New Insights into the Hydrocarbon Prospectivity of Offshore Nova Scotia*

Hamish Wilson[1]

Search and Discovery Article #40638 (2010)
Posted November 15, 2010

* Adapted from an oral presentation at AAPG Annual Convention and Exhibition, New Orleans, Louisiana, USA, April 11-14, 2010

[1]RPS Energy, London, United Kingdom. (tracey.dancy@rpsgroup.com)

Abstract

Emerging plays in Brazil Ghana and Morocco have triggered interest in searching for analogue plays in conjugate margins. Using paired margins is a powerful way to evaluate basins in search of overlooked plays. Insights gained from the Rockall Porcupine and Orphan have been used to evaluate systems and plan exploration programmes.

Interest in Morocco and NS has been triggered by licence activity. Using data/maps across the margin is vital in understanding the critical synrift/early post-rift play systems. The paper is based on work undertaken for OETR in Halifax and studies completed on the Moroccan margin. Both margins show that when integrated into play analyses there is potential for significant volumes of hydrocarbons. The use of conjugate margin models is critical in developing models for de-risking hydrocarbon prospectivity.

Jurassic and Cretaceous delta systems with associated slope turbidites can be postulated and de-risked using high quality seismic data. Reservoir deposition and salt movements are inter-related and numeric models backed by seismic data show that reservoir quality facies can exist. The Jurassic carbonate bank is a proven play system in NS and Morocco. Proving a world-class source system is vital to the hydrocarbon prospectivity of both margins. Extensive shows, commercial discoveries, and evidence of by-passed oil demonstrate source systems that produce hydrocarbons. The paper will show forensic geochemical work being used to type the shows and link the fluids to specific source bed sequences. Traditional sourcing models rely on Jurassic and Cretaceous delta systems, but may not be supported by the geochemical data. We postulate there must be a deeper source. The location of the break up unconformity and the relationship between evaporite deposition and lacustrine environments will be explained. The models are based on plate scale tectonic modelling combined with fault mapping using high quality deep seismic on both margins.

We will show the development of Jurassic and Cretaceous models, several plays, including Jurassic carbonates, delta and deep marine reservoir systems, sourced locally or from deeper syn-rift lacustrine sediments. Extensive large-scale salt related structures show potential of a high value petroleum province on both sides of the Atlantic. The play evaluations are based on a rigorous understanding of sequence stratigraphy built on existing and new biostratigraphic and seismic stratigraphic studies.

Selected References

Gradstein, F.M. and J.G. Ogg, 2004, Recommended color coding of stages, *in* F.M. Gradstein, J.G. Ogg, and A.G. Smith (eds.) A geologic time scale 2004, p. 465-468.

Haq, B.U., J. Hardenbol, and P.R. Vail, 1987, The chronology of the fluctuating sea level since the Triassic: Science, v. 235, p. 1156-1167.

Labails, C. and J-L Olivet, 2007, The South Moroccan margin and the first phases of Central Atlantic opening (French): C. Labails PhD thesis University of Bretagne Occidentale, Brest, France, 2 volumes, 215 p.

Shimeld, J., 2004, A comparison of salt tectonic subprovinces beneath the Scotian slope and Laurentian Fan, 24th Annual GCS-SEPM Foundation Bob F. Perkins Research Conference, Houston, p. 502-532, CD-Rom.

Wade, J.A., 2000, Depth to pre-Mesozoic and pre-Carboniferous basements: Geological Survey of Canada Open-File Report 3842, scale 1:250,000, 1 sheet.

Wade, J.A., B.C. MacLean, and G.L. Williams, 1995, Mesozoic and Cenozoic stratigraphy, eastern Scotian shelf: New interpretations: Canadian Journal of Earth Science, v.32, .1462-1473.

Wade, L., R. Wang, and M.A. Horton, 1993, Estimation of mechanical rock properties using wireline geophysical measurements: Institution of Mining and Metallurgy Transactions, Section A Mining Industry, v. 102, p. 1-70.

NEW INSIGHTS INTO THE HYDROCARBON PROSPECTIVITY OF OFFSHORE NOVA SCOTIA

Hamish Wilson – RPS Energy

On behalf of the OETR PFA project team

Challenges to exploration .....its the Geology

- Inability to predict reservoir
- Lack of a world class source rock and an understanding of the ‘petroleum system’

……the Nova Scotia Department of Energy provided the funding to the research organisation, OETR to commission the PFA project..


NOVA SCOTIA
Department of Energy


OETR

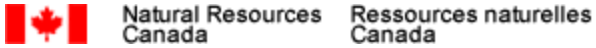

RPS Energy


CNSOPB
CANADA-NOVA SCOTIA
OFFSHORE PETROLEUM BOARD


DALHOUSIE
UNIVERSITY
Inspiring Minds


CANADA
1842
GEOLOGICAL SURVEY · COMMISSION GÉOLOGIQUE


SAINT MARY'S
UNIVERSITY
SINCE 1802
One University. One World. Yours.


Natural Resources Canada
Ressources naturelles Canada


BeicipFranlab


Ifremer


BioSTRATIGRAPHIC
Associates International


TGS


GeoPro


FUGRO


ion
GX TECHNOLOGY


IHS

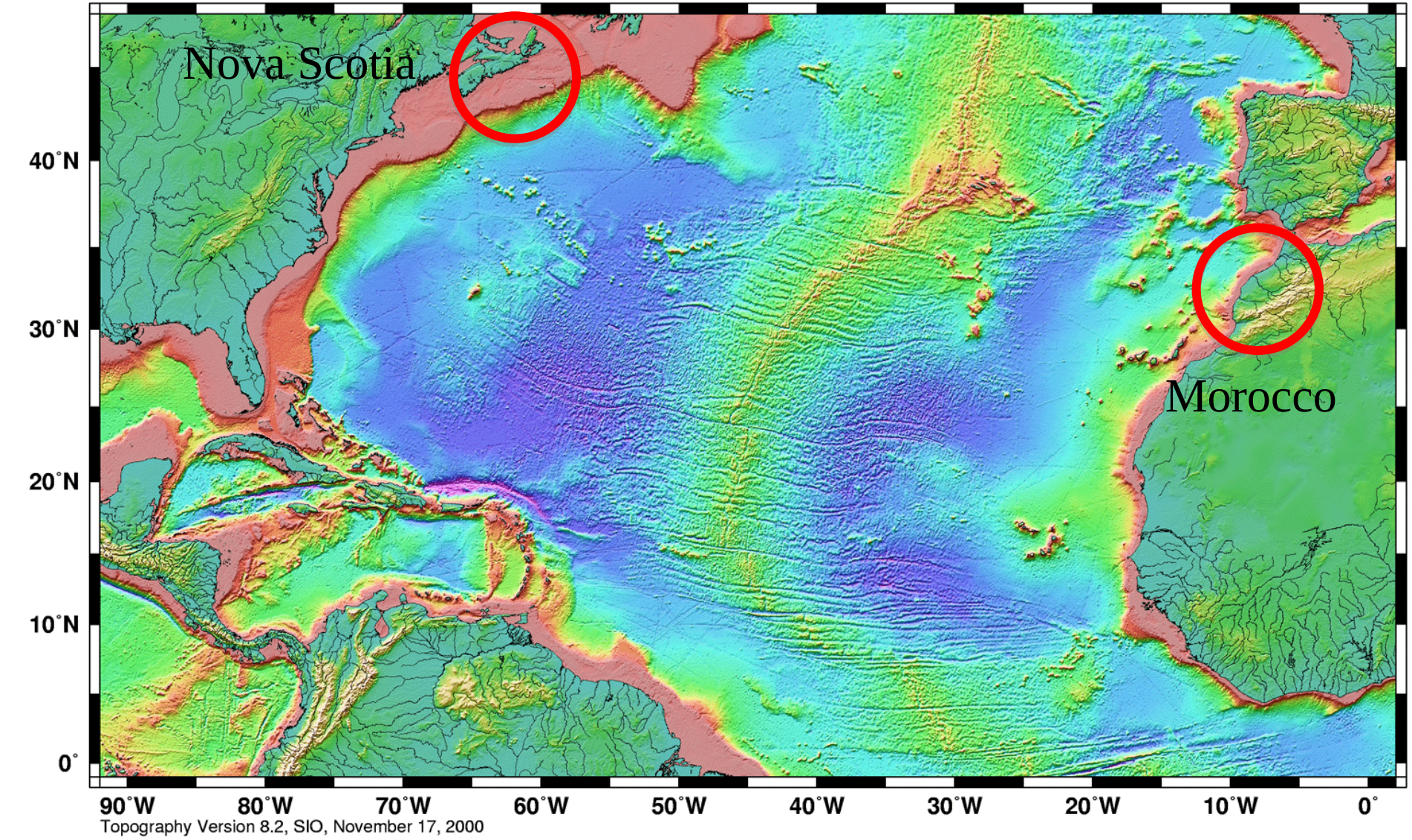

G G
L

RPS Energy

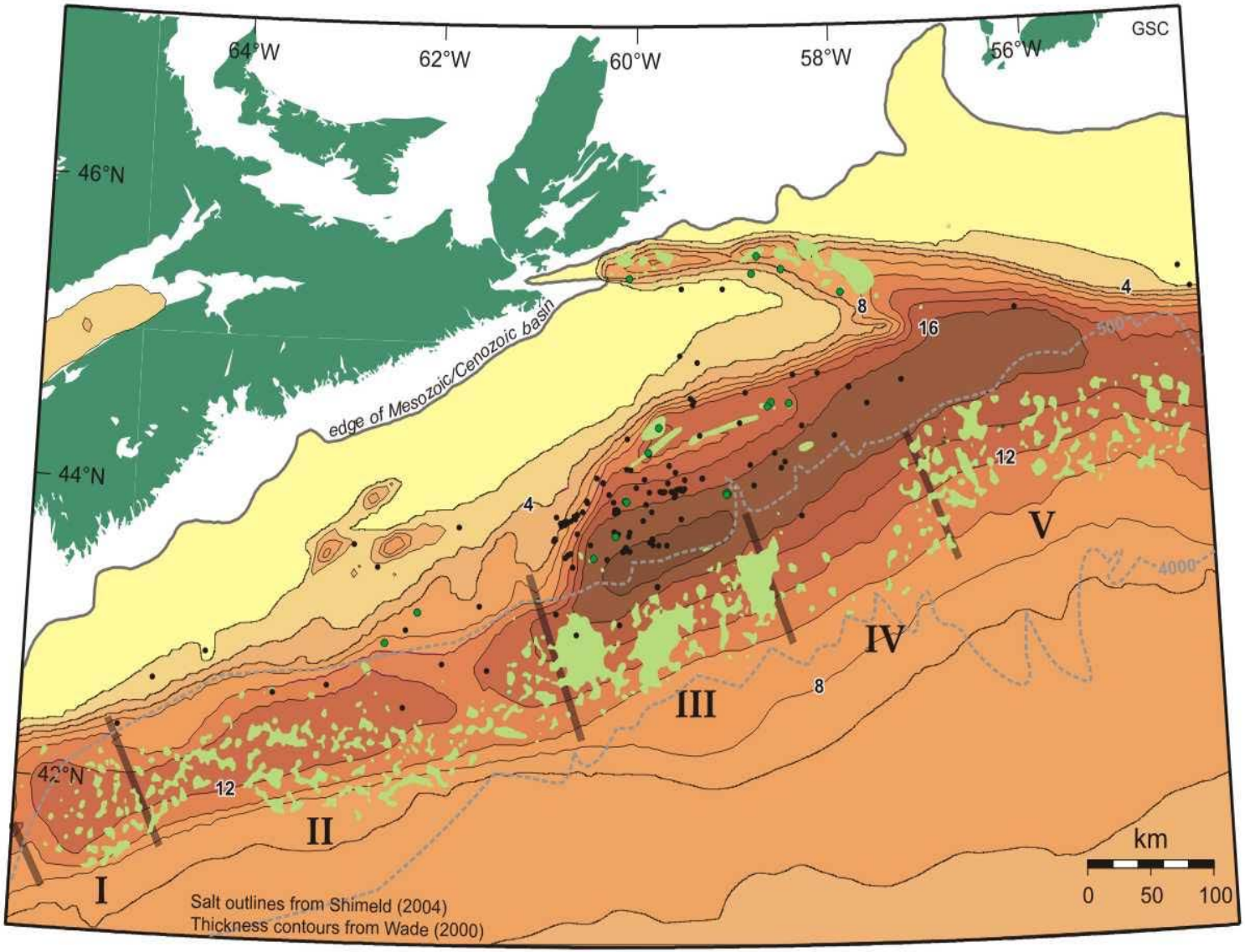
Themes

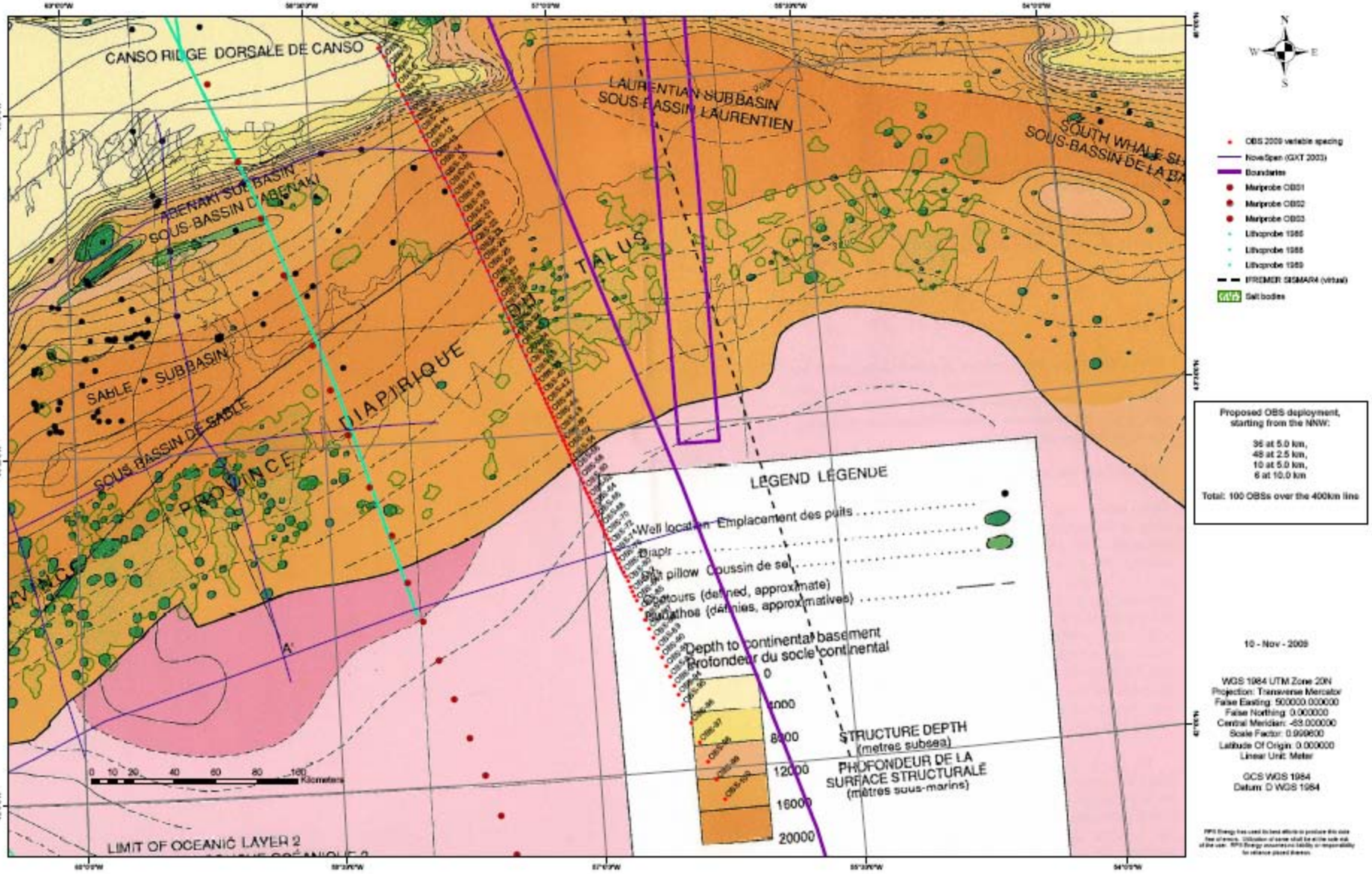
Three important insights that have bearing on prospectivity and understanding risks

- Rift history and relationship between rifting, volcanism, evaporites, and carbonates
- Bio stratigraphy – including an evaluation of the nano fossils has resolved many of the seismic/well ties issues
- Salt interpretation – two phases of salt movement, the first caused by gravity slumping on salt detachment surfaces, and the second diapiric, remobilising the thrust faults

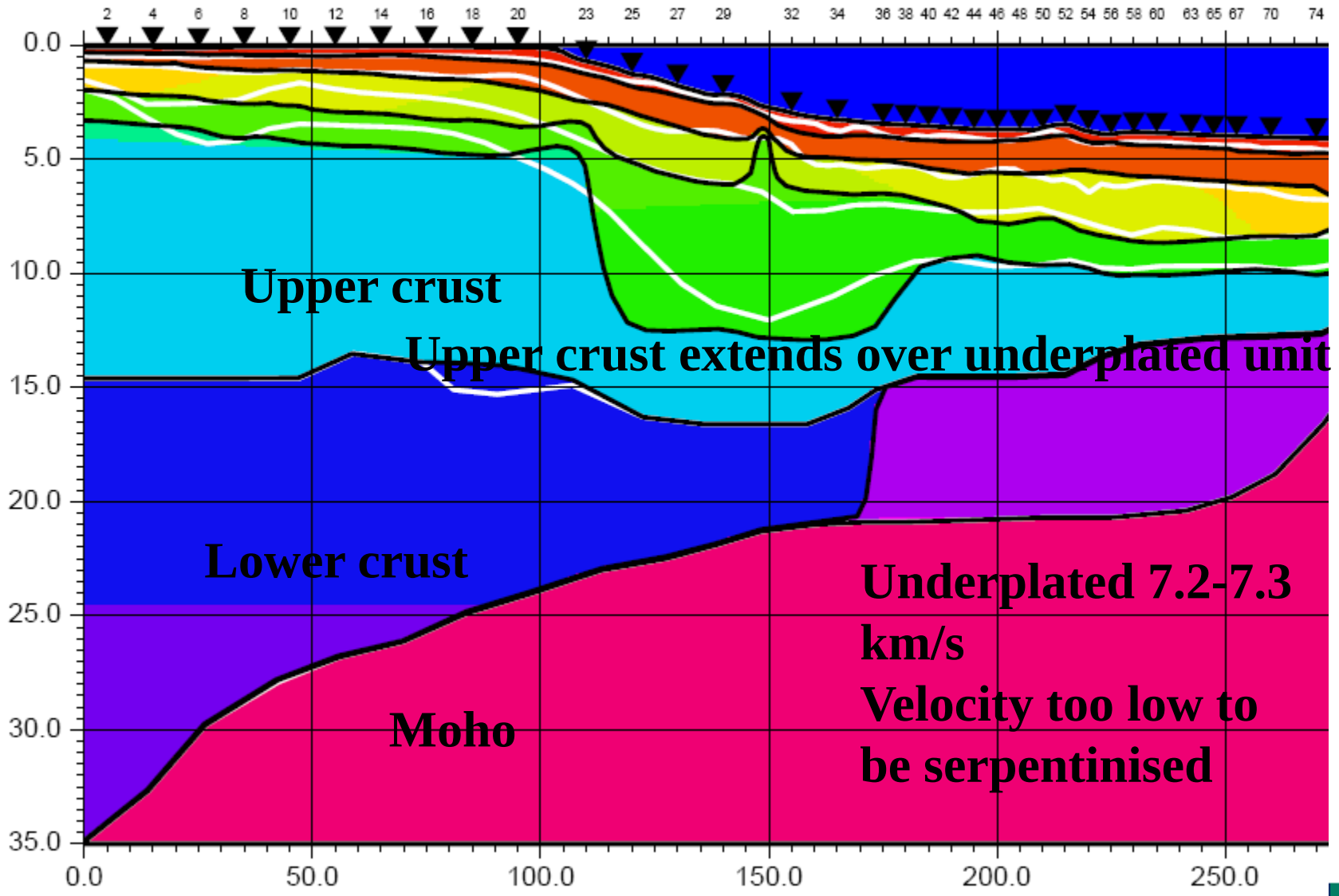


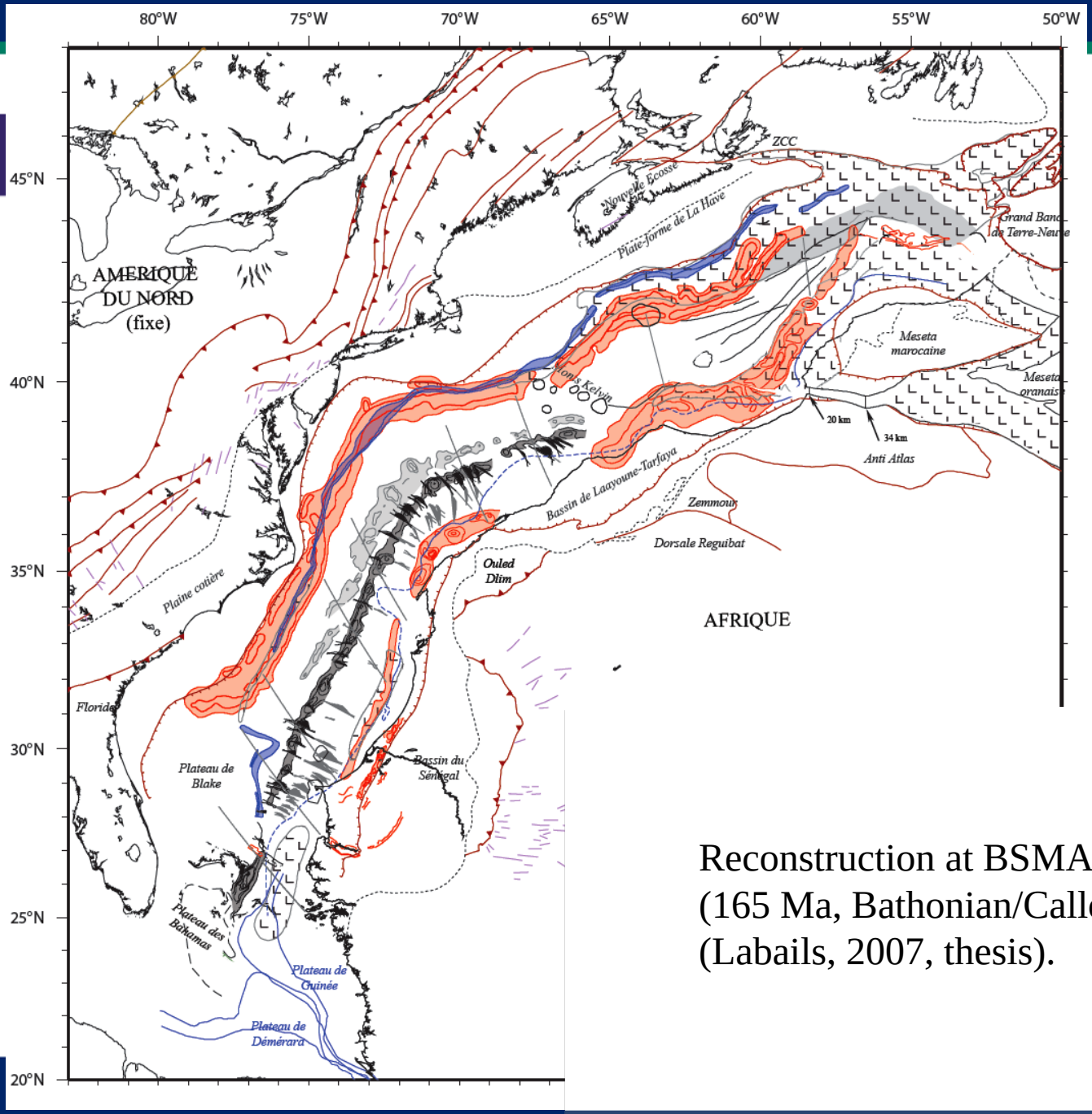
Bathymetry of the Central Atlantic ocean


64°W
62°W
60°W
58°W
56°W
GSC
46°N
44°N
42°N
edge of Mesozoic/Cenozoic basin
4
8
16
12
4
8
500
4000
I
II
III
IV
V
km
0
50
100
Salt outlines from Shimeld (2004)
Thickness contours from Wade (2000)


CANSO RIDGE DORSALE DE CANSO
LAURENTIAN SUB BASIN
SOUS-BASSIN LAURENTIEN
SOUTH WHALE SH
SOUS-BASSIN DE LA BA
ARENAKI SUB BASIN
SOUS-BASSIN D'ARENAKI
SABLE SUBBASIN
SOUS BASSIN DE SABLE
DIAPIRIQUE
PROVINCE
TALUS
DH
A'
LIMIT OF OCEANIC LAYER 2
0 10 20 40 60 80 100 Kilometers
LEGEND LEGENDE
Well location Emplacement des puits
Diapir
Salt pillow Coussin de sel
Contours (defined, approximate)
Isobathes (définies, approximatives)
Depth to continental basement
Profondeur du socle continental
0
4000
8000
12000
16000
20000
STRUCTURE DEPTH
(metres subsea)
PROFONDEUR DE LA
SURFACE STRUCTURALE
(mètres sous-marins)
N
W
E
S
OBS 2009 variable spacing
NovaSpan (GXT 2003)
Boundaries
Manprobe OBS1
Manprobe OBS2
Manprobe OBS3
Lithoprobe 1986
Lithoprobe 1988
Lithoprobe 1989
IFREMER SISMAR4 (virtual)
Salt bodies
Proposed OBS deployment,
starting from the NNW:
36 at 5.0 km,
48 at 2.5 km,
10 at 5.0 km,
6 at 10.0 km
Total: 100 OBSs over the 400km line
10 - Nov - 2009
WGS 1984 UTM Zone 20N
Projection: Transverse Mercator
False Easting: 500000.000000
False Northing: 0.000000
Central Meridian: -63.000000
Scale Factor: 0.999600
Latitude Of Origin: 0.000000
Linear Unit: Meter
GCS WGS 1984
Datum: D WGS 1984

Forward Modeling Nova Scotia 2



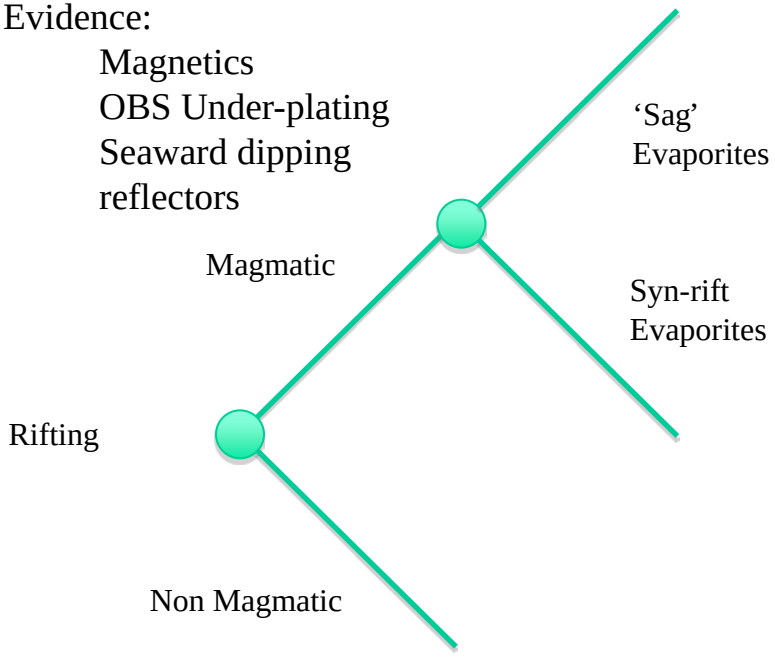


Reconstruction at BSMA
(165 Ma, Bathonian/Callovian limit)
(Labails, 2007, thesis).

DETERMINING THE RIFTING MODEL

Evidence:

- Magnetics
- OBS Under-plating
- Seaward dipping reflectors



Evidence:

- Non faulted base salt (i.e.flat)
- Age of salt ('young')
- Marine source rocks
- Low relief post rift topography

Evidence:

- Faulted base salt – salt in the rifts
- Age of salt ('old')
- Lacustrine source rocks
- High relief post rift topography

OETR Play Fairway Analysis – Biostratigraphy Project

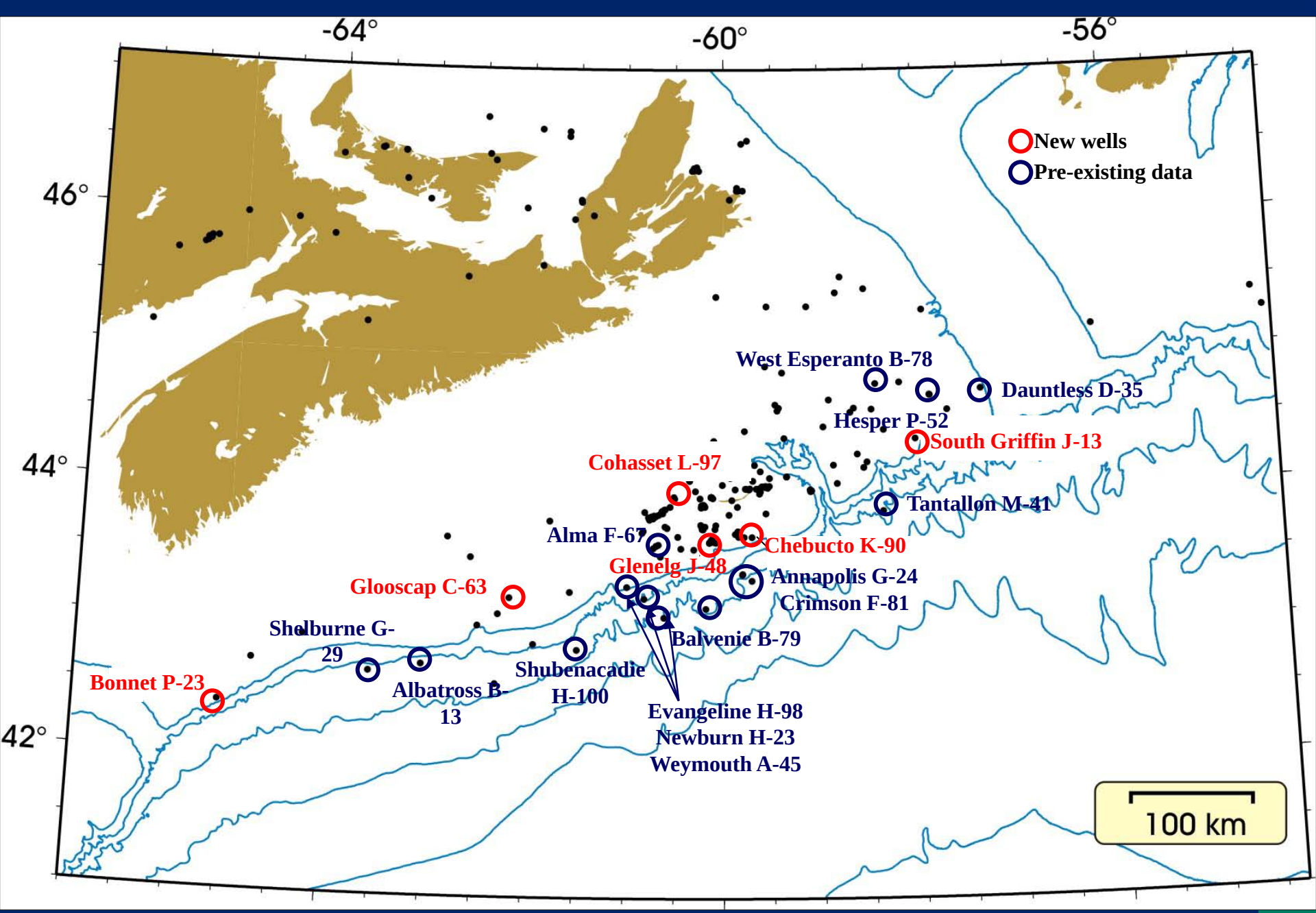
Aims of the project:

- To provide calibration of the seismic surfaces from well penetrations;
- To quantify major stratigraphic breaks within the well sections and suggest their local/regional extent;
- To determine depositional environments at the well locations and how these change with time.

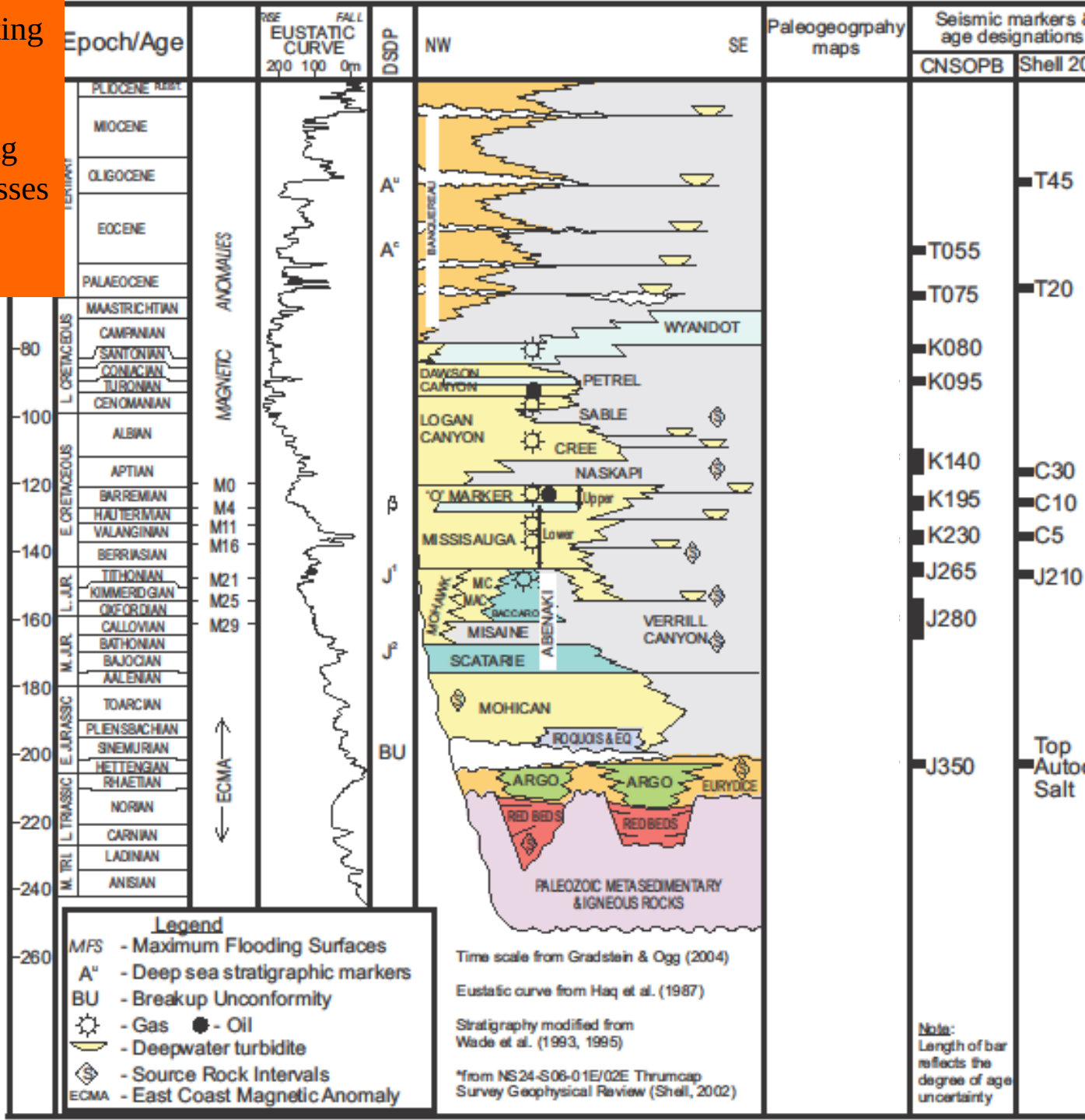
OETR Play Fairway Analysis – Biostratigraphy Project

Based on:

- Integrated new quantitative micropalaeontological, nannofossil and palynological data from 900 samples from 6 wells;
- Integration and interpretation of pre-existing biostratigraphic data from 14 additional wells;
- Wells chosen to provide maximum geographic spread and stratigraphic penetration across the outer shelf to slope area;
- All wells chosen are tied to seismic;
- All biostratigraphic data are integrated with wireline and seismic data through several iterations.


-64°
-60°
-56°
46°
44°
42°
New wells
Pre-existing data
West Esperanto B-78
Dauntless D-35
Hesper P-52
South Griffin J-13
Cohasset L-97
Tantallon M-41
Alma F-67
Chebucto K-90
Glenelg J-48
Annapolis G-24
Crimson F-81
Glooscap C-63
Balvenie B-79
Shelburne G-29
Shubenacadie H-100
Albatross B-13
Bonnet P-23
Evangeline H-98
Newburn H-23
Weymouth A-45
100 km

Previous problems of integrating results from different biostratigraphic disciplines appears to be due to reworking caused by gravity-flow processes on the palaeo-delta slope



RPS Energy

Albian/Aptian boundary

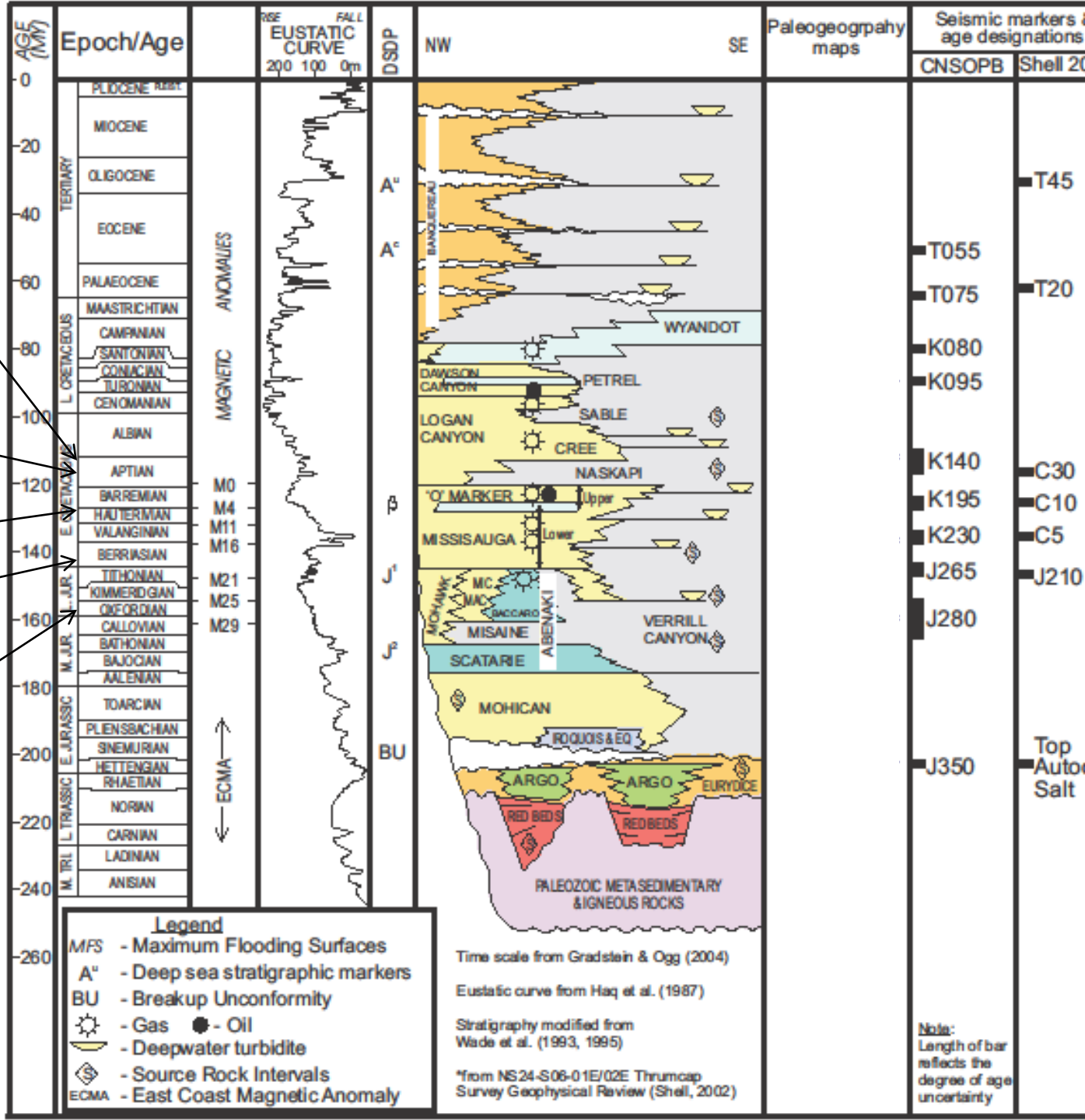
Intra-Aptian age

Intra-Hauterivian age

Tithonian age

Top Callovian age

MFS

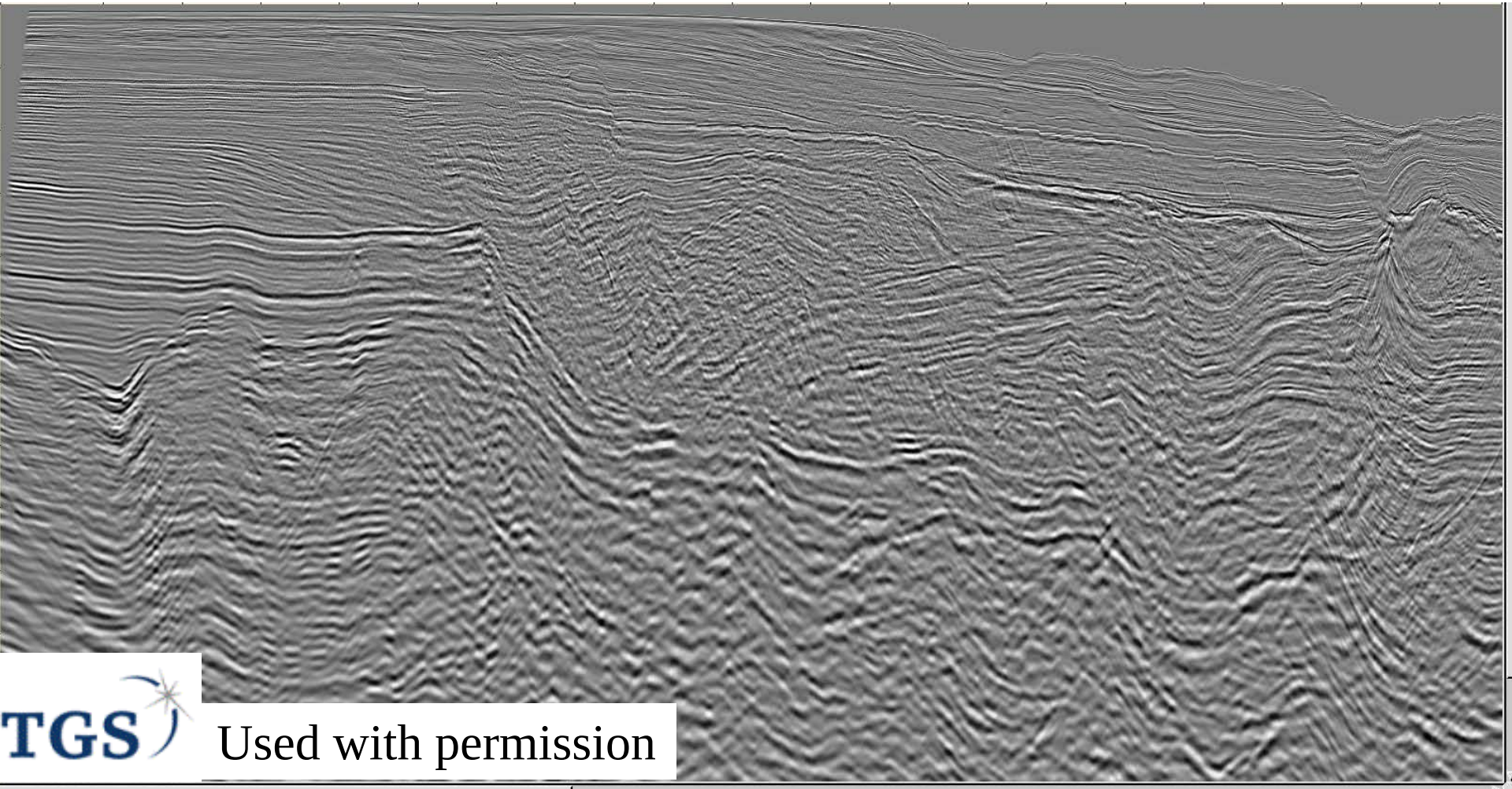


Salt interpretation

- Based on reprocessed TGS and GXT seismic data and an extensive 3D grid of the core exploration area
- Enhanced imaging
  - Combined with bio stratigraphy
  - Improved salt model

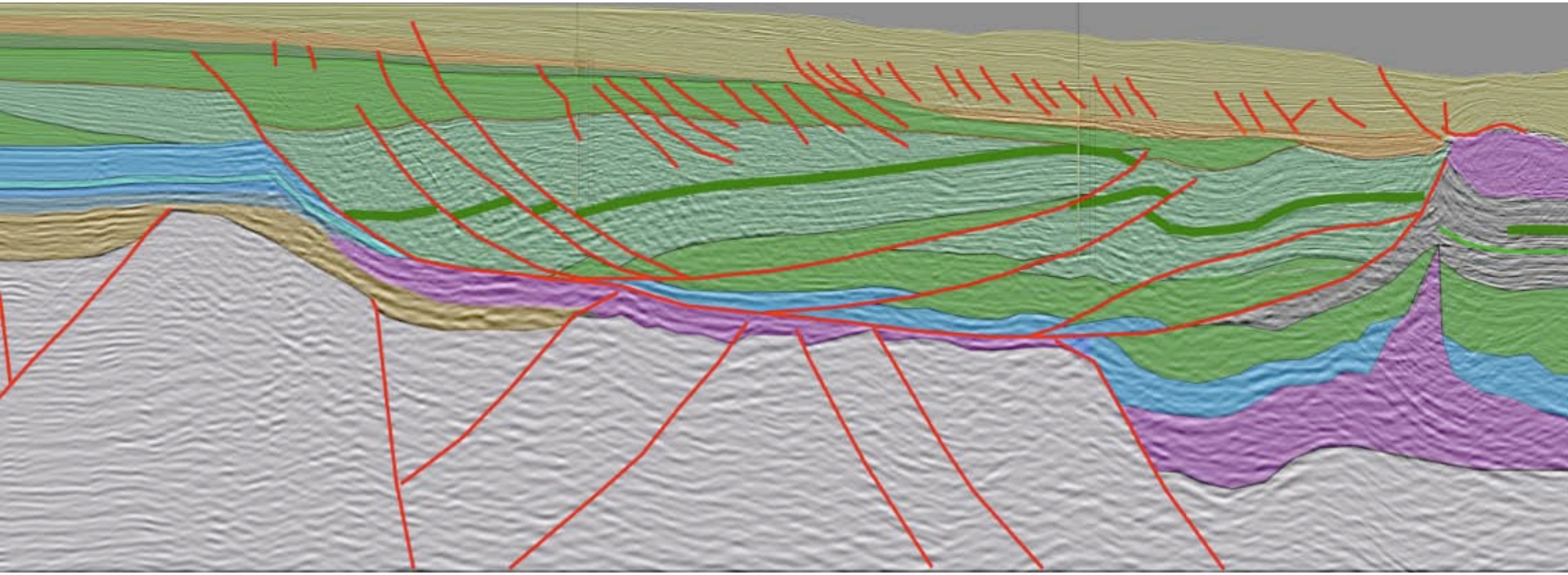
……..Revised salt interpretation…..

Reprocessed TGS Dip Line



TGS Used with permission

Preliminary Interpretation model



TGS Used with permission

BeicipFranlab