High-Resolution Sequence Stratigraphy of the Cretaceous Gallup System, New Mexico, U.S.A.

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Outlines

1. Introduction of the research
2. Sequence stratigraphy analysis
3. Discussion and conclusion

Introduction

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- The existence of the high-frequency sequence stratigraphic cyclicity in the Gallup system
- High-frequency sequence stratigraphic framework reconstruction – key stratigraphic unit and surface
- Controlling mechanisms
- Re-evaluation of lithostratigraphy in sequence stratigraphy domain

Geological Settings of the Gallup Sandstone

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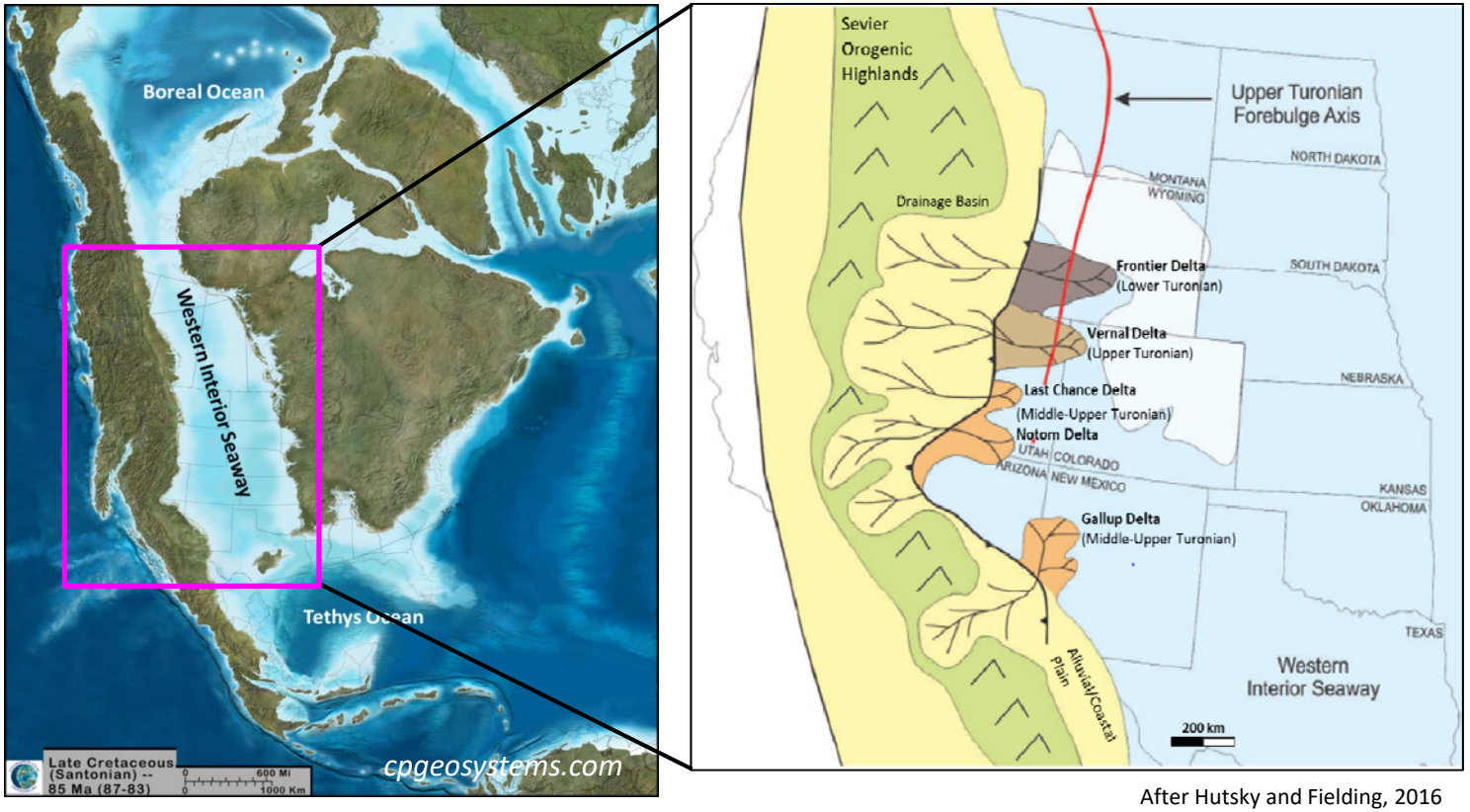
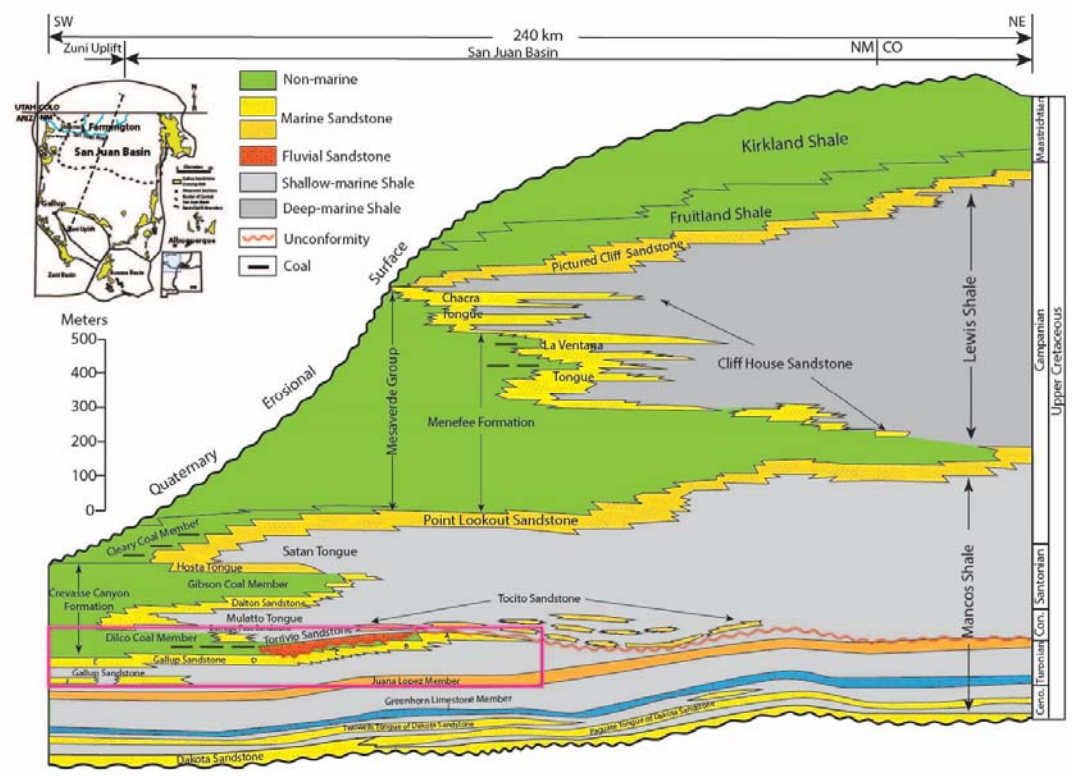
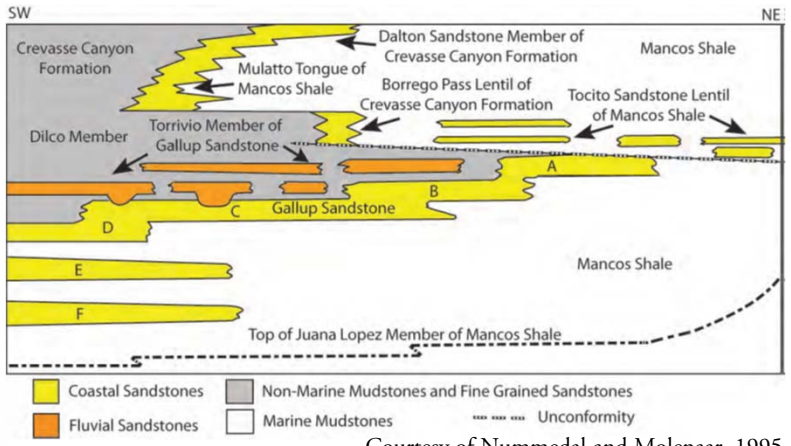


After Hutsky and Fielding, 2016

Geological Settings of the Gallup Sandstone



Modified after Fassett, 2013; Dubiel, 2013; Nummedal and Molenaar, 1995; Jennette and Jones, 1995



Courtesy of Nummedal and Molenaar, 1995

- Six lithostratigraphic sandstone tongues are identified in the Gallup Formation – alphabetic order

Geological Settings of the Gallup Sandstone

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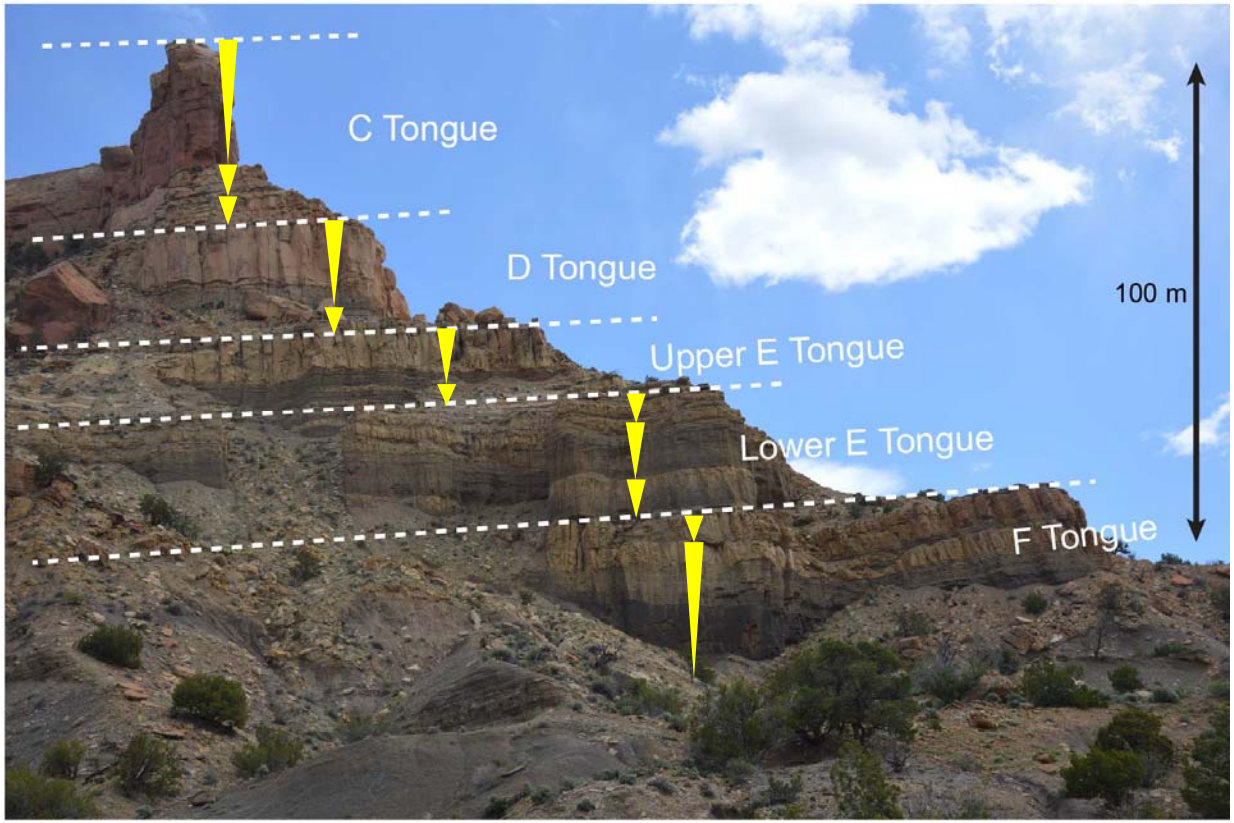


High-frequency sequence stratigraphy

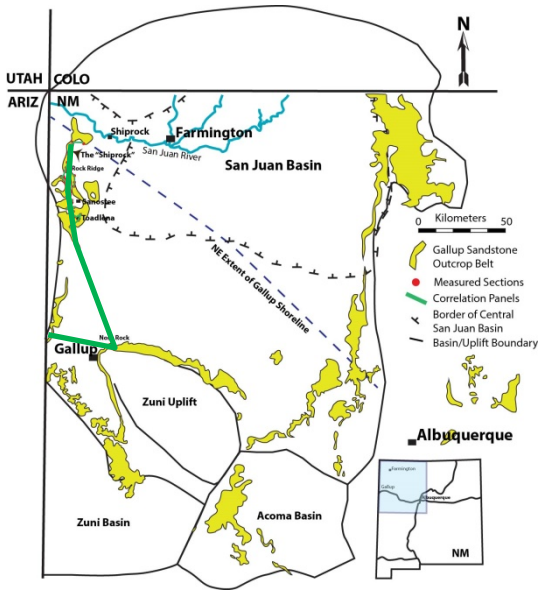
- The sandstone tongues are more equivalent to depositional sequences or sequence sets

Methods

The world-class outcrops provide high-resolution stratigraphic data to test the high-frequency cyclicity.

Methods:

- 71 sedimentological measured sections – average distance between sections is less than 1 km
- A significant number of photo panoramas
- Key surfaces "walking-out" correlations



Key Methods

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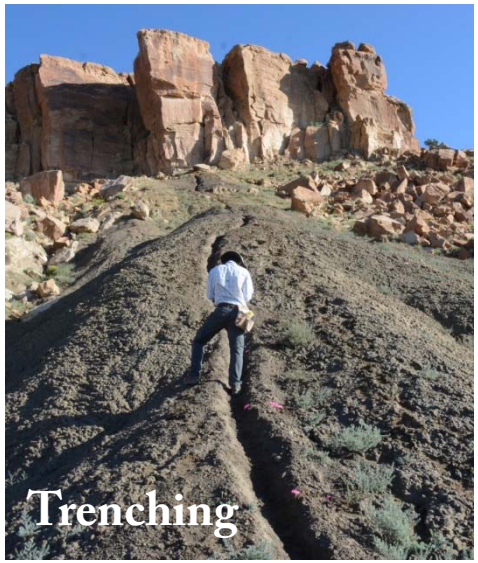
- Trenching to measure covered sections in the slopes and to reveal bentonite
- Bentonite layers provide isochronous controls and datums



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Basic Building Block - Parasequence

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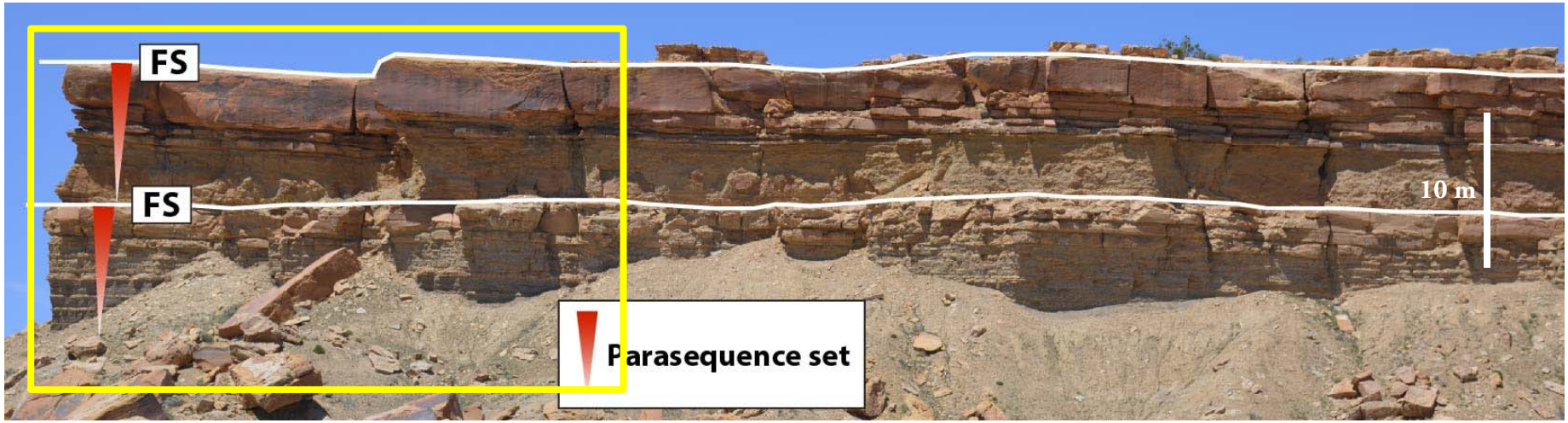

- Parasequence is used as the basic building block to reconstruct sequence stratigraphy
- Flooding surface (FS) is the fundamental bounding surface

High-Frequency Sequence Stratigraphy

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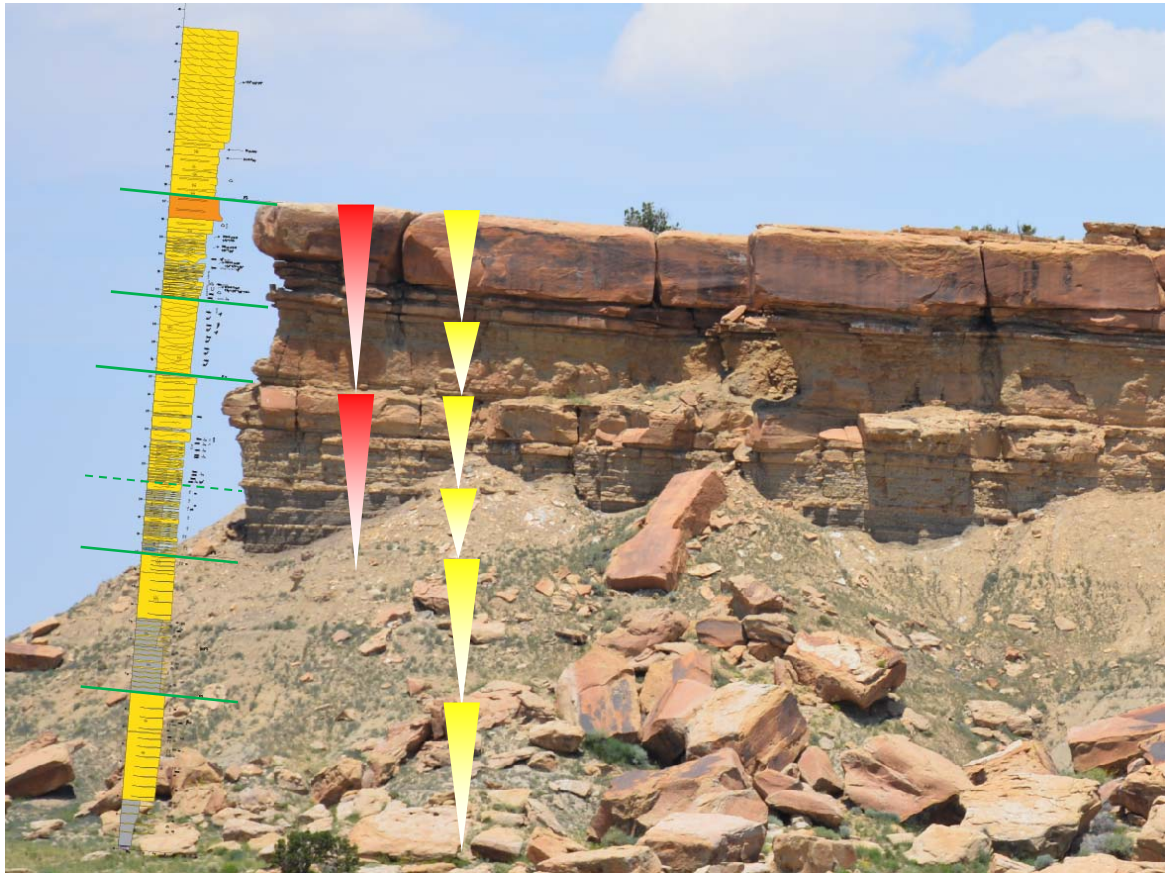
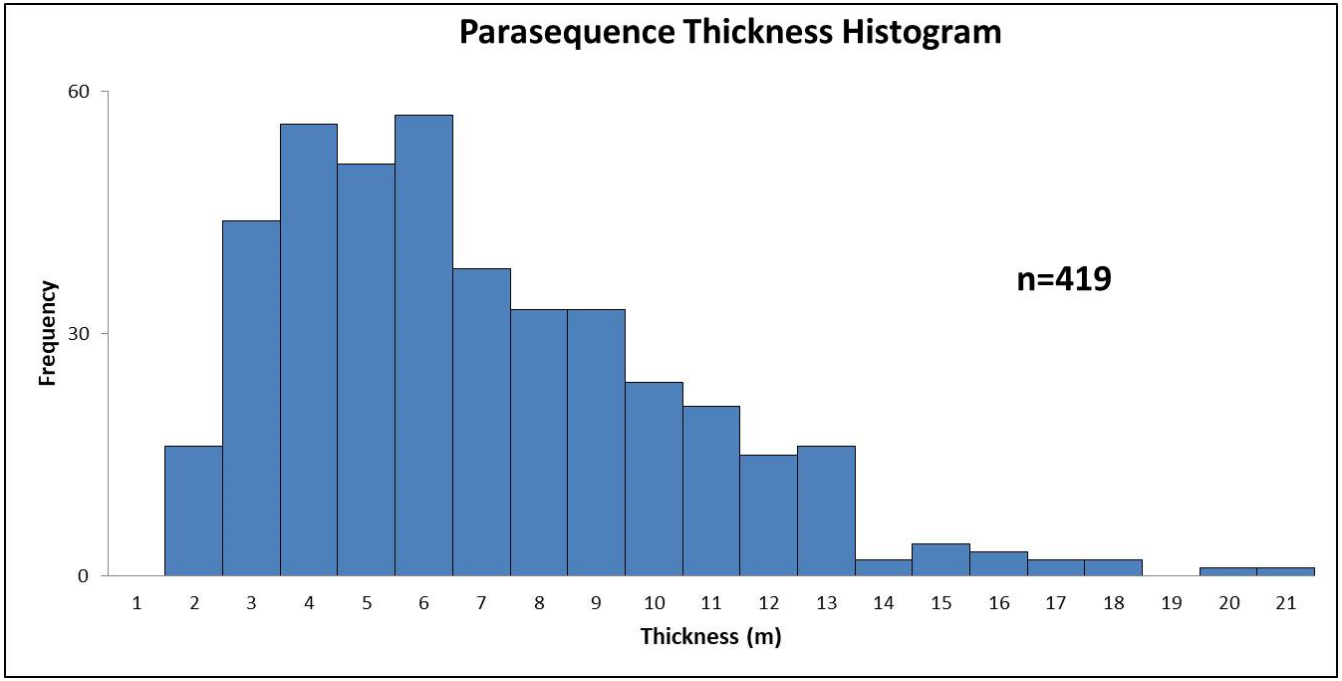


Parasequence Characterization



The thicknesses of parasequence vary from 1 to 20m, with an average thickness of 6.2m. Most parasequences are 3-9m thick. Note that thickness of parasequence is determined by accommodation, sediment supply, and position along depositional profile.

Sequence Boundary Identification

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Subaerial erosional surface

Subaqueous erosional surface

Key Surfaces –RS/TSE

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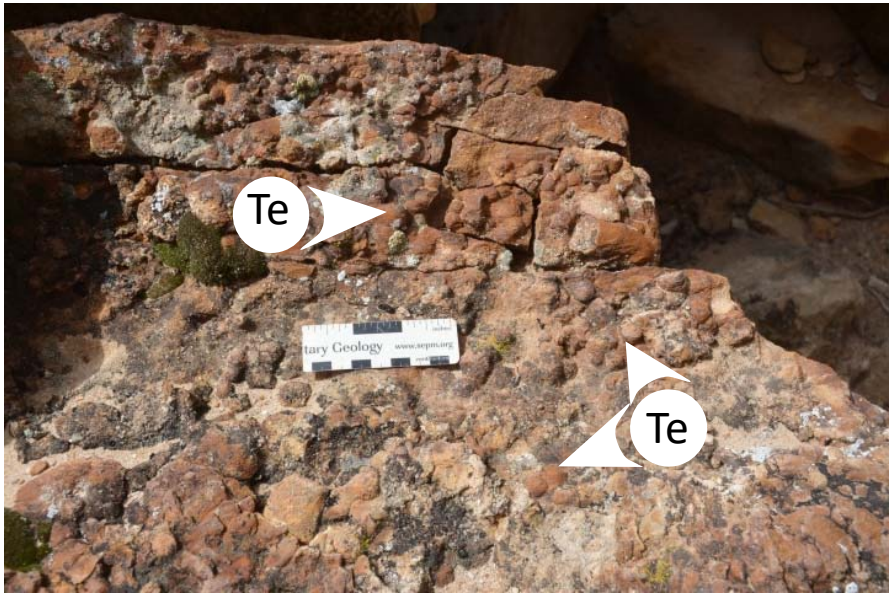

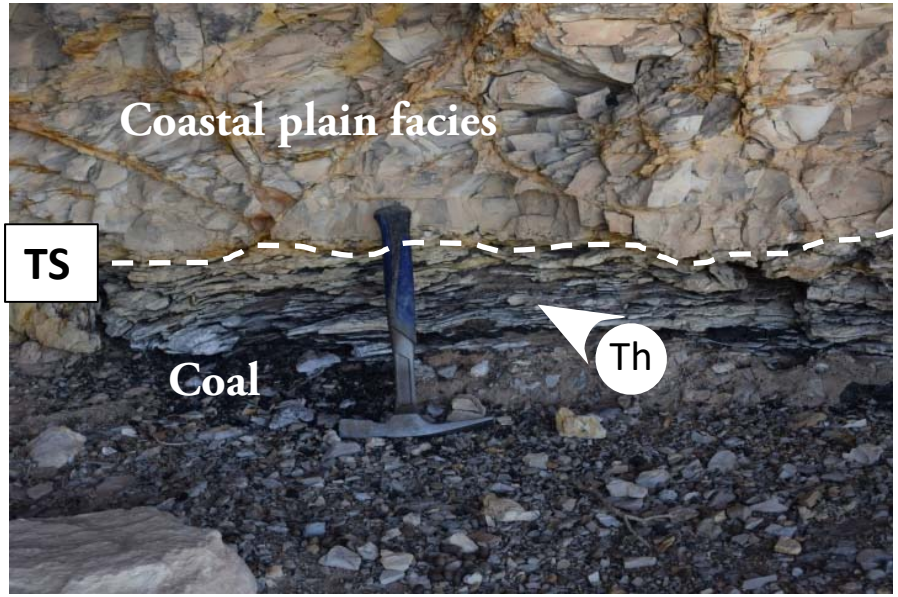

Glossifungites ichnofacies marks the transgressive surface of erosion

Key Surfaces –RS/TSE

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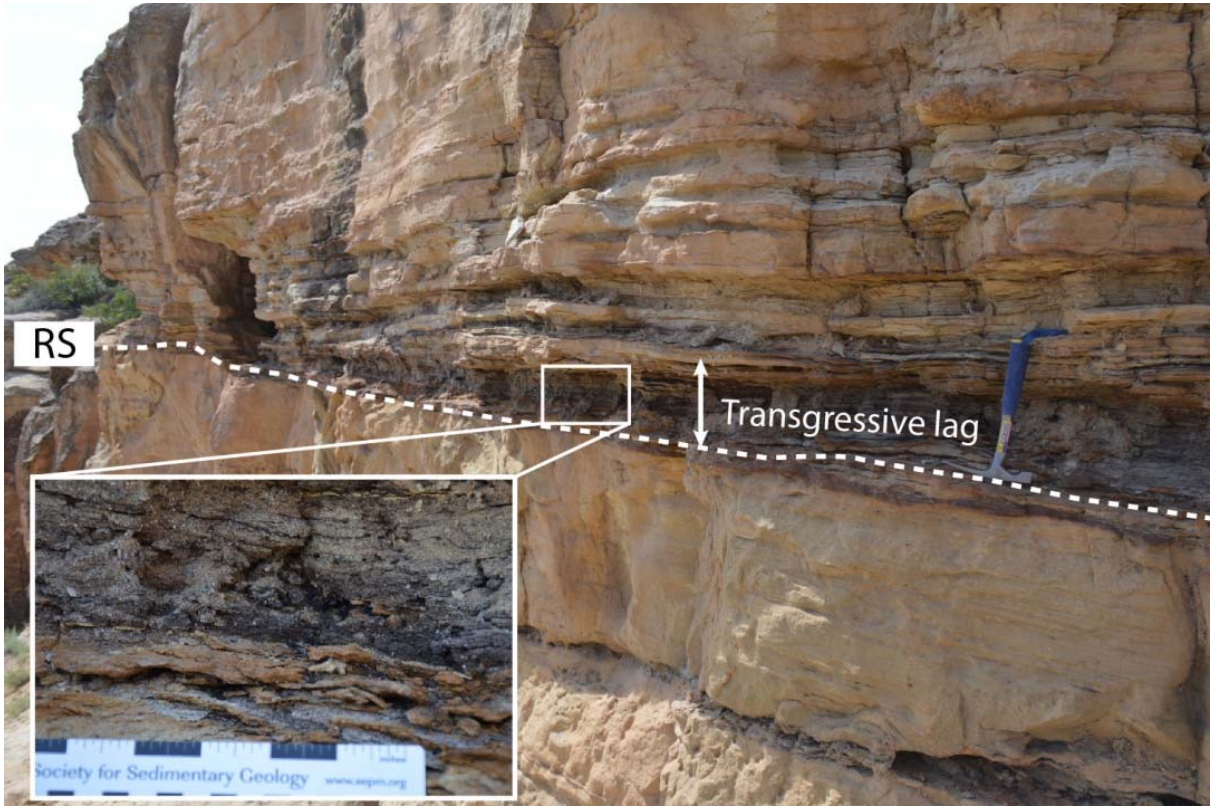

High-Resolution Sequence Stratigraphy

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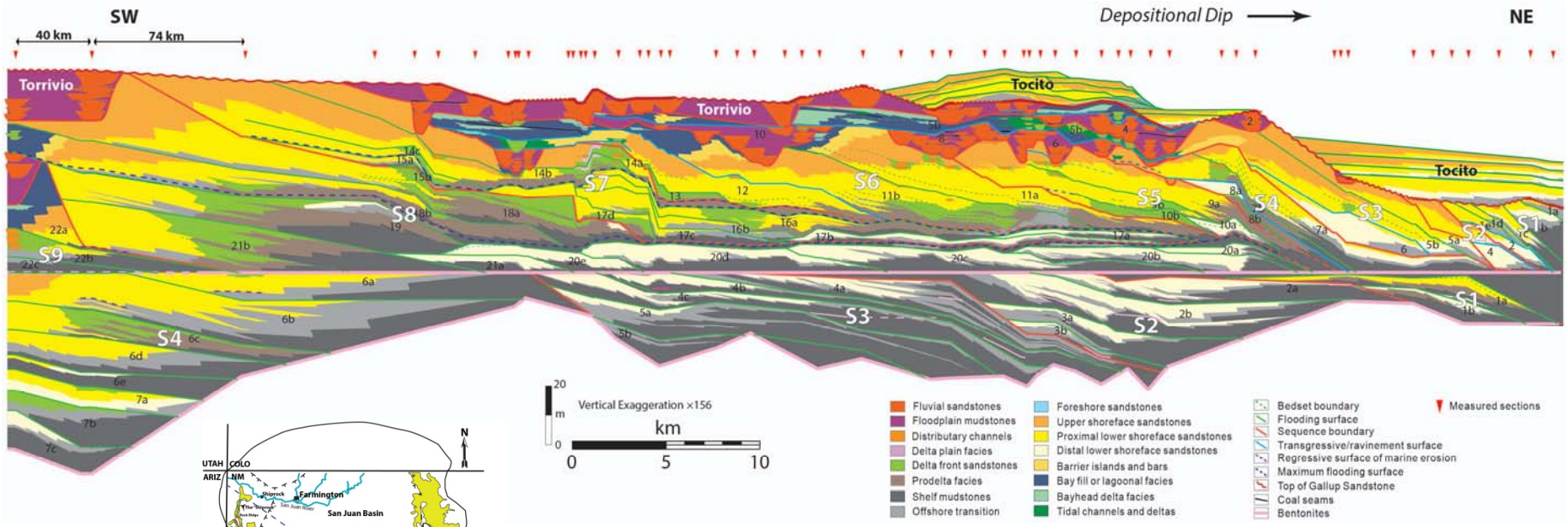

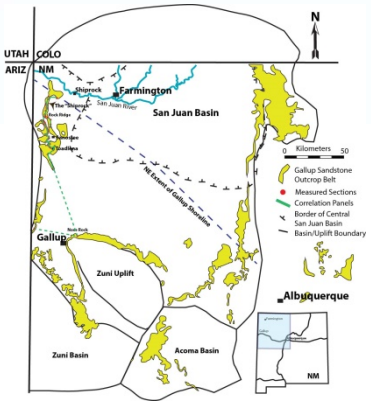

- The lower Gallup: 4 sequences, 7 parasequence sets, and 19 parasequences.
- The upper Gallup: 9 sequences, 22 parasequence sets, and 47 parasequences.

High-Resolution Sequence Stratigraphy

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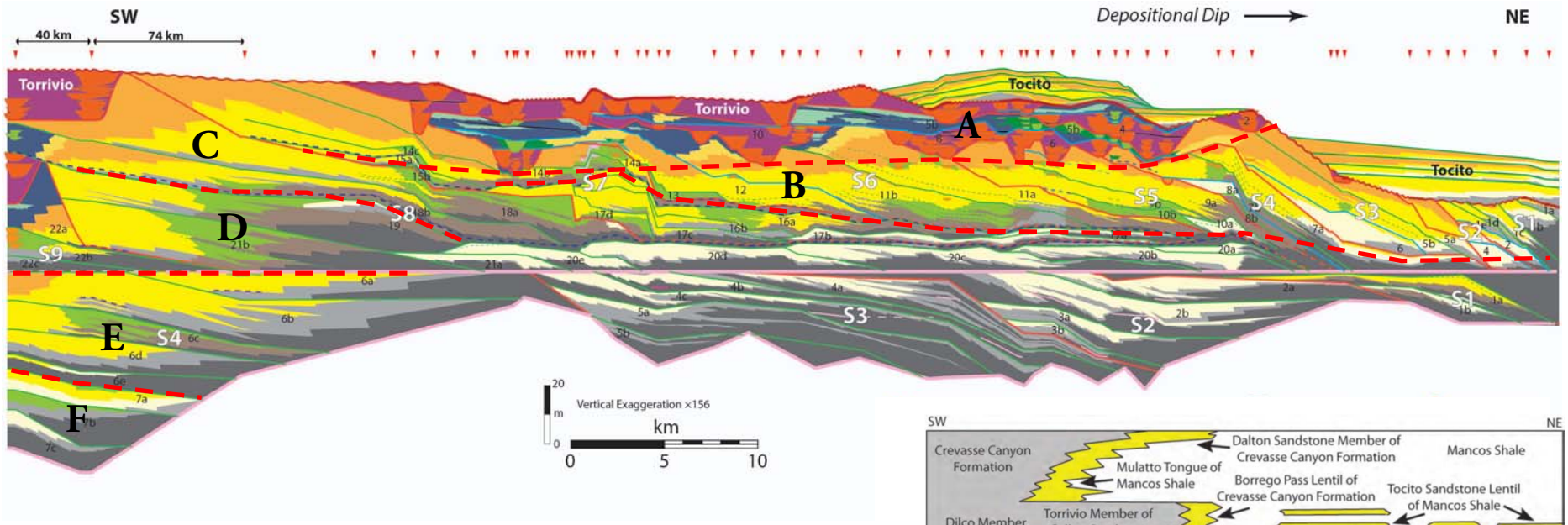
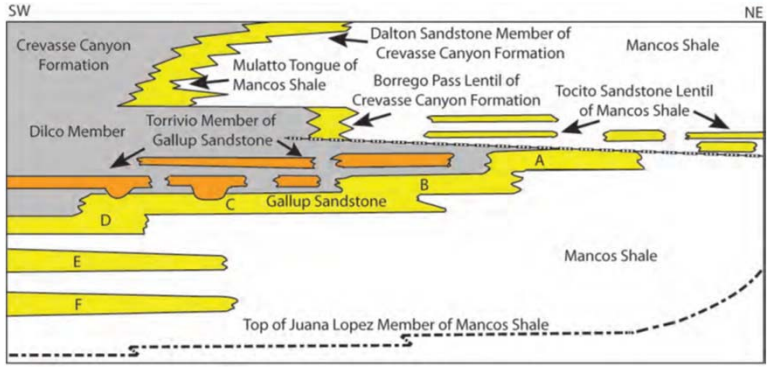
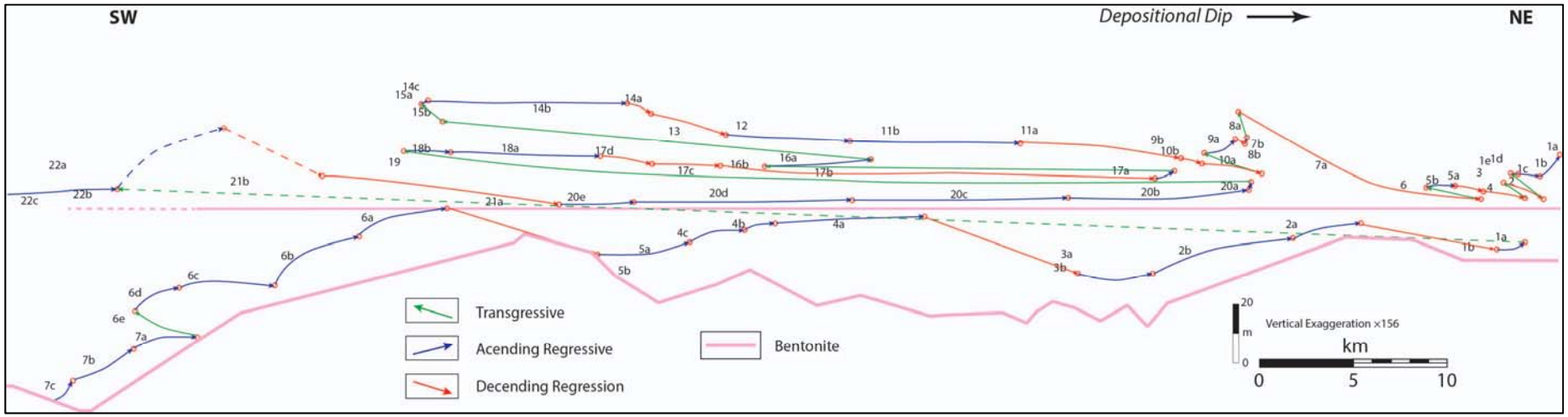




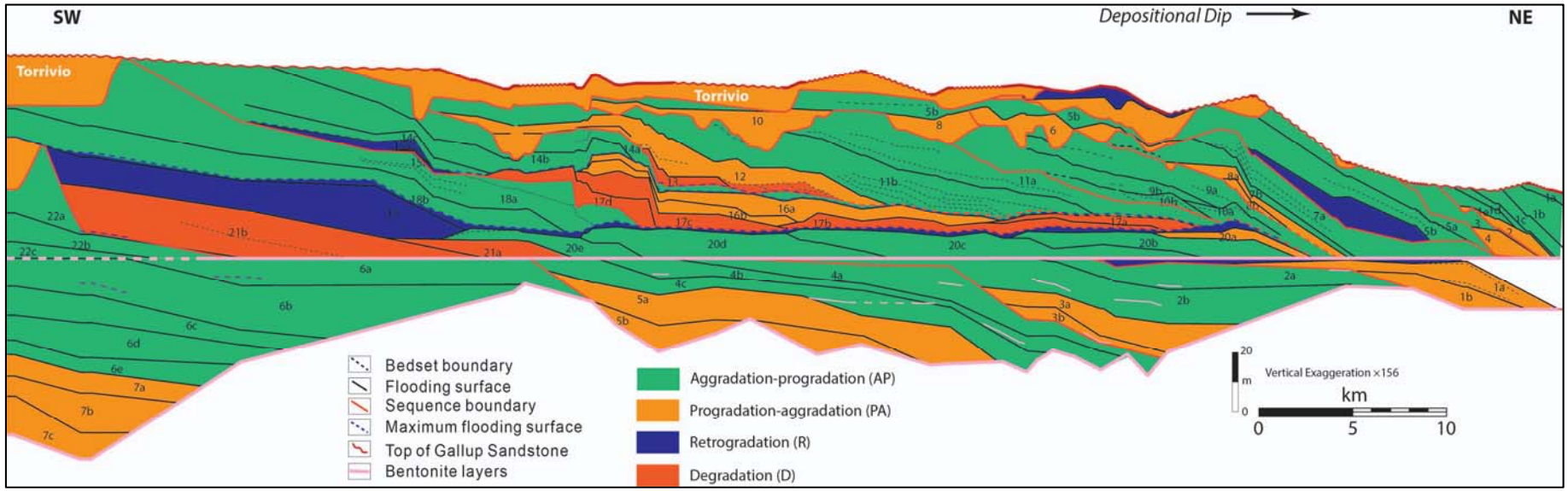
- Sequences show clinoforms – synchronicity
- Sandstone tongues are diachronous – time translation

Shoreline Trojectory



- The shoreline migration shows overall low-angle trajectory.
- descending regressive shoreline trajectory indicates relative sea level fall and correlates to sequence boundaries.
- PS 21 and 20 document a total shoreline advance of 57 km in low angle – FSST and LST.

Accommodation Succession



- Four-fold accommodation successions: AP, PA, R, and D
- PA – LST; AP – HST; R – TST; D - FSST

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Dominant high-frequency cyclicity control

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Fm	Sequence	Parasequence Set	Parasequence	Systems Tract	Accommodation Succession	Shoreline Trajectory	Shoreline Migration Distance (km)	Relative sea level change (m)
Upper Gallup	1	1	1a, 1b, 1c, 1d, 1e	HST	APD	Ascending regressive	→4	1
							←1.5	6
		2	2	LST	PA	Ascending regressive	→2.2	-7
	2	3	3	HST	APD	Ascending regressive	←1.2	14
		4	4	LST	PA	Ascending regressive	→2.2	-16
	3	5	5a, 5b	HST	APD	Ascending regressive	→3	18
		6	6	LST	PA	Ascending regressive	←2.8	25
	4	7	7a, 7b	HST	APD	Ascending regressive	→13	7
							←0.6	10
		8	8a, 8b	LST	PA	Ascending regressive	→0.2	5
							→0.5	-18
	5	9	9a, 9b	HST	APD	Ascending regressive	→2.6	16
							←3.2	7
		10	10a, 10b	FSST	D	Descending regressive	→9	-28
	6	11	11a, 11b	HST	APD	Ascending regressive	→18	23
		12	12	LST	PA	Ascending regressive	→6.5	10
		13	13	FSST	D	Descending regressive	→4	-28
	7	14	14a, 14b, 14c	HST	APD	Ascending regressive	→12.5	22
		15	15a, 15b	TST	R	Transgressive	←24	12
		16	16a, 16b	LST	PA	Ascending regressive	→5.5	2
							←22	18
		17	17a, 17b, 17c, 17d	FSST	D	Descending regressive	→31	-37 ←
	8	18	18a, 18b	HST	APD	Ascending regressive	→11	18
		19	19	TST	R	Transgressive	←44	24
		20	20a, 20b, 20c, 20d, 20e	LST	PA	Ascending regressive	→37	5
		21	21a, 21b	FSST	D	Descending regressive	→22	-20
	9	22	22a, 22b, 22c	HST	APD	Ascending regressive	→6?	34 ←
Lower Gallup	1	1	1a, 1b	LST	PA	Ascending regressive	→1.5	3
							→7.5	-9
	2	2	2a, 2b	HST	APD	Ascending regressive	→14.5	18
		3	3a, 3b	LST	PA	Ascending regressive	→4	5
							→8	-14
	3	4	4a, 4b, 4c	HST	APD	Ascending regressive	→12.5	12
		5	5a, 5b	LST	PA	Ascending regressive	→5	8
							→8	-15
	4	6	6a, 6b, 6c, 6d, 6e	HST	APD	Ascending regressive	→16.5	35
							←3.5	5
		7	7a, 7b, 7c	LST	PA	Ascending regressive	→6	20

- Very similar values of the maximum relative sea level fall and rise can represent eustatic sea level change
- The estimated volume of sea level change concurs with the ephemeral Antarctic ice sheet in the Cretaceous time hypothesis
- Glacio-eustatic control

Dominant high-frequency cyclicity control

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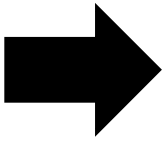
- Radiometric time scale and biozones estimation – a total duration of about 1.2 ma of the Gallup Formation

Total Duration	Seq. Strat. Unit	Number of Units	Duration
1.2 ma	Sequence	13	92.3 ka
	Parasequence set	29	41.4 ka
	Parasequence	66	18.2 ka



Milankovitch Cycles	
Eccentricity	100 ka
Obliquity	41 ka
Precession	19-24 ka

Conclusions

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- High-frequency sequence stratigraphy is documented in the Cretaceous Gallup system.
- 13 sequences, 29 parasequence sets, and 66 parasequences are identified using high-resolution sequence stratigraphic analysis.
- Descending regressive, ascending regressive, and transgressive shoreline trajectories are resulted from the combination of the changes in relative sea level and sediment supply.
- Accommodation successions reflect sequence stratigraphic evolution.
- The estimated relative sea level changes and depositional durations suggest a Milankovitch cycle dominated glacio-eustasy control of the high-frequency stratigraphic cyclicity.

Acknowledgements

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Thank you!