Microbial, Algal, and Metazoan Dominated Highstand Carbonate Buildups and the Link to Lowstand Evaporite Distribution, Pennsylvanian of the Paradox Basin, SE Utah*

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Abstract

In addition to water depth and accommodation space variation, water quality appears to have been a major control on dominant faunal components of carbonate buildups in the carbonate/evaporite system of the Pennsylvanian (Desmoinesian) of the Paradox Basin, in southeastern Utah. Throughout the several million year history of alternating transgressive/highstand carbonate deposition on the basin margins and highs, and lowstand evaporite deposition in the basin, carbonate buildup thickness and faunal dominance can be related to basin geometry and the resultant spatial distribution of lowstand evaporites. Exposures of the basin's western shelf along the San Juan River in the Goosenecks region reveal a distinctive vertical progression of carbonate buildup types. In the lowest 3rd order sequence of the shelf, the oil bearing buildups are limited to two stacked 4th order sequences; the first with 2-4 m thick phylloid algal biostromes, which is overlain by a sequence with bryozoan and tubular foraminifera packstones capped by complex Chaetetes (a calcareous sclerosponge) heads and framestones. Stromatolites encrusted the top of Chaetetes heads before the mound became entombed in evapo-moldic silty dolomite. In the overlying 3rd order sequence of the lower Akah, 4th order sequences are capped by microbial boundstones forming progressively thicker deposits in two stacked sequences, ultimately culminating in mounds > 5 m thick. Carbonate buildups in 3/5 of the 4th order sequences within the upper Akah sequence return to high energy Chaetetes dominated mounds. In the overlying 3rd order Desert Creek sequences there are no buildups in outcrop, but phylloid algal, bryozoan, and coralline-algal buildups occur on and adjacent to topographic highs such as the giant Aneth Field (Chidsey et al., 1996). Spectacular and well studied phylloid mound complexes are exposed in outcrops along the San Juan River in the 3rd order sequence of the lower Ismay.

In these Desmoinesian sequences, microbial buildups are limited to the tops of 4th order sequences, during a portion of a basin evolution (Akah sequences) when evaporites where expanding farther onto the shelf on all sides of the almost filled basin. This unique

association suggests that hypersalinty may have favored microbial carbonate buildup development. Shallow open marine conditions favored either phylloid buildups with higher energy settings dominated by Chaetetes, and deeper settings dominated by bryozoa.

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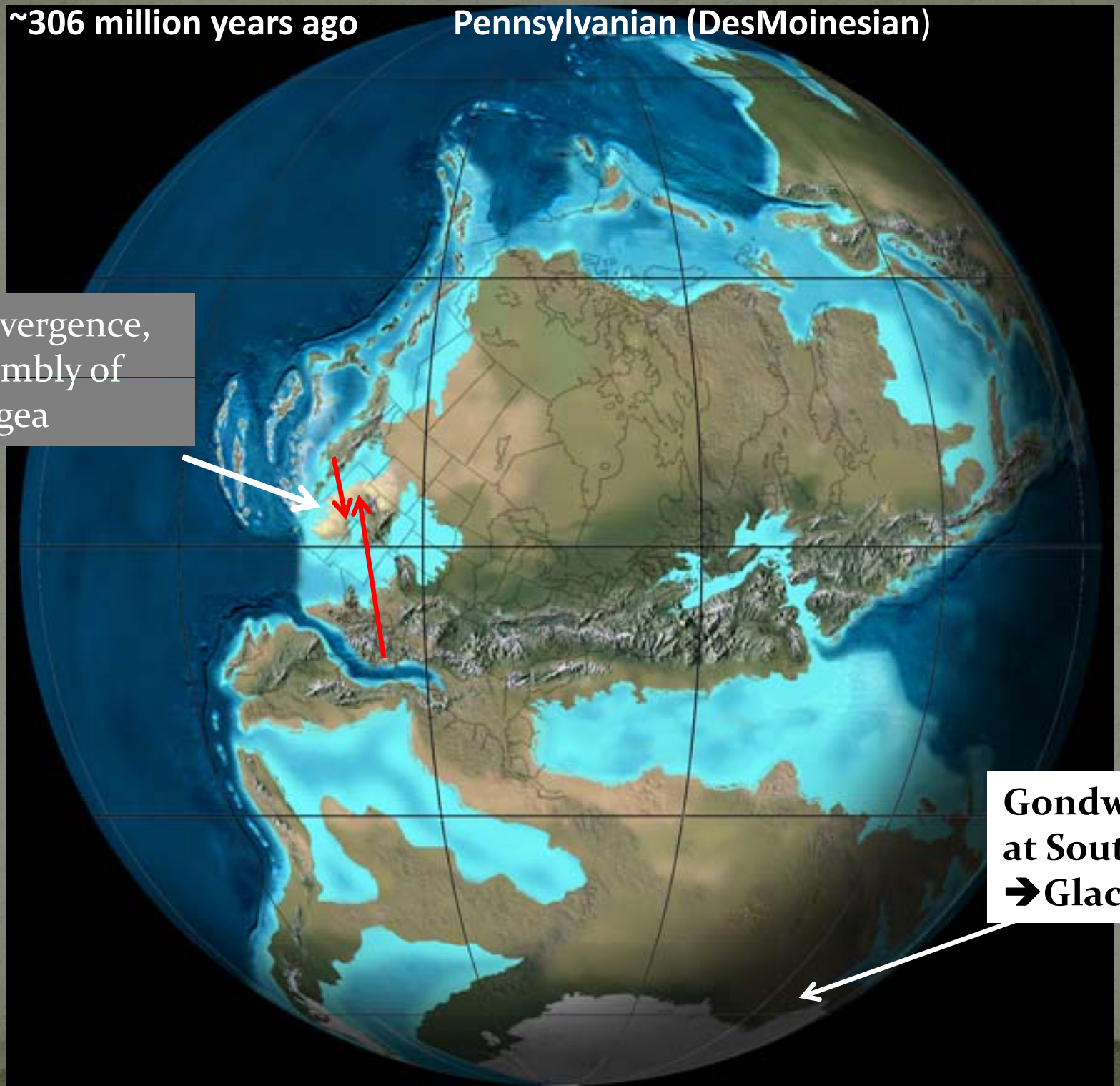
Evaporite, Carbonate, Siliclastic Systems

- Paradox basin SE Utah
- Mesozoic of the Arabian plate
- Offshore Brazil-Santos and Campos basins
- Off shore Angola
- Permian Reef Complex, West Texas and New Mexico

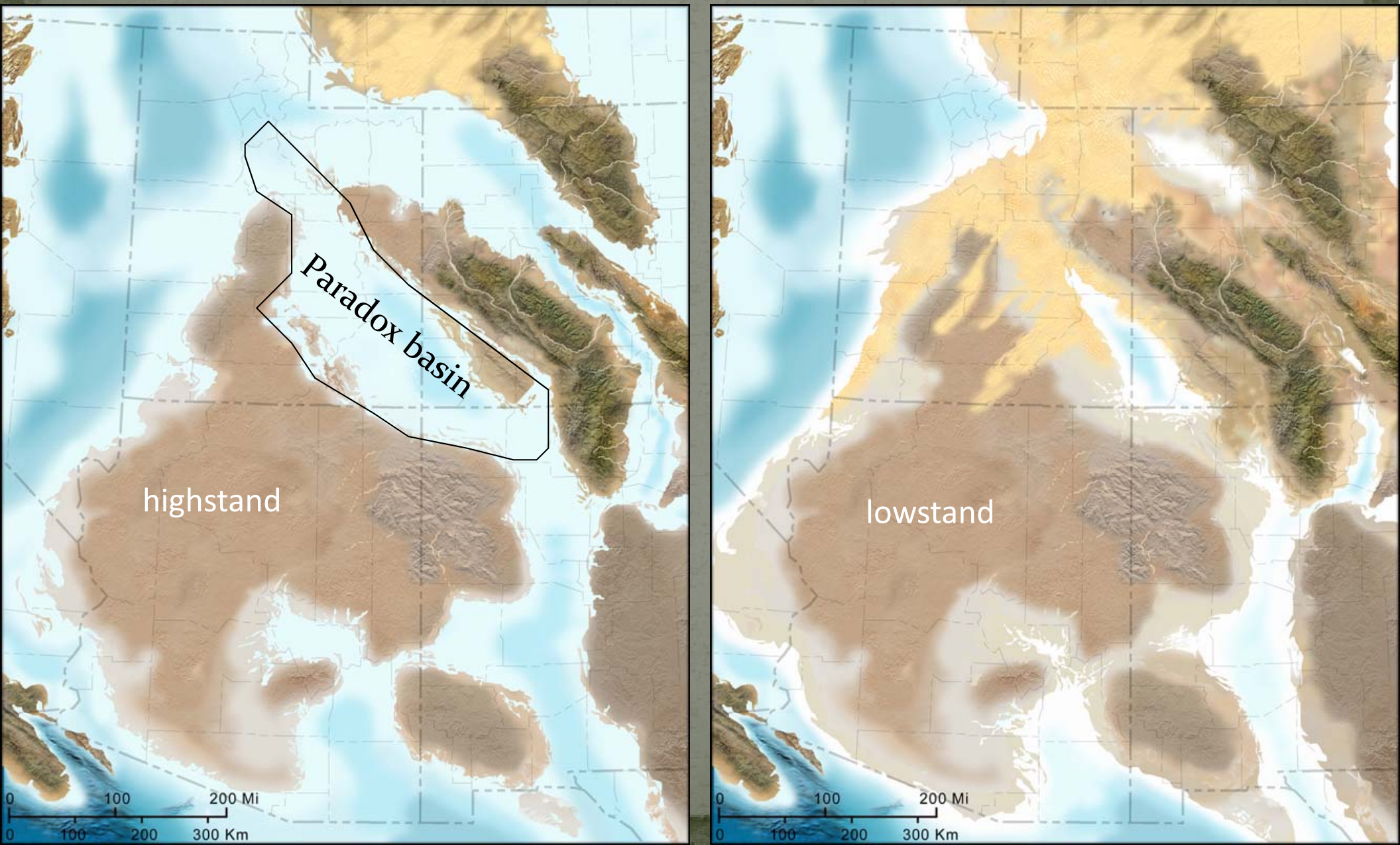


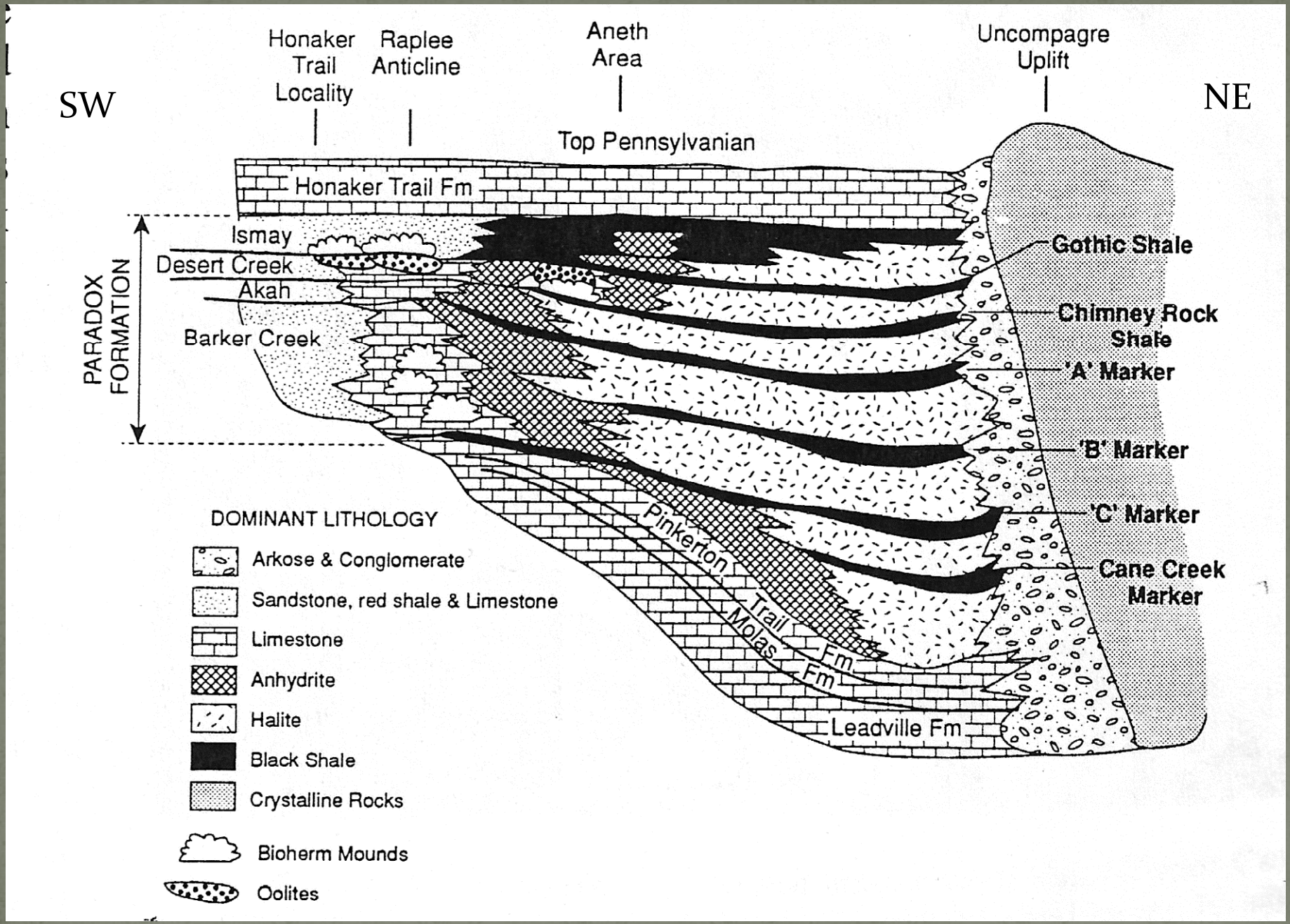
Modified from Blakey, 2008 RMGSA

Pennsylvanian (DesMoinesian)

Modified from Blakey, 2008 RMGSA

Impacts of high vs. low sealevel



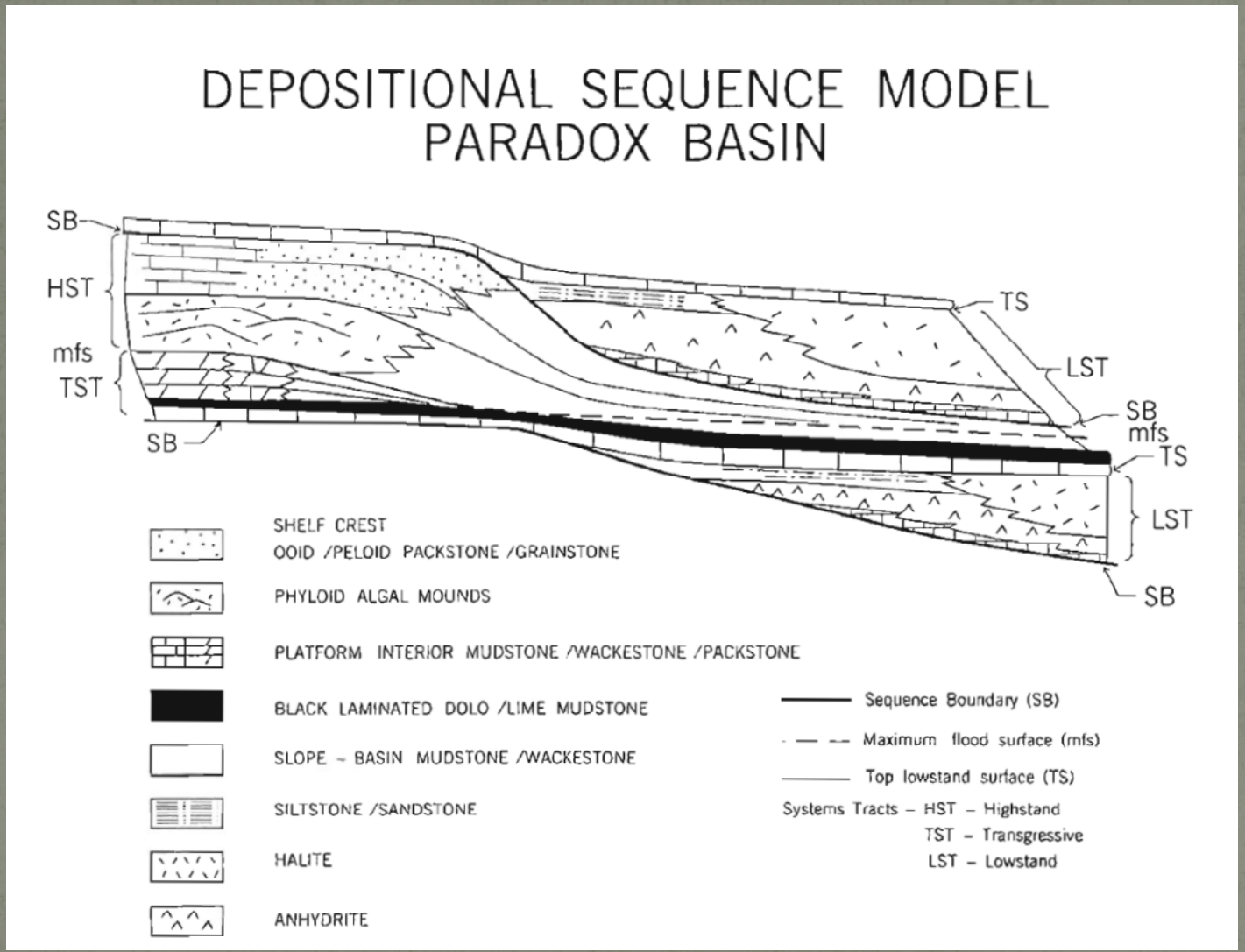


Williams-Stroud, 1994

Paradox basin evolution

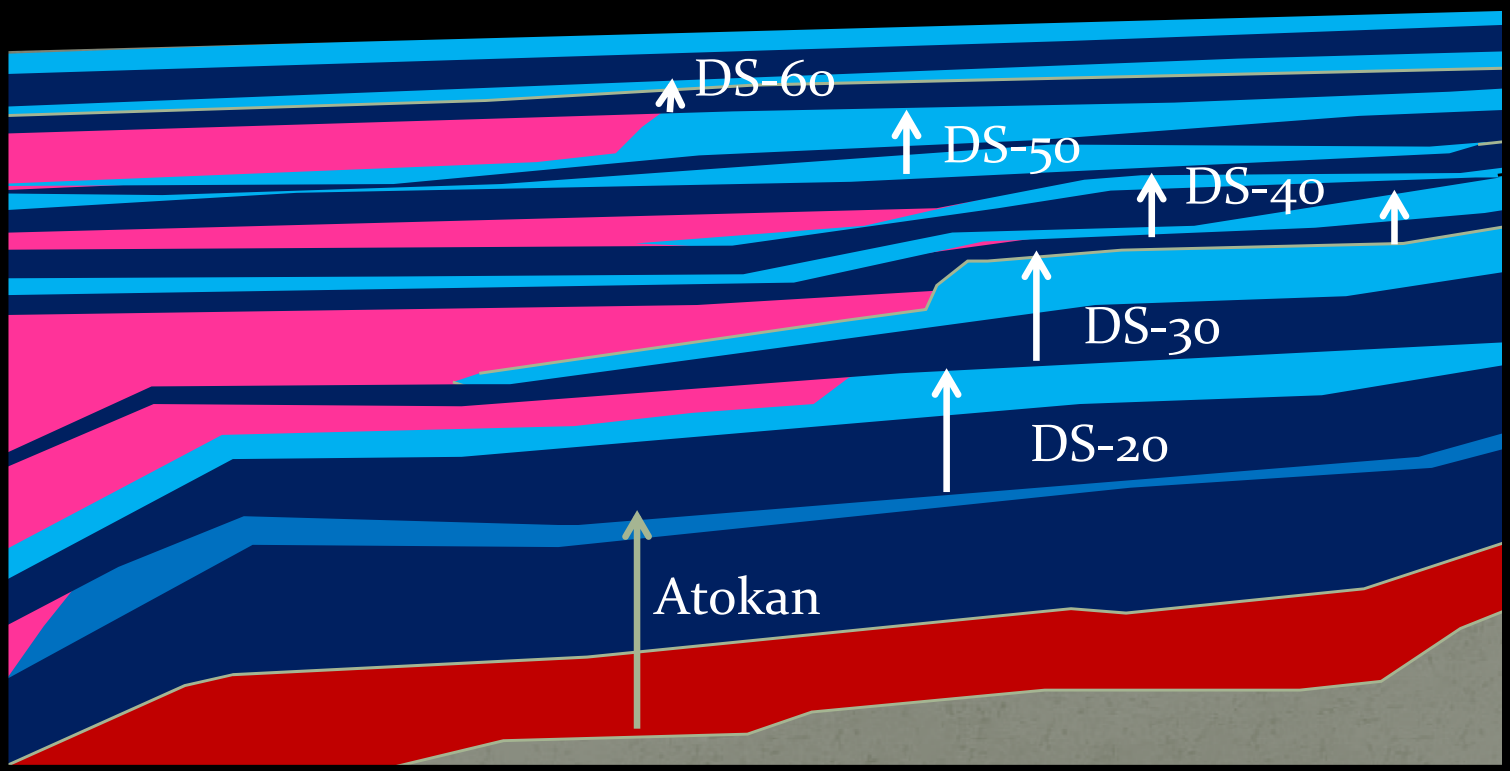
- Atokan Flooding – Pinkerton Trail Formation carbonates
- Desmoinesian- Maximum subsidence
  - Up to 3km of basin filling sediments
  - Lowstand evaporites and eolian deposits
  - Transgressive to Highstand shelf carbonates, with mound development, minor evaporites
  - Hermosa Group-Paradox Fm, Honaker Trail Fm
- Missourian to Virgillian grainstone lid, non-marine transition

Paradox basin -Sequence Stratigraphy



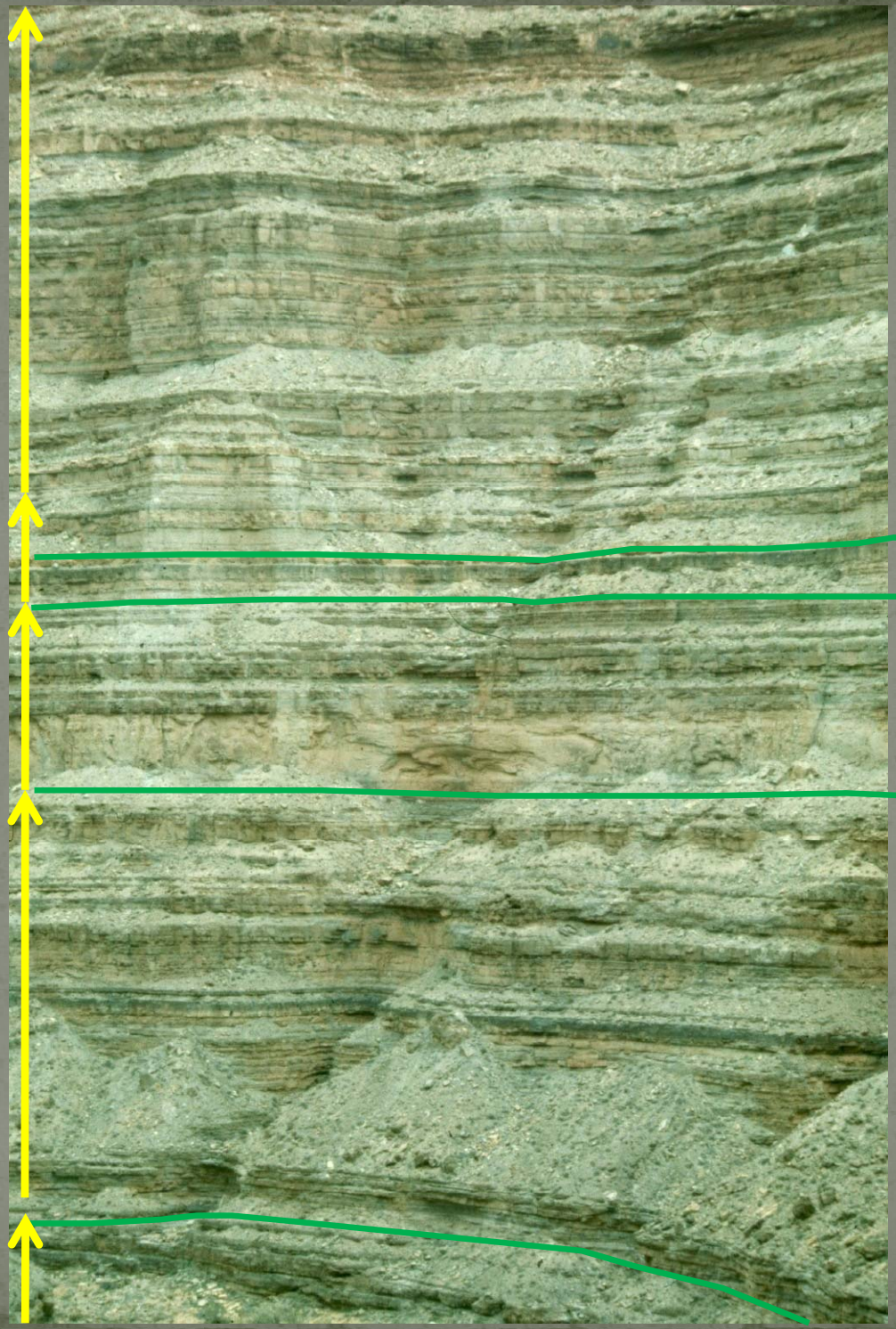
Weber Sarg and Wright, 1995

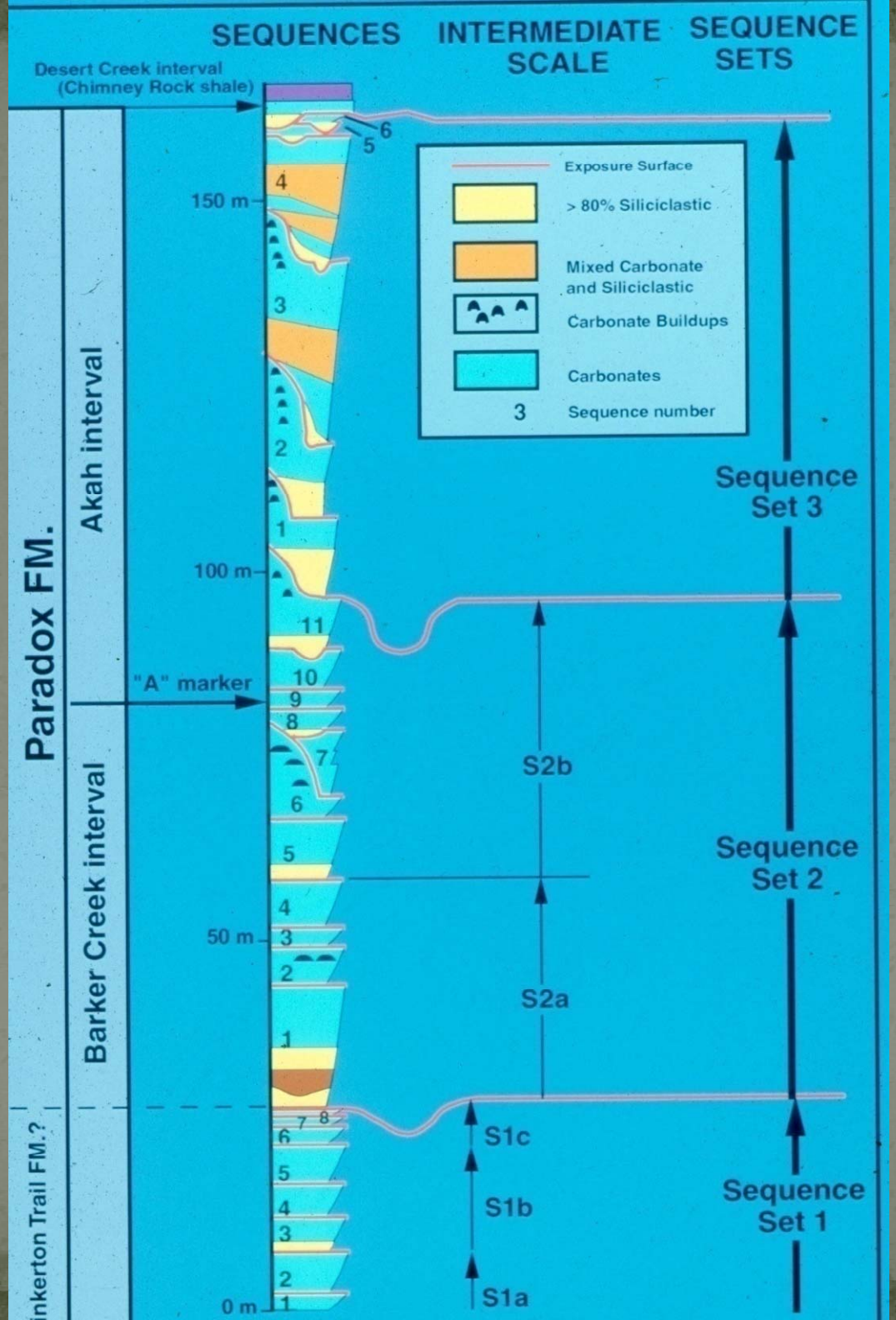
Sequence Geometries, southern margin Paradox basin



Modified from Sarg 2001

Western Shelf "Goosenecks" of the San Juan River





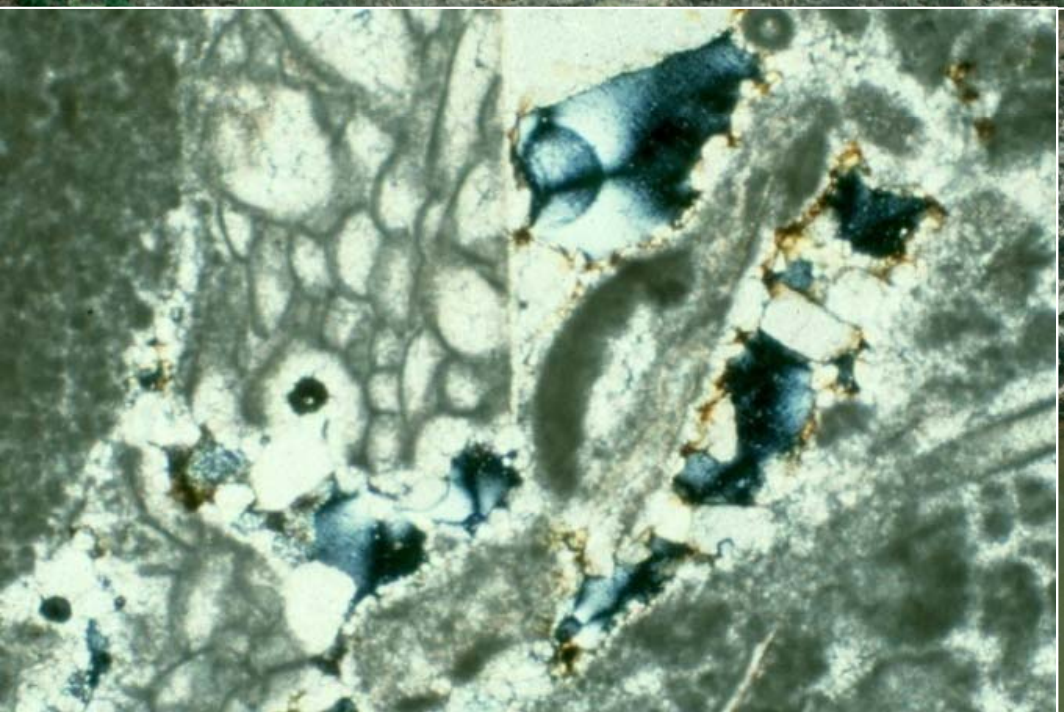
- Western Shelf
  - Barker Creek
  - Akah

Gianniny and Simo, 1996


Barker Creek interval
Basal phylloid biostromes, Bryozoan, Chaetetes buildups-

Barker Creek interval

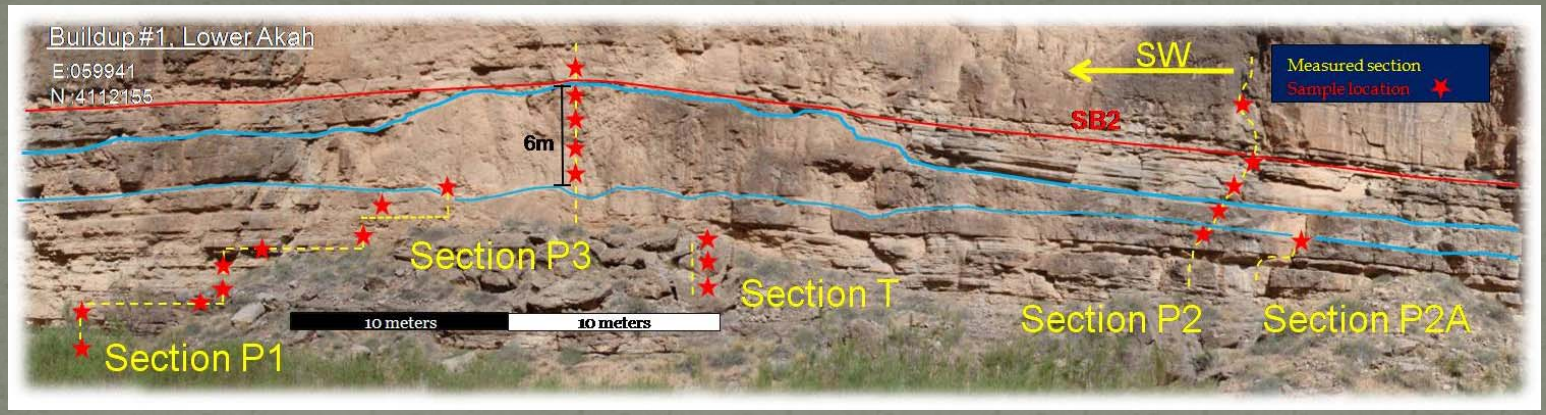
Basal phylloid biostromes, Bryozoan, Chaetetes buildups-



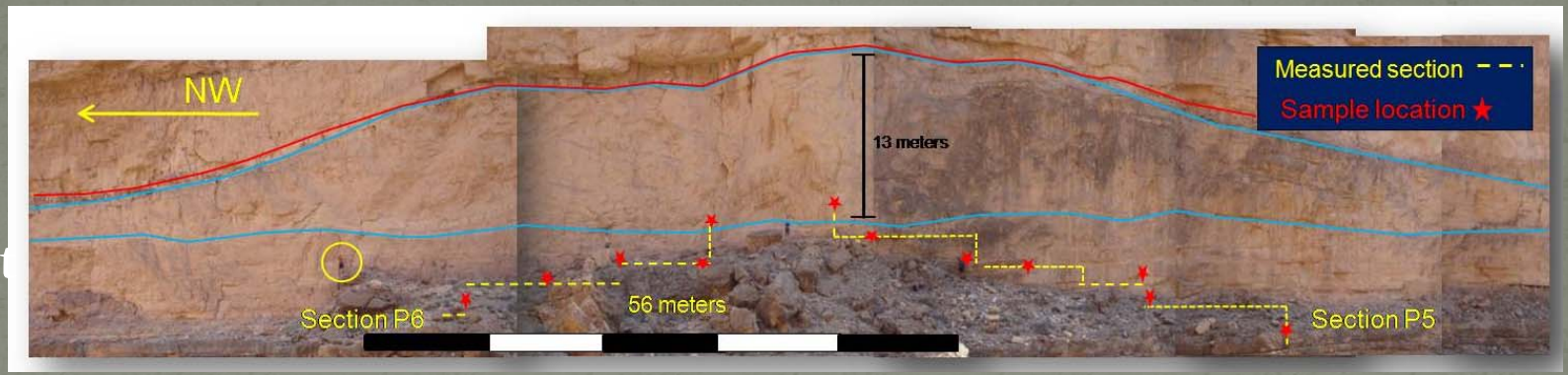

BARKER CREEK DIGITATE STOMATOLITES
NOT BIOHERM FORMING SEE PETERSON AND GIANNINY,
BOOTH 80 THIS AFTERNOON!

Lower Akah Microbial Buildups –clotted laminar fabric

Buildup 1
RM 39.0
River right



Buildup 2
RM 39.2
River Right



Buildup 3
RM 39.2

Buildup facies: Layered Thrombolite

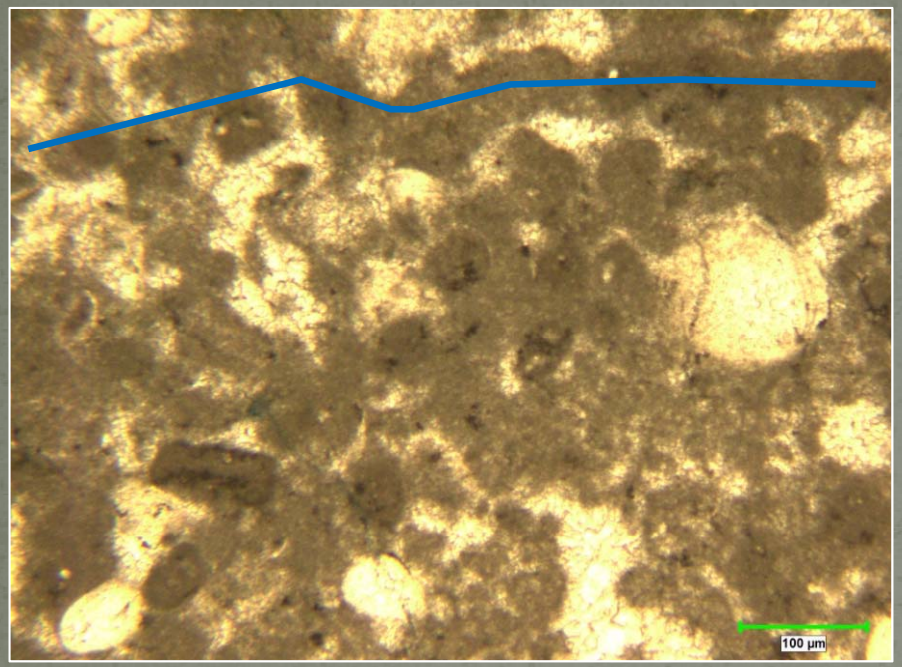
Sample location:
Buildup 2

Non-binding organisms include:

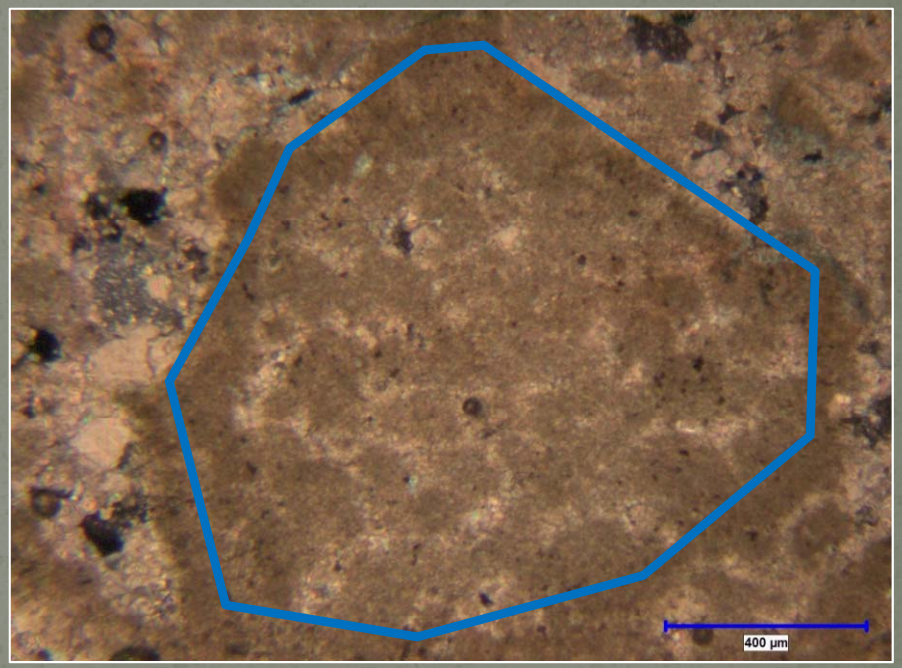
- Brachiopods
- Ostracods
- Foraminifera

Cut slab with laminated thrombolitic texture

Microbial Textures: Lower Akah Mounds

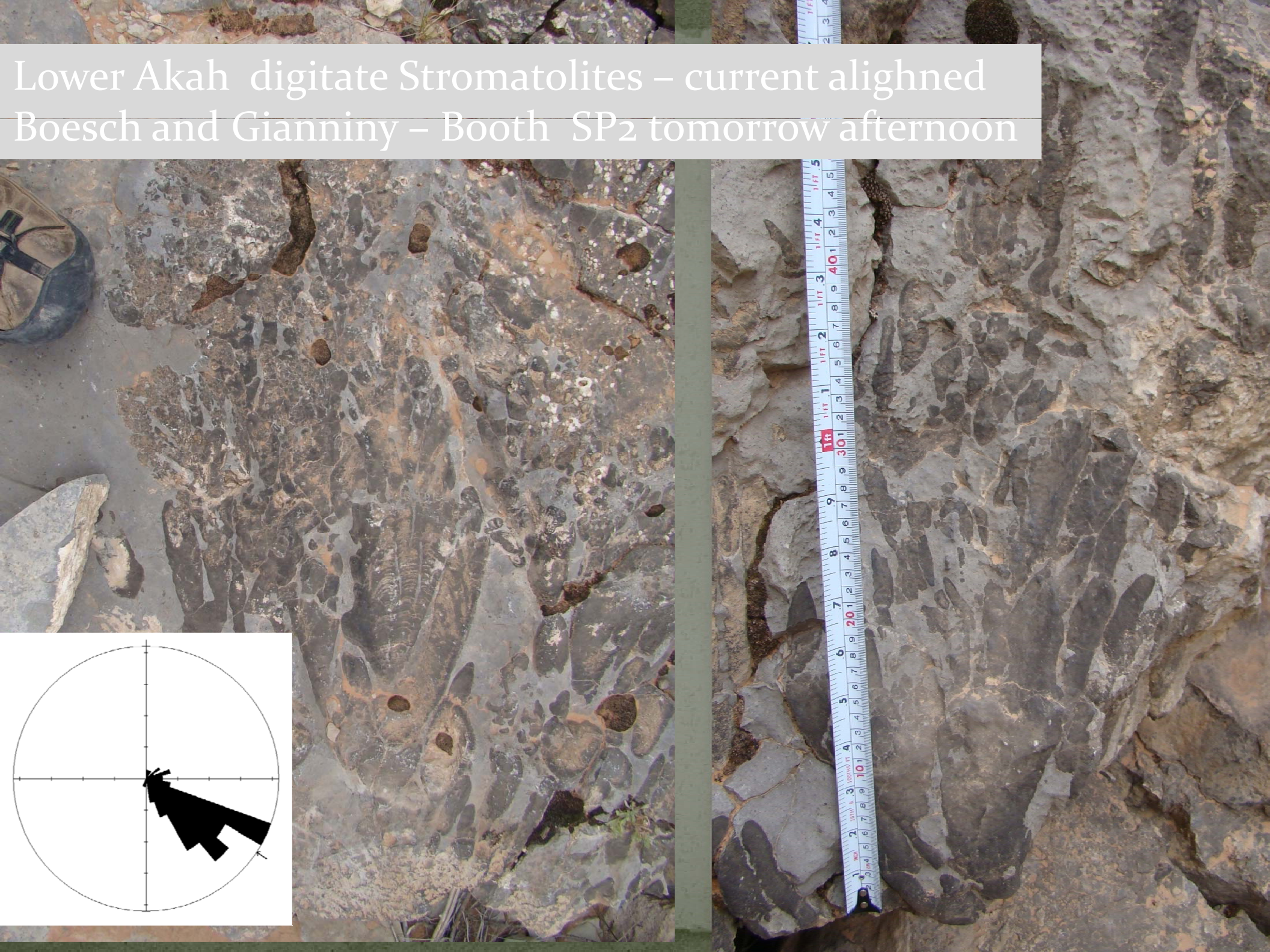


Common peloidal texture dispaying strung peloids and clotted textures

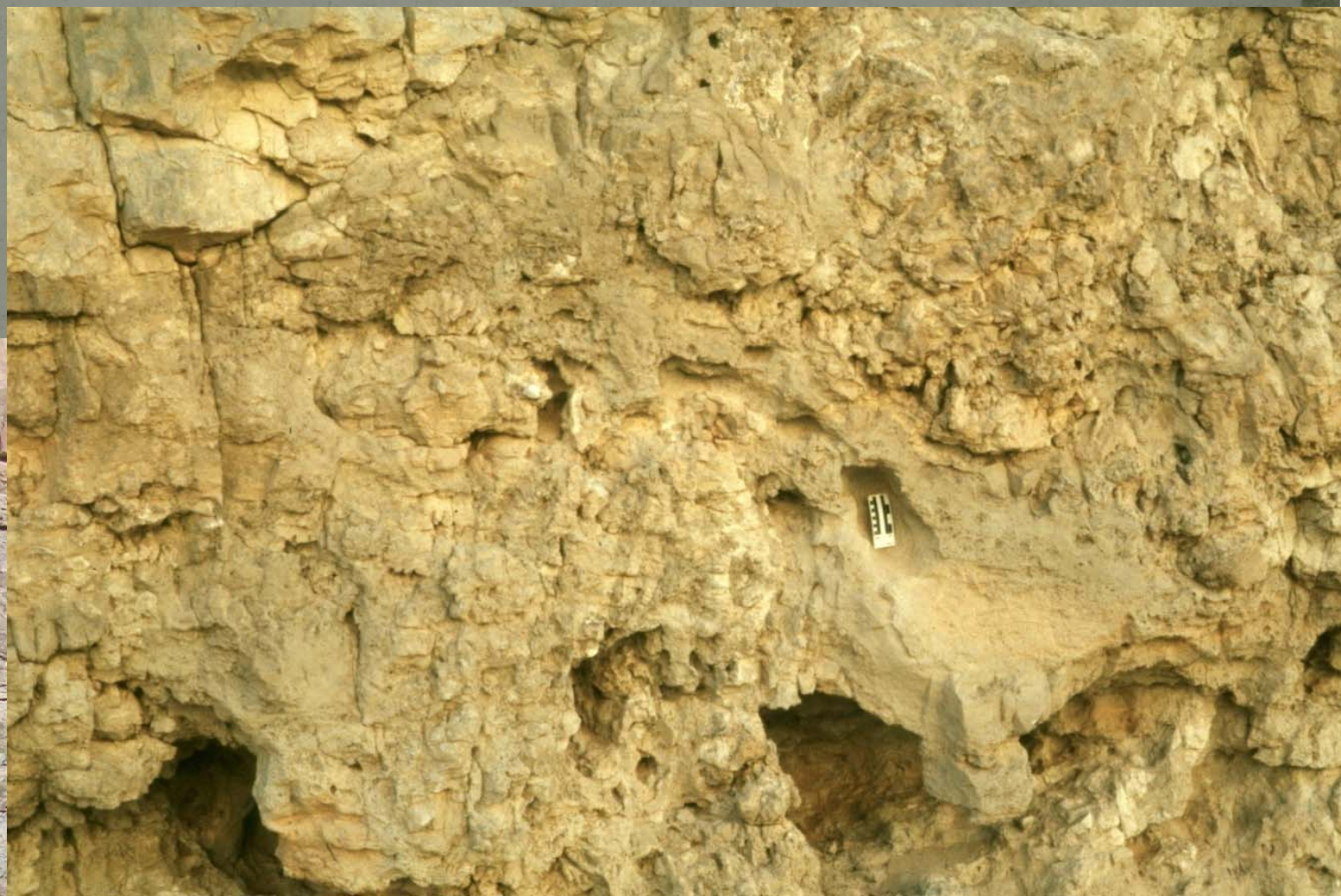


Micritic crust binding clotted peloids in disrupted (sparite) matrix

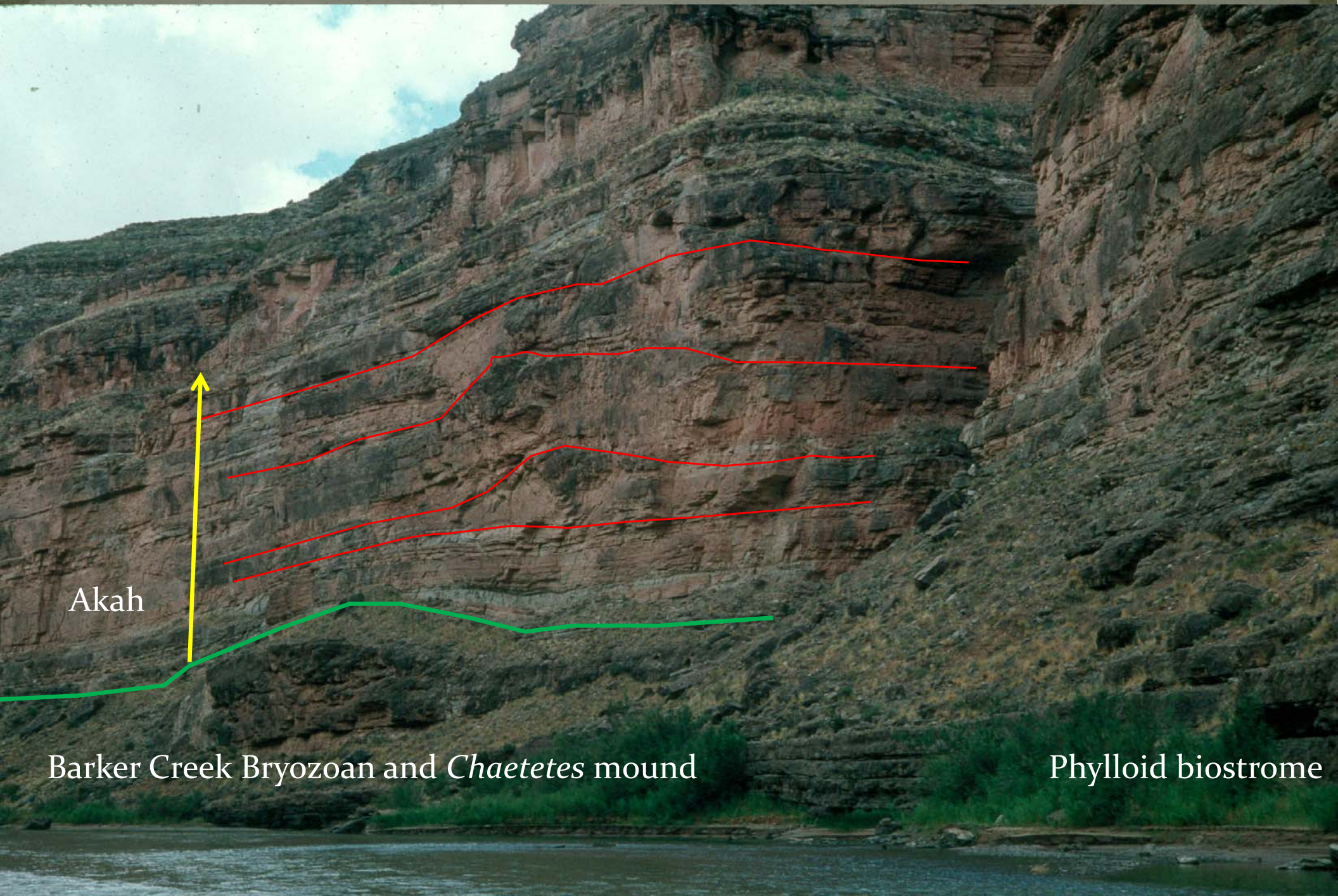
Lower Akah digitate Stromatolites – current alighned Boesch and Gianniny – Booth SP2 tomorrow afternoon



Upper Akah- Stromatolitic boundstone capped by *Chaetetes* framestone parasequences, linear and isolated

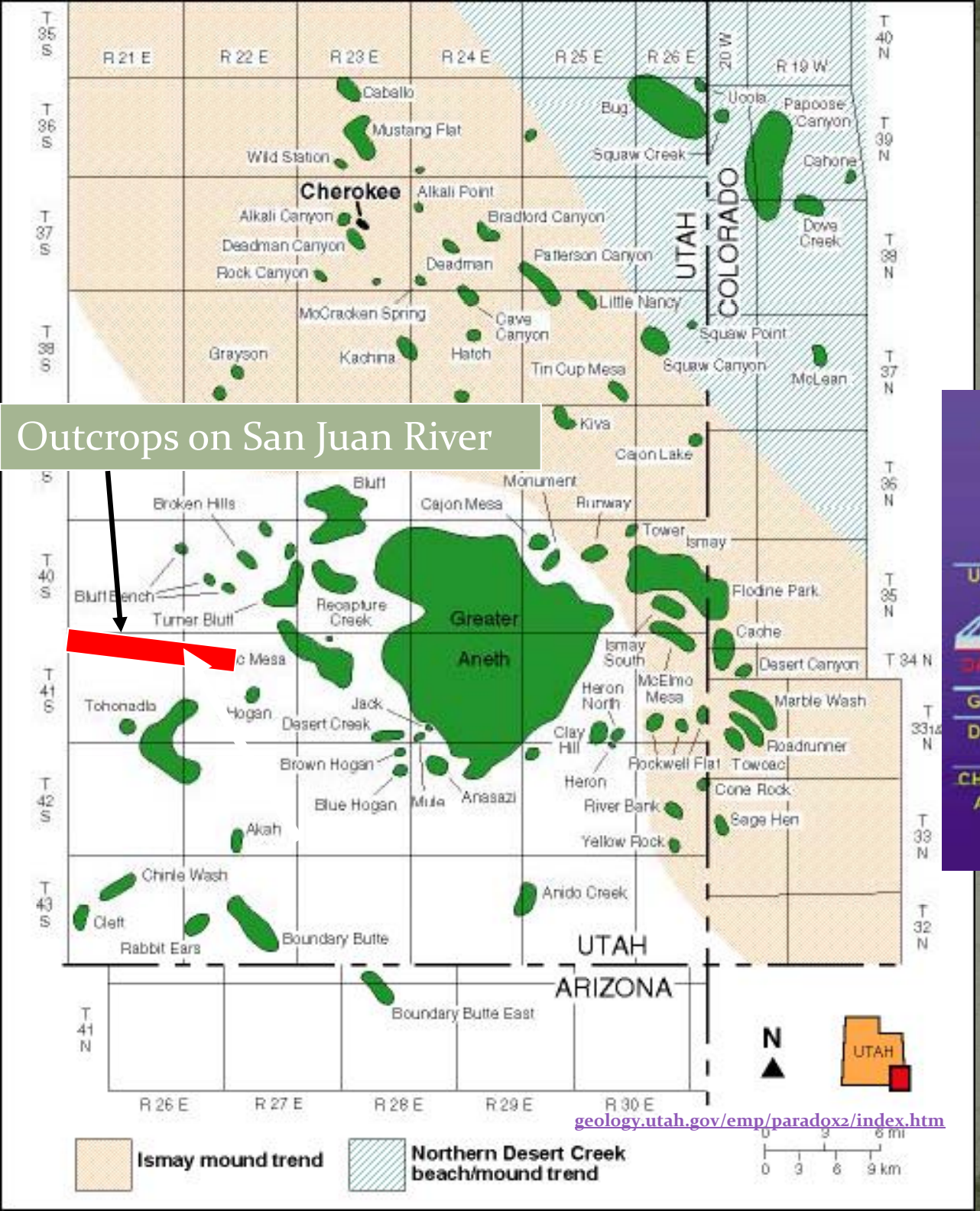


Stacked Buildups of Barker Creek and Akah intervals

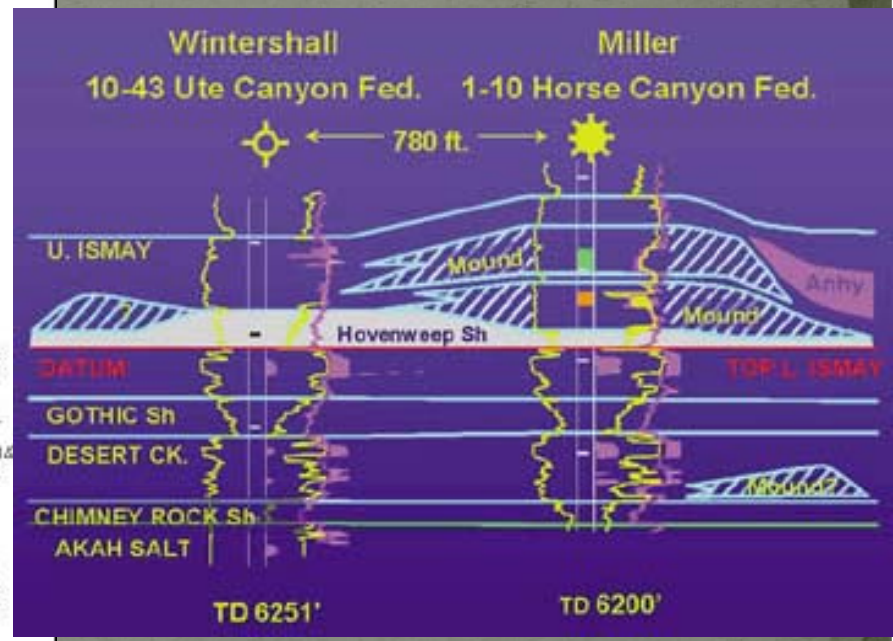


Desert Creek and Ismay Phylloid mounds

Outcrops on San Juan River



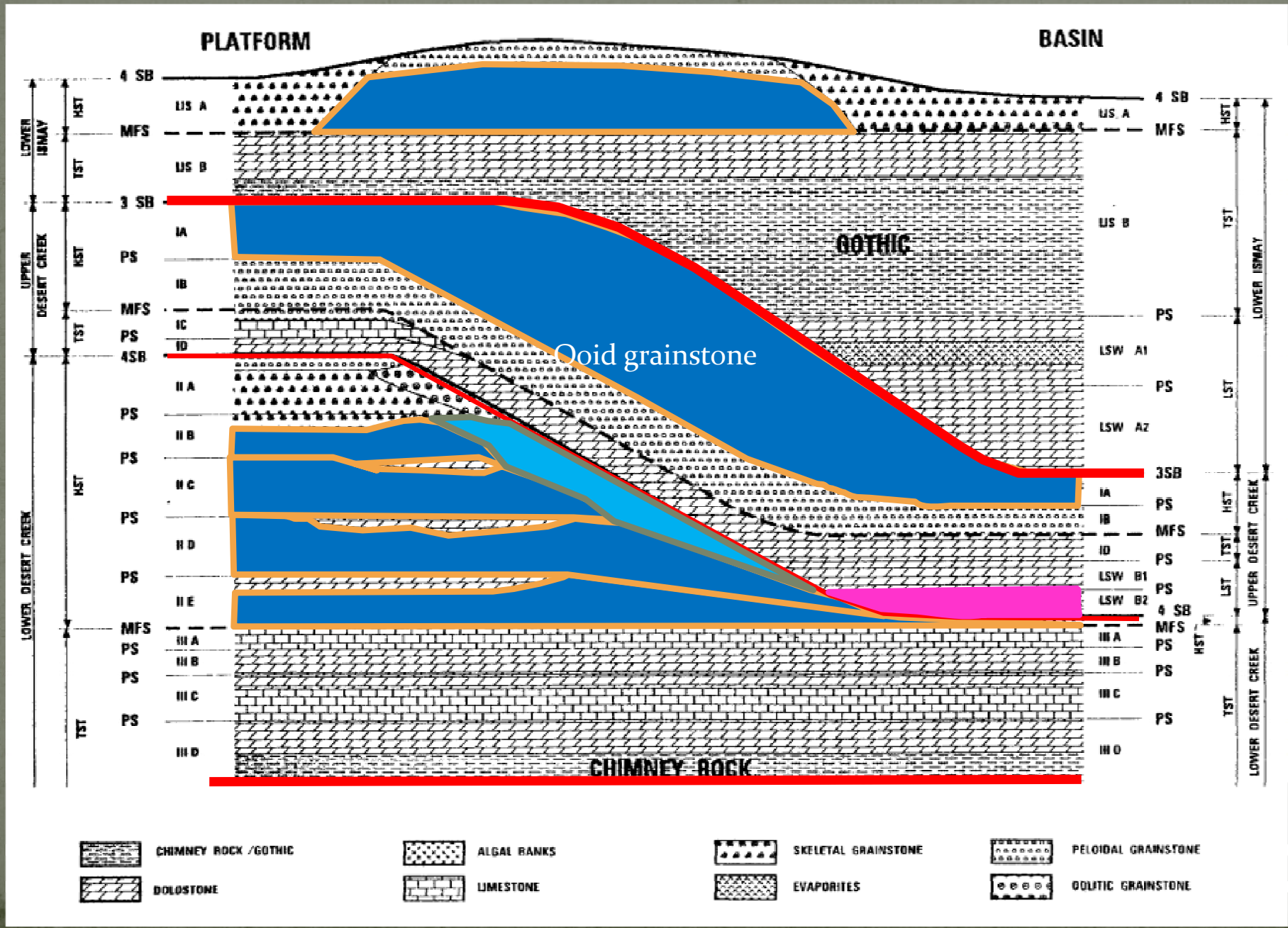
geology.utah.gov/emp/paradox2/index.htm

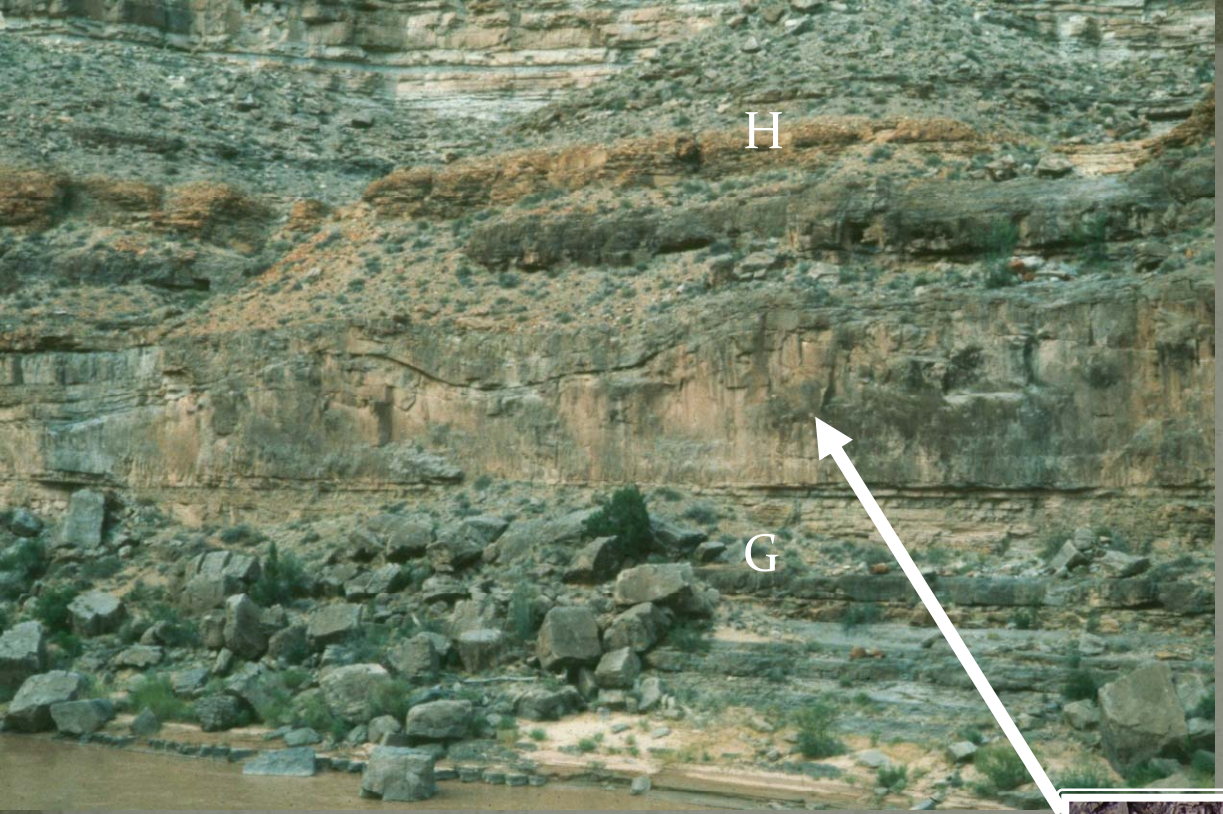


From Johnson et al. 2001

Aneth McElmo Unit schematic sequence stratigraphy

Modified from Weber et al.



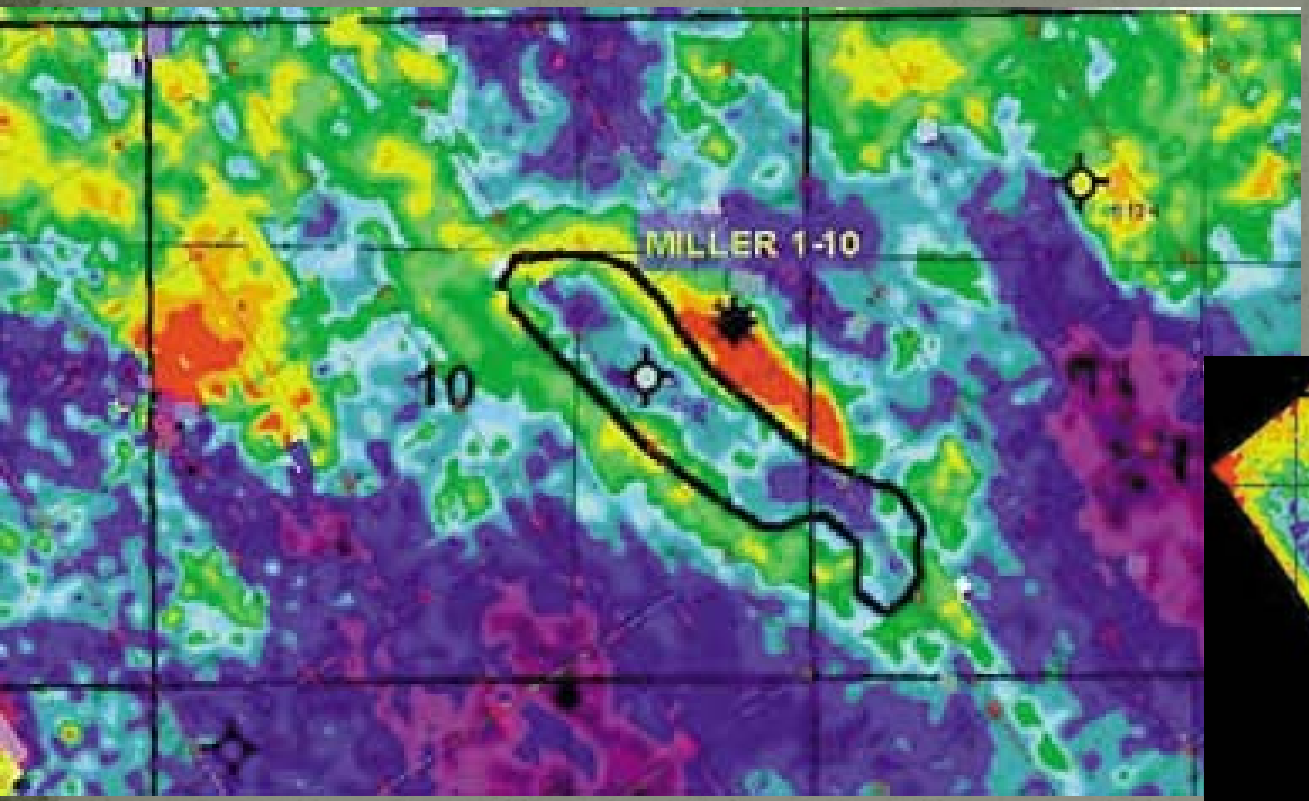


Traditional Phylloid algal mound reservoirs

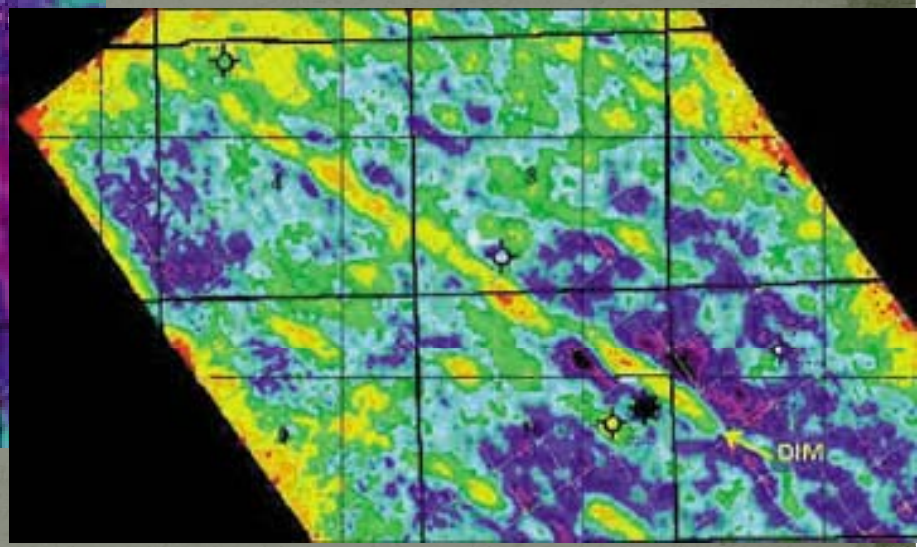
Outcrop exposures near Eight Foot Rapid, Lower Ismay

Much studied

Interacting faults, biological growth of mounds, and salt dissolution



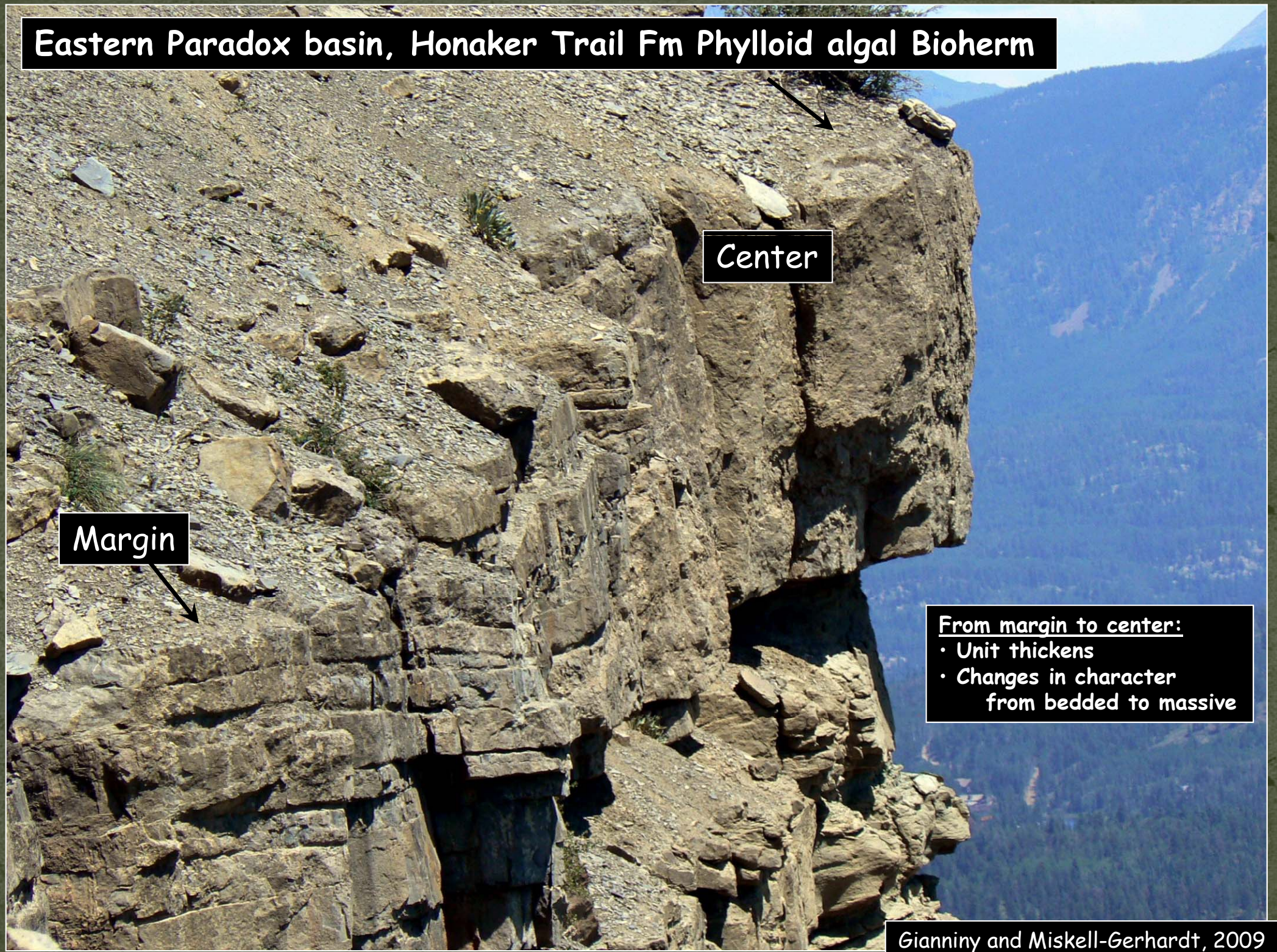
Upper Ismay Mound geometries – atoll-like



Fault geometries
- controls on shale thickness
- salt dissolution, and
-sandstone thickness variation

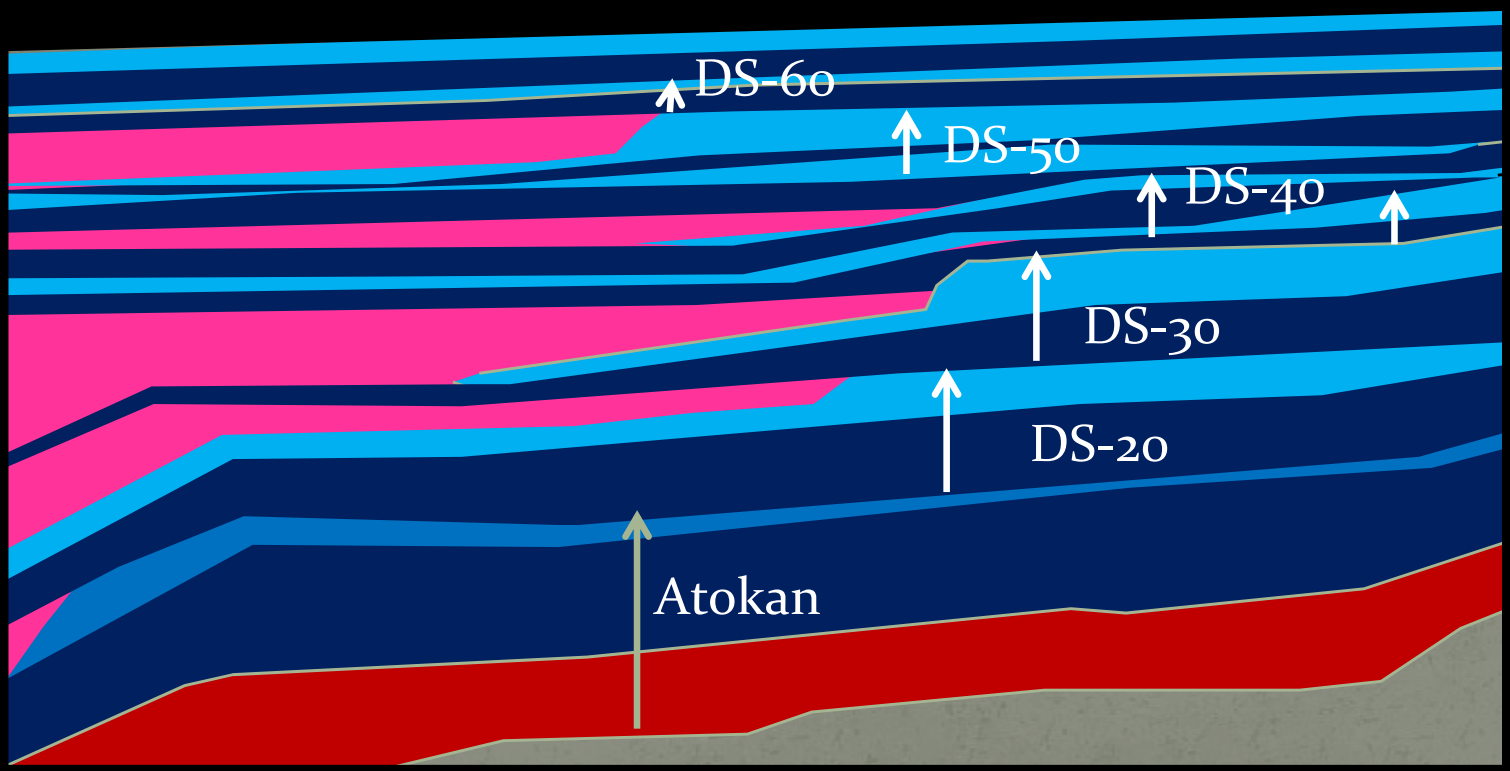
From Johnson et al., 2001 geology.utah.gov/emp/paradox/index.htm

Eastern Paradox basin, Honaker Trail Fm Phylloid algal Bioherm



Gianniny and Miskell-Gerhardt, 2009

Sequence Geometries, southern margin Paradox basin



Honaker Trail Fm

Ismay

Desert Creek

Akah

Barker Creek

Pinkerton Trail Fm

Modified from Sarg 2001

Conclusions: Mound Faunal Elements

- Microbial boundstones, up to 20m thick
- Phylloid Algal biostromes and bioherms – Aneth field stacked parasequences
- *Chaetetes* framestone reefs-Upper Akah also multi sequence stacking

Changing dominance-

Microbial – hypersalinity? Co-occur with maximum salt

Water depth- photic zone phylloid mounds, possible wave reworking in Ismay (Ritter and Grammer)

Chaetetes "reefs" associated with ooids and highest energy