Wolfcamp Facies and Stacking Patterns in the Delaware Basin, West Texas: Insights into Mechanisms and Patterns of Sediment Delivery and Facies Architecture*

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Abstract

Although general patterns of facies distribution in Leonard basinal successions are reasonably well known in the Permian Basin, Wolfcamp rocks are much less known, especially in the Delaware Basin. The Wolfcamp succession is commonly subdivided into A, B, C, and D successions that have been correlated widely, in large part on wireline logs alone. Core-based facies studies suggest much less lateral continuity. We used legacy and modern cores to define facies and their vertical and lateral distribution within the upper Wolfcamp using integrated conventional and chemostratigraphic core description methods. Seven facies were defined, each containing varying amounts of detrital and biogenic quartz, calcite, dolomite, and clay minerals. Illite is the dominant clay mineral although chlorite is locally abundant suggesting multiple sediment input sources. Of particular note for understanding sediment transport mechanism and defining correlations are the calcitic and dolomitic facies. The former, which are largely restricted to the upper Wolfcamp ("A" and upper "B" units), comprise clay to gravel size carbonate detritus indicative of platform shedding during sea level highstands. Dolomitic mudrock facies, which probably formed during maximum platform flooding, are perhaps the most correlative. Three scales of cyclicity are apparent. The uppermost Wolfcamp (unit "A") comprises thick (70-80 ft thick) cycles composed of basal detrital quartz siltstone facies indicative of lowstand shedding, overlying TOC-rich, argillaceous siliceous mudrocks suggestive of maximum flooding, and capping detrital carbonates related to highstand shedding. These highstand deposits consist of high frequency (3 to 6 ft thick) cycles of calcareous and argillaceous mudrocks. Intermediate scale cycles (20 to 50 ft thick), which characterize the lower part of Wolfcamp "B" but are also lateral equivalents of upper unit "B" carbonate dominated facies, comprise basal dolomitic mudrocks and overlying argillaceous siliceous mudrocks. Although uppermost Wolfcamp (unit "A") deposits document probable sea level

driven changes in sediment supply, underlying rocks suggest a dominance of eolian quartz sediment supply interrupted episodically by carbonate event deposits. The lateral discontinuity of platform-derived deposits suggests a dominance of point sourcing which makes lateral correlations difficult.

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AAPG Annual Meeting 2018

Salt Lake City, UT

Bureau of Economic Geology

Mudrock Systems Research Laboratory

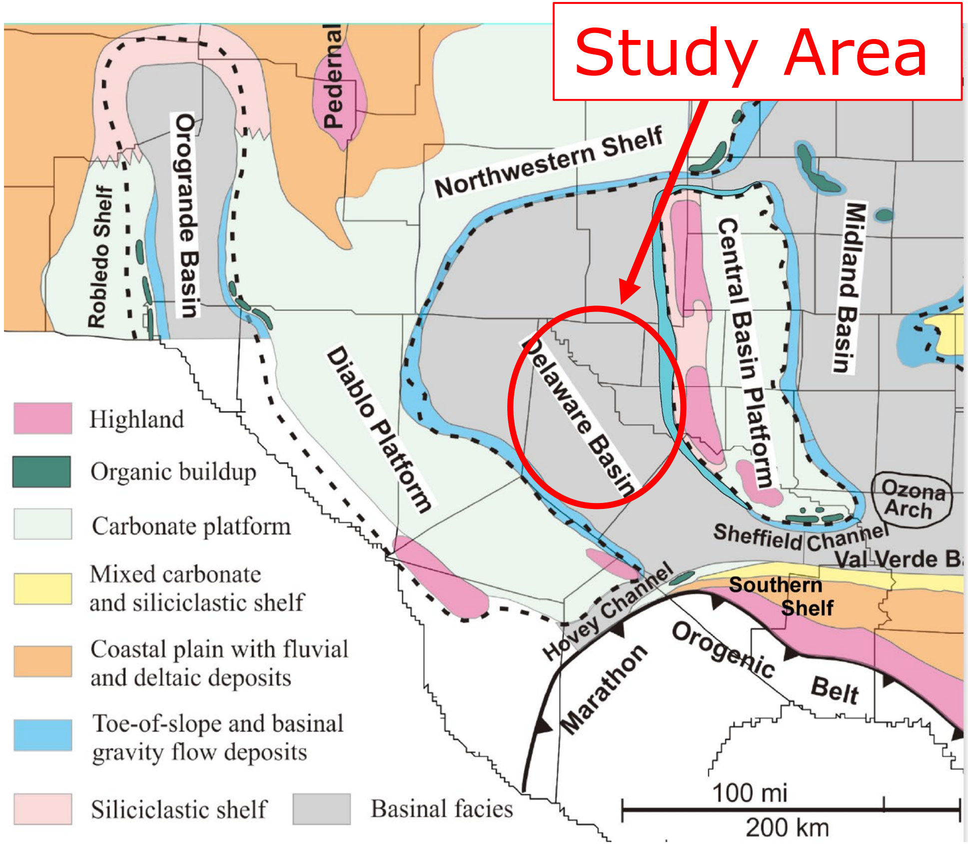
The University of Texas at Austin Jackson School of Geosciences

Some Key Findings and Take Away Points

- Upper Wolfcamp A, lower Wolfcamp A, & Wolfcamp B display distinct facies characteristics
- Upper Wolfcamp A is gradational to the Bone Spring
- The type and source of silica differs between the Upper Wolfcamp A (dominantly detrital) and underlying units (dominantly biogenic).
- Detrital carbonate mudstone-wackestones provide the best basis for temporal correlation
- Detrital carbonate debrites define point-sourced, channelized debris flows that are poorly correlative

Delaware Basin Wolfcamp Study

Note:
Multiple sources of detrital sediment surrounded the Delaware Basin

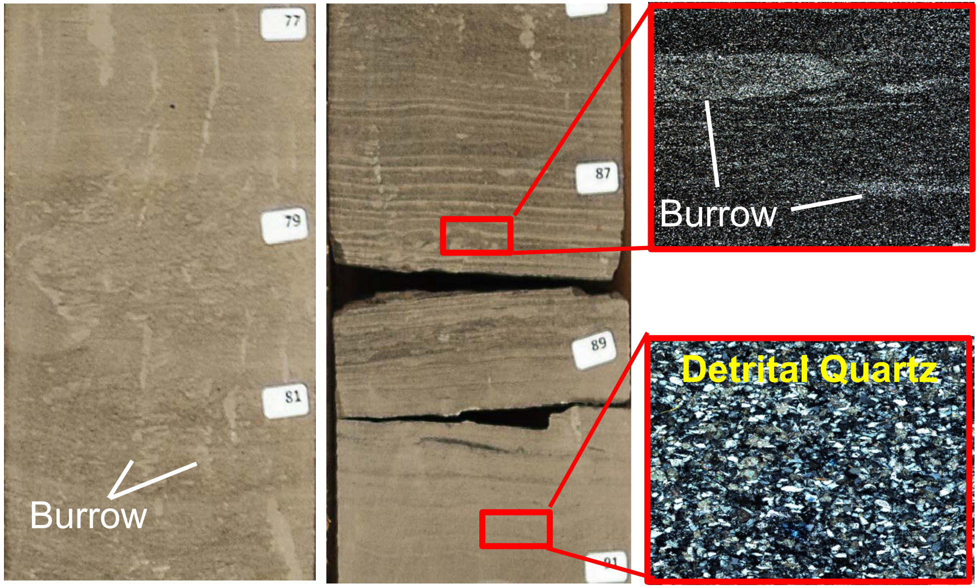


From Fu et al, (2019, in press)

Primary Wolfcamp Facies

Coarse-grained Siliciclastic Facies

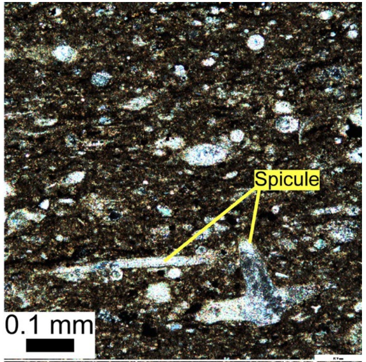
Detrital Quartz Sandstone-Siltstone

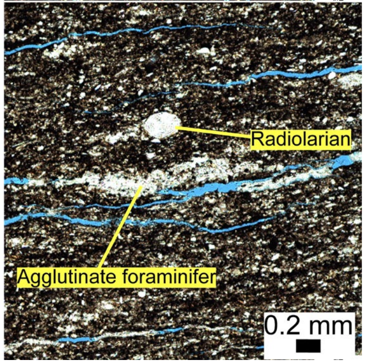


- Uppermost Wolfcamp A only
- Coarse-grained detrital quartz & feldspars
- Burrowed-laminated-massive
- Low to absent TOC
- Distribution & composition variable

Primary Wolfcamp Facies

Fine-grained Siliciclastic Facies





- Argillaceous Siliceous Mudstone
- Chloritic Siliceous Argillaceous Mudstone

•Subequal silica & clay minerals

•Biogenic silica & fine grained detrital silica

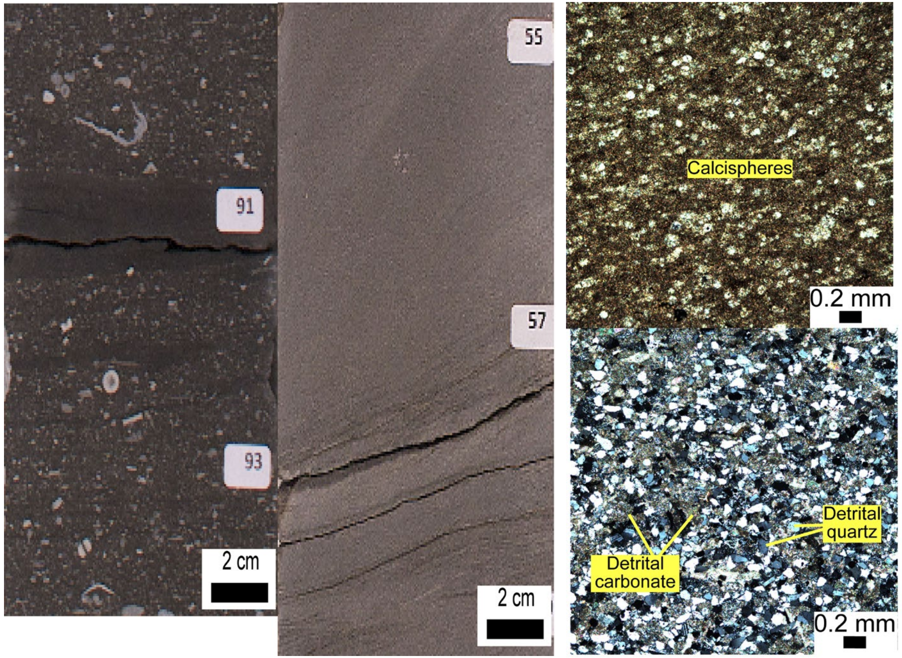
•Illite & chlorite content vary

•Total clay mineral content varies

•TOC higher in non-chloritic mudstones

Primary Carbonate Facies

Fine-grained Carbonate Facies



- Carbonate Mudstone-Wackestone
- Dolomitic Mudstone

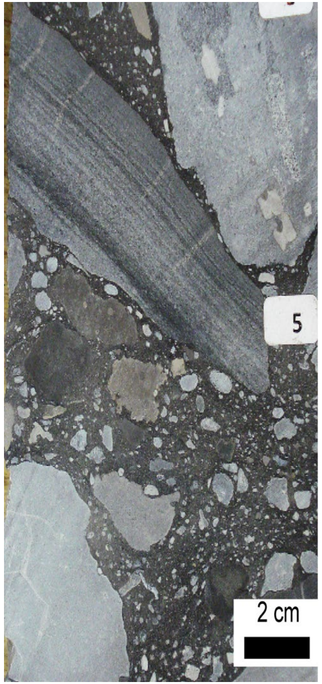
•Finer-grained platform-derived, detrital carbonate debris with variable detrital & biogenic silica and illite

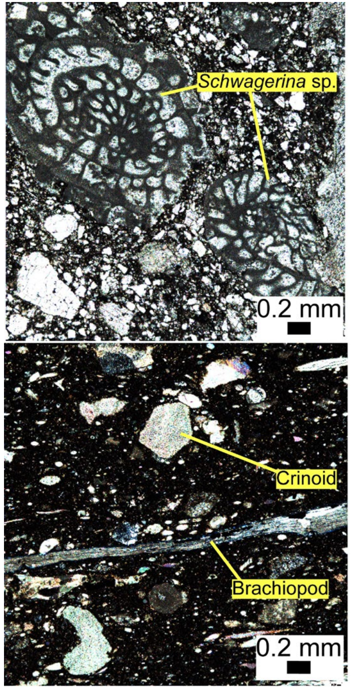
•Thin, locally correlative beds

•Low TOC

Primary Carbonate Facies

Coarse-grained Carbonate Facies





- Mud-supported Carbonate Debrite

•Coarser-grained, platform-derived, detrital carbonate clasts and grains in mudrock matrix

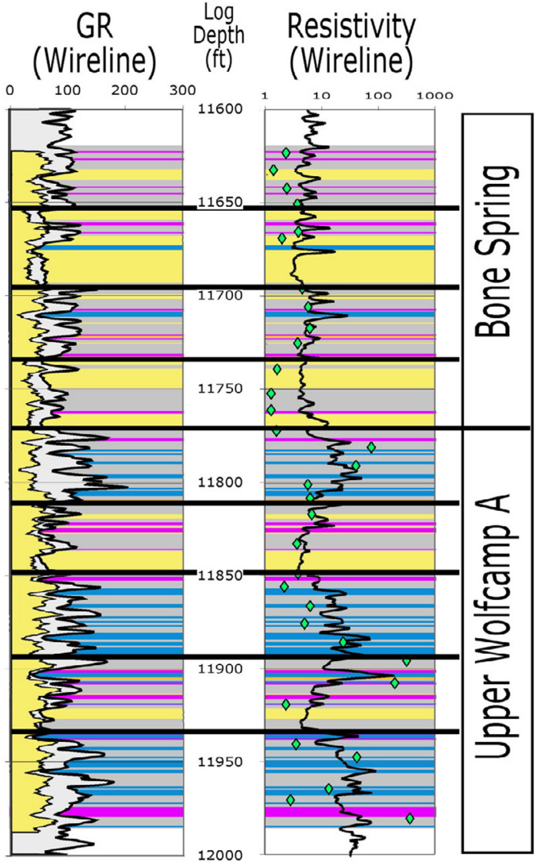
•Thick beds

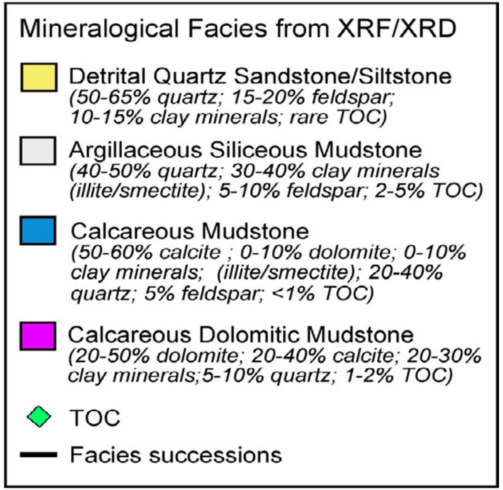
•Not readily correlative

•Low TOC

Bone Spring – Uppermost Wolfcamp A

Facies & Log Response

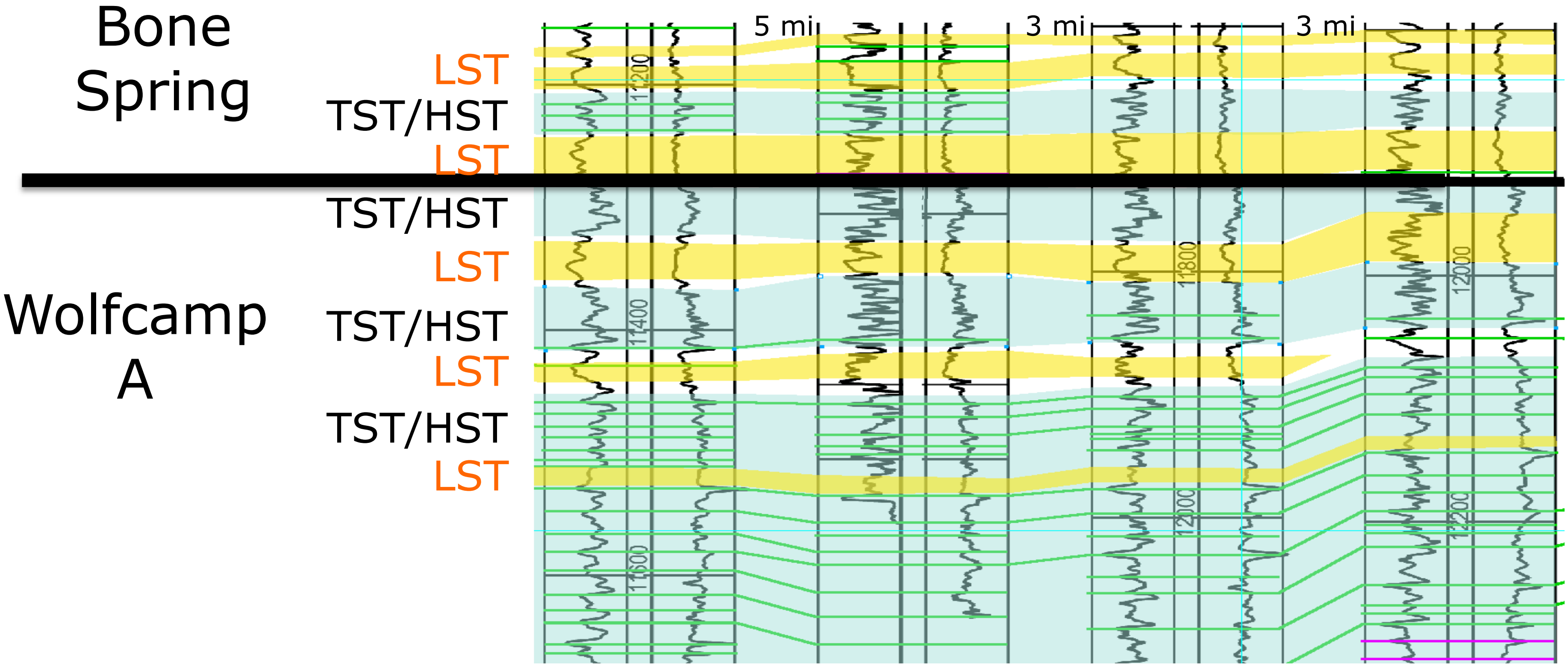




Note:

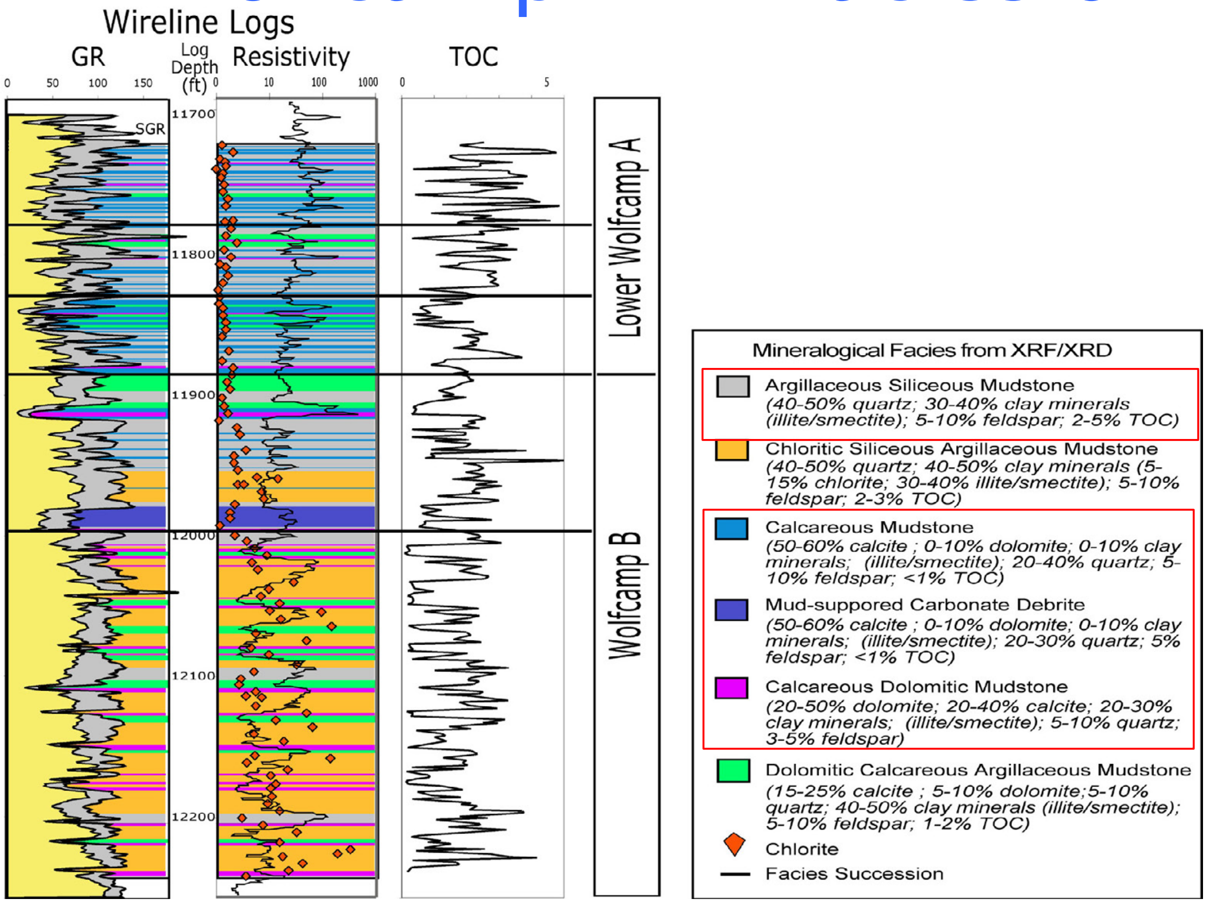
- 4 Facies
- Excellent tie between facies & log response
- Cyclicity
- Quartz-dominated cycles in lower Bone Spring; Carbonate-dominated cycles in upper Wolfcamp
- Higher TOC associated with carbonate facies

Bone Spring – Upper Wolfcamp A Facies Stacking



Siliciclastic-dominated facies
Carbonate-dominated facies

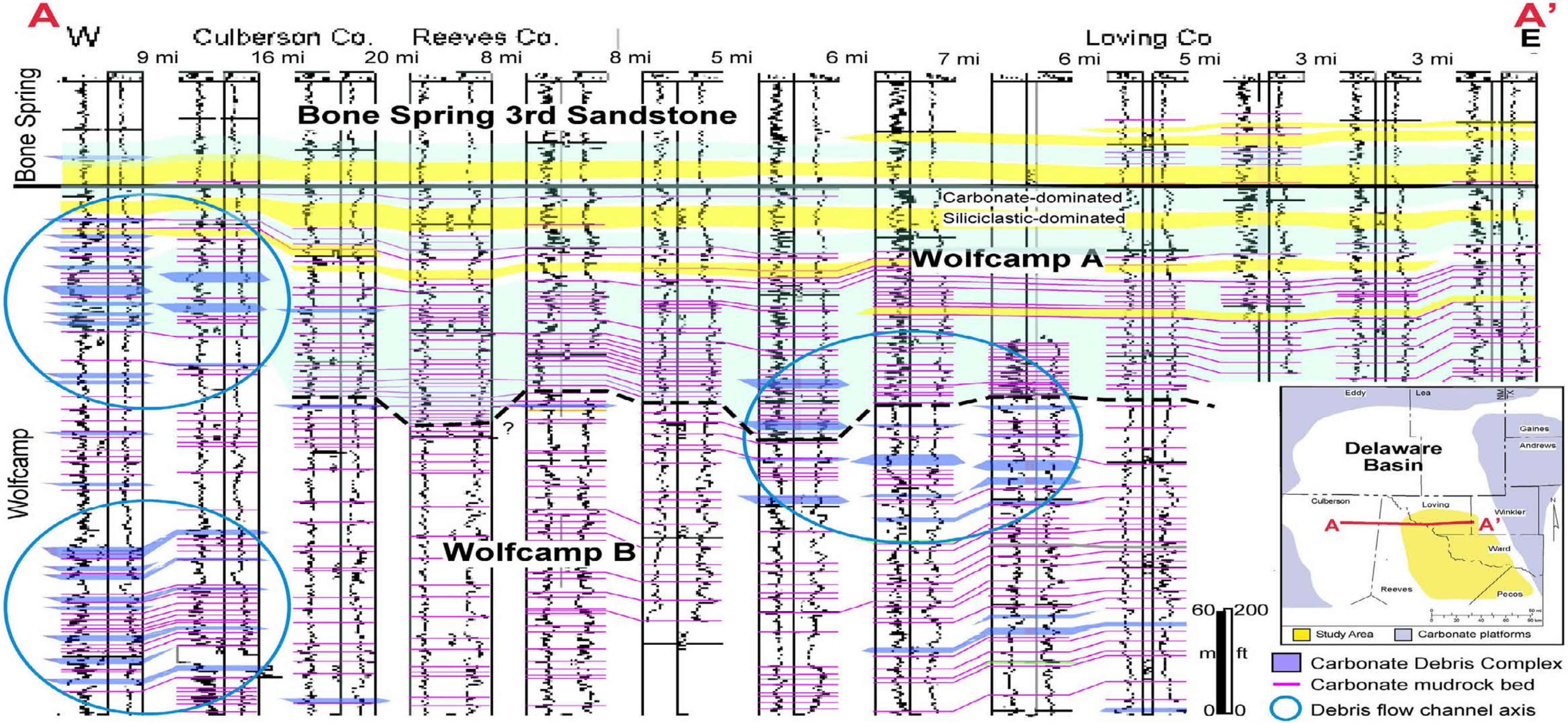
Wolfcamp A-B Facies & Log Response



Note:

- 6 facies
- 4 log facies
- Cyclicity
- Strong tie between carbonate facies and GR
- Higher TOC in Wolfcamp A
- Abundance of chlorite in lower Wolfcamp B

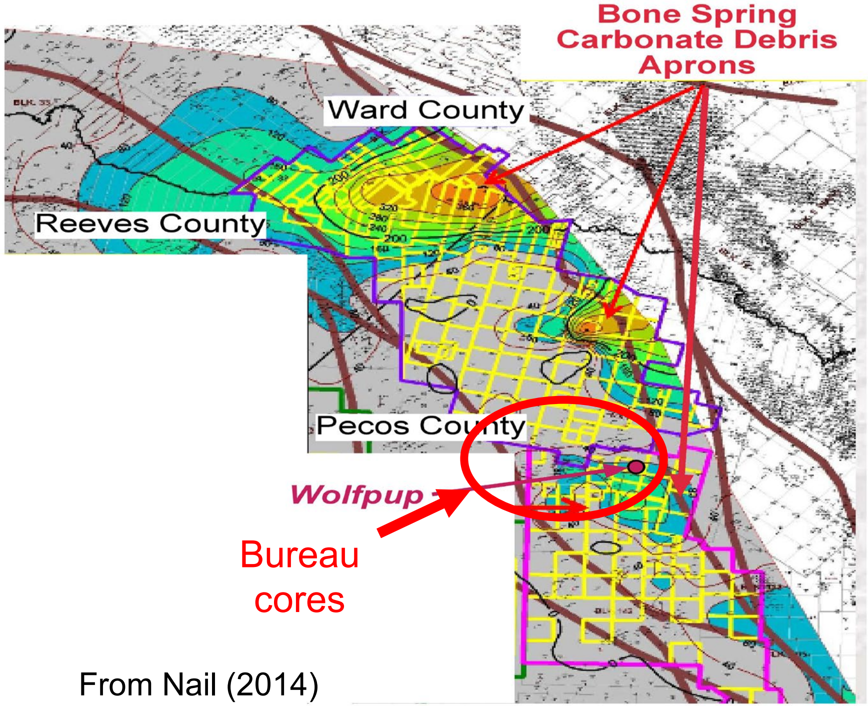
Facies Architecture & Correlations



Evidence of Carbonate Debris Point-Sourcing

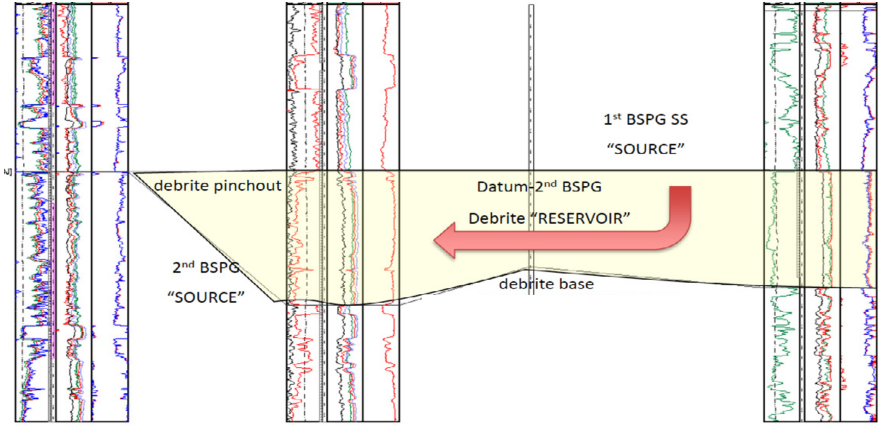
- Definable on logs
- Fan geometry?
- Related to sequences (HST? LST?)

Point Sourced Debris Complexes



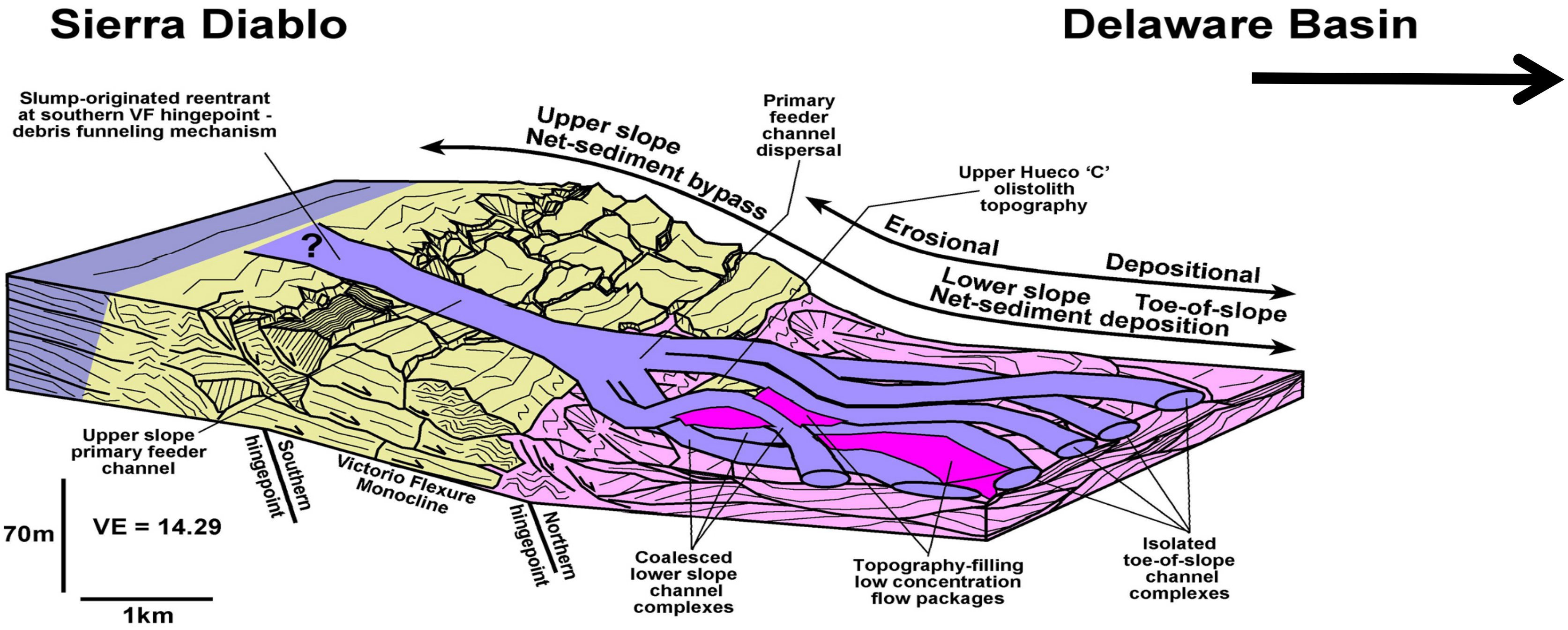
From Nail (2014)

Debris Bed Correlations



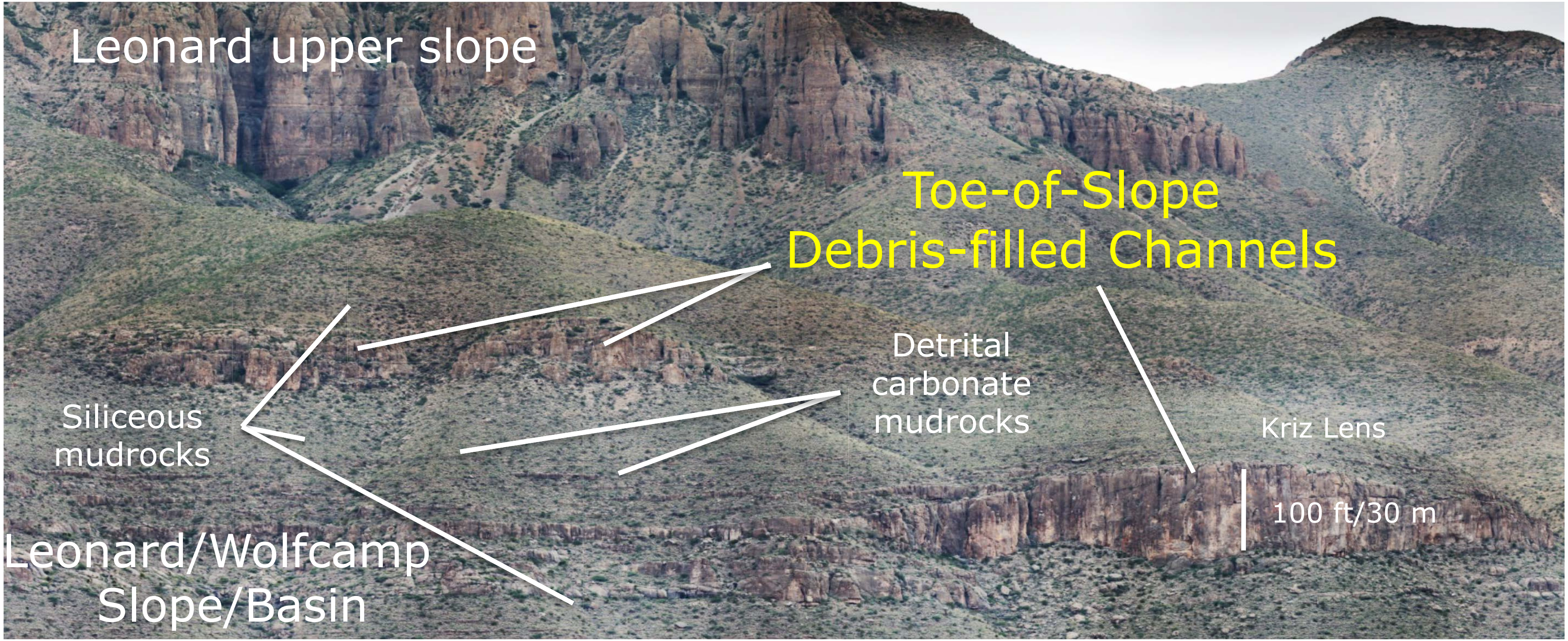
Wolfcamp Carbonate Debris Flows

Depositional Model:



Playton and Kerans (2002,2006)

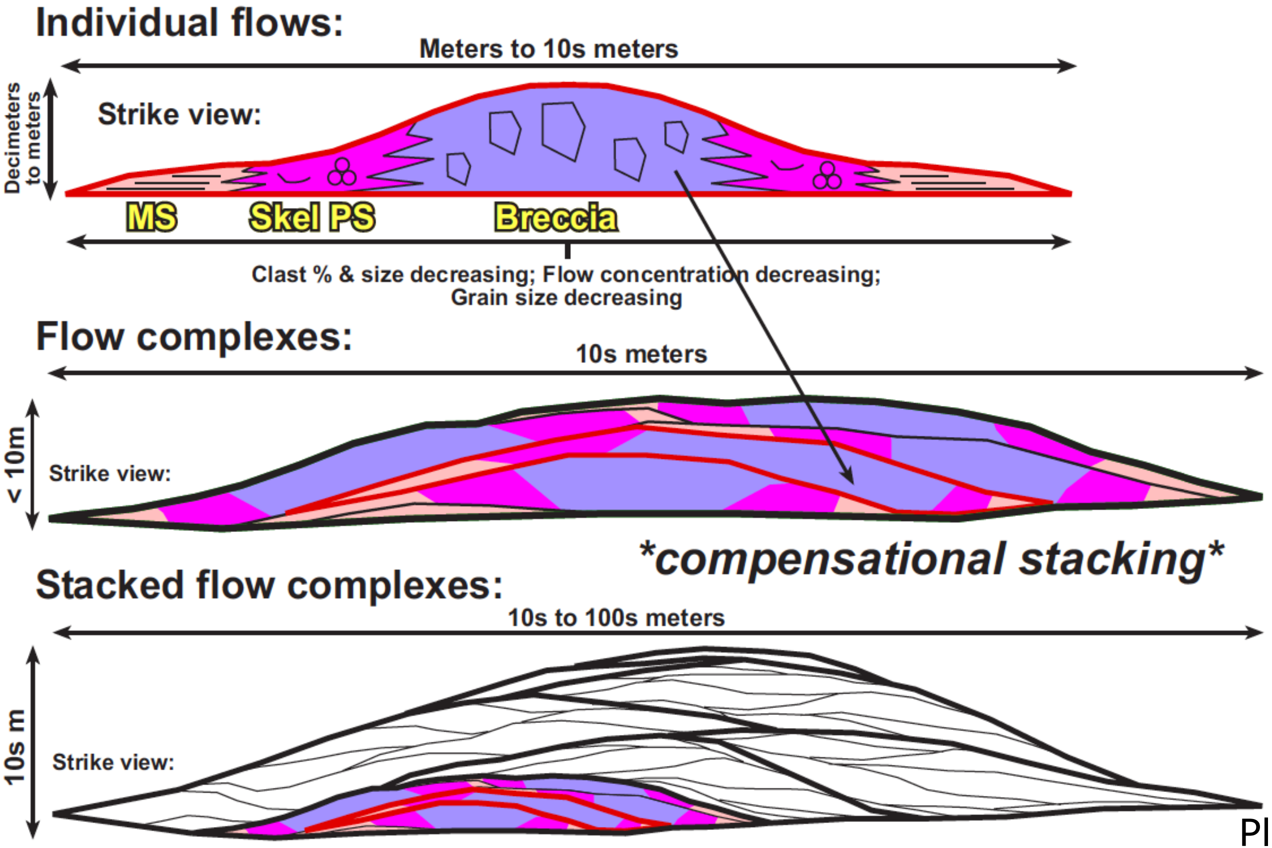
Leonard/Wolfcamp Carbonate Debris Flows:



Sierra Diablo, West Texas

Wolfcamp Carbonate Debris Flows

Internal Facies Architecture



Playton and Kerans (2002, 2006)

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Some Remaining Challenges & Questions

- Can distinctions be made between detrital, biogenic, and authigenic forms of silica and carbonate?

- Is eolian transport the dominant mechanism for detrital quartz sediment input in the lower Wolfcamp A and Wolfcamp B?

- Is sea level change a control on sediment flux in the lower Wolfcamp A and Wolfcamp B?

- What is the architecture of the carbonate debrites?

- Can sequence stratigraphic principles be applied to the Wolfcamp?

Thanks for Listening!

Time for Your Questions.

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