Hydrocarbon Potential of the Jurassic Source Rock in the Guiana Basin*

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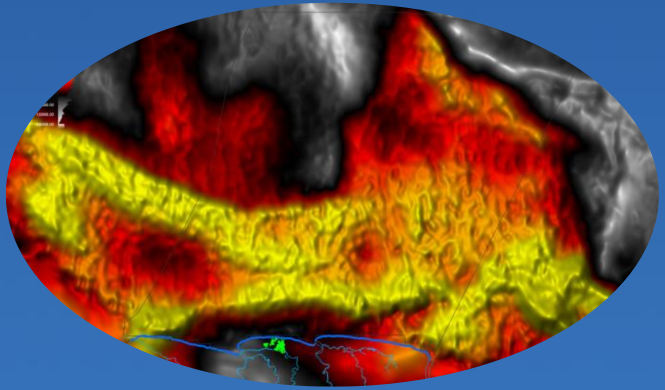
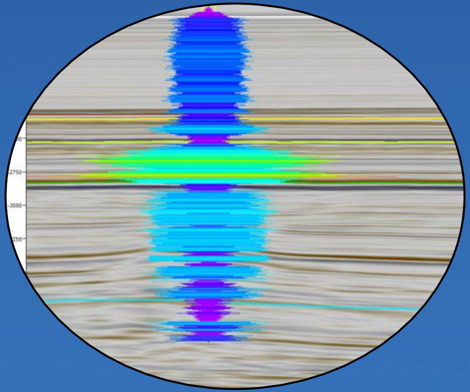
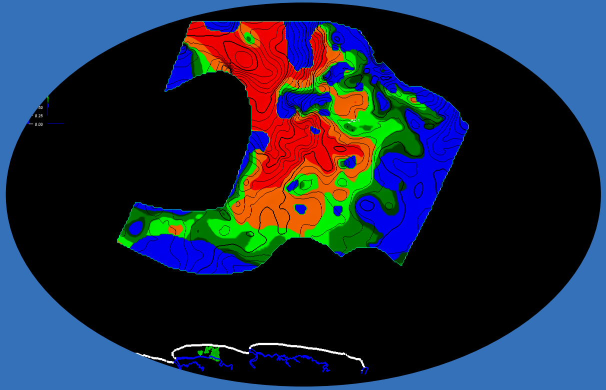
Abstract

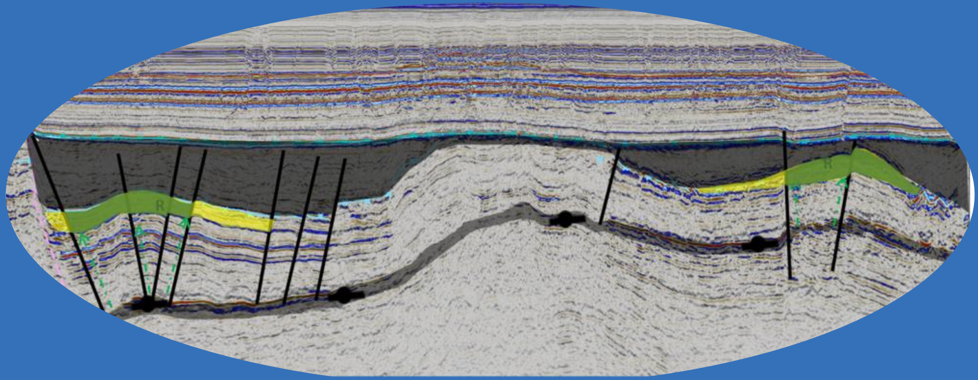
Mid- to upper-Jurassic age source rocks, and their related petroleum systems, have played a major role in generating some of the world's largest oil and gas fields. Middle-Upper Jurassic source rocks are mainly found in the Middle East (Hanifa-Naokelkan-Sargelu-Dukhan formations), the Caspian region (various formation names), West Siberia (Bazhenov Formation), North Sea (Kimmeridgian Clay), and Gulf of Mexico (Haynesville Shale). These rocks are predominantly marine shale and marly limestone with kerogen types II and III and have charged Upper Jurassic to Cretaceous oil and gas reservoirs The Guyana – Suriname basin displays the geologic elements described above. Mid to late Jurassic age graben structures, filled with syn-rift sediments, overlain by post rift, passive margin, prograding marine sediments from mid Cretaceous to present can be identified on seismic lines offshore Suriname. None of these graben structures have been penetrated by wells. The questions therefore are; 'Is there mature source rock and related petroleum systems within the grabens of the Guyana – Suriname Basin like that of the North Sea graben and the Kimmeridgian Petroleum System?" "How much hydrocarbons have been generated" "What are the implications for the Suriname part of the Guiana Basin" Analysis of crude oil in the Upper Cretaceous reservoirs onshore Suriname revealed the presence of a possible Mid Jurassic Source Rock. These oils were described as having been derived from an unknown source rock, probably strongly restricted lacustrine environment, of Jurassic or less likely Cretaceous age. All onshore Cretaceous oil impregnations and some Palaeocene oils analyzed, fall in this category. It is believed that this oil was generated by source rocks within the Jurassic grabens and is likely to be part of an intra-grabenal petroleum system that has not yet been drilled. The evidence presented indicate: The Jurassic source rock is mature for hydrocarbon generation. The Jurassic source rock has the generated tremendous amounts of hydrocarbons The Jurassic source rock in the Suriname part of the Guiana basin can play an important role within the oil and gas industry for Suriname.

Hydrocarbon Potential of the Jurassic Source Rock in the Guiana Basin







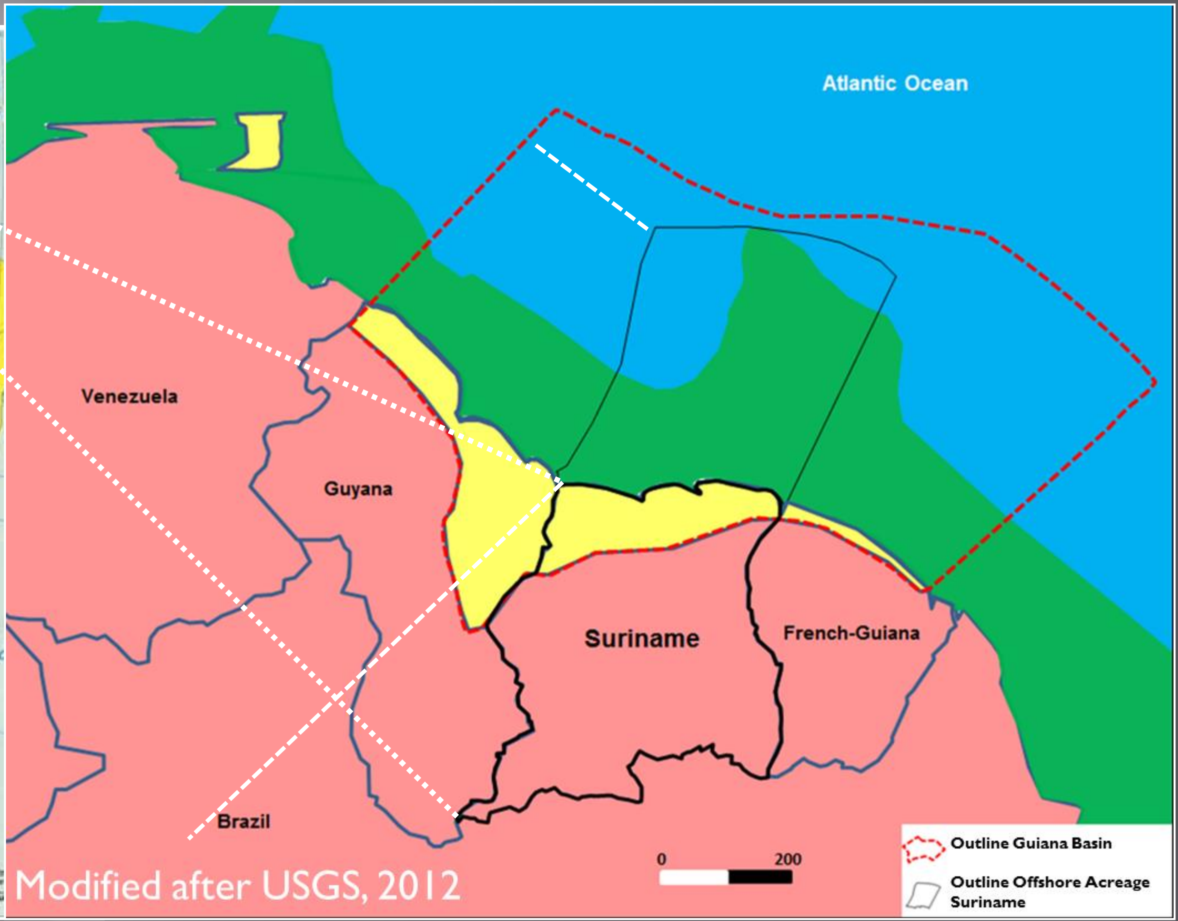


Cape Town, 07 November 2018   Clyde Griffith MSc

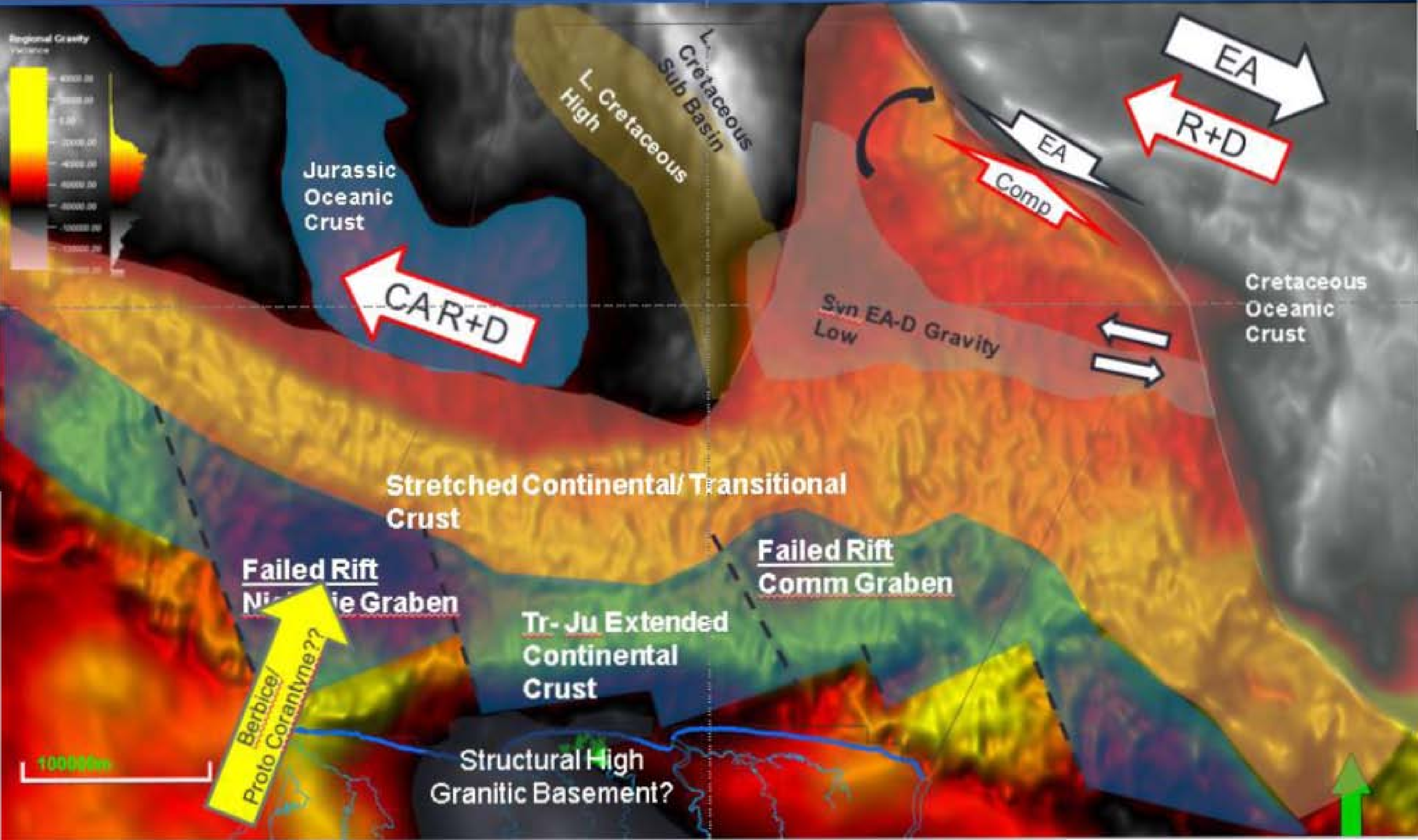
Outline

- ✓Geological Setting
- ✓Tectonic Evolution
- ✓Source Rock Potential
- ✓Workflow
- ✓Assumptions & Limitations
- ✓Results
- ✓Conclusions
- ✓Recommendations

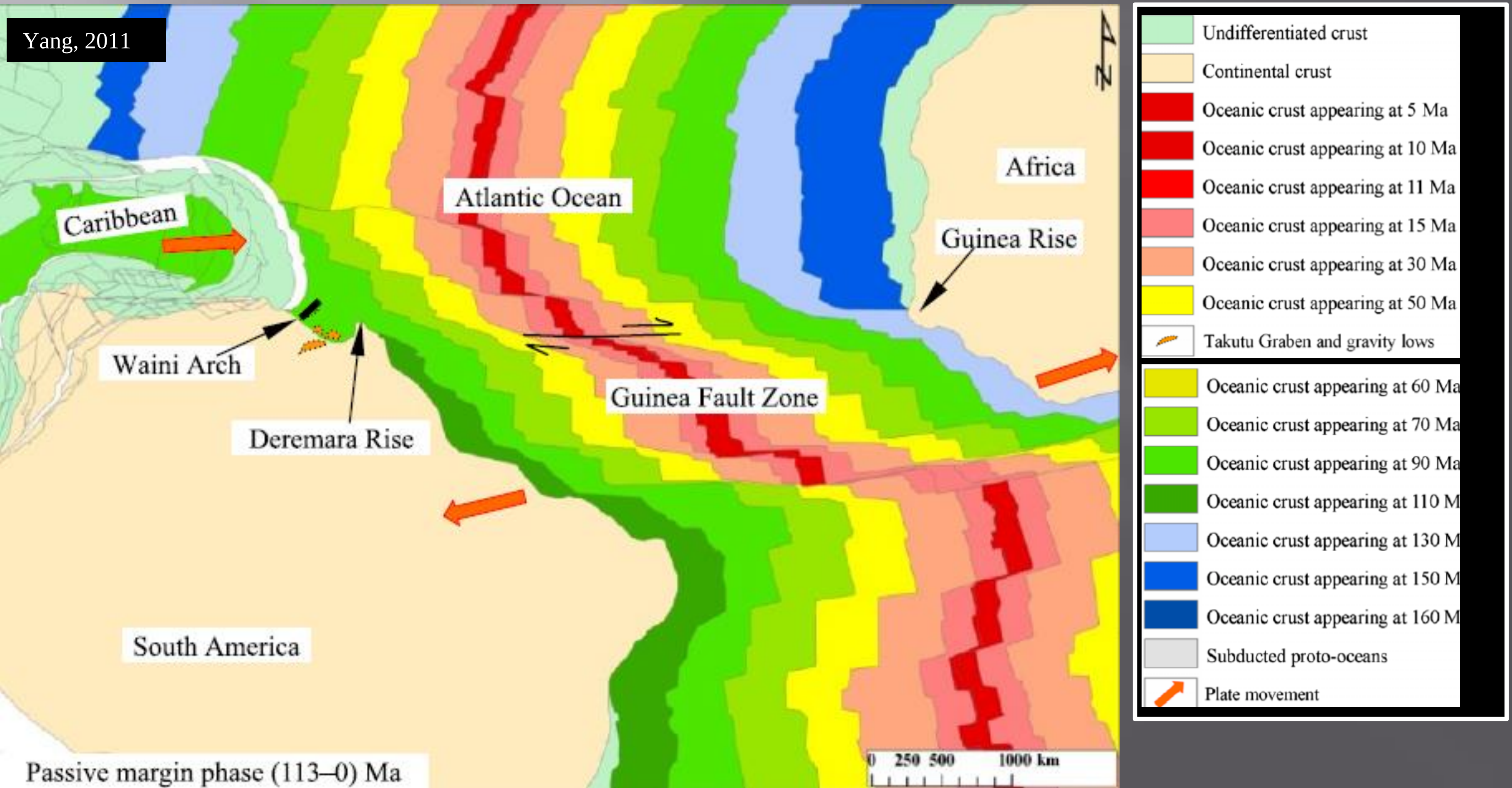
Geological Setting



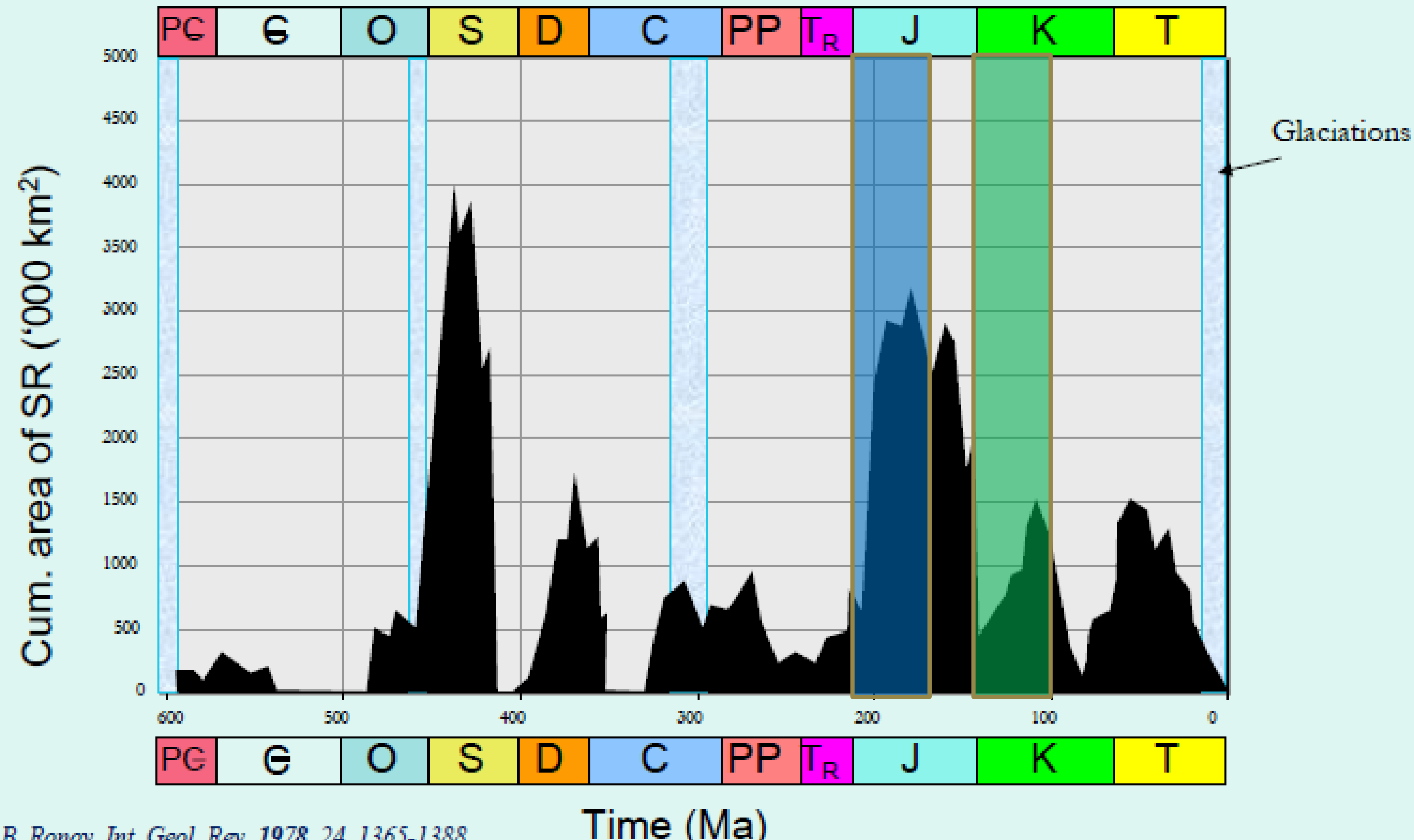
Tectonic Evolution



Passive Margin

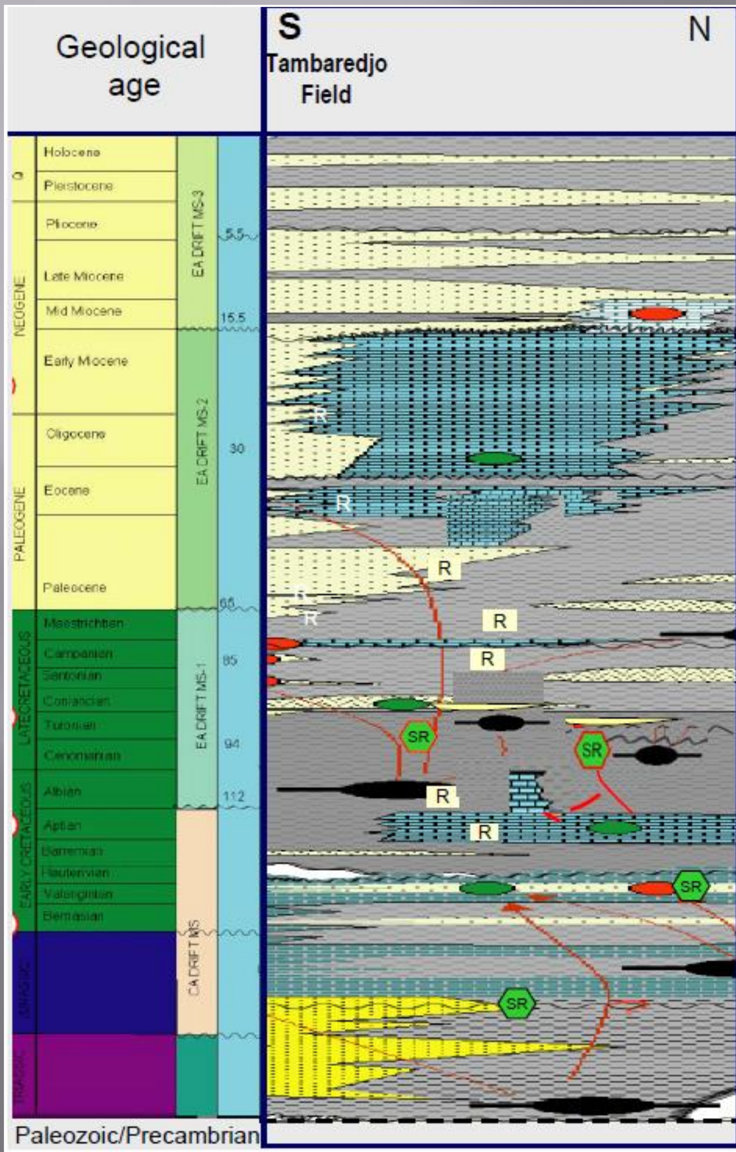


Source Rock Potential



After A.B. Ronov, Int. Geol. Rev, 1978, 24, 1365-1388

Source Rock Potential



Basinal Area, Tertiary, immature, Type II/III?, **Abary well**

Basinal Area, ACT, TOC, 0.70 - 16.00, Vre 0 - 0.85, Type II/III, immature – early mature, **several wells**

Demerara Plateau, early mature, **A2-1 well**

Demerara Plateau, Mid Jurassic, Type I?, TOC 1.5?, immature, **A2-1 Well**

Takutu Graben, E-M Jurassic (Type I, VRe 0.2 - 3), immature – over mature, **Robertson Research, 1981**

Indications

1. Oil from Onshore Cretaceous: An unknown source rock, probably strongly restricted, **lacustrine of Jurassic** or less likely **Cretaceous** age.
   I. All these severely biodegraded samples have carbon isotopes (whole oil) between –24.0 and –24.8 o/oo
   II. Characteristic biomarkers (such as: low 3R/5R-hopane ratio, high 24/4R, high gammacerane, and a C29-sterane predominance).

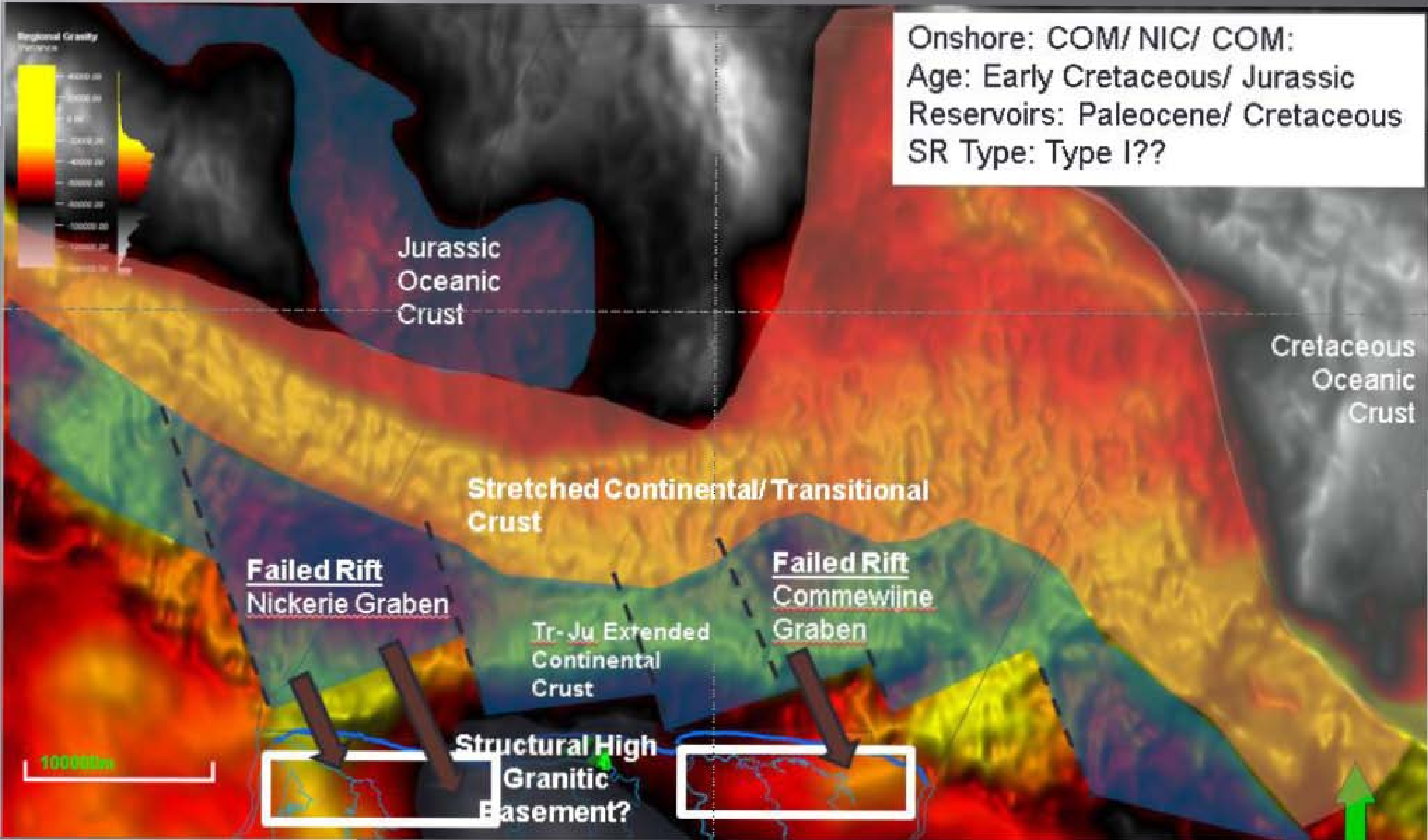
- In addition, offshore well A2-1, drilled on the Demerara Plateau, penetrated Syn Rift **Middle Jurassic Source Rock** with TOC 1-2%.
- Similarly, the Takutu Graben of onshore Guyana, interpreted as a failed arm of the **Early Jurassic** North Atlantic rifting, has proven source rock with TOC <2.5%.

CURRENT ACTIVITIES

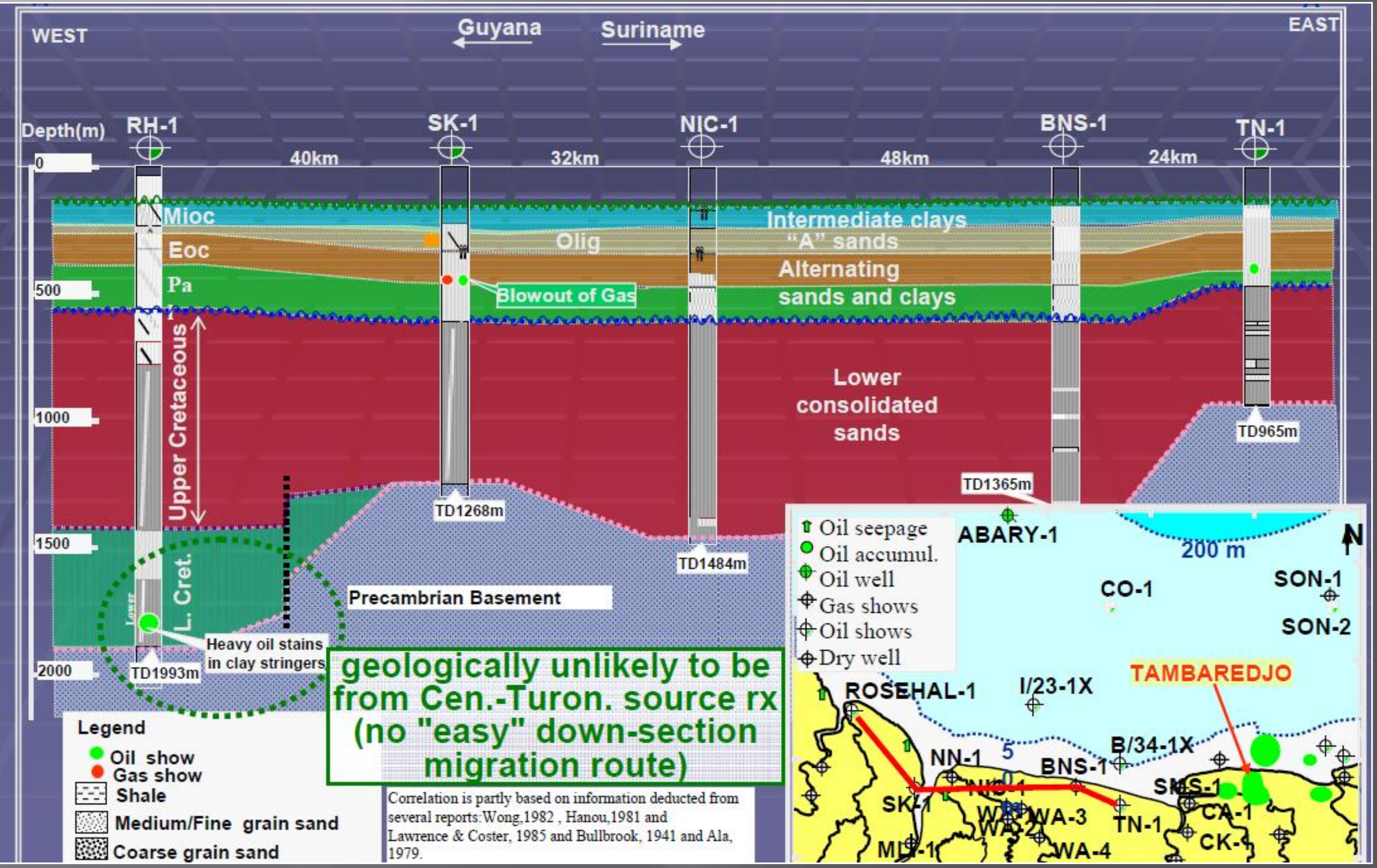
EXPLORATION & APPRAISAL

In October 2017, the Araku-1 exploration well in Suriname was drilled to a total depth of 2,685 metres and no significant reservoir quality rocks were encountered. The well has been plugged and abandoned. Logging and sampling proved the presence of gas condensate, which in combination with high quality 3D seismic data, has de-risked deeper plays which offer significant future exploration potential in the Group's acreage. See full Araku Press Release.

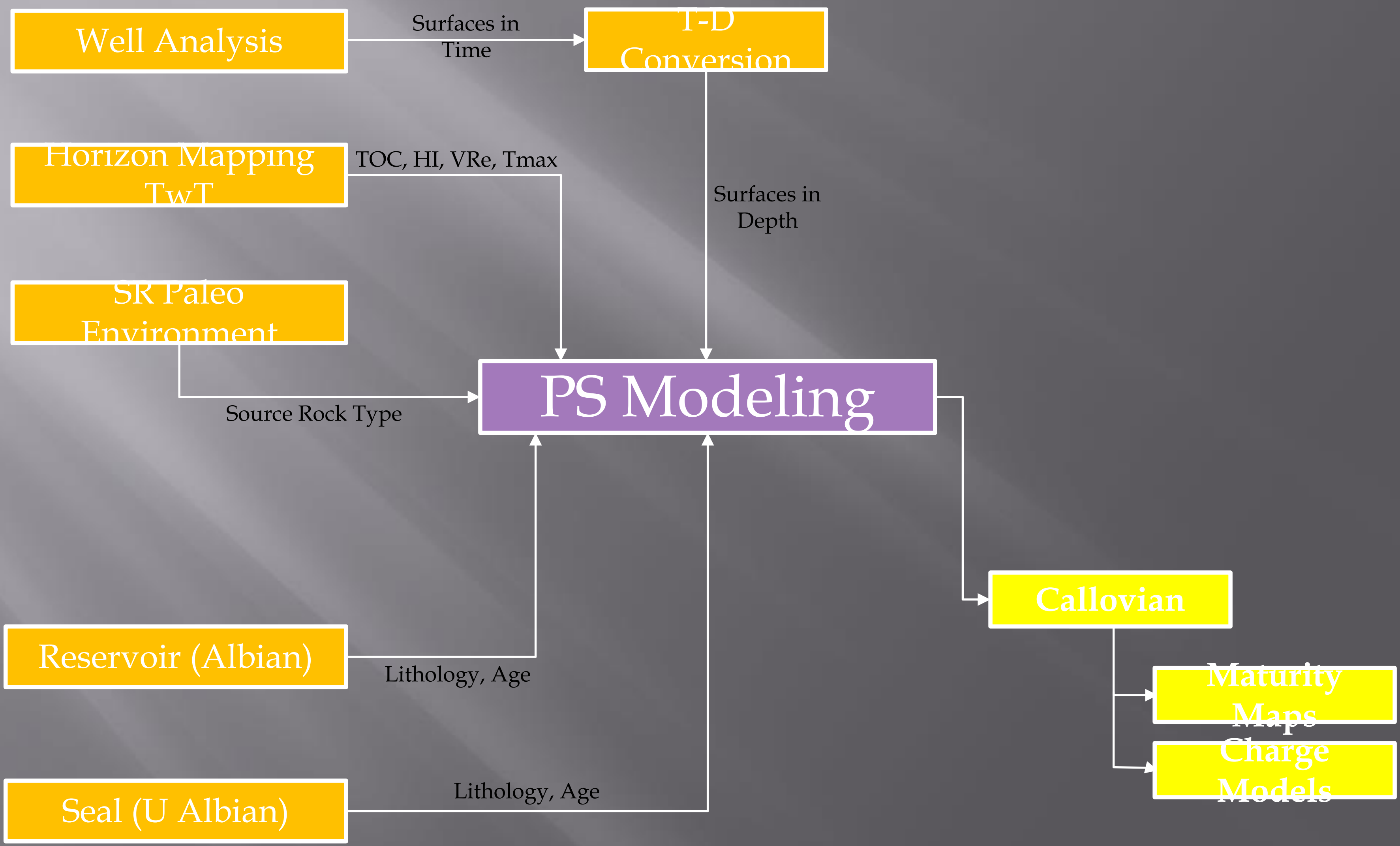
Onshore Oil Correlation Suriname



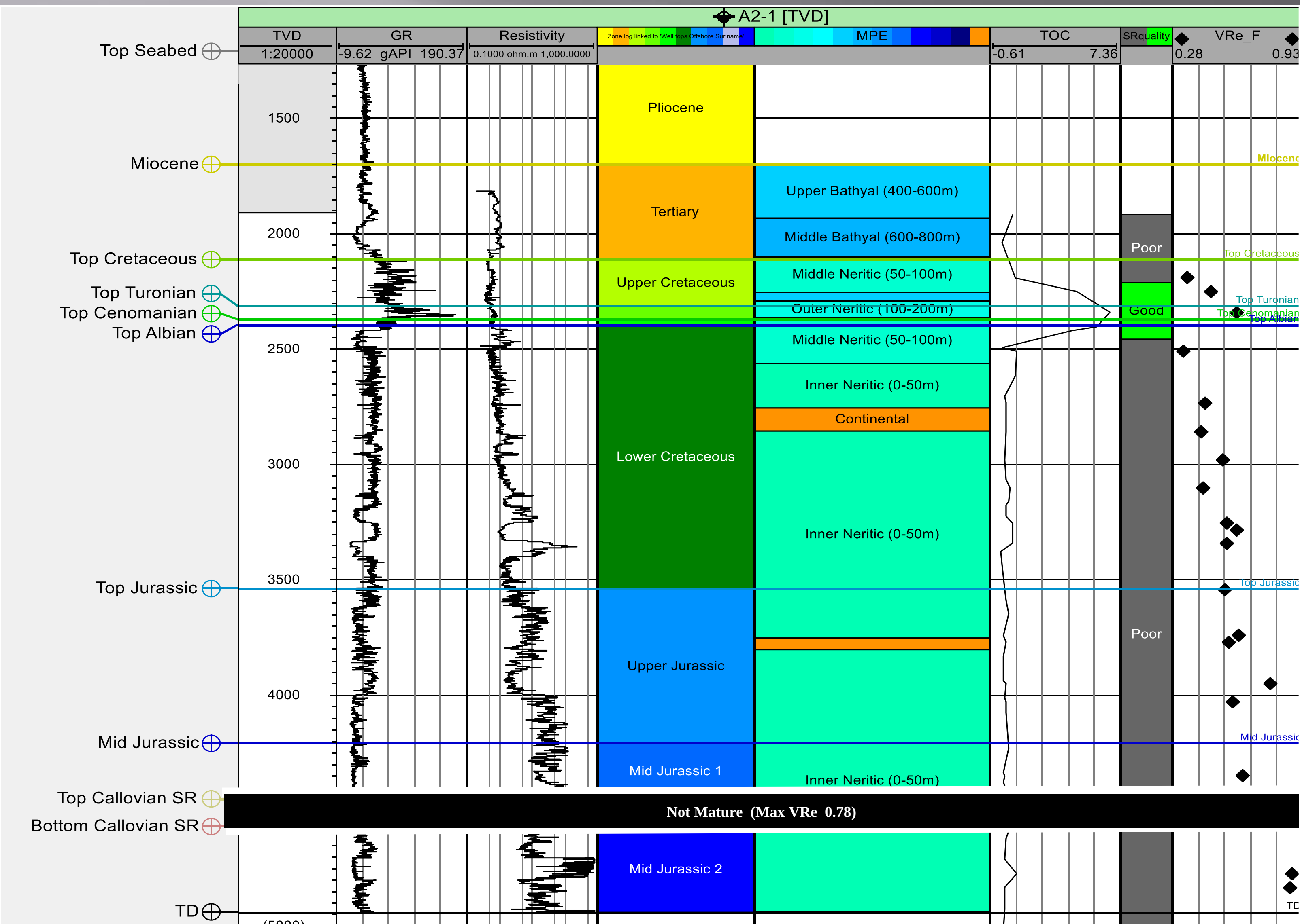
Onshore Oil Correlation Guyana



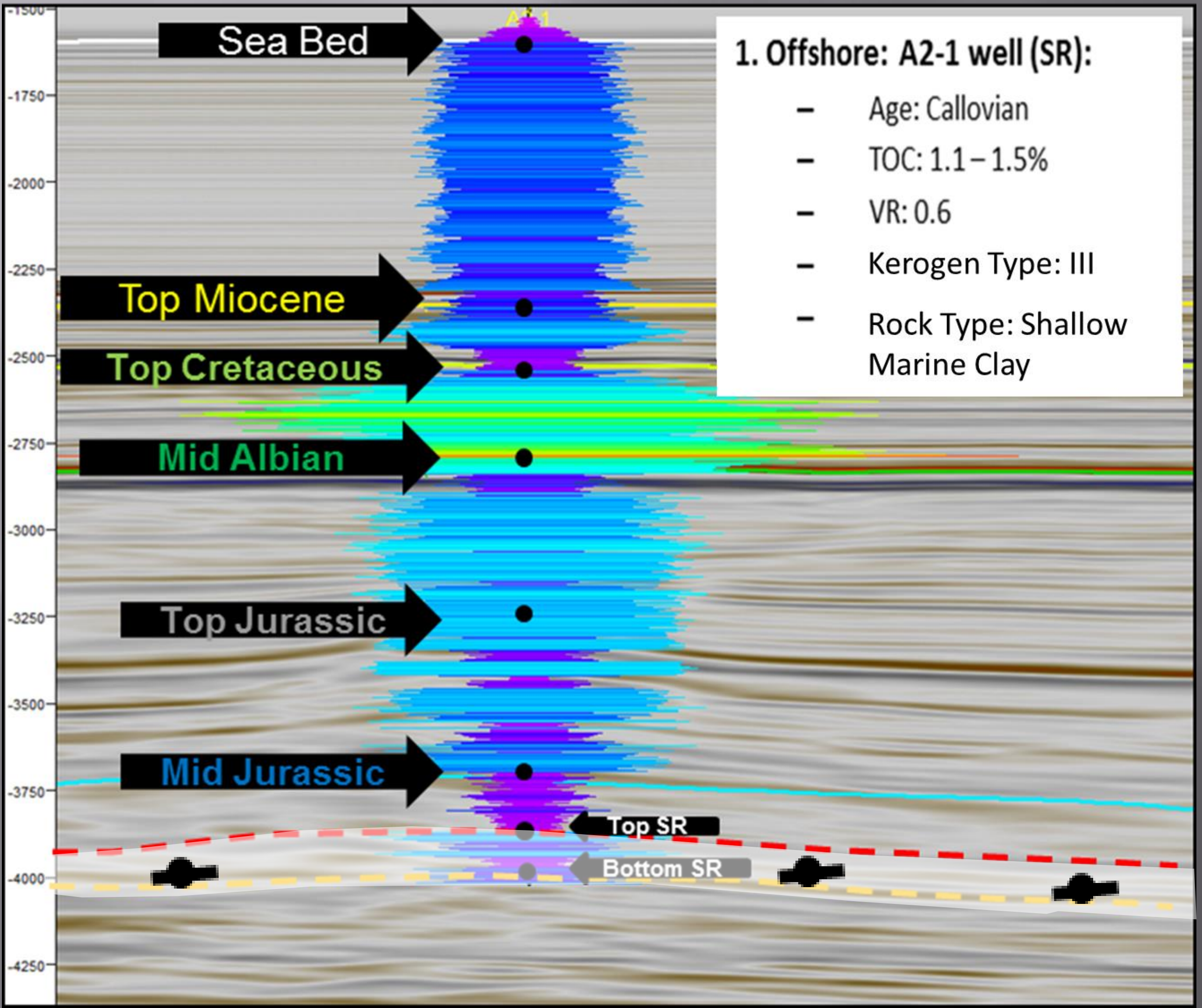
Workflow


Well Analysis
Surfaces in Time
T-D Conversion
Horizon Mapping TwT
TOC, HI, VRe, Tmax
Surfaces in Depth
SR Paleo Environment
Source Rock Type
PS Modeling
Callovian
Reservoir (Albian)
Lithology, Age
Maturity Maps
Charge Models
Seal (U Albian)
Lithology, Age

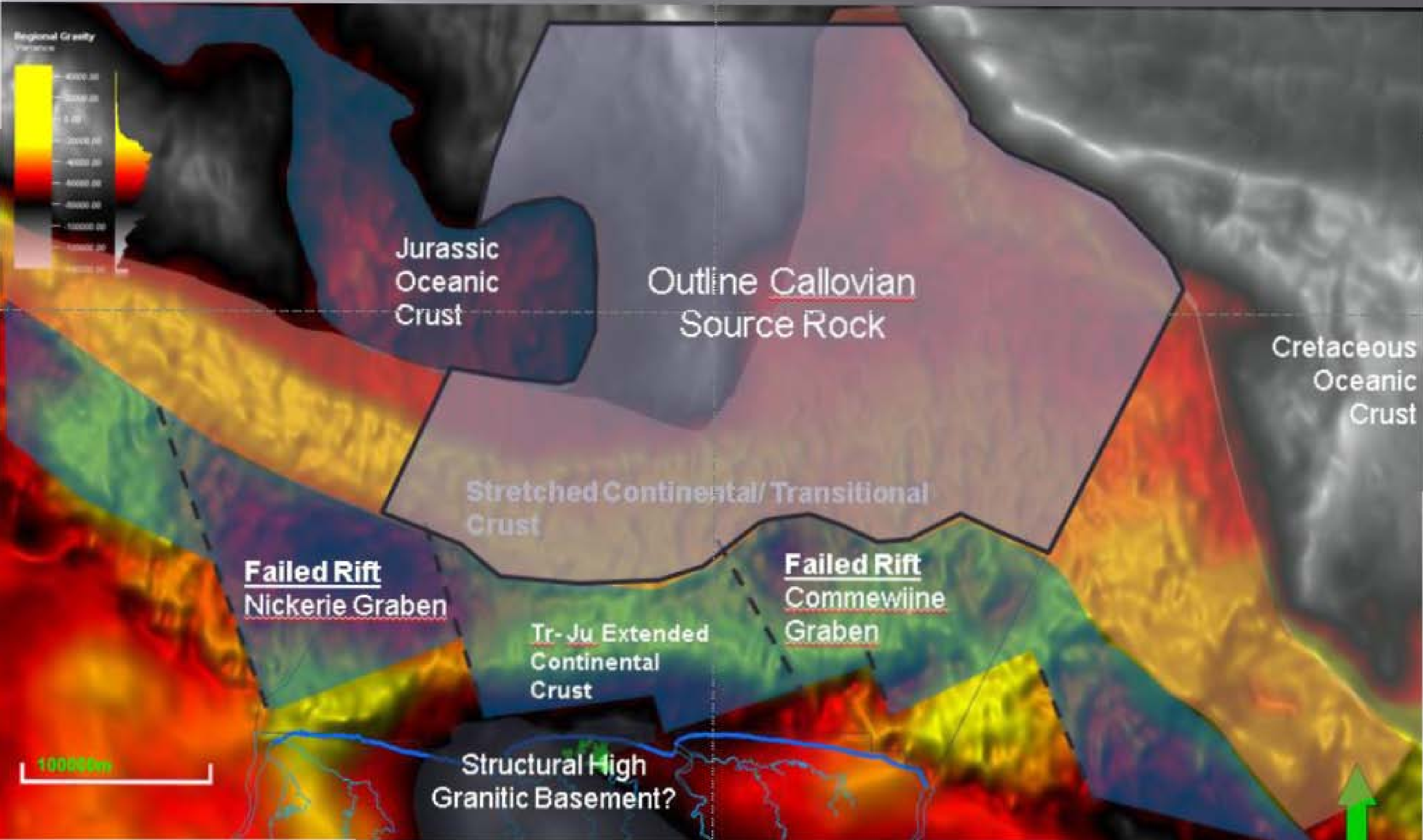
Well Analysis

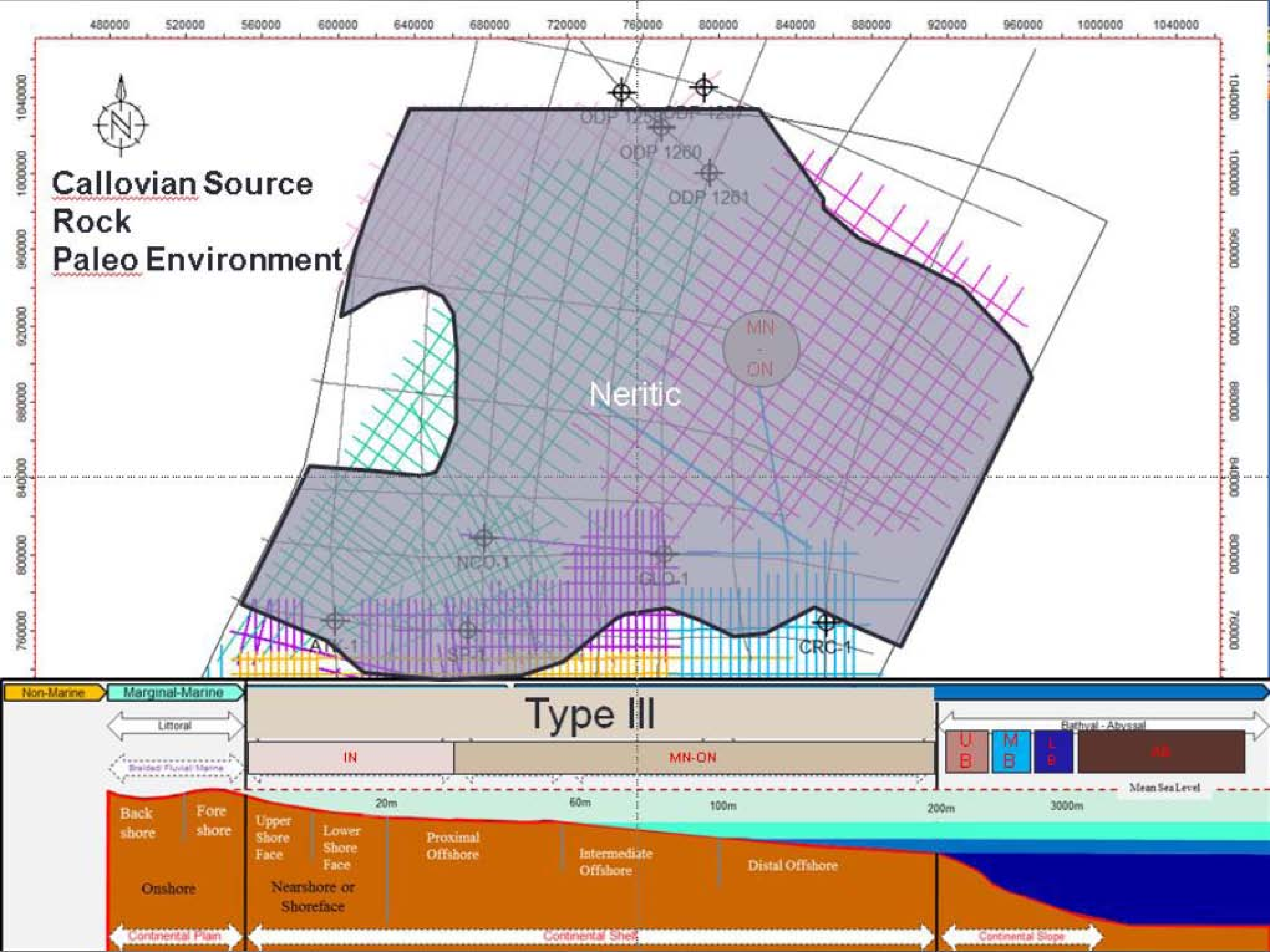


Well Analysis



Outline Callovian Source Rock





Callovian Source Rock
Paleo Environment
480000
520000
560000
600000
640000
680000
720000
760000
800000
840000
880000
920000
960000
1000000
1040000
ODP 1260
ODP 1261
Neritic
MN
-
ON
NCO-1
GLO-1
SP-1
CRC-1
Non-Marine
Marginal-Marine
Littoral
Type III
IN
MN-ON
Bathyal - Abyssal
U B
M B
L B
AB
Mean Sea Level
20m
60m
100m
200m
3000m
Back shore
Fore shore
Upper Shore Face
Lower Shore Face
Proximal Offshore
Intermediate Offshore
Distal Offshore
Onshore
Nearshore or Shoreface
Continental Plain
Continental Shelf
Continental Slope

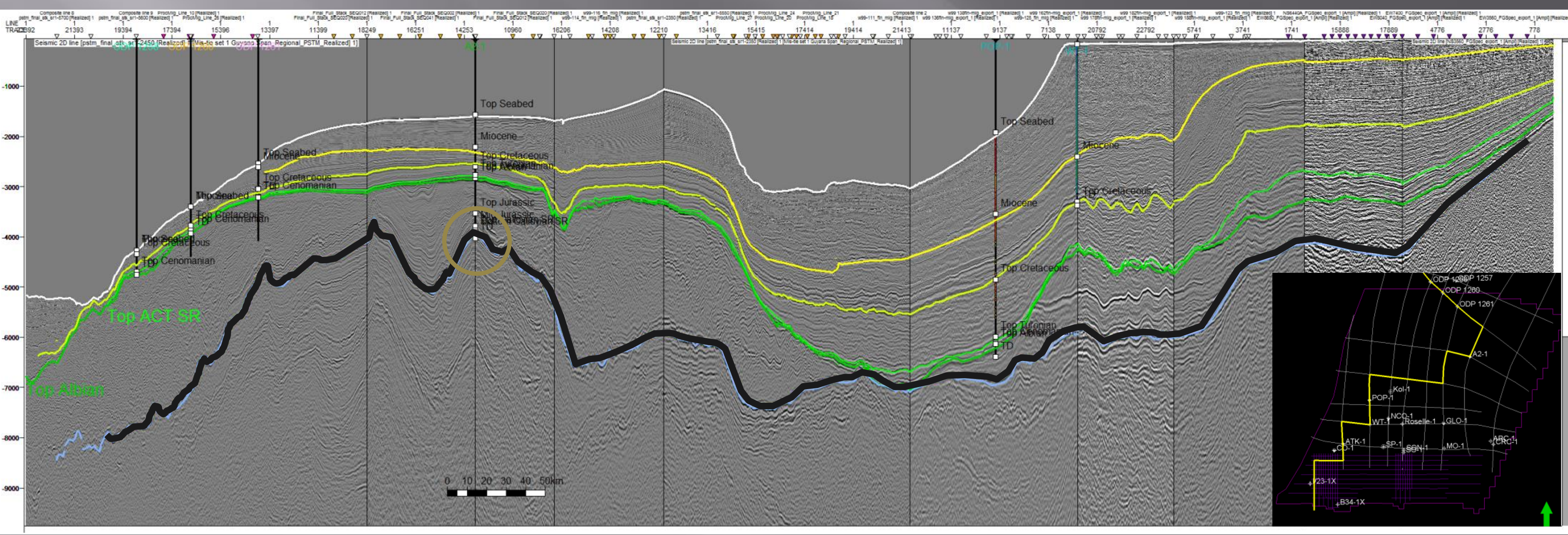
- Homogeneous distribution of source rock, reservoir and seal
- Presence of Albian **Sandstone** reservoir (N/G = 60%, Sw = 20%)
- Lateral Seal Shale Upper Albian
- Maturity based on Vitrinite Reflectance Classification by Peters, 1994
- Type II/III source rock modeled as Type III source rock in Neritic zone

- No faults taken into account for charge model
- Carrier beds in model defined as vertical up to reservoir-seal interval followed by lateral migration up structure
- Software used cannot model Type II/III source rock
- Software used does not permit ranges for input parameters (TOC, HI)

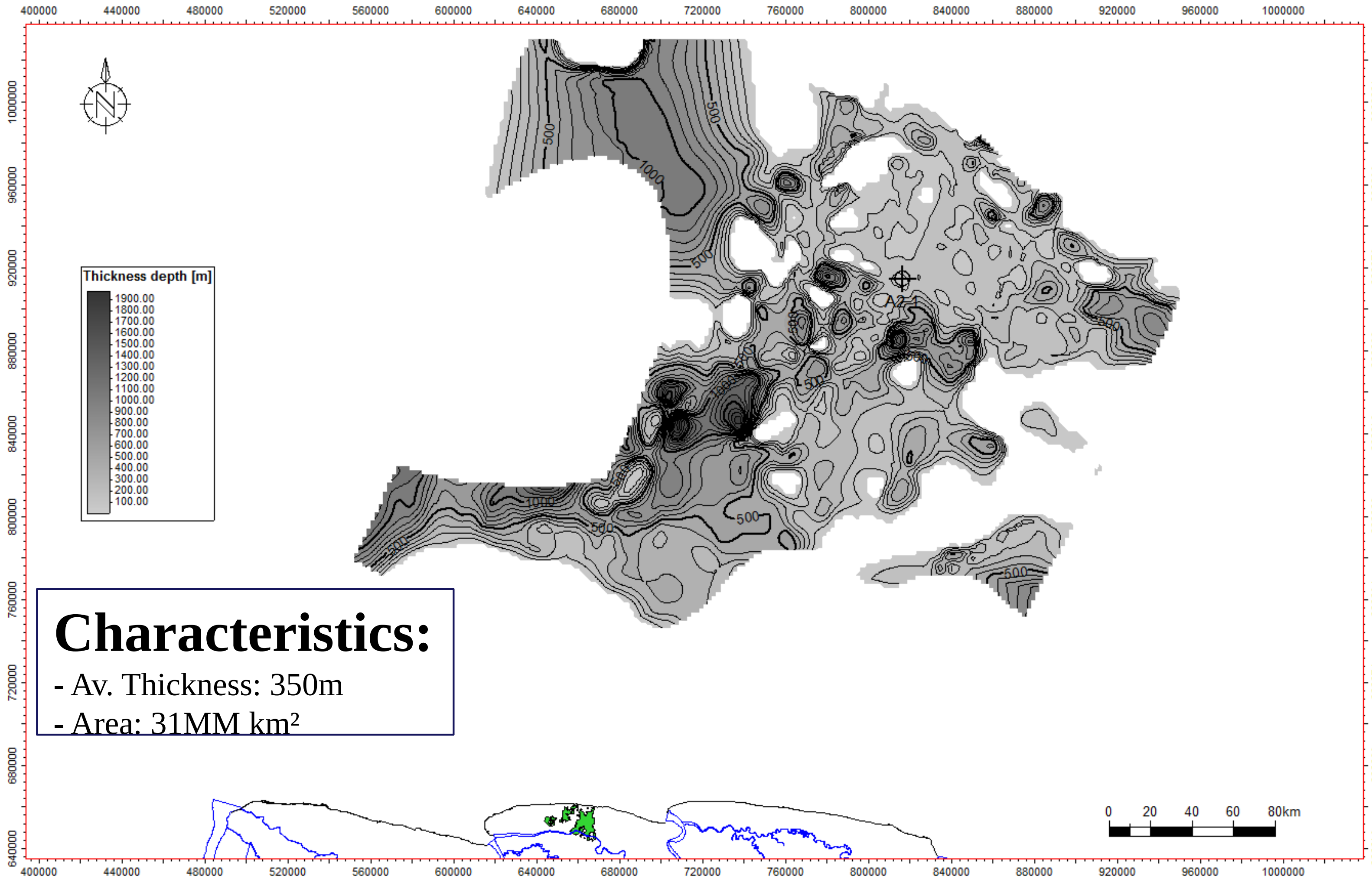
Input Horizons

- Sea bed
- Near Top Miocene
- Intra Paleocene
- Top Cretaceous

- Mid Turonian
- Mid Albian
- Top Callovian SR
- Bottom Callovian SR

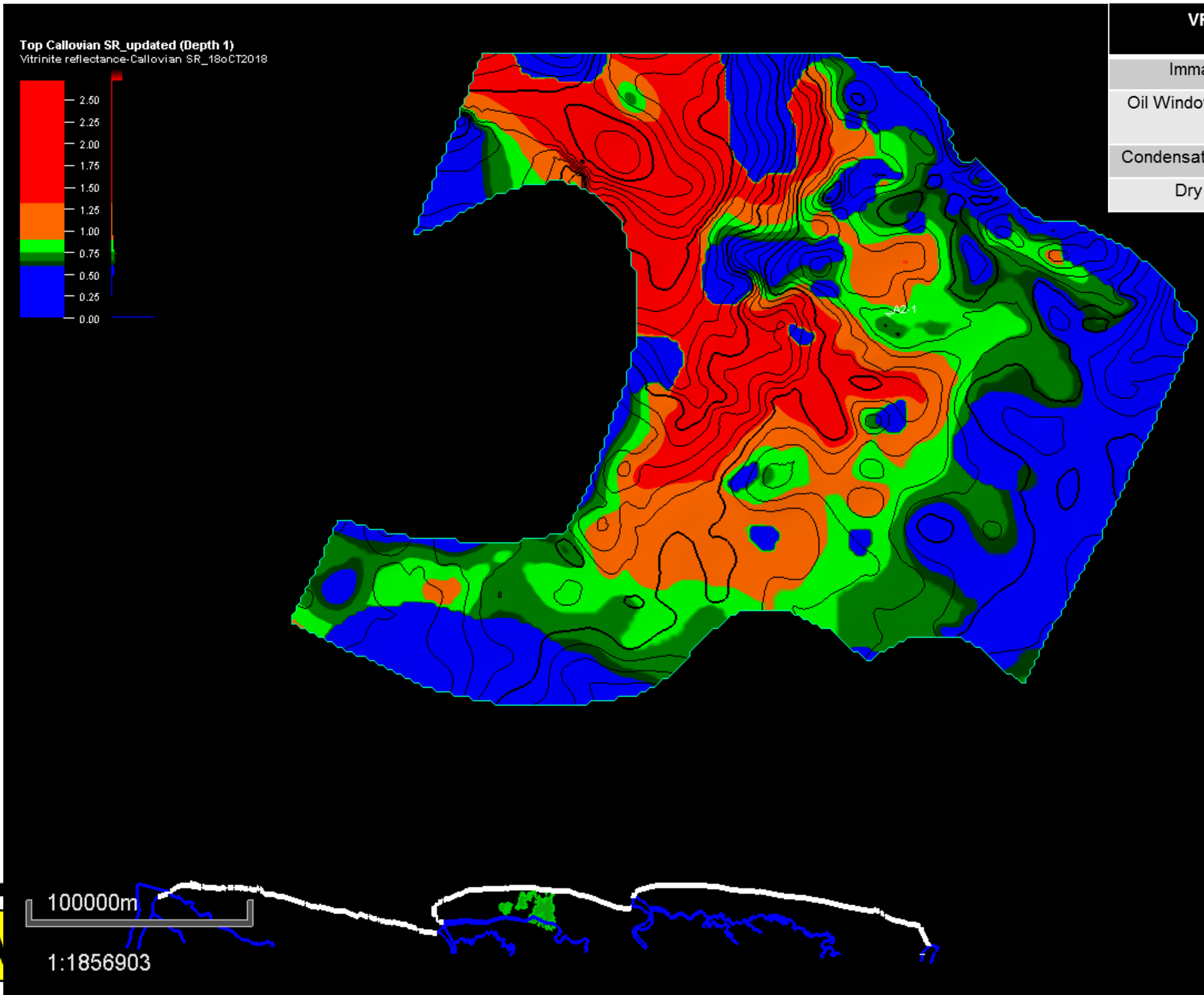


Elements	Input
Topography	Albian (Critical Moment)
Source rock - Kerogen - TOC - HI - Thermal gradient	Callovian Type: III 2 450 30°C/ km
Reservoir	Albian/ Aptian
Reservoir Lithology	Sandstone (Analog from FG-2 well)
Seal	Albian Regional Seal
Seal Lithology	Shale

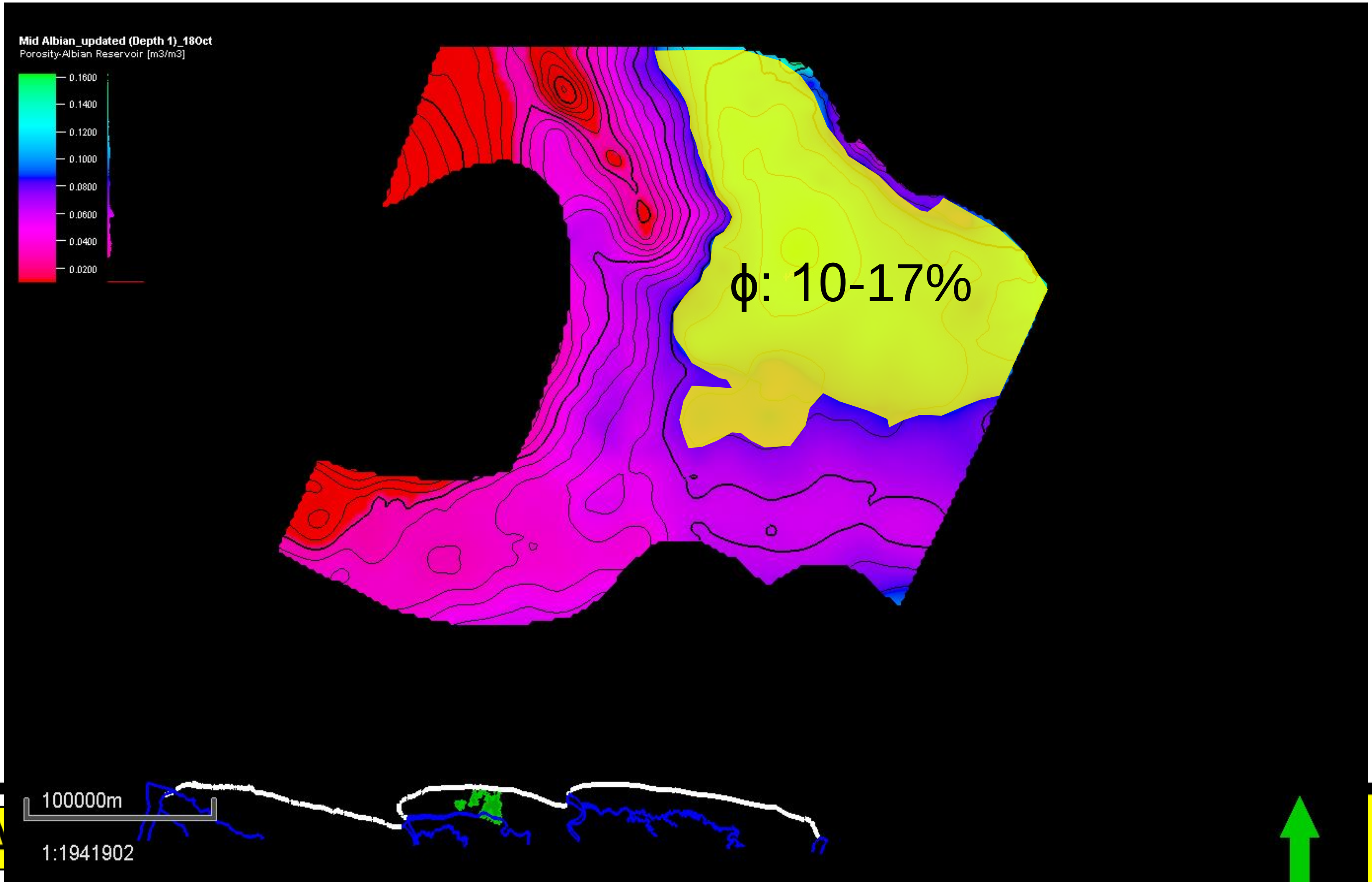


Characteristics:

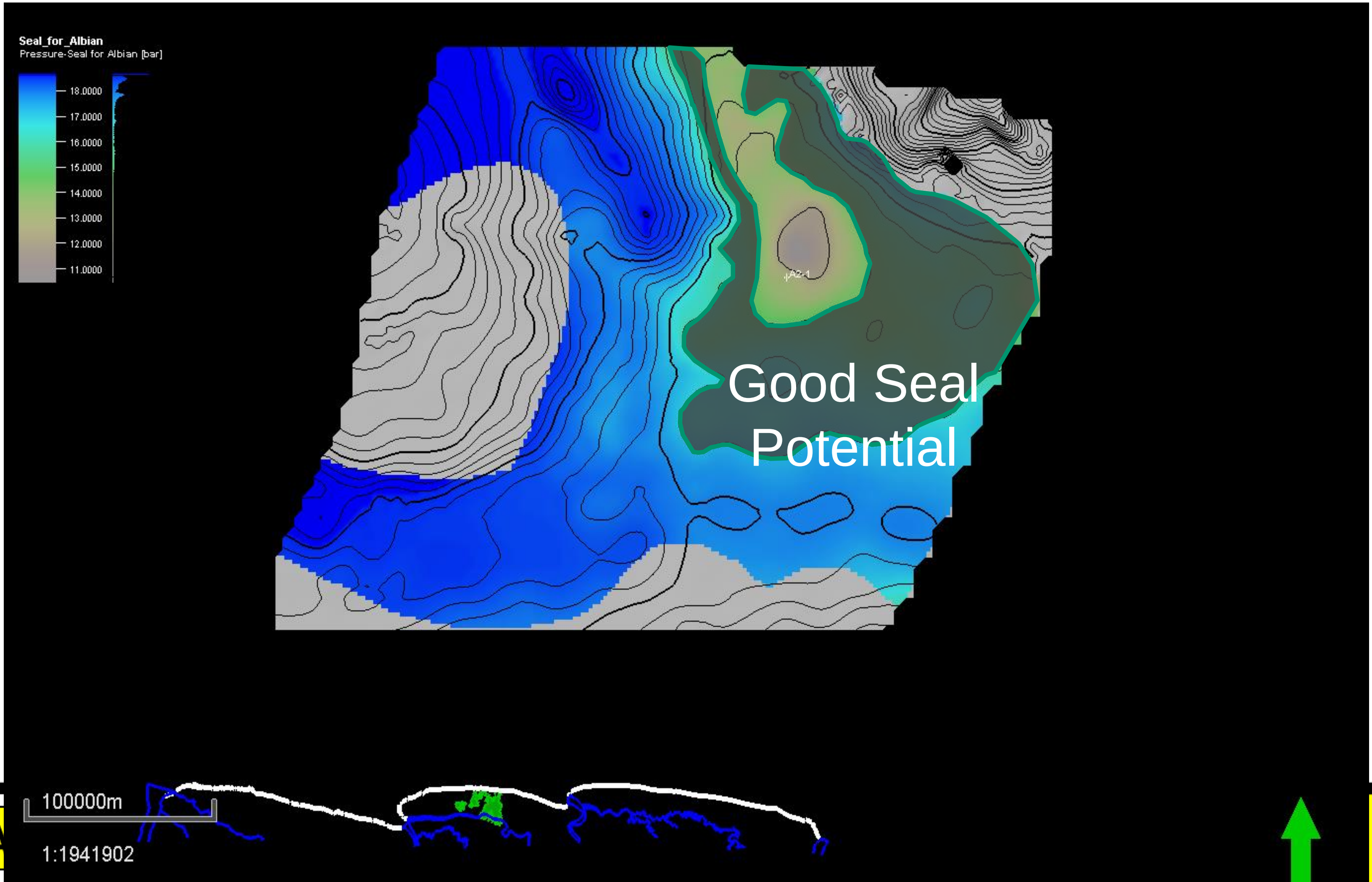
- Av. Thickness: 350m
- Area: 31MM km²

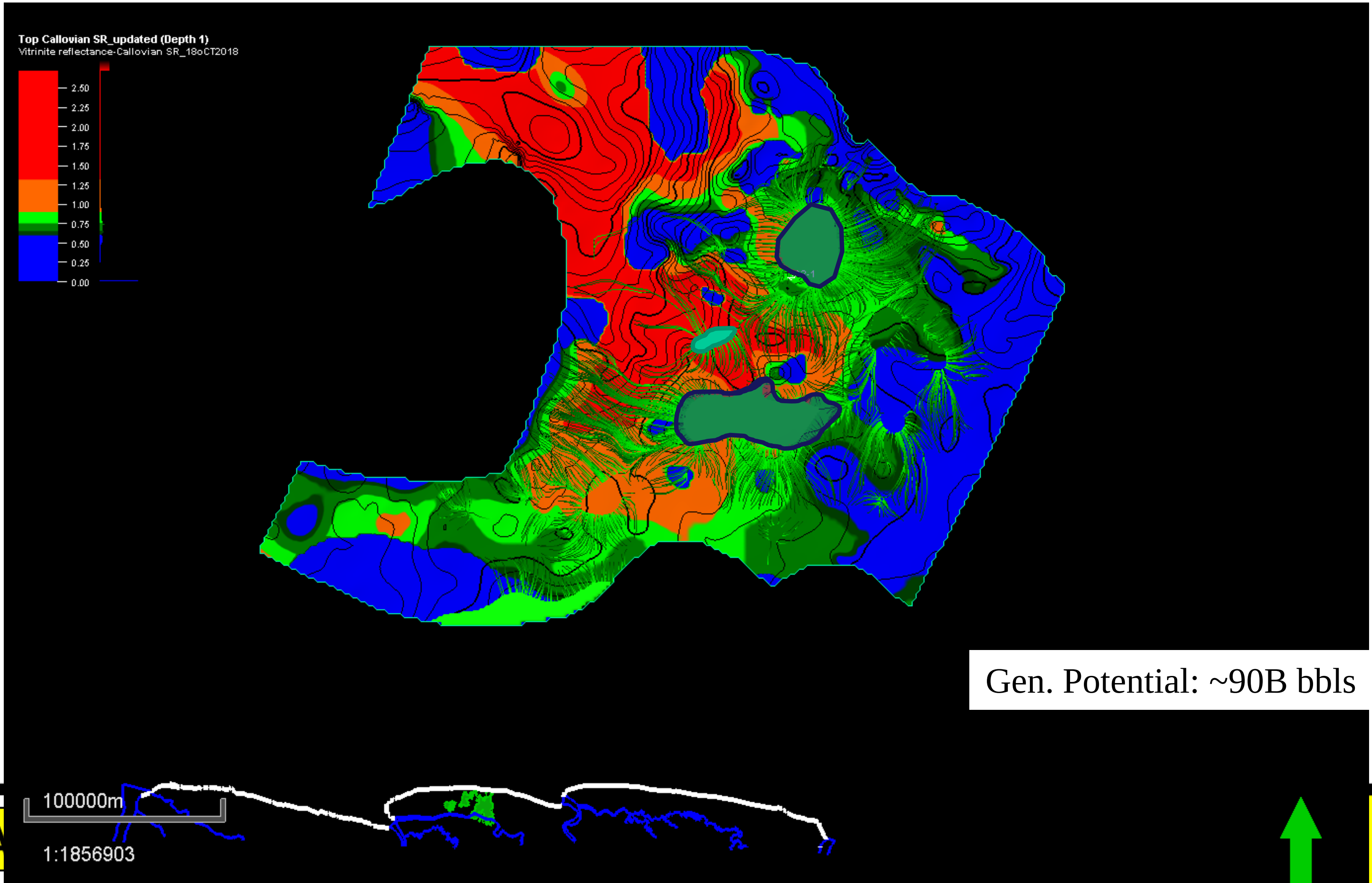


VRe	Proposed by PC (Peters, 1994)
Immature	0.20 – 0.60
Oil Window Maturity	0.60 – 0.65 0.65 – 0.90
Condensate/ Wet gas	0.90 – 1.35
Dry gas	> 1.35

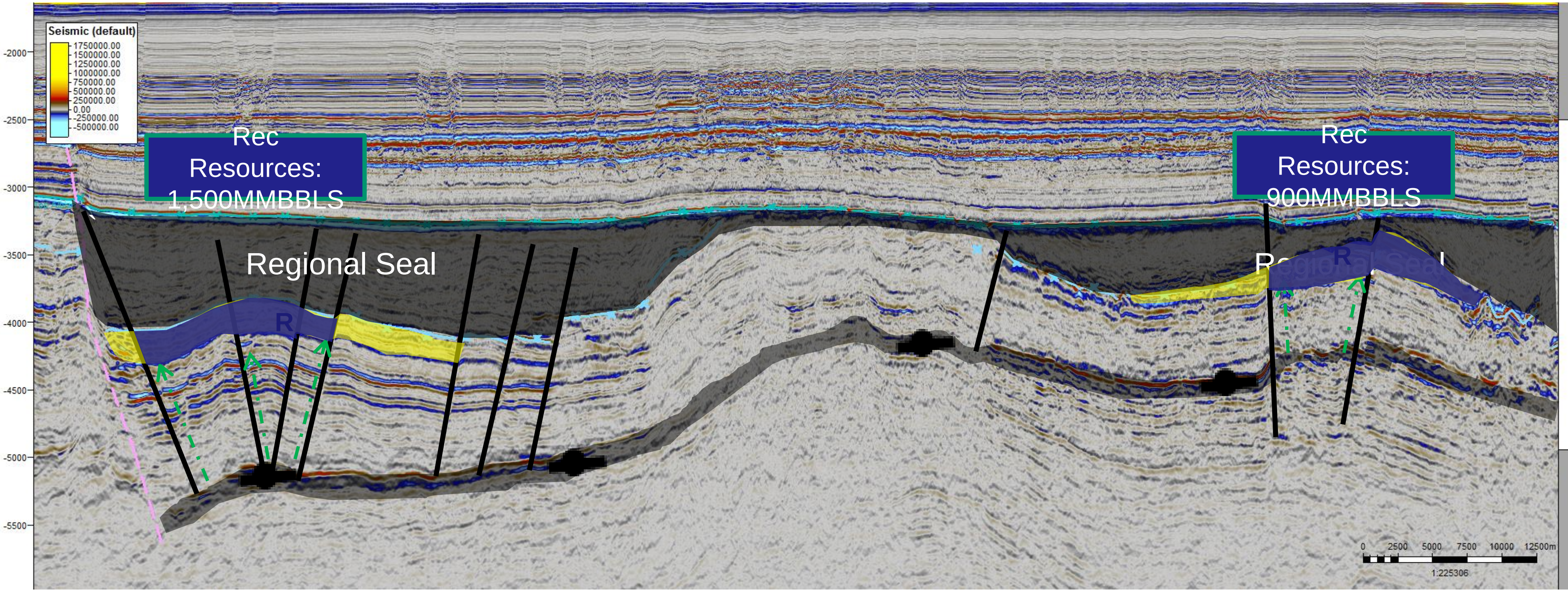

Mid Albian_updated (Depth 1)_18Oct
Porosity-Albian Reservoir [m3/m3]
0.1600
0.1400
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
ϕ: 10-17%
100000m
1:1941902

STAA


Seal_for_Albian
Pressure-Seal for Albian [bar]
18.0000
17.0000
16.0000
15.0000
14.0000
13.0000
12.0000
11.0000
Good Seal Potential
100000m
1:1941902

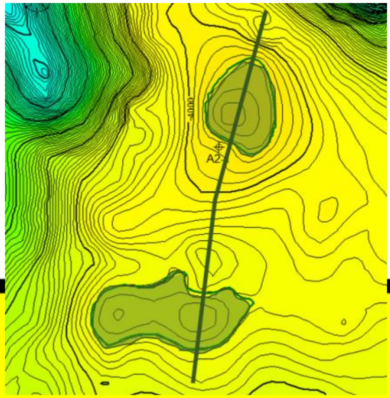


Gen. Potential: ~90B bbls



Risks:

- Leaking Faults
- Breach of Regional Seal
- Preservation



- Evidence indicates that there is a deeper Source Rock potential in the Guiana Basin, which is of Callovian age.
- The Guiana Basin has prolific Source Rock Potential for the Demerara Plateau
- Lower Cretaceous Plays have been upgraded

- **Maturity and Migration Model need improvement.**
  - Maturity Model needs to be updated with influences of Basin Evolution/ dynamics, Paleo Heatflow, Correction for erosion, various Facies Transitions
  - Migration Model needs to be updated with faults, Facies Transitions and Carrier Beds Analysis

Thank You For Your Attention

Questions