# Is the Cretaceous an Effective Petroleum System Offshore Suriname?*

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## Abstract

The Suriname-Guyana Basin is a passive, continental-margin-style sedimentary basin which has all of the elements required to become an important hydrocarbon province. These elements include the presence of one proven mature source rock of Cenomanian-Turonian age and indications of two older source rocks; one of Albian/Aptian age, and the other of Jurassic age.

The tectonic evolution of the basin can be subdivided into three stages:

i) Equatorial Late Jurassic-Early Cretaceous ‘Rift Phase’ related to the opening of the central Atlantic,
ii) Early Cretaceous ‘compression-influenced Passive Margin’ related to the opening of the south Atlantic, and
iii) Late Cretaceous—Recent ‘Passive Margin’ phase related to the opening of the south Atlantic.

The history of the Suriname-Guyana Basin has since late Cretaceous been influenced by a passive, trailing-margin style of plate tectonics, resulting in a basin deposition typified by gradual subsidence, little tectonic activity and numerous periods of erosion. As a result, there is great variety in the stratigraphy and depositional history in the basin sediments. The Cretaceous and Tertiary sediments are characterized by interbedded sands and shales, deposited in a variety of marine and non-marine environments, and marine carbonates.

A relatively stable, continually subsiding basement received a wedge of sediments, which thicken seaward and thin up-dip towards the Guyana Shield. Numerous cycles of transgression and regression, dependent on the relationship between the rate of basement subsidence and the sedimentation rate, resulted in both marine/non-marine deposition as well as four major erosional episodes. It is within this setting that the primary elements for one or more petroleum systems evolved.

The first requirement for the existence of a petroleum system is a mature source rock. The majority of the offshore wells drilled between the 1960's and 2011 encountered oil and gas shows. In addition, the Abary-1 well, drilled in 1974 by Shell, demonstrated the presence of moveable hydrocarbons. The large Tambaredjo Field (>900 MMbbl STOIIP; 170 MMbbl rec.) and the much smaller Calcutta Field, both onshore Suriname, are located within the same hydrocarbon basin and are part of the most known petroleum system in the basin to date. This system comprises the known mature Cenomanian—Turonian source rock offshore, Paleocene fluvial sandstone reservoirs and calcareous shale seals and structural and stratigraphic traps onshore Suriname. Recent drilling in the basin demonstrates the existence of a fully contained Cretaceous petroleum system comprising the known Cenomanian-Turonian source together with deep-water turbidite sandstone reservoirs encased in the calcareous shales that are the said source rock. The migration from source to reservoir seems to occur in-situ. The North Coronie 1 well also penetrated hydrocarbon-bearing sandstones in the Turonian interval overlying thick Cenomanian source rocks.

Geochemical analyses conducted by MAERSK Oil on oil samples recovered from four offshore wells demonstrate a very mature Cenomanian-Turonian source. The very thick Upper Albian-Cenomanian section of the key offshore well NCO-1 formed the basis for a thorough source rock-oil correlation and for obtaining source rock specific kinetics used for petroleum systems modeling. Similarly, both Murphy and Shell, having conducted geochemical analyses on oils produced from onshore wells, have concluded that there are at least three source rocks in the basin, the Cenomanian-Turonian being the one most understood. The Cenomanian-Turonian shale interval is a classic shelf-edge black shale interpreted to be an upwelling facies with laminations of organic-rich lenses and paper-thin carbonate streaks. Analyses also indicate marine Kerogen type II with TOC normally being 3-5% ranging up to 30%. Indications of an Albian-Aptian source and a Jurassic source are also present. Analyses done by Murphy indicate that the Albian-Aptian source contain a mixed amorphous/woody kerogen that is oil prone and was deposited in deltaic to marginal-marine environments, while the Late Jurassic source contains lacustrine algal kerogens that are oil prone.

Is the Cretaceous an effective petroleum system? The Suriname-Guyana Basin demonstrates the presence of all the required elements, though not without geologic risk that is consistent with deep-water turbidite reservoirs. Discovery of commercial

quantities of oil in Cretaceous reservoirs has been elusive, however, one or two Cretaceous mature source rocks are proven responsible for charging the Paleocene and Eocene fluvial reservoirs onshore Suriname.

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# IS THE CRETACEOUS AN EFFECTIVE PETROLEUM SYSTEM OFFSHORE SURINAME ?

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- Basin Configuration & Evolution
- Source Rocks
- Migration
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- Conclusions

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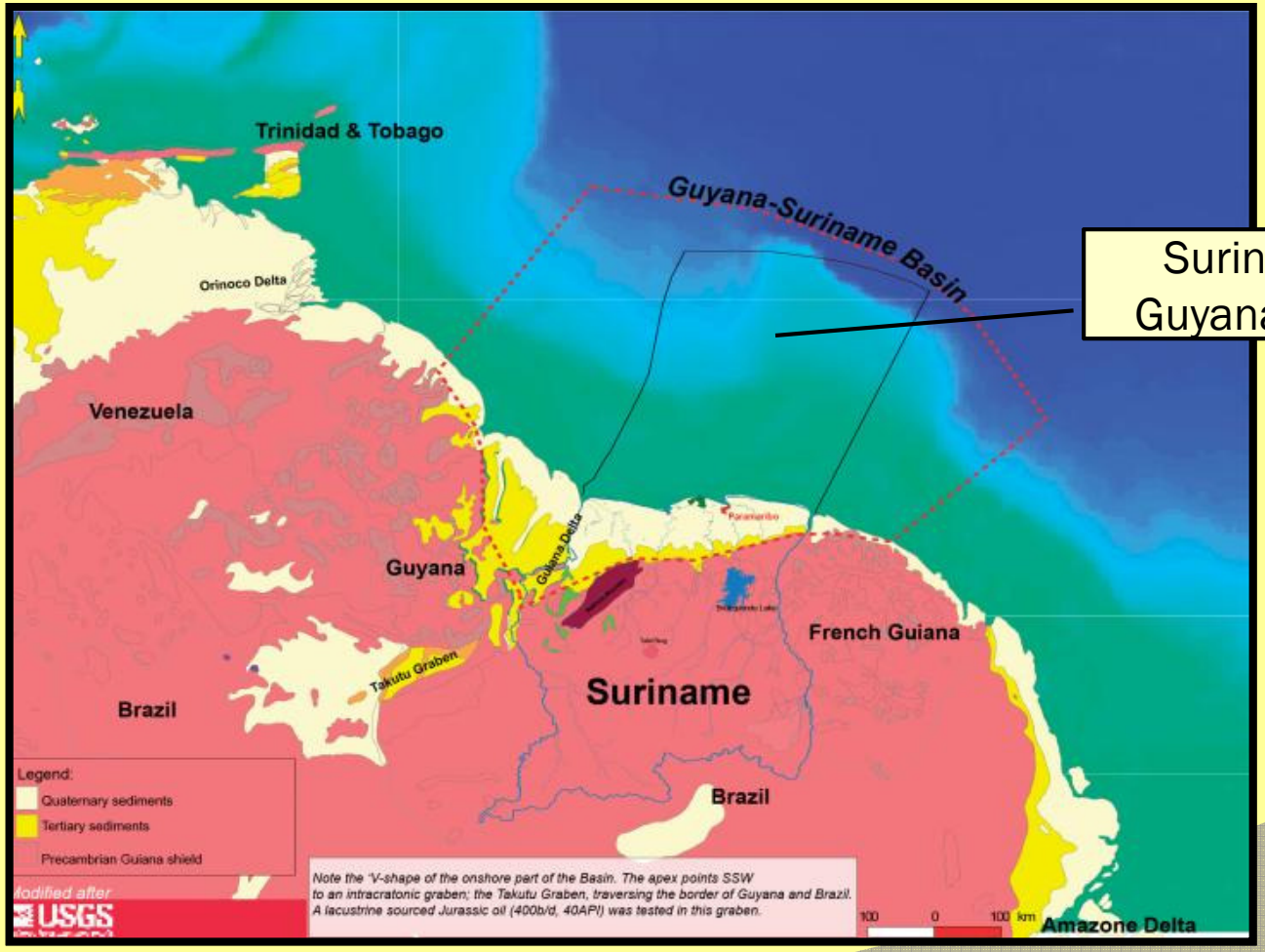
# Suriname-Guyana Basin




Suriname - Guyana Basin

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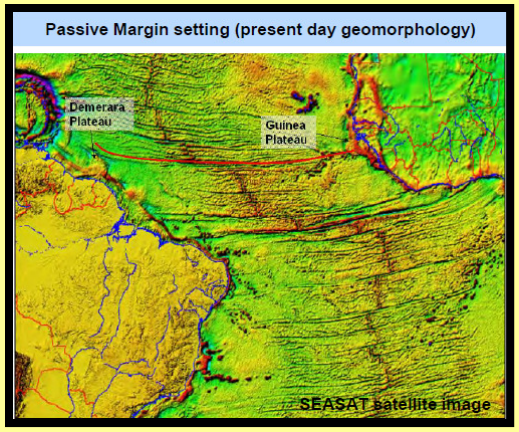
# Basin Configuration & Evolution

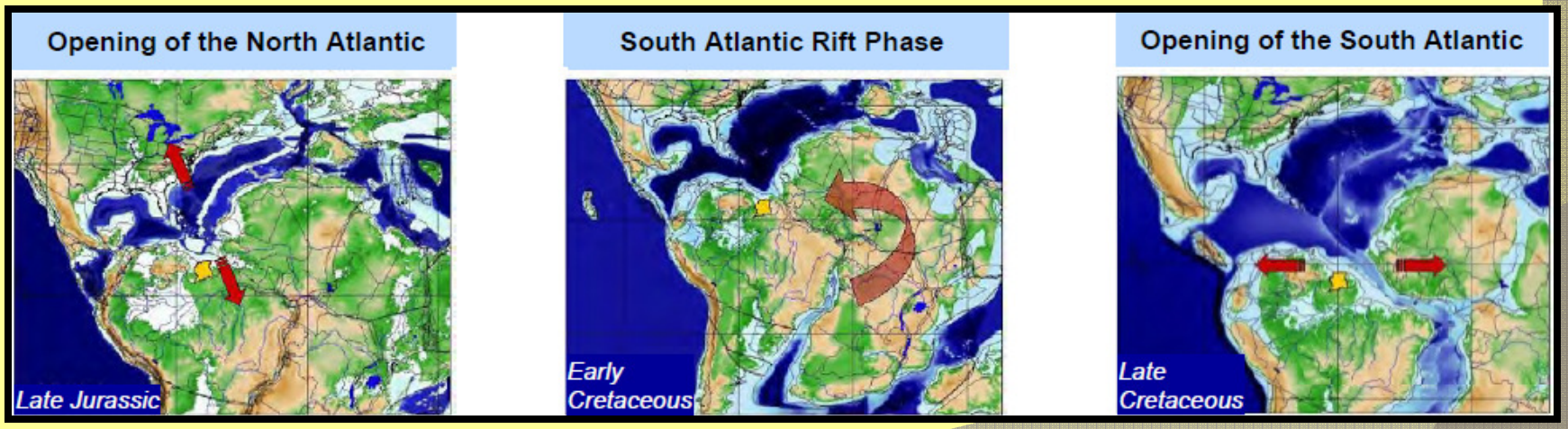



Two distinct break-up / rift episodes:

1. Opening of the North Atlantic
2. Opening of the South Atlantic

Followed by:

1. Development of a passive margin

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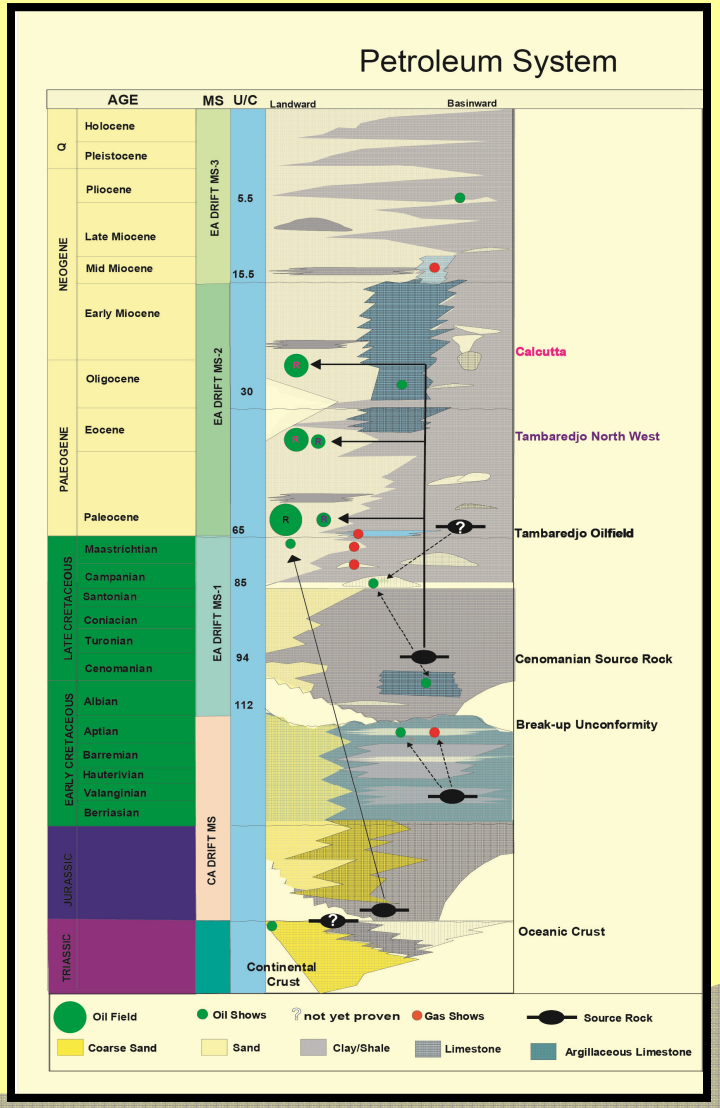
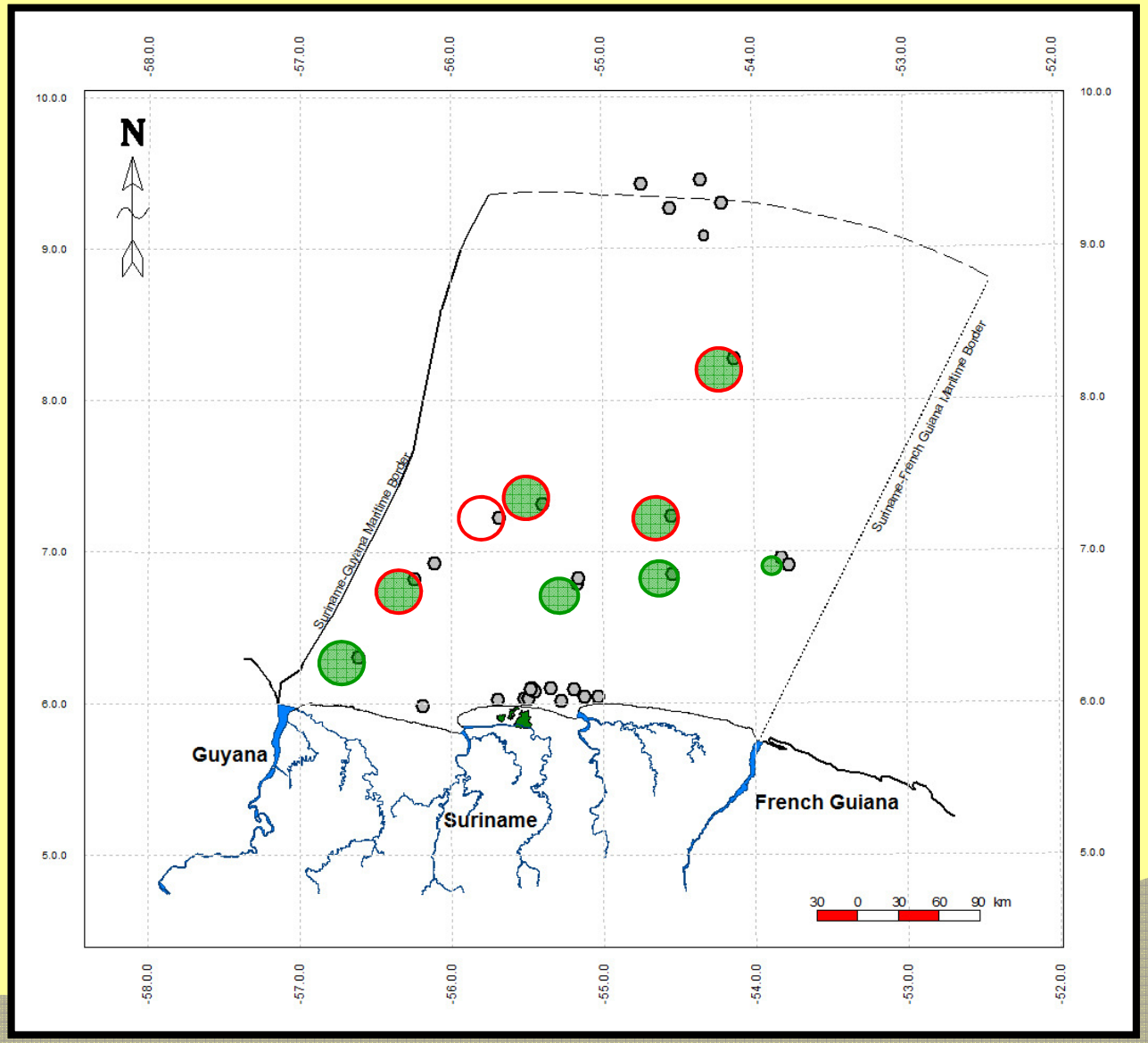
# Petroleum System & Stratigraphy



# Oil & Gas shows in Cretaceous




= oil and gas shows
= oil shows
= gas shows
= well

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# Oil & Gas – SR correlation

3 different oil types in Suriname encountered:

- Onshore :

1. Proven PS with Mid Cretaceous Marine SR
2. Lower Cretaceous Deltaic SR
3. Lower – Middle Jurassic Lacustrine SR

- Offshore :

1. Oil shows from Mid Cretaceous Marine SR
2. Gas shows from proximal deltaic gas prone facies of the Mid Cretaceous Marine SR

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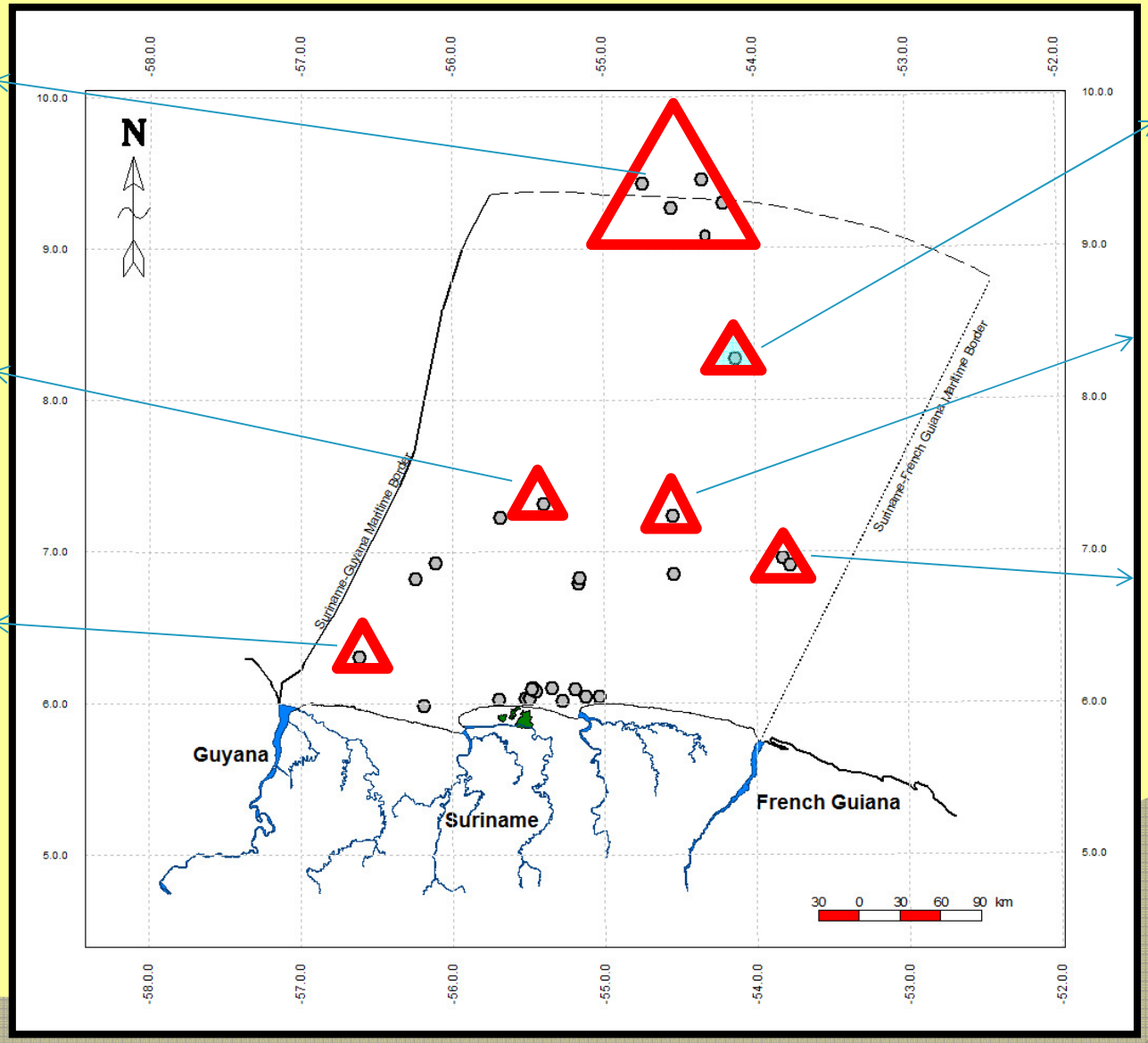
# Quality of Cretaceous Source Rocks

**DSDP**
San-Cen:
2-16%TOC
Albian :
0.7-7.5%TOC

**NCO-1**
Cen-Tur:
1.9-6.3%TOC
Albian:
1.7-5.1%TOC

**I23-1x**
Cen:
1%TOC
Albian:
0.9-3%TOC
Aptian:
1.8%TOC




**A2-1**
Cen-Tur:
4.2-7%TOC
Callovian:
1-1.5%TOC

**GLO-1**
Cen-Tur:
1-2%TOC
Albian: 1%TOC

**CRC-1:**
Con-Tur:
1.59%TOC
Middle Albian:
1.13%TOC

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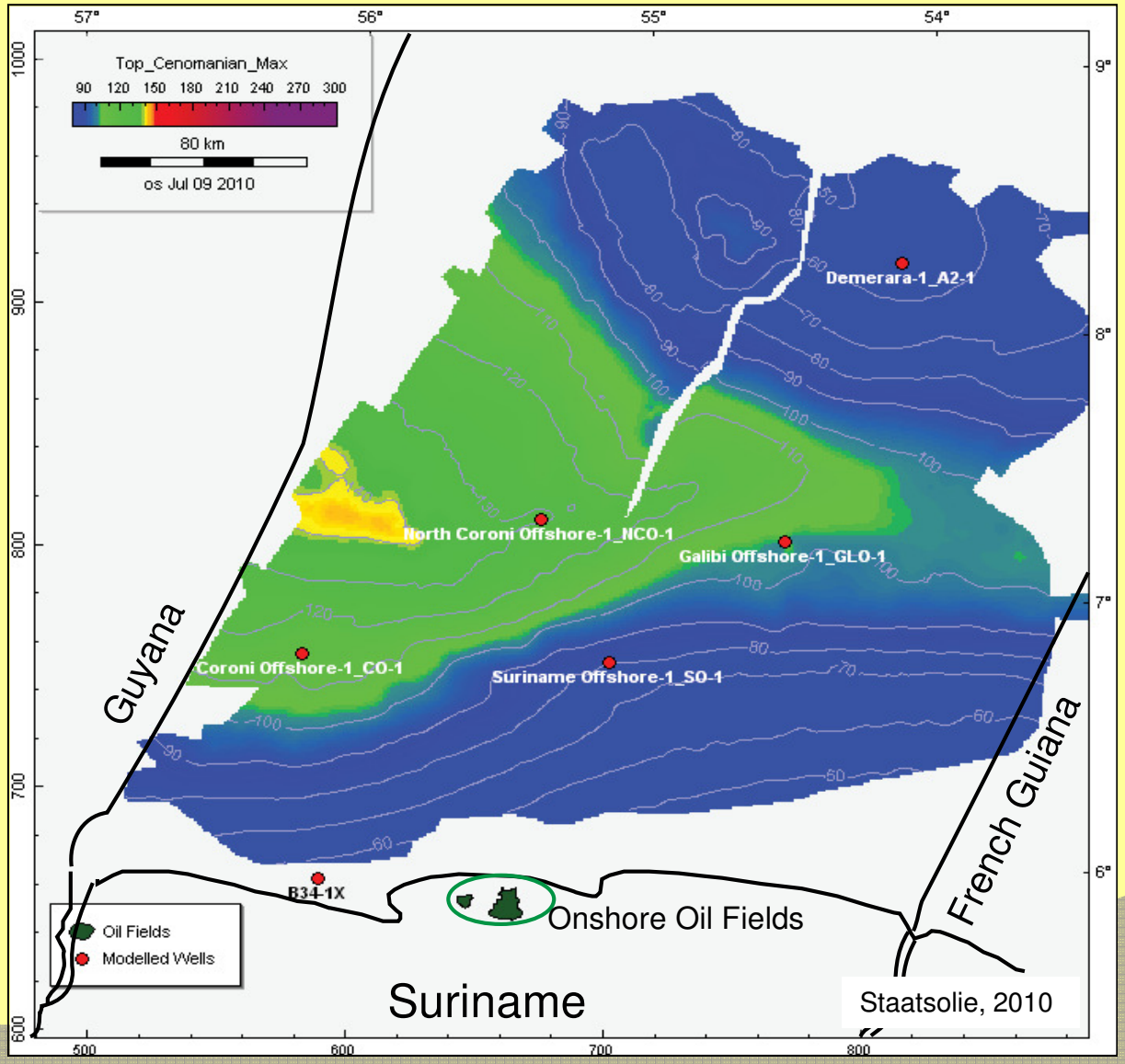
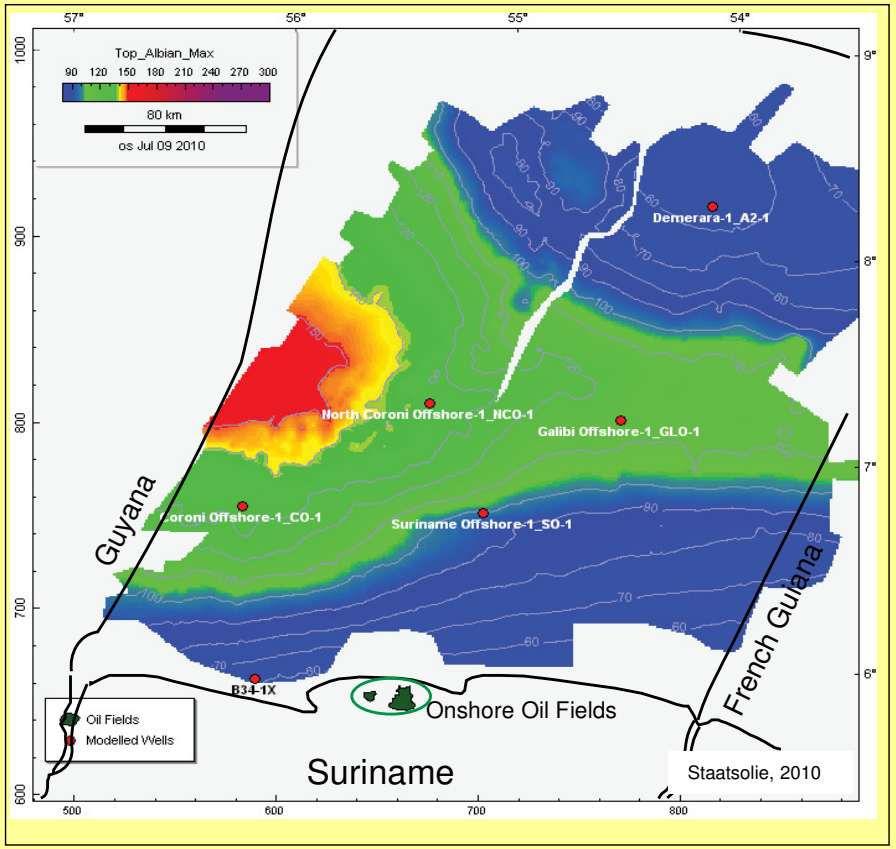
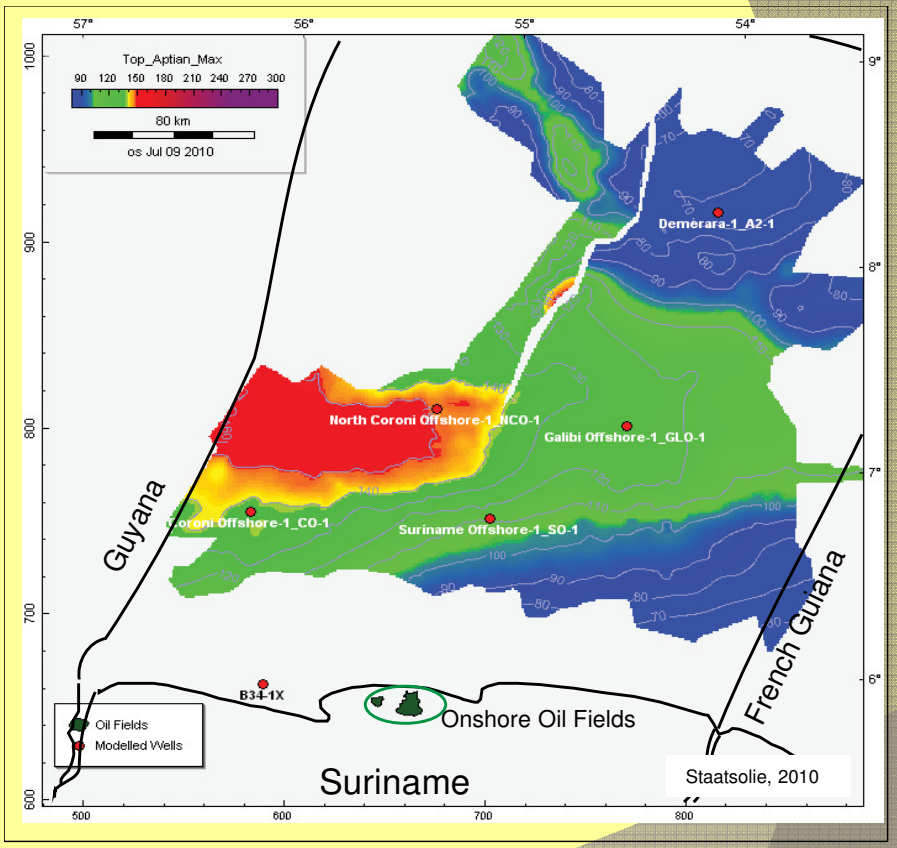
# Cenomanian Turonian SR



# Lower Cretaceous SR

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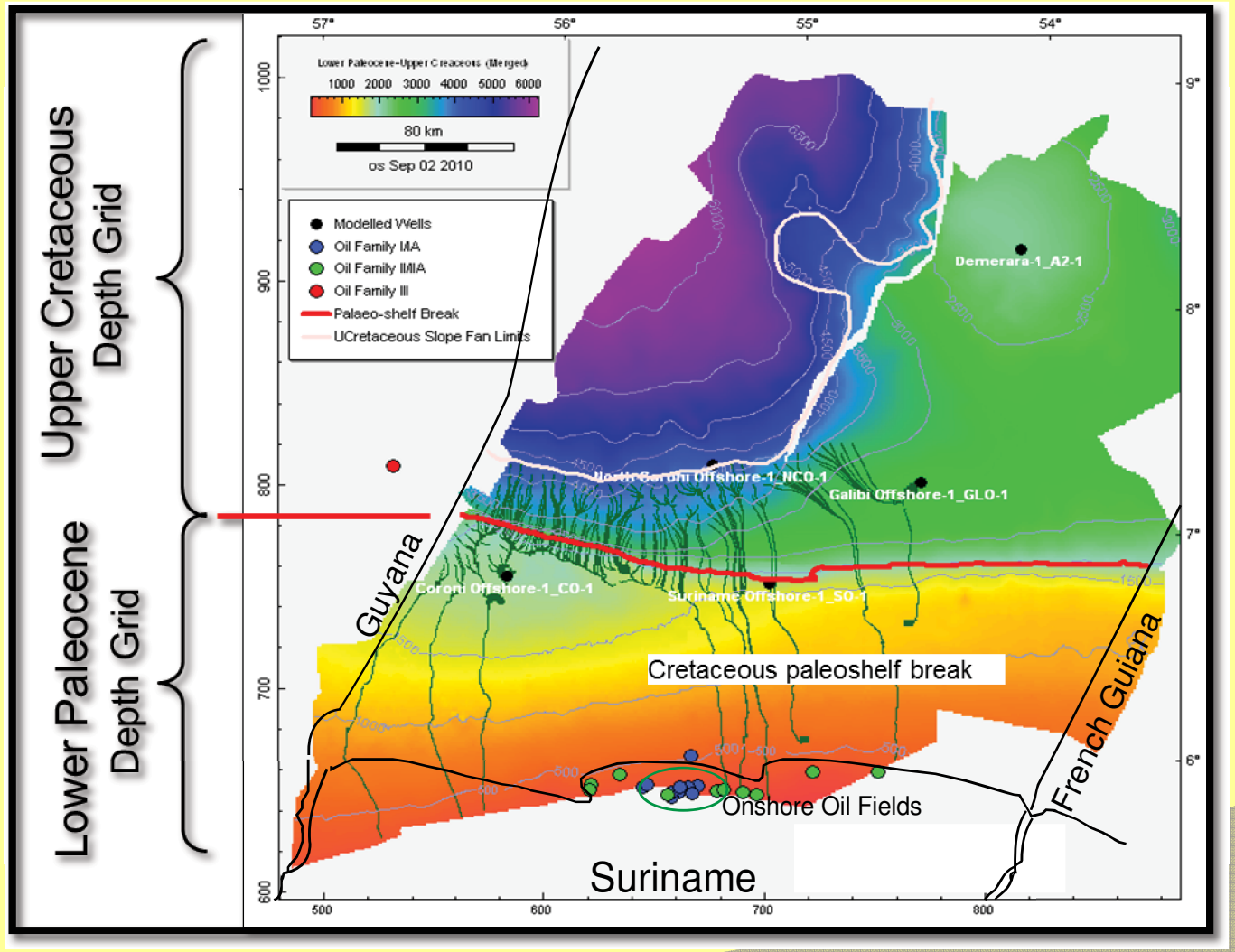
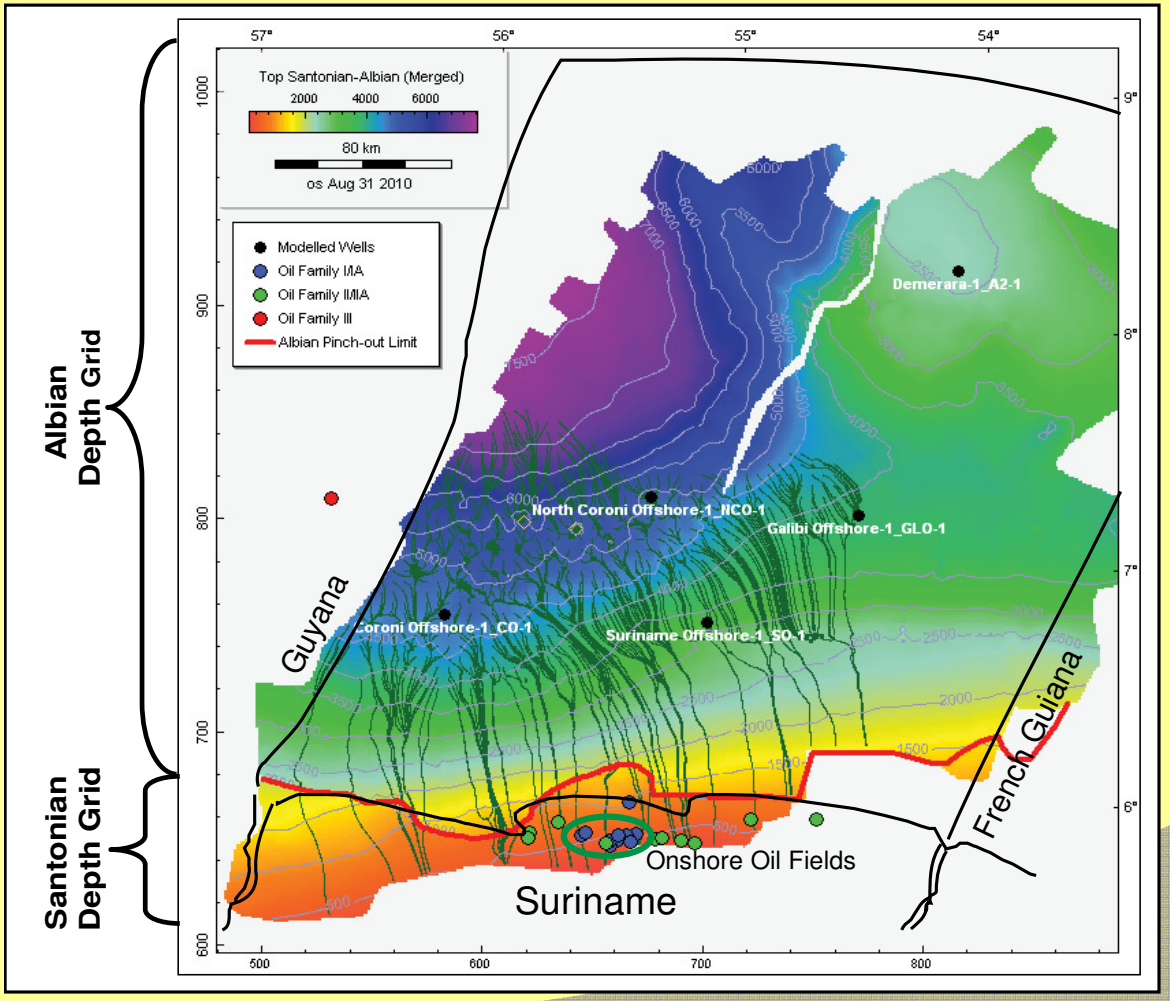
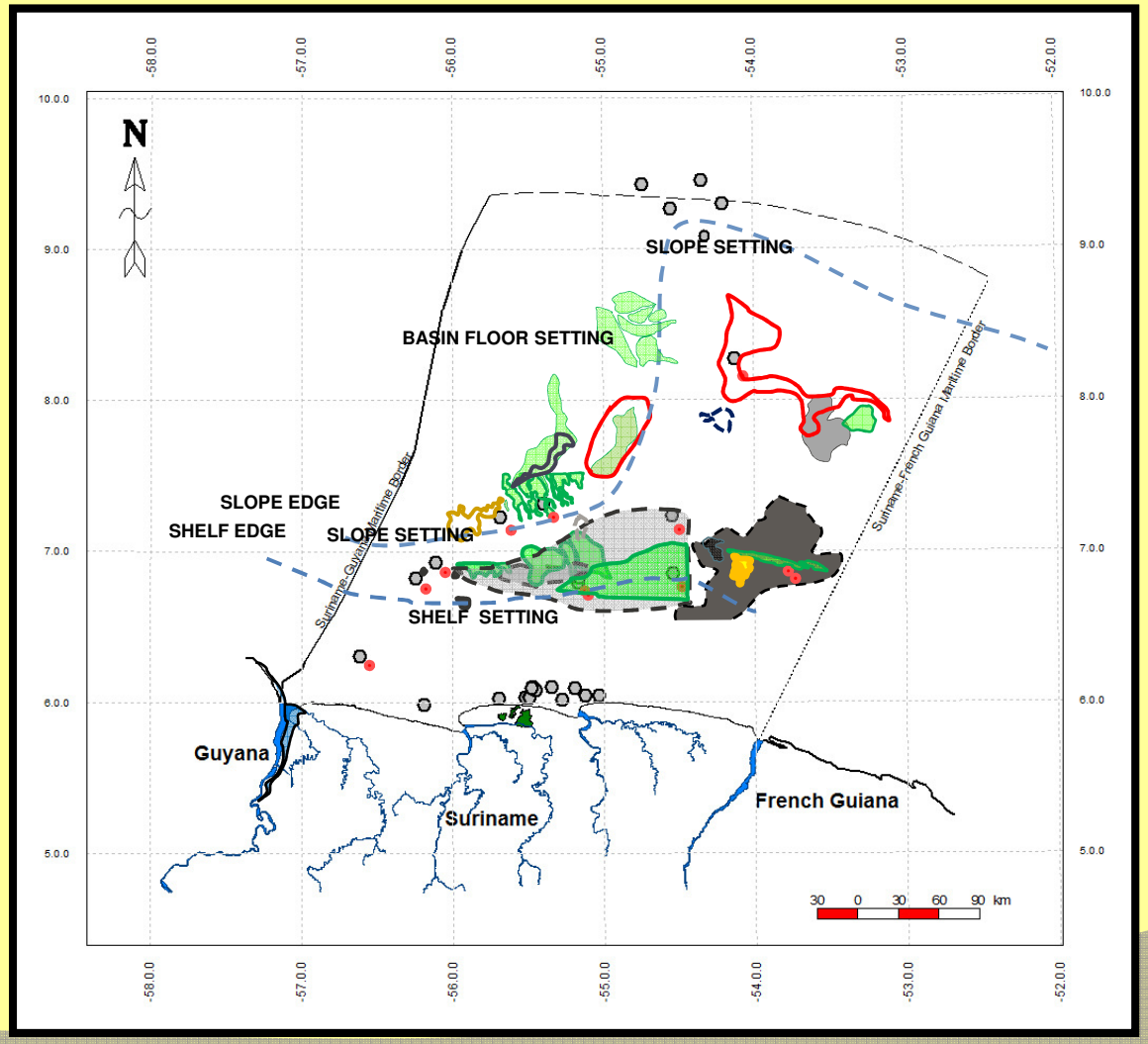
# Migration Cenomanian Turonian SR



# Migration Lower Cretaceous SR



# Cretaceous Plays Concepts Offshore Suriname




Lwr Cretaceous - Albian

Lwr Cretaceous - Aptian

M – U Cretaceous

Tertiary

Exploration Wells

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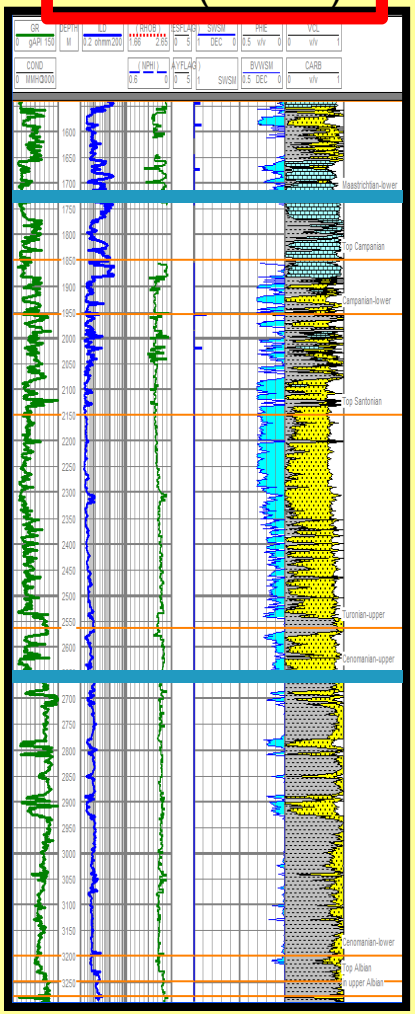
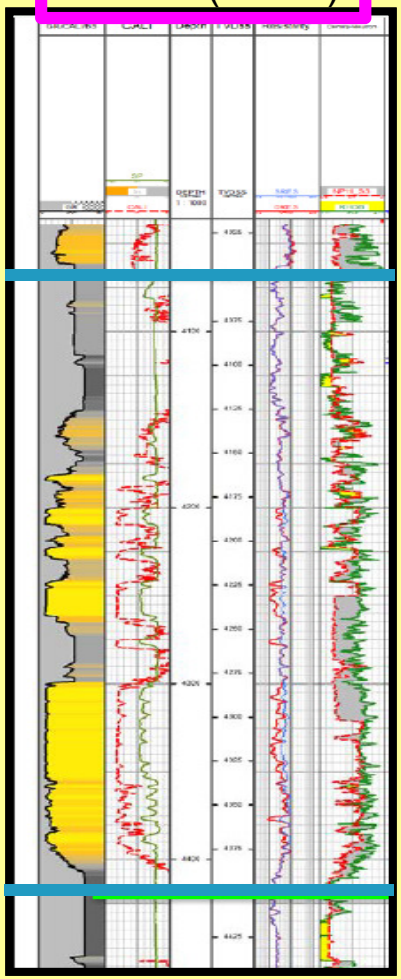
# Reservoir Quality

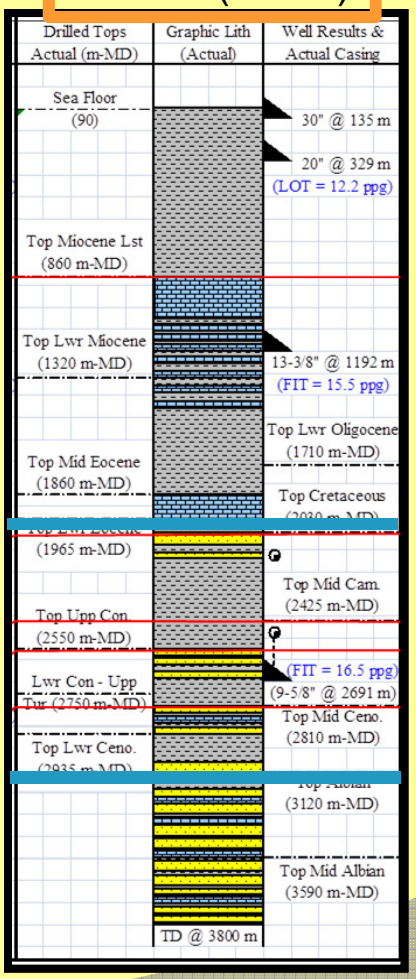
CO-1 ( 1966)

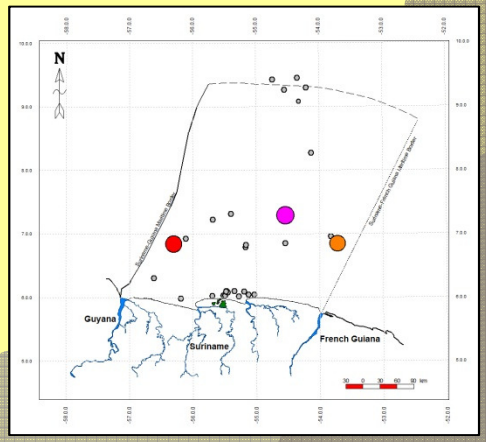


GLO-1(1971)



CRC-1(2010)

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# Conclusions :

- Proven Cenomanian Turonian Petroleum System  onshore Suriname
- Possibility of other Petroleum System with a Lower Cretaceous Source Rock
- The Cretaceous has good potential for a working Petroleum System offshore Suriname.

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# Thank You