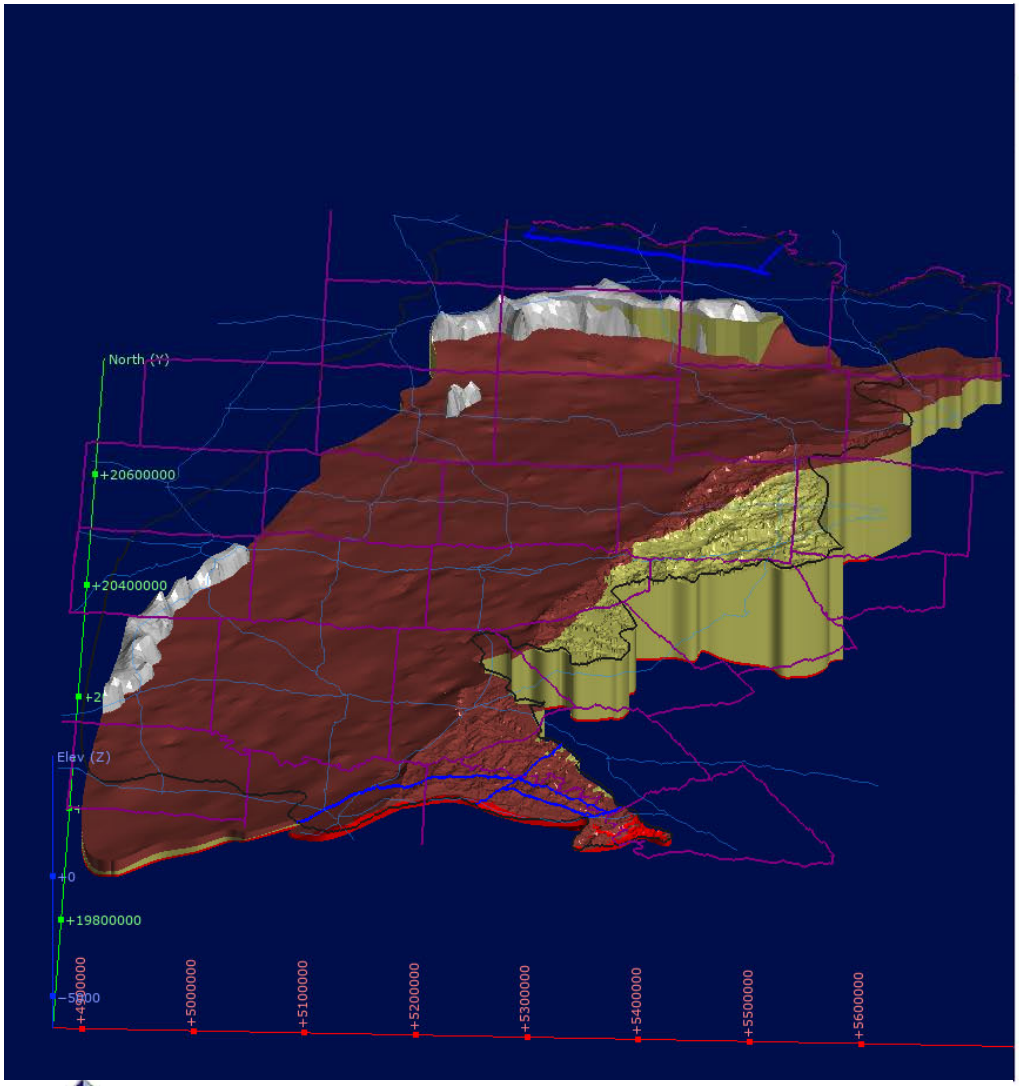


Layers 8 and 9



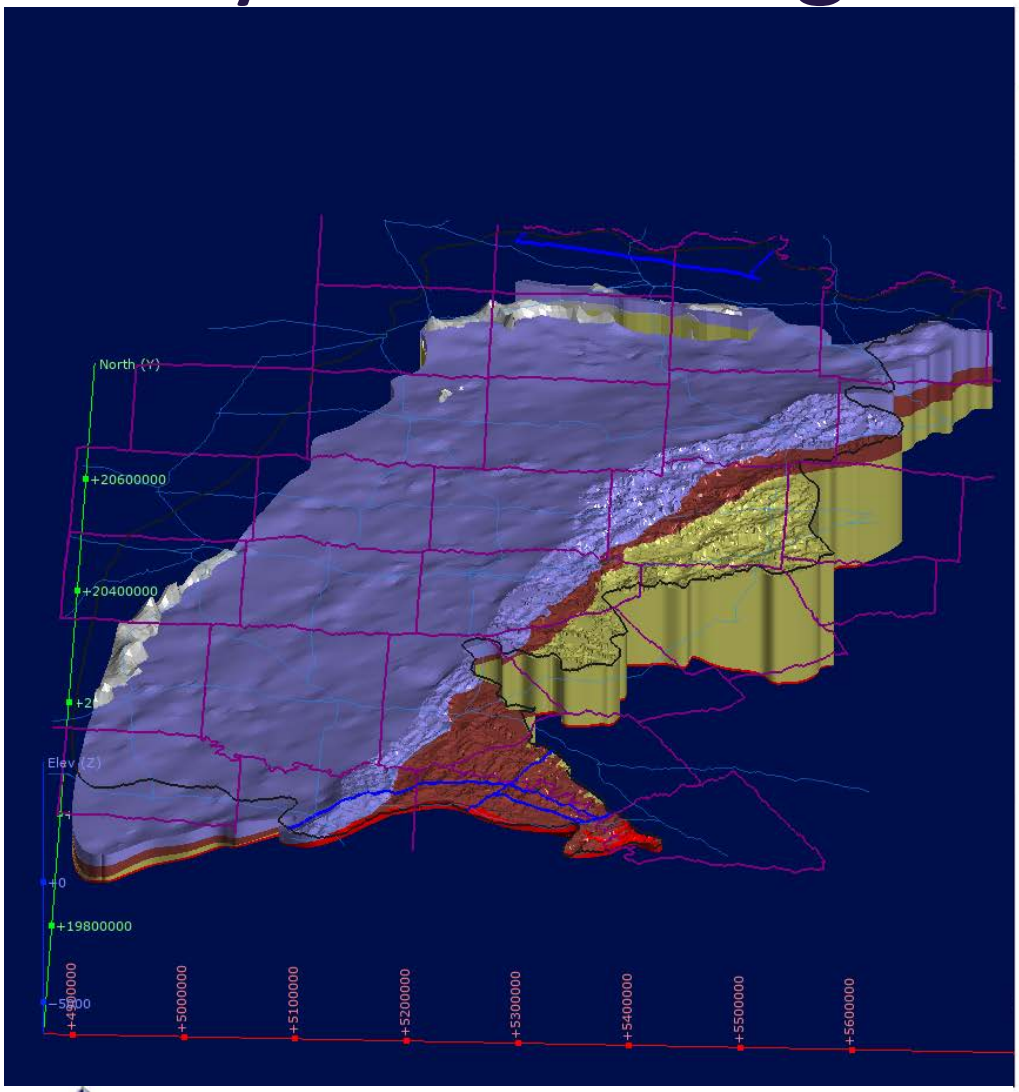
Million Years Ago (Ewing, 2016)	Era	System	Series or Stage	Group	Formation	Reef	Member or Limesone	Model Layer
2	Ceno-zoic	Quaternary - Pleistocene			Alluvium Leona **Seymour**			1A
130	Mesozoic	Cretaceous		Albian	Edwards			1B
				Comanchean	Trinity		Antlers Twin Mtn Travis Peak	
				Coahulian			**Hosston**	
275	Paleozoic	Permian	Leonard	Clear Fork	Choza Vale Arroyo		Lytle Bullwagon Standpipe	2
280				Wichita - Albany	**Leuders**			3
					Clyde, Waggoner Ranch (GAT)		Talpa Grape Creek	
			Wolfcamp		Belle Plains, Petrolia (GAT)		Bead Mountain Jagger Bend, Valera Elm Creek	
292					Putnam, Nocona, (GAT)		Admiral **Coleman Junction**	
		Pennsylvanian		Cisco	Santa Anna Branch Sedwick Moran Pueblo		Dothan, Camp Colorado Stockwether, Saddle Creek	4
			Virgilian		Harpersville		Crystal Falls **Breckenridge**	
300					Thrifty Graham	Carbonate Banks	Blach Ranch Ivan Gunsight, Bunger	5
303			Missourian	Canyon	Caddo Creek Brad Placid Winchell Wolf Mountain		**Home Creek** Colony Creek Ranger Clear Creek, Cedarton	6
307					**Palo Pinto**		Wiles, Wynn	7
			Desmoin-esian	Strawn	**Mineral Wells** Brazos River Mingus Grindstone Creek Lazy Bend		**Dog Bend** Capps, Dobbs Valley Buck Creek	8
			Atokian	Atoka	Smithwick			
320			Morrowan	Morrow	**Marble Falls**		Marble Falls	9

Layers 7 through 9



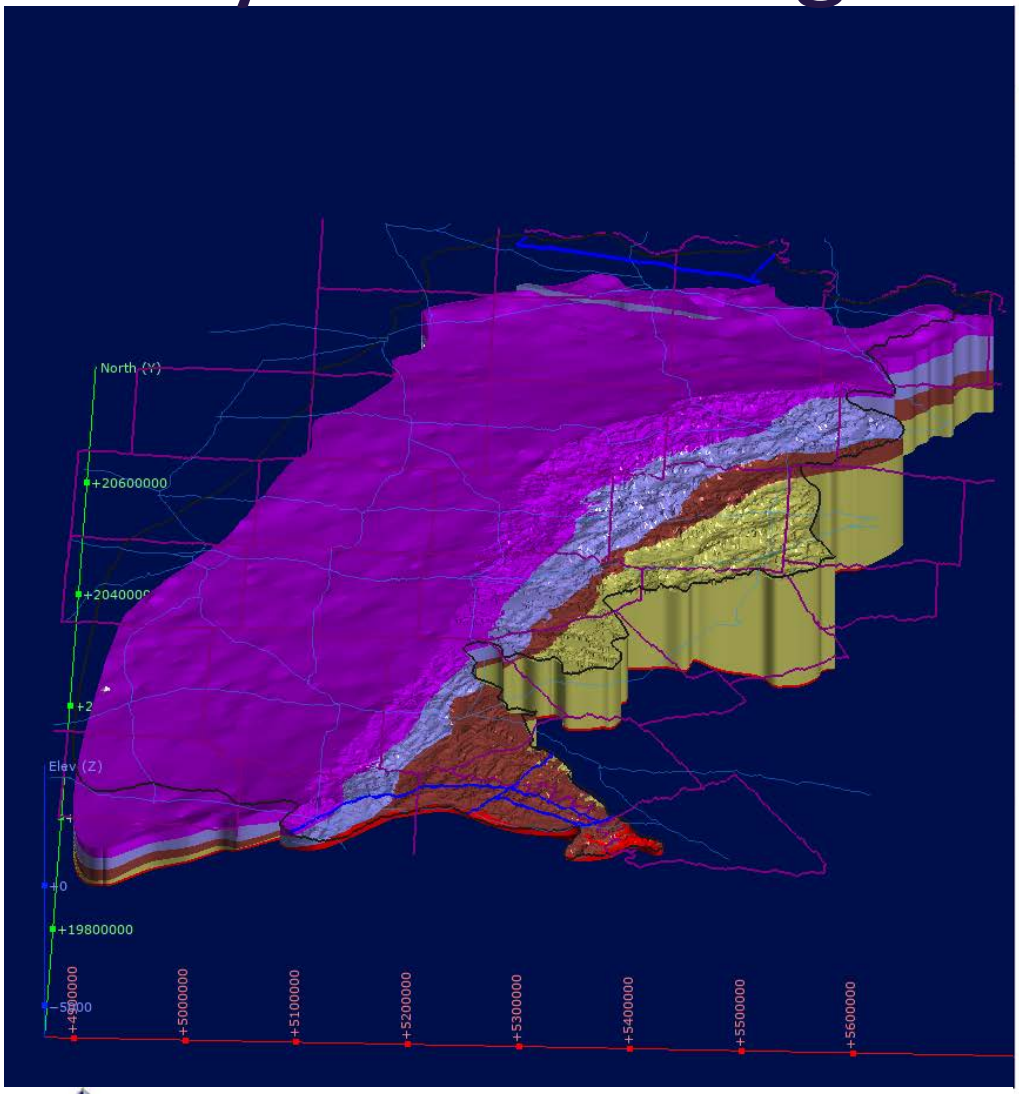
Million Years Ago (Ewing, 2016)	Era	System	Series or Stage	Group	Formation	Reef	Member or Limesone	Model Layer
2	Ceno-zoic	Quaternary - Pleistocene			Alluvium Leona **Seymour**			1A
	Mesozoic	Cretaceous		Albian	Edwards			1B
				Comanchean	Trinity		Antlers Twin Mtn Travis Peak	
130				Coahuilian			**Hosston**	
275	Paleozoic	Permian	Leonard	Clear Fork	Choza Vale Arroyo		Lytle Bullwagon Standpipe	2
280				Wichita - Albany	**Leuders**			3
					Clyde, Waggoner Ranch (GAT)		Talpa Grape Creek	
			Wolfcamp		Belle Plains, Petrolia (GAT)		Bead Mountain Jagger Bend, Valera Elm Creek	
292					Putnam, Nocona, (GAT)		Admiral **Coleman Junction**	
		Pennsylvanian	Virgilian	Cisco	Santa Anna Branch Sedwick Moran Pueblo Harpersville		Dothan, Camp Colorado Stockwether, Saddle Creek Crystal Falls	4
							Breckenridge	
300					Thrifty	Carbonate Banks	Bluch Ranch Ivan	5
303					Graham		Gunsight, Bunger	
			Missourian	Canyon	Caddo Creek		**Home Creek** Colony Creek	6
					Brad		Ranger Clear Creek, Cedarton	
					Placid Winchell Wolf Mountain			
					Palo Pinto		Wiles, Wynn	7
307				Strawn	**Mineral Wells**		**Dog Bend**	8
			Desmoin-esian		Brazos River Mingus Grindstone Creek Lazy Bend		Capps, Dobbs Valley Buck Creek	
			Atokian	Atoka	Smithwick			
320			Morrowan	Morrow	**Marble Falls**		Marble Falls	9

Layers 6 through 9



Million Years Ago (Ewing, 2016)	Era	System	Series or Stage	Group	Formation	Reef	Member or Limesone	Model Layer
2	Ceno-zoic	Quaternary - Pleistocene			Alluvium Leona **Seymour**			1A
	Mesozoic	Cretaceous		Albian	Edwards			1B
				Comanchean	Trinity		Antlers Twin Mtn Travis Peak	
130				Coahuilan			**Hosston**	
275	Paleozoic	Permian	Leonard	Clear Fork	Choza Vale Arroyo		Lytle Bullwagon Standpipe	2
280				Wichita - Albany	**Leuders**			3
					Clyde, Waggoner Ranch (GAT)		Talpa Grape Creek	
					Belle Plains, Petrolia (GAT)		Bead Mountain Jagger Bend, Valera Elm Creek	
292					Putnam, Nocona, (GAT)		Admiral **Coleman Junction**	
			Wolfcamp	Cisco	Santa Anna Branch Sedwick			4
					Moran Pueblo		Dothan, Camp Colorado Stockwether, Saddle Creek	
		Pennsylvanian	Virgilian		Harpersville		Crystal Falls	
							Breckenridge	5
300					Thrifty	Carbonate Banks	Bluch Ranch	
							Ivan	
303					Graham		Gunsight, Bunger	
			Missourian	Canyon	Caddo Creek		**Home Creek**	6
							Colony Creek	
					Brad		Ranger Clear Creek, Cedarton	
					Placid			
					Winchell			
					Wolf Mountain			
307					**Palo Pinto**		Wiles, Wynn	7
			Desmoin-esian	Strawn	**Mineral Wells**		**Dog Bend**	8
					Brazos River			
					Mingus		Capps, Dobbs Valley	
					Grindstone Creek		Buck Creek	
					Lazy Bend			
			Atokian	Atoka	Smithwick			
320			Morrowan	Morrow	**Marble Falls**		Marble Falls	9

Layers 5 through 9



Million Years Ago (Ewing, 2016)	Era	System	Series or Stage	Group	Formation	Reef	Member or Limesone	Model Layer
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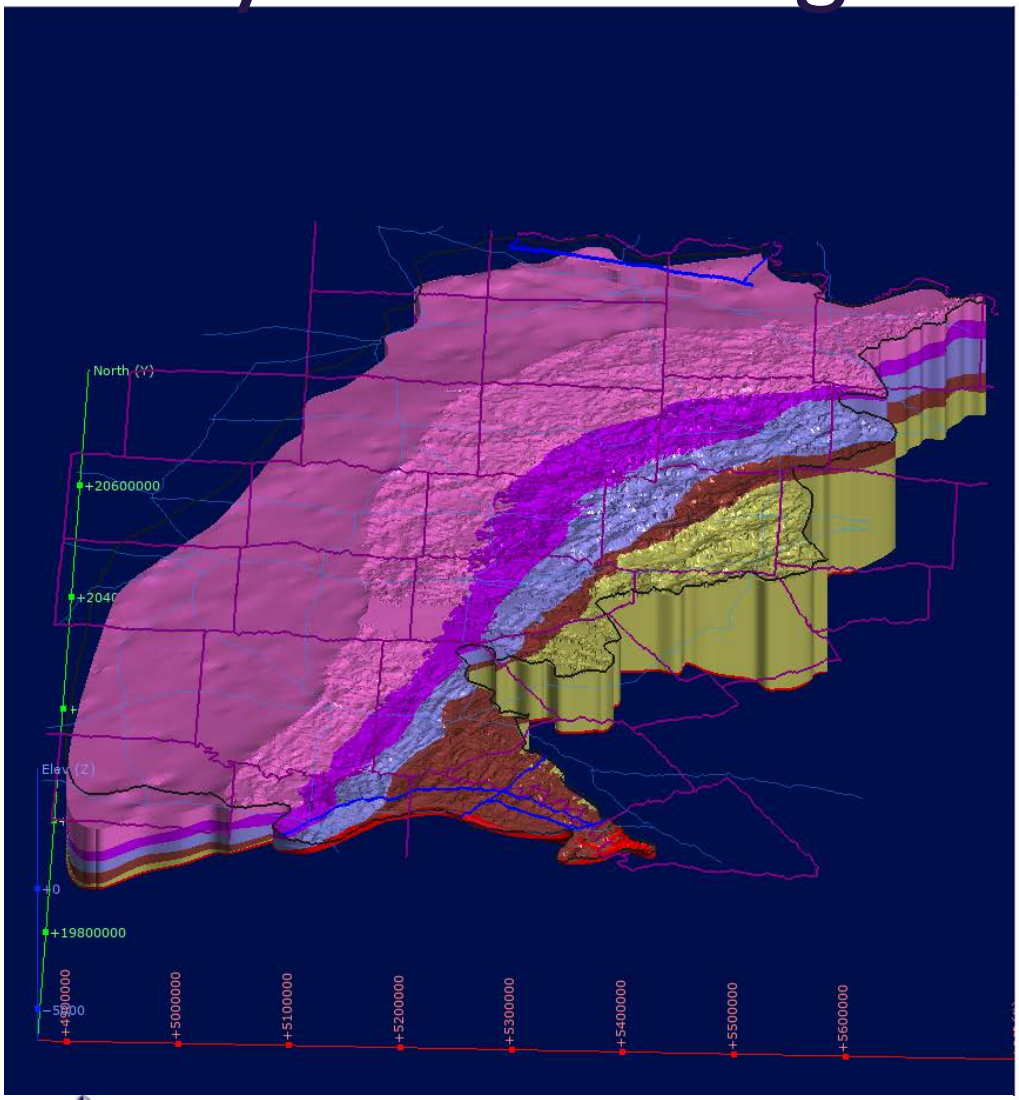
130	Mesozoic	Cretaceous		Albian	Edwards			1B
				Comanchean	Trinity		Antlers Twin Mtn Travis Peak	
				Coahulian			**Hosston**	
275	Paleozoic	Permian	Leonard	Clear Fork	Choza Vale Arroyo		Lytle Bullwagon Standpipe	2
280				Wichita - Albany	**Leuders**			3
					Clyde, Waggoner Ranch (GAT)		Talpa Grape Creek	
			Wolfcamp		Belle Plains, Petrolia (GAT)		Bead Mountain Jagger Bend, Valera Elm Creek	
292					Putnam, Nocona, (GAT)		Admiral **Coleman Junction**	
				Cisco	Santa Anna Branch Sedwick Moran Pueblo Harpersville		Dothan, Camp Colorado Stockwether, Saddle Creek Crystal Falls	4
300		Pennsylvanian	Virgilian				**Breckenridge**	5
					Thrifty Graham	Carbonate Banks	Bluch Ranch Ivan Gunsight, Bunger	
303			Missourian	Canyon	Caddo Creek Brad Placid Winchell Wolf Mountain		**Home Creek** Colony Creek Ranger Clear Creek, Cedarton	6
					Palo Pinto		Wiles, Wynn	7
307			Desmoin-esian	Strawn	**Mineral Wells** Brazos River Mingus Grindstone Creek Lazy Bend		**Dog Bend** Capps, Dobbs Valley Buck Creek	8
			Atokian	Atoka	Smithwick			
320			Morrowan	Morrow	**Marble Falls**		Marble Falls	9

Layers 4 through 9



Million Years Ago (Ewing, 2016)	Era	System	Series or Stage	Group	Formation	Reef	Member or Limesone	Model Layer
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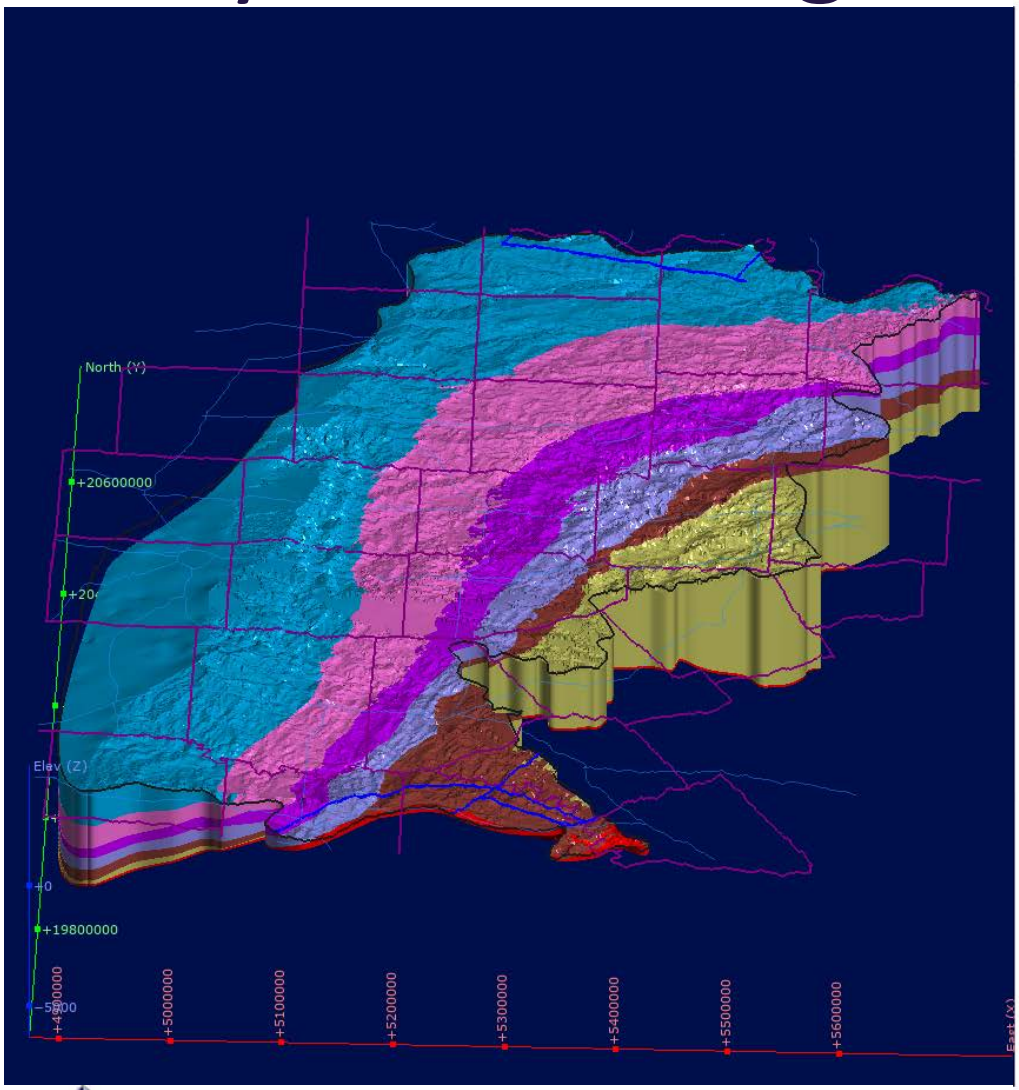
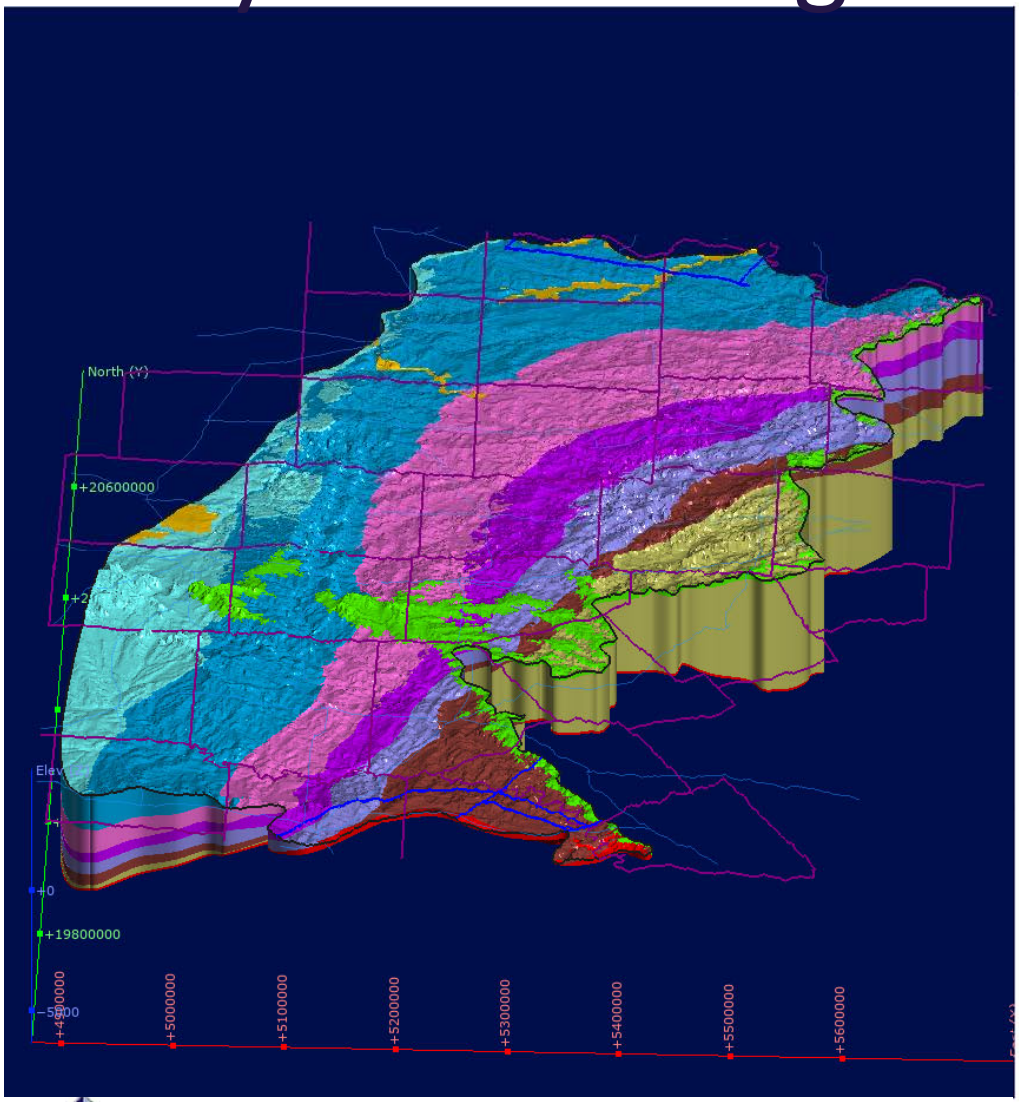
130	Mesozoic	Cretaceous		Albian	Edwards			1B
				Comanchean	Trinity		Antlers Twin Mtn Travis Peak	
				Coahulian			**Hosston**	
275	Paleozoic	Permian	Leonard	Clear Fork	Choza Vale Arroyo		Lytle Bullwagon Standpipe	2
280				Wichita - Albany	**Leuders**			3
					Clyde, Waggoner Ranch (GAT)		Talpa Grape Creek	
					Belle Plains, Petrolia (GAT)		Bead Mountain Jagger Bend, Valera Elm Creek	
292					Putnam, Nocona, (GAT)		Admiral **Coleman Junction**	
			Wolfcamp	Cisco	Santa Anna Branch Sedwick Moran Pueblo Harpersville		Dothan, Camp Colorado Stockwether, Saddle Creek Crystal Falls	4
300		Pennsylvanian	Virgilian		Thrifty Graham	Carbo Reef Banks	Bluch Ranch Ivan Gunsight, Bunger	5
303			Missourian	Canyon	Caddo Creek Brad Placid Winchell Wolf Mountain		**Home Creek** Colony Creek Ranger Clear Creek, Cedarton	6
307					**Palo Pinto**		Wiles, Wynn	7
			Desmoin-esian	Strawn	**Mineral Wells** Brazos River Mingus Grindstone Creek Lazy Bend		**Dog Bend** Capps, Dobbs Valley Buck Creek	8
			Atokian	Atoka	Smithwick			
320			Morrowan	Morrow	**Marble Falls**		Marble Falls	9

Layers 3 through 9

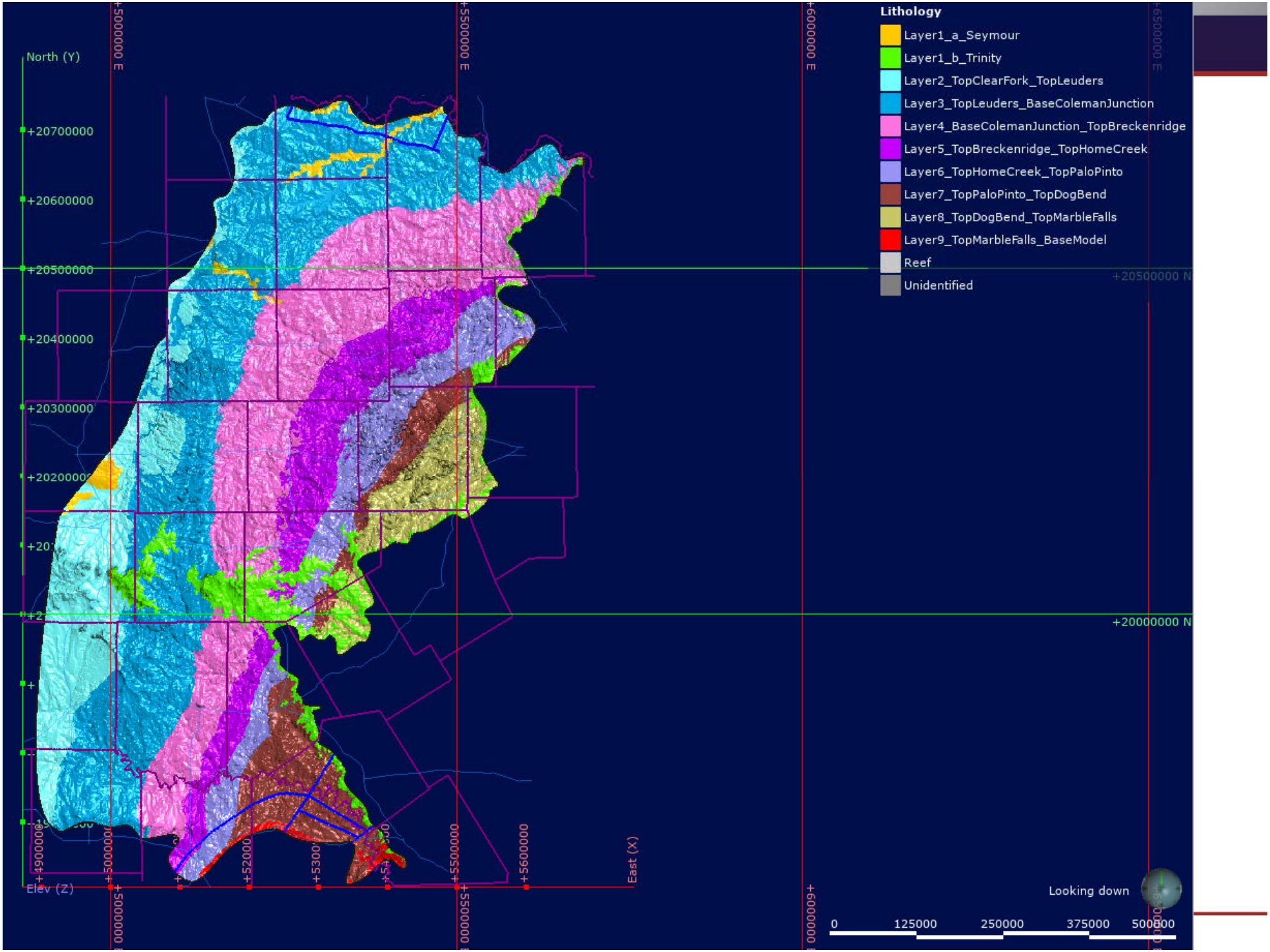


Million Years Ago (Ewing, 2016)	Era	System	Series or Stage	Group	Formation	Reef	Member or Limesone	Model Layer
2	Ceno-zoic	Quaternary - Pleistocene			Alluvium Leona **Seymour**			1A
130	Mesozoic	Cretaceous		Albian	Edwards			1B
				Comanchean	Trinity		Antlers Twin Mtn Travis Peak **Hosston**	
				Coahulian				
275	Paleozoic	Permian	Leonard	Clear Fork	Choza Vale Arroyo		Lytle Bullwagon Standpipe	2
280				Wichita - Albany	**Leuders**	Carbonate Banks		3
					Clyde, Waggoner Ranch (GAT)		Talpa Grape Creek	
			Wolfcamp		Belle Plains, Petrolia (GAT)		Bead Mountain Jagger Bend, Valera Elm Creek	
292					Putnam, Nocona, (GAT)		Admiral **Coleman Junction**	
		Pennsylvanian		Cisco	Santa Anna Branch Sedwick			4
					Moran Pueblo		Dothan, Camp Colorado Stockwether, Saddle Creek	
			Virgilian		Harpersville		Crystal Falls **Breckenridge**	
300					Thrifty		Blach Ranch Ivan	5
303					Graham		Gunsight, Bunger	
			Missourian	Canyon	Caddo Creek		**Home Creek** Colony Creek	6
					Brad		Ranger Clear Creek, Cedarton	
					Placid Winchell Wolf Mountain			
307					**Palo Pinto**		Wiles, Wynn	7
			Desmoin-esian	Strawn	**Mineral Wells**		**Dog Bend**	8
					Brazos River			
					Mingus		Capps, Dobbs Valley	
					Grindstone Creek		Buck Creek	
					Lazy Bend			
			Atokian	Atoka	Smithwick			
320			Morrowan	Morrow	**Marble Falls**		Marble Falls	9

Layers 1 through 9



Million Years Ago (Ewing, 2016)	Era	System	Series or Stage	Group	Formation	Reef	Member or Limesone	Model Layer
2	Ceno-zoic	Quaternary - Pleistocene			Alluvium			1A
					Leona			
					Seymour			
	Mesozoic	Cretaceous		Albian	Edwards			1B
				Comanchean	Trinity		Antlers	
							Twin Mtn	
							Travis Peak	
130				Coahuilan			**Hosston**	
275	Paleozoic	Permian	Leonard	Clear Fork	Choza		Lytle	2
					Vale		Bullwagon	
					Arroyo		Standpipe	
280				Wichita - Albany	**Leuders**			3
					Clyde, Waggoner Ranch (GAT)		Talpa	
							Grape Creek	
			Wolfcamp		Belle Plains, Petrolia (GAT)		Bead Mountain	
							Jagger Bend, Valera	
							Elm Creek	
					Putnam, Nocona, (GAT)		Admiral	
292							**Coleman Junction**	
				Cisco	Santa Anna Branch			4
					Sedwick			
					Moran		Dothan, Camp Colorado	
					Pueblo		Stockwether, Saddle Creek	
		Pennsylvanian	Virgilian		Harpersville		Crystal Falls	
							Breckenridge	
300					Thrifty	Carbo Reefs Banks	Bluch Ranch	5
							Ivan	
303					Graham		Gunsight, Bunger	
			Missourian	Canyon	Caddo Creek		**Home Creek**	6
							Colony Creek	
					Brad		Ranger	
							Clear Creek, Cedarton	
					Placid			
					Winchell			
					Wolf Mountain			
307					**Palo Pinto**		Wiles, Wynn	7
			Desmoin-esian	Strawn	**Mineral Wells**		**Dog Bend**	8
					Brazos River			
					Mingus		Capps, Dobbs Valley	
					Grindstone Creek		Buck Creek	
					Lazy Bend			
			Atokian	Atoka	Smithwick			
320			Morrowan	Morrow	**Marble Falls**		Marble Falls	9


Lithology
Layer1_a_Seymour
Layer1_b_Trinity
Layer2_TopClearFork_TopLeuders
Layer3_TopLeuders_BaseColemanJunction
Layer4_BaseColemanJunction_TopBreckenridge
Layer5_TopBreckenridge_TopHomeCreek
Layer6_TopHomeCreek_TopPaloPinto
Layer7_TopPaloPinto_TopDogBend
Layer8_TopDogBend_TopMarbleFalls
Layer9_TopMarbleFalls_BaseModel
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North (Y)
East (X)
Elev (Z)
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+20600000
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+20400000
+20300000
+20000000 N
+20500000 N
+5500000 E
+6000000 E
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Looking down
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250000
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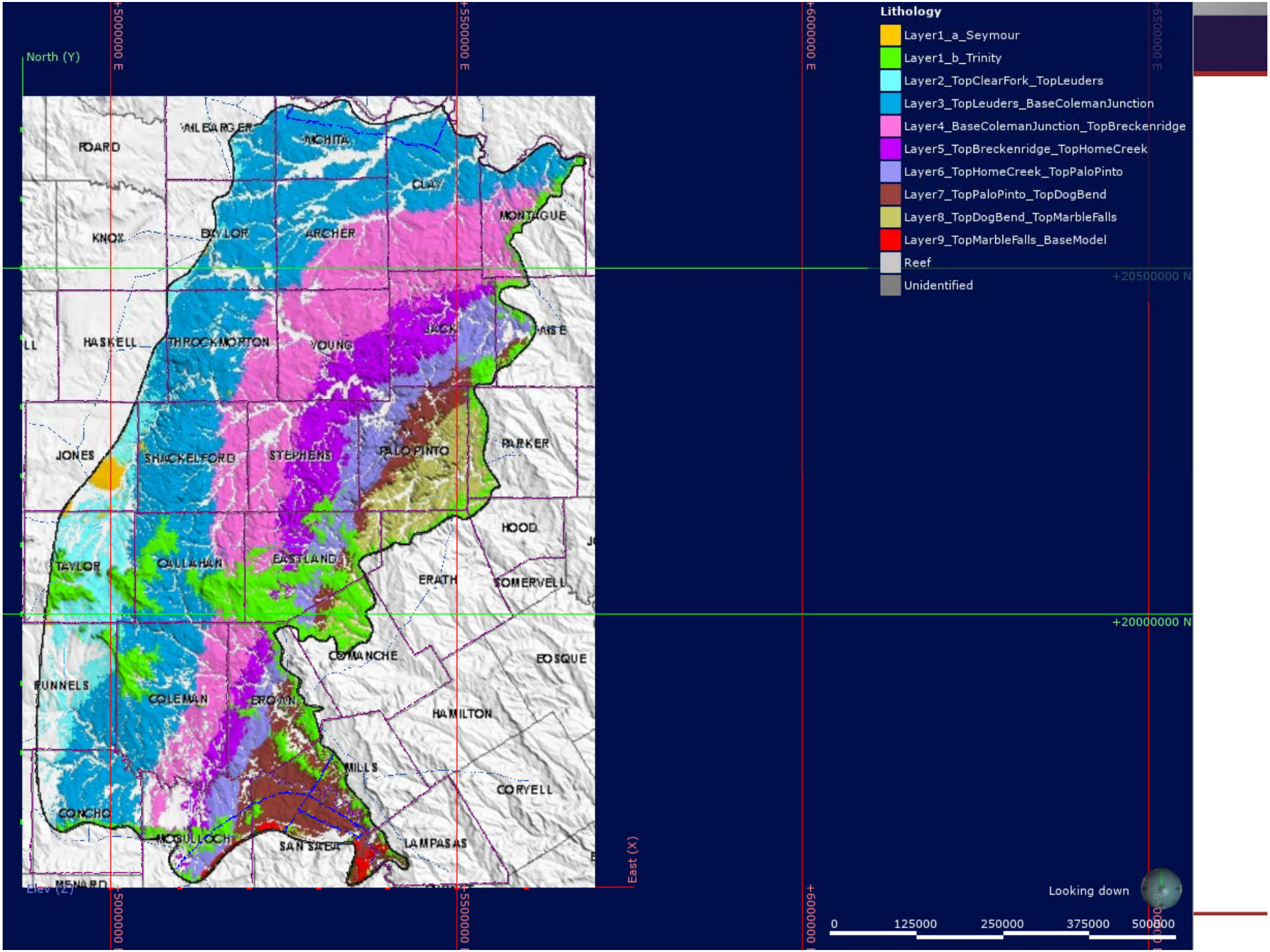
Lithology
Layer1_a_Seymour
Layer1_b_Trinity
Layer2_TopClearFork_TopLeuders
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Layer5_TopBreckenridge_TopHomeCreek
Layer6_TopHomeCreek_TopPaloPinto
Layer7_TopPaloPinto_TopDogBend
Layer8_TopDogBend_TopMarbleFalls
Layer9_TopMarbleFalls_BaseModel
Reef
Unidentified
North (Y)
East (X)
Elev (Z)
+20500000 N
+20000000 N
+5500000 E
+6000000 E
+6500000 E
Looking down
0
125000
250000
375000
500000
FOARD
KNOX
BAYLOR
ARCHER
CLAY
MONTAGUE
HASKELL
THROCKMORTON
YOUNG
JACK
JONES
SHACKELFORD
STEPHENS
PALO PINTO
PARKER
HOOD
TAYLOR
CALLAHAN
EASTLAND
ERATH
SOMERVELL
COMANCHE
EOSQUE
RUNNELS
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BROWN
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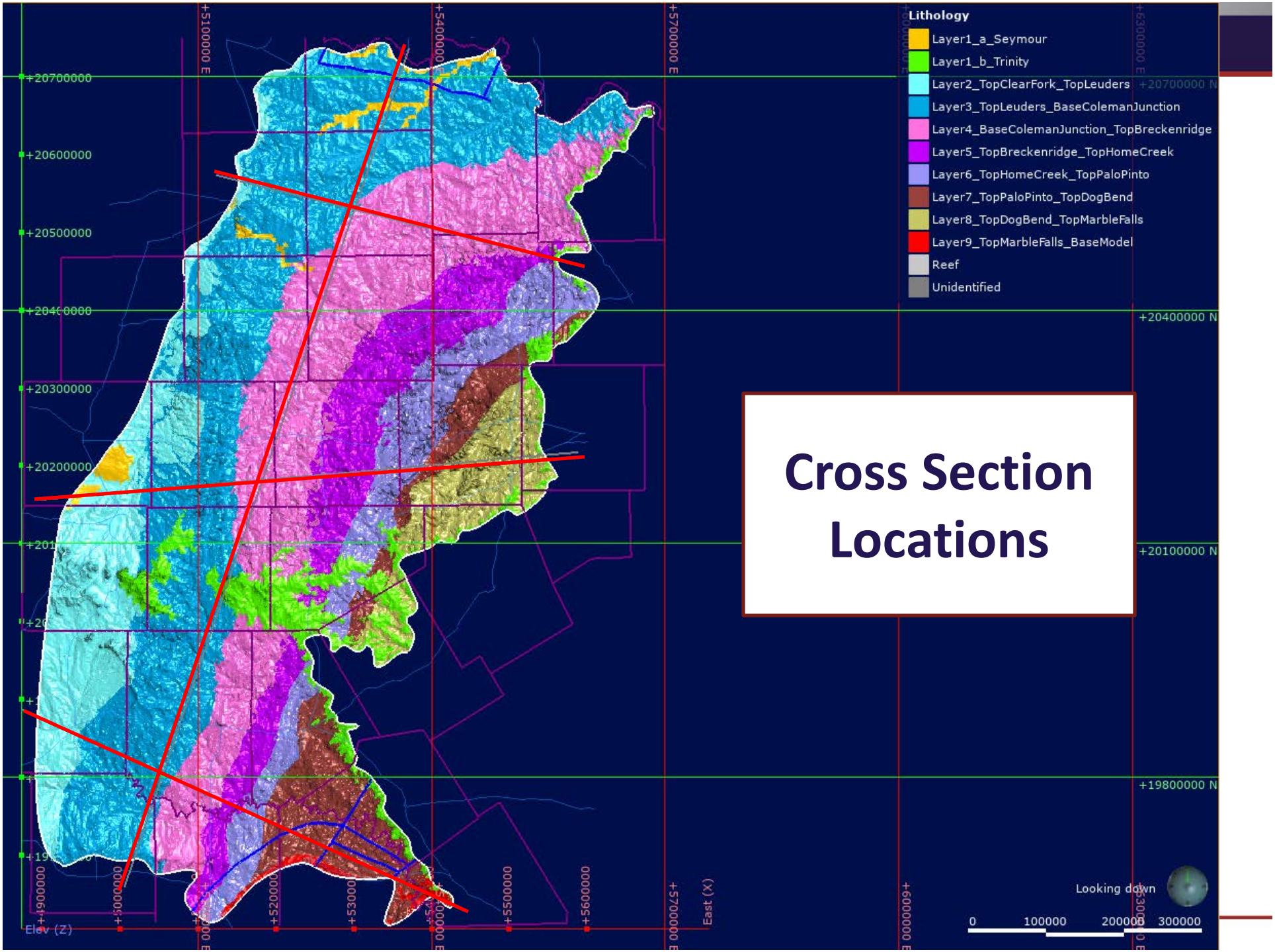
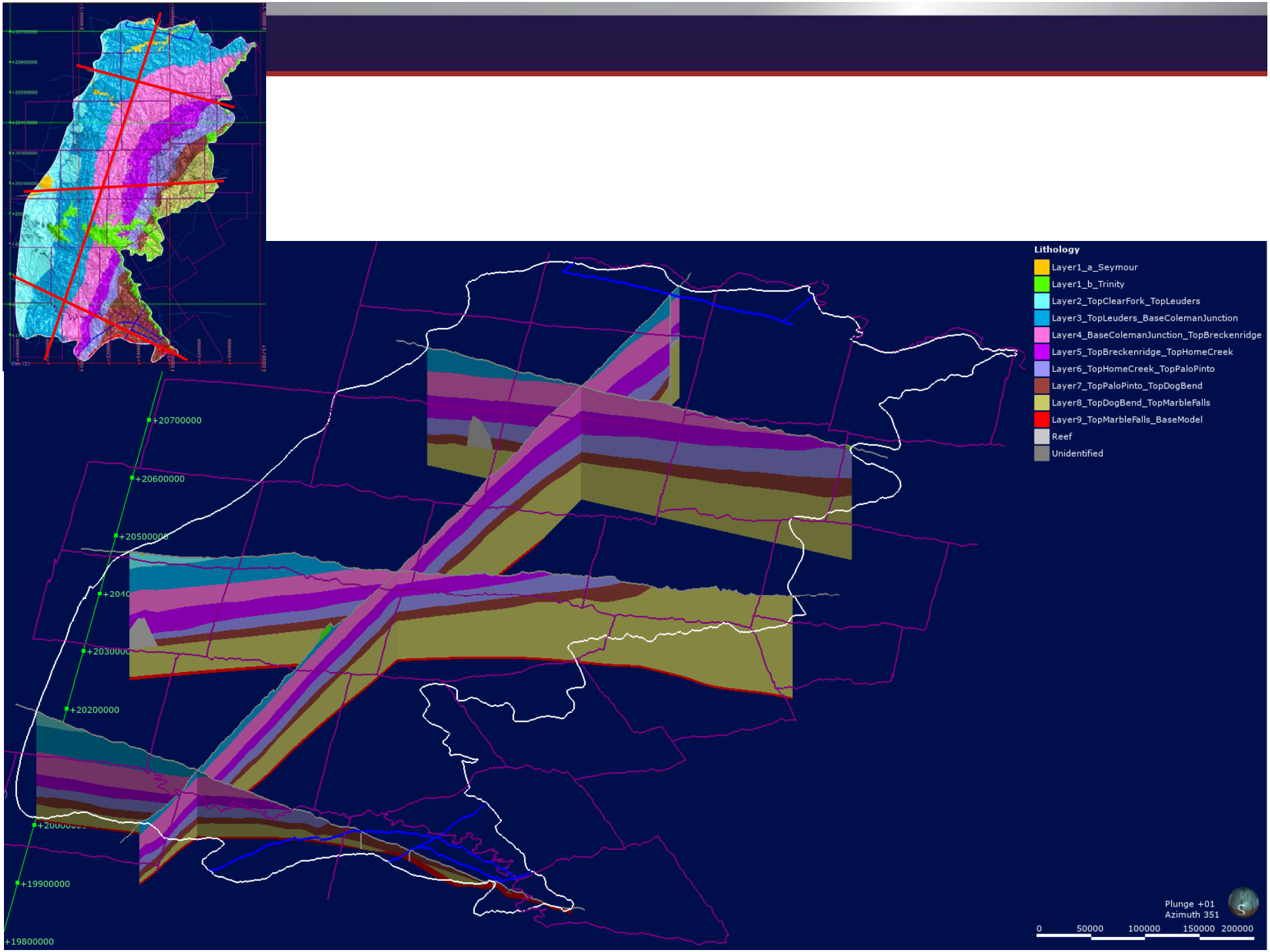
CORYELL
CONCHO
MCCULLOCH
SAN SABA
LAMPASAS
MENARD



Cross Section Locations


Lithology
Layer1_a_Seymour
Layer1_b_Trinity
Layer2_TopClearFork_TopLeuders
Layer3_TopLeuders_BaseColemanJunction
Layer4_BaseColemanJunction_TopBreckenridge
Layer5_TopBreckenridge_TopHomeCreek
Layer6_TopHomeCreek_TopPaloPinto
Layer7_TopPaloPinto_TopDogBend
Layer8_TopDogBend_TopMarbleFalls
Layer9_TopMarbleFalls_BaseModel
Reef
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+20600000
+20500000
+20200000
+19900000
+19800000
Plunge +01
Azimuth 351
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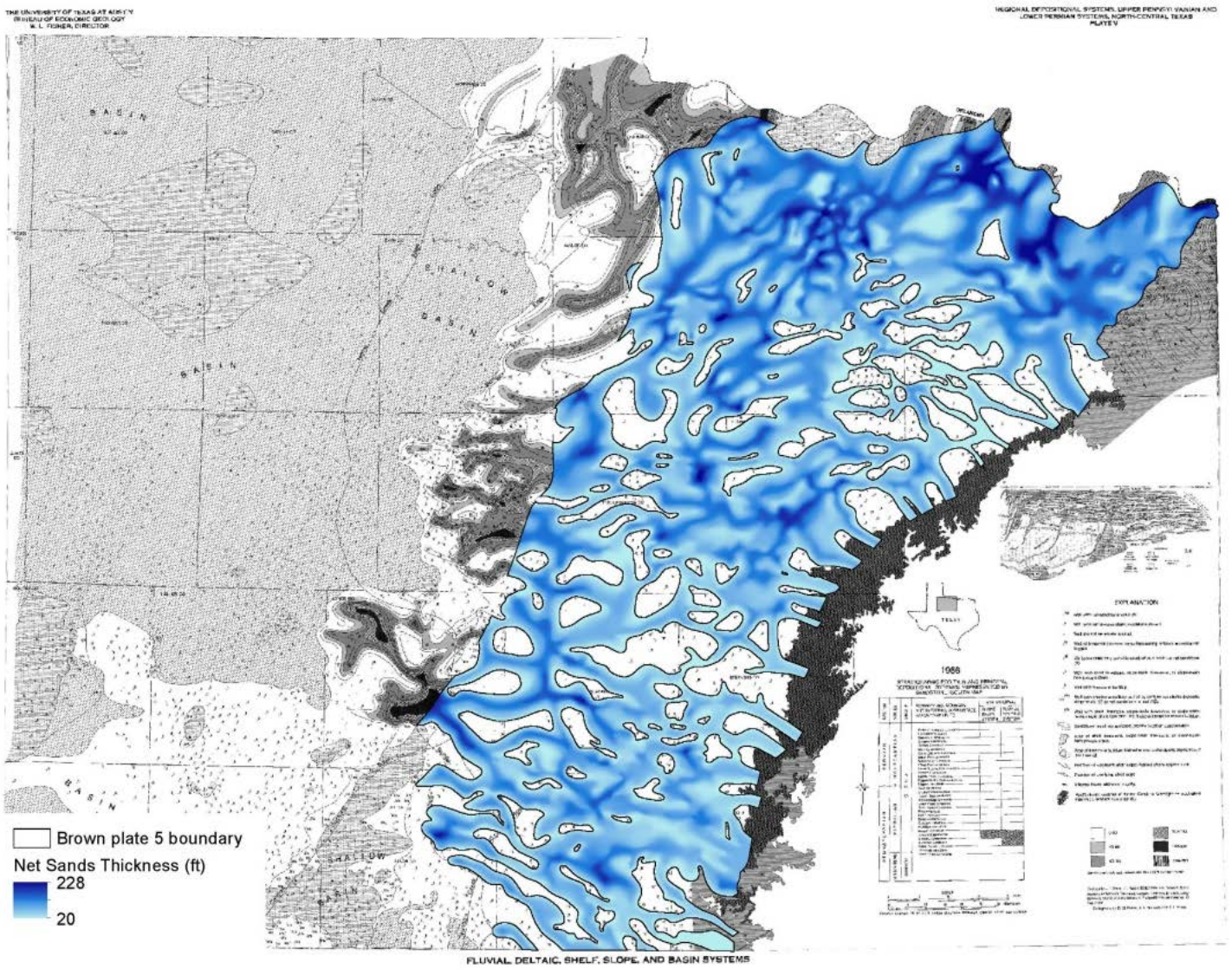
50000
100000
150000
200000

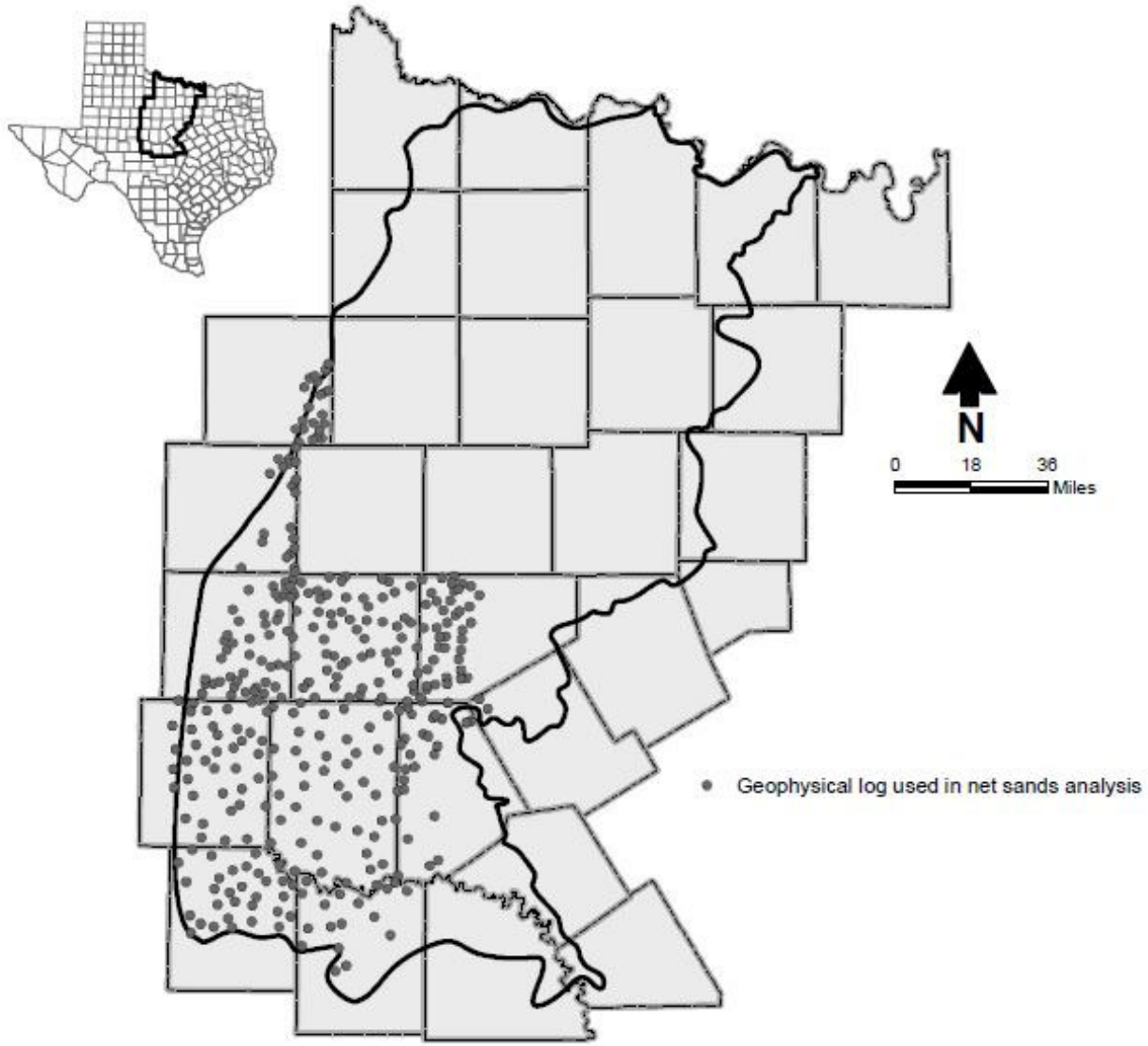
Net Sandstone Map Data Sources

Source	Plate	Layer
Brown and others (1990)	Plate II – Regional Sandstone Isolith Home Creek to Salem School Interval	4
	Plate V – Regional Sandstone Isolith Salem School to Bunger Interval	
	Plate VI – Regional Sandstone Isolith Bunger to Gunsight Interval	
	Plate VII – Regional Sandstone Isolith Gunsight to Ivan Interval	
	Plate VIII – Regional Sandstone Isolith Ivan to Black Ranch Interval	
	Plate IX – Regional Sandstone Isolith Black Ranch to Breckenridge Interval	
	Plate X – Regional Sandstone Isolith Breckenridge to Crystal Falls Interval	5
	Plate XI – Regional Sandstone Isolith Crystal Falls to Flippen Interval	
	Plate XII – Regional Sandstone Isolith Flippen to Saddle Creek Interval	
	Plate XIII – Regional Sandstone Isolith Saddle Creek Interval to Lower Stockwether Interval	
	Plate XIV – Regional Sandstone Isolith Lower Stockwether to Stockwether Interval	
	Plate XV – Regional Sandstone Isolith Stockwether to Camp Colorado Interval	
	Plate XVI – Regional Sandstone Isolith Camp Colorado to Dothan Interval	
	Plate XVII - Regional Sandstone Isolith Dothan to Sedwick Interval	
	Plate XVIII – Regional Sandstone Isolith Sedwick to Coleman Junction Interval	
Erxleben (1975)	Plate IV – Net Sandstone Thickness Wolf Mountain Shale Interval	6
	Plate VI – Net Sandstone Thickness Placid Shale Interval	
	Plate VIII – Net Sandstone Thickness Colony Creek Shale Interval	
Cleaves (1975)	Plate XII – Net Sandstone Isolith Map Devil's Hollow Fluvial-Deltaic Facies	7
	Plate XIV – Net Sandstone Isolith Map Turkey Creek Fluvial-Deltaic Facies	

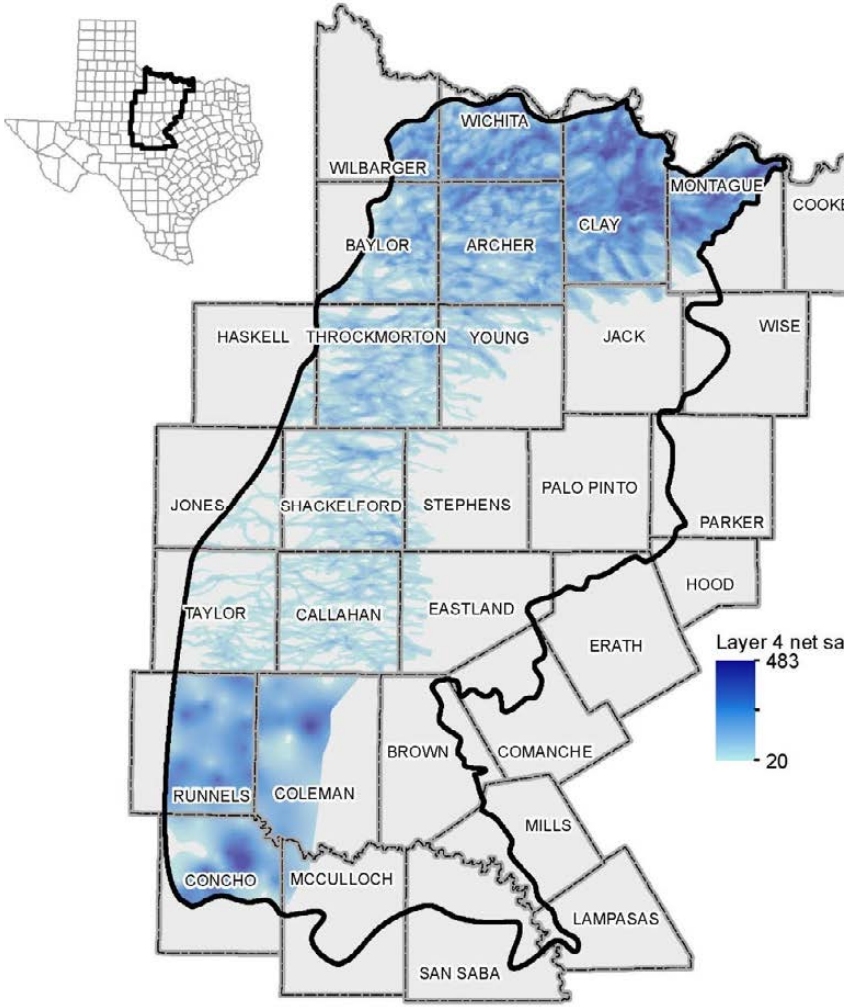
Plate V from Brown and others (1990) illustrating regional sandstone isolith for the Salem School to Bunger interval within the Lower Cisco Group



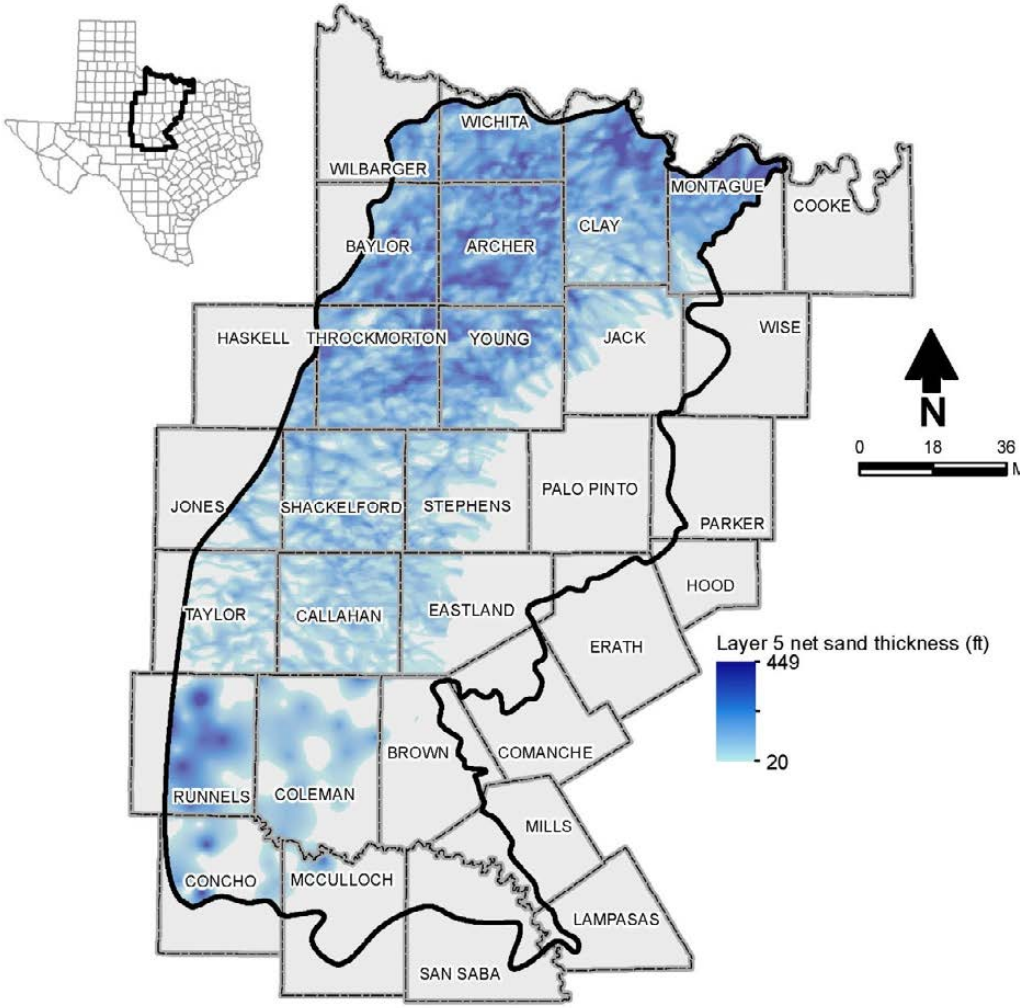
Net Sand Data Points



Net Sand Isopachs

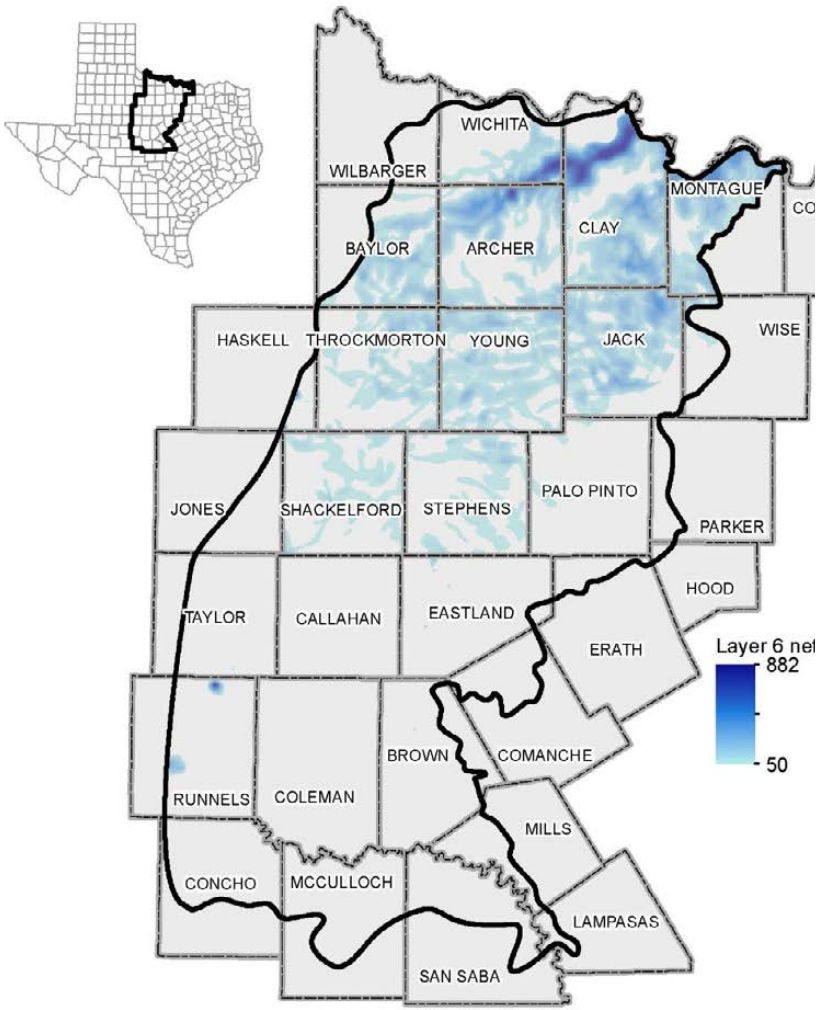


Layer 4

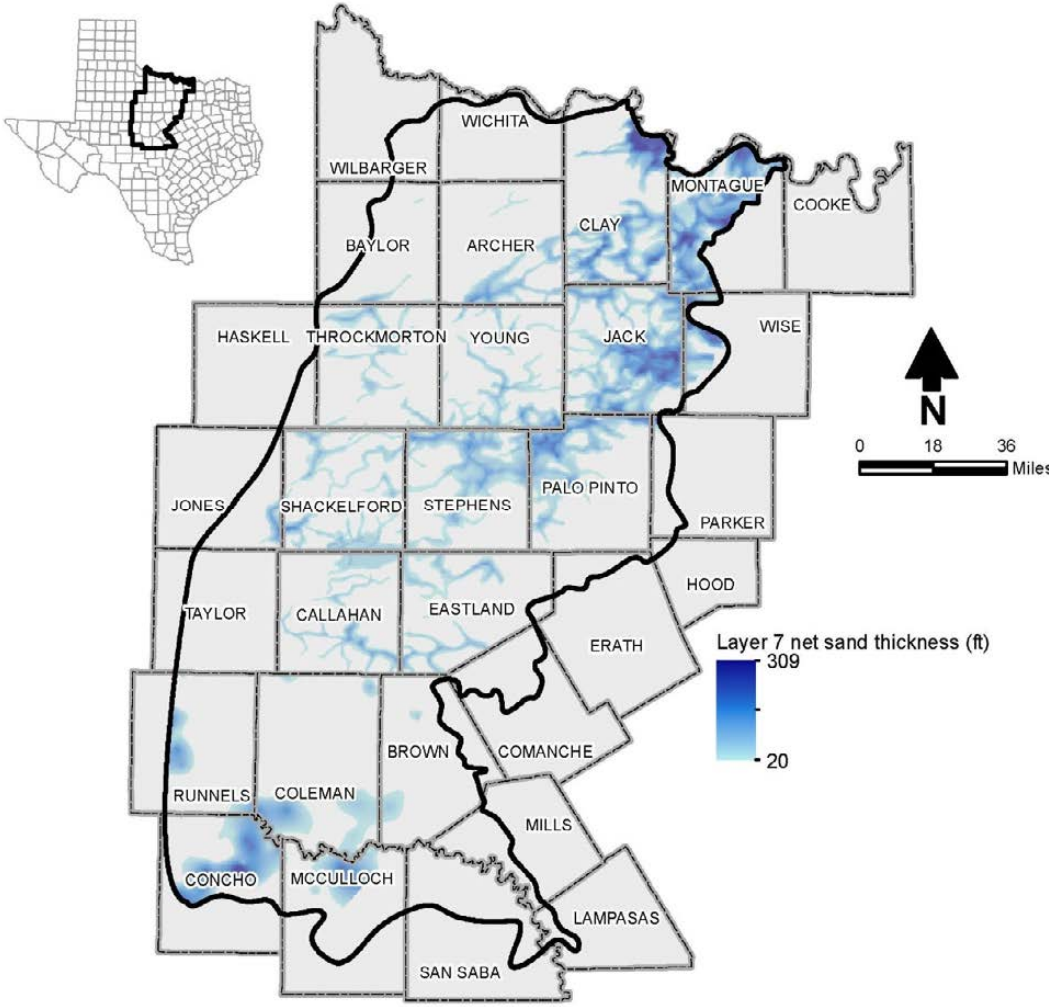


Layer 5

Net Sand Isopachs



Layer 6



Layer 7

Project Schedule

- ~~June 1, 2019 - Start date~~
- ~~August 6, 2019 - SAF1~~
- ~~June 1, 2020 - Interim Deliverable~~
- ~~July 2020 - SAF2*~~ Today!
- March 31, 2021 - Study Completion Date
- ~ April 2021 - SAF3

Components of Conceptual Model

1. Physiography and climate
2. Geology
3. Hydrostratigraphy
4. Hydrostratigraphic framework
5. Water levels and regional groundwater flow
6. Recharge
7. Rivers, streams, reservoirs, springs and other surface water features
8. Hydraulic properties
9. Subsidence
10. Discharge
11. Water quality

Contact Info

https://www.twdb.texas.gov/groundwater/models/gam/cstb/cstb.asp

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210-854-9374

Texas Water Development Board

Thank you!

Cross Timbers Aquifer Conceptual Model

Stakeholder Advisory Forum #2

August 14, 2020

DBS&A Daniel B. Stephens & Associates, Inc. a Geo-Logic Company

Allan R. Standen LLC Groundwater & Natural Resource Consulting

Blanton & Associates, Inc.
Environmental Consulting • Planning • Project Management

Appendix C

DBS&A Team Handout

Texas Water Development Board

SUMMARY: DEVELOPING A CONCEPTUAL MODEL FOR THE CROSS TIMBERS AQUIFER

OVERVIEW

In 2019, the team of Daniel B. Stephens & Associates, Inc. (DBS&A), Allan R. Standen LLC, and Blanton & Associates, Inc. (the DBS&A Team) was retained by the Texas Water Development Board (TWDB) to develop a conceptual model for the Cross Timbers Aquifer (the Project). The conceptual model will be used at a later date to develop a groundwater availability model (GAM) of this aquifer.

PROJECT SUMMARY

By statute, the TWDB is required to develop numerical groundwater flow models of the major and minor aquifers in Texas. The Cross Timbers Aquifer was designated as a new minor aquifer in December 2017. The aquifer consists of four Paleozoic-age water-bearing formations including, from oldest to youngest, the Strawn, Canyon, Cisco, and Wichita groups. The aquifer is primarily composed of limestones, shales, and sandstones.

As a precursor to developing the GAM, the DBS&A Team is developing the conceptual model for the Cross Timbers Aquifer to describe the best understanding of how groundwater moves through the aquifer system. To develop this conceptual model, the DBS&A Team is compiling data related to physiography and climate, geology and aquifer extent, hydrostratigraphy, hydrostratigraphic framework, water levels and regional groundwater flow, recharge, surface water features, hydraulic properties, discharge, and water quality in the study area.

As part of the process to develop the conceptual model, the DBS&A Team requested input and information from the public and private sector, including regional water planning groups, groundwater conservation districts (GCDs), Texas Commission on Environmental Quality, Texas Parks and Wildlife Department, Texas Department of Agriculture, water utilities, educational groups, agricultural interests, environmental interests, private landowners, industry, and groundwater consultants.

Stakeholder Participation

Three stakeholder advisory forums (SAFs) are planned for the Project:

1. ***Was held August 6, 2019 at the offices of Middle Trinity GCD in Stephenville, TX***
2. ***Will be held August 14, 2020 via "live" web-based public meeting***
3. ***Will be held after the DBS&A Team submits its final draft deliverables to the TWDB (March 2021)***

All three SAFs are open to the public; this announcement is for the second SAF.

Texas Water Development Board

PROJECT STATUS

The DBS&A Team began work on the Project in June 2019. The Project will be completed by March 2021, when the team submits its final report to the TWDB. The DBS&A Team has compiled and analyzed data related to the geology, aquifer extent, and hydrostratigraphy for the study area, and submitted the draft 3D model to TWDB on June 1, 2020. Project results to date will be shared with stakeholders at the upcoming SAF in August 2020. Figure 1 shows the surface geology for the study area. Figure 2 shows the hydrostratigraphic column.

During the remaining project period, the DBS&A Team will compile and analyze data related to physiography and climate, water levels and regional groundwater flow, recharge, rivers, streams, reservoirs, springs and other surface water features, hydraulic properties, discharge, and water quality in the study area. Results will be presented in a final draft deliverable to be submitted in March 2021.

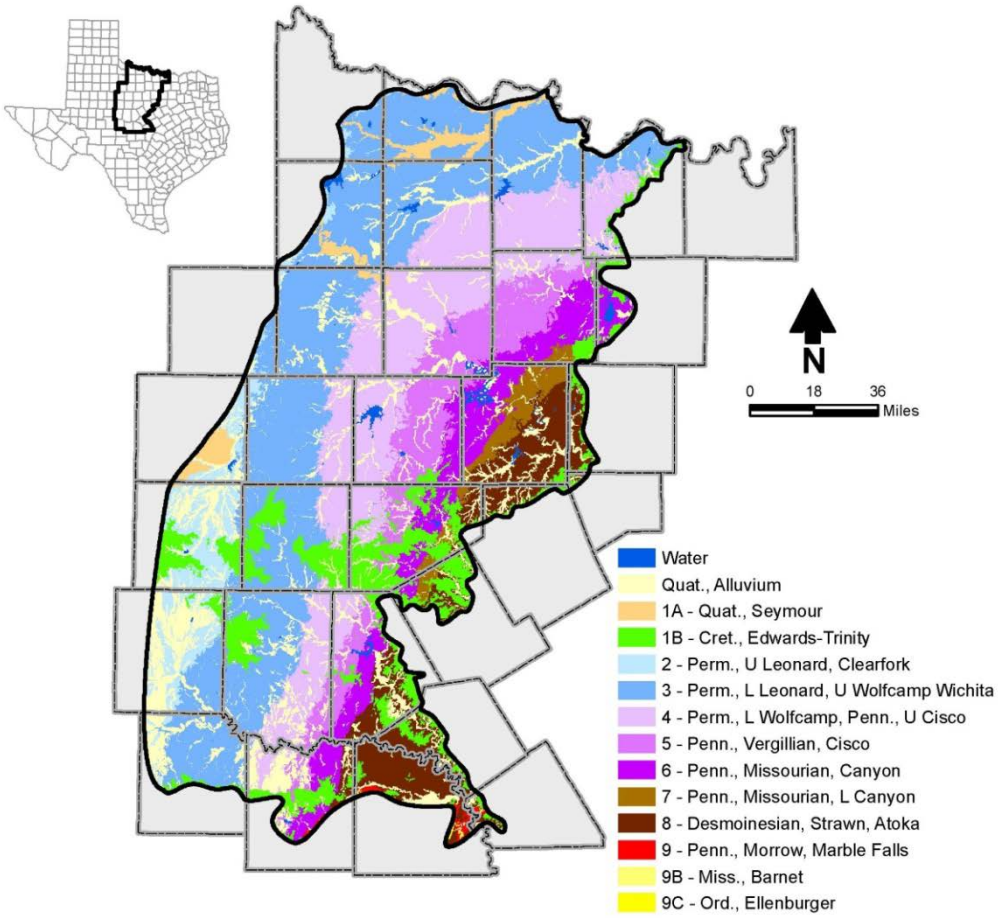

Figure1. DRAFT Surface geology of the Cross Timbers Aquifer.

Million Years Ago (Ewing, 2016)	Era	System	Series or Stage	Group	Formation	Reef	Member or Limestone	Model Layer
2	Cenozoic	Quaternary - Pleistocene			Alluvium			1A
					Seymour			
	Mesozoic	Cretaceous		Albian	Edwards			1B
				Comanchean	Trinity		Antlers	
							Twin Mtn	
				Coahuilian			Travis Peak	
130							**Hosston**	
275	Paleozoic	Permian	Leonard	Clear Fork	Choza		Lytle	2
					Vale		Bullwagon	
					Arroyo		Standpipe	
280				Wichita - Albany	**Leuders**			3
					Clyde, Waggoner Ranch (GAT)		Talpa	
							Grape Creek	
			Wolfcamp		Belle Plains, Petrolia (GAT)		Bead Mountain	
							Jagger Bend, Valera	
							Elm Creek	
					Putnam, Nocona, (GAT)		Admiral	
292							**Coleman Junction**	
				Cisco	Santa Anna Branch			4
					Sedwick			
					Moran		Dothan, Camp Colorado	
					Pueblo		Stockwether, Saddle Creek	
		Pennsylvanian	Virgilian		Harpersville		Crystal Falls	
							Breckenridge	5
300					Thrifty	Carbonate Banks	Blach Ranch	
							Ivan	
					Graham		Gunsight, Bunger	
303							**Home Creek**	
			Missourian	Canyon	Caddo Creek		Colony Creek	6
					Brad		Ranger	
							Clear Creek, Cedarton	
					Placid			
					Winchell			
					Wolf Mountain			
					Palo Pinto		Wiles, Wynn	7
307				Strawn	Mineral Wells		**Dog Bend**	8
			Desmoinesian		Brazos River			
					Mingus		Capps, Dobbs Valley	
					Grindstone Creek		Buck Creek	
					Lazy Bend			
			Atokian	Atoka	Smithwick			
320			Morrowan	Morrow	**Marble Falls**		Marble Falls	9

Figure 2. DRAFT Hydrostratigraphic column for the Cross Timbers Aquifer.

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