Sedimentology and Petroleum Potential of the Devonian/Mississippian Three Forks and Bakken Formations and Equivalent Strata in Central and Western Montana*

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Abstract

The Devonian/Mississippian Bakken Formation is a prolific producer of hydrocarbons across much of the Williston Basin in western North Dakota and eastern Montana. The success of the Bakken play in the Williston Basin has sparked more recent interest in exploring time equivalent strata to the west in frontier areas in central and north-central Montana.

To evaluate the hydrocarbon potential of these upper Devonian and lower Mississippian rocks and to predict their distribution in Montana, we integrated results from detailed analysis of outcrops, core, geochemistry, mineralogy, and well log character.

In Montana, rocks of the Bakken and Three Forks Formations preserve a wide variety of sedimentologic characteristics that reflect complex local changes in depositional environment. Sediments are commonly intensely bioturbated, contain abundant siliciclastic detritus, and are characterized by highly variable weight percentages of organic matter and carbonate.

In general, lithofacies variability is interpreted to reflect deposition of a mixed carbonate-clastic sedimentary system within a generally oxic foreland basin to the west and a well aerated shelfal environment to the east. Taking into account the diachroneity of facies belts, we infer that coarser grained siltstone facies represent proximal deposits related to prograding shoreface systems whereas finer grained mudstones were deposited contemporaneously in more distal environments sourced from local sources. Abundance of hummocky cross stratification in siltstone and very fine grained sandstone from several localities suggest that storms were an important mechanism for dispersing siliciclastic sediment in the foreland basin and across the shelf, whereas a diverse suite of trace fossils suggests subsequent reworking by a robust infauna.

Our analysis of Devonian/Mississippian outcrops in Montana suggest the presence of several sub-basins that contain organic rich mudrock intervals genetically related to coarser grained lithofacies in other parts of the basin. Based on preliminary thin-section and mineralogic

analyses, some of these sub-basins are interpreted to have a potential for hydrocarbon generation in areas outside the Williston Basin and southern Alberta Basin.

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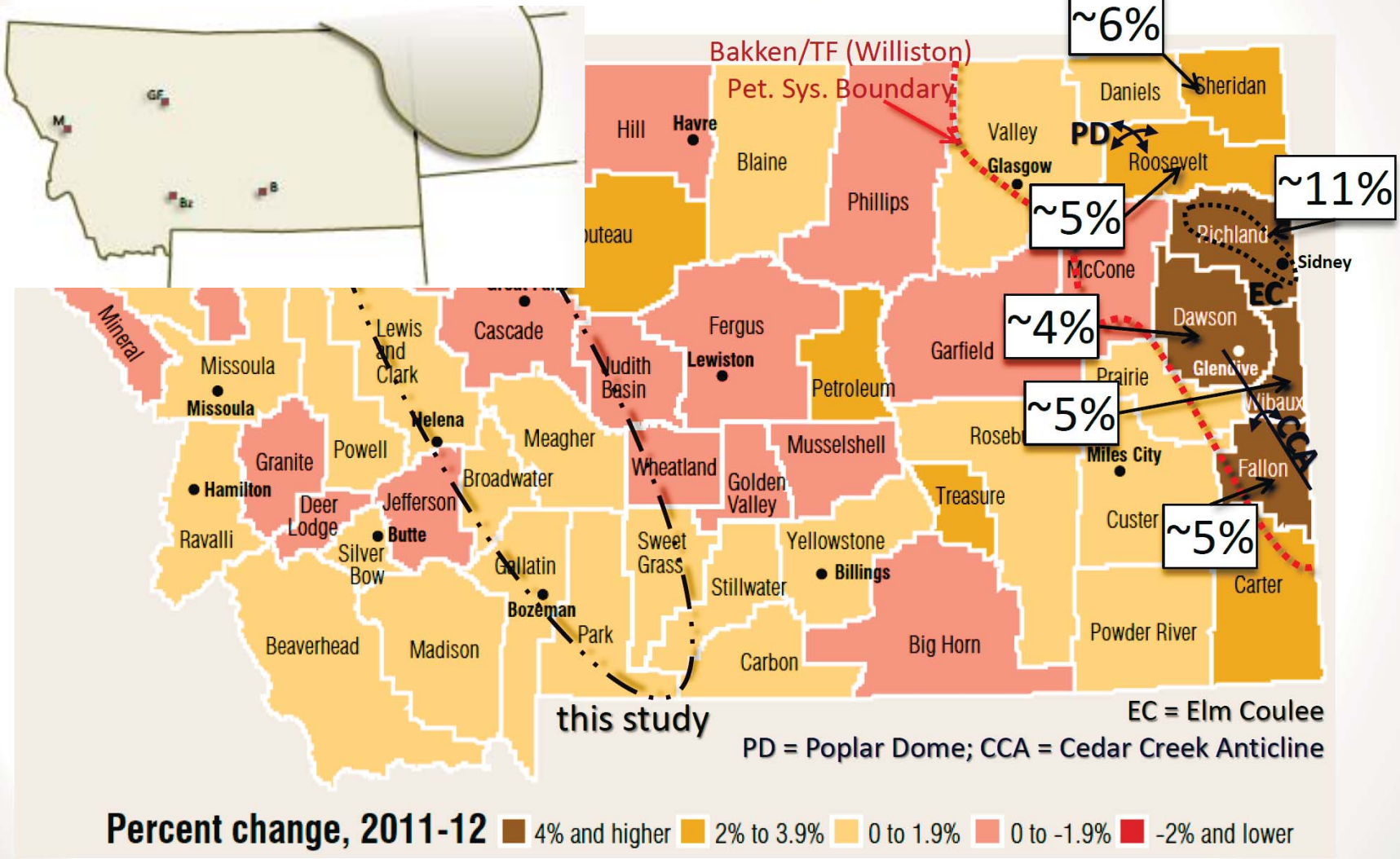
M.H. Hofmann, M.S. Hendrix, T. Nagase
The University of Montana

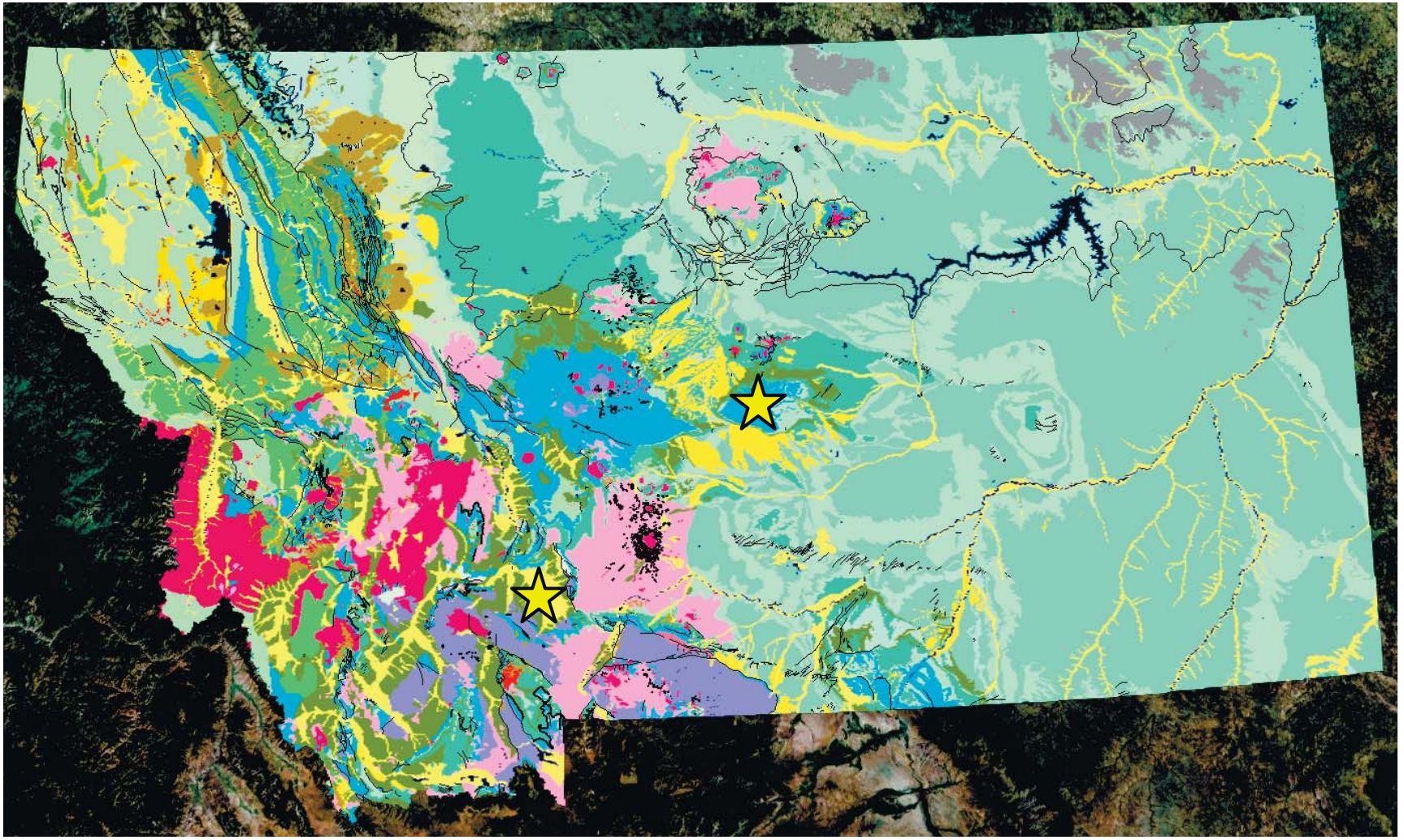
Thanks to: ConocoPhillips

Montana population growth



Modified from : Missoulian; Bureau of Business and Economic Research, the University of Montana-Missoula

Montana Geology



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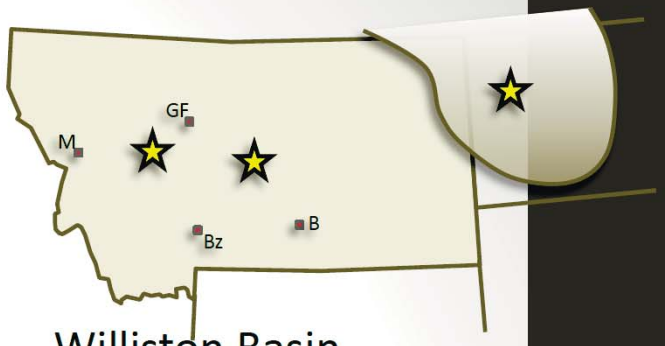

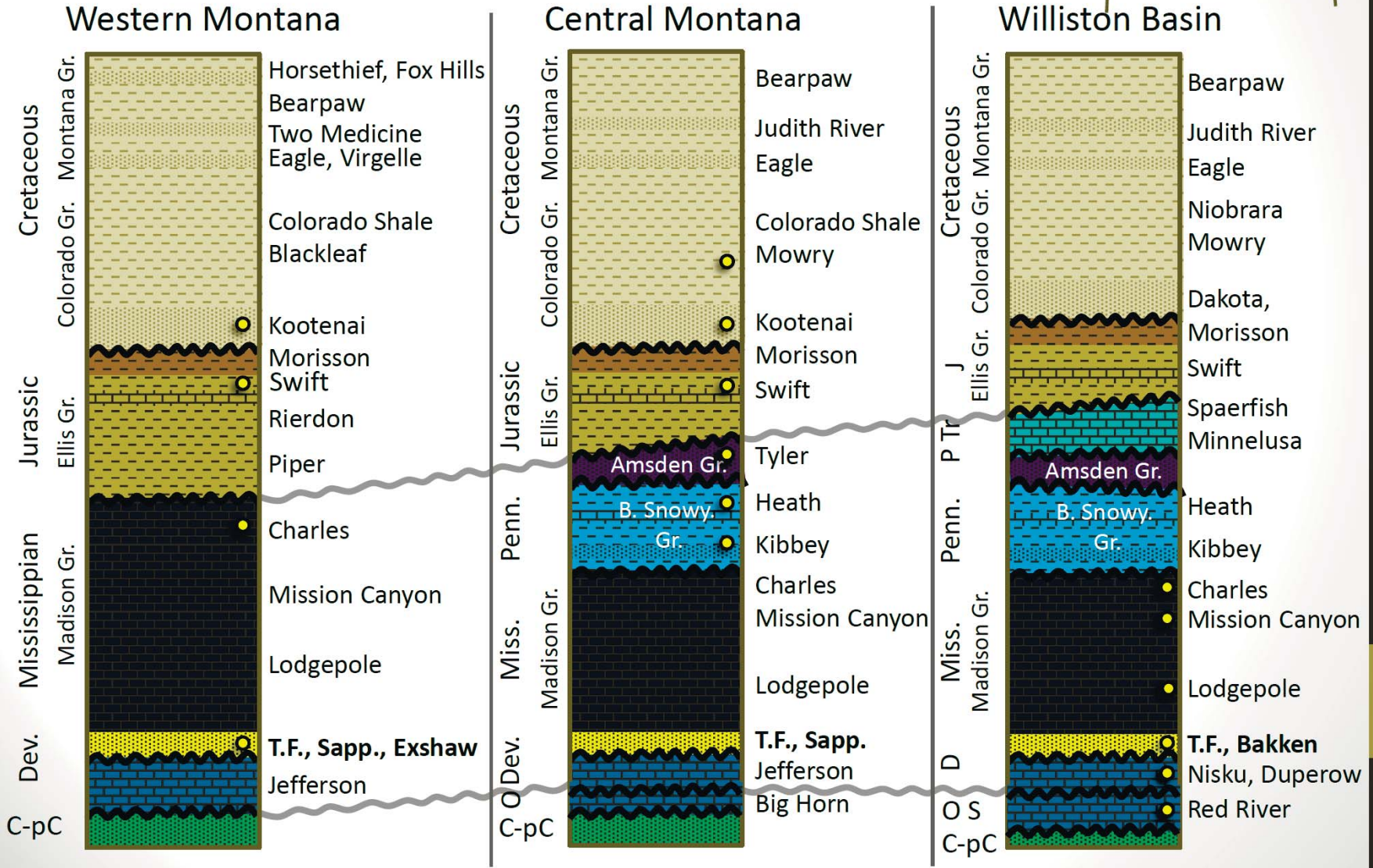

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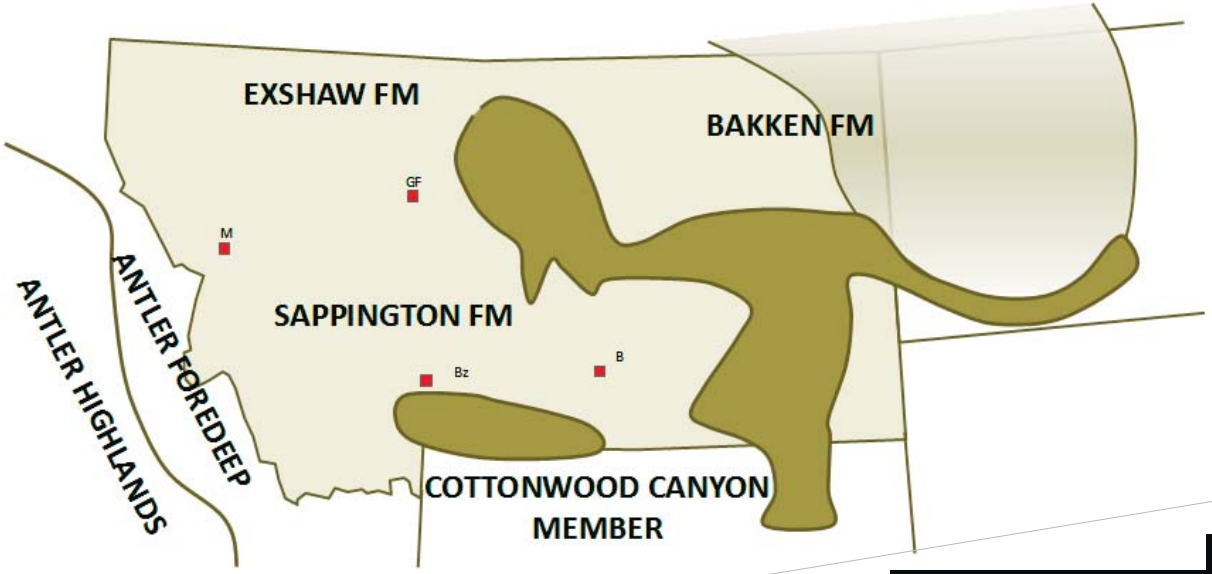
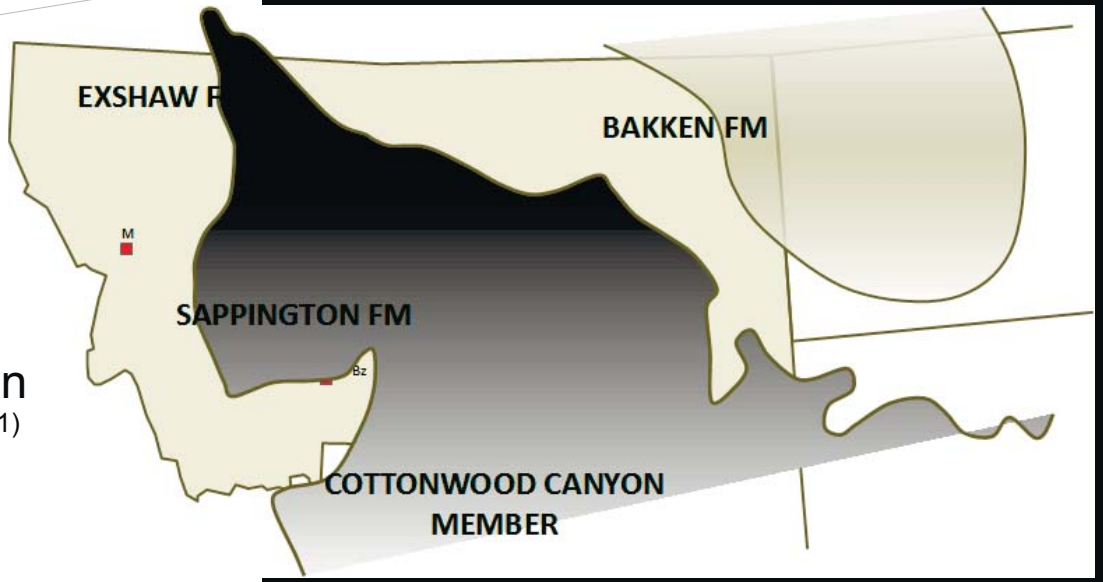


Late Devonian

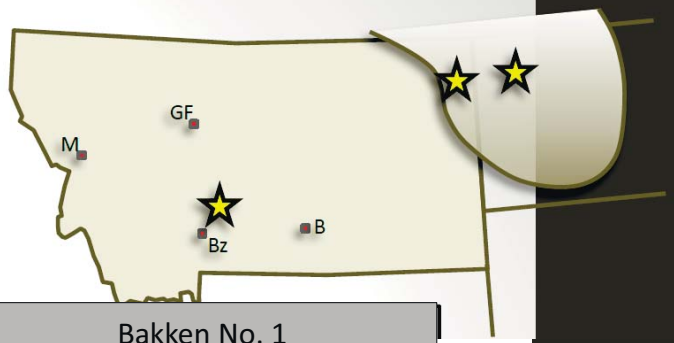
(source Baars, 1972)

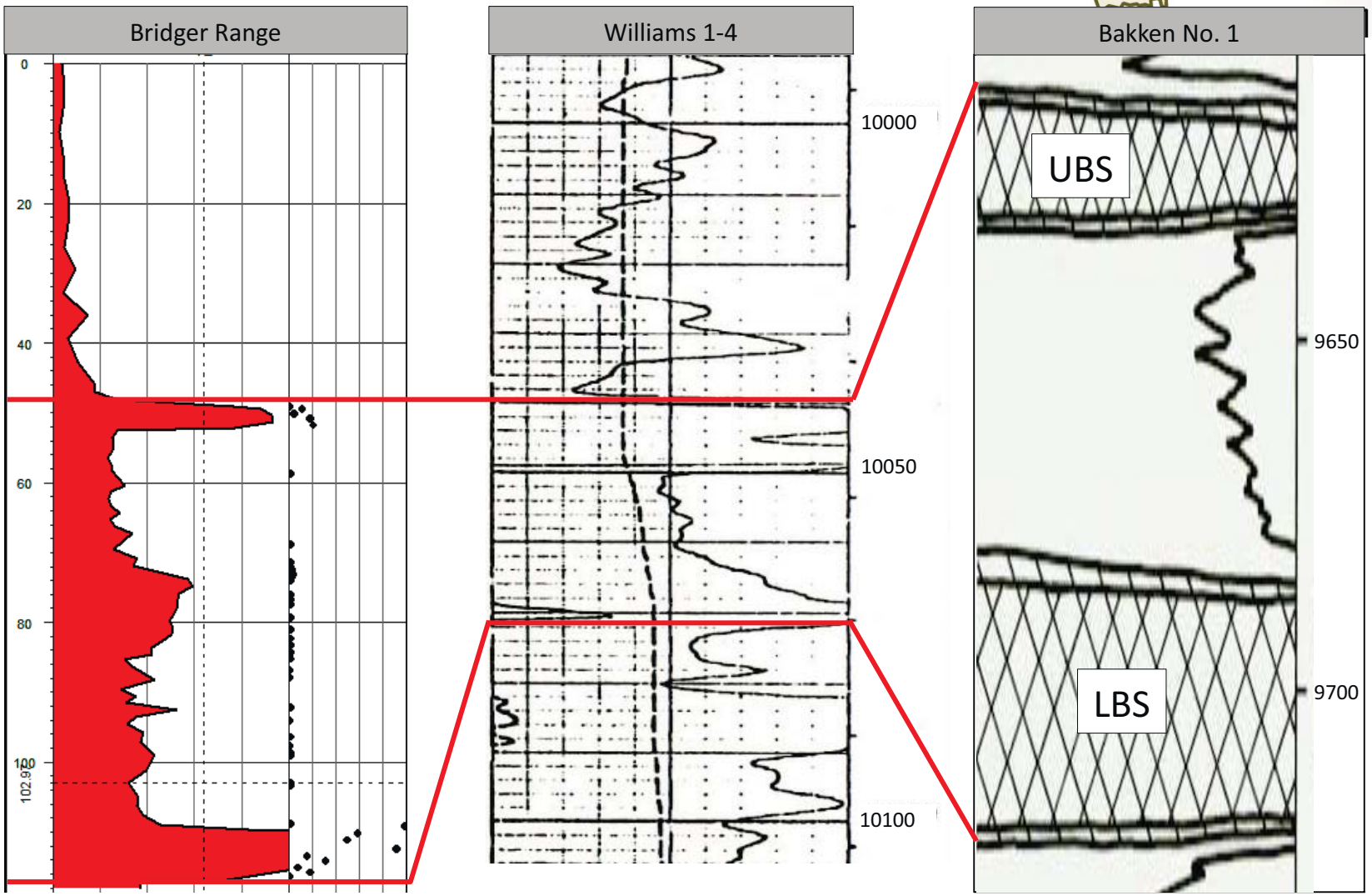


(Middle) Late Devonian

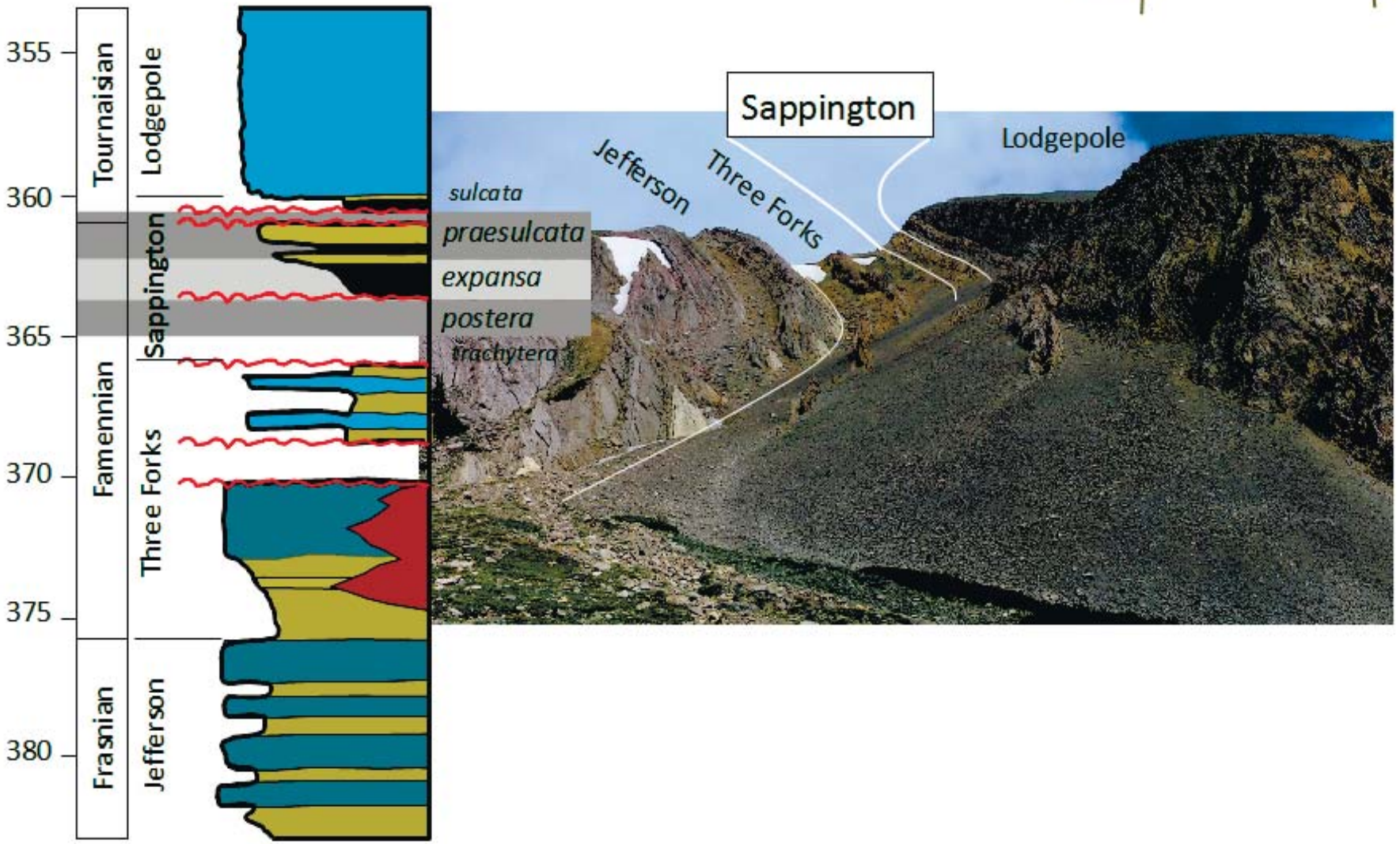
(Source Blakey, 2011)

Bakken/Sappington log facies



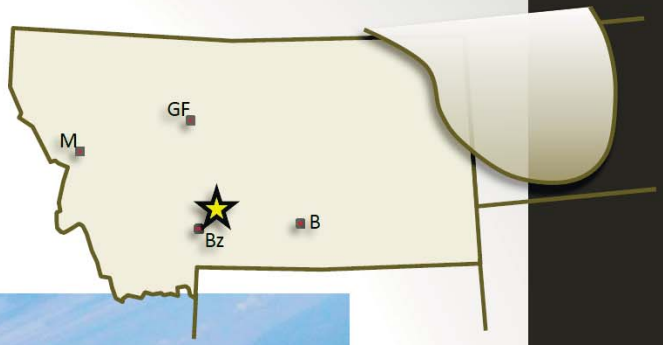


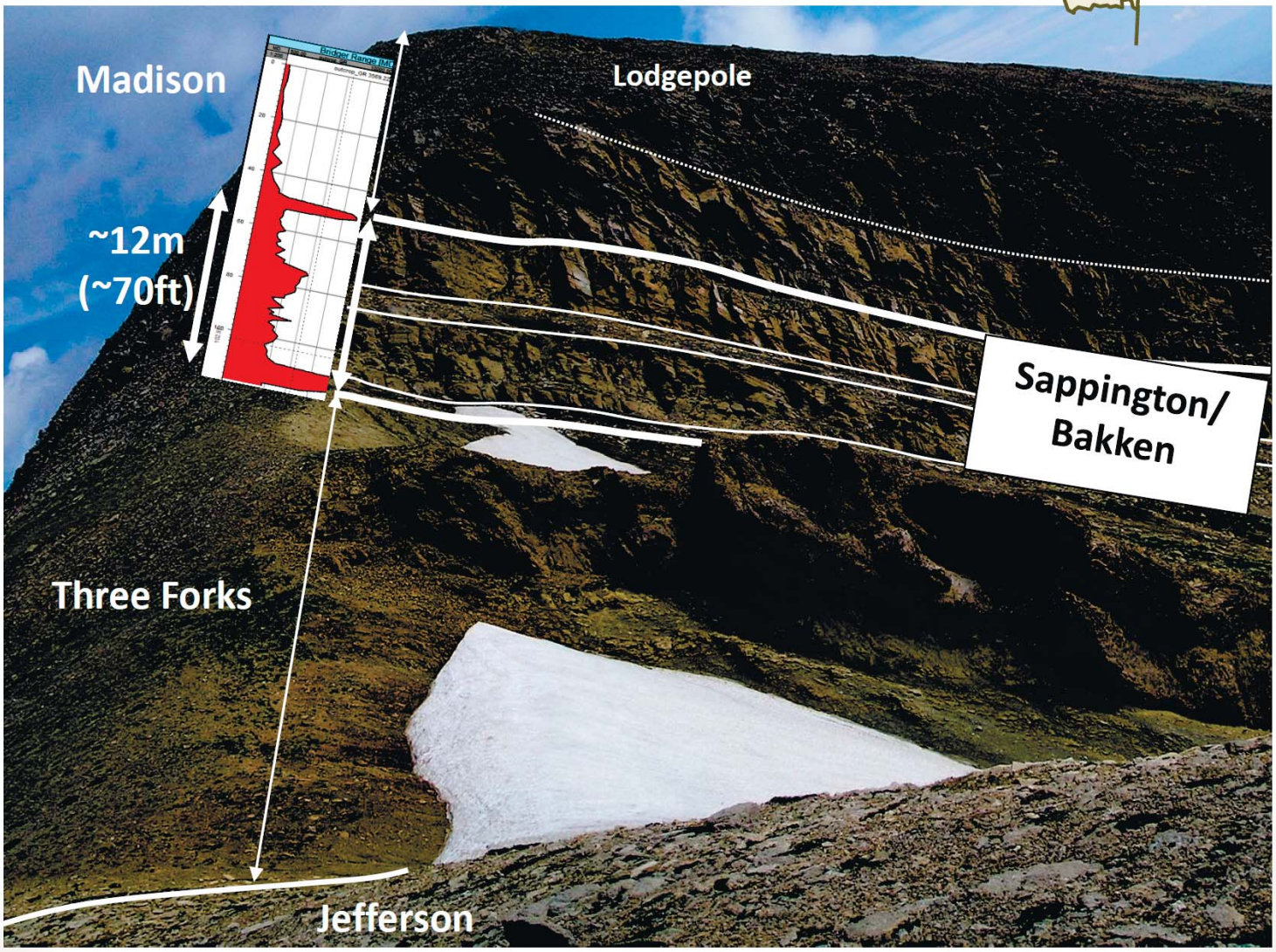
Devonian Strata



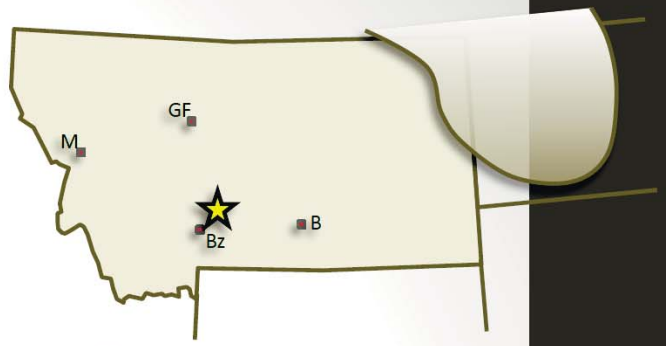
Sources: Sandberg et al., 1972; Johnson et al., 1985; Huber, 1986; Kaufmann, 2006; Johnston et al.,2010

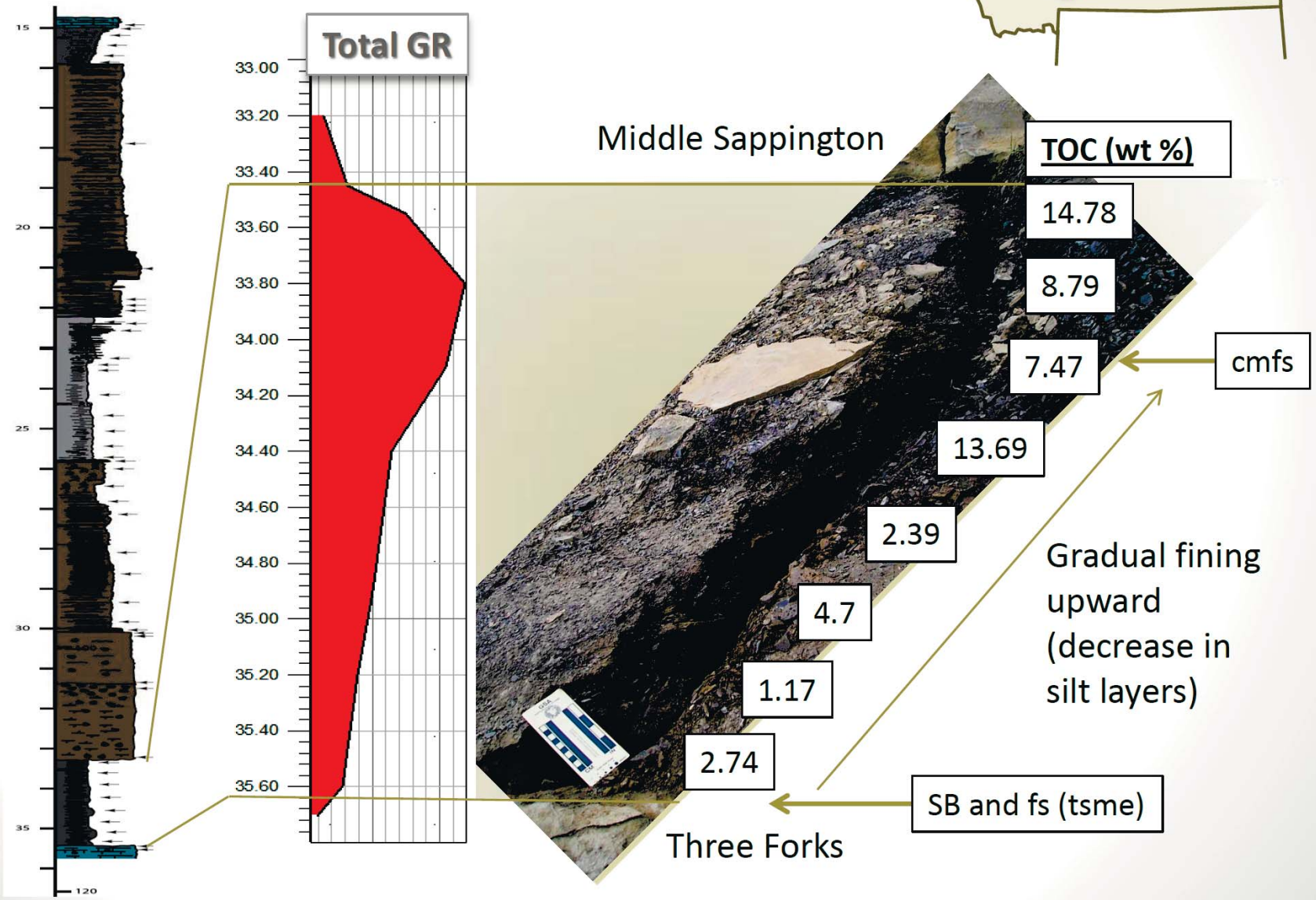
Bridger Range



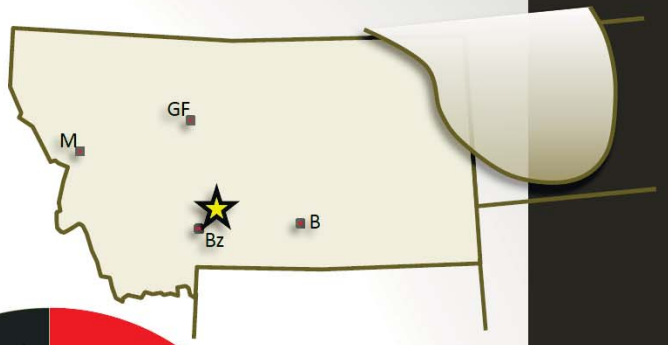


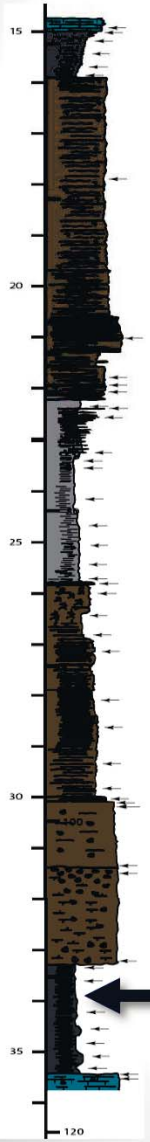
Lower Mudstone

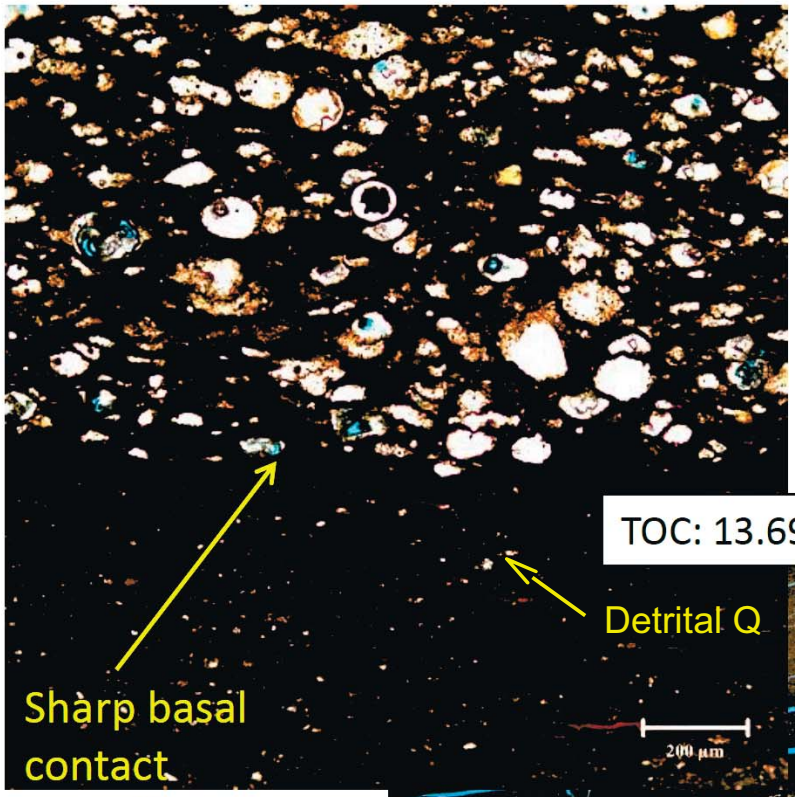


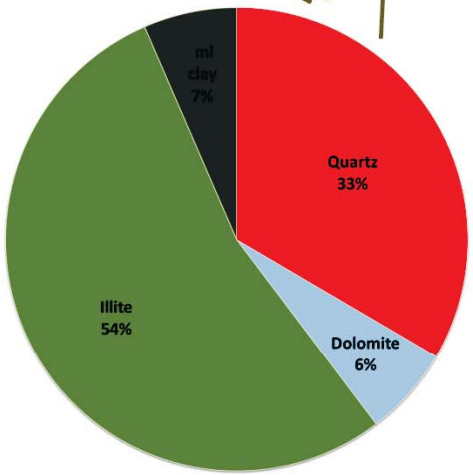


Organic rich mudstone









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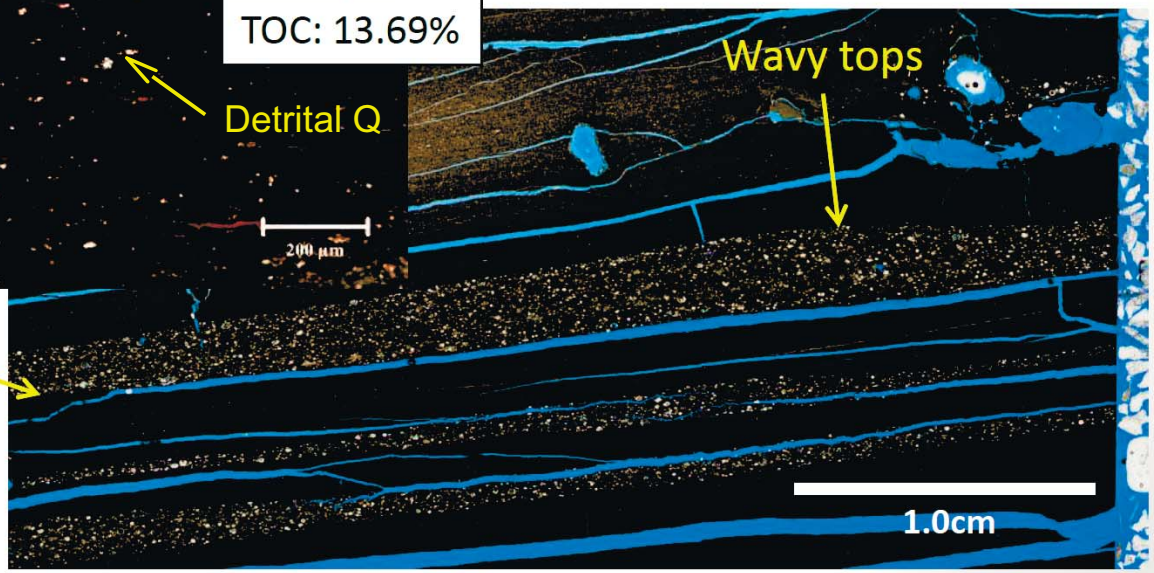
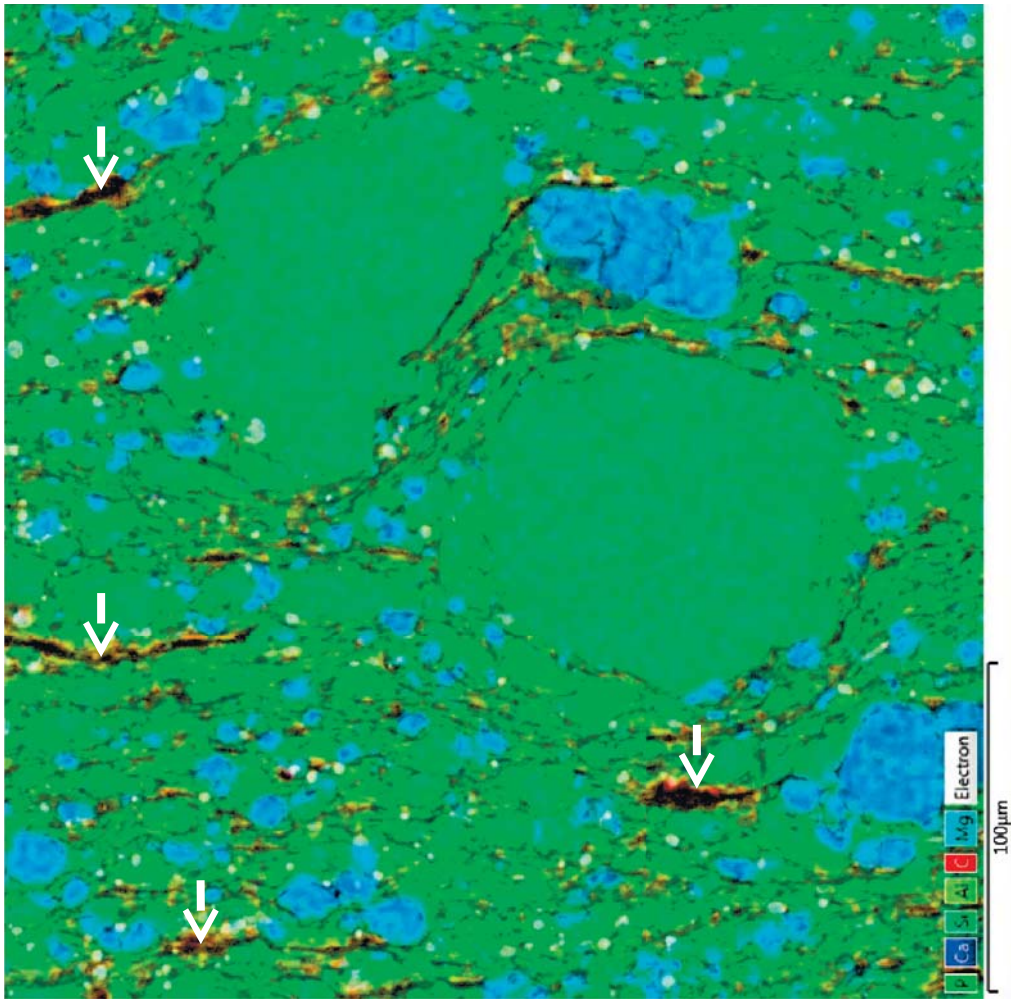
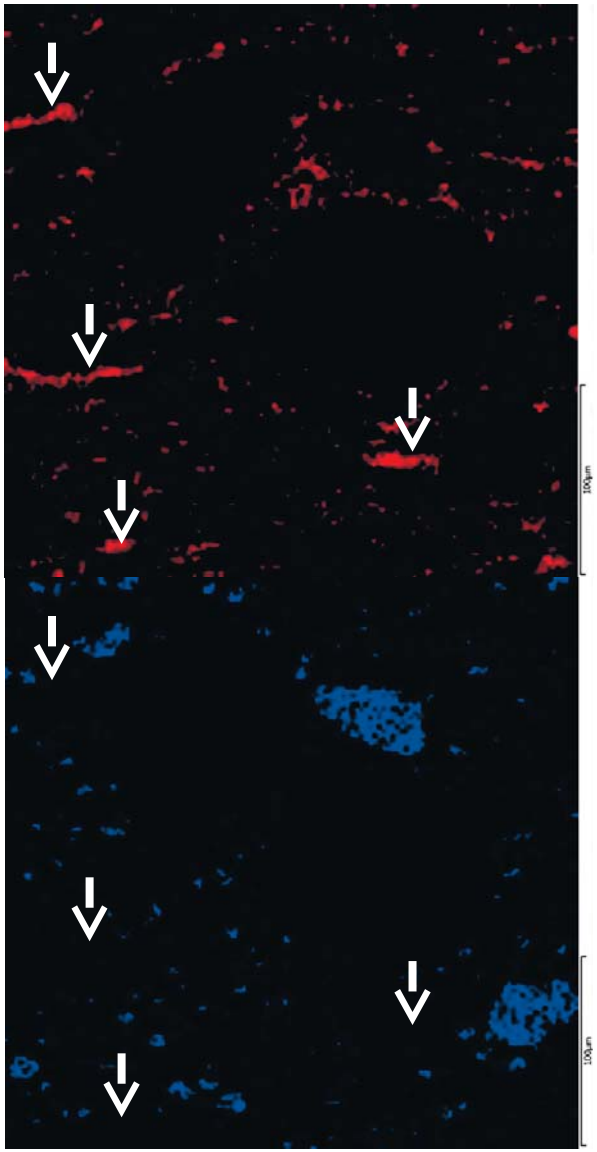


Facies has potential for intra-particle porosity

Organic rich mudstone





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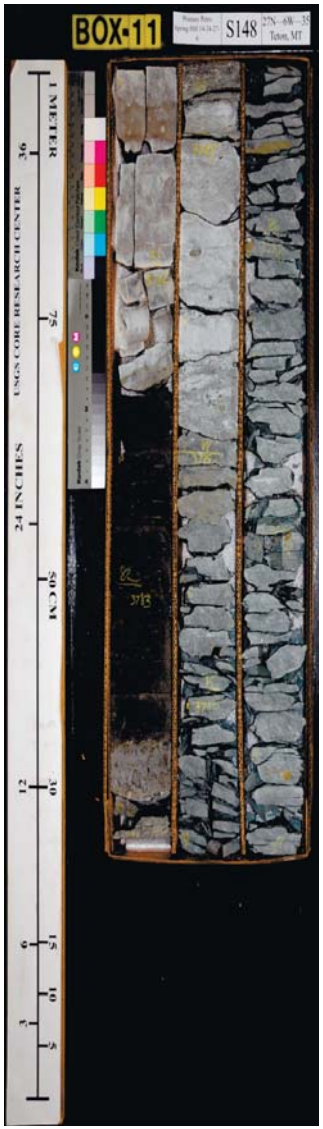
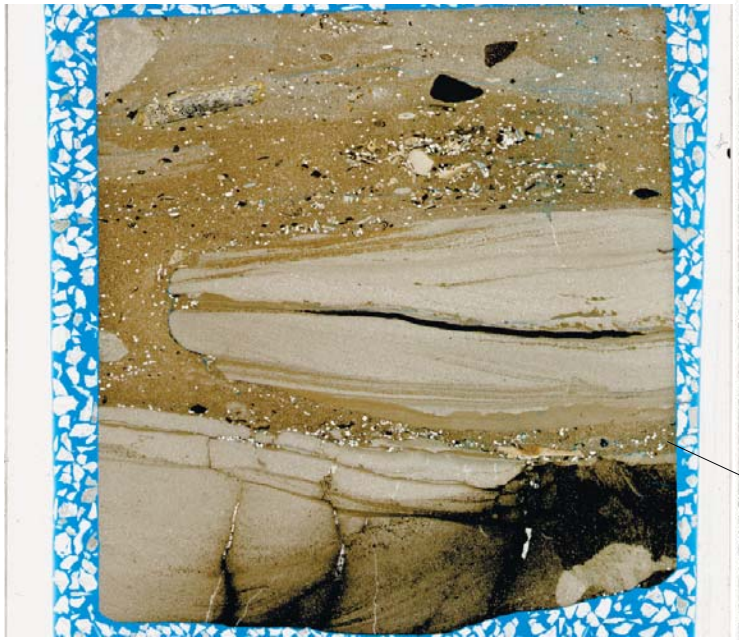
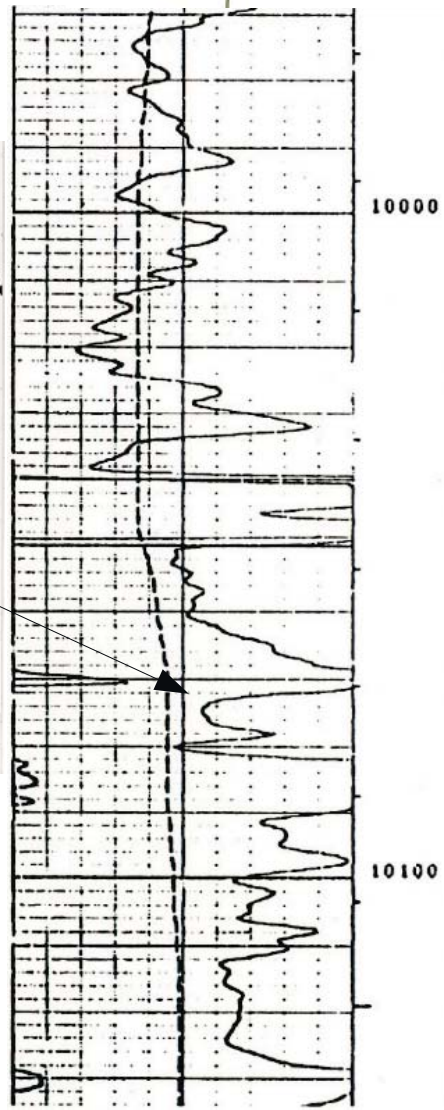


Spring Hill
14-34-27-6



1-4 Williams

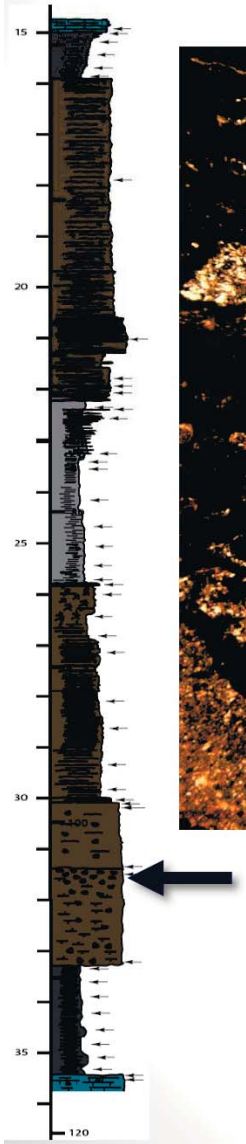


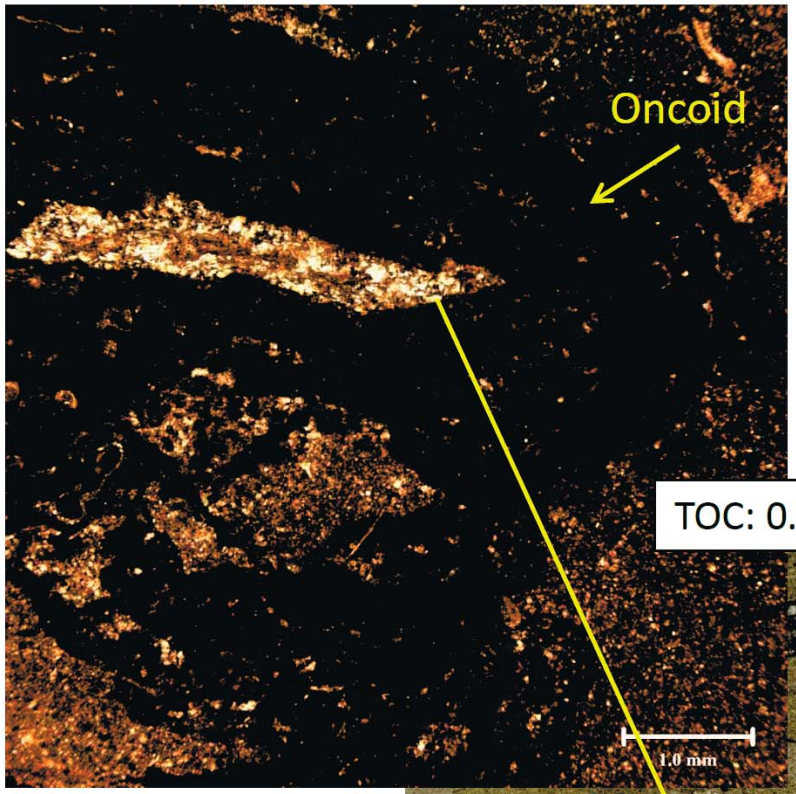
Basal contact:

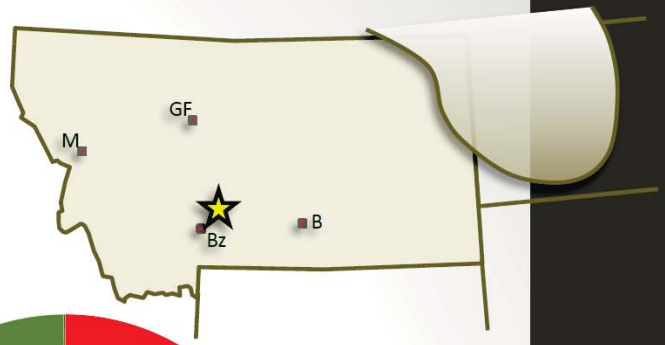
Erosive, Rip-up clasts,
Subaerial exposure surface

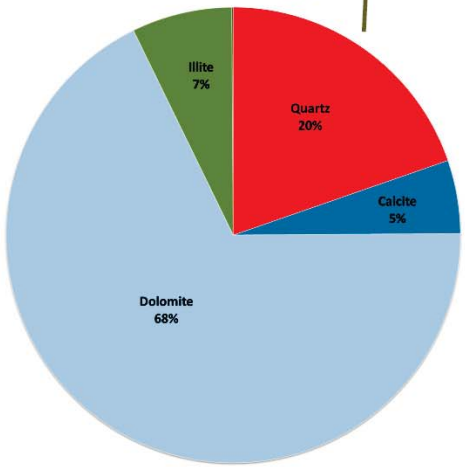
Photo courtesy USGS CRC

Oncoid silty grainstone









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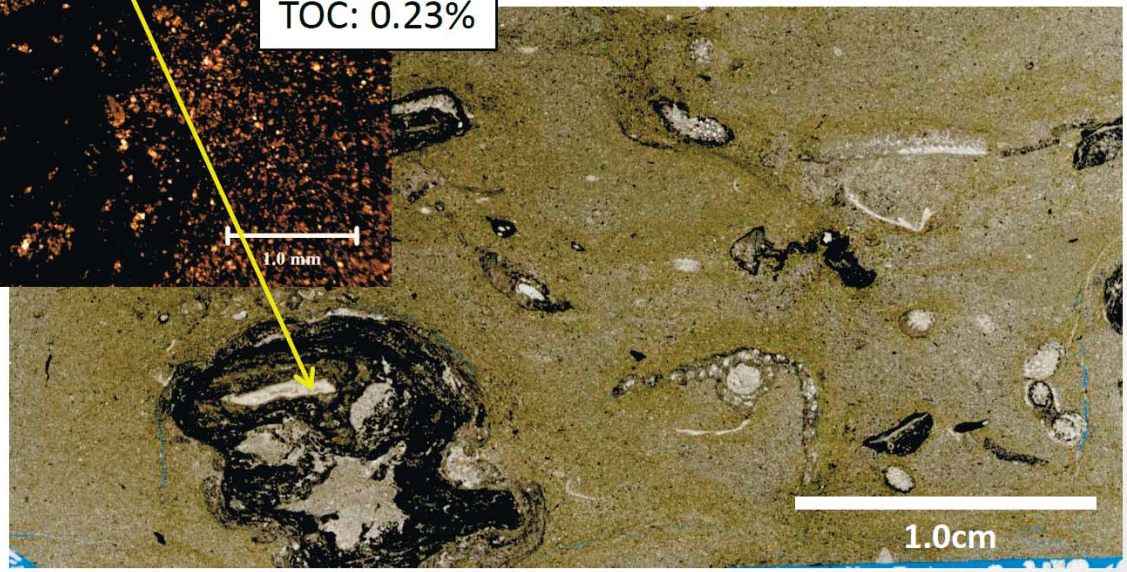
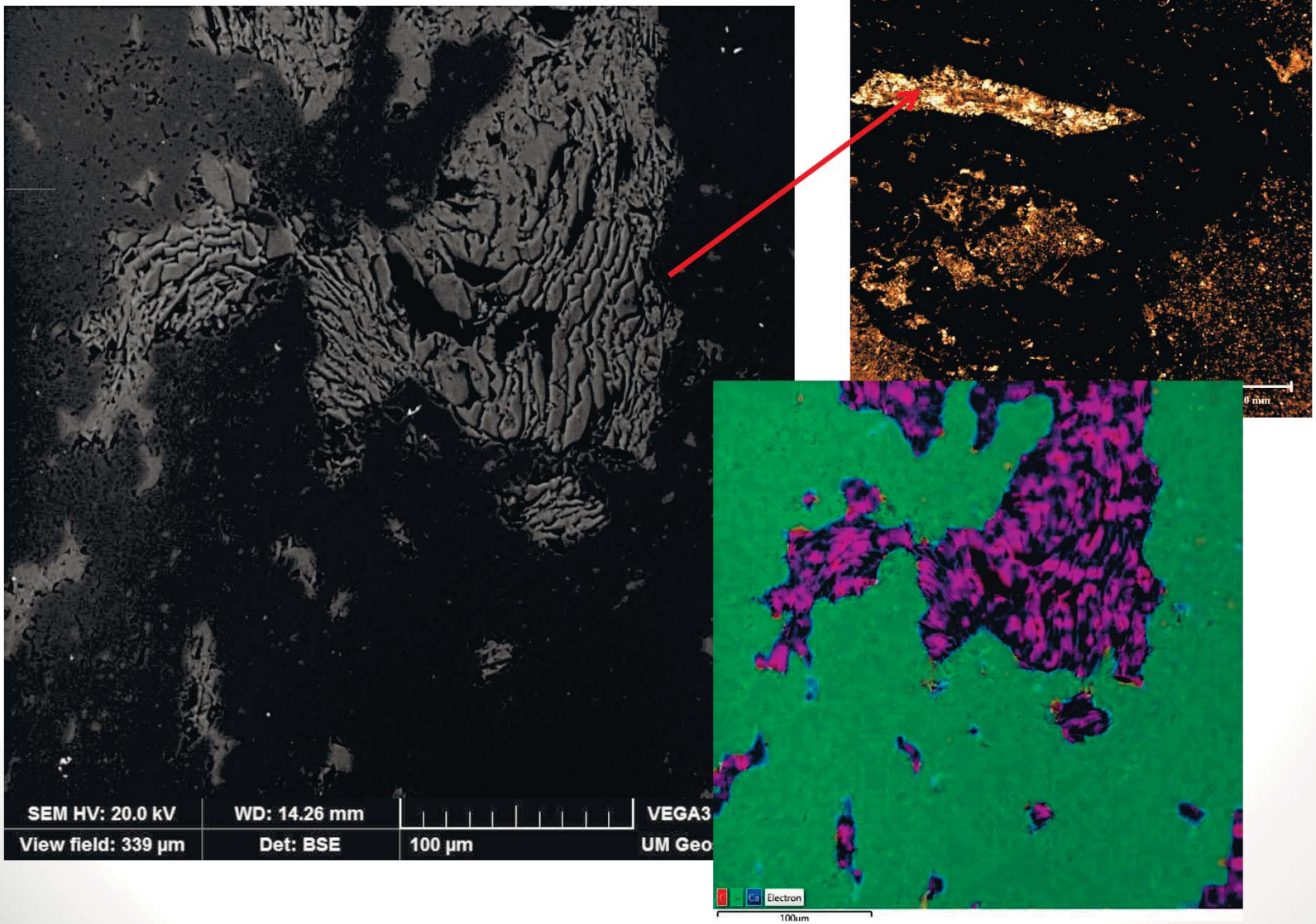
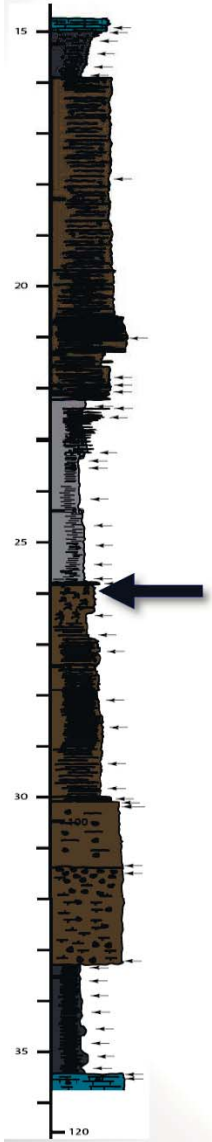


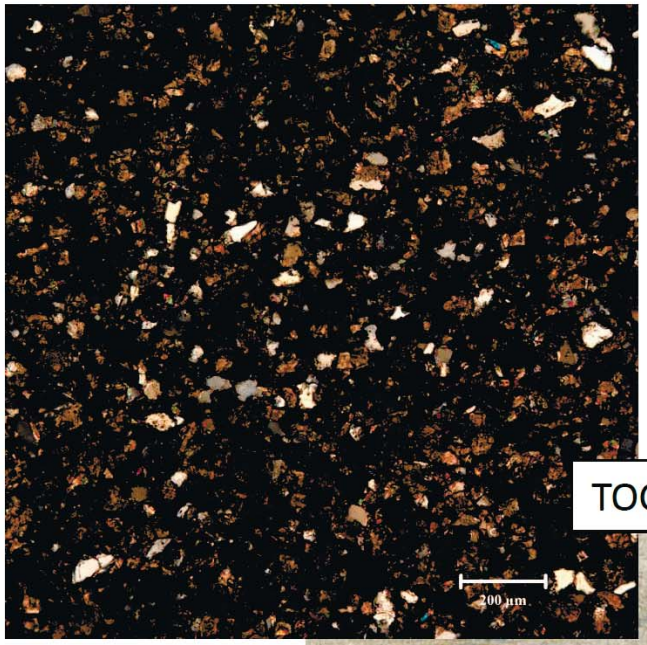
Facies has potential for moldic and intra-particle porosity

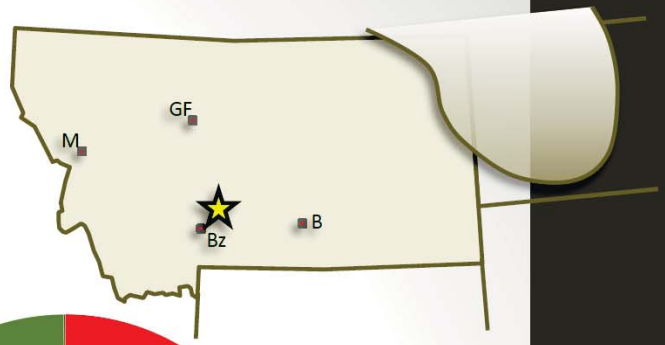
Intra-particle/Moldic Porosity

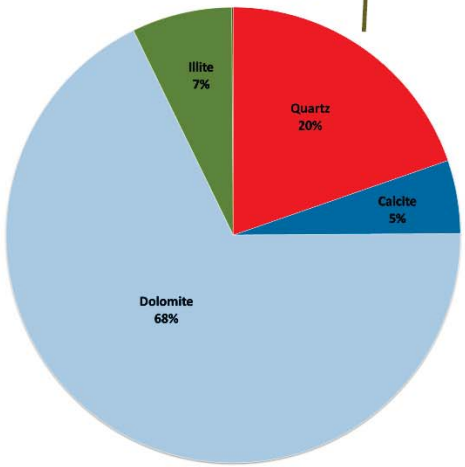


Silty vf sandstone









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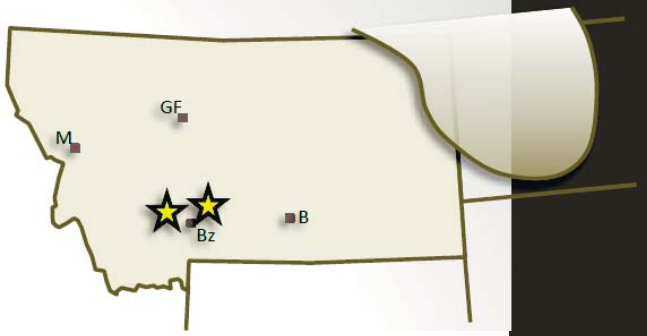
Coarsest facies; Potential for inter-particle porosity; dolomite fills mainly pore space

Middle Mudstone



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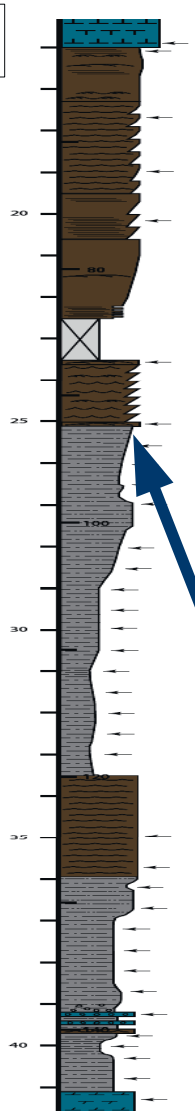

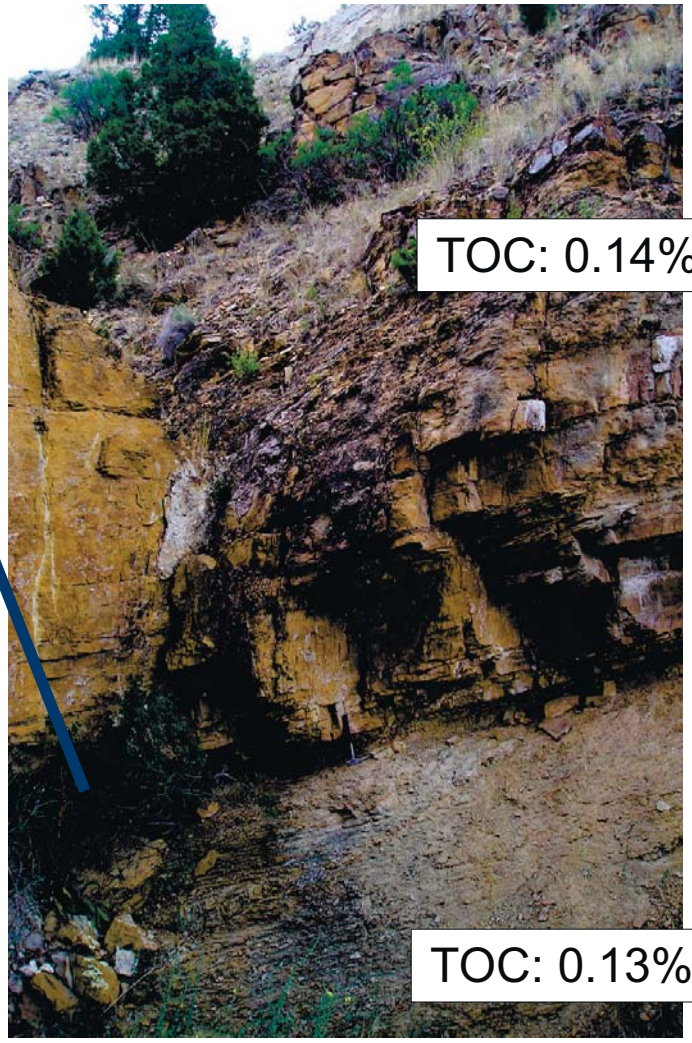

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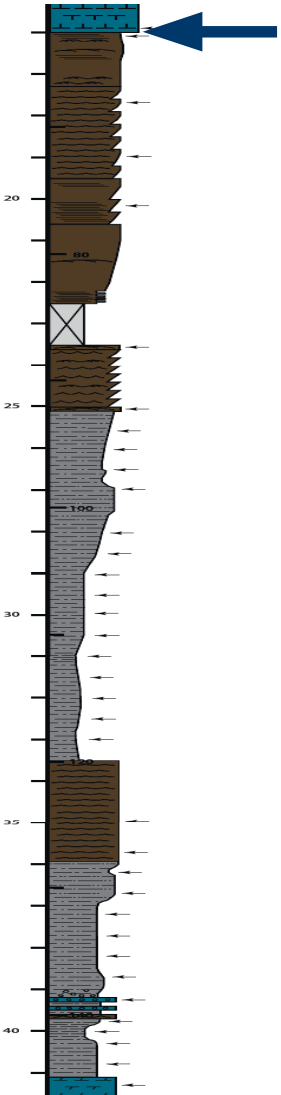
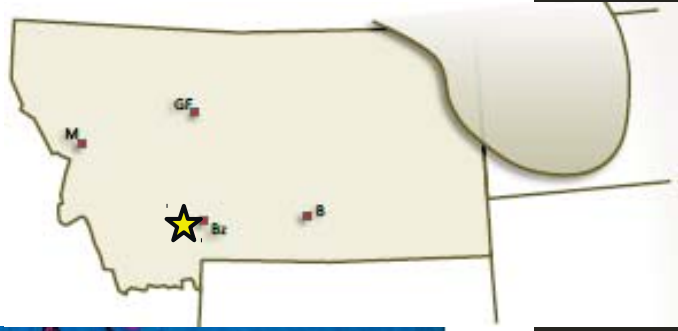
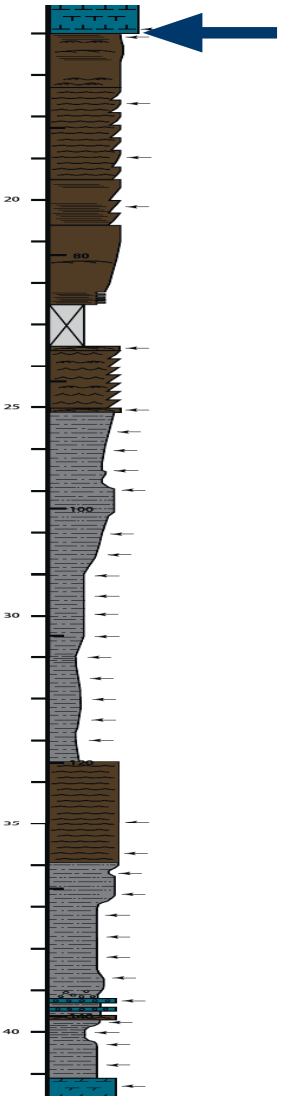
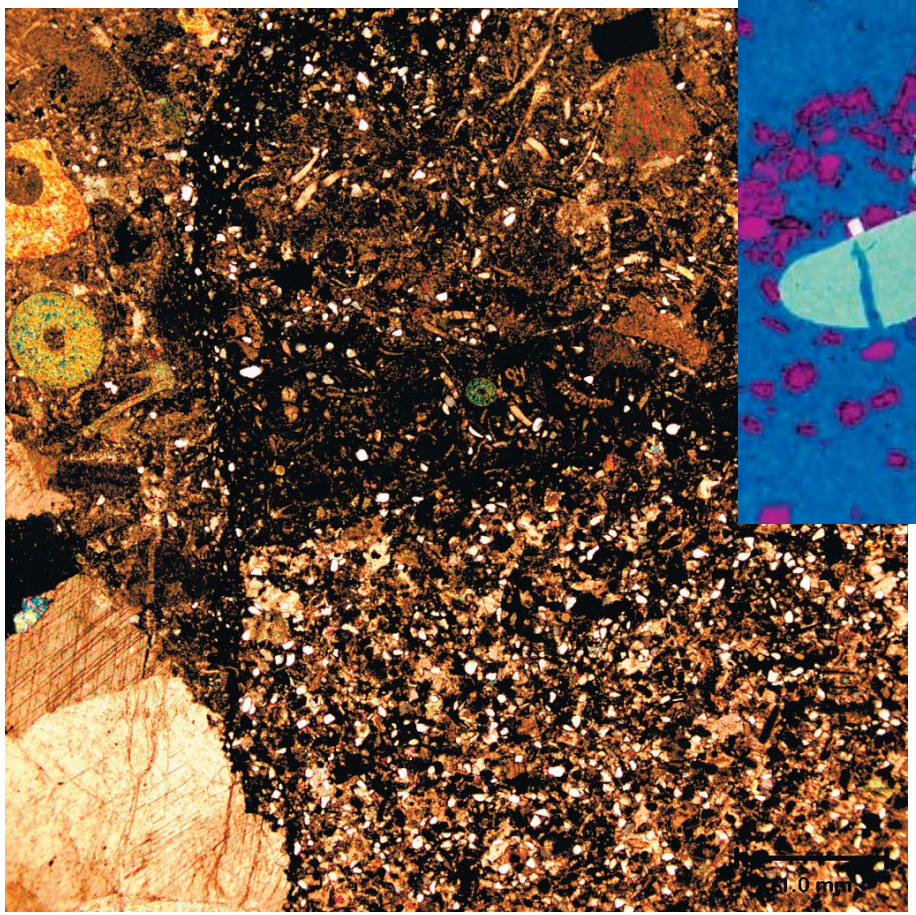
Sappington - Lodgepole contact

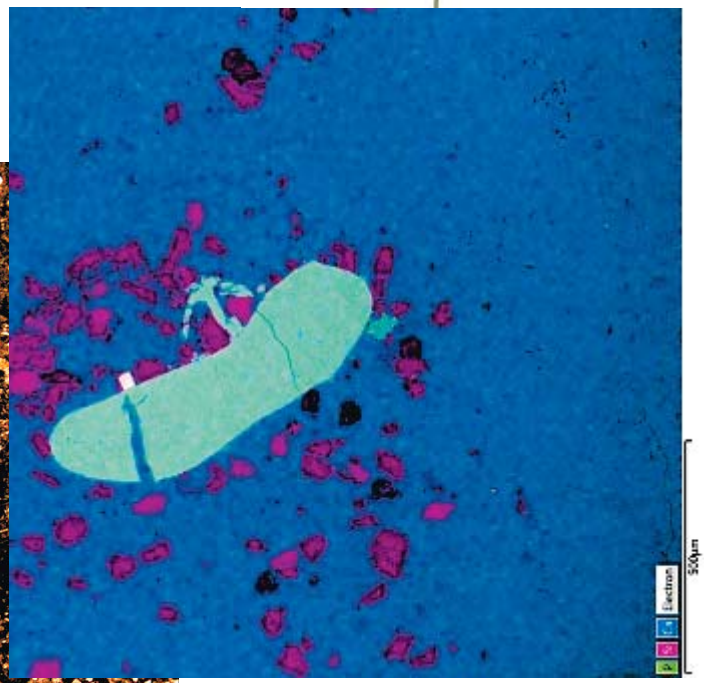


Sappington - Lodgepole contact

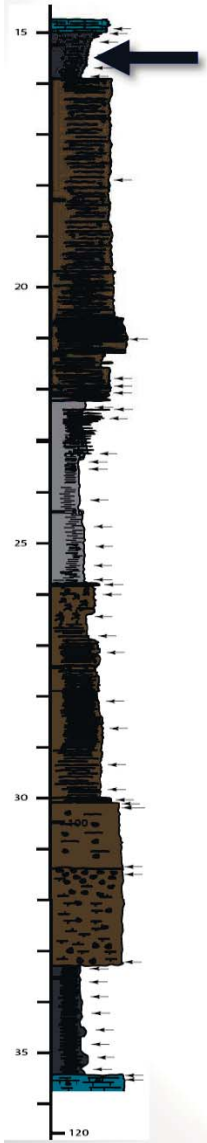


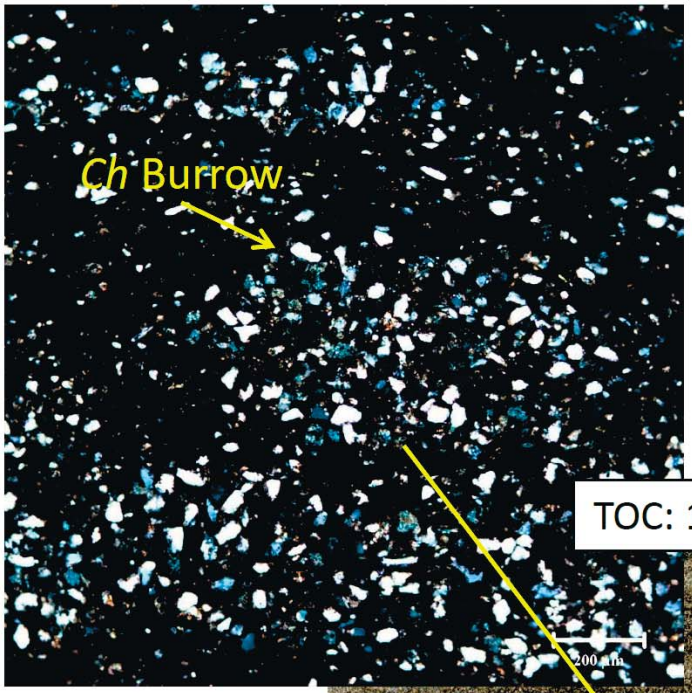


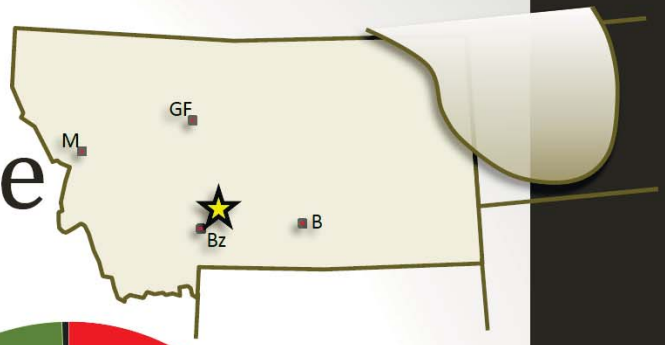


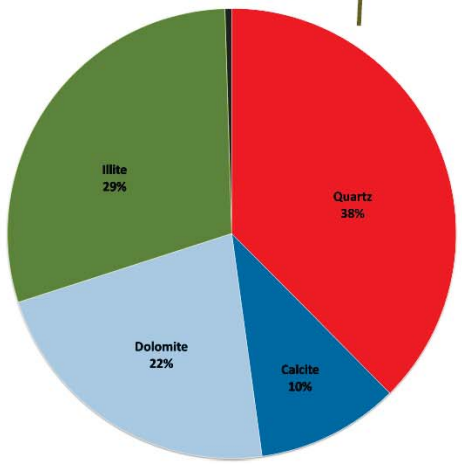


Bioturbated silty mudstone









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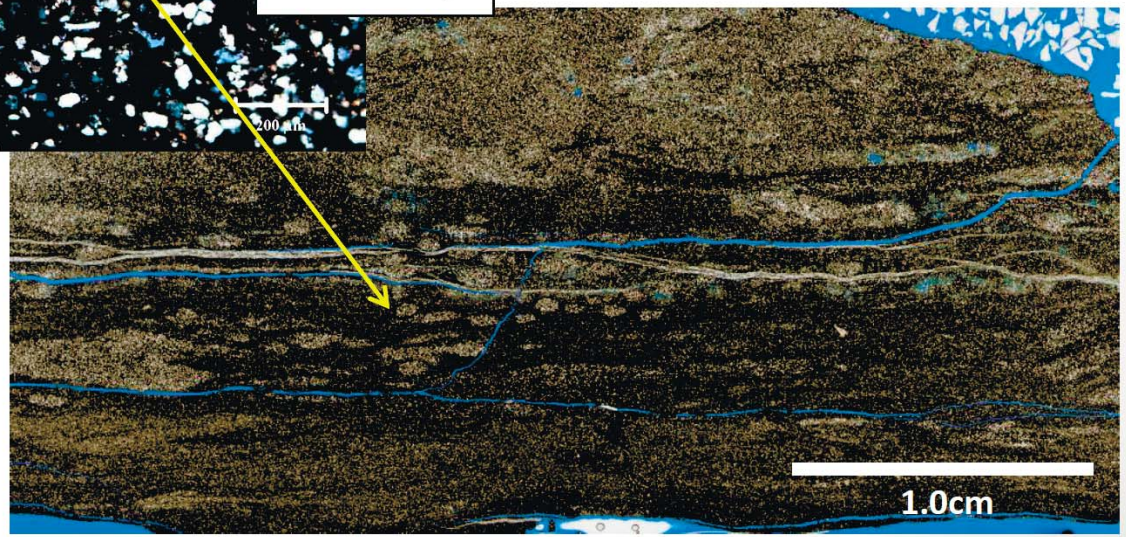
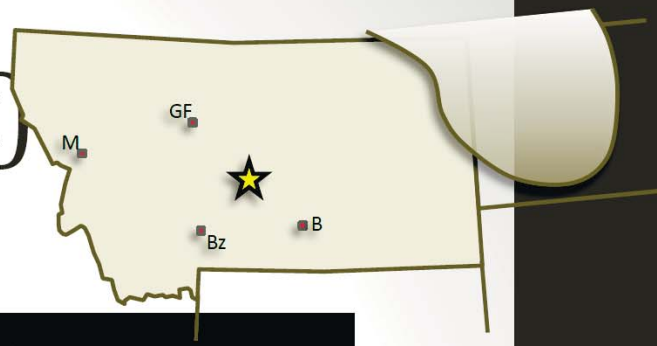


Facies has potential for inter-particle porosity in coarse silt facies

Upper Shale (basal contact) Big Snowy Mtn.



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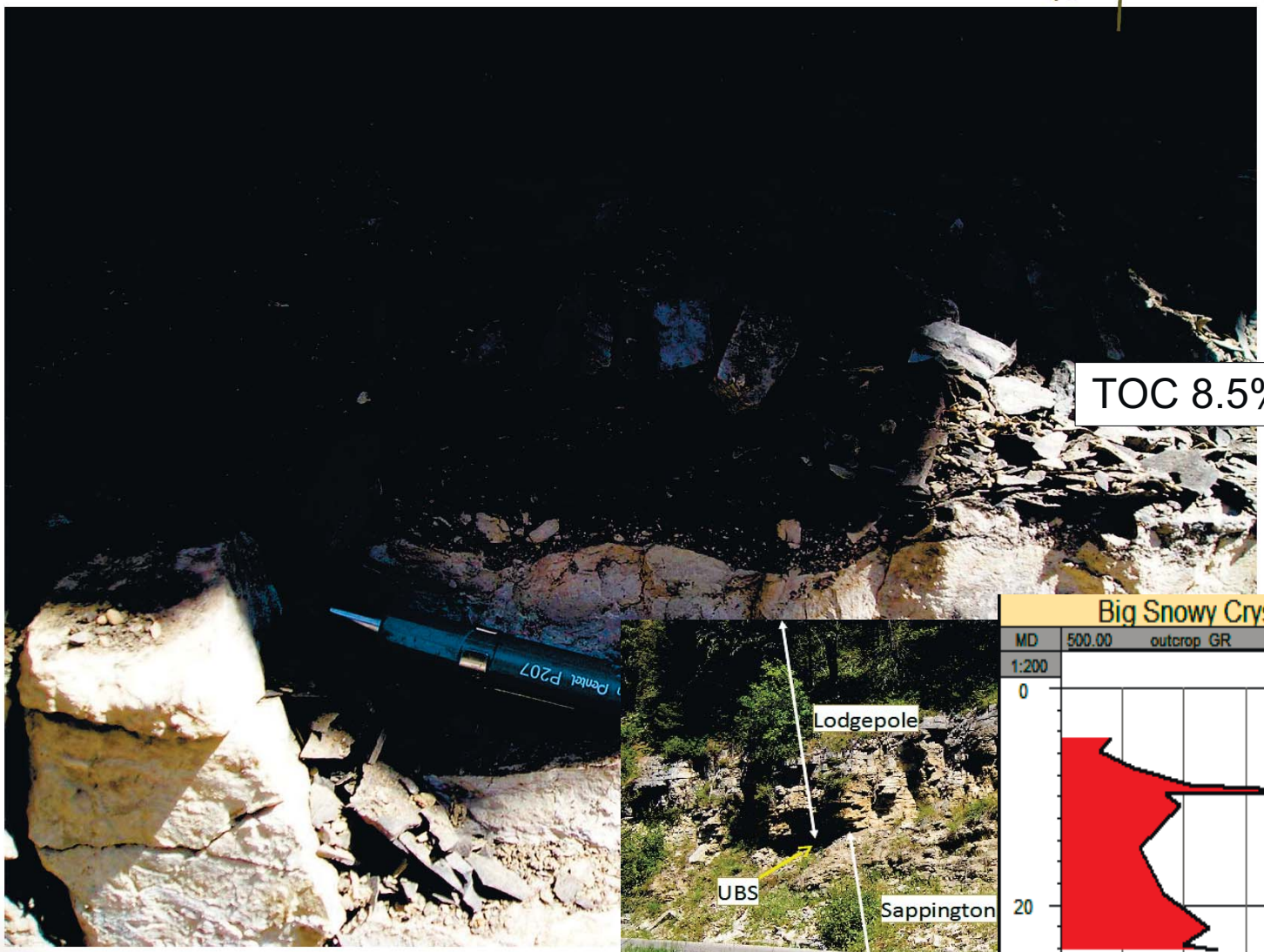
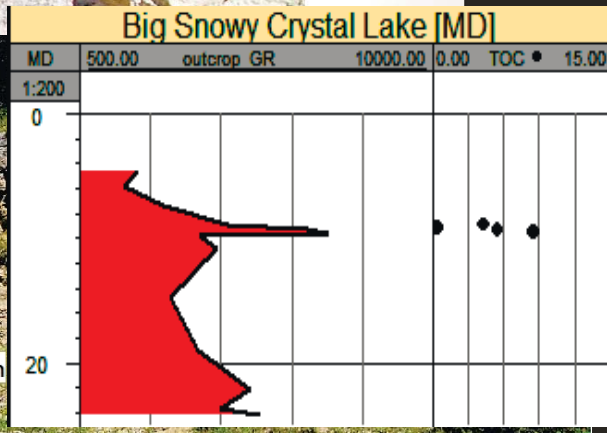
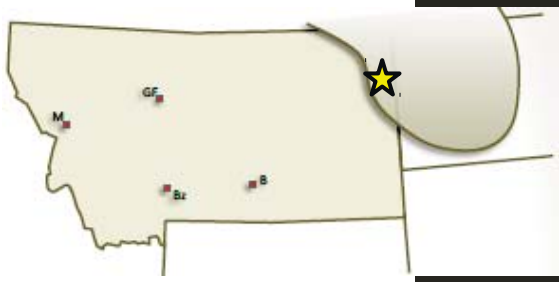
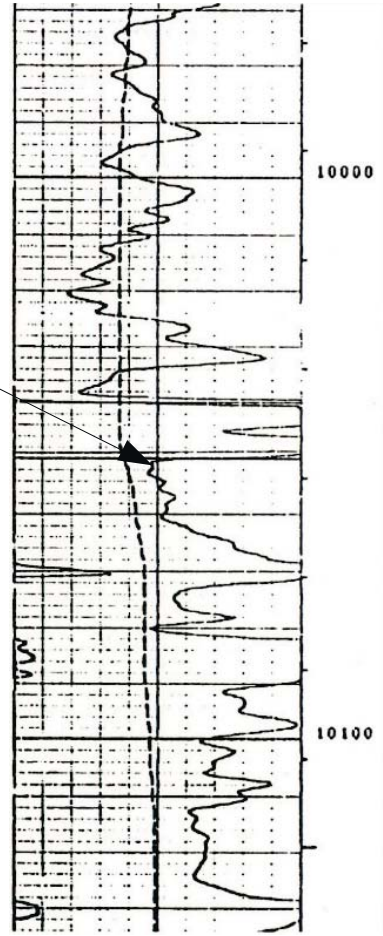


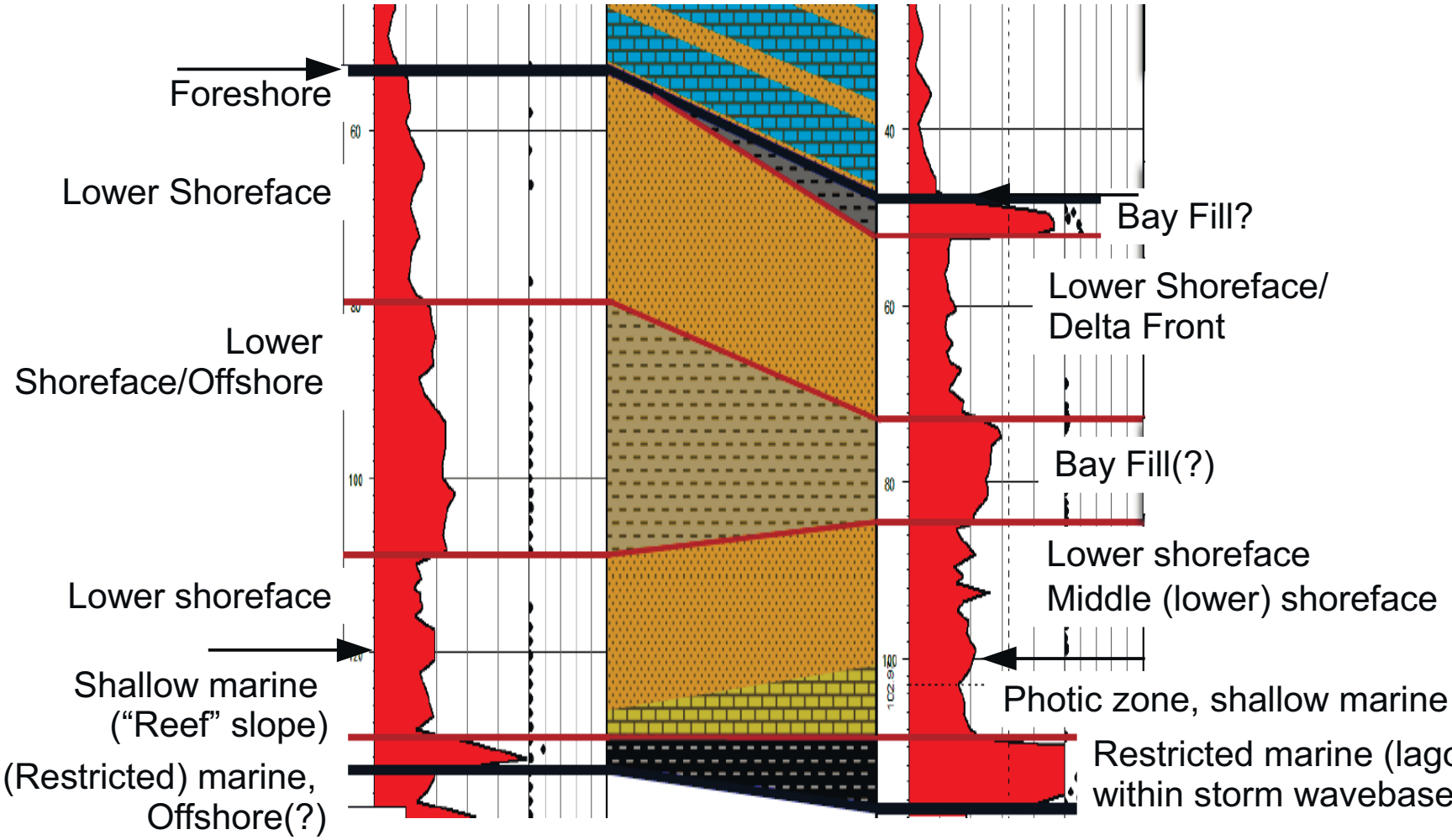


Upper Shale (basal contact) western basin (Williams 1-4)

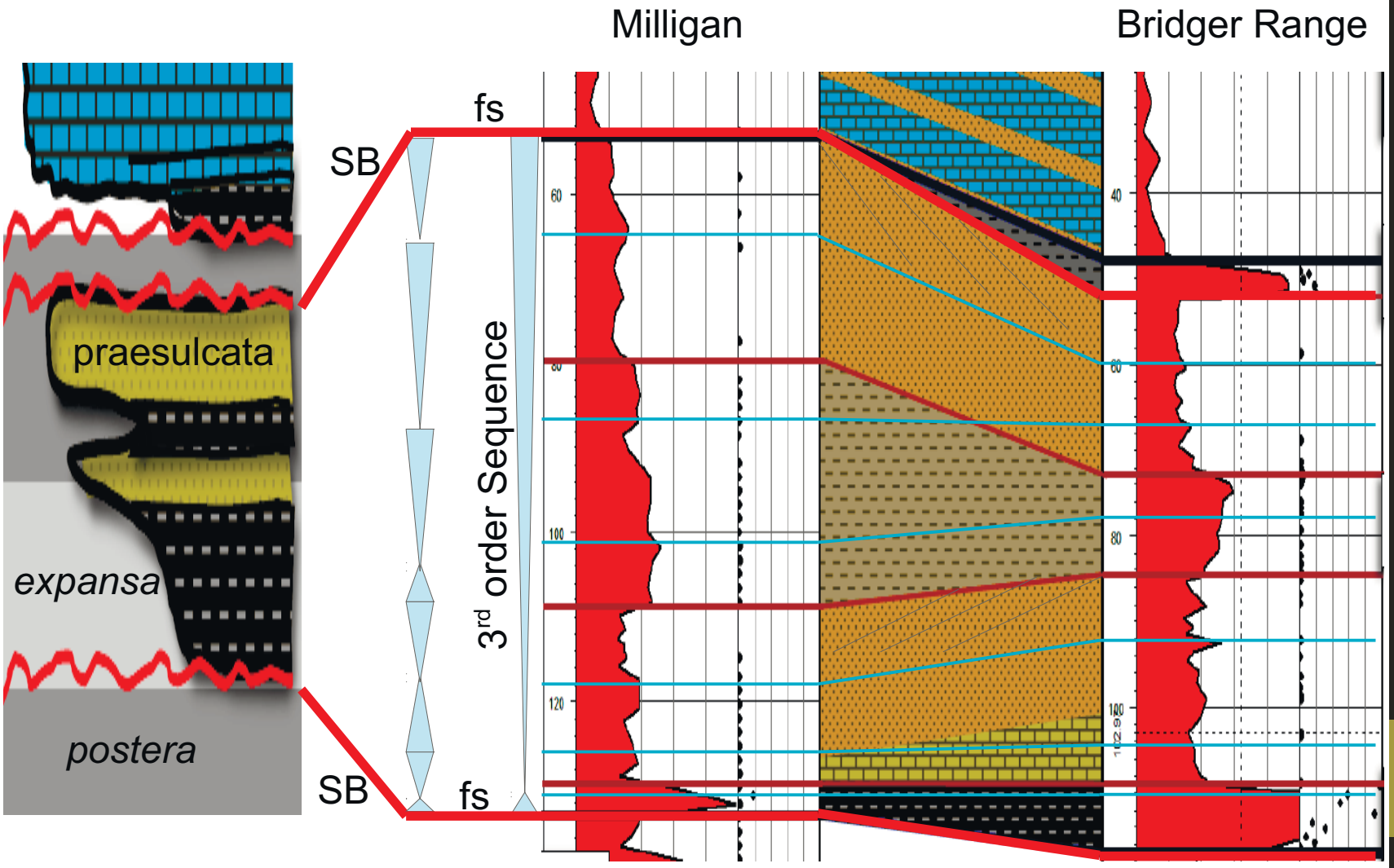




Facies Summary



Depositional Cycles




Thanks!