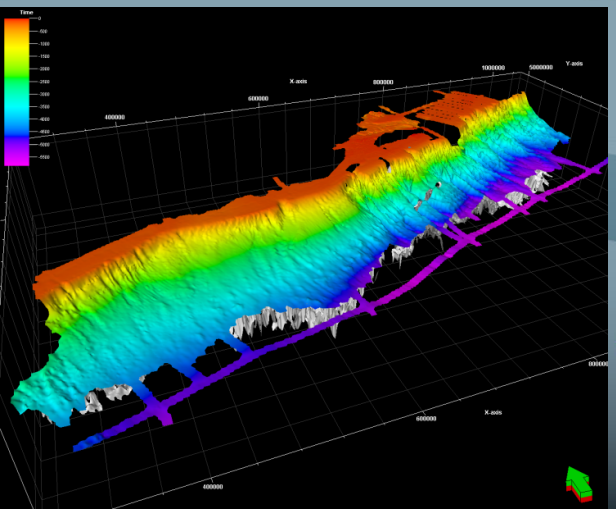
Nova Scotia
OFFSHORE

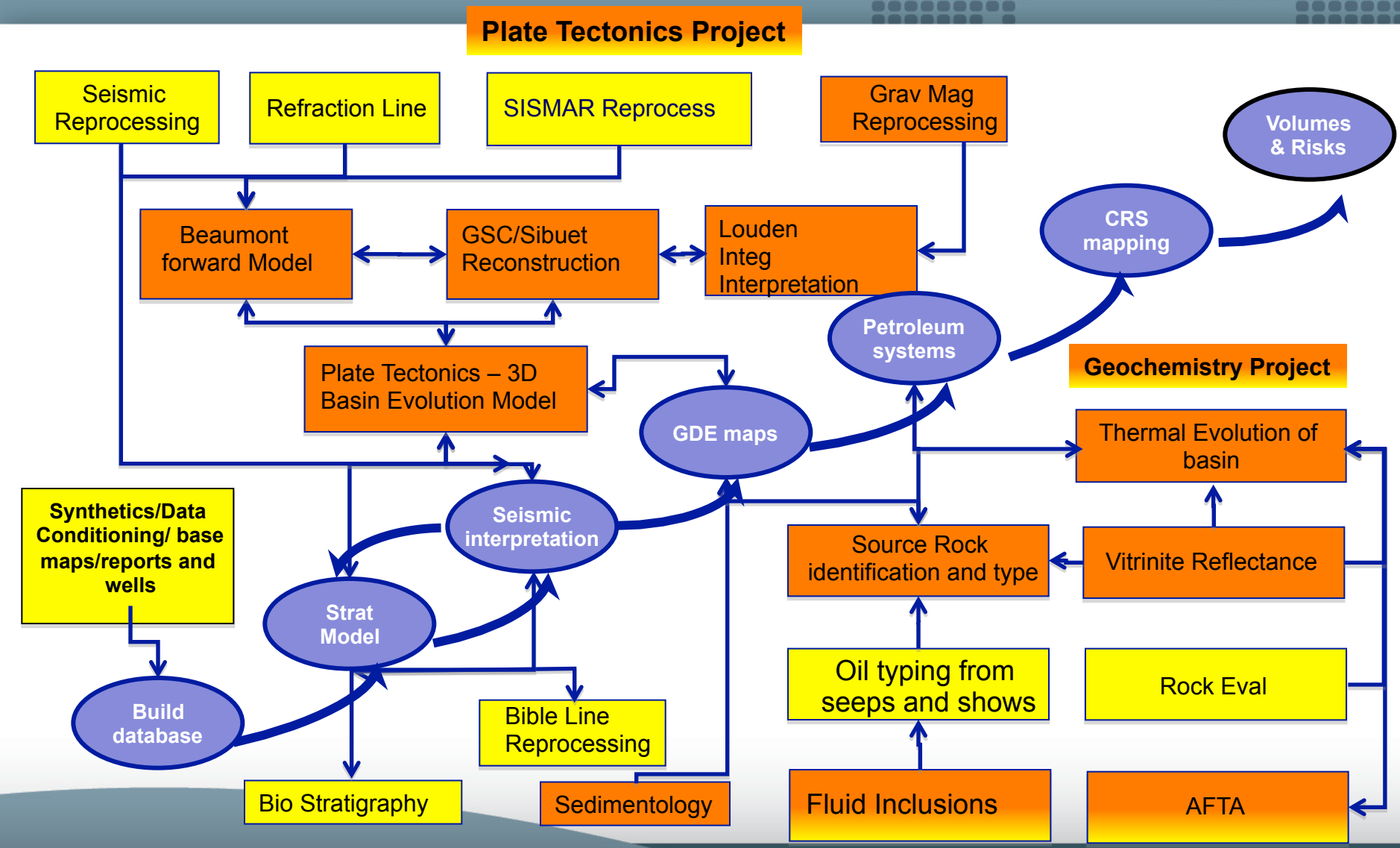
Play Fairway Analysis Seminar - summary



OETR Offshore Energy Technical Research Association

NEW GEOSCIENCE. NEW OPPORTUNITY.

Play Fairway Analysis - Workflow

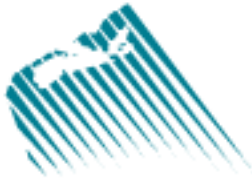


PFA Project - BEICIP

External Contractors

Halifax academic/GSC

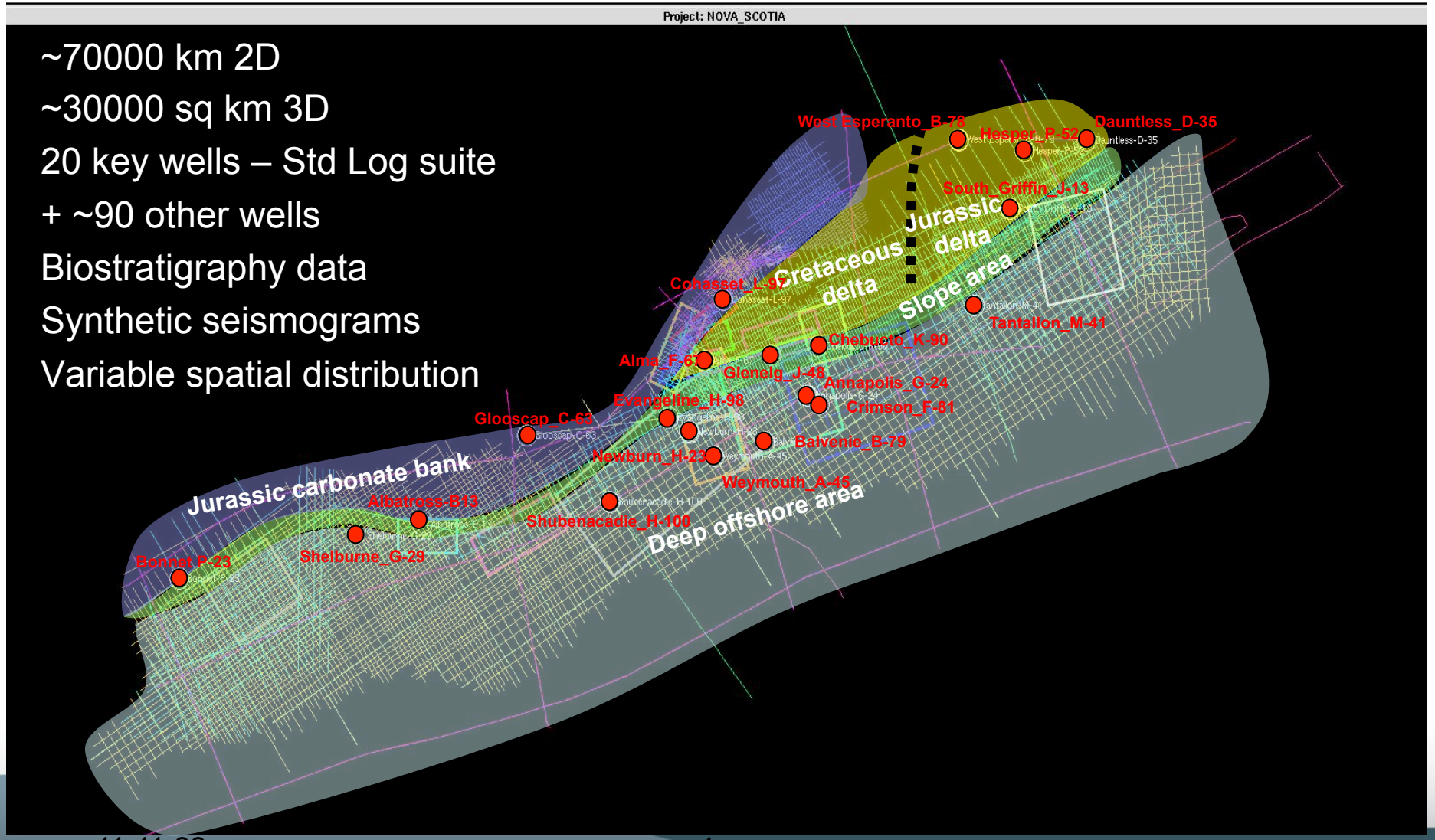
CNSOPB



CANADA-NOVA SCOTIA
OFFSHORE PETROLEUM BOARD

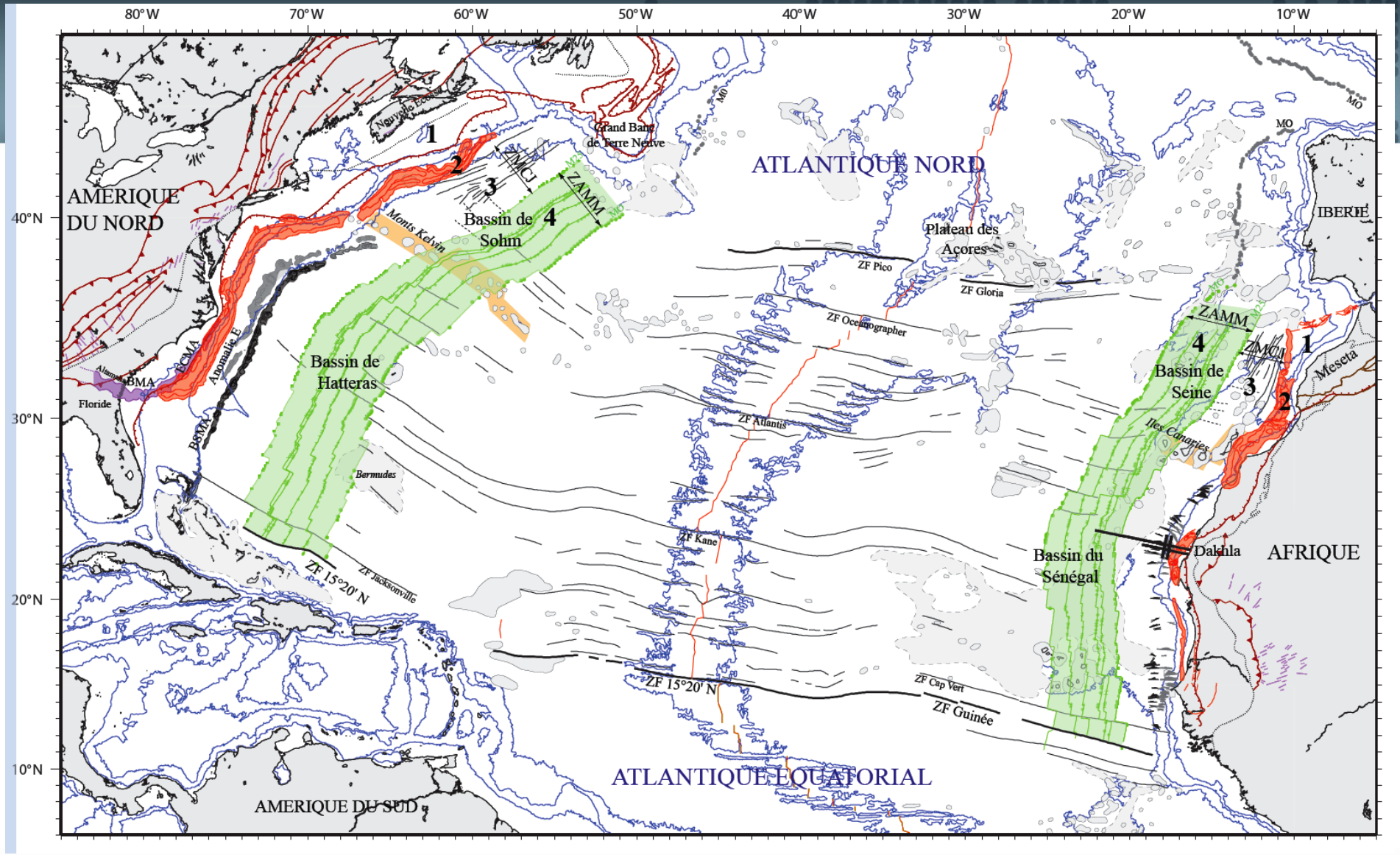
Natural Resources Canada
Ressources naturelles Canada

Database


Project: NOVA_SCOTIA
~70000 km 2D
~30000 sq km 3D
20 key wells – Std Log suite
+ ~90 other wells
Biostratigraphy data
Synthetic seismograms
Variable spatial distribution
West Esperanto_B-76
Hesper_P-62
Dauntless_D-35
South_Griffin_J-13
Jurassic delta
Cretaceous delta
Slope area
Cohasset_L-97
Tantallon_M-41
Chebucto_K-90
Alma_F-67
Glenelg_J-48
Annapolis_G-24
Crimson_F-81
Evangeline_H-98
Glooscap_C-63
Balvenie_B-79
Newburn_H-23
Weymouth_A-45
Jurassic carbonate bank
Albatross_B-13
Shubenacadie_H-100
Deep offshore area
Bonnet P-23
Shelburne_G-29

Summary

- Rifting History
- Reservoir prediction
- Geochemistry
- 3D petroleum systems
- Play maps & Yet To Find
- Key messages
- Risks (comments)



Central Atlantic between FZ Pico-Gloria and 15°20'-Guinea. In red, ECMA and WACMA (Labails, 2007, thesis). In green, Mezozoic magnetic anomalies.

Rifting model - KEY CONCLUSIONS

- Nova Scotia / Morocco are conjugate ***volcanic*** passive margins
- Sub-aerial spreading initiated by CAMP event in the Earliest Jurassic
- Salt basins confined to continental crust stretched in Late(?) Triassic
- Early post rift water depths < 200m (anoxic conditions - ? a new petroleum system)

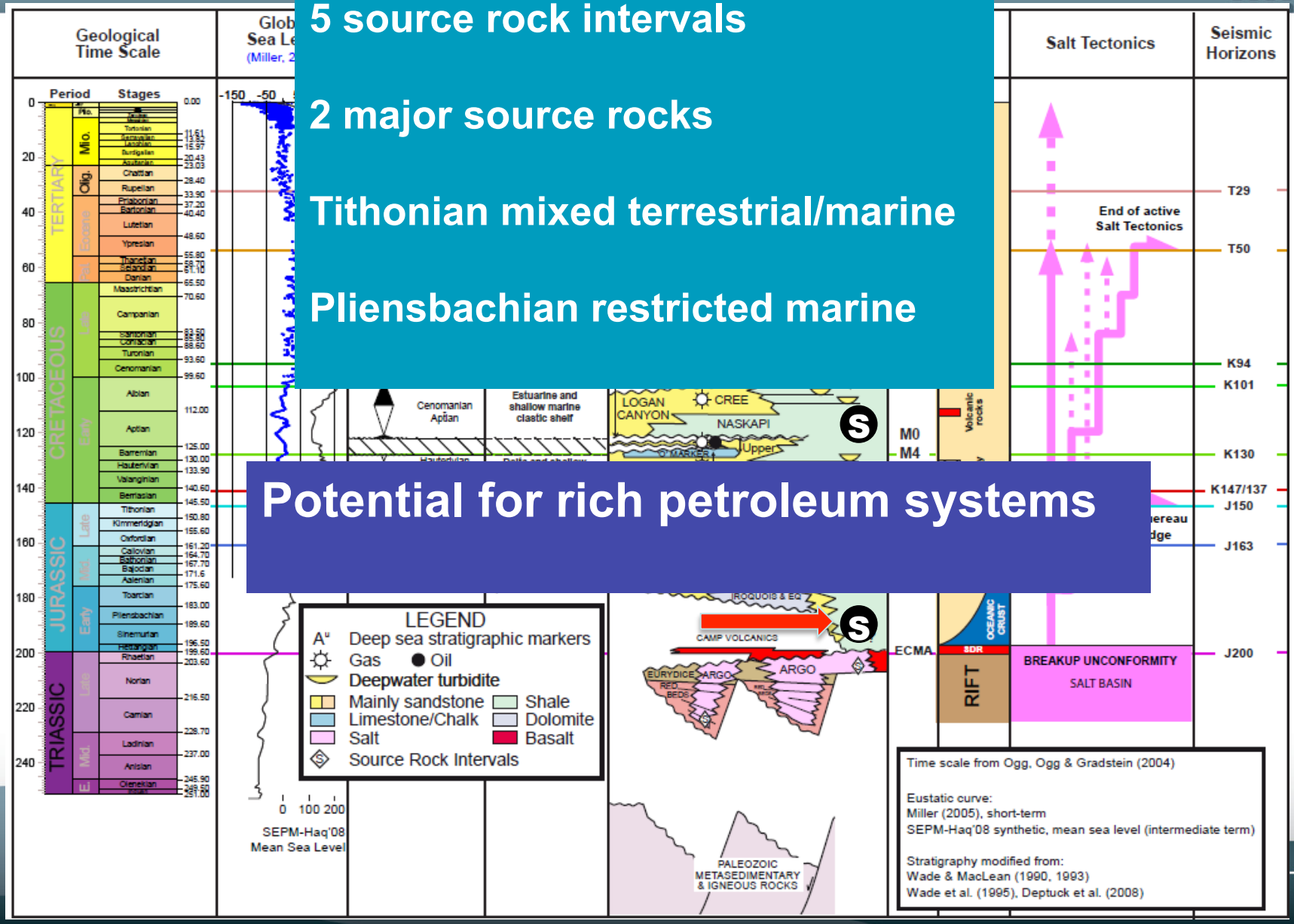
Reservoir de-risking

- Several major sediment entry points
  - **Sable system**
  - **Mohican graben (clastic or calsi-turbidites)**
  - **Mohawk graben (clastic or calsi-turbidites)**
  - **Shelburne delta (newly identified)**
- Reservoir presence & distribution can be de-risked
  - **Understanding paleo slope morphology is key**
  - **3D imaging**
  - **Shelf to slope attribute analysis**

Source rocks

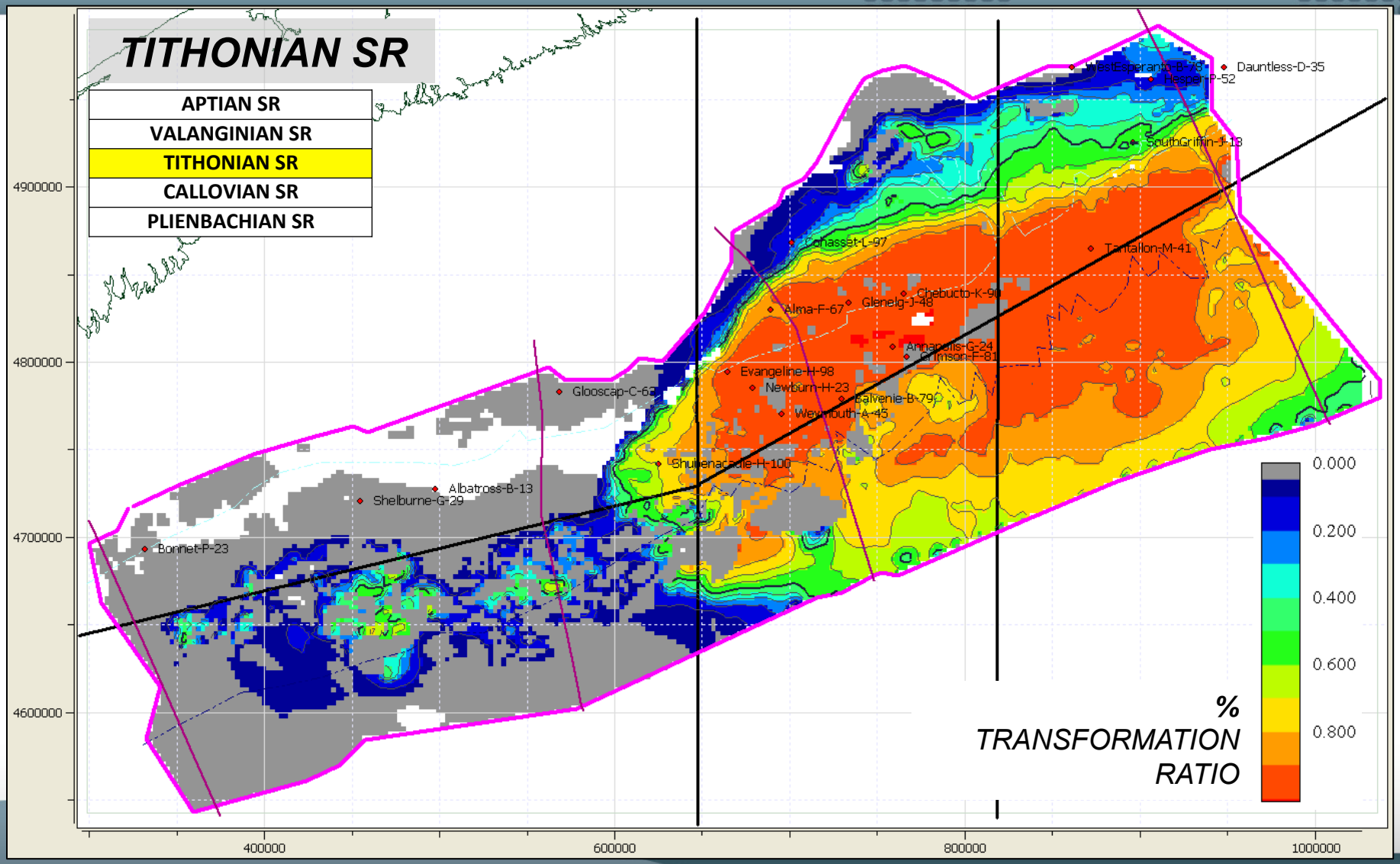
- 5 source rock intervals
- 2 major source rocks
- Tithonian mixed terrestrial/marine
- Pliensbachian restricted marine

Potential for rich petroleum systems



Source Rocks Modeling – Transformation Ratio

Nova Scotia OFFSHORE



Pliensbachian Transformation ratio

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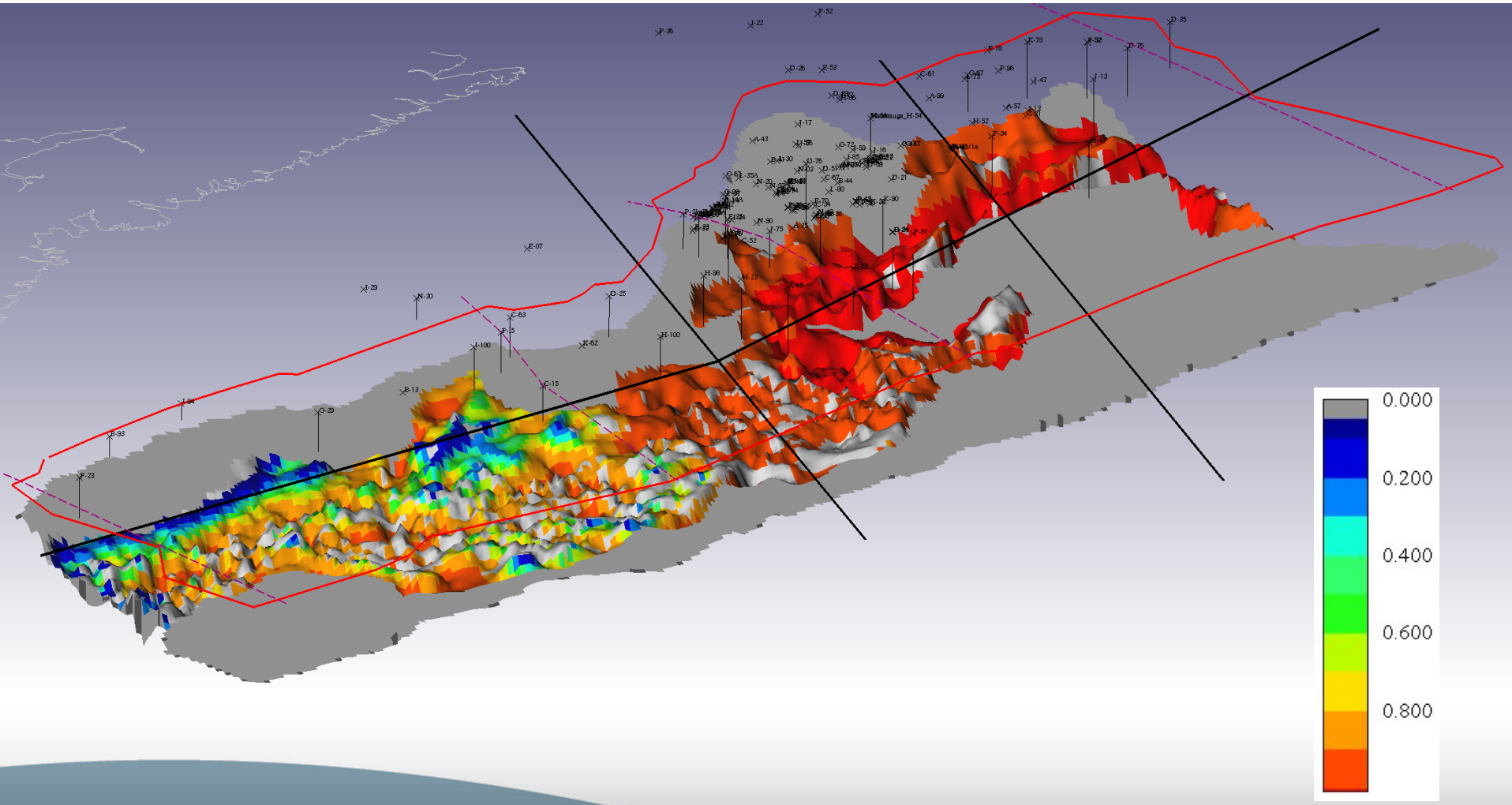
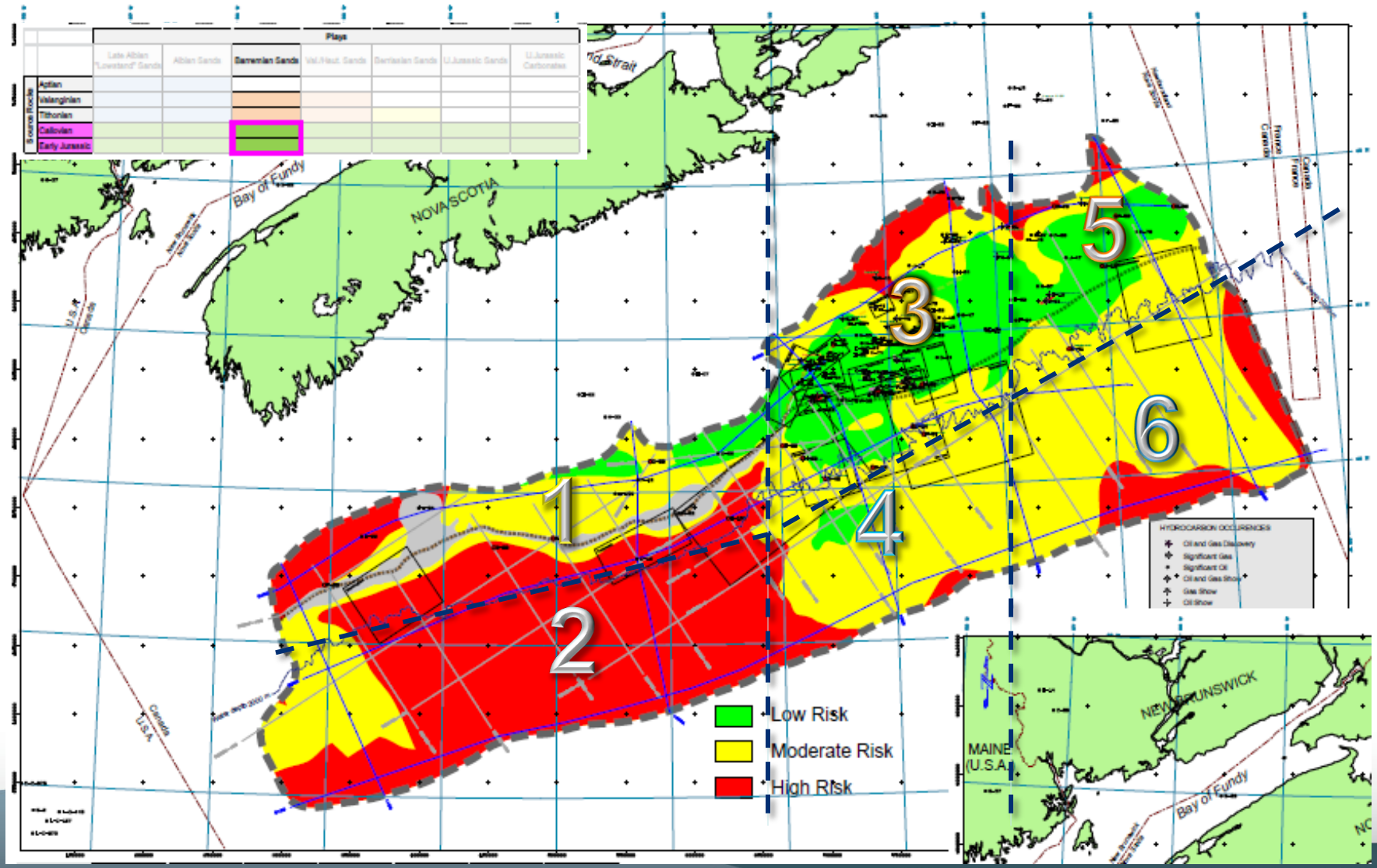
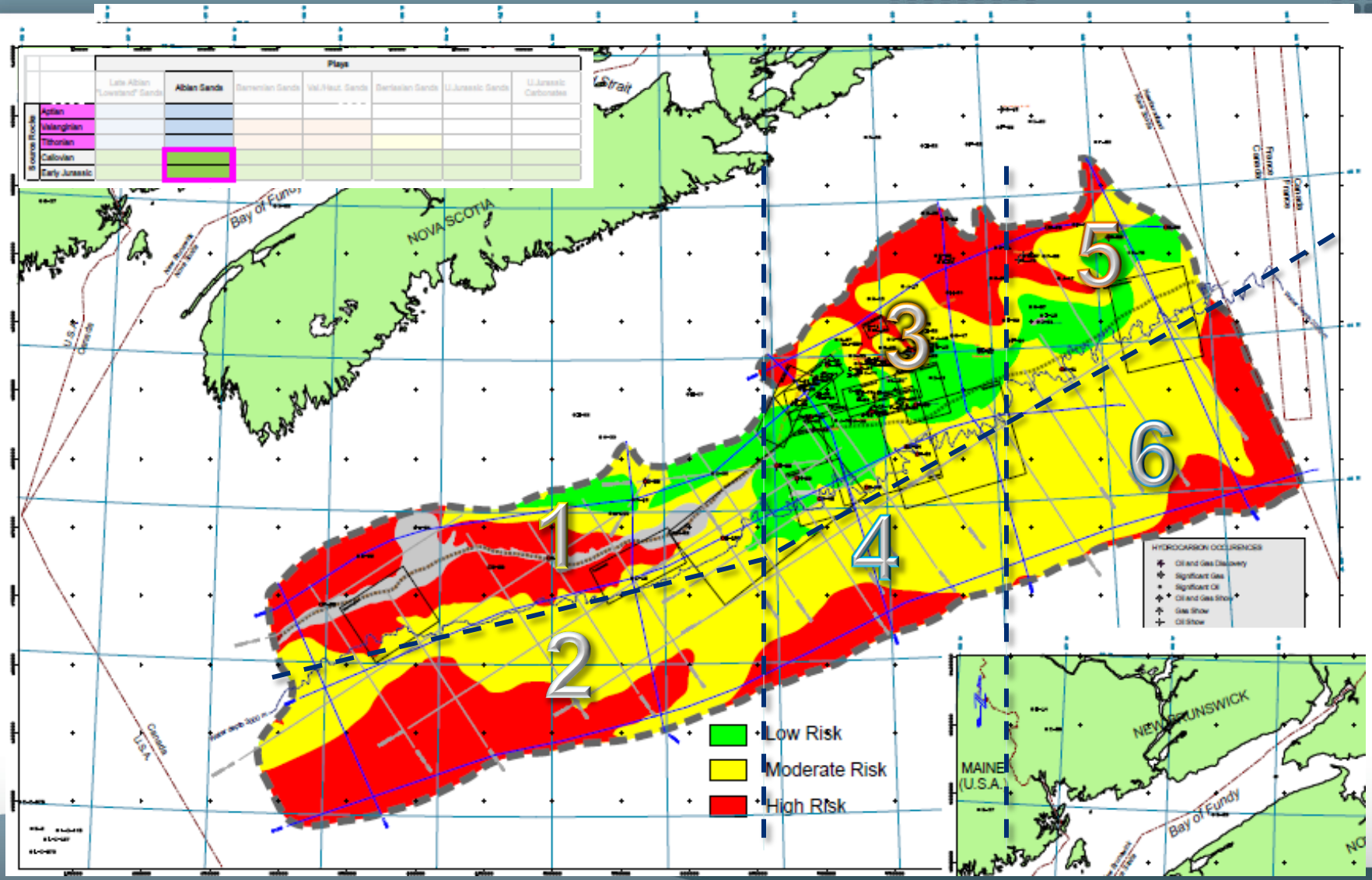


Barremian sands play (1)



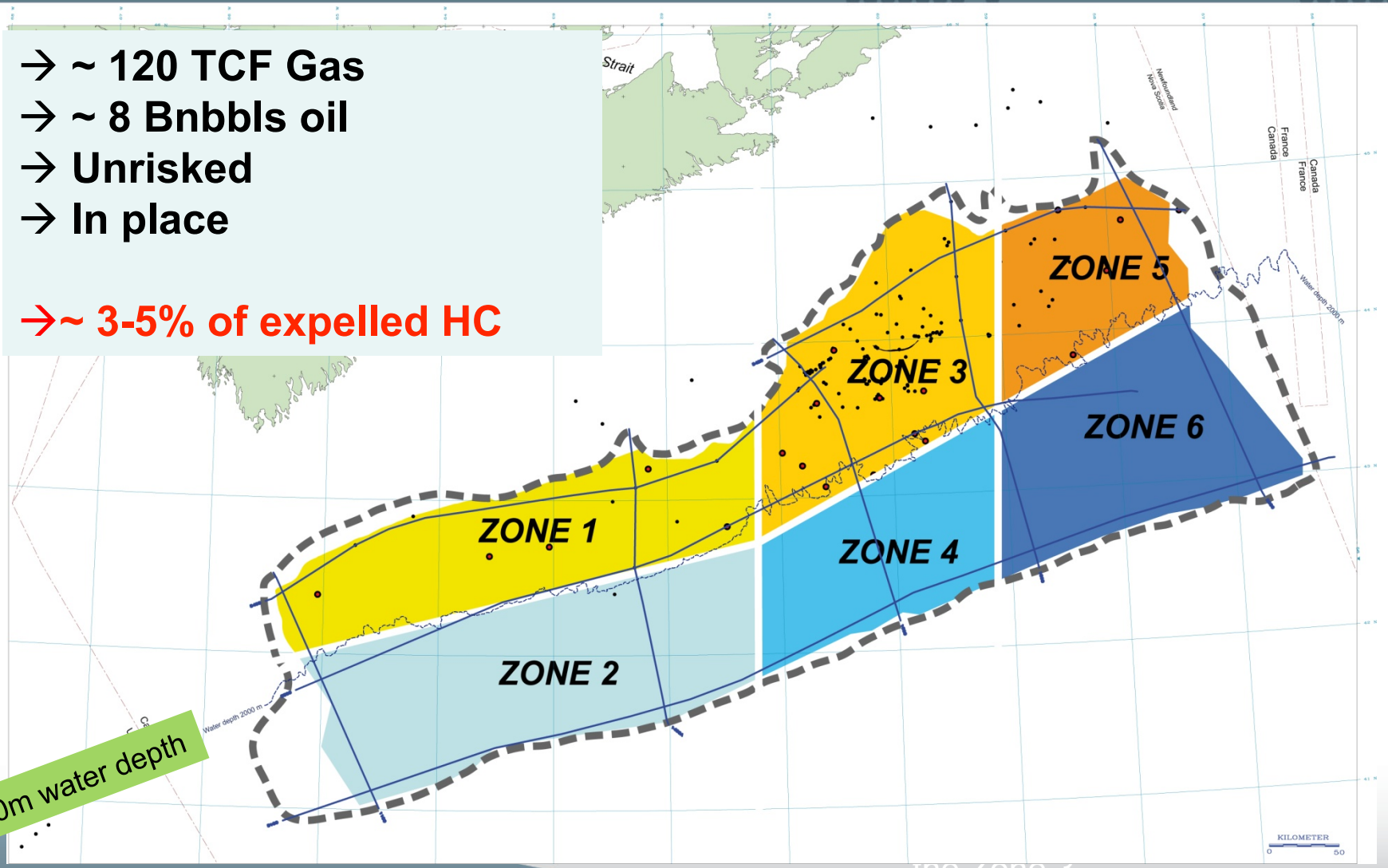
Albian sands play (1)



Resource estimate

- → ~ 120 TCF Gas
- → ~ 8 Bnbbls oil
- → Unrisked
- → In place

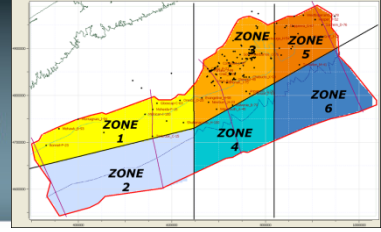
→~ 3-5% of expelled HC



2000m water depth

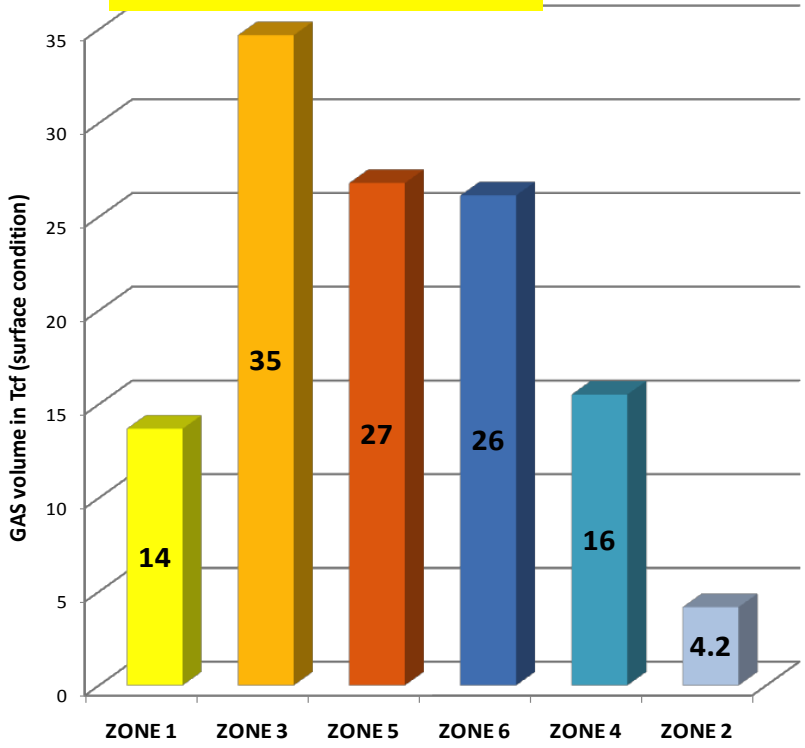
the Zone 3

Ranking of the different zones

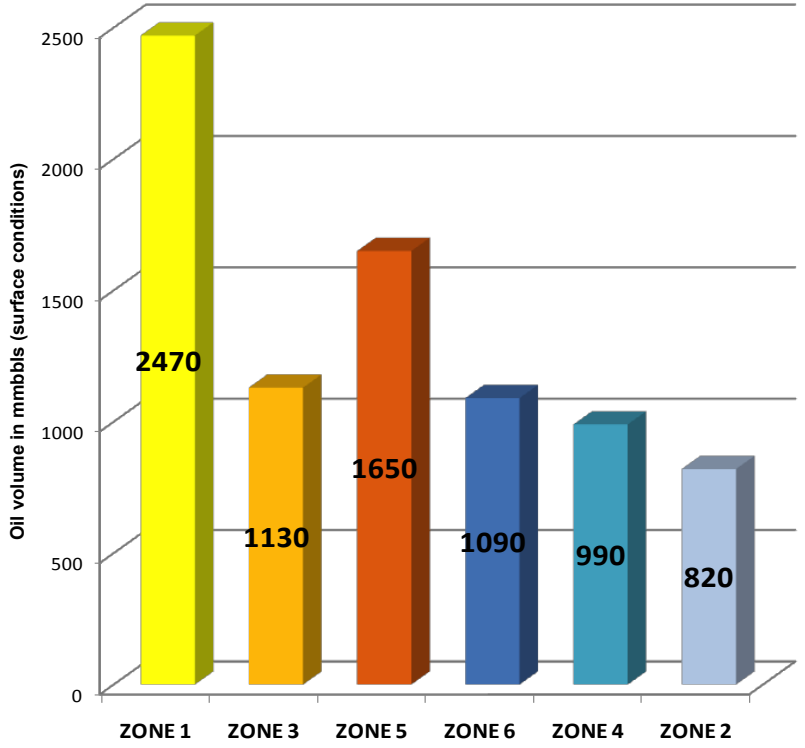


ZONE RANKING by GAS volume IN PLACE
GRAND TOTAL (unrisked)
All Plays (in Tcf)

Zone 3 - 1/3 discovered

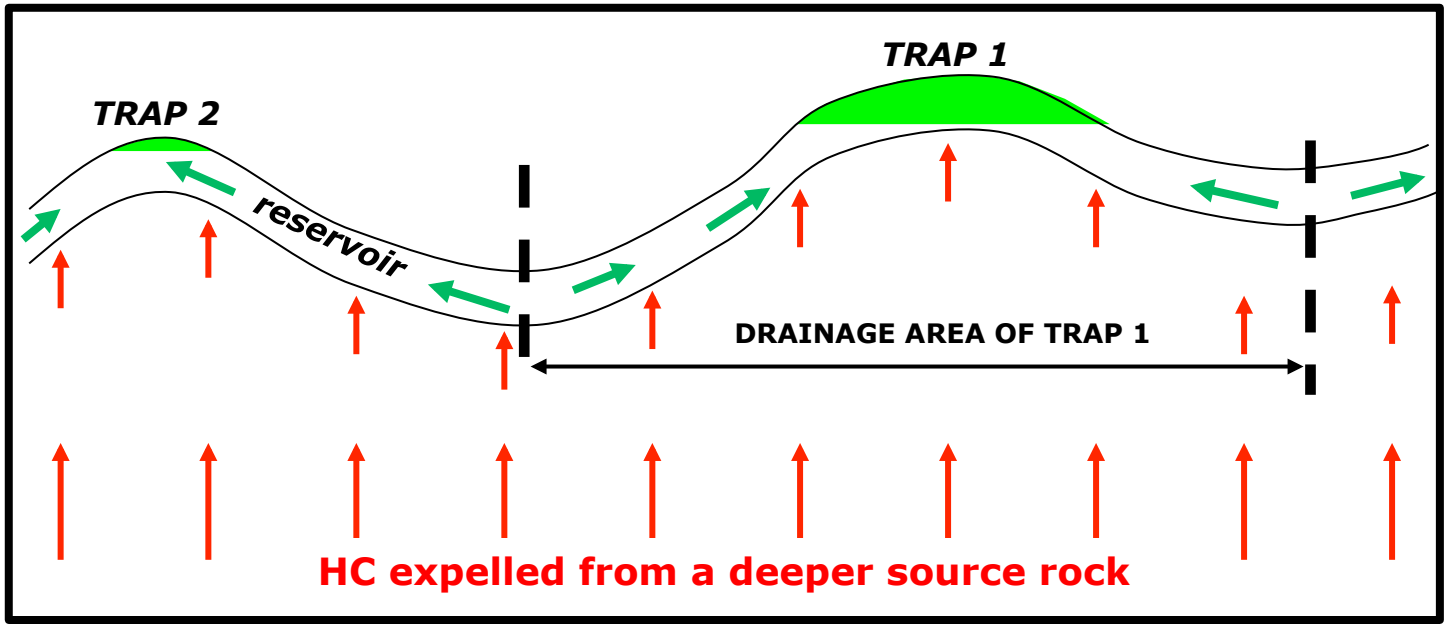


ZONE RANKING by OIL volume IN PLACE
GRAND TOTAL (unrisked)
All Plays (in mmbbls)



Resource estimate – unrisked/in place

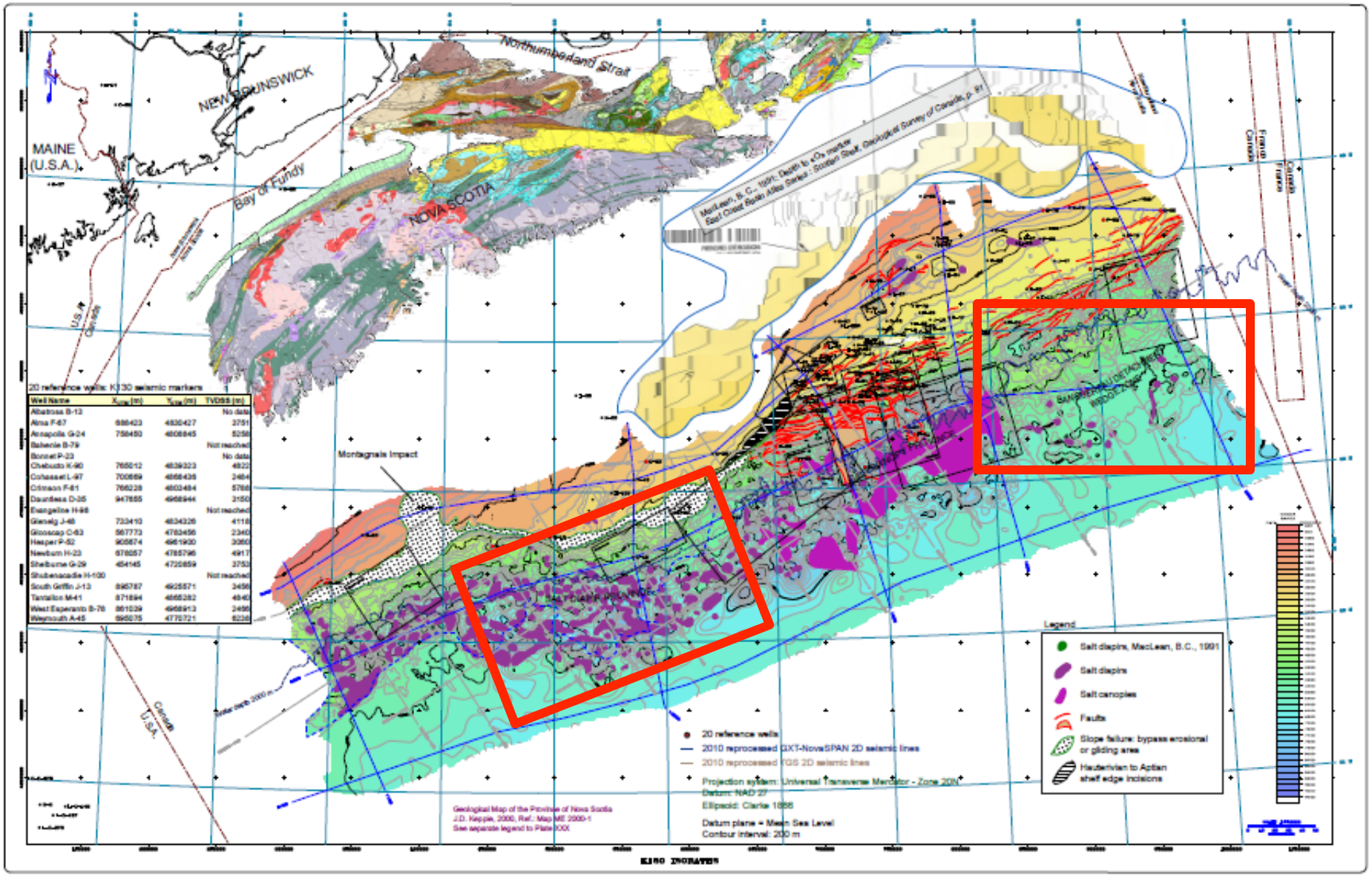
DRAIN and PETPOT Concept



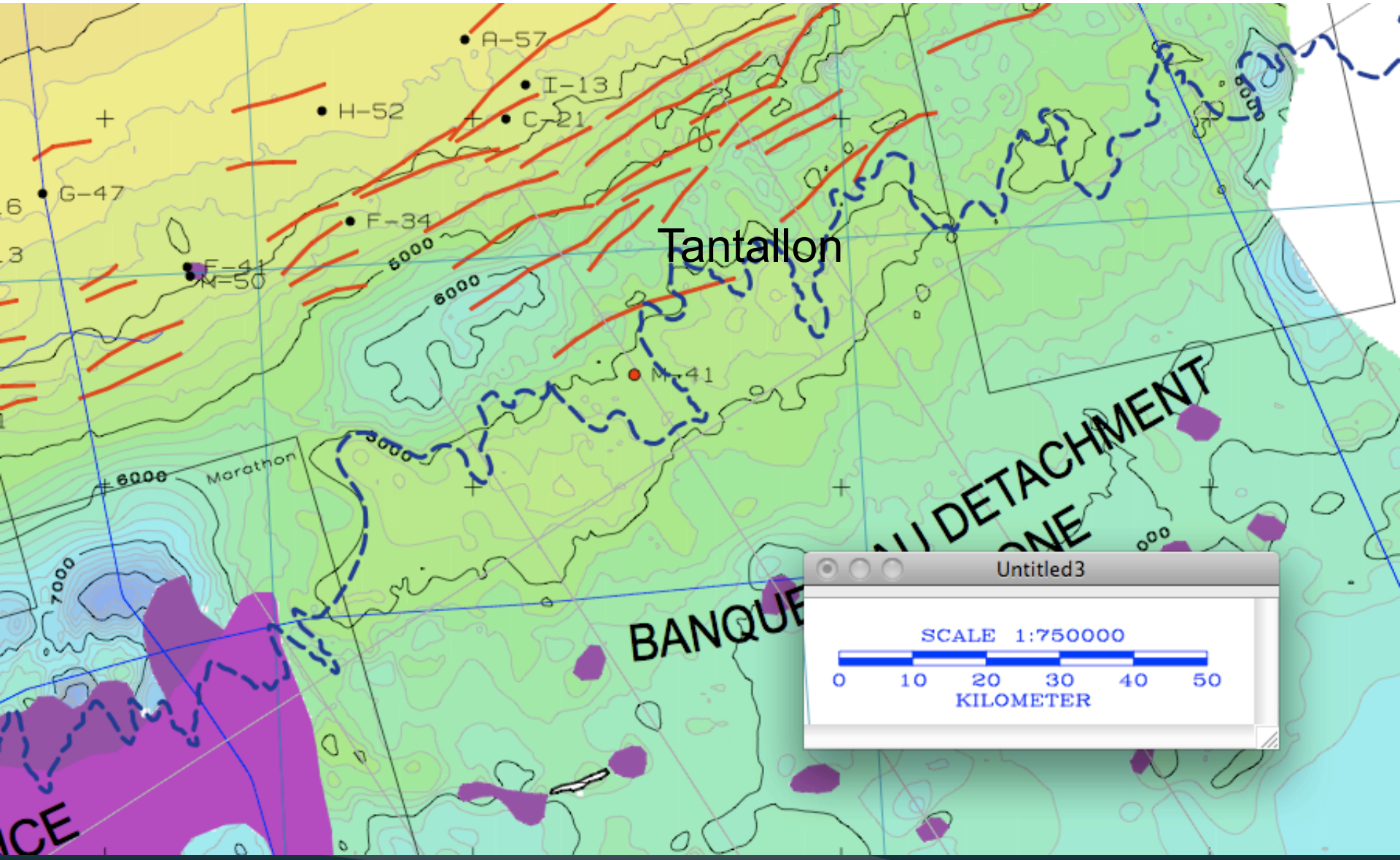
→ 3D TEMIS petroleum systems approach

→ Only simple closed structure (4 ways traps > 2 sq km)

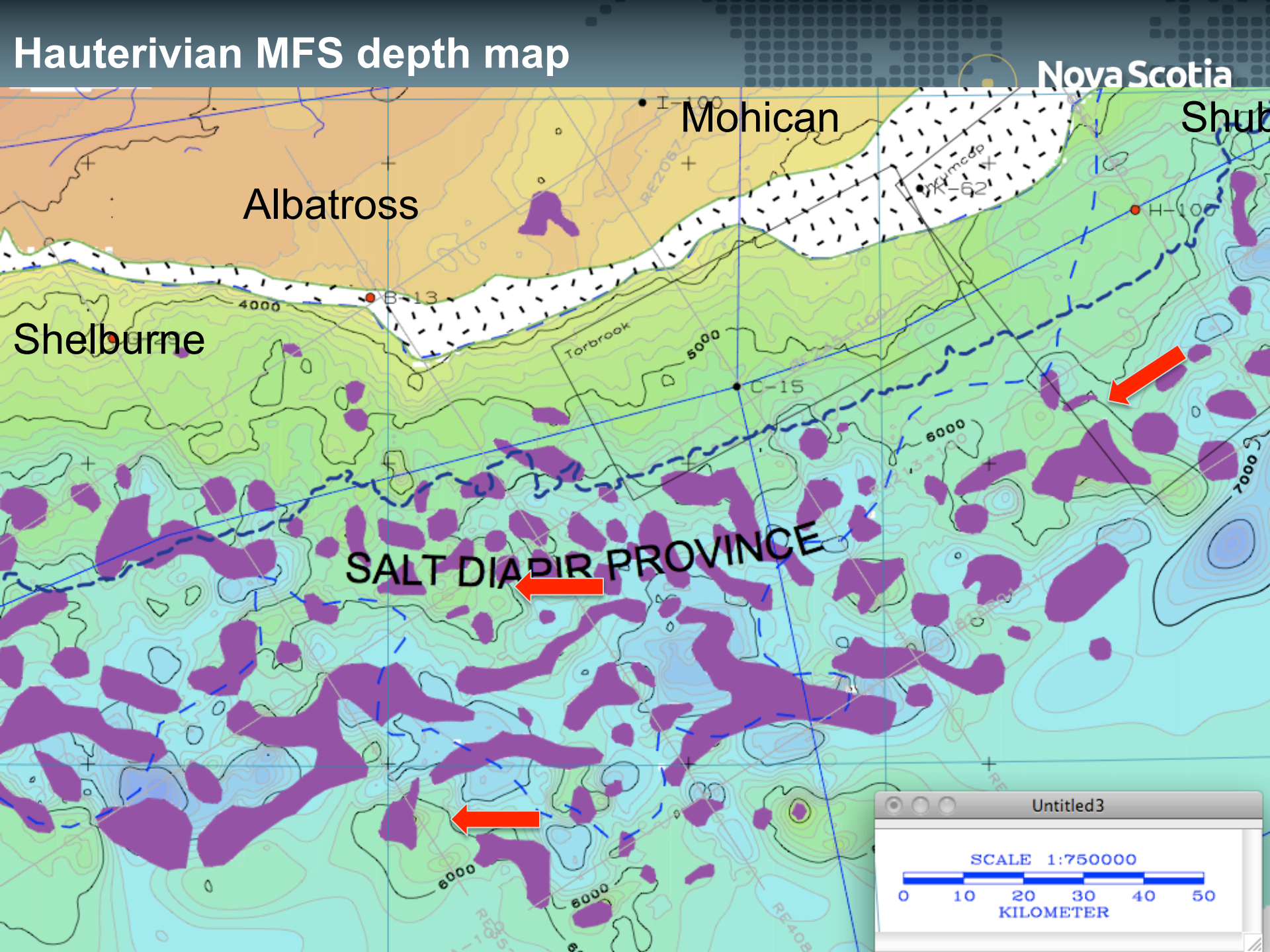
→ More complex traps not considered


Northumberland Strait
NEW BRUNSWICK
MAINE (U.S.A.)
Bay of Fundy
NOVA SCOTIA
Montagnais Impact
20 reference wells: K130 seismic markers
Well Name | TVDSS (m)
Albatross B-13 | No data
Alma F-67 | 3751
Annapolis G-24 | 5258
Balsenie B-79 | Not reached
Bonnet P-23 | No data
Chebucto K-90 | 4822
Cohasset L-97 | 3484
Crimson F-81 | 5766
Dauntless D-35 | 3150
Evangeline H-98 | Not reached
Glenelg J-46 | 4118
Glooscap C-63 | 2340
Hesper P-52 | 3060
Newburn H-23 | 4917
Shelburne G-29 | 3753
Shubenacadie H-100 | Not reached
South Griffin J-13 | 3456
Tantallon M-41 | 4840
West Esperanto B-76 | 3498
Weymouth A-45 | 6236
Legend
Salt diapirs, MacLean, B.C., 1991
Salt diapirs
Salt canopies
Faults
Slope failure: bypass erosional or gliding area
Hauterivian to Aptian shelf edge incisions
20 reference wells
2010 reprocessed GXT-NovaSPAN 2D seismic lines
2010 reprocessed TGS 2D seismic lines
Projection system: Universal Transverse Mercator - Zone 20N
Datum: NAD 27
Ellipsoid: Clarke 1866
Datum plane = Mean Sea Level
Contour interval: 200 m
Geological Map of the Province of Nova Scotia
J.D. Keppie, 2000, Ref.: Map ME 2000-1
See separate legend to Plate XXX

Hauterivian MFS depth map



Hauterivian MFS depth map



Example lead volume

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Probability Input Sheet

Play Type — Big Tancook

Reservoir Parameters	Probability 1	0.5	0	MEAN	Distribution Shape
Total Play Area (km^2)	20	40	60	40	Triangular
Fraction of Area Under Trap	1	1	1	1	Triangular
Fraction of Trap Filled	1	1	1	1	Triangular
Discounted Play Area (km^2)	20.0	40	60.0	40.0	
Net Pay (m)	20	70	120	70	Triangular
Porosity	0.14	0.18	0.22	0.18	Triangular
Hydrocarbon Saturation	0.55	0.65	0.75	0.65	Triangular
Depth of Reservoir (m)	4000	5000	6000	5000	Triangular
Z	1.3	1.25	1.2	1.25	Triangular
Gas Volume Factor	278.0	332.0	383.8	331.3058	
Fraction of Pore Volume Oil Bearing	1	1	1	1.000	Triangular
GOR (m3/m3)	232.68	290.85	349.02	290.85	
Formation Volume Factor (Oil)	1.200	1.300	1.400	1.3	
Prospect Adequacy	1.00	1.00	1.00	1	Triangular
Liquids Yield (BBL/MMCF)	20	30	40	30	Triangular
Oil Recovery Factor	0.25	0.35	0.45	0.35	Triangular
Gas Recovery Factor	0.6	0.7	0.8	0.7	Triangular
H2S content	0.001	0.002	0.003	0.002	Triangular
CO2 content	0.02	0.035	0.04	0.031667	Triangular
Surface Loss Factor		0.05			
Marketable Gas Fraction	0.907	0.913	0.929	0.916333	Triangular
	181.453349	2688.8893	12882.483		
Risk Parameters					
Play Adequacy	100	1			
Other Parameters					
Pressure gradient (kPa / m)	10.02	Sfc Pressure (kPa)		101.3	
Temperature gradient (°C / 100 m)	2.8	Surface Temp (°C)		4	
	1	0.5	0.0	MEAN	
Reservoir Temperature (°C)	44.6	72.6	100.6	72.6	
Reservoir Pressure (kPa)	40181.30	50201.30	60221.30	50201.30	
Gas to BOE conversion factor (MCF/BBL)	6				

Deterministic Totals		Gas in Oil	Liquids in Gas
Raw GIP (E^9m^3)	0	73.2942	
Raw GIP (Bcf)	0	2588.3114	
Raw OIP (E^6m^3)	252		0
Raw OIP (MMBbls)	1585.80324		0
Recoverable Gas (E9m3)	0	25.65297	
Recoverable Gas (Bcf)	0	905.90898	
Recoverable Oil (E6m3)	88.2		0
Recoverable Oil (MMBbls)	555.031134		0
Marketable Gas (E9m3)	0		
Marketable Gas (Bcf)	0		
Risked totals			
Play risked GIP (E^9m^3)	0	73.2942	
Play risked OIP (E9m3)	252		0
Play risked Rec. Gas (E9m3)	0		
Play risked Rec. Oil (E9m3)	88.2		
Play risked Mktbl. Gas (E9m3)	0		

Key Assumptions

- Closed structure exists
- P50 area = 40 km^2
- P50 oil pay = 70 m

Unrisked OOIP

- Mean = 1.6 Billion Bbls

Key messages

- Multiple proven petroleum systems
  - **Several source rocks (terrestrial/marine)**
  - **& regional marine EJ**
- Multiple reservoir possibilities
  - **Major proven delta (Sable) – north**
  - **Clastic input along margin and south west**
  - **Carbonate bank**
- Substantial resource (~120 TCF + 8 bnbbls)
  - **~3-5% of expelled hydrocarbons**
- Potential for rich petroleum system
- Multiple plays

Risks

- Charge
  - **Proven in East**
  - **Model risk in West (extent of EJ source)**
- Reservoir
  - **Extensive regional evidence for presence**
  - **Distribution - detailed seismic stratigraphy & attribute analysis**
- Traps
  - **Multiple possibilities in shallow & deep water**
  - **Detailed structural mapping**
- De-risking - 3D seismic