Stratigraphic Study of the Turonian Semilla Sandstone Member of the Mancos Shale, San Juan Basin, New Mexico

Scott Kennedy
scottkennedy@mines.edu
M.S. Geology
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Project Summary

Complete a stratigraphic study of the Semilla Sandstone member of the Mancos Shale of the San Juan Basin, New Mexico using both outcrop observation and petrographic thin section analysis.

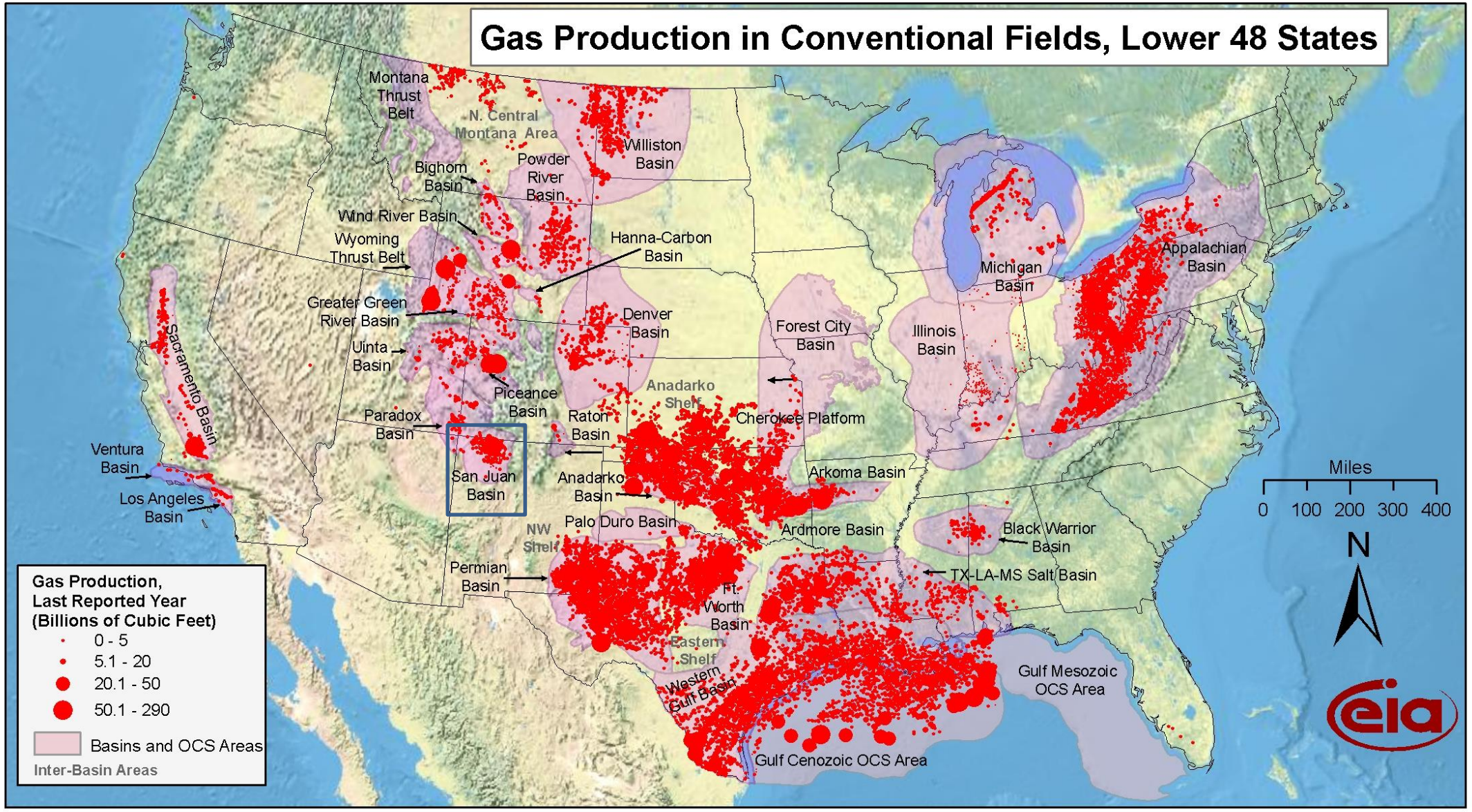
Compare those findings to the time equivalent type 1 sand of the Codell Sandstone.

Use those comparisons to gain a greater understanding of the regional deposition of these two sands and of the depositional mechanisms of linear shelf sands.

Presentation Outline

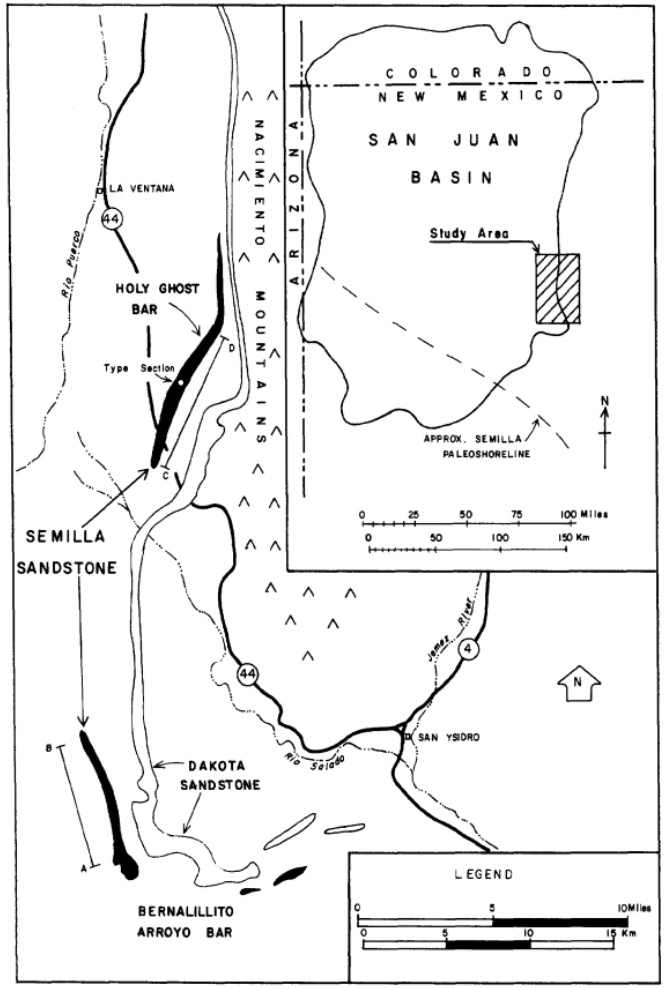
- Study Area
- Regional Geology
- Depositional Environment
- Semilla Outcrop Analysis and Stratigraphy
- Codell Petrographic and Core Analysis
- Conclusions
- Further Work

Study Area



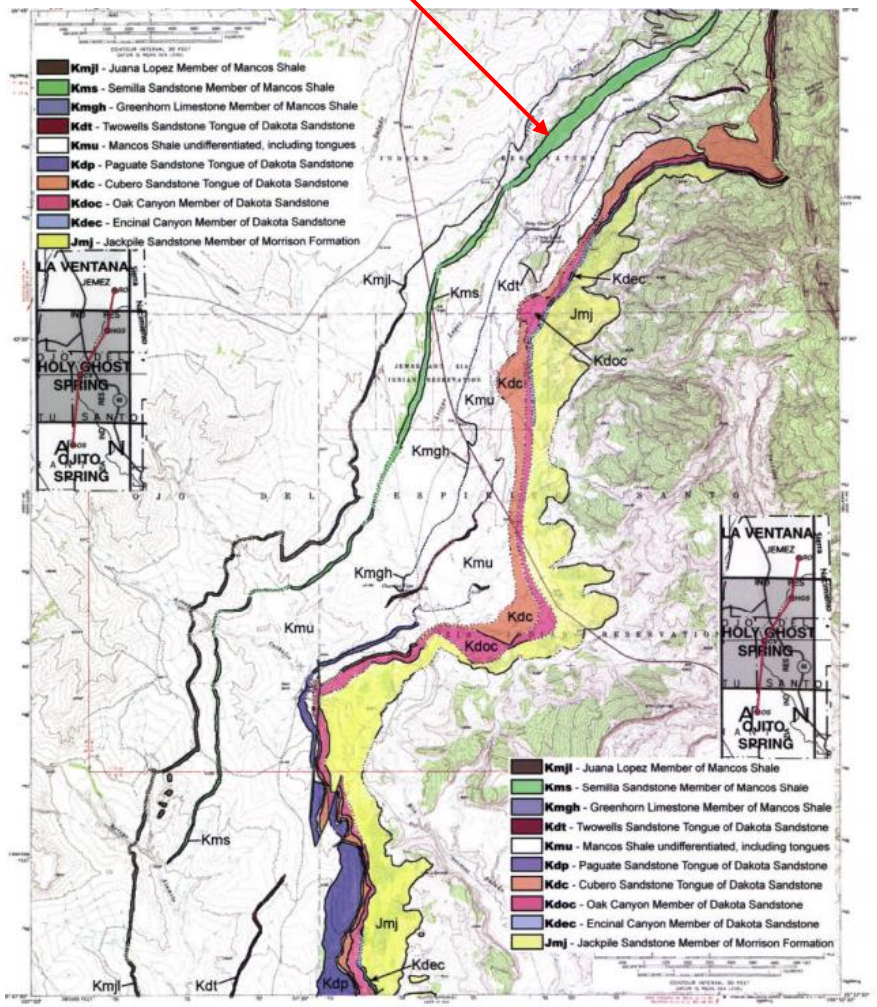
Source: Energy Information Administration based on data from HPDI, IN Geological Survey, USGS
Updated: April 8, 2009

Study Area



From La Fon, 1981

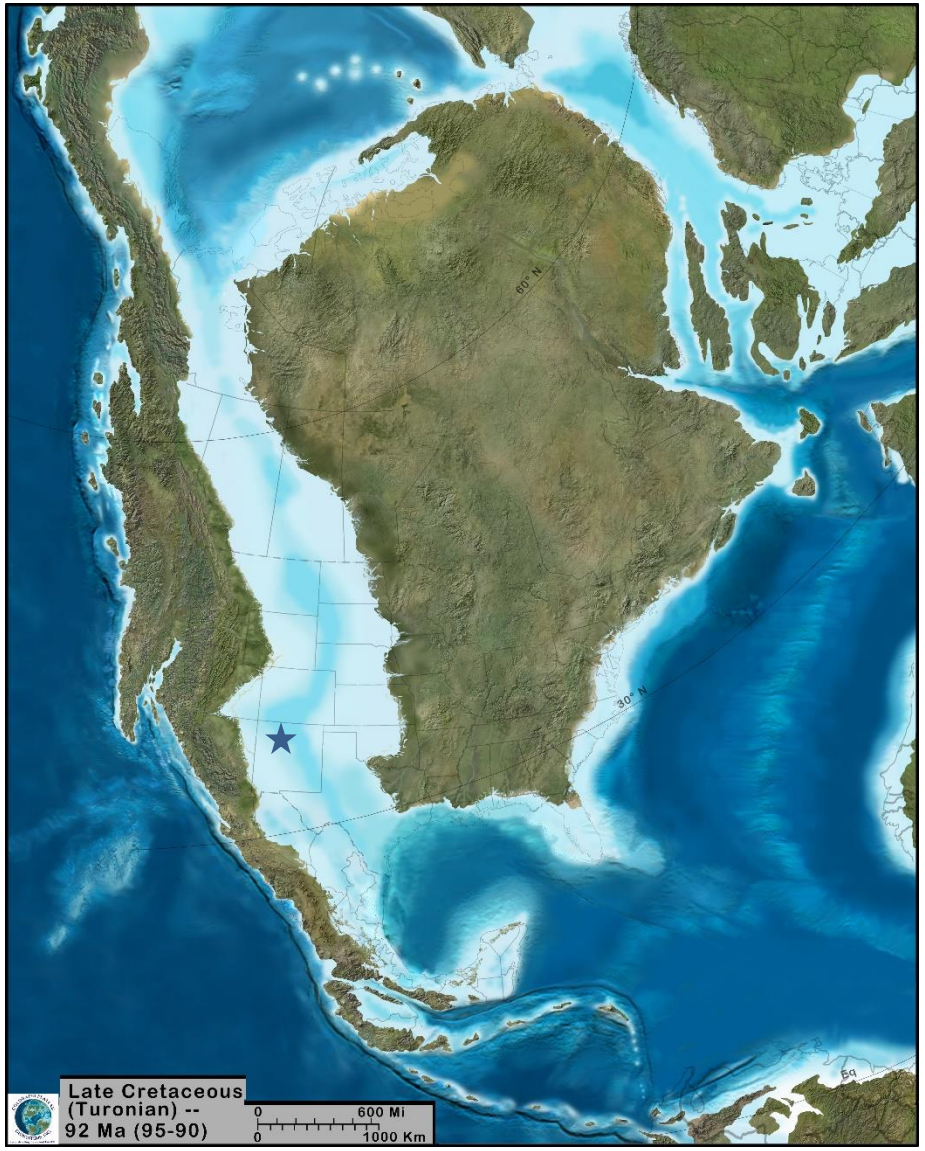
Semilla outcrops (green)



From Owen et al. 2007

- Left: Semilla Outcrops studied by La Fon, 1981, shows the Holy Ghost Bar, the type section
- Right: More detailed mapping from Owen et al. 2007
- Total outcrop length is about 35 miles long
- All of these outcrops are located on Zia Pueblo and Jemez Pueblo lands, which has made access difficult.

Regional Geology

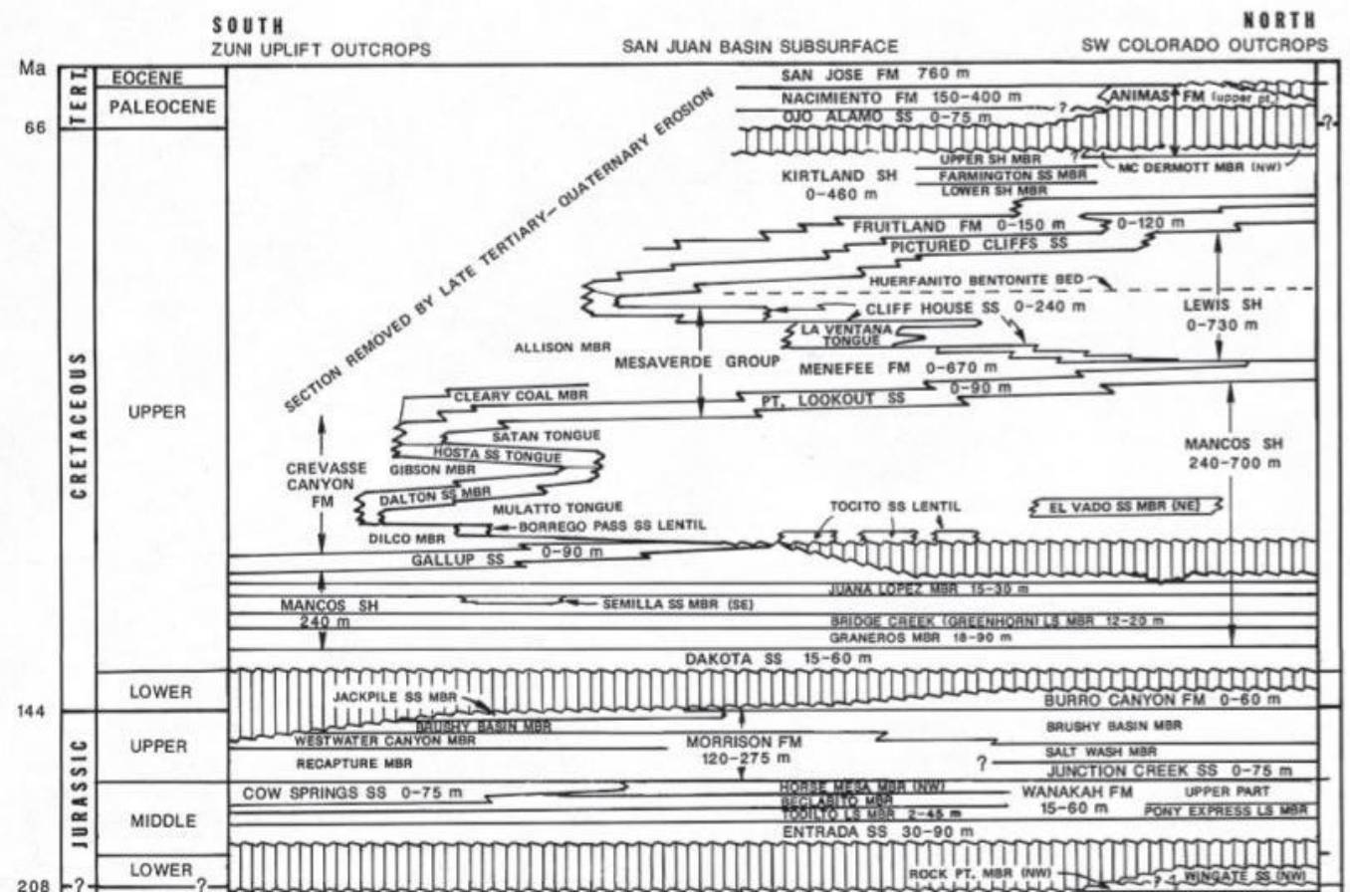


From Blakey, 2014

- The Semilla was deposited during the Turonian in the Western Interior Seaway
- Time equivalent shales, sandstones and limestones were deposited throughout the seaway
- The Semilla is time equivalent to the Codell Sandstone of the Denver Basin and the Turner Sandstone of the Powder River Basin

Regional Geology

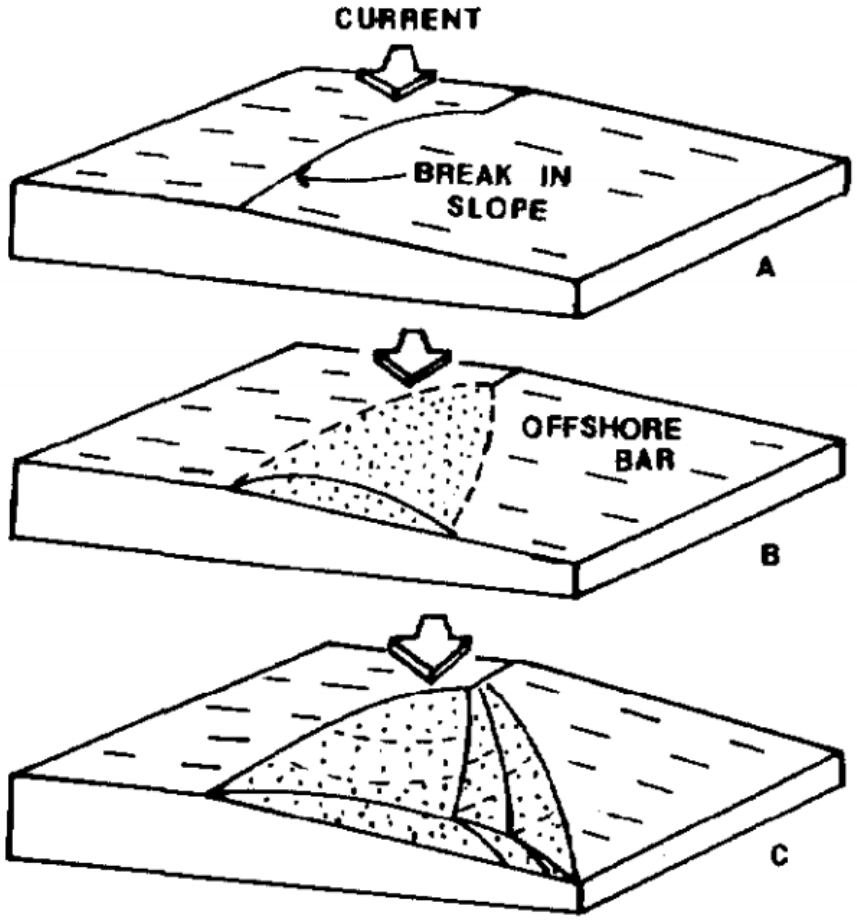
- The San Juan Basin is known for its Cretaceous aged reservoirs and source rocks
- Deposition of the shallow marine Dakota Sandstone
- Lower Mancos Shale deposited with two sand members: the Semilla and the Juana Lopez Member
  - The Semilla is the final regressive deposit of the Greenhorn Cyclothem
- Seaway regression depositing shoreline Gallup Sandstone
- More, smaller accommodation space changes with the deposition of the Upper Mancos Shale
- The regressive Mesaverde Group overlays the Mancos



From Molenaar and Baird, 1989

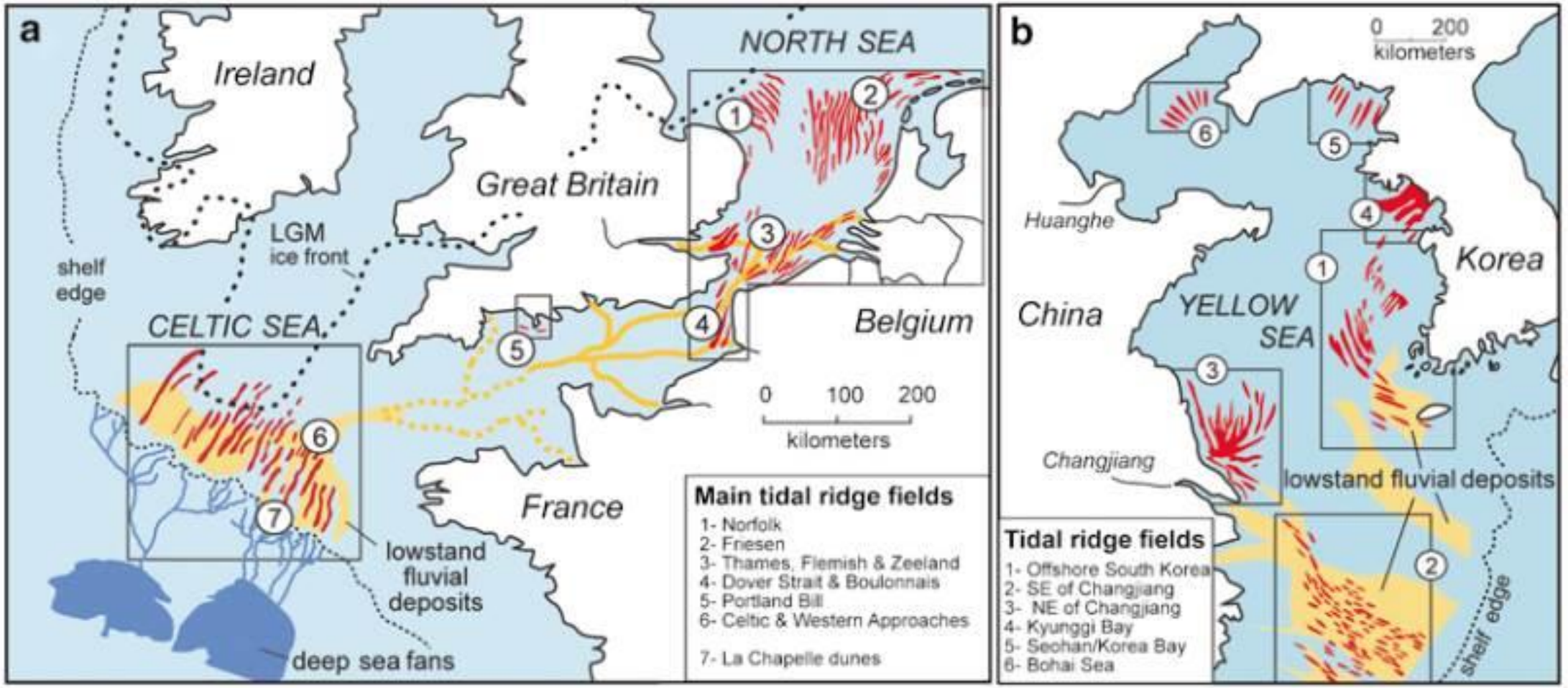
Depositional Environment

- The Semilla is a linear shelf sand, deposited 10s of Km offshore
- Small breaks in the slope of the shelf initiate localized deposition and prograde seaward
- Shoaling upward creates coarsening upward stratigraphy
- These sands can be tide, wave or storm dominated
  - Usually show evidence of all three



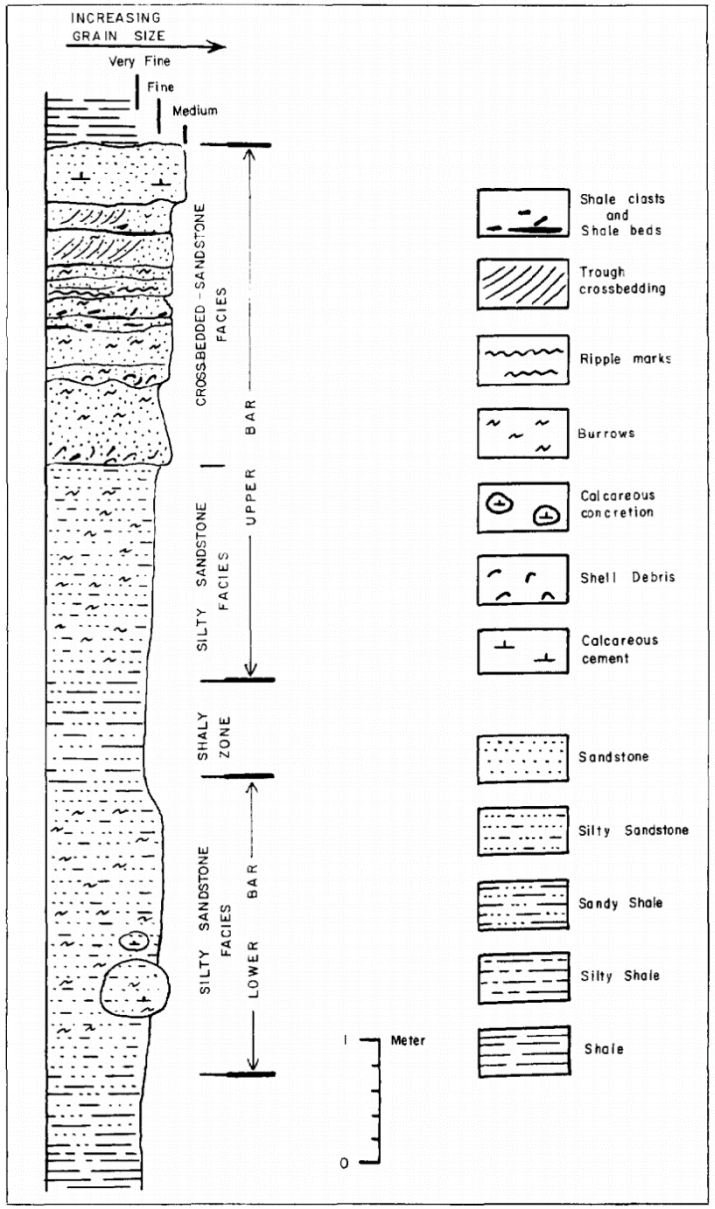
From La Fon, 1981

Depositional Environment



- Orientations of linear shelf sands can vary greatly depending on tidal current direction
- Bars form subparallel to current direction

Semilla Stratigraphy

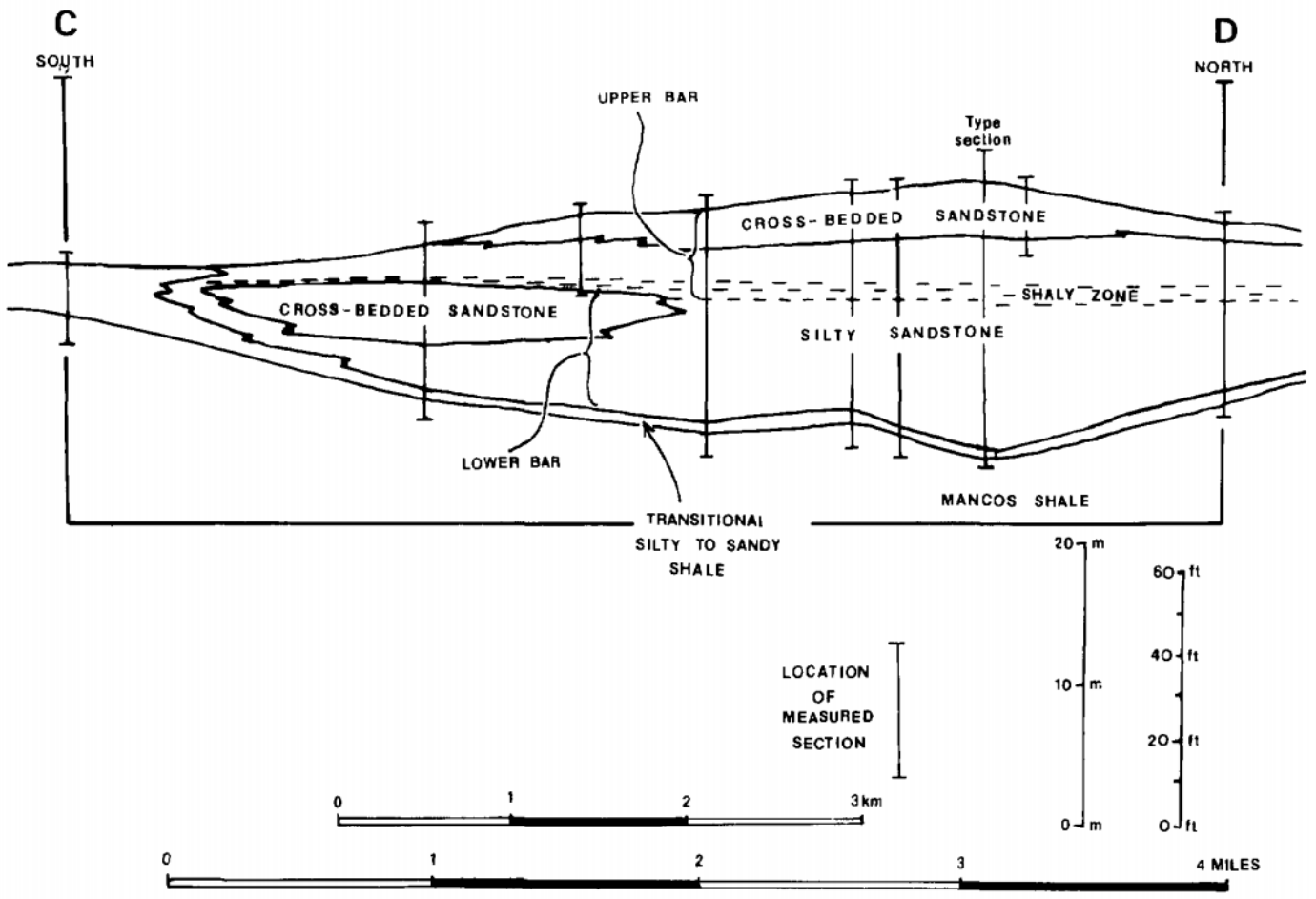


From La Fon, 1981

- Silty sandstone facies
  - Makes up the bulk of the formation
  - Extensive bioturbation
  - Lacks sedimentary structures
- Crossbedded sandstone facies
  - Located at the tops of bar packages
  - Gradational contact with underlying silty sandstone facies
  - Less bioturbation and dominantly trough cross stratified
  - From shoaling of the bars
- Transitional facies (Mancos)
  - A 3-6 feet thick silt facies of the Mancos
  - Contemporaneous to bar deposits
- Lithology
  - There is a higher percentage of lithics and igneous minerals than expected
  - Indicates a possible volcanic source

Semilla Outcrop Analysis

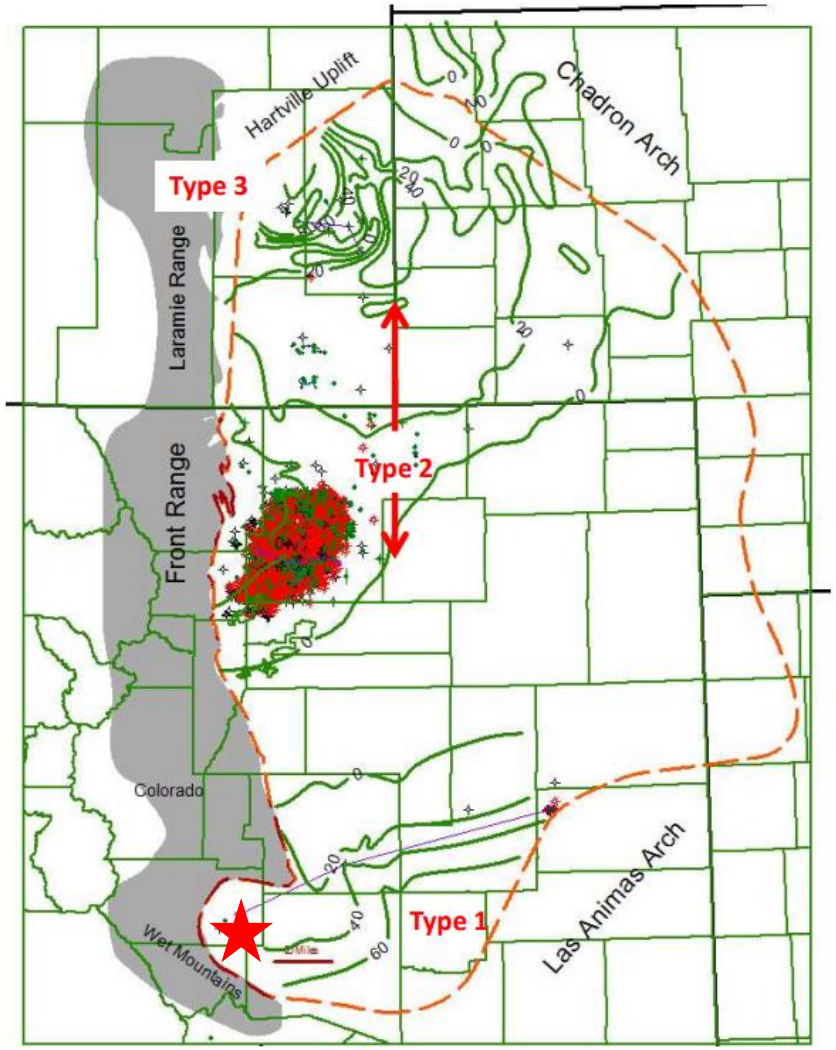
- Outcrop diagram from La Fon showing the Holy Ghost Bar, which reaches heights of about 60 feet
- Silty sandstone facies below overlain by cross-bedded sandstone facies
- This coarsening up sequence represents increased current velocity as more sediment is deposited
- In this bar, there are two bars stacked on top of each other, separated by a shaly zone



From La Fon, 1981

Codell

- The type 1 sand looks stratigraphically similar to the Semilla
- The star shows the approximate location of the Forest Mackenzie #1-3 Well that cored this section of Codell



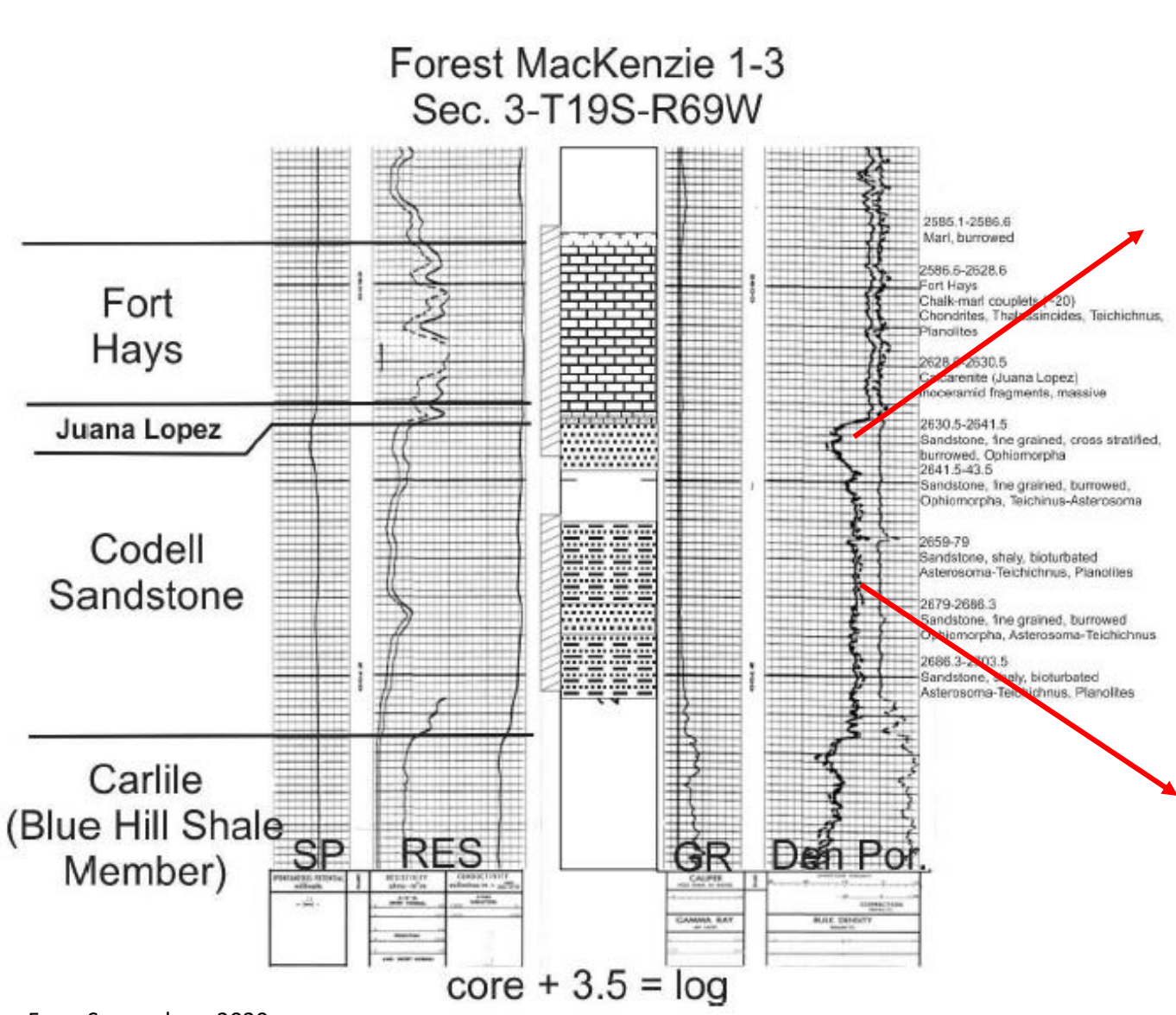
From Sonnenberg 2020

Type 3 Sandstone: fine-grained, parallel to cross stratified to ripple cross stratified; contains sparse burrows; deposited in intertidal to marine environments, contains abundant authigenic clays that reduce porosity and permeability

Type 2 Sandstone: impermeable, bioturbated, fine-grained marine shelf sandstone; contains thin hummocky cross stratified beds; no central bar facies present (eroded?); most of the existing production comes from this sandstone type

Type 1 Sandstone: Marine shelf or shoreline bars; good porosity and permeability; sheet-like distribution

Codell Log Analysis

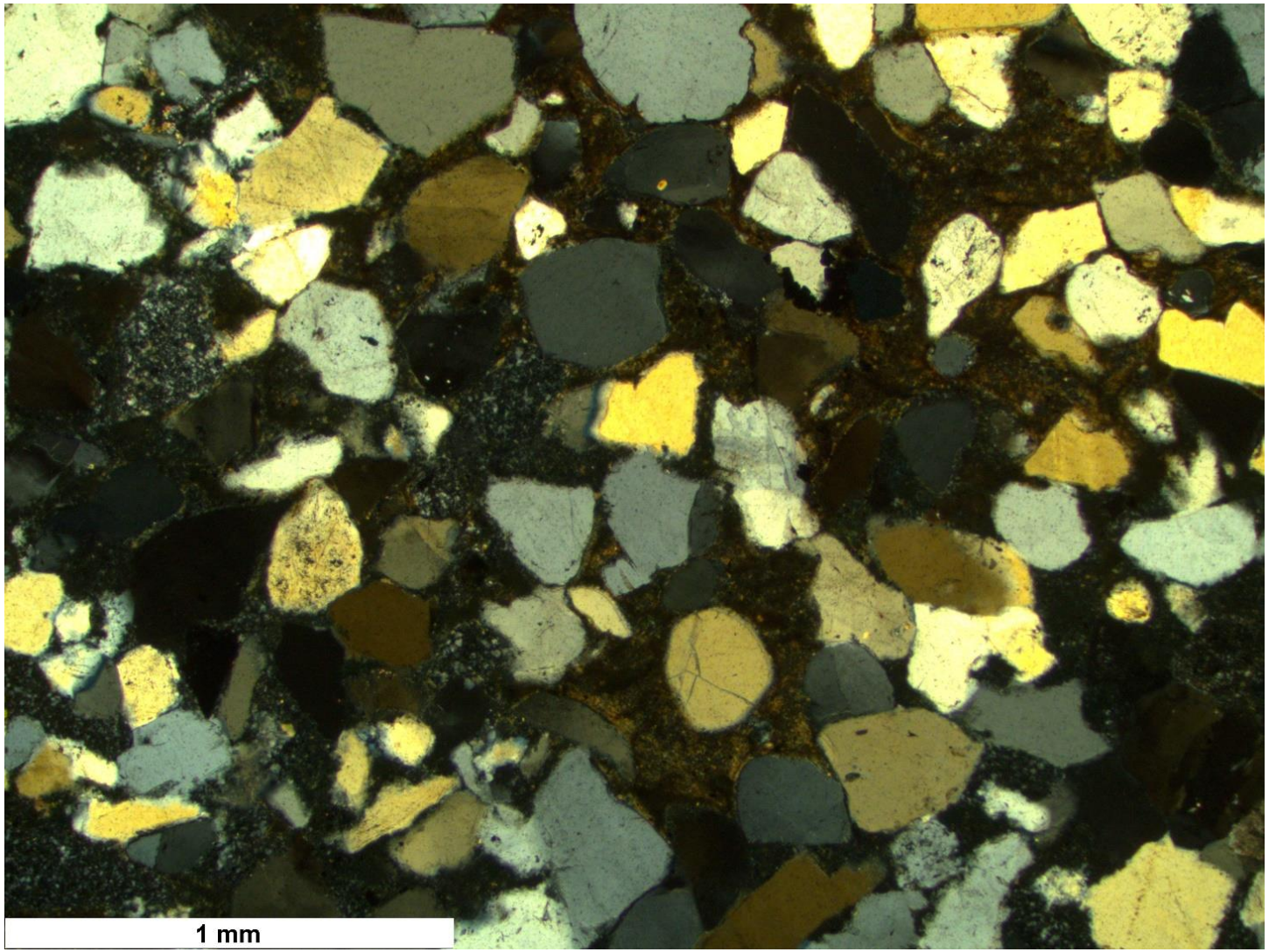


From Sonnenberg 2020

Well sorted, cross stratified upper sand unit

More poorly sorted, lam-scrammed, lower sand

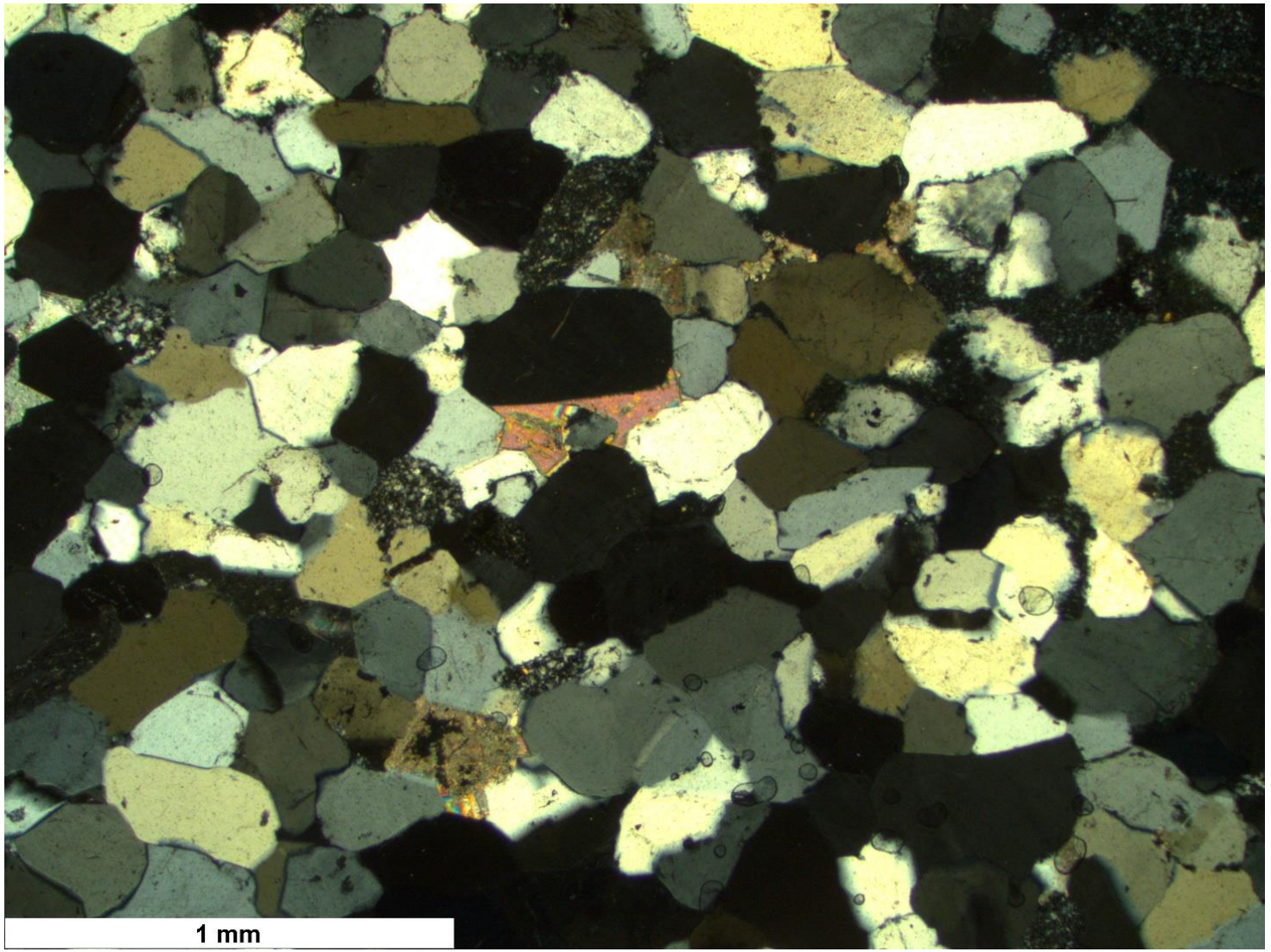
Codell Petrographic Analysis



Thin Section MAC-L2688.2

- The main detridal minerals in this thin section are quartz and chert
- Thin section analysis helps us more easily discern these two types of silica
- Clay cementation is common in this lower sand

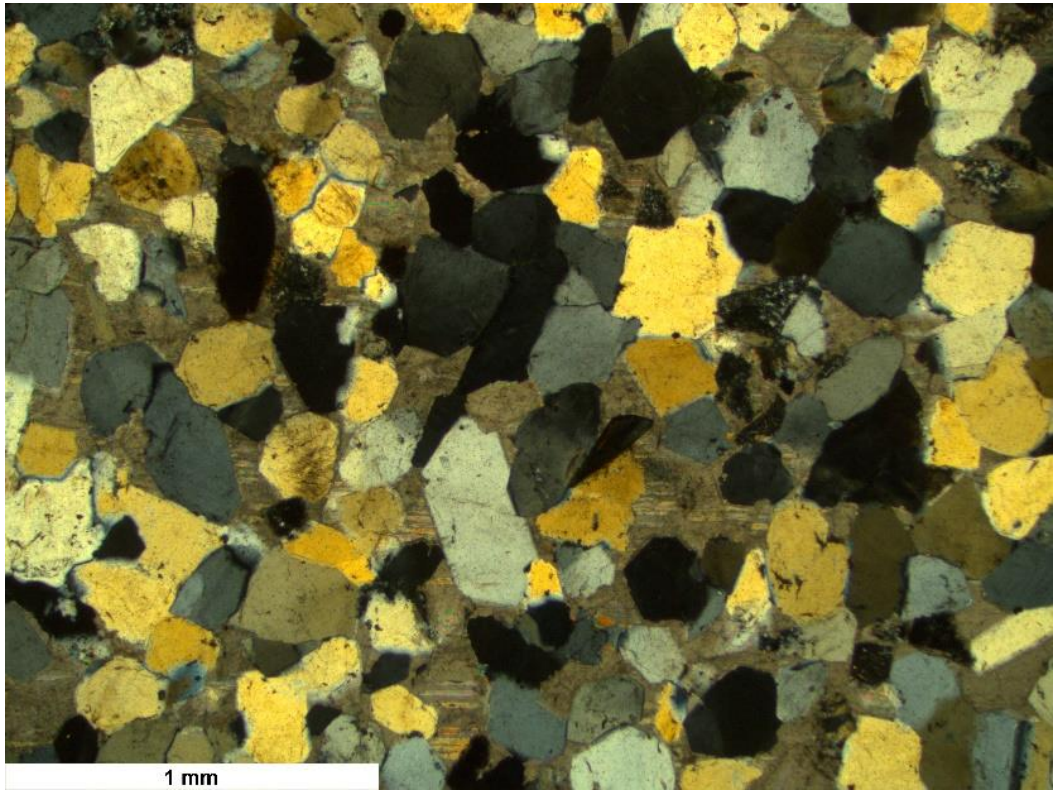
Codell Petrographic Analysis

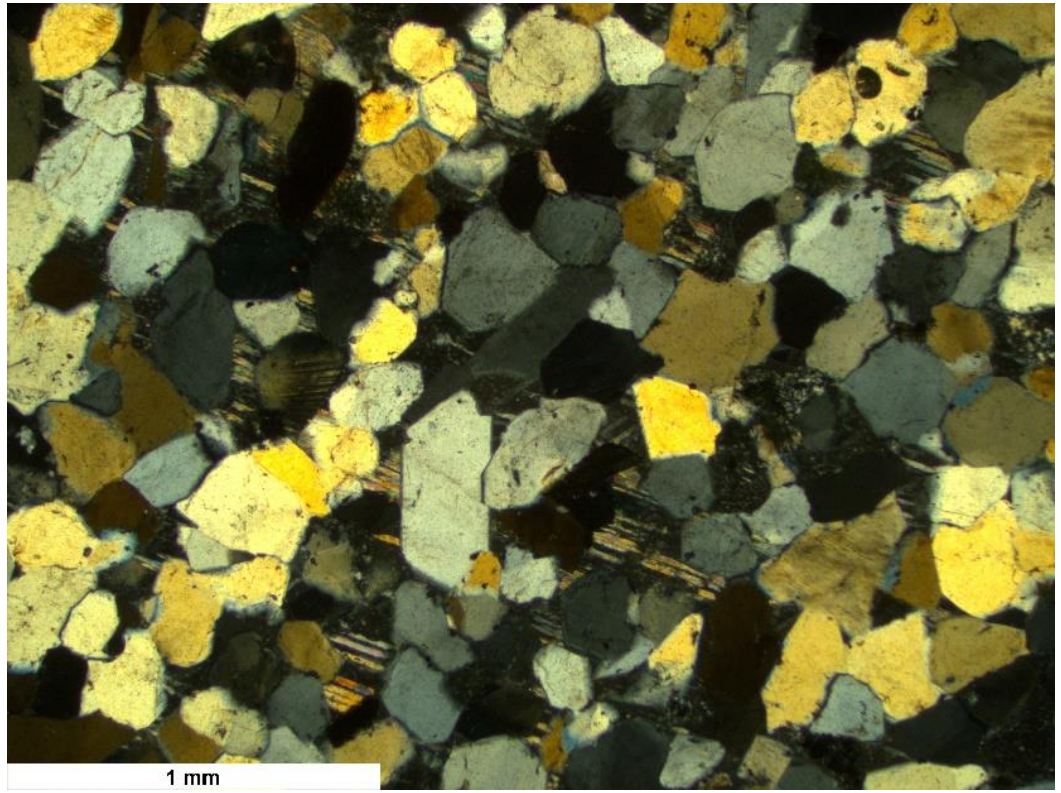


Thin Section MAC-L2688.2

- Beautiful quartz overgrowths are located in localized areas of the silty sandstone
- Grains are actually texturally mature
- This carbonate cement formed after the quartz overgrowths

Codell Petrographic Analysis

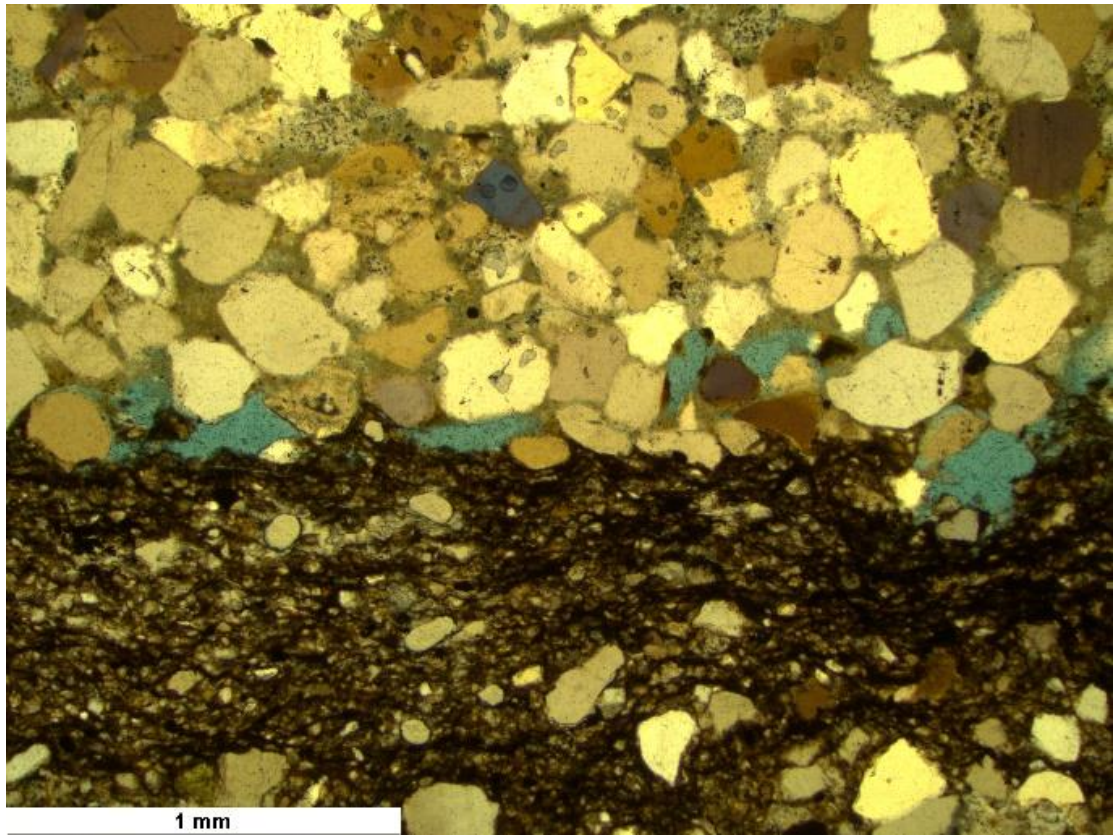


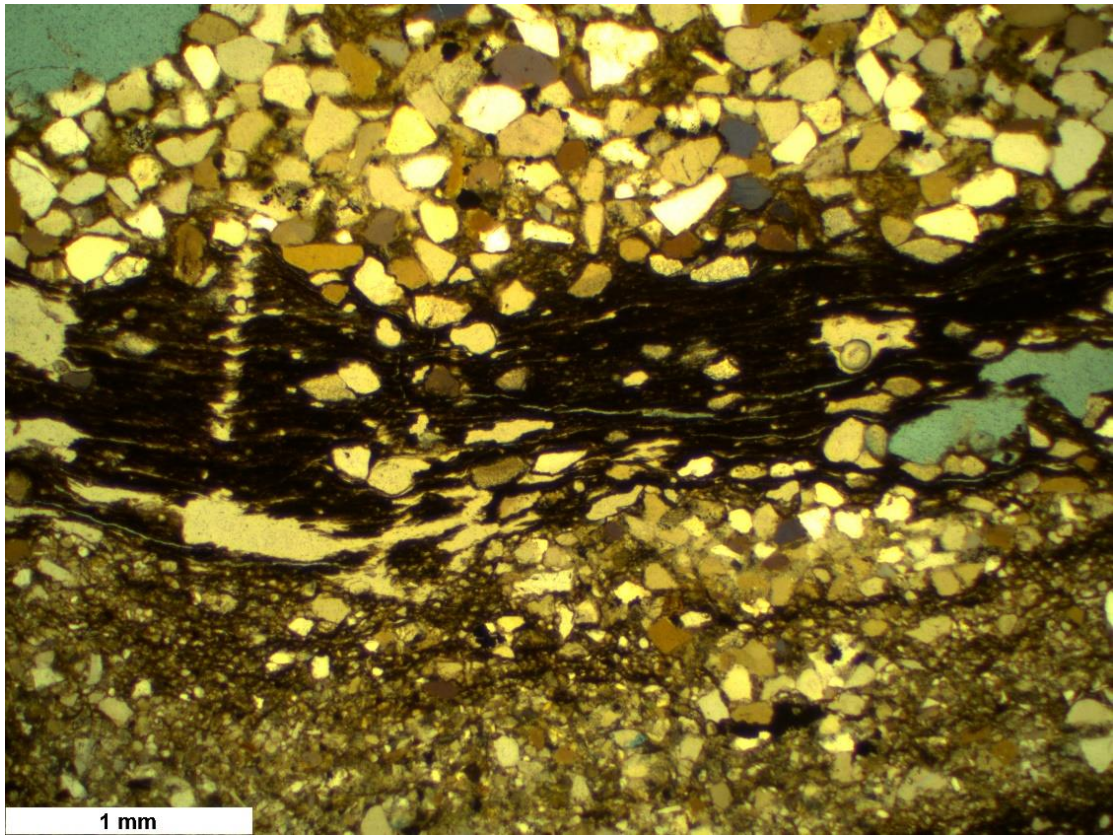


Thin Sections MAC-L2688.2

- This petrographic thin section shows crystalographically continuous carbonate cement covering about a 2mm by 2mm area

Codell Petrographic Analysis

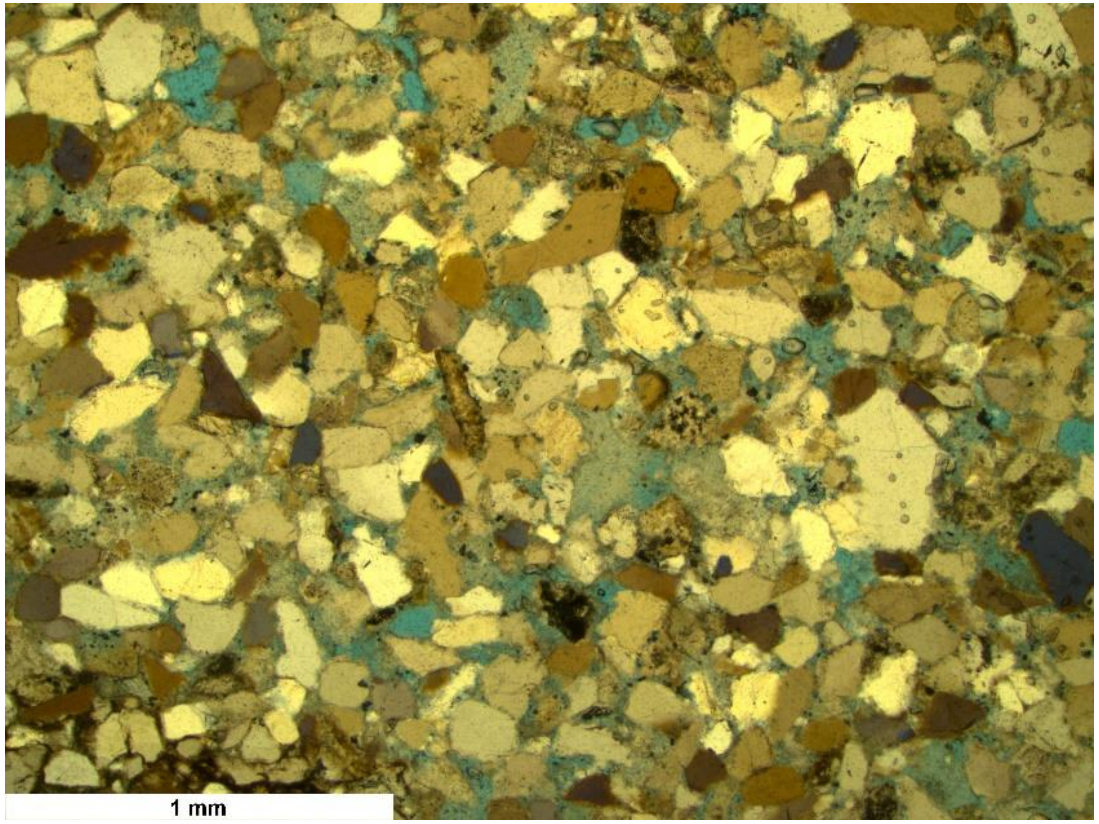


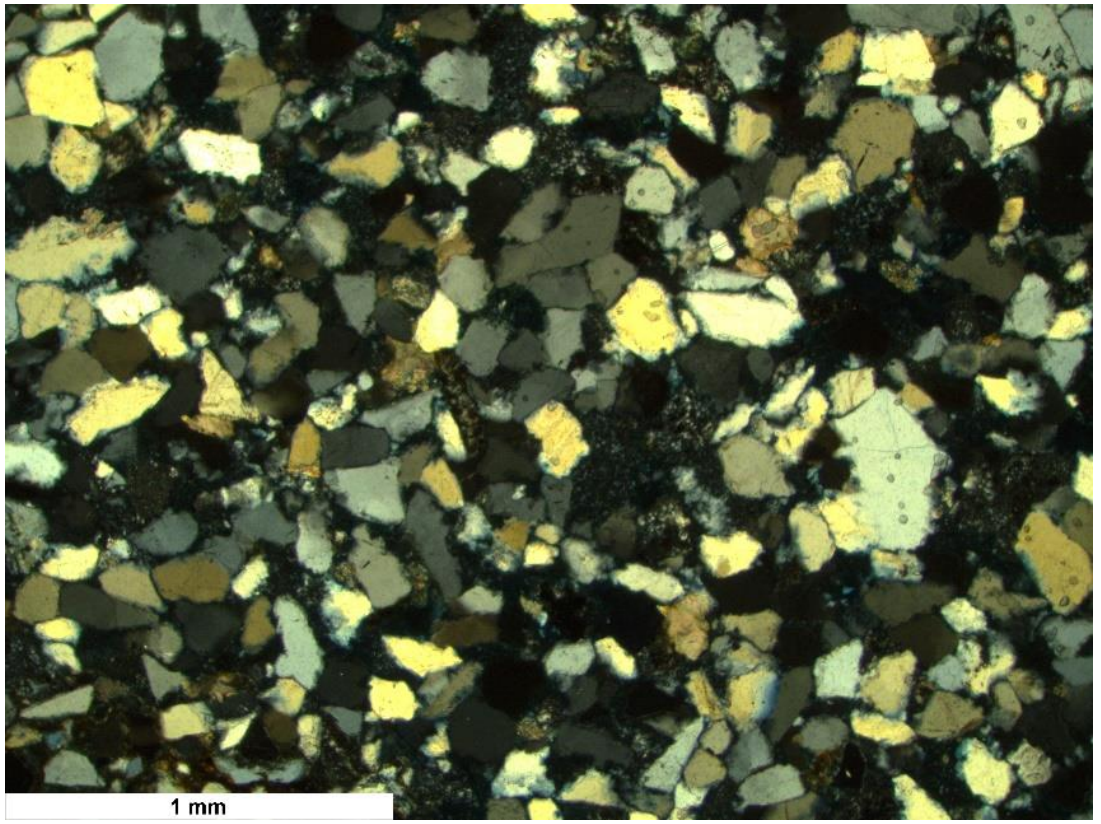


Thin Section MAC-L2688.2

- Grain plucking in a mud drape in the lower sand
- Some fracture porosity in these drapes
- In some parts of the lower sand, the drapes have been completely scrambled by bioturbation

Codell Petrographic Analysis

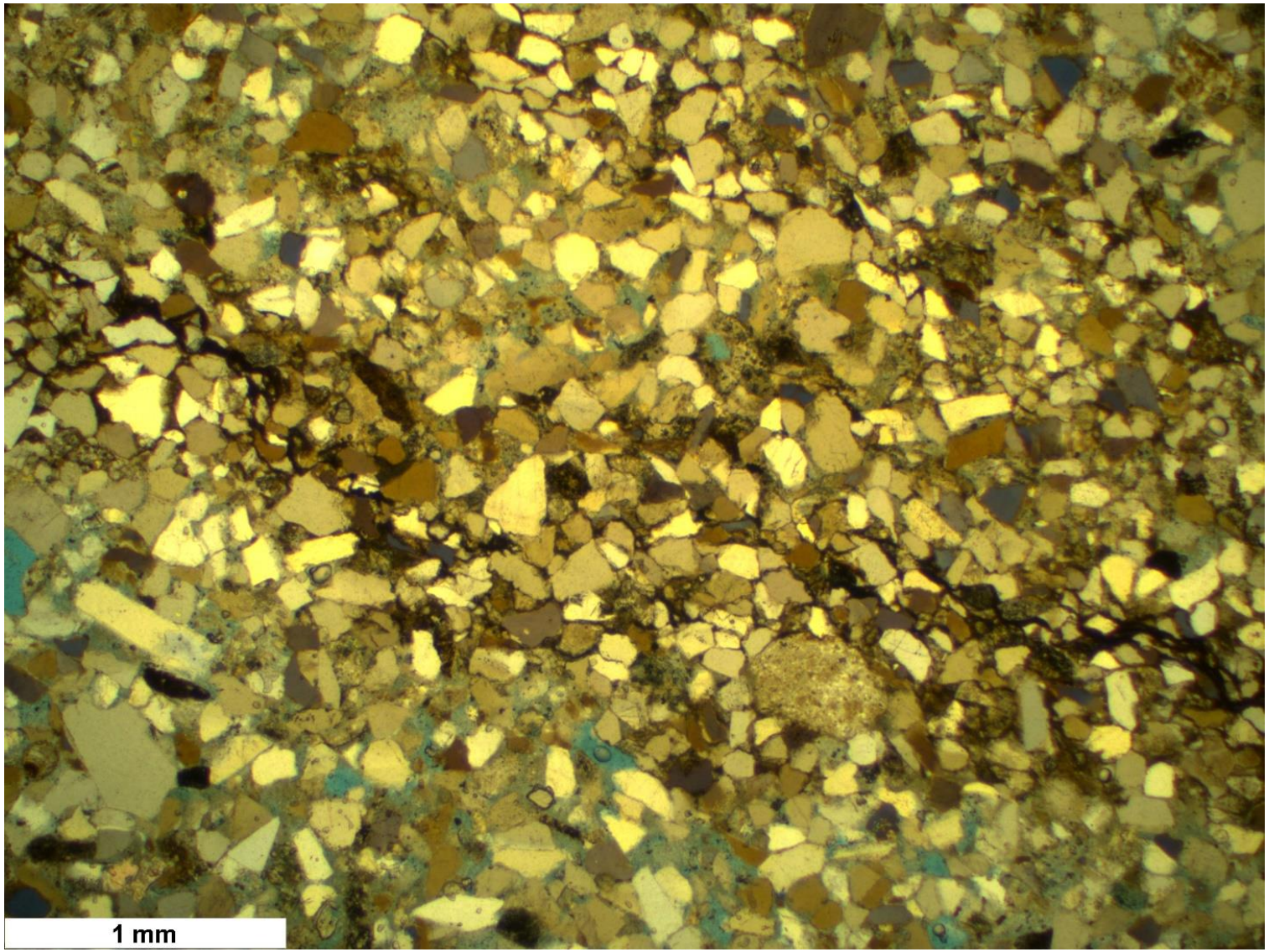




Thin Section MAC-U2640.3

- Upper, cross stratified sand showing much better porosity
- Both intergranular porosity and microporosity

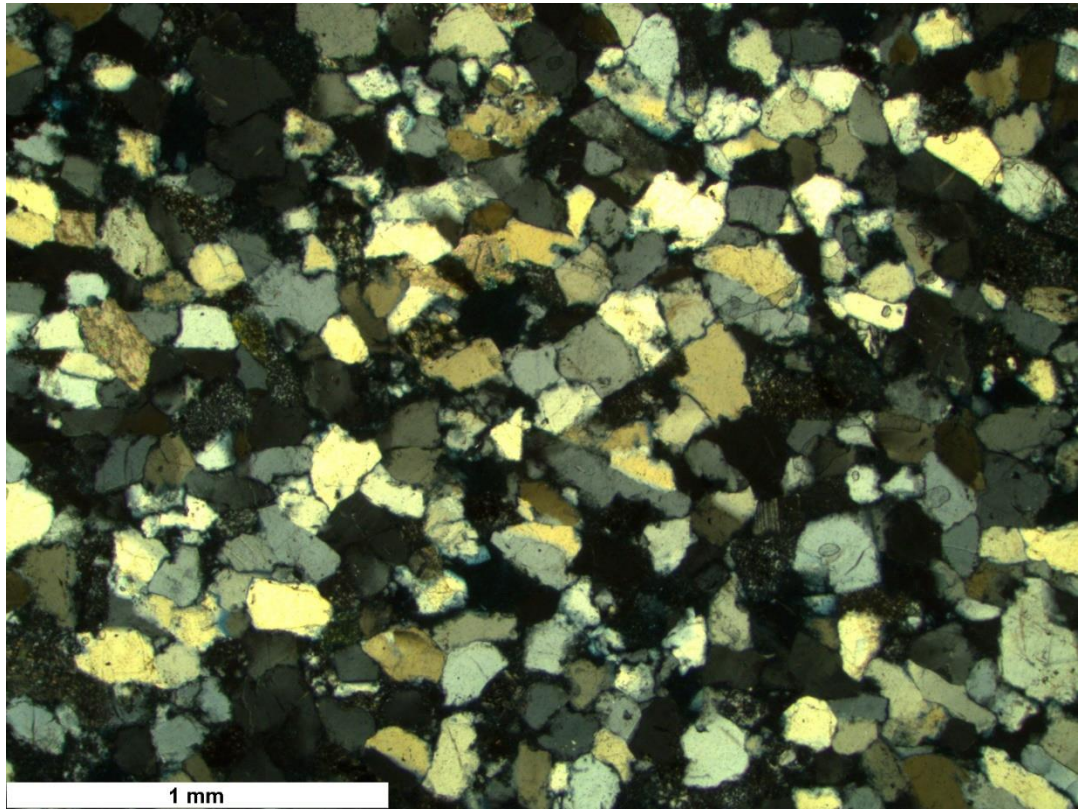
Codell Petrographic Analysis



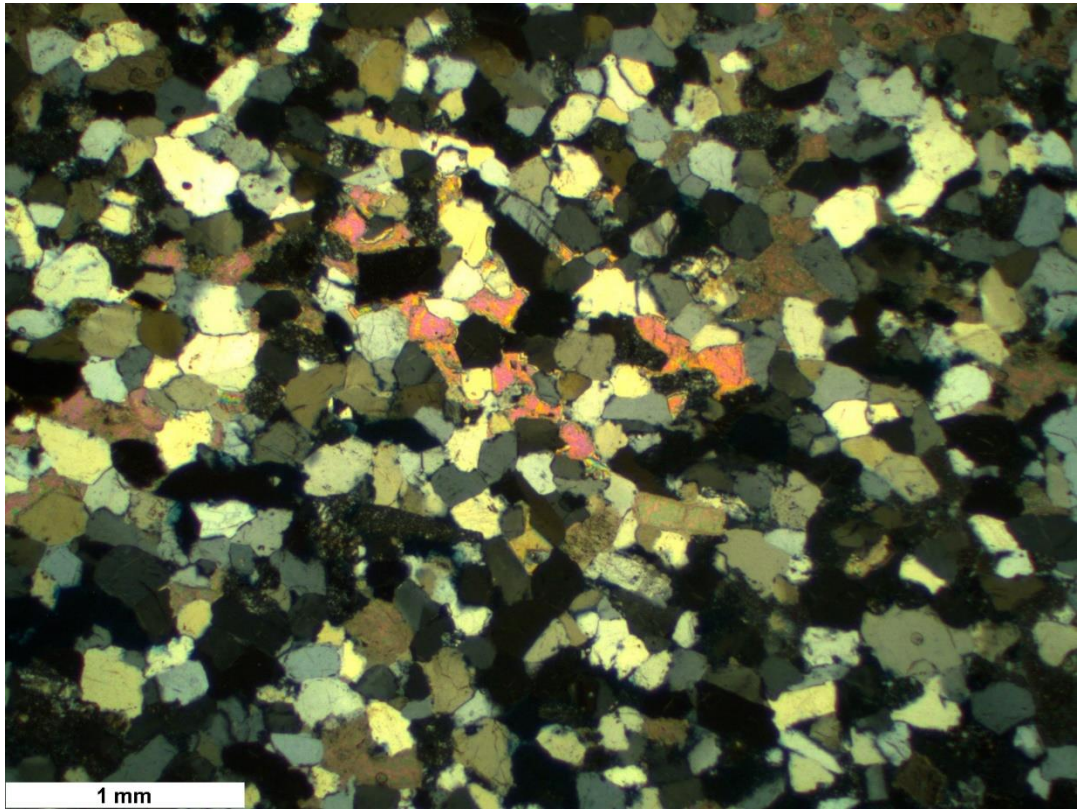
Thin Section MAC-U2640.3

- Laminations from the core shown in thin section
- Filled with clay minerals
- Area around lamination lacks pores and is a barrier to fluid flow

Codell Petrographic Analysis



Thin Section MAC-U2638.1



Thin Section MAC-U2637.6

- Some areas of the Upper Cross Stratified Sand are more compacted and more cemented
- Thin section MAC-U2638.1, left, shows more, less defined quartz overgrowths
- Thin Section MAC-U2637.6, right, shows carbonate cementation

Conclusions

- Semilla is similar stratigraphically to the type 1 sand of the Codell
  - Both are underlain by a more silty sand and capped by a cross stratified, more well sorted sand
- Semilla bar complexes appear to be more discontinuous than those in the Codell
- The source for the Semilla is likely more of an igneous origin than the Codell
- The dominant mechanism of deposition of the Semilla deserves more thorough investigation

Further Work

- Gain access to the Semilla Outcrops
- Perform outcrop analysis and mapping
- Take samples and perform petrographic thin section analysis of Semilla
- Continue with Codell analysis and comparisons
  - Look at quartz overgrowths under the CL SEM

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