sCore: A Classification Scheme for Organic Mudstones Based on Bulk Mineralogy*

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Abstract

In recent years, operators have produced large quantities of hydrocarbon from organic shale reservoirs. Horizontal drilling and multi-stage stimulations, targeting sections with superior reservoir and completion quality, have been proven as key to their development. Organic mudstones are fine-grained sedimentary rocks with total organic content above 1.5% that typically consist of complex mineralogy that may be heterogeneous at very small scales. Although numerous cores have been studied and described, there is no published mineralogy-based classification scheme for these rocks. This paper defines a methodology for creating a detailed mineralogy-based description for organic mudstones using core and geochemical log data.

The proposed classification scheme is based on a ternary diagram created specifically for organic mudstones. It is based on a combination of core- and log-based mineralogical relationships. The primary classes are siliceous mudstone, carbonate-rich mudstone and argillaceous mudstone. Sub-classes are based on relative amounts of these three mineral groups. A mineralogy-based classification may help provide a better understanding of depositional conditions and identify target zones for completion. A common metric for the description of organic mudstones will also facilitate comparison of such reservoirs from different areas, formations, basins, and continents. A secondary objective is to provide a log display that flags other descriptive parameters that impact reservoir quality, completion quality and/or operational efficiency. The log display presented here will provide a consistent description of the organic shale section and the input necessary for proper decision making when planning a drilling development project.

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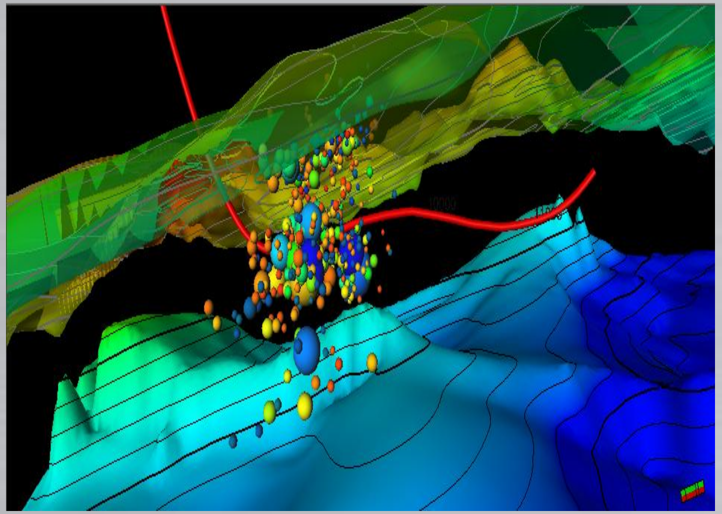
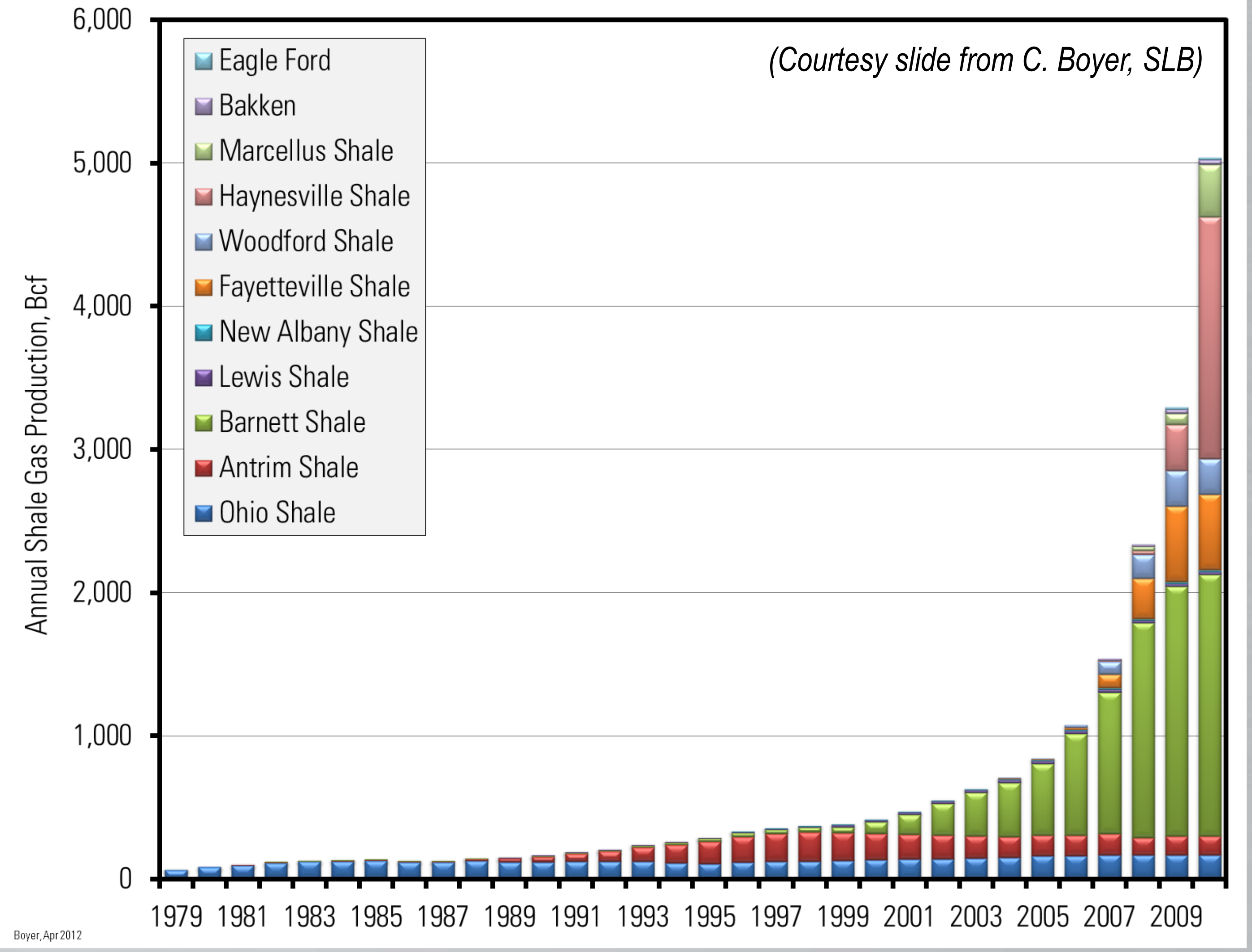
Schlumberger

Development of Shale Gas Reservoirs – Production Drivers

1. Horizontal drilling and
2. Multi-stages hydraulic fracture treatments

Identification of the zones with the best reservoir quality (RQ) and completion quality (CQ)



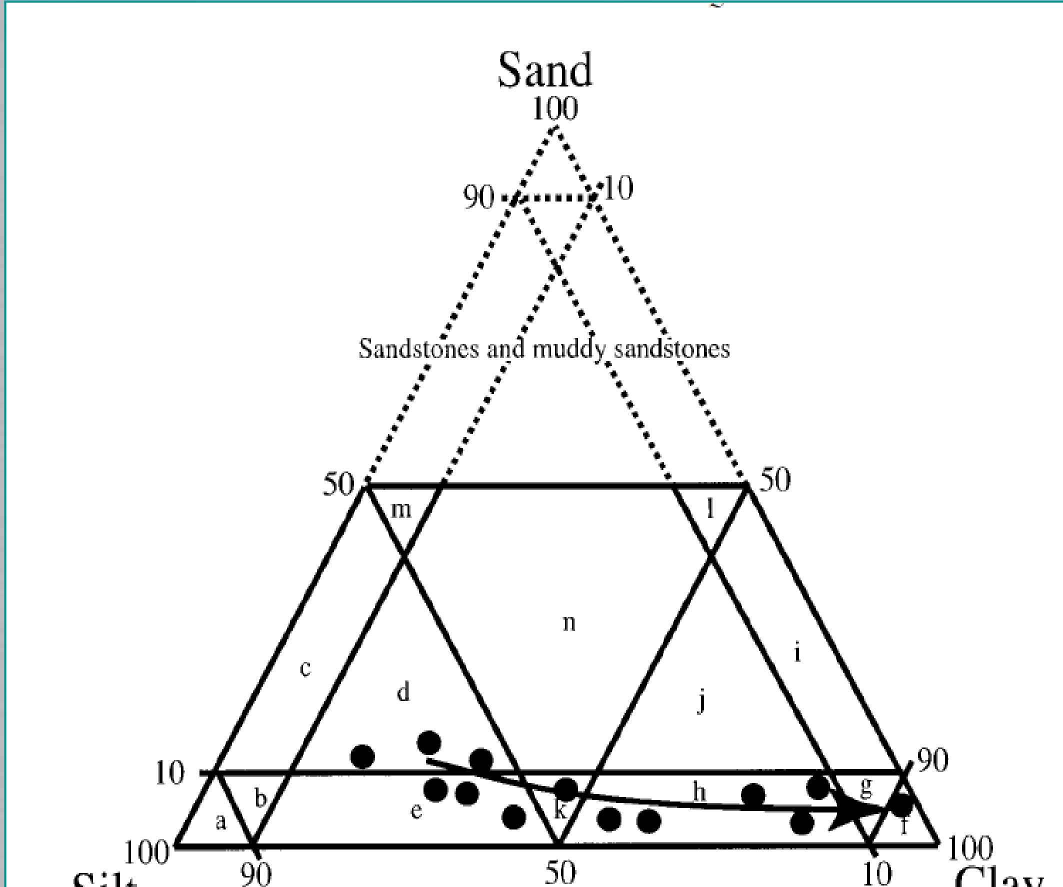


→ Well Placement
→ Optimum Production

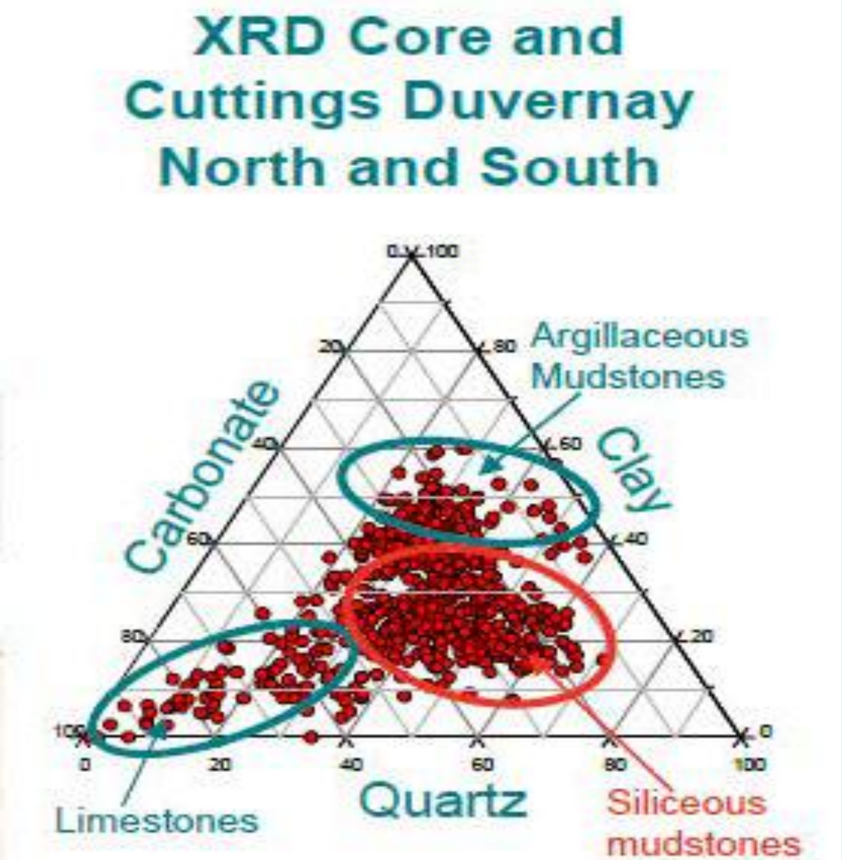
Objective

To provide a mineralogy- and log-based lithofacies classification scheme for organic mudstones by integrating core data (optical petrography), geochemical, borehole images and conventional log data

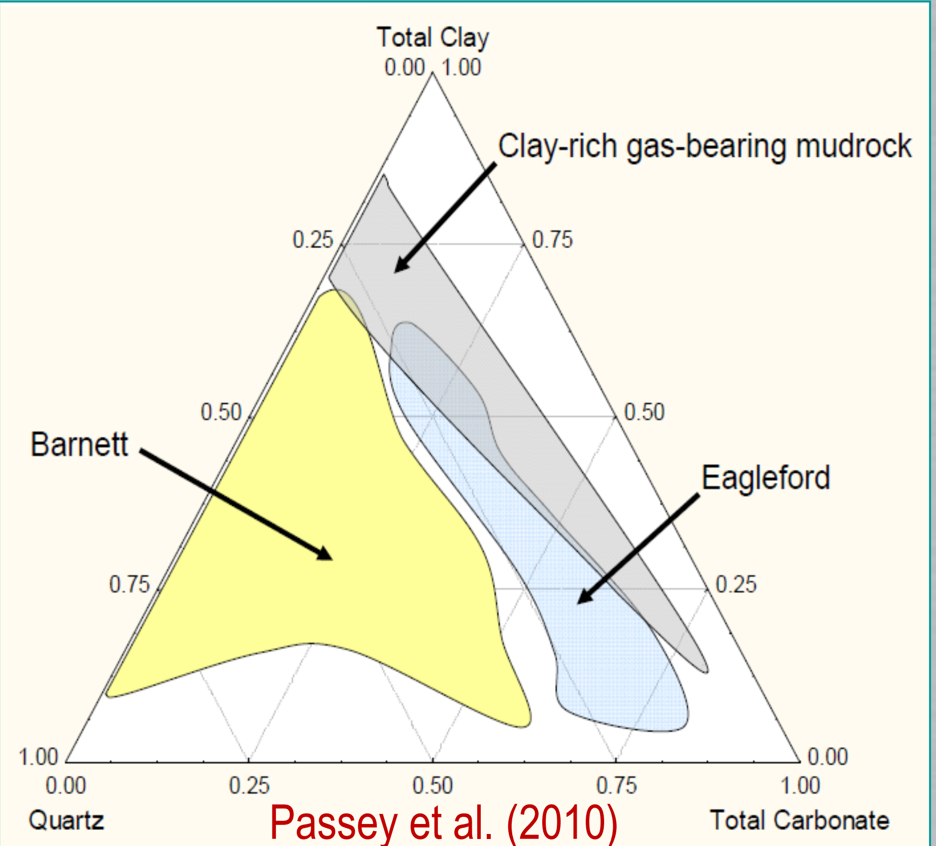
Previous work: “Shale” Classification



Macquaker and Adams (2003)

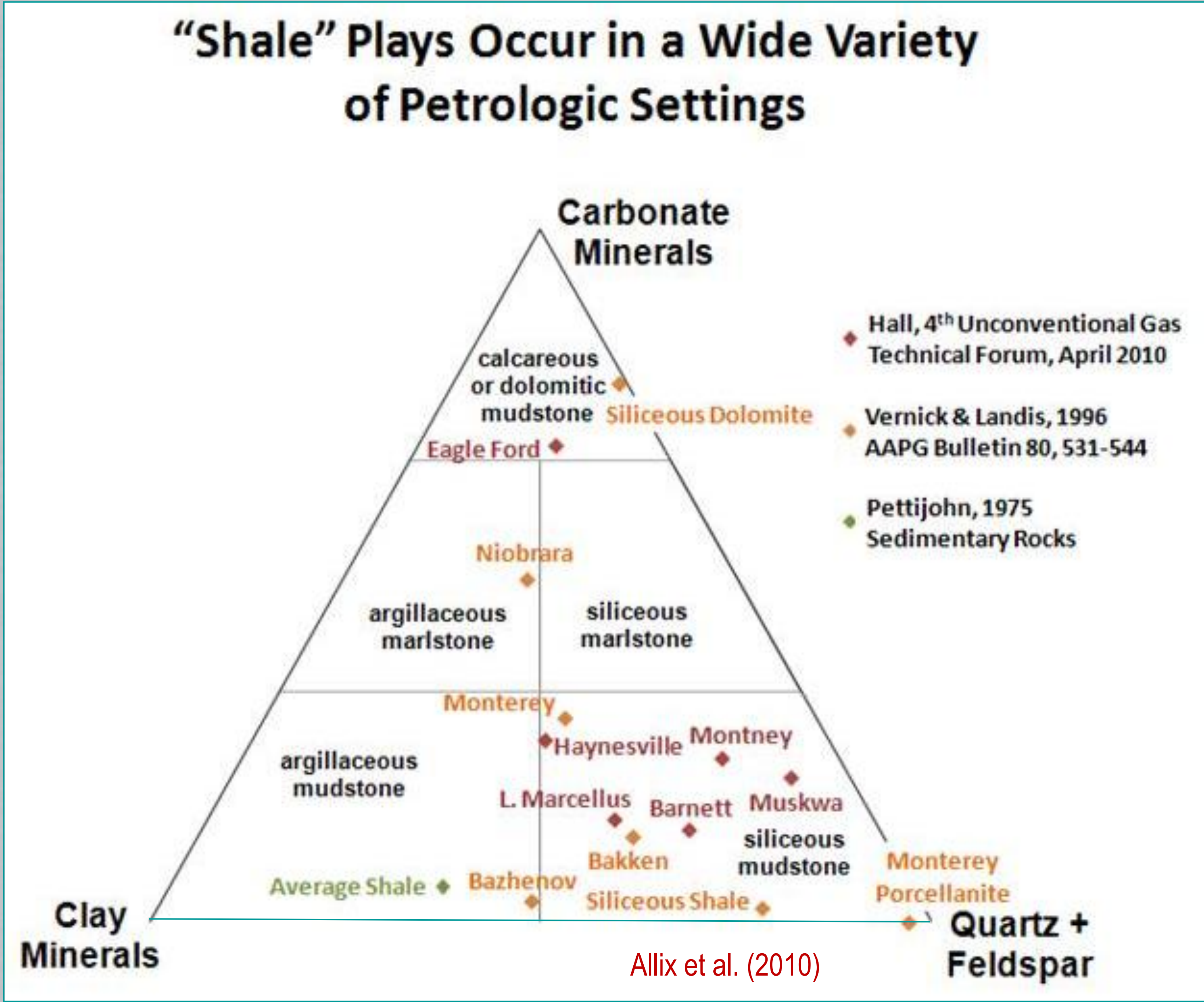


Dunn et al. (2012)



Passey et al. (2010)

Previous work: “Shale” Classification



Allix et al. (2010)

sCore: Classification for Organic Mudstones

Classification of organic mudstones:

"<u>Dominated</u>": a mudstone containing more that 80 % of a particular component

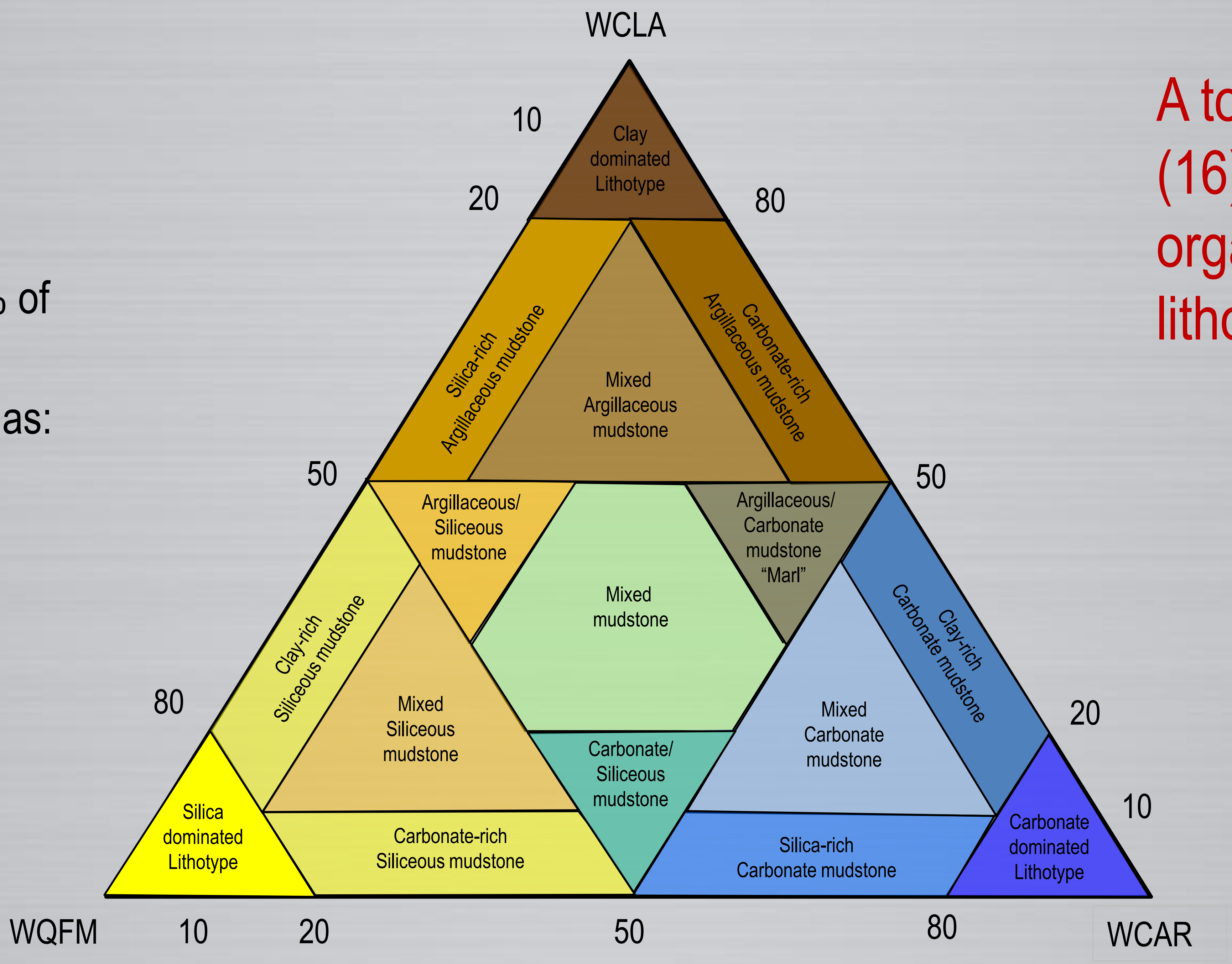
50% and 80% are described as:

<u>Siliceous</u> (50%<WQFM<80%),

<u>Argillaceous</u> (50%<WCLA<80%), and

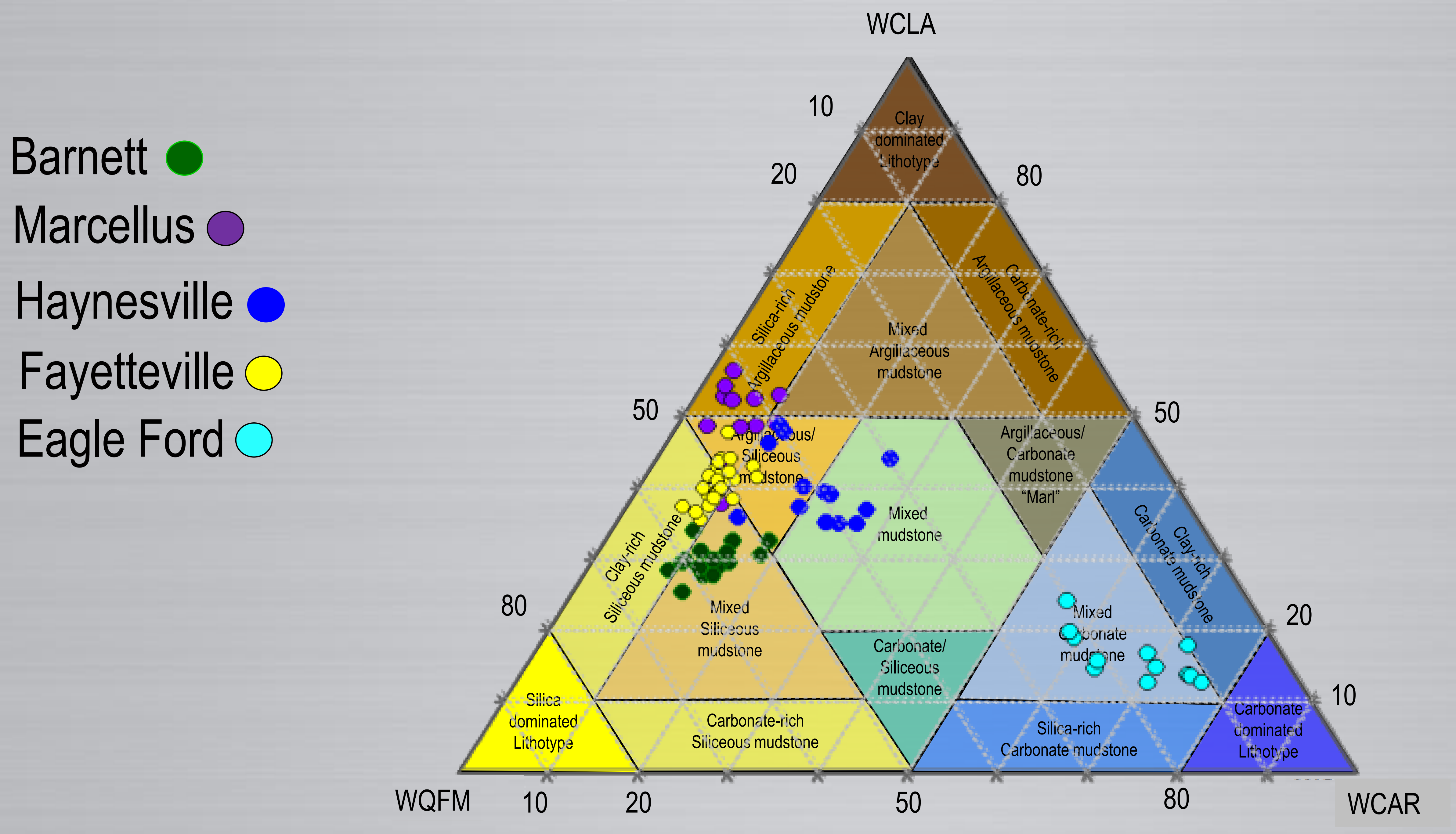
<u>Carbonate</u> (50%<WCAR<80%)

"<u>Rich</u>": between 20 and 50%

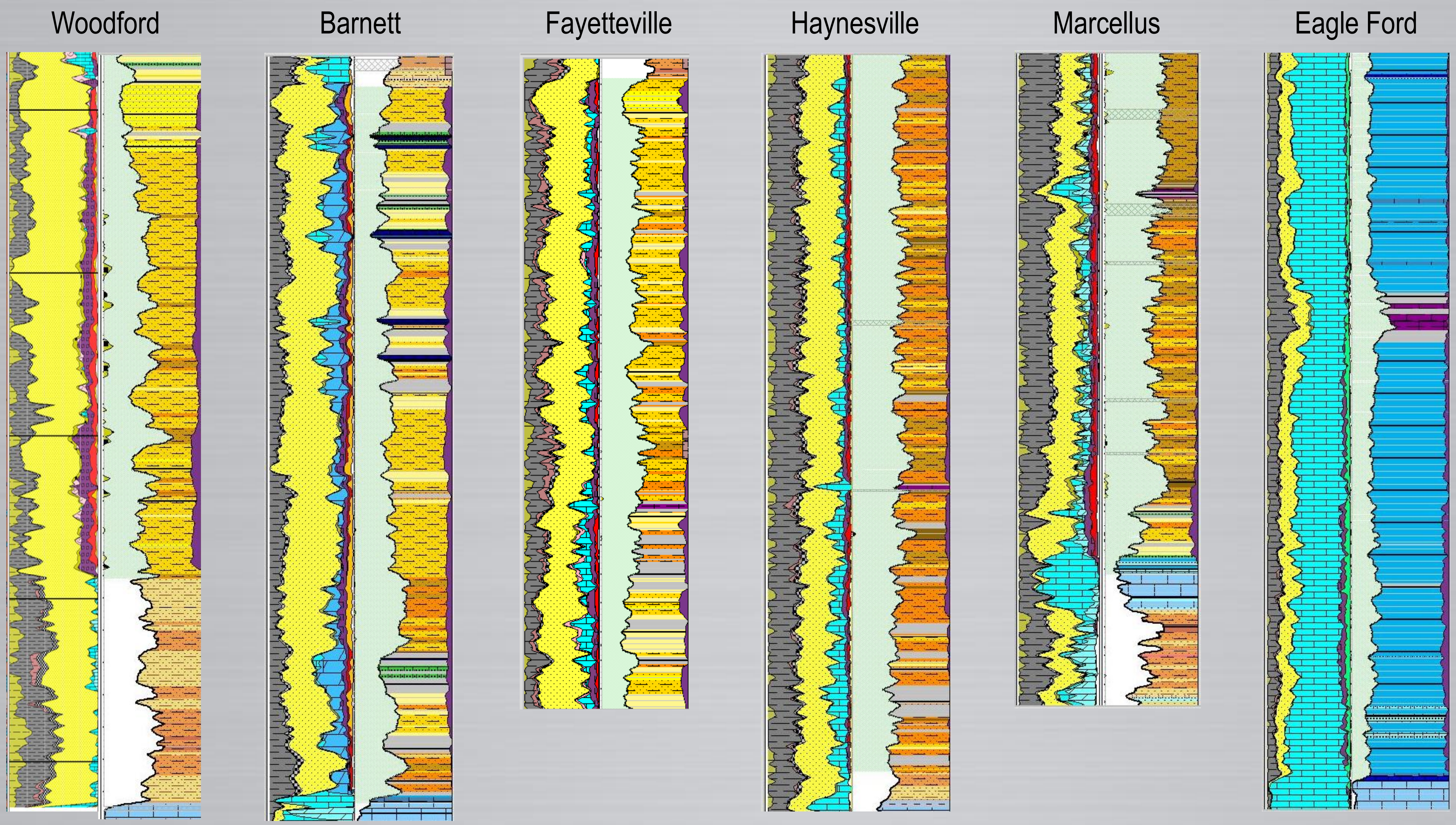


A total of sixteen (16) different organic mudstone lithofacies.

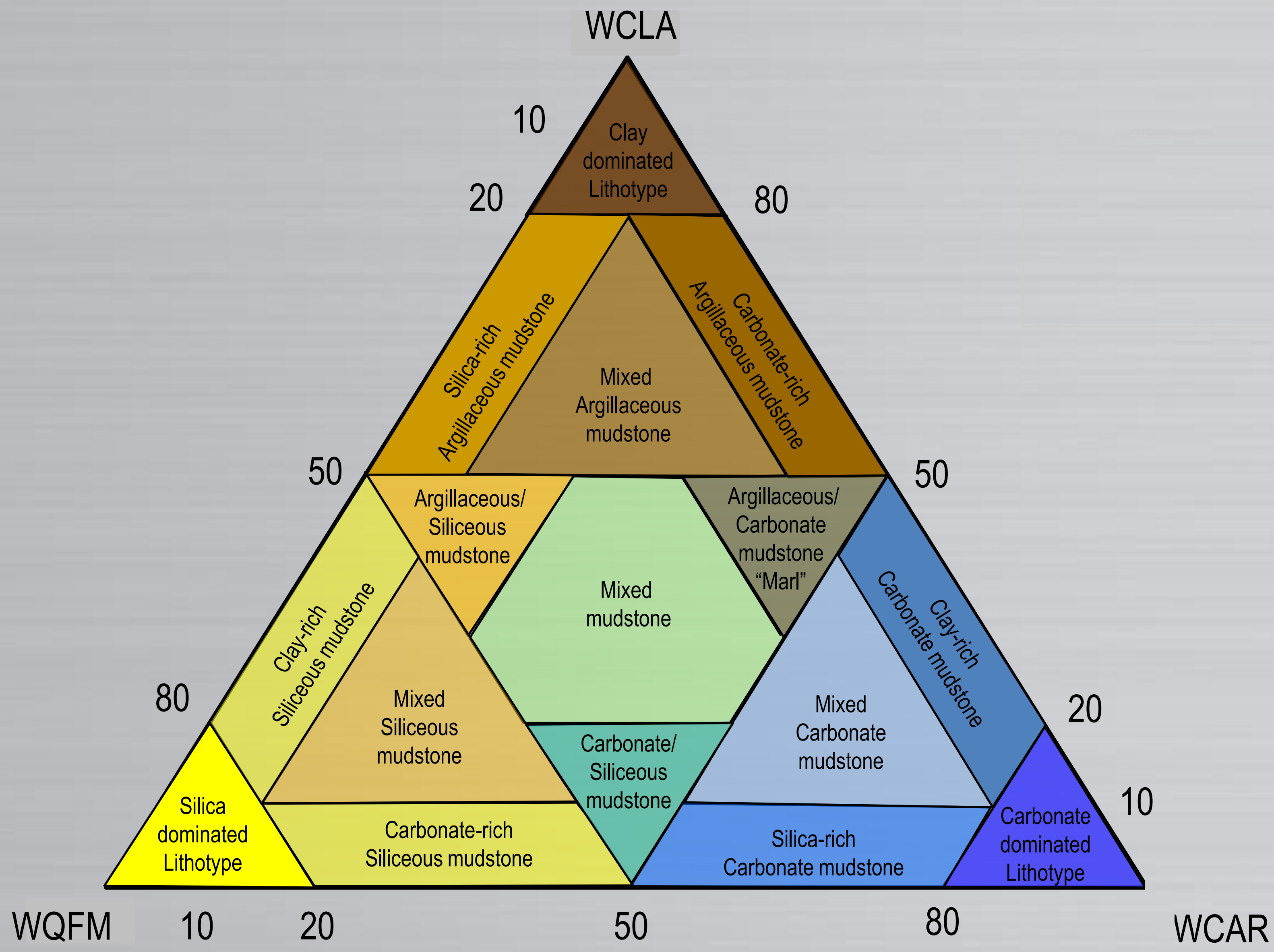
Shale Plays : Variations in Bulk Mineralogy



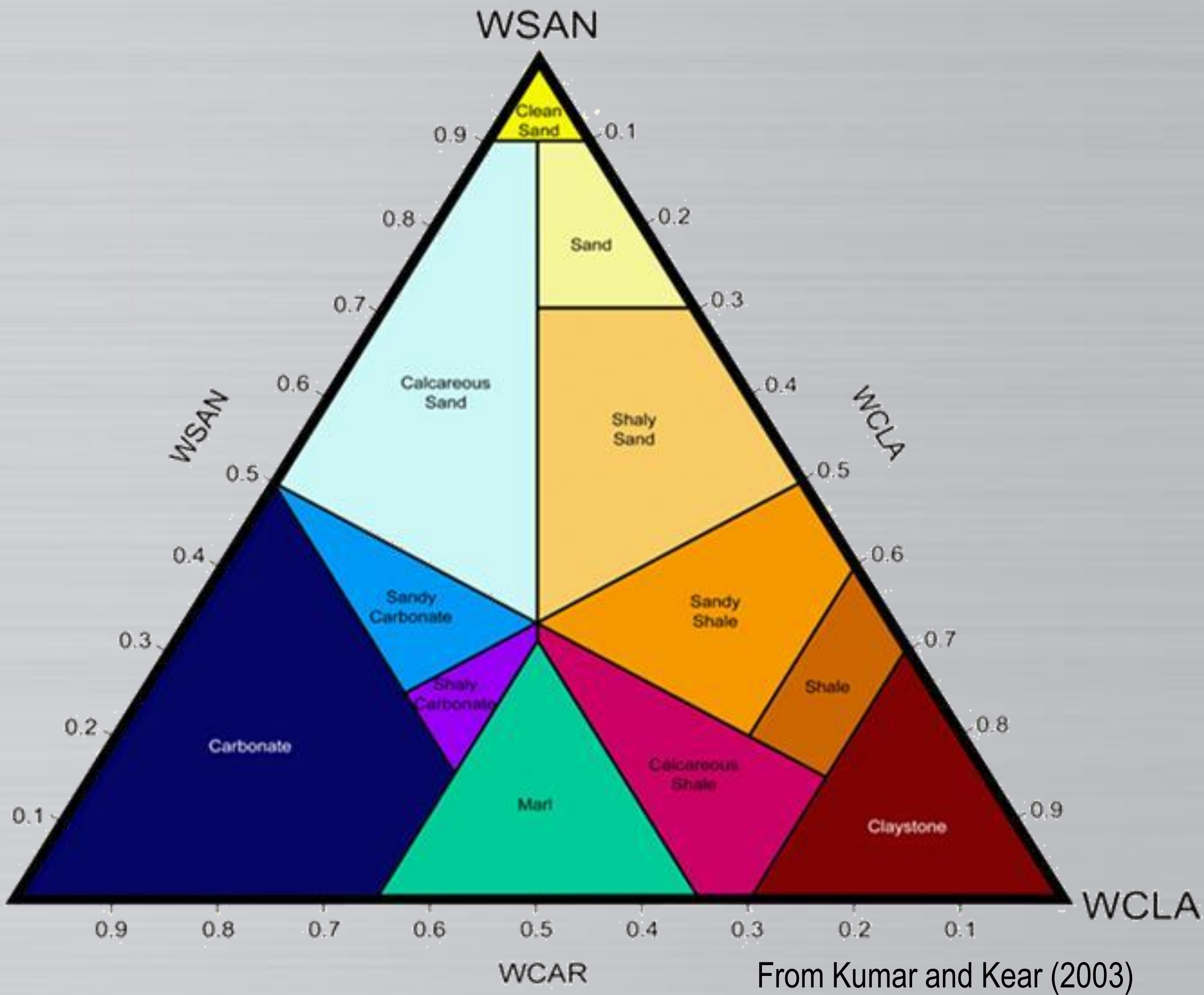
Lithology Variations - All organic mudstones are not the same



Conventional (*i*Core*) and Unconventional (*s*Core) Ternary Plots



*s*Core



From Kumar and Kear (2003)

*i*Core*

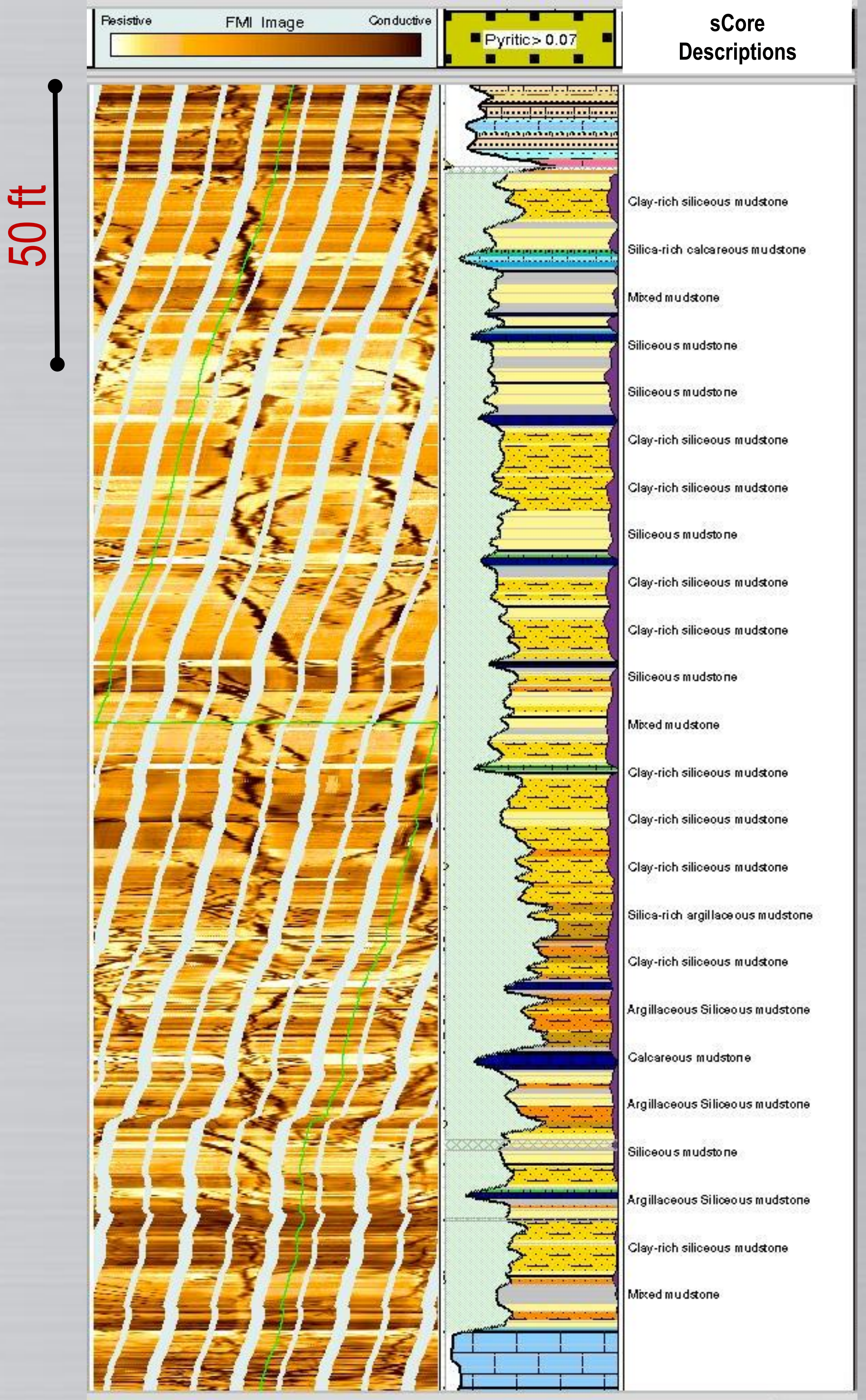
*** Mark of Schlumberger**

sCore Log Display

Generates a mineralogy-based lithofacies column for organic mudstones, defined by the "Organic mudstone" ternary diagram

Combines both *i*Core* and *s*Core to cover lithofacies in both conventional and unconventional intervals.

- Additional modifiers are:
  - TOC > 0.07 ("organic rich")
  - Pyrite > 0.07 ("pyritic")
- Additional Flags:
  - Presence of smectite
  - Bad hole
  - Presence of carbonate strings (nodules, beds)
  - Mineral Brittleness (Wang and Gale, 2009)



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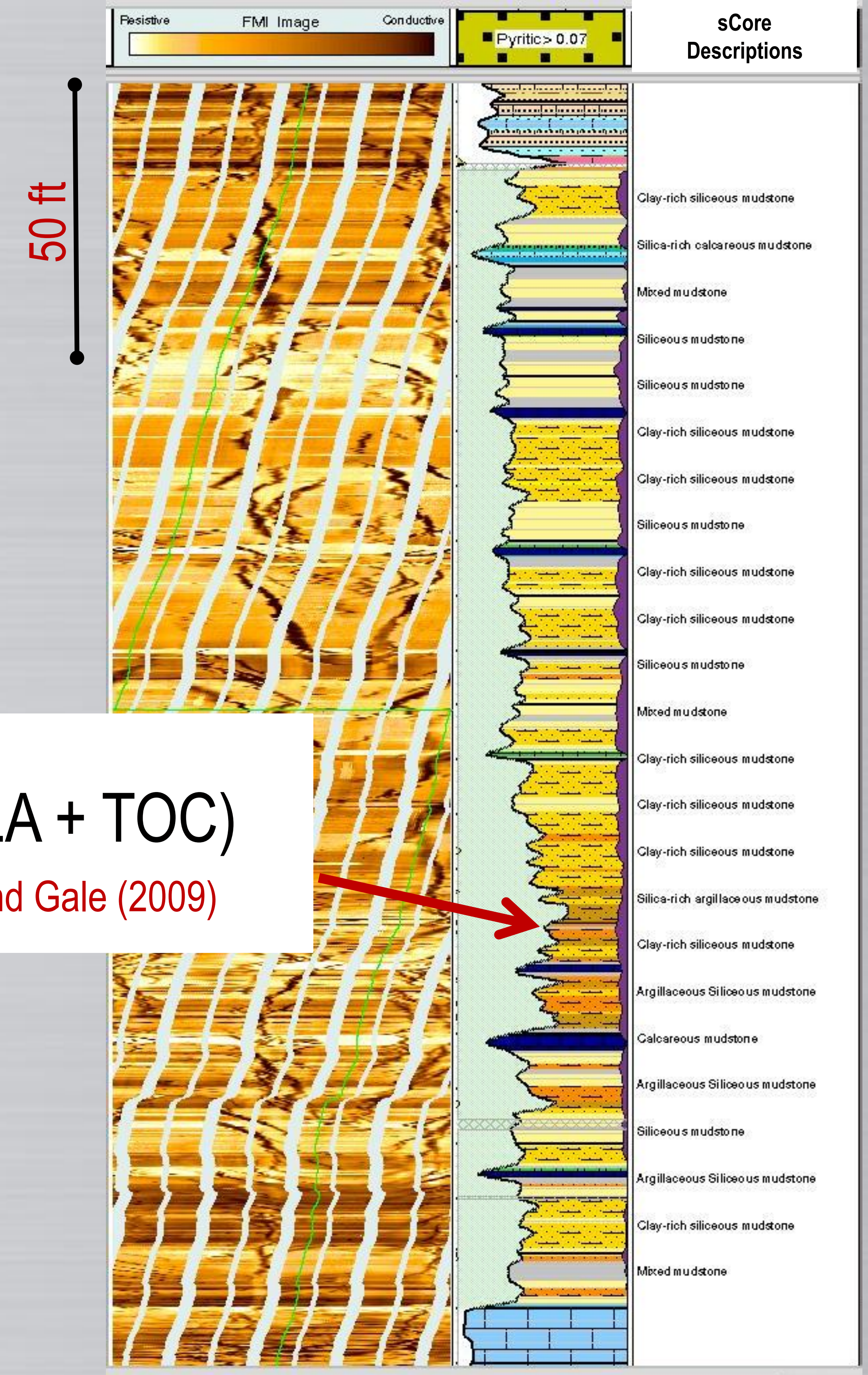
*s*Core Log Display



MBI = (WQFM + WCAR)/(WQFM + WCAR + WCLA + TOC)

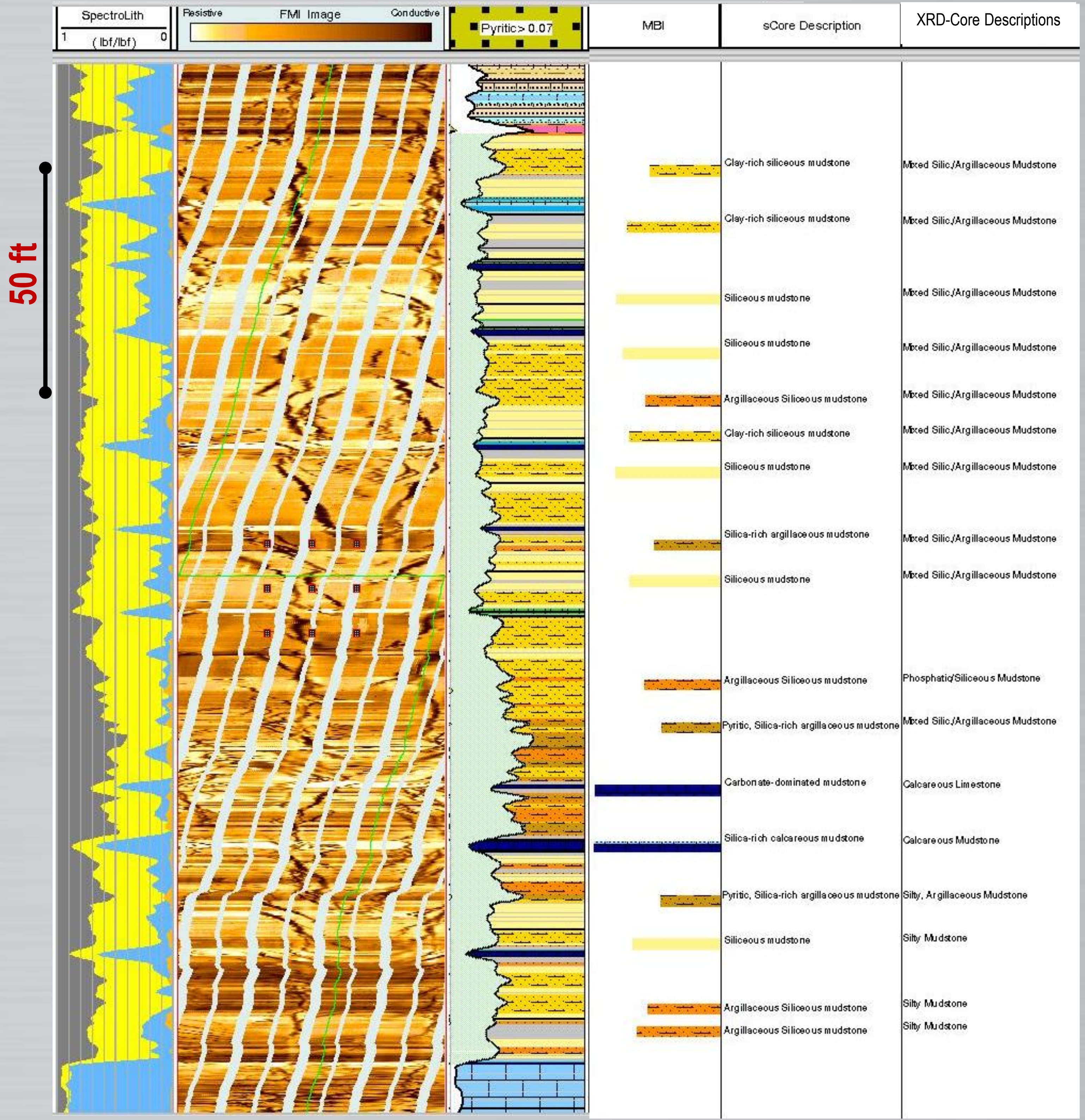
Modified from Wang and Gale (2009)

MBI = Completion Quality Indicator

Any kind of “Bulk-Minerology” data

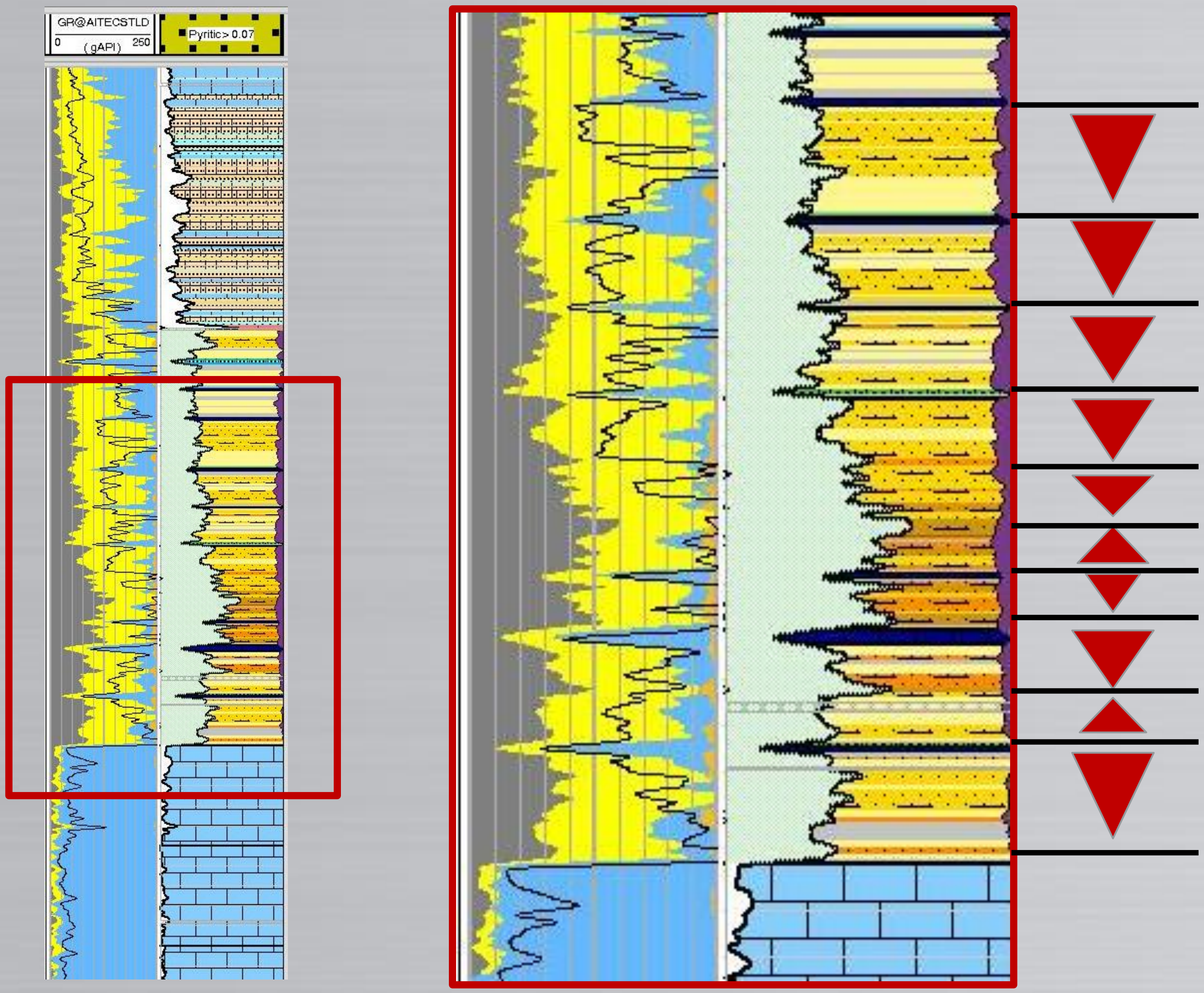
XRD data

- Whole core
- Sidewall core
- Cuttings

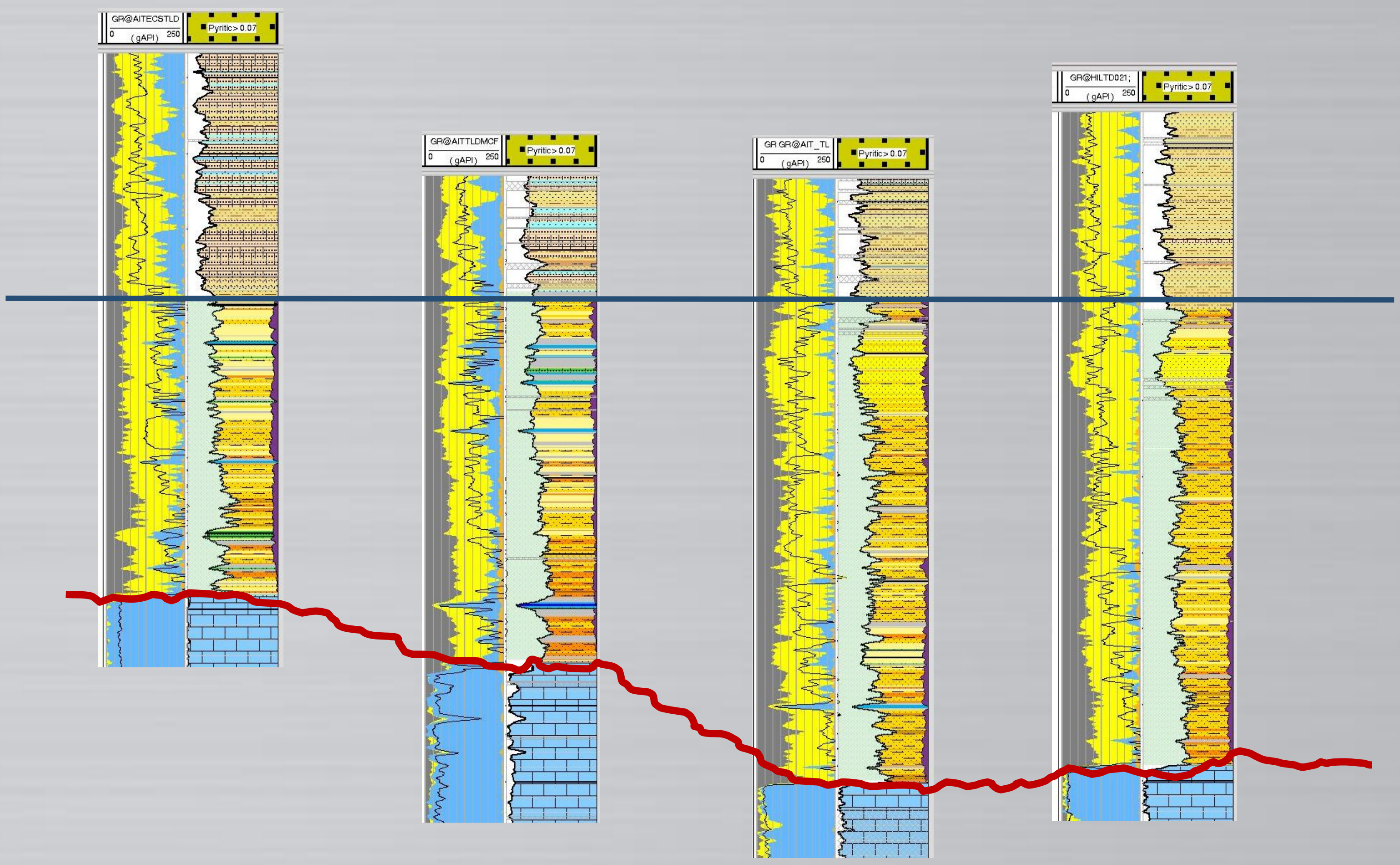


Aid with Sequence Stratigraphic Interpretation

Parasequence identification

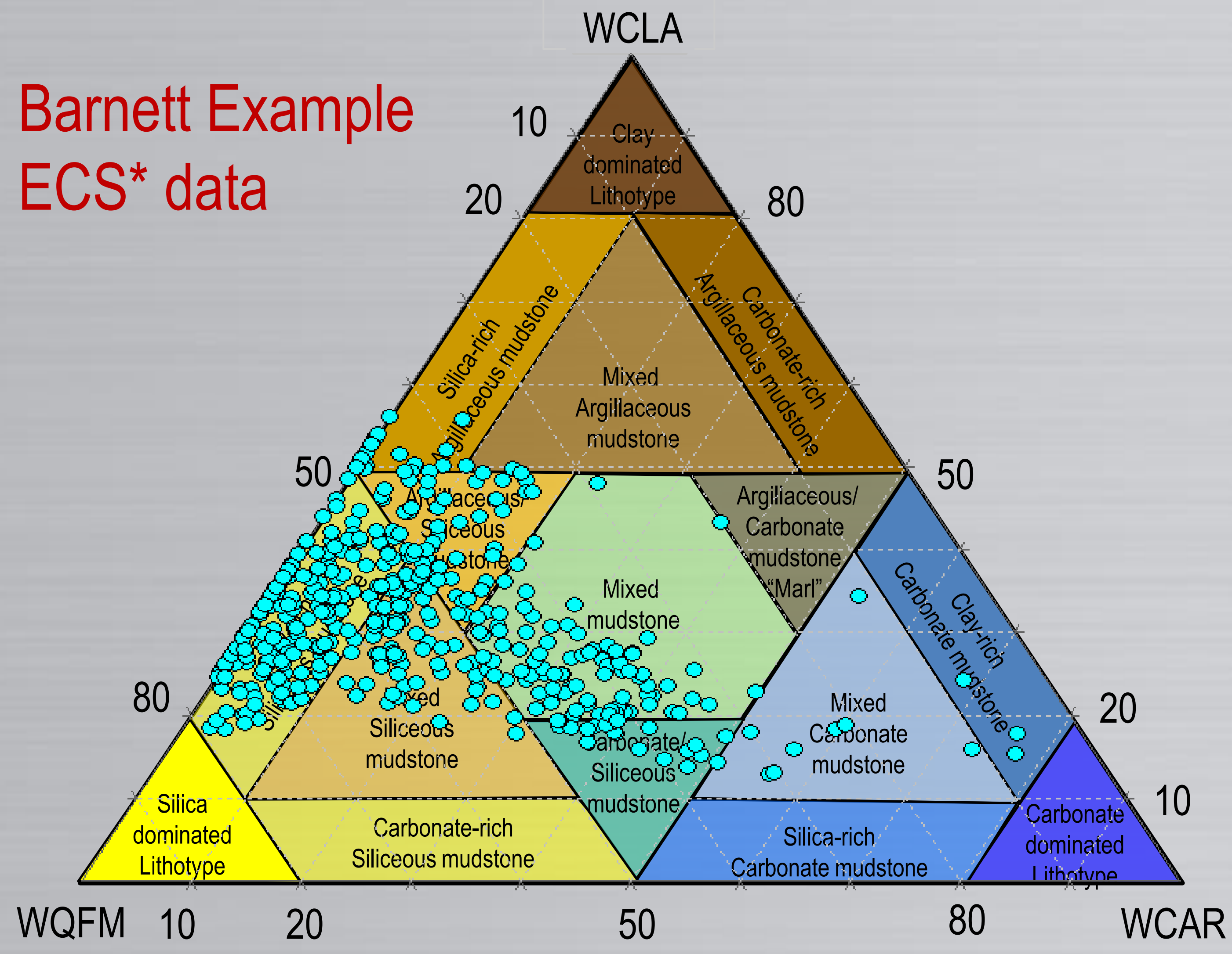


Correlations



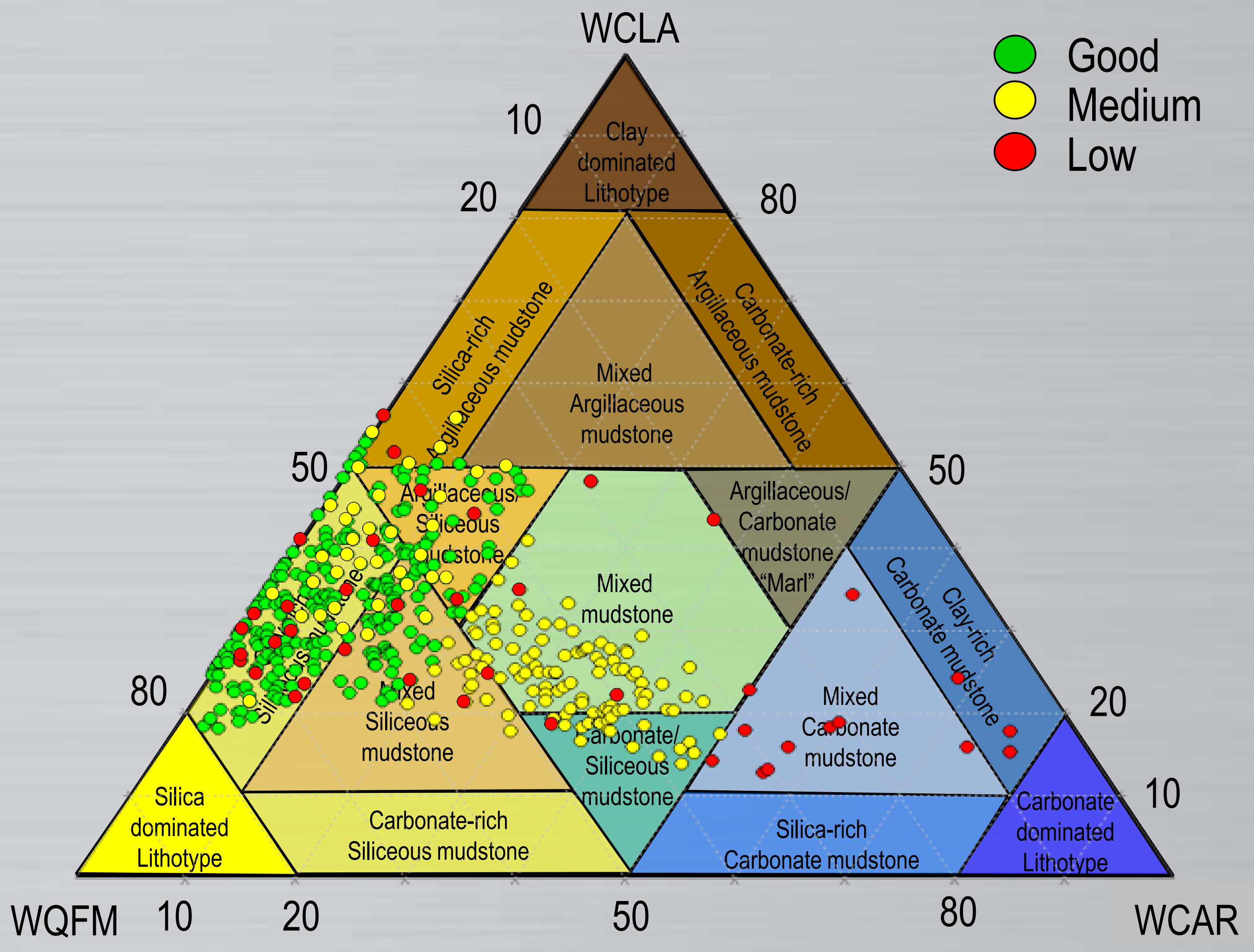
Reservoir Quality (RQ)

Barnett Example
ECS* data



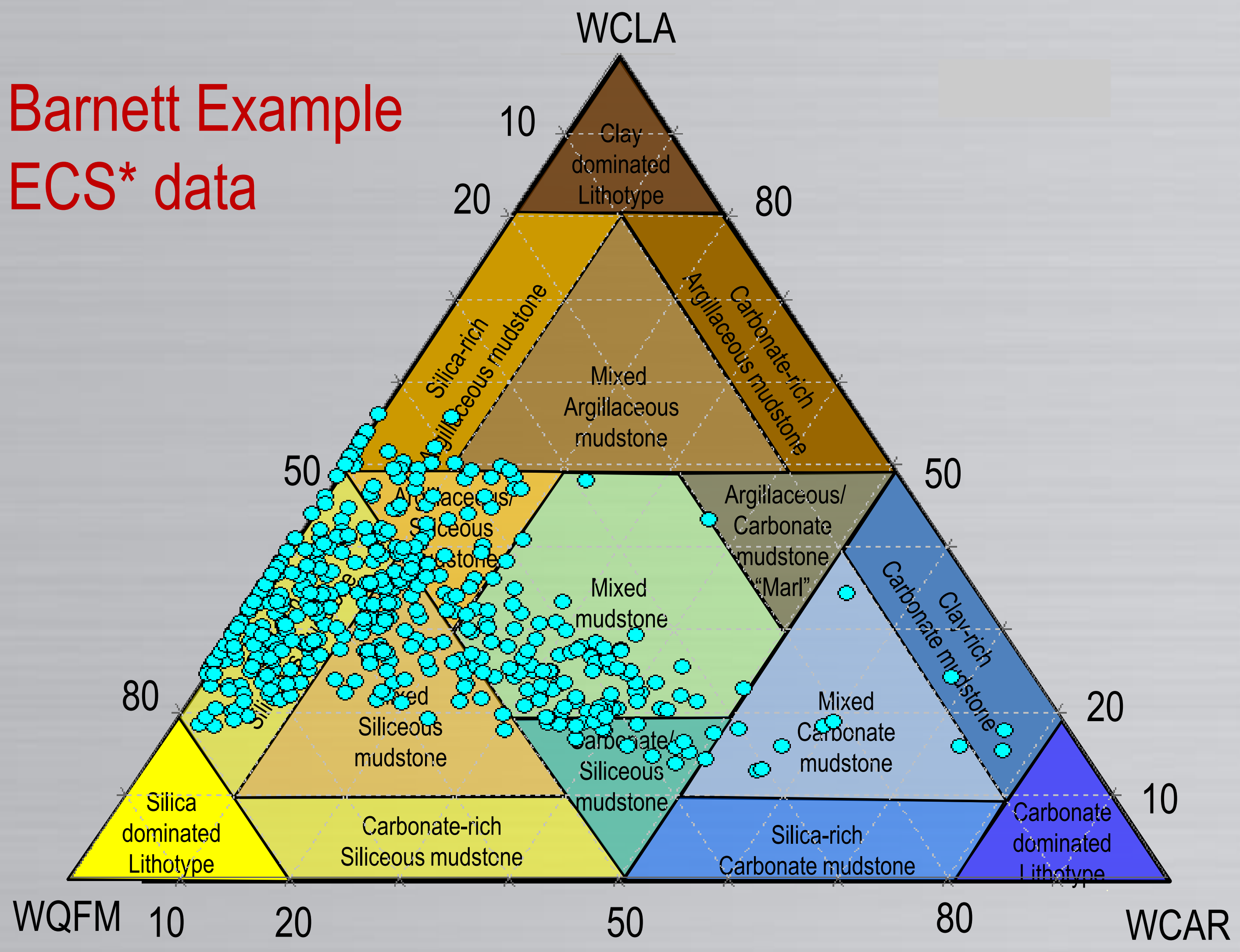
↑Silica + ↑Porosity = Biogenic Silica

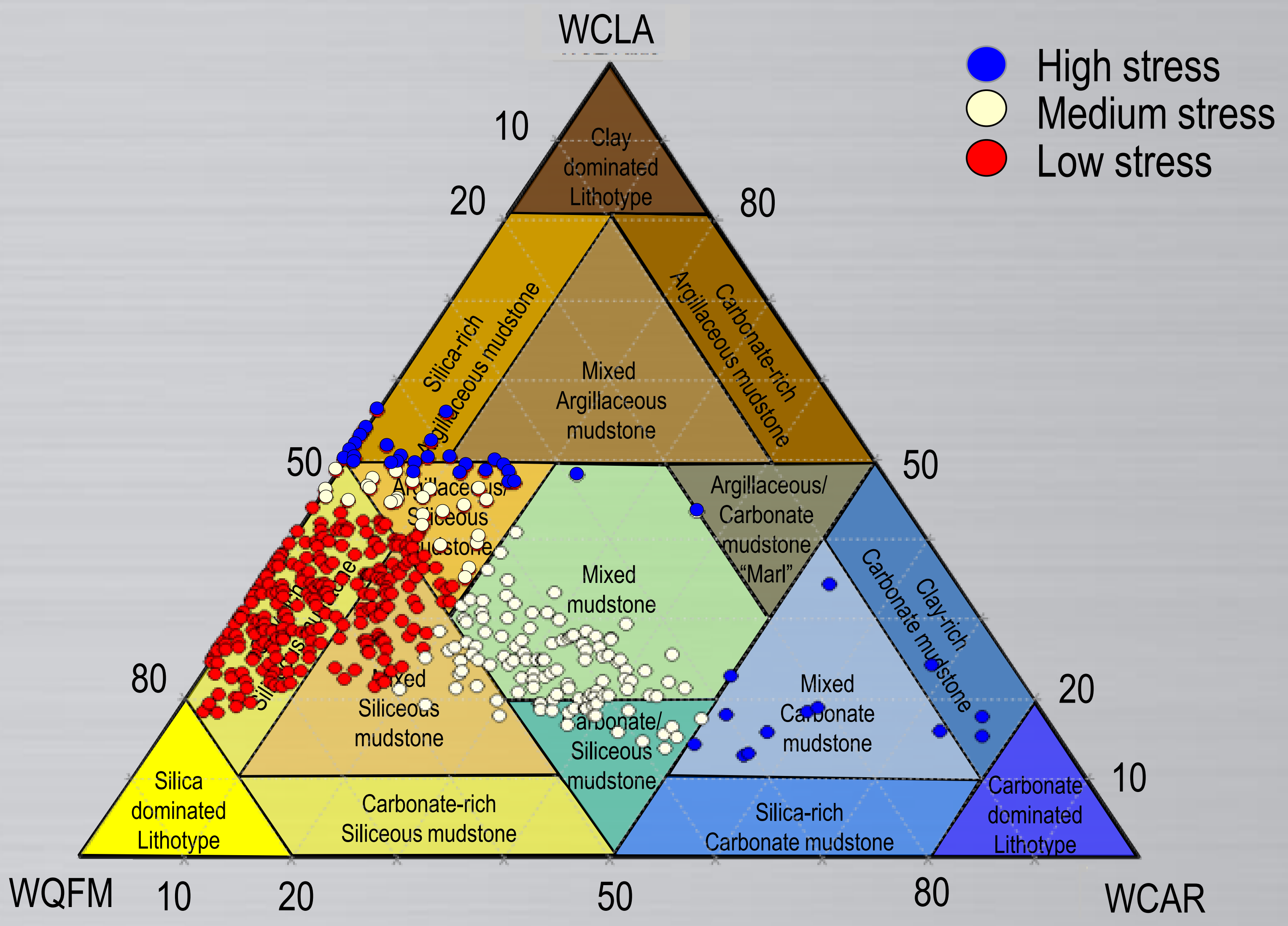
↑Silica + ↓Porosity = Detrital Silica



Completion Quality (CQ)

Barnett Example
ECS* data





Conclusions - sCore

- Applicable to any kind of “bulk-minerology” data: log, cores & cuttings
- Common metric for the description of organic mudstones around the world
  - Facilitates comparison of these reservoirs
- Provides the basis for parasequence definition and sequence stratigraphy
- Provides a log display that highlights other parameters that impact RQ & CQ and should lead to improved:
  - Landing point selection
  - Well placement
  - Operational efficiency
  - Completion design (stages, perfs, fluid type, etc)

Optimized Production and R.O.I.