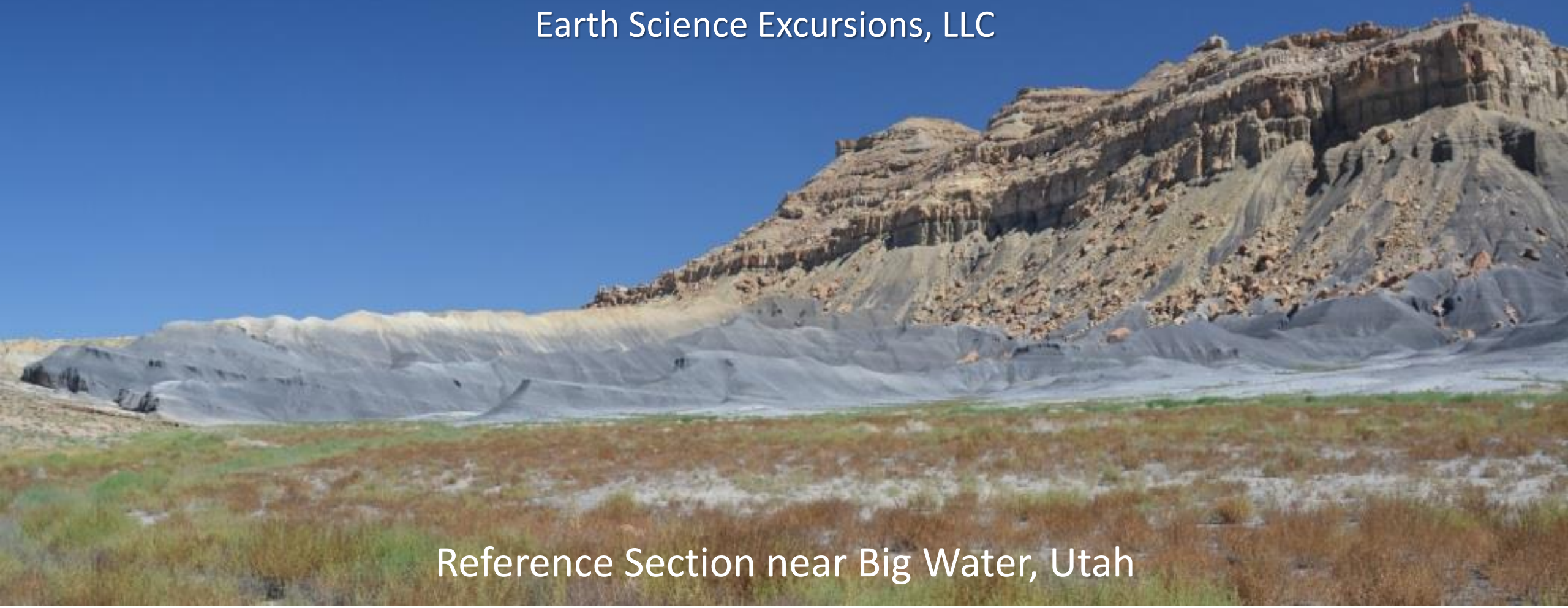


**CRETACEOUS TROPIC SHALE OF SOUTHERN UTAH: AN UNDERUTILIZED NATURAL  
OBSERVATORY ON PUBLIC LANDS FOR RESEARCH IN SHALE DEPOSITIONAL FACIES  
AND PROCESSES, MID-CRETACEOUS PALEOCLIMATES AND CARBON BURIAL**

Fred Zelt  
Earth Science Excursions, LLC



Reference Section near Big Water, Utah



# Croton Canyon, southeastern Kaiparowits Plateau, Utah





# Croton Canyon, southeastern Kaiparowits Plateau, Utah



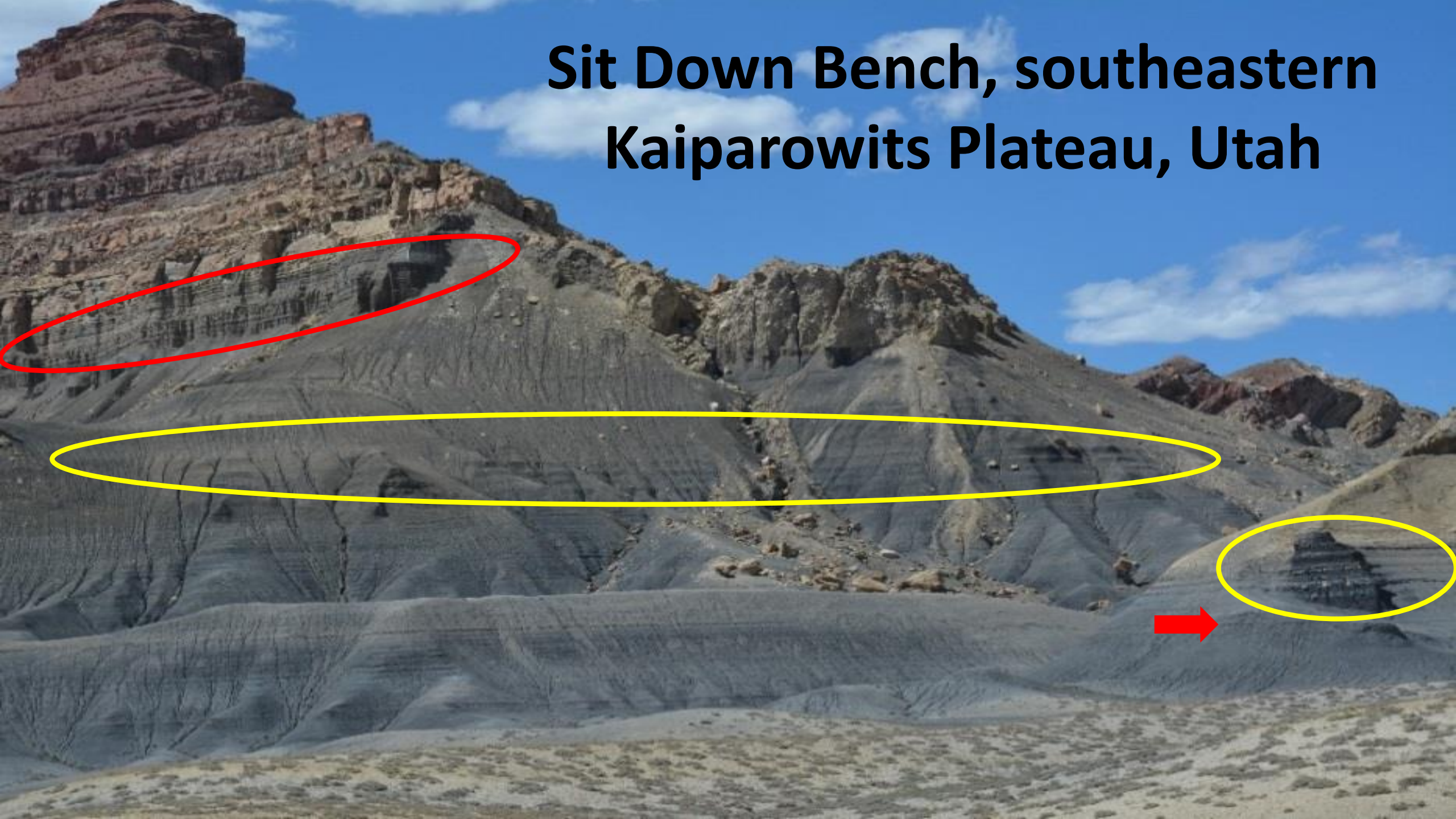


# Sit Down Bench, southeastern Kaiparowits Plateau, Utah



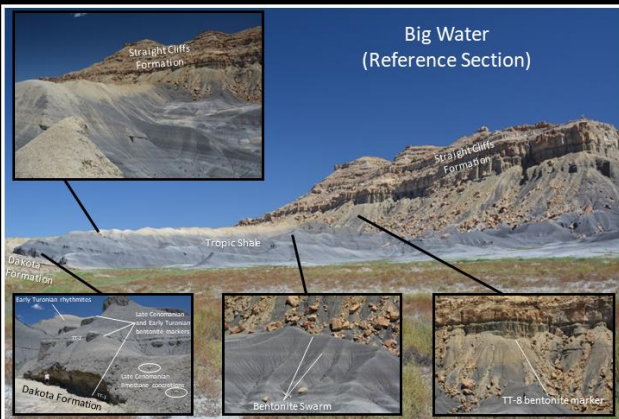
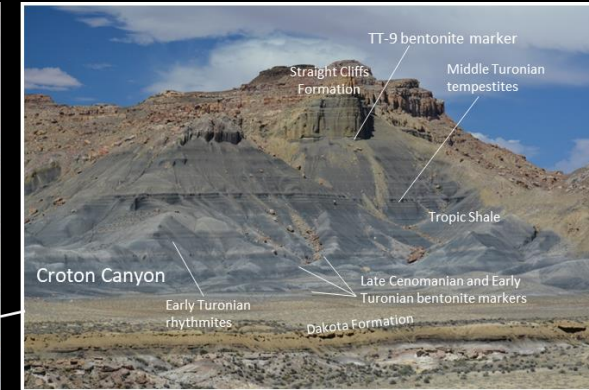
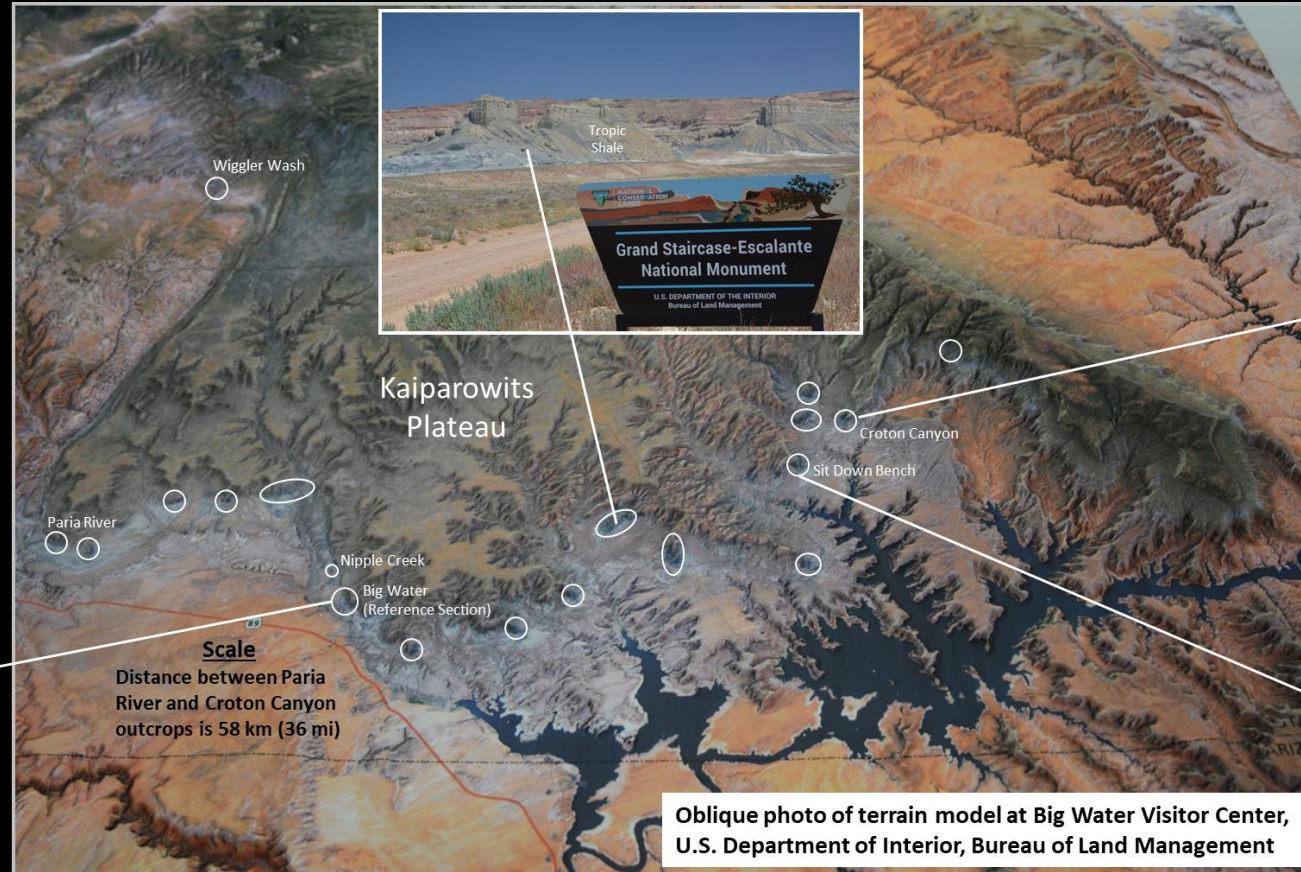


# Sit Down Bench, southeastern Kaiparowits Plateau, Utah



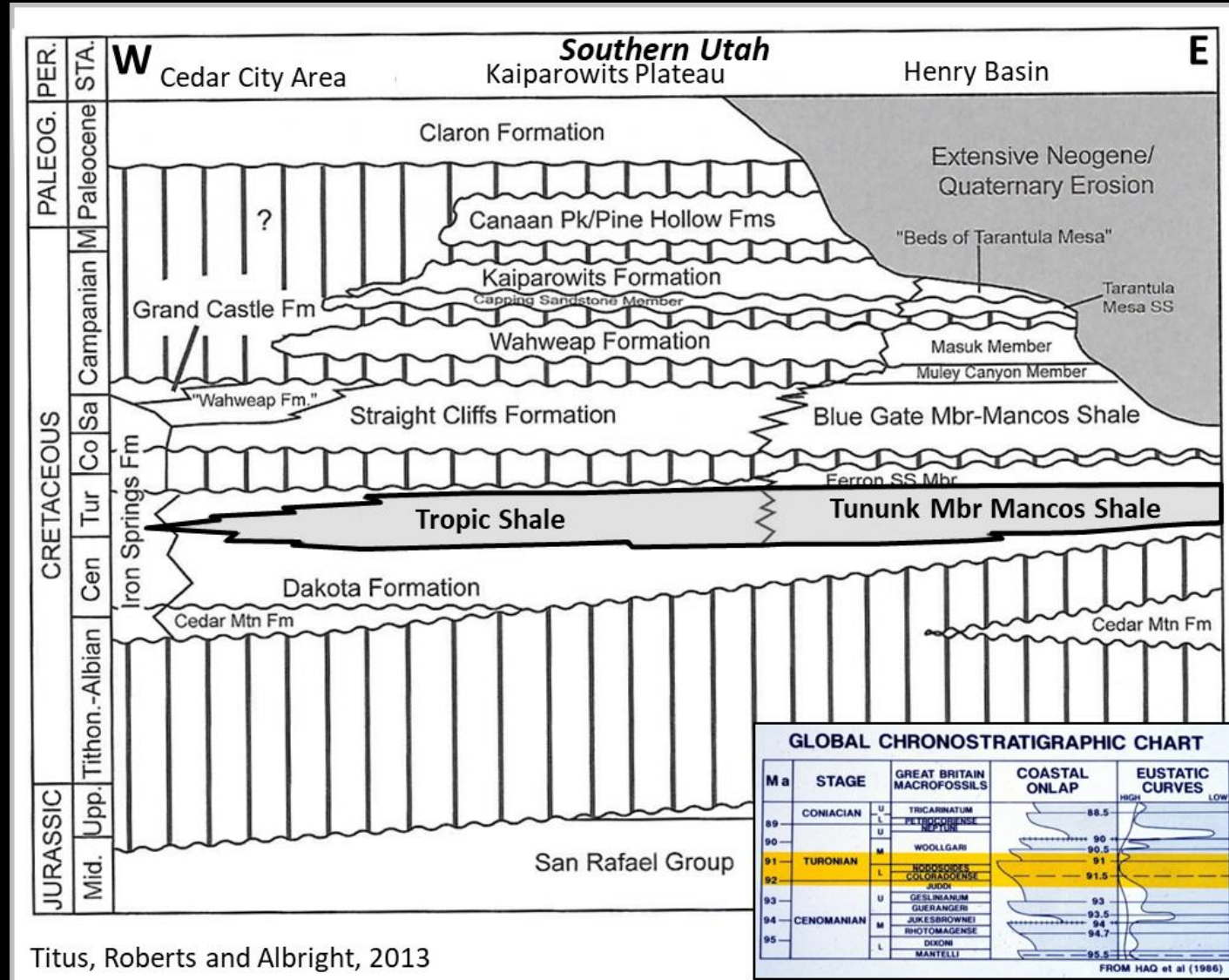
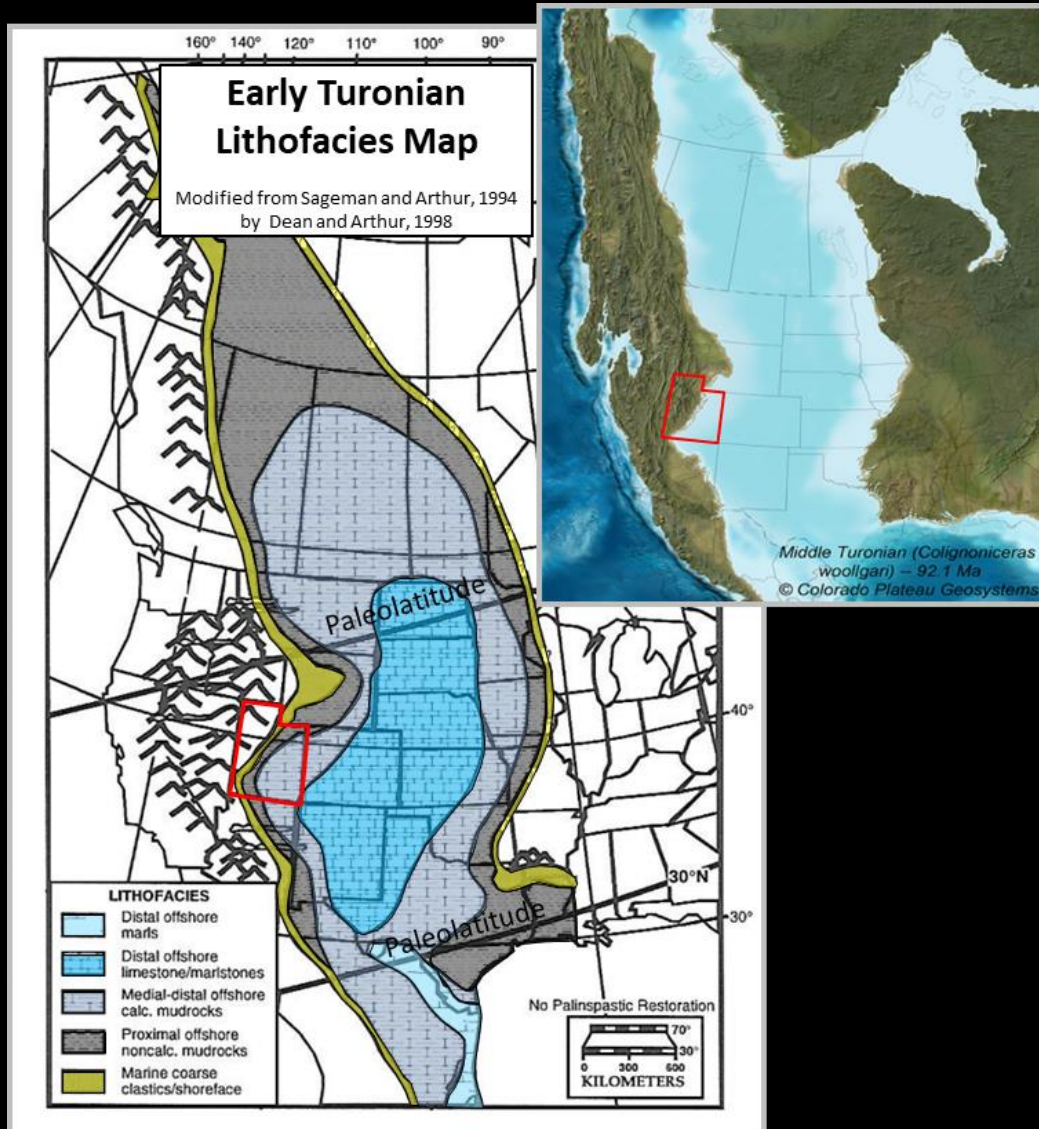


# Tropic Shale outcrops on public land, southern flank of Kaiparowits Plateau, Utah



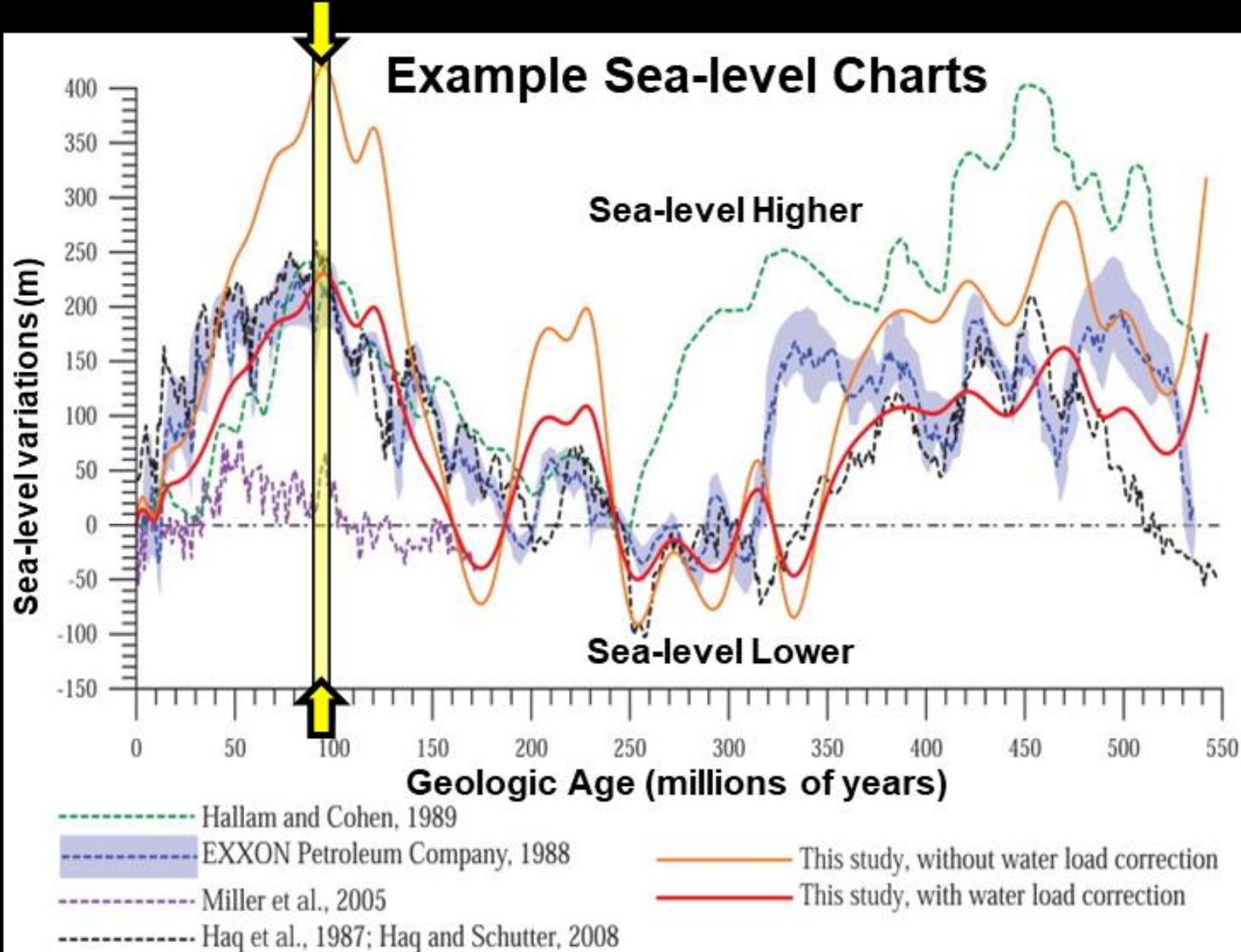


# Foreland Basin Setting





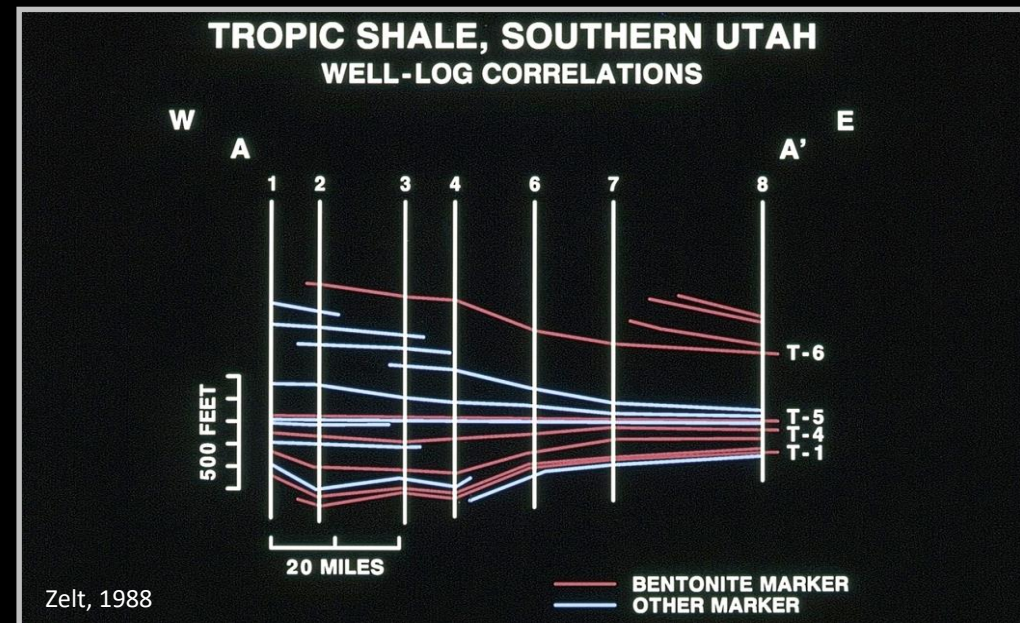
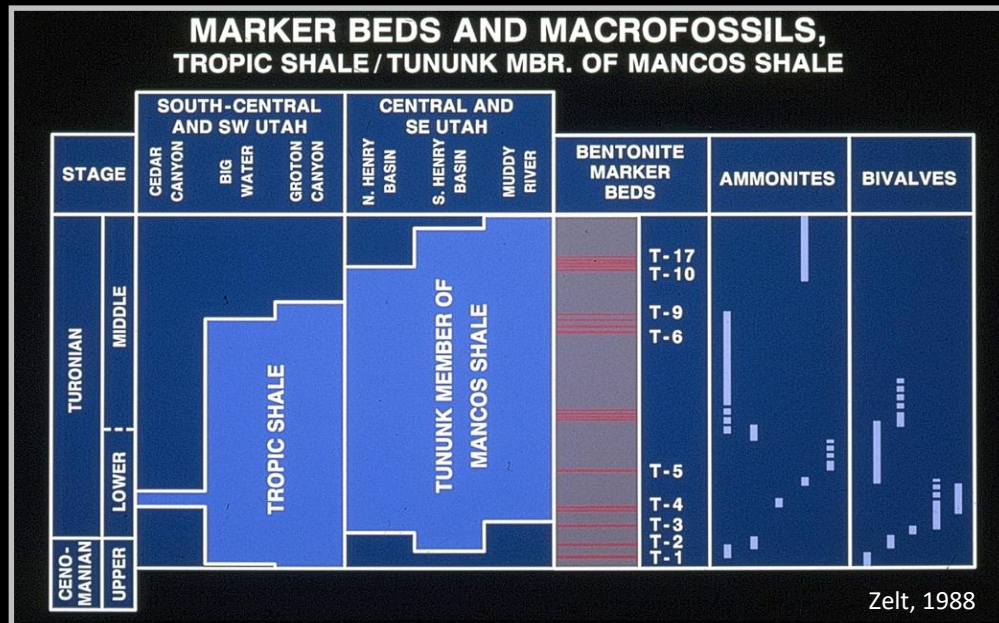
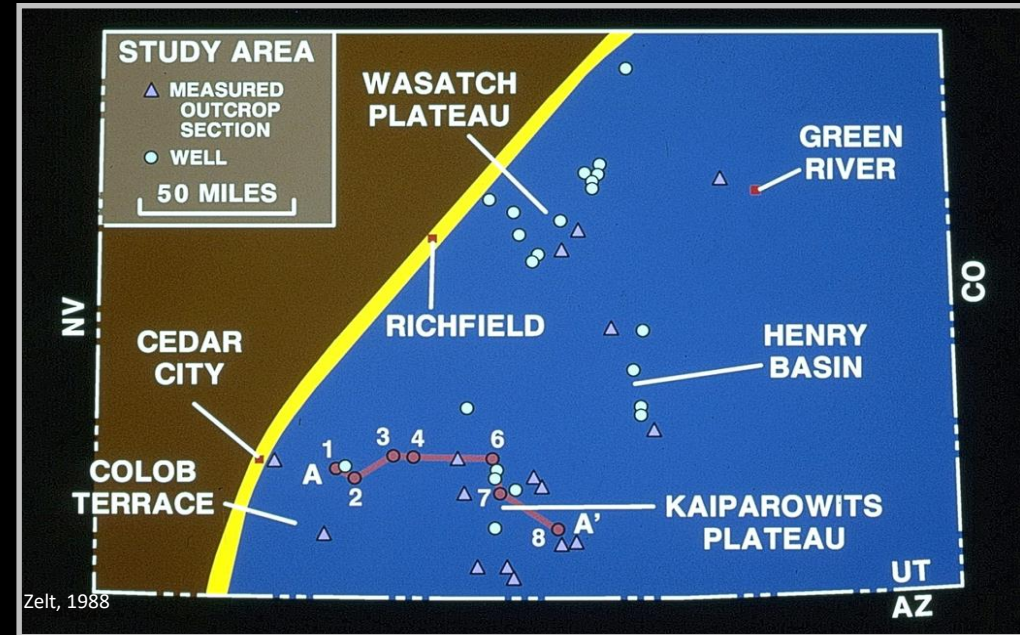
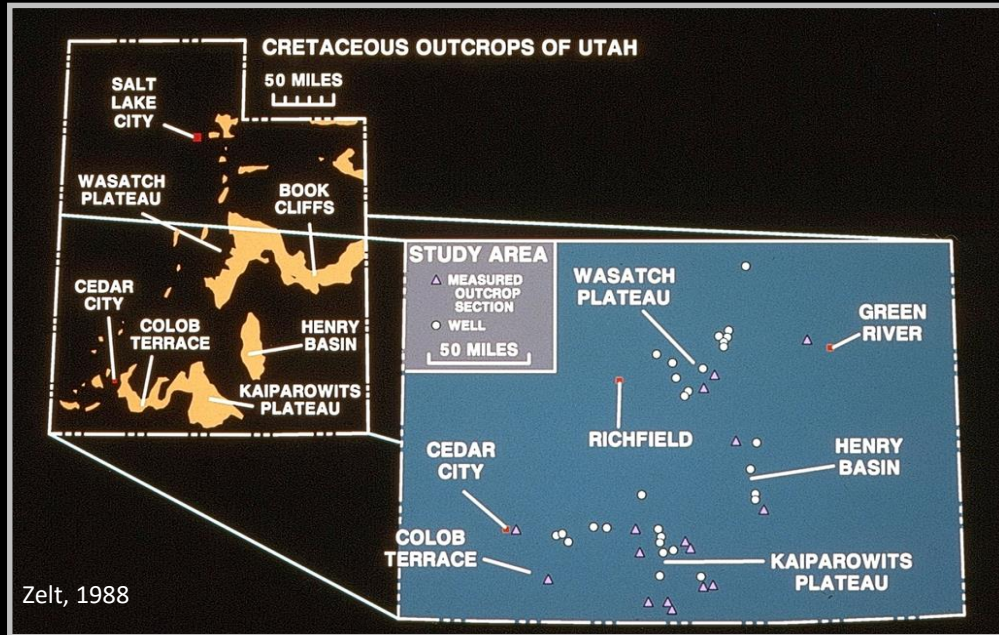
## Example Sea-level Charts



**Early  
Turonian  
Maximum  
Marine Flood**



# Tropic Shale Physical Stratigraphy and Biostratigraphy





# TROPIC SHALE, SOUTHERN UTAH

W

LITHOFACIES

E

A

A'

1

2

3

4

6

7

8

STRAIGHT  
CLIFFS  
FM.

TROPIC  
SHALE

DAKOTA  
FM.

500 FEET

20 MILES

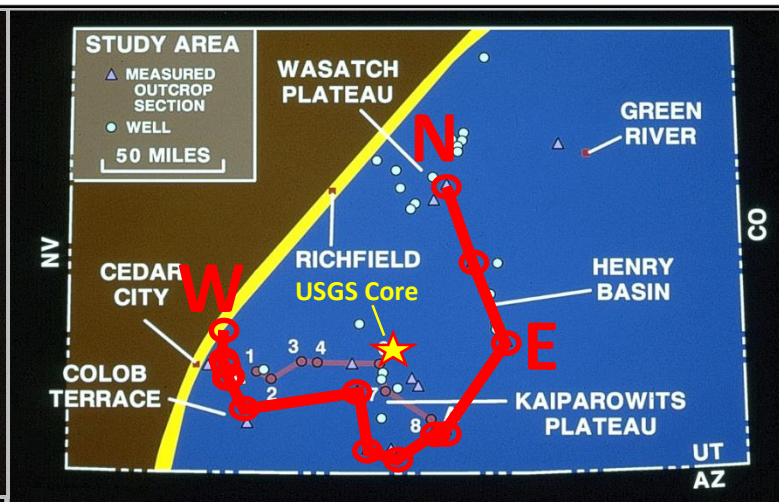
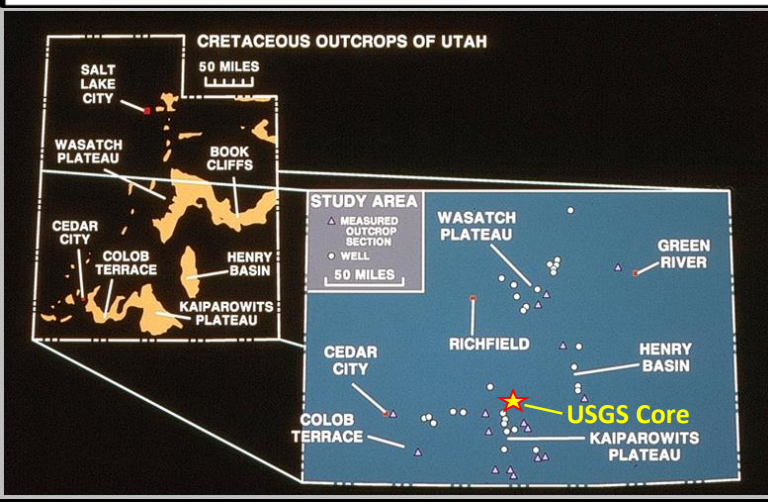
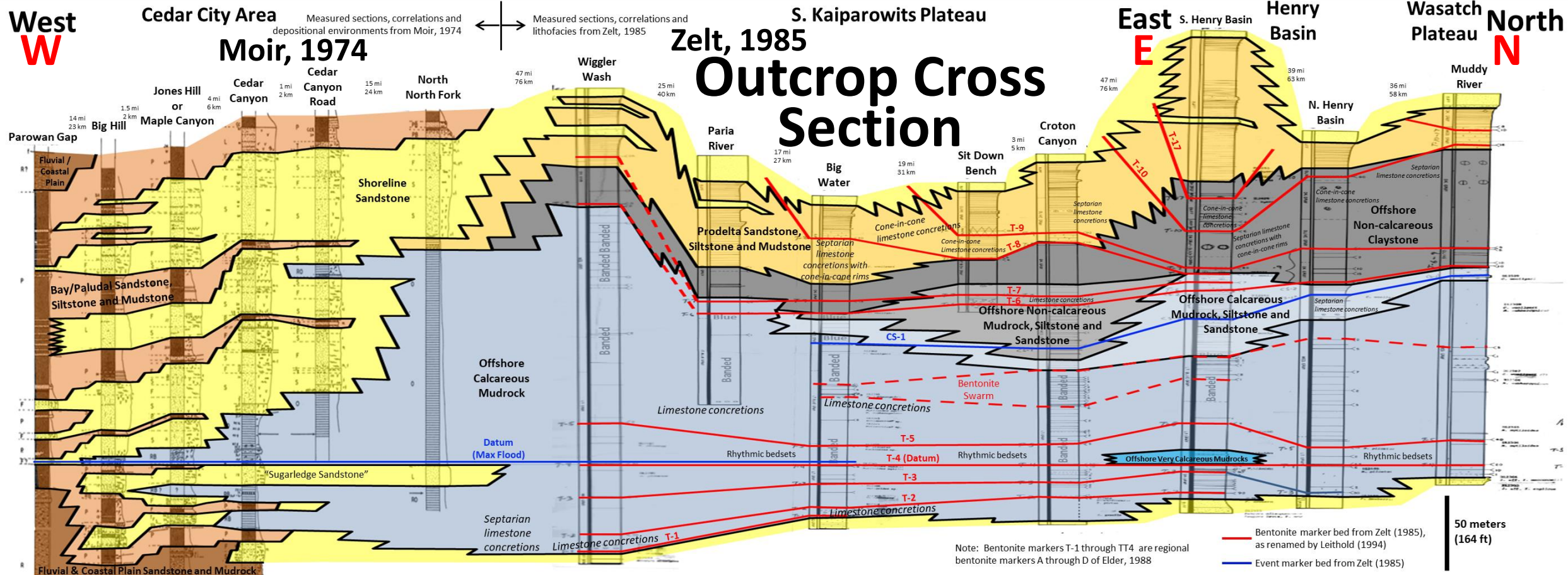
LITHOFACIES

SANDSTONE  
 SILTSTONE-  
MUDSTONE

NON-CALC. CLAYSTONE  
 CALCAREOUS  
CLAYSTONE-CLAYSHALE

V. CALCAREOUS  
CLAYSTONE-CLAYSHALE  
 BENTONITIC, CALCAREOUS  
MUDSTONE-CLAYSTONE





# Tropic, Tununk and Equivalents

Outcrop sections from Moir, 1974 and Zelt, 1985



West

Cedar City Area

Measured sections, correlations and depositional environments from Moir, 1974

Measured sections, correlations and lithofacies from Zelt, 1985

S. Kaiparowits Plateau

East

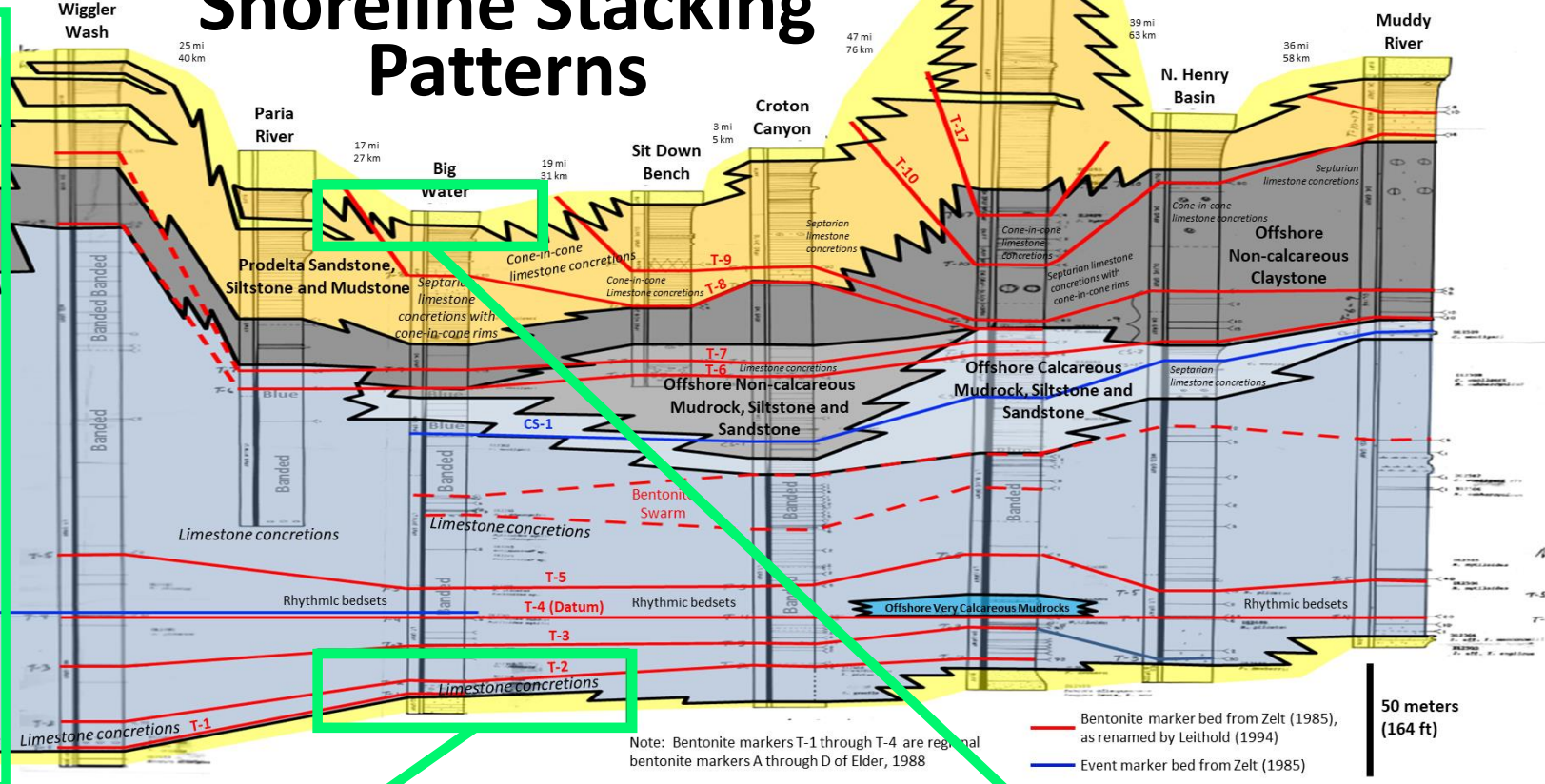
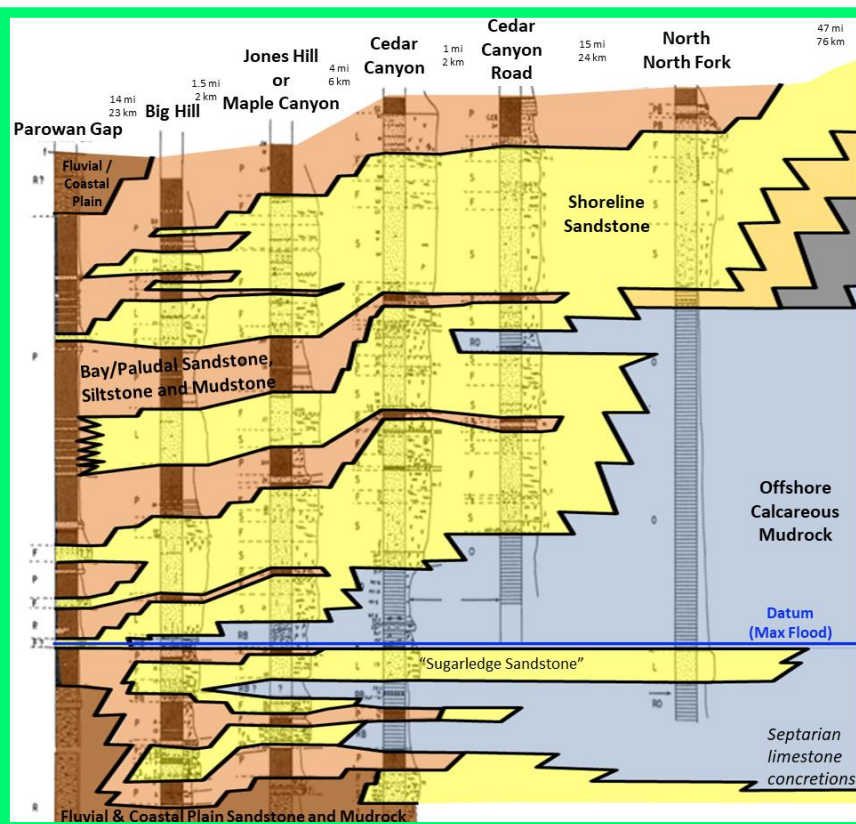
S. Henry Basin

Henry Basin

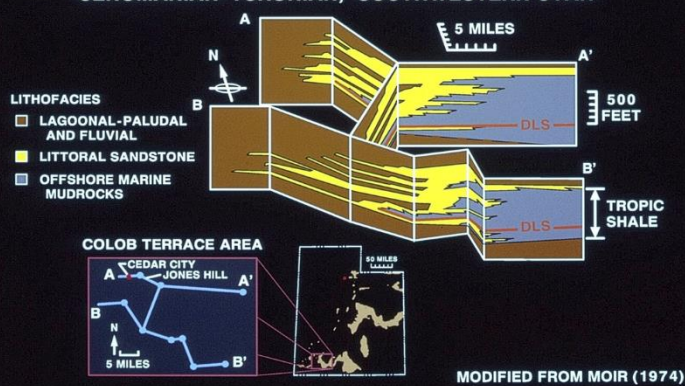
Wasatch Plateau

North

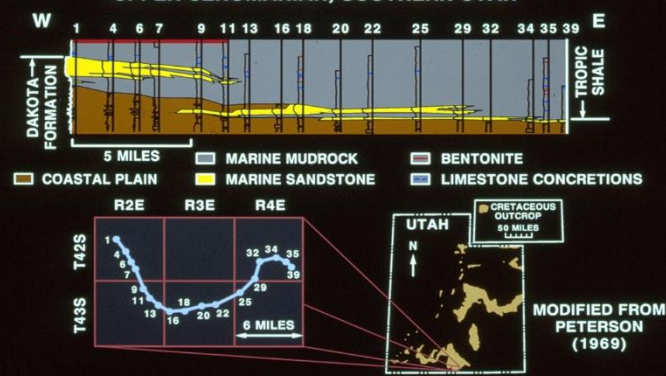
# Shoreline Stacking Patterns



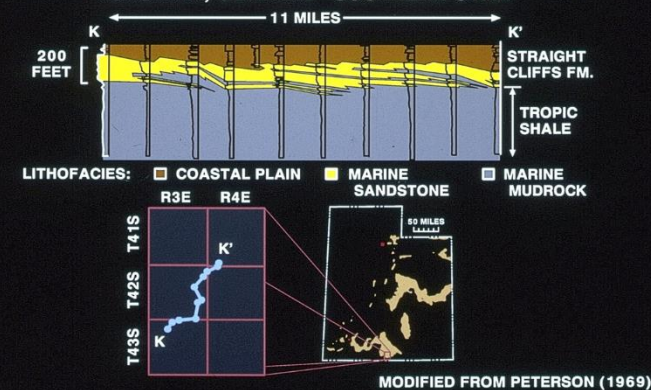
## AGGRADATIONAL SHORELINE STACKING, CENOMANIAN-TURONIAN, SOUTHWESTERN UTAH



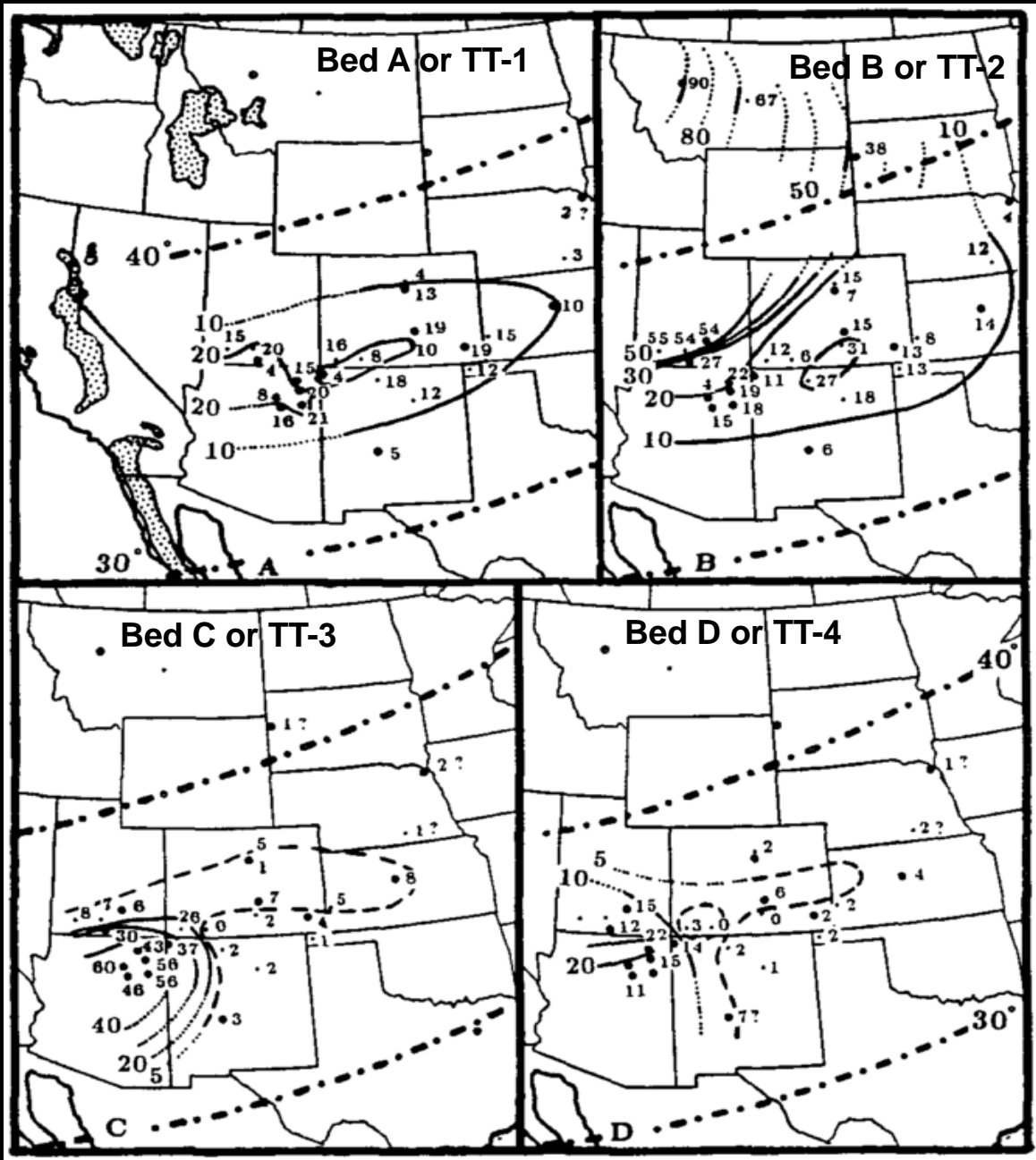
## RETROGRADATIONAL PARASEQUENCE STACKING UPPER CENOMANIAN, SOUTHERN UTAH



## PROGRADATIONAL SHORELINE STACKING TURONIAN, CENTRAL SOUTHERN UTAH



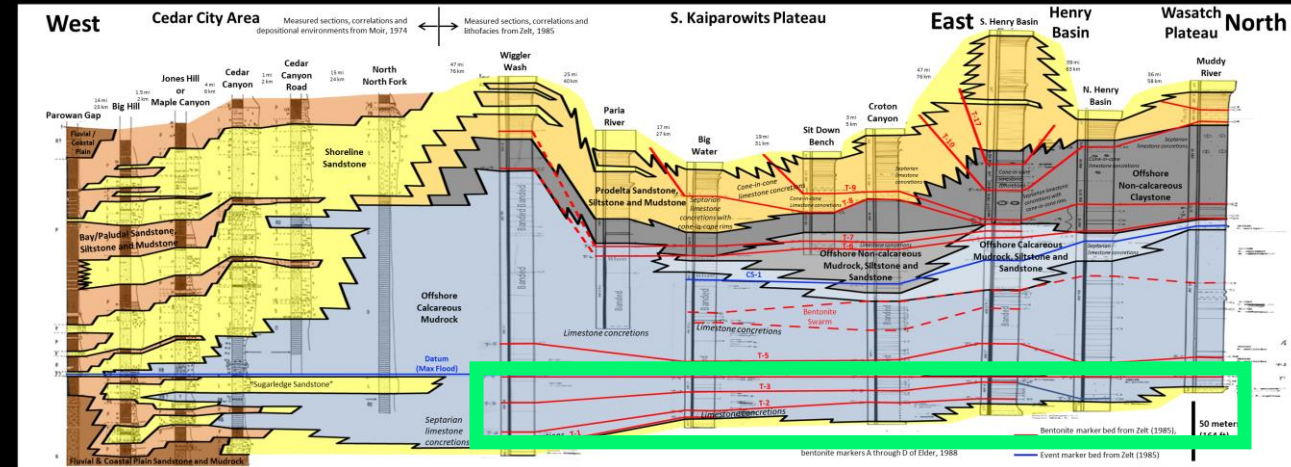




Thickness in centimeters from Elder, 1988

## Thickness of altered ash beds in lower Tropic Shale and equivalent strata

From Elder, 1988



- Marker beds and intervening strata have been correlated over a large area, by many researchers
- Opportunity to rigorously observe carbon burial and more across depositional environments
- Radiometric age dates and Milankovich cycles provide constraints on absolute burial rates



West

Cedar City Area

Measured sections, correlations and depositional environments from Moir, 1974

S. Kaiparowits Plateau

Measured sections, correlations and lithofacies from Zelt, 1985

East

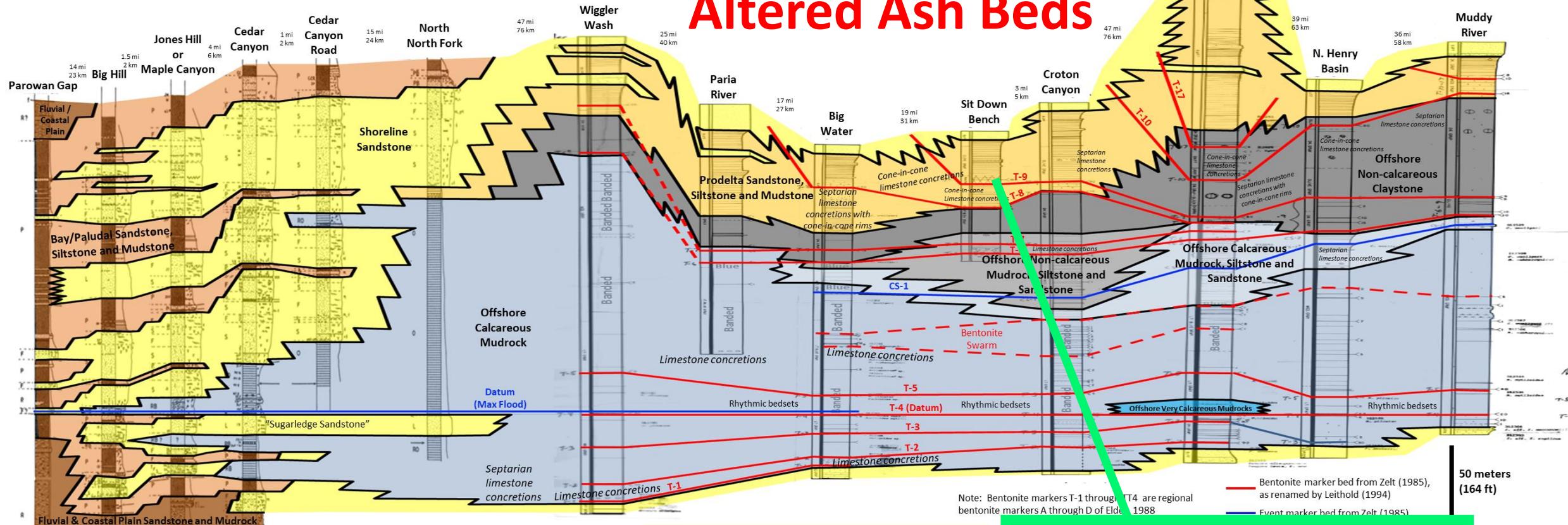
S. Henry Basin

Henry Basin

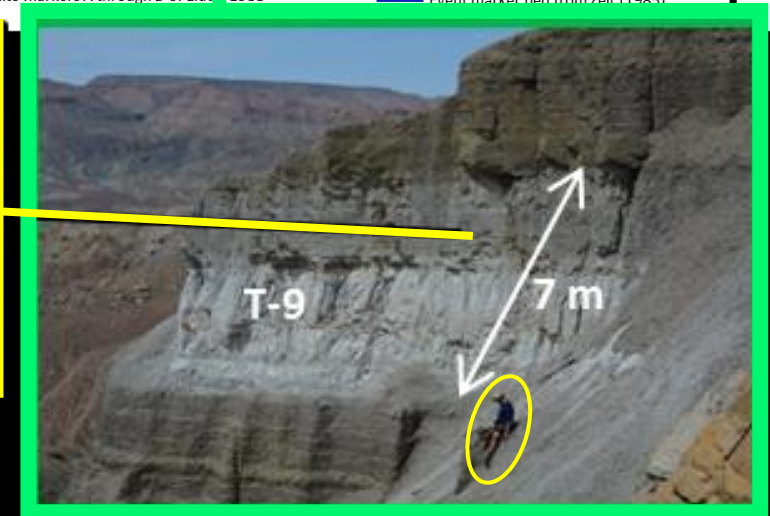
Wasatch Plateau

North

# Altered Ash Beds



- Opportunity to observe sedimentology of altered ash beds in different depositional facies and environments
- Radiometric age dating of altered ash in coal within stacked shoreline/coastal plain section may test correlation with marine strata





West

Cedar City Area

Measured sections, correlations and depositional environments from Moir, 1974

Measured sections, correlations and lithofacies from Zelt, 1985

S. Kaiparowits Plateau

# Max Flood

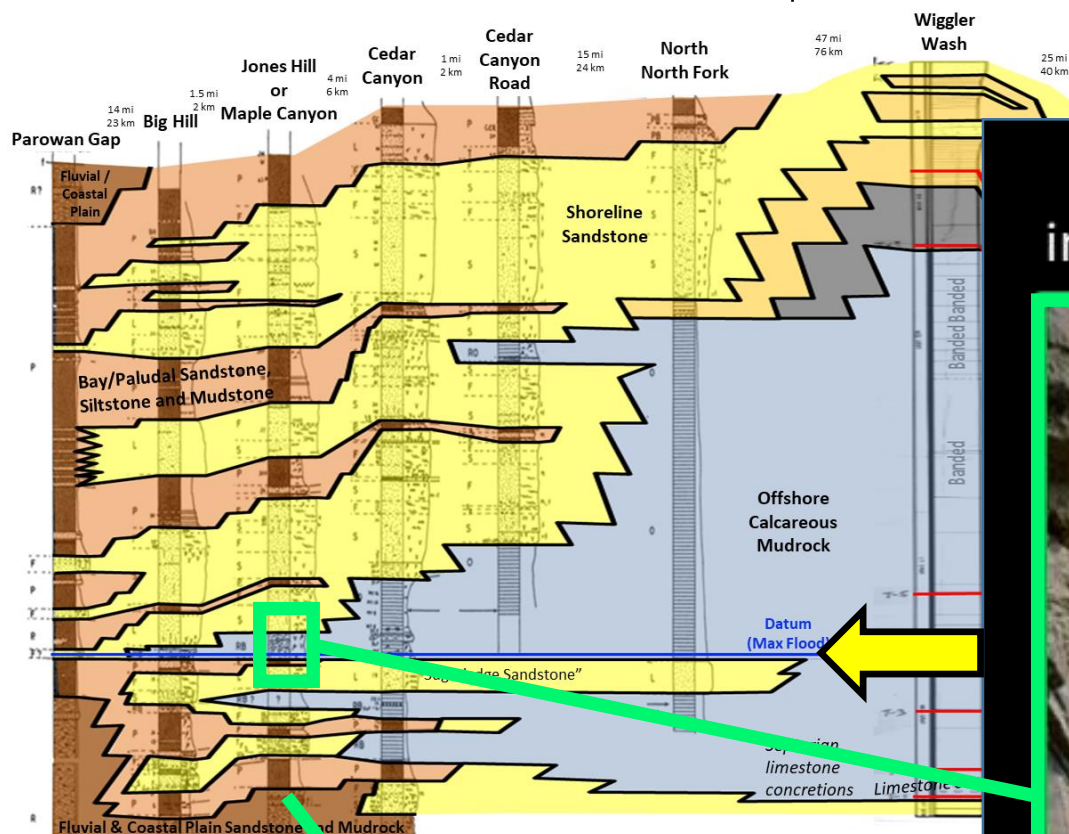
East

S. Henry Basin

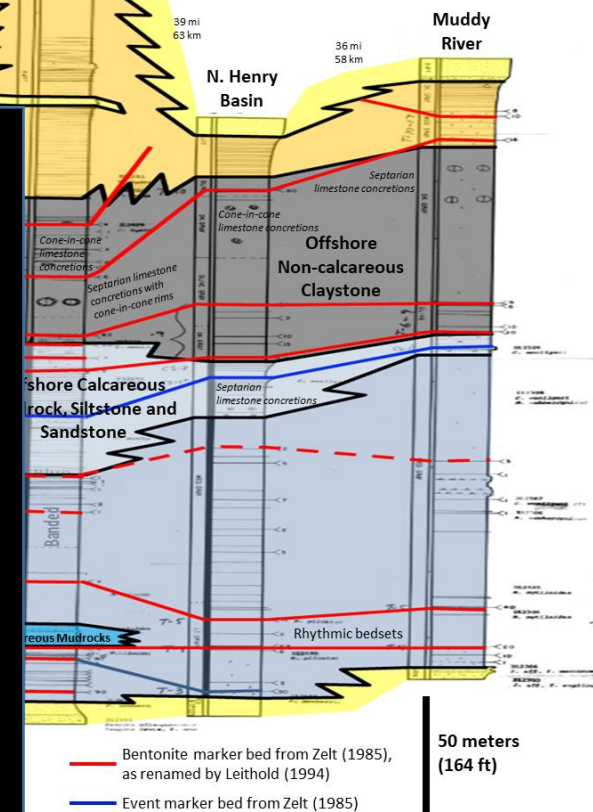
Henry Basin

Wasatch Plateau

North



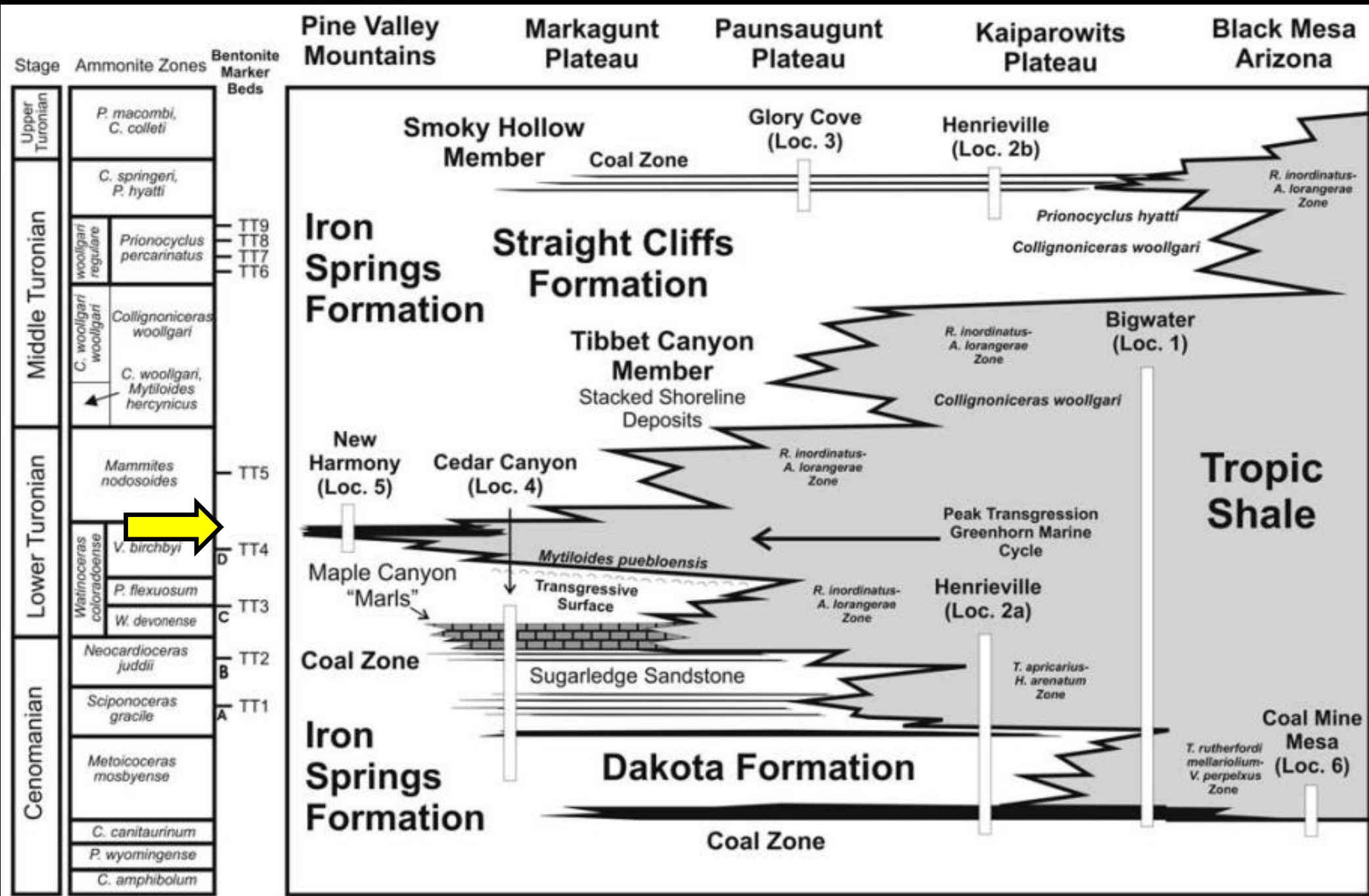
## Early Turonian maximum flood interval, Jones Hill / Maple Canyon



Jones Hill or  
Maple Canyon







# Tropic Shale Foram Study

Tibert and Leckie, 2017



West

Cedar City Area

Measured sections, correlations and depositional environments from Moir, 1974



Measured sections, correlations and lithofacies from Zelt, 1985

S. Kaiparowits Plateau

Max Flood

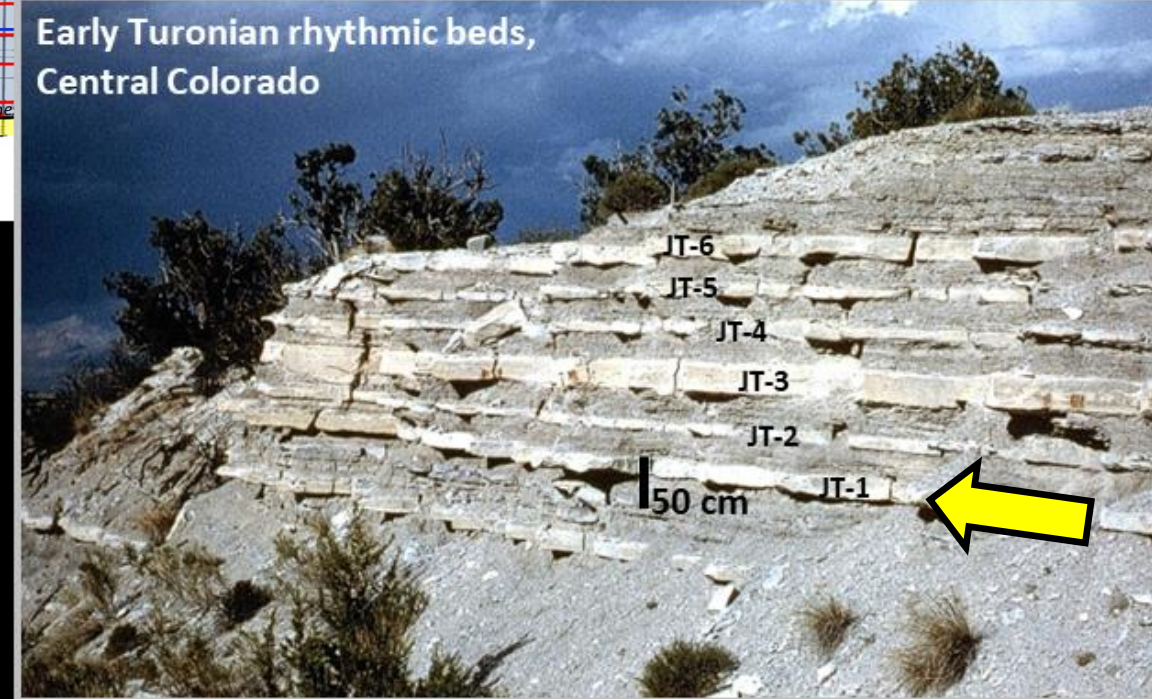
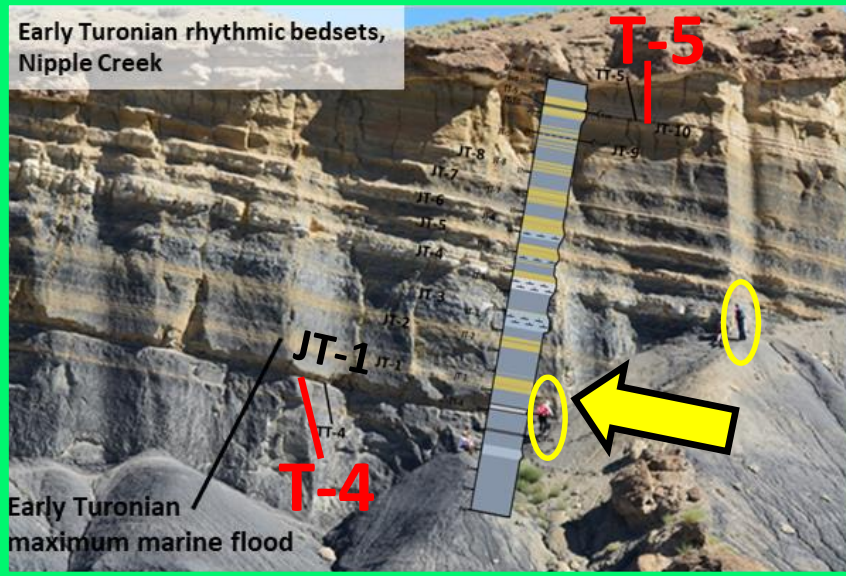
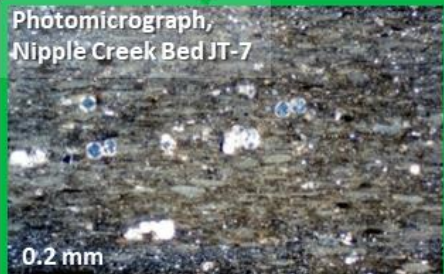
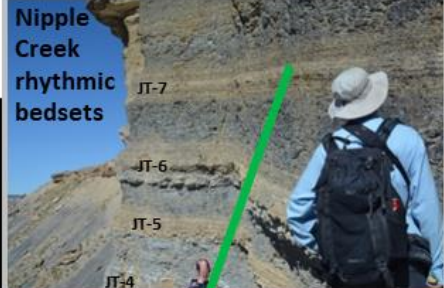
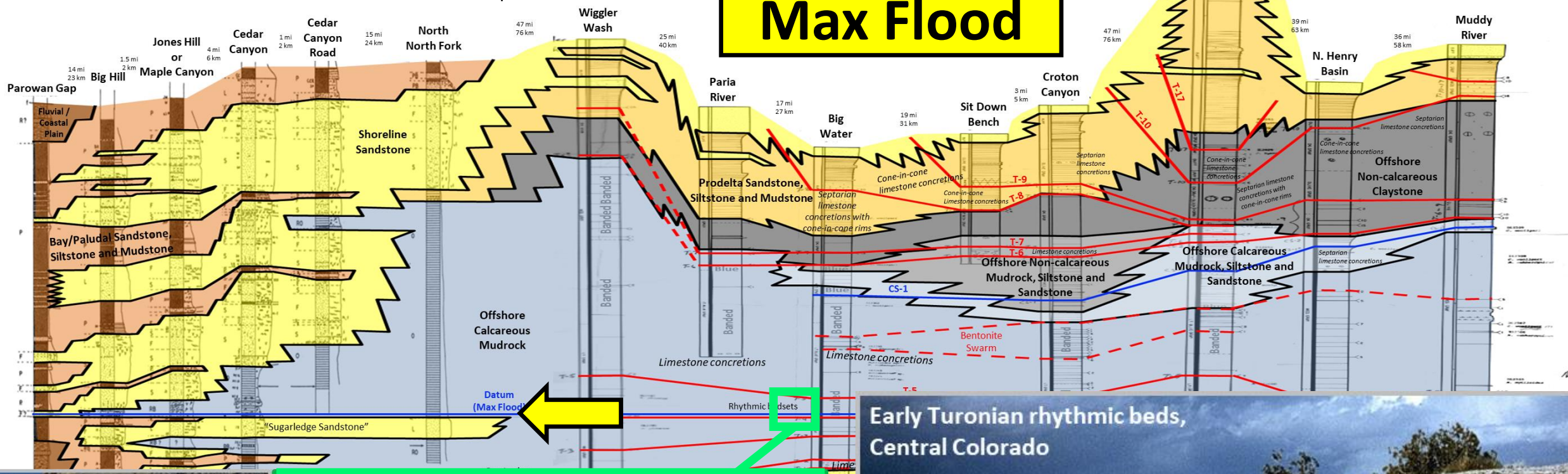
East

S. Henry Basin

Henry Basin

Wasatch Plateau

North





West

Cedar City Area

Measured sections, correlations and depositional environments from Moir, 1974

Measured sections, correlations and lithofacies from Zelt, 1985

S. Kaiparowits Plateau

# Chemostratigraphy and Milankovich Cycles

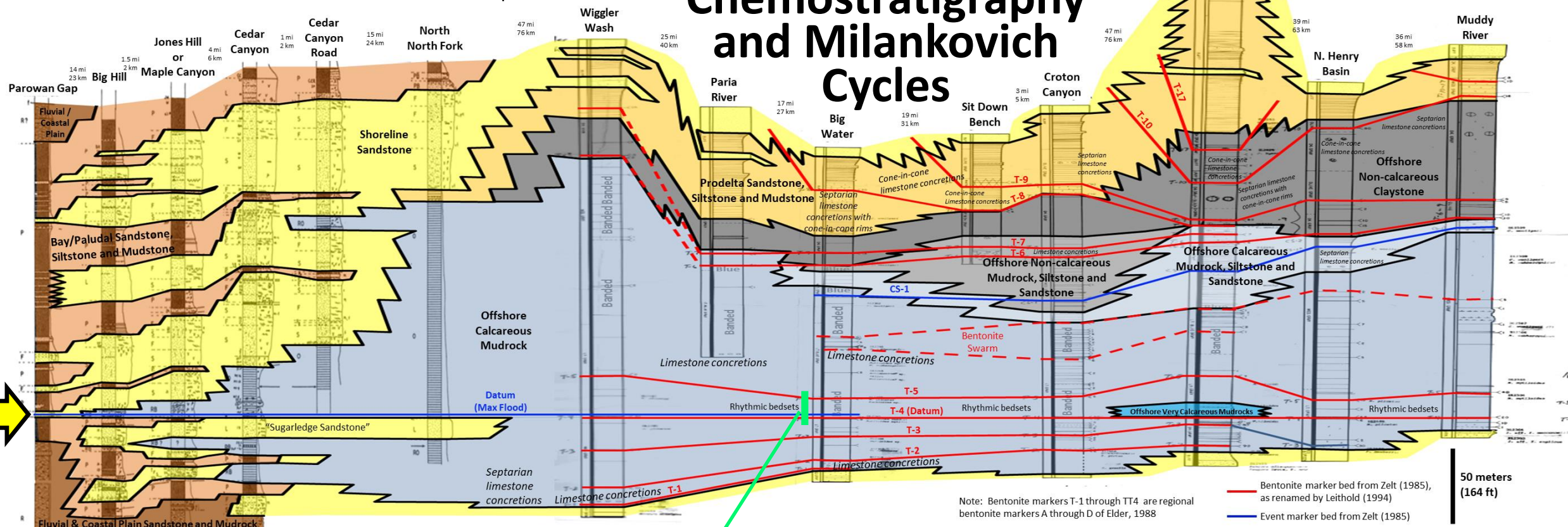
East

S. Henry Basin

Henry Basin

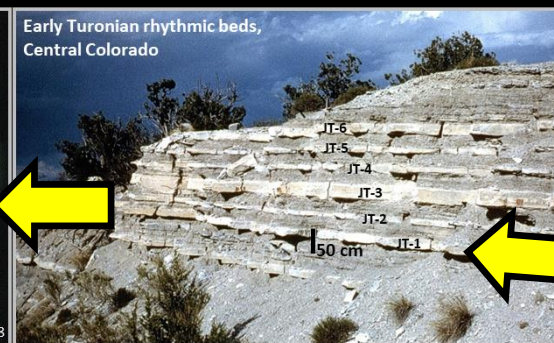
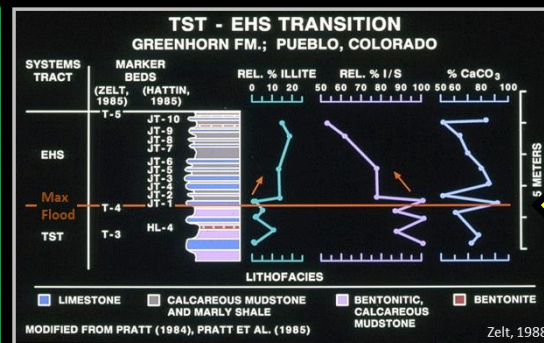
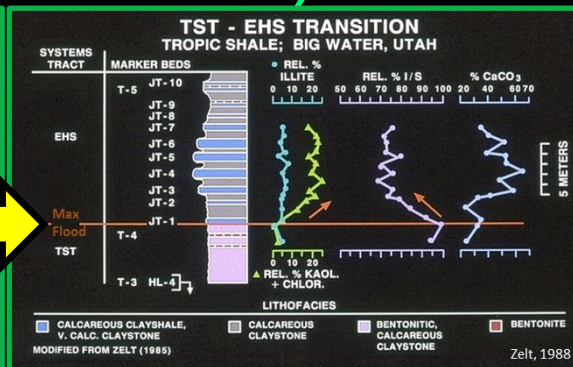
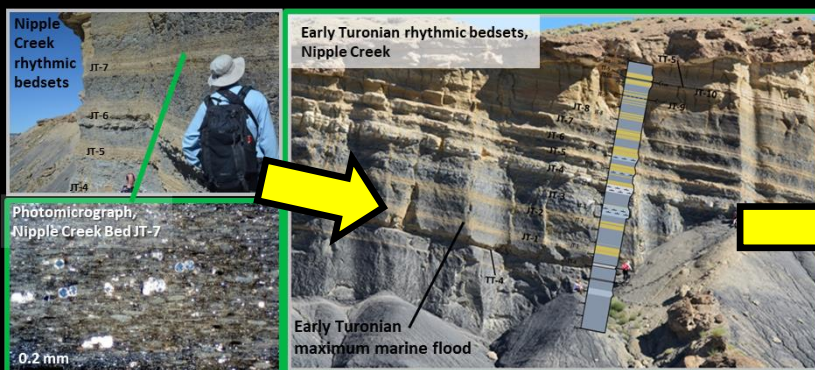
Wasatch Plateau

North

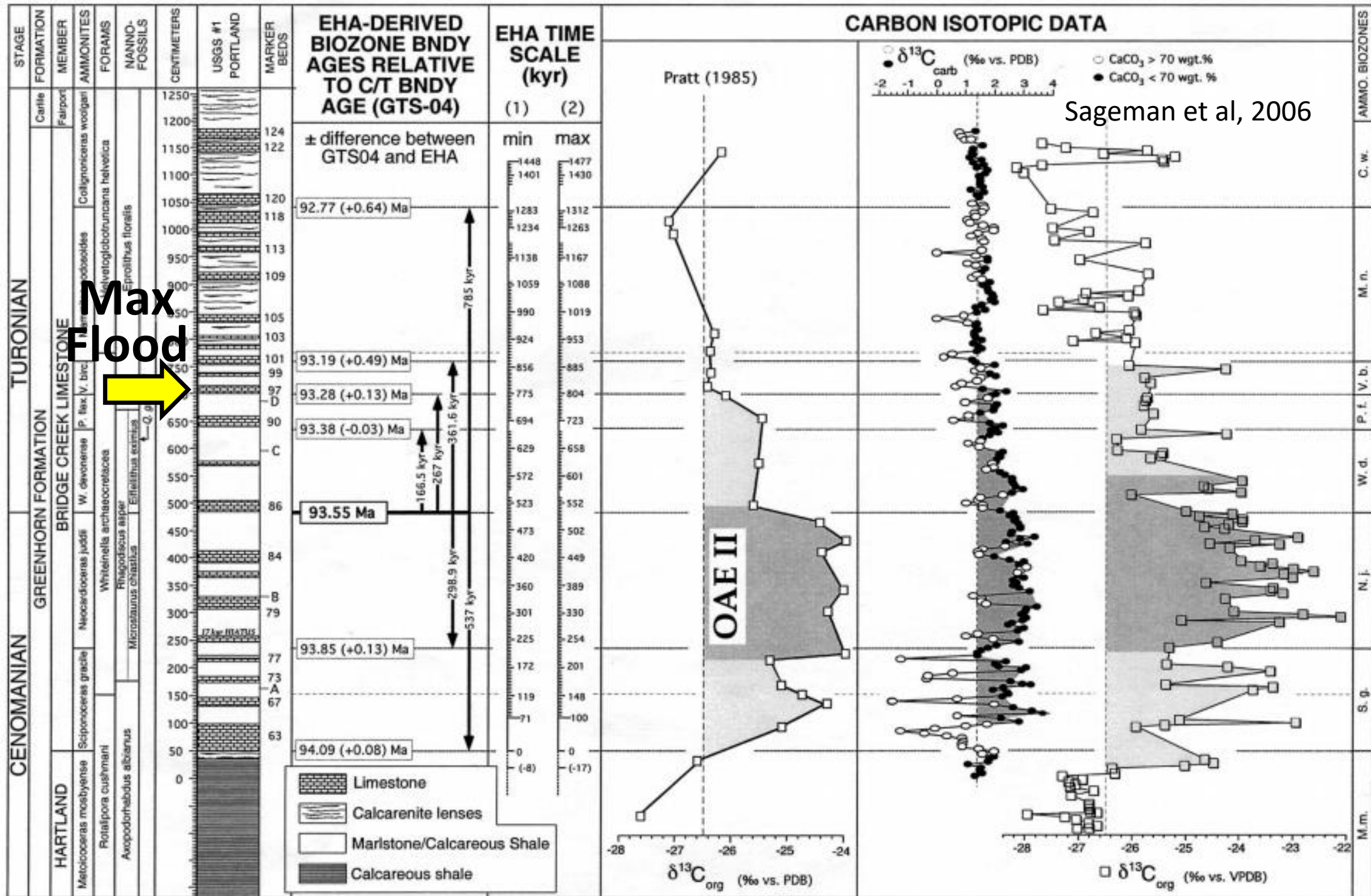


Southern Utah

Central Colorado







# Stable Carbon Isotopes in Colorado

By Pratt and Sageman et al

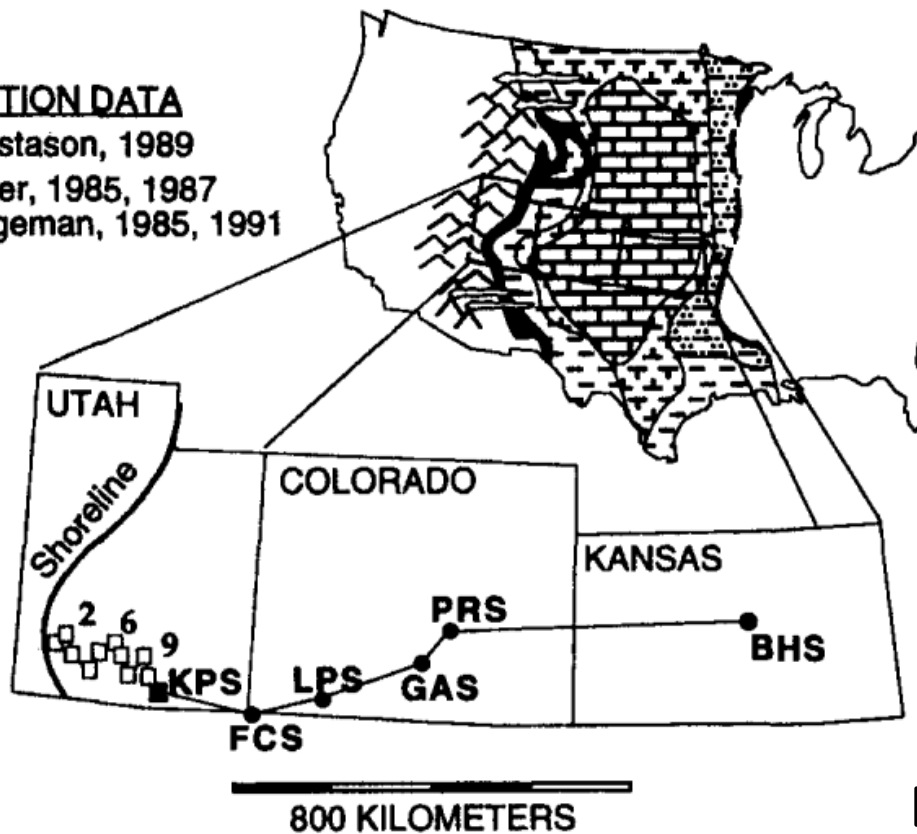


# Correlation of parasequences in transgressive phase

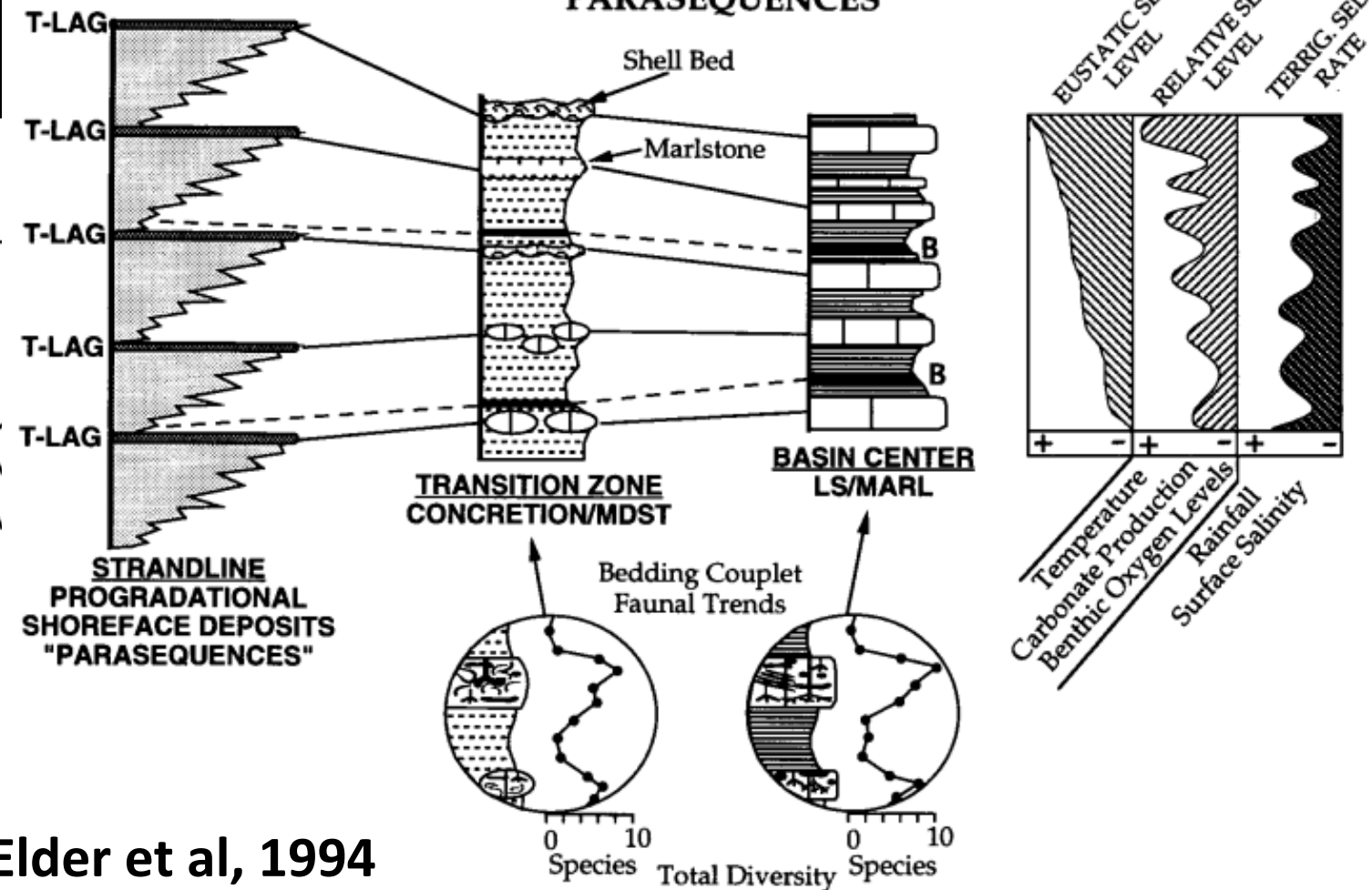
By Elder et al

## SECTION DATA

- Gustason, 1989
- Elder, 1985, 1987
- Sageman, 1985, 1991



## MODEL FOR CORRELATION OF GREENHORN PARASEQUENCES



Elder et al, 1994



West

Cedar City Area

Measured sections, correlations and depositional environments from Moir, 1974



Measured sections, correlations and lithofacies from Zelt, 1985

S. Kaiparowits Plateau

# Concretion Types

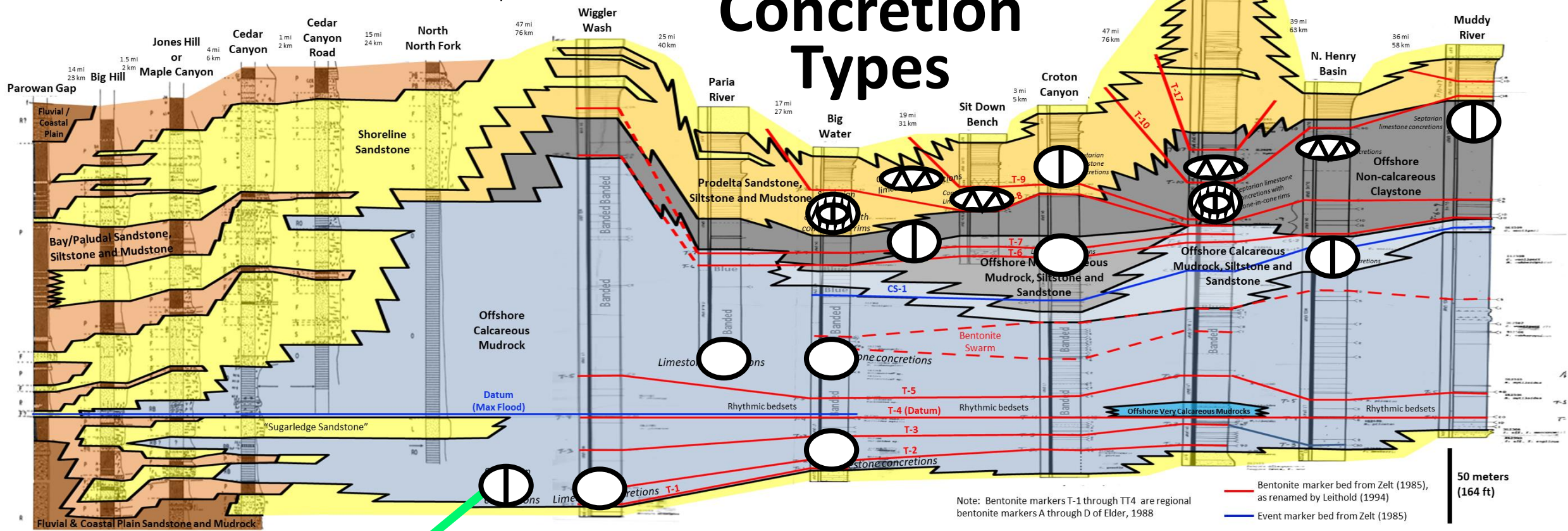
East

S. Henry Basin

Henry Basin

Wasatch Plateau

North



Note: Bentonite markers T-1 through TT4 are regional bentonite markers A through D of Elder, 1988

— Bentonite marker bed from Zelt (1985), as renamed by Leithold (1994)  
— Event marker bed from Zelt (1985)

50 meters (164 ft)

Late Cenomanian septarian limestone concretion



From Joe's Rock Shop, Orderville, Utah

## Lateral Variation in Limestone Concretions



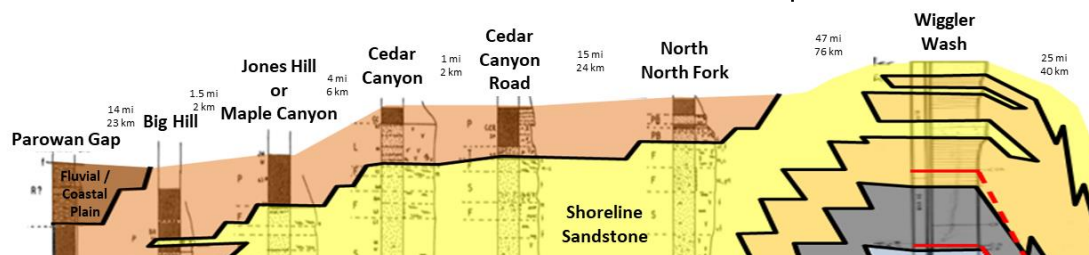


West

Cedar City Area

Measured sections, correlations and depositional environments from Moir, 1974

Measured sections, correlations and lithofacies from Zelt, 1985



# Tempestites

## Including gutter casts

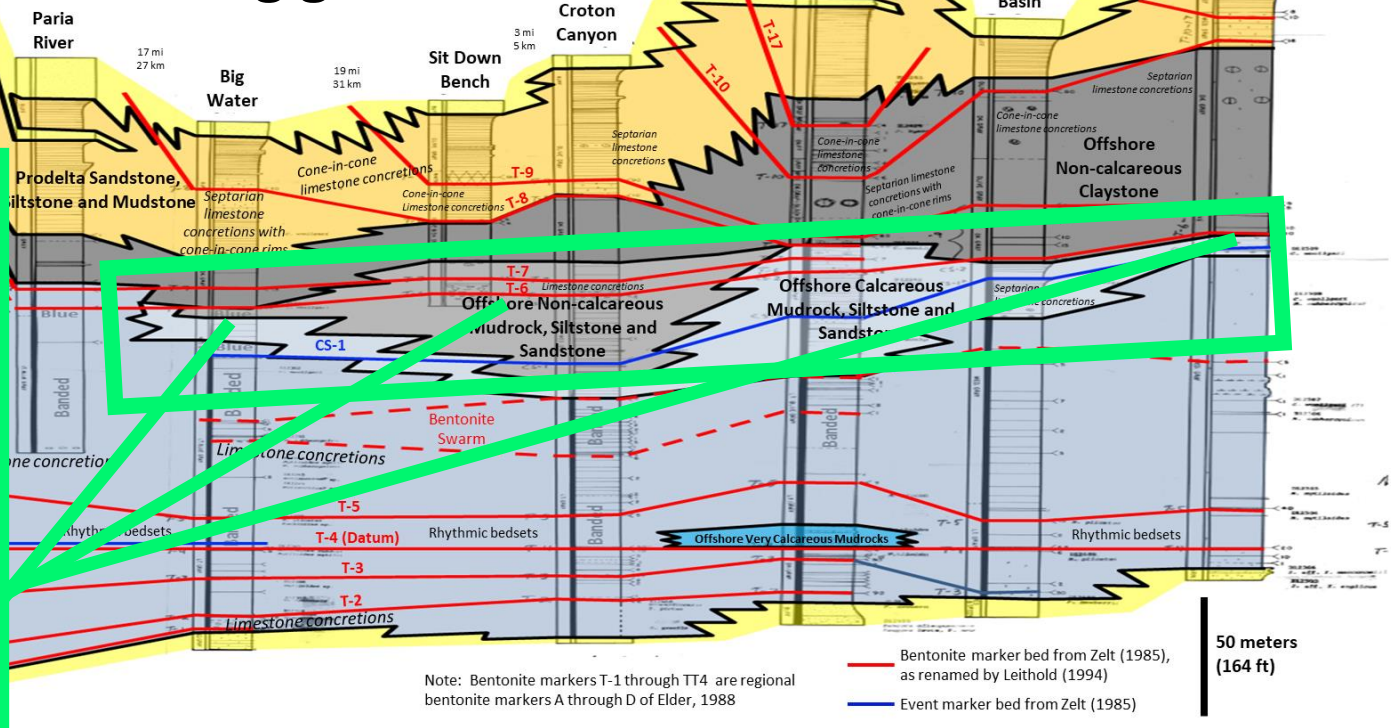
East

S. Henry Basin

Henry Basin

Wasatch Plateau

North



## Gutter Casts in Middle Turonian Tempestites, SE Kaiparowits Plateau



## Lateral Variation in Storm Deposits

Bioclastic calcarenites

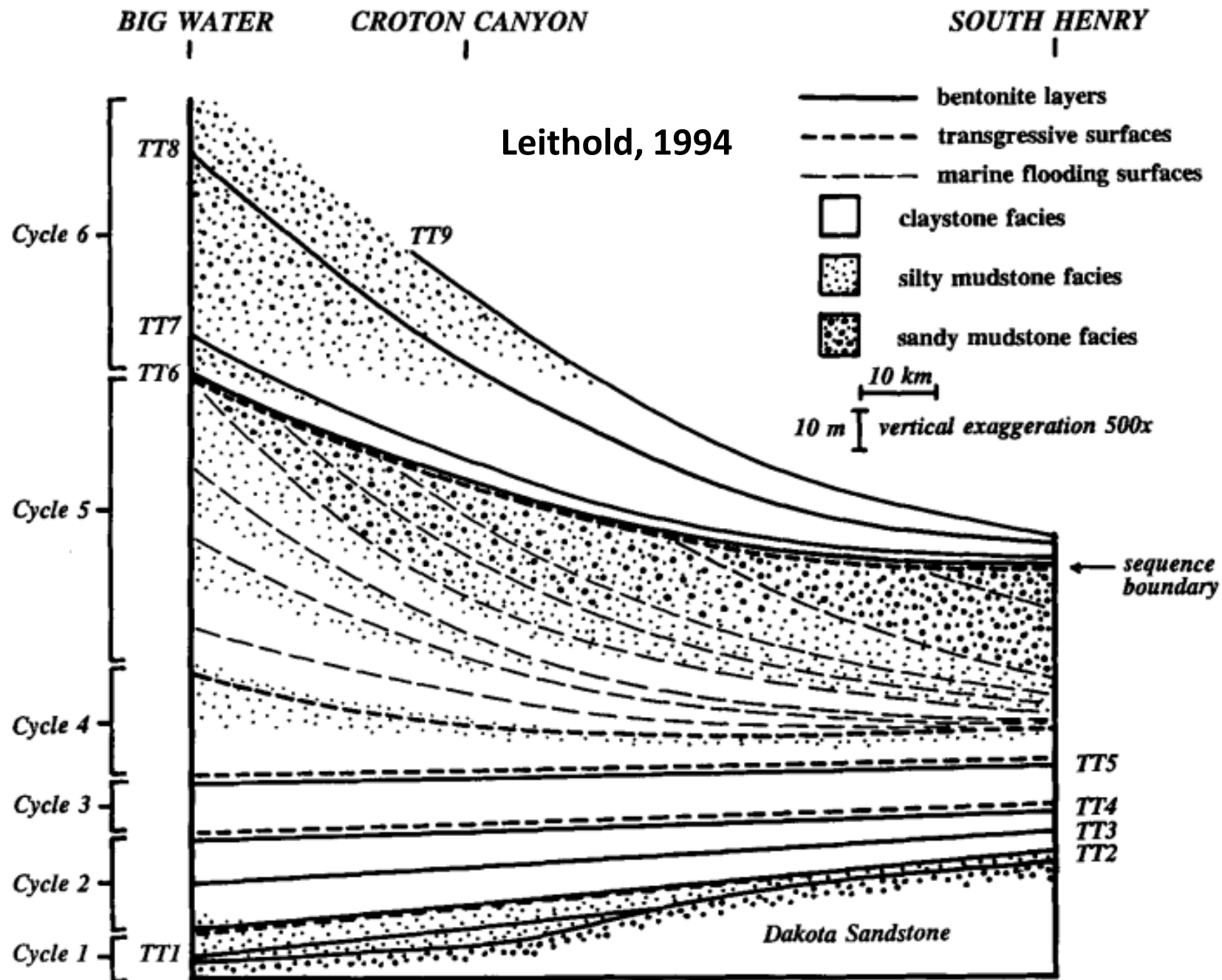
Quartz sandstones in gutter casts

Laminated &amp; x-laminated quartz sandstone beds

Margin

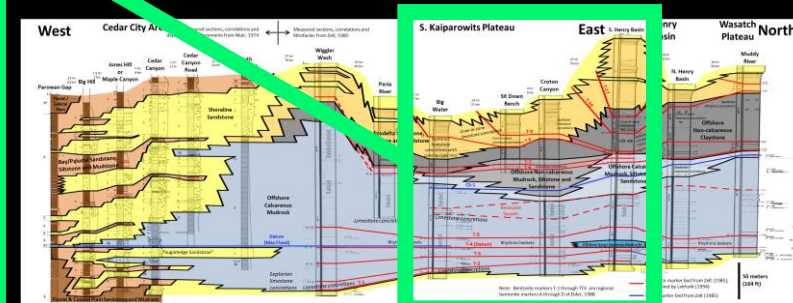
Axis





# Stratigraphy in southern Kaiparowits Plateau and southern Henry Basin

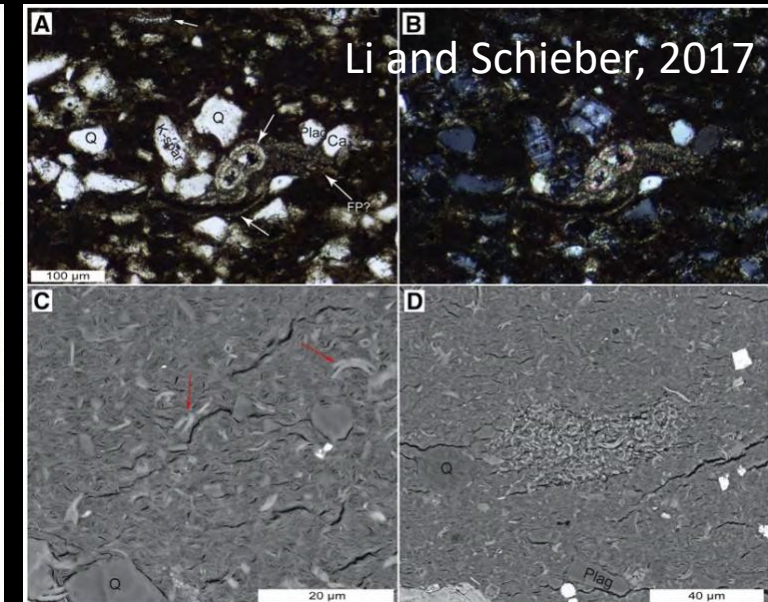
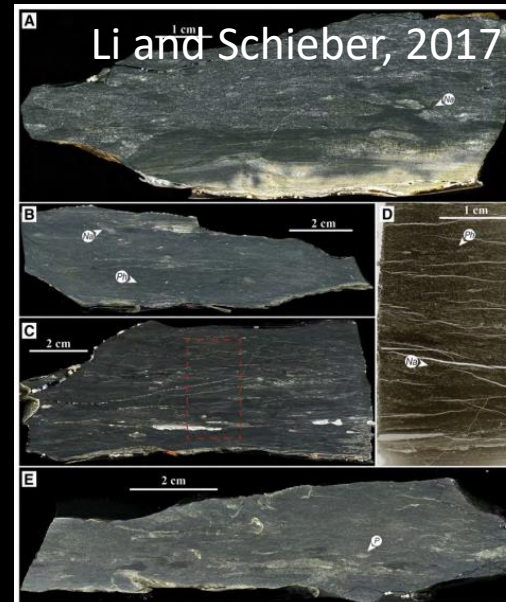
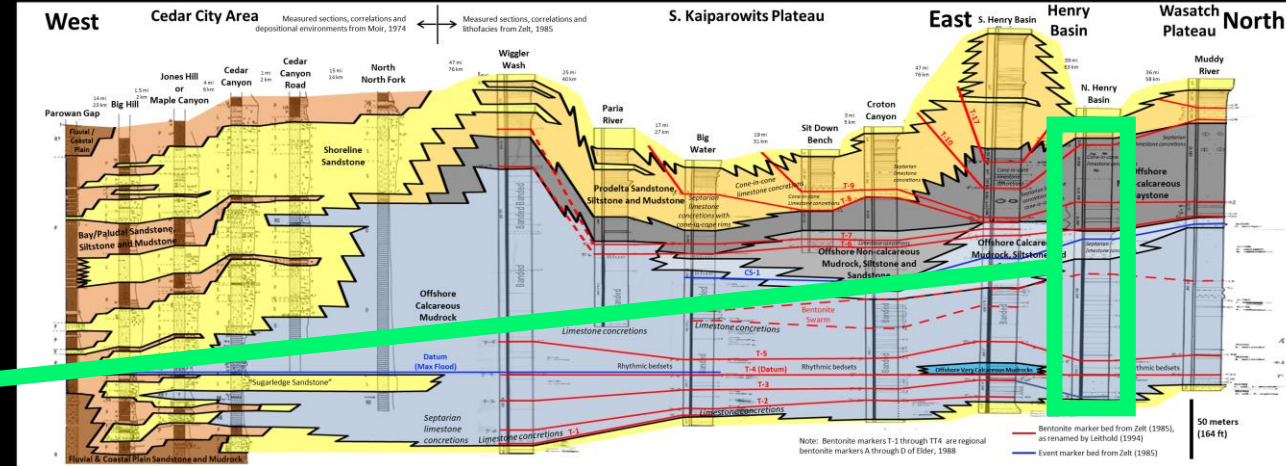
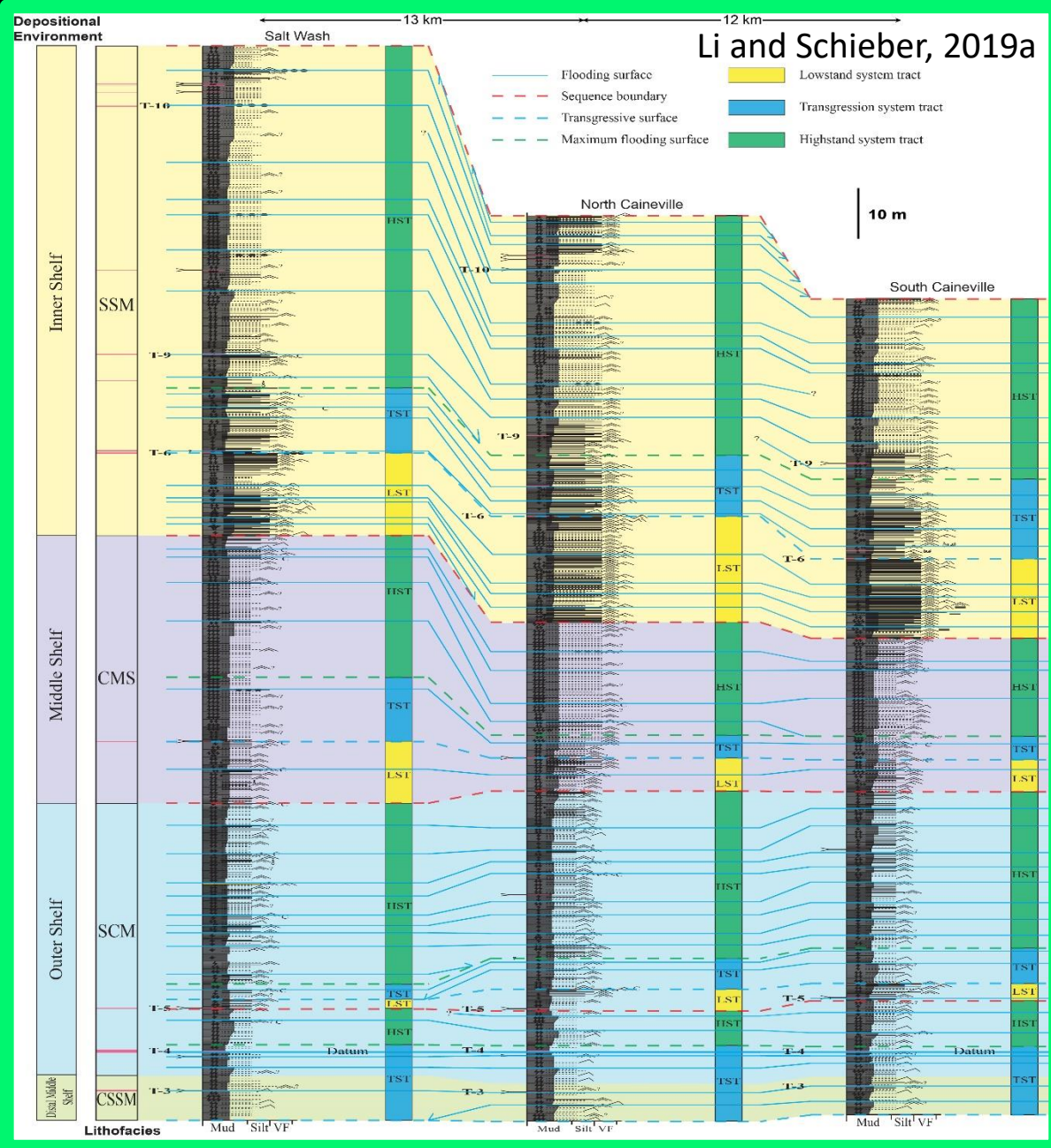
By Leithold





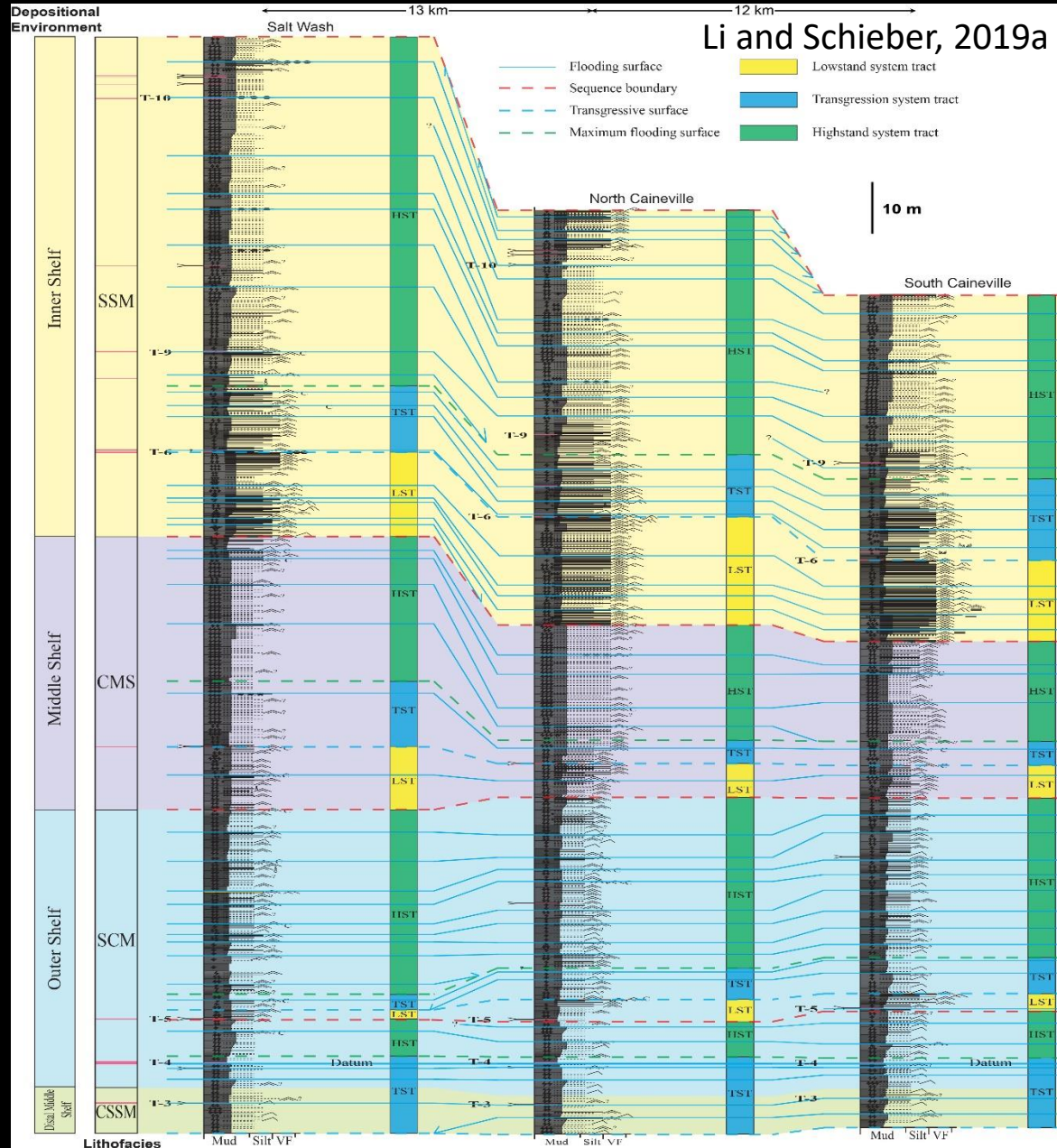
# Detailed sedimentology and stratigraphy in northern Henry Basin

By Li and Schieber

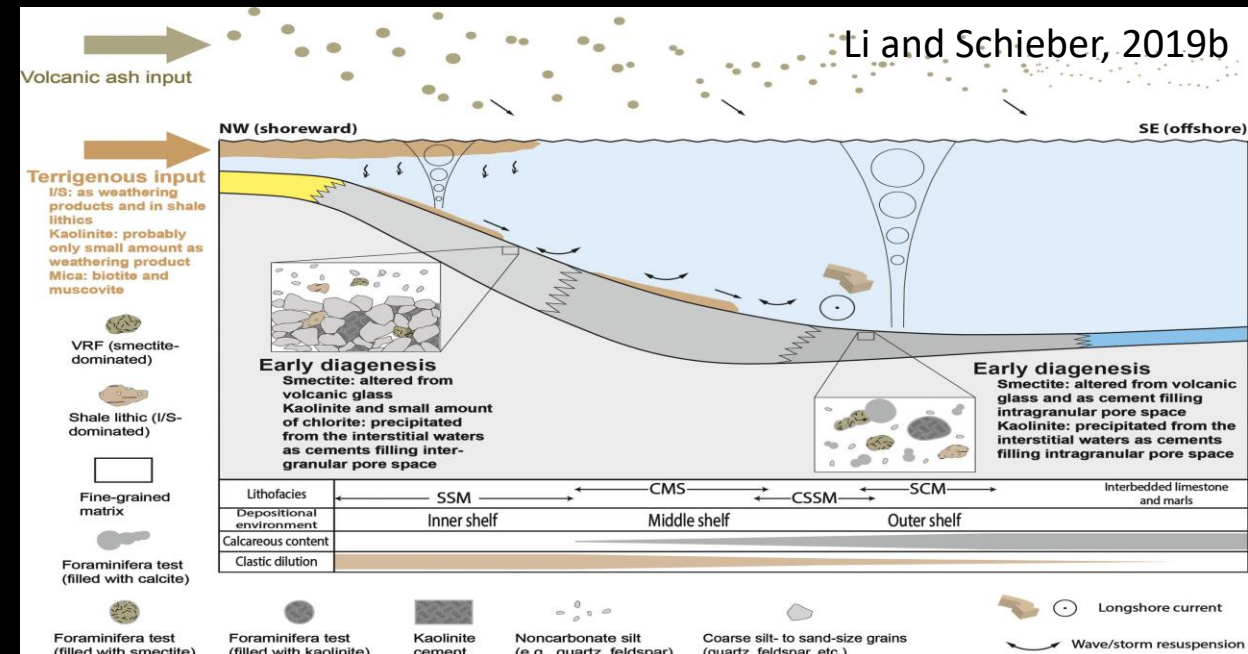
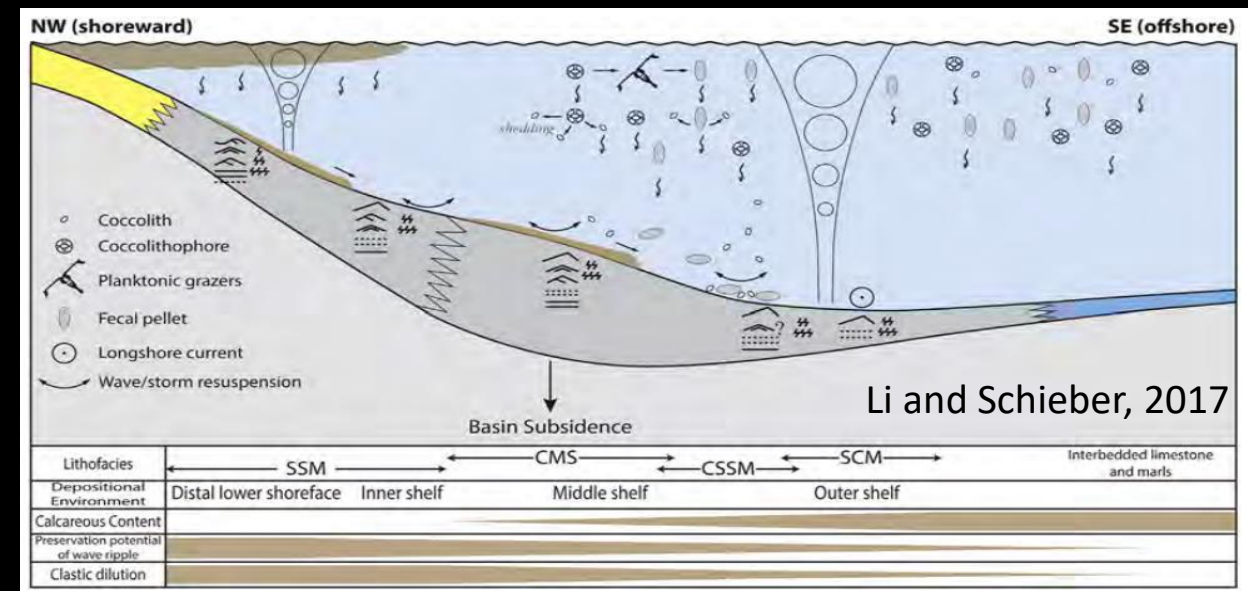




# N. Henry Basin detailed sed & strat

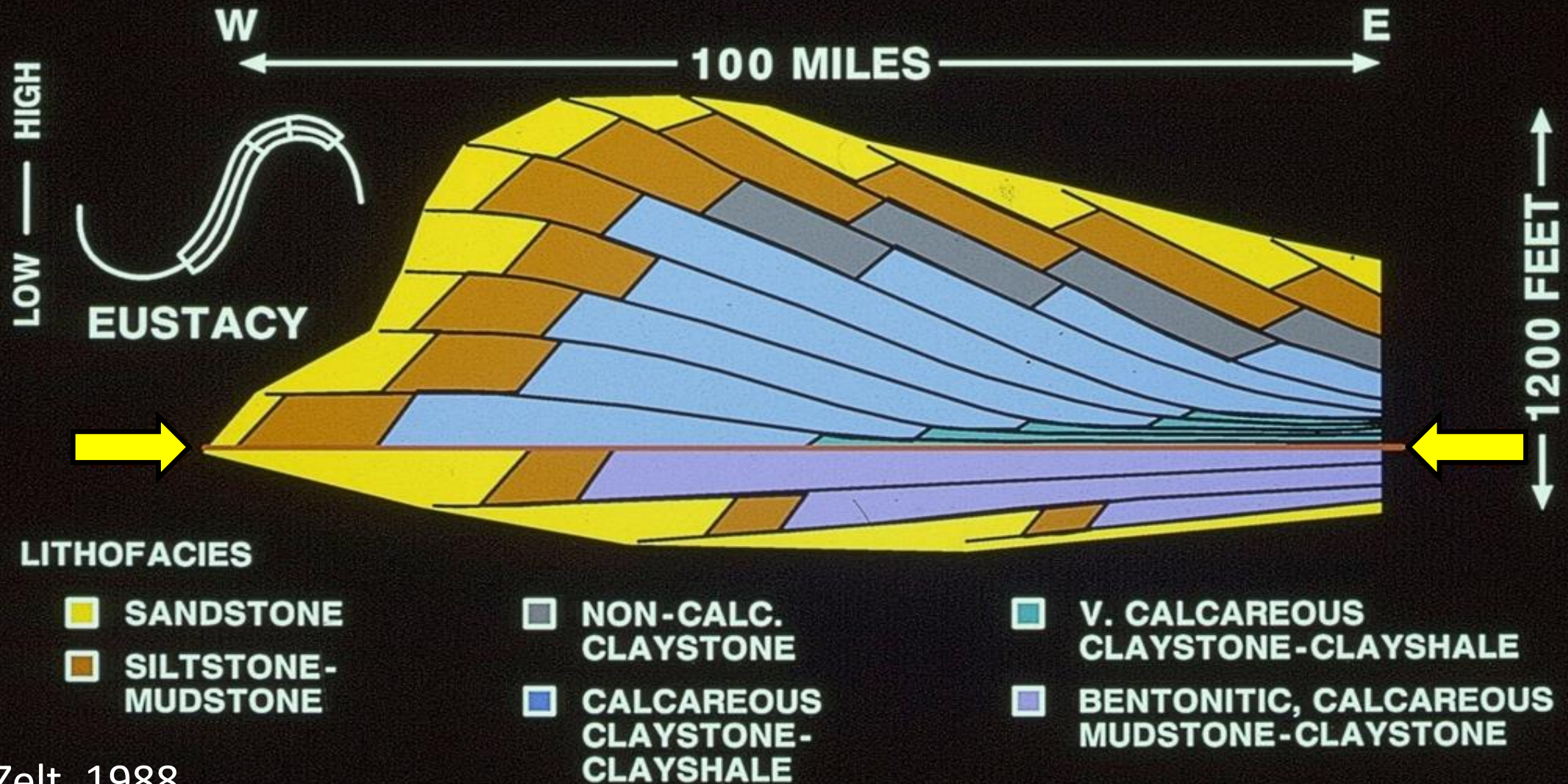


# Depositional and diagenetic models





# GENERALIZED CROSS SECTION TROPIC SHALE, SOUTHERN UTAH

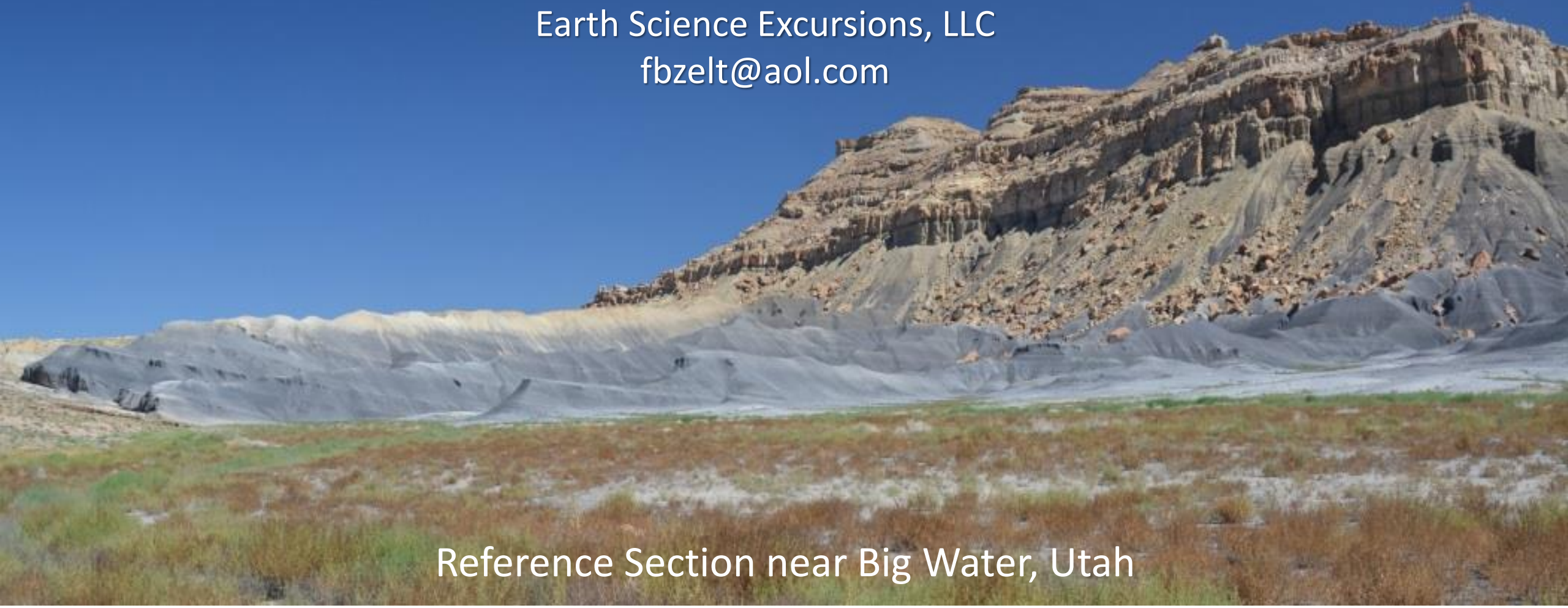




**CRETACEOUS TROPIC SHALE OF SOUTHERN UTAH: AN UNDERUTILIZED NATURAL  
OBSERVATORY ON PUBLIC LANDS FOR RESEARCH IN SHALE DEPOSITIONAL FACIES  
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Fred Zelt  
Earth Science Excursions, LLC  
fbzelt@aol.com

Reference Section near Big Water, Utah





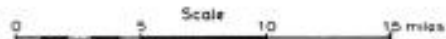
**Extra Slide**



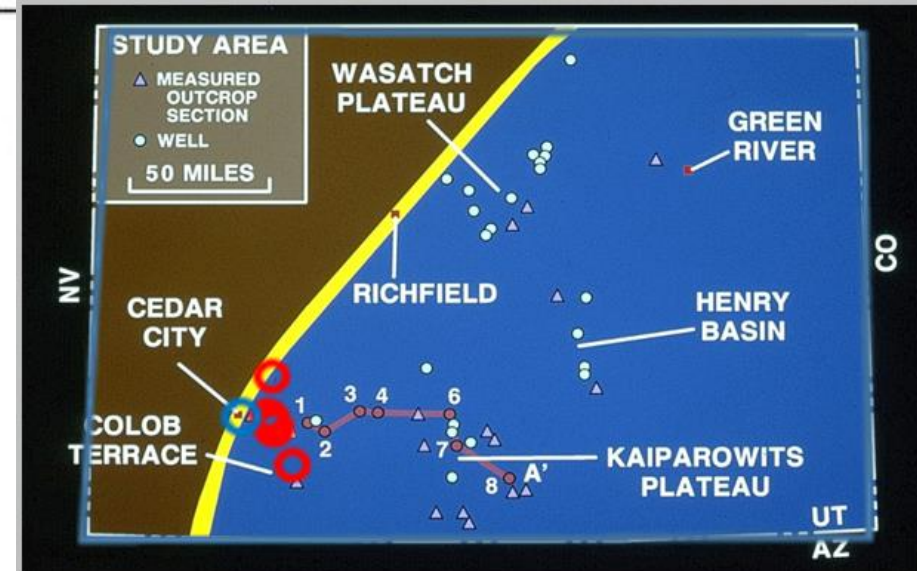
### LOCATION of STRATIGRAPHIC CROSS-SECTIONS

Detailed cross-sections

General cross-section

 HURRICANE

SAINT GEORGE



## Locations of cross sections and measured sections in Moir, 1974

MOIR (1974) Plate 6