



COLORADO SCHOOL OF  
**MINES**  
**MUDTOC**

Scott Kennedy, M.S. Candidate, Summer 2022

**STRATIGRAPHIC STUDY OF THE TURONIAN SEMILLA SANDSTONE  
MEMBER OF THE MANCOS SHALE, SAN JUAN BASIN, NEW MEXICO**

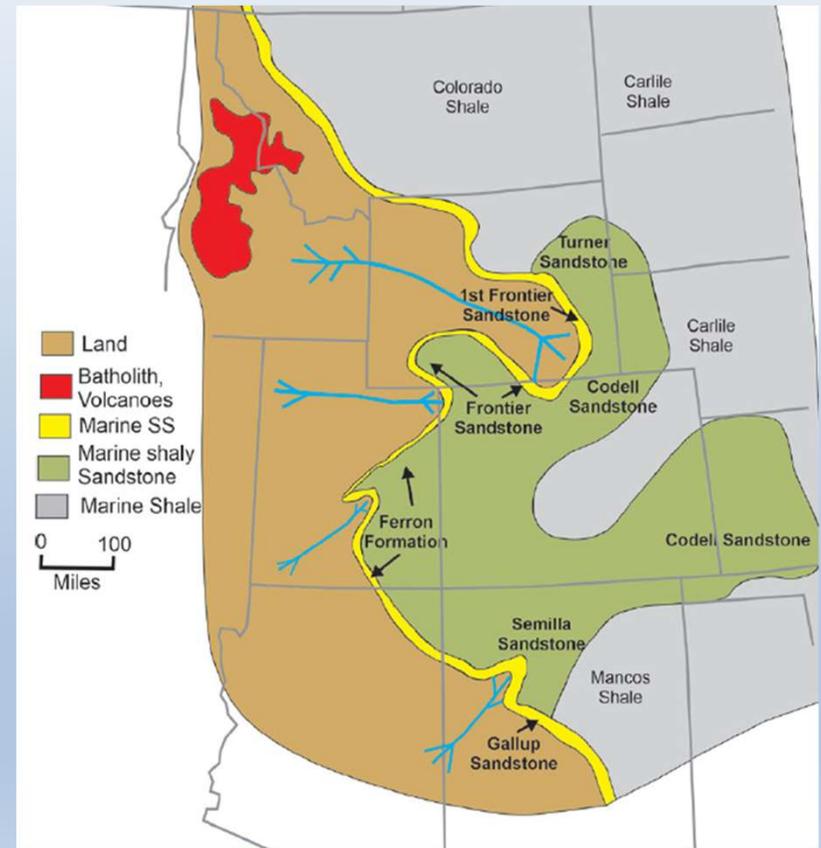
# Outline

- Geologic Background
- Study Area
- Facies Descriptions
- Outcrop Studies
- Outcrop and Core Descriptions
- Depositional Environment
- Conclusions and Future Work

# Geologic Background

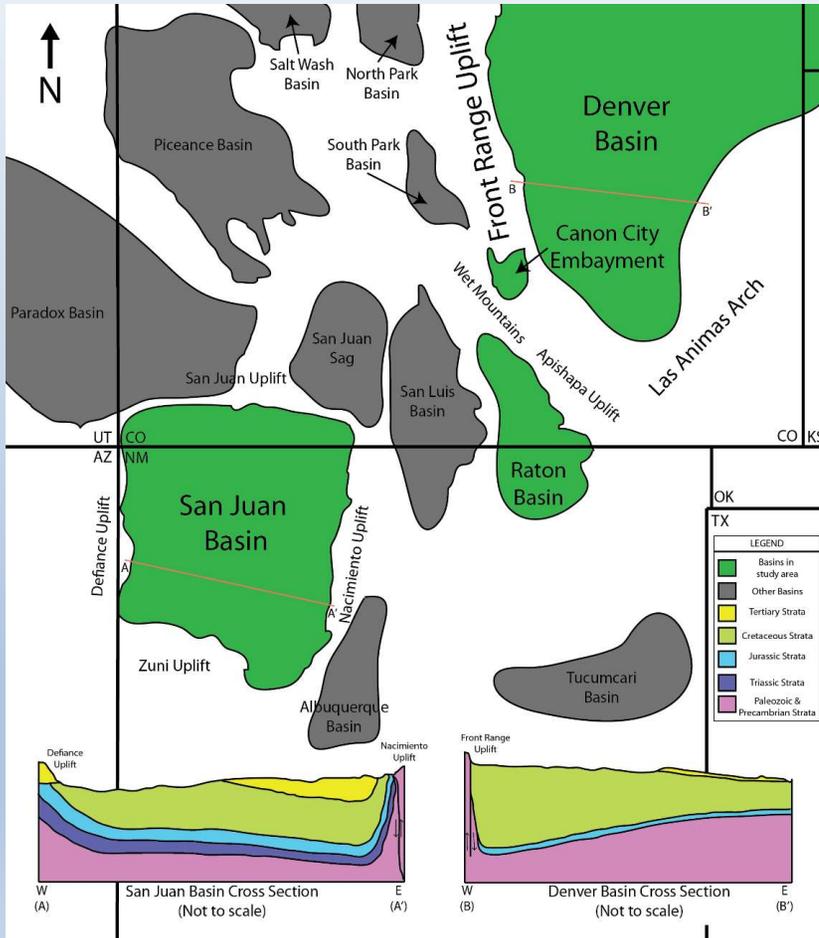


Blakey, 2016



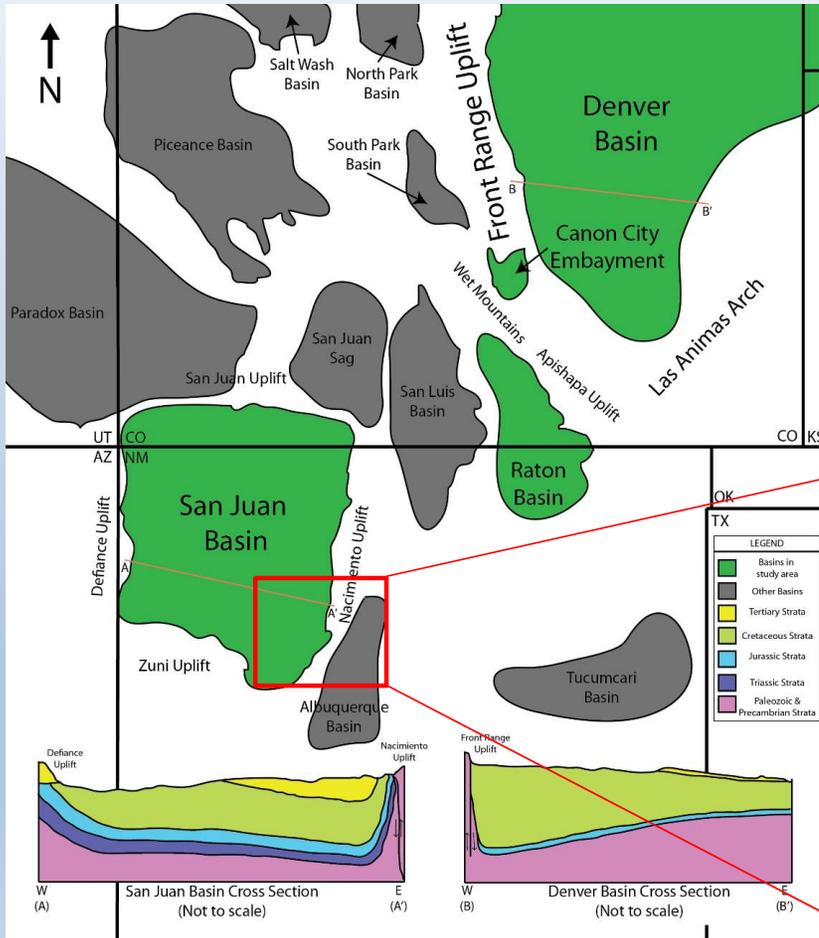
Sonnenberg, 2021

# Study Area

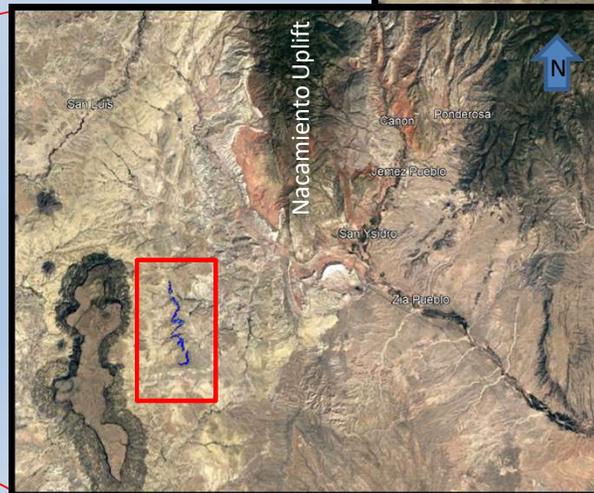
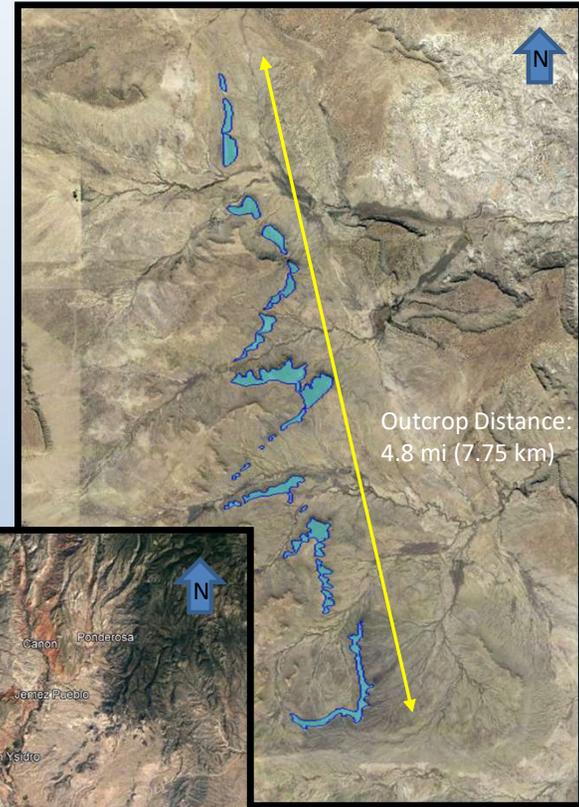


Age	Eastern San Juan Basin		Raton Basin	Southern Denver Basin
	S	N		
Coniacian	Mancos Shale		Pierre Shale	Pierre Shale
	Niobrara Fm.		Niobrara Fm.	Niobrara Fm.
	Galloup Sandstone			
89.8 Ma	Juana Lopez Mbr.		Juana Lopez Mbr.	Juana Lopez Mbr.
Turonian	Semilla Sandstone Mbr.		Codell Sandstone Mbr.	Codell Sandstone Mbr.
	Mancos Shale		Carlile Shale	Carlile Shale
93.9 Ma	Greenhorn Limestone		Greenhorn Limestone	Greenhorn Limestone
Cenomanian	Graneros Shale Mbr.		Graneros Shale	Graneros Shale

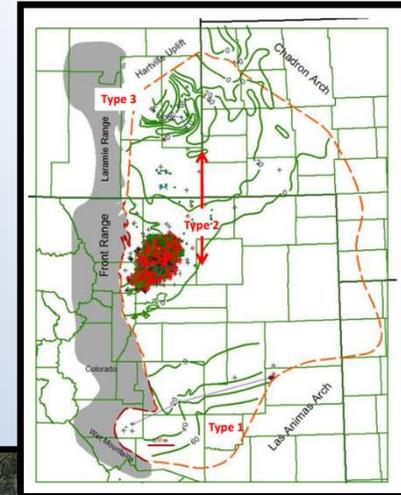
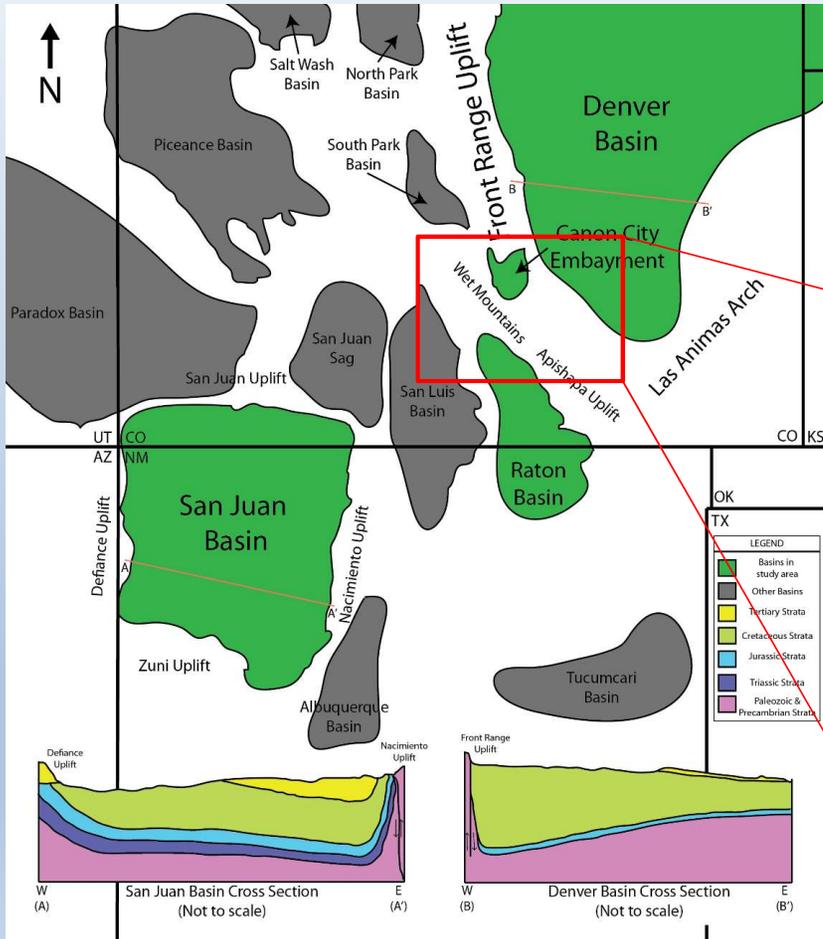
# Study Area



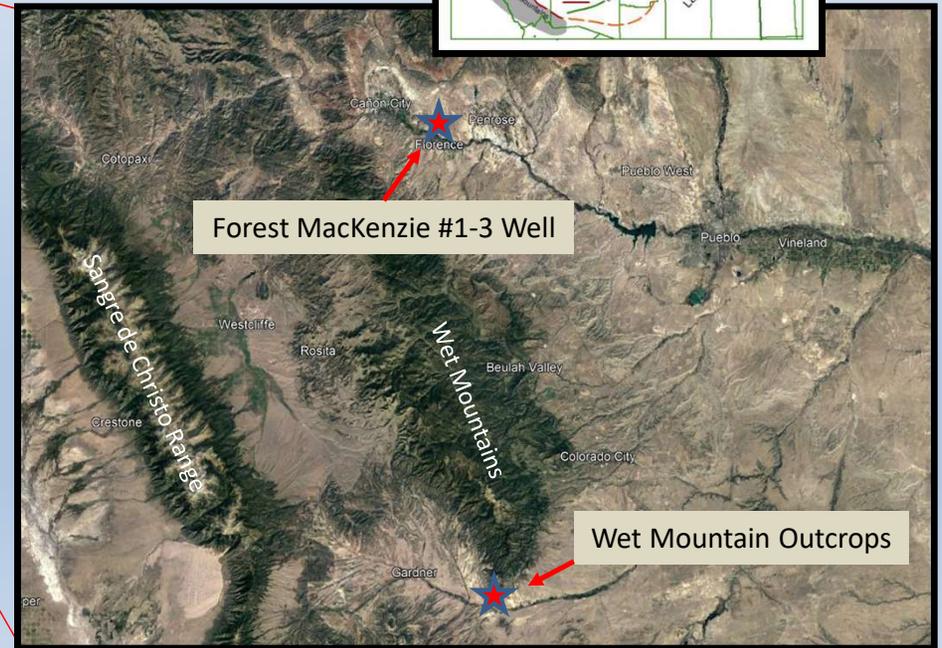
Right: Semilla Outcrops at the Bernalillito Arroyo Bar (light blue)



# Study Area



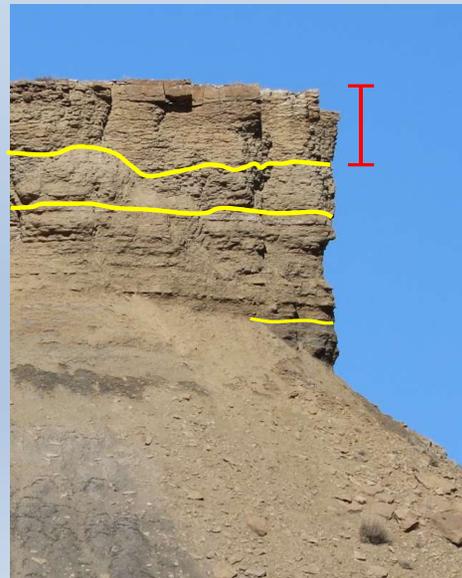
Sonnenberg, 2020



# Facies 1

## Cross Stratified Sandstone Facies

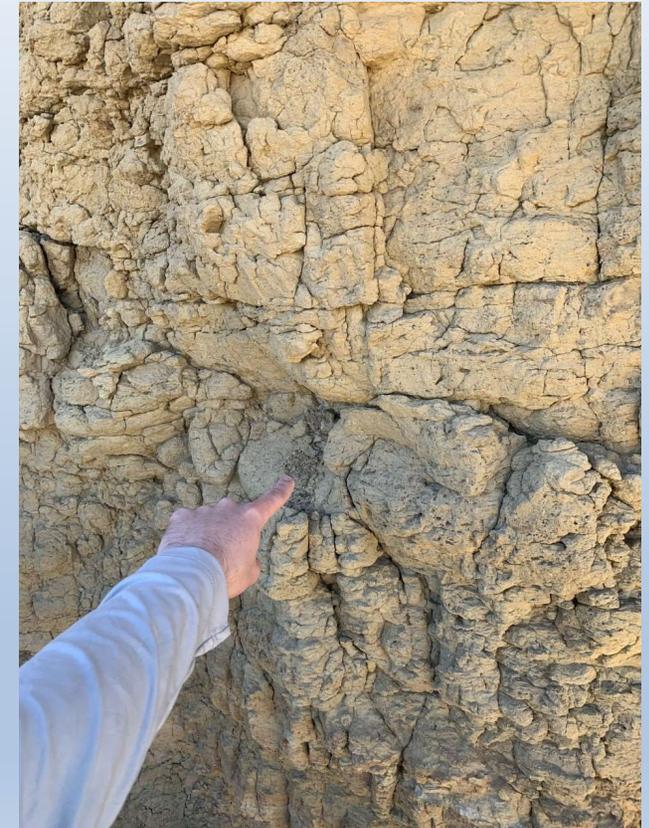
Lithology	Sandstone
Grain Size	Medium to Fine
Sedimentary Structures	Cross stratification, HCS, bidirectional cross stratification, ripple cross stratification
Thickness in outcrop	0.25m to 2m
Bioturbation	Destroys sed. structures in some places, others not present. Majority horizontal
Other Notes	Erosive lower contact with facies 2. Paleocurrent measurements indicate currents flowing southeast.



## Facies 2

### Bioturbated Sandstone Facies

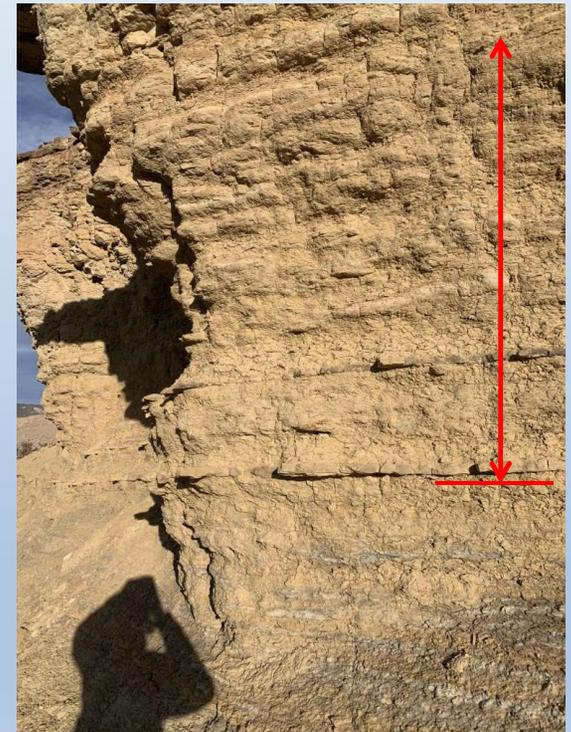
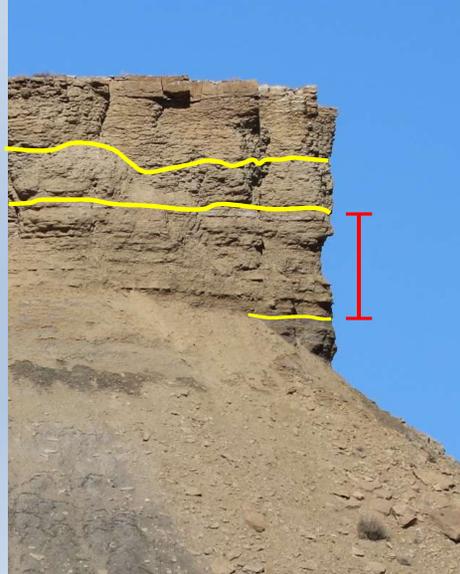
Lithology	Sandstone
Grain Size	Fine
Sedimentary Structures	Commonly destroyed by bioturbation, one documented swale
Thickness in outcrop	0.75m to 1.1m
Bioturbation	Pervasive throughout the facies, destroying all sedimentary structures
Other Notes	Most consistent thickness of all the facies



# Facies 3

## Heterolithic Facies

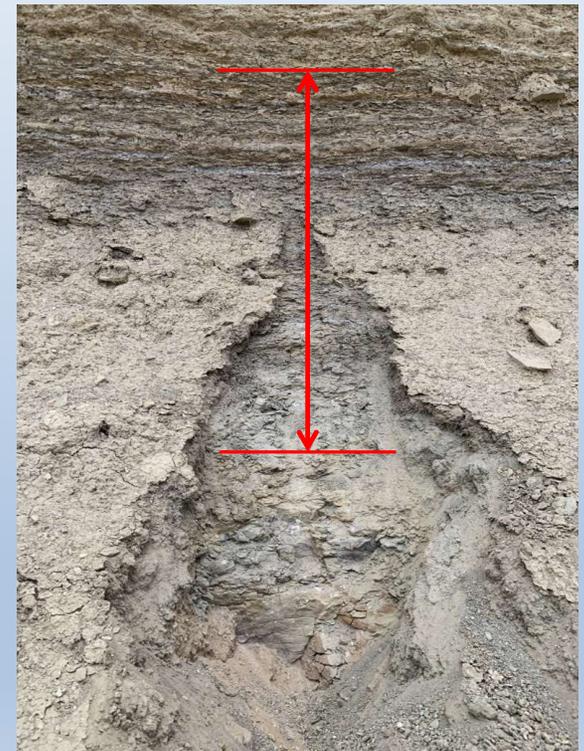
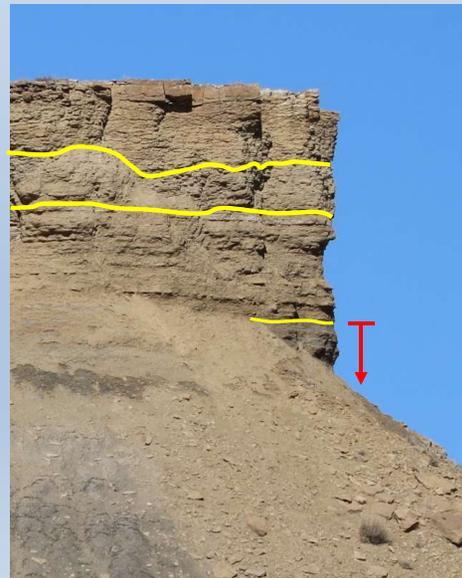
Lithology	Heterolithic (alternating beds of sand and siltstone)
Grain Size	Fine grained sandstone Silt sized grains in siltstone
Sedimentary Structures	Ripple cross stratification in sandstone beds
Thickness in outcrop	1.5m to 4m
Bioturbation	Present in siltstone beds
Other Notes	Sandstone beds on cm scale. Boundary with lower facies noted when sandstone beds are no longer present



# Facies 4

## Siltstone Facies

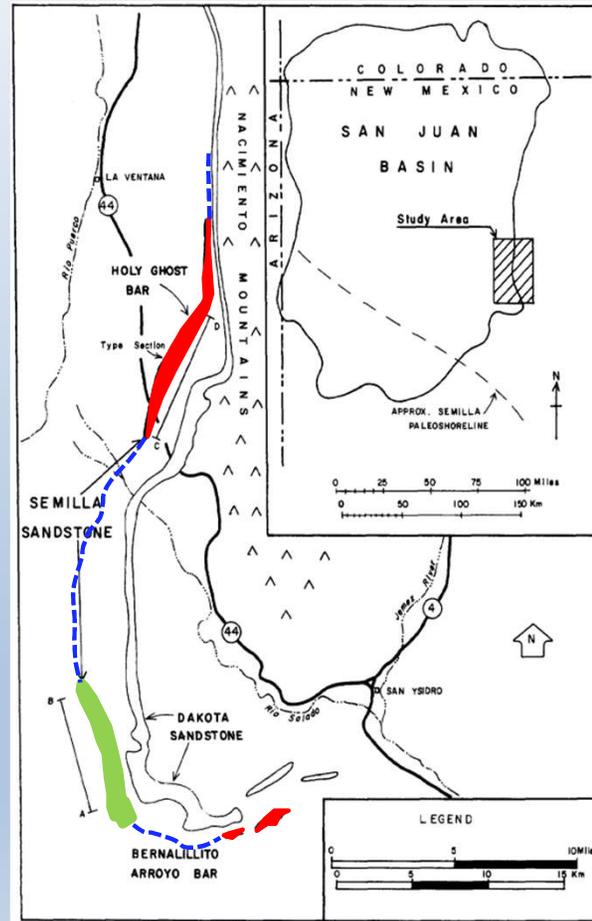
Lithology	Siltstone
Grain Size	Silt
Sedimentary Structures	None seen in outcrop scale
Thickness in outcrop	1.5m to 2.5m
Bioturbation	Pervasive
Other Notes	Septarian concretions reaching 1m in diameter. Present in bar complexes and in inter bar areas



# Facies 4

## Siltstone Facies

Lithology	Siltstone
Grain Size	Silt
Sedimentary Structures	None seen in outcrop scale
Thickness in outcrop	1.5m to 2.5m
Bioturbation	Pervasive
Other Notes	Septarian concretions reaching 1m in diameter. Present in bar complexes and in inter bar areas



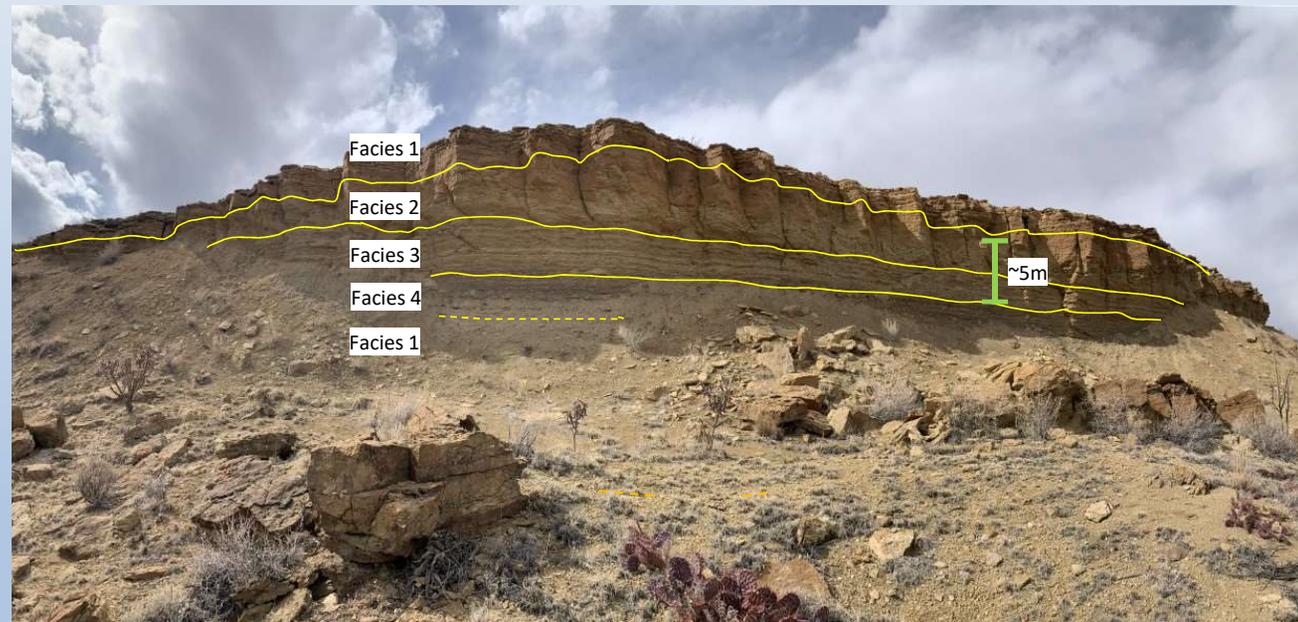
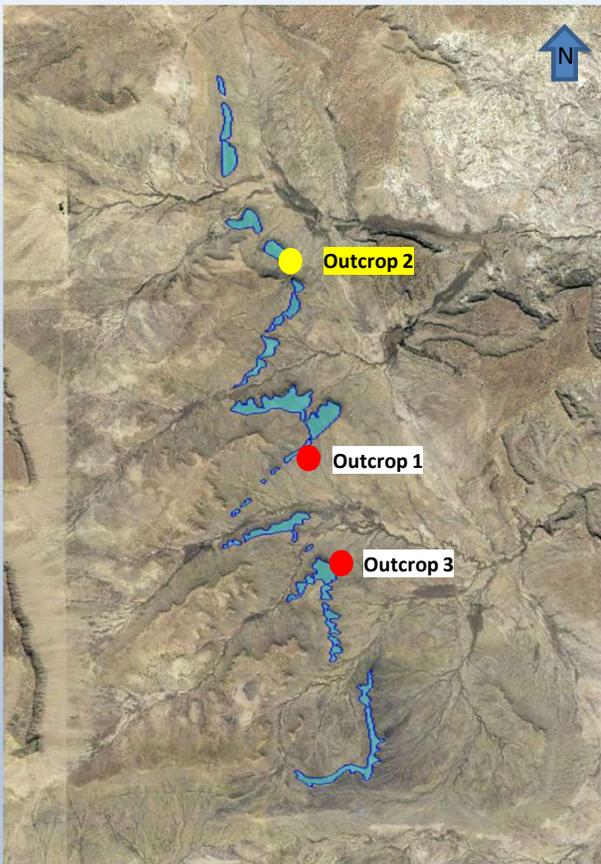
Modified from La Fon, 1981

**Green:** main outcrop area, Bernalillito Arroyo Bar, with all four facies present

**Red:** other outcrops with all four facies present

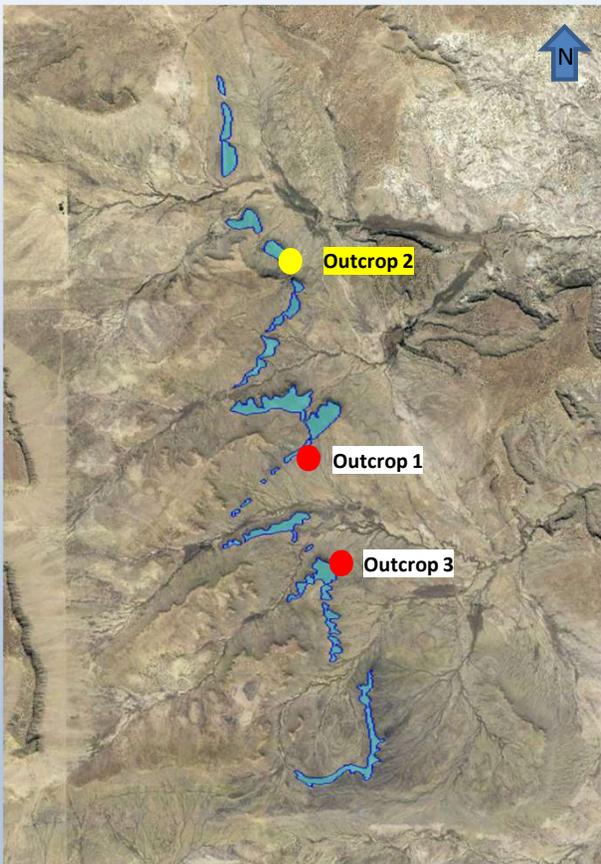
**Blue dashed:** only facies 4 present, mappable by presence of septarian concretions (Owen et al. 2007)

# Outcrop Studies

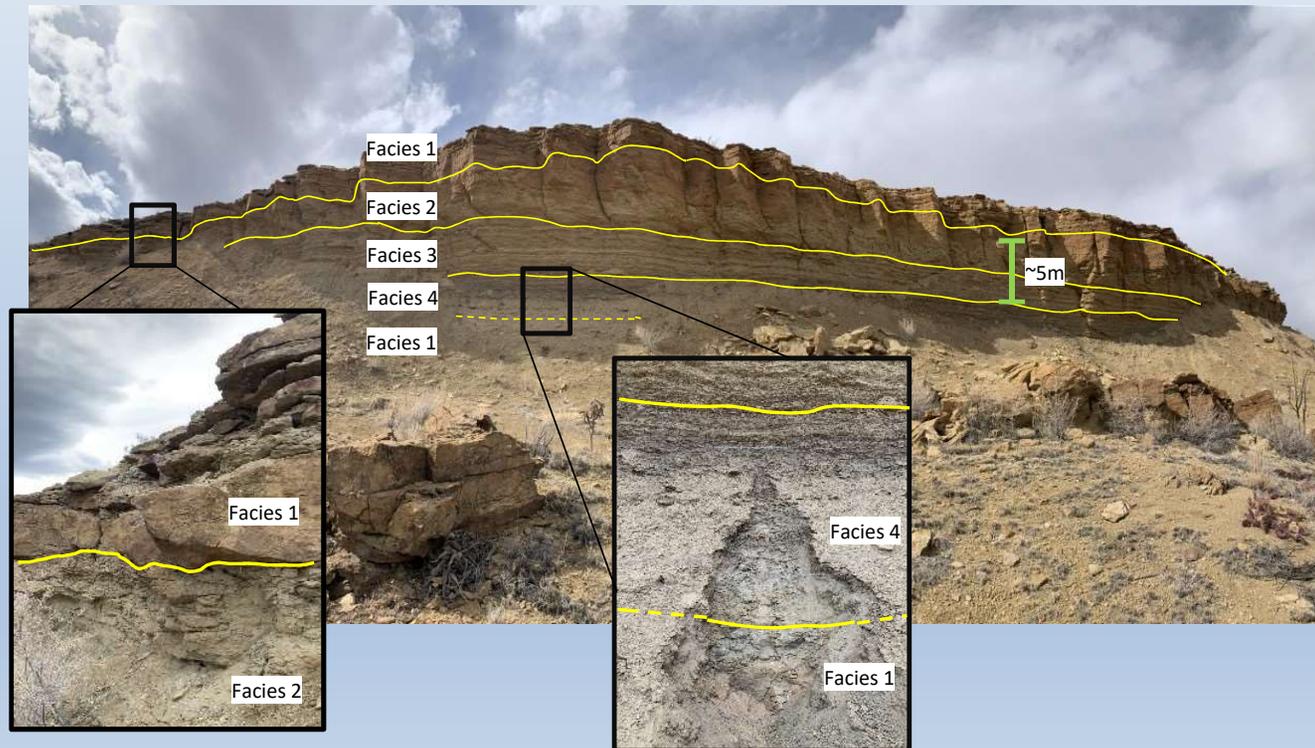


- Facies 1:** Cross Stratified Sandstone
- Facies 2:** Bioturbated Sandstone
- Facies 3:** Heterolithic Facies
- Facies 4:** Siltstone

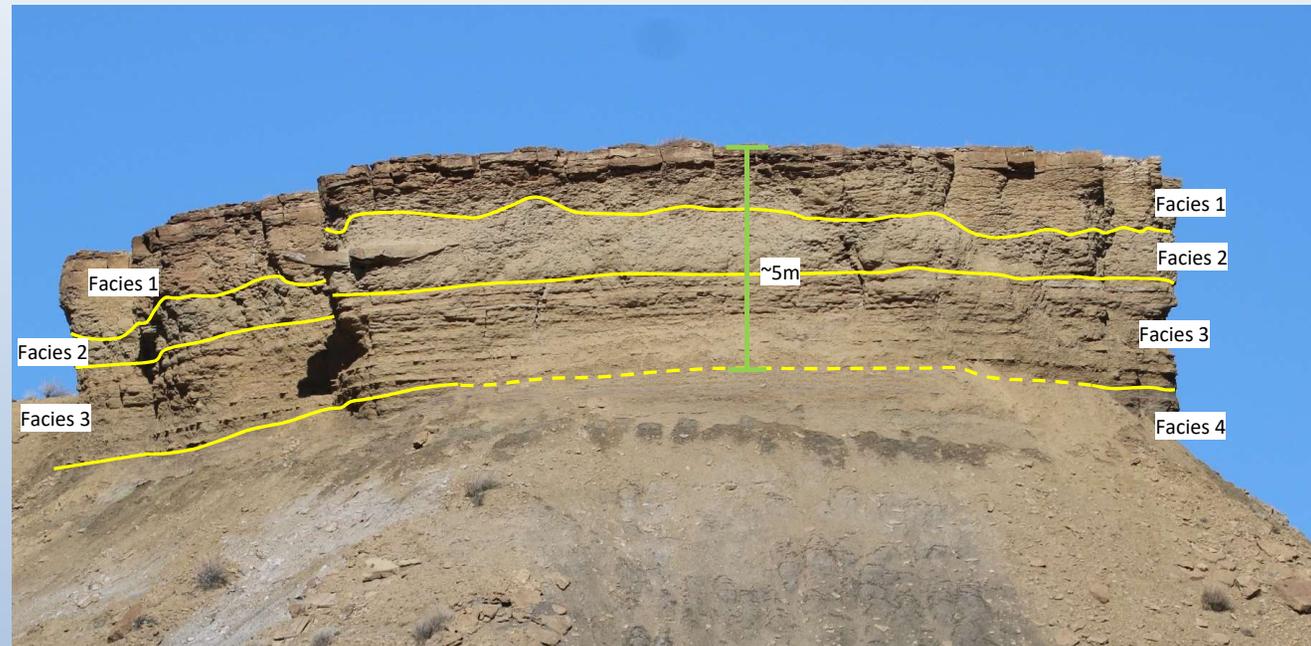
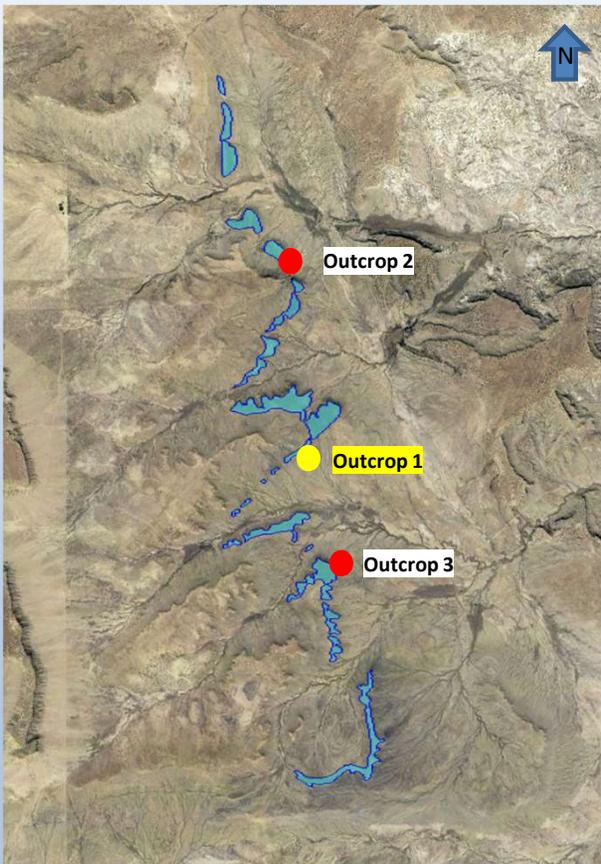
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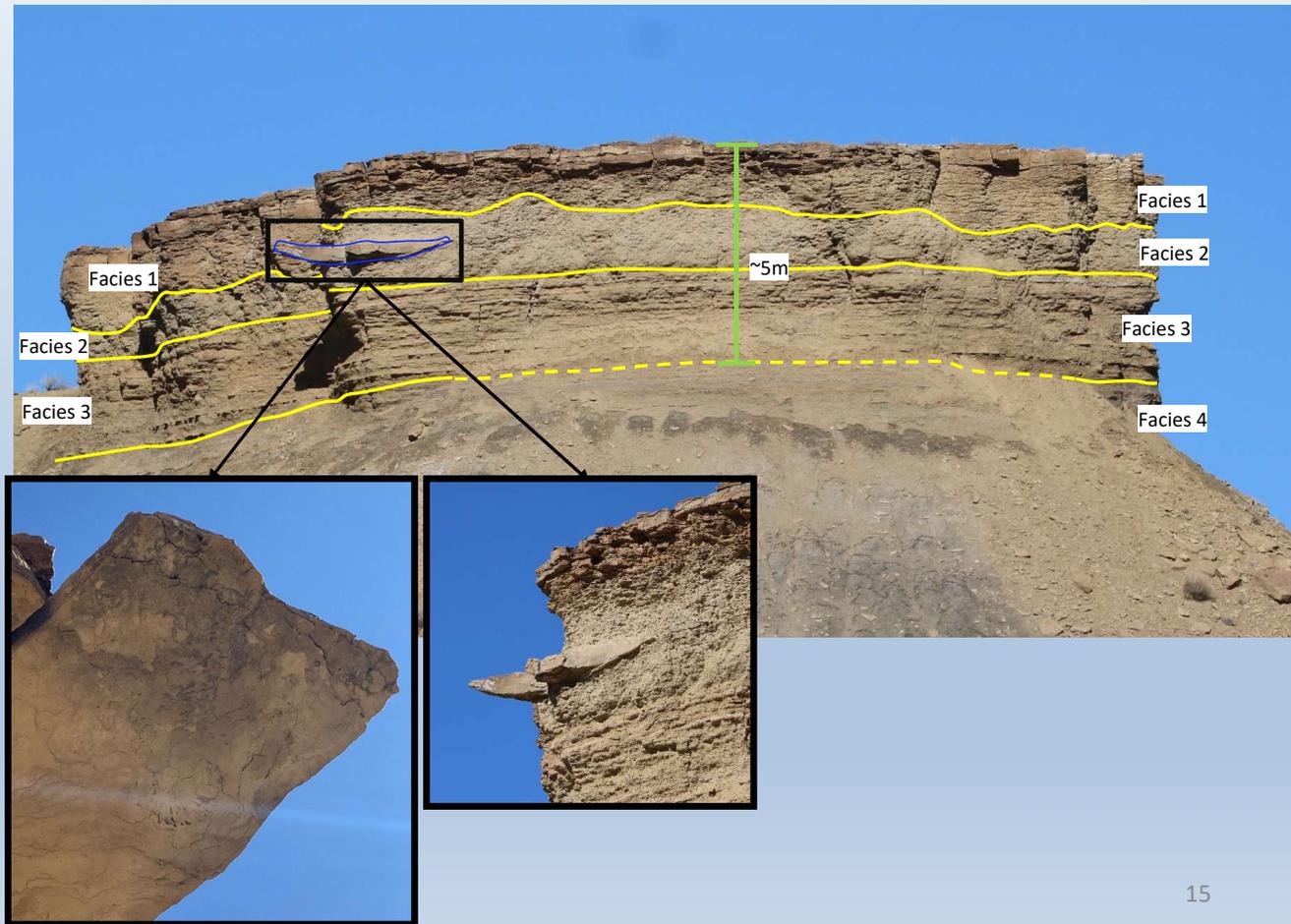
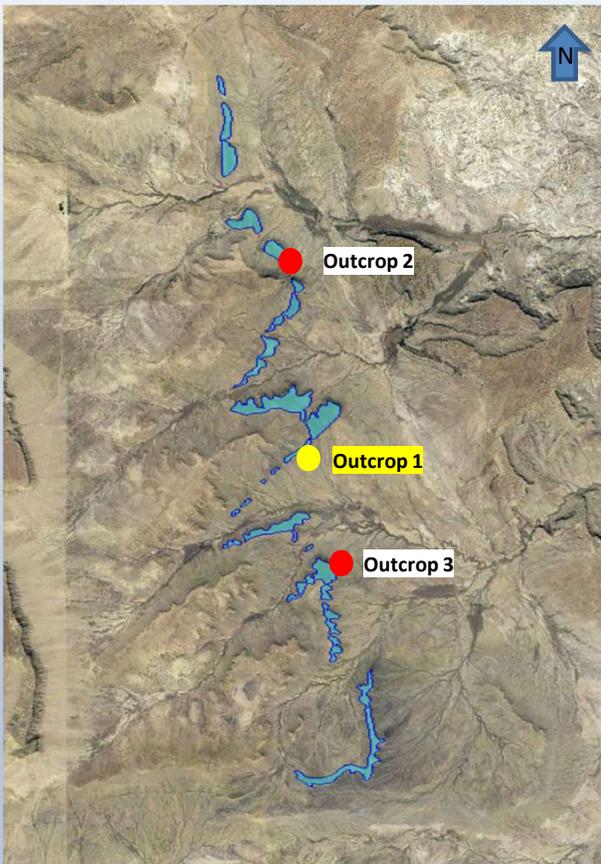


# Outcrop Studies



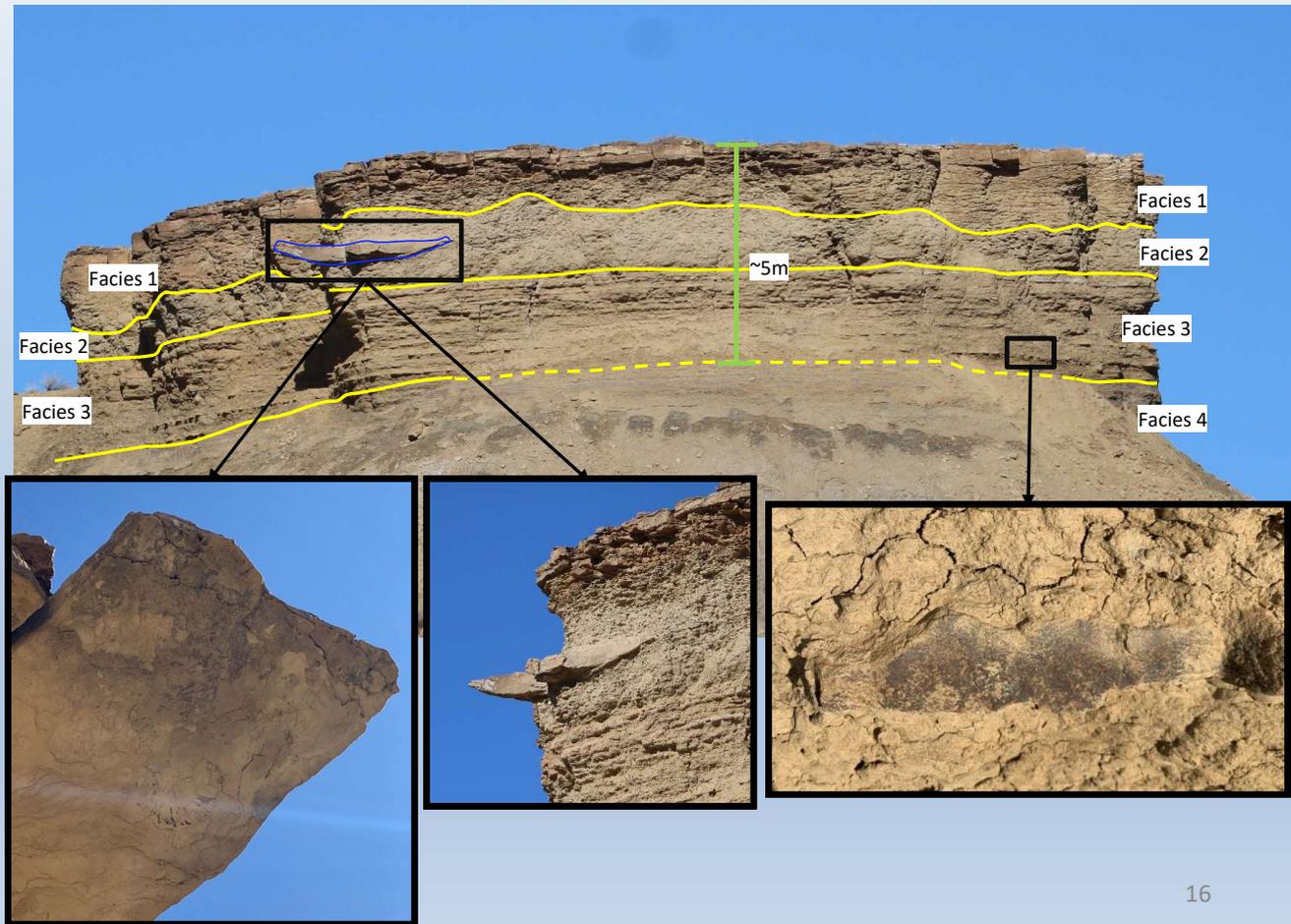
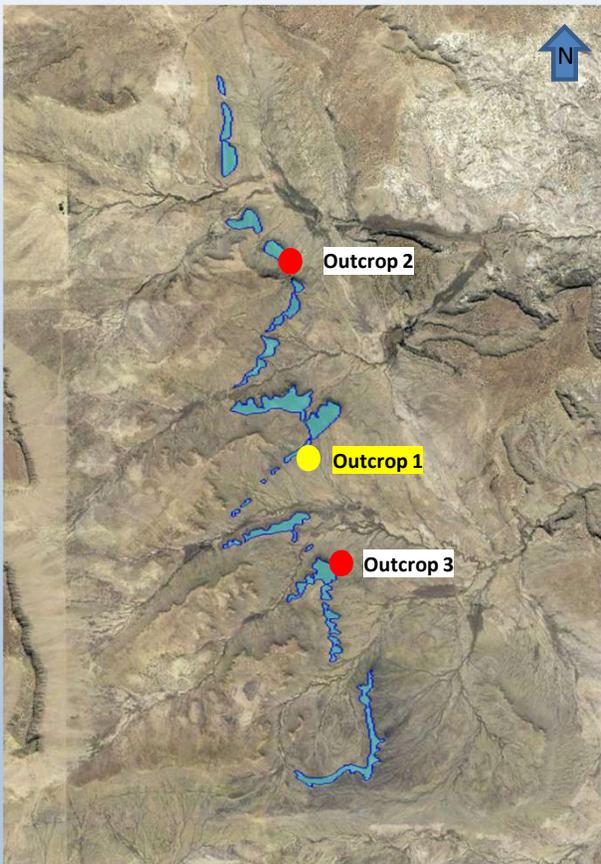
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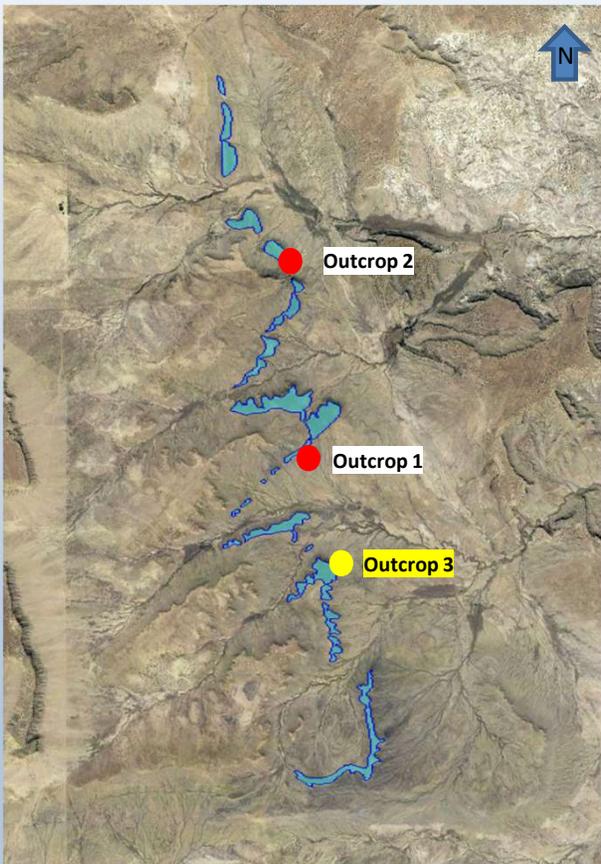
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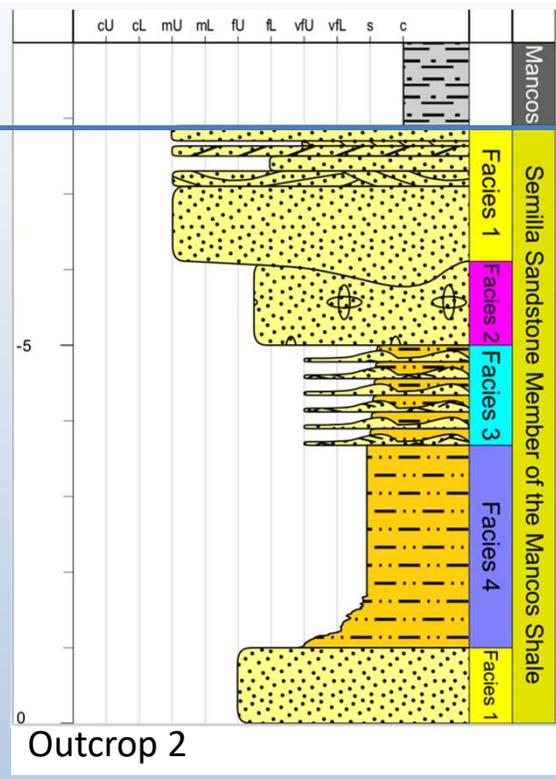
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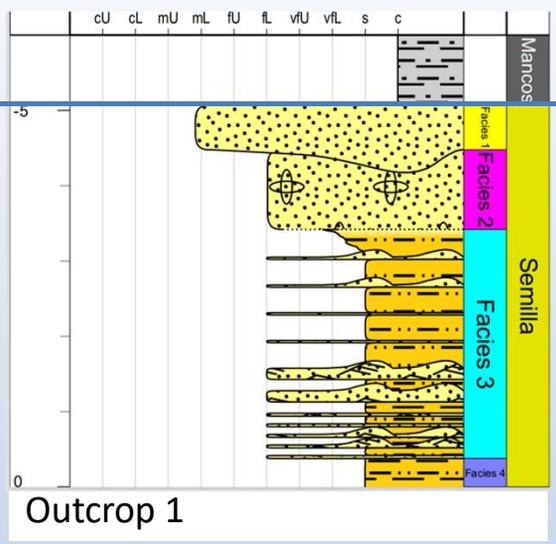


- Facies 1:** Cross Stratified Sandstone
- Facies 2:** Bioturbated Sandstone
- Facies 3:** Heterolithic Facies
- Facies 4:** Siltstone

North

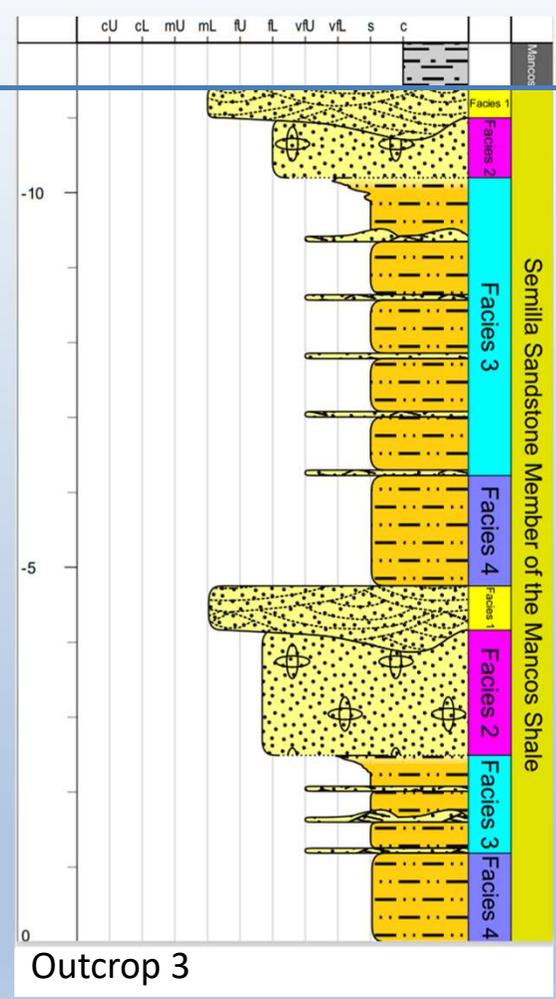


Outcrop 2

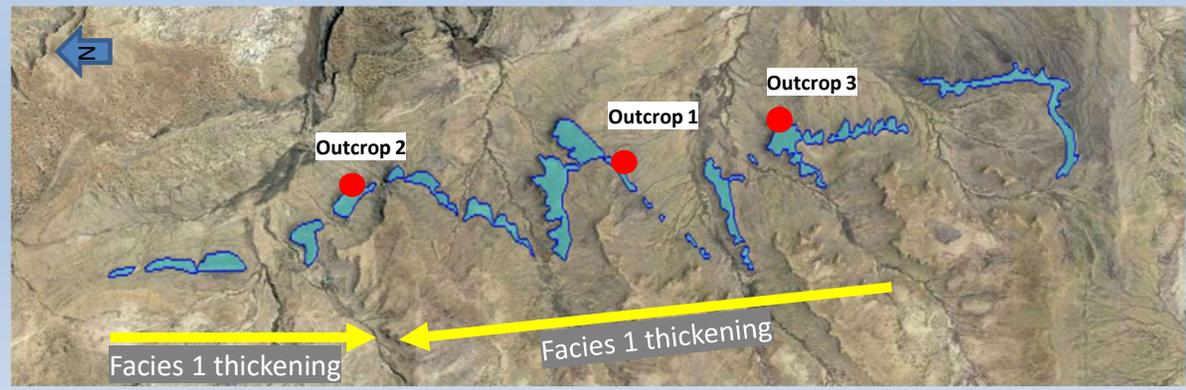


Outcrop 1

South



Outcrop 3

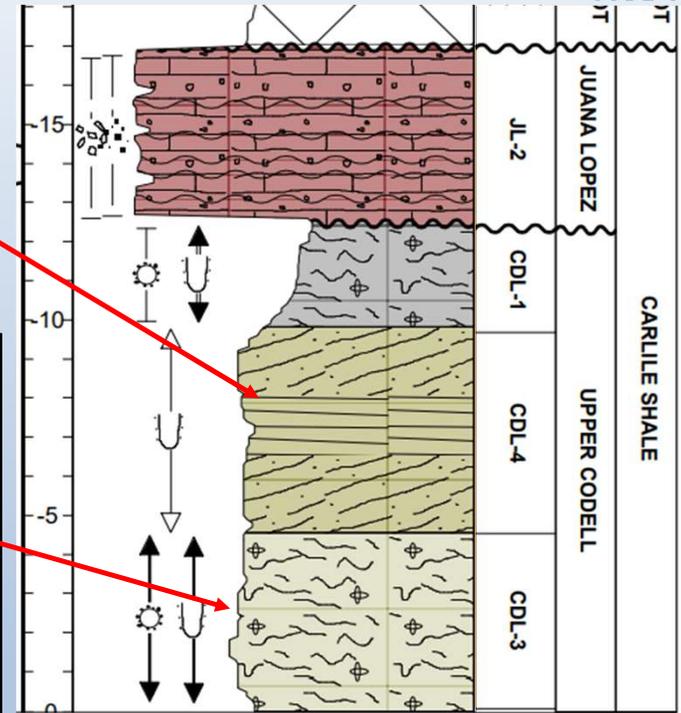
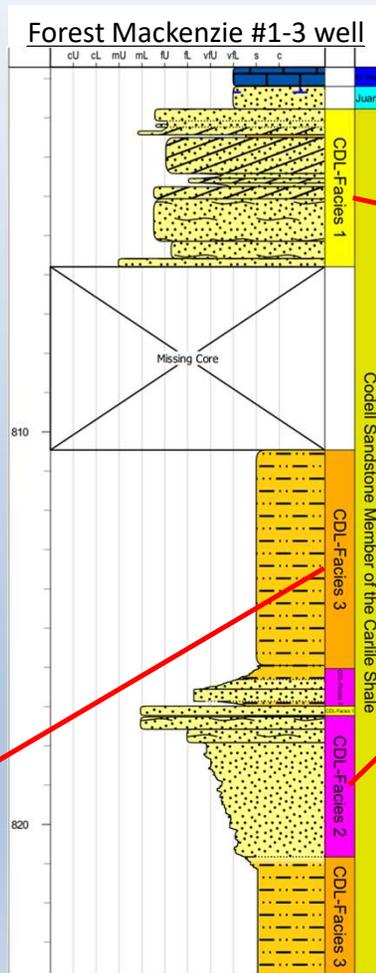


# Codell – Core and Outcrop Descriptions

**CDL-Facies 1:** Cross stratified, medium to fine grained sandstone with bioturbation ranging from 3 to absent

**CDL-Facies 2:** pervasively bioturbated, fine to very fine grained sandstone with no sedimentary structures preserved

**CDL-Facies 3:** pervasively bioturbated sandy siltstone with Teichichnus and Planolites burrows



Lewis, 2013

**Left:** Forest MacKenzie #1-3 well (Canon City Embayment) description, lower Ft. Hays, Juana Lopez and Codell Sandstone section

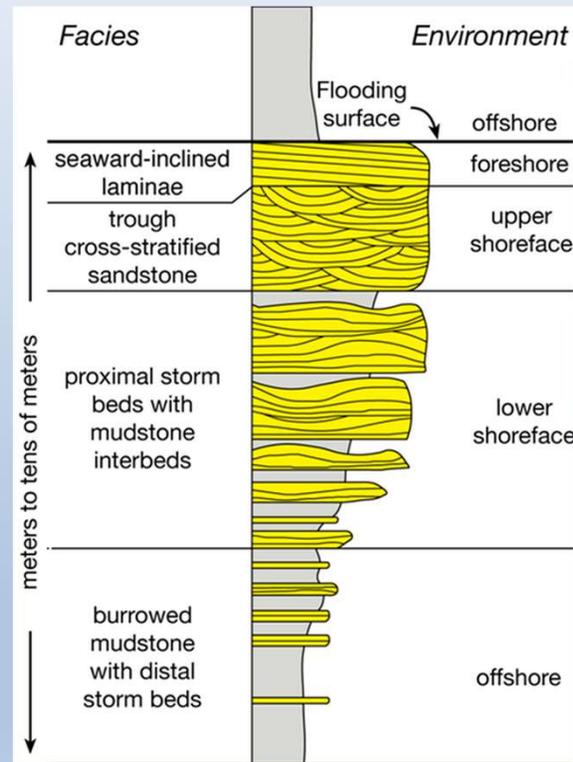
**Up:** Codell Sandstone outcrop from the Wet Mountains (northern Raton Basin), described by Topher Lewis in 2013



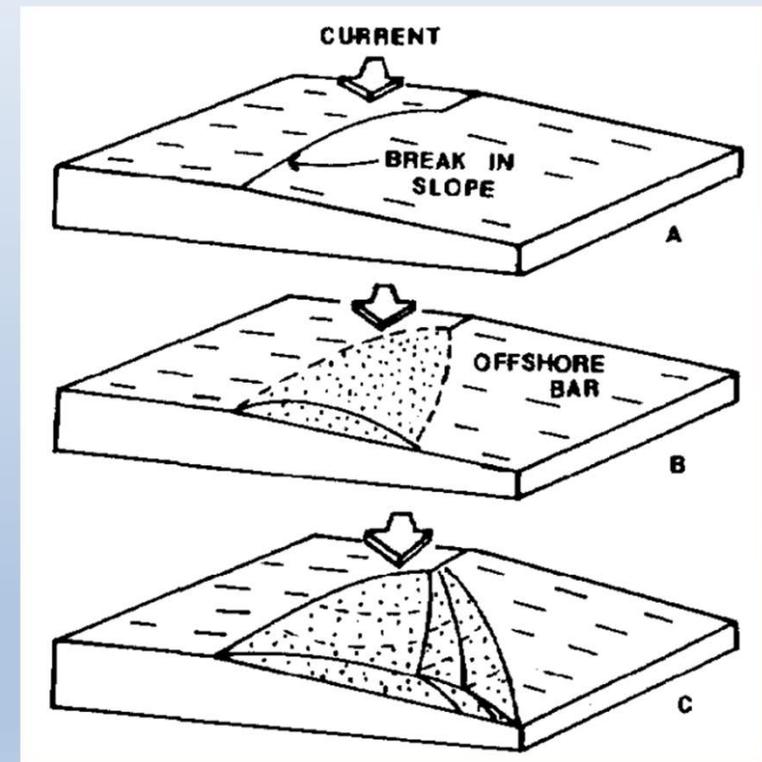
# Depositional Environment

Lewis, 2013, on the Codell: “the Codell Sandstone is not an isolated current-derived shelf sand, it is a depositional remnant of a **shoreface** deposit with no remaining shoreline connection.”

La Fon, 1981 on the Semilla: “surface tracing of outcrops... reveals two sand bodies formed as discrete, offshore sand bodies enclosed within the Mancos Shale... the Semilla Sandstone and most other **bars** formed as a result of storm processes.”



Van Wagoner et al., 1990



La Fon, 1981

# Depositional Environment

## Semilla Interpretations

Author	Date	Interpreted Depositional Environment
Dane, et al.	1968	Shallow marine waters
La Fon	1981	Offshore shallow-marine sandbars
Flemming	1989	Shelf Sand Ridge

## Codell Interpretations

Author	Date	Interpreted Depositional Environment
Pinel	1977	Shelf bar
Aulia	1982	Shelf bar
Mclane	1982	Shoreline origin
Weimer and Sonnenberg	1988	Marine shelf or shoreline bar
Lewis	2013	Shoreface

Observation	Interpretation (shoreface or ridge)
Facies change in thickness	Both
Facies thin completely near the edges of outcrop area in Semilla	Both
No evidence of erosion at edges of outcrop area in Semilla	Both
Sandstone coarsens upward	Both
Trace fossils match those seen in shallow marine environments	Both
No evidence of subaerial exposure (root zones or coal beds)	Ridge

# Conclusions & Future Work

<u>Conclusions</u>	<u>Future questions to answer in this project</u>
<p>1. The Codell and Semilla are time equivalent and very stratigraphically similar.</p>	<p>1. Does the Semilla show similar discontinuity in the subsurface upon analysis of well log data?</p>
<p>2. Based on these comparisons, their depositional environment are interpreted to be similar (with changes in proximity to source).</p>	<p>2. What lithological differences can be found between the Codell and Semilla after petrographic analysis and what can that show about proximity to source?</p>
<p>3. Outcrop studies of the Semilla show evidence of being deposited as shelf ridges, with pinching out of facies and no evidence of subaerial exposure.</p>	<p>3. What does Codell / Semilla deposition / preservation look like in the area between the San Juan Basin and the Raton Basin?</p>
<p>4. The Semilla shows promise as a CCS reservoir.</p>	

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