New Hydrocarbon Opportunities in Upper Cretaceous Strata of Eagle Plain Basin, Northern Yukon Territory*

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Abstract

Eagle Plain Basin is a relatively unexplored sedimentary basin with recognized hydrocarbon potential located in northern Yukon Territory. The Cretaceous succession contains estimated resources of 108 MMbbls of crude oil and 350 Bcf of natural gas (Osadetz et al., 2005); with the Cretaceous section commonly considered a secondary target to Upper Paleozoic strata. Of 35 wells drilled in the basin, 32 were drilled prior to 1978; these are mainly concentrated in south-east Eagle Plain where access is easiest and the most significant hydrocarbon shows have been targeted in Laramide-related anticline and fault traps.

The Cenomanian Parkin Formation consists of a basal transgressive pebbly sandstone member with high-quality reservoir characteristics and an overlying shale member. The Parkin shale member is overlain by cycles of deltaic sandstones of the Fishing Branch Formation which have tested significant volumes of gas, with rates up to 3,300 mcf/day. Recent field work discovered large outcrops within the western part of the Eagle Plain Basin of large scale convoluted interbedded sandstone and shales, with deformation involving an up to 100m section of strata of the Parkin shale member. These are interpreted as mass-transport deposits, and indicate the presence of a shelf-slope break in the Cenomanian basin with relief of at least 100m. This adds a new degree of complexity to previous interpretation of low-angle ramp style basin morphology (Dixon, 1992).

Recognition of a shelf-slope break with sand-rich slump deposits could have profound implications for hydrocarbon potential of the Parkin and Fishing Branch sandstones, opening the door for a variety of new large play opportunities, e.g., shelf-margin delta and turbidite fan sandstones. Such plays are host to very large gas accumulation within world-class basins. The gas charged Chinkeh sandstone of the Liard Basin in British Columbia could also provide an analogue for the basal Parkin sandstone. Thick units of known

and potential source rock are identified in Eagle Plain Basin and the presence of migration pathways is evident from previous exploration; thus, timing is the key for hydrocarbon accumulation. Petroleum systems in the basin are the subject of an ongoing study incorporating outcrop, well logs, and core, supplemented by reprocessed seismic data optimized for shallower intervals of the basin.

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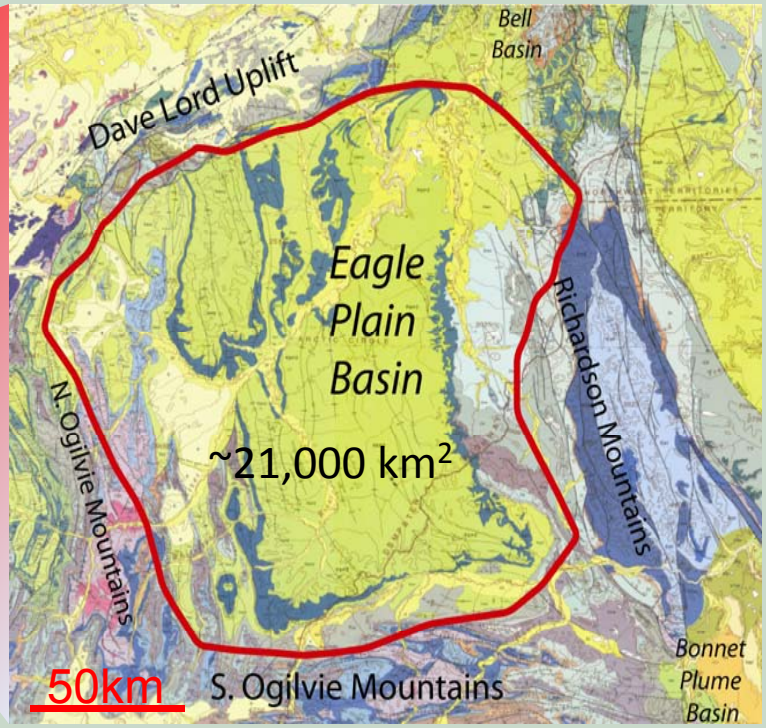
New Hydrocarbon Opportunities in Upper Cretaceous Strata of Eagle Plain Basin, Northern Yukon Territory

Kevin Jackson, Per Kent Pedersen (U of Calgary)
and Larry S. Lane (GSC)

Objectives

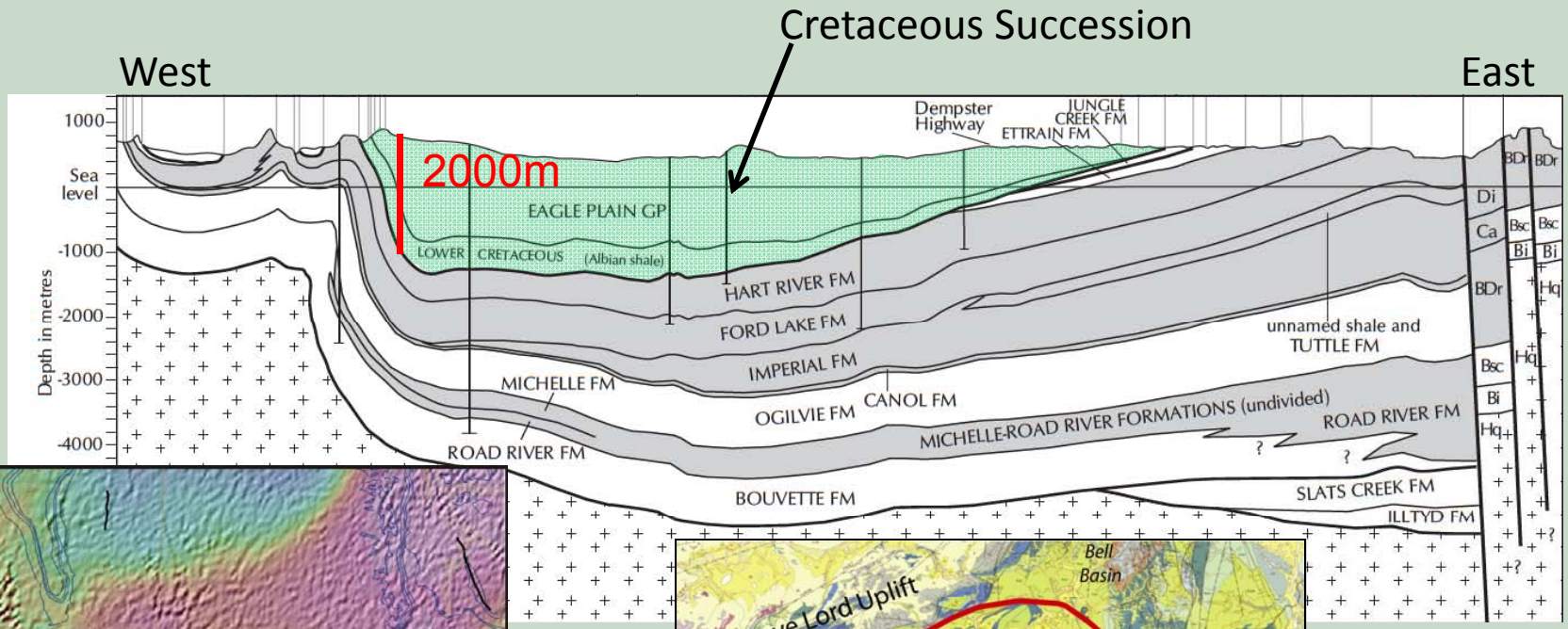
- Introduction to Eagle Plain Basin
- Geologic Setting and Depositional Model
- Petroleum Systems
- Stratigraphy and Reservoir Facies
- Conceptual Play Opportunities
- Implications for Hydrocarbon Assessment

Eagle Plain Basin, Yukon Territory

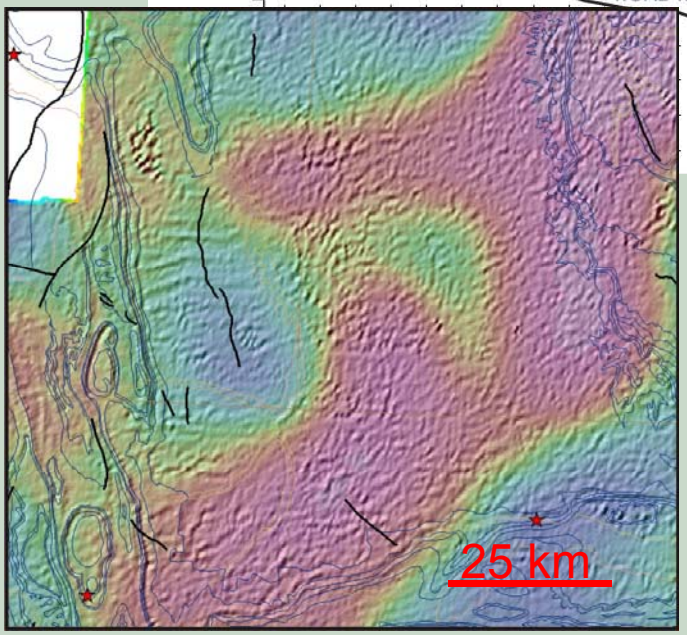


(Norris, 1984)

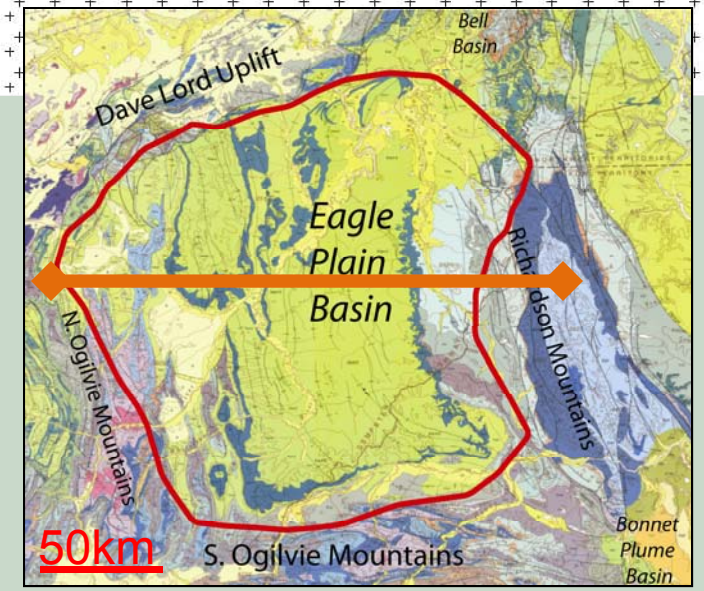
Eagle Plain Basin, Yukon Territory



(Osadetz et al., 2005)

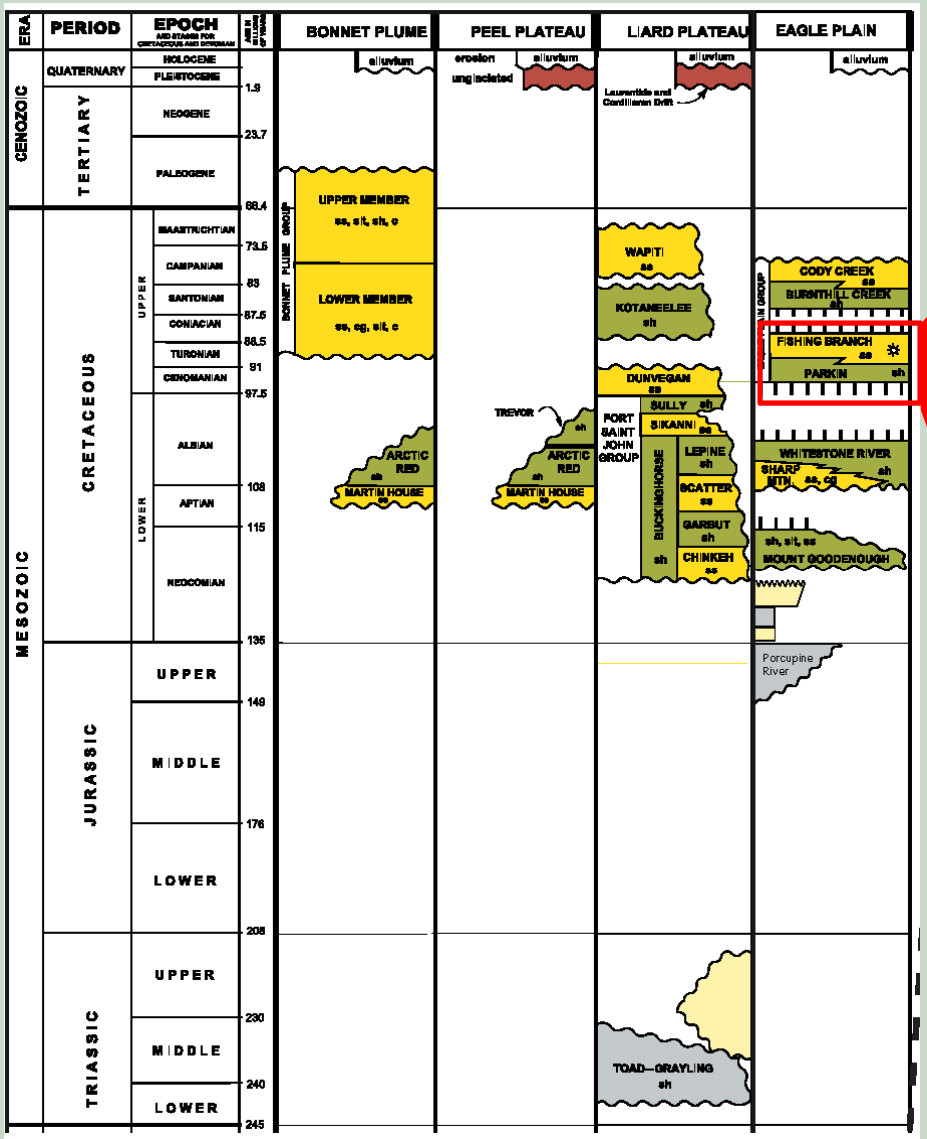


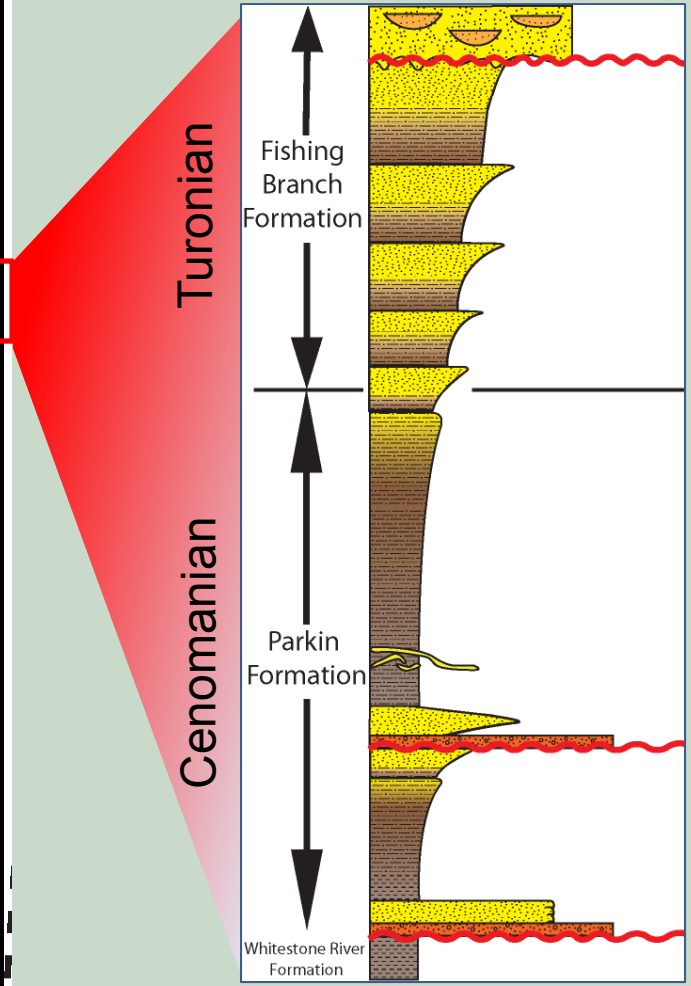
Aeromag (Nicholas Pinet, pers. comm. 2010)



(Norris, 1984)

Upper Cretaceous Stratigraphy

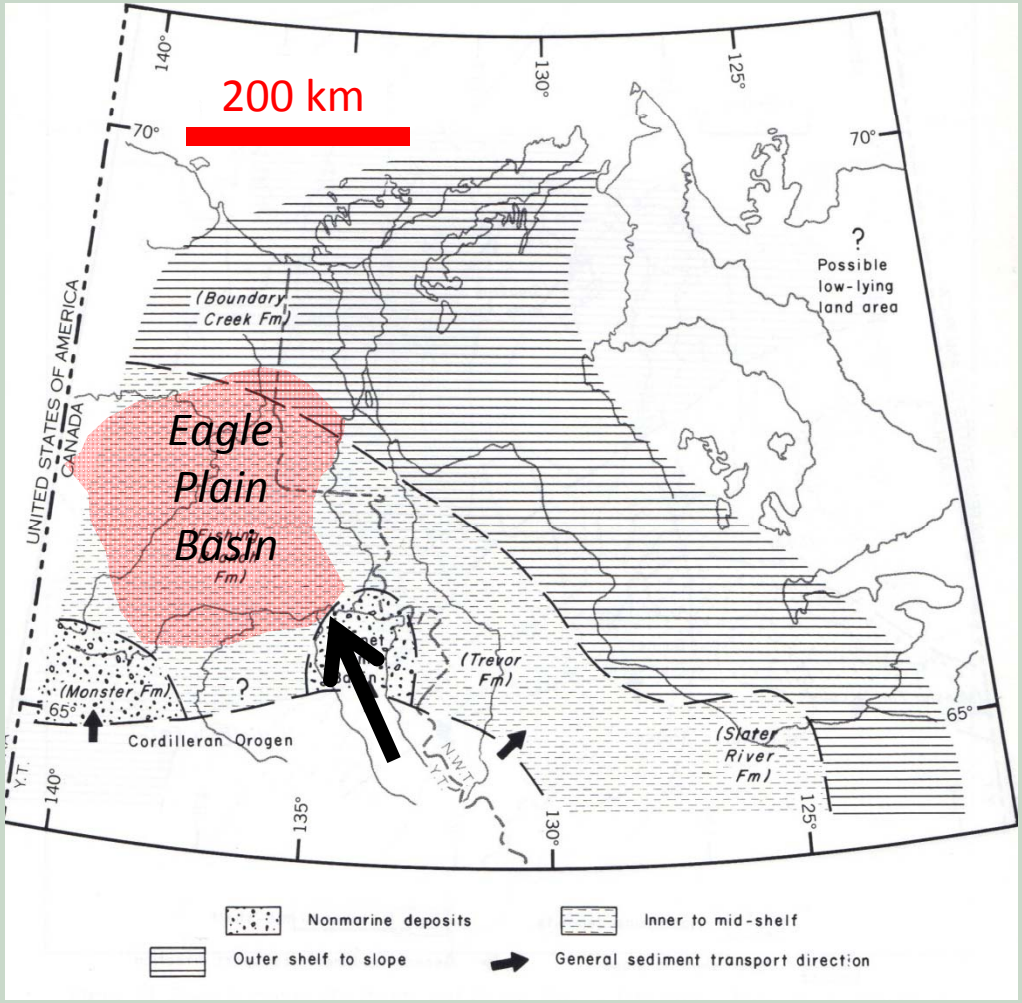




(Osadetz et al., 2005)

Geologic Setting

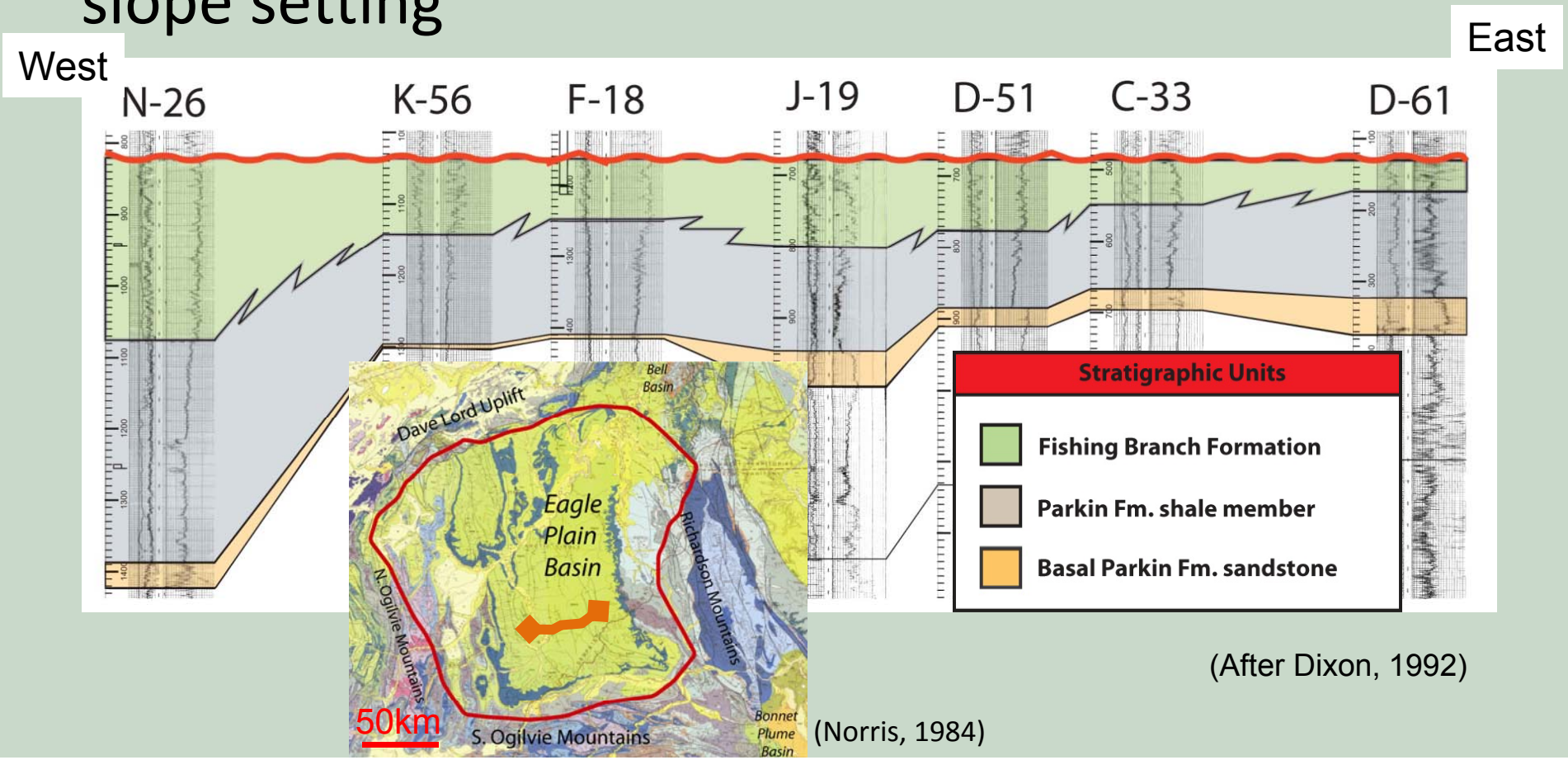
- Located at northern terminus of Canadian Foreland Basin during Cretaceous



Turonian paleogeography (Dixon, 1992)

Depositional Model

- Previous model based on lithostratigraphic correlations, interpreted as low-angle ramp-style slope setting



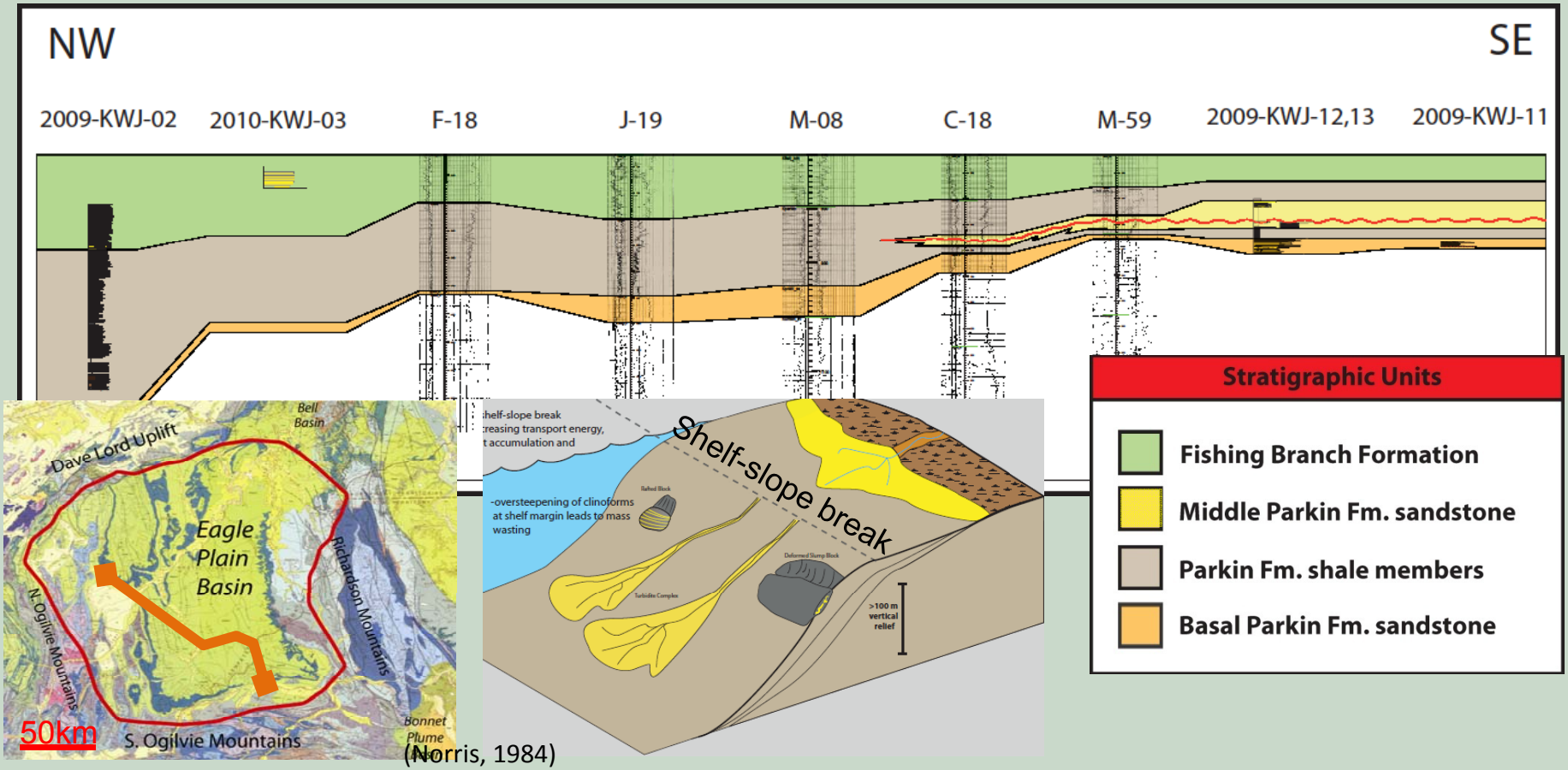
(After Dixon, 1992)

(Norris, 1984)

Depositional Model

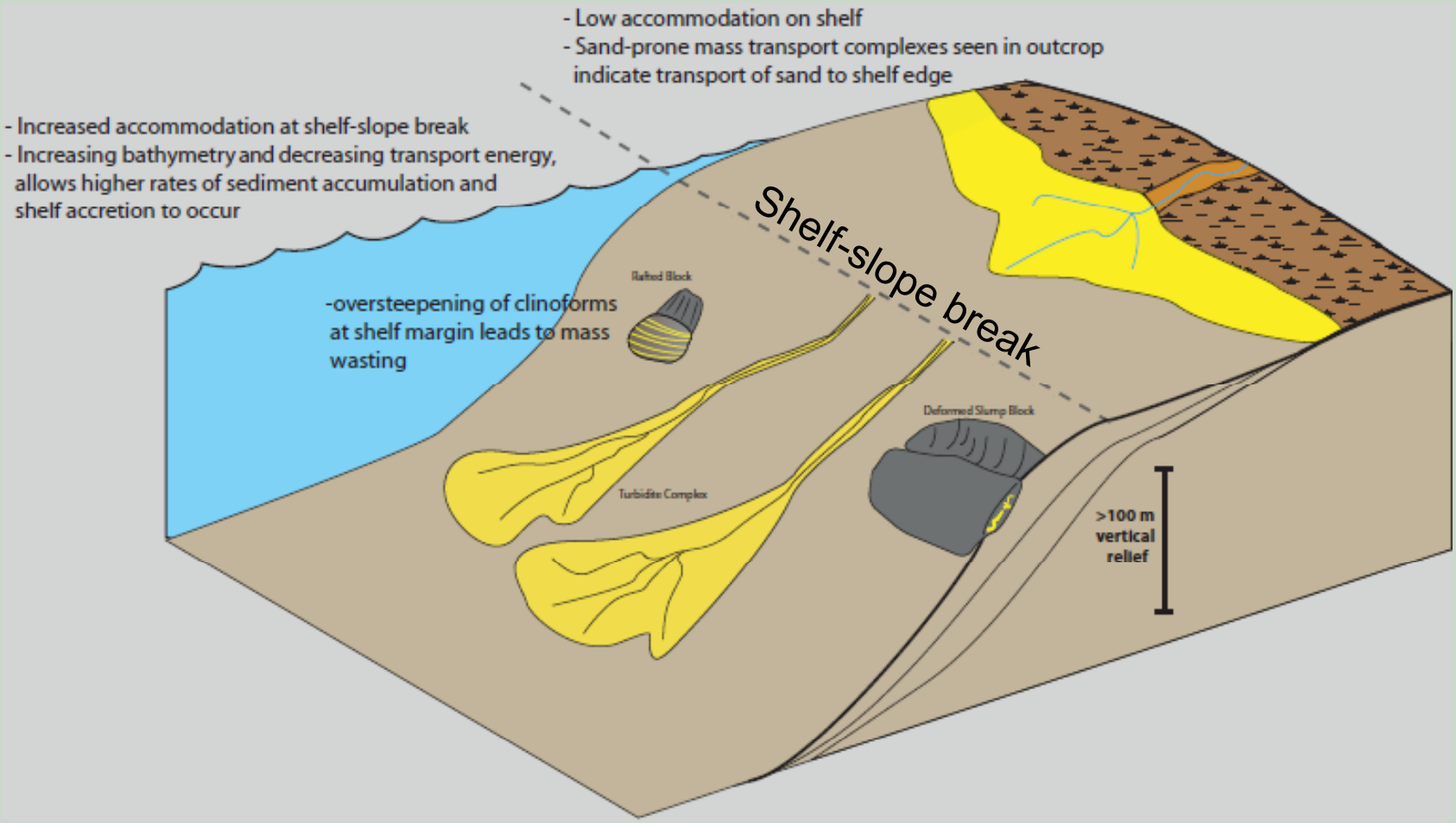
- Current research indicates a significant shelf-slope break in the Cretaceous Eagle Plain Basin

New sequence stratigraphic model:

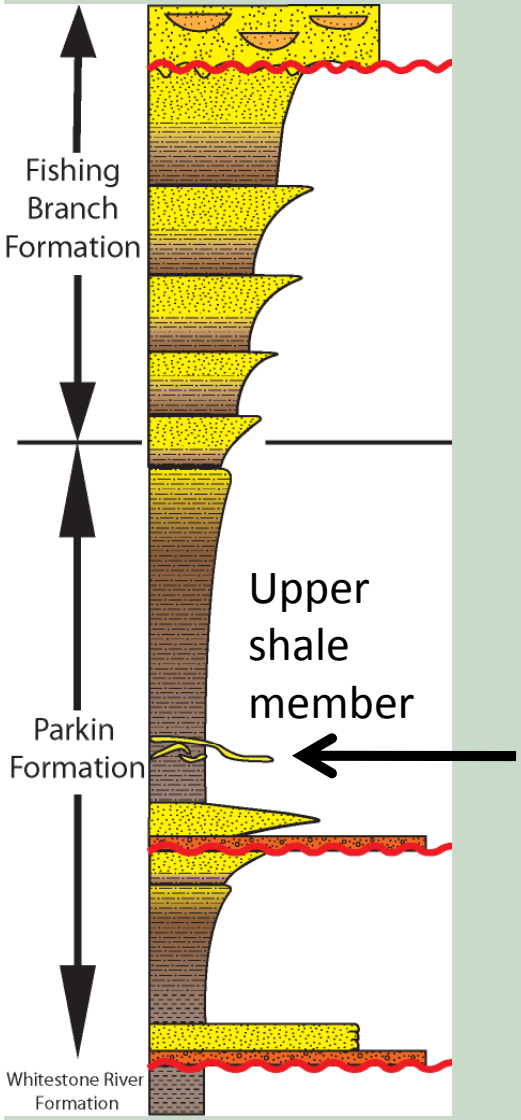


(Norris, 1984)

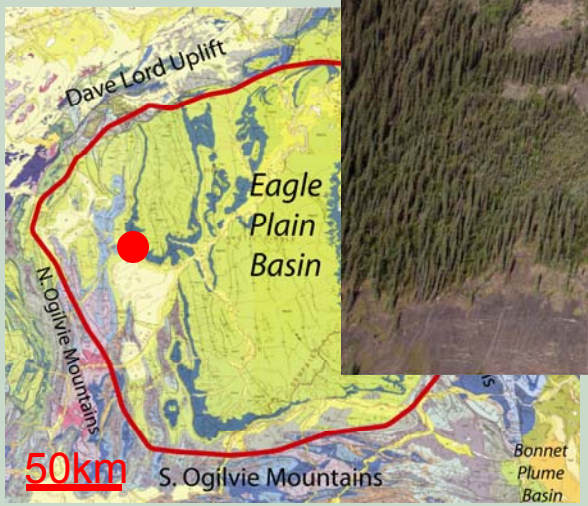
Large-Scale Mass Transport

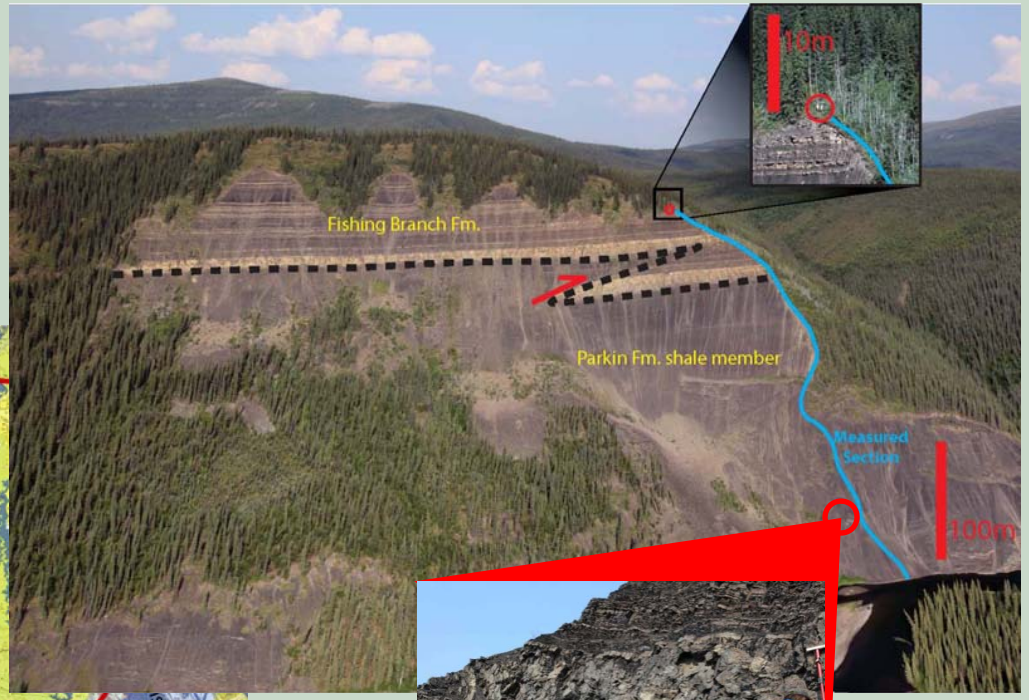


Large-Scale Mass Transport



- Large slump blocks of shales and fine-grained sandstones within the upper shale member of the Parkin Formation in western Eagle Plain

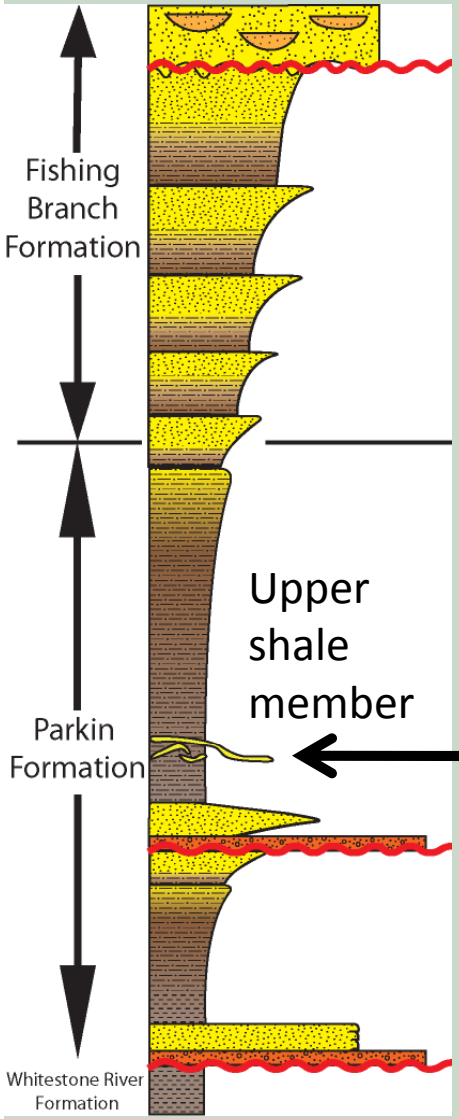


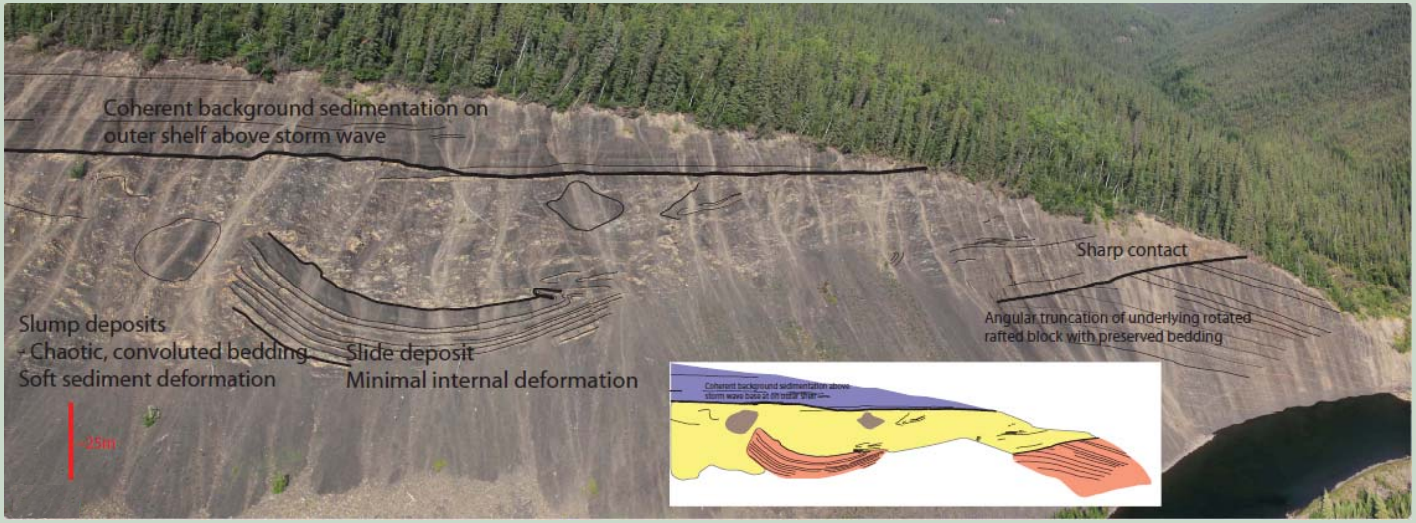


Slumped block

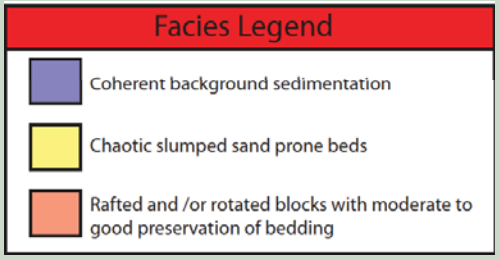
(Norris, 1984)

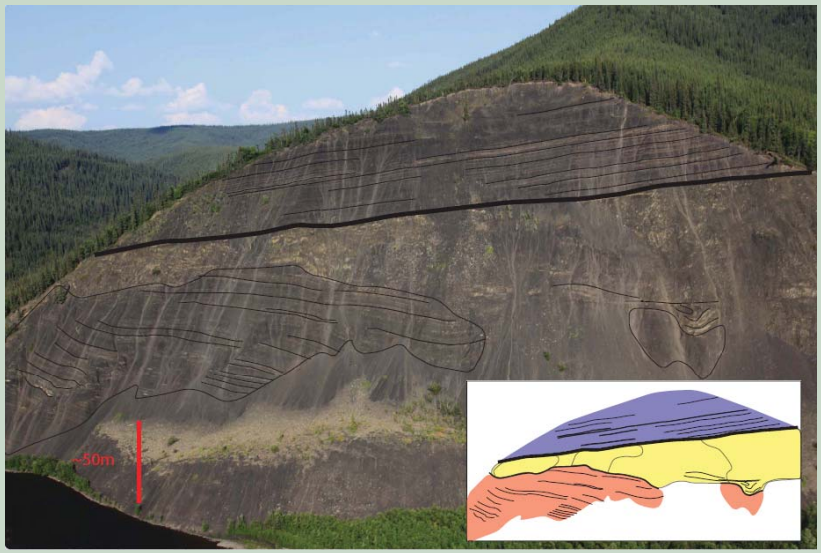
Large-Scale Mass Transport



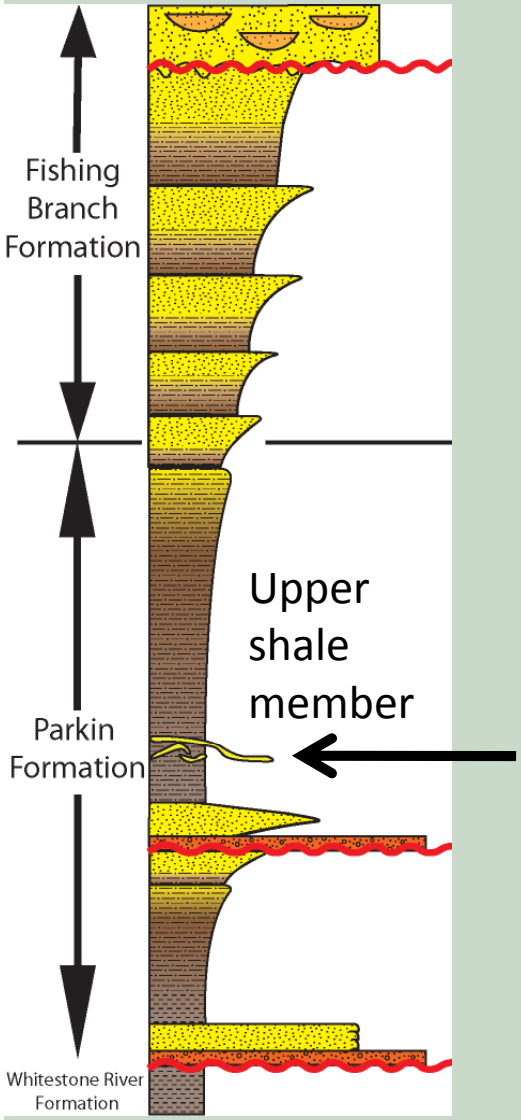


Sand-prone slump and slide deposits (>100m) in outcrop



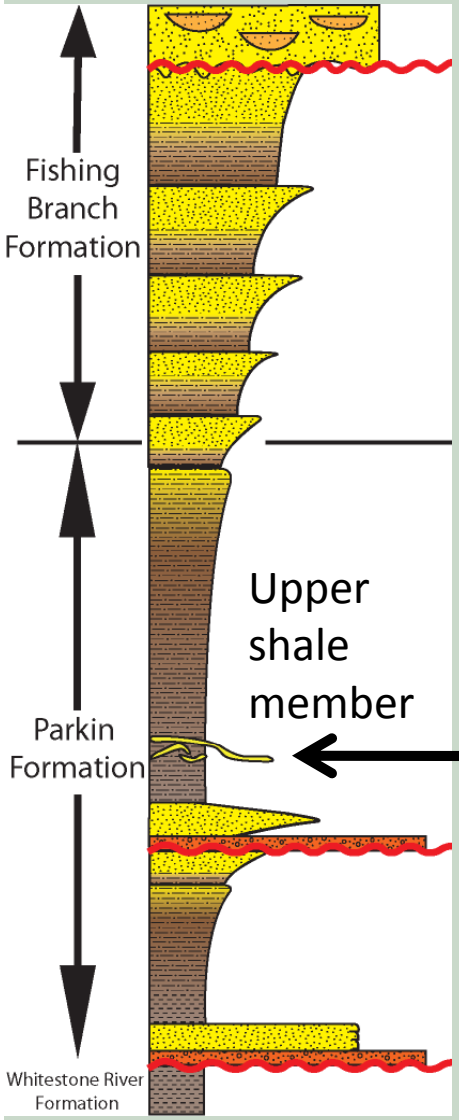


Large-Scale Mass Transport



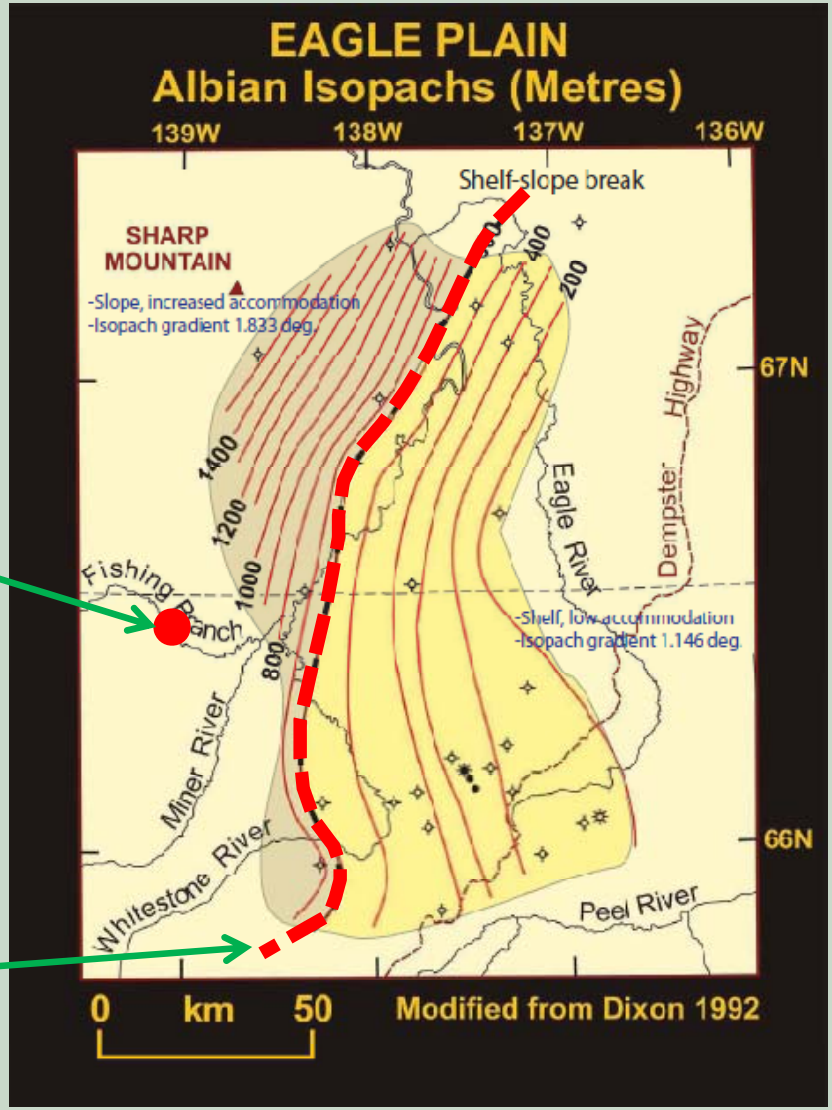
Chaotic bedding in slump deposits with storm-generated bedforms

Shelf-Slope Break

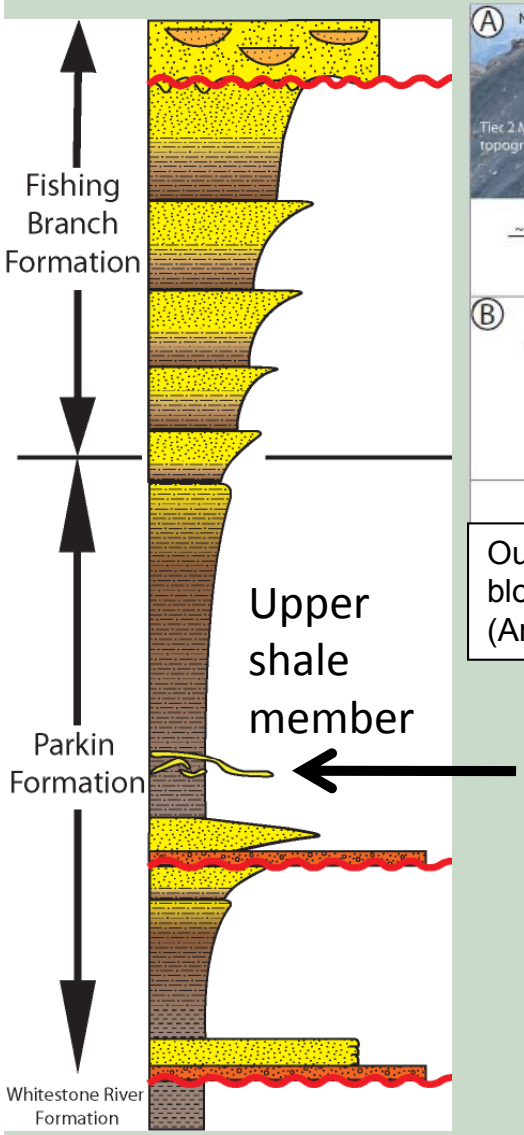


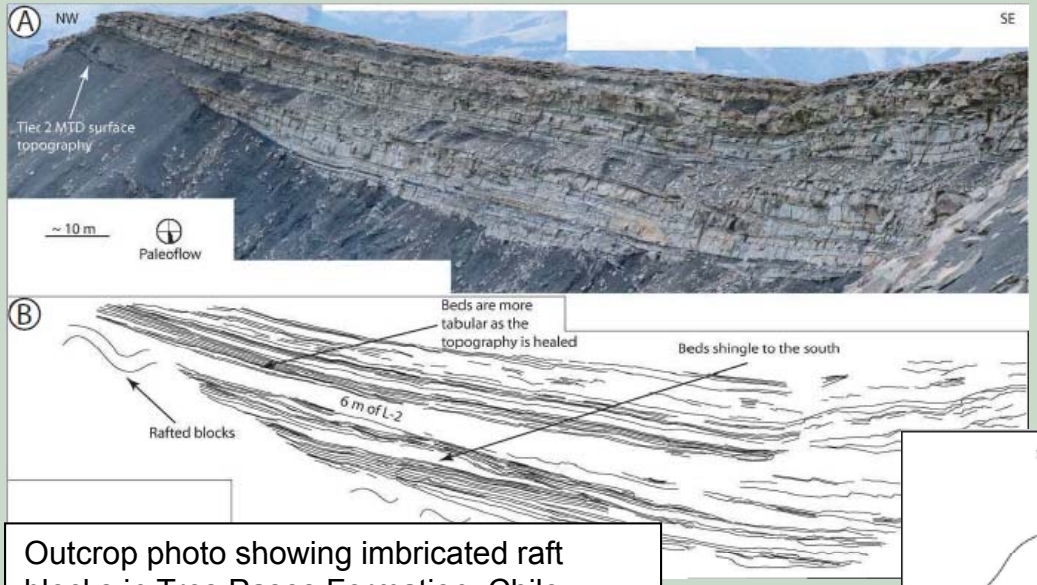
Mass transport deposits in outcrop

Interpreted shelf-slope break

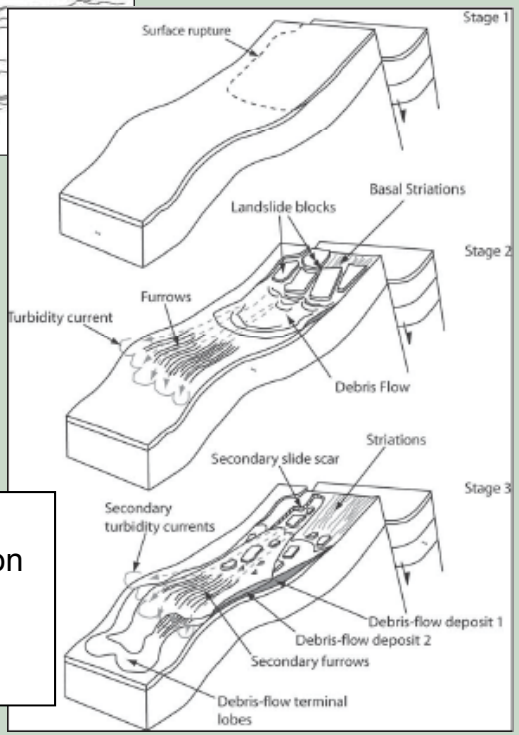


Analog Slope Systems



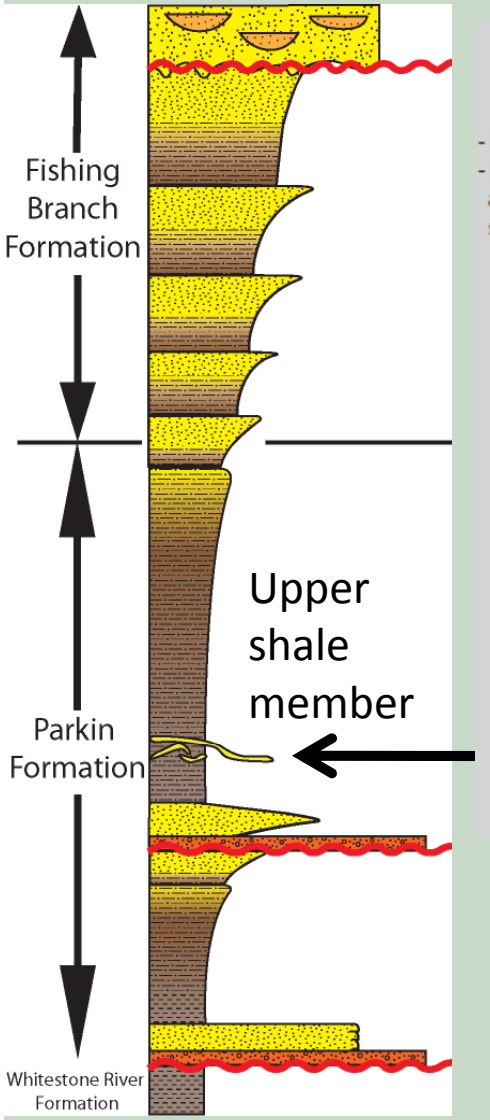


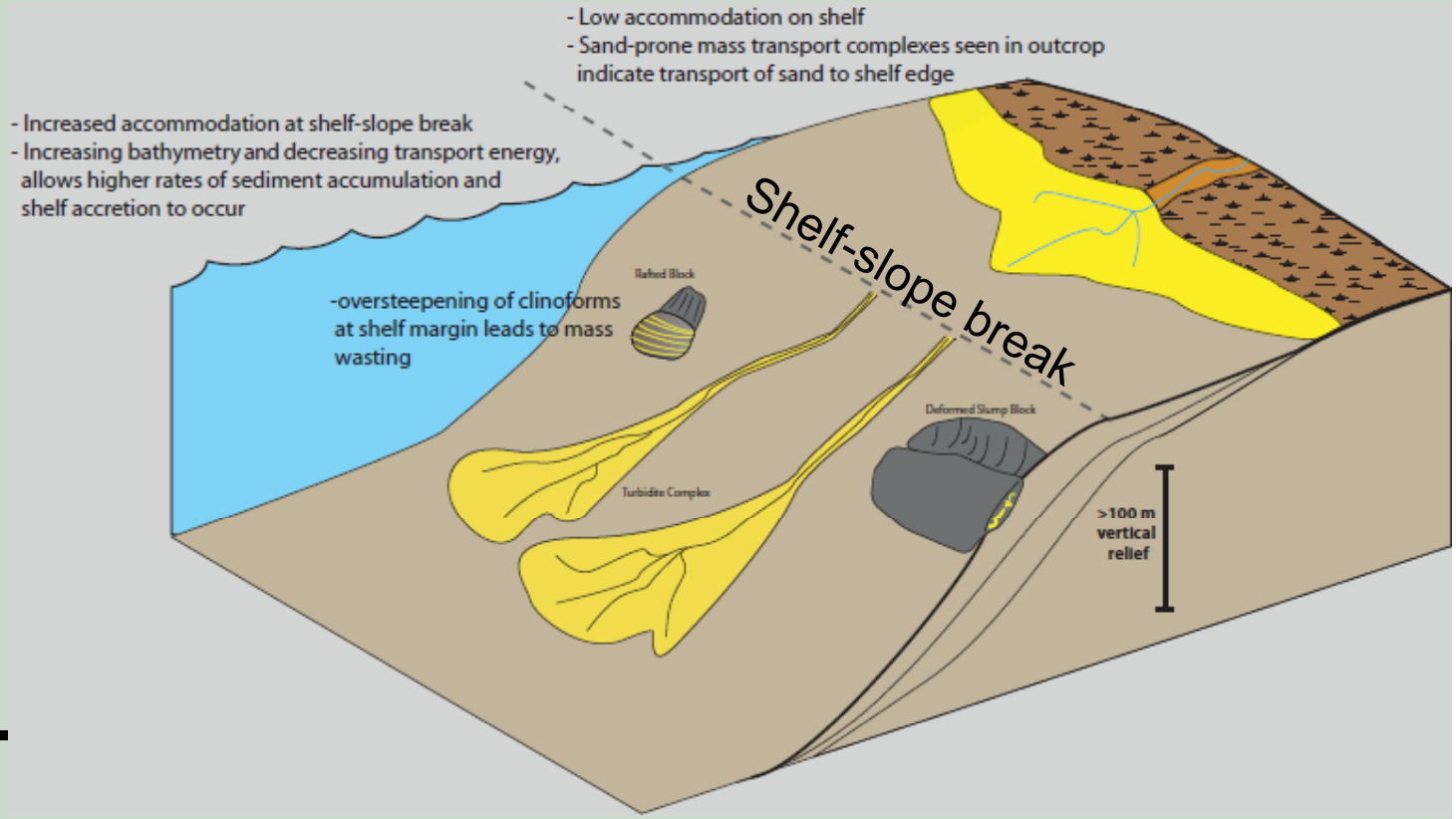
Outcrop photo showing imbricated raft blocks in Tres Pasos Formation, Chile (Armitage et al., 2009)



Proposed mechanisms for submarine mass transport based on seismic data from Miocene shelf-slope deposits, offshore Angola (Gee et al., 2006).

Large-Scale Mass Transport

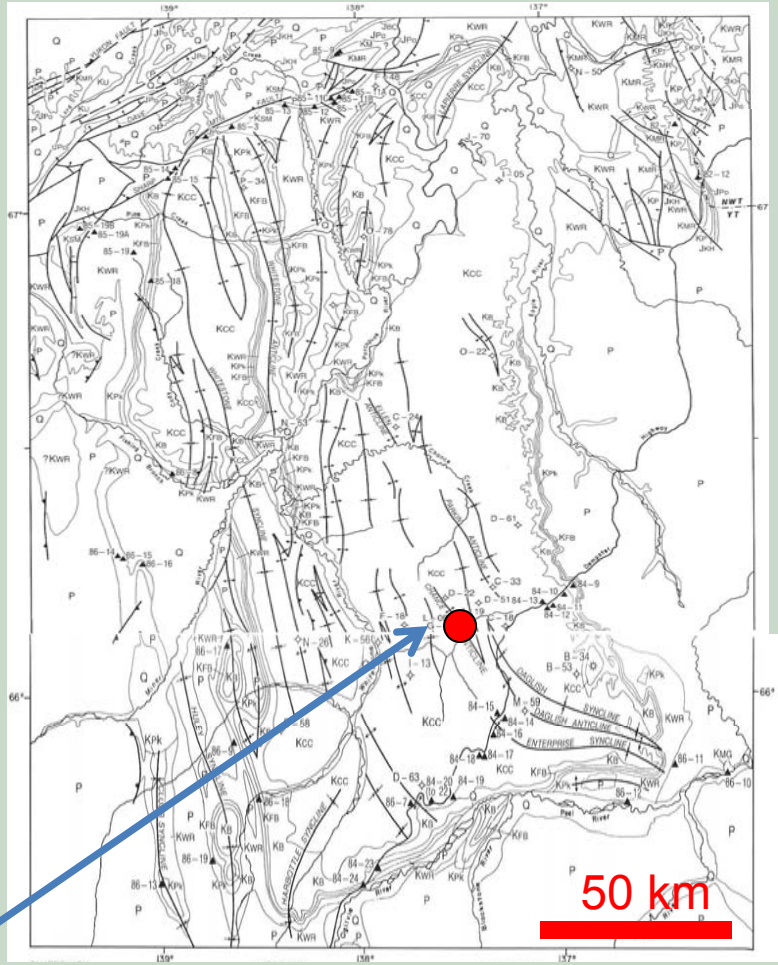




- Shelf-basin floor relief of >100m
- Sandy slump deposits at the at shelf edge

Cretaceous Petroleum Systems

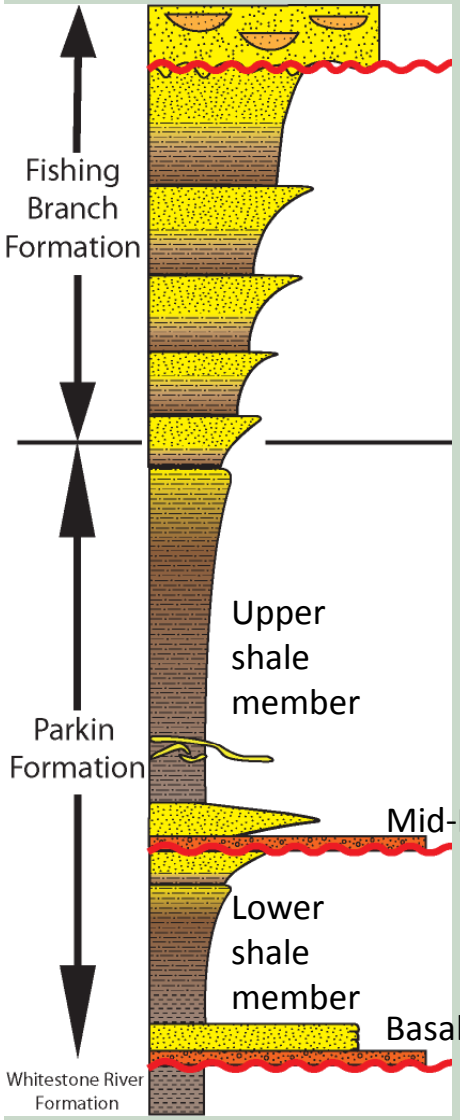
- 34 exploration wells drilled since 1957
- Primarily N-S oriented, Laramide-aged structural traps targeted for exploration
- Type II and III gas-prone source rocks
- Estimated 349 Bcf, 108 MMbls in Cretaceous (Osadetz, 2005)



Fishing Branch Fm. flowed 3,300 Mcf/day at Chance G-08 well

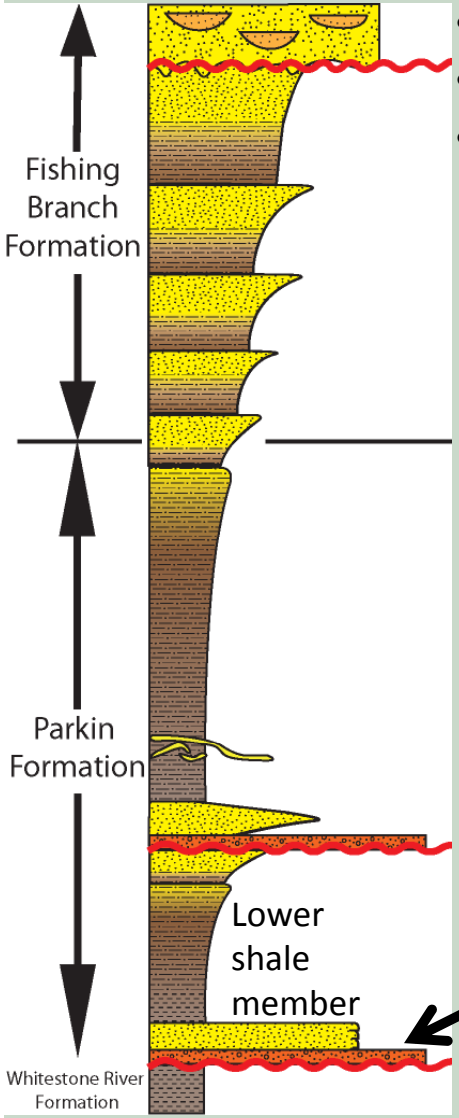
(Dixon, 1992)

Reservoir Units

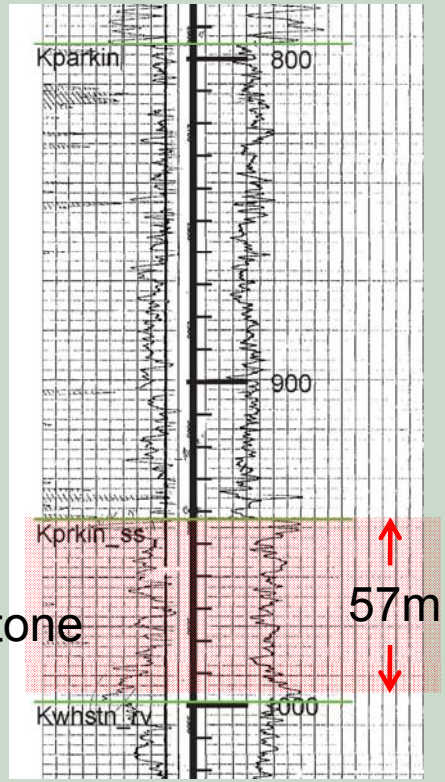


- Basal Parkin Fm. sandstone member
- Mid Parkin Fm. sandstone member
- Fishing Branch Fm. deltaic and fluvial sandstones

Basal Parkin Fm. sandstone member



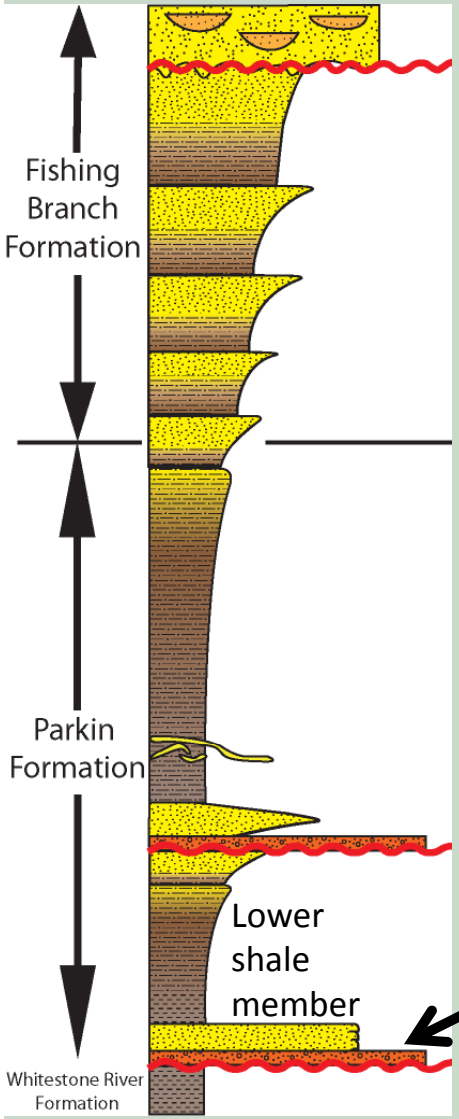
- Marine and non-marine transgressive unit overlying Lower Albian shale
- Variable thickness
- Overlain by lower shale member

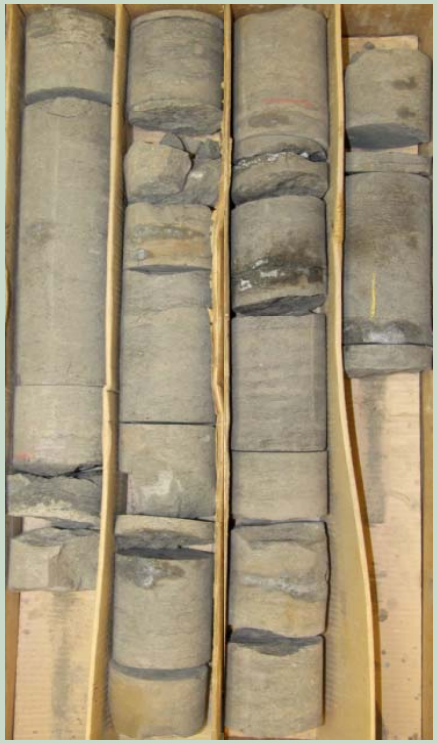


Basal
Parkin
Sandstone

Well M-08

Basal Parkin Fm. sandstone member



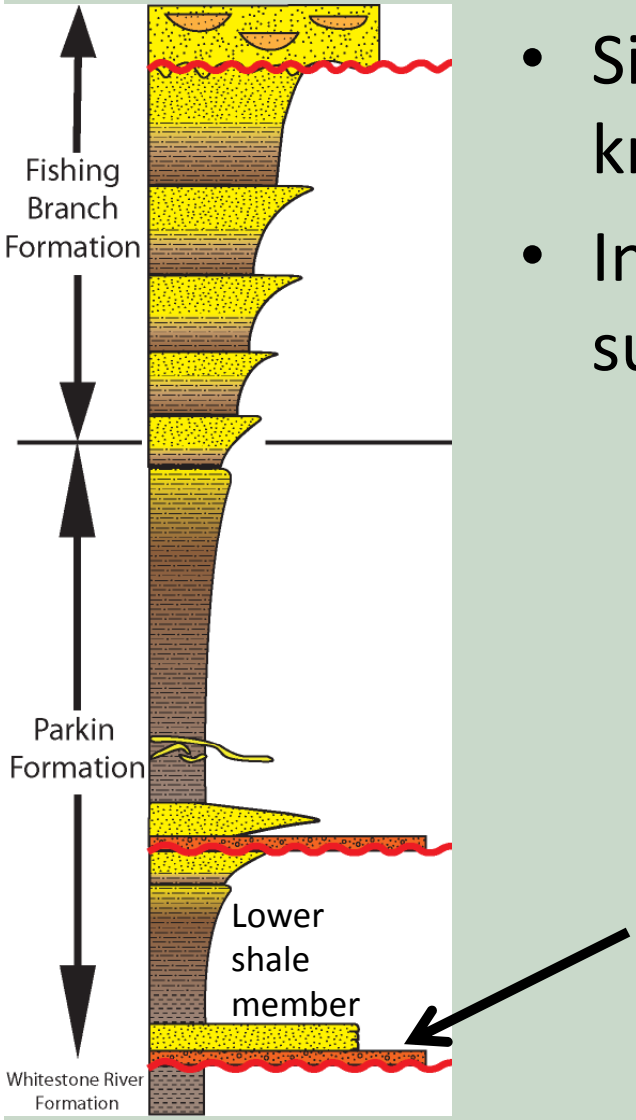


Basal
Parkin
Sandstone

Marine sandstone

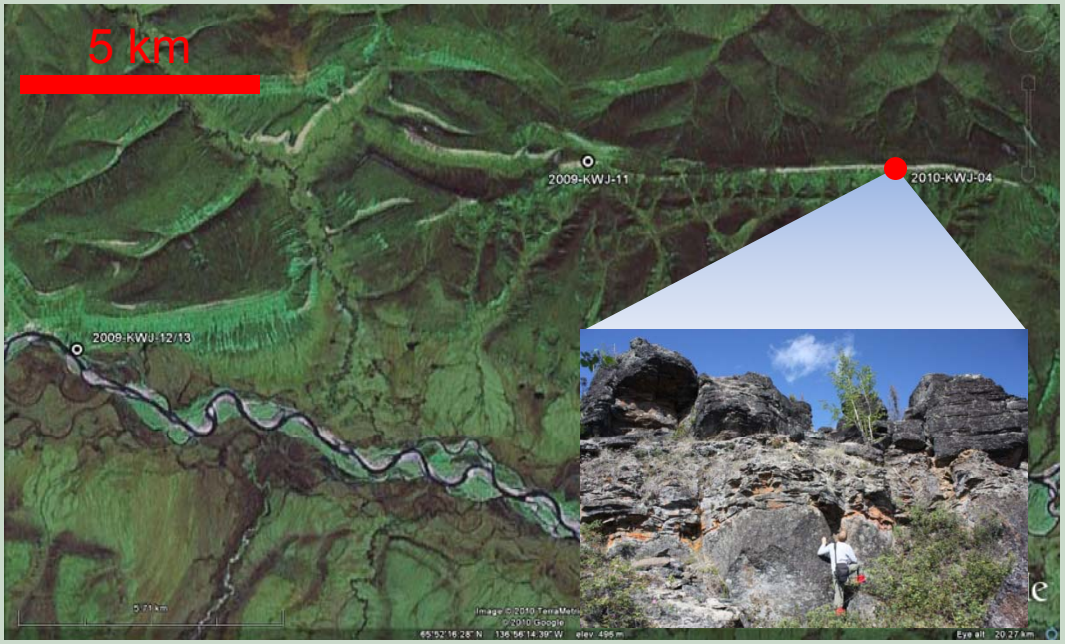
Fluvial conglomerate

Basal Parkin Fm. sandstone member

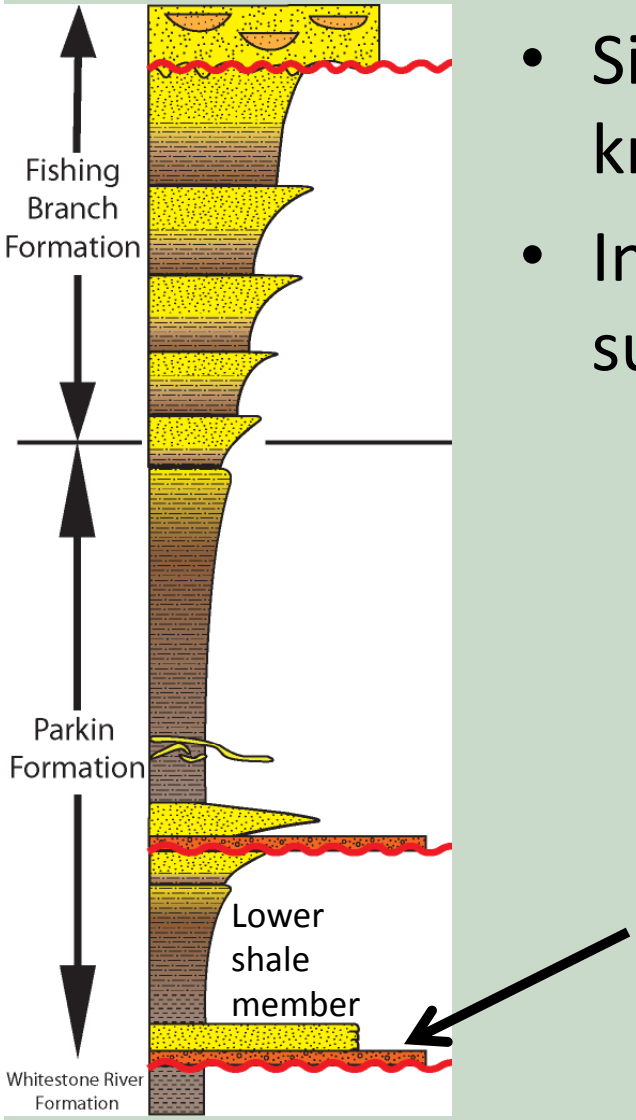


- Significant lateral facies transitions over km's
- Interbedded fluvial and marine deposits suggests stepwise transgression

Fluvial-dominated



Basal Parkin Fm. sandstone member



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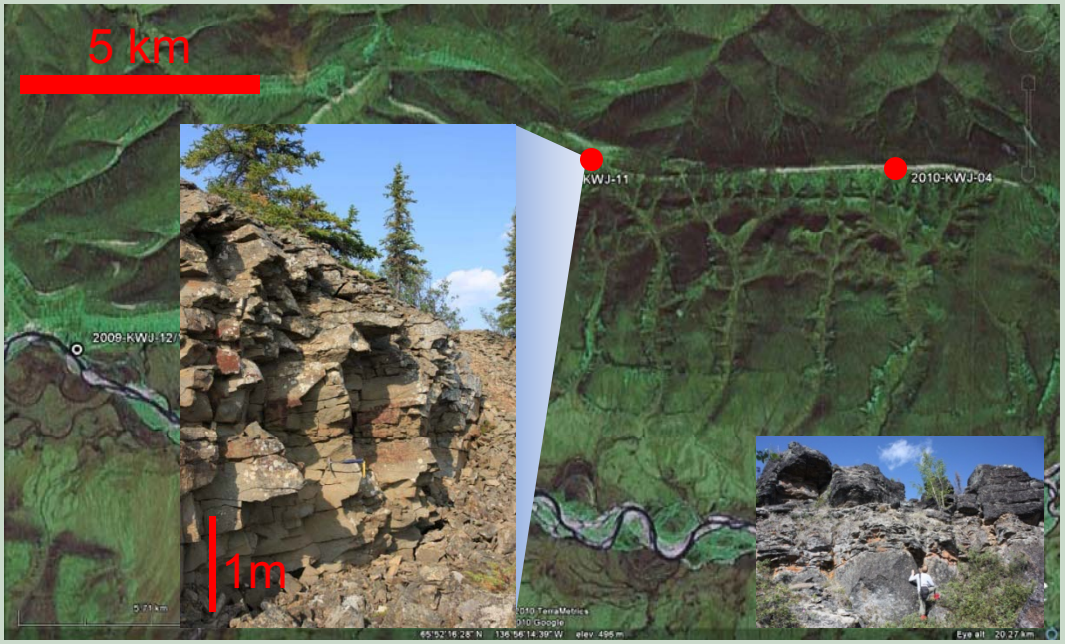
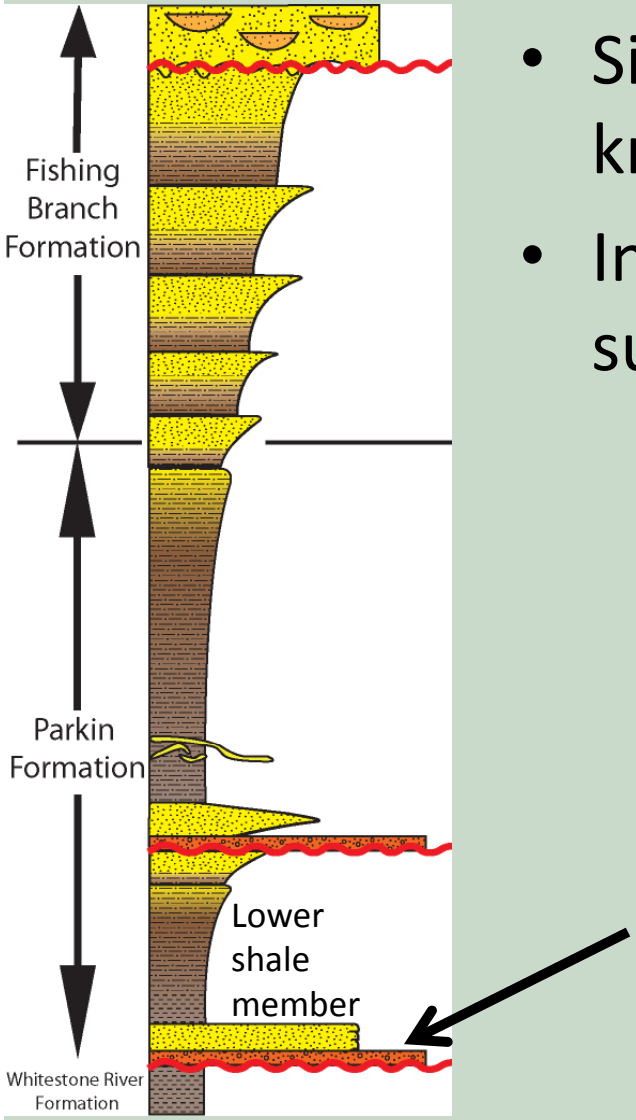
Marine and fluvial



Basal Parkin Fm. sandstone member



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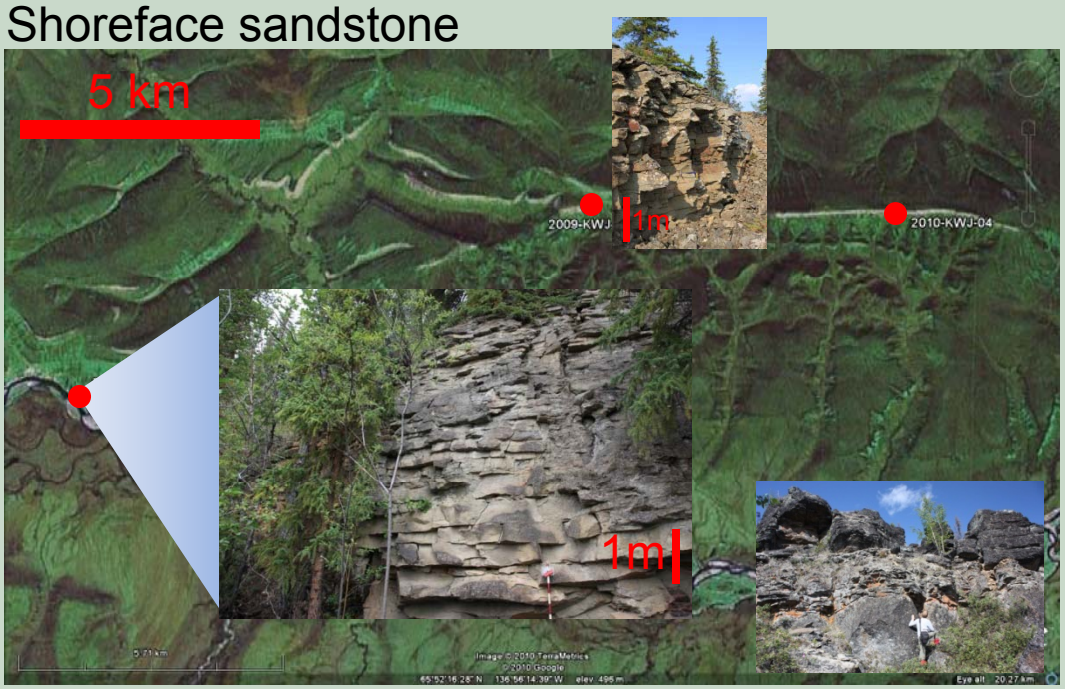
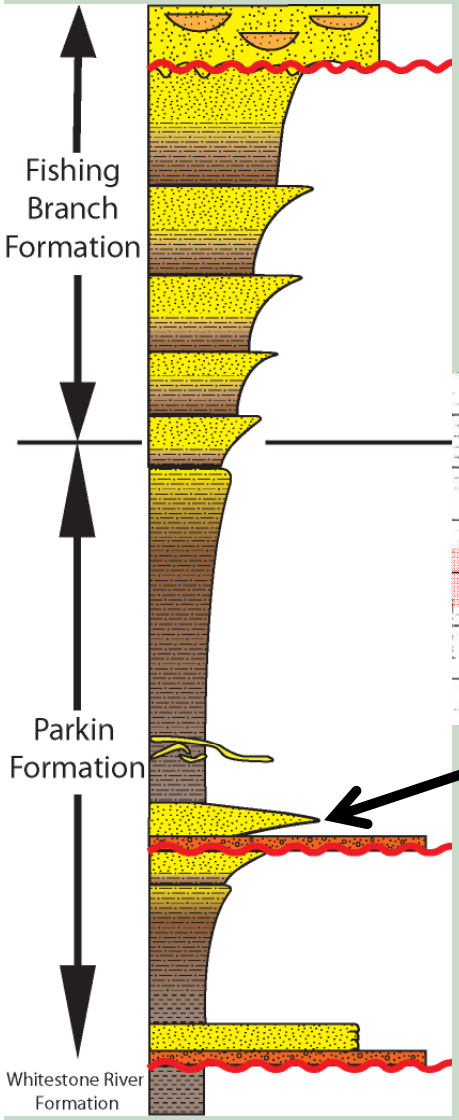
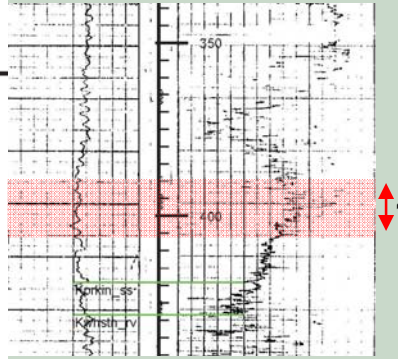


Mid Parkin Fm. sandstone member

- Marine sandstones with chert pebble lag above unconformity
- Previously undocumented depositional break in middle of Parkin Fm.

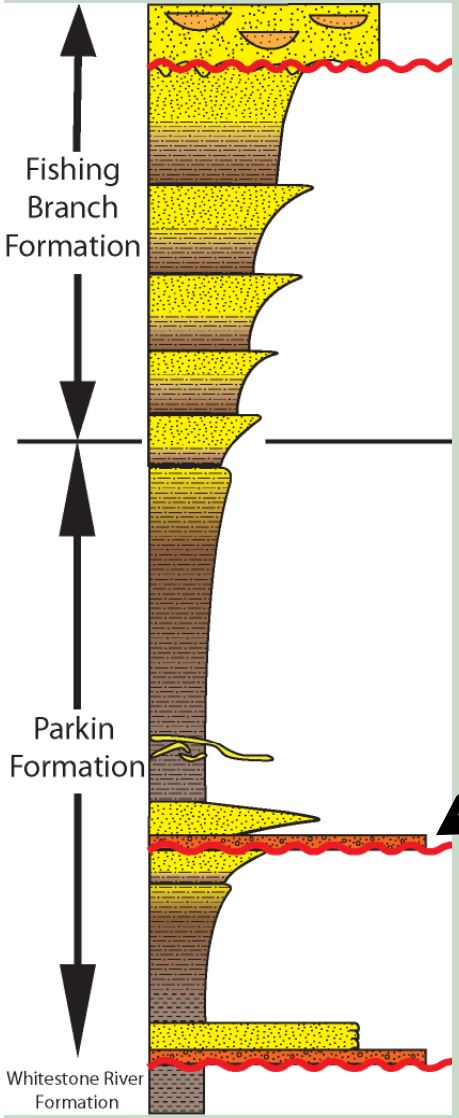




~30m

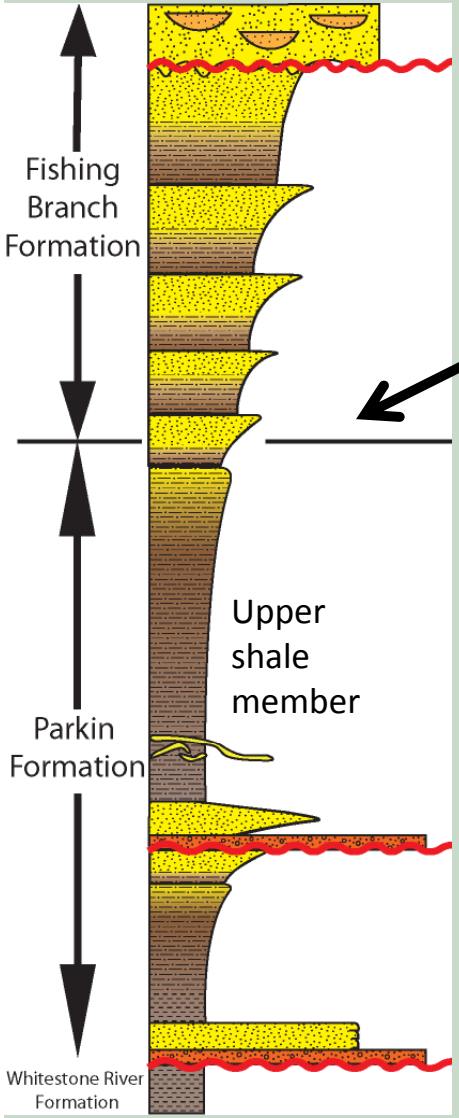
M-59

Mid Parkin Fm. sandstone member

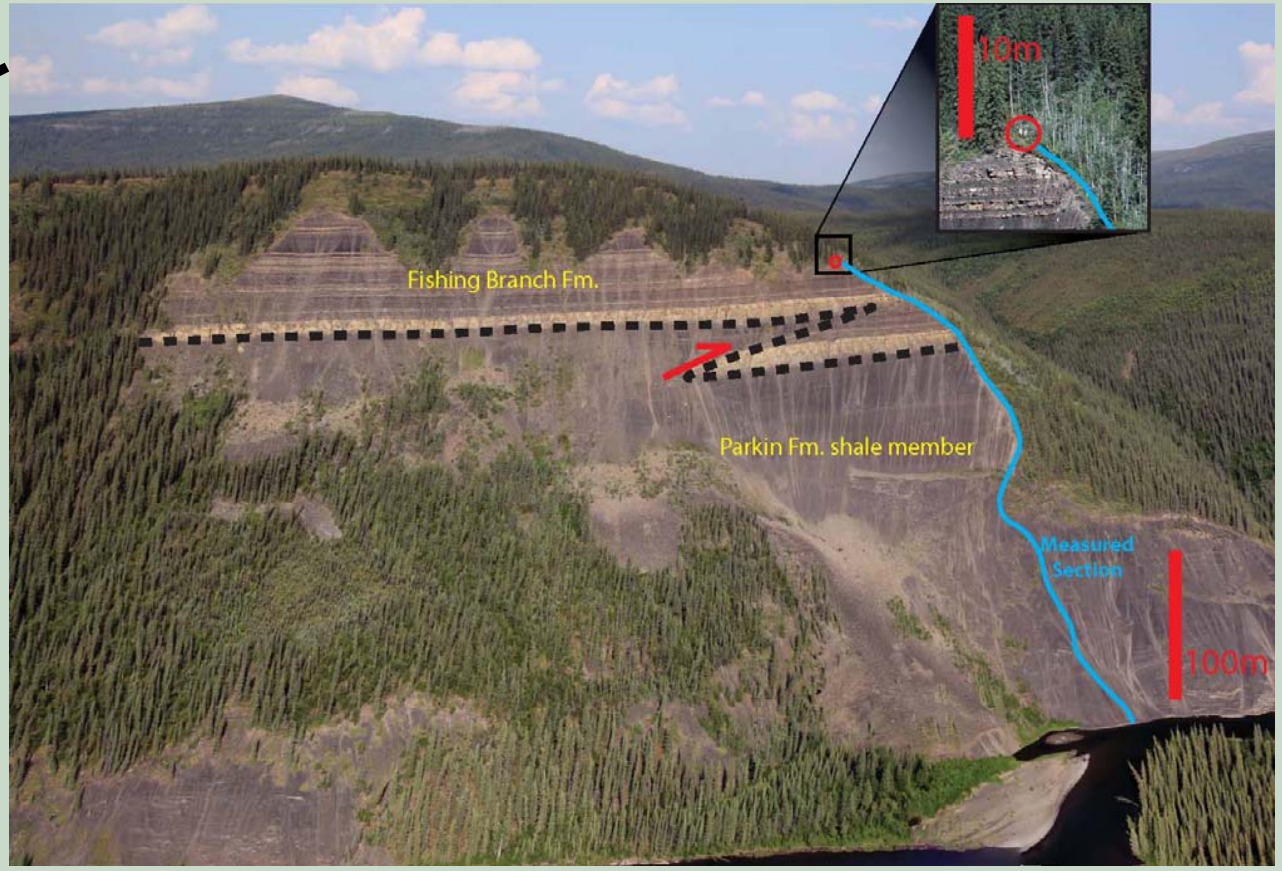


- Marine sandstones with chert pebble lag above unconformity
- Previously undocumented depositional break in middle of Parkin Fm.

Fishing Branch Fm.



- Upward coarsening cycles of shale to fine- and medium-grained pro-deltaic sandstones
- Facies change to hummocky fine sandstones in south Eagle Plain



Fishing Branch Fm.

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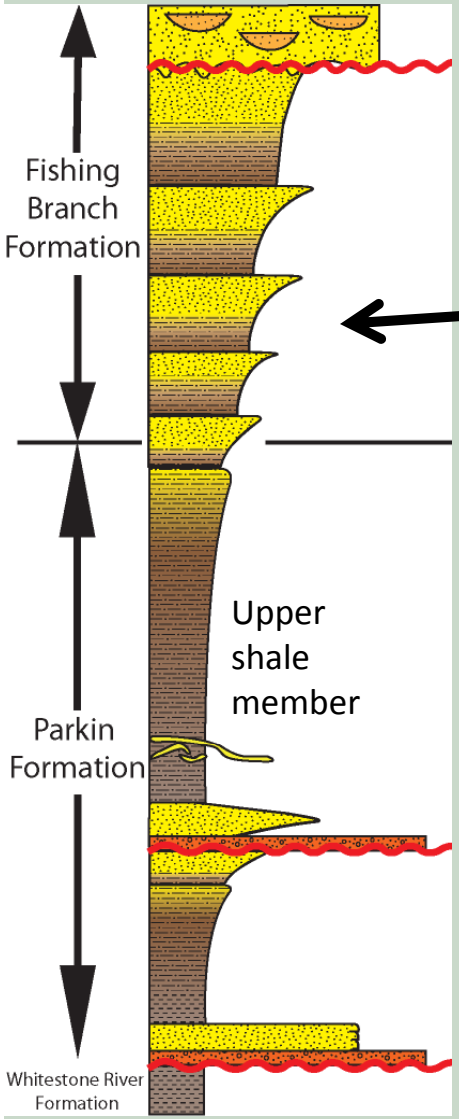
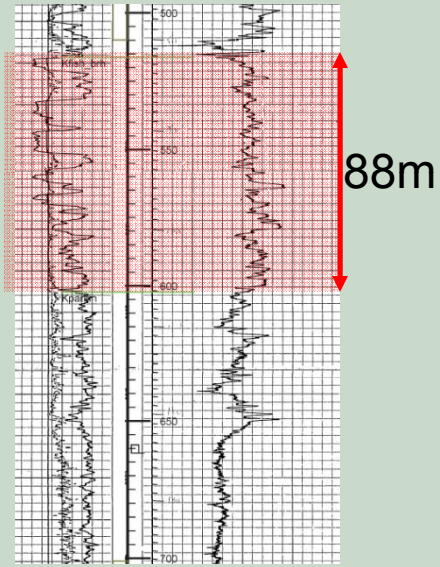
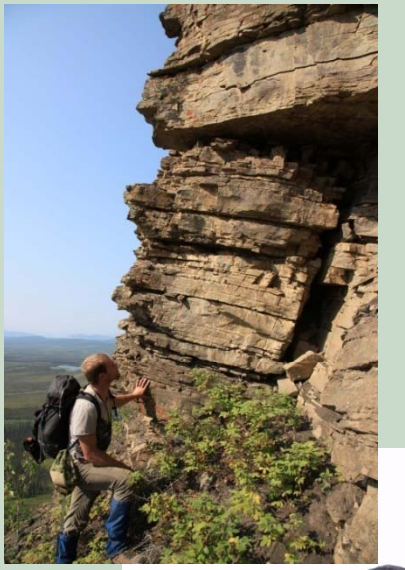
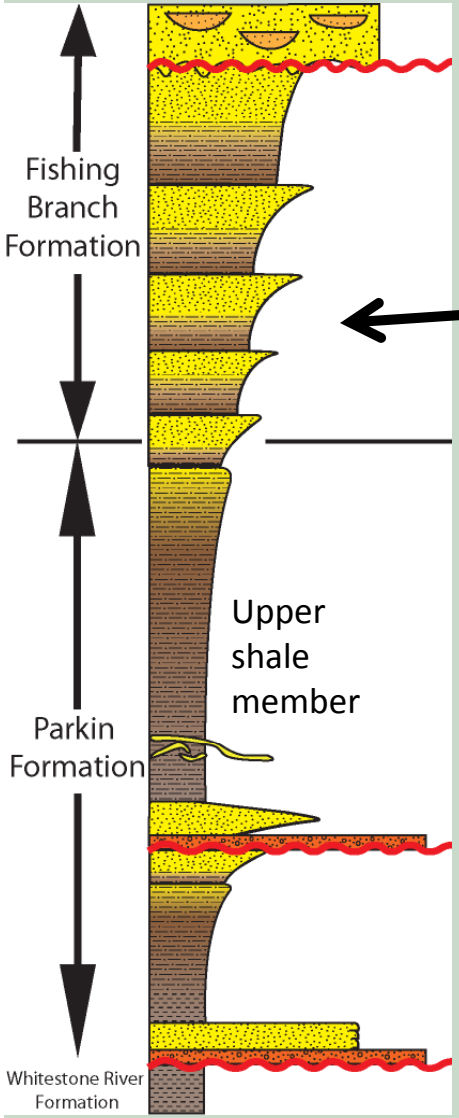




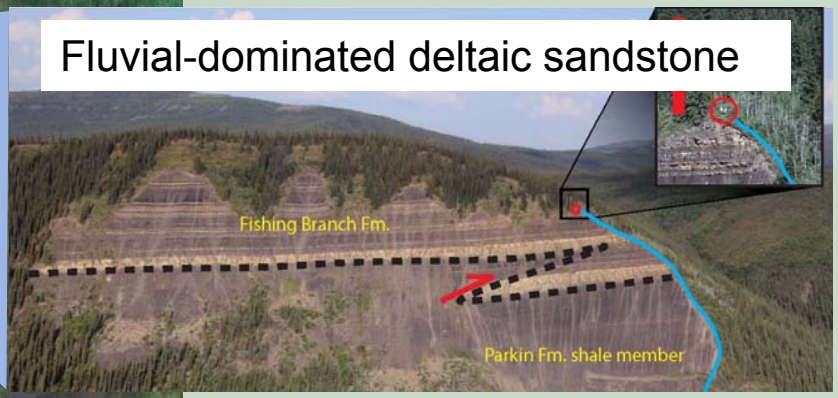


Fishing Branch Fm.



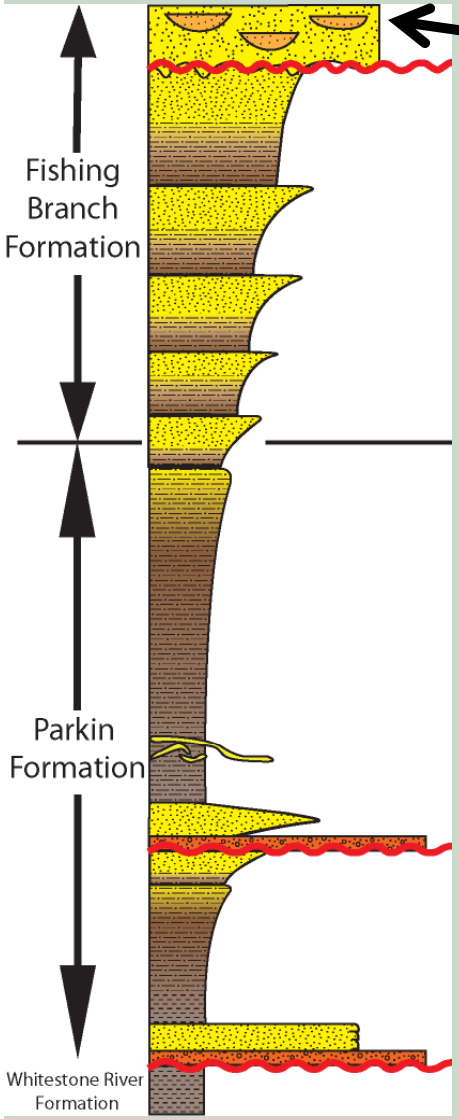
- Upward coarsening cycles of shale to fine- and medium-grained pro-deltaic sandstones
- **Facies change to hummocky fine sandstones in south Eagle Plain**

Fluvial-dominated deltaic sandstone



Hummocky marine sandstone

Fishing Branch Fm.



Previously undocumented unconformity and fluvial unit capping Fishing Branch Fm.

Reservoir Facies

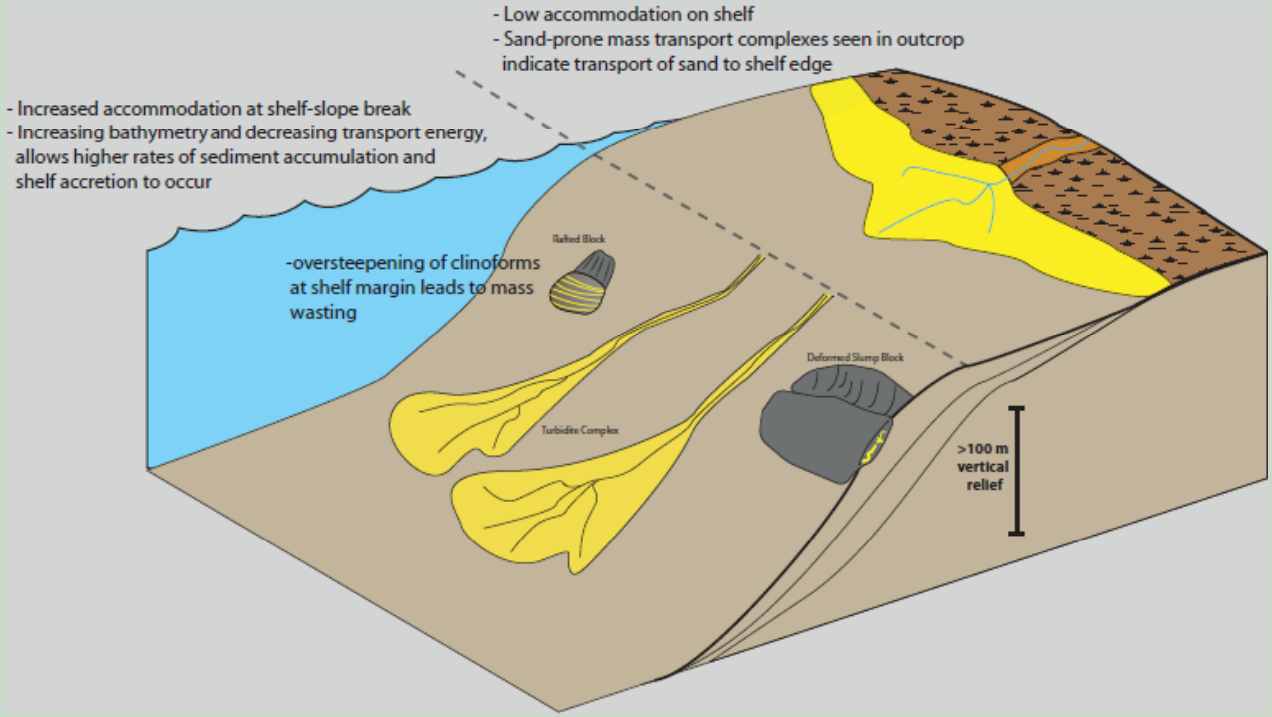
- Coarse-grained sandstones and conglomerates occur within all three main sandstones in the succession

Basal and Middle Parkin Formation

Fishing Branch Formation

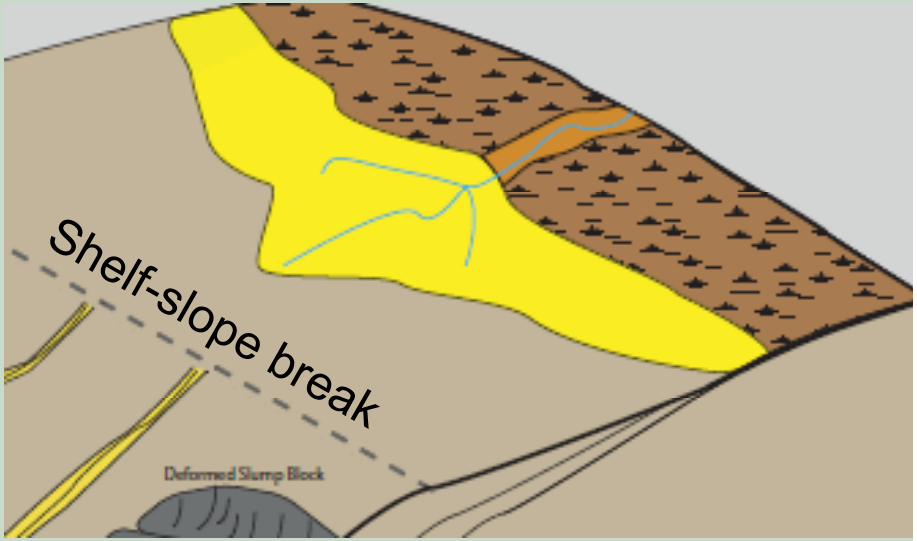
New Conceptual Plays

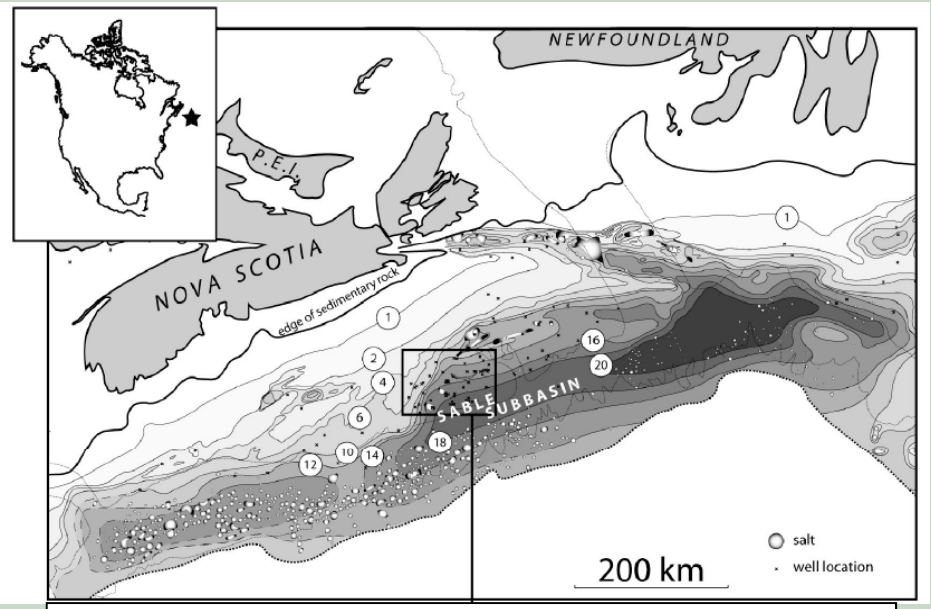
- Recognition of shelf-slope transition opens up new hydrocarbon potential in the Parkin Fm. and Fishing Branch Fm.



New Conceptual Plays

- Shelf-margin delta play, landwards of shelf-slope break

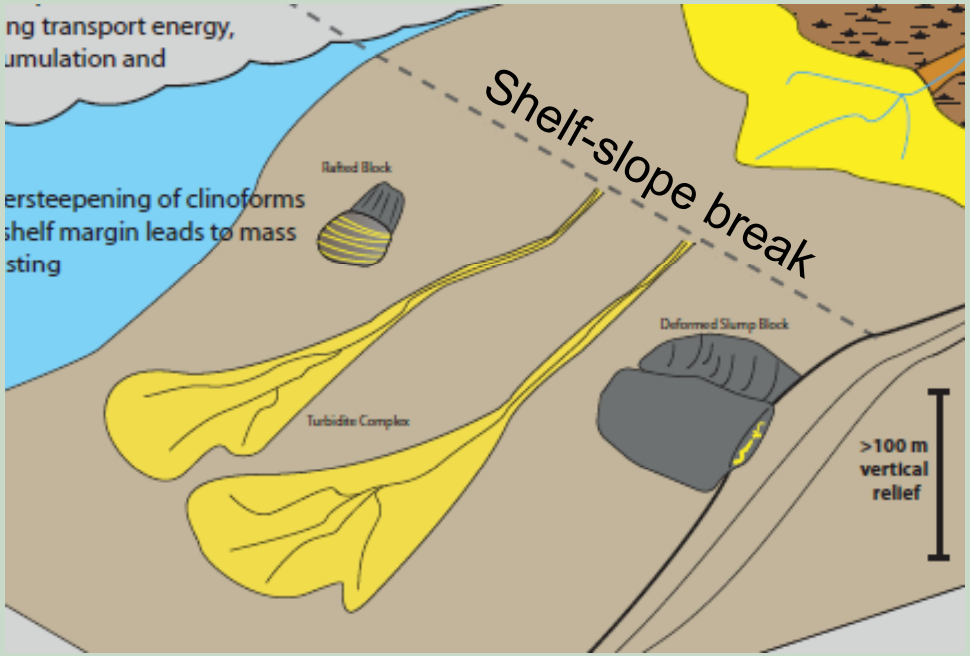


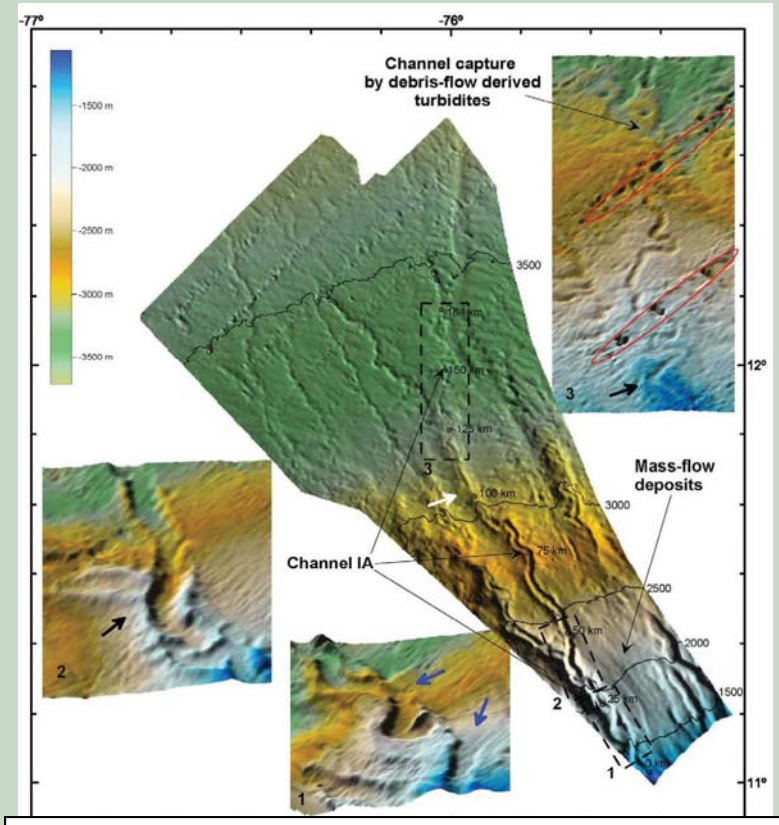


Estimated 4527 Bcf OGIP offshore Nova Scotia in shelf-margin delta sands (Cummings and Arnott, 2005)

New Conceptual Plays

- Turbidite fan play, basinwards of shelf-slope break
- Huge global petroleum reserves



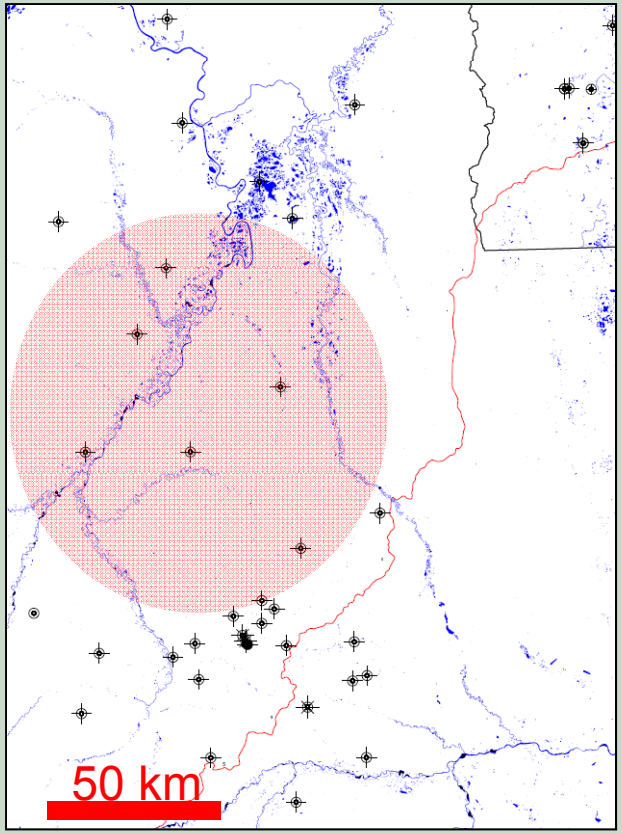


Coloured bathymetric map of turbidite channel, Magdalena Fan, Colombia (Estrada et al., 2005).

Influence on Hydrocarbon Assessment

Play Type	Mean gas (Bcf)	Mean oil (MMbbls)
Stratigraphically Trapped Hydrocarbons in Cretaceous Sandstones	118.45	40.47
Structurally Trapped Hydrocarbons in Cretaceous Sandstones	230.89	67.34
	349.34 Bcf	**107.81 MMbbls**

(Osadetz et al., 2005)



- Vast unexplored area with high potential for large gas accumulations in Cretaceous stratigraphic traps
- Industry interest

Conclusions

- Petroleum systems exist in Cretaceous strata of Eagle Plain Basin based on drilling results and production tests
- New depositional model necessary to basin morphology and predict distribution of reservoir facies
- >100m shelf-basin floor relief provides accommodation space for accumulation of thick sandstones and potential for shelf-edge delta or turbidite fan play
- Future hydrocarbon assessments must take in to account new stratigraphic framework

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